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Coal Seam Gas (CSG) Wells and Gathering Regional Interests Development Approval (No.1)

An application for a RIDA under the *Regional Planning Interests Act 2014*

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Contents

1. Introduction

1.1 Purpose

The Applicant proposes to undertake petroleum activities within an Area of Regional Interest (ARI) including Priority Agricultural Area (PAA) and Strategic Cropping Area (SCA). This report provides the required supporting information for an application for a Regional Interests Development Approval (RIDA) under the *Regional Planning Interests Act 2014* (RPI Act).

1.2 Scope

Arrow Energy (Arrow) is an integrated coal seam gas (CSG) company that explores and develops gas fields, produces and sells CSG and generates electricity. Arrow has been developing CSG since 2000 and supplying it commercially since 2004. The company delivers almost 20 per cent of Queensland's gas supply from its five CSG fields in the Surat Basin in south-east Queensland and the Bowen Basin in central Queensland.

A Gas Sales Agreement (GSA) between Arrow and the Shell operated QCLNG joint venture was announced in December 2017 which will see the commercialisation of most of Arrow's gas reserves in the Surat Basin through its Surat Gas Project (SGP). The collaboration between the parties relies upon the co-use of existing Arrow and QGC-operated infrastructure such as gas compression, processing and transmission infrastructure as well as water transport and treatment facilities. Utilising existing upstream infrastructure will reduce the potential for negative impacts to landholders and to communities.

In April 2020 Arrow received a Final Investment Decision from its shareholders to begin the construction and operation of the first phase of the SGP. This important decision from our shareholders allows Arrow to meet the commercial and technical obligations of the GSA.

This application addresses one component of the SGP, being 11 CSG wells and approximately 13 km of gathering proposed on 12 Lot on Plans within Petroleum Leases (PL) 252 and 260. The Lot on Plans the subject of this RIDA are 57SP193329, 36DY45, 1RL2451, 1DY931, 70DY138, 1RP154777, 1DY787, 2RP106958, 12SP193328, 2RP99387, 2DY787, and 60DY802. Figure 1-1 shows the location of these properties and Section 1.5 provides additional detail of the land holdings.

The proposed works occur wholly within PL252 and PL260 and are authorised under Environmental Authority (EA) EPPG00972513.

This RIDA application does not include resource activities associated with the installation or operation of CSG wells and gathering on other land

parcels/properties. Such activities would be the subject of a separate RIDA application if required.

1.3 Context

Section 29 of the RPIA requires that a RIDA be accompanied by a report that:

- Assesses the resource activity or regulated activity's impact on the area of regional interest; and
- Identifies any constraints on the configuration or operation of the activity.

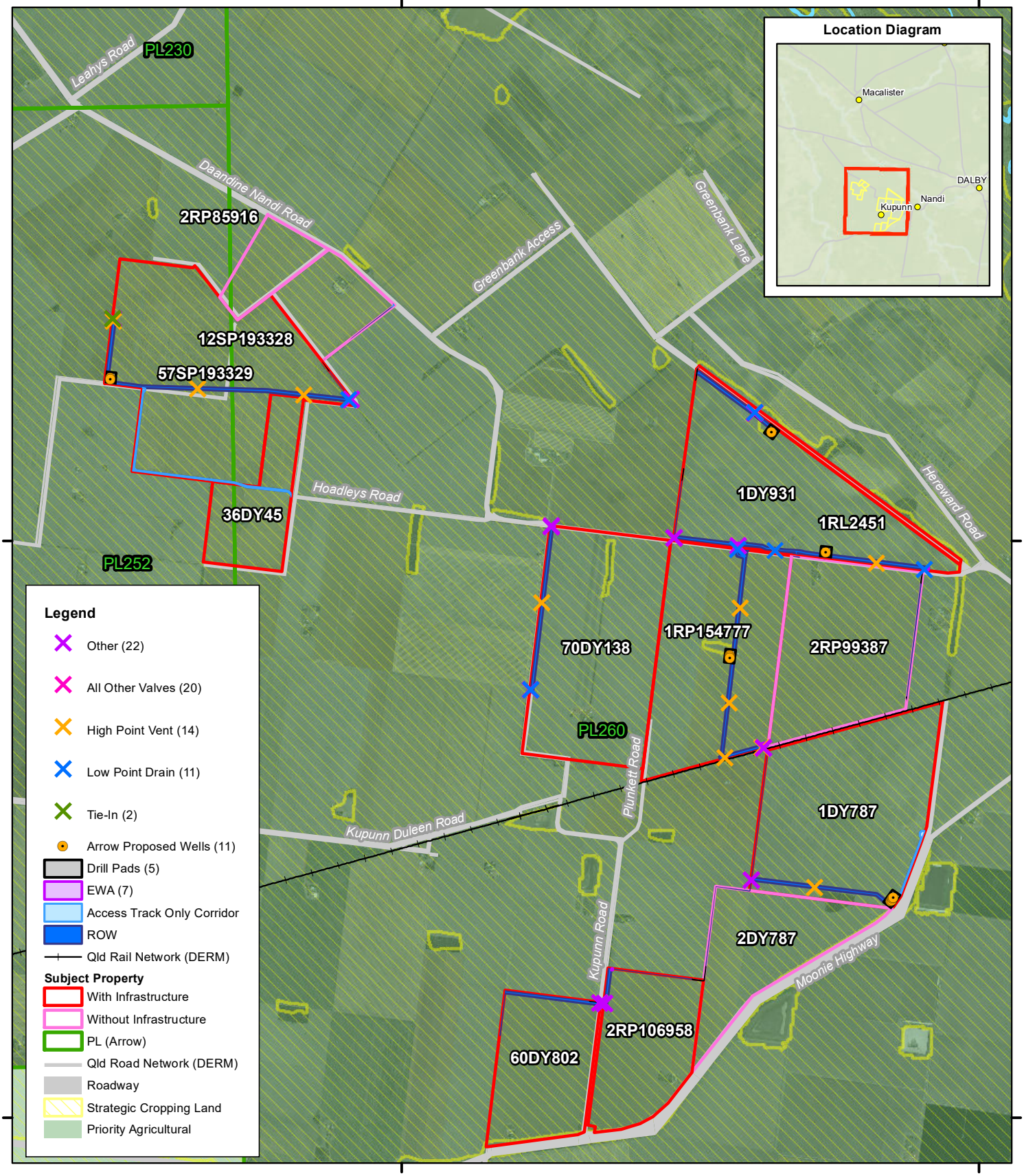
The *RPI Act Guideline 01/14 - How to make an assessment application for a regional interests development approval under the Regional Planning Interests Act 2014* provides further guidance about the matters to be addressed by an assessment application report. These requirements and the sections where they are addressed is listed in Table 1-1.

This report has also been drafted in accordance with the RPI Act Guidelines that directly address resource activities proposed in PAA and SCA, the guideline on identification of Priority Agricultural Land Use (PALU) and the RPI Act Guideline companion guide.

Table 1-1: Assessment Report Information Requirements

Information Requirement	Section Addressed
The location, nature, extent (in hectares) and duration of the surface impacts of the proposed activity.	Refer Sections 4-4
A description of the impact of the proposed activities on the feature, quality, characteristic or other attribute of the area.	Refer to sections 4 and 5
Include a table identifying the location and surface area of each of the proposed activities.	Refer to Section 2
The report must also include an explanation of how the proposed activity will meet the required outcome/s and address the prescribed solution/s contained in the assessment criteria for the area of regional interest.	Refer to Section 11

Figure 1-1 – Map of Project Infrastructure



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Rev	Date	Revision Description	Org	Chk	Eng	QA	App
2	20.07.21	Issued for review (RIDA Infrastructure)	CO	AH	–	–	AH
1	01.07.21	Issued for review (RFS Infrastructure)	AF	AH	–	–	AH
0	25.06.21	Issued for review	AF	AH	–	–	AH

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Print Date: 23/07/2021

1.4 Applicant

The Applicant for this RIDA application are the following Arrow Energy entities (being the tenement holders for PLs 252 and 260):

- Arrow Energy Pty Ltd – ABN 73 078 521 936;
- Arrow (Tipton) Pty Ltd – ABN 17 114 927 507;
- Arrow (Tipton Two) Pty Ltd – ABN 36 117 853 755; and
- Arrow CSG (Australia) Pty Ltd – ABN 54 054 260 650.

1.5 Land Subject to the Application

Table 1-2 identifies the relevant Local Government Area, zoning and Regional Plan for all of the land the subject of this application.

Table 1-2 – Land Description

Local Government	Western Downs Regional Council
Zoning	Rural and Rural Activity
Regional Plan	Darling Downs Regional Plan
Areas of Regional Interest	PAA, SCA

The land parcels that are the subject of this application are listed in Table 1-3 and illustrated on Figure 1-1.

Table 1-3 - Land Parcels the Subject of this Application

Lot Plan	Mapped as Area of Regional Interest (ARI)	
	PAA	SCA
57SP193329	Yes	Yes
36DY45	Yes	Yes
1RL2451	Yes	Yes
1DY931	Yes	Yes
70DY138	Yes	Yes
1RP154777	Yes	Yes
1DY787	Yes	Yes
60DY802	Yes	Yes
2RP106958	Yes	Yes
12SP193328	Yes	Yes
2RP99387	Yes	Yes
2DY787	Yes	Yes

1.6 Arrow Activities

Arrow is an integrated coal seam gas (CSG) company, exploring and developing gas fields, producing and selling CSG, and generating electricity. Arrow has been safely and sustainably developing CSG since 2000 and supplying it commercially since 2004. Arrow delivers approximately 20 per cent of Queensland's gas from CSG fields in the Bowen and Surat basins.

Arrow owns one of Queensland's largest power stations, Braemar 2 near Dalby, and has interests in a further two, with power generation capacity equivalent to the power requirements of around 800,000 homes. Arrow's first Surat Basin tenure was granted in March 2000 and Arrow drilled its first Surat Basin exploration well in June 2001.

1.6.1 Overview of the Surat Gas Project (SGP)

Arrow Energy is expanding its coal seam gas (CSG) operations in the Surat Basin through the SGP. The project seeks to commercialise gas reserves held in Arrow's petroleum tenements. The proposed wells and associated gathering infrastructure are essential infrastructure to the SGP.

On 1 December 2017, Arrow Energy and the Shell-operated QCLNG joint venture announced a Gas Sales Agreement (GSA) to commercialise the majority of Arrow's gas reserves in the Surat Basin. The collaboration between the parties will see the use of existing QGC-operated infrastructure such as gas compression, processing and transmission infrastructure as well as water transport and treatment facilities. Improving the utilisation of the existing upstream infrastructure will reduce impacts to landholders, communities and the environment.

The nature of the delivery points for the sales gas within this commercial agreement enables Arrow to develop and commercialise its Surat tenure whilst reducing the land disturbance footprint of its SGP development beyond that approved by the Australian and Queensland government in 2013. Arrow is also progressing a Water Services Agreement for the receipt of raw water, storage, processing and re-delivery of treated water, utilising capacity made available by the Water Services provider. This similarly reduces the land disturbance footprint of the SGP development in comparison to plans presented in 2013.

The SGP project is being delivered via numerous 'batches' of workscope. Several batches have received all of the necessary regulatory approvals and landholder agreements and have either commenced the installation of infrastructure or are planned for installation in the coming months.

The workscope the subject of this RIDA application is:

- 11 CSG wells on 5 well pads (mix of vertical and deviated wells);
- Water & Gas Flowlines from wells to Header (DN160-DN450) ~ 13 km (26 km pipe in total); and
- Associated gasfield infrastructure.

1.6.2 Applicant's co-existence commitments

Arrow considers coexistence to mean allowing Australia to enjoy the full benefits from both agricultural and resource industries. In collaboration with farmers of Intensively Farmed Land ("IFL"), Arrow co-created 12 commitments to coexistence in the Surat Basin in 2012:

1. No permanent alienation
2. Minimised operational footprint - less than 2% of total IFL area
3. Flexibility on CSG well locations, but all wells located by edge of farm paddocks
4. Pad drilling (up to 8 wells from a single pad) used where coal depth and geology allows
5. Spacing between wells maximised (average of between 800m - 1500m)
6. Pitless drilling only
7. No major infrastructure facilities on IFL (dams, compression stations, gas gathering stations, water treatment)
8. Treated CSG water used to substitute existing users' allocations on IFL*
9. No brine/salt treatment or disposal on IFL
10. Flexibility on power supply option - above or below ground
11. Fair compensation - including elements of 'added value'
12. Continued proactive engagements with community and transparency on coexistence field activities

*Commitment 8 refers to the area of greatest predicted drawdown on the Condamine Alluvium resulting from CSG extraction by Arrow Energy.

These commitments are consistent with Table 3, Prescribed Solution (a) for Required Outcome 2.

In the Surat Basin, Arrow's innovations support coexistence with land users, optimise gas production, reduce costs and minimise impacts.

Arrow's tenure uniquely overlies high-quality black soil farmland that includes irrigated, laser-levelled cropping farms (intensively-farmed land; IFL). To inform and co-develop innovation to minimise impact, Arrow established community reference groups. Members include stakeholders that provide robust feedback (irrigator groups, landholders, local and state governments).

Outcomes:

- Area wide planning: individuals and groups of neighbouring landholders contribute knowledge of land and farming requirements to collectively shape field development plans and improve coexistence.
- Land access rules: apply to all staff and contractors on farms, and enforced up to and including termination.
- 12 published coexistence commitments, including minimising Arrow's operational footprint to less than 2% of total IFL area (minimal footprint now adopted in legislation).
- Delivering government and landholder supported research trials on private properties to explore interconnectivity between target coal seams and overlaying farming aquifers.
- Simultaneous operations matrix - agreed prioritisation of landholder and Arrow activities during construction and operation phases.
- Technical innovations to demonstrate coexistence with established, multi-generational agricultural operations – allowing them to continue long after CSG development, including the use of deviated wells from multi-well pads.

The traditional 800m x 800m grid pattern field development, completely unsuitable for IFL, has been eliminated. The benefits of deviated drilling and multi-well pads include a smaller over-all footprint (between 25-50% of a traditional vertical well field design), including:

- up to eight wells on one pad up to 110m x 200m, instead of eight separate well pads of 110m x 100m
- greater distance between pads (up to 2km)
- less gathering pipelines
- concentrated presence (infrastructure and staff access) in a smaller area
- well pads can be located in paddock corners and less productive areas to reduce impact on farming practices.

IFL well designs include double concrete and steel casing to about 80m, sealing wells from shallow farming aquifers. Further down-hole, swellable packers above and below target coal seams, ensure zonal isolation.

Surat Basin wells each target multiple coal seams, whose thickness is typically measured in centimetres not metres. Swellable packers have reduced solids production from interburden to negligible levels, reducing workover frequency and impacts on farming operations.

A number of forums including the Arrow Surat Community Reference Group and the IFL Committee along with multiple community meetings have been held for many years now to improve the flow of information to the community and to improve co-existence outcomes across the areas that Arrow operates. Through the IFL Committee, Arrow has developed a draft Construction and Operations

simultaneous operations matrix (SIMOPS) to identify how Arrow can coexist with landholders throughout the construction and operations project phases. The draft SIMOPS will be tailored to individual property requirements, in collaboration with landholders.

To ensure Arrow coexists with agricultural interests, it continues to stand by 12 published coexistence commitments for Surat Basin intensively-farmed land (IFL). Arrow continues to actively demonstrate coexistence between landholders and CSG companies is possible and that, by working together, the benefits of both the agricultural and resource industries can be realised.

1.6.3 Area Wide Planning

Area Wide Planning (AWP) is a unique program developed by Arrow to incorporate landholders' knowledge into our field development plans. Landholders and Arrow staff work together to identify locations for infrastructure, such as well pads, gathering lines and access tracks, across farming districts and on flood plains.

The process strengthens Arrow's ability to coexist with agricultural activities and allows landholders to influence the location of infrastructure early in our development planning phase. After an initial 'shed' meeting with the broader landholder group of an SGP batch, planning and discussions continue one-on-one with those landholders that express interest in working with Arrow and with landholders where infrastructure is proposed. Specific landholder agreements are then formalised in Conduct and Compensation Agreements ("CCAs"). The program demonstrates a commitment to genuine engagement and a commitment to preserving the values that are important to landholders.

1.7 Existing Authorities

The following sections outline the necessary approvals that Arrow already hold for the construction and operation of the proposed activities the subject of this RIDA application. Relevant extracts of these approvals are provided in Appendix 1.

1.7.1 Arrow's Petroleum Authorities

The following Petroleum Authorities issued under the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) and Environmental Authorities issued under the *Environmental Protection Act 1994* relate to the planned activities (refer to Figure 1-1).

Table 1-5 – Arrow Petroleum Authorities

Tenure	Grant Date	Holder/s	EA Name	EA Number
PL252	20 September 2008	• Arrow Energy Pty Ltd • Arrow CSG (Australia) Pty Ltd	Dalby Expansion Project (DXP)	EPPG00972513
PL260	1 April 2011	• Arrow (Tipton) Pty Ltd • Arrow (Tipton Two) Pty Ltd • Arrow CSG (Australia) Pty Ltd		

1.7.2 Regional Interests Development Approvals

No existing RIDAs have been identified in association with the land parcels included within the scope of this application.

1.7.3 Other Approvals Required

The following agreements are required prior to the commencement of the gas field development on the land the subject of this RIDA application:

- Conduct and Compensation Agreement with the landholder/occupier of each land parcel pursuant to the P&G Act; and
- Crossing agreements with Western Downs Regional Council for activities that interact with local roads.

2. Application Form Information

2.1 Parcel Details and Proposed Activity

Table 2-1 provides a summary of the proposed activity, location and proposed disturbance area in the context of the total area of the land parcel. Figures illustrating the location of disturbance on each land parcel are provided in Appendix 3.

Table 2-1 – Parcel Details and Proposed Activities

Parcel	Whole/Part	Activity	Area of Surface Disturbance (ha)		Parcel Size
			PAA	SCA	
57SP193329	Part	Gas Field Development	12.56	11.3	**306.2**
36DY45	Part	Gas Field Development	0.5	0.5	**89**
1RL2451	Part	Gas Field Development	0.1	0.02	**12.6**
1DY931	Part	Gas Field Development	12.25	11	**241**
70DY138	Part	Gas Field Development	4.8	4.8	**258.9**
1RP154777	Part	Gas Field Development	8.9	8.4	**245.7**
1DY787	Part	Gas Field Development	6.2	6.2	**266.4**
60DY802	Part	Gas Field Development	2.8	2.8	**129.2**
2RP106958	Part	Gas Field Development	1.1	1.1	**128**
12SP193328	Part	Gas Field Development	0	0	66.2
2RP99387	Part	Gas Field Development	0	0	202.8
2DY787	Part	Gas Field Development	0	0	132.6
Total			**49.14 ha**	**46.12 ha**	**2,078.6 ha**

The resource activity of gas field development comprises the following activities:

- Right of Way;
- Access Track;
- Laydown Area;
- Extra Workspace;
- Multi-well pad;
- Single well pad;
- Buried gathering lines;
- High Point Vents;
- Low point drains;
- Water take-off points;

- Future service connections;
- Subterranean deviated drilling trajectories;
- Fencing; and
- Signage.

Section 3 provides additional details regarding the proposed activities. Section 4 provides further information regarding the extent of disturbance to SCA and PAA (construction vs operational) on each land parcel.

2.2 Property Details

Schedule 1 of the *RPI Act* defines a property as follows:

> *(a) if an area managed as a single agricultural enterprise consists of 1 lot—the lot; or*
>
> *(b) otherwise—all the lots that—*
>
> > *(i) are owned by the same person or have 1 or more common owners; and*
> >
> > *(ii) are managed as a single agricultural enterprise; and*
> >
> > *(iii) form a single discrete area because 1 lot is adjacent, in whole or part, to another lot in that single discrete area (other than for any road or watercourse between any of the lots).*

The results of title searches undertaken to determine 'properties' associated with the land parcels included within the scope of the application is provided in Table 2-2. No other land parcels adjoining or surrounding these lots are owned by this landowner.

Table 2-2 – Property Details

Parcel	Part of a Property >1 Lot (Yes/No)	Parcels comprising the Property
57SP193329	Yes	'Property 1' - comprising the impacted parcels (57SP193329 and 36DY45) plus the following additional parcels 2RP85916 and 12SP193328 which will not be disturbed by surface gas field infrastructure. The area of Property 1 is approximately 508 ha.
36DY45	Yes	
12SP193328	Yes	
1RL2451	Yes	'Property 2' - comprising the impacted parcels (1RL2451, 1DY931, 70DY138, 1RP154777, 1DY787, 2RP106958 and 60DY802) plus 2RP99387 and 2DY787 which will not be disturbed by surface gas field infrastructure. The area of Property 2 is approximately 1,617 ha.
1DY931	Yes	
70DY138	Yes	
1RP154777	Yes	
1DY787	Yes	
60DY802	Yes	
2RP106958	Yes	
2RP99387	Yes	
2DY787	Yes	

Appendix 3 provides additional details regarding the properties and extent of infrastructure related to each land parcel.

2.3 Land Use

2.3.1 Current and Surrounding Land Use

The current land use of parcels contained within the scope of this application is dryland cropping of grain, legumes, cotton and oilseed crops, with some isolated patches of remnant vegetation and areas utilized for rural residential purposes.

Land parcels surrounding are also utilized for dryland cropping, as well as some areas of irrigated cropping of grain and cotton and isolated patches of remnant vegetation.

Appendix 3 provides further descriptions of the land use of each impacted land parcel and Appendix 5 shows the land use mapping (from Queensland Land Use Mapping Program (QLUMP)).

2.3.2 Easements

No easements have been identified on the land parcels included within the scope of this RIDA application.

2.3.3 Overlapping Resource Authorities

In addition to Arrow held resource authorities (refer to Table 1-5), the following resource authority exists over parts of two land parcels included in the scope of this application (being 60DY802 and 36DY45).

Table 2-3 – Overlapping Resource Authorities

Tenure Type/Number	Holder	Grant Date	Related Environmental Authority
EPC1770	New Emerald Energy Pty Ltd	12/11/2009	EPSX00446313

2.3.4 SCL Protection Certificates

No SCL Protection Certificates are held for all or part of the land parcels the subject to this application.

2.3.5 Title Searches

Copies of titles searches for the land parcels the subject of this application are presented in Appendix 2.

2.3.6 Road Reserves

The following road reserves are not subject to this application due to their use as infrastructure. Further, Arrow will negotiate voluntary agreements with the relevant authority for each road prior to commencement of disturbance.

Table 2-4 – Road Reserves crossed by Project Infrastructure

Road	Description
Daandine Nandi Road	Between 1DY931 and 1RP154777
Kupunn Road	Western boundary of 70DY138
Plunkett Road	Between 70DY138 and 1RP154777
Proposed Road	Unconstructed and/or dedicated
Proposed Road	Unconstructed and/or dedicated
Proposed Road	Unconstructed and/or dedicated
Proposed Road	Unconstructed and/or dedicated
Proposed Road	Unconstructed and/or dedicated

Gathering lines will be required to cross some of these roads. These crossings will be constructed either by open cut or underbore method.

Arrow will ensure that one lane remains open during construction to provide ongoing access to existing traffic and that impacts to the local community are minimised as much as possible. Methods to reduce impacts to the community will include the preparation of Traffic Management Plans, that includes a “procedure for notifying Council and road authorities prior to any traffic disruptions or road closures”.

To further minimise impacts to road users, traffic flow is managed through standard traffic control practices (such as temporary traffic lights, stop / go personnel, prioritisation of emergency vehicles etc), and these are identified in the Traffic Management Plan. Arrow manages amenity impacts in the same way for all other construction activities, including on-site noise, dust and light mitigation measures and restricting work hours to day time wherever possible.

In terms of community engagement, Arrow notifies landholders in the immediate area up to two weeks in advance via email or phone. Arrow also advertise online or in print as required which is often a condition of the relevant road crossing permit and also engage with bus companies in the area who operate school services.

3. Resource Activities

3.1 Definition of activities

Definitions of activities used to describe the proposed resource activities in Section 3.2 are provided in Table 2-2. Appendix 3 provides details on the location and extent of resource activities specific to each land parcel.

Table 3-1 – Definition of Activities

Resource Activity	Definition
Right of Way	A corridor for buried gathering lines (water and gas) between wells and associated infrastructure and connecting into a gathering network.
Access Track	A track for vehicles and equipment to access resource activities, not more than 6 m in width (10 m width if drainage is required)
Multi-well pad	A pad for two or more petroleum wells and associated infrastructure of dimensions no more than 15,000 m² during construction and no more than 500 m² during operation
Single well pad	A pad for a single petroleum well and associated infrastructure of dimensions no more than 10,000 m² during construction and no more than 120 m² during operation
Low point drain	A piece of buried infrastructure which captures water from low elevation points in a gas gathering line and above ground infrastructure that transfers that water to an adjacent water gathering line, with an operational footprint of 6 m by 6 m.
High Point Vent	A piece of infrastructure 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, with an operational footprint of 6 m by 6 m.
Future service connection	A piece of infrastructure constructed along the water and gas networks to assist with commissioning / maintenance purposes, with an operational footprint of 2 m by 2 m.
Valves	Above ground valve are required on connecting pipelines to allow sections of pipeline to be isolated, with an operational footprint of 2 m by 2 m. Valves will be located adjacent existing access tracks and/or fence lines to minimise the impact on landholder activities

Resource Activity	Definition
Laydown assessment area	An area used to lay down or store equipment required during construction, no more than 40,000 m².
Buried Linear Infrastructure	Buried HDPE gathering lines (water and gas) between wells and associated infrastructure and connecting into a gathering network. Depth of Cover over buried infrastructure will be a minimum of 900 mm and may also contain electrical and/or communication cable.
Fencing	Cattle Panel fencing around well pad infrastructure By exception security fencing may be installed
Extra Workspace	Where additional space outside of the ROW is required to enable safe construction. The extra workspace subject of this application will be associated with road crossings.
Signage	Pipeline signage will be installed along the gathering network atop fences to reduce the disturbance footprint required and minimise impacts to cropping activities.

3.2 Description of project and work activities

Arrow is developing further gas production on its PL252 and PL260, including additional buried gathering (gas and water) lines and production wells (see Appendix 3 for further details).

The proposed petroleum activities to occur on the land parcels the subject of this RIDA application include the following:

- Site preparation and establishment of access tracks (utilising existing access tracks and disturbed areas wherever practicable)
- Establishment of up to seven extra workspaces
- Digging trenches within the identified Right of Way ("ROW") and stockpiling of spoil and materials within the RoW
- Installation of 12,562 m of high density polyethylene (HDPE) gathering lines (gas and water), up to 630mm diameter and buried to a depth of 900 mm
- 14 High Point Vents, 11 Low Point Drains, 10 pairs of isolation valves and 22 future service connections
- Backfill of the trench using existing materials
- Undertaking reinstatement and rehabilitation of the ROW
- Making temporary breaks within, and re-establishment of, fencing

- Drilling and installation of 11 CSG production wells on 5 well pads, including well head facilities (2 are single-well pads and 3 are multi-well pads)
- Undertaking inspections and monitoring on a periodic basis.

3.3 Construction Activities Description

3.3.1 Access Tracks

Access tracks to the well sites will be constructed within a width of up to 10m. Due to the flat to gently undulating terrain minimal disturbance is expected to be required to construct the access tracks. Gravel or road base will be imported to provide a stable base for construction access and for operations where the track will remain

As previously stated, existing access will be utilised as far as possible. The location of additional access tracks on land subject to this application is described and illustrated in Appendix 3.

3.3.2 Wells

Following installation of access to the well site, the well pad will be prepared. The location and size of well pad on each land parcel is described and illustrated in Appendix 3. These wells will be constructed so as to enable water and gas production from the deeper coal seams of the Walloon Coal Measures.

The depth of wells will range from approximately 200 m to 800 m, with an average depth of approximately 450-500 m. There will be a mix of two single well pads and three multi well pads. The wells are designed for a 30-year life. No hydraulic fracturing activities are proposed in any of the development areas as per condition 4 of Arrow's approval under the EPBC Act (EPBC 2010/5344).

Depending on the well depth, it will take up to one week to drill each well (schedule of drilling activities is provided in Section 4.4.2) however drilling activities can take longer if circumstances determine, for example, wet weather or operational issues. The top section of each well between the targeted coal seam and the surface will be cased and cemented through the non-gas producing strata to prevent cross-contamination between groundwater aquifers

The size of well pads are determined by several factors, including the number of wells, the type of wells, the type and manoeuvrability of drill rigs, the existing land use, the equipment stored temporarily on the pad, the area required for offices, light vehicle parking, equipment and supplies deliveries and the required separation distance between wells and the area required to complete drilling operations safely.

Sizes of each of the well pads the subject of this application is provided at Appendix 3. Once all wells on a pad are installed, the footprint of the pad will be

stabilised outside the infrastructure footprints to meet EA and landholder requirements.

As the location of the well pads is flat, the well pads the subject of this application will be minimal disturbance pads. For minimal disturbance well pads the topsoil will be left in place. Site preparation works will be carried out using earthmoving equipment such as graders, excavators and bulldozers. Where the subgrade material is deemed to be inadequate and unsuitable for heavy vehicle access or where all weather access is required, consideration shall be given to:

- Amendment of soil (using additives and / or dynamic compaction); or
- Use of technologies (rig mats, tracked vehicles, roll-out sheets, etc.). Typically these technologies are utilised and reused to support each activity; or
- Clear, grub and remove unsuitable material and replace with more suitable material such as gravel.
- Any well sites that are prone to flooding will be designed with careful consideration of the potential impact of overland flow during rainfall and flood conditions.

The well sites the subject of this applciaiton have been located on the fringes of Intensively Farmed Land (IFL), in corners of paddocks, and near access tracks, right of ways, easements and road reserves, in areas that minimise the impact on farming. These well locations were determined following consultation with the landholder to ensure that impacts to their operations and lifestyle are minimised as much as possible.

3.3.3 Gathering Lines

Disturbance for the construction of the gathering lines on parcels within the scope of this application will be limited to the RoW and EWA's as illustrated in Appendix 3. The installation of gathering networks on Intensively Farmed Land (IFL) will be achieved with minimal disturbance of cultivated regions. To achieve this, existing land profiles will be re-established, mixing of soil layers will be avoided and current levels of compaction retained.

Gathering Line Construction

Construction of the gathering lines will require the following activities to be undertaken:

- Detailed survey of the RoW and construction areas
- Installing temporary gates and fences as required
- Establishment of temporary EWA's as required
- Clearing vegetation, where required, and grading the RoW to prepare a safe construction working area (on average the construction RoW will be 30 m in width to provide area to spread soil during rehabilitation)

- Establishement of Erosion and Sediment Controls, which typically includes spreading 5t/ha gypsum on top of the exposed sub soil, installation of of sediment traps (there are various types), installation of cross berms/banks to control the flow of water across the RoW. Site specific Erosion and Sediment Control Plans are developed for high risk areas e.g. areas containing slopes greater than 5% and/or nearby to a natural watercourse.
- Separating and stockpiling topsoil and subsoil to protect and preserve the biological properties of the topsoil
- Delivering pipe sections along the RoW, an activity referred to as 'stringing'
- Welding the low pressure HDPE pipe sections together to form 'a string'
- Creating a trench in which to lay the pipeline. The trench is excavated by a trenching machine or excavator and may include the use of chain or bucket wheel trenches, excavators or rock excavation hammers
- Lowering the pipeline strings into the trench and placing padding (e.g. finely screened trench subsoil) around the pipe to protect the pipe from external damage
- Backfill and compaction of the trench spoil (refer to following sub-section for additional details)
- Installation of high point vents, low point drains or valves;
- Returning the subsoil and topsoil to their original horizons
- Testing the integrity of the pipeline by pneumatic testing or filling it with water and pressurising it to above the maximum allowable operating pressure (i.e. hydrostatic pressure testing)
- Cleaning up, restoring and progressively rehabilitating the construction RoW and all temporary tracks, gates and fences
- Installing permanent gates and signage where required

Installation of multiple pipelines in a single RoW is generally sequential, i.e.; the first pipeline is installed and the trench backfilled before the next pipeline installation commences. A diagram of a typical construction Right-Of-Way (RoW) with multiple pipelines is provided in .

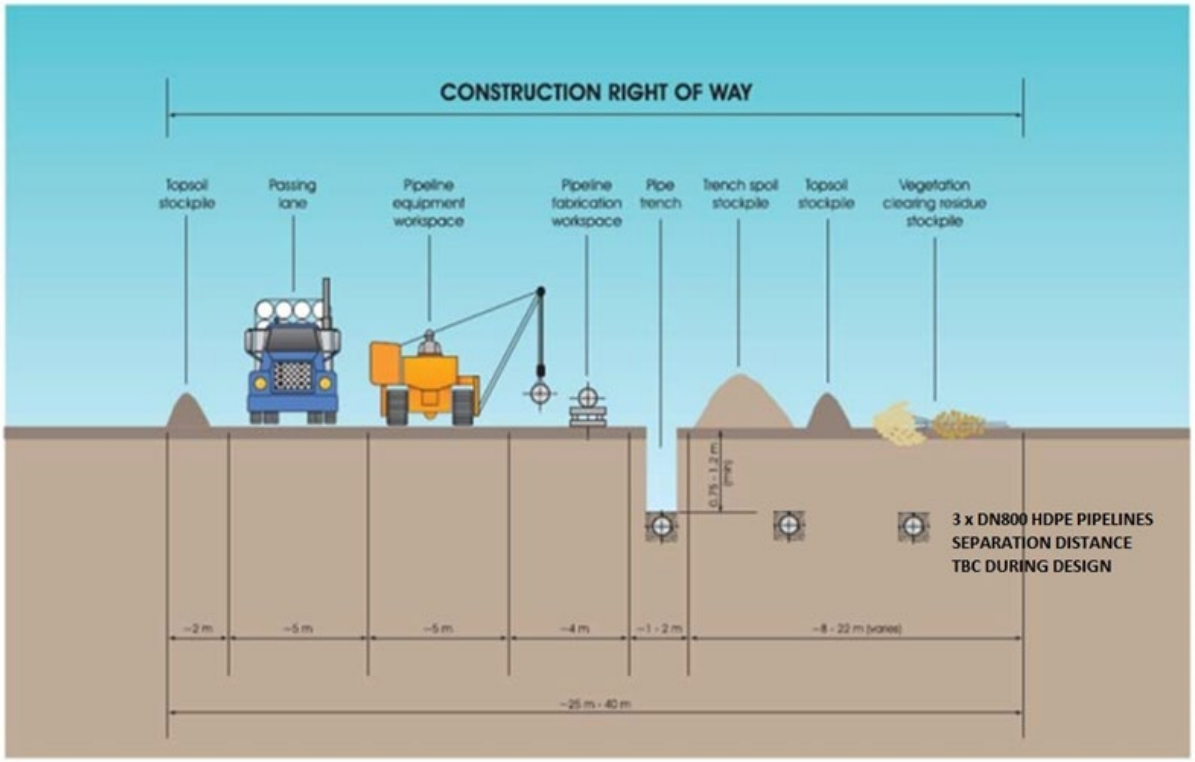


Figure 3-1 Typical Profile ROW Layout (Exact configuration to be confirmed during design)

The width of the construction RoW has been reduced as far as possible to minimise surface impacts, however, Arrow has also ensured that adequate space is available to safely construct the pipeline and implement the necessary mitigation measures (e.g. separation of soil stockpiles) to provide the best reinstatement outcome.

Backfill and Compaction Management

Backfill and compaction of the trench spoil. To create a stable landform after pipelines are lowered in, the pipeline trenches are backfilled and compacted to the requirements of Australian Standard AS/NZS 2566 Buried Flexible Pipelines Part 1: Structural Design.

Compaction and testing of embedment / backfill in trenches and bell holes is completed to AS/NZS 2566 Buried Flexible Pipelines Part 2: Installation.

These requirements are specified for in the Arrow Specification for PE Gathering Systems (ORG-ARW-PPL-SPR-00005).

An extract of the backfill and compaction specification that Arrow mandates to contractors is provided in the Table 15-1 and 15-2 below.

Table 15-1: Backfill Grading

Description of Backfill Layer Material	Maximum Particle Size in any Dimension (Grading)
Around the pipe, and to 150 mm above pipe	Embedment material as specified in AS/NZS 2566.1
From 150 mm above pipe, to 300mm below natural surface	Rock -150 mm Clay- 150 mm
From 300mm below natural surface to underside level of topsoil or seed stock layer	Soft spoil to 80mm
Stored topsoil spread over finished surface	N/A

Table 15-2: Minimum Relative Compaction [Note 1]

Soil type	Test Method	Trafficable Areas		Non-Trafficable Areas	
		Embedment Material %	Embedment Material %	Trench /Embankment Fill Material %	Trench /Embankment Fill Material %
Cohessionless	Density Index AS1289.5.6.1	70	70	60	60
Cohesive	Standard Dry Density Ratio AS1289.5.4.1	95	95	90	90

Note 1: Source: AS2566.2:2002 Table 5.5

The embedment material surrounding the pipe, and up to 150mm above the pipe, is screened so that the max particle size less than 20mm.

The Arrow gathering pipeline specification (ORG-ARW-PPL-SPR-00005_3.0_Specification for PE Gathering Systems) requires a minimum 90% standard dry density (SDDR) ratio in non-trafficable areas, and 95% in trafficable areas, tested to Aust Standard 1289.5.4.1.

90% SDDR refers to well compacted soil, which has been compacted mechanically, i.e. using a compaction roller on an excavator or similar. As an example of what 90% compaction feels like, if you press your thumb down as hard as you can on the surface there will be a slight indentation.

Trench compaction testing frequency is per below:

- Compact in 300mm Layers (measured loose/unconsolidated).
- One test in the embedment zone every 250m.

- One test in the backfill zone every 250m - tests shall be conducted in alternate layers at locations nominated by the Principals Representative.

The installation contractor is required to comply with these compaction values and is required to provide compaction test reports from an accredited soil testing company, to verify that adequate compaction has been achieved. This process minimises the risk of localised subsidence over the pipeline.

Minimising subsidence post construction is controlled by strict adherence to the compaction specification described above. Compaction test records provided by the construction contractor are checked and verified by Arrow Energy.

The subsoil in the trenches is mechanically compacted (as described above) however the topsoil layer is not compacted. Once reinstatement of the ROW is completed, the landholder is able to resume cropping on the ROW.

Extra Work Areas

Areas of additional work areas (EWA) adjacent to the ROW will be required to provide additional temporary construction areas for truck turn around areas and for road crossings. The location of EWA's on land parcels included in the scope of this application are illustrated in Appendix 3.

These EWA are temporary for the duration of the works only and are able to be utilised for the previous use upon the completion of construction.

Strategic Cropping Areas Soils Management

The topsoil and subsoil excavation depths for the cropping soils in SCA will be determined based on their specific soil properties. These soils will be backfilled into the trench in the reverse sequence they were removed and returned to a depth of at least 900mm immediately above the pipe so future cultivation with standard agricultural equipment may occur.

Erosion and Sediment Control

The Soil Management Report (refer to Appendix 8) summarises the erodibility ratings of the various soil types encountered along the ROW and proposed management measures. Erodibility is determined by the rate of infiltration at the surface, permeability of the soil profile, coherence of the soil particles, lack of vegetative cover, loss of soil organic matter and surface sealing. Erosion and sediment controls w be identified, documented and implemented as part of soil preparation works. These measures will remain in place until full restoration of the disturbance area is achieved.

Restoration

Restoration of the ROW will be conducted progressively and will be completed within four months (see table 4-4 for a more detailed schedule of activities). The ROW will be returned to pre-development condition for the agreed post-development land uses.

Management strategies for restoration of the gathering lines are summarised in Table 3-2 below.

Table 3-2 Management strategies for restoration.

Restoration of Gathering Lines (RoW)	
Policy	To achieve a stable ROW and return land to predevelopment land condition and use.
Background information and context	Land disturbed by the Project's activities will be returned to predevelopment condition. Restoration will be undertaken progressively during the construction period. Suitable baseline soil studies will be carried out so that the return to pre-existing land use can be confirmed.
Performance criteria	Stable landforms within the ROW Restored land areas able to sustain predevelopment land use activities
Implementation strategy	ROW reinstated to predevelopment landform Stockpiled topsoil will be respread on graded surfaces in an even layer to assist natural regeneration of vegetation Ripping or scarifying to ameliorate compacted soils undertaken as required Management strategies in place to minimise the likelihood of compaction (minimise traffic, monitor the workability of the soils materials) Sowing of cropping land (in consultation with the landholder) Monitor ROW to ensure the landforms and watercourses are stable
Monitoring	Regular inspection and monitoring and consultation with landholder
Reporting	Reporting to be undertaken in accordance with the Project EMS
Corrective actions	Investigation and recording of corrective actions will be conducted in accordance with the Project EMS

3.4 Operations

3.4.1 Operational activities

Other ongoing activities will be required to be undertaken by the Tenement Holder to support the operation of the pipeline, including:

- Monitoring and maintenance associated with the well head and above ground infrastructure
- Regular inspections to ascertain whether there are weeds and pests requiring management on the well pad, access tracks, reinstated RoW and immediately surrounding areas and the most appropriate method of management given the surrounding activities (e.g. use of a pesticide or herbicide which will not negatively impact on any surrounding crops or farm biosecurity requirements);
- Weed and pest management in accordance with the Environmental Authority, the *Biosecurity Act 2014*, the *Local Government Act 2009* and the Land Access Code 2016;
- Regular inspections for any erosion or subsidence associated with the well pad, access tracks, reinstated RoW and its immediate surrounds, and the most appropriate method of management and mitigation;
- Regular inspections to ascertain whether the area used for construction has been successfully rehabilitated with an establishment of appropriate ground cover (as the case may be) and the soil has stabilised adequately and, if not, what further management actions are required.

Access to the site for operations and maintenance will be undertaken according to the Land Access Code (September 2016) and the requirements of the relevant legislation.

Generally, works will temporarily cease during wet weather to minimise impacts to the land and soil erosion.

In accordance with the co-existence commitments, operational activities will be undertaken in consultation with the Landholder and Occupier in in a manner (timing) to minimise impacts on the Land.

Given that the pipelines and associated cables of the gathering infrastructure will be buried to a minimum depth of 900mm, land users are able to resume previous land use activities on top of the gathering lines provided that the use does not include excavation activities. Whilst deep-rooted vegetation cannot be re-established directly across the pipeline, shallow root cropping and grassland re-establishment is encouraged and no long-term impacts would be expected to such areas.

3.4.2 Operational Infrastructure

The following section provides a summary of the additional operational infrastructure (additional to the buried pipelines & associated cables) that are associated with the gas production. This infrastructure will remain in place for the life of the gas field , which is estimated to be 10 years. The location and scale of infrastructure on each land parcel is described and illustrated in Appendix 3.

Well

The Arrow 'standard' well site will be used for the project and will include the wellhead metering skid, vent, control cabinet and generator. The standard wellhead metering skid provides the following functionality:

- Connection of the well to the gas / water gathering network;
- Overpressure protection of the gas / water gathering network;
- Control of gas flow under turndown conditions;
- Metering of gas and water for control, surveillance and reporting.

The well will be fenced and occupy a footprint of up to 120 m² (refer to Plate 3-1).

Plate 3-1 - Typical Well Head Facility and Infrastructure

Work over of wells will continue for the life of the project. The frequency of work overs will generally be every 2 years for the first two work overs and then every 3 years thereafter. A work over is the process of performing major maintenance or remedial treatments on a gas well. In many cases, a work over implies the removal and replacement of the production tubing string and is done by a specific work over rig.

Low Point Drain (LPD)

A piece of infrastructure which captures water from low elevation points in a gas gathering line and transfers that water to an adjacent water gathering line, with an fenced operational footprint of 6 m by 6 m. LPD's are installed above the pipeline and will therefore be located within the disturbance area required for the gathering lines. LPD's will be located adjacent existing access tracks and/or fence lines to minimise the impact on landholder activities. The location of LPD's are illustrated in Appendix 3.

Plate 3-2 - Image a Low Point Drain

High Point Valve (HPV)

A piece of infrastructure which enables gases that build up within water gathering lines to be released to atmosphere and have an operational footprint of 6 m by 6 m.. HPV's are installed above the pipeline and will therefore be located within the disturbance area required for the gathering lines. HPV's will be located adjacent existing access tracks and/or fence lines to minimise the impact on landholder activities. The location of HPV's are illustrated in Appendix 3.

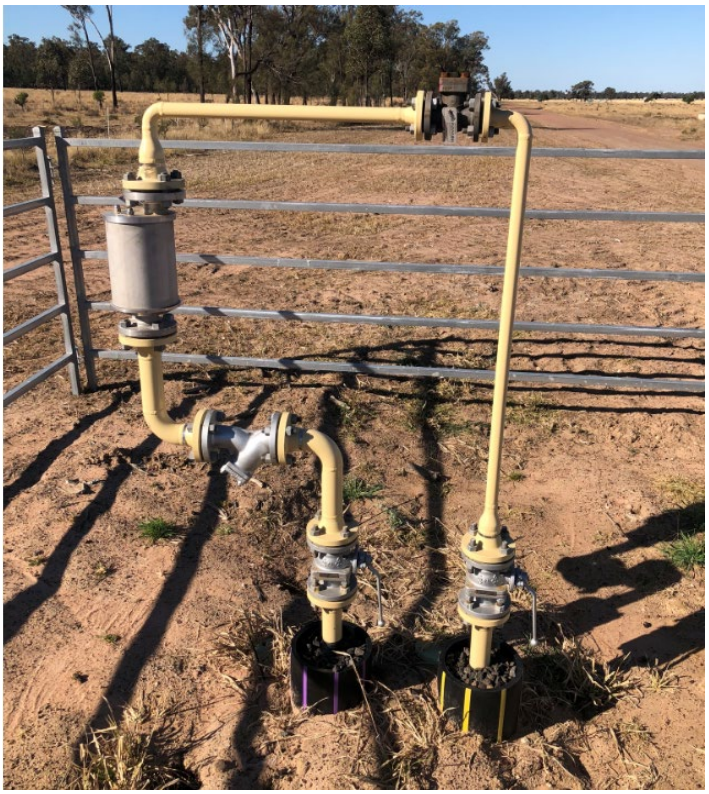


Plate 3-2 - Image of High Point Vent

Valves

Above ground valve are required on connecting pipelines to allow sections of pipeline to be isolated, with an operational footprint of 2 m by 2 m. Valves will be located adjacent existing access tracks and/or fence lines to minimise the impact on landholder activities. The location of valves are illustrated in Appendix 3.

Images of a valve prior to constrcuton, during construction, post construction and then post rehabilitation are included below.

Plate 3-3 – Image of a valve

Plate 3-4 – Image of valves during construction within the ROW

Plate 3-5 – Image of a valve post construction once the ROW has been backfilled

Plate 3-6 – Image of a valve and the ROW post reinstatement

Signage

Pipeline signage will be installed along the gathering network atop fences to reduce the disturbance footprint required and minimise impacts to cropping activities.

Access Tracks

The extent of new and existing access tracks which will be used during the operation phase of the gas field is illustrated in Appendix 3.

3.5 Decommissioning

3.5.1 Decommissioning of the infrastructure

At the conclusion of the activity, the pipeline will be decommissioned. This involves:

- Removal of all surface infrastructures;
- Squeeze off of existing flow lines at tee off position;
- Cut and cap the existing pipeline at tee off position;
- Purging the pipeline by filling it with water and/or nitrogen;
- Remove water from the water flowline and dispose produced water in accordance with waste management plan;
- Backfill, compaction and rehabilitation of all excavations in accordance with the Environmental Authority and the Environmental Management Plan.
- Leaving buried infrastructure in place; and Landholder endorsement of rehabilitated locations;
- Testing and completion of all field inspection checklists to ensure decommissioning has been completed to meet engineering safety standards;
- Completion of all relevant Certificates of Confiormity to meet all requirements of the APGA Code of Practice.
- Arrow will hold insurance and ongoing liability for de-commissioned buried infrastructure until the relevant petroleum authority is relinquished to the Government.
- Following relinquishment of the relevant authority, the Government will assume the liability for the de-commissioned infrastructure.

3.5.2 Final rehabilitation from operational footprint

The rehabilitation involves:

Rehabilitation Action	Description
Soil Assessment	Assessment of the soil type at the site and the risks of impacts of the proposed rehabilitation activities in accordance with Arrow's Land Disturbance Procedure. A plan of rehabilitation is then developed to support the return of the site to the surrounding land use.
Soil compaction	Where soil is likely to have become compacted the soil will be treated (i.e. deep ripped) to alleviate the compaction. This will occur prior to reshaping the upper layers of the soil stratum.
Sodic soil amelioration	When sodic soil is encountered it will be blended with an appropriate soil ameliorant (i.e. gypsum or a calcium based ameliorant) during rehabilitation to reduce depressiveness. Topsoil will then be placed above the sodic soils.
Topsoil management	Topsoil which was stripped and stored as part of the construction activities will be re-spread as part of the stabilisation and rehabilitation activities. Correctly preserved topsoil can assist greatly with establishment of vegetation. Where necessary, the topsoil will be ameliorated with gypsum, lime or organic mulch to improve soil structure, infiltration and soil aeration which in turn promotes vegetation establishment.
Establishment of vegetation	The surface of the land will be returned to its former use, or a use consistent with its former use and current surrounding land uses as identified in the initial rehabilitation assessment. Where the area is to be established for grazing this will involve reseeding with a seed mix complementary to the surrounding grasses, application of fertiliser if required and stock proof fencing of the area if required to protect the establishing vegetation.

3.6 CSG Water Management Strategy

Arrow has in place a CSG water management strategy (CSG WMS) for the Surat Gas Project (SGP). It is derived from Arrow Energy's corporate Coal Seam Gas Water and Salt Management Strategy (Arrow Energy, 2013), which summaries the overarching management framework implemented by Arrow for water and salt. This document outlines the management of CSG water resulting from activities arising from the SGP Field Development Plan. The CSG WMS provides a basis for compliance with government policy and sets out the method for managing produced water for Arrow's Surat Basin tenements.

CSG water from the SGP will be treated at existing Arrow facilities and at QCLNG facilities operated by QGC. The majority of CSG water will be treated by

QGC using its existing water management network of dams and transfer pipelines and will be treated at the existing Kenya water treatment facility. Water treated by QGC will then be returned to Arrow as treated water. Some water for the SGP will be treated at existing Arrow water treatment facilities at Daandine and Tipton.

The treated water will be prioritised for supply as substitution of existing Condamine Alluvium groundwater allocations, most likely for irrigation. This water will be returned to these end users via a beneficial use network, with the exact route to be determined after consultation with end users. Remaining treated water will be supplied to existing users, including via the existing SunWater Chinchilla beneficial use scheme. More detailed information about the Condamine Alluvium is provided in Section 8.

4. Priority Agricultural Land Use (PALU)

4.1 Overview

PAAs are strategic areas, identified on a regional scale, that contain significant clusters of a region's high value intensive agricultural land uses. The PAA surrounding the land relevant to this application includes areas of high value agricultural land uses, in particular areas of dryland cropping and grazing.

Within the PAA, Priority Agricultural Land Use (PALU) is given priority by ensuring that the location of resource activities can coexist with these uses.

4.2 Land Use Designations

4.2.1 Regional Plan

The wells and gathering project is identified as being located on PAA under the Darling Downs Regional Plan (2013) (the Regional Plan).

4.2.2 Priority Agricultural Land Uses

The Regional Plan identifies the Priority Agricultural Land Use (PALU) within the region as:

> *Priority Agricultural Land Use (PALU) means a land use included in class 3.3, 3.4, 3.5, 4 or 5.1 under the Australian Land Use and Management (ALUM) Classification Version 7, May 2010 published by the Department of Agriculture, Fisheries and Forestry ABARES, Australian Government.*

The relevant ALUM land use classes are:

- Class 3.3 – Cropping
- Class 3.4 – Perennial horticulture
- Class 3.5 – Seasonal horticulture
- Class 4 – Production from Irrigated Agriculture and Plantations, which includes:
  - Class 4.1 Irrigated plantation forestry
  - Class 4.2 Grazing irrigate modified pastures
  - Class 4.3 Irrigated Cropping
  - Class 4.4 Irrigated perennial horticulture

- Class 4.5 Irrigated seasonal horticulture
- Class 4.6 Irrigated land in transition.

- Class 5.1 – Intensive Horticulture.

Land use mapping of the parcels impacted by the wells and gathering infrastructure (refer to Appendix 5) has identified a large number of land use classes, of which only the following are defined as a PALU under the Regional Plan:

- Class 3.3 – Cropping; and
- Class 4 - Production from Irrigated Agriculture and Plantations, secondary class 4.3 Irrigated cropping.

Other land uses identified in the Regional Plan as a PALU will not be impacted by the project.

4.2.3 Queensland Land Use Mapping Program

The Queensland Land Use Mapping Program (QLUMP) (refer to Appendix 5) classifies land use according to the *Australian Land Use and Management Classification Version 8, October 2016.*

As the Regional Plan classifies PALU based on V7 of ALUM, a comparison of the V7 and V8 of ALUM (primary and secondary level classes) has indicated that there was only one change to PALU land classes listed in the Regional Plan:

- 4.1 Irrigated plantation forestry (v7) was updated to Irrigated plantation forests (V8).

4.3 Identification of PALU

The RPI Act Guideline 07/14: *How to identify a priority agricultural land use* (PALU) was consulted to determine if the Land within the Darling Downs Regional Plan is, or has been, utilised as PALU.

Section 2 of the RPI Regulation states that :

> *For land or property in relation to PALU, means the land or property has been used for PALU for at least 3 years during the 10 years immediately before an assessment application is made in relation to the land.*

To determine the extent of PALU on land included within the scope of this application, an assessment of the historical and current land use within the study area was undertaken for the years 2011 - 2020 utilising the following information sources:

- Reference to GIS satellite imagery (Appendix 3) and the Darling Downs Regional Plan (Department of State Development, Infrastructure and Planning, 2013) to confirm the Project is located within a PAA.

- Examination of aerial photography and satellite imagery for years 2011-2020 (Appendix 3 & 4)
- Reference to the Queensland Land Use Mapping Program (QLUMP) to confirm dominant Australian Land Use and Management (ALUM) classification for the area, cropping and grazing native vegetation (Appendix 5).
- Department of Science, Information Technology, Innovation and the Arts (DSITIA) Forage Crop Frequency Data for the years 2011 – 2020 (Appendix 6),

A summary of the findings is provided in Table 4-1 and additional details are provided in Appendices 4 to 6 as outlined above.

Table 4-1 – Outcome of Identification of PALU on land parcels & properties

Parcel	QLUMP Classification (refer to Appendix 5)	Cropping Frequency >3 in past 10 years (Appendix 6)	Field Review of Area to be disturbed (refer to Appendix 3 & Appendix 4)	PALU
Property 1				
57SP193329*	Cropping (Class 3.3)	**Yes**	**Used for dryland and irrigated crops**	**Yes**
36DY45*	Cropping (Class 3.3)	**Yes**		**Yes**
2RP85916	Cropping (Class 3.3)	**Yes**		**Yes**
12SP193328	Cropping (Class 3.3)	**Yes**		**Yes**
Property 2				
1DY931*	Cropping (Class 3.3)	**Yes**	**Used for dryland and irrigated crops**	**Yes**
70DY138*	Cropping (Class 3.3)	**Yes**		**Yes**
1RP154777*	Cropping (Class 3.3)	**Yes**		**Yes**
1DY787*	Cropping (Class 3.3)	**Yes**		**Yes**
60DY802*	Cropping (Class 3.3)	**Yes**		**Yes**
2RP106958*	Cropping (Class 3.3)	**Yes**		**Yes**
2RP99387	Cropping (Class 3.3)	**Yes**		**Yes**
2DY787	Cropping (Class 3.3)	**Yes**		**Yes**
1RL2451*	Grazing / Native Vegetation	**No**	**Parcel used as a road**	**No**

*Note – parcels impacted by infrastructure are marked with **

4.3.1 Outcome of PALU Identification

As outlined in Table 4-1, PALU has been identified as occurring in the disturbance area on all impacted land parcels apart from 1RL2451; which is a leased portion of a road reserve on the NE boundary of Lot 1DY931.

This parcel is presently vegetated with remnant vegetation and was found to have been cropped <3 times in the past 10 years (refer to Appendix 6). This is supported by examination of aerial/satellite imagery over the past 10 years (refer to Appendix 4).

As a result, the potential impact of the proposed activities on PALU on this land parcel is not addressed further in this application.

4.4 Extent and Impact to PALU

The extent of impact on PALU on each property is provided in Table 4-2 and Table 4-3 for properties that are comprised of greater than a single parcel.

Table 4-2 - Extent of Impact on PALU on Property 1

Parcel	Infrastructure (refer to Appendix 3)	Parcel Size (Ha)	PALU on Parcel (Ha)	Surface Disturbance to PALU (Ha) during Construction	Surface Impact to PALU (Ha) – during Operations	% PALU on Parcel impacted during construction	%PALU on Parcel impacted during operations
57SP193329	**Construction Disturbance:** **1 x well pad, ROW for buried infrastructure** **Operational disturbance:** **2 x wells, 3 km of gathering, 3 x HPVs, 1 LPD, 4 x valves, 4 x future connection services, access track and 2 x subterranean deviated well trajectories**	306.2	284.3	12.56	4.18	4.4%	1.47%
36DY45	**500 m of access track**	89	83	0.5	0.5	0.6%	0.6%
2RP85916	**Nil**	46.6	46.6	0	0	0.00%	0.00%
12SP193328	**Subterranean deviated well trajectory**	66.2	64.9	0	0	0.00%	0.00%
Property Total		496.7	478.8	13.06	4.68	2.7%	0.98%

Table 4-3 - Extent of Impact on PALU on Property 2

Parcel	Infrastructure (refer to Appendix 3)	Parcel Size (Ha)	PALU on Parcel (Ha)	Surface Disturbance to PALU (Ha) during Construction	Surface Impact to PALU (Ha) – during Operations	% PALU on Parcel impacted during construction	%PALU on Parcel impacted during operations
1RL2451	**Construction Disturbance:** **40 m of gathering** **Operational disturbance:** **Nil**	12.6	12.6	0.12	0	0.95%	0.00%
1DY931	**Construction Disturbance:** **2 x well pad, ROW for buried infrastructure** **Operational disturbance:** **2 x wells, 3.3 km of gathering, 1 HPV, 5 x LPDs, 5 x valves, 6 x future service connections, 3 x EWAs and 1.25 km of access track**	241	241	12.25	3.14	5.08%	1.30%
70DY138	**Construction Disturbance:** **ROW for buried infrastructure** **Operational disturbance:** **1.6 km of gathering, 2 x HPVs, 2 x LPDs, 2 x valves, 1 EWA, 2 x subterranean deviated well trajectories and 4 x future service connections**	258.9	258.9	4.79	1.6	1.90%	0.62%

Parcel	Infrastructure (refer to Appendix 3)	Parcel Size (Ha)	PALU on Parcel (Ha)	Surface Disturbance to PALU (Ha) during Construction	Surface Impact to PALU (Ha) – during Operations	% PALU on Parcel impacted during construction	%PALU on Parcel impacted during operations
1RP154777	**Construction Disturbance:** **1 x well pad, ROW for buried infrastructure** **Operational disturbance:** **3 x wells, 2.5 km of gathering, 2 x HPVs, 4 x LPDs, 2 x valves, 2 x future service connections, 2 x EWAs, subterranean deviated well trajectory and 1 km of access track**	245.7	245.7	8.9	2.27	3.50%	0.92%
1DY787	**Construction Disturbance:** **1 x well pad, ROW for buried infrastructure** **Operational disturbance:** **4 x wells, 1.3 km of gathering, 1 HPV, 2 x valves, 2 x future service connections, subterranean deviated well trajectory and 800 m of access track**	266.4	266.4	6.16	2.12	2.30%	0.80%
60DY802	**Construction Disturbance:** **ROW for buried infrastructure** **Operational disturbance:** **1 km of gathering, 1 HPV, 1 LPD, 2 x future service**	129.2	129.2	2.81	0.94	2.20%	0.73%

Parcel	Infrastructure (refer to Appendix 3)	Parcel Size (Ha)	PALU on Parcel (Ha)	Surface Disturbance to PALU (Ha) during Construction	Surface Impact to PALU (Ha) – during Operations	% PALU on Parcel impacted during construction	%PALU on Parcel impacted during operations
	connections, subterranean deviated well trajectory and 2 x valves						
2RP106958	**Construction Disturbance:** **ROW for buried infrastructure** **Operational disturbance:** **350 m of gathering, 1 HPV, 1 LPD, 2 x future service connections, 1 EWA, 2 x subterranean deviated well trajectories and 2 x valves**	128	128	1.05	0.35	0.82%	0.27%
2RP99387	**Subterranean deviated well trajectory**	202.8	202.8	0	0	0.00%	0.00%
2DY787	**2 x subterranean deviated well trajectories**	132.6	132.6	0	0	0.00%	0.00%
Property Total		1617.2	1617.2	36.08	10.42	2.23%	0.64%

4.4.1 Extent of Surface Impacts

The construction disturbance outlined in Tables 4-2 and 4-3 relate to the establishment of well pads, drilling of wells, clearing of the RoW to enable the associated pipelines and linear infrastructure to be installed, associated extra works space and construciotn access. Details of the constructon disturbance per property is provided in Appenidix 3.

The operational surface impact relates to the footprint of the surface operational infrastructure including wells, high point vents, low point drains, fibre optic cable pits and operational access. All operational surface infrastructure, apart from the wells, will be located within the disturbance footprint of the construction RoW for the buried infrastructure.

During construction, PALU activities will not be able to continue within the construction footprint for the duration of construiton. However, this disruption to activities is considered to be temporary only and not a loss of land on the property used for PALU as:

- The construction disturbance is temporary and will last for less than 12 months (refer to Section 2 for construction duration);
- The pre-existing PALU can recommence on the land following construction, apart from areas with surface infrastructure;
- Greater than 98% of the area of PALU on the properties pre-constuction will be available for PALU post construction and for the remainder of the duration of operation of the wells and gathering infrastructure on the property.

As outlined in Table 4-2 and Table 4-3, the surface imapcts associated with the operation of the wells and gathering infrastructure are small and result in less than a 2% loss of land available for PALU on each parcel and property.

Refer to the following sections for information around the nature of the impacts to PALU.

4.4.2 Reduction in Yields

Arrow have previously engaged agronomists to determine reductions in yield for a number of reasons, including improving rehabilitation and reinstatement measures and as a way of determining appropriate levels of compensation for impacts to farming land. The time taken to return land to cropping where pervious pipeline projects on intensively farmed land have been restored after construction is difficult to ascertain, as the impact is largely determined by the soil moisture at the time.

The higher the soil moisture, the greater the impacts to land. Impacts due to the construction of linear infrastructure such as the gathering infrastructure can last 5 years, even on heavy cracking clay soils. Research indicates typical yield

reductions could be in the order of 10-15% initially, reducing down to nil after 5 years.

The timeframes quoted refer to land levelling and also apply to compaction during construction. It should be noted that the 10-15% is for an activity across the whole paddock whereas the construction of the wells and gathering infrastructure will only cover between 0.6% and 5.08% of PALU on each parcel the subject of the RIDA application, so impacts to yields will reduce accordingly.

As an example, the expected reduction in yield where the construction is 5.08% of the PALU, an expected reduction in yield for the first crop following construction will be in the magnitude of 0.51% – 0.76%. At the other end of the scale, where impacts are 0.6% of the PALU, the forecast reduction in yield will be between 0.06% and 0.9% in the initial period following construction.

4.4.3 Nature of Surface Impacts to PALU

The nature of surface impact to PALU subject to this application will involve construction duration disturbance of up to 46 ha (across all Lots combined) to the existing land use. The scale of impact to PALU on each land parcel is illustrated on the Property Maps in Appendix 3 and summarised in Table 4-2.

The installation of well pads and gathering networks on Intensively Farmed Land (IFL) will be achieved with minimal disturbance of cultivated regions. To achieve this, existing land profiles will be re-established, mixing of soil layers will be avoided and current levels of compaction retained.

Following completion of the construction, reinstatement and commissioning phases of the well pads and gathering lines, with normal agricultural activities, including cropping activities, able to be re-established up to the operational well areas and over the gathering lines. While there are some impacts following initial rehabilitation including ripping of the disturbed portion of the paddock, compaction in the construction area will be aided by the natural remediation through the wetting and drying of soils. Ultimately rehabilitation of the area includes the removal of all above ground infrastructure and then ripping of all the compacted area to assist with returning the soil to its pre-disturbance condition.

The proposed depth of cover for the gathering on these land parcels will be 900 mm, which is considered sufficient to enable existing cropping activities to occur post construction. This has been evidenced on previous pipeline projects on intensively farmed land between Daandine and Tipton.

