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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*

Updated Report incorporating revised project layout and responses to the two Requirement Notices received from DSDILGP

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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).

An application for a Regional Interests Development Approval (RIDA) under the *Regional Planning Interests Act 2014* (RPI Act) was submitted to the Department of State Development, Infrastructure, Local Government and Planning (DSDILGP) on 20 September 2021. The DSDILGP subsequently issued two Requirements Notices in regard to the application.

This report provides the required supporting information for the application for the RIDA and has been updated to address the two Requirements Notices issued by the Department of State Development, Infrastructure, Local Government and Planning (DSDILGP), including a revision to the project infrastructure layout on the properties

A summary of the Requirements Notice and how each point has been addressed has been provided to DSDILGP with this Report.

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 & associated deviated well paths from 4 well pads, an additional 16 deviated well paths, approximately 13.6 km of gathering proposed and 4km of new and upgraded access tracks on 13 Lot on Plans within Petroleum Leases (PL) 252 and 260. The Lot on Plans the subject of this RIDA are 2RP85916, 12SP193328, 57SP193329, 36DY45, 1RL2451, 1DY931, 70DY138, 1RP154777, 1DY787, 2RP106958, , 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.

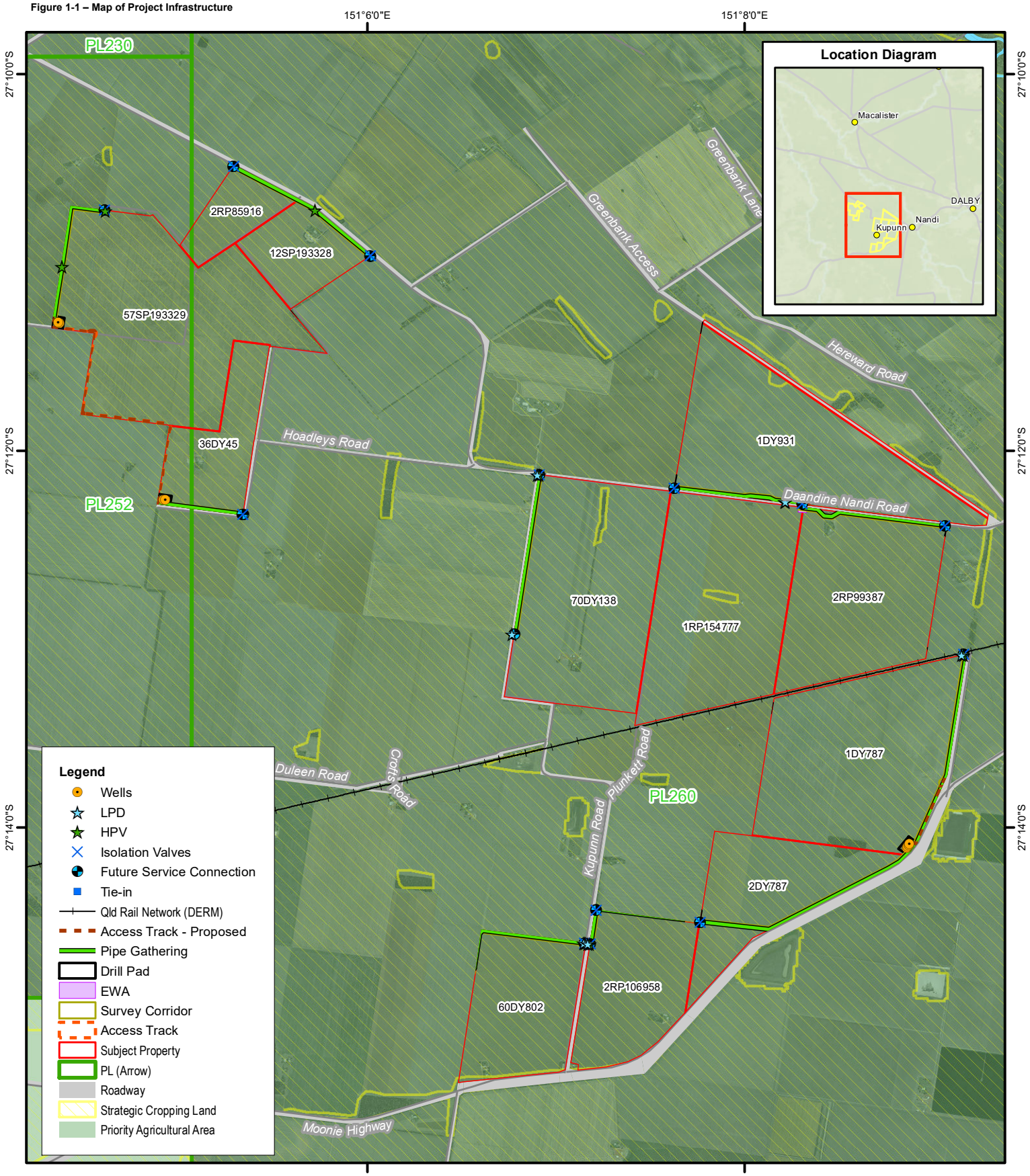
This report has also been drafted in accordance with the RPI Act Guidelines that directly address resource activities proposed in PAA and SCA, the guideline on identification of Priority Agricultural Land Use (PALU) and the RPI Act Guideline companion guide.

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	Refer to Section 11

Information Requirement	Section Addressed
address the prescribed solution/s contained in the assessment criteria for the area of regional interest.	

Figure 1-1 – Map of Project Infrastructure



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Rev	Date	Revision Description	Dft	Chk	Eng	QA	App
D	30.03.22	Revised Infrastructure Points	CO	AH	--	--	AH
C	30.03.22	Update to RFS	CO	AH	--	--	AH
B	30.03.22	Update to RFS	JJ	AH	--	--	AH
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Source: Arrow Energy Limited
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Queensland Government

Wells and Gathering Infrastructure on Warakirri Properties

Uncontrolled (D)

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Print Date: 6/04/2022

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
2RP85916	Yes	Yes
12SP193328	Yes	Yes
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
2RP99387	Yes	Yes

Lot Plan	Mapped as Area of Regional Interest (ARI)	
	PAA	SCA
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 work scope. 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 work scope the subject of this RIDA application is:

- 11 CSG wells on 4 well pads (including associated subterranean deviated well paths);
- 16 subterranean deviated well paths, drilled from well pads located on parcels outside the scope of this application;
- Water & Gas Flowlines from wells to Header (DN160-DN450) ~ 13.5 km (~27 km pipe in total);
- Access tracks (approximately 4km of new and upgraded tracks); and
- Associated gas field 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.

Arrows co-existence commitments and implementation of activities are consistent with Table 3, Prescribed Solution (a) for Required Outcome 2 by:

- providing for mutual benefits to the landholder (through compensation and infrastructure upgrades) and Arrow (through ability to access CSG resources);
- negotiating with landholders in regard to their land practices and schedules and developing simultaneous operations matrices to identify how Arrow can coexist with landholders through the project phases and not cause agricultural activities to need to pause and restart;
- where practicable, construction activities will be undertaken during harvesting and planting or when the paddocks are in fallow;
- ensuring the land is returned to full productive capacity as quickly as possible and undertaking all activities with regard to the landholder and their operations;

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.

Details of the landowner's involvement in the Area Wide Planning program is provided in Appendix 9.

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 EPBC Approval

On 19 December 2013, Arrow Energy received an approval from the Federal Government under the Environment Protection and Biodiversity Conservation Act 1999 for the Surat Gas Project (EPBC 2010/5344). This approval covers the area the subject of this RIDA application. The relevant conditions from this approval are related to groundwater and the requirement for a CSG Water Monitoring and Management Plan (WMMP), conditions 13 – 25. A copy of the EPBC approval is presented at Appendix 1 and a copy of Arrow's WMMP can be found on the company's website at the following location: https://www.arrowenergy.com.au/environment/groundwater/water-monitoring-management-plans.

1.7.2 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		

1.7.3 Regional Interests Development Approvals

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

1.7.4 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	
2RP85916	Part	Gas Field Development	1.54	1.54	46.58
12SP193328	Part	Gas Field Development	1.93	1.93	66.23
57SP193329	Part	Gas Field Development	4.71	4.7111.3	**306.20**
36DY45	Part	Gas Field Development	2.66	2.66	**89.02**
1RL2451	Part	Gas Field Development	0.00	0.00	**12.62**
1DY931	Part	Gas Field Development	3.74	3.74	**241.04**
70DY138	Part	Gas Field Development	3.68	3.68	**258.86**
1RP154777	Part	Gas Field Development	0.11	0.11	**245.70**
1DY787	Part	Gas Field Development	6.77	6.77	**266.40**
60DY802	Part	Gas Field Development	2.14	2.14	**129.18**
2RP106958	Part	Gas Field Development	0.83	0.83	**127.99**
2RP99387	Part	Gas Field Development	3.07	3.07	202.82
2DY787	Part	Gas Field Development	4.66	4.66	132.64
Total			**35.84 ha**	**35.84 ha**	**2125.28 ha**

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

- Right of Way;
- Access Track;
- Extra Work Area (EWA);
- Multi-well pad;
- Buried linear infrastructure;
- High Point Vents;
- Low point drains;
- Isolation Valves;

- Tie-ins;
- 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.