As an example, the image below (Plate 4-1) shows Arrow's Theten farm and a RoW where crops have been re-established post construction compared to the condition of the surrounding crops. The photo was taken approximately 12 months after construction. The rehabilitated RoW includes two HDPE pipes

(DN630 and DN450) running parallel to the access track within the edge of the cropped area of the paddock.

Plate 4-1 - Image of the re-establishment of crops within a pipeline ROW

Additional temporary indirect impacts to PALU will occur on some land parcels including:

- Use of alternate access for accessing areas adjacent the areas subject ot construction distubance;
- Limitation of access to adjacent land with large agricultural equipment, particularly where the distubance runs perpendicular to the cropping direction;
- Temporary isolation of areas of paddocks due to the location of the pipeline alignment.

In general, the landholder will be able to plant or harvest directly up to the RoW corridor as there will be no gap or break between the RoW and where a landholder can farm. Circumstances where temporary impact may occur include:

- Parallel scenario can disrupt planting rows along the edge of the RoW during construction, where the RoW doesn't line up with the guess row of the planter
- Perpendicular scenario creates a new headland alongside the RoW during construction only and this may result in a reduction in potential yield due to vehicle traffic and double planting
- Compaction in the ROW area

The majority of surface impacts will be temporary and limited to the duration of construction only (refer to Section 4.4.2). Areas where indirect impacts may potentially occur as a result of the construction process have been identified in Appendix 3

4.4.4 Construction Timeframe

The construction timeframes for each activity on each parcel of land is presented in Table 4-4. The timeframes presented are at a high level and will be ultimately reduced once all inputs are known such as engineering requirements and timing to obtain materials. Timeframes for gathering construction are at a high level at present and will be optimised closer to the start of construction based on some uncertainty including the conclusion of this RIDA application.

Clearing for gathering will more than likely be undertaken at the same time as the pads and tracks and then construction of the gathering following this, while the wells are drilled so that they can be hooked up (connected to the gathering) once the wells are completed. So, the overall timeframe shouldn't increase once the gathering schedule has been finalised. It should be noted that the current timeframes may also be subject to change should the landowner identify any impacts to farming activities.

Table 4-4 : Schedule of activities

Infrastructure	Start	Finish	Total Days
1DY787			
Pads and tracks construction	16 Feb 2023	27 Feb 2023	10
Longswamp 311 drill	27 Feb 2023	5 Mar 2023	6
Longswamp 312 drill	5 Mar 2023	10 Mar 2023	6
Longswamp 313 drill	10 Mar 2023	16 Mar 2023	6
Longswamp 314 drill	16 Mar 2023	21 Mar 2023	6
Longswamp 311 DHC	26 Mar 2023	30 Mar 2023	5
Longswamp 312 DHC	31 Mar 2023	5 Apr 2023	5
Longswamp 313 DHC	6 Apr 2023	10 Apr 2023	5
Longswamp 314 DHC	11 Apr 2023	16 Apr 2023	5
1DY931			
Pads and tracks construction	16 Feb 2023	21 Feb 2023	5
Longswamp 326 drill	21 Mar 2023	25 Mar 2023	4
Longswamp 326 DHC	16 Apr 2023	20 Apr 2023	4
Longswamp 375 drill	7 May 2023	10 May 2023	4
Longswamp 375 DHC	14 June 2023	18 June 2023	4
1RP154777			
Pads and tracks construction	16 Feb 2023	10 Mar 2023	20
Longswamp 371 drill	20 Apr 2023	26 Apr 2023	6
Longswamp 372 drill	26 Apr 2023	1 May 2023	6
Longswamp 373 drill	1 May 2023	7 May 2023	6
Longswamp 371 DHC	30 May 2023	4 June 2023	5
Longswamp 372 DHC	4 June 2023	9 June 2023	5
Longswamp 373 DHC	9 June 2023	14 June 2023	5
57SP193329			
Pads and tracks construction	16 Feb 2023	10 Mar 2023	20
Stratheden 162	22 Mar 2023	28 Mar 2023	6
Stratheden 163	28 Mar 2023	2 Apr 2023	6
Stratheden 162	2 May 2023	7 May 2023	5

Infrastructure	Start	Finish	Total Days
Stratheden 163	7 May 2023	12 May 2023	5
All lots			
Gathering installation (including rehabilitation and reinstatement)	16 Feb 2023	14 June 2023	Approx, 4 months

4.4.5 Production and Productive Capacity

Construction of the gas field infrastructure may result in the temporary loss of crop from within the area impacted by construction where:

- Crop is disturbed prior to harvesting;
- Crop is unable to be planted or planting is delayed due to timing of construction;
- Compaction post rehabilitation for a period until the disturbance has been ripped and remediated by wetting of soils.

In addition, the nature of disturbance may result in a temporary decrease in the productive capacity of the disturbed area. Arrow will implement a range of management measures during construction to minimize the extent of impacts and duration of recovery of the productive capacity.

These measures include preservation of removed topsoil, clear separation to excavated topsoil and sub-soil, replacement to match existing horizons compaction relief and utilization of ameliorants (gypsum and organic matter/fertilizer) during rehabilitation (refer to Section 8 for additional details). Based on past experience in the area, Arrow have found that implementation of such measures returns the impacted areas to full productive capacity within 5 years. This period is also dependent on soil type, rainfall and cropping regime.

4.4.6 Overland Flow

Based on past experience in the area (previous pipelines constructed), Arrow have not observed any pipeline subsidence or impacts to overland water flow or creation of waterlogged areas.

Surface elevations decrease from approximately 338 to 330.5 mAHD in a southeast to northwest direction within 3 km of the subject parcels. Mapping of subject lots of this application with contour lines at 1 m intervals within a 3,000 m buffer of the properties included within the scope of this application is provided in Appendix 7.

Slopes within 3km of the subject parcels have been determined from a Digital Elevation Model (DEM) constructed at 1m resolution from Light Detection and Ranging (LiDAR) data collected in 2020 over the area. Slopes were derived at a 10 by 10m (100 m^2) resolution to limit over-representation of small features. The majority (>96%) of slope is greater than 0.03% (300 mm per km). The area of slope classes is presented in Table 4-5 and Figure 4-1.

Table 4-5: Slopes within 3km of the subject parcels, derived from the 2020 DEM.

Slope Class (Slope %)	Area (hectare) of the Parcels	Area (%) of the Parcels	Area (hectare) outside but within 3km of the Parcels	Area (%) outside but within 3km of the Parcels
< 0.01	7.22	0.38	56.92	0.43
0.01 – 0.03	54.01	2.81	380.25	2.86
0.03 – 0.06	167.98	8.74	1,173.34	8.83
0.06 – 0.12	480.34	24.98	3,119.77	23.47
0.12 – 0.5	1,111.70	57.82	6,382.58	48.02
> 0.5	101.42	5.27	2,178.51	16.39
Total	1,922.67	100.00	13,291.37	100.00

The SGP was approved by the Australian Government under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC) decision 2010/5344 on 19 December 2013. A Stage 1 CSG Water Monitoring and Management Plan (WMMP) (Arrow Energy, 2018) and Updated CSG WMMP (Arrow Energy, 2019) have been prepared and were approved by the Minister on 18 December 2018 and 22 November 2019 respectively.

The WMMPs address the Australian Government approval conditions relating to the assessment, management and mitigation of surface and groundwater impacts as a result of project development, including subsidence caused by depressurisation of the CSG reservoir, and also addresses relevant Arrow commitments in the SGP environmental impact statement (EIS) (Arrow Energy, 2012) and Supplementary Report to the EIS (SREIS) (Arrow Energy, 2013).

The WMMP describes the cause of subsidence due to depressurisation of the CSG reservoir:

> *"Coal seam gas occurs within coal formations through adsorption to the surface of the coal under hydrostatic pressure. Depressurisation of the coal seams below a threshold (by groundwater extraction) reduces hydrostatic pressure and liberates the gas from the formation. As the pressure falls, the gas migrates to the extraction wells. This process requires substantial lowering of groundwater pressure.*
>
> *At any point below the ground surface, the weight of overlying strata is supported partly by water pressure and partly by the fabric of the rock mass. Any reduction in water pressure therefore results in an increased proportion of the load being carried by the rock mass, leading to compression of the rock. The combined compression over the thickness of rock strata affected by reduced water pressure results in subsidence at the ground surface.*

A Subsidence Technical Memorandum (Coffey Environments Australia Pty Ltd, hereafter referred to as Coffey, 2018) was prepared to support Arrow's Stage 1 WMMP. This provided modelling of the predicted magnitude of subsidence, including a review of ground movement observations and groundwater level monitoring carried out in proximity to existing Arrow domestic CSG projects, as well as an assessment of risks posed by subsidence to assets within or in close proximity to operations. The modelling indicates that any subsidence that occurs will be relatively widespread and even.

Since the Subsidence Technical Memorandum (Coffey, 2018), Arrow has undertaken further analysis of Interferometric Synthetic Aperture Radar (InSAR) data collected from ongoing monitoring. InSAR measurements provide data on movement of the ground surface and are recorded at fixed time periods from points across the landscape within the Surat Basin.

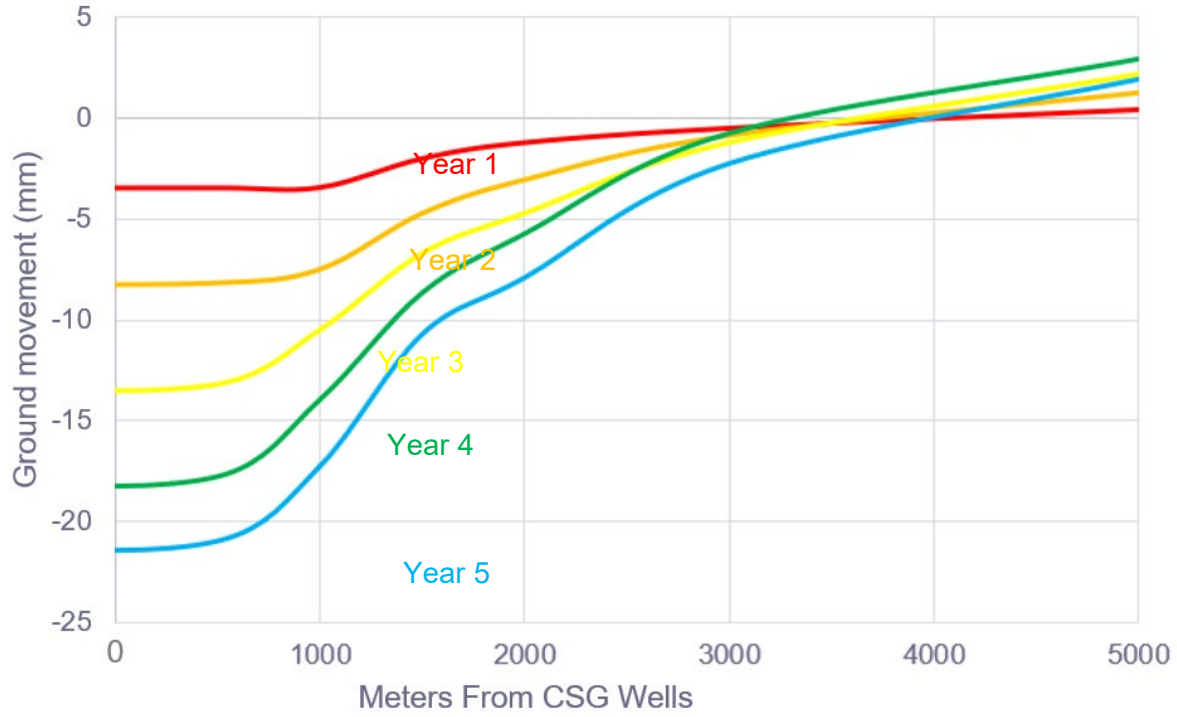
The spatial variation from these measurements indicates that natural ground movement is not static and varies both spatially and temporally. In order to describe how the potential ground movement correlates to CSG activities, Arrow has analysed InSAR measurements based on the distance to the closest existing CSG well and the duration that each well had been operating, as shown in Figure 4-1 for Arrow's existing Daandine production field.

This analysis indicates a clear correlation between the magnitude of CSG subsidence and the proximity to the wells. When looking at the average ground movement from the Sentinel InSAR dataset between 2015 and 2020 the area that had the most subsidence is within 500 m of the wells, decreasing to background ground movement at around 3,000 m from the wells. It is apparent that the rate of subsidence also decreases with time as the water production rate of a well decreases.

This CSG related subsidence results in a change in slope of approximately 25 mm per kilometre (0.0025%) at Daandine, with the change in slope observed at Arrow's existing Tipton production field being lower. In comparison, approximately 96% of the area in the vicinity of the subject parcels has an existing slope of greater than 300 mm per kilometre (0.03%) as presented in Table 4-5.

A change in slope of 25 mm per kilometre will result in a variation to the existing slopes of less than 8% for these areas, and a variation of greater than 8% for those areas with flatter existing slopes. Modelling indicates that the rate of subsidence decreases with time. The maximum magnitude of subsidence, as predicted in the modelling undertaken by Coffey (2018), is less than 125 mm in Arrow's SGP tenements, and in the area of the subject parcels is approximately 50 mm.

Figure 4-1: Ground movement at Daandine with time and distance from a well



4.4.7 Weed and Pathogen Management impact on PALU

If not appropriately managed, the introduction and/or spread of weeds and pathogens may impact on the conduct of PALU by:

- Reducing yield quantity due to increased competition by weeds for soil nutrients;
- Requiring increased weed control or management activities by the landholder.

Arrow is committed to ensuring that our activities do not result in the introduction of weeds or pathogens that could lead to reduced yields or increased load on the landholder to manage. Section 8.2 provides details of biosecurity measures that will be implemented.

4.5 Measures to Minimise Impacts to PALU

Arrow typically starts our engagement with landholders via Area Wide Planning approximately 2 years before planned activities. This engagement generally results in fruitful discussions that result in infrastructure placement and construction practices that are tailored to a particular land parcel by taking into

consideration current and future landholder infrastructure and farming practices/property management logistics, and minimise impacts to PALU.

The construction and operational footprint of the activity and potential impacts to PALU have to date been minimised through:

- Reducing the number and location of extra work areas (EWAs) to the minimum necessary to safety construct the pipeline in compliance with EA requirements. This has taken into consideration the extra work area required to construct watercourse crossings and infrastructure crossings, areas for stockpiling of vegetation, areas of side slope and additional stockpile areas adjacent areas of ROW.
- Increasing the depth of cover above the pipeline to 900mm (rather than 750mm), to enable pre-existing landholder activities, in particular agricultural activities such as ploughing, planting and harvesting to continue post construction;
- Alignment of the pipeline adjacent to land parcel and/or property boundaries wherever possible;
- Aligning the gathering around the boundary of cropped areas or within areas of properties with less intensive agricultural activity;
- Placement of end of pipeline infrastructure adjacent to existing petroleum infrastructure;
- Utilisation of existing disturbance/infrastructure for access tracks and laydown areas;
- Locating high point vents, low point drains, inspection pits and valves adjacent to property boundaries and access tracks and outside of cropped areas so that they do not have any impact on PALU on the property
- Prompt reinstatement of the ROW to enable cropping activities to re-establish post construction and continue during pipeline operation;
- Implementation of soil management measures as detailed in the following sections;
- Arrow will adopt a simultaneous operations approach where it is safe to do so that agricultural activities in the balance of the paddock can be undertaken while construction is occurring;
- Arrow has previously provided heavy vehicle crossing points and if this is agreed to by the relevant landholder along the RoW, they will be installed in appropriate locations;
- The gathering has been engineered such that a vehicle of 14 tonne axle weight can be driven over the top of it, thus enabling typical farm machinery (such as a John Deere Cotton Round Bale Picker) to continue operation post installation of the pipelines;
- Adopting appropriate weed management practices as described earlier in section 4.3.5.

Refer also to measures provided in Section 4.3.

5. Strategic Cropping Areas

5.1 Overview

SCAs consist of the areas shown on the strategic cropping land (SCL) trigger map as SCL. SCL is land that is, or is likely to be, highly suitable for cropping because of a combination of the land's soil, climate and landscape features.

5.2 Extent of SCL on Alignment

For purpose of application, Arrow accepts the extent of SCL as mapped. The extent of SCL on the parcels included in the scope of this application is illustrated on Figure 1-1 and summarised in Table 5-1.

5.3 Nature of Surface Impacts to SCL

The nature of surface impact to SCL on parcels subject to this application will involve disturbance of up 44 ha (Lots combined) to the existing land use. The location of impact on each land parcel is illustrated in Appendix 3 and scale of impact on SCL detailed in Table 5-1 including construction impact and surface impact during operations.

Table 5-1 – Scale of Impact to SCA

Parcel	Parcel Size (Ha)	Area SCL on parcel (Ha)	Surface Disturbance to SCL (Ha) during Construction	Surface Impact (Ha) during operations	% Impact on SCL - construction	% Impact on SCL during operations
57SP193329	306.2	306.2	11.3	4.18	3.7%	1.37%
36DY45	89	89	0.5	0.5	0.56%	0.56%
1RL2451	12.6	6.6	0.02	0	0.3%	0.00%
1DY931	241	239.4	11	3.14	4.6%	1.31%
70DY138	258.9	255.9	4.8	1.6	1.87%	0.63%
1RP154777	245.7	234.9	8.4	2.27	3.6%	0.97%
1DY787	266.4	266.3	6.2	2.12	2.3%	0.80%
60DY802	129.2	125.9	2.8	0.94	2.2%	0.75%
2RP106958	128	127.5	1.1	0.35	0.86%	0.27%
2RP99387	202.8	202.8	0	0	0%	0%
2DY787	132.6	129.3	0	0	0%	0%
12SP193328	66.2	66.2	0	0	0%	0%
Total	2,078.6	2,050	46.12	15.1	2.2%	0.7%

Table 5-1 illustrates the reduction in impacts to SCL from the construction phase through to the operational phase. The majority of impacts to SCL are temporary in nature, in partocualr the wellpads, which will be significantly reduced in size following completion of drilling and the pipeline Right of Way. This is because, following completion of the construction and reinstatement phases for the wells and gathering infrastructure, normal agricultural activities will recommence, with existing agricultural activities, including cropping activities, able to re-establish over the gathering infrastructure and areas subject to construction disturbance not required for operational infratructure.

The minimum depth of cover for the gathering lines will be 900mm which is considered sufficient to enable existing cropping activities to occur post construction. Activities requiring excavation or establishment of permanent infrastructure are restricted above the gathering lines.

The activity will not result in a material or significant impact on SCL on the property or on the SCL in the area due to the implementation of mitigation measures (refer to Section 4.5 as applied to PAA and Section 7) and the small percentage of short term construction disturbance comparable to the mapped SCL of impacted properties (refer to Table 5-1). Through implementation of these measures, the land can be restored to pre-existing land condition and pre-existing land use.

A soils assessment of the land associated with the Project has been undertaken and is documented within the AECOM Soil Assessment Report which accompanies this application and is provided in its entirety in Appendix 8. This report provides a characterisation of the current condition of the land and soils, evaluation of the potential impact of the proposed activity on SCL and recommendations in regards to management measures to minimise any predicted impacts to SCL.

In addition, Arrow will seek to work with the landholder to ensure that proposed measures are compatible with existing land management practices on the property. Adjustments to mitigation measures may be made (e.g. stripping depth, amelioration rates, fertiliser type and rates) based on feedback from the landholder.

6. Deviated Wells

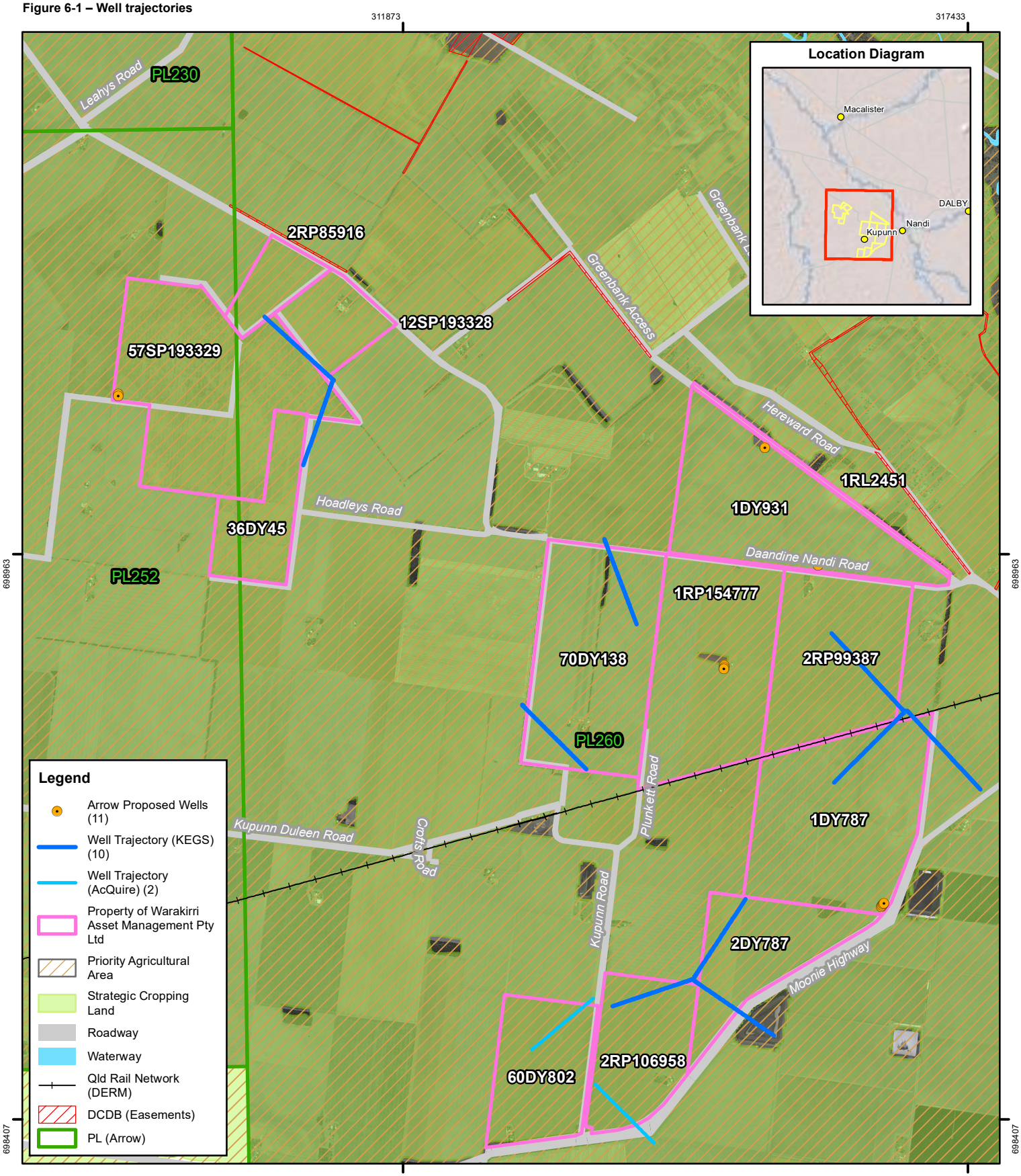
Traditionally, CSG wells are drilled vertically and spaced approximately 800 m apart. Deviated wells are a way of minimising the surface disturbance by locating multiple wells at a single location and drilling underground well trajectories across neighbouring properties, thereby reducing the number of sites required for above ground infrastructure.

Deviated Well trajectories are considered preliminary activities, and are typically at depths greater than 200 m below the surface at the point they cross into neighbouring properties. As such, there should be no impact on the business or land use of the neighbouring property.

Entry Notices under Section 39 of the Mineral and Energy Resources (Common Provisions) Act 2014 (QLD) and Regulation 17 Mineral and Energy Resources (Common Provisions) Regulation 2016 (QLD) are required to be provided to landholders prior to deviated well activities, unless this right is waived by the landholder. In addition to issuing an Entry Notice, Arrow will ensure that deviated well trajectories are fully incorporated into the Dial-Before-You-Dig process and then also at the completion of drilling.

There will be up to 12 deviated wells entering the land the subject of this application. These wells will enter the land at a subterranean point and be drilled from neighbouring properties. The well trajectories from neighbouring properties are illustrated in Figure 6-1. These will have no impacts on cropping activities or the productivity of the land. This is in addition to the trajectories from wells proposed to be located on the subject land.

Figure 6-1 – Well trajectories



Metres 0 1,000 2,000

N

Rev	Date	Revision Description	Org	Chk	Eng	QA	App
2	23/09/21	Refresh map	TS	TS	--	--	AH
0	19.07.21	Issued for use	TS	TS	--	--	AH

arrow energy go further

Scale @ A4: 1:50,000
Coordinate System: GDA 1994 MGA Zone 56

Status: IFU
Issued to: Andrew Hall
Author: tstringer

Source: Arrow Energy Limited
Geoscience Australia
Queensland Government

Warakirri Asset Management Pty Ltd

Trajectories

(2)

Document: V:\Products\Australia\Queensland\Surat_Basin\Land_Access\210719_RITM0322486_DK_P3_WarakirriAssetManagement_Trajectories_AH\DuleenKupunnP3_Warakirri_Infrastructure_Trajectories_2.mxd

Print Date: 23/09/2021

7. Landholder Consultation

7.1.1 Consultation Process

Consultation with the landowner commenced on 1 April 2019 and will continue throughout the duration of the project. The land intersected by the field development plan, where mapped PAA and SCA will be impacted, is listed in Section 1.5 of this report.

Arrow is seeking voluntary agreements with the landowner and will amend this application should agreements be obtained by providing additional notice to the Department of State Development, Infrastructure, Local Government and Planning (DSDILGP) of these agreements. Arrow's land access process involves four steps which are included in Table 7-1.

Table 7-1 – Arrow Energy Access Process

Step	Activities
Area Wide Planning (AWP)	• First landholder engagement including discussion of proposal and identification of areas of concern • Concept layout • Site scouting • Issued For Site Assessment (IFSA) GIS layer
Site Assessment	• Subject Matter Experts review IFSA GIS layer to identify required agreements • Site assessment including review and assessment of concerns raised by landholder • Released From Survey (RFS) GIS layer
Drafting and presenting Conduct and Compensation Agreements (CCAs)	• RFS GIS layer reviewed, scope is locked, budget approved - termed Final Layout Approval (FLA) • Drafting of CCA/AA • Presenting CCA/AA to landholder including proposed measures to address concerns raised
Negotiating and executing CCAs	• Negotiating on measures to address any outstanding concerns • Negotiations to settle terms and conditions and compensation amount • Execution (signing) of CCA/AA by landholder and Arrow

The strategy to engage with the landholder the subject of the land parcels is as follows:

Land Liaison Officer's (LLO) contact the landholder directly and then meet with them to describe the project. During initial discussions, all property constraints are discussed and captured on a map. A landholder questionnaire is used to capture additional information about the property. If it's considered appropriate,

conceptual maps of Arrow's proposed development may be provided during this meeting.

Questions raised by the landholder are answered by the LLO either by phone or email-depending on the nature of the question and detail required. All interactions are captured in file notes.

During initial scouting (which the landholder is encouraged to attend) the field design is established. If the property being scouted is used for cropping activities, then further consideration is given to the placement of infrastructure with regard to their farming operation i.e. HPV / LPD locations, placement and orientation of well pads to align with A-B Farming tracks, access tracks, pipelines (including placement of pipelines within the ROW).

This information is then surveyed and the results are included in a sketch map which is presented back to the LH to confirm the accuracy of the survey.

Arrow provides landholders with a minimum of 20 business days up to 140 business days to consider the sketch map and provide feedback. The timing allowed for this step is dependent on the proposed development and the complexity. Arrow always respond to any concerns about the proposed development or other issues identified by the landholder.

Arrow will negotiate in good faith with landholders and aim to reach voluntary agreement. This means that each of our engagements with landholders and their legal representatives are to be undertaken in a manner that:

- demonstrates respect
- demonstrates open and transparent dialogue
- adopts the technique of active listening
- is empathetic to grievances/complaints and seeks to resolve disputes in a timely manner
- provides transparency of our proposed activities and potential impacts
- allows sufficient time to negotiate and reach agreement (e.g. recognising that an agreement will not be resolved in a single or even a few meetings)
- Seeks to be as efficient as possible in the use of time and provides an acceptable outcome for both parties.

Details of the specific interactions between Arrow and the landowner and their representatives the subject of this RIDA application are included in Appendix 9 which is confidential and not for public release.

7.2 RIDA Consultation Requirements

A summary of the steps undertaken versus the DILGP's guideline to meet the prescribed solution is provided in Table 7-2. Additional information is presented in Appendix 9 which is confidential and not for public release.

Table 7-2 – DILGP Guideline

Guideline	Arrow Activity
1) write to the landowner seeking a meeting to:- a. explain the nature and extent of the proposed activity and the likely impacts from the proposed activity b. discuss the nature of the activities conducted by the landowner on the land and the nature of the landowner's concerns	Arrow has undertaken this step.
2) consider the information provided by the landowner and provide the landowner with a written strategy for addressing the landowner's concerns	Arrow has undertaken this step.
3) provide sufficient time for the landowner to consider the strategy (i.e. a minimum of 20 business days)	Arrow has undertaken this step.
4) consider and respond in writing to any concerns raised by the landowner in relation to the strategy	Arrow has undertaken this step.
5) provide the landowner with sufficient time to consider the revised strategy (i.e. a minimum of 10 business days).	Arrow has undertaken this step.

7.3 Status of Consultation

A summary of the progress of consultation with the landowner is provided in Appendix 9. This Appendix is considered confidential and not subject to public release.

8. Management of Mitigation Measures

8.1 Site Selection and Assessment of Alternates

The initial stages of site selection for the gas field infrastructure the subject of this application involved a desktop assessment of topographical and ecological mapping, preliminary landholder discussions and field scouting where access to the alignment was available.

Key steps involved:

- Site scouting activities;
- Ecological and cultural heritage desktop analyses;
- Ecological field assessments;
- Engineering and constructability assessments;
- Desktop soil assessment;
- Detailed landholder discussions; and
- Cultural heritage field assessments.

The current layout has taken into account the competing interests of stakeholders, environmental and cultural values, cropping land and landholders whilst selecting a route that is feasible, safe and cost-effective. Engineering, constructability, environment, cultural heritage, overlapping tenure holders and landholders have all been considered during the route selection process.

The design and construction of the layout has been focused on minimising impacts to land by locating the alignment along fence lines and roadways where possible (refer to Appendix 3).

Where this is not possible, sections of the infrastructure has been located to try and minimize impacts as much as practicable and will be constructed on the edges of paddocks where possible (refer to Appendix 3, which contains a summary of property specific constraints impacting on the alignment on the land parcels).

Further minor refinements to the alignment may be required in response to design and engineering work and negotiations with landholders. Any proposed refinements that may arise will be subject to internal Arrow assessment processes.

8.2 Biosecurity Measures

Arrow is aware of the potential impact of the introduction of weeds and/or pathogens on land holdings as a result of their activities and have existing procedures in place to manage this such as Arrow's Biosecurity Guideline (ORG-ARW-HSM-GUI-00123). Comprehensive biosecurity measures will be introduced for the proposed gasfield development and will include:

- Discussion of property specific biosecurity requirements with landholders;
- Preconstruction weed survey and removal where required;
- Establishment of approved access to the ROW;
- Wash down of vehicles and equipment prior to arrival on site & maintenance of 'clean' status;
- Brush down / clean down of equipment between properties to prevent the transfer of soil or pathogens between properties;
- Pre & post construction monitoring and control as required.

8.3 Reinstatement and rehabilitation

Reinstatement and rehabilitation measures will be applied to all areas disturbed during construction as soon as practical following the completion of the construction of authorised petroleum activities.

All reinstatement and rehabilitation will be carried out in accordance with the Environmental Authority requirements. Generally, this will include:

- Stockpiling of grasses, woody vegetation after clearing and prior to construction;
- Segregation of topsoil to ensure topsoil integrity when soil clearing is required as part of construction;
- Reinstatement of the land contours/land surface and drainage;
- Reinstatement of topsoils;
- Utilisation of soil ameliorants such as gypsum, fertiliser & organic matter;
- Implementation of stabilisation measures (which may include re-seeding for local grass specifies if applicable).

Measures outlined in Section 6 of the Soil Assessment Report (refer to Appendix 8) will also be implemented.

The construction footprint of the land will be returned to its previous general state and use once construction is completed and rehabilitation is undertaken leaving only the operational footprint and, the land will be visually consistent with the surrounding land features. Periodic monitoring will be undertaken to ensure integrity of the rehabilitation.

Detailed erosion and sediment control measures will also be implemented and maintained consistent with Section 6 of the Soil Assessment Report and the

Environmental Authority during construction, and as required following construction.

Other reinstatement activities will include:

- Removal of any foreign construction material and waste;
- Restoration of fencing as required.

8.4 Monitoring and Management of Subsidence

The WMMP is the primary document which outlines how Arrow will monitor for and manage subsidence, if it occurs.

The primary framework for the monitoring and management of subsidence caused by CSG production, which may alter existing ground slopes and therefor overland flow as discussed in Section 4.4.4, is provided in the Stage 1 WMMP. The Technical Memorandum (Coffey, 2018) in the Stage 1 WMMP addressed Interferometric Synthetic Aperture Radar (InSAR) observations and groundwater monitoring data available in 2018, (covering the period July 2012 to December 2015), and provided:

- Assessment of the long-term subsidence associated with proposed Arrow SGP operations based on:
  - A review of ground movement observations and groundwater level monitoring carried out in proximity to existing Arrow domestic CSG projects (these current domestic CSG projects do not form part of the SGP)
  - Estimates of subsidence based on predicted groundwater drawdown from the Environmental Impact Statement (EIS) and the Supplementary Report to the EIS (SREIS).
- An assessment of risks posed by subsidence to assets within or in close proximity to Arrow SGP operations
- Recommendations for additional ground movement monitoring such as strategically located geodetic monitoring and extensometers
- Recommended trigger levels derived from the calculated assessments of potential subsidence and taking into account the outcomes of the risk assessment process
- Recommendations for continuing monitoring for the Arrow SGP.

The WMMPs describe a program for monitoring ground movement that Arrow has been implementing and will continue to implement. The WMMP also describes the process for annual reporting of the results of the ongoing monitoring to the regulator.

The WMMP includes a three-tier subsidence management framework.

- Tier one is a screening level and involves comparison of satellite data at a 1km x 1km grid to identify areas of downward ground movement of more than 8mm per year.
- Tier two is an investigation level and involves comparison of changes in the slope of the ground or differential movement, with criteria specific to each asset class (e.g. linear infrastructure, cultivated lands).
- Tier three is the trigger threshold and is developed based on a site specific assessment of impacts changes to drainage and impacts to farming.

Any exceedance of the trigger threshold requires Arrow to implement an action plan, including mitigation measures, to minimise impact of CSG related subsidence. The mitigation measures, if required, will be tailored to site-specific conditions, impact cause, timing and magnitude.

The program for monitoring ground movement provided in the Stage 1 WMMP includes satellite imaging using InSAR, groundwater level monitoring, geodetic ground movement monitoring monuments and an extensometer array. Arrow has proposed amendments to the Commonwealth Department of Agriculture, Water and Environment (DAWE) for the Stage 1 WMMP. These amendments are to provide additional monitoring methods, including bi-annual collection of LiDAR where there is insufficient reliable InSAR data, and bi-annual surveying of benchmark locations to cross-check the LiDAR and InSAR data.

Arrow has acquired InSAR monitoring data back to 2006. Current InSAR monitoring is conducted using the European Space Agency Sentinel satellite constellation, with an acquisition frequency of every six days. Arrow has also acquired airplane borne LiDAR in 2012, 2014 and 2020. This InSAR and LiDAR monitoring provides a baseline from which future data can be assessed to determine changes in vertical ground elevation and slopes, and also provides a snapshot of current non-CSG ground movement. An example of a baseline report for Lot 1 DY931 and Lot 1 RL2451, providing information on the derived digital elevation model and slopes from the LIDAR survey, is provided in Appendix 11.

Arrow has also installed six permanent geodetic ground movement monitoring stations. These stations are Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS), and provide centimetre-level accuracy at these stations for comparison to InSAR and LiDAR data. Three of the stations are co-located at one site and independently monitor the soil movement compared to the deeper Condamine Alluvium aquifer and the Surat Basin formations from which the CSG subsidence propagates.

8.5 Potential Impact to the Condamine Alluvium Aquifer

The groundwater resources of the Condamine Alluvium have been extensively developed and are used for a range of water supply purposes including irrigation, urban use, commercial use, industrial use, stock-intensive, aquaculture, and stock and domestic uses. The Condamine Alluvium is incised into the Walloon Coal Measures in most of the central part of the alluvium.

The Walloon Coal Measures is the target for coal seam gas (CSG) production along the western margins of the Condamine Alluvium footprint, including in the area of the subject parcels, which can therefore potentially impact the groundwater resources of the Condamine Alluvium. The degree of impact will depend partly upon the hydraulic connectivity between the Condamine Alluvium and the Walloon Coal Measures.

The Office of Groundwater Impact Assessment (OGIA) initiated the Condamine Connectivity Project following the publication of the first Surat Underground Water Impact Report (UWIR) in 2012. This project has been progressively improving knowledge about the connectivity in the Condamine Alluvium. The project has used multiple lines of investigation, including: reinterpreting geology with particular focus on the contact between the Condamine Alluvium and the Walloon Coal Measures; mapping regional groundwater level differences between the two systems; and analysing the hydrochemistry of the two systems.

Arrow undertook a direct evaluation of the connectivity at two sites in 2013 and 2014, including drilling, coring and running pumping tests and numerically analysing the test data, with this data provided to OGIA as part of the project. Details of the investigations, approach and outcomes were compiled in an investigation report (Groundwater connectivity between the Condamine Alluvium and the Walloon Coal Measures: a hydrogeological investigation report, OGIA 2016).

The project concluded that there was a low level of connectivity between the Condamine Alluvium and the Walloon Coal Measures. It was conceptualised that vertical flow and interaction between the Condamine Alluvium and the upper parts of the Walloon Coal Measures is impeded by a combination of the undifferentiated clay transition zone at the base of the alluvium and the firm mudstone/siltstone interburden of the Walloon Coal Measures, in which its coal seams are embedded.

The degree to which flow is impeded therefore depends upon the combined thickness and vertical hydraulic conductivity of these two units. Assessment of the potential for connectivity between the Condamine Alluvium and underlying Walloon Coal Measures has continued, with more recent data reaffirming

previous findings that suggested low connectivity, as modelled in the 2016 and 2019 versions of the UWIR.

Modelling in the most recent UWIR (2019) indicates that the maximum impact to the Condamine Alluvium as a result of CSG production is expected to be around 0.2 m of drawdown in the north-west of the Condamine Alluvium and less than 0.05 m across the majority of the area, as shown in Figure XX below.

It is predicted that there will be a net loss of water from the Condamine Alluvium to the Walloon Coal Measures of about 73 GL over the next 100 years due to CSG development, 35% less than the impact predicted in 2016. The volume that is due to Arrow's activity is estimated at about 58 GL over the next 100 years. For comparison, the total potential take from Condamine Alluvium licences and stock & domestic users is about 52 GL per year (or 5200 GL over 100 years).

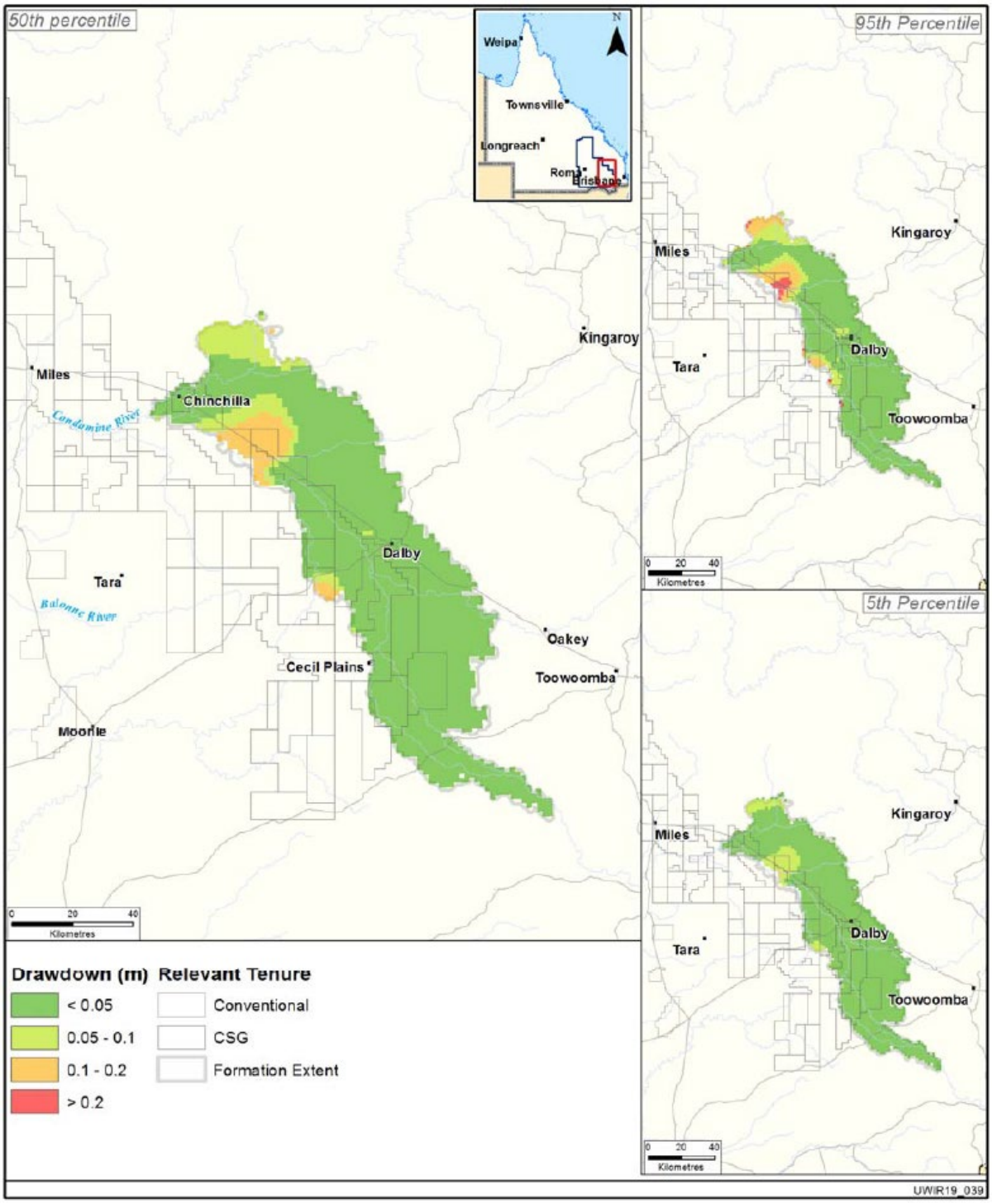


Figure 8-1: Modelled drawdown of the Condamine Alluvium aquifer as a result of CSG production (OGIA, 2019).

Mitigation of Potential Impact to the Condamine Alluvium Aquifer

To mitigate the loss of groundwater from the Condamine Alluvium as a result of Arrow's activities, Arrow has committed to:

1. Maximise beneficial use of produced water,
2. Where practical, return water to the region from which it is produced, and
3. Offset our impact on the Condamine Alluvium in the area of greatest predicted Arrow drawdown.

Following community consultation, Arrow committed to achieving this mitigation through substitution of allocation. Substitution of allocation is the beneficial use of coal seam water by providing it to existing Condamine Alluvium groundwater licence holders as a substitute to their approved entitlements. Instead of pumping groundwater from the Condamine Alluvium, a number of irrigators will be able to use Arrow's treated water through the Condamine Alluvium Substitution Scheme.

Construction of the scheme will enable Arrow to offset its predicted impact to the Condamine Alluvium in accordance with regulatory approval granted under Environmental Protection and Biodiversity Conservation Act 1999 (Cwth) (EPBC Act). The scheme will ensure Arrow maximises local beneficial use of coal seam water taken from the Walloon Coal Measures during gas production from this area, whilst the water that would have otherwise been pumped from the Condamine Alluvium will remain in the aquifer to offset Arrow's impact to the Condamine Alluvium.

The location of greatest predicted drawdown has been modelled by OGIA in the 2012, 2016 and 2019 UWIRs to occur on the western edge of the Condamine Alluvium. The exact location of the maximum predicted impact has been predicted to occur in slightly different parts of the western edge of the Condamine Alluvium and future UWIRs may predict different locations as well. Nevertheless, Arrow has designed the Substitution Scheme to supply water to this area. If there is insufficient interest in the Substitution Scheme to meet the Substitution Target, Arrow may offset it's impact to the Condamine Alluvium by purchasing allocations for the Condamine Alluvium to reduce extraction of groundwater from the alluvium.

9. Public Notification

The Land is not mapped as Priority Living Area (PLA). Accordingly this assessment application does not meet the definition of a notifiable application pursuant to Section 34(2) of the RPI Act or section 13 of the *Regional Planning Interests Regulation 2014*.

Arrow has also undertaken consultation with the relevant landholders as part of an Area-Wide planning process and negotiations related to the gas field infrastructure. Pursuant to s35(1)(b) of the Act, if the application is to be notified, Arrow will provide a copy of the notice to each impacted landholder along the alignment where there is no voluntary agreement in place and therefore exemptions under the Act do not apply.

Regardless if it is determined that notification is required or not, a copy of the full application will be provided to the landowner immediately following lodgement of the application. Also, letters have been sent to stakeholders advising them of this applciation.

10. Financial Assurance

Arrow is required to provide estimated rehabilitation costs (ERC) for the gas field infrastructure prior to any disturbance as per the conditions of the relevant EAs which authorise activities on the petroleum authorities where the infrastructure will be situated. This ERC provides for the rehabilitation of land back to its original landform.

11. Assessment Application Fees

This assessment application is accompanied by the fee prescribed under the RPI Regulation 2014.

Schedule 4 of the RPI Regulation provides a definition of the expected area of impact for an assessment application, which means the area in which:

- The activity is proposed to be carried out; and
- Carrying out the activity is likely to have an impact

Given the authorised petroleum activities and the expected area of impact (49 ha) on land parcels subject to this application, the following assessment application fees have been calculated and were paid in two instalments on 21 July 2021 ($26,980) and 28 July 2021 ($458).

Area of Regional Interest	Nature of assessment application	Fee
Priority Agricultural Area	For an assessment application with an expected area of impact of 30 hectares or more, but less than 100 hectares	$13,719.00
Strategic Cropping Area	For an assessment application with an expected area of impact of 30 hectares or more, but less than 100 hectares	$13,719.00
Total		**$27,438.00**

12. Required Outcome Assessment

12.1 Priority Agricultural Area

The PAA Assessment Criteria provides a required outcome for activities in PAAs that deals with impacts on a property level and a regional level. As the authorised petroleum activities are situated on more than two lots across the region, impacts on a regional level (Required Outcome 2) apply for the purposes of this assessment application.

Schedule 2, Part 2 of the RPI Regulation set out the Required Outcomes and prescribed solutions for activities carried out in a PAA. Please refer to Table 11-1for evidence associated with the prescribed solution of Required Outcome 1 and refer to for evidence associated with the prescribed solution of Required Outcome 2.

Table 12-1 - PAA Assessment Criteria – Required Outcome 1

Required Outcome 1 - Managing impacts on use of property for priority agricultural land use in a priority agricultural area This section applies if the activity is to be carried out on a property in a priority agricultural area. The activity will be carried out on a property in a priority agricultural area and will not result in a material impact on the use of the property for a priority agricultural land use.	
Prescribed Solution	**Evidence/Response**
(1) Subsections (2) and (3) each state a prescribed solution for required outcome 1.	
PS (2) The application demonstrates the activity will not be located on land that is used for a priority land use.	As demonstrated in Section 4.3 the proposed activity will not be located on land that is used for a priority land use on 1RL2451.

PS (3) The application demonstrates all of the following i. If the applicant is not the owner of the land and has not entered into a voluntary agreement with the owner: a. The applicant has taken all reasonable steps to consult and negotiate with the owner about the expected impact of carrying out the activity on each priority agricultural land use for which the land is used; and	The applicant is not the owner of land. A summary of landholder consultation undertaken is provided in Section 7 and Appendix 9.

ii. Carrying out the activity on the property will not result in a loss of more than 2% of both: a. The land on the property used for a priority agricultural land use; and b. The productive capacity of any priority agricultural land use on the property	As demonstrated in Section 4.4 (Tables 4-2 and 4-3), carrying out the activity will not result in the loss of more than 2% of both the land on the property used for PALU and the productive capacity of PALU on the property as the maximum extent of the operational footprint on any one parcel is 1.47%, and 0.98% on a property. It is acknowledged that the construction footprint for the wells and associated gathering infrastructure will impact on an extent greater than 2% of some land parcels and property, however the reduction in area available for a PALU and reduction in productive capacity is not considered to be a loss as: • The surface impact of any area greater than 2% due to the construction of th wells and gathering infrastructure is short term and temporary for the period of construction only (>12 months). The PALU will be able to recommence upon completion of construction in areas not within the operational footprint, will not be impacted by operational activities and therefore not considered to be a loss of land on the parcel/property used for a PALU;

	• The impact to the productive capacity of PALU on the land disturbed for construction will be limited to the area of disturbance and implementation of proposed mitigation measures will ensure the capacity of the land temporarily disturbed is returned to the pre-construction condition. One of Arrow's key Co-existence commitments (refer to Section 1.6.2) is to minimise it's operational footprint to less than 2% of the total Intensively Farmed Land area such as the land holdings associated with the gas field development.

iii.	the activity cannot be carried out on other land that is not used for a priority agricultural land use, including for example, land elsewhere on the property, on an adjacent property or at another nearby location;	The project layout has been selected to minimise impacts to PALU as much as practicable including locating the pads, tracks and pipeline along fence lines and roads, in the corners or edges of paddocks and across non-productive areas of land where possible. Discussion about the selection of the project layout is presented in Section 7 and specific land parcels constraints influencing the location of the layout is presented in Appendix 3. Land that is not being used for PALU has been selected as much as possible, however the majority of the area is intensively farmed and therefore impacts to PALU is unavoidable. The activity cannot be carried out on other land as evidenced by the need to transport gas and water from future wells to existing facilities located at Daandine. The use of these existing facilities greatly reduces the impacts from avoiding having to construct new facilities.

iv.	the construction and operation footprint of the activity on the part of the property used for a priority agricultural land use is minimised to the greatest extent possible.	The proposed area of construction of the project has been selected to have minimal impact where possible (refer to Section 3 & 4.4 and property maps in Appendix 3). The following mitigation measures will be employed to avoid and minimise impacts as much as practicable during construction and operation of the project: • Minimise the disturbance footprint and vegetation clearing • Construct well pads on edges or the corner of paddocks • Place infrastructure on the boundary of properties and /or adjacent roads where practicable • Use existing roads and tracks, where practicable • Reduce the width of construction ROW within areas of sensitivity to the greatest extent practicable without compromising the safety of workers • Reduction of well pad size for the operational phase of the wells; • Ensure construction activities do not extend beyond the work site boundaries • Mark site boundaries clearly for site-specific sensitive areas that require avoidance

v.	the activity will not constrain, restrict or prevent the ongoing conduct on the property of a priority agricultural land use, including, for example, everyday farm practices and an activity or infrastructure essential to the operation of a priority agricultural land use on the property	As outlined in Section 4.34 the proposed activity will have a temporary impact on the operation of PALU associated with construction area, which will be able to recommence following construction. To this extent, the design and location of infrastructure minimises the impacts on the agricultural use of the Land. As evidenced by Section 4.4 the authorised petroleum activity will not constrain, restrict or prevent the ongoing use of the balance of the Land for agricultural activities.
vi.	the activity is not likely to have a significant impact on the priority agricultural area	Due to the nature, duration and limited extent of the expected area of impact of the authorised petroleum activities, there will not be significant impact on the use of the majority of the Land for agricultural purposes. The impacts on PALU will be temporary and the mitigation measure to be implemented will ensure that the productive capacity of the land impacted by construction will be returned to pre-construction condition for the majority of the land. Refer to Section 4.4 for additional information.

vii.	the activity is not likely to have an impact on land owned by a person other than the applicant or the land owner mentioned in paragraph (a).	The authorised petroleum activities, due to the nature and extent of the expected area of impact, will not have an impact upon other landowners or neighbours. Subsidence is expected to occur resulting in changes in slope of approximately 25mm per kilometre, which will result in a variation to the existing slopes of less than 8% for the majority (96%) of the surrounding lands, and a variation of greater than 8% to existing slope for those areas with flatter (existing slopes of 0.03% or less) topography. Further, the location of infrastructure, construction methods and rehabilitation has taken into consideration any potential impacts on water overland flow. Arrow undertakes a detailed study during detailed design using LIDAR and modelling. This ensures that we have a baseline and can ensure that post rehabilitation the overland flow is not affected. Therefore no additional impact is expected from the proposed development and no impacts on other landowners or neighbours should be expected from overland flow.

Table 12-2 PAA Assessment Criteria – Required Outcome 2

Required Outcome 2 - managing impacts on a region in relation to use of an area in the region for a priority agricultural land use The activity will be carried out on out on 2 or more properties in a priority agricultural area in a region. The activity will not result in a material impact on the region because of the activity's impact on the use of land in the priority agricultural area for 1 or more priority agricultural land uses.	
Prescribed Solution	Evidence/Response
The application demonstrates all of the following	

(1) (a) if the activity is to be carried out in a priority agricultural area identified in a regional plan—the activity will contribute to the regional outcomes, and be consistent with the regional policies, stated in the regional plan	The Darling Downs Regional Plan PAA co-existence criteria enable compatible resource activities to co-exist with high-value agricultural land uses within PAAs. This will in turn maximise opportunities for economic growth to ensure that the Darling Downs remains a resilient, diversified and prosperous region. The key drivers for preparing the plan included the following factors which are supported by Arrow's SGP and the proposed gasfield project which will deliver gas and water to existing facilities and provide economic and employment outcomes for the region while respecting and co-existing with the agricultural users of the area: • enable opportunities for economic growth to ensure our regions are resilient and prosperous • protect areas of regionally significant agricultural production from incompatible resource activities while maximising opportunities for co-existence of resource and agricultural land uses • safeguard the areas required for the growth of towns • drive the region's economic diversity and opportunity • identify infrastructure outcomes that will support economic growth Further, the proposed construction and operation of the gasfields project is consistent with Regional policy 2 which is to: *Maximise opportunities for co-existence of resource and agricultural land uses within Priority Agricultural Areas.* As discussed in Section 1.6.2, Arrow considers coexistence to mean allowing Australia to enjoy the full benefits from both agricultural and resource industries. Arrow has made 12 commitments to

	coexistence on Intensively Farmed Land ("IFL") in the Surat Basin: 1. No permanent alienation 2. Minimised operational footprint - less than 2% of total IFL area 3. Flexibility on CSG well locations, but all wells located by edge of farm paddocks 4. Pad drilling (up to 8 wells from a single pad) used where coal depth and geology allows 5. Spacing between wells maximised (average of between 800m - 1500m) 6. Pitless drilling only 7. No major infrastructure facilities on IFL (dams, compression stations, gas gathering stations, water treatment) 8. Treated CSG water used to substitute existing users' allocations on IFL 9. No brine/salt treatment or disposal on IFL 10. Flexibility on power supply option - above or below ground 11. Fair compensation - including elements of 'added value' 12. Continued proactive engagements with community and transparency on coexistence field activities *Commitment 8 refers to the area of greatest predicted drawdown on the Condamine Alluvium resulting from CSG extraction by Arrow Energy.

(b) the activity can not be carried out on other land in the region that is not used for a priority agricultural land use, including, for example, land elsewhere on a property, on an adjacent property or at another nearby location	The gasfields project will feed gas and water from future wells to Arrow's existing Daandine facility and then onto QGC's existing facility at David and Harry. The current layout provides for the least impacts to landholders in the region and reduces the operational footprint as much as possible. Information about the selection of the layout is provided in Section 7. Further, by utilising these existing facilities at Daandine and David, reduces the need for multiple new large facilities to be constructed in the region. Where PALU cannot be avoided, the layout has been selected to minimise impacts to PALU as much as practicable including locating well pads on edges or the corner of paddocks and the gathering along fence lines and roads and across non-productive areas of land where possible (refer to Appendix 3). There are no alternatives which would reduce impacts to the area any further than the current design will allow.

(c) the construction and operation footprint of the activity on the area in the region used for a priority agricultural land use is minimised to the greatest extent possible	The proposed area of construction of the gasfields project has been selected to minimise the impact on land used for PALU through an AWP process (refer to Section 7) and minimisation of disturbance on impacted properties (refer to Section 3.4 and property maps in Appendix 3). The following mitigation measures will be employed to avoid and minimise impacts as much as practicable during construction and operation of the project: • Minimise the disturbance footprint and vegetation clearing • Use existing roads and tracks, where practicable • Reduce the width of construction ROW within areas of sensitivity to the greatest extent practicable without compromising the safety of workers • Ensure construction activities do not extend beyond the work site boundaries • Mark site boundaries clearly for site-specific sensitive areas that require avoidance

(d) the activity will not result in widespread or irreversible impacts on the future use of an area in the region for 1 or more priority agricultural land uses	Arrow's first co-existence commitment states, No permanent alienation. Arrow is committed to co-existence with regional communities and in particular agricultural practices in the areas where it operates. As demonstrated throughout the application, the impact to PALU of the proposed gasfields project will be temporary, reversible and limited to the land parcels included within the layout. Upon completion of construction, impacted PALU activities will be able to recommence and will not be impacted by operational activities. Arrow has constructed and operated multiple gasfield wells and pipelines over the past 15 years or more and is confident that this project will have no great impact on the area and certainly would not foresee any widespread or irreversible impact from its operation. Subsidence is expected to occur resulting in changes in slope of approximately 25 mm per kilometre, which will result in a variation to the existing slopes of less than 8% for the majority (96%) of the surrounding lands, and a variation of greater than 8% to existing slope for those areas with flatter (existing slopes of 0.03% or less) topography. Modelling indicates that the rate of subsidence decreases with time, and that the subsidence in the area will reach a maximum of approximately 50 mm. The subsidence that occurs is predicted to be relatively widespread and even.

(e) the activity will not constrain, restrict or prevent the ongoing use of an area in the region for 1 or more priority agricultural land uses, including, for example, infrastructure essential to the operation of a priority agricultural land use	Arrow employs AWP to discuss its proposed development activities and to understand the operations, needs and requirements of an individual landholder. Information obtained during AWP and at shed meetings with local communities is used to best locate infrastructure to ensure impacts to the individuals and communities lifestyles, and employment and economic activities are minimised as much as possible. This is particularly so when co-existence with farming practices is required. Details of existing farming practices, machinery operation and future aspirations are key considerations to ensure co-existence but also for factors such as ensuring the safety of Arrow staff, contractors and personal but more importantly the safety and security of landholders, their families and their visitors as well as the local community.
(2) Subsection (3) applies if the activity is to be carried out in a priority agricultural area that includes a regionally significant water source and— (a)if the activity is to be carried out under an authority to prospect or a petroleum lease under the *Petroleum and Gas (Production and Safety) Act 2004*—the activity is likely to produce CSG water; or (b)if the activity is to be carried out under a mineral development licence or a mining lease under the *Mineral Resources Act 1989*—the activity is likely to produce associated water.	Appendix 10 is Arrow's CSG Water Management Plan which provides for the management of water across the PLs where the project will be constructed and operated. The Plan also includes information about net replenishment. The Plan states that Arrow has committed to offsetting its component of modelled likely flux impacts to the Condamine Alluvium in the area of greatest predicted drawdown as a result of CSG water extraction from the Walloon Coal Measures and is conditioned to do so under its Federal environmental approval.

(3) Also, the application must demonstrate the applicant has in place a strategy or plan for managing the CSG water or associated water that provides for the net replenishment of the regionally significant water source. (4) For subsection (3), ***net replenishment*** of a regionally significant water source is the replacement to the water source, whether directly or indirectly, of all water that is no longer available for a priority agricultural land use in a priority agricultural area because carrying out a resource activity in the area produces CSG water or associated water.	The offsetting mechanism will be through substitution of allocations and/or purchase of allocations. Modelled flux impact will vary with the development of successive groundwater models. The 'final' modelled flux impact will be predicted immediately prior to completion of the SGP. Any discrepancy between the 'final' model prediction and the amount Arrow has actually offset (through substitution or purchase of allocation) will be addressed at the end of the SGP. Arrow will review the 'final' quantum of flux to be offset having regard to updated model predictions and information obtained from relevant hydrogeological investigations. If required, Arrow will then undertake additional offset.
(5) Subsection (6) applies for each property on which the activity is to be carried out if the applicant is not the owner of the land and has not entered into a voluntary agreement with the owner. (6) The application must demonstrate the matters listed in this schedule, section 3 for a prescribed solution for required outcome 1 for the property.	Refer to Table 12-1 – PAA Assessment Criteria for Required Outcome 1.

12.2 Strategic Cropping Area

The SCA Assessment Criteria provides a required outcome for activities in SCAs that deals with impacts on Strategic Cropping Land (SCL). As the authorised petroleum activities are situated on an area of SCL and is being undertaken on more than two lots across the region, impacts on a regional level, Required Outcomes 1,2 and 3 apply for the purposes of this assessment application.

Schedule 2, Part 4 of the RPI Regulation set out the Required Outcomes and prescribed solutions for activities carried out in a SCA. Please refer to Table 11-3 for evidence associated with the prescribed solution of Required Outcome 1, Table 11-4 for evidence associated with the prescribed solution of Required Outcome 2 and refer to Table 11-5 for evidence associated with the prescribed solution of Required Outcome 5.

Table 12-3 - SCA Assessment Criteria – Required Outcome 1

Required Outcome 1 - managing impacts on strategic cropping land in the strategic cropping area	
Prescribed Solution	Evidence/Response
The application demonstrates the activity will not be carried out on strategic cropping land that meets the criteria stated in schedule 3, part 2	The construction and operation of the gasfields project will be carried out on SCL.

Table 12-4 - SCA Assessment Criteria – Required Outcome 2

Required Outcome 2 - managing impacts on strategic cropping land in the strategic cropping area (1) This section applies if the activity— (a) does not meet required outcome 1; and (b) is being carried out on a property (SCL) in the strategic cropping area. (2) The activity will not result in a material impact on strategic cropping land on the property (SCL).	
Prescribed Solution	**Evidence/Response**
The application demonstrates all of the following	
(a) if the applicant is not the owner of the land and has not entered into a voluntary agreement with the owner—the applicant has taken all reasonable steps to consult and negotiate with the owner of the land about the expected impact of carrying out the activity on strategic cropping land;	The applicant is not the owner of land. A summary of landholder consultation undertaken is provided in Section 7 and in Appendix 9. Arrow has already undertaken consultation with the landholder's lawyer as part of an Area Wide Planning (AWP) process and with neighbours and the local community as part of shed meetings and community consultation across the region. .
(b) the activity cannot be carried out on land that is not strategic cropping land, including, for example, land elsewhere on the property (SCL), on adjacent land or at another nearby location;	The current layout provides for the least impacts to landholders in the region and reduces the operational footprint as much as possible. The vast majority of the layout is mapped as SCL and could not be avoided. Refer to Figure 1-1 and Figure 1-2. Also, Arrow has located the project on each property by utilising boundaries and running in parallel with roads and fence lines where possible to try and minimise impacts to the landholder.

	The project cannot be entirely carried out on land that is not strategic cropping land due to the extent of SCL on the layout area and consideration of other constraints as detailed in Appendix 3.
(c) the construction and operation footprint of the activity on strategic cropping land on the property (SCL) is minimised to the greatest extent possible;	The proposed area of construction of the gasfields project has been selected to have minimal impact where possible (refer to Section 3.4 and property maps in Appendix 3). The following mitigation measures will be employed to avoid and minimise impacts as much as practicable during construction and operation of the project: • Minimise the disturbance footprint and vegetation clearing • Use existing roads and tracks, where practicable • Reduce the width of construction ROW within areas of sensitivity to the greatest extent practicable without compromising the safety of workers • Ensure construction activities do not extend beyond the work site boundaries • Mark site boundaries clearly for site-specific sensitive areas that require avoidance

(d) if the activity will have a permanent impact on strategic cropping land on a property (SCL)—no more than 2% of the strategic cropping land on the property (SCL) will be impacted.	Arrow considers that the carrying out the activity will not result in the a permanent impact on SCL on a property as : • The surface impact due to the construction of the project is short term and temporary. The pre-existing land use will be able to recommence upon completion of construction and will not be impacted by operational activities for the most part; • The impact to the productive capacity of the land will be limited to the area of disturbance and implementation of proposed mitigation measures will ensure the capacity is return to the pre-construction condition. • gathering will be buried to a depth of at least 900 mm below surface to allow for most agricultural practices and use of machinery above The area of temporary disturbance and the % impact on SCA each property is summarised in Table 5-1 and demonstrates that less than 2% of each property will be impacted during operations by the project. Refer to Section 5.3 for additional details. Lastly, one of Arrow's key Co-existence commitments (refer to Section 1.6.2) is to minimise it's operational footprint to less than 2% of the total Intensively Farmed Land area such as the land holdings in the project area.