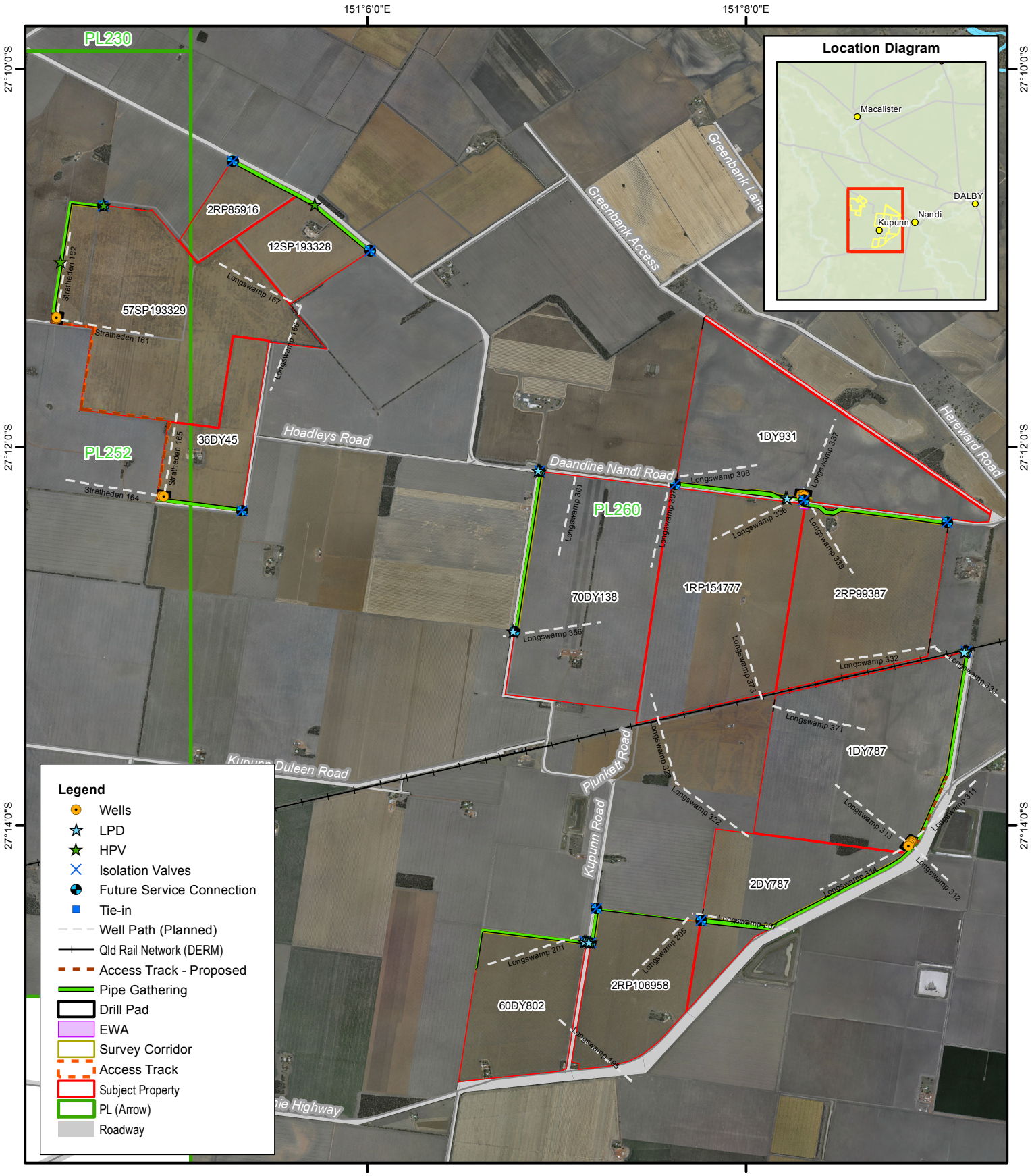
Note : As illustrated on Figure 2-1, some subterranean deviated drilling trajectories will be located on parcels within the scope of this application where the drill pad for these trajectories are located on adjacent parcels outside the scope of this application. The activities on these adjacent land parcels are outside the scope of this application and will be subject to a separate RIDA application, if required (i.e. where those activities are not exempt activities).

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.



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Rev	Date	Revision Description	Org	Chk	Eng	QA	App
E	24.06.22	Issued for Use	JJ	AH	--	--	AH
D	30.03.22	Revised Infrastructure Points	CO	AH	--	--	AH
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Print Date: 24/06/2022

Table 2-2 – Property Details

Parcel	Part of a Property >1 Lot (Yes/No)	Parcels comprising the Property
2RP85916	Yes	'Property 1' – comprising four parcels. . The area of Property 1 is approximately 508 ha.
57SP193329	Yes	
36DY45	Yes	
12SP193328	Yes	
1RL2451	Yes	'Property 2' – comprising nine parcels. 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/property.

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, 2RP99387
Kupunn Road	Western boundary of 70DY138
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 daytime 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
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 (type of valve) constructed along the water and gas networks to assist with commissioning / maintenance purposes, with an operational footprint of 2m by 2m.
Valves(Isolation)	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
Tie-in	A tie-in is the connection of a pipeline to a facility, to other pipeline systems or the connecting together of different sections of a single pipeline.
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

Resource Activity	Definition
	infrastructure will be a minimum of 900 mm and may also contain electrical and/or communication cable.
Subterranean deviated drilling trajectory / path	The subterranean (underground pathway) of the deviated well.
Fencing	Cattle Panel fencing around well pad infrastructure. By exception security fencing may be installed. In addition, breaks will be made in existing fencing to enable installation of the buried infrastructure within the ROW. Fence breaks will be reinstated post construction.
Extra Work Area	Where additional area outside of the ROW is required to enable safe construction. The extra work area 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 five extra workspaces to facilitate road crossings
- Digging trenches within the identified Right of Way ("ROW") and stockpiling of spoil and materials within the RoW
- Installation of 27.13 km of high-density polyethylene (HDPE) gathering lines (gas and water) over a distance of 13.57 km, up to 630mm diameter and buried to a depth of 900 mm.
- 9 High Point Vents, 6 Low Point Drains, 14 pairs of isolation valves and 28 future service connections and 2 tie-ins.
- 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 4 well pads, including well head facilities & associated infrastructure (all are multi-well pads with deviated well paths)
- Installation of an additional 16 subterranean deviated well paths (drilled from well pads located on parcels outside the scope of this application)
- 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 and existing access tracks will be upgraded where required. The location of additional access tracks on land subject to this application is described and illustrated in Appendix 3.

3.3.2 Deviated Wells & Trajectories

Traditionally, CSG wells are drilled straight down. These are called vertical wells. Where conditions allow, we can use 'deviated' wells instead. These are wells that are drilled at angles away from vertical. In the Surat Basin, on intensively farmed land, we group multiple wells on single, larger pads. From the surface, the bores slant away at around 70 degrees to intersect multiple, thin coal seams.

Deviated drilling lets us reach the same amount of gas underground from a much smaller area on the surface which is very important for reducing our impacts on high-production farmland. Deviated wells are operated exactly the same as a vertical well from the same surface well head facility with the major benefit being the cumulative surface impact is considerably lower because we are able to operate less wells than a traditional vertical well formation.

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.

There will be up to 27 deviated wells entering the land the subject of this application, 11 of which will be located on well pads within the scope of the application, and 16 will be drilled from well pads on neighbouring properties and outside the scope of this application. The deviated wells drilled from neighbouring properties the land (within the application scope) at a subterranean point at a depth of greater than 190 m. The well trajectories included in the scope of this application are illustrated on

Figure 2-1. The location, length and depth of the well trajectories beneath each land parcel is also detailed and illustrated in Appendix 3.

The depth of wells will range from approximately 200 m to 800 m, with an average depth of approximately 450-500 m. Each well pad will be 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).

Surat Basin wells each target multiple coal seams, whose thickness is typically measured in centimetres not metres. To construct a 'deviated well', the surface section is firstly drilled from ground level to a depth of between 50 and 120 metres. This section is cased with steel casing and cemented to the surface, sealing wells from shallow farming aquifers. Further down-hole, swellable packers installed above and below target coal seams, ensure zonal isolation.

A special angled drill bit is then inserted and is able to be 'steered' away from the other wells on the same pad. The deviated section of the well can reach coal seams to a vertical depth of around 600m and can extend to a horizontal length of up to 800m away from the well pad. This enables us to target all of the coals without impacting the agricultural land directly above.

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 application 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.

Arrow assesses deviated Well trajectories on a case-by-case basis to determine whether directional drilling is an advanced activity or a preliminary activity by having regard to the impact (if any) of the activity on the landowner's business or land use activities. 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.

Arrow will also negotiate a Deviated Well Agreement with landowners for any deviated wells on their property or include them within a CCA. Arrow ensures that deviated well trajectories are fully incorporated into the Dial-Before-You-Dig process and then also at the completion of drilling.

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 23 m in width to provide area to spread soil during rehabilitation)
- Establishment of Erosion and Sediment Controls, which typically includes spreading 5t/ha gypsum on top of the exposed sub soil, installation 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.

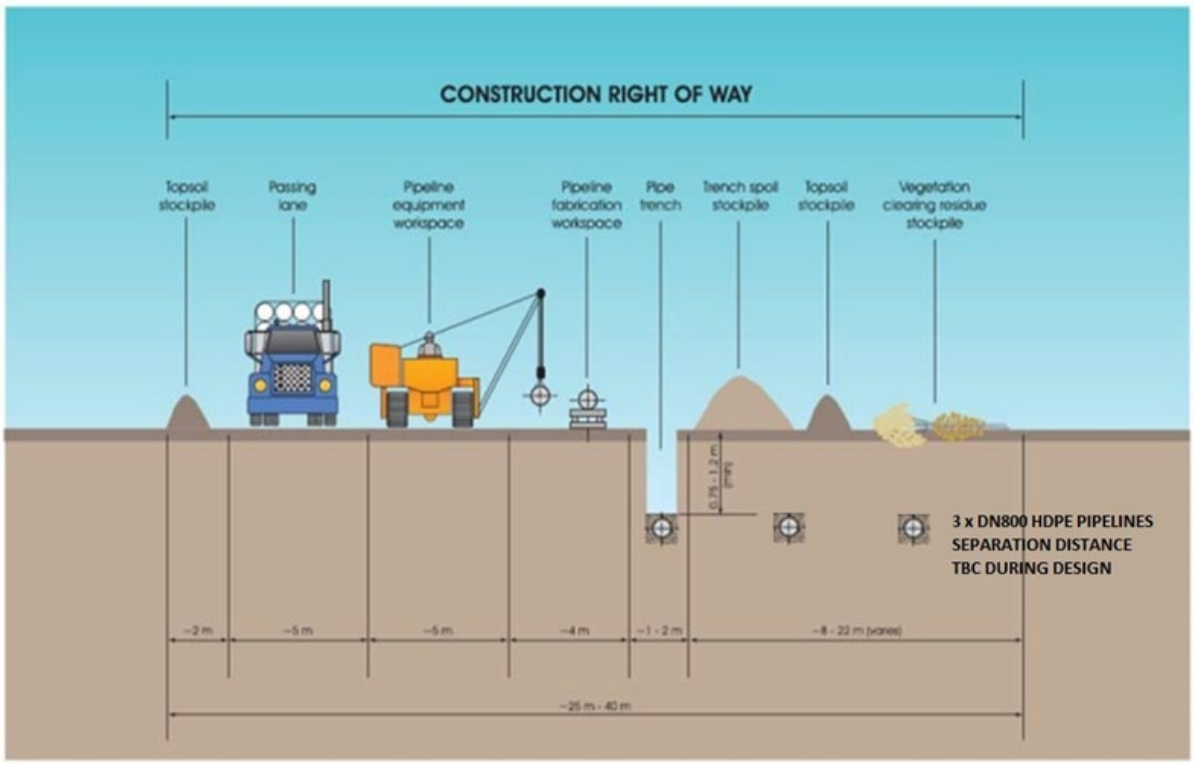


Figure 3-1 Typical Profile ROW Layout (Exact configuration to be confirmed during design)

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. All deviated wells will be subject to dial before you dig requirements.

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 Site

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 for a single well (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.

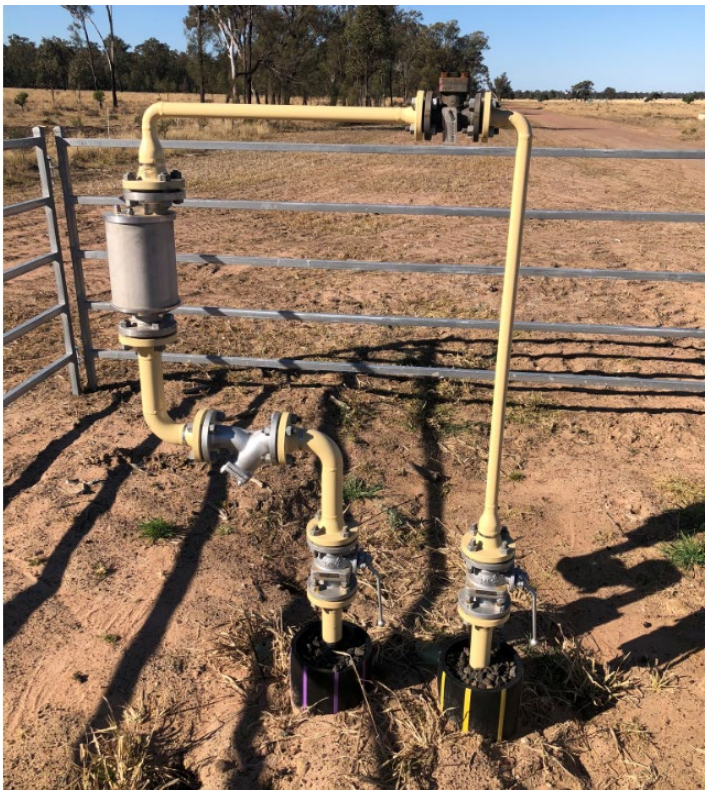


Plate 3-2 - Image of High Point Vent

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 construction, 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

Future Services Connections

A future service connection (FSC) is to connect temporary equipment used during the commissioning phase of a pipeline, such as hoses, valves and vents. Once commissioning has been completed and prior to the operation of the pipeline, this equipment will be removed and the FSC will not be used again, unless it was necessary for maintenance purposes.

Tie-ins

A tie-in is the connection of a pipeline to a facility, to other pipeline systems or the connecting together of different sections of a single pipeline.

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 wells, gathering lines and associated infrastructure 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 Conformity 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 the surrender of the relevant authority, the decommissioned infrastructure remains the property of the previous authority holder.

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.

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, access track (0.34km new & 1.95km upgraded)[1]** **Operational disturbance:** **2 x wells on 1 well pad, 3 km of gathering, 2 x HPVs, 2 x tie-ins, 2 x isolation valves, 2 x future connection services, 0.34km new access track[1] and 5 x subterranean deviated well trajectories**	306.20	303.7	4.71	0.54	1.55%	0.18%
36DY45	**Construction Disturbance:** **1 x well pad, ROW for buried infrastructure, access track (0.02km new, 0.79km upgraded) [1]** **Operational Disturbance:** **2 x wells on 1 well pad, 1.84 km of gathering, 2 x isolation valves, 2 x future services connections, access track (0.02km new, 0.79km upgraded) [1] and 2 x subterranean deviated well trajectories**	89.02	86.77	2.66	0.20	3.06%	0.23%

2RP85916	**Construction Disturbance:** **ROW for buried infrastructure** **Operational Disturbance:** **1.34 km of gathering, 2 x isolation valves, 2 x future services connections**	46.58	46.58	1.54	0.01	3.30%	0.03%
12SP193328	**Construction Disturbance:** **ROW for buried infrastructure** **Operational Disturbance:** **1.68 km of gathering, 1 x HPV, 2 x isolation valves, 2 x future services connections, 1 x Subterranean deviated well trajectory**	66.23	64.01	1.93	0.02	3.02%	0.03%
Property Total		508.03	501.06	10.84	0.77	2.16%	0.15%

Notes

1. Only new access track has been included in the footprint calculation for construction and operational surface impact as the upgrade to existing tracks does change or impact on the existing use of the track. Access track upgrade works will occur ahead of any disturbance for the installation of wells or gathering infrastructure and will be scheduled in consultation with the landholder and ensure that access is maintained where required during upgrade works.

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	**Nil**	12.6	0.00	0.00	0.00	0.00%	0.00%
1DY931	**Construction Disturbance:** **1 x well pad, ROW for buried infrastructure, access track (0.048km upgraded)[2]** **Operational disturbance:** **3 x wells on one well pad, 2.35 km of gathering, 1 HPV, 1 x LPDs, 4 x isolation valves, 4 x future service connections, access track (0.048km upgraded) [2], 4 x Subterranean deviated well trajectories**	241.04	240.34	3.74	0.18	1.58%	0.07%
70DY138	**Construction Disturbance:** **EWA, ROW for buried infrastructure** **Operational disturbance:** **3.19km km of gathering, 1 HPV, 2 x LPDs, 4 x isolation valves, 2 x future service connections, 3 x Subterranean deviated well trajectories**	258.86	256.41	3.68	0.03	1.44%	0.01%

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:** **EWA, ROW for buried infrastructure** **Operational disturbance:** **0.04 km of gathering, 2 x subterranean deviated well trajectories**	245.70	245.34	0.11	0.00	0.04%	0.00%
1DY787	**Construction Disturbance:** **1 x well pad, ROW for buried infrastructure, access track (0.83km new), EWA** **Operational disturbance:** **4 x wells on one well pad, 4.47 km of gathering, access track (0.83km new),1 HPV, 1 x LPD, 2 x isolation valves, 4 x future service connections, 6 x subterranean deviated well trajectories**	266.40	263.27	6.77	1.13	2.57%	0.43%
60DY802	**Construction Disturbance:** **ROW for buried infrastructure** **Operational disturbance:** **1.88 km of gathering, 1 HPV, 1 LPD, 2 x isolation**	129.18	126.96	2.14	0.02	1.68%	0.02%

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
	valves, 2 x future service connections,2 x subterranean deviated well trajectory						
2RP106958	**Construction Disturbance:** **EWA, ROW for buried infrastructure** **Operational disturbance:** **0.70 km of gathering, 1 HPV, 1 LPD, 4 x isolation valves, 4 x future service connections,2 x subterranean deviated well trajectories**	127.99	126.27	0.83	0.04	0.65%	0.03%
2RP99387	**Construction Disturbance:** **EWA, ROW for buried infrastructure** **Operational disturbance:** **2.62 km of gathering, 1 x HPV, 2 x isolation valves, 2 x future services connections, 2 x Subterranean deviated well trajectory**	202.82	200.94	3.07	0.00	1.53%	0.00%
2DY787	**Construction Disturbance:** **ROW for buried infrastructure**	132.64	130.83	4.66	0.00	3.56%	0.00%

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
	Operational disturbance: **4.05 km of gathering, 3 x subterranean deviated well trajectories**						
Property Total		1617.25	1590.36	25	1.4	1.57%	0.09%

Notes

2. Only new access track has been included in the footprint calculation for construction and operational surface impact as the upgrade to existing tracks does change or impact on the existing use of the track. Access track upgrade works will occur ahead of any disturbance for the installation of wells or gathering infrastructure and will be scheduled in consultation with the landholder and ensure that access is maintained where required during upgrade works

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 construction access. Details of the construction disturbance per property is provided in Appendix 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 construction. 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 construction disturbance will be timed to align with periods of fallow, to avoid interruption to PALU on the parcels;
- The pre-existing PALU can recommence on the land following construction, apart from areas with surface infrastructure;
- Greater than 99.5% of the area of PALU on the properties pre-construction 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 impacts associated with the operation of the wells and gathering infrastructure are small and result in less than a 0.5% 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 0.04% and 3.56% of the PALU on each parcel the subject of the RIDA application, so impacts to yields will reduce accordingly (i.e. yield reduction only occurs within impacted area and not across the entire parcel) and would not exceed 2%.

Using Lot 36DY45 as an example

- Area of PALU on this parcel is 86.77 ha
- Area of surface disturbance during construction is 2.66 ha
- Area of surface impact during operations is 0.20 ha
- This means that of the 2.66 ha disturbed during construction, 2.46 will be returned for a PALU post construction, while 0.2ha will remain as operational footprint.

For the purpose of this example, a worst-case assumption of 40% yield reduction (i.e. 60% yield) has been used (to be very conservative), for the area disturbed during construction & returned to PALU post construction.

The area subject to surface impacts during operations (0.20 ha) will have a 0% yield, as it will not be available for PALU for the duration of operational activities. 100% yield (pre-existing yield) will continue on the remainder of the parcel (84.11 ha).

The area subject to surface disturbance during construction and returned to PALU post construction is 2.46 ha.

- 2.46 ha @ 60% yield, equates to 1.47 ha @ 100% yield, or the loss of an equivalent of 0.99 ha @ 100% yield (2.46 ha – 1.47 ha)
- The 0.2 ha operational footprint equates to the loss of 0.2 ha @ 100% yield
- This equates to a 1.37% reduction in yield across the full parcel ((0 ha +0.2 ha) / 86.77 *100%) in the initial period following construction

Using the same methodology above for each property, an assumed 40% yield reduction across the area disturbed for construction, would result in a Property yield reduction of 0.96% for Property1 and 0.68% for Property 2.

As the actual yield reduction within the disturbance area is expected to be significantly less (10-15%, compared to the assumed 40%). Therefore the expected yield reduction across the parcel will also be significantly less than the

worst case example provided above and therefore demonstrated to be less than 2% on the example parcel and across the Properties.

This reduced yield will also only be for the initial period following construction and yields will continue to improve over time. Therefore, at no time will the loss of productive capacity be greater than 2% on any parcel and therefore property.

Loss of productive capacity is also addressed in the compensation package offered to the landholder (refer to Appendix 9).

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 35.84 ha and (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.