Table 12-5 - SCA Assessment Criteria – Required Outcome 3

Required Outcome 3 - managing impacts on strategic cropping land in the strategic cropping area (1) This section applies if the activity— (a) does not meet required outcome 1; or (b) is being carried out on 2 or more properties (SCL) in the strategic cropping area. (2) The activity will not result in a material impact on strategic cropping land in an area in the strategic cropping area.	
Prescribed Solution	Evidence/Response
The application demonstrates all of the following	
(1) The application demonstrates all of the following— (a) the activity cannot be carried out on other land in the area that is not strategic cropping land, including, for example, land elsewhere on the property (SCL), on adjacent land or at another nearby location;	As discussed in Section 7.1, the current layout provides for the least impacts to landholders in the region and reduces the operational footprint as much as possible. The vast majority of land is mapped as SCL and could not be avoided. Refer to Figure 1-1 and Figure 1-2. Also, Arrow has located the project on each individual property by utilising boundaries and running in parallel with roads and fence lines where possible to try and minimise impacts to the landholder. The project cannot be entirely carried out on land that is not strategic cropping land due to the extent of SCL in the area and consideration of other constraints as detailed in Appendix 3.
(b) if there is a regional plan for the area in which the activity is to be carried out—the activity will contribute to the regional outcomes, and be consistent with the regional policies, stated in the regional plan;	The Darling Downs Regional Plan encourages co-existence between compatible resource activities with high-value agricultural land uses. This will in turn maximise opportunities for economic growth to ensure that the Darling Downs remains a resilient, diversified and prosperous region.

	The key drivers for preparing the plan included the following factors which are supported by Arrow's SGP and the proposed gasfields project which will deliver gas and water to existing facilities and provide economic and employment outcomes for the region while respecting and co-existing with the agricultural users of the area: • enable opportunities for economic growth to ensure our regions are resilient and prosperous • protect areas of regionally significant agricultural production from incompatible resource activities while maximising opportunities for co-existence of resource and agricultural land uses • safeguard the areas required for the growth of towns • drive the region's economic diversity and opportunity • identify infrastructure outcomes that will support economic growth The proposed construction and operation of the project is consistent with Regional policy 2 which is to: • Maximise opportunities for co-existence of resource and agricultural land uses within Priority Agricultural Areas.

(c) the construction and operation footprint of the activity on strategic cropping land is minimised to the greatest extent possible;	The proposed area of construction of the project has been selected to have minimal impact where possible (refer to Section 3.3 and property maps in Appendix 3). The following mitigation measures will be employed to avoid and minimise impacts as much as practicable during construction and operation of the project: • Minimise the disturbance footprint and vegetation clearing • Use existing roads and tracks, where practicable • Reduce the width of construction ROW within areas of sensitivity to the greatest extent practicable without compromising the safety of workers • Ensure construction activities do not extend beyond the work site boundaries • Mark site boundaries clearly for site-specific sensitive areas that require avoidance
(d) either— (i) the activity will not have a permanent impact on the strategic cropping land in the area; or (ii) the mitigation measures proposed to be carried out if the chief executive decides to grant the approval and impose an SCL mitigation condition.	Arrow's first co-existence commitment states, No permanent alienation. Arrow is committed to co-existence with regional communities and in particular agricultural practices in the areas where it operates. Arrow considers that the carrying out the activity will not result in the a permanent impact on SCL on a property as : • The surface impact due to the construction of the project is short term and temporary for the most part. The pre-existing land use will be able

	to recommence upon completion of construction and will not be impacted by operational activities except for the above ground infrastructure; • The major impact to the productive capacity of the land will be limited to the area of disturbance and implementation of proposed mitigation measures will ensure that the capacity is returned to the pre-construction condition. Mitigation measures will be implemented to ensure that the productive capacity of the land is returned to its pre-existing condition post construction (refer to Sections 5 and 8. Once the project concludes and is decommissioned, the land will be returned to its former use and rehabilitated to the same or similar condition as it was prior to being constructed, as per relevant conditions within Arrow's environmental approvals including each relevant environmental authority.
(2) Subsection (3) applies for each property (SCL) on which the activity is to be carried out if the applicant is not the owner of the land and has not entered into a voluntary agreement with the owner. (3) The application must demonstrate the matters listed in this schedule, section 11 for a prescribed solution for required outcome 2 for the property (SCL).	Arrow intends to negotiate a voluntary CCA with the landholder has already successfully negotiated several CCAs with landholders in the area.

(4)	Refer to Table 12-4 – SCA Assessment Criteria for Required Outcome 2.

13. References

Environmental Impact Statement (EIS) Assessment Report under the Environmental Protection Act 1994, Surat Gas Project

Code of Environmental Practice Onshore Pipelines, Australian Pipeline Industry Association, June 2013

RPI Act Statutory Guideline (11/16), specifically guidelines 2, 3, 6 and 7, Department of State Development, Infrastructure, Local Government and Planning, 2014

14. Definitions

Definitions of terms used in this standard:

Term	Definition
Arrow	Arrow Energy Pty Ltd
AS	Australian standard
BUN	Beneficial Use Network
CSG	Coal seam gas
DSDILGP	Department of State Development, Infrastructure, Local Government and Planning (
DoE	Department of Environment (Commonwealth)
EA	Environmental Authority
EIS	Environmental impact statement
EMP	Environmental management plan
EPBC Act	Commonwealth Environmental Protection and Biodiversity Conservation Act 1994
EP Act	Environmental Protection Act 1994
PPL	Petroleum pipeline licence
RIDA	Regional interests development application
ROW	Right of way

Appendices

Appendix 1: Existing Approvals - Extracts

PL 252 Resource authority public report

Queensland Government

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PL 252 Resource authority public report

Queensland Government

Permit details

Permit ID:	PL 252
Status:	Granted
Lodged date:	19/02/2007
Grant date:	20/09/2008
Commencement date:	20/09/2008
Expiry date:	19/09/2038
Plan/program expiry date:	30/06/2025
Current term:	30 years
Work program type:	
Conditions:	
Locality:	SOUTH-WEST OF DALBY WITHIN THE WALLOON COAL MEASURES
Remarks:	.
Act permit granted under:	Petroleum and Gas (Production and Safety) Act 2004
Act now administered under:	Petroleum and Gas (Production and Safety) Act 2004

Holders

Authorised holder representative (AHR)

FERGUSON, Suzanne
C/- Tenement Manager GPO Box 5262 Brisbane QLD 4001

Holders

	Holder name	Share %	Status	Held from	Held to	Authorised holder
*	ARROW ENERGY PTY LTD GPO Box 562 Brisbane QLD 4001	70.000000000000	Current	06/01/2011		Yes
*	ARROW CSG (AUSTRALIA) PTY LTD C/- Tenement Manager GPO Box 5262 Brisbane QLD 4001	30.000000000000	Current	05/10/2010		No
	ARROW ENERGY LTD	70.000000000000	Former	21/12/2009	06/01/2011	
	SHELL CSG (AUSTRALIA) PTY LTD	30.000000000000	Former	21/12/2009	05/10/2010	
	ARROW ENERGY LTD	100.000000000000	Former	08/07/2008	21/12/2009	
	ARROW ENERGY NL	100.000000000000	Former	19/02/2007	08/07/2008	

Tenancy type: Tenancy in Common

PL 252 Resource authority public report

Queensland Government

Area

Location:	View Map
Mining district:	Dalby
Local authority:	Western Downs Regional Council
Area:	25 Sub-blocks
Exclusions:	
Marked out date:	

Sub-blocks

BIM	Block	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Brisbane	2749	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

Background land

No data available

Survey plans

Plan No.	Description	Date received	Locality	Volume	Folio
MP38492	PWLs - "Stratheden #10, 11, 12, 13, 14"	02/03/2009	DUCKLO		
MP38493	PWL - STRATHEDEN 16, 18, 19	02/03/2009	DUCKLO		
MP38744	PWL - "Stratheden #15"	09/03/2010	DUCKLO		
MP38734	PWL - "Stratheden #17, 20, 22 & 24, 25, 26, 27"	09/03/2010	DUCKLO		
MP38853	PWL - "Stratheden #5"	18/08/2010	DUCKLO		
MP39583	PWL - Stratheden #60 & 61	12/11/2012	RANGES BRIDGE		
MP39593	PWL - Stratheden #40, 41, 42, 43, 44, 45, 46	14/12/2012	RANGES BRIDGE		
MP43663	PWL - STRATHEDEN 62, 63, 64, 65, 66, 67, 68, 69	14/10/2013	DUCKLO		
MP45812	PWL OF STRATHEDEN 111, STRATHEDEN 112, STRATHEDEN 113, STRATHEDEN 114, STRATHEDEN 115 AND STRATHEDEN 116	23/08/2018	RANGES BRIDGE		

Relinquishment details

No data available

Sub-blocks retained

No data available

Term history

Term	Date notice issued	Date lodged	Date approved	Date commenced	Date term ends	Term	Act granted under
2008 - 2038		19/02/2007	20/09/2008	20/09/2008	19/09/2038	30 years	Petroleum and Gas (Production and Safety) Act 2004

PL 252 Resource authority public report

Queensland Government

Native title

Outcome	Process
All land subject to Native Title (<10%) is excluded from the permit area	Predominantly Exclusive Land

Purpose and minerals

Purpose
PETROLEUM

Minerals
Coal Seam Gas

Related permits

Pre-requisite permits:	ATP 790
Applied from permits:	WMA 2014; WMA 2015; WMA 2016
Dependent permits:	WMA 2; WMA 3; WMA 4; WMA 5; WMA 2017

Financial

Rent details

Area units:	75
Rate/unit area:	$159.30

PL 252 Resource authority public report

Queensland Government

Activities

Activity name	Activity / Dealing No	Status	Date received	Expected completion	Date completed	Remarks
Coordination arrangement	347503	Requested	28/04/2021			
Coordination arrangement	347490	Requested	28/04/2021			
Add excluded land	213520	Approved	19/07/2017		23/08/2017	Approval given to add excluded land namely land that may be subject to native title.
Later Development Plan Due		Requested	24/06/2014	19/09/2018		LDP DUE 19/09/2018.
Later Development Plan		Closed	06/06/2013	30/06/2014	18/06/2014	LDP DUE 19-SEP-2013. LDP RECEIVED 06/06/13, WITHIN TIMEFRAME, FOR PERIOD OF 5 YRS FROM 20/09/2013 TO 19/09/2018. CHECKLIST COMPLETED. TAS REQUIRED. LDP FORWARDED TO DELEGATE FOR APPROVAL 20/05/14.LDP APPROVED BY REGIONAL DIRECTOR ON 18/06/14 FOR THE PERIOD TILL 19/09/2018.
Change of holder name	1020891	Closed	06/01/2011	06/01/2011	06/01/2011	Changed name from ARROW ENERGY LTD to ARROW ENERGY PTY LTD
Coordination arrangement	131810	Approved	11/10/2010		20/03/2019	
Change of holder name	1019581	Closed	05/10/2010	05/10/2010	05/10/2010	Changed name from SHELL CSG (AUSTRALIA) PTY LTD to ARROW CSG (AUSTRALIA) PTY LTD
Change of holder name	1012587	Closed	08/07/2008	08/07/2008	08/07/2008	Changed name from ARROW ENERGY NL to ARROW ENERGY LTD
Later Development Plan		Closed	22/02/2007	19/04/2007	20/09/2008	INITIAL DEVELOPMENT PLAN LODGED WITH APPLICATION FOR A TERM OF 5 YEARS TO COMMENCE 20 SEP 2008 TO EXPIRE 19 SEP 2013

PL 260 Resource authority public report

Queensland Government

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PL 260 Resource authority public report

Queensland Government

Permit details

Permit ID:	PL 260
Status:	Granted
Lodged date:	08/01/2008
Grant date:	16/03/2011
Commencement date:	01/04/2011
Expiry date:	31/03/2041
Plan/program expiry date:	30/06/2025
Current term:	30 years
Work program type:	
Conditions:	Entry into relevant arrangement (a) The holders of PL 260 must enter into contract(s), coordination arrangement(s) or other arrangement(s) (relevant arrangement(s)) to supply petroleum produced from the area of PL 260, where the relevant arrangement(s) provide for: i. the supply of petroleum produced from the area of PL 260 to occur by no later than 31 December 2018; and ii. the volume of petroleum produced from the area of PL 260 to equal or exceed 300TJ by 31 December 2019. (b) The holders of PL 260 must provide the following to the department administered by the Minister by no later than 30 June 2017: i. evidence of the relevant arrangement(s) to supply petroleum produced from the area of PL 260 which meets the requirements of clause (a); and ii. a written declaration that the petroleum produced from the area of PL 260 will meet all or some of the petroleum required to be supplied under the relevant arrangement. (c) The Minister may determine that s/he is not satisfied that the holders of PL 260 have entered into relevant arrangement(s) if the Minister reasonably believes: i. a relevant arrangement relating to PL 260 is not an arm's length commercial transaction; or ii. supply under the relevant arrangement is unlikely to be carried out.
Locality:	SOUTH OF DALBY
Remarks:	Prerequsite tenure Id's ATP 683
Act permit granted under:	Petroleum and Gas (Production and Safety) Act 2004
Act now administered under:	Petroleum and Gas (Production and Safety) Act 2004

Holders

Authorised holder representative (AHR)

FERGUSON, Suzanne
C/- Tenement Manager GPO Box 5262 Brisbane QLD 4001

Holders

	Holder name	Share %	Status	Held from	Held to	Authorised holder
*	ARROW CSG (AUSTRALIA) PTY LTD C/- Tenement Manager GPO Box 5262 Brisbane QLD 4001	30.000000000000	Current	05/10/2010		No
*	ARROW (TIPTON TWO) PTY LTD GPO Box 5262 Brisbane QLD 4001	28.000000000000	Current	09/08/2010		No
*	ARROW (TIPTON) PTY. LTD. GPO Box 5262 Brisbane QLD 4001	42.000000000000	Current	02/04/2009		Yes
	SHELL CSG (AUSTRALIA) PTY LTD	30.000000000000	Former	09/08/2010	05/10/2010	
	ARROW (TIPTON TWO) PTY LTD	40.000000000000	Former	09/09/2009	09/08/2010	
	SHELL CSG (AUSTRALIA) PTY LTD	18.000000000000	Former	02/04/2009	09/08/2010	
	ARROW (TIPTON) PTY. LTD.	60.000000000000	Former	22/01/2008	02/04/2009	
	BEACH PETROLEUM (SURAT) PTY LTD	40.000000000000	Former	22/01/2008	09/09/2009	

Tenancy type: Tenancy in Common

PL 260 Resource authority public report

Queensland Government

Area

Location:	View Map
Mining district:	Dalby
Local authority:	Western Downs Regional Council
Area:	72 Sub-blocks
Exclusions:	
Marked out date:	

Sub-blocks

BIM	Block	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Brisbane	2678	A					F	G				L	M	N			Q	R	S	T		V	W	X	Y	Z
Brisbane	2750	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Brisbane	2751						F																			
Brisbane	2822	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	
Brisbane	2894	A	B	C	D		F	G	H																	

Background land

No data available

Survey plans

Plan No.	Description	Date received	Locality	Volume	Folio
MP43668	PWL - LONGSWAMP 7 & 8	05/11/2013	RANGES BRIDGE		
MP38962	PWL - LONGSWAMP 25, LONGSWAMP 26	18/01/2018	SPRINGVALE		
MP45800	PWL - LONGSWAMP 27	06/02/2018	Nandi		
MP45805	PWL OF LONGSWAMP 32, LONGSWAMP 33, LONGSWAMP 34, LONGSWAMP 35	20/04/2018	DUCKLO		
MP45806	PWL OF LONGSWAMP 28, LONGSWAMP 29, LONGSWAMP 30, LONGSWAMP 30R & LONGSWAMP 31	20/04/2018	NANDI & DUCKLO		

Relinquishment details

No data available

Sub-blocks retained

No data available

Term history

Term	Date notice issued	Date lodged	Date approved	Date commenced	Date term ends	Term	Act granted under
2011 - 2041		08/01/2008	16/03/2011	01/04/2011	31/03/2041	30 years	Petroleum and Gas (Production and Safety) Act 2004

PL 260 Resource authority public report

Queensland Government

Native title

Outcome	Process
Land subject to Native Title is excluded from the permit area	Predominantly Exclusive Land

Purpose and minerals

Purpose
Gas, OIL

Minerals
Coal Seam Gas

Related permits

Pre-requisite permits:	ATP683 (CONSENT GIVEN) P&G ACT

Financial

Rent details

Area units:	216
Rate/unit area:	$159.30

Activities

Activity name	Activity / Dealing No	Status	Date received	Expected completion	Date completed	Remarks
Add excluded land	213527	Approved	19/07/2017		23/08/2017	Approval given to add excluded land namely land that may be subject to native title.
Later Development Plan Due		Requested	12/06/2014	31/03/2016		LDP DUE 31/03/2016.
Change of holder name	1019581	Closed	05/10/2010	05/10/2010	05/10/2010	Changed name from SHELL CSG (AUSTRALIA) PTY LTD to ARROW CSG (AUSTRALIA) PTY LTD
Change of holder name	1016426	Closed	09/09/2009	09/09/2009	09/09/2009	Changed name from BEACH PETROLEUM (SURAT) PTY LTD to ARROW (TIPTON TWO) PTY LTD

Permit

Environmental Protection Act 1994

Environmental authority EPPG00972513

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

Environmental authority number: EPPG00972513

Environmental authority takes effect on 19 August 2021

Environmental authority holder(s)

Names(s)	Registered address
ARROW ENERGY PTY LTD	Level 39 111 Eagle Street BRISBANE QLD 4001
AUSTRALIAN CBM PTY LTD	Level 39 111 Eagle Street BRISBANE CITY QLD 4000 Australia
ARROW (TIPTON) PTY. LTD.	Level 39 111 Eagle Street BRISBANE CITY QLD 4000 Australia
ARROW (DAANDINE) PTY. LTD.	Level 39 111 Eagle St BRISBANE CITY QLD 4000 Australia
ARROW CSG (AUSTRALIA) PTY LTD	Level 39 111 Eagle Street BRISBANE CITY QLD 4000 Australia
ARROW (TIPTON TWO) PTY LTD	Level 39 111 Eagle Street BRISBANE CITY QLD 4000 Australia
CLEANCO QUEENSLAND LIMITED	Comalco Place Level 32 12 Creek St BRISBANE CITY QLD 4000 Australia

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Resource Activity, Ancillary 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	PL252

ABN 46 640 294 485

Queensland Government

Resource Activity, Ancillary 14 - Electricity Generation, 1: Generating electricity by using gas at a rated capacity of 10MW electrical or more	PL238, PL258, PL252, PL194, PL198, PL230, PL260
Resource Activity, Ancillary 15 - Fuel burning, Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour	PL238, PL258, PL252, PL194, PL198, PL230, PL260
Resource Activity, Ancillary 56 - Regulated Waste Storage Receiving and storing regulated waste	PL230
Resource Activity, Ancillary 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.	PL198, PL230, PL260, PL238, PL258
Resource Activity, Ancillary 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 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	PL238, PL258, PL252, PL194, PL198, PL230, PL260
Resource Activity, Ancillary 64 - Water treatment, 2: Desalinating, in a day, the following quantity of water, allowing the release of waste to waters other than seawater, (b) more than 5ML	PL238, PL258, PL252, PL194, PL198, PL230, PL260
Resource Activity, Schedule 3, 06: A petroleum activity carried out on a site containing a high hazard dam or a significant hazard dam	PL238, PL258, PL252, PL194, PL198, PL230, PL260
Resource Activity, Schedule 3, 07: A petroleum activity involving injection of a wastefluid into a natural underground reservoir or aquifer	PL238, PL258, PL252, PL194, PL198, PL230, PL260
Resource Activity, Schedule 3, 08: A petroleum or GHG storage activity, other than items 1 to 7, that includes an activity from Schedule 2 with an AES	PL238, PL258, PL252, PL194, PL198, PL230, PL260

Additional information for applicants

Environmentally relevant activities

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

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

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

Contaminated land

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

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

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

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

Take effect

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

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

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

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

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Sustainable Planning Act 2009* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

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

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

Clancy Mackaway
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Date issued: 19 August 2021

Enquiries:
Energy and Extractive Resources
Department of Environment and Science
Phone: 3330 5715
Email: EnergyandExtractive@des.qld.gov.au

Appendix 2: Title Searches

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**16558189**	**Search Date:**	17/09/2021 16:45
Date Title Created:	10/01/1984	**Request No:**	38600414
Previous Title:	14004244, 14004245		

ESTATE AND LAND

Estate in Fee Simple

LOT 1 CROWN PLAN DY787
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703441498 08/07/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 703441498

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11805224 (POR 1V)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**18087248**	**Search Date:**	16/09/2021 07:47
Date Title Created:	18/01/1991	**Request No:**	38572524
Previous Title:	15138129, 15138130		

ESTATE AND LAND

Estate in Fee Simple

LOT 1 CROWN PLAN DY931
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703441530 08/07/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 703441530

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11881050 (POR 5V)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current State Tenure Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**17695007**	**Search Date:**	16/09/2021 07:47
Date State Tenure Created:	21/10/1995	**Request No:**	38572523
Creating Dealing:			

DESCRIPTION OF LAND

Tenure Reference: RL 16/2451

Lease Type: NO TERM

LOT 1 CROWN PLAN RL2451
Local Government: WESTERN DOWNS

Area: 13.300000 Ha. (ABOUT)

Area Description:
The road separating subdivision 1 of portion 5V from subdivisions 3 and 4 of portion 263.

No Forestry Entitlement Area

Purpose for which granted:
NO PURPOSE DEFINED

REGISTERED LICENSEE

Dealing No: 703441530 08/07/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
FOR WARAKIRRI AGRICULTURAL LAND TRUST II

COMMENCEMENT DATE

Commencement Date: 16/05/1955

CONDITIONS

NIL

ENDORSEMENTS

NIL

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Corrections have occurred - Refer to Historical Search

** End of Current State Tenure Search **

Information provided under section 34 Land Title Act (1994) or section 281 Land Act (1994)

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**15605217**	**Search Date:**	16/09/2021 07:47
Date Title Created:	24/01/1977	**Request No:**	38572529
Previous Title:	12793043, 14237145, 14239015		

ESTATE AND LAND

Estate in Fee Simple

LOT 1 REGISTERED PLAN 154777
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703441470 08/07/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 703441470

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11355018 (POR 63)
Deed of Grant No. 11901015 (POR 3V)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**50272040**	**Search Date:**	16/09/2021 07:47
Date Title Created:	30/06/1999	**Request No:**	38572530
Previous Title:	14017190, 14017191		

ESTATE AND LAND

Estate in Fee Simple

LOT 2 CROWN PLAN DY787
Local Government: WESTERN DOWNS

LOT 2 REGISTERED PLAN 106958
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703783902 24/12/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 509 370 TRUSTEE
UNDER INSTRUMENT 703783902

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 13745006 (POR 2V)
Deed of Grant No. 13745007 (POR 59)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**14584120**	**Search Date:**	16/09/2021 07:49
Date Title Created:	10/05/1971	**Request No:**	38572535
Previous Title:	14058218, 14058220, 14058222		

ESTATE AND LAND

Estate in Fee Simple

LOT 2 REGISTERED PLAN 85916
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 718742192 11/05/2018

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 718742192

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 12050012 (POR 13)

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**15689193**	**Search Date:**	16/09/2021 07:47
Date Title Created:	16/09/1977	**Request No:**	38572528
Previous Title:	14057123, 14057124, 14057125		

ESTATE AND LAND

Estate in Fee Simple

LOT 2 REGISTERED PLAN 99387
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 705330929 16/01/2002

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 705330929

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 12042048 (POR 1V)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**50272040**	**Search Date:**	16/09/2021 07:49
Date Title Created:	30/06/1999	**Request No:**	38572534
Previous Title:	14017190, 14017191		

ESTATE AND LAND

Estate in Fee Simple

LOT 2 CROWN PLAN DY787
Local Government: WESTERN DOWNS

LOT 2 REGISTERED PLAN 106958
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703783902 24/12/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 509 370 TRUSTEE
UNDER INSTRUMENT 703783902

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 13745006 (POR 2V)
Deed of Grant No. 13745007 (POR 59)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**50634412**	**Search Date:**	16/09/2021 07:47
Date Title Created:	03/11/2006	**Request No:**	38572522
Previous Title:	40052662		

ESTATE AND LAND

Estate in Fee Simple

LOT 12 SURVEY PLAN 193328
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 718742192 11/05/2018

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 718742192

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11205098 (POR 12)

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**13047163**	**Search Date:**	16/09/2021 07:47
Date Title Created:	08/08/1957	**Request No:**	38572525
Previous Title:	11192119		

ESTATE AND LAND

Estate in Fee Simple

LOT 36 CROWN PLAN DY45
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 718384463 08/11/2017

WARRAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 718384463

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11192119 (POR 36)

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**50634411**	**Search Date:**	16/09/2021 07:47
Date Title Created:	03/11/2006	**Request No:**	38572521
Previous Title:	40052661		

ESTATE AND LAND

Estate in Fee Simple

LOT 57 SURVEY PLAN 193329
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 718384463 08/11/2017

WARRAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 718384463

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11366020 (POR 17)

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**13883004**	**Search Date:**	16/09/2021 07:47
Date Title Created:	18/05/1966	**Request No:**	38572527
Creating Dealing:			

ESTATE AND LAND

Estate in Fee Simple

LOT 60 CROWN PLAN DY802
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703441470 08/07/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 703441470

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11167081 (POR 60)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**16517101**	**Search Date:**	16/09/2021 07:47
Date Title Created:	08/09/1983	**Request No:**	38572526
Previous Title:	11748129		

ESTATE AND LAND

Estate in Fee Simple

LOT 70 CROWN PLAN DY138
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 703394503 15/06/1999

WARAKIRRI ASSET MANAGEMENT PTY LTD A.C.N. 057 529 370 TRUSTEE
UNDER INSTRUMENT 703394503

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 11748129 (POR 3 A OVER V)

2. MORTGAGE No 715264553 19/08/2013 at 15:36
AUSTRALIA AND NEW ZEALAND BANKING GROUP LIMITED A.C.N. 005 357 522

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Appendix 3: Land Parcel and Property Details

Property 1: **57SP193329, 36DY45, 2RP85916 and 12SP193328**

Property Details

- This property is designated as cropping (Class 3.3).
- This property is presently utilised for dryland and irrigated crops.
- Proposed infrastructure is to be located on parcels 57SP193329 and 36DY45. No infrastructure is proposed to be located on the parcels 12SP193328 and 2RP85916.
- There is one proposed well pad on this property, and it is located in a corner of the paddock on Lot 57SP193329.
- Approximately half of the gathering proposed for this property is located on the boundary of the paddock while the remaining gathering traverses the middle of the paddock across 57SP193329.
- The majority of access track proposed for this property is located on the western boundary of the paddock while a section of track traverses the middle of the paddock across 36DY45.
- Two deviated well trajectories enter 57SP193329 and one of those also enters 12SP193328 from a neighbouring property at a subterranean depth of at least 200 m.
- Surrounding land use is generally cropping.

Image of Lot 57SP193329

Image of Lot 57SP193329

Image of Lot 36DY45

Image of Lot 36DY45

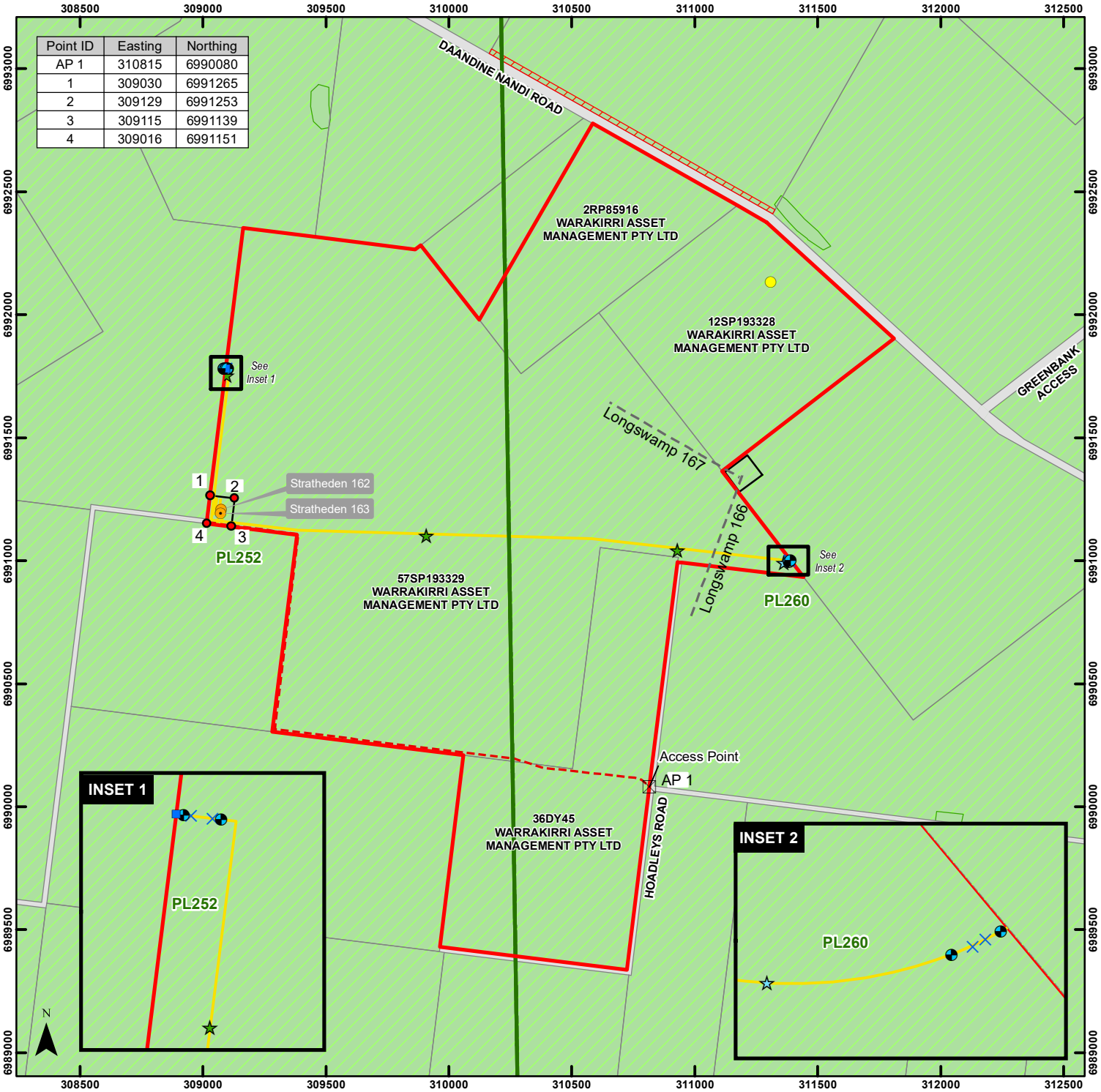
Field Layout Summary

- The locations of above ground infrastructure is indicative only at this stage and once an engineering review has been undertaken they will be re-located to more strategic locations to minimise impacts to farming activities.
- Arrow will utilise existing landholder access tracks to infrastructure and will upgrade existing tracks as necessary.
- The proposed gathering and access tracks traversing the boundaries are located to avoid and minimise impacts to farming activities as much as possible.
- Gathering is proposed to be located across the paddock on 57SP193329 to create a connection with wells located to the East of this property
- The access track proposed to be located across 36DY45 will be constructed to enable the use of the existing access point off Hoadley's Road. Using this access can help to avoid houses and small blocks

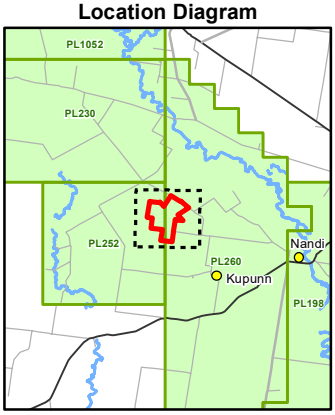
Infrastructure summary

- 1 x 2-well multi-well pad – 1.15 ha (during construction) – reducing to 175 m ² (during operation)
- Pipeline Right of Way – 9 ha (during construction)
- Access track – 2.85 ha (operational footprint)
- 3 x high point vents – 0.0108 ha (operational footprint)
- 1 x low point drain – 0.0036 ha (operational footprint)
- 4 x valves – 0.00008 ha (operational footprint)
- 2 x subterranean deviated well trajectories

CCA Map



Location Diagram



Tenement: PL252, PL260

LotPlan: 57SP193329, 12SP193328, 36PDY45, 2RP85916

Well/s: Stratheden - SE162, SE163

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 200 400 600 800

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:22,500

Legend

- Arrow Well (Proposed)
- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Tie-in
- Access Point
- LPD (Proposed)
- HPV (Proposed)
- Proposed RoW – 30m wide
- Access Track
- Well Area
- Subject Property
- EWA
- Property Boundary
- Strategic Cropping Area
- Priority Agricultural Area
- PL (Arrow)

Rev	Date	Revision Description	Org	Chk	Eng	QA	Appr
2	06/09/2021	SCA & PAA added to map	AW	BJ	_	_	GG
1	29/07/2021	Issued for Use	CO	BJ	_	_	GG
0	26/07/2021	Issued for review	AW	BJ	_	_	GG

Data Source: Arrow Energy Limited, QSpatial

arrow energy go further

Status: IFU
Issued To: G.Gunther
Author: awolhuter

Surat Basin

(2)

Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_WARAKIRRI_57SP193329_RITM0326633_2.mxd

Print Date: 7/09/2021

Property 2: **1DY931, 70DY138, 1RP154777, 1DY787, 60DY802, 2RP106958, 2RP99387, 2DY787 and 1RL2451**

Property Details

- This property is designated as cropping (Class 3.3), except for Lot 1RL2451 which is designated as grazing / native vegetation.
- This property is presently utilised for dryland and irrigated crops, except for Lot 1RL2451 which is used as a road.
- Proposed infrastructure is to be located on parcels 1DY931, 70DY138, 1RP154777, 1DY787, 60DY802, 2RP106958 and 1RL2451. No infrastructure is proposed to be located on the parcels 2RP99387 and 2DY787.
- There are four well pads proposed to be located on this property.
- Of these, there are two single well pads proposed to be located on 1DY931. Both of these well pads are proposed to be located on the boundary of this lot. Gathering and access tracks are also proposed to be located along the boundary of this lot along with the valves and low point drains proposed for this lot.
- There is a proposed 4-well multi-well pad to be located on 1DY787 in the south eastern corner of the paddock next to the Moonie Highway. There is also gathering proposed to be located along the southern boundary of this lot along with a valve and future service connection and an access track proposed to run parallel to the Moonie Highway.
- There is a 3-well multi-well pad proposed to be located on 1RP154777 towards the middle of the paddock. An access track will traverse half the length of the paddock with gathering traversing the length of the paddock and then a section of the southern boundary. The low point drains and high point vents proposed for this lot are located on the boundaries or within the RoW.
- Gathering is proposed to be co-located with an existing access track on 70DY138 with associated infrastructure located within the RoW also.
- Gathering is proposed to be located along the northern boundary of 60DY802 and a section of gathering is proposed to be located along the western boundary of 2RP106958.
- There is a proposed future gathering crossing location on the road 1RL2451.
- There are 10 deviated well trajectories proposed to enter this property from neighbouring lots at a subterranean depth of at least 200 m.
- Surrounding land use is generally cropping.

Image of Lot 1DY931

Image of Lot 1DY931

Image of Lot 70DY138

Image of Lot 70DY138

Image of Lot 1RP15477

Image of Lot 1RP15477

Image of Lot 1DY787

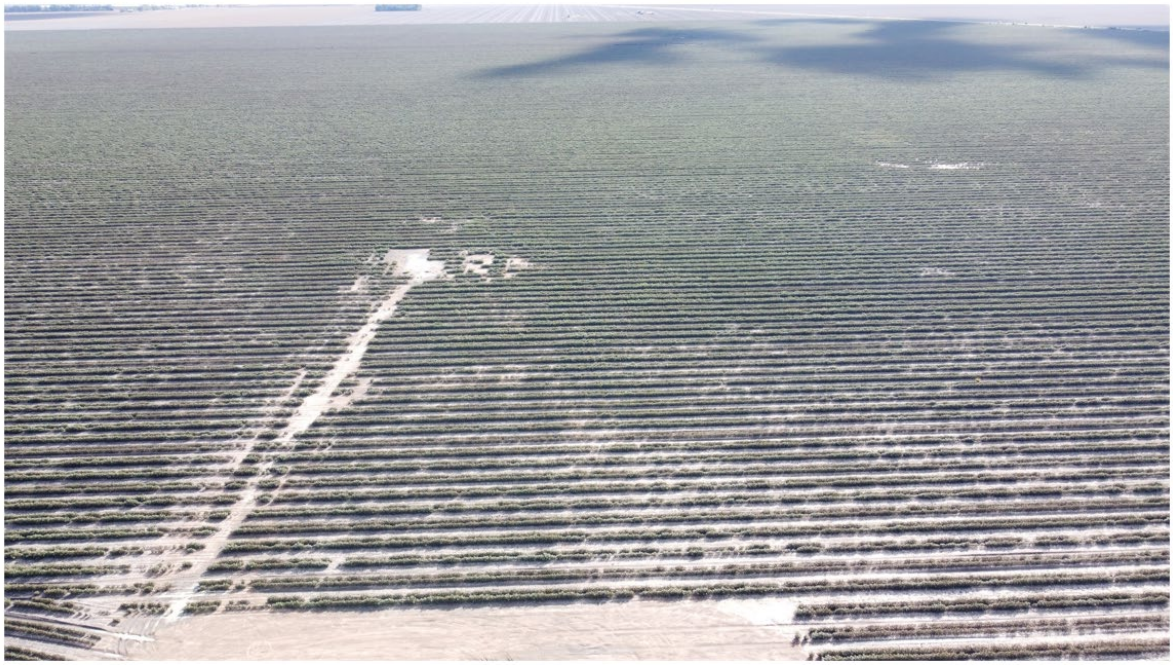


Image of Lot 1DY787

Image of Lot 60DY802

Image of Lot 2RP106958

Image of Lot 2RP106958

Image of Lot 1RL2451 (the tree line in the back of photo)

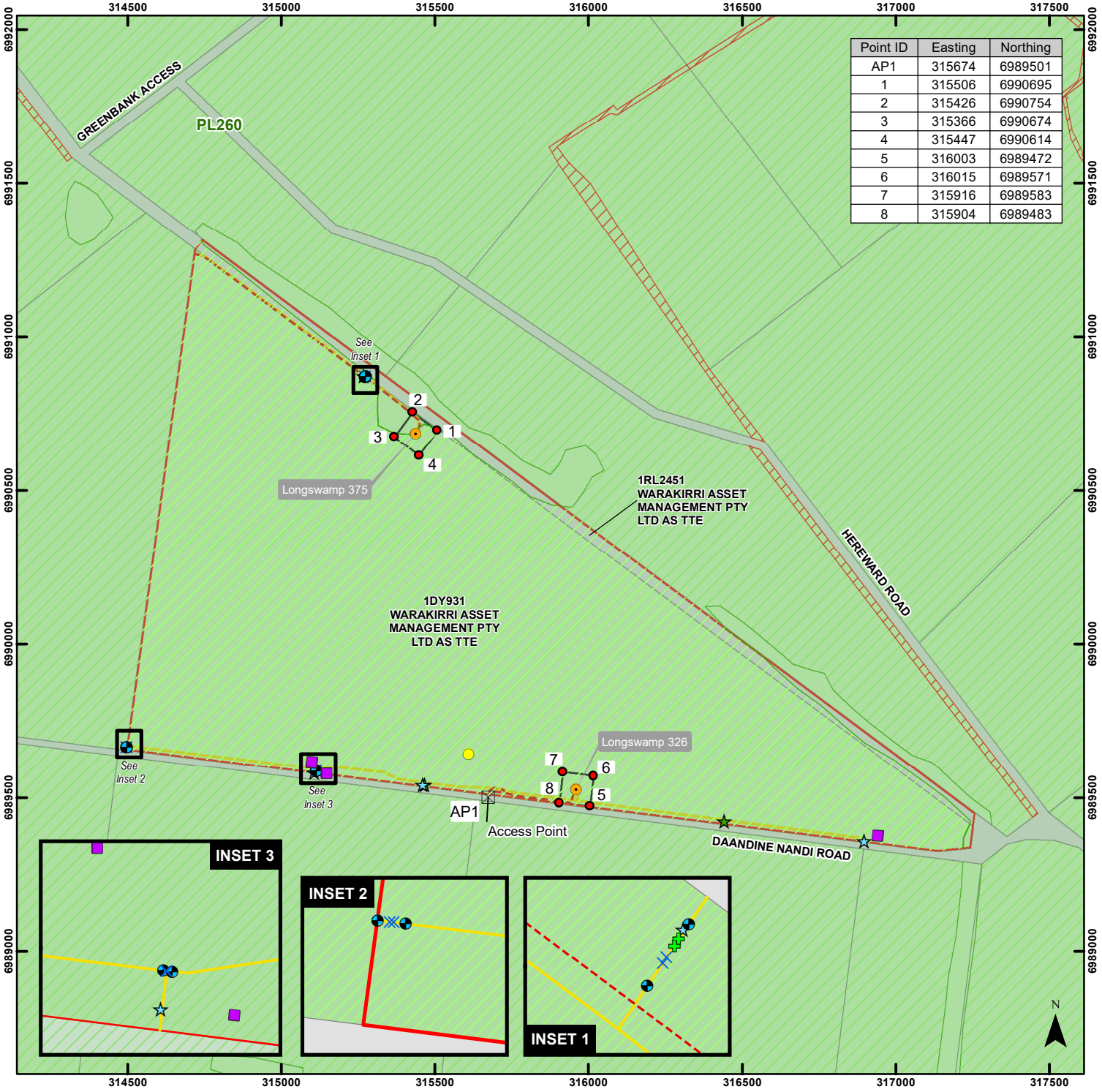
Field Layout Summary

- The locations of above ground infrastructure is indicative only at this stage and once an engineering review has been undertaken infrastructure will be re-located to more strategic locations to minimise impacts to farming activities.
- Arrow will utilise existing landholder access tracks to access infrastructure and will upgrade existing tracks as necessary.
- The section of gathering proposed to be located on 2RP106958 is adjacent the road to minimise impacts. This pipeline will be constructed as close to the road as possible.
- The proposed infrastructure on 1DY931 is to be located along property boundaries and adjacent existing roads and access tracks to avoid and/or minimise impacts to farming activities.
- The proposed infrastructure on 1DY787 is adjacent the Moonie Highway. The proposed access track runs adjacent the highway and the well pad is positioned in the corner to minimise impacts. The proposed gathering location has been selected because it is the shortest and most direct route.
- The proposed infrastructure on 60DY802 is directly adjacent the northern boundary of the property to minimise impacts to farming activities.
- The proposed well pad on 1RP154777 has been located next to a shed in the centre of the property to utilise an existing disturbed area and in a location with an existing access point. The proposed access track has been selected to utilise existing access and the proposed gathering is situated along this existing access. The selection of the location for this well pad has allowed Arrow to exclude less accessible areas of the property and also allows Arrow to minimise impacts to farming activities as much as practicable.
- The proposed gathering on 70DY138 is directly adjacent Kupunn Road on an existing access track located on the property boundary to minimise impacts to farming activities.

Infrastructure summary

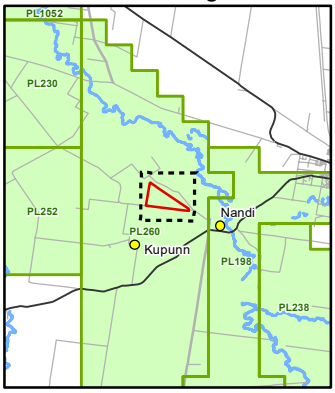
- 2 x single well pads – 2 ha (during construction) - reducing to 240 m² (120 m² each) (during operation)
- 1 x 3-well multi-well pad – 1.3 ha (during construction) - reducing to 230 m² (during operation)
- 1 x 4-well multi-well pad – 1.45 ha (during construction) - reducing to 285 m² (during operation)
- Pipeline Right of Way – 30 ha (during construction)
- Access track – 1 ha (operational footprint)
- 11 x high point vents – 0.032 ha (operational footprint)
- 10 x low point drains – 0.036 ha (operational footprint)
- 16 x valves – 0.00032 ha (operational footprint)
- 10 x subterranean deviated well trajectories
- Up to 7 x Extra Work Areas - 0.25 ha (during construction)

CCA Map



Point ID	Easting	Northing
AP1	315674	6989501
1	315506	6990695
2	315426	6990754
3	315366	6990674
4	315447	6990614
5	316003	6989472
6	316015	6989571
7	315916	6989583
8	315904	6989483

Location Diagram



Tenement: PL260

LotPlan: 1RL2451, 1DY931

Well/s: Longswamp 326, Longswamp 375

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 160 320 480 640

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:18,000

Legend

- Arrow Well (Proposed)
- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Future Connection Branch
- Access Point
- LPD (Proposed)
- HPV (Proposed)
- Proposed RoW – 30m wide
- Access Track
- Well Area
- Subject Property
- EWA
- Property Boundary
- PL (Arrow)
- Road

Rev	Date	Revision Description	Dsg	Chk	Eng	QA	Appr
3	06/09/2021	SCA & PAA added to map	AW	AH	_	_	AH
2	03/08/2021	Issued for Use	CO	BJ	_	_	GG
1	29/07/2021	Issued for Use - Infrastructure Update	CO	BJ	_	_	GG
0	26/07/2021	Issued for review	JL	BJ	_	_	GG

arrow energy go further

Status: IFU
Issued To: A Hall
Author: awolhuter

Surat Basin

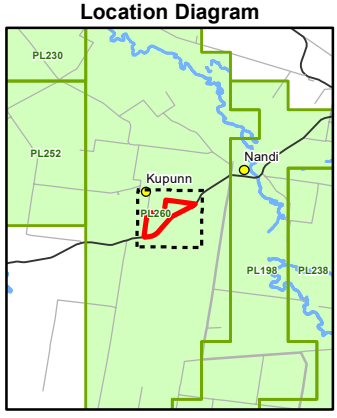
(3)

Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_Warakirri_1RL2451_1DY931_RITM0326633_3.mxd

Print Date: 6/09/2021

CCA Map

Location Diagram



Tenement: PL260

LotPlan: 2DY787, 2RP106958

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 150 300 450 600

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:19,000

Legend

- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- LPD (Proposed)
- HPV (Proposed)
- Proposed RoW – 30m wide
- Well Path (Planned)
- Well Area
- Subject Property
- EWA
- Property Boundary
- Priority Agricultural Area
- Strategic Cropping Area
- Road
- PL (Arrow)

Rev	Date	Revision Description	Orig	Chk	Eng	QA	Appr
3	06/09/2021	SCA & PAA added to map	AW	AH	_	_	AH
2	03/08/2021	Issued for Use, Revised EWA	CO	BJ	_	_	GG
1	30/07/2021	Issued for Use, Revised Infrastructure	CO	BJ	_	_	GG
0	26/07/2021	Issued for use	JL	BJ	_	_	GG

arrowenergy go further

Status: IFU
Issued To: A Hall
Author: awolhuter

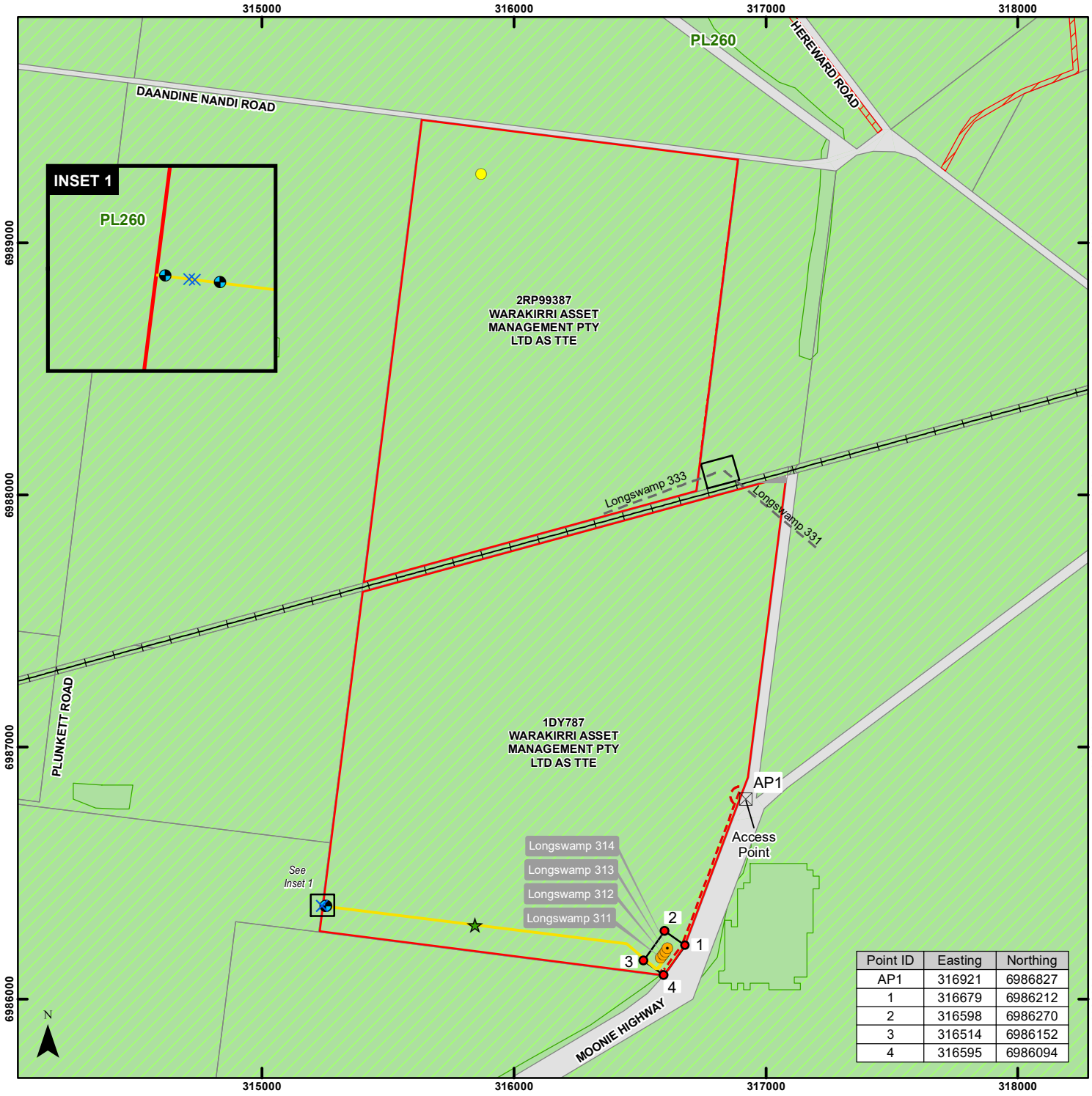
Surat Basin

(3)

Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_WARAKIRRI_2DY787_2RP106958_RITM0326633_3.mxd

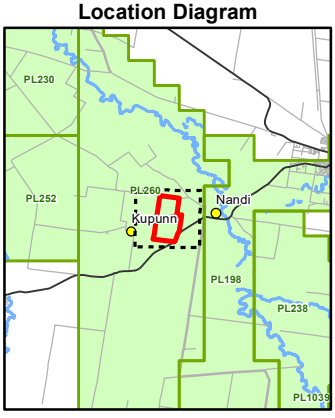
Print Date: 6/09/2021

CCA Map



Point ID	Easting	Northing
AP1	316921	6986827
1	316679	6986212
2	316598	6986270
3	316514	6986152
4	316595	6986094

Location Diagram



Tenement: PL260

LotPlan: 2RP99387, 1DY787

Well/s: Longswamp 311, 312, 313, 314

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 200 400 600 800

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:22,000

Legend

- Arrow Well (Proposed)
- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- HPV (Proposed)
- Proposed RoW – 30m wide
- Access Track
- Well Path (Planned)
- Well Area
- Subject Property
- Property Boundary
- Strategic Cropping Area
- Priority Agricultural Area
- PL (Arrow)

Rev	Date	Revision Description	Dsg	Chk	Eng	QA	Appr
2	06/09/2021	SCA & PAA added to map	AW	AH	_	_	AH
1	30/07/2021	Issued for Use	CO	BJ	_	_	GG
0	26/07/2021	Issued for review	JL	BJ	_	_	GG

Data Source: Arrow Energy Limited, QSpatial

arrow energy go further

Status: IFU
Issued To: A Hall
Author: awolhuter

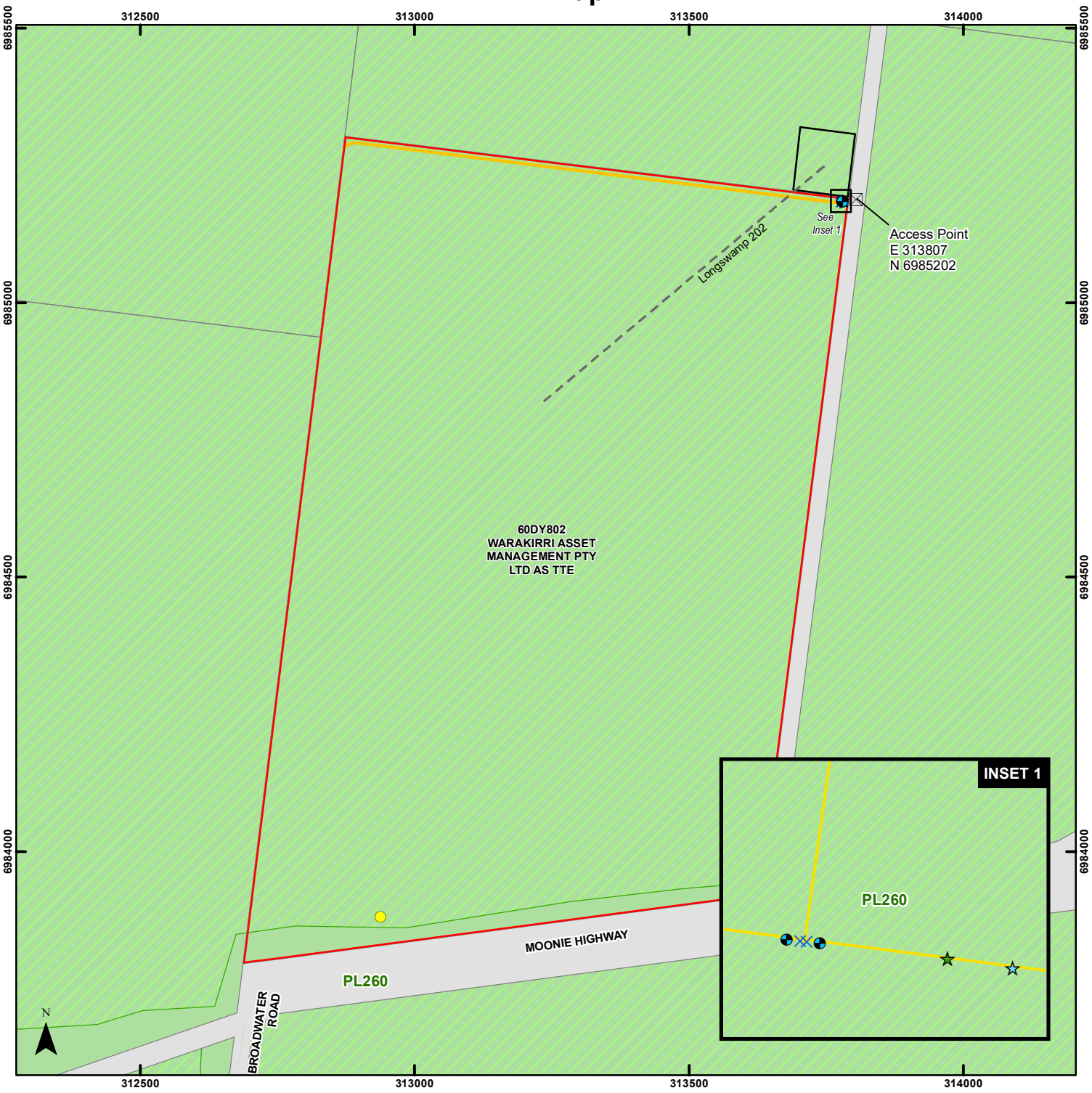
Surat Basin

(2)

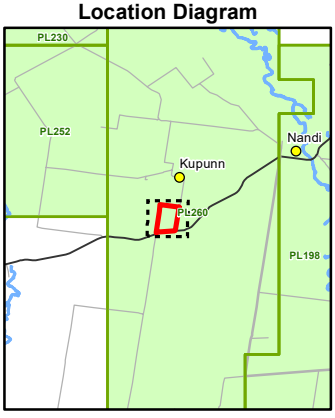
Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_WARAKIRRI_2RP99387_1DY787_RITM0326633_2.mxd

Print Date: 6/09/2021

CCA Map



Location Diagram



Tenement: PL260

LotPlan: 60DY802

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 100 200 300 400

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:10,000

Legend

- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- LPD (Proposed)
- HPV (Proposed)
- Proposed RoW – 30m wide
- Well Path (Planned)
- Well Area
- Subject Property
- Property Boundary
- Strategic Cropping Area
- Priority Agricultural Area
- PL (Arrow)

Rev	Date	Revision Description	Org	Chk	Eng	QA	Appr
2	06/09/2021	Issued for Use	AW	AH	_	_	AH
1	30/07/2021	Issued for Use	CO	BJ	_	_	GG
0	30/07/2021	Issued for use	JL	BJ	_	_	GG

Data Source: Arrow Energy Limited, QSpatial

arrow energy go further

Status: IFU
Issued To: A Hall
Author: awolhuter

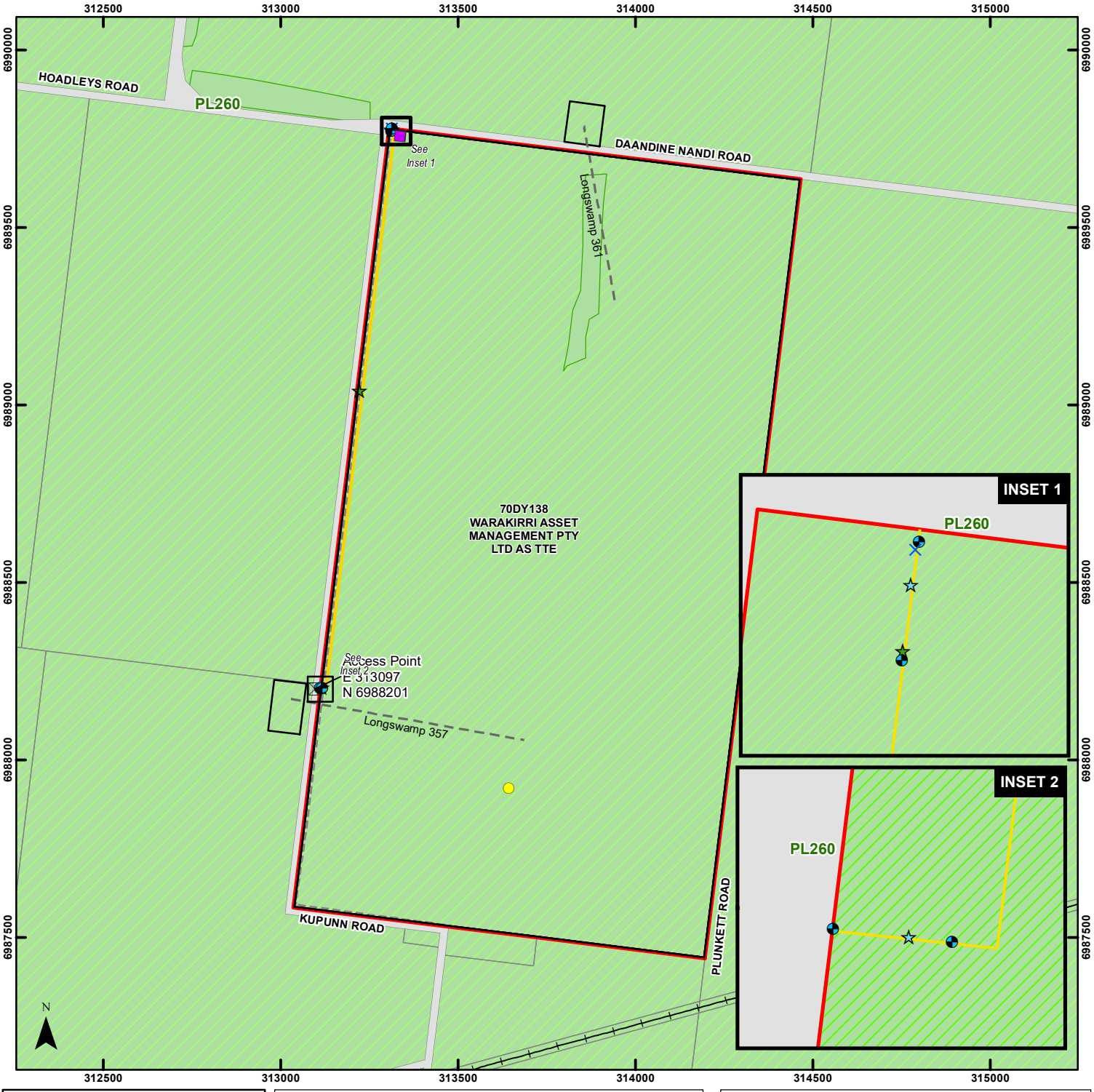
Surat Basin

(2)

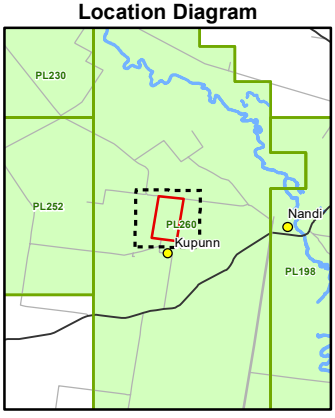
Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_WARAKIRRI_60DY802_RITM0326633_2.mxd

Print Date: 6/09/2021

CCA Map



Location Diagram



Tenement: PL260

LotPlan: 70DY138

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 150 300 450 600

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:15,500

Legend

- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- LPD (Proposed)
- HPV (Proposed)
- Proposed RoW – 30m wide
- Existing Access Tracks
- Well Path (Planned)
- Well Area
- Subject Property
- EWA
- Property Boundary
- Strategic Cropping Area
- Priority Agricultural Area
- Road
- PL (Arrow)

Rev	Date	Revision Description	Org	Chk	Eng	QA	Appr
1	06/09/2021	SCA & PAA added to map	AW	AH	_	_	AH
1	30/07/2021	Issued for Use	CO	BJ	_	_	GG
0	26/07/2021	Issued for use	JL	BJ	_	_	GG

arrow energy go further

Status: IFU
Issued To: A Hall
Author: awolhuter

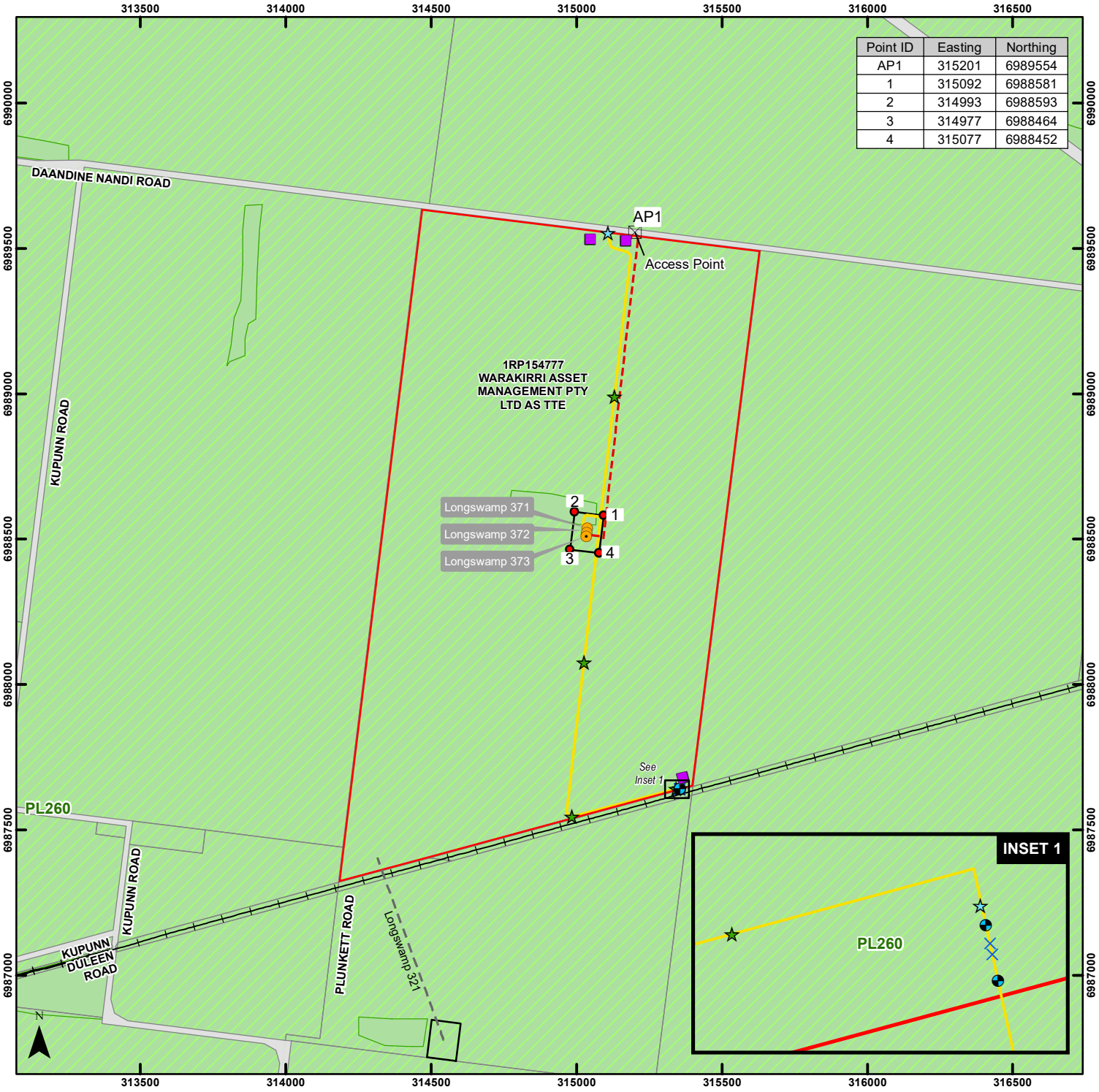
Surat Basin

(2)

Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_WARAKIRRI_70DY138_RITM0326633_2.mxd

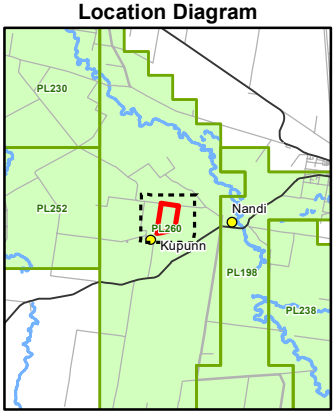
Print Date: 6/09/2021

CCA Map



Point ID	Easting	Northing
AP1	315201	6989554
1	315092	6988581
2	314993	6988593
3	314977	6988464
4	315077	6988452

Location Diagram



Tenement: PL260

LotPlan: 1RP154777

Well/s: Longswamp 371, Longswamp 372, Longswamp 373

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 190 380 570 760

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:19,000

Legend

- Arrow Well (Proposed)
- Future Service Connection
- Isolation Valves
- Access Point
- LPD (Proposed)
- HPV (Proposed)
- Proposed RoW – 30m wide
- Access Track
- Well Path (Planned)
- Well Area
- Subject Property
- EWA
- Property Boundary
- Strategic Cropping Area
- Priority Agricultural Area
- PL (Arrow)

Rev	Date	Revision Description	Org	Chk	Eng	QA	Appr
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1	30/07/2021	Issued for Use	CO	BJ	_	_	GG
0	26/07/2021	Issued for use	JL	BJ	_	_	GG

Data Source: Arrow Energy Limited, QSpatial

arrow energy go further

Status: IFU
Issued To: A Hall
Author: awolhuter

Surat Basin

(2)

Document: V:\Products\Australia\Queensland_Common\Land_Access\Conduct and Compensation Maps\Surat\MXD\SB_CCA_WARAKIRRI_1RP154777_RITM0326633_2.mxd

Print Date: 6/09/2021

Appendix 4: Aerial photography and satellite imagery for years 2011-2020 for 1RL2451

Based on the aerial imagery below, it appears that the area leased for a road is remnant vegetation, it is not mapped as SCA and it can be demonstrated to not be PAA, due to the imagery showing remnant vegetation which demonstrates a lack of cropping over the past 10 years.