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

- Use of alternate access for accessing areas adjacent the areas subject to construction disturbance;
- Limitation of access to adjacent land with large agricultural equipment, particularly where the disturbance 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 potential for these impacts will be minimised by scheduling the construction activities to occur when the parcel is fallow, thus minimising potential for any disruption to planting or harvesting activities. 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.

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

4.4.4 Buried Infrastructure

All buried is infrastructure is designed to enable previous PALU activities to recommence post construction on areas not utilised for operations, including tilling, cropping & crossings by heavy agricultural equipment. Future farm plans are also taken into consideration in planning and designing the gas field infrastructure.

Gathering lines will be installed with a minimum dept of 900mm, while the deviated sub-terranean well trajectories have a minimum depth of 190m. Arrow provides the landholder with maps and plans of the location of all buried infrastructure. In addition, all deviated wells are registered on dial before you dig.

The buried infrastructure does constrain the location of future deep excavations on the property e.g dams or bores. However, any new farm infrastructure or excavations can take the location of the buried gas field infrastructure into consideration in sighting such activities. As such, the buried infrastructure is not considered to constrain, restrict or prevent the ongoing conduct of PALU on the properties.

4.4.5 Construction Timeframe

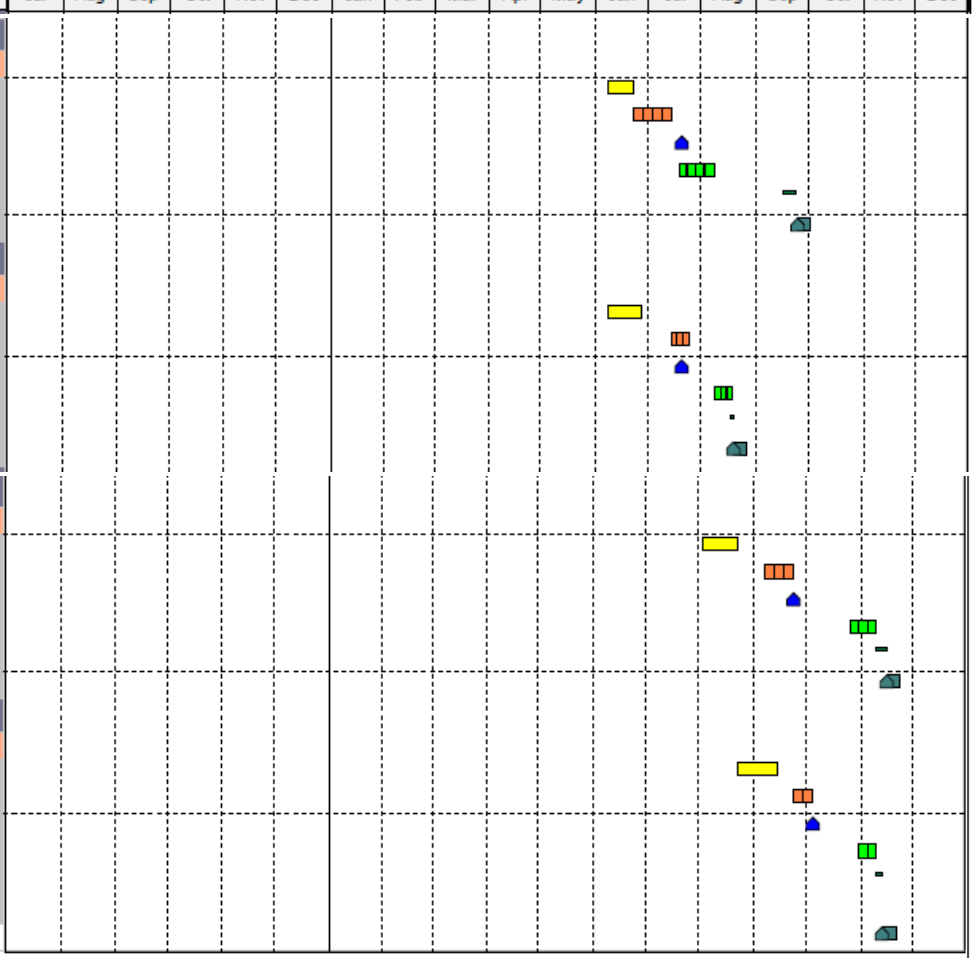
The drilling, completion and well hook-up timeframes for each well on each relevant parcel of land is presented in Table 4-4. The timeframes presented are at a high level and will be ultimately reduced once all inputs are known such as engineering requirements and timing to obtain materials. Timeframes for gathering construction are not finalised 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 be undertaken at the same time as the pads and tracks prior to drilling the first well 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

IA: DKP3 — Printed Date: 07-Apr-22

AE AcQuire Programme	Activity Name	Start	Finish	Drill Deviated	Drill Vertical
LS310		08-Jun-23	01-Oct-23	4	0
1DY787 - Warakirri Asset Man Pty Ltd		08-Jun-23	01-Oct-23	4	0
Site & Pad Prep		08-Jun-23	22-Jun-23	0	0
Well - Production Drilling		22-Jun-23	14-Jul-23	4	0
Well - Install - Stage 1 Install		20-Jul-23	15-Sep-23	0	0
Well - Down Hole Completion Drilling		19-Jul-23	07-Aug-23	0	0
Well - Install Stage 2 Hook/MC		16-Sep-23	23-Sep-23	0	0
Wells Commissioning		24-Sep-23	01-Oct-23	0	0
LS336		08-Jun-23	26-Aug-23	3	3
57SP193329 - Warakirri		08-Jun-23	26-Aug-23	3	3
Site & Pad Prep		08-Jun-23	27-Jun-23	0	0
Well - Production Drilling		14-Jul-23	25-Jul-23	3	3
Well - Install - Stage 1 Install		20-Jul-23	29-Jul-23	0	0
Well - Down Hole Completion Drilling		08-Aug-23	18-Aug-23	0	0
Well - Install Stage 2 Hook/MC		17-Aug-23	18-Aug-23	0	0
Wells Commissioning		19-Aug-23	26-Aug-23	0	0
LS370		03-Aug-23	23-Nov-23	3	0
1RP154777 - Warakirri Asset Man Pty Ltd		03-Aug-23	23-Nov-23	3	0
Site & Pad Prep		03-Aug-23	22-Aug-23	0	0
Well - Production Drilling		07-Sep-23	23-Sep-23	3	0
Well - Install - Stage 1 Install		23-Sep-23	09-Nov-23	0	0
Well - Down Hole Completion Drilling		25-Oct-23	09-Nov-23	0	0
Well - Install Stage 2 Hook/MC		09-Nov-23	15-Nov-23	0	0
Wells Commissioning		15-Nov-23	23-Nov-23	0	0
SE160		22-Aug-23	21-Nov-23	2	0
57SP193329 - Warakirri		22-Aug-23	21-Nov-23	2	0
Site & Pad Prep		22-Aug-23	14-Sep-23	0	0
Well - Production Drilling		23-Sep-23	04-Oct-23	2	0
Well - Install - Stage 1 Install		04-Oct-23	09-Nov-23	0	0
Well - Down Hole Completion Drilling		30-Oct-23	09-Nov-23	0	0
Well - Install Stage 2 Hook/MC		09-Nov-23	13-Nov-23	0	0
Wells Commissioning		13-Nov-23	21-Nov-23	0	0
Duleen Kupunn P3	Duleen Kupunn P3 -	13-Nov-23	21-Nov-23		



4.4.6 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.

The potential for these impacts will be minimised by scheduling the construction activities to occur when the parcel is fallow, thus minimising potential for any disruption to planting or harvesting activities.

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.

As outlined in Section 4.4.2, potential impacts to the productive capacity of the parcels/properties is expected to be less than 2%.

4.4.7 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.

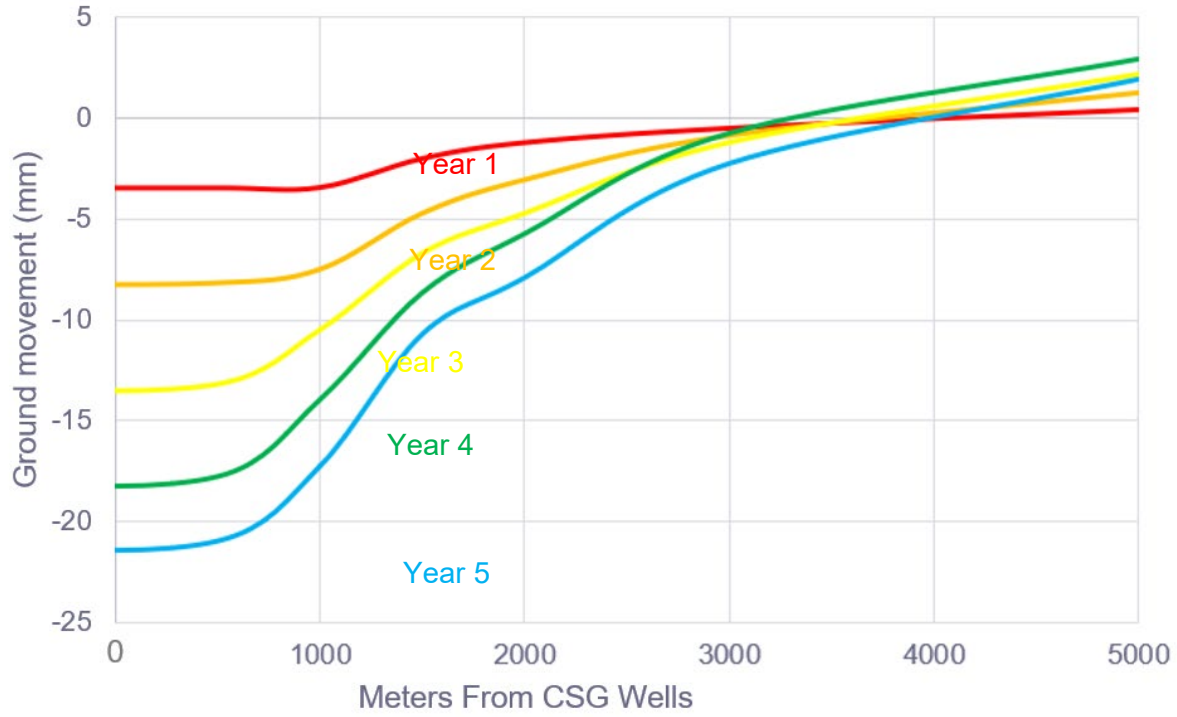
The spatial variation from these measurements indicates that natural ground movement is not static and varies both spatially and temporally. In order to describe how the potential ground movement correlates to CSG activities, Arrow has analysed InSAR measurements based on the distance to the closest 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



4.4.8 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 34.93 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	306.22	306.22	4.71	0.53	1.54%	0.17%
36DY45	89.02	89.02	2.66	0.20	2.99%	0.23%
2RP85916	46.58	46.58	1.54	0.01	3.30%	0.03%
12SP193328	66.23	66.23	1.93	0.02	2.92%	0.03%
1RL2451	12.62	6.63	0.00	0	0.00%	0.00%
1DY931	241.04	239.42	3.74	0.21	1.56%	0.09%
70DY138	258.86	255.95	3.68	0.02	1.44%	0.01%
1RP154777	245.70	243.46	0.11	0.00	0.04%	0.00%
1DY787	266.40	266.37	6.77	1.13	2.54%	0.40%
60DY802	129.18	125.91	2.14	0.02	1.70%	0.02%
2RP106958	127.99	127.52	0.83	0.04	0.65%	0.03%
2RP99387	202.82	202.82	3.07	0.02	1.52%	0.01%
2DY787	132.64	129.29	4.66	0.01	3.60%	0.01%
Total	2,125.28	2,105.44	35.84	2.21	1.7%	0.10%

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 short term and all impacts are temporary in nature, in particular the well pads, 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 infrastructure.

The extent of the operational footprint that will remain post construction during operations is provided in Table 5-1. This will include the operational footprint of the well pads and the footprint of high point vents, low point drains, isolation and tie in valves and future service connections.

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 regard 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. Landholder Consultation

6.1.1 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 6-1.

Table 6-1 – 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.

6.2 RIDA Consultation Requirements

A summary of the steps undertaken versus the DILGP's guideline to meet the prescribed solution is provided in Table 6-2. Additional information is presented in Appendix 9 which is confidential and not for public release.

Table 6-2 – 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.

6.3 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.

7. Management of Mitigation Measures

7.1 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.

7.2 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.

7.3 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 (pre-activity condition) 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.

7.4 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. Baseline reports for all lots the subject of this application, providing information on the derived digital elevation model and slopes from the LIDAR survey, are 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.

7.5 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 7-1 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).

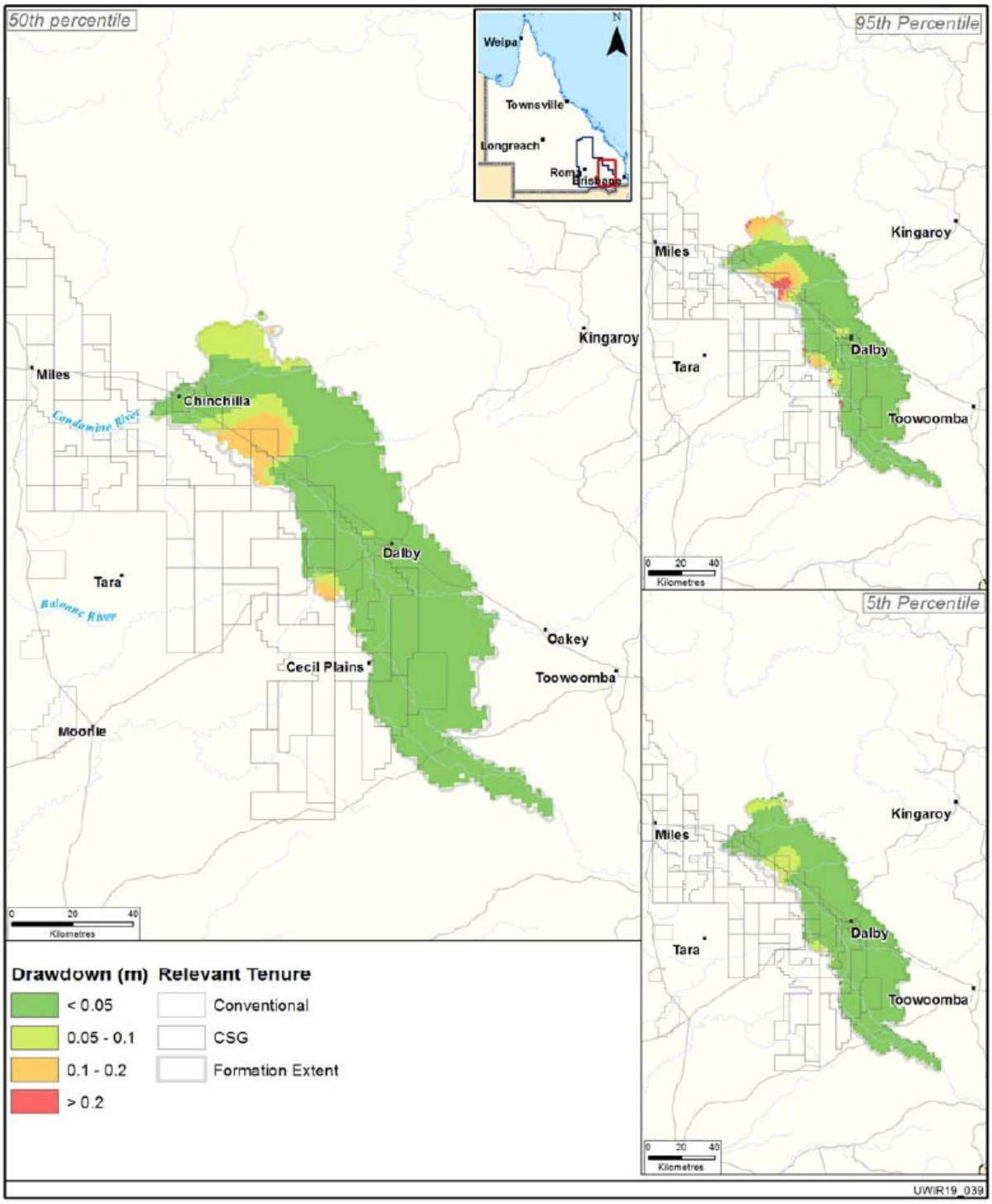


Figure 7-1: Modelled drawdown of the Condamine Alluvium aquifer as a result of CSG production (OGIA, 2019).

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.

8. 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 undertaken consultation with the relevant landowner as part of an Area-Wide planning process and negotiations related to the gas field infrastructure. Pursuant to s35(1)(b) of the Act, DSDILGP have advised that the application is to be notified. As such, Arrow will notify the application and provide a copy of the notice to the landowner.

9. 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.

10. 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 (35.84 ha) on land parcels subject to this application, the following assessment application fees have been calculated and were paid on 20 September 2021.

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**

11. Required Outcome Assessment

11.1 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 0.43%, and 0.15% 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% on Property 1 (2.16%), however the temporary reduction in area available for a PALU and reduction in productive capacity is not considered to be a loss greater than 2% as: • The construction activities will be scheduled to occur when the land is in fallow, so as to not interrupt or temporarily halt PALU on the land parcel; • The surface impact of any area greater than 2% due to the construction of the 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. As illustrated in Section 4.4, any predicted reduction in yields will be significantly less than 2% over the parcels and the property. Refer to Section 4.4 for additional details. One of Arrow's key Co-existence commitments (refer to Section 1.6.2) is to minimise its 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 • 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. In addition, it has been agreed with the landholder that the construction activities will occur when the land is fallow to further minimize potential impact on the ongoing conduct of PALU. 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 authorized 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 landowner 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. Refer to Section 1.6.2 for additional details.

(b) the activity cannot 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 • Placement of operational infrastructure on property boundaries and adjacent existing access as far as possible • 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. The use of sub-terranean deviated well trajectories is not considered to have the potential to cause widespread or irreversible impacts on the future use of the area for one or more PALU as: • the minimum depth of the deviated well trajectories will be

	200m – well below the depth of cropping activities • the well trajectories (paths) will be recorded on dial before you dig to ensure that any potential activities at a great depth (e.g. water bores) can be safety located without the potential to contact or be impacted by the well paths

(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.

11.2 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 landowner'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-. 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 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 its 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. 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 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.

12. 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

13. 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

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

BM	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

Obligations under the *Environmental Protection Act 1994*

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

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

This environmental authority incorporates the following schedules:

Schedule A – General
Schedule B – Water
Schedule BE – Coal Seam Gas Water Injection Trial
Schedule C – Regulated Dams
Schedule D – Land
Schedule E – Acoustic
Schedule F – Air
Schedule G – Waste
Schedule H – Rehabilitation
Schedule I – Definitions

Words and phrases which are underlined are defined in *Schedule I – Definitions*.

Schedule A – General

General 1 This environmental authority authorises the carrying out of the following resource activities:

(a) The petroleum activities listed in *Schedule A, Table 1 – Authorised Petroleum Activities* to the extent they are carried out in accordance with the activity's corresponding total number and maximum disturbance;

(b) The following specified relevant activities:
   i. Regulated waste storage – receiving and storing regulated waste other than tyres;
   ii. Sewage treatment – operating sewage treatment works, other than no-release works, with a total daily peak design capacity of 21 to 100 EP;

(c) For the specified relevant activities listed in (General 1 (b)) above, another activity where Schedule 2 of the Environmental Protection Regulation 2008 (the Regulation) provides exemption for the activity, but only to the extent of the circumstances stated in Schedule 2 of the Regulation; and

(d) Incidental activities that are not otherwise specified relevant activities.

General 2 This environmental authority does not authorise environmental harm unless a condition contained in this environmental authority explicitly authorises that harm. Where there is no condition, the lack of a condition shall not be construed as authorising harm.

General 7 All monitoring must be undertaken by a suitably qualified person.

General 8 If requested by the administering authority in relation to investigating a complaint, monitoring must be commenced within 10 business days.

General 9 All laboratory analyses and tests must be undertaken by a laboratory that has NATA accreditation for such analyses and tests.

General 10 Notwithstanding condition (General 9), where there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

Schedule A, Table 1 - Authorised Petroleum Activities

Petroleum Activity(ies)	Total Number of Authorised Petroleum Activities	Maximum Disturbance Authorised
Total coal seam gas wells, including: Core wells Exploration wells Development wells Production wells	1,566 wells	1,566 ha
Communication towers	10	10 units, 10 ha
Injection well(s) and associated facilities	1	4 ha
Compressor units	40	40 units, 8 ha
Central gas processing facilities	2	2 facilities, 8 ha
Regulated structures	22	22 dams
Water treatment facilities	2	12 ML/d (each), 2 ha
Sewage treatment plants	2	Less than 450 EP (each), 0.15 ha
Sewage treatment plants	10	Less than 100 EP (each), 0.15 ha
Power stations	1	40 MW, 1.2 ha

General 11 Monitoring and sampling must be carried out in accordance with the requirements of the following documents (as relevant to the sampling being undertaken), as amended from time to time:

(a) for waters and aquatic environments, the Queensland Government's Monitoring and Sampling Manual 2009 – *Environmental Protection (Water) Policy 2009*

(b) for groundwater, Groundwater Sampling and Analysis – A Field Guide (2009:27 GeoCat #6890.1)

(c) for noise, the *Environmental Protection Regulation 2008*

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

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

(f) for dust, Australian Standard AS3580.