1RL2451– Imagery illustrates the proposed area to be disturbed by the wellfield development has consistently been vegetated since 2011 and has not been used for a PALU

<table>
<tr><td>23/01/2011
  </td><td>17/1/2013
  </td></tr>
<tr><td>28/02/16
  </td><td>03/12/2016
  </td></tr>
<tr><td>28/01/2019
  </td><td>02/06/2020
  </td></tr>
</table>

arrow energy
go further

Appendix 5: Queensland Land Use Mapping Program (QLUMP)

Land use in this mapping is classified according to the Australian Land Use and Management Classification (ALUMC) Version 8, 2016, based upon land use within the Condamine natural resource management region as at 2012.

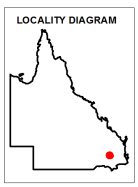
Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets



N

0 680 1360 2040 2720 3400 m

This product is projected into GDA 1994 Queensland Albers

The land use dataset is a product of the Queensland Land use Mapping Program (QLUMP), at a nominal scale of 1:50,000. The layer is a polygon dataset with each feature having attributes describing land use . It presents the most current land use information available in Queensland.

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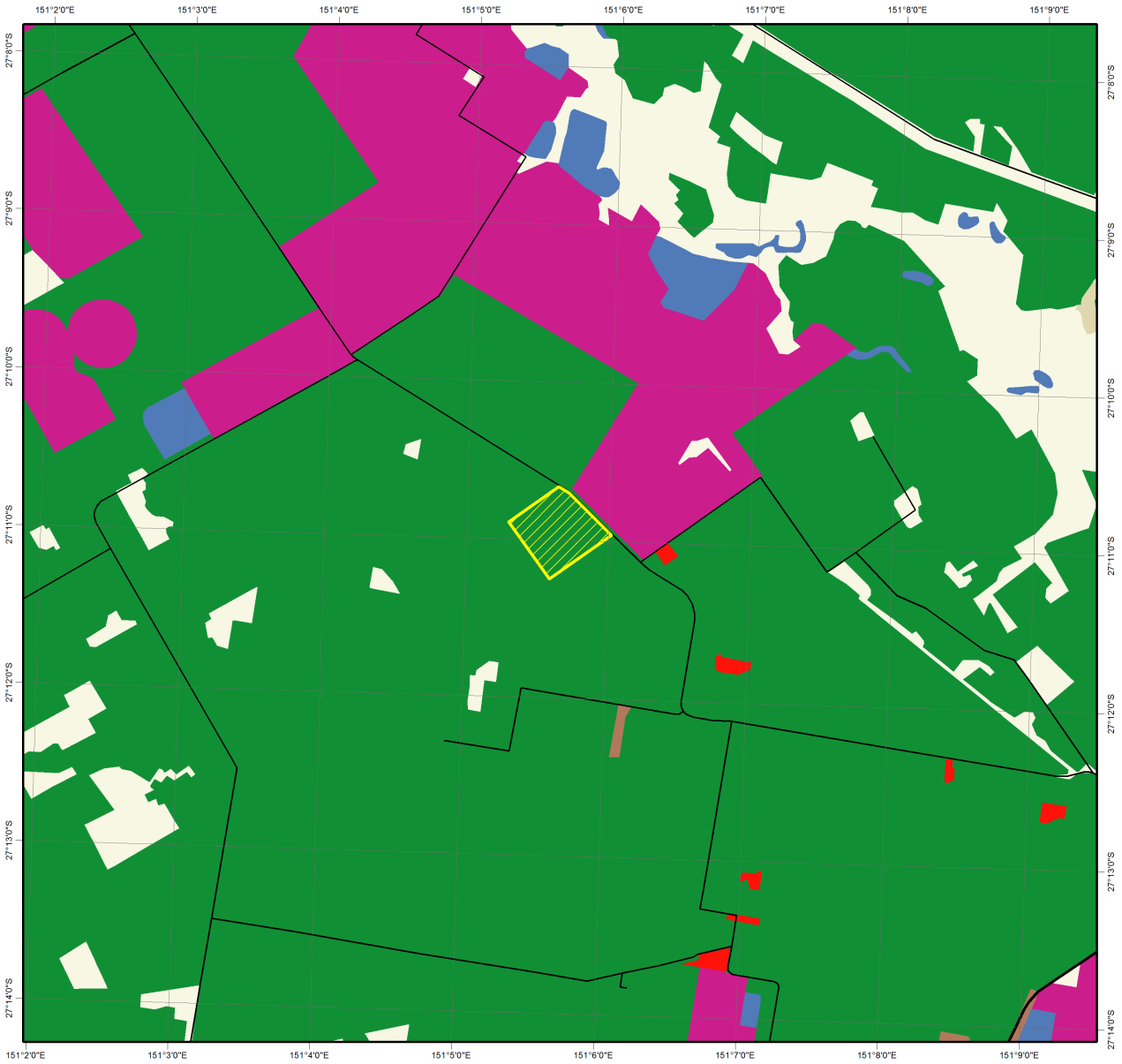


Land Use

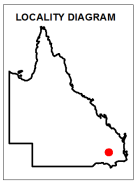
Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Nature conservation
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets

LOCALITY DIAGRAM



N

0 680 1360 2040 2720 3400 m

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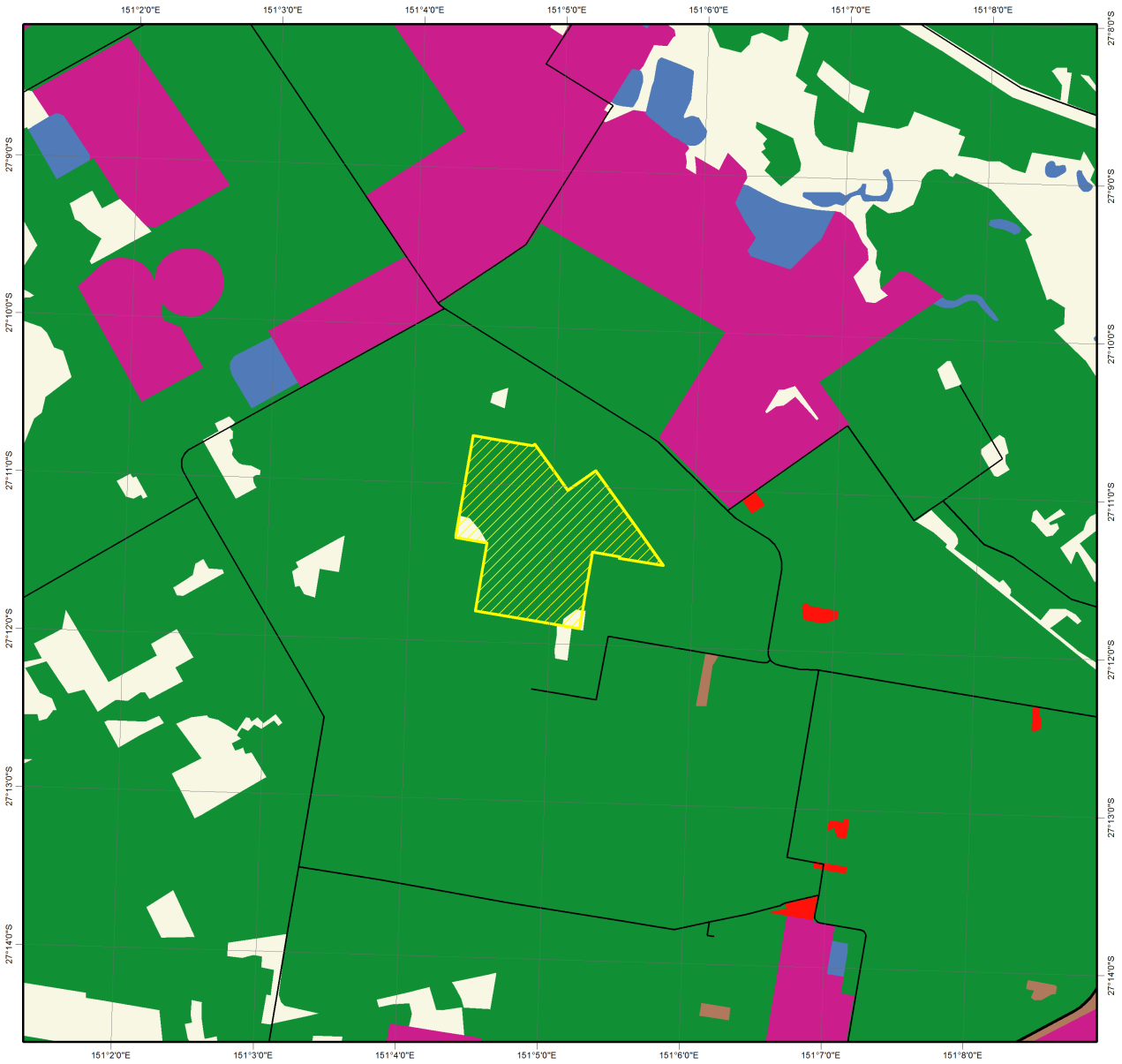


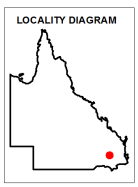
Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets



N

0 680 1360 2040 2720 3400 m

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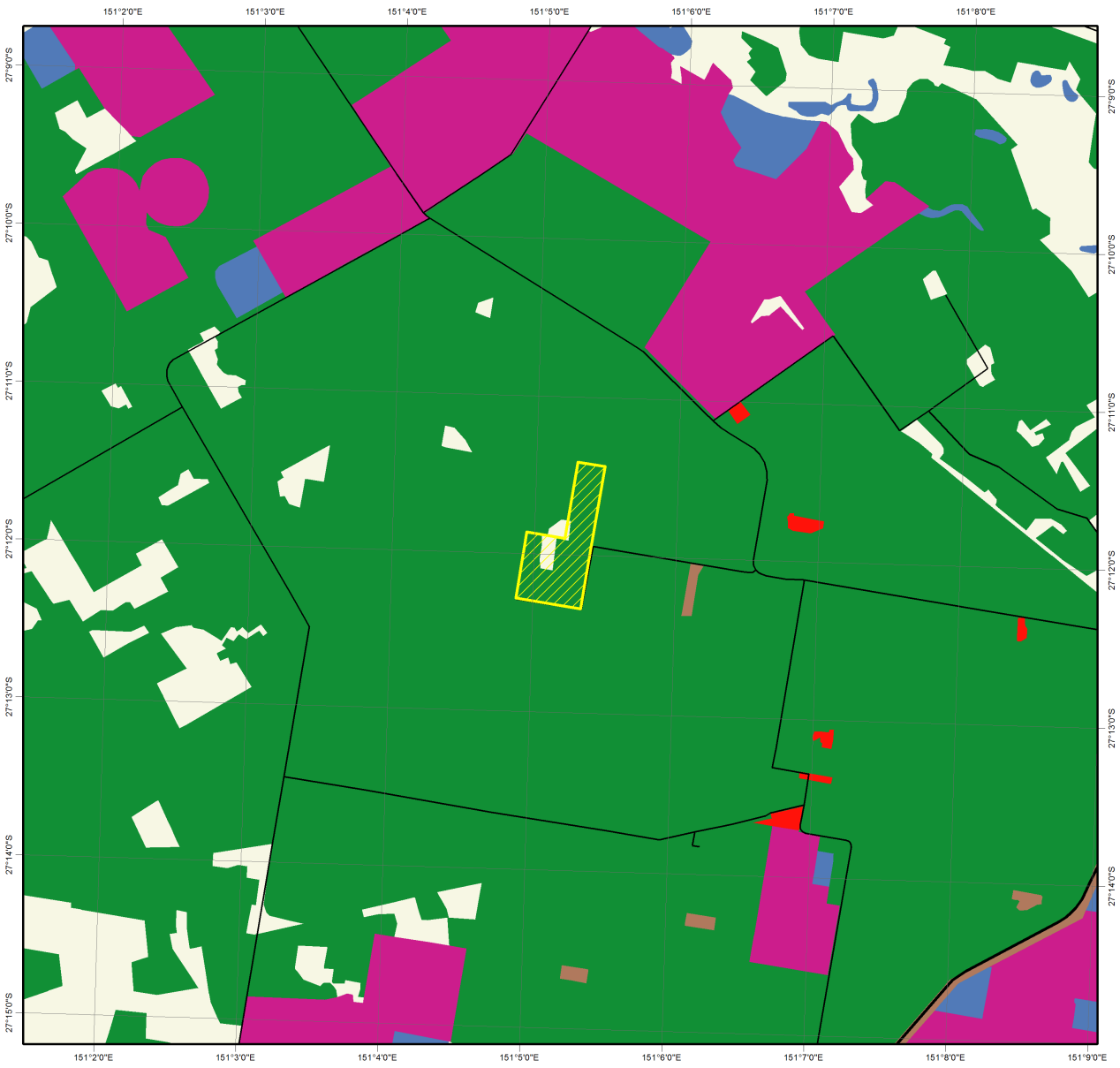


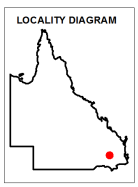
Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets



N

0 680 1360 2040 2720 3400 m

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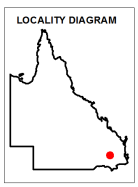
Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Nature conservation
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Intensive animal production
- Residential and farm infrastructure
- Services
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets



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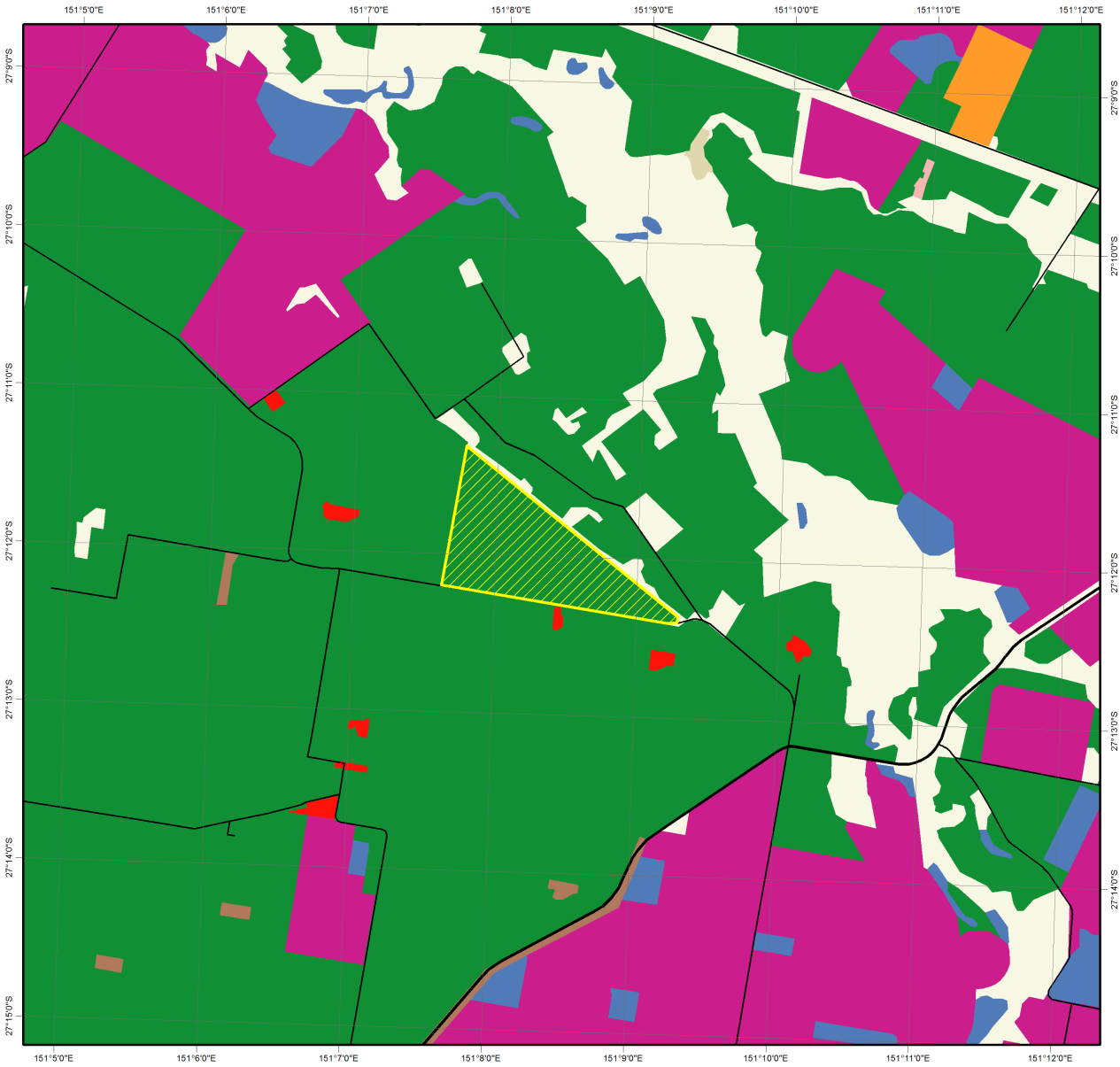

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

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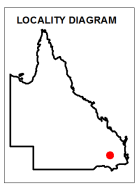

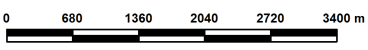

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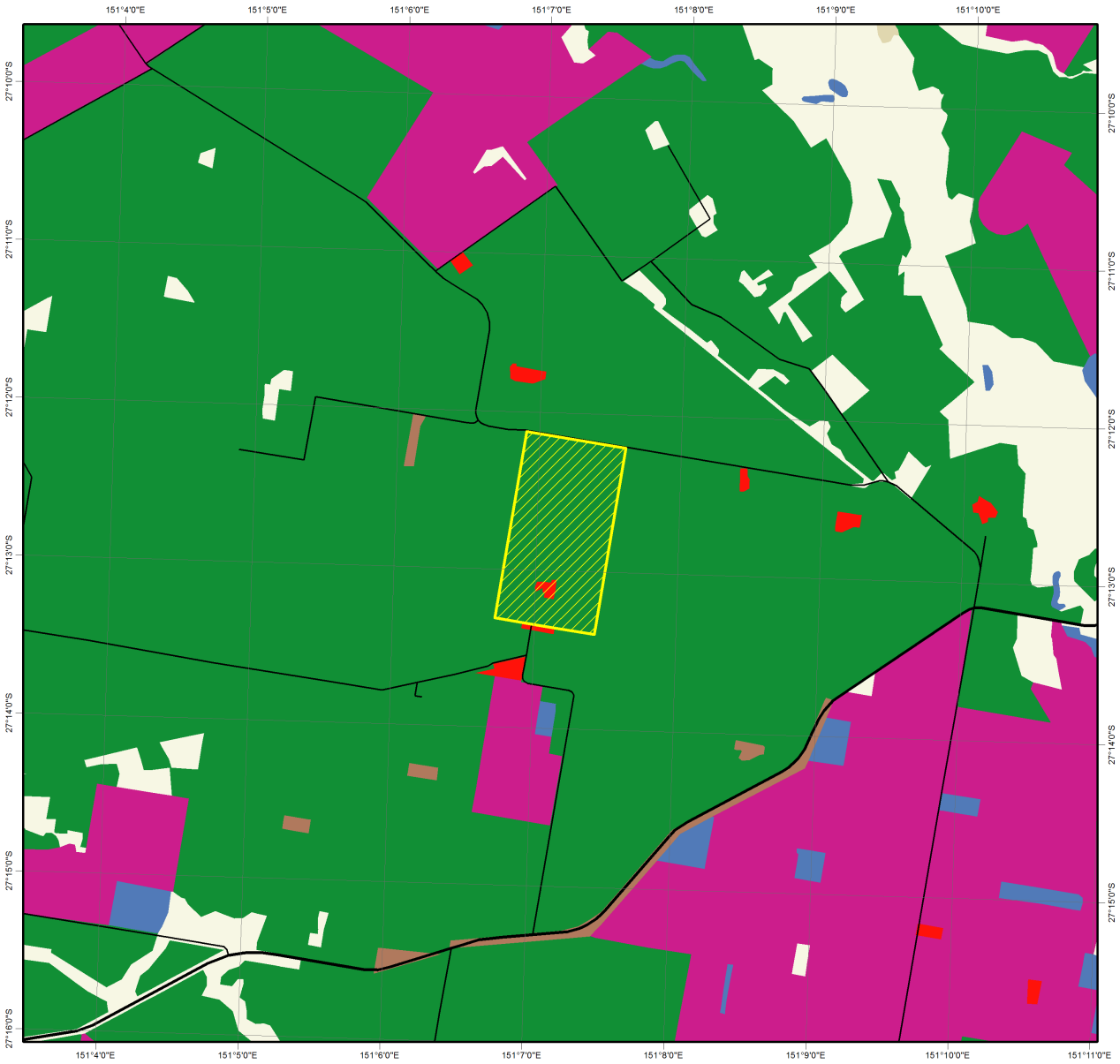


Land Use

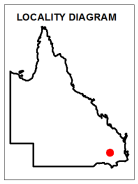
Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Nature conservation
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets

LOCALITY DIAGRAM



N

0 680 1360 2040 2720 3400 m

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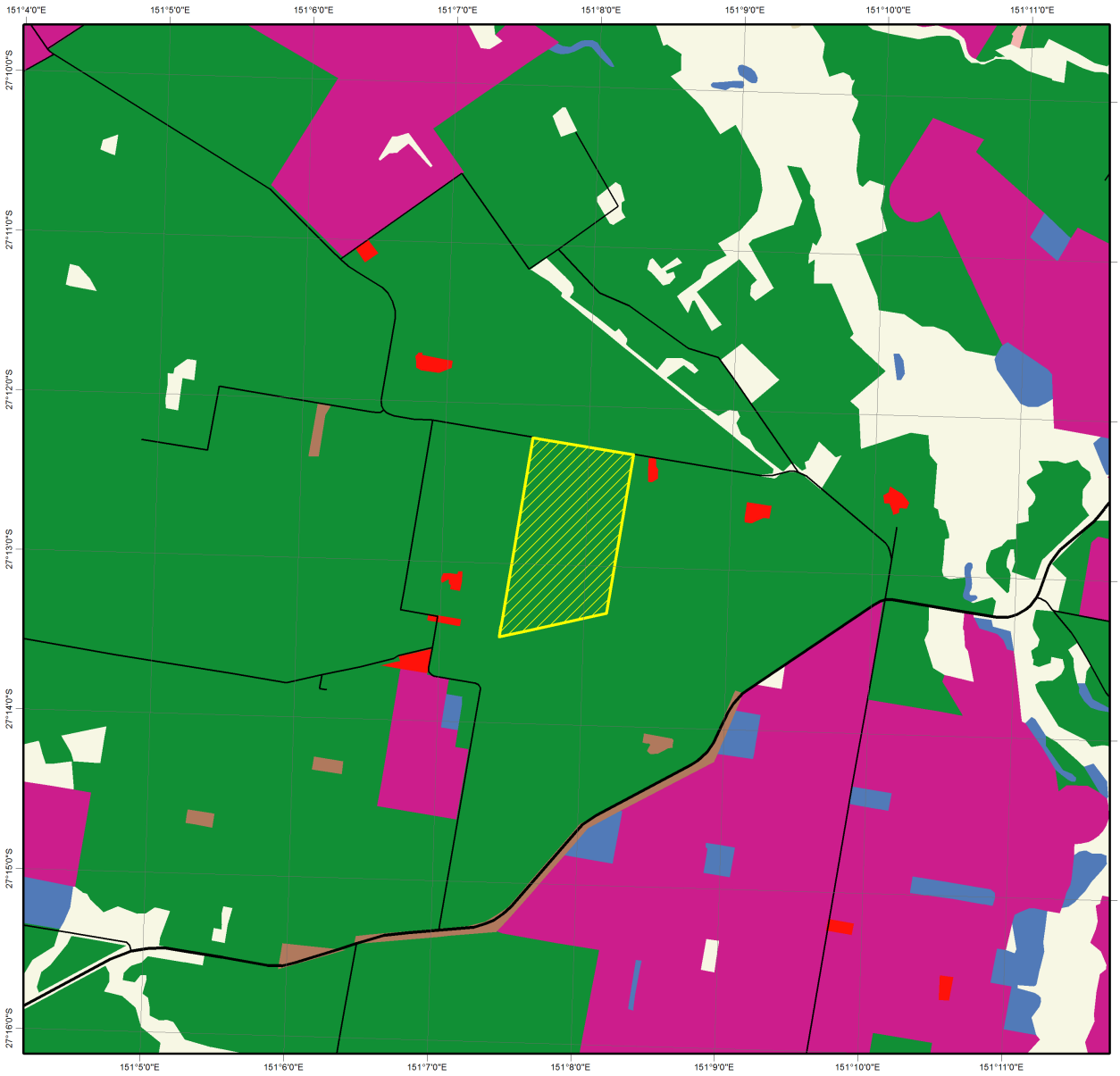

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Nature conservation
- Other minimal use
- Grazing native vegetation
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- Intensive animal production
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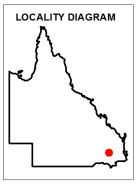
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets

LOCALITY DIAGRAM



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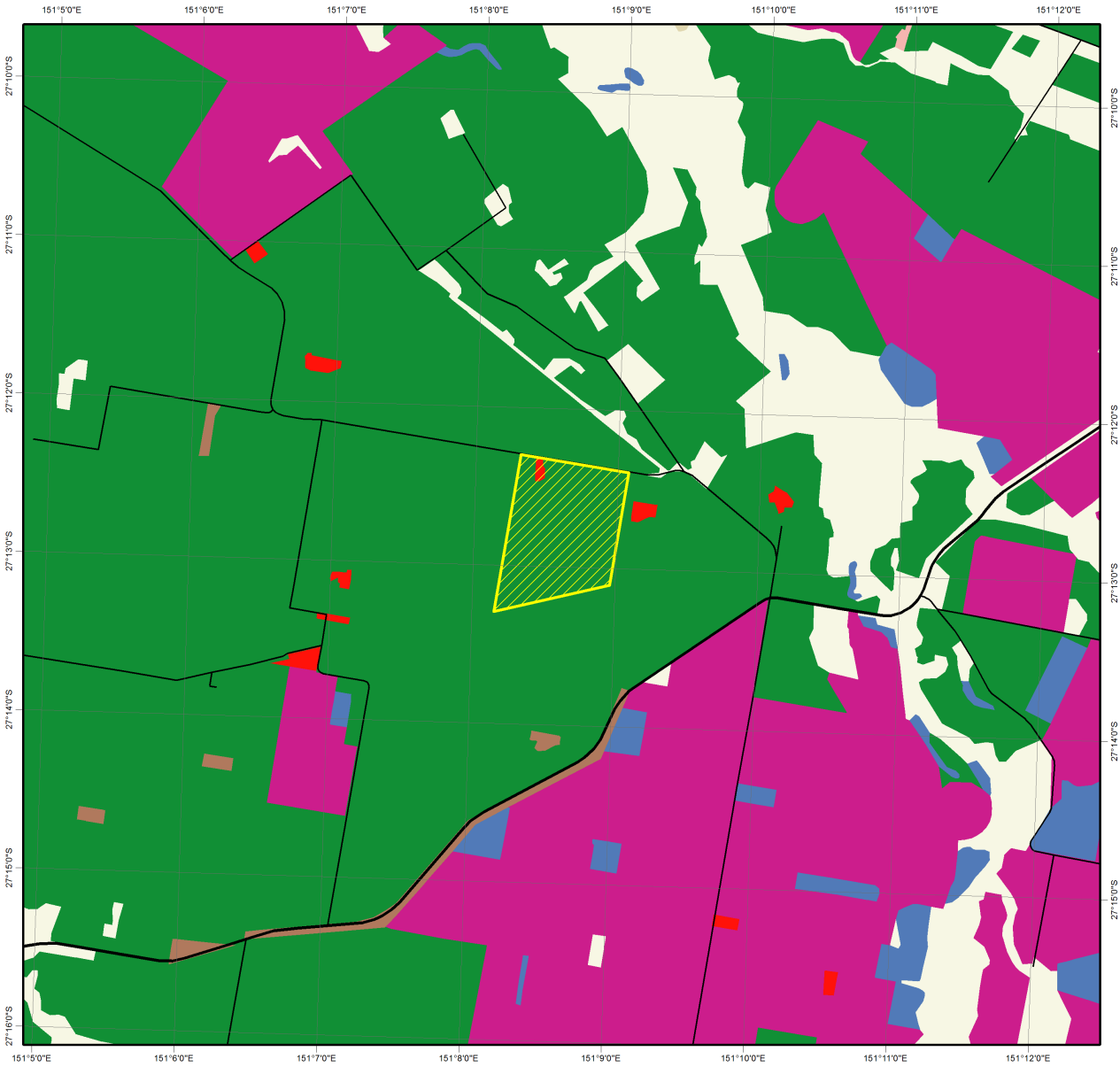

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Nature conservation
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Intensive animal production
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
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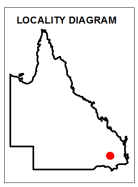

N

0 680 1360 2040 2720 3400 m

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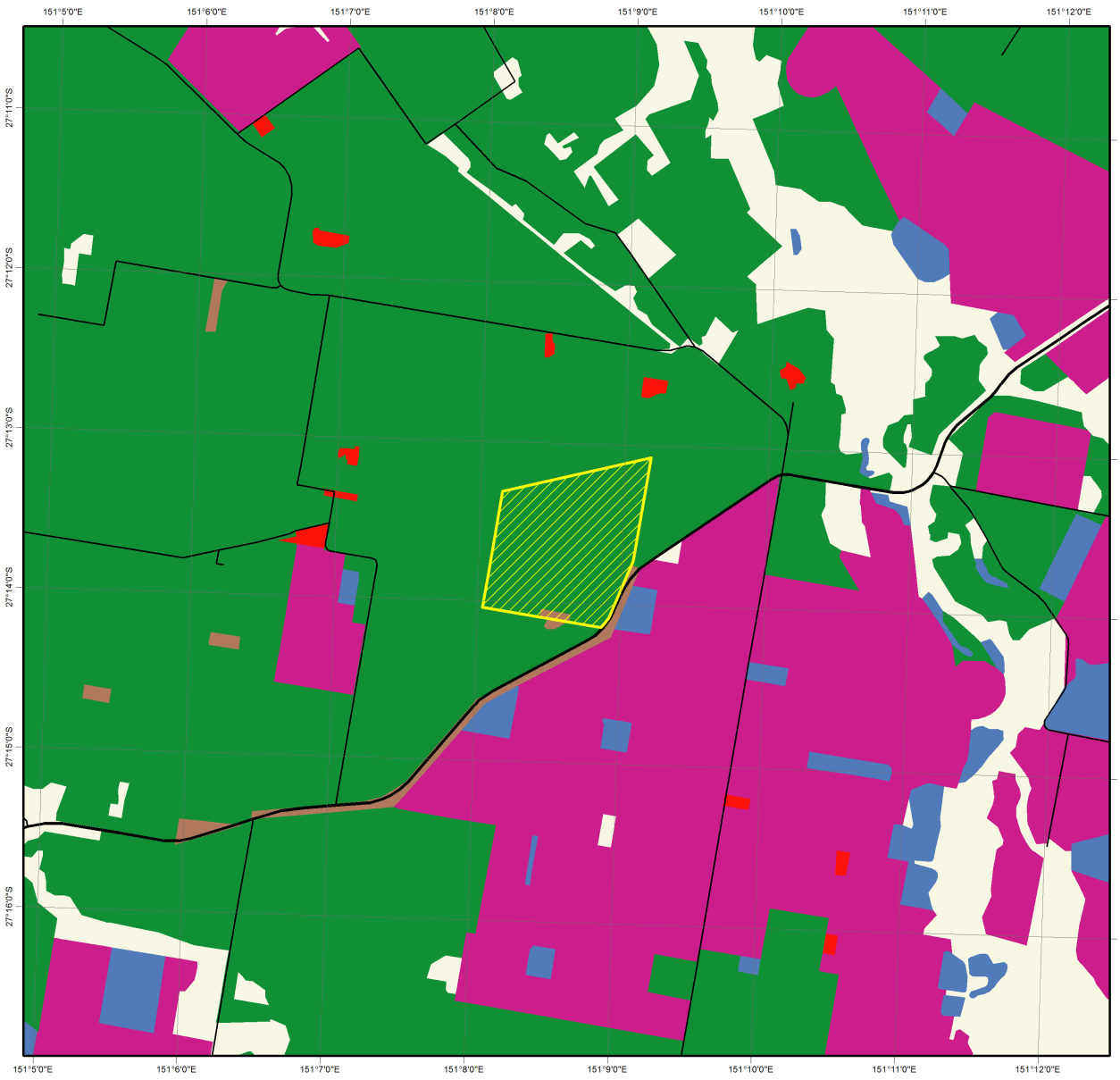


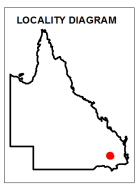
Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

- Selected Lot and Plan
- Other minimal use
- Grazing native vegetation
- Cropping
- Irrigated cropping
- Residential and farm infrastructure
- Reservoir/dam
- Freeways / motorways; Highways
- Secondary roads; Streets



N

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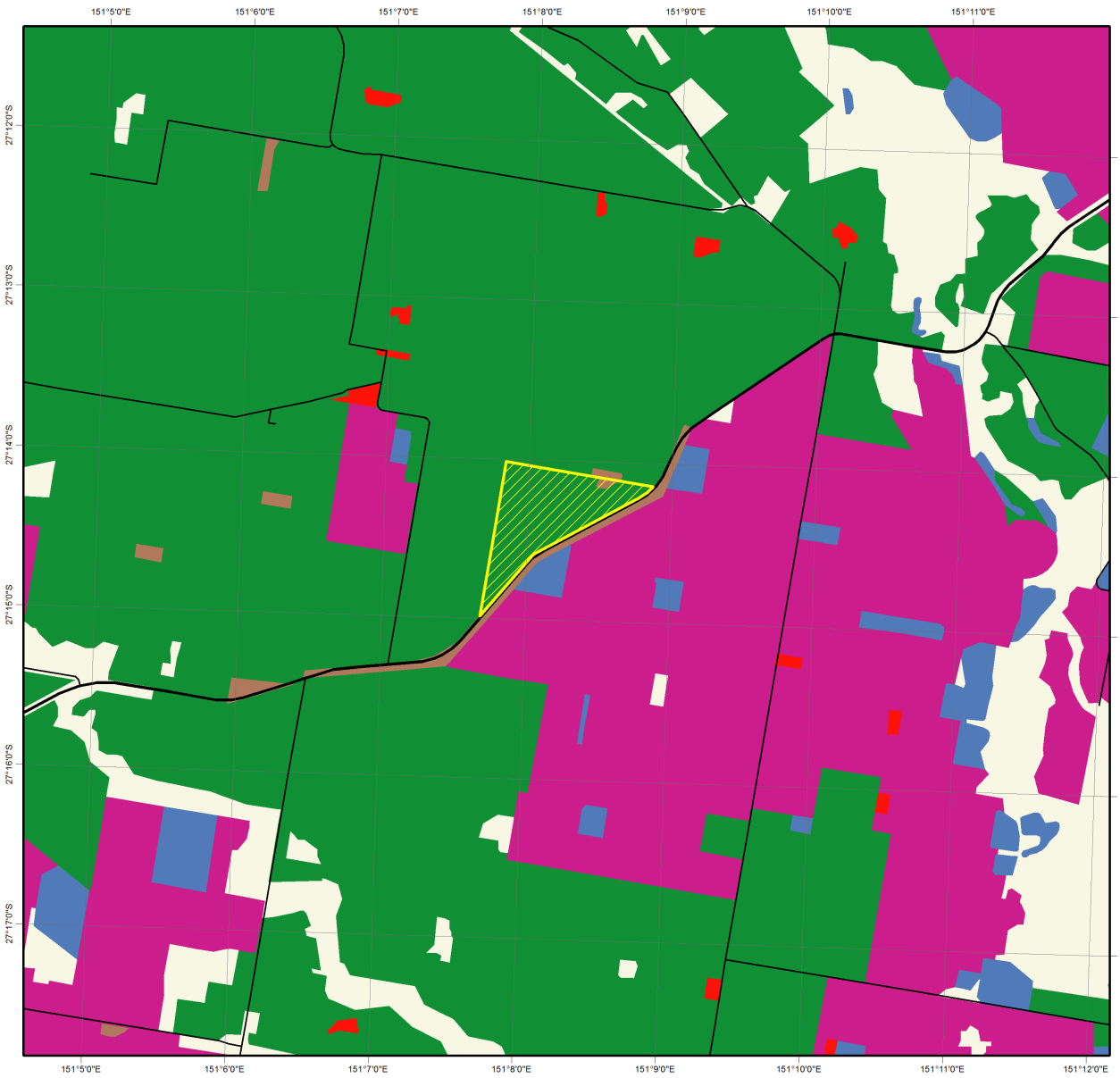

Land Use

Queensland Land Use Mapping Program

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ALUM v8 Secondary level

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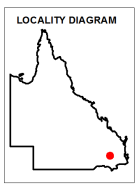

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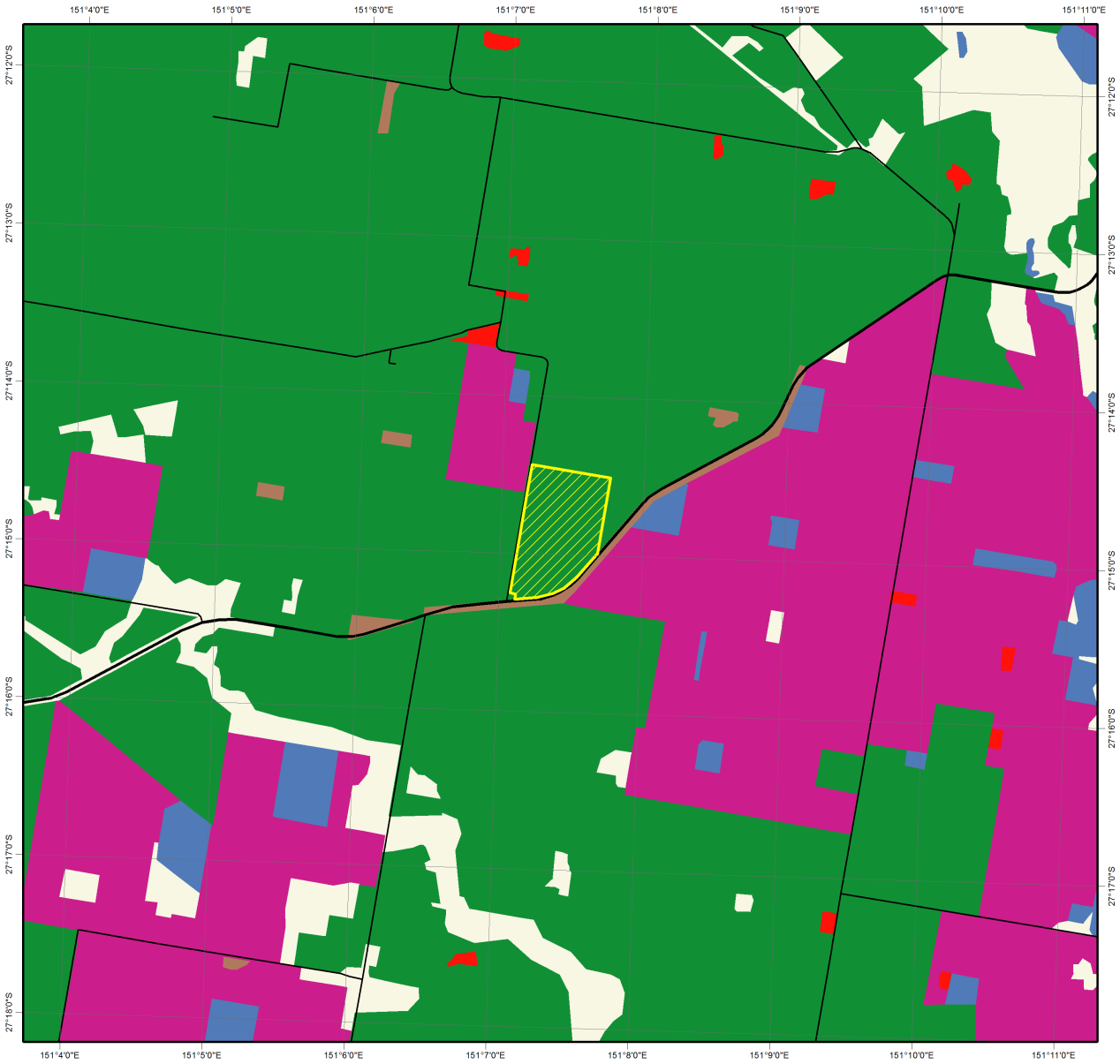

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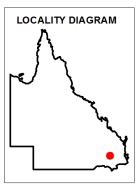

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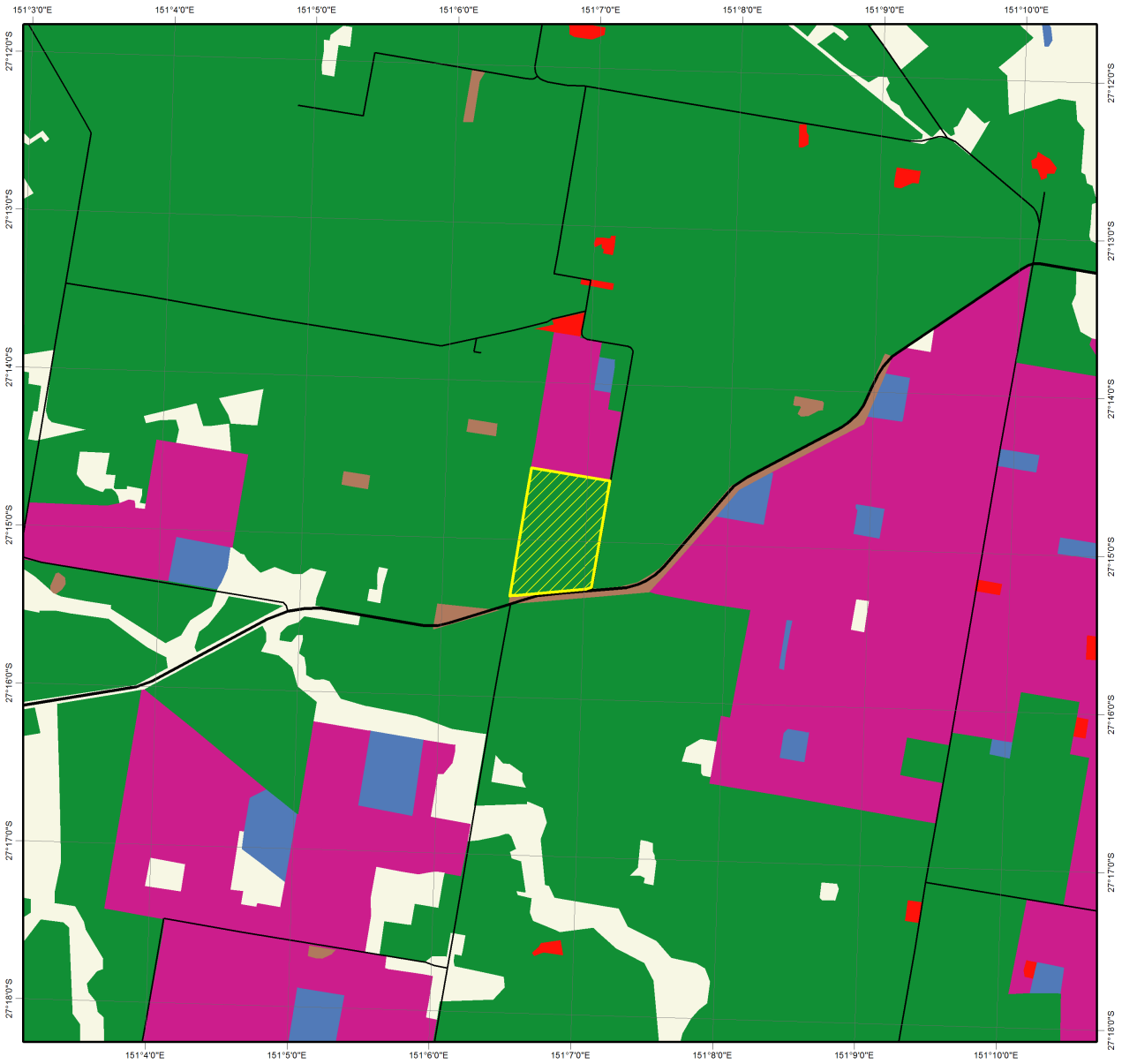

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

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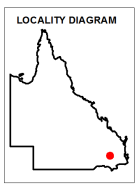

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Appendix 6: Forage Crop Frequency Data for the years 2011 – 2020

arrow energy
go further

FORAGE REPORT: CROP FREQUENCY

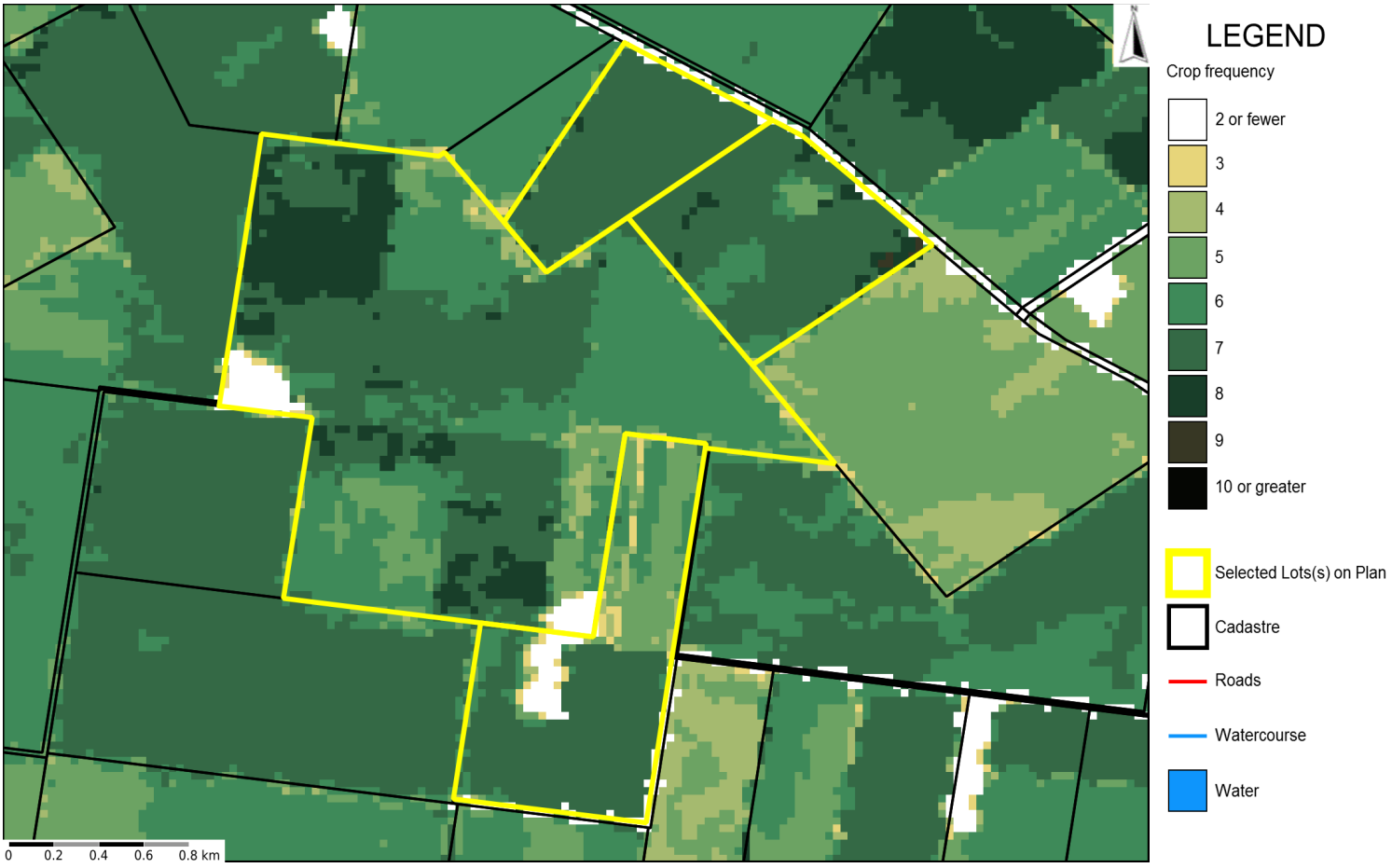
http://www.longpaddock.qld.gov.au/forage June 25, 2021 Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc. Label: noLabel

Queensland Government

Introduction

This report presents maps of crop frequency for your chosen area, and chosen time period. Maps are based on time-series analysis of satellite imagery (30-m spatial resolution), for both the summer and winter growing seasons, aimed at detecting cycles of greenness in vegetation. Composite satellite images that display the maximum greenness within a summer or winter growing season for each year are also provided, as a visual reference. For further information refer to the FORAGE User Guide (https://data.longpaddock.qld.gov.au/static/forage_user_guide.pdf) .

Estimated total crop frequency map (2011 - 2020)



How to interpret the information

Crop-frequency mapping: Coloured areas on the maps indicate locations where active crops have been detected three or more times in the summer or winter growing seasons, for the time period specified. The map on this page shows "Total Frequency" which is a count of the number of times that an active crop was detected. The maps on the following page show the summer and winter crop frequency, respectively. Analysis of satellite imagery can result in some misclassification, so it is recommended to view the composite imagery (see below) to help confirm the presence of a crop in a given season.

Mapping of broad groups of crops: Crop frequency is also separated into estimates of the broad crop groups within the area. This estimation is based on an automated classification approach (see https://www.qld.gov.au/environment/land/management/mapping/statewide-monitoring/crops for more detail).

In the winter season the classification differentiates between the groups:

- Cereal crops (e.g. wheat, barley, oats);
- Pulse crops (e.g. chickpea).

In the summer season the classification differentiates between the groups:

- Coarse-grain and pulse (e.g. sorghum, maize, mungbean);
- Cotton crop.

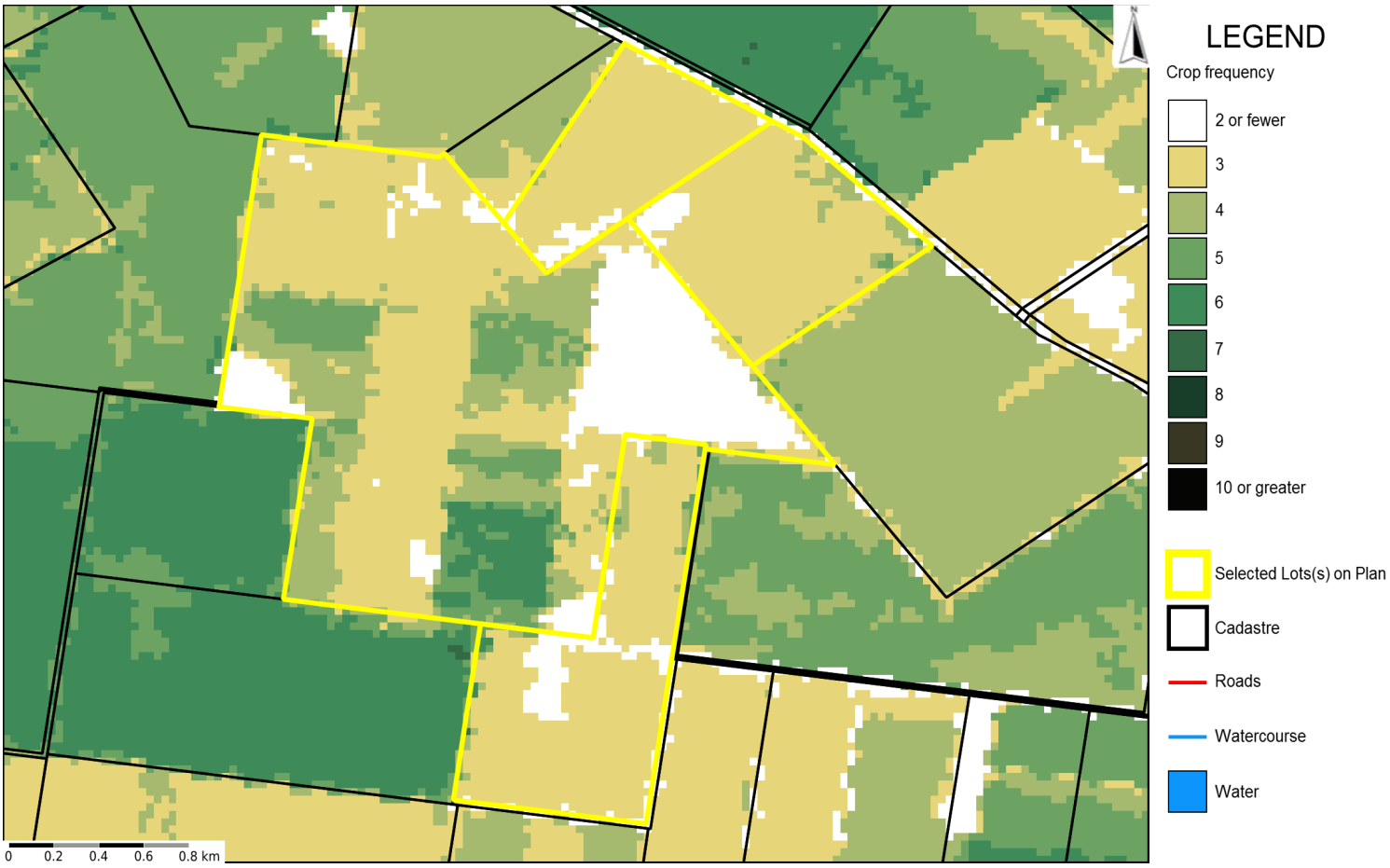
Composite satellite imagery: Due to the limitations of the automated method used to detect active cropping, it is recommended to view the seasonal composite images (pages 5 onward), compiled to represent the maximum greenness (per pixel) within a growing season. Cropped areas will generally appear bright green in the imagery compared with the surrounding landscape. Even if the crop-frequency mapping does not indicate cropping in an area, it is important to check each composite image to confirm that cropping has not been undertaken. Sometimes it will not be possible to clearly identify cropped areas in the imagery, e.g in some wetter seasons the entire landscape might appear green. In this case, it is recommended to undertake further investigation using other information sources. Note: the composite images are only used to confirm the presence or absence of cropping activity; it is not possible to visually differentiate between the crop groups.