General 12 In addition to the requirements under Chapter 7, Part 1, Division 2 of the *Environmental Protection Act 1994*, the administering authority must be notified through the Pollution Hotline and in writing, as soon as possible, but within 48 hours of becoming aware of any of the following events:

(a) any unauthorised significant disturbance to land

(b) potential or actual loss of structural or hydraulic integrity of a dam

(c) when the level of the contents of any regulated dam reaches the mandatory reporting level

(d) when a regulated dam will not have available storage to meet the design storage allowance on 1 November of any year

(e) potential or actual loss of well integrity

(f) when the seepage trigger action response procedure required under condition (Water 13(g)) is or should be implemented

(g) unauthorised releases of any volume of prescribed contaminants to waters

(h) unauthorised releases of volumes of contaminants, in any mixture, to land greater than:

i. 200 L of hydrocarbons; or

ii. 1 000 L of brine; or

iii. 5 000 L of untreated coal seam gas water; or

iv. 5 000 L of raw sewage; or

v. 10 000 L of treated sewage effluent.

(i) groundwater monitoring results from a landholder's active groundwater bore monitored under the stimulation impact monitoring program which is a 10% or greater increase from a previous baseline value for that bore and which renders the water unfit for its intended use

(j) monitoring results where two out of any five consecutive samples do not comply with the relevant limits in the environmental authority.

General 13 Petroleum activities that cause significant disturbance to land must not be carried out until financial assurance has been given to administering authority as security for compliance with

the environmental authority and for any costs or expenses, or likely costs or expenses, mentioned in section 298 of the *Environmental Protection Act 1994.*

General 16 Petroleum activities involving significant disturbance to land cannot commence until the development of written contingency procedures for emergency environmental incidents which include, but are not necessarily limited to:

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

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

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

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

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

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

(g) procedures to notify the administering authority, local government and any potentially impacted landholder.

General 17 All plant and equipment must be maintained and operated in their proper and effective condition.

General 18 The following infrastructure must be signed with a unique reference name or number in such a way that it is clearly observable:

(a) regulated dams and low consequence dams

(b) exploration, appraisal and development wells

(c) water treatment facilities

(d) brine encapsulation facilities

(e) landfill cells

(f) sewage treatment facilities

(g) specifically authorised discharge points to air and waters

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

(i) field compressor stations

(j) central compressor stations

(k) gas processing facilities; and

(l) pipeline compressor stations.

General 19 Measures to prevent fauna being harmed from entrapment must be implemented during the construction and operation of well infrastructure, dams and pipeline trenches.

General 20 For activities involving significant disturbance to land, control measures that are commensurate to the site- specific risk of erosion, and risk of sediment release to waters must be implemented to:

(a) allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities

(b) minimise soil erosion resulting from wind, rain, and flowing water

(c) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain, and flowing water

(d) minimise work-related soil erosion and sediment runoff; and

(e) minimise negative impacts to land or properties adjacent to the activities (including roads).

General 21 Petroleum activities must not cause environmental nuisance at a sensitive place, other than where an alternative arrangement is in place.

General 22 A certification must be prepared by a suitably qualified person within 30 business days of completing every plan, procedure, program and report required to be developed under this environmental authority, which demonstrates that:

(a) relevant material, including current published guidelines (where available) have been considered in the written document

(b) the content of the written document is accurate and true; and

(c) the document meets the requirements of the relevant conditions of the environmental authority.

General 23 All plans, procedures, programs, reports and methodologies required under this environmental authority must be written and implemented.

General 24 All documents required to be developed under this environmental authority must be kept for five years.

General 25 All documents required to be prepared, held or kept under this environmental authority must be provided to the administering authority upon written request within the requested timeframe.

General 26 A record of all complaints must be kept including the date, complainant's details, source, reason for the complaint, description of investigations and actions undertaken in resolving the complaint.

Schedule B – Water

Water 1	Contaminants that will or may cause environmental harm must not be directly or indirectly released to any waters, except as authorised by condition (B15).
Water 2	The extraction of groundwater as part of the petroleum activity(ies) from underground aquifers must not directly or indirectly cause environmental harm to a wetland.
Water 3	Petroleum activities must not occur in or within 200m of a: (a) wetland of high ecological significance, other than that authorised by *Schedule D, Table 3 — Significant residual impacts to prescribed environmental matters* (b) Great Artesian Basin Spring (c) subterranean cave GDE.
Water 3A	Despite condition (Water 3), petroleum activities may occur within 200m of a wetland of high ecological significance, provided they are directly associated with activities authorised per condition (Water 3(a)).
Water 4	Only construction or maintenance of linear infrastructure is permitted in or within any wetland of other environmental value or in a watercourse.
Water 5 A	The construction or maintenance of linear infrastructure in a wetland of other environmental value must not result in the: (a) clearing of riparian vegetation outside of the minimum area practicable to carry out the works; or (b) ingress of saline water into freshwater aquifers; or (c) draining or filling of the wetland beyond the minimum area practicable to carry out the works.
Water 5 B	After the construction or maintenance works for linear infrastructure in a wetland of other environmental value are completed, the linear infrastructure must not: (a) drain or fill the wetland (b) prohibit the flow of surface water in or out of the wetland (c) lower or raise the water table and hydrostatic pressure outside the bounds of natural variability that existed before the activities commenced (d) result in ongoing negative impacts to water quality (e) result in bank instability; or (f) result in fauna ceasing to use adjacent areas for habitat, feeding, roosting or nesting.

Water 6 The construction or maintenance of linear infrastructure activities in a watercourse must be conducted in the following preferential order:

(a) firstly, in times where there is no water present

(b) secondly, in times of no flow

(c) thirdly, in times of flow, providing a bankfull situation is not expected and that flow is maintained.

Water 7 The construction or maintenance of linear infrastructure authorised under condition (Water 4) must comply with the water quality limits as specified in *Schedule B, Table 1 – Release limits for construction or maintenance of linear infrastructure*.

Schedule B, Table 1 – Release limits for construction or maintenance of linear infrastructure

Water quality parameters	Units	Water quality limits
Turbidity	Nephelometric Turbidity Units (NTU)	For a wetland of other environmental value, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within a 50m radius of the construction or maintenance activity. For a watercourse, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within 50m downstream of the construction or maintenance activity.
		For a wetland of other environmental value, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within a 50m radius of the construction or maintenance activity. For a watercourse, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within 50m downstream of the construction or maintenance activity.
Hydrocarbons	-	For a wetland of other environmental value, or watercourse, no visible sheen or slick

Water 8 Monitoring must be undertaken at a frequency that is appropriate to demonstrate compliance with condition (Water 7).

Water 9 A register must be kept of all linear infrastructure construction and maintenance activities in a wetland of other environmental value and watercourses, which must include:

(a) location of the activity (e.g. GPS coordinates (GDA94) and watercourse name)

(b) estimated flow rate of surface water at the time of the activity

(c) duration of works, and

(d) results of impact monitoring carried out under condition (Water 8).

Water 10 Measures must be taken to minimise negative impacts to, or reversal of, any river improvement works carried out in River Improvement Areas by Queensland's River Improvement Trusts.

Water 11 Petroleum activity(ies) on floodplains must be carried out in a way that does not:

(a) concentrate flood flows in a way that will or may cause or threaten a negative environmental impact; or

(b) divert flood flows from natural drainage paths and alter flow distribution; or

(c) increase the local duration of floods; or

(d) increase the risk of detaining flood flows.

Water 12 A seepage monitoring program must be developed by a suitably qualified person which is commensurate with the site-specific risks of contaminant seepage from containment facilities, and which requires and plans for detection of any seepage of contaminants to groundwater as a result of storing contaminants by 1 August 2019.

Water 13 The seepage monitoring program required by condition (Water 12) must include but not necessarily be limited to:

(a) identification of the containment facilities for which seepage will be monitored

(b) identification of trigger parameters that are associated with the potential or actual contaminants held in the containment facilities

(c) identification of trigger concentration levels that are suitable for early detection of contaminant releases at the containment facilities

(d) installation of background seepage monitoring bores where groundwater quality will not have been affected by the petroleum activities authorised under this environmental authority to use as reference sites for determining impacts

(e) installation of seepage monitoring bores that:

i. are within formations potentially affected by the containment facilities authorised under this environmental authority (i.e. within the potential area of impact)

ii. provide for the early detection of negative impacts prior to reaching groundwater dependent ecosystems, landholder's active groundwater bores, or water supply bores

iii. provide for the early detection of negative impacts prior to reaching migration pathways to other formations (i.e. faults, areas of unconformities known to connect two or more formations)

(f) monitoring of groundwater at each background and seepage monitoring bore at least annually for the trigger parameters identified in condition (Water 13(b))

(g) seepage trigger action response procedures for when trigger parameters and trigger levels identified in conditions (Water 13(b)) and (Water 13(c)) trigger the early detection of seepage, or upon becoming aware of any monitoring results that indicate potential groundwater contamination

(h) a rationale detailing the program conceptualisation including assumptions, determinations, monitoring equipment, sampling methods and data analysis; and

(i) provides for annual updates to the program for new containment facilities constructed in each annual return period.

Water 14 A bore drill log must be completed for each seepage monitoring bore in condition (Water 13) which must include:

(a) bore identification reference and geographical coordinate location

(b) specific construction information including but not limited to depth of bore, depth and length of casing, depth and length of screening and bore sealing details

(c) standing groundwater level and water quality parameters including physical parameter and results of laboratory analysis for the possible trigger parameters

(d) lithological data, preferably a stratigraphic interpretation to identify the important features including the identification of any aquifers; and

(e) target formation of the bore.

B15 The release of treated CSG water is authorised to occur in accordance with:

(a) *Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters;*

(b) *Schedule B Table 3 – Treated CSG Water Release Limits for Monitoring Point M1 – Daily Monitoring;* and

(c) *Schedule B, Table 4 – Treated CSG Water Release Limits for Monitoring Point M1 – Quarterly Monitoring*.