FORAGE REPORT: CROP FREQUENCY

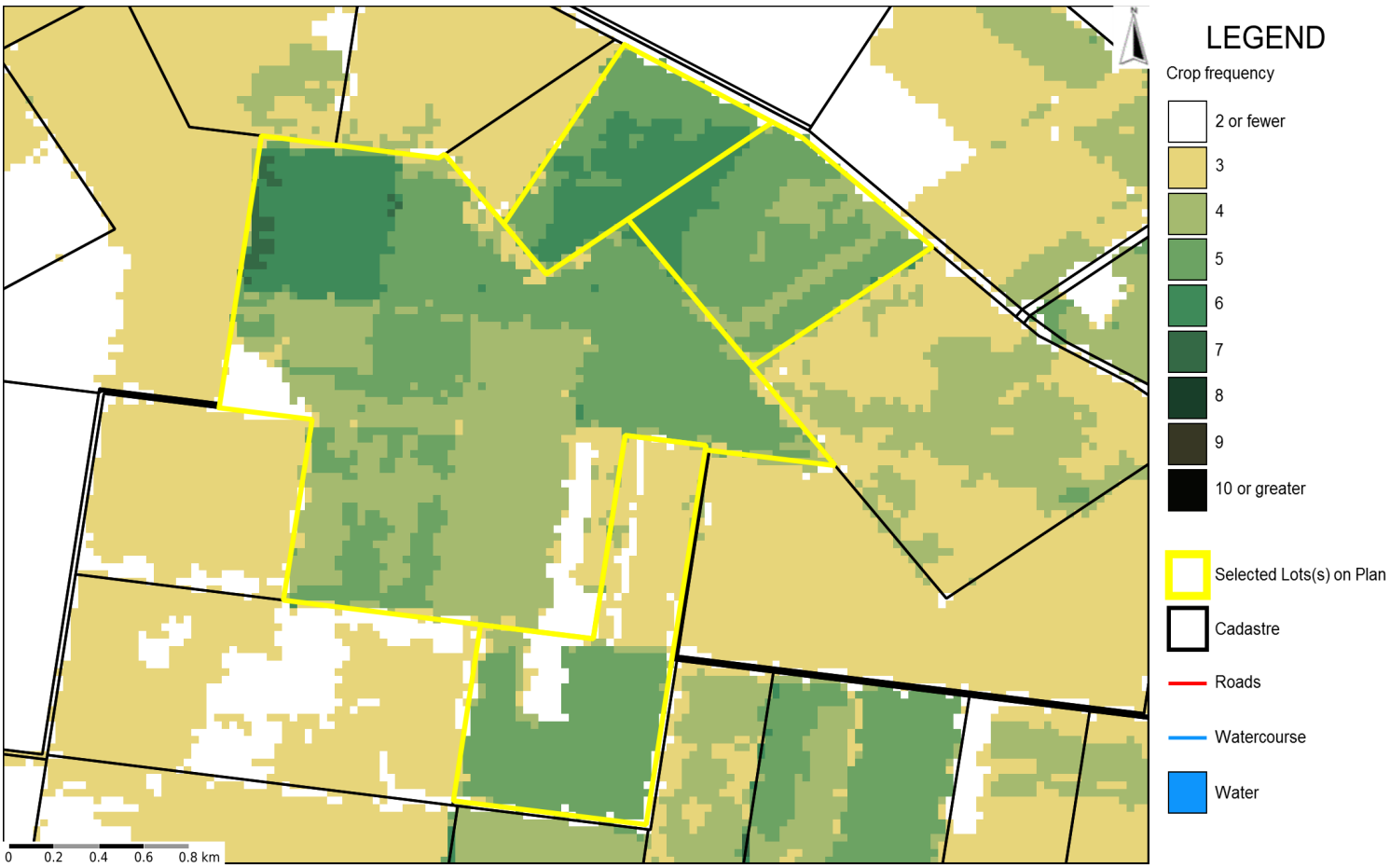
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

Queensland Government

Estimated frequency map for summer (February) crops (2011 - 2020)



Estimated frequency map for winter (September) crops (2011 - 2020)

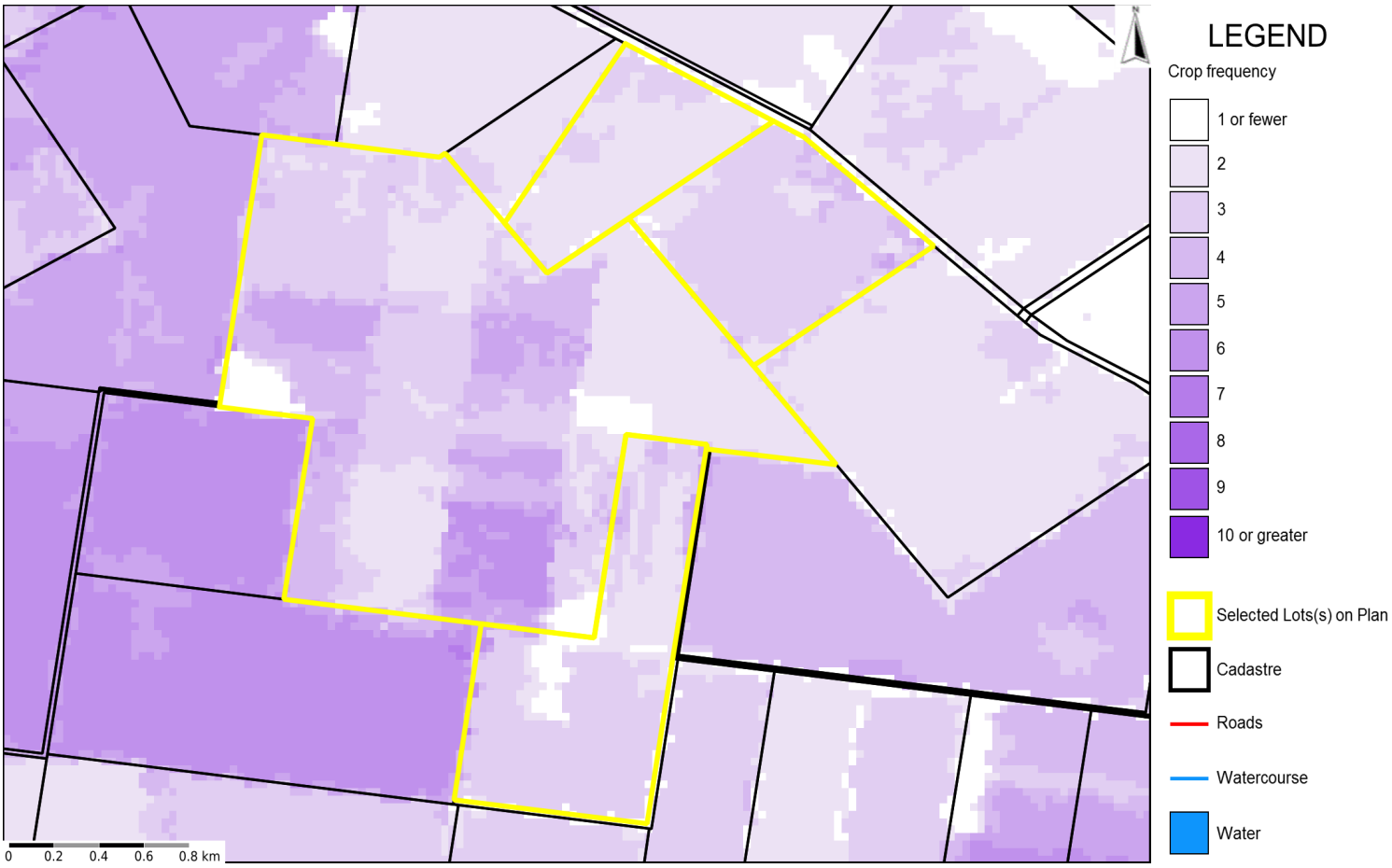


FORAGE REPORT: CROP FREQUENCY

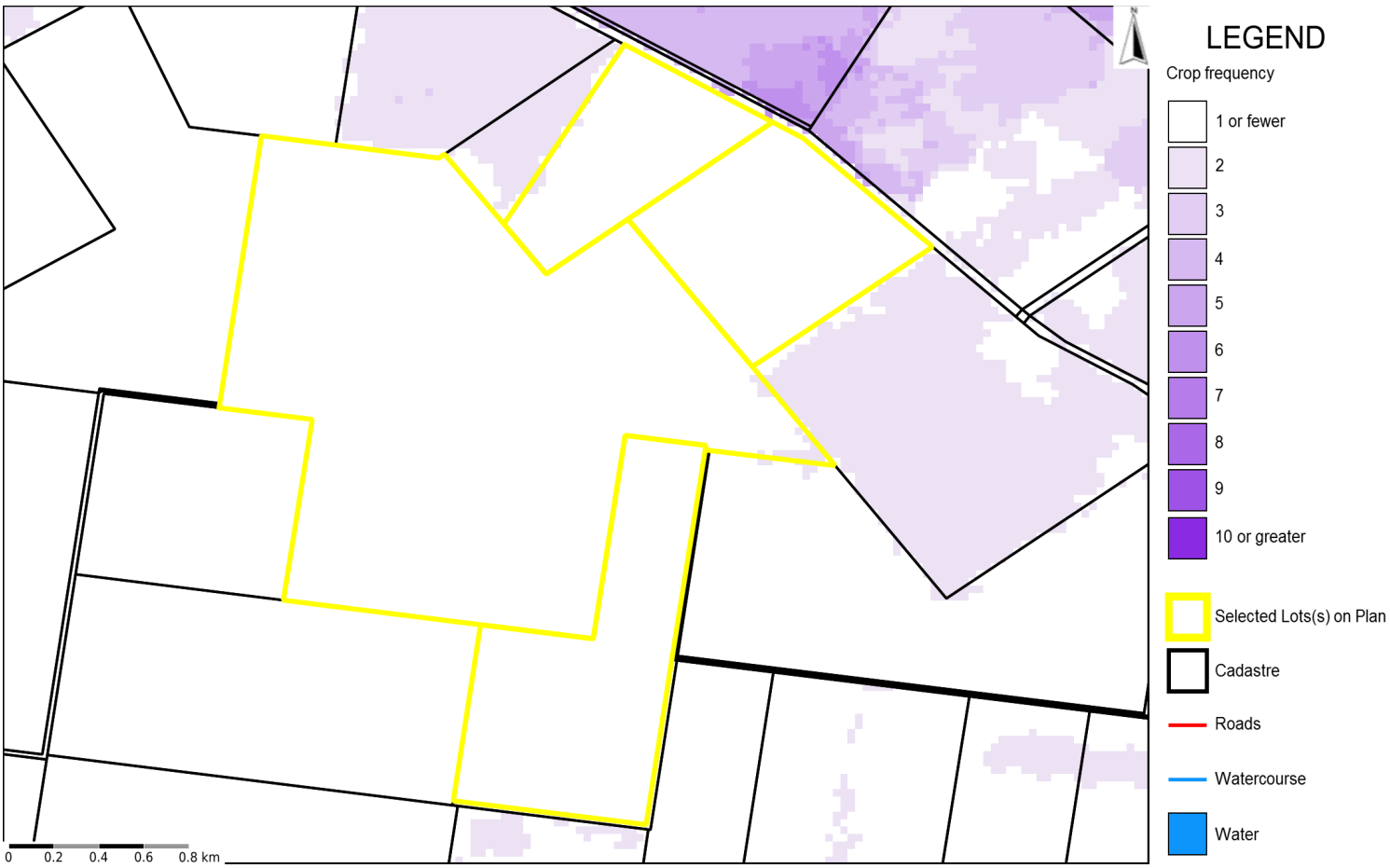
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

Queensland Government

Estimated frequency map for summer (February) coarse grain and pulse crops (2011 - 2020)



Estimated frequency map for summer (February) cotton crops (2011 - 2020)



FORAGE REPORT: CROP FREQUENCY

http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

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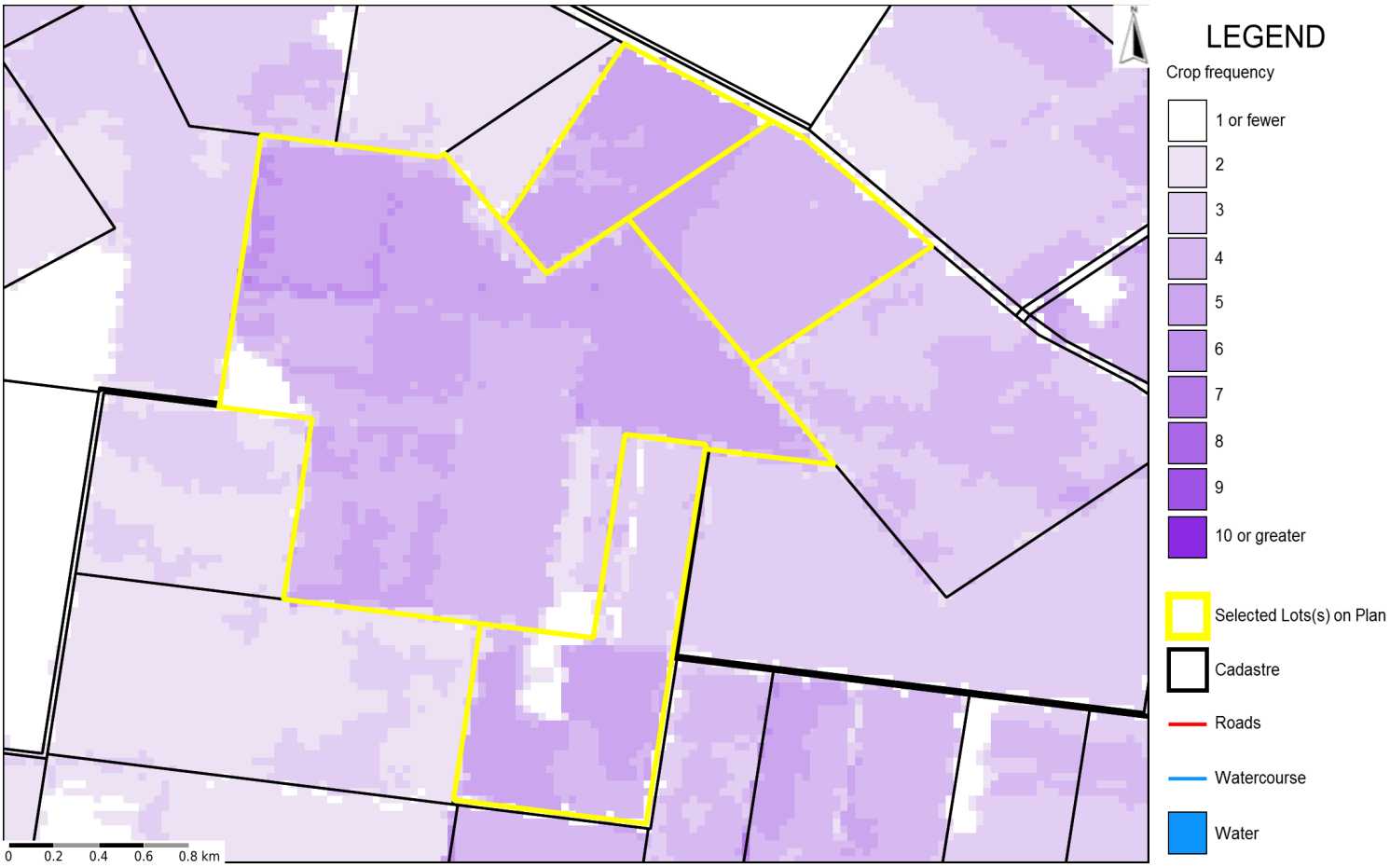
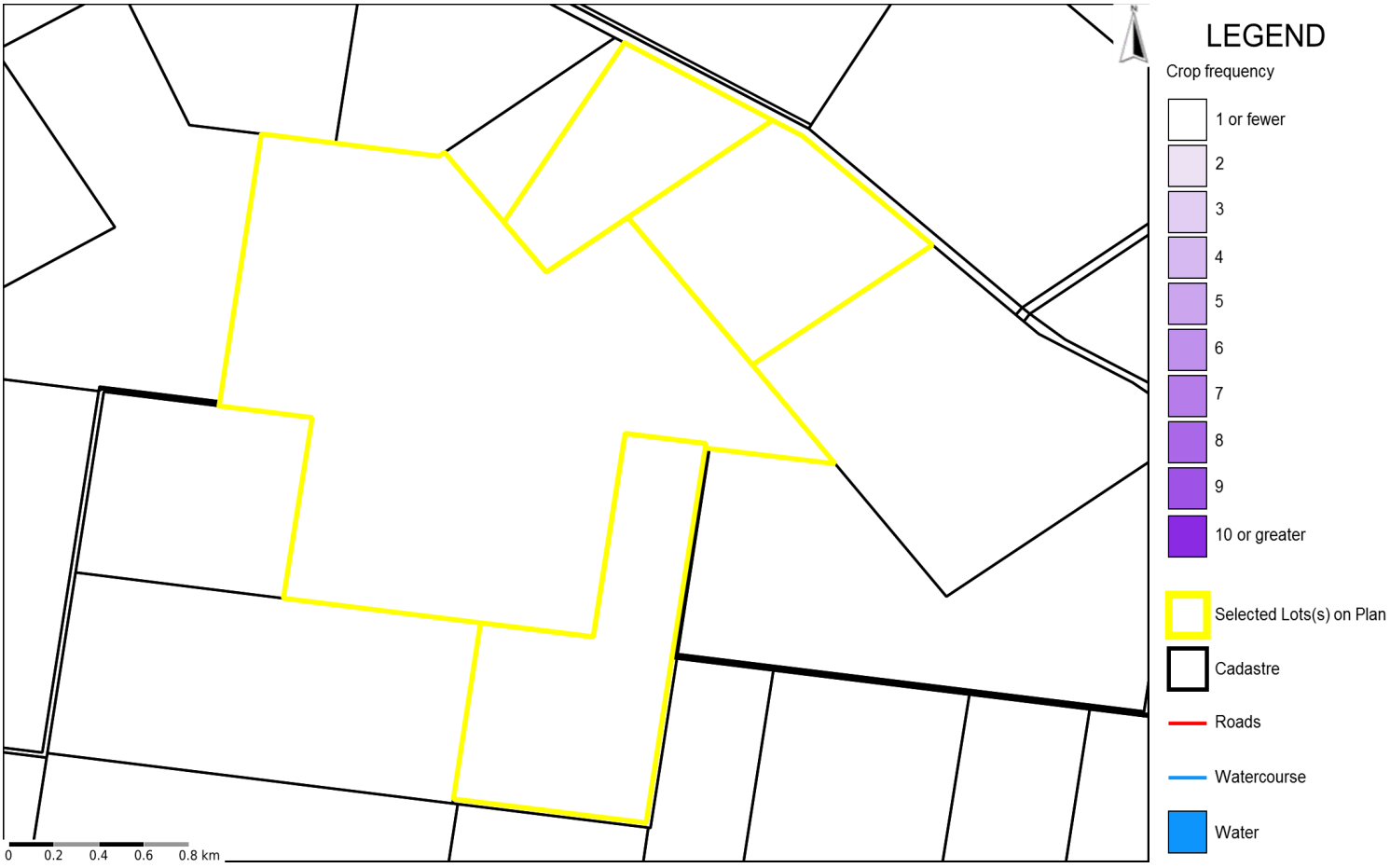
Estimated frequency map for winter (September) cereal crops (2011 - 2020)



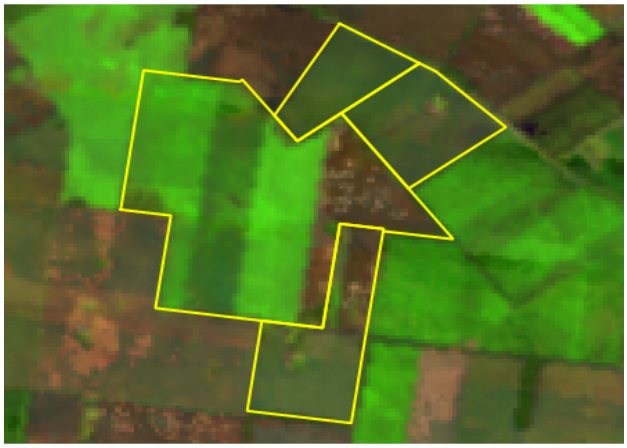
Estimated frequency map for winter (September) pulse crops (2011 - 2020)



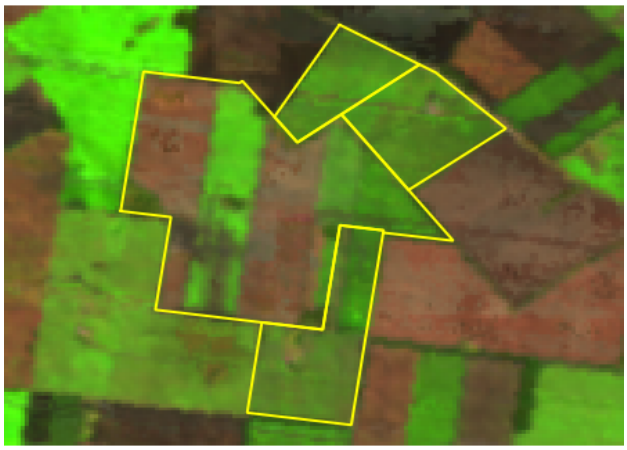
FORAGE REPORT: CROP FREQUENCY

Queensland Government

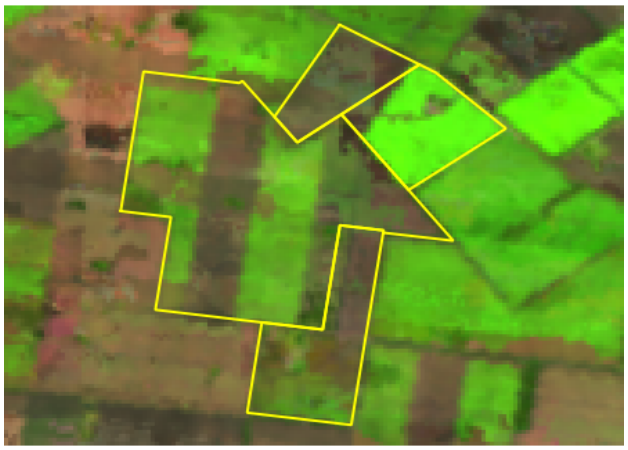
February (left) and September (right) images for 2011

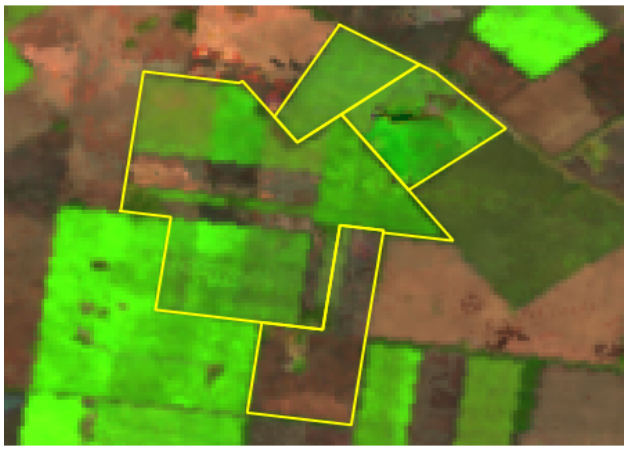


February (left) and September (right) images for 2012



February (left) and September (right) images for 2013



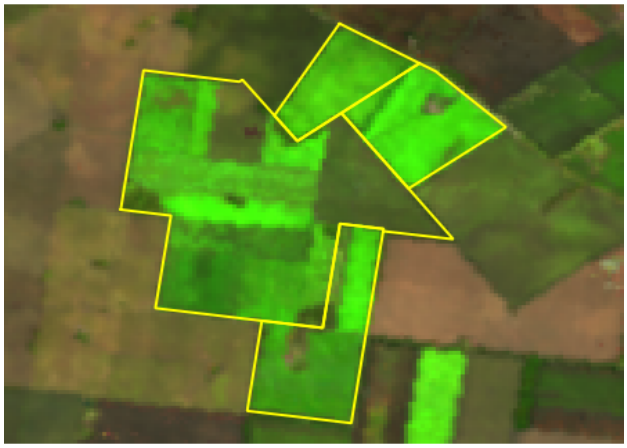


FORAGE REPORT: CROP FREQUENCY

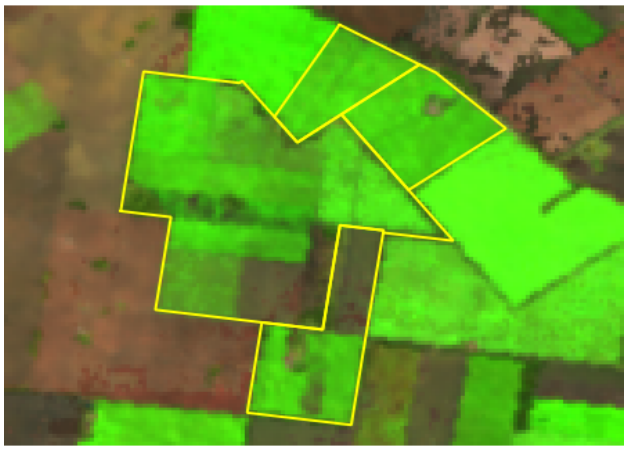
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

Queensland Government

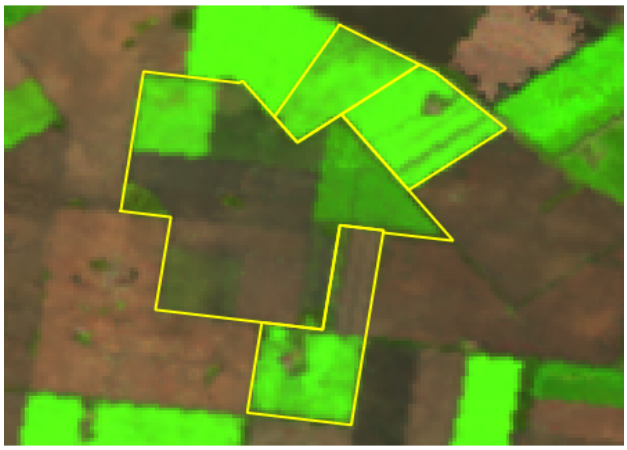
February (left) and September (right) images for 2014



February (left) and September (right) images for 2015



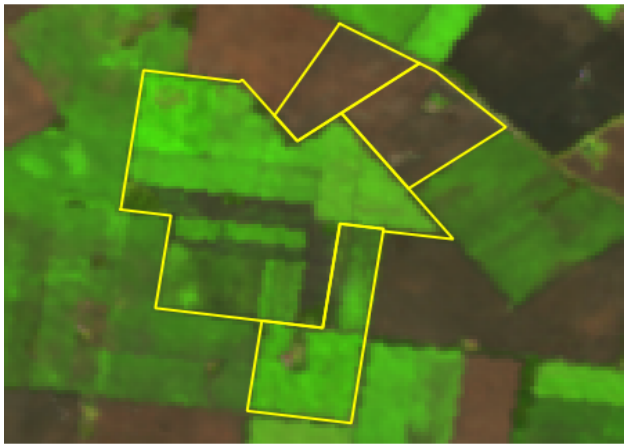
February (left) and September (right) images for 2016



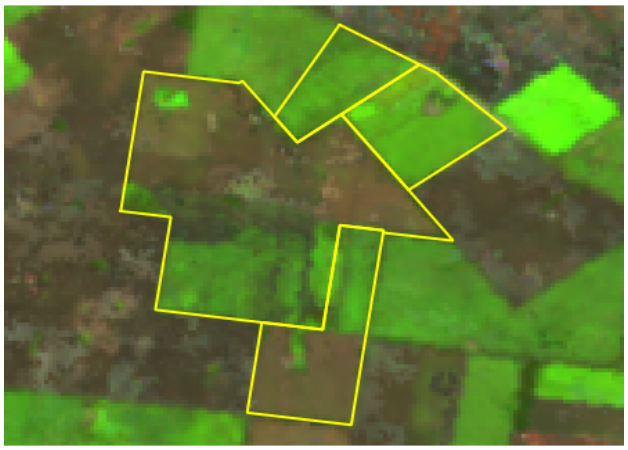
FORAGE REPORT: CROP FREQUENCY

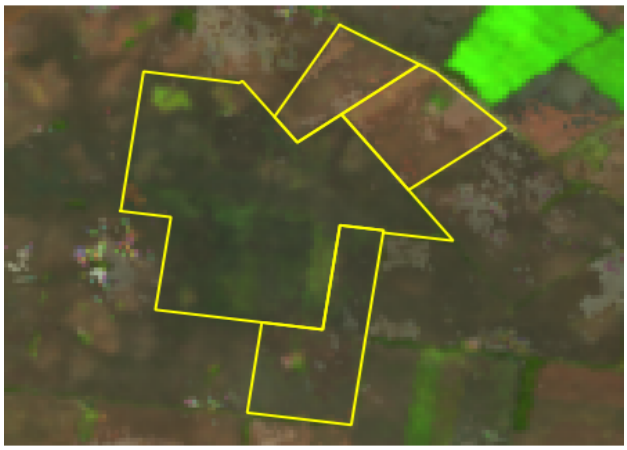
Queensland Government

February (left) and September (right) images for 2017



February (left) and September (right) images for 2018





February (left) and September (right) images for 2019

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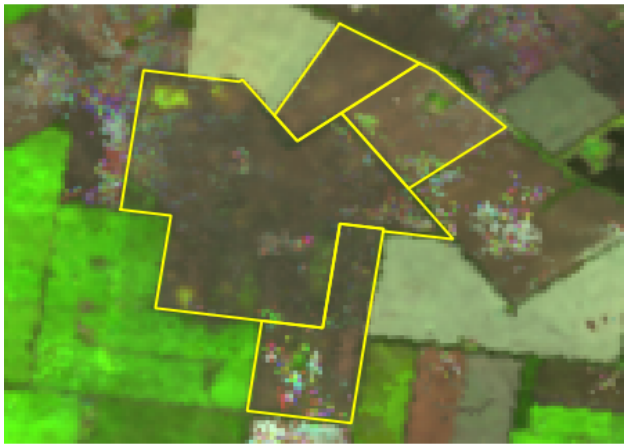
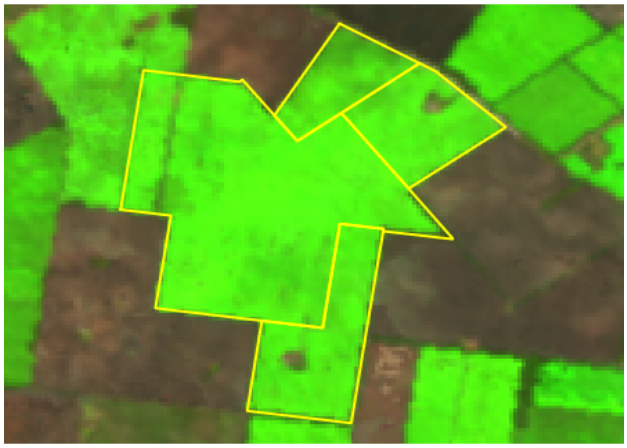
February (left) and September (right) images for 2020





Disclaimer

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Queensland Government

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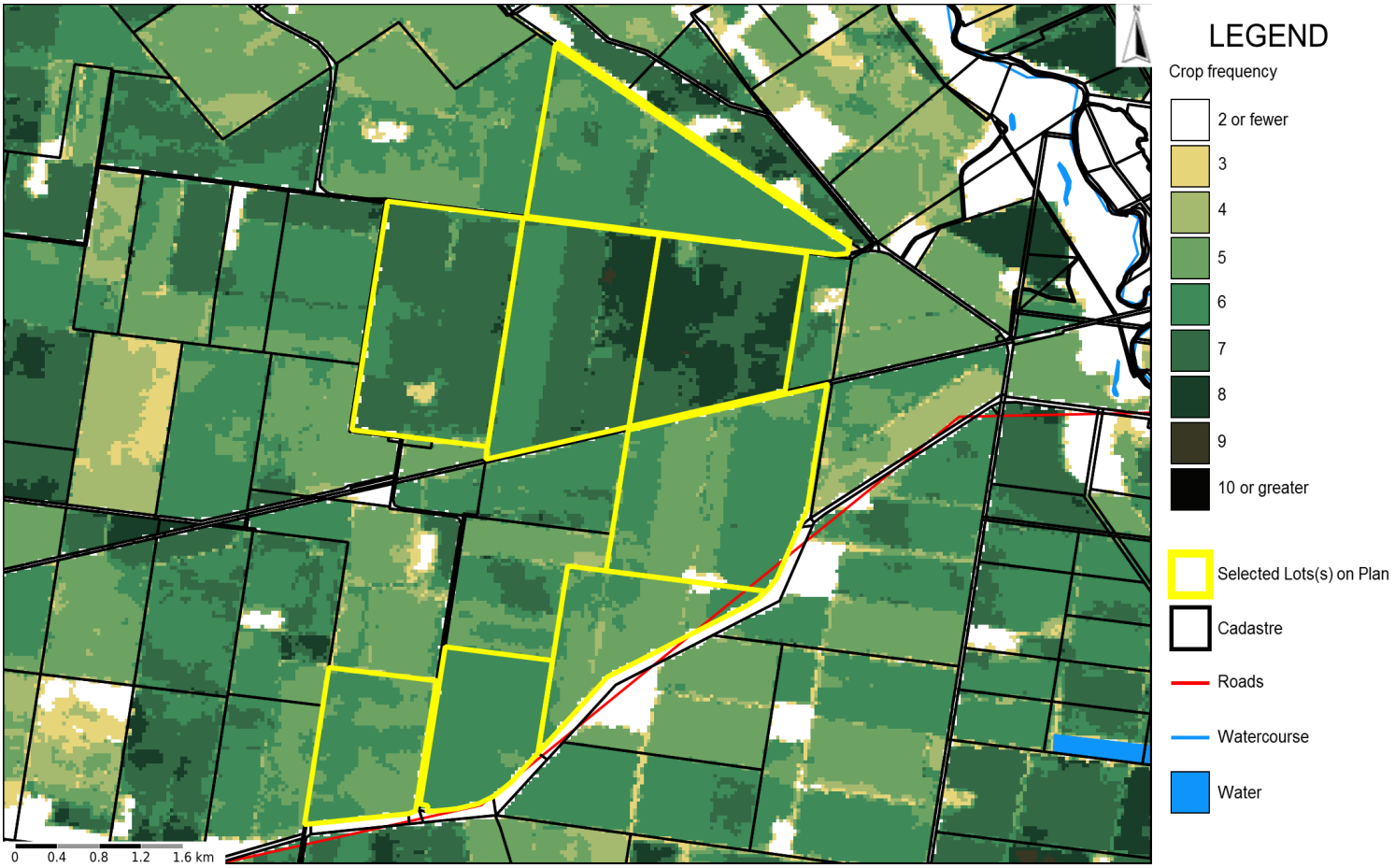

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FORAGE REPORT: CROP FREQUENCY

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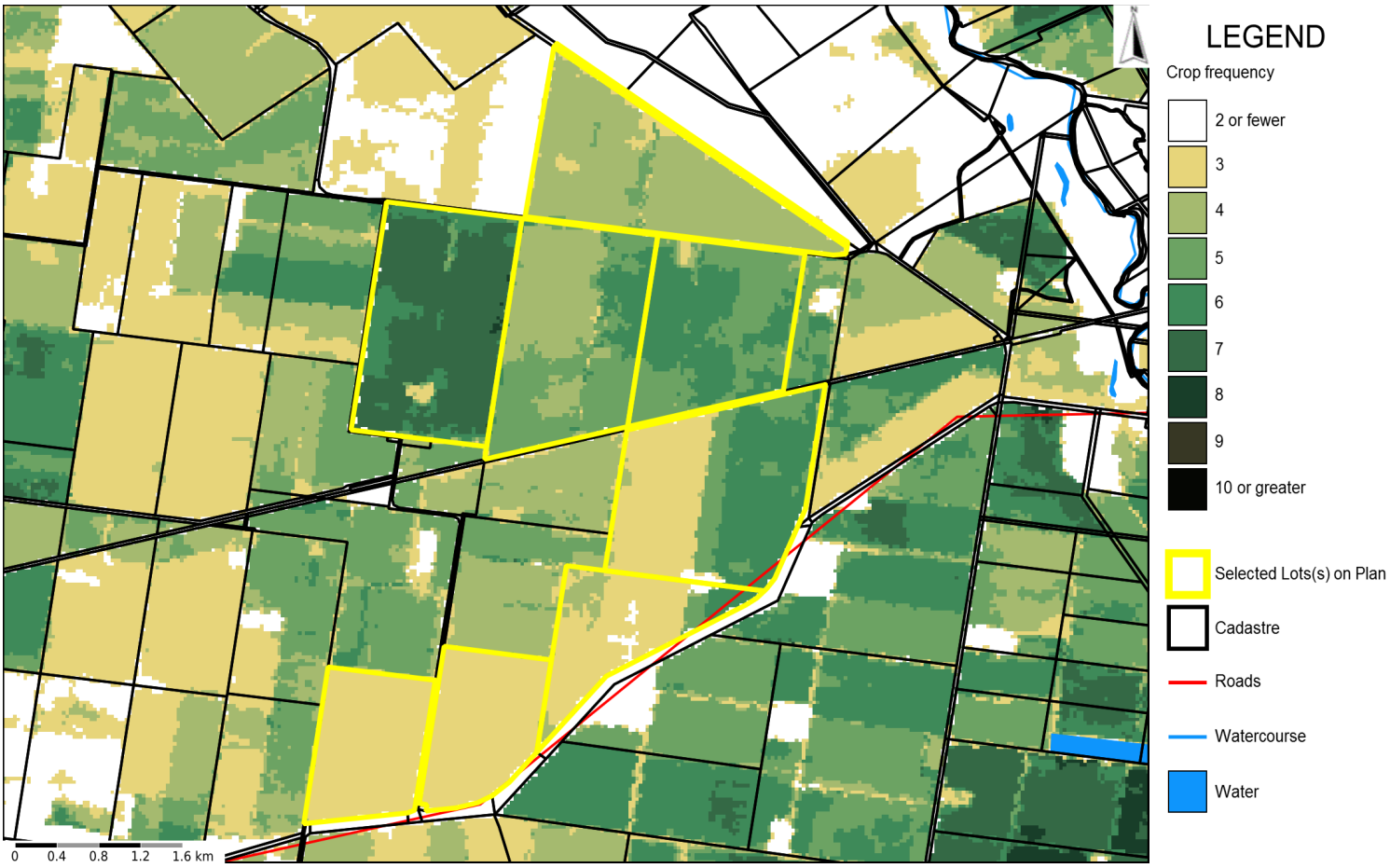
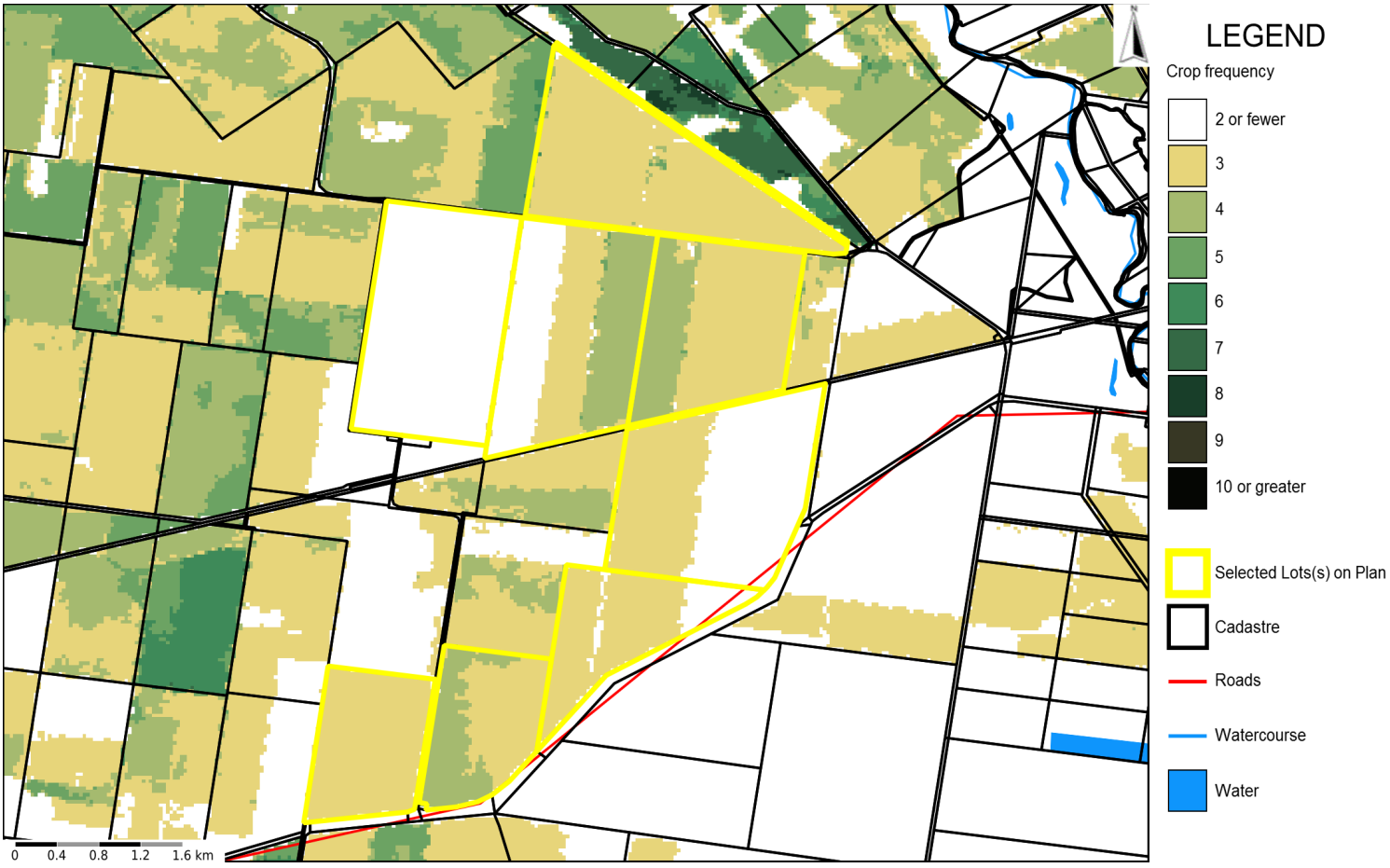
Queensland Government

Estimated frequency map for summer (February) crops (2011 - 2020)



Estimated frequency map for winter (September) crops (2011 - 2020)



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Queensland Government

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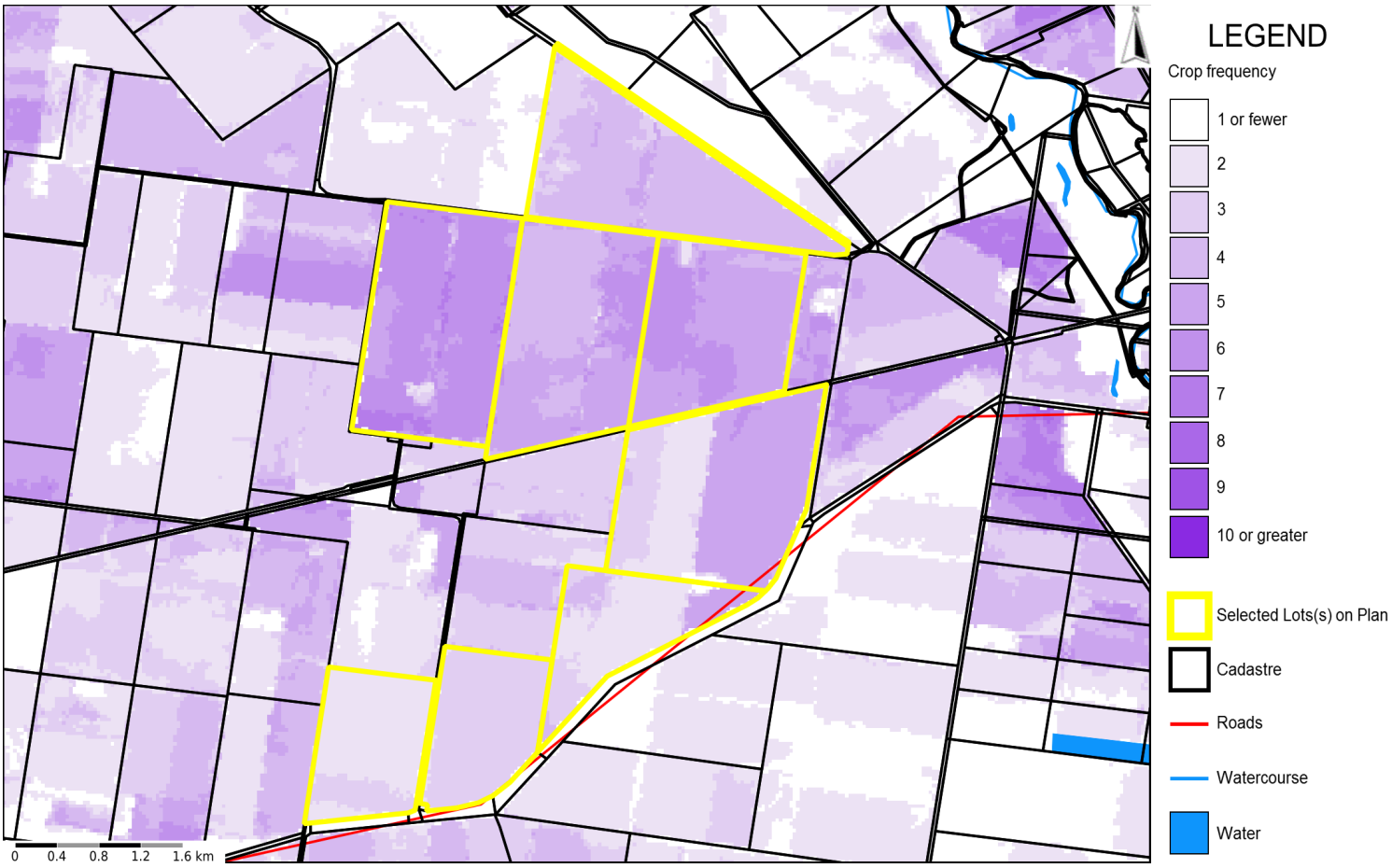

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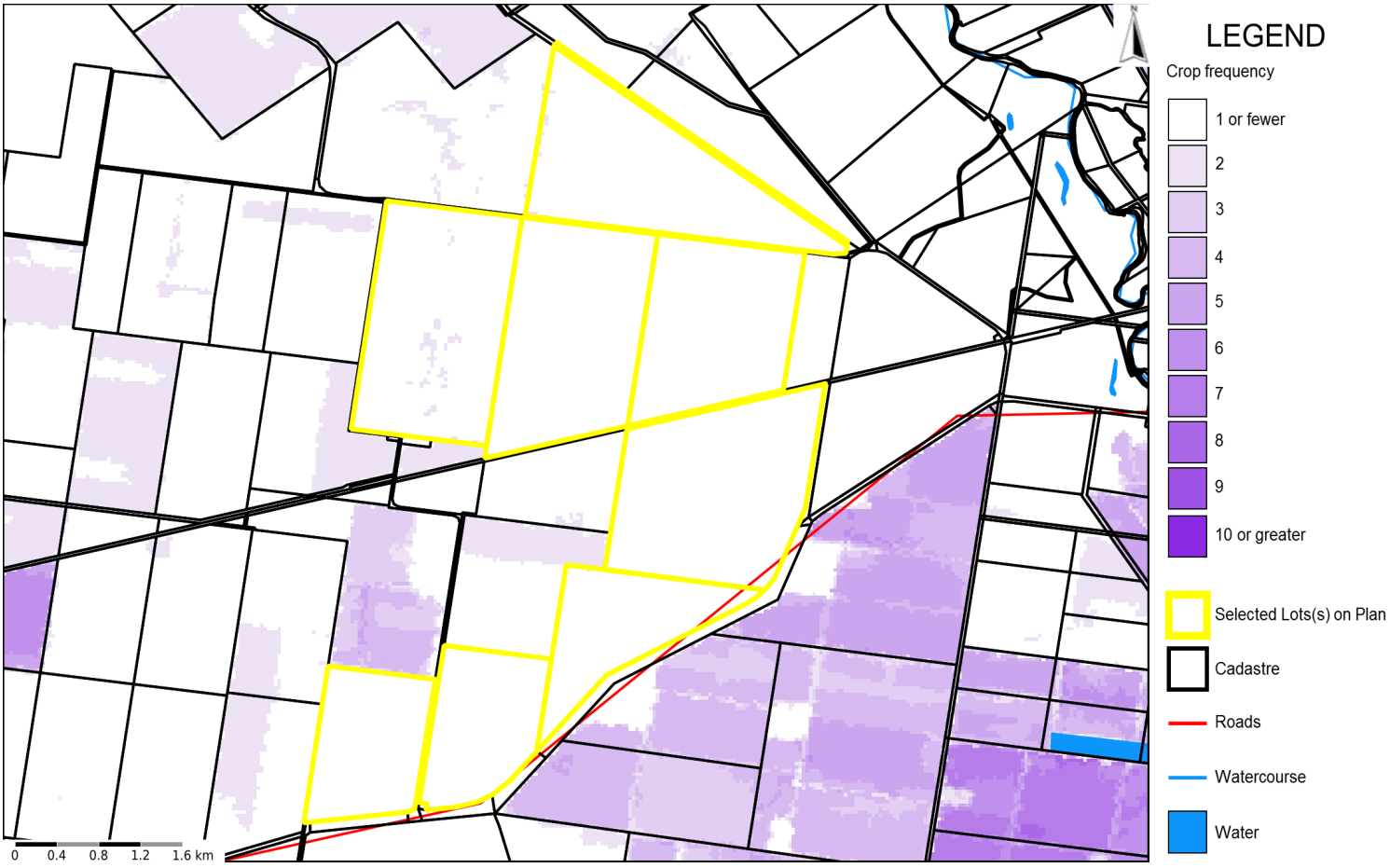

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Queensland Government

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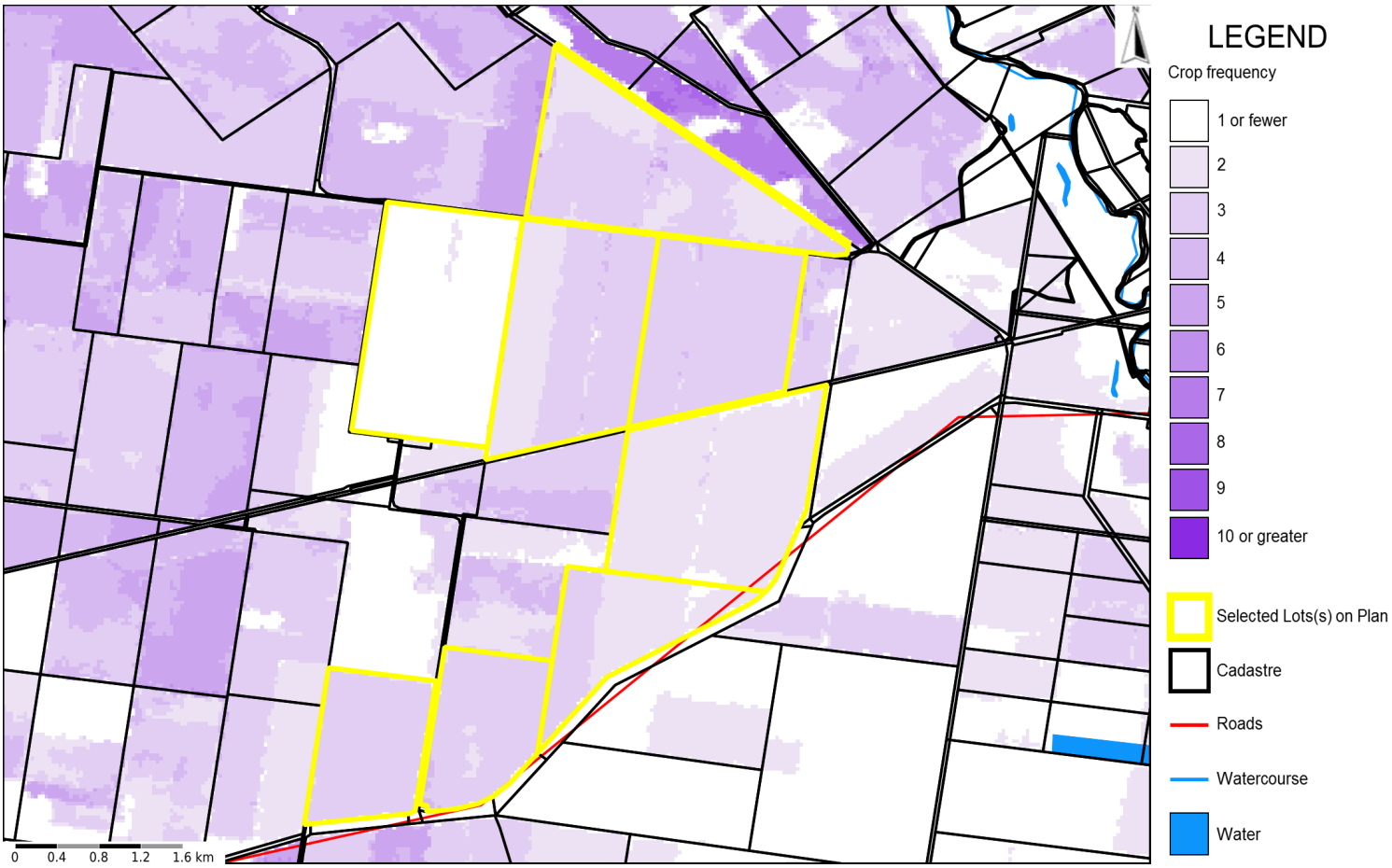

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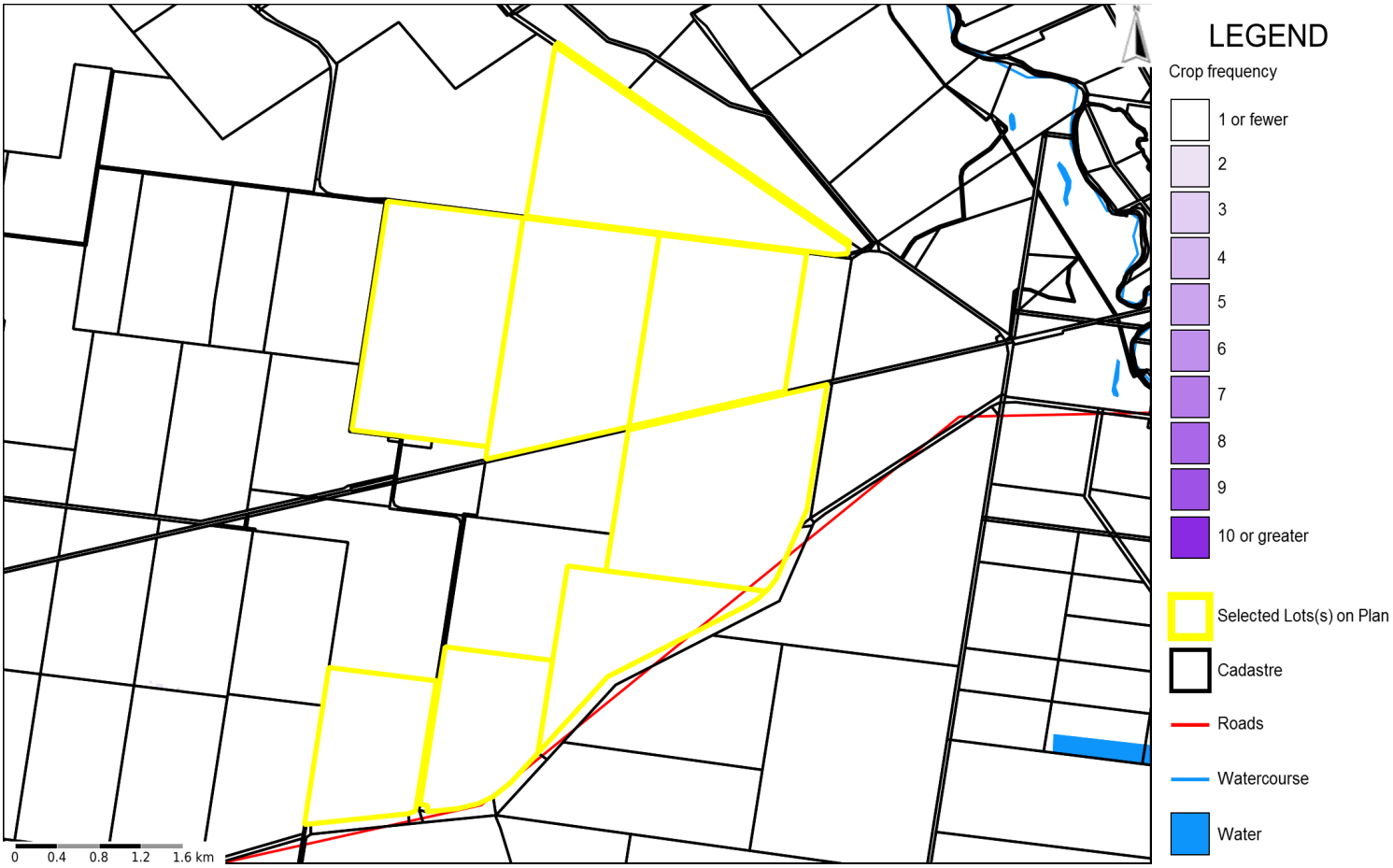

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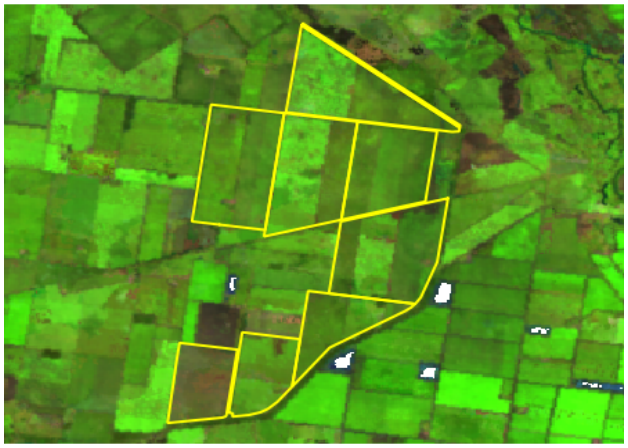
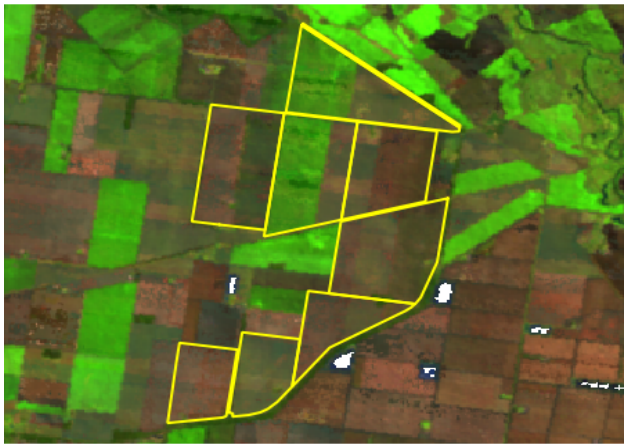
Queensland Government

February (left) and September (right) images for 2011





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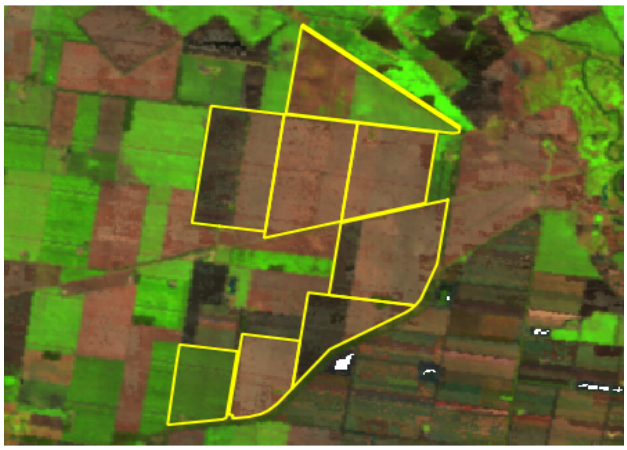

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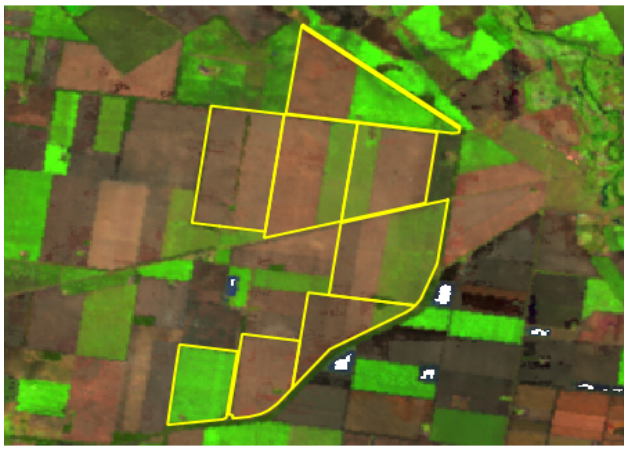

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Queensland Government

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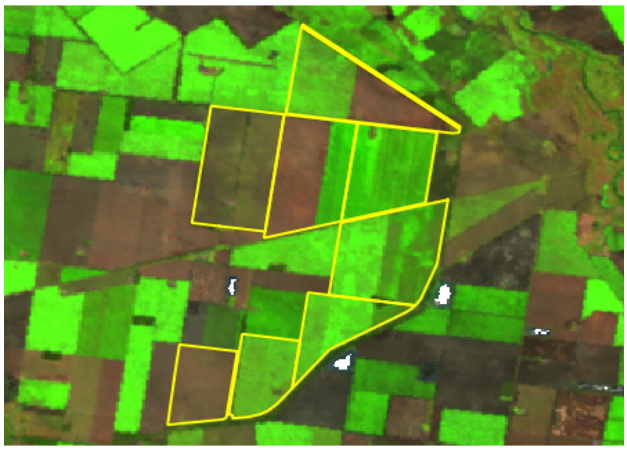

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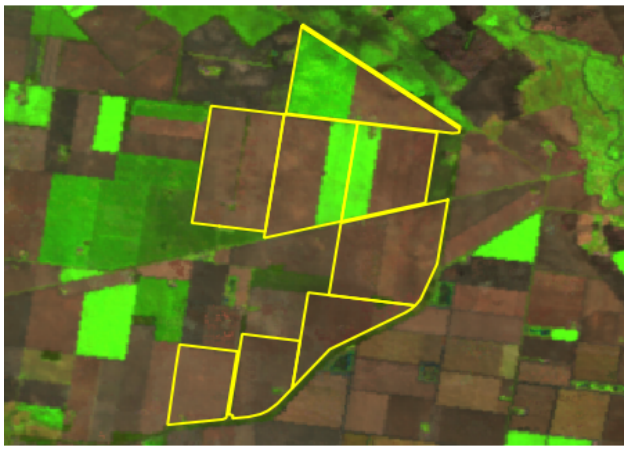

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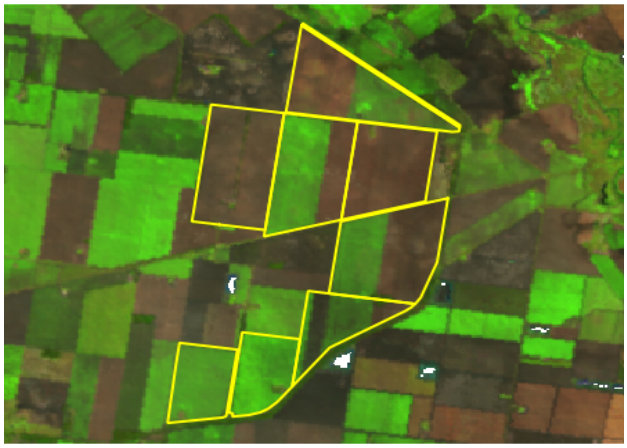

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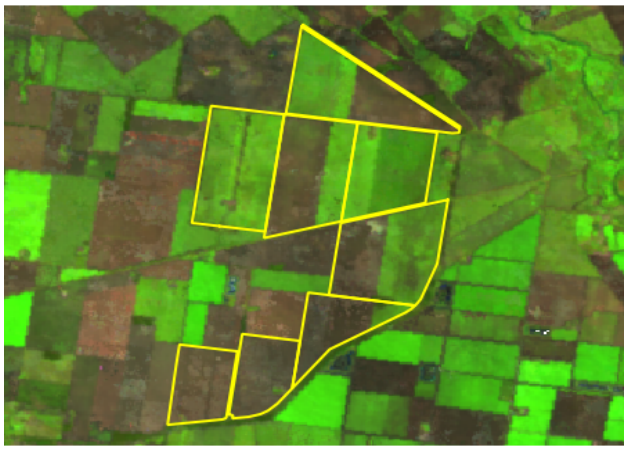

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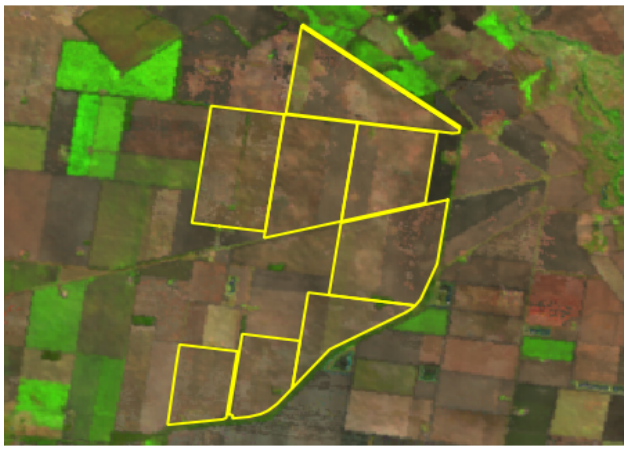

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Queensland Government

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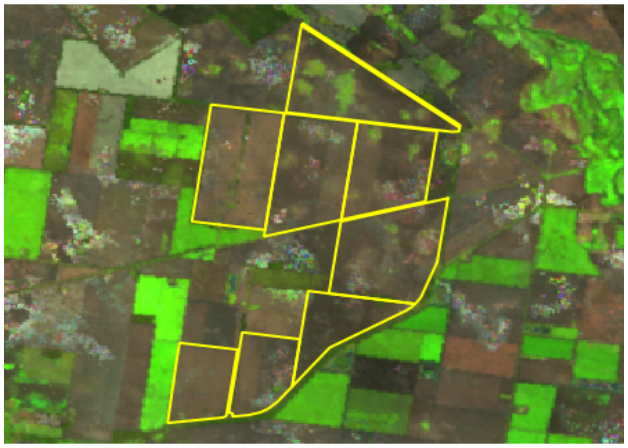

Disclaimer

Appendix 7: Topography Map Series

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309000 309500 310000 310500 311000 311500 312000

6993000 6992500 6992000 6991500 6991000 6990500 6990000 6989500 6989000

ROAD

2RP85916
WARAKIRRI ASSET
MANAGEMENT PTY LTD

12SP193328
WARAKIRRI ASSET
MANAGEMENT PTY LTD

57SP193329
WARRAKIRRI ASSET
MANAGEMENT PTY LTD

36DY45
WARRAKIRRI ASSET
MANAGEMENT PTY LTD

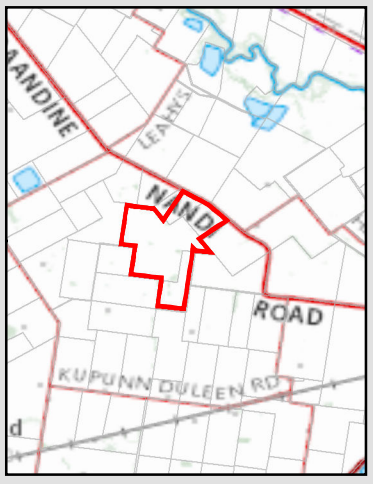
331m
330m
331m
331m
332m

HOADLEYS ROAD

Legend

- Contours- 1m interval
- Subject Property
- Property boundary

Location Diagram



Scale @ A3: 1:12,500 **Coordinate System:** GDA 1994 MGA Zone 56

0 200 400 600 800 1,000 Metres

N

Contour interval: 1 Metre

Rev	Date	Revision Description	Drp	Chk'd	Eng	QA	App
0	20/09/2021	Initial issue.	AW	AH	--	--	AH

Source:
Arrow Energy Limited, Geoscience Australia, Queensland Government

Status: IFU
Issued to: A Hall
Author: awolhuter

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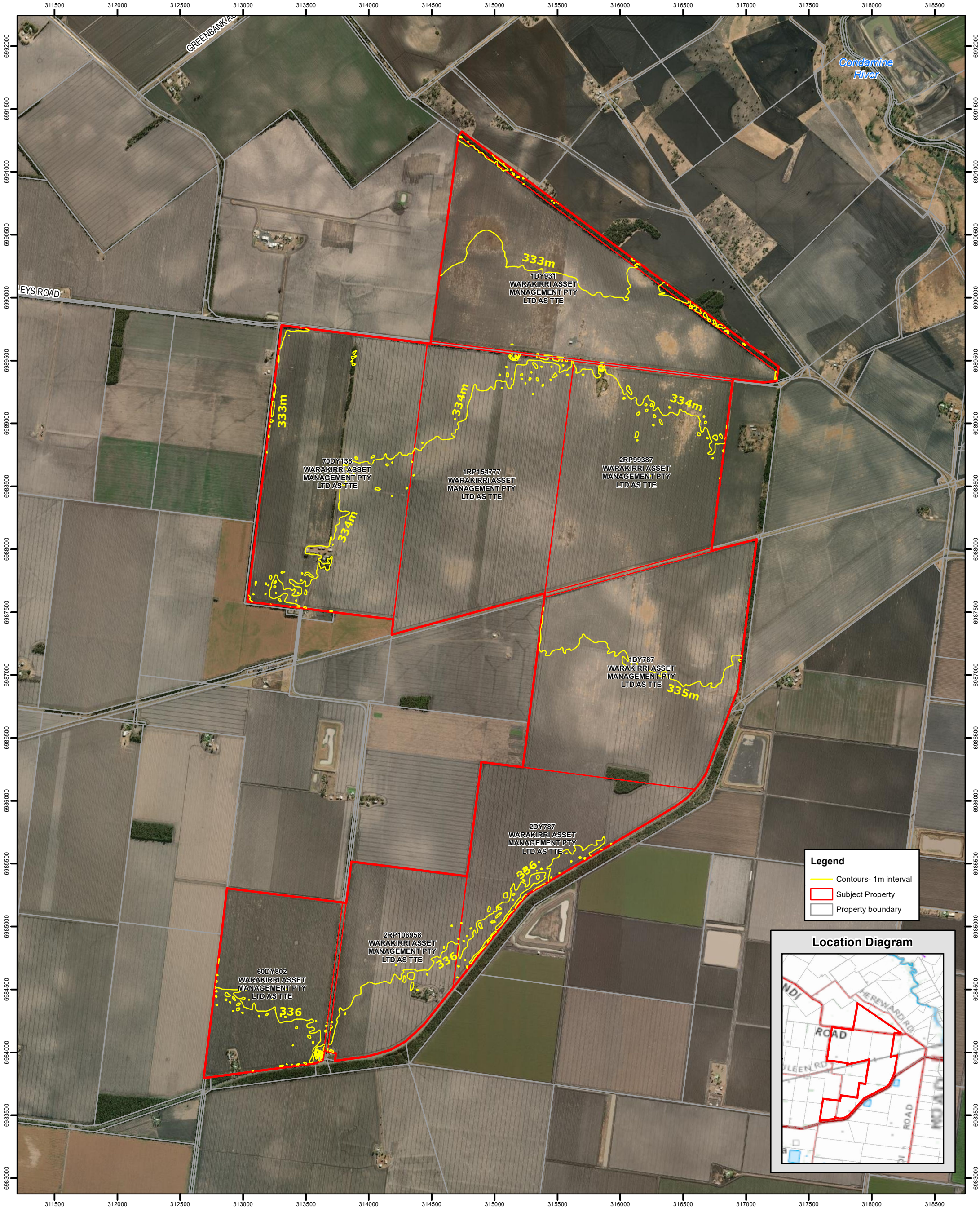
Surat Basin
Warakirri Asset Management Property 1

- Topography

Document: V:\Products\Australia\Queensland\Surat_Basin\Land_Access\210914_RITM0339524_Warakirri_contours_AH\RITM0339524_Property1_WarakirriContours.mxd

NOT FOR CONSTRUCTION

Print Date: 20/09/2021



Scale @ A3: 1:27,000 **Coordinate System:** GDA 1994 MGA Zone 56

Metres
0 200 400 600 800 1,000

N

Contour interval: 1 Metre

Rev	Date	Revision Description	Org	Chk'd	Eng	QA	App
0	20/09/2021	Initial issue.	AW	AH	--	--	AH

Source:
Arrow Energy Limited, Geoscience Australia, Queensland Government

Status: IFU
Issued to: A Hall
Author: awolhuter

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Surat Basin
Warakirri Asset Management Property 2

- Topography

Document: V:\Products\Australia\Queensland\Surat_Basin\Land_Access\210914_RITM0339524_Warakirri_contours_AH\RITM0339524_Property2_WarakirriContours.mxd

NOT FOR CONSTRUCTION

Print Date: 20/09/2021

Appendix 8: Soils Report

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Prepared for
Arrow Energy Pty Ltd
ABN: 73078521936

Wells and Gathering Construction

Phase 1 Desktop Soil Assessment

07-Sep-2021

Commercial-in-Confidence

Wells and Gathering Construction

Phase 1 Desktop Soil Assessment

Client: Arrow Energy Pty Ltd

ABN: 73078521936

Prepared by

AECOM Australia Pty Ltd
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ABN 20 093 846 925

07-Sep-2021

Job No.: 60651803

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Wells and Gathering Construction

Ref 60651803

Date 07-Sep-2021

Prepared by Max Setchfield

Reviewed by Navjot Kaur/Simon Muniandy

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	29-Jul-2021	Draft for client review	Navjot Kaur Technical Lead - Acid Sulfate Soils	
0	07-Sep-2021	Final	Navjot Kaur Technical Lead - Acid Sulfate Soils	

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List of Figures

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was appointed by Arrow Energy Pty Ltd (Arrow) to undertake a desktop soil assessment for the proposed development of new wells and gathering (herein referred to as the 'Project'), to support Arrow's Regional Interests Development Approval (RIDA) application under the Regional Planning *Interests Act 2014* (RPI Act).