B16 The quality of the treated CSG water being released must be:

(a) monitored at the frequency specified, and

(b) comply with each quality characteristic release limit and limit type,

specified in *Schedule B Table 3 – Treated CSG Water Release Limits for Monitoring Point M1 – Daily Monitoring* and *Schedule B, Table 4 – Treated CSG Water Release Limits for Monitoring Point M1 – Quarterly Monitoring* when measured at the monitoring point M1 specified in *Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters*.

Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters

Water Source and Location	Release Point	Location (GDA94, MGA zone 56)	Monitoring Point	Receiving Waters Description
Treated CSG Water from the reverse osmosis water treatment plant and treated water dam located on PL230	R1, defined as the outlet of discharge pipe to Wilkie Creek	6995465 mN 303004 mE	M1, defined as the sample point in the discharge pipeline point to release into Wilkie Creek	Wilkie Creek

Schedule B, Table 3 – Treated CSG Water Release Limits for Monitoring Point (M1) – Daily Monitoring

Quality Characteristic	Unit	Release Limit(s)	Limit Type	Monitoring Frequency
Electrical conductivity	µS/cm	580	80th percentile, based on at least 5 samples with not less than 60 minutes between samples	Daily during release
pH	pH Unit	6.5 - 9	Range	Daily during release
Suspended Solids	mg/L	180	Maximum	Daily during release
Boron	mg/L	0.37	Maximum	Daily during release

Schedule B, Table 4 – Treated CSG Water Release Limits for Monitoring Point (M1) – Quarterly Monitoring

Quality characteristic	Unit	Maximum Release limit	Monitoring frequency
Aluminium	mg/L	0.2	The first release day of each quarter
Antimony	ml/L	0.003	
Arsenic	mg/L	0.007	
Barium	mg/L	0.7	
Bisphenol A	mg/L	0.2	
Boron	mg/L	4	
Bromide	mg/L	7	The first release day of each quarter
BTEX			
Benzene	mg/L	0.001	
Toluene	mg/L	0.8	
Ethylbenzene	mg/L	0.3	
Xylene (m & p)	mg/L	0.6	
Cadmium	mg/L	0.002	
Chromium	mg/L	0.05	
Copper	mg/L	2	

Quality characteristic		Unit	Maximum Release limit	Monitoring frequency
Cyanide		mg/L	0.08	The first release day of each quarter
Fluoride		mg/L	1.5	
Iodide		mg/L	0.5	
Iron		mg/L	0.3	
Lead		mg/L	0.01	
Manganese		mg/L	0.5	
Mercury		mg/L	0.001	
Molybdenum		mg/L	0.05	
Nickel		mg/L	0.02	
Nonylphenol		mg/L	0.5	
PAH (as B(a)P TEF) Species: benz[a]anthracene benzo[b+j]fluoranthene benzo[k]fluoranthene benzo[a]pyrene chrysene dibenz[a,h]anthracene indeno[1,2,3-cd]pyrene	 TEF: 0.1 0.1 0.1 1.0 0.1 1.0 0.1	µg/L	0.01	
Selenium		mg/L	0.01	The first release day of each quarter
Silver		mg/L	0.1	
Strontium		mg/L	4	
Total Petroleum Hydrocarbons (TPH)		mg/L	0.2	
Vanadium		mg/L	0.05	
Zinc		mg/L	3	
Radium-226 Lead-210 Polonium-210 Radium-228		mSv/year	0.5 The dose for each parameter is summed to give the total dose which must be less than or equal to 0.5 mSv/year	

B17 If the monitoring required by condition (B16) indicates that any of the quality characteristic release limits specified in *Schedule B, Table 4 – Treated CSG Water Release Limits for Monitoring Point M1 – Quarterly Monitoring* have been exceeded at any time during any release of treated CSG water, the environmental authority holder must, within five (5) business days of notifying the administering authority of the exceedance, unless a longer time is agreed to by the administering authority:

(a) complete an investigation into the exceedance, which includes an analysis of the (potential and actual) causes for the exceedance; and

(b) provide a written report to the administering authority on completion of the investigation that includes:

i. details of the investigation carried out;

ii. any actions taken to prevent impacts to waters that may be used for drinking water;

iii. the cause for the exceedance;

iv. all water quality monitoring results pertaining to the investigation;

v. any general observations;

vi. methodology(ies) and any relevant calculations used; and

vii. corrective actions to rectify the cause of the exceedance.

B18 Where an exceedance of a quality characteristic release limit specified in *Schedule B, Table 4 – Treated CSG Water Release Limits for Monitoring Point M1 – Quarterly Monitoring* is being investigated in accordance with condition (B17), the investigation and reporting required by condition (B17) is not required if a subsequent exceedance occurs, during investigation of the initial exceedance, which has resulted from the same cause that triggered the initial exceedance.

B19 Prior to commencing any release of treated CSG water authorised under this environmental authority, a stream flow gauging station (GP1) must be installed.

B20 The stream flow gauging station (GP1) must be installed in accordance with *Schedule B, Table 5 – Contaminant Release During Flow Events*.

Schedule B, Table 5 – Contaminant Release During Flow Events

Receiving water description	Gauging station description	Latitude or northing (GDA94)	Longitude or easting (GDA94)	Minimum Flow in Receiving Water Required for a Release Event	Flow recording Frequency
Wilkie Creek	Gauging station 1 (GP1)	50-100 metres upstream of Release Point R1	50-100 metres upstream of Release Point R1	0.14 m^3/s	At 6 hour intervals during discharge (minimum twice daily)

B21 The flow rate of treated CSG water released from the release point authorised in *Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters* must not exceed a ratio of 1 part of the flow rate of the treated CSG water being released to 4 parts of the measured upstream receiving water flow rate.

B22 The volume of treated CSG water released from the release point authorised in *Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters* must not exceed a maximum of 8ML/day.

B23 The following characteristics of the treated CSG water released must be measured and recorded daily during all release events:

(a) the volume of treated CSG water released through the release point R1;

(b) the date and time of release commencing and ceasing;

(c) the release rate;

(d) for any change in the release rate:

i. the date and time of the change;

ii. the new release rate; and

iii. water levels and flow rate during the discharge event.

(e) water levels and flow rate during the discharge event;

(f) water quality characteristics monitoring results; and

(g) details of any observed impacts/conditions.

B24 Prior to commencing any release of treated CSG water authorised under this environmental authority, each monitoring and release point specified in *Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters* must be marked and readily identifiable from the banks of Wilkie Creek.

B25 The quality of the receiving waters must be monitored daily during release of treated CSG water at locations representative of the receiving waters determined in accordance with condition (B31), for the following water quality characteristics:

(a) Electrical conductivity (µS/cm);

(b) pH (pH Unit);

(c) Turbidity (NTU);

(d) Suspended Solids (mg/L);

(e) Calcium (mg/L);

(f) Magnesium (mg/L);

(g) Fluoride (mg/L);

(h) Sulphate (mg/l); and

(i) Boron (mg/L).

B26 If water has been released from authorised release points listed in *Schedule B, Table 2 – Contaminated Release Points, Sources and Receiving Waters*, the holder of this environmental authority must undertake an annual assessment of the contaminants of treated CSG water to determine the risk of environmental harm from release of treated CSG water to surface waters. This should consider the contaminants mentioned in the ANZECC & ARMCANZ 2000 guidelines. This annual assessment must be included in the Annual Return.

B27 Prior to the release of treated CSG water to Wilkie Creek a Receiving Environment Monitoring Program (REMP) must be developed and implemented to monitor, identify and describe any adverse impacts to surface water environmental values, water quality and flows due to the authorised release of treated CSG water to Wilkie Creek.

B28 The REMP required by condition (B27) must include periodic monitoring for the effects of the release on the receiving environment as a result of treated CSG water releases to waters from the release location (R1) specified in Table B15 - Treated CSG Water Release Point, Source and Receiving Waters.

B29 The quality of the receiving waters must be monitored at the locations specified in Schedule B, *Table 6 – Receiving Water Upstream Background Sties and Downstream Monitoring Points.*

Schedule B, Table 6 – Receiving Water Upstream Background Sites and Downstream Monitoring Points

Monitoring Points	Receiving Waters	Northing (GDA94)	Easting (GDA94)
Upstream background monitoring point			
Monitoring Point (M2)	Wilkie Creek	50 – 100 metres upstream of Release Point R1	50 – 100 metres upstream of Release Point R1
Downstream monitoring point			
Monitoring Point (M3)	Wilkie Creek	150 – 200 metres downstream of Release Point R1	150 - 200 metres downstream of Release Point R1

B30 The REMP required by Condition (B27) must:

(a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g. seasonality);

(b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected;

(c) include monitoring from background reference sites (e.g. upstream or background) and downstream sites from the release;

(d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the Queensland Water Quality Guidelines 2006. This should include monitoring during periods of natural flow irrespective of other discharges;

(e) include monitoring and assessment of dissolved oxygen saturation and temperature and all water quality parameters listed in Condition (B25);

(f) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, BATLEY and/or the most recent version of *AS5667.1 Guidance on Sampling of Bottom Sediments*);

(g) include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology;

(h) apply procedures and/or guidelines from ANZECC and ARMCANZ 2000 and other relevant guideline documents;

(i) describe sampling and analysis methods and quality assurance and control; and

(j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data.

B31 A report outlining the findings of the REMP, including all monitoring results and interpretations in accordance with conditions (B27) to (B30) must be prepared annually. This must include a determination of the risk of environmental harm from release of treated CSG water to the receiving environment waters.

Schedule BE – Coal Seam Gas Water Injection Trial

BE1 The only fluids authorised to be injected into an aquifer(s) are those fluid types specified in *Schedule BE, Table 1 – Details of Authorised Fluid Injection*.

Schedule BE, Table 1 – Details of Authorised Fluid Injection

Well Location (GDA94, MGA zone 56)	Injection Well Number / Reference	Target Formation and Perforated Zone	Fluid Type	Maximum Injection Rate ML/d	Hydraulic Impact Zone	Water Quality Impact Zone
313669 mE 6967949 mN	Tipton-193	Precipice Formation, between 1040m to 1110m depth	Treated CSG water[1]	4	9,340 m radius from injection well	148 m radius from injection well

[1] Treated CSG water means any fluid that contains any proportion of treated CSG water, blended or otherwise.

BE2 Fluid injection must be in accordance with the quantities and locations listed in *Schedule BE, Table 1 – Details of Authorised Fluid Injection*.

BE3 The holder of this environmental authority must notify the administering authority the commencement date of the trial at least seven (7) days prior to its commencement.