The proposed Project is located approximately 15 km south-west of Dalby along the Moonie Highway, shown in **Figure 1**.

1.1 Site Description

The impacted land parcels and approximate disturbance areas are summarised in **Table 1**:

Table 1 Project disturbance area

Petroleum Tenure (PL)	Land parcel	Parcel size (Ha)	Disturbance area (Ha)
PL 252/ PL 260	Lot 57 of SP193329	294.9	11.3
	Lot 36 of DY45	89.0	0.51
PL 260	Lot 1 of RL2451	12.6	0.12
	Lot 1 of DY931	241	11.78
	Lot 70 of DY138	254.9	4.8
	Lot 1 of RP154777	245.7	8.65
	Lot 1 of DY787	266.4	6.2
	Lot 60 of DY802	129.2	2.8
	Lot 2 of RP106958	127.8	1.1
Total		**1661.5**	**47.26**

1.2 Proposed Disturbance

The two main components of the Project are construction of well pads and associated gathering pipeline and other infrastructure. A generalised disturbance overview of these components is given below.

1.2.1 Well Pads

In general, the sizes of the well pads can be managed so that the maximum level of overall disturbance is consistent with the existing EA intensity of impact (1 ha per well for a single well pad to 0.3 ha per well for up to eight well pad).

The size of well pads is determined by several factors, including

- the number of wells,
- the type of wells,
- the type and manoeuvrability of drill rigs,
- the terrain which determines whether cut and fill earthworks are required,
- whether the area is cleared or supports vegetation,
- the existing land use,
- the equipment stored temporarily on the pad,
- the area required for offices, light vehicle parking, equipment and supplies deliveries and

- the required separation distance between wells and the area required to complete drilling operations safely.

In some cases, additional area is required for areas with higher slope, heavy vegetation and/or to provide sufficient room for cut and fill earthworks batters, diversion drainage and additional erosion and sediment controls. As such, including the additional area (if needed), the total disturbance area varies between 1 ha for single well pads, 1.15 ha (2-well pad), 1.3 ha (3-well pad and 1.45 ha for 4-well multi-well pad.

Well locations will be determined following consultation with the landholder to manange impacts to their operations and lifestyle. . As such, well sites are located in areas that reduce impact on farming where possible, such as:

- on the fringes of Intensively Farmed Land (IFL)
- in corners of paddocks
- or areas of land unsuitable for farming
- on or near access tracks, easements and road reserves
- Right of ways

The key steps in the well pad construction are given below:

- Clearing of the area (if not already cleared by agricultural activities), including stripping and stockpiling of topsoil. For minimal disturbance well pads the topsoil will be left in place.
- Laying and levelling the well pad foundations to provide a stable platform for the drilling rig.
- Carrying out site preparation works using earthmoving equipment such as graders, excavators and bulldozers. Where the subgrade material is deemed to be inadequate and unsuitable for heavy vehicle access or where all weather access is required, consideration shall be given to:
    - Amendment of soil (using additives and / or dynamic compaction); or
    - Use of technologies (rig mats, tracked vehicles, roll-out sheets, etc.); or
    - Clear, grub and remove unsuitable material and replace with more suitable material such as gravel.

For this Project, a total of five well pads are being proposed including one minimal disturbance well pad.

1.2.2 Gathering and Pipelines

The main disturbance area will be a common easement, containing water/gas pipelines and fibre optic/power cables within an approximately 30 m wide right of way (ROW) for gathering on these properties. (**Plate 1**).

Conventional trenching for pipeline installation involves an open trench between 1-2 m wide and approximately 2.0 m deep to install, inspect or maintain piping, conduits or cables. After installation, the trench is backfilled with the original material and the surface is restored.

Where the pipelines are required to be installed below existing roads or infrastructure, other trenchless technologies such as thrustbore may be used.

The key steps in the pipeline construction are given below:

- Detailed survey of the ROW and construction areas.
- Establishing temporary access tracks if necessary.
- Installing temporary gates and fences as required.
- Clearing vegetation, where required, and grading the ROW to prepare a safe construction working area (on average the ROW will be 30 m in width).
- Separating and stockpiling topsoil and subsoil to protect and preserve topsoil.

- Crossing watercourses, roads and existing buried pipelines by open cut, boring or alternate trenchless technology (e.g. Horizontal Directional Drilling [HDD] methods) depending upon the type and nature of the crossing.
- Delivering pipe sections along the ROW.
- Welding the low-pressure high-density polyethylene (HDPE) pipe sections together to form ‘a string’.
- Creating a trench in which to lay the pipeline. The trench is excavated by a trenching machine and may include the use of rock saws, excavators, rock hammers or blasting in hard rock terrain.
- Lowering the pipeline strings into the trench and placing padding (e.g. screened trench subsoil) around the pipe to protect the pipe from external damage.
- Returning the subsoil and topsoil to their original horizons.
- Testing the integrity of the pipeline by pneumatic testing or filling it with water and pressurising it to above the maximum allowable operating pressure (i.e. hydrostatic pressure testing).
- Cleaning up, restoring and progressively rehabilitating the construction ROW and all temporary and permanent tracks, gates and fences.

Installation of multiple pipelines in a single ROW is sequential. The first pipeline is installed, and the trench backfilled before the next pipeline installation commences.

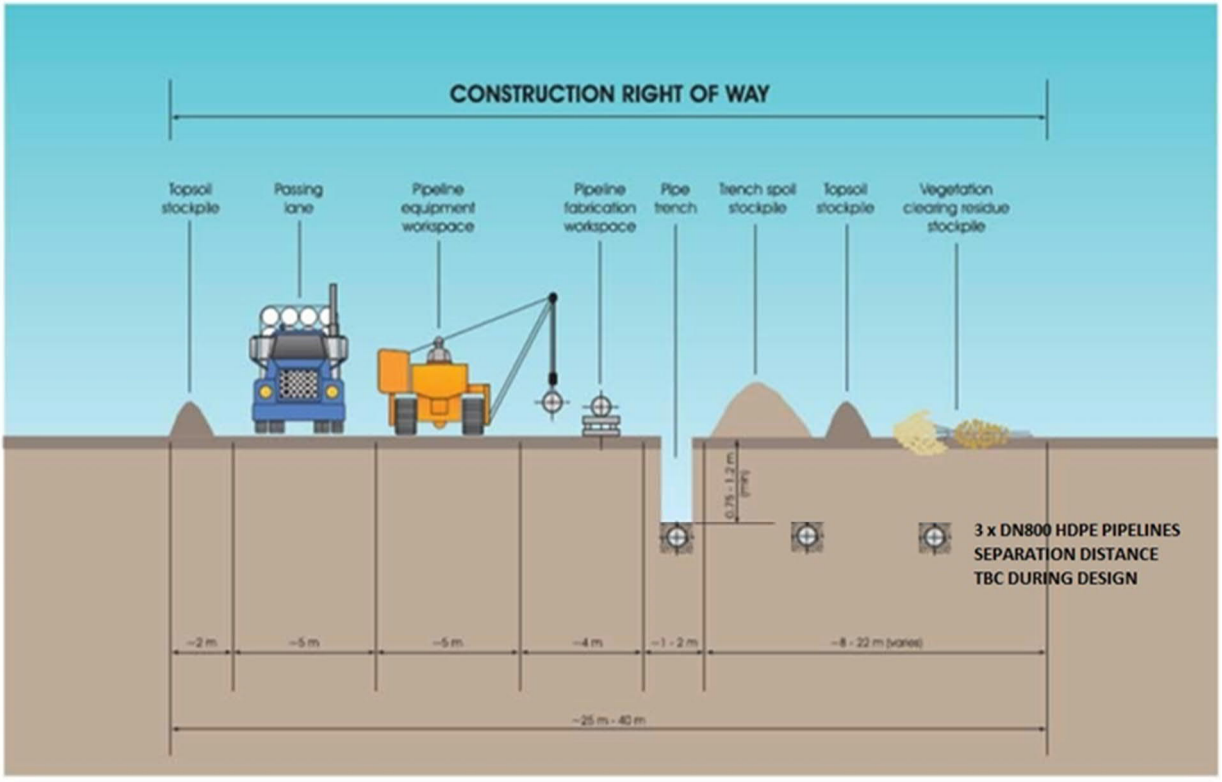
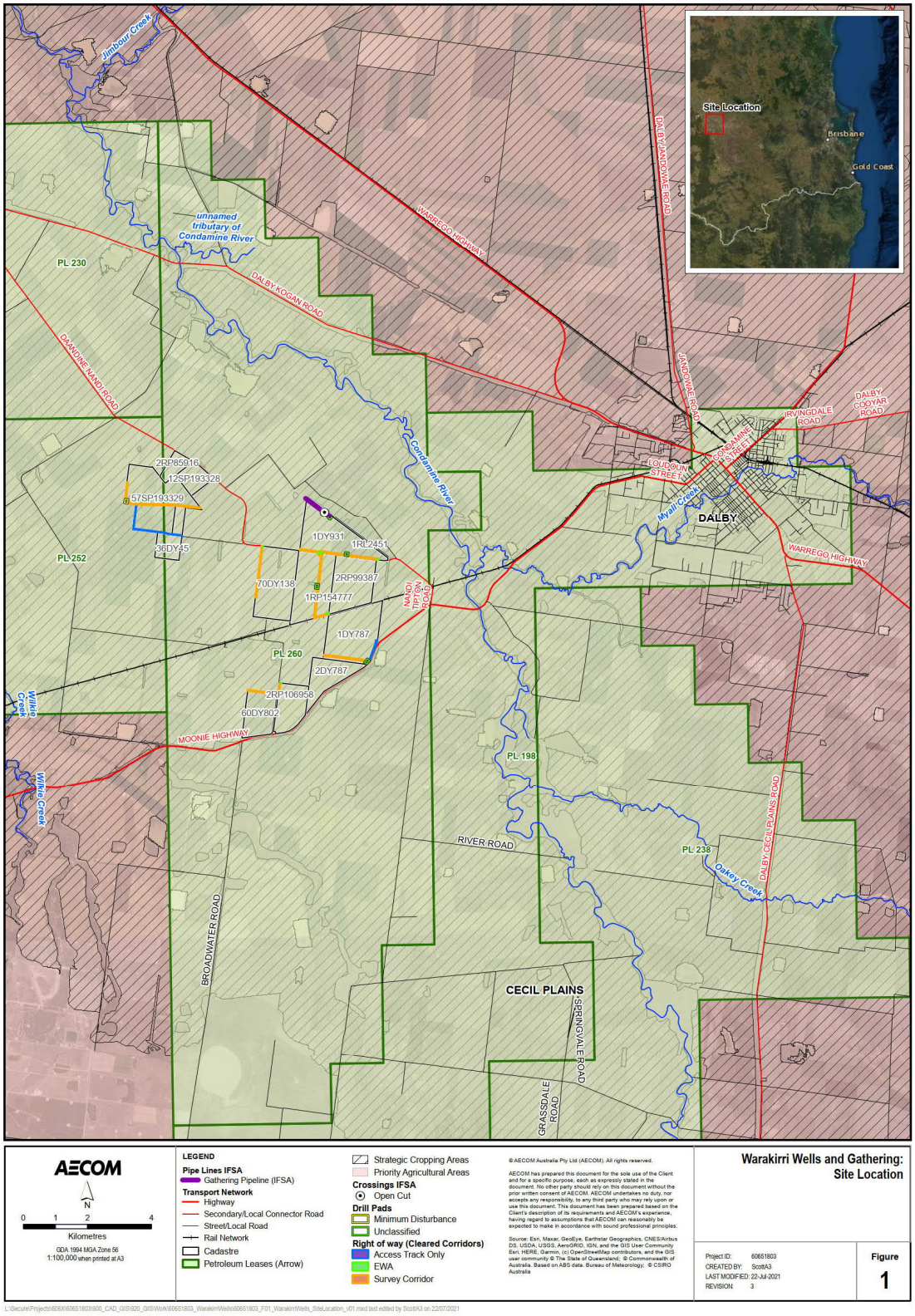


Plate 1 Typical Pipeline ROW Layout

Figure 1 Project Site Location



2.0 Objective

The key objectives of the desktop soil assessment for the Project were to:

- Assess various soil types within the Project.
- Assess key issues including soil degradation, loss of productivity and subsidence related to the identified soil types.
- Provide strategies to manage these identified soil issues during construction.

3.0 Scope of Works

The scope of works for undertaking the desktop soil assessment includes:

- Desktop review encompassing:
  - Review of available mapping and publications sourced from the Queensland Government Open Data Portal and Queensland Spatial Catalogue.
  - Review of available data provided by Arrow relevant to the Project.
- Preparation of this desktop soil assessment report, including recommendations for each soil type including soil stripping, stockpile storage, returning topsoil and subsoil to trench, addition of ameliorants and/or fertilizers (if needed), compaction strategies, erosion controls, post-construction inspection and maintenance regimes.

4.0 Methodology

The methodology for the desktop soil assessment is summarised below:

4.1 Relevant legislation and guidelines

The key legislation applicable to the works undertaken as part of this desktop soil assessment is the RPI Act, administered by the Department of Infrastructure, Local Government and Planning (DILGP). The Act restricts the carrying out of resource of regulated activities where the activity is not exempt from the provisions of the RPI Act, or a RIDA has not been granted.

The Act identifies four Areas of Regional Interest (ARIs), including: a priority agricultural area (PAA); a priority living area (PLA); the strategic cropping area (SCA); and a strategic environmental area (SEA). The alignment (the resource activity) intersects PPA and SCA.

- PAA: an area which includes one or more areas used for a priority agricultural land uses (PALU), identified in the relevant regional plan. PALUs may include certain types of agriculture, plantations, and/or intensive horticulture. In the case of the alignment, the PALUs are identified in the Darling Downs Regional Plan.
- SCA: defined as an area mapped as potential Strategic Cropping Land (SCL) on the Department of Natural Resources, Mines and Energy (DNRME) trigger map. The SCL is likely to be highly suitable for cropping due to a combination of the soil, climate, and landscape features.

This desktop soil assessment has been prepared in accordance with Australian legislations, Standards and Guidelines and Arrow's Standard Operating Procedures (SOP) for Surat Basin including:

- *RPI Act, Statutory Guideline 02/14, Carrying out resource activities in a Priority Agricultural Area,* State of Queensland, Department of State Development, Manufacturing, Infrastructure and Planning, August 2019
- *RPI Act, Statutory Guideline 03/14 Carrying out resource activities in a Strategic Cropping Area,* State of Queensland, Department of State Development, Manufacturing, Infrastructure and Planning, August 2019
- *Environmental Authority EA0002659 Non-Scheduled Petroleum Activity Petroleum Pipeline Licence -PPL2052,* dated 5 February 2021

- *Environmental Authority EPPG00972513,* dated 14 January 2021
- *Guidelines for Soil Survey along Linear Features,* Soil Science Australia, 2015
- *Arrow Land Disturbance Procedures* (ORG-ARW-HSM-PRO-00146)

4.2 Desktop review

The purpose of the desktop review was to obtain background information within the Project on potential soil types and landscapes, information on the underlying geology and topography and understand potential PAA and SCA limitations.

The Project area presented in the desktop mapping and interpretations is represented by a 1 km buffer applied to the proposed drill pads and gathering network (ROW, crossing and pipeline).

4.2.1 Publicly available data

The desktop review involved a search of publicly available soil data, sourced from the Queensland Government Open Data Portal and Queensland Spatial Catalogue, including:

- Priority Agricultural Area mapping (Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), 2013).
- Strategic Cropping Land trigger map (Department of Natural Resources and Mines (DNRME), 2020).
- Central Darling Downs Land Management Manual (Harris *et al.*, 1999).
- Australian Soil Resource Information System (ASRIS) Atlas of Australian Soils (Northcote *et al.*, 1960-1968).

This information was used to develop a map of soils and physical limitations for the Project.

4.2.2 Arrow provided data

Arrow provided the following data to assist in validating the potential soil types and landscapes likely to occur within the Project area, including:

- Disturbance areas of the drill pads, ROW, pipeline and crossing.
- Standard pipeline construction, rehabilitation requirements and procedures.
- Relevant Environmental Authorities (EA).

4.3 Suitably Qualified Person

AECOM confirms that the desktop review and interpretation of available data, has been undertaken directly or under the supervision of a suitably qualified person (SQP). Copies of curriculum vitae have been provided in **Appendix A**.

5.0 Desktop Review

5.1 Topography and geomorphology

5.1.1 Regional physiography

The Project area is located wholly within the Condamine Central Lowlands physiographic region (**Figure 2**). The region is described as a low-lying area of undulating siltstone hills with alluvial sediments on the floodplains of the Condamine River and highly weather bedrock on the slopes (CSIRO, 2011).

5.1.2 Topography

Regionally, there is a north-south topographic high of the Taroom Hills and an east-west topographic high of the Great Dividing Range. Two major drainage systems separate these topographic highs: the Condamine River and Wilkie Creek, both draining towards the north-west (**Figure 1**).

The surface elevation across the Project area is relatively flat at 330 m Australian Height Datum (mAHD), which is consistent with the area being located on the Condamine Lowlands and floodplains of the Condamine River (**Figure 2**) (State of Queensland, 2021).

The digital elevation model (DEM) for the Project area is presented in **Figure 3**[1], and was used to calculate the slope of the surrounding landscape. Based on the calculations, the slope within majority of the Project area range from near level (<1%) to 3%,.

5.2 Surface geology

Based on the Queensland detailed surface geology (presented in **Figure 4**) the Project area is a part of the extensive Surat and Clarence Moreton Basins, including a sequency of sedimentary rocks (Kumbarilla Beds [JKk] and Springbok Sandstone [Jis]) overlain by surficial Cenozoic sediments (undifferentiated alluvium and the Condamine Alluvium) (DNRME, 2018). These alluvium units are described as unconsolidated [Qs], poorly consolidated [TQ] and semi-consolidated [Qa] sediments typically comprised of sand, silt and clay (DNRME, 2019).

Shallow soils likely to be disturbed in the Project area are expected to be dominated by the Condamine Alluvium, which is an extensive accumulation of Tertiary to Quaternary age alluvial sediments, forming a broad (greater than 20 km wide) alluvial plain, extending from Millmerran to Chinchilla. The thickness ranges from less than 10 m to more than 120 m in the floodplain near Dalby (DNRME, 2019). The sediments are dominated by coarse grained gravels and sands, interbedded with clays. The coarse-grained alluvium is associated with higher transmissibility and are the primary source of groundwater.

[1] The DEM for the Project area was sourced from the 1 second Shuttle Radar Topographic Mission (SRTM) DEM-S (smoothed) v1.0 (Geoscience Australia, 2021).

Figure 2 Regional Physiography- Central Lowlands Province

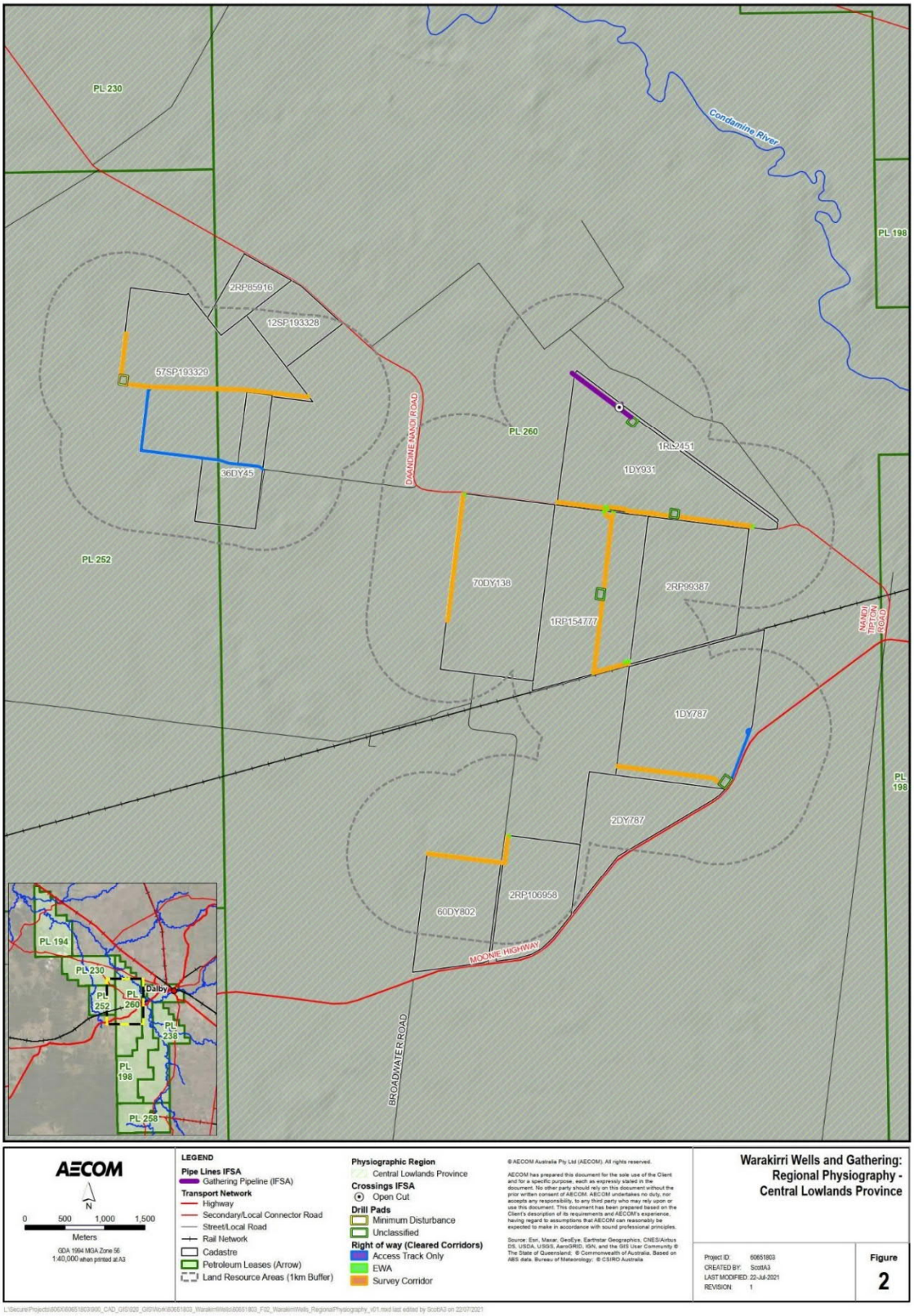


Figure 3 Slope Class and Slope Range (%)

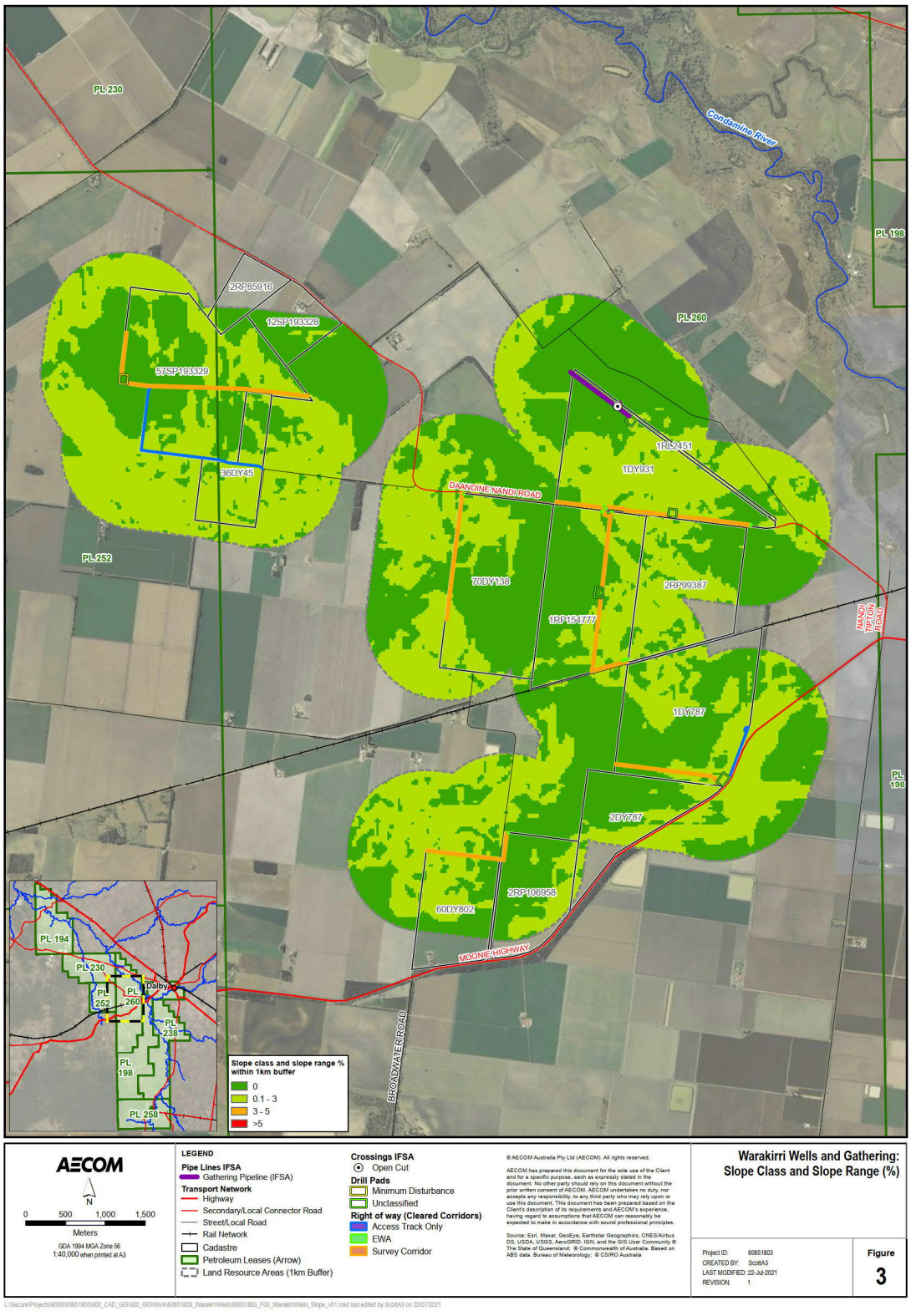
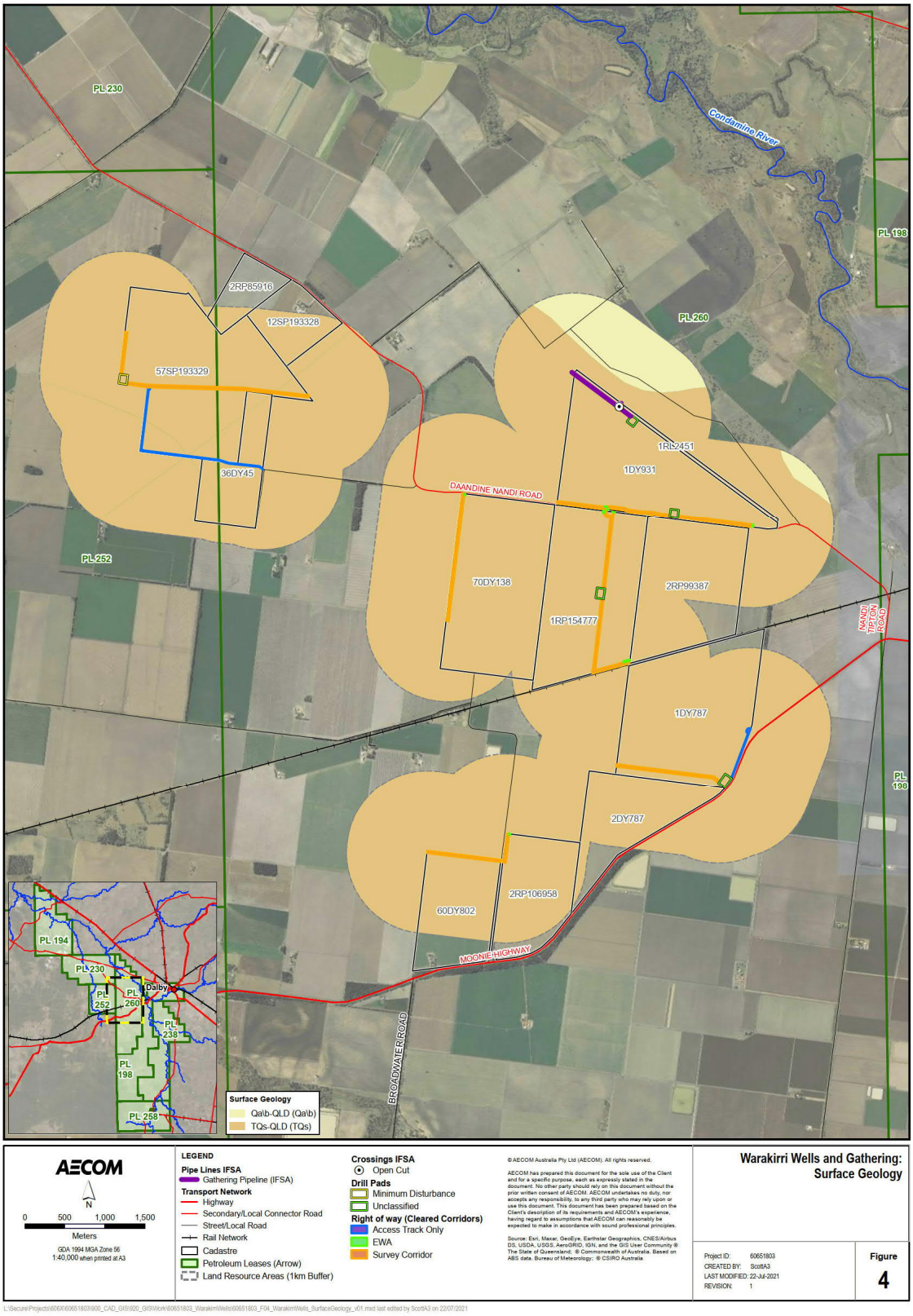


Figure 4 Surface Geology



5.3 Atlas Soil Landscape Units

The relevant soil landscape units have been sourced from the ASRIS Atlas of Australia Soil (Northcote *et al.*, 1960-1968) (herein referred to as 'the Atlas'), which was compiled by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to provide a nationally consistent description of Australian soils. Mapped units are published at a scale of 1:2,000,000, but the original 10 map compilation were at scales from 1:250,000 to 1:500,000. This scale mapping is commonly used for desktop studies.

The soil landscape units identified in the Atlas provide a description of the physical environmental, displaying the occurrence and distribution of geological regimes, landscape units and associated soil types. Soil landscape units are reoccurring soil mapping units with shared geology, landform, soil and vegetation associations. More than one soil type can occur within a landscape unit, represented with a dominate and several subdominant types.

The Atlas indicates two soil landscape units within 1 km of the proposed drill pads and gathering network, which are summarised in **Table 2**, and presented graphically in **Figure 5**.

The dominant soil type of each landscape unit is presented alongside the corresponding Australian Soil Classicisation (ASC) soil order and Principle Profile Form (PPF), to aid in the interpretation of soil types encountered along the alignment and is based on Ashton & Mackenzie (2001).

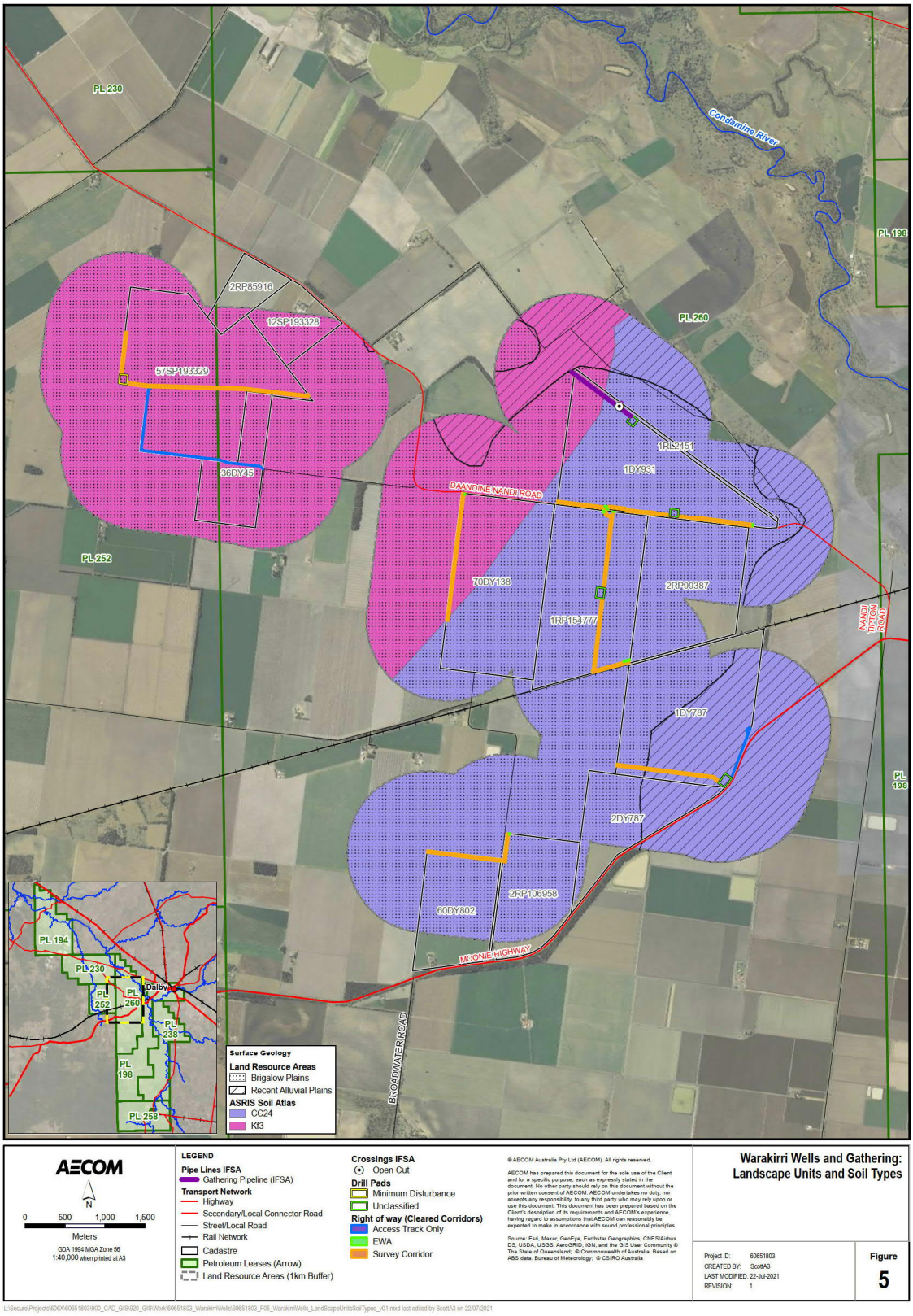
Table 2 Soil landscapes which intersect the Project

Soil landscape units	Landform description	Dominant soil type[1]	Dominant PPF[2]	Dominant ASC Group[3]
CC24	Plain	Dominant soils are grey cracking clays with some dark cracking clays	Ug5.24, Ug5.28, Ug5.16	Vertosol
Kf3	Plain with very low sandy rises and banks separated by flats and depressions	Dominant soils are dark cracking clays	Ug5.16	Vertosol

Notes:

1. ASRIS Atlas of Australian Soils (Northcote *et al*., 1960-1968)
2. Principal Profile Form (Northcote, 1974)
3. Dominant Australian Soil Classification (Isbell, 2002)

Figure 5 Soil Landscape Units



5.4 Land Resource Area: Central Darling Downs

Due to the broad scale of the Atlas (1:2,000,000), a review of the Land Resource Areas (LRA) mapping was used to further assess the soil types within the Project. LRA identified to intersect the Project are presented in **Table 3.**

LRAs have been determined from the Central Darling Downs Land Management Manual (Harris *et al.*, 1999), and are based on the combination of geology, landscape features (slope/relief), vegetation and groups of soils. LRA maps are not designed to strictly identify soils in a particular map unit but predict their probable occurrence.

Land suitability indicates the identified LRAs have agricultural potential as cropping land (broadacre and horticulture) and pasture (sown and native pastures).

Typical soil characteristics show a good correlation with the soil landscape units mapped in the Atlas (Northcote *et al.*, 1960-1968), with the Project likely to mainly encounter cracking clay soils.

The typical soil types likely to be encountered in each LRA, along with generic soil properties, are detailed in the following subsections.

5.4.1 Recent alluvial plains (1a)

Common soils within this LRA are deep to very deep (0.8 to 1.8 m) coarse, self-mulching cracking clays on recent alluvial plains on mixed basalt/sandstone alluvium. Soil are distributed along the active floodplain of the Condamine River and tributaries, including river terraces, streambanks, old river channels and plains.

Generic soil features include a medium to heavy clay, self-mulching surface soils, which are moderate to coarse and granular. The surface soil is often non-sodic and can sometimes be lightly crusted. The subsoil is commonly sodic to strongly sodic with medium to very high salinity. The profiles have an alkaline trend, consistent with depth.

The land is suitable for dryland/irrigated cropping and grazing of native pastures, depending on the risk presented by inundation and erosion.

Native vegetation has mostly been cleared but contains fringing woodland to open forests of river gum, Queensland blue gum and some acacia species.

5.4.2 Brigalow plains (5a/5b)

Typical soils associated with this LRA are deep to very deep (1.0-1.6 m), self-mulching grey cracking clays with shallow gilgai on the brigalow claysheet. Soils are located on flat to very gently sloping undulating brigalow clay plains north of Warra and around Kupunn, west of Dalby.

Generic soil features include an angular blocky surface structure, which is strongly alkaline. The subsoil is often a structured clay, with mild alkalinity in the upper subsoils, tending to strongly acidic deeper in the profile. The subsoil is both strongly sodic and saline.

The land is suitable for continual grain and cotton cropping, only limited by strongly sodic and saline subsoils. The soils are susceptible to erosive flooding.

Native vegetation has mostly been cleared but contains brigalow, belah, wilgas scrub and black tea tree in low lying areas.

Table 3 Identified LRAs in the Central Darling Downs (Harris *et al.*, 1999)

LRA	Landform description	Major soils	Estimated ASC	Agricultural land classification	Typical vegetation	Generic physical and chemical soil properties				
						Soil (m)	pH	Dispersion[1]	Sodicity[2]	Salinity[3]
Recent alluvial plains (1a): Condamine	Board level plains of mixed basaltic and sandstone alluvium	Black and grey cracking clays with bleached sands or loams over brown or black clays	Vertosol	A1 – crop land: broadacre and horticulture	Poplar box or Queensland blue gum open woodlands, or grasslands	Surface soil: 0-0.15	8.7	Low	Non-sodic	Very low
						Upper subsoil: 0.15-0.6	9.1	Medium	Sodic	Medium
						Lower subsoil: 0.6-1.4	8.1	Medium	Strongly sodic	High to Very high
Brigalow plains (5a/5b): Kupunn	Flat plains, with gently undulating clays plains with shallow to deep gilgai	Grey self-mulching cracking clays	Vertosol	A1 – crop land: broadacre and horticulture	Brigalow, belah forest with wilga with some black tea tree	Surface soil: 0-0.05	8.5	Low	Non-sodic	Low
						Upper subsoil: 0.05-1.2	9.0	Low to medium	Sodic	Low
						Lower subsoil: 1.2-1.5	4.3	High	Strongly sodic	High

Notes:

1. Clay dispersion is measured as a dispersion ratio (Baker and Eldershaw, 1993)
2. Sodicity calculated as the percentage of exchangeable sodium (ESP) (Baker and Eldershaw, 1993)
3. Salinity estimated from the measurement of the electrical conductivity in a 1:5 suspension of soil to water (Shaw, 1988)

5.4.3 Summary

Based on available chemical and physical data from the Central Darling Downs Land Management Manual (Harris *et al.*, 1999) (**Table 3**), soils within the Project are expected to have an alkaline upper subsoil (pH 8.0 to 9.0). The soils are also expected to be sodic or strongly sodic and have medium to very high levels of salinity in the subsoil. Levels of sodicity and salinity are generally expected to be lower in surface soils, increasing with depths in the soil profile.

A summary of identified LRA within the Central Darling Downs Land Management Manual (Harris *et al.*, 1999), cross-referenced with the Atlas soil landscape units and associated ASC soil classification is presented in **Table 4**.

Based on the available Atlas and LRA mapping, the soils within the Project are expected to be is dominated by self-mulching cracking clays, such as Vertosols.

Table 4 Summary of the Project soil units and LRA

LRA	Soil landscape units (ASRIS)	Dominant ASC	Land parcels	Approximate disturbance area (ha)	% of total Project area
Recent alluvial plains (1a)	CC24	Vertosol	Lot 1 of DY787	4.1	8.7%
	Kf3	Vertosol	-	0	0%
Brigalow plains (5a/5b)	CC24	Vertosol	Lot 1 of DY787 Lot 1 of RL2451 Lot 1 of DY931 Lot 1 of RP154777 Lot 2 of RP106958 Lot 60 of DY802 Lot 70 of DY138	25.4	37.5%
	Kf3	Vertosol	Lot 57 of SP193329 Lot 36 of DY45 Lot 1 of DY931	17.7	53.8%

6.0 Disturbance Management

The major limiting factors for the soils encountered within the Project area are soil structure and texture, along with subsoil salinity and sodicity issues. The proposed management options for these issues are presented in the following subsections.

6.1 Topsoil suitability and management

The generic soil properties in the Central Darling Downs Land Management Manual (Harris *et al.*,1999), were reviewed against the criteria set out in the *Selection of Topdressing Material for Rehabilitation of Disturbed Areas in the Hunter Valley* (Elliott and Veness, 1981) to determine the suitability of available soil material for reuse as topsoil, as detailed in **Table 5**. The depth of primary growth media was estimated using the reported plant available water capacity. These estimates should be reviewed following a detailed pre-characterisation assessment of soils within the Project area to assist in identifying rooting depth and nutrient deficiencies.

Table 5 Guide to estimated stripping depths

LRA	Estimated primary growth media (m)	Limiting factors
Recent Alluvial Plains (1a)	0.15-0.2	Soils have a narrow moisture range for effective workability, which can be improved by adding a sandier textured material.
Brigalow Plains (5a/5b)	0.2-0.25	Gypsum can be incorporated into the subsoil material to limit dispersion and erosion.

6.2 Soil stripping and stockpiling/storage

The Project area largely crosses existing agricultural land, with some isolated clusters of timbered areas along the lot/plan boundaries. Where clearing is required, timber should be cleared and retained for chipping or habitat recreation. Chipping can provide a useful soil amendment and limit weed growth.

Suitable topsoil should be stripped for the width of the pipeline trench and access track plus (nominally) 1 m each side of the trench. The estimated primary growth media depths provided in **Table 5** can be used as a guide.

Topsoil and subsoil (which may have dispersive or sodic subsoil horizons) should be stockpiled separately to avoid mixing. Topsoil management should be undertaken in line with the requirements listed in Arrow's *Land Disturbance Procedure* (ORG-ARW-HSM-PRO-000146).

Stockpiles are not recommended to exceed 3 m in height, to manage degradation through physical, biological and chemical processes. Based on the typical ROW construction, stockpiling is expected to be undertaken in section along the length of the trench to maintain access/egress. The stockpile should not be compacted to reduce surface runoff and facilitate infiltration.

Stockpiles should be in place for the minimum duration practicable to safely install the infrastructure, which is understood to be typically less than three months. Where practicable work should be staged to not extend over a wet season. In situations where this is unavoidable, quick vegetation such as pasture species and mulches can be used to reduce surface erosion.

Consideration should be made for drainage flow direction and diversions in place to prevent stockpile erosion. Appropriate erosion and sediment control measures should be documented prior to works commencing.

6.3 Returning topsoil/spoil to the trench

Excavated soils should be returned to the trench in the pre-disturbance soil profile. Topsoil that has been stripped can be re-spread as part of stabilisation and rehabilitation activities.

Sodic soils are expected to be encountered along the alignment and should be blended with appropriate soil ameliorants (gypsum and organic matter) during the rehabilitation process to reduce the

potential for soil dispersion. Sampling and analysis of soil prior to reuse is recommended to assist in identifying nutrient deficiencies and ameliorant requirements. The use of such ameliorants should also be discussed with landholders prior to application.

The disturbance area should be re-shaped into a stable landform with consideration for surface drainage lines.

6.3.1 Compaction Strategies

The backfilling and compaction of the trench is also dependant on the use of appropriate equipment suited for compacting soil in trenches, ensuring the soil is moisture conditioned (i.e. if the soil is too wet or dry to compact) adding moisture based on the inherent moisture content.

The soils are generally placed in thin layers (typically 300 to 400 mm), adding moisture conditioning, if needed, followed by thorough tampering with the bucket (or a roller attachment for the excavator). The site-specific compaction strategies should be informed by the geotechnical assessment and construction design for various components including well pads, gathering, pipeline, access tracks etc.

Compaction of surface layers within the ROW disturbance areas should be undertaken in a way to improve the water infiltration capacity and aeration along the contour, prior to the re-shaping and re-spreading of topsoil and revegetation.

6.4 Reinstatement and erosion controls

The different soil types traversed by the alignment have variable erodibility characteristics, determined primarily by soil structure, texture and sodicity. An overview of the erodibility ratings associated with each soil type is provided in **Table 6**, based on typical Queensland soils described in the Department of Transport and Main Roads (DTMR) Road Drainage Manual (DTMR, 2019).

An estimate of the long-term soil loss from both sheet and rill erosion can be calculated using the Revised Universal Soil Loss Equation (RUSLE) (IECA, 2008). This issue is less of a concern in the Project area due to the flat terrain, including many laser levelled paddocks.

Erosion and sediment controls should be identified, documented and implemented as part of soil preparation works. These documents should remain in place until stabilisation of the disturbance area is achieved.

Table 6 Typical Erodibility Ratings

Soil type and ASC	Description of erodibility characteristics	Erodibility rating
Uniform non-cracking clays - *Dermosols*	Light to heavy clays with strong structure: • fine aggregates • coarse aggregates	Very Low (1) Low (2) to Moderate (3)
Uniform cracking clays – *Vertosols*	Light medium to heavy clays that shrink and crack open when dry and swell when wet, gilgai micro relief common.	Low (2) to moderate (3)

6.5 Construction inspection and maintenance regimes

The disturbance area should continue to be visually monitored until such time that the site is considered effectively stabilised or rehabilitated, in line with Arrow's rehabilitation criteria. To help in adequate rehabilitation, the quantity of ameliorants needed (if any) for topsoil and subsoil based on pre-construction land use are generally calculated based on site specific laboratory analysis.

After completion of pipeline installation, cropped areas should be stabilised to combat erodible / dispersive surface soils (below topsoil) and then topped with a topsoil dressing to match the thickness and quality of the surrounding topsoils of undisturbed areas, as a minimum.

Ideally, topsoils stripped during pipeline installation would have been stockpiled and reused in the same location and to the same thicknesses to match the original soil profile as closely as was practical. Inspection and maintenance should include assessment of surface stabilisation (e.g. lack of erosion of

the topsoil / crop-supporting layer and the health of surface vegetation) in accordance with Arrow's rehabilitation criteria.

Waterway crossings (if any) might require specific inspection and maintenance regimes, which should be considered at the time of conceptualising and designing each crossing.

7.0 Conclusions

The proposed Project area intersects two ARIs, PAA (PALU) and SCA, and as such requires a RIDA application to be submitted under the RPI Act.

Based on the desktop review of the geology, landscape features, vegetation and groups of soils, two landscape units (CC24 and KF3) and two land resource areas (Recent alluvial plains and Brigalow plains) were identified within 1 km of the proposed drill pads and gathering network.

The Project is located between the Condamine River and Wilkie Creek, described as the Condamine Lowlands. The area contains low-lying siltstone hills with alluvial sediments on the floodplains of the Condamine River and highly weather bedrocks on the slopes. The low-lying area has an elevation of 330 mAHD and slope ranges from near level <1% to 3%.

The surface geology is a part of the Surat and Clarence Moreton Basins, dominated by alluvial sediments overlying sedimentary rocks. The Condamine Alluvial sediments are extensive and can range in thickness from 10 m to more than 120 m in the floodplain near Dalby.

Based on the existing mapping (a scale of 1:2,000,000), the soils within the study area were dominated by self-mulching cracking clays (i.e Vertosol). The available mapping reviewed as part of the desktop review are not designed to strictly identify soils in a particular map unit but predict their probable occurrence.

Based on available chemical and physical data from the Central Darling Downs Land Management Manual (Harris *et al.*, 1999), most soils along the alignment are expected to have an alkaline upper subsoil (pH 8.0 to 9.0). The soils are also expected to be sodic or strongly sodic and have medium to very high levels of salinity in the subsoil. Levels of sodicity and salinity are generally expected to be lower in surface soils, increasing with depths in the soil profile.

The major limiting factors for the soils encountered within the Project area are soil structure and texture, along with subsoil salinity and sodicity issues. Most issues are likely able to be controlled by suitable soil handling, construction management practices and application of appropriate spoil ameliorants (gypsum and organic matter).

8.0 Recommendations

It is recommended that a detailed soil investigation be undertaken to refine the assessment of soils identified within the Project area, with the objective to facilitate the creation of suitable control measures which are reflective of site-specific soil conditions.

Further soil investigations are recommended to be generally completed prior to any earth works commencing within the ROW.

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10.0 Limitations

AECOM Australia Pty Ltd (AECOM) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Arrow Energy Pty Ltd (Arrow) and only those third parties who have been authorised in writing by AECOM to rely on this soil assessment (report).

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It is prepared in accordance with the scope of work and for the purpose outlined in the professional services agreement (10315CNT) and Call-off-Order (COO) dated 25 November 2020.

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

Appendix A

Curriculum Vitae

Simon Muniandy
ANZ Upstream Oil and Gas Market Sector Lead

Qualifications
Bachelor of Science (Hons, Geology)

Career History

Areas of Experience
- Conventional and Unconventional Oil and Gas
- Programme and Project Management
- Contamination Assessment and Remediation
- Geology, hydrogeology, & geochemistry
- Operations Management

Career Summary
Simon is the ANZ Upstream Oil and Gas Market Sector Lead and Technical Director with more than 20 years' experience in the geoscience/environmental industry, with projects across Australia, Pacific Islands, Papua New Guinea and S.E. Asia. Simon has a leading role the Oil and Gas market sector responsible for the delivery of AECOM projects to the onshore upstream oil and gas industry across ANZ.

Simon has extensive experience in the oil and gas and mining industry specifically in the risk management of environmental liabilities related to the acquisition, operation, decommissioning and demolition of facilities associated with all aspects of these industries.

Simon has managed the design, implementation and execution of a range of environmental projects including decommissioning and remediation of fuel terminals, marine, aviation and retail facilities. Simon also has extensive experience in upstream unconventional oil and gas, including development approvals and associated environmental assessments, baseline monitoring, water/brine management related to treatment and storage infrastructure, surface water discharge and aquifer storage. Simon has also been responsible for the design, management and execution of a $20M (Office of Groundwater Impact Assessment) groundwater monitoring bore program for Santos.

Due to his achievements associated with the OGIA drilling project, Simon was awarded the URS Pyramid Award for project management in 2014.

Simon has been able to apply his oil and gas industry experience to work collaboratively to achieve his Client's objectives and develop business for AECOM across technical disciplines and geographies.

Detailed Experience

ANZ Upstream Oil and Gas Market Sector Lead
Queensland Office, AECOM Australia Pty Ltd
Simon is responsible for the delivery of upstream oil and gas projects across ANZ. His responsibilities include; health and safety, cost control, contract management, scheduling and resourcing to enable the flawless execution of AECOM projects for our oil and gas clients. Whilst Simon's remit is across all AECOM technical services, he reports to Asia Pacfic Environment Managing Director

Work Group Manager Geoscience and Remediation Services, Queensland
Queensland Office, AECOM Australia Pty Ltd
As Work Group Manager, Simon is responsible for the leadership and management of the Geoscience and Remediation Services group consisting of approximately 30 staff. Simon is accountable for the group's financial performance, technical direction, business development and the technical delivery of a wide range services including:

- Contaminated land assessments and remediation
- Hydrogeological assessments and modelling
- Geochemistry
- Soil Science
- Geophysics
- Geology

Client Management
Santos & Caltex - National Client Account Manager, AECOM Australia Pty Ltd
Simon was AECOM's national client account manager for Santos & Caltex, responsible for the successful delivery of all AECOM projects nationally and throughout the Pacific. Simon provides Santos & Caltex with a single point of contact for contract or issues critical to project delivery. Simon also is Principal in Charge for a range of Coal Seam Gas (Coal Bed Methane) groundwater and environmental projects including; the management of associated water, infrastructure decommissioning, remediation and environmental assessments. His responsibilities as the National Client Account Manager include:

- Contracts negotiation and reporting;
- Financial management;
- Project support and technical review;
- Stakeholder management;
- Strategy Planning, Budgeting and Forecasting;
- Health and Safety Management and Leadership.

Project Management
Project Manager, ExxonMobil Environmental Services - Major Projects, Mobil Oil Australia, Australia, PNG, Indonesia
Simon was the Project Manager responsible for the management of ExxonMobil's environmental liabilities associated with the operation and/or decommissioning of major facilities in Australia. Critical to the successful execution of projects was the ability to evaluate risk and prioritise a large number of sites across the portfolio, then effectively manage the environmental risk and commercial objectives for each site.

Simon has successfully completed multi-million dollar site assessment and remediation projects across Australia with a number of projects receiving recognition for flawless execution across health and safety (zero recordable incidents), on schedule and under budget. Simon was responsible for the following portfolios:

- Non-Operating Distribution Terminals and Pipelines (National);
- Aviation Terminals (National);
- Marine Fuel Terminals (Queensland);
- PNG LNG Office and Housing;
- Oil Field Divestment – Aceh, Indonesia

His responsibilities as a project manager with ExxonMobil Environmental Services included:

Duties:

- Management of environmental risks and liabilities;
- Management of consultants and contractors on major projects (>$15M AUD).
- Technical review and stewardship of environmental assessment and remediation.

Skills:

- Contractor Management;
- Cost and budget controls;
- Health and safety stewardship;
- Technical expertise including soil and groundwater remediation, and risk assessment;
- Risk management;

- Communication of project risks and analysis to stakeholders including senior management.

Oil and Gas

Project Director, Shallow Groundwater Assessment, QGC

Design and construction of 44 groundwater monitoring bores in the Surat Basin Aquifers targeted: Springbok Sandstone and Walloon Coal Measures. The groundwater monitoring program to assess CGS impacts on groundwater and potential groundwater dependant ecosystems. A small mobile drill rig to install shallow groundwater well, compliant with the Code of Practice and API specifications. The project received an QGC Wells team award for excellence.

Project Manager, Spring Gully and Taloona Evaporation Pond Assessment and Remediation

Assessment of an 83ha and 10ha brine storage and evaporation ponds, and development and design of a remedial strategy to protect nearby sensitive receptors. The multidisciplinary delivery team has produced the first remediation and approvals plan of this type in the CGS industry in QLD.

Principal in Charge, Water Facilities Upgrade Project Scotia – Design Phase, Brisbane Team, Queensland

In 2012 URS designed and subcontracted the construction and supervised the filed assembly and oversaw commissioning of a managed aquifer recharge (MAR) water injection system. URS was commissioned to design and oversee construction of the injection equipment and manage the design of the reverse osmosis plant. URS had previously successfully installed the injection bore and had performed hydrogeological testing to ensure that the aquifer had the capacity to accept the required injection volume and rate.

Principal in Charge, Deep Monitoring Program, Queensland

URS engaged a combination of large oil and gas service providers (Halliburton, Weatherford, GE Oil & Gas) and smaller scale drilling and services companies to design a turnkey approach for developing, managing and executing large scale groundwater drilling projects for Coal Seam Gas (CSG) operators.

The 16-well campaign based in Roma, targeted zones of the Springbok and Hutton sandstones to depths of up to 1,150 mBGL. In order to manage potential influxes from gas bearing units (Walloon Coal Measures), a full BOP stack (annular, double rams) was been employed, and all auxiliary gear on site (mud systems, generators, pumps) were intrinsic safety rated.

URS was responsible for the planning, procurement, management and delivery of a groundwater well installation campaign targeting aquifers in close proximity to, and underlying economics CSG reserves. Our technical team, comprising experienced project managers, field hydrogeologists, site supervisors, drilling and completions engineers enable the delivery of reliable groundwater monitoring infrastructure which is designed, drilled and completed to CSG standards.

Principal in Charge, Old Bogandilla, Emu Park Wells, Queensland

URS was commissioned to design, procure and manage the installation of a 1500m deep monitoring well at Old Bogandilla site and a 1600m deep brine injection monitoring well at Emu Park site, located near Roma QLD. The project was completed on budget without any recordable health and safety incidents.

Principal in Charge, Roma MAR Pumping Tests, Queensland

During the construction phase of the Roma Managed Aquifer Recharge Project (MAR), URS was commissioned to perform pumping tests on the Roma MAR injection bores. The objective to gain a better understanding of the hydraulic parameters of target aquifers and to determine the bore efficiency of each injection bore.

Principal in Charge, MAR Numerical Model, Queensland

The project included, update of the numerical model for injection which URS had previously designed, review baseline assessments of all private bores within the Roma MAR injection impact zone, provide recommendations on remedial actions which may be required due to injection.

Principal in Charge, Regional Bore Inventory- Data Review, Queensland

In order to comply with the Queensland Department of Environment Resource Management, Baseline Assessment Guidelines for Roma Regional Bore Inventory, the Client required data collected by their field staff to be reviewed by a third party. URS attended 10% of the baseline assessments being conducted by the Client RBI team and reviewed all information presented in the baseline assessment reports completed by the Client RBI team, enabling sign off by the regulator.

Principal in Charge, Landholder Bore Investigations, Queensland

The Client was required to conduct down-hole surveys of landholder bores in the Fairview field. The surveys will be used to establish which formation the well is screened in, review the construction of the bore and the integrity of the casing, and to determine their suitability for use as ongoing groundwater monitoring points. URS was commissioned to manage the down-hole survey of the bores and perform the data analysis of the survey data. Use of existing bores for monitoring purposes gave a large cost saving to the client.

Project Manager, Regional Bore Inventory - Roma Fairview Arcadia Valley, Queensland
The aim of the project was to collect accurate, verifiable and representative information on the private bores within and surrounding the clients' petroleum leases or Authorities to Prospect (ATPs). The baseline assessments were required to assist with any potential make good agreements with landholders and the assessment was a requirement of the Queensland Water Act 2000. The baseline assessment included all water bores within and potentially surrounding coal seam gas tenures, including water bores not formally registered or notified to the Department of Environment and Resource Management.

Project Manager, Narrabri Surface Water Monitoring, New South Wales
Development and completion of a baseline surface water monitoring program for the Clients Narrabri operations. Scope of work incudes; site familiarisation and orientation, desktop analysis and site selection, map preparation, detailed catchment characterisation, monthly field visits, sampling, preparation of post monitoring memorandums, tracking and review of laboratory data, reporting and data analysis.

Project Manager, Narrabri Environmental Monitoring, New South Wales
Field groundwater and environmental monitoring for the Narrabri operations team including, collection of 22 groundwater samples, collection of 16 raw CSG groundwater samples and collection of 5 surface water samples, and tracking and review of lab data.

Project Manager, Screening Study – Hydraulic Connectivity Studies
Assessment of telemetry bores for suitability of aquifer hydraulic assessment. There were 70 private bores that have been equipped with telemetry to monitor groundwater levels within the bores. During the regular operation of these bores by the landholder, water level data is collected on the drawdown and recovery within the wells. This information alongside flow rates and information available through various sources can be used to determine localised aquifer hydraulics. The desktop assessment through interrogation of all available information was to identify which of the approximate 70 bores have the suitability for further analysis for hydraulic assessment, based on; Groundwater level pumping and recovery data, pumping rate is constant, and availability of well flow rate or volume of water extracted.

Project Manager, Scotia MAR – Injection Equipment Modification and Implementation, Queensland
URS was commissioned to investigate the modification of existing Managed Aquifer Recharge equipment used for permanent use in a separate scheme. The study lead to a full redesign of the existing system and project management of the design of a separate reverse osmosis plant.

Environmental Studies
Principal in Charge GE Project Eldridge - Due Diligence Assessment
URS was commissioned by GE to perform Due Diligence assessment for the sale of 5 chemical sites across eastern Australia. The project required that URS complete the entire project; desk top, intrusive assessment and reporting) within two weeks. GE were able to successfully complete the transaction based on the timeliness and quality of the URS reports.

Principal in Charge – Santos Moonie to Brisbane Pipeline Assessment and Decommissioning Plans
URS were appointed as the environmental consultants to assess and manage the environmental impacts and decommission planning for the entire 300km Moonie Brisbane crude oil pipeline. Through an extensive review of operational records, URS were able to rank each section of the pipeline for the risk of impacts and tailored an assessment process for each risk level (high, medium low,). On the basis of the assessment URS identified a limited number of impacted site requiring remediation or further risk assessment, ensuring management of Santos risk into the future.

In preparation for the potential decommissioning of the pipeline URS prepared an abandonment plan recommending the most cost effective and safest options for decommissioning the pipeline along its entire length including; agricultural regions, urban residential regions, road and rail crossings, and creek crossings. On the basis of the plan Santos were able to select the best decommission techniques for all section of the pipeline.

Team Leader/Principal in Charge, Various environmental projects, Mobil/Shell/Caltex/BP, Australia, Pacific Islands, S.E. Asia
Simon has successfully filled a number of key roles (project manager, technical reviewer, Principal in Charge) on contaminated site assessment and remediation projects for the oil majors. Simon has acted as a team leader for URS contaminated site projects in Victoria, Northern Territory and Queensland where his tasks included the management and technical review of multiple projects to ensure the technical delivery of project for our Clients.

Project Manager, Department of Planning and Infrastructure, Northern Territory
Simon was the project manager for the remediation and ongoing assessment of the Darwin Waterfront Redevelopment. The project management included the development and completion of remedial work plans for each of the construction areas, independent environmental consultant supervision of construction and remedial works, ongoing groundwater monitoring of the site, assessment of former navy fuel storage tanks,

bio-remediation of hydrocarbon contaminated soil, groundwater modelling of the site, trial installation of groundwater interception drains and assessment of 800,000m^3 of imported fill.

Project Manager, Soil and groundwater contamination assessment Leederville Pty Ltd, Cranbourne South, Victoria
Soil and groundwater contamination assessment of former pastoral grazing land rezoned for residential development. Simon had involvement in the planning and conduct of the field component, project management, reporting and also remediation and validation of impacted areas. Following the final assessment report the auditor was able to provide the client with a Certificate of Statutory Environmental Audit for the site.

Project Manager, Confidential Client, Ansett Facilities, Tullamarine, Victoria
A potential purchaser of the Ansett maintenance facilities at Tullamarine required a due diligence environmental site assessment performed prior to purchase. Involvement included managing field activities on two sites simultaneously, three drill rigs and three field staff. Installation of eight groundwater wells to depths of up to 50 m and approximately 60 soil boreholes. Simon was also involved in the groundwater modelling and production of detailed lithological cross-sections and reporting.

Project Manager, Groundwater Assessment, Orica Engineering Pty Ltd, Yarraville, Victoria
A large chemical plant adjacent to the Yarra River required a detailed groundwater assessment prior to the divestment of part of the site. Simon's involvement included installing aquifer specific wells across the three significant aquifers at the site, utilising sophisticated drilling and well installation techniques. Simon also project managed the groundwater monitoring component, involving analysis of non-standard, organic, analytes.

Project Manager, Mirvac Victoria Pty Ltd, The Heath, Heatherton, Victoria
The project involved a groundwater nitrate investigation, assessment of extent and rate of migration of groundwater nitrate plume extending beneath former market garden area. This included the review of possible remediation technologies for groundwater nitrate.

Project Manager, Auspine Pty Ltd, Kalangadoo, Tarpeena, SA and Scotsdale, Tasmania
Simon was the project manager for timber processing and treatment plants, requiring on-going monitoring of groundwater to assess for potential site use impacts on groundwater. Involvement also included groundwater sampling, reporting and peer review.

Project Manager, Australand Apartments Pty Ltd, Abbotsford, Victoria
Australand were developing a former textile mill on the banks of the Yarra River in Abbotsford, Melbourne. The site requires a statement or certificate of environmental audit prior to the completion of the residential development. Involvement included project management of field staff for the installation of 11 groundwater bores, groundwater flow modelling, conceptual geological and groundwater modelling and reporting. Issues in completing to fieldwork included, drilling on an asbestos contaminated site, liaison with CFMEU representatives, OH&S consultants, local council and residents.

Project Manager, Beverford Pty Ltd, Sheep Dip Assessment, Swan Hill, New South Wales
Two former sheep dips are located in a proposed residential subdivision area. Simon's involvement included project management, initial site inspections, sampling and cement stabilisation trials for remediation and disposal of arsenic contaminated soil.

Geotechnical Investigations
Project Manager, Henty Goldmine West Coast, Tasmania
Henty was developing a major extension to the underground workings involving a long drive requiring two vent shaft for ventilation and emergency exists. Involvement included geotechnical logging the pilot hole for Vent Shaft 2, consisting of over 600 m of diamond core. Simons' involvement also extended to point load testing of core samples, organising mine geologists and field staff.

Project Manager, Temco Pty Ltd, Bell Bay, Tasmania
An additional wastewater storage dam was required by a major industry. Simon's involvement included geotechnical investigations of soil and installations of groundwater wells providing information for the dam design.

Project Manager, Comalco Pty Ltd, Bell Bay, Tasmania
A major erosion gully had developed below a historical landfill on the Tamar River causing and increase risk of a landslip occurring. Simon's involvement included soil and groundwater sampling, groundwater and landfill leachate modelling, land slip modelling using SLIP software, reporting, risk assessment and further investigation recommendations.

Project Manager, Leightons Pty Ltd, Melbourne, Victoria
A major petroleum company proposed to develop a large tank farm adjacent to West Swanson Dock. The initial assessment involved geotechnical and environmental components. Simon's involvement included geotechnical logging of 30 - 40 m deep, cored boreholes.

Project Manager, Hydro Tasmania Pty Ltd, Meander Dam, Meander, Tasmania
Soil mapping and sampling to locate sufficient quality and quantity of clay to construct an earth dam wall. Issues included working in remote areas and logistics.

Project Manager, Eastern Treatment Plant, Tertiary Treatment Plant Investigation, Melbourne, Victoria
Excavation of approximately 20 testpits and the construction of three groundwater piezometers to provided geotechnical information for the design of the tertiary treatment plant. Testpits were excavated to a depth of 4 m and bag and bulk samples were collected, in-situ consistency was measured and lithologies logged. Bulk samples were used for standard compaction tests and bag samples were used for particle size analysis and Atterburg limits. Three deeper boreholes were advanced with SPTs performed and U63 collected during drilling. Piezometers were then installed to investigate groundwater levels in the area. Simon's involvement included the reporting of this project which establishing background geology and hydrogeology, summarising field results, laboratory results and allowable soil bearing pressures.

Project Manager, John Mullen Partners, Aldi Food Stores, Melbourne, Victoria
The project involved a joint geotechnical and environmental investigation of numerous proposed Aldi Food stores in Melbourne. Simon's involvement in these projects ranged from fieldwork to project management. The geotechnical component consisted of a limited number of testpits, usually one at each corner of the proposed building and one or two in the vicinity of the proposed car park and CBR testing and limited reporting on allowable bearing pressures for footings and reporting CBR results for pavement design.

Project Manager, Melbourne Water, Mains Water Supply Pipeline, Melton, Victoria
The project involved the geotechnical investigation of a small section of a proposed mains water supply pipeline, where the proposed route went beneath a railway. Simon's involvement included drilling two auger and cored bores on either side of the railway, the installation of piezometers in each bore and surveying the borehole levels. The core was logged, specifically weathering, fracture density and hardness. This information was reported and supplied to the contractor for excavation design.

Project Manager, Melbourne Water, Bridge Investigation, Koo wee rup, Victoria
A geotechnical investigation of a small bridge crossing was required for this project. Simon's involvement included drilling two boreholes, conducting SPTs and collection U63 tubes during drilling and the installation of piezometers. Reporting consisted of regional and local geological and hydrogeological conditions, field and laboratory results and discussion of soil bearing capacities.

Project Manager, Nillumbik City Council, Bridge Investigation, Diamond Creek, Melbourne, Victoria
The project involved a geotechnical investigation of a small foot bridge. Simon's involvement included drilling two boreholes, conducting SPTs and collection U63 tubes during drilling, the installation of piezometers and performing DCPs. Reporting consisted of regional and local geological and hydrogeological conditions, field and laboratory results and discussion of soil bearing capacities. In addition, the project involved liaison with anthropologists and representatives of the local aboriginal tribe.

Project Manager, Radfords Abattoir Pty Ltd, Effluent Lagoon Liner Investigation, Warragul
As a part of a wastewater irrigation project a geotechnical investigation of a proposed effluent storage lagoon site was performed. Simon's involvement ranged from project management to fieldwork. A number of testpits were excavated and bulk samples collected for compaction and tri-axial permeability testing at a range of compaction and moisture conditions. Based on the results of the fieldwork and laboratory results, recommendations were made as to the suitability of the material for uses as a lagoon liner and the required compaction and moisture conditions for the construction of the liner.

Mining
Exploration Geologist Duketon, Western Australia
Exploration geology experience involved a broad range of field, office and managerial tasks. Simon was involved in fieldwork including design and implementation soil sampling program, regional and local scale geological mapping, regolith mapping and geomorphology mapping, groundwater level mapping and supervision of test bore installation for dewatering, supervision and logging of RC, RAB, and diamond core drilling. Office work consisted of database management, GIS management including plan and section production, ore body modelling and wire-framing and geological interpretation and drilling program design. Managerial work consisted of logistical organisation, coordinating drill-rigs and other associated heavy machinery, field technicians, and surveyors.

Wastewater Projects
Exploration Geologist Kraft Foods Ltd, Mil Lel, Mt Gambier, South Australia
The project involved wastewater irrigation assessment and monitoring. High strength, industrial wastewater has been irrigated onto pasture for a number of years. Environmental Protection Act (EPA) required as a part of the licence agreement, the annual monitoring of soils

and biennial monitoring of groundwater, to be reported annually. Simon's involvement included project management, fieldwork and reporting. The report summarises the data, interpolates trends and makes recommendations for reducing adverse environmental impacts. The report is reviewed by an independent reviewer for South Australian EPA.

Exploration Geologist, Starwood Pty Ltd, Bell Bay, Tasmania
Wastewater irrigation assessment for a wood processing plant proposing to reuse the wastewater generated from the plant. The Department of Primary Industries, Water and Environment (DPIWE) required a detailed assessment of the soil and groundwater characteristics of the proposed irrigation site before irrigation could commence. The assessment included soil mapping and sampling, groundwater well installation and sampling, infiltration, permeability and water holding capacity testing. Simon was involved in project manager, fieldwork and reporting.

Exploration Geologist, North West Rendering Pty Ltd, Devonport, Tasmania
Wastewater irrigation and effluent lagoon assessment for a proposed rendering plant site in northern Tasmania. The assessment consisted of soil mapping, soil sampling, infiltration and permeability testing and a lagoon condition assessment. Simon had involvement in project management, soil sampling, permeability and infiltration tests, and reporting.

Exploration Geologist, Sandhurst Development Joint Venture Pty Ltd, Carrum Downs, Victoria
A large residential and golf-course development is utilising treated effluent from the Eastern Treatment Plant for irrigation purposes. Prior to irrigating the effluent EPA require baseline groundwater quality data. The project consisted of the installation and sampling of groundwater monitoring wells and the decommissioning of old irrigation wells. Simon was involved in project management and reporting.

Exploration Geologist, Melbourne Water, Werribee Golf Course and Equestrian Centre, Werribee, Victoria
Western Treatment Plant is providing the Werribee golf course and equestrian centre with treated effluent for irrigation. Prior to irrigating the effluent *EPA* require baseline groundwater quality data. The project consisted of the installation and sampling of groundwater monitoring wells. Simon was involved in project management and reporting.

Exploration Geologist, Coliban Water, Envirosafe 2001, Victoria
Conducting site selection and site assessment for wastewater treatment projects in seven regional Victorian towns, involving GIS assessment, detailed soil and groundwater assessments, permeability testing, salinity susceptibility and agronomic recommendations. The work was performed in conjunction with geotechnical and anthropological assessments.

Exploration Geologist, Wagga Wagga City Council, Wagga Wagga, Victoria
A new industrial area located to the north of Wagga Wagga required a new large effluent treatment system. Simon's involvement included geophysical interpretation and field soil mapping to determine the suitability of proposed effluent irrigation sites.

Exploration Geologist, Oztek Rendering Plant Wadonga, Victoria
As a part of a works approval application for the rendering plant, Oztek required the installation of a groundwater monitoring network surrounding the effluent treatment lagoons and irrigation area. Simon's involvement included, project management and data interpretation and reporting of results to EPA for the works approval.

Exploration Geologist, Epsom Racecourse Redevelopment, Cheltenham, Victoria
The project required the redevelopment of the Epsom racecourse required the relocation of a significant remnant wetland, requiring a detailed soil and groundwater assessment of the existing wetland and the proposed relocation position. This included analysis of bulk density, permeability and major chemical constituents of the soil.

Training
Santos Eastern Queensland, NSW and Cooper Basin Level 1 & 2 inductions

URS Project Manager Certification - 2012

First Aid International Training - 2012

ExxonMobil Stakeholder Engagement Training - 2011

ExxonMobil LPS Training 2007 (annually updated through 2012)

40hr URS Health and Safety Training - 2004

URS Project Management Training (2 days) - 2004

ExxonMobil Incident Investigation Training - 2005

Fundamentals of Groundwater Science, Technology and Management - 2002

Defensive driving and FWD course - 1999

Mining and Resource Contractors Safety and Training Association (MARCSTA) - 3 day training course - 1999

Remote Area Survival Course - 1999

Professional History

2012 - Present
AECOM Services Pty Ltd (formerly URS Australia Pty

Ltd), Brisbane
Principal Geologist

2008 - 2011
Mobil Oil Australia
Contractor

2004 - 2008
URS Australia Pty Ltd, Melbourne
Associate Environmental Scientist

2003 - 2004
Coffey Geosciences Pty Ltd, Victoria
Victorian Environmental Manager

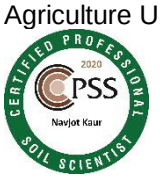
2001 - 2003
Coffey Geosciences Pty Ltd
Environmental Scientist

2000
Van de Graaff and Associates Pty Ltd
Soil Scientist

1999
Johnson’s Well Mining
Exploration Geologist

Navjot Kaur
Technical Lead - Acid Sulfate Soils, Principal Soil Scientist

Qualifications
Certified Professional Soil Scientist (CPSS) 2016 to present
MSc (Hons) Agronomy, Punjab Agriculture University, Punjab, India
BSc (Hons) Agriculture Science, Punjab Agriculture University, Punjab, India



Affiliations
Member of Australian Society of Soil Science
Member of Australian Land and Groundwater Association

Awards
URS International Pyramid Award of Excellence - Health and Safety 2011

URS International Pyramid Award of Excellence - Health and Safety 2009

URS 4sight Health and Safety Excellence Award - 2008

University Merit scholarship and awarded merit certificate in Both BSc and MSc

Career History
Navjot Kaur is an Environmental professional with technical background and competent knowledge of soil science and more than 17 years' experience in working with natural resource sector with respect to environmental management. At AECOM she is placed as Principal Soil Scientist with the Geoscience and Remediation Services team.

Her project experience includes environmental impact statement (EIS) assessments from soils perspective including land and soil classification as per Australian Soil Classification (ASC) system; Land Suitability, Land Use, Good Quality Agriculture Land (GQAL) and Strategic Cropping Land (SCL) assessment; Identification and management of acid sulfate soils (ASS); Land Rehabilitation including assessment of potential impacts of problem soils and mitigation measures, erosion and sediment control, topsoil reuse and management

She was also involved in various contaminated site assessments involving Phase I and Phase II site investigations including soil and groundwater sampling, Quantitative and Qualitative Risk Assessment for human health and environmental receptors and Remediation works including development of sampling and analysis plans (SAP), remedial action plans (RAP) and site management plans (SMP).

Her project management experience includes scope development, cost estimation, project administration, budget management, cost control, project completion sub-contractor administration, bid/tender evaluation, procurement and invoicing. She was also involved in supervision of junior staff and sub-contractors

She also has extensive experience with various data management software (gINT, ESDAT, EQUIS) and MS office for graphs, logs, presentations, statistics and report preparation.

Detailed Experience
Navjot's range of experience includes conducting environmental management works on oil & gas, mining, commercial and industrial sites undertaking the following:

- Environmental Impact Assessment
  - Soil and Land Classification based on Australian Soil Classification System
  - Land Suitability, Strategic Cropping Land (SCL) and Topsoil assessment
  - Identification and management of Acid Sulfate Soils (ASS)
  - Site reinstatement and rehabilitation
- Environmental Sites Assessment and Remediation:
  - Environment and Human health risk assessment and mitigation
  - Soil, soil gas, surface water and groundwater investigations
  - Remediation of hydrocarbon, metals, salts and solvent impacted sites
- Environmental Compliance:
  - Environmental Management Plans (EMP) development and implementation
  - Environmental audits (internal and 3rd party) and approvals/ license documents
  - Incident response, monitoring, sampling, mitigation, and reporting
- Water Management:
  - Dewatering programs and groundwater treatment systems
  - Bore drilling and well installation; compliance monitoring and sampling
- Waste Management:
  - Contaminated/ hazardous and non-hazardous waste management and transport
  - Drilling waste management including drilling muds disposal
- Health, Safety & Environment:
  - Development and implementation of project specific health and safety plans
  - Conduct inductions, risk assessments, incident investigation, auditing
- Data management, Interpretation and Report Writing
  - Data management software (gINT, ESDAT, EQUIS) and MS office for graphs, logs, statistics and report preparation
- Project Management:
  - scope development, cost estimation, project administration, budget management, cost control and project completion
  - Contractor administration, bid/tender evaluation, procurement and invoicing
  - Supervision of junior staff and contractors

Key Projects at AECOM:

- Acid Sulfate Soils intrusive investigation and development of ASSMP for Cross River Rail – Rail Integration System (RIS) – Lead Acid Sulfate Soils Specialist - Co-ordination of fieldwork, data analysis, interpretation and Reporting
- Frac Ponds Decommissioning and Rehabilitation, QGC, Technical Lead and Project Manager. Co-ordination of fieldwork, data analysis, interpretation and Reporting
- Acid Sulfate Soil assessment for road upgrade works at Walkerston Bypass, Mackay, Project – Desktop assessment, data analysis and reporting as per Qld Guidelines
- Contaminated land and Acid Sulfate Soil assessment for underground rail tunnel in Brisbane – Desktop assessment
- Acid Sulfate Soil assessment for road upgrade works at Port Alma Road, Bajool, Project – Desktop assessment, data analysis and reporting as per Qld Guidelines
- Stage 1 and Stage 2 Contamination Investigation across the whole RAAF Base Amberley – Desktop, fieldwork, data analysis and reporting
- Stage 1 and Stage 2 Contamination Investigation across the whole Gallipoli Barracks Enoggera – Desktop, fieldwork, data analysis and reporting
- Stage 2 Contamination Investigation across the whole Jennings Defence Base – Desktop, fieldwork, data analysis and reporting
- Soil Assessment for PFAS and other Contaminants for Growler Project, RAAF

Amberley - Desktop assessment, data analysis and reporting

- Coastal Acid Sulfate Soil assessment (CASS) for North East Link (NELA) Project – Desktop assessment, data analysis and reporting as per Victorian Guidelines
- Land Capability Assessment for onsite Effluent Disposal at a site in Melbourne. It included assessment of topsoil and subsoil and water balance calculations.
- Coastal Acid Sulfate Soil assessment (CASS) for Melbourne Metro Project – Desktop assessment, data analysis and reporting as per Victorian Guidelines
- Stage C Groundwater Assessment – AACO Base, Oakey – Reporting
- Groundwater Radioactive Assessment - Defence Science and Technology Group, Fishermans' bend – Fieldwork and reporting
- Exxon Mobil Altona Refinery Sediment Assessment - project management and reporting
- Coastal Acid Sulfate Soil assessment (CASS) for Edithvale and Bonbeach Level Crossing Removal (LXRA) Projects - Desktop assessment, data analysis and reporting as per Victorian Guidelines
- Project manager, Soil sampling at Oakey Base for PFC assessment in Soils for disposal
- Project manager, Soil sampling at Oakey Civil Terminal for PFC assessment in Soils for disposal
- Santos Remediation Project at Roma – Project team, fieldwork and reporting
- Oakey Groundwater Investigation, AACO base Oakey – Project team, fieldwork and reporting
- Growler Project, RAAF Base Amberley Additional Soil Characterization including assessing soils for PFC contamination
- C-17 Project RAAF Base Amberley Additional Soil Characterization including assessing soils for PFC contamination
- Contamination Investigation for Acid storage dam, Incitec Pivot, Phosphate Hill
- Origin Energy, Deep Drilling for groundwater monitoring wells at Ironbark.
- LendLease – RNA Showgrounds Development Project – Contaminated land and ASS investigation and management – Team member
- Part of the Team for Origin Energy CSG Dams Remediation Project SELECT Phase
- Defence – RAAF Base Amberley, Phase 1 and site contamination Investigation, C17, Growler, Battlefield airlifter etc. – fieldwork and reporting
- Caltex Gold Coast Airport, JUHI and PRA Remediation including ASS management
- UPSS Inspections at various sites for Goodman Pty Ltd – Project Team, fieldwork and reporting
- Deputy Project manager (DPM) for BP contaminated land investigation at Charters Towers.
- Caltex Sites Groundwater Investigation at North Queensland - DPM
- Origin Energy former gasworks sites Bundaberg, QLD Project Team, fieldwork and reporting.
- Origin Energy former gasworks sites, Maryborough, QLD Project Team, fieldwork and reporting.
- Remediation Plans for Origin Energy former gasworks sites at Warwick and Bundaberg, QLD Team lead.
- Part of the Team for Origin Energy CSG Dams Remediation Project Phase 2.
- Origin Energy Asbestos Investigation Project – Project Team, fieldwork and reporting.
- Caltex UPSS 2014, reporting for select sites.
- Phase I Environmental Investigation at different sites for Goodyear Pty Ltd – Project Team, fieldwork and reporting
- Soils and topography as part of the EIS for a major underground combined Bus and Train (BAT) tunnel project in Brisbane – Team lead.

Historical Projects:

- Groundwater monitoring sampling and report writing for key Shell retail and distribution sites in and across Brisbane – Project team
- Groundwater investigation including halogenated compounds for an Industrial site

(BOC), fieldwork and report preparation – Project team

- Environmental Site assessment (Phase I and Phase II) – Project Manager/Site Supervisor.
- Posted on secondment for an year with a major CSG project (Santos), Data manager for Quality control and assurance of environmental data
- CSG Pipeline Construction (Origin Energy via East Coast Pipeline) – Project Manager, SCL and Topsoil Assessment.
- Disposal Options for Drilling Muds for CSG industry (Origin energy) – Project Team, Desktop review, field trials.
- CSG Gas fields EIS – Project Team, Soil survey and land assessment.
- Major underground tunnel project – Team lead, ASS investigation and management.
- Site closure for Box cut mine – Team Lead, Dewatering, Soil treatment and re-interment.
- Soils and groundwater remediation including ASS soils management at a major fuel distribution centre (ExxonMobil) – Project Team
- ASS soils investigation for various projects at Brisbane Airport including fieldwork – Project team
- Marine sediment sampling program associated with the proposed LNG (Liquefied Natural Gas) plant in the Port of Gladstone (Santos)
- Marine Sediment analysis involving a proposed dredge area for the removal of the subsea section of a decommissioned pipeline bundle (Caltex Refineries Pty Ltd)

Conferences
Soil Science Conference, Canberra, 2018

Mine Closure, Brisbane 2012

Training
- AECOM Certified Project Manager
- Acid Sulfate Soils; Identification, Assessment and Management, Three day short Course
- Nature and Distribution of Queensland Soils as per Australian System of Classification, Two Day Training
- Software Training gINT, Three day training
- Software Training ESDAT, one day training
- How to Write Effective Reports, one day training at Australian Institute of Management (AIM)
- 40 Hour Health and Safety Training (HAZWOPER)
- 30215 QLD Construction Industry Safety Induction (Blue Card)
- PMASUP236A Operate Vehicle in the Field 4WD,
- Santos Environment Health and Safety Induction Rev 7.3 including gas Certificate
- Senior First Aid and CPR training
- Australian Institute of Petroleum Permit System
- MOBIL Loss Prevention System Training
- Shell Coles Express Online Induction A and B
- Shell Approved Retail and Distribution Permit Holder Training
- Working in Electrified Territory (WET), Safely Accessing the Rail Corridor (SARC), Fatigue Management, Category 3 Medical
- Rail Industry Worker (RIW) card

Other Languages
Punjabi, Hindi

Professional History

2020 - Present
AECOM
Principal Soil Scientist – Technical Lead Acid Sulfate Soils

2016 - 2020
AECOM
Senior Soil Scientist - RCE

2014 - 2016
AECOM
Professional Environmental Scientist - RCE

2008 - 2013
URS Australia Pvt Ltd
Soil Scientist

2005 - 2008
Simmonds and Bristow Pvt Ltd
Scientist

2003 - 2004
Sydney Environmental & Soil Laboratory Pvt Ltd
Analyst

Appendix 9: Summary of Progress of Consultation (Confidential – Not for Public Release)

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Appendix 10: Arrow CSG Water Management Plan

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target zero

Appendix 10 - CSG Water Management Plan

Surat Gas Project

CSG Water Management Plan

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Contents

Tables

Figures

1. Introduction

1.1 Location and Project Description

This Coal Seam Gas Water Management Plan (CWMP) is for Arrow Energy Pty Ltd.'s (Arrow) Surat Gas Project (SGP). The project development area is located approximately 160 km west of Brisbane in Queensland's Surat Basin and extends from the township of Wandoan in the north towards Millmerran in the south, in an arc through Dalby (Figure 1-1). The towns of Wandoan, Chinchilla, Kogan, Dalby, Cecil Plains, Millmerran, and Miles are located in or adjacent to the project development area.

The SGP will be a phased development over the approximate 40 year life of the project. Within the Surat Basin Arrow operates existing domestic gas facilities referred to as the Dalby Expansion Project (DXP). The SGP will utilise existing DXP water assets (e.g. dams and water treatment plants), and will also provide water to existing QGC operated assets. Over the life of the project, new assets will be developed by drilling wells and constructing associated infrastructure to transport both gas and water.

The project development area comprises Petroleum leases (PLs) 194, 198, 230, 238, 252, 258, 260, 185, 253, 304, 305, 491, 492, 493, 494, 1039, 1040, 1041, 1042, 1043, 1044 and ATP 676.

1.2 Purpose

The purpose of this CWMP is to:

- Address the requirements of section 126 of the EP Act as required for a site specific EA application (in this instance a site specific amendment application) ;[1]
- Address Arrow's commitment under the Surat Gas Project Environmental Impact Statement (EIS) to produce a CWMP; and
- Describe how SGP's CSG water will be managed in a way that protects and maintains environmental values whilst balancing social and economic considerations.

This CWMP has been prepared in accordance with the following Queensland Government regulatory guidance documents:

- The *Environmental Protection Act 1994* (Qld) (EP Act) – specifically Section 126 (1) and 126 (2); and
- The Department of Environment and Heritage Protection *Coal Seam Gas Water Management Policy*[2] – specifically its prioritisation hierarchy for managing and using CSG water and for managing saline waste.

Figure 1-1 Surat Gas Project Development Area

[1] Section 126 requirements for each project EA are provided as part of each site specific EA application.

[2] Queensland Department of Environment and Heritage Protection (2012*), Coal Seam Gas Water Management Policy*.

Plan

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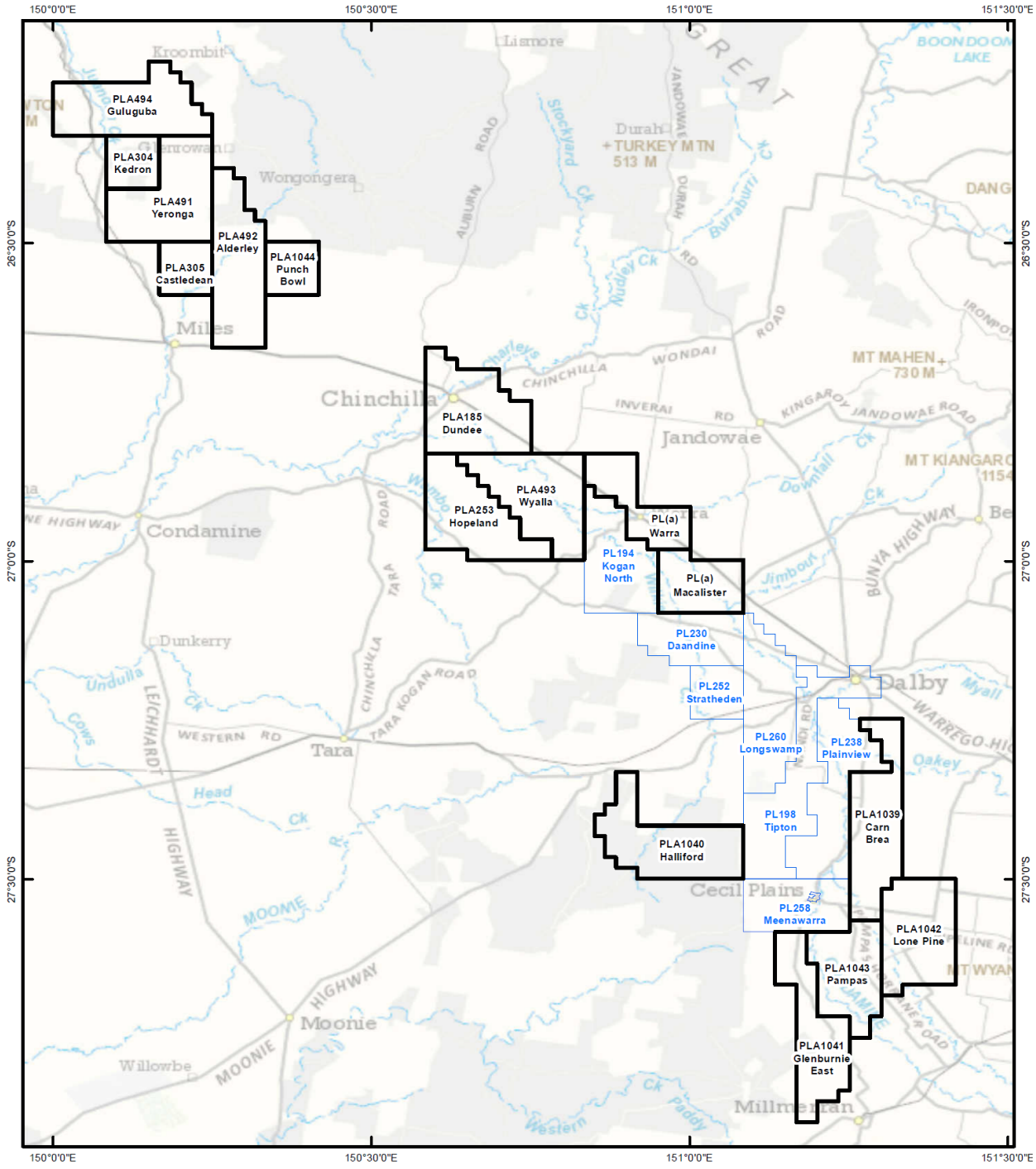

PL Granted (Arrow)

PL Application

N

Coordinate System: GCS GDA 1994

0 5 10 20
km

Surat Gas Project Tenures

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Date: 9/04/2018

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1.3 Scope

The scope of this CWMP includes:

- Characterisation of CSG water and the existing environment;
- Description of current and proposed CSG water management including the use, treatment, storage and beneficial use of water; and
- Description of procedures, controls and monitoring programs that minimise risk of CSG water management causing environmental harm.

The strategies for managing CSG water described in this CWMP align with Arrow Energy's broader vision for CSG water management in the Surat basin, as outlined in its Surat Gas Project CSG Water Management Strategy[3].

1.4 Conformance Table

Table 1-1 lists specific CWMP regulatory requirements specified under Section 126 of the EP Act, and identifies the relevant sections of the CWMP which address each specific requirement.

Table 1-1 EP Act Conformance Table

Requirement Under Section 126 of the EP Act	Relevant Section of CWMP
The quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant activity.	Section 3.1
The flow rate at which the applicant reasonable expects CSG water will be generated.	Section 3.1
The quality of the water, including changes in the water quality that the applicant reasonably expects will happen while each relevant activity is carried out.	Section 3.2
The proposed management of CSG water including use, treatment, storage or disposal.	Section 4 and 5
The measurable criteria (the management criteria) against which the applicant will monitor and assess the effectiveness of water management including: • The quantity and quality of the water used, treated, stored or disposed of; • Protection of environmental values affected by each relevant activity; and the disposal of waste, including, for example, salt.	Section 6
The action proposed to be taken if any of the management criteria are not complied with, to ensure the criteria will be able to be satisfied in the future.	Section 6

[3] Arrow Energy (2017), *Surat Gas Project CSG Water Management Strategy*, Rev: 0, Doc No: ORG-ARW-ENV-STR-00001.

1.5 Project Approvals

Table 1-2 lists the status of Arrow Energy's CSG water management approvals applicable to the scope of this CWMP.

Table 1-2 Arrow Energy's CSG Water Management Approvals in the Surat Basin

Responsible Department	Area of Regulation	Requirement of Regulation	Status
Department of Environment and Science	CSG activities including CSG water management	Environmental Authorities (EAs)	Approved - Dalby Expansion Project EA (EPPG00972513) for PLs194, 198, 230, 238, 252, 258 and 260.
			Approved - EA North for PLs 304, 305, 491, 492, 494, and 1044.
			Approved - EA South PLs 185, 253, 493, 1039, 1040, 1041, 1042, and 1043.
			Approved - EA Kogan – for PLs 1052 and 1053
			Approved - EA Hopeland for PL 253.
			Approved – EA Kenya Pipelines and Brine Dams PPL 2034
		CWMP	Finalised May 2018 to support EA applications and updated June 2020 to support the Hopeland EA amendment application

1.6 DES CSG Water Management Policy

The *CSG Water Management Policy* (DEHP, 2012) outlines the Queensland Government's position on the management of CSG water and guides CSG operators to consider the feasibility of using such water to meet the obligations of the EP Act as part of developing their CSG water management strategies and plans.

The 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, and for managing saline waste.

The policy focuses on the management and use of CSG water under the EP Act, and does not change obligations the *Water Act 2000* (Water Act), including 'making good' any relevant impacts that may result from a CSG operation on water bores. Such measures executed under the Water Act may require the provision of water to mitigate impacts.

Arrow has adopted the DES prioritisation hierarchy as its starting point for determining the options for management of CSG water and brine. DES's prioritisation hierarchies for

CSG water and brine are presented in Figure 1-2. In accordance with the Policy, Arrow evaluates potential management options for water and brine against the prioritisation hierarchy, and implements Priority 1 options wherever feasible. Where Priority 1 options are not feasible, Priority 2 options are implemented. In determining the feasibility of options, factors that may be considered include technical and economic aspects in assessing identified options.

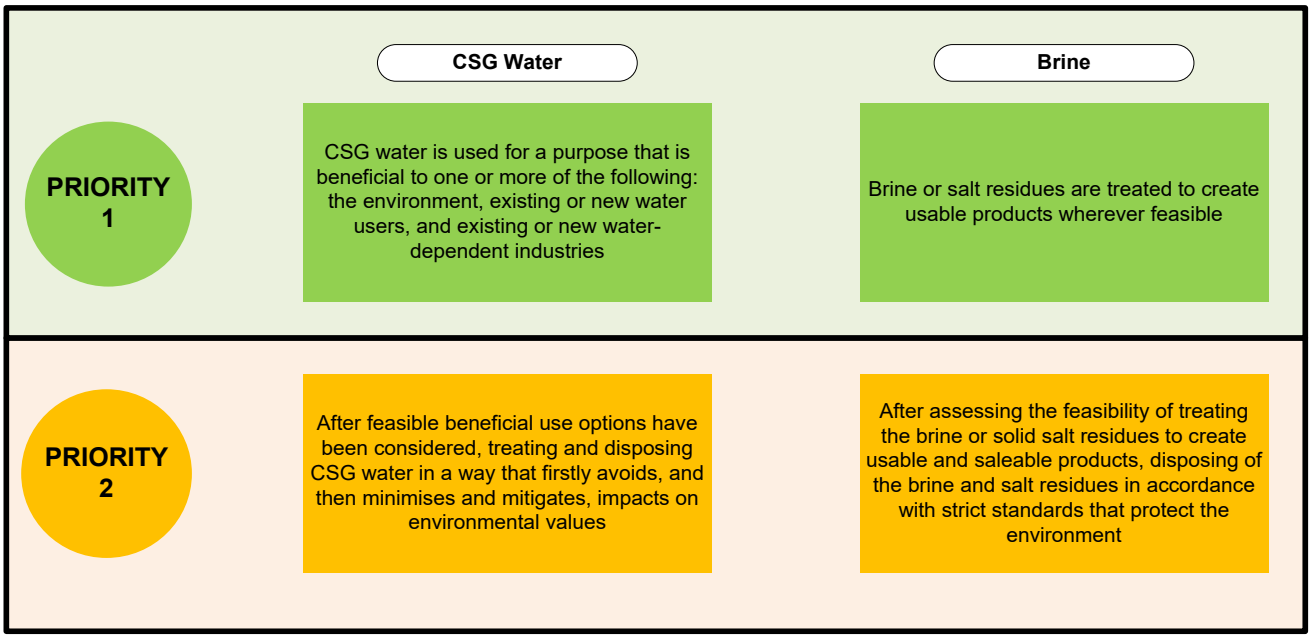


Figure 1-2 DES Prioritisation Hierarchies for CSG Water and Brine Management

2. Existing Environment

2.1 Climate

The Darling Downs has a warm climate typical of subtropical regions with mean temperatures in the project development area ranging from a mean monthly minimum of 3.6 in winter months (June to August) to a mean monthly maximum of 35°C in summer months (December to February).

The majority of rain falls between November and February. The average annual rainfall varies across the region and ranges from an average of 20 to 40 mm a month in winter, to 70 to 100 mm a month in summer. Around 20 thunderstorm days per year occur in the region, often involving strong winds, heavy rainfall and flooding.

2.2 Surface Water

The regional surface water environment is represented by four drainage basins, all of which intersect the SGP development area: Condamine-Culgoa Basin (Condamine River and Balonne River), Fitzroy Basin (Dawson River), Border Rivers Basin (Weir and Macintyre rivers and Macintyre Brook), and Moonie Basin (Moonie River). The Condamine-Culgoa, Border Rivers, and Moonie basins form part of the Murray-Darling drainage division, while the Fitzroy Basin is part of the North-East Coast drainage division.

Basins can be divided into sub-basins, with six sub-basins in the project development area: Balonne River, Condamine River, Macintyre Brook, Macintyre and Weir rivers, Moonie River and Dawson River. The Condamine is the predominant sub-basin within the project development area, accounting for over 50% of the total area.

The location or origin of each drainage basin is as follows:

- The Condamine-Culgoa Basin forms the northern headwaters of the Murray-Darling river system;
- The Border Rivers Basin, comprising the Weir and Macintyre rivers, lies mostly within Queensland. Macintyre Brook is a major tributary of the Macintyre River, which eventually joins the Weir River near Talwood, Queensland;
- The Moonie Basin contains the Moonie River, a tributary of the Barwon River forming part of the Murray-Darling Basin; and
- The Fitzroy Basin is located in central eastern Queensland and contains the Dawson River sub-basin. The Fitzroy River is formed by the confluence of the Dawson and MacKenzie rivers and then flows into the Coral Sea north of Rockhampton.

The project area is characterised by an extensive network of watercourses that are largely ephemeral, with varying geomorphic stream types that provide geomorphic diversity and contribute to habitat diversity. Rivers and creeks are generally intermittent, with surface waters in many streams receding to disconnected pools and dry beds during the dry season.

Potential water uses within catchments that include the SGP are:

- Agricultural (crop production and stock watering)
- Pastoral;
- Urban;
- Power generation;
- Mining; and
- Recreation.

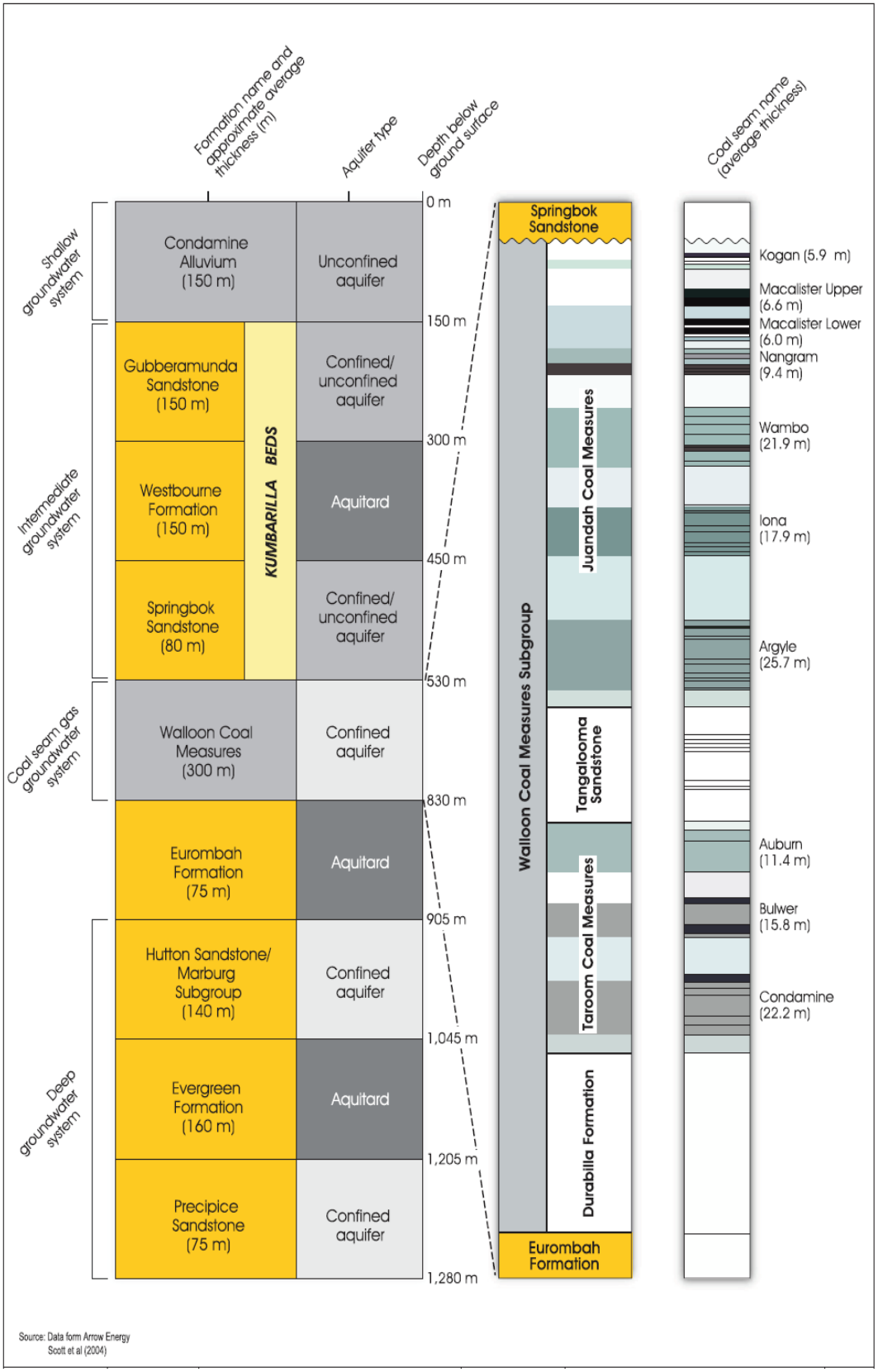
2.3 Groundwater

The geology of the Surat Basin is presented in Figure 2-1, and reflects approximately 200 million years of sedimentation producing a sedimentary sequence with up to a 2,500 m maximum depth. Geology underlying the project area consists of a sequence of interbedded aquifers and aquitards and is situated on the eastern section of the Great Artesian Basin (GAB) and the western margin of the Clarence-Moreton Basin.

The following groundwater systems have been identified in the vicinity of the project area (listed in order of increasing depth):

- Shallow groundwater system – Condamine Alluvium;
- Intermediate groundwater system – Gubberamunda Sandstone, Westbourne Formation and Springbok Sandstone;
- Coal seam gas groundwater system – Walloon Coal Measures; and
- Deep groundwater system – Hutton Sandstone, Evergreen Formation and Precipice Sandstone.

Figure 2-1 SGP Groundwater Geology



2.4 Terrain, Geology and Soils

2.4.1 Terrain

Topography of the SGP area is characterised by gently undulating land formed by fluvial deposition and erosion processes. Rock outcrops are present where resistance to erosion and channel scour has occurred. The underlying geology and geomorphic conditions have influenced the landscape and the area is characterised by the Great Dividing Range highlands, the Kumbarilla Ridge uplands and four drainage basins, the Condamine-Culgoa, Fitzroy, Border Rivers and Moonie.

2.4.2 Geology

Gas reserves within the SGP project area are primarily contained within the Walloon Coal Measures. The Walloon Coal Measures were formed during the Middle Jurassic period and are characterised by carbonaceous mudstone, siltstone, minor sandstone and coal. The geology of the Walloon Coal Measures is presented above in Figure 2-1 and comprises the following formations:

- Juandah Formation;
- Tangalooma Sandstone;
- Taroom Coal Measures; and
- Euromah Formation.

Only the Juandah Formation and Taroom Coal Measures are targeted for CSG production for the SGP.

2.4.3 Soils

Soil types across the SGP 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.
- Cracking Clays - Widespread across the Project area.
- Uniform Non-cracking Clays - Occurring on gently undulating plains and rises, and upper slopes of hills.
- Texture Contrast Soils - Sharp textural contrast between surface and subsoil horizons of low agricultural value.
- Uniform Loams and Clays - Loams found along upper slopes whereas clay occur on lower slopes.
- Sands and Sandy Loams - Consists of alluvial and residual sands found on plains.
- Skeletal, Rocky or Gravelly Soils - Occur adjacent to rocky outcrops.

2.4.4 Land Use

The SGP is located within the Darling Downs, which is an important agricultural area. The land use in the area is strongly related to the different soil types and topography. Soils within the project development area are dominated by heavy clays, which form rich agricultural soil around the Condamine River. These soils are characterised by self-mulching, cracking clays with a deep profile. At higher elevations, shallow, gravelly soils are present.

Soil erosion is evident in areas where brigalow woodland has been extensively cleared. Agricultural land use within the project development area ranges from concentrated agriculture on the Condamine River floodplain, where many paddocks have been laser-levelled to achieve effective flood irrigation, through to cattle grazing in more marginal areas located to the north and west. Limited agricultural activity exists in areas of higher elevation and within state forests.

Current agricultural activities in the greater Darling Downs region include:

- Dryland broadacre farming;
- Irrigated broadacre farming;
- Horticulture;
- Fruit;
- Vineyards;
- Livestock industries; and
- Timber production.

3. CSG Water Characteristics

This section presents forecast CSG water production data and expected water quality.

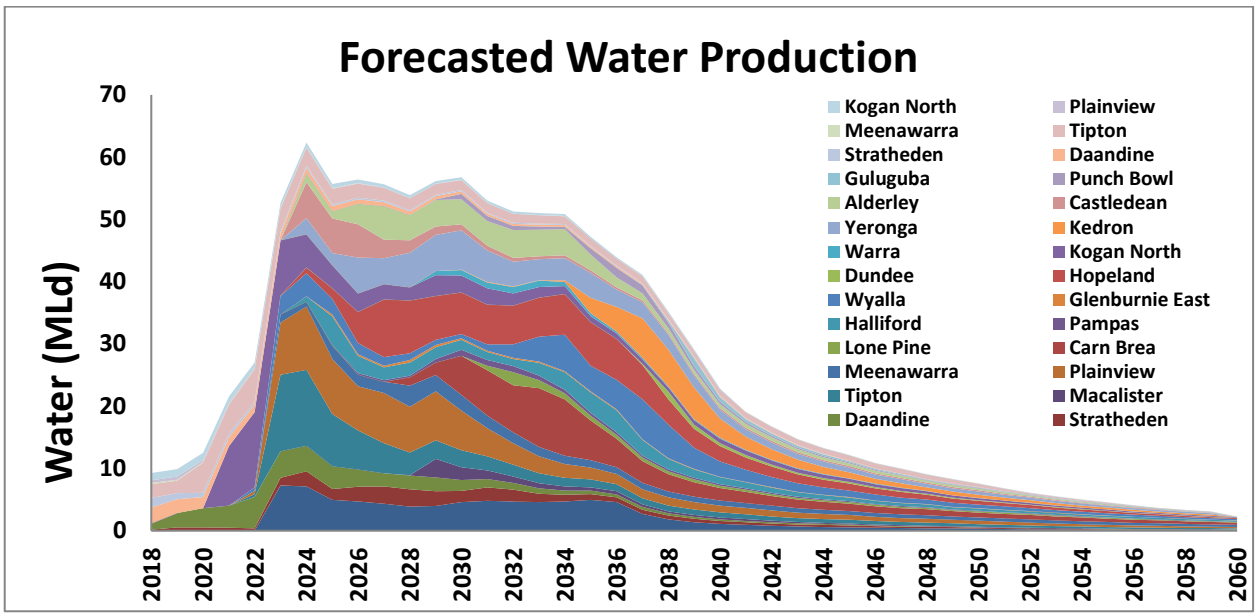
3.1 CSG Water Quantity

CSG is the name given to naturally occurring gas trapped in underground coal seams by water and ground pressure. The gas lines the open fractures between the coal (called cleats) and the inside of the pores within the coal (the matrix). Coal seams store both gas and water. When the water pressure is reduced, the gas is released. In the production process, the water pressure is reduced when a well is drilled into a coal seam and the water is gradually pumped out of the seam. This allows the gas to flow to the surface via the well. CSG water production volumes and qualities vary considerably with location, well-spacing and coal seam depth. Water production forecasts fluctuate over time as a product of progressively commissioning and decommissioning wells to meet Gas Sale Agreements. For these reasons, forecasts for the timing, volumes and quality of CSG water production are updated on a monthly basis. Production forecasting involves the following steps:

1. Developing key assumptions such as expansion areas, gas sales targets and gas usage for production activities;
2. Simulating the required production rates using a reservoir engineering model;
3. Developing and maintaining well program based on forecast timing; and
4. Reviewing model performance against actual production data and history matching.

Figure 3-1 presents the CSG water production forecast for the SGP. The forecast indicates that approximately 400 GL of water will be produced over the life of the project. Water production starting in 2018 was the continuation of production in the existing DXP EA development areas, with production from new areas commencing in 2021. Water production peaks at a flow rate of approximately 62 ML/day achieved in 2024. Water production will diminish from the peak until project completion in approximately 2060.

Figure 3-1 SGP Forecasted Water Production



3.2 CSG Water Quality Characteristics

3.2.1 CSG Water at the Well

The SGP targets the Walloon Coal Measures. CSG water quality in these formations varies from slightly brackish to brackish. The water typically has the following characteristics:

- pH of approximately 8 to 9;
- Salinity in the range of 5,000 to 13,000 µS/cm (i.e. brackish);
- Suspended solids that will usually settle out over time;
- Trace metals and low levels of nutrients.

Table 3-1 presents a summary of expected water quality for wells across the SGP development area.

Table 3-1 SGP Expected Water Quality[4]

Parameter	LOR	Units	10%	Median	90%
Alkalinity					
Bicarbonate Alkalinity as CaCO3	1	mg/L	389.8	815.5	1387.0
Carbonate Alkalinity as CaCO3	1	mg/L	< 1	27.5	119.7
Hydroxide Alkalinity as CaCO3	1	mg/L	< 1	< 1	< 1
Total Alkalinity as CaCO3	1	mg/L	392.6	872	1440.0
Major Anions					
Bromide	0.02	mg/L	3.6	4.99	10.6
Chloride	1	mg/L	1040.0	1705	4231.0
Fluoride	0.1	mg/L	1.0	1.8	2.6
Silicon	0.05	mg/L	7.5	8.2	9.5
Sulfate as SO4 2-	1	mg/L	< 1	< 1	2.0
Sulfide as S2-	0.1	mg/L	< 0.1	< 0.1	< 0.1
Major Cations					
Calcium	1	mg/L	4.0	9	39.7
Magnesium	1	mg/L	2.0	3	13.0
Potassium	1	mg/L	5.0	7	13.0
Sodium	1	mg/L	1233.0	1630	2720.0
Major Ions					
Ionic Balance	0.01	meq/L	21.5	106.72	191.9
Total Anions	0.01	meq/L	85.9	171.1	256.3
Total Cations	0.01	meq/L	86.2	171.4	256.6
Metals (Dissolved)					
Aluminium	5	µg/L	< 5	< 5	12.8
Arsenic	0.2	µg/L	< 0.2	< 0.2	0.6
Barium	0.5	µg/L	603.4	1100	4212.0
Beryllium	0.1	µg/L	< 0.1	< 0.1	< 0.1
Boron	5	µg/L	235.6	340	590.0
Cadmium	0.05	µg/L	< 0.05	< 0.05	0.1
Chromium	0.2	µg/L	< 0.2	< 0.2	2.4
Cobalt	0.1	µg/L	< 0.1	< 0.1	< 0.1
Copper	0.5	µg/L	< 0.5	< 0.5	2.0
Ferric Iron	0.05	mg/L	< 0.05	< 0.05	0.2
Ferrous Iron	0.05	mg/L	< 0.05	< 0.05	0.5
Hexavalent Chromium	0.01	mg/L	< 0.01	< 0.01	< 0.01
Lead	0.1	µg/L	< 0.1	< 0.1	< 0.1
Manganese	0.5	µg/L	2.0	9	45.0
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.1	µg/L	< 0.1	< 0.1	2.0

[4]The information presented in this table is aggregated data from production sampling at Arrow's Dalby Expansion Project and exploration sampling across ATP tenures proposed for conversion to PLs as part of the SGP. A < value indicates observations below the limit of reporting.

Nickel	0.5	µg/L	< 0.5	< 0.5	1.0
Selenium	0.2	µg/L	< 0.2	< 0.2	0.2
Strontium	1	µg/L	1036.0	1920	9234.0
Trivalent Chromium	0.01	mg/L	< 0.01	< 0.01	< 0.01
Vanadium	0.2	µg/L	< 0.2	< 0.2	10.0
Zinc	1	µg/L	< 1	< 1	16.0
Metals (Total)					
Aluminium	5	µg/L	20.0	640	4244.0
Arsenic	0.2	µg/L	< 0.2	< 0.2	2.0
Barium	0.5	µg/L	717.2	1250	4510.0
Beryllium	0.1	µg/L	< 0.1	< 0.1	< 0.1
Boron	5	µg/L	250.0	360	580.0
Cadmium	0.05	µg/L	< 0.05	< 0.05	0.2
Chromium	0.2	µg/L	< 0.2	2	9.4
Cobalt	0.1	µg/L	< 0.1	< 0.1	3.0
Copper	0.5	µg/L	0.5	3	18.0
Lead	0.1	µg/L	< 0.1	1.4	8.0
Manganese	0.5	µg/L	8.0	31	118.4
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.1	µg/L	< 0.1	< 0.1	0.4
Nickel	0.5	µg/L	< 0.5	1	6.0
Selenium	0.2	µg/L	< 0.2	< 0.2	0.2
Strontium	1	µg/L	1136.0	2110	9496.0
Vanadium	0.2	µg/L	< 0.2	< 0.2	1.4
Zinc	1	µg/L	< 1	13	65.4
Nutrients					
Ammonia as N	0.01	mg/L	0.8	1.13	1.7
Nitrate as N	0.01	mg/L	< 0.01	0.01	0.1
Nitrite + Nitrate as N	0.01	mg/L	< 0.01	0.01	0.1
Nitrite as N	0.01	mg/L	< 0.01	< 0.01	< 0.01
Reactive Phosphorus as P	0.01	mg/L	< 0.01	0.01	0.0
Total Kjeldahl Nitrogen as N	0.1	mg/L	0.9	1.3	1.8
Total Nitrogen as N	0.1	mg/L	0.9	1.3	1.8
Total Phosphorus as P	0.01	mg/L	0.0	0.06	0.2
Organic Carbon					
Dissolved Organic Carbon	1	mg/L	< 1	6	14.1
Total Organic Carbon	1	mg/L	< 1	13	35.1
Physico-Chemical					
Electrical Conductivity @ 25°C	1	µS/cm	5640.0	7070	13060.0
pH Value	0.01	pH Unit	8.1	8.385	8.6
Suspended Solids (SS)	5	mg/L	11.9	100.5	520.5
Total Dissolved Solids @180°C	5	mg/L	3190.0	4215	7546.0
Turbidity	0.1	NTU	6.1	50	401.8
Silica					

Reactive Silica	0.1	mg/L	14.1	15.9	19.2
Silica	0.1	mg/L	15.7	17.4	20.4

3.3 Arrow Energy CSG Water and Salt Management Strategy

Arrow is committed to managing CSG water in a way that maximises beneficial use and that minimises environmental impact. To demonstrate this, Arrow has developed a Surat Gas Project Water Management Strategy[5] to ensure that the SGP manages water and salt consistently and within the Queensland Government regulatory framework. The strategy is supported by a series of plans and procedural documents to ensure that the following objectives are achieved:

- Communicate corporate policy and principles for the management of CSG water and salt;
- Align with the regulatory framework that applies to the:
  - Gathering, treatment, storage, distribution, beneficial use and disposal of CSG water and salt;
  - Monitoring and management of groundwater and predicted impacts to groundwater level changes in quality;
- Facilitate management of CSG water and salt in a way that maximises beneficial use and minimises the potential for environmental impacts; and
- Establish a framework for development of aquifer, surface water and infrastructure groundwater monitoring programs.

3.3.1 Water and Salt Management Options

Arrow CSG Water and Salt Management Strategy aligns with the DES CSG Water Management Policy as defined in Section 1.6.

To ensure that the most sustainable CSG water management portfolio is implemented, Arrow evaluates all strategy management options using a systematic and transparent multi-criteria assessment (MCA) process (refer Figure 3-2). The performance of each identified option is assessed against a set of weighted criteria and options selected as either “preferred”, “reserved” or “not preferred” based on the weighted score derived from the MCA[6].

Preferred options are prioritised for investment whilst reserved options continue to be evaluated through targeted feasibility studies. Non-preferred options are put on hold. To ensure that Arrow’s approach to CSG water utilisation remains reflective of the latest information, MCAs may be updated on a periodic basis.

[5] Arrow Energy (2017), *Surat Gas Project CSG Water Management Strategy*, Rev: 0, Doc No: ORG-ARW-ENV-STR-00001.
[6] Safety is a core value of Arrow Energy and all activities and processes require safety to be at the forefront of assessment. Therefore, safety is not incorporated into the MCA.

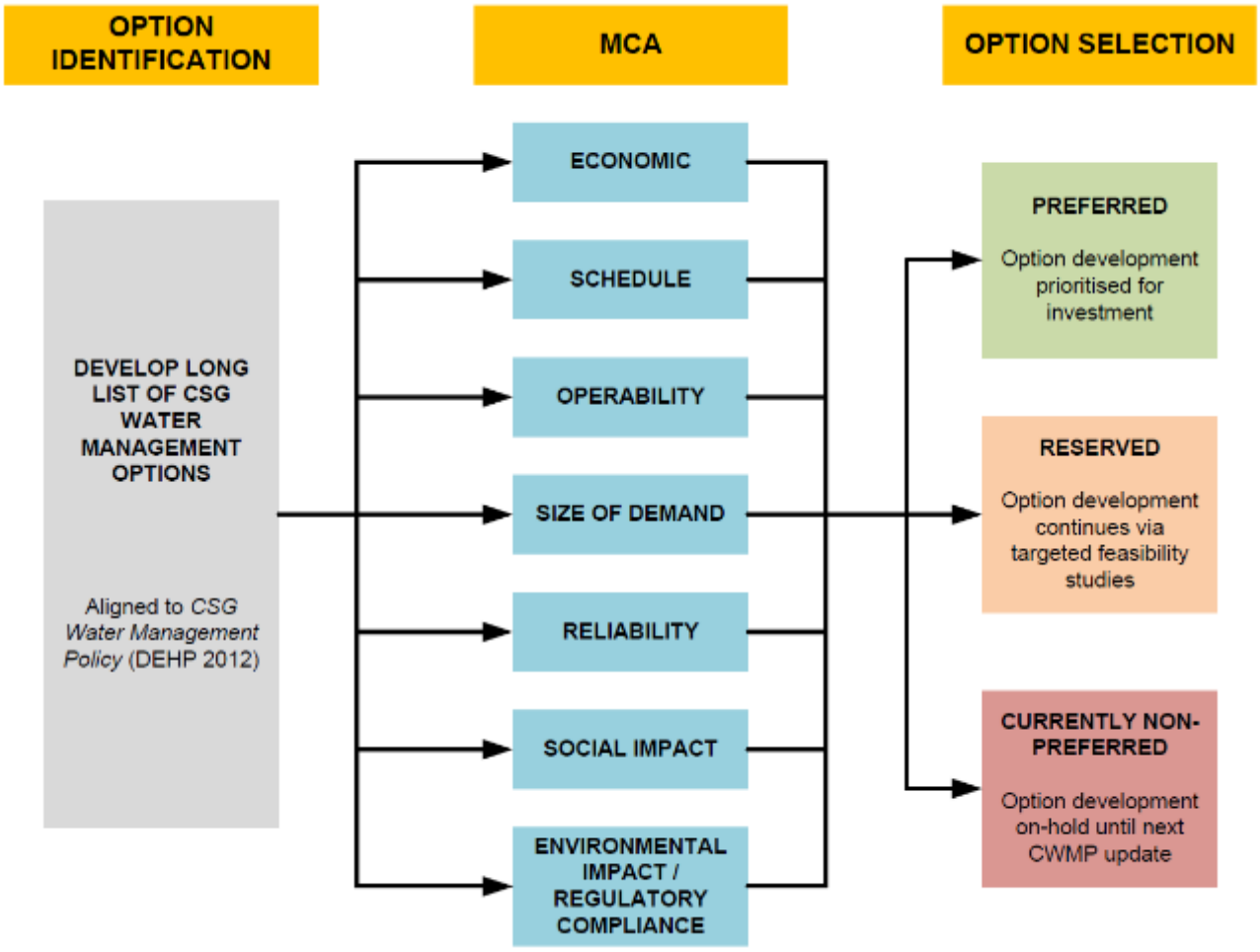


Figure 3-2 Option Selection and MCA Framework

3.4 Water management options

This section presents the water management options considered for the SGP. Saline waste management is discussed in Section 3.5.

Implementation of the preferred CSG water management options will result in the distribution of CSG water to a range of beneficial uses. Currently identified options are described below.

3.4.1 Agricultural uses

Irrigation is the predominant water use within the SGP development area. Options exist to provide water to existing irrigators, to replace other water sources used for irrigation (including through substitution of their existing groundwater allocations), or to supply water to new irrigation projects.

Key considerations for providing CSG water to end users for irrigation include:

- The ability of end users to take large volumes of water regularly and reliably;
- The location of end users in relation to the water treatment facility (due to the cost of transporting water over large distances);
- The approvals framework;

- The extent to which the user is going to become reliant on water supplied by Arrow; and
- The appropriateness of the supply given the short term nature of CSG water availability.

The water and implications of its use will be the responsibility of the end users. Arrow retains no control over how the water is used beyond the transfer point.

Where practical, Arrow's preferred management option for CSG water is beneficial use through substitution of existing groundwater allocations in the operating area. Substitution of allocations has the advantage that it constitutes both a beneficial means of managing produced CSG water, and a means of offsetting the potential impacts of Arrow's CSG production to bore owners with groundwater allocations.

Currently, there is no regulatory basis to facilitate substitution. Therefore, Arrow would develop a commercial scheme to support the supply of treated CSG water to groundwater users who hold allocations. Under this scheme end users would receive and utilise water supplied by Arrow in lieu of their groundwater allocations.

Arrow has committed to offsetting its component of modelled likely flux impacts to the Condamine Alluvium in the area of greatest predicted drawdown, as a result of CSG water extraction from the Walloon Coal Measures. This can be achieved through a beneficial use network that will distribute water to groundwater users within specified areas of the Condamine Alluvium to mitigate the modelled likely flux impact by substitution of their allocations. These users, or other existing users, could be offered excess water in addition to the substitution requirements to manage peaks in the water production profile.

3.4.2 Other agricultural uses

Other potential agricultural beneficial uses include provision of water for livestock watering purposes (including feedlots) or for aquaculture.

3.4.3 Discharge

Discharge of treated CSG water to watercourses is a reserved option in the event that other beneficial uses of CSG water are temporarily unavailable.

3.4.4 Urban uses

Urban supply remains a potential CSG water end use, but is subject to further negotiation and a suitable supply arrangement that economically satisfies regulatory requirements.

3.4.5 New uses

Over the course of the SGP, water demands across areas in which Arrow operates will vary and it is anticipated that new opportunities for use of treated and untreated water may emerge.

Whilst Arrow may choose to evaluate any such opportunities in accordance with the adopted selection methodology (refer Section 3.3.1), supply to new users is not a preferred water management option. This is because the CSG water supply will only be available for a reasonably short period of time, and the development of new water reliant uses may result in potential legacy issues when CSG water is no longer available.

3.4.6 Aquifer injection

Aquifer injection, either for re-pressurisation or as a means for CSG water management, is not currently proposed for the SGP due to the potential risks and the lack of an appropriate regulatory system.

3.4.7 Ocean outfall

Disposal of CSG water to the sea via an ocean outfall pipeline is recognised as a technically feasible option, but currently non-preferred due to environmental and community concerns, and potential schedule impact.

3.4.8 Alignment of Arrow and DES priorities

A summary of the CSG water management options is presented in Table 3-2 which aligns Arrows preferred and non-preferred options with the DES prioritisation hierarchy.

Table 3-2 CSG water management – alignment of Arrow and DES priorities

Arrow priority	Option	Comments	DES Priority
Preferred	Arrow operational supply	Dust suppression, construction, potable, etc.	Priority 1
	Substitution of allocations	Beneficial use to existing abstractors (virtual injection)	Priority 1
	Industrial supply to existing users	Non-Arrow use, where established	Priority 1
Reserved	Discharge to watercourse	Subject to Environmental Authority conditions	Priority 2
	Urban water supply	Subject to negotiation and approvals	Priority 1
Non-preferred	MAR	Managed aquifer recharge	Priority 1
	Industrial supply to new users	Non-Arrow use, where established	Priority 1
	Ocean outfall	Non-preferred due to environmental and community concerns, and potential schedule impact	Priority 2
	Deep aquifer injection	Currently no identified target aquifer	Priority 2

3.5 Brine and salt management options

Water treatment processes that include desalination, such as reverse osmosis, produce a brine stream by-product.

Assuming an average salt concentration of 4,500 mg/L for CSG water in the Surat Basin, treatment of CSG water via reverse osmosis (to ~500 mg/L TDS) will generate in the order of 4 tonnes of salt per megalitre of treated water. Raw water feed concentrations vary across tenements and may also change over time within a given CSG field. Brine stream concentrations will therefore change accordingly.

Specific measures are required to manage the storage and use (or disposal) of brine. A range of brine management options are identified, and described in the following sections.

3.5.1 Salt recovery

The concentrated brine by-product of desalinated water from the Surat Basin coal measures is comprised primarily of sodium chloride, sodium carbonate and sodium bicarbonate salts. A range of options for salt recovery are under consideration for the SGP.

i. Non-selective salt recovery and landfill

Non-selective recovery can be undertaken in purpose designed, lined solar evaporation ponds, through other thermal processes, or using mechanical crystallisers. The mixed salt product recovered has little or no commercial value, therefore landfill of the solid product is required, either in third-party landfills, or through encapsulation of the solid salts in purpose designed cells.

ii. Selective salt recovery

SSR requires the selective crystallisation of salts from RO brine to provide separate end product streams – typically sodium chloride, sodium carbonate and sodium bicarbonate, enabling commercial opportunity for sale of the product. A waste salt by-product is also produced that is dependent on the chemical characteristics of the brine processed at the salt recovery facility.

SSR is currently a reserved option because work to date has demonstrated that the recovered salt product has only modest value and the market is fully supplied by existing low cost producers. Furthermore, the process is energy intensive and substantial transport distances to market would present issues of safety and cost. The combined energy and transport requirements would also result in high emissions intensity for the final product.

3.5.2 Brine injection

Brine injection requires identification of a target formation with permeability and parameters sufficient to enable injection and storage, and where the water quality is such that injection of the brine will not impact the environmental values of the groundwater system.

To date, suitable aquifers have not been identified within Arrow's Surat tenements, and brine injection is a non-preferred management option.

3.5.3 Ocean outfall

As for water, disposal of brine to the sea via an ocean outfall pipeline is recognised as a technically feasible option, but is currently non-preferred.

3.5.4 Alignment of Arrow and DES Priorities

A summary of the brine and salt management options is presented in Table 3-3 which aligns Arrows preferred and non-preferred options with the DES prioritisation hierarchy.

Table 3-3 Saline waste management – alignment of Arrow and DES priorities

Arrow priority	Option	Comments	DEHP Priority
Preferred	Non-selective salt recovery and landfill encapsulation	Solid product landfill in purpose designed regulated waste facilities	Priority 2
Reserved	Selective salt recovery	Currently uneconomic, unable to demonstrate a commercial market, has high emissions intensity and greater safety risk.	Priority 1
Non-preferred	Brine injection	Currently no identified target aquifer	Priority 2
	Ocean outfall	Non-preferred due to community concerns, and potential schedule impact	Priority 2

4. SGP Coal Seam Water Management Network

4.1 SGP Water Management

As stated in Section 1, the SGP will utilise existing DXP gas and water assets (e.g. water treatment plants), but will also provide both gas and water to existing QGC assets. SGP water management will comprise six main process components:

1. CSG production wells and associated water gathering system;
2. Water transfer pipeline(s);
3. Aggregation dam(s);
4. Water Treatment Plants (WTP);
5. Treated water dam(s) and associated beneficial use offtakes; and
6. Brine dam(s).

Figure 4-1 provides a conceptual diagram of this process. Figure 4-2 provides an overview of the proposed SGP water management network.

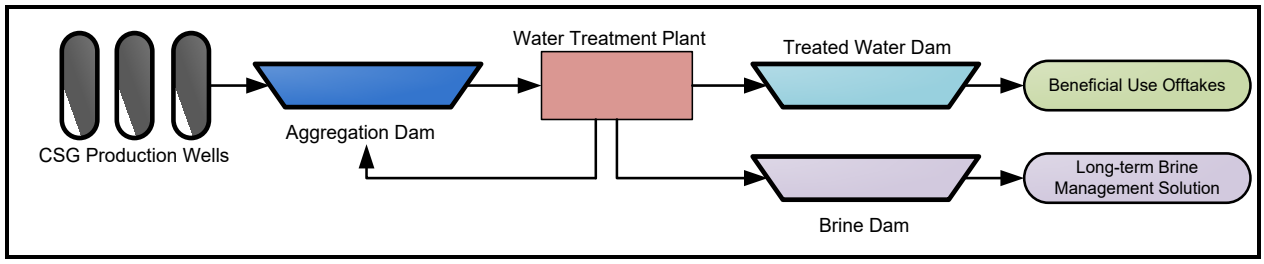


Figure 4-1 Conceptual Diagram of CSG Water Management

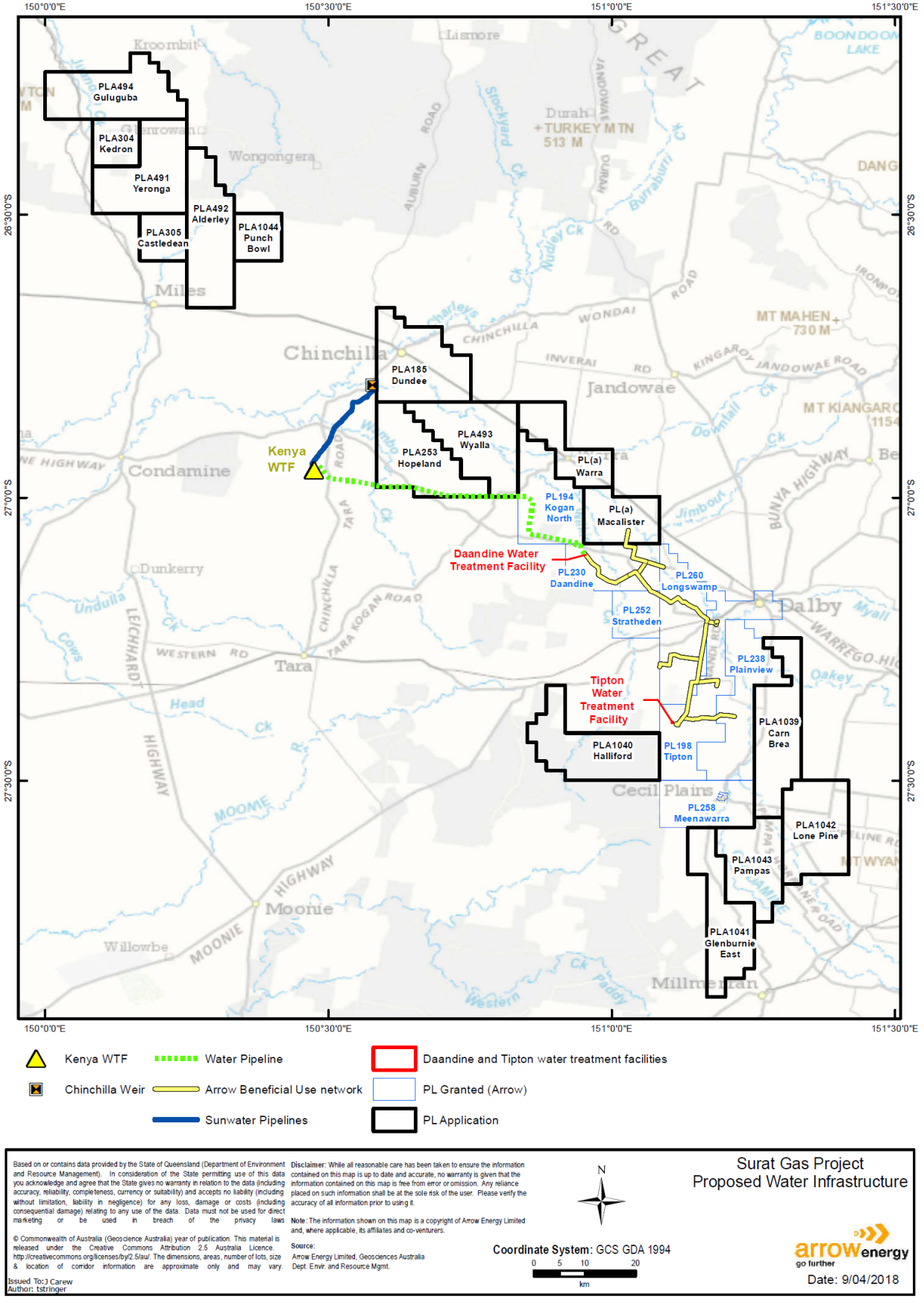


Figure 4-2 Proposed SGP CSG Water Management Network

4.1.1 Gathering System and Storage

CSG water is gathered via a network of buried HDPE low pressure pipes to a series of aggregation dams. Arrow Energy defines its dams as follows:

- **Aggregation Dams** – contain CSG water from gathering network. Aggregation dams provide a buffer to address variations in CSG water production and water treatment capacity.
- **Treated Water Dams** – contain treated CSG water. Treated water dams provide a buffer between treatment plant output and beneficial use demand.
- **Central Gas Processing Facility (CGPF) and WTP Utility Dams** – contain waste lubricants and chemicals used in treatment and compression systems.
- **Brine Dams** – contain brine produced from the reverse osmosis water treatment process.

DES requires that consequence categories of dams are assessed. The DEHP 2013 *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*[7] provides guidance on the assessment process. Arrow has implemented the assessment procedure outlined in the manual.

4.1.2 CSG Water Treatment

Arrow Energy currently treats CSG water through a process of MF and RO. QGC uses similar technologies at its Kenya water treatment facility. MF is a microporous membrane separation process with selectivity on the basis of the size of the particle. Most MF membranes are screen filters with the feed inlet pressure serving as the driving force for filtration. The membranes allow the removal of turbidity, bacteria, cysts and particulates from the water to sizes of 0.1 to 3 µm. Following MF, water is treated using RO to remove dissolved salts. RO is significantly more complex than MF and involves the separation of salts from solution through a semi–permeable, microporous membrane under elevated hydrostatic pressure creating a permeate stream of treated CSG water and a brine waste stream containing concentrated salts.

4.1.3 Brine Management

Water treatment processes that include desalination, such as reverse osmosis, produce a brine stream by-product. The resulting brine will be stored in purpose built brine storage dams until such time as Arrow selects a brine management solution. A range of brine management options have been identified and are described above in Section 3.4.

Both Arrow and QGC WTPs include (or have planned) technologies to minimise the brine stream and thereby reduce the number of required brine storage dams. The Kenya facility already has thermal brine concentrators to produce a highly concentrated brine stream whilst the Arrow facilities plan to utilise membrane concentration technology to further concentrate the brine stream.

[7] Queensland Department of Environment and Heritage Protection, *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures,* DEHP, Queensland, Australia (ESR/2016/1934).

4.1.4 Beneficial Use

As detailed above in section 3.4, the preferred DES CSG water management strategy is beneficial use. Across the SGP, the most substantial beneficial use option is irrigation. Other major beneficial use options include supply to industrial users (power stations or coal mines) and intensive livestock (feedlots, piggeries). Selection of beneficial use options requires careful consideration of the predicted water volumes, stakeholder requirements and Arrow's approval obligations.

Arrow's preferred management option for CSG water is beneficial use through substitution of existing Condamine Alluvium groundwater allocations. Under this scheme end users would receive and utilise water supplied by Arrow in lieu of their groundwater allocations. Arrow has committed to offsetting its component of modelled likely flux impacts to the Condamine Alluvium in the area of greatest predicted drawdown as a result of CSG water extraction from the Walloon Coal Measures and is conditioned to do so under its Federal environmental approval.

A beneficial use network (BUN) will be constructed to distribute treated water to groundwater users within specified areas of the Condamine Alluvium. Users connected to the network will receive water from the Tipton and Daandine facilities as well as a proportion of Arrow's water treated at the QGC Kenya facility. Water from the Kenya facility will be provided back to the Arrow BUN via pipeline. The proposed BUN and associated water pipelines are presented above in Figure 4-2. Any remaining treated water from Kenya will be supplied to the existing SunWater beneficial use scheme which connects Kenya to the Chinchilla weir.

It is expected that treated water distributed by Arrow will be supplied under conditions in the relevant EA or by using the relevant End of Waste Code. Treated water specifications from all of the water treatment facilities will meet the requirements of these approvals.

A small portion of produced water may selectively be used by Arrow for construction purposes or dust suppression, or may be supplied for industrial uses (e.g. coal mines or power stations) or stock watering.

4.2 Arrow Daandine Water Management Network

As discussed in section 4.1, the SGP will integrate with Arrow's existing facilities at both Daandine and Tipton. The Daandine water management network connects Daandine, Kogan North and Stratheden fields to a WTP at Daandine. Figure 4-3 schematically illustrates Daandine water management network infrastructure.

4.2.1 Dams

The Daandine water management network includes six (6) dams. Five dams are located within the Daandine field, and a sixth dam is located at Kogan North. The Kogan North dam enables aggregation and transfer of CSG water to the Daandine WTP for treatment. Table 4-1 lists dam storage characteristics.

Table 4-1 Daandine Water Management Network Storages

Dam Description	Volume at Mandatory Reporting Level (ML)	Volume at Spillway (ML)	Volume at Design Storage Allowance (ML)
Daandine Aggregation Dam	1,239	1,458	1,166
Daandine Feed Water	418	458	392
Daandine Treated Water	208	238	199
Daandine Brine	1,096	1,184	1,045
Daandine Utility	31	48	26
Kogan North	299	427	261

Note: DSA and MRL volumes have been updated to reflect the 2017 Annual Dam Inspections (AECOM, 2017).

4.2.2 Water Treatment Plant

In December 2009, Arrow Energy constructed and commissioned a 12 ML/d water treatment plant (WTP) at Daandine, to facilitate beneficial use and align Arrow's operation with the *CSG Water Management Policy* (DEHP, 2012).

For a description of the water treatment process refer to section 4.1.2. For characterisation of treated CSG water quality refer to section 3.

4.2.3 Beneficial Use

A number of beneficial use offtakes have been developed as part of the Daandine water management network. Table 4-2 identifies currently operating offtakes and peak daily usage. Additional offtakes will be added when the SGP enters the development phase. These offtakes will form part of the proposed Arrow BUN.

Table 4-2 Current Daandine Third Party Water Off-takes

Beneficial Use Offtake	Peak daily usage (ML/day)	DEHP Hierarchy Priority
Irrigation	8*	Priority 1
Power Station	1.5	Priority 1
Power Station	1	Priority 1
Arrow Projects (construction and operational uses)	1	Priority 1
Feedlot	1	Priority 1

Note: Irrigation offtake rate has no minimum or maximum under the existing agreement. Supply rates are limited to pumping and pipeline infrastructure at 8ML/day.

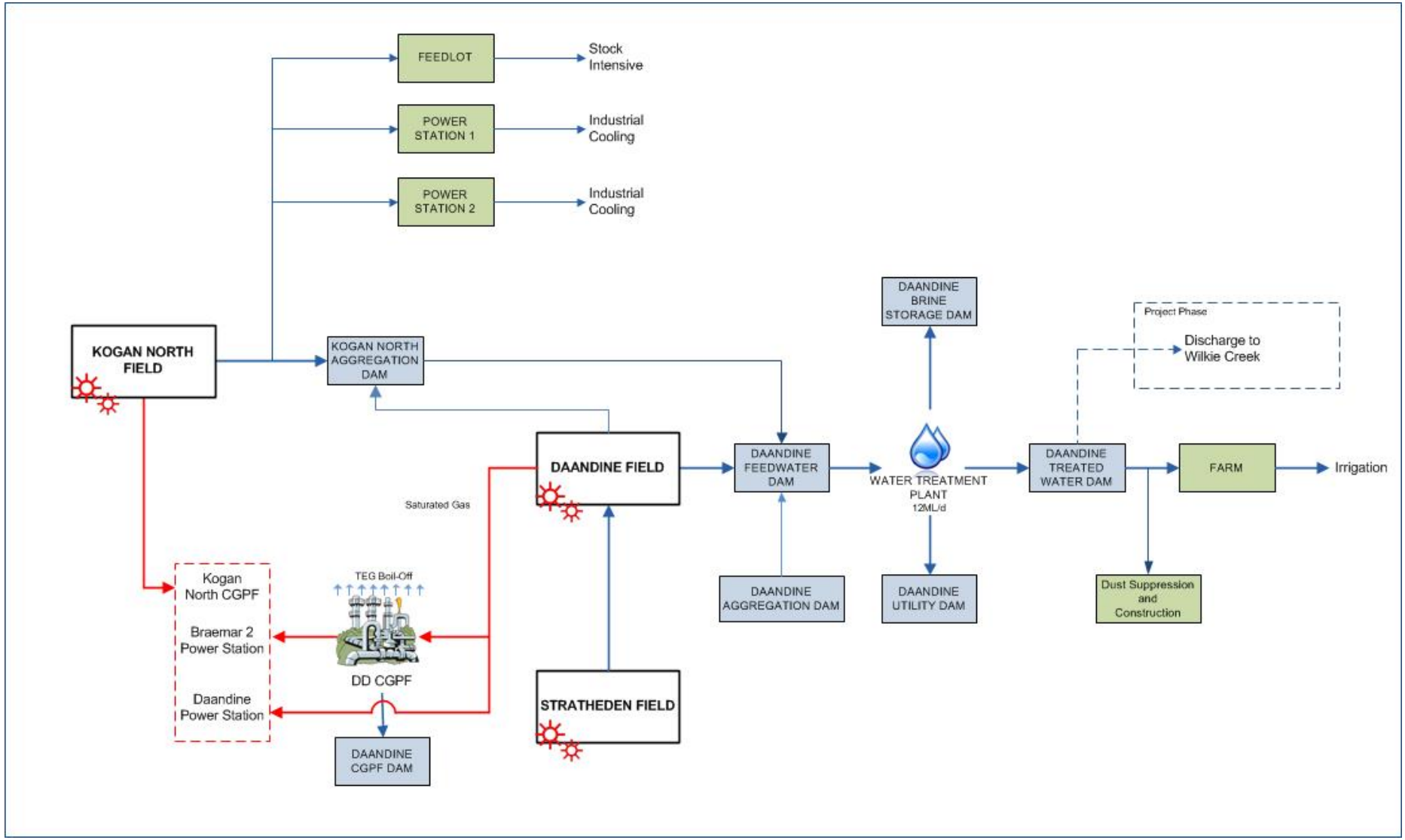


Figure 4-3 **Schematic diagram of the Daandine Water Management Network**

4.2.4 Brine Management

Brine at Daandine is currently stored in a dam compliant with the DEHP 2013 *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*[8] and the DXP EA conditions. Arrow is currently pursuing brine management options in line with its Surat CSG Water and Salt Management Strategy (refer Section 3.5). A long term brine management solution has not been selected at this stage.

4.2.5 Contingency Discharge

Arrow is currently licensed under the DXP EA to release treated CSG water to Wilkie Creek. Arrow is committed to maximising beneficial use of its CSG water prior to disposal methods and thus discharge to Wilkie Creek is held as a contingency measure to adapt to seasonal fluctuation in irrigation demand or to preserve dam integrity during excessive rainfall. The infrastructure required to facilitate discharge to Wilkie Creek has not yet been constructed.

4.3 Arrow Tipton Water Management Network

Figure 4-4 illustrates the existing Tipton water management network.

4.3.1 Dams

Refer to Section 4.1.1 for a description of the gathering network and conditions pertaining to dams. Arrow operates six (6) dams at Tipton. Table 4-3 provides dam storage characteristics for Tipton.

Table 4-3 Tipton Storage Characteristics

Dam Description	Volume at Spillway (ML)	Volume at Mandatory Reporting Level (ML)	Volume at Design Storage Allowance (ML)
Tipton Aggregation Dam 1	1,443	1,240	1,096
Tipton Aggregation Dam 2	2,046	1,728	1,781
Feedwater Dam	422	388	357
Treated Water Dam	422	404	367
Brine Dam	1,141	989	879
Utility Dam	61	57	41

Note: DSA and MRL volumes have been updated to reflect the 2017 Annual Dam Inspections (AECOM, 2017).

4.3.2 Water Treatment Plant

In April 2013, Arrow Energy commissioned a 12 ML/d WTP at Tipton to facilitate beneficial use and align Arrow's operations with the updated CSG water management policy (DEHP, 2012). For a description of the water treatment process refer to Section 4.1.2. For characterisation of treated CSG water quality refer to Section 4.2.

[8] Queensland Department of Environment and Heritage Protection, *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures,* DEHP, Queensland, Australia (ESR/2016/1933).

4.3.3 Beneficial Use

Table 4-4 outlines the beneficial use offtakes from Tipton. The only current offtake is supply to a feedlot. Additional offtakes will be added when the SGP enters the development phase. These offtakes will form part of the proposed Arrow BUN.

Table 4-4 Tipton Third Party Water Offtakes

Beneficial Use Offtake	Maximum Possible Volume (ML/day)	DEHP Hierarchy Priority
Feedlot	Min = 1.75, Max = 4	Priority 1

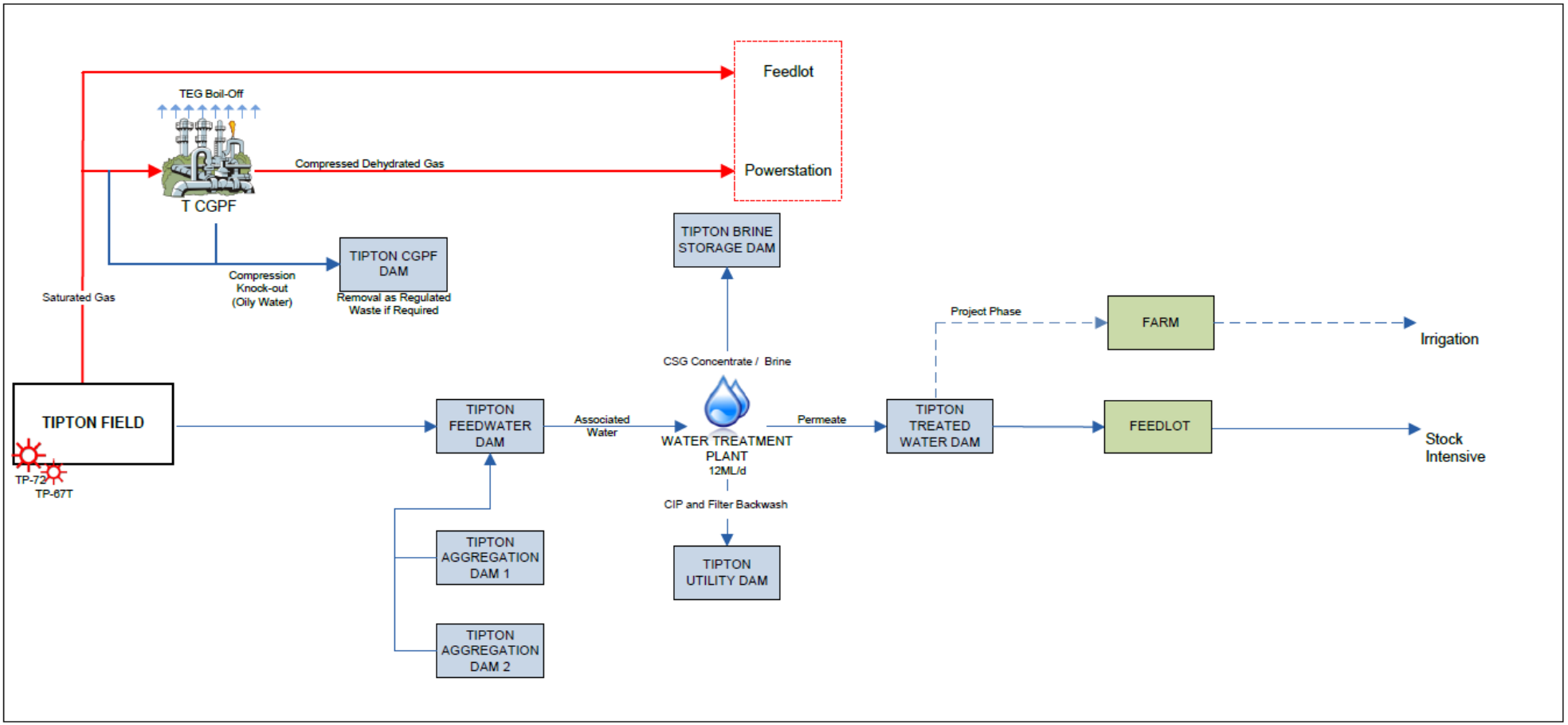


Figure 4-4 **Schematic diagram of the Tipton Water Management Network**

4.3.4 Brine Management

Brine at Tipton is currently stored in a dam compliant with the DEHP 2013 Manual for Assessing Consequence Categories and Hydraulic Performance of Structures and the DXP EA conditions. Arrow is currently pursuing brine management options in line with its Surat CSG Water and Salt Management Strategy (refer Section 3.5). A long term brine management solution has not been selected at this stage.

5. RISK MANAGEMENT

Arrow implements a standardised approach to risk management enabling risks to be ranked and prioritised across all operations. Arrow's approach to risk management seeks to:

- Identify and understand risks inherent to the business; and
- Apply adequate risk response by:
    - Decreasing the likelihood and consequence of adverse effects;
    - Increasing the likelihood and impact of positive effects;
    - Implementing effective controls;
    - Setting boundaries for risk acceptance;
    - Focusing assurance activities towards the highest areas of risk.

5.1 SGP Risk Assessment

An assessment of the risks related to CSG water management for the SGP was completed in March 2018. The risk assessment used the Arrow Energy framework[9]. Table 5-1 summarises the most pertinent CSG water management risks for the DXP, alongside mitigation measures that will control all risks to acceptable levels.

The risk assessment shows that:

- Most risks are ranked as Low considering existing management controls;
- Risks related to the failure of the WTP to achieve desired design water quality, the failure to secure off-take agreements and the failure to deliver a long term brine management solution ranked as Medium;
- For risks which ranked as Medium, the residual risk ranking is Low after consideration of risk response measures.

[9] Arrow Energy, 2018 *Arrow Energy Risk Management Procedure, Appendix 1 - Risk Assessment Matrix*, Version 5.0, Doc No: ORG-ARW-RMT-PRO-00001.

Table 5-1 Summary of Risk Assessment

Hazard / Threat	Consequences	Existing Controls	Current Risk Ranking	Risk Response	Residual Risk Ranking
Dam Break – collapse of the structure due to any possible cause	Dam break has the potential to cause: harm to humans; harm to the environment; general economic loss or property damage; and non-compliance with EA conditions.	Dams are designed and operated in accordance with Queensland regulation. Monitoring and maintenance is undertaken in accordance with Dam Operating Plans. Annual dam inspections conducted. Weekly operator inspections of dam levels.	LOW *Aggregation Dam* LOW *Treated Water Dam* LOW *Brine Dam*	Implementation of emergency procedures as defined in the Dam Operating Plans.	LOW *Aggregation Dam* LOW *Treated Water Dam* LOW *Brine Dam*
Failure to contain – seepage - significant changes to Groundwater from seepage	Seepage has the potential to cause: harm to humans; harm to the environment; general economic loss or property damage; and non-compliance with EA conditions.	Dams are designed and operated in accordance with Queensland regulation. Regular monitoring of groundwater quality in the immediate vicinity of regulated dams as per the Groundwater Monitoring Program. Seepage controls such as HDPE liners and collection systems are in place where required by Queensland regulation. Brine management dams include capability to capture any seepage that may pass through HDPE lining. Monitoring and maintenance undertaken in accordance with Dam Operating Plans.	LOW *Aggregation Dam* LOW *Treated Water Dam* LOW *Brine Dam*	Implementation of emergency procedures as defined in the Dam Operating Plans.	LOW *Aggregation Dam* LOW *Treated Water Dam* LOW *Brine Dam*
Failure to Contain – overtopping – releases due to overtopping of the structure	Overtopping has the potential to cause: harm to humans; harm to the environment; general economic loss or property damage; and	Dams are designed and operated in accordance with Queensland regulation. Operation of storages in accordance with dam operating plans and EA conditions. Adherence to DSA and MRL operating rules.	LOW	Construct contingency release infrastructure. Implementation of emergency procedures (including emergency discharge strategy) as defined in the Dam Operating Plans.	LOW

Hazard / Threat	Consequences	Existing Controls	Current Risk Ranking	Risk Response	Residual Risk Ranking
	non-compliance with EA conditions.	Water production forecasting and water balance modelling. Emergency spillways on dams.			
Failure of water treatment plant to achieve required water quality	Plant failure has the potential to cause: an inability to use treated CSG water for intended beneficial use options; and non-compliance with EA conditions.	Upstream buffer storage to allow for temporary system shut down to resolve potential issues. Automated monitoring within the WTP system to allow for early detection and mitigation of issues. Automated water quality sampling in permeate dam prior to beneficial use. Ability to retreat water from permeate dam if there are significant exceedances.	LOW	Further in-field blending to address potential exceedances. Water treatment plant upgrades (including pre and post treatment systems) or replacements to achieve water quality objectives. Option to turn down / shut in wells if upstream storage becomes limiting.	LOW
Failure to secure water off-takes	Insufficient off-takes have the potential to require disposal of CSG water instead of beneficial use.	CSG water utilisation portfolio to be maintained with sufficient capacity (above upper bound water production curves) to address this risk. Market analysis and identification of off-take opportunities.	LOW	Ability to provide excess capacity into existing SunWater beneficial use pipeline to Chinchilla weir.	LOW
Failure to deliver long-term brine management solution.	No long-term brine management solution has the potential to: require additional brine storage construction when existing capacity is exhausted; and increase operational footprint and create additional impact on environmental receptors.	Brine feasibility studies to identify a long term brine management solution (refer Section 3.5). Construction of additional brine storage dams.	MODERATE[10]	Full evaluation of multiple options in order to ensure long term management approach will be in place.	LOW

[10] Risk ranks as moderate due to costs associated with disposal at a third-party waste facility.

6. MANAGEMENT CRITERIA

6.1 Measurable Criteria

Arrow Energy has defined Measurable Criteria for the SGP in accordance with Section 126 (1) of the *EP Act 1994*. To ensure criteria are targeted towards those CSG water management activities and elements that require greatest control, they have been developed from the outcomes of the risk assessment described in Section 5. The Measurable Criteria will be used to monitor and assess the effectiveness of CSG water management across a range of indicators and will be reported in the annual return.

Table 6-1 presents the measurable criteria required to satisfy the requirements of the EP Act. The criteria will be re-evaluated if required as a result of changes in the way which Arrow manages CSG water.

Table 6-1 Measurable Criteria

Management Component	Objectives	Environmental Value Protected	Controls	Measurable Criteria
Transmission of CSG water via pipelines	Effective containment of water throughout transmission activities from well to beneficial use / disposal.	Surface and groundwater quality. Soil quality (including structural and chemical properties).	Regular monitoring and maintenance in accordance with asset integrity and maintenance plan. Process safety in design and controls.	No reportable unplanned releases of CSG water.
Storage of CSG water in regulated dams	Effective containment of CSG water in dams. Regulated dams operated and maintained in accordance with approvals.	Surface and groundwater quality. Soil quality (including structural and chemical properties).	Annual dam integrity inspections. Groundwater monitoring program. Scheduled maintenance of infrastructure and facilities. Dam operating plans. Water balance modelling to develop operating philosophy and strategy.	Water level below DSA at Nov-1.[11] No breaches of MRL. Annual inspections completed. No unplanned releases.
Beneficial Use	Maximise beneficial use of CSG water. Ensure that supplied beneficial use water is in accordance with approvals.	Surface and groundwater quality. Soil quality (including structural and chemical properties).	Regular monitoring of the qualities and quantities of water suppled for beneficial use. Scheduled maintenance of infrastructure and facilities. CSG Water and Salt Management Strategy.	Water supply agreements in place. Water quality for beneficial use meets approval conditions.
Management of salt and brine	Management of salt in accordance with the regulatory framework.	Land use capability, having regard to economic considerations. Surface and ground water quality. Soil quality (including structural and chemical properties).	Continual assessment of feasible options for beneficial use and/or disposal of salt in accordance with the CSG Water Management Policy 2012. Containment of salt and brine in fit for purpose storage infrastructure operated and maintained in accordance with approvals.	Water level below DSA at Nov 1. No breaches of MRL. Annual inspections completed. No reportable unplanned releases.

[11] If the dam is a regulated structure as per the failure to contain overtopping scenario in the *Queensland Department of Environment and Heritage Protection, Manual for Assessing Consequence Categories and Hydraulic Performance of Structures,* DEHP, Queensland, Australia (ESR/2016/1933).

6.2 Response Procedures

Should any of the Measurable Criteria in Table 6-1 not be met, the following response procedure will be implemented:

- Where relevant, reporting of incident in line with DES requirements;
- Evaluation (including root cause analysis) of the underlying cause of the criteria not being met;
- Review of relevant procedures, protocols and management plans and make changes where required;
- Implementation of corrective actions to address underlying cause. This, for example, could include:
    - Engineering solutions;
    - Amendments to operating procedures; and/or
    - Change to management process.

6.3 Arrow Operating Procedures

Arrow Energy commits its staff to the adoption of a series of procedures that control important elements of CSG water management. These procedures include:

- 99-H-PR-0010 (5) Incident Reporting Recording and Investigation Procedure;
- ORG-ARW-HSM-PRO-00016 (8) Chemical Management Procedure;
- ORG-ARW-HSM-PRO-00066 (4) Waste Management Procedure; and
- ORG-ARW-HSM-PRO-00073 (7) Land Rehabilitation Procedure.

Each of Arrow Energy's procedures is reviewed regularly in order to ensure that all operating factors are considered, and that procedures continue to reflect latest understanding.

7. MONITORING

7.1 Environmental Monitoring

7.1.1 Surface Water

Contingency discharge of treated CSG water to watercourses is a potential option in the event that other beneficial uses of CSG water are temporarily unavailable. Prior to the release of treated CSG water to a watercourse, Arrow will develop a Receiving Environment Monitoring Plan (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, water quality, and flows due to authorised releases. The REMP will be developed in accordance with granted EA conditions. Arrow does not currently have any installed watercourse release infrastructure.

7.1.2 Groundwater

The Groundwater Monitoring Program will provide for the early detection of significant risks and changes in groundwater quality and levels as a result of activities authorised under the SGP EAs.

The Groundwater Monitoring Program will be based on the current program at Arrow's DXP and may include:

- regular monitoring of groundwater quality in the immediate vicinity of regulated dams;
- monitoring of background sites;
- monitoring of dam water quality;
- establishment of site-specific environmental values for the shallow groundwater system;
- development of site-specific trigger values;
- ongoing monitoring of groundwater to identify environmental impacts; and
- implementation of management actions in the event of environmental impact.

Monitoring groundwater quality at dam sites requires installation of monitoring bores in close proximity to dams. The exact location of these bores is guided by geotechnical investigations to identify the direction in which in groundwater impact is likely to travel. Background sites are also installed at distances of 500m to 1,500m (where access allows) both up and down gradient of the dams.

Site-specific trigger levels are developed by considering the background groundwater quality, established trigger levels (such as ANZECC water quality criteria), and the potential impacts of seepage from regulated dams. Ongoing monitoring is then used to identify whether, and to what extent, environmental impacts, with reference to the aforementioned criteria, are occurring. Where unacceptable impacts have occurred, management actions are initiated to remedy these.

7.2 Monitoring of CSG Water Management Dams

In accordance with dam operating plans, Arrow Energy will conduct the following monitoring:

- Weekly monitoring:
    - Dam water levels monitored against MRL and DSA;
    - Visual inspections to consider integrity issues; and
    - Visual inspections for algae, surface slicks or fauna interaction.
- Monthly Monitoring:
    - Visual structural inspection for early identification of integrity issues; and
    - Identification of any changes to the dam service/contents.
- Biannual monitoring:
    - Groundwater impact monitoring for physico-chemical parameters.
- Annual monitoring:
    - Each regulated dam will be inspected by a suitably qualified and experienced person with an Annual Inspection Report prepared and certified; and
    - An assessment of the DSA will be undertaken on or before 1 November each year.

8. REPORTING

8.1 Annual Return

In accordance with the requirements of the SGP EAs, Arrow Energy will complete and submit an Annual Return which will include an evaluation of the effectiveness of the management of CSG water under the criteria described in Section 126(1)(e) of the EP Act.

8.2 Annual Inspection Report

Arrow Energy will provide to DES upon request a copy of the Annual Inspection Report for each of its regulated structures. This will be certified by a suitably qualified and experienced person and will include any recommended actions to ensure the integrity of inspected dam.

8.3 Annual Monitoring Report

An Annual Monitoring Report summarising monitoring results over the previous 12 month period will be prepared and made available to DES upon request. All monitoring results will be retained for no less than five years.

8.4 Incident Reporting

If any contaminant levels are identified as having caused, or have the potential to cause environmental harm, this will be reported to DES in accordance with EP Act and EA requirements.

9. REFERENCES

ANZECC & ARMCANZ 2000, Australian and New Zealand guidelines for fresh and marine water quality, ANZECC & AMCANZ, Australia.

Arrow Energy, 2018 *Arrow Energy Risk Management Procedure, Appendix 1 - Risk Assessment Matrix*, Version 5.0, Doc No: ORG-ARW-RMT-PRO-00001.

Arrow Energy, 2013 Coal Seam Gas Water Management Plan – Surat Basin, Rev: 0, Doc No: ENV11-133.

Arrow Energy 2017, *Surat Gas Project CSG Water Management Strategy*, Rev: 0, Doc No: ORG-ARW-ENV-STR-00001.

Arrow Energy, 2017 Dalby Expansion Project (DXP) – Dam Operating Plan, Rev: 2, Doc No: 19-W-PL-0001.

Arrow Energy, 2013 Daandine Expansion – Field Development Plan, Rev: 3, Doc No: 05-PE-PL-0002 (3).

Arrow Energy, 2017 Daandine and Kogan North Water Management Review, Rev: 0, Doc No: 05-W-REP-0012.

Arrow Energy, 2017 Monthly Daandine Water Operations Report, Rev: 0, Doc No: 05-W-REP-0015.

Arrow Energy, 2017 Monthly Tipton Water Operations Report, Rev: 0, Doc No: 00-W-REP-0008.

Arrow Energy, 2017 Tipton West Management Review, Rev: 0, Doc No: 00-W-REP-0007, Arrow Energy, Australia.

Department of Environment and Heritage Protection, 2017 Environmental Authority: Arrow Energy Dalby Expansion Project, Permit No: EPPG00972513, effective 21 September, Queensland, Australia.

Department of Environment and Heritage Protection, 2013 *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*, Queensland, Australia (ESR/2016/1934).

Department of Environment and Heritage Protection, 2012 Coal Seam Gas Water Management Policy, Queensland, Australia.

Sinclair Knight Merz, 2012 Daandine Gas Project Environmental Assessment of Wilkie Creek, SKM, Australia.

Appendix 11: Example Baseline Report

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Report

Safe Work. Strong Business.

Baseline Report

Surface Elevation Data – 1DY931 & 1RL2451

Version	1
Released	20/07/2021

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Contents

List of Figures

1. Purpose

This Report provides the following surface elevation datasets overlaid for lots on plans, 1DY931 & 1RL2451 :

- 2012 Digitial Elevation Model (DEM) (Figure 1),
- 2014 DEM (Figure 2),
- 2020 DEM (Figure 3),
- Slope analysis (at 10 m by 10 m squares) of 2012 DEM (Figure 4),
- Slope analysis (at 10 m by 10 m squares) of 2014 DEM (Figure 5), and
- Slope analysis (at 10 m by 10 m squares) of 2020 DEM (Figure 6).

Electronic copies of the above datasets can be made available upon request.

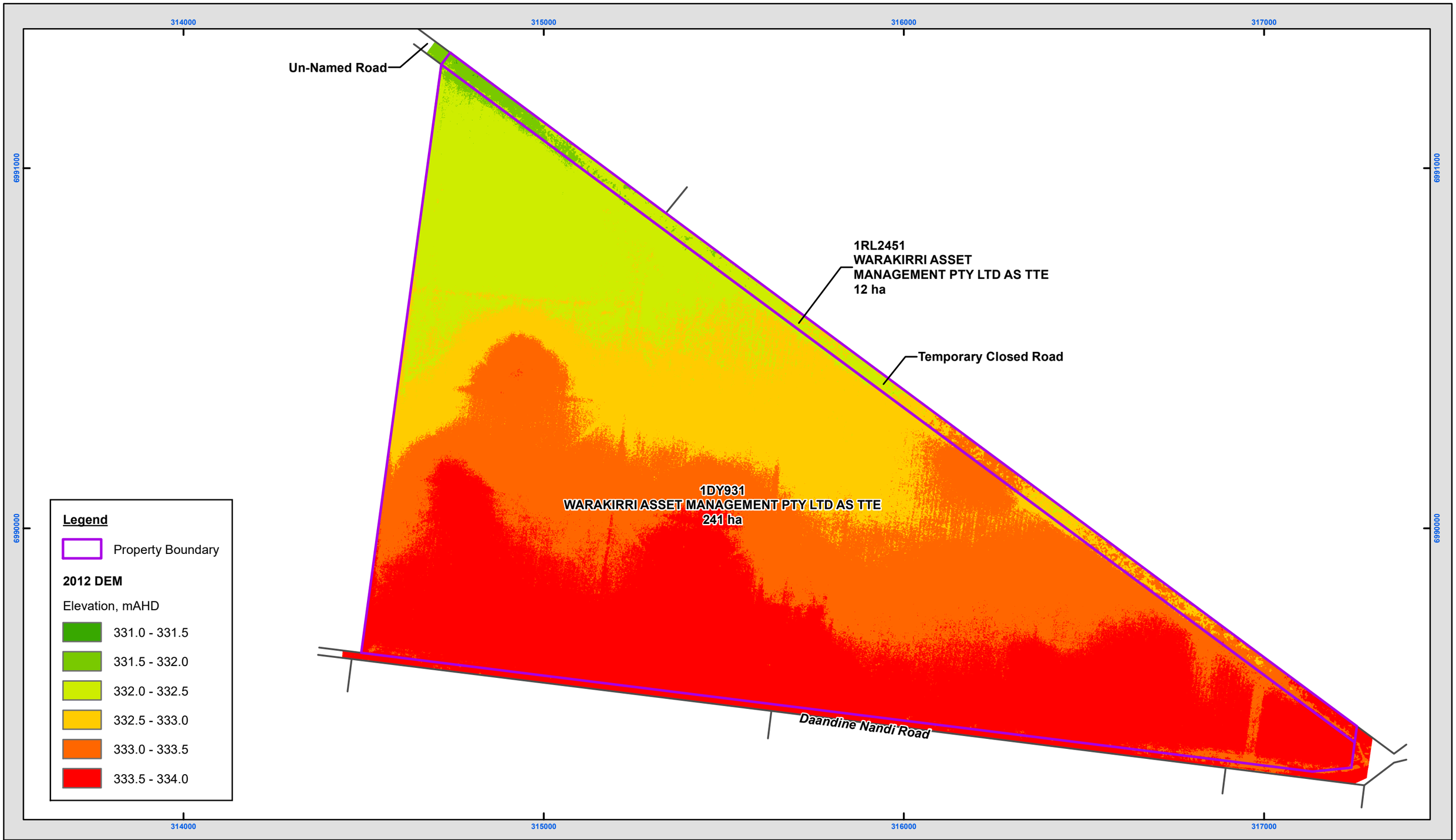

Figure 1 : 2012 DEM : Lots on Plans 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

NOT FOR CONSTRUCTION

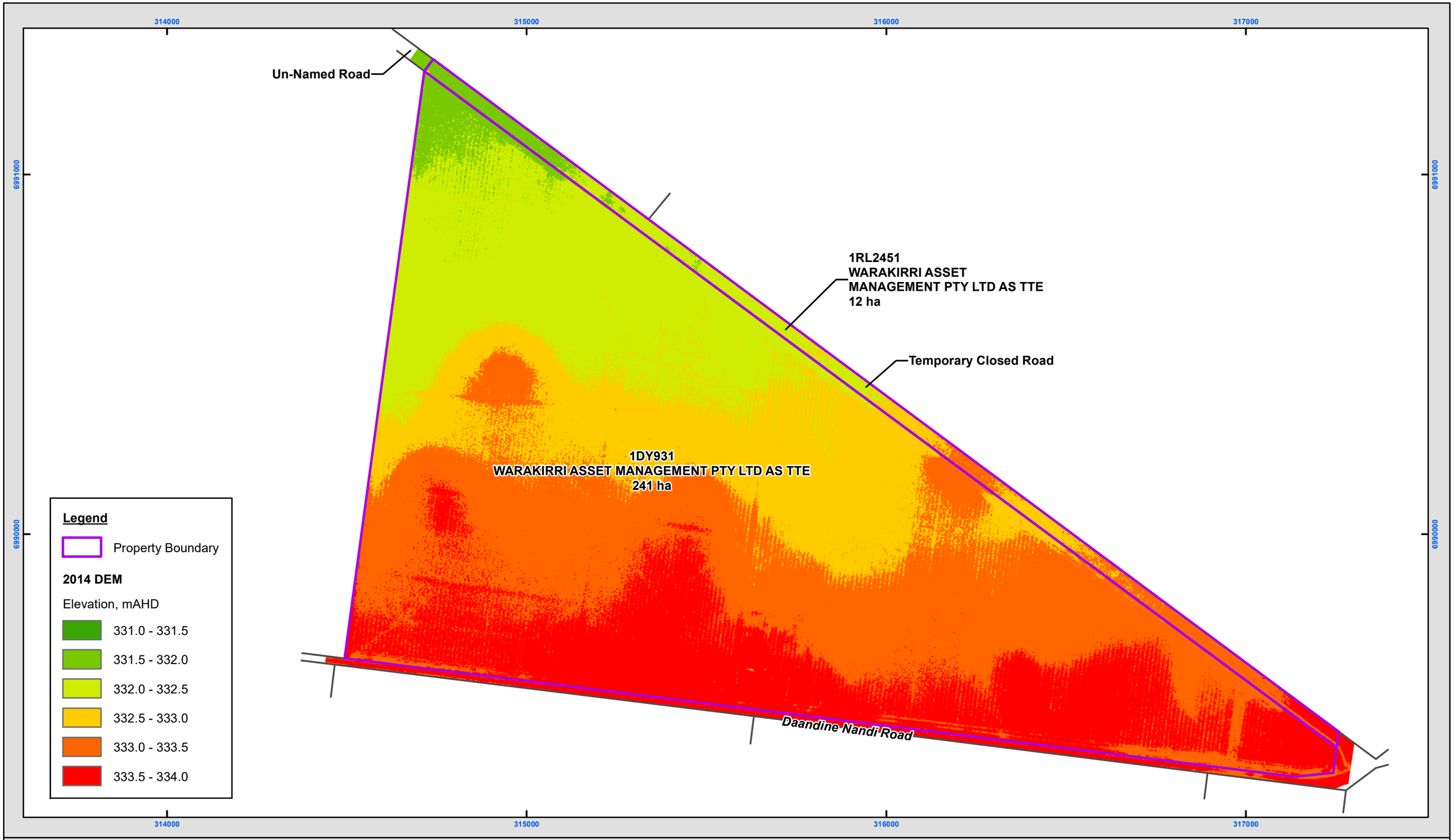

Figure 2 : 2014 DEM : Lot on Plan 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

NOT FOR CONSTRUCTION

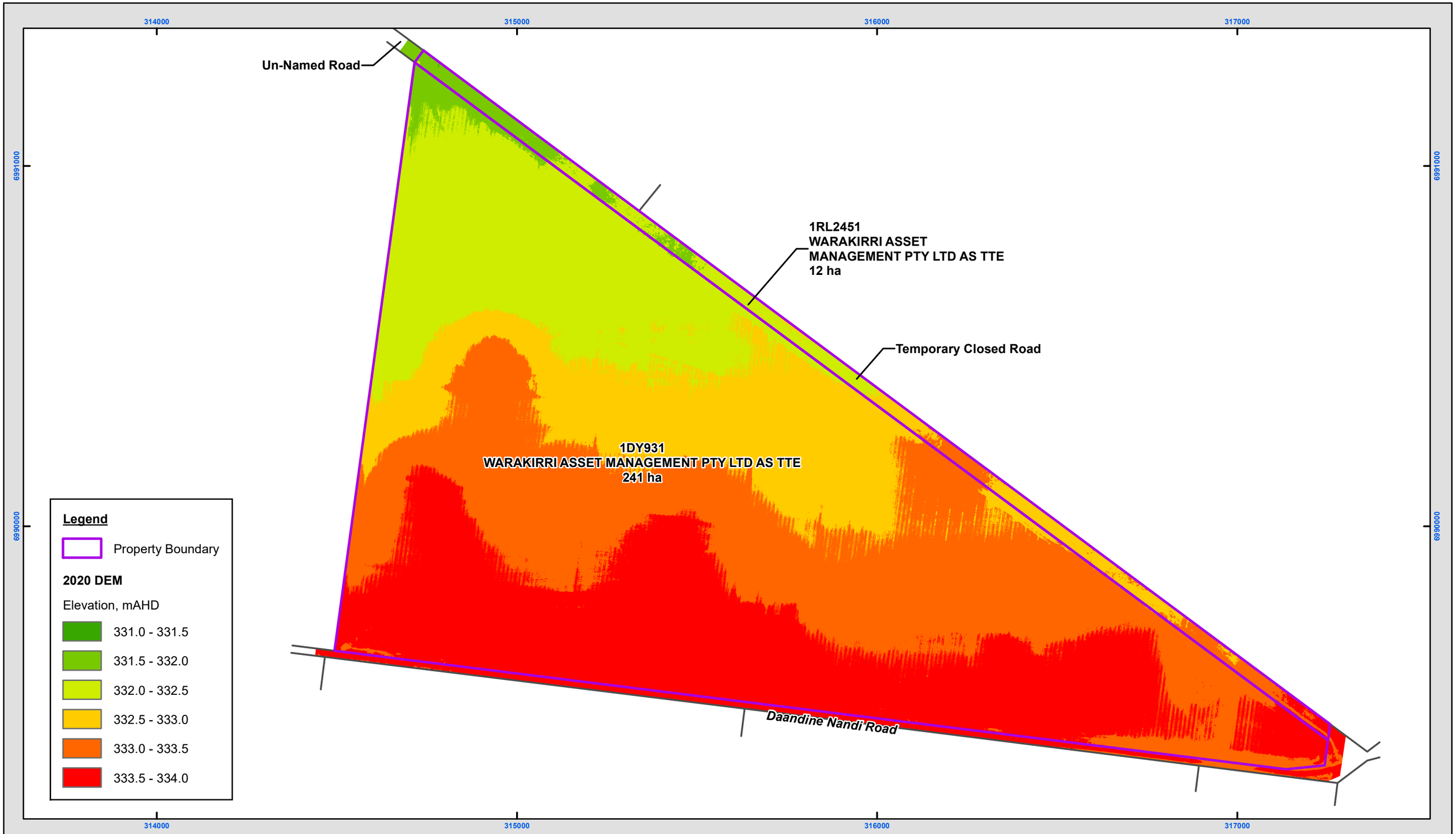

Figure 3 : 2020 DEM : Lot on Plan 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA2020 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

NOT FOR CONSTRUCTION

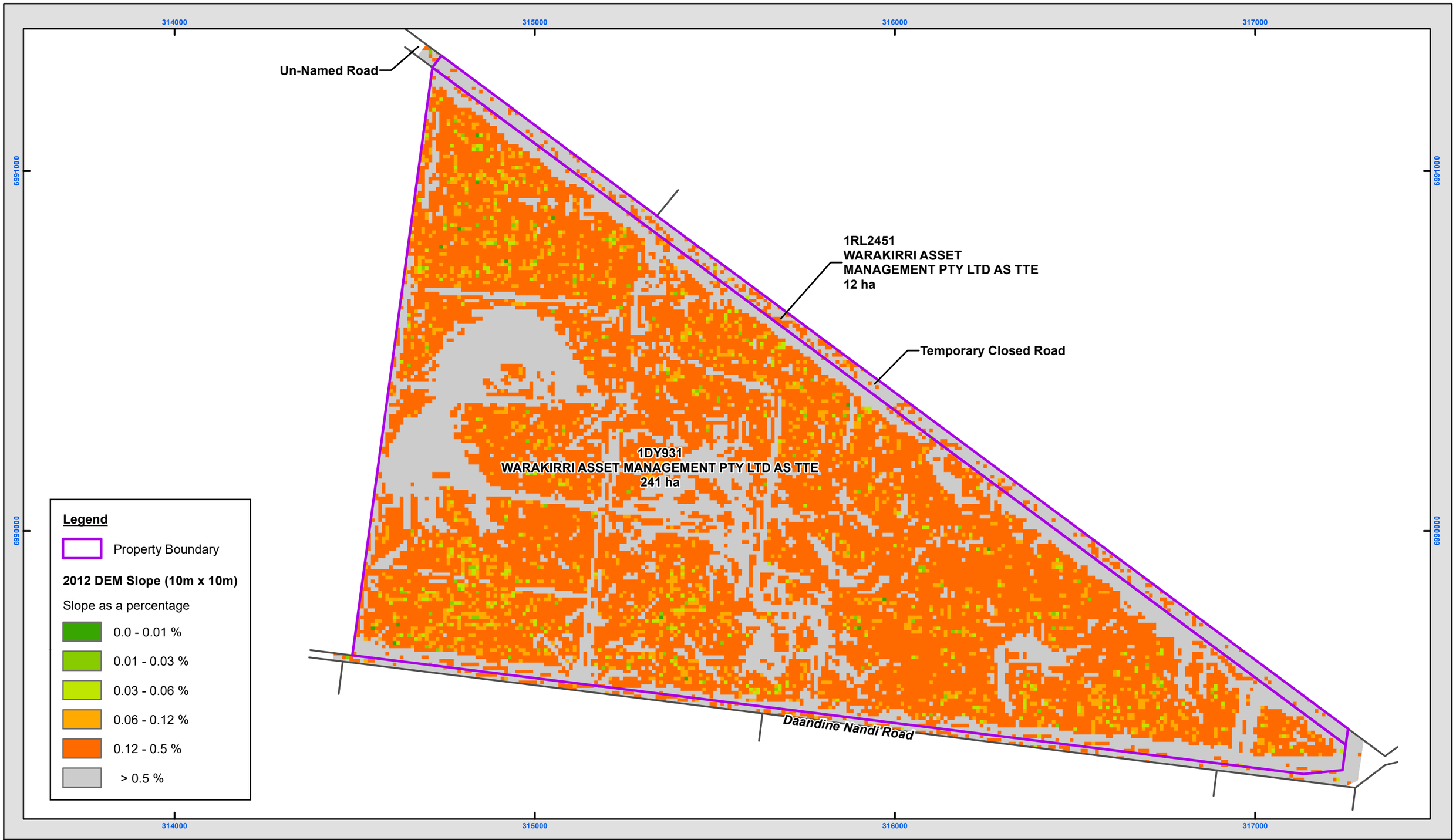

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM : Lot on Plan 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

NOT FOR CONSTRUCTION

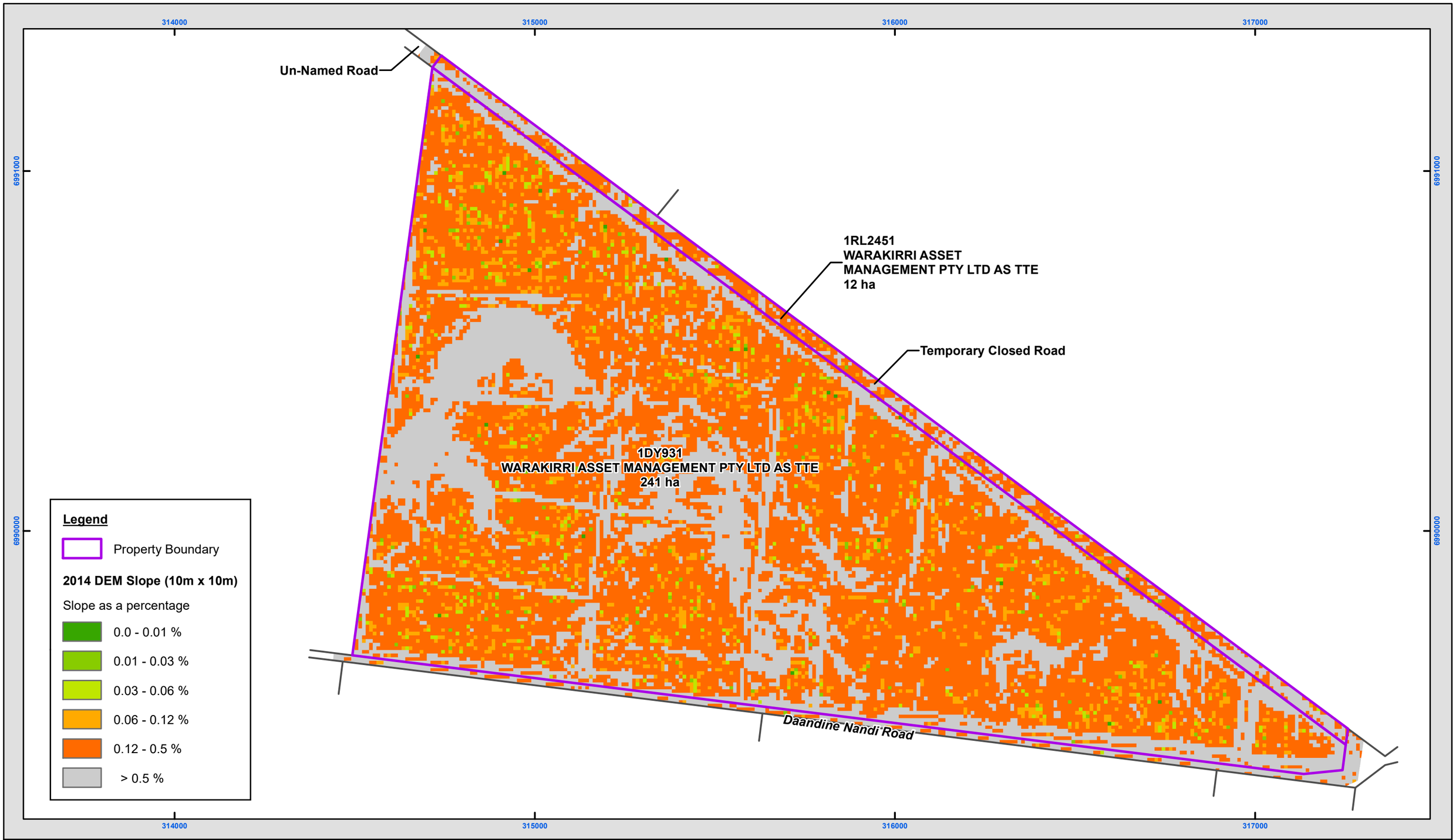

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM : Lot on Plan 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

NOT FOR CONSTRUCTION

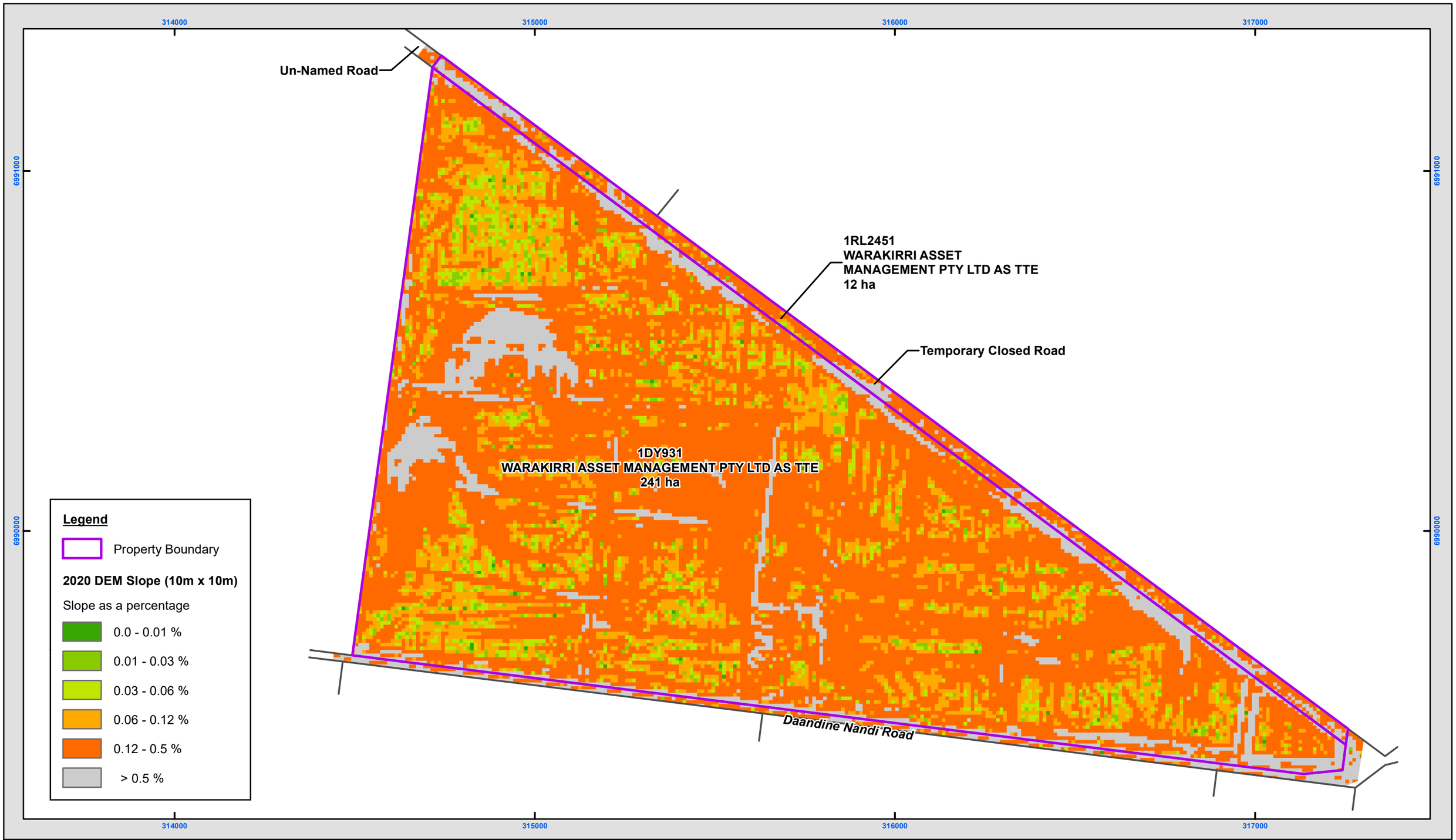

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM : Lot on Plan 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA2020 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

NOT FOR CONSTRUCTION