BE4 The injection trial is limited to a period of 180 days of injection, followed by a six-month recovery period.

BE5 Injection must cease immediately upon becoming aware that environmental harm is caused or threatened to be caused as a result of the injection activities.

BE6 The construction of the Tipton-193 injection well must be carried out in accordance with the well construction requirements described in the most recent version of the Department of Environment and Heritage Protection's "CSG Water Injection Well Construction Requirements", as amended from time to time.

BE7 The Tipton-193 injection well must be mechanically functional such that there is no significant fluid movement into a water resource aquifer through vertical channels adjacent to the well bore hole.

BE8 The construction, operation and maintenance of the injection well specified in *Schedule BE, Table 1 – Details of Authorised Fluid Injection* must be undertaken in a way that prevents and/or minimises impacts to the environmental values of the target formation and ensures the integrity of the bore.

BE9 The injection pressure must not exceed 90 percent of the formation fracture pressure.

BE10 The quality of the fluid being injected into the injection well specified in *Schedule BE, Table 1 – Details of Authorised Fluid Injection* must comply with the contaminant limits prescribed in *Schedule BE, Table 2 – Specific Contaminant Limits for Injection Fluid*.

Schedule BE, Table 2 – Specific Contaminant Limits for Injection Fluid

Quality Characteristics	Release Limits	Limit Type
pH (pH units)	Minimum 6.5, Maximum 10	Range
Total Dissolved Solids (TDS)[1]	Mean TDS of injection fluid must not exceed median TDS of formation water measured in background water quality monitoring well	Maximum
Dissolved Oxygen	500 µg/L	Maximum
Total suspended solids	25 mg/L	Maximum

[1] Electrical conductivity is an acceptable proxy measurement for measuring TDS of the injection fluid. If used, the conversion from EC to TDS must be stated and confirmed with laboratory monitoring results.

BE11 A The quality of the fluid being injected into the injection well specified in *Schedule BE, Table 1 – Details of Authorised Fluid Injection* must be monitored at the frequency specified in *Schedule BE, Table 3 – Monitoring Parameters and Frequencies for Injection Fluid*.

BE11 B The administering authority must be notified in writing as soon as reasonably practicable, but within 48 hours of becoming aware of:

(a) migration of injected fluid out of the target formation; or

(b) a loss of hydraulic isolation of the target formation; or

(c) the detection of groundwater contaminants that were not detected in background samples; or

(d) an injection fluid monitoring result that does not comply with any one of the parameters in *Schedule BE, Table 2 – Specific Contaminant Limits for Injection Fluid*.

Schedule BE, Table 3 – Monitoring Parameters and Frequencies for Injection Fluid

Monitoring parameter	Unit	Monitoring frequency during injection
Temperature of target formation	°C	N/A
Injection fluid temperature	°C	Continuous
Inlet pressure	KPa	Continuous
Fluid flow rate	L/sec	Continuous
	ML/day	Daily
Dissolved Oxygen (DO)	µg/L	Daily
Electrical Conductivity	µS/cm	Daily
pH	pH units	Daily
Turbidity	NTU	Daily
Sodium	mg/L	Weekly
Potassium	mg/L	Weekly
Calcium	mg/L	Weekly
Magnesium	mg/L	Weekly
Chloride	mg/L	Weekly
Sulphate as SO_4	mg/L	Weekly
Carbonate / Bicarbonate	mg/L	Weekly
Bromine	mg/L	Monthly
Fluoride	mg/L	Monthly
Iodide	mg/L	Weekly
Silica	mg/L	Monthly
Iodine	mg/L	Monthly
Nitrate	mg/L	Monthly
Total organic carbon	mg/L	Weekly
Total Dissolved Solids	mg/L	Weekly
Redox Potential	mV	Weekly
Total Hardness as CaCO3	mg/L	Weekly

Monitoring parameter	Unit	Monitoring frequency during injection
Total Alkalinity as CaCO3	mg/L	Weekly
Hydroxide alkalinity as CaCO3	mg/L	Weekly
Carbonate Alkalinity as CaCO3	mg/L	Weekly
Bicarbonate Alkalinity as CaCO3	mg/L	Weekly
Total suspended solids	mg/L	Weekly
Bromide	mg/L	Weekly
Aluminium	mg/L	Monthly
Arsenic	mg/L	Monthly
Barium	mg/L	Monthly
Boron	mg/L	Monthly
Copper	mg/L	Monthly
Iron	mg/L	Monthly
Manganese	mg/L	Monthly
Mercury	mg/L	Monthly
Nickel	mg/L	Monthly
Strontium	mg/L	Monthly
Zinc	mg/L	Monthly
Total Petroleum Hydrocarbons	µg/L	Monthly
BTEX	µg/L	Monthly

BE12 Notwithstanding conditions (BE9) and (BE10), the injection of treated CSG water into the injection well specified in *Schedule BE, Table 1 – Details of Authorised Fluid Injection* must have considered the recommendations for water blending described in the following documents, where appropriate:

(a) Surat Gas Project – Geochemical Blending and Compatibility Study: Tipton Injection Trials, March 2013; and

(b) Surat Gas Project – Geochemical Blending and Compatibility Study: Tipton Injection Trials – Phase 2, March 2013.

BE13 The holder of this environmental authority must provide for non-chemical disinfection of injection fluid if results of six-monthly testing of injected fluid show levels of coliform bacteria, sulphate reducing bacteria or iron fixing bacteria that has potential to cause adverse impacts on the groundwater within the target formation.

BE14 An Injection Management Plan which has been certified by a suitably qualified person must be developed and implemented prior to the carrying out of the trial fluid injection activity(ies).

BE15 The Injection Management Plan must include but not necessarily be limited to:

(a) estimated volumes and rates of water to be injected;

(b) a description of the physical, chemical and biological components and their concentrations of the water to be produced;

(c) details of how and where the fluid will be produced, aggregated, stored and kept separate from other waters until it is treated and injected;

(d) details of where the fluid is proposed to be treated including a description of the treatment process;

(e) a water quality compatibility assessment which demonstrates that the injection fluid has inconsequential reactivity with the target formation and native groundwater it will come into contact with;

(f) the regional characteristics of the receiving environment;

(g) identification of the water quality impact zone and the hydraulic impact zone;

(h) identification of any fluid injection well, all existing bores, springs, lakes, wetlands, environmental assets and watercourses connected to groundwater, faults and other geologic features that occur within the water quality impact zone and the hydraulic impact zone;

(i) identification of the environmental values and water quality objectives of the potential water quality impact zone of the target formation in accordance with the *Environmental Protection (Water) Policy 2009* and the *Queensland Water Quality Guidelines 2009*;

(j) an assessment of the potential for migration of injection fluid or native groundwater out of the target formation through wells, bores, springs, connected watercourses, faults or other geologic features likely to impact on other aquifers;

(k) a risk assessment identifying potential hazards, their inherent risk, preventative measures for the management of potential hazards and details on sampling and analysis methods to verify preventative measures of potential hazards, including frequency and locations and quality assurance and control;

(l) control measures that will be implemented for fluid storage, treatment and injection to prevent or control the release of a contaminant or waste to the environment other than the release authorised in *Schedule BE, Table 1 – Details of Authorised Fluid Injection* and *Schedule BE, Table 2 – Specific Contaminant Limits for Injection Fluid*;

(m) verification methods to assess performance of the injection activities;

(n) the indicators or other criteria against which the performance of fluid injection will be assessed;

(o) procedures that will be adopted to regularly review the monitoring program;

(p) reporting procedures to management and the administering authority should unforeseen or non-compliant monitoring results be recorded; and

(q) procedures that will be implemented to prevent unauthorised environmental harm from unforeseen or non-compliant monitoring results.

BE16 A Receiving Environment Monitoring Program (REMP) for Injection Activities which has been certified by a suitably qualified person must be developed and implemented to monitor, identify and describe any adverse impacts to the following values of the target formation due to the injection of treated CSG water:

(a) hydraulic response;

(b) water quality response; and

(c) any other groundwater environmental values identified.

BE17 The REMP for Injection Activities required by condition (BE16) must be developed and implemented prior to the carrying out of the trial fluid injection activity(ies).

BE18 The REMP for Injection Activities required by condition (BE16) must include, but not necessarily be limited to:

(a) methods to validate the assumptions, predicted impacts and the effectiveness of the proposed preventative measures associated with the modelled water quality impact zone and hydraulic impact zone;

(b) monitoring of the hydraulic response to the trial injection at the well(s) referred to in condition (BE18)(f)(ii);

(c) monitoring of the water quality of the injection fluid during injection for the parameters listed in *Schedule BE, Table 3 – Monitoring Parameters and Frequencies for Injection Fluid*;

(d) monitoring of the water quality response following the completion of the injection trial recovery period through sampling of the target aquifer, within the water quality impact zone, for the parameters listed in *Schedule BE, Table 3 – Monitoring Parameters and Frequencies for Injection Fluid*;

(e) a definition of the background water quality of the Precipice Sandstone to be used for monitoring compliance with *Schedule BE, Table 2 – Specific Contaminant Limits for Injection Fluid* and for reporting in the Injection Trial Report required by condition (BE19);

(f) the installation and use of a minimum of two wells:

i. one of which accesses the target aquifer within the water quality impact zone; and

ii. the other of which is placed at an adequate distance to determine the extent of the hydraulic response to the injection;

(g) methods for the analysis and interpretation and a description of the statistical basis on which conclusions will be drawn to verify the assumptions of the injection proposal; and

(h) a demonstration of how the REMP will validate assumptions, predicted impacts and the effectiveness of quality assurance and control measures.

BE19 Upon completion and within two (2) months of the completion of the injection trial's recovery period the holder of the authority must submit to the administering authority an Injection Trial Report prepared by a suitably qualified person.

BE20 The Injection Trial Report must include, but not necessarily be limited to:

(a) details of the injection well including but not limited to:

i. location details (GDA94);

ii. the inferred lithology *;

iii. casing details including type, outer diameter (mm), wall thickness (mm) and locations (depth from and to in metres);

iv. cementing details including type, hole diameter (mm), casing outer diameter (mm) and locations (depth from and to in metres);

v. calculated target formation fracture pressure; and

vi. target formation pressure prior to injection;

(b) a detailed interpretation of the logs and other tests conducted during drilling and construction or refurbishment of the well against their specific objectives;

(c) a completed well schematic diagram;

(d) a temperature survey;

(e) a cement integrity log;

(f) outcomes of the injection trial including, but not limited to:

i. well head injection rates versus formation pressure;

ii. target formation pressure within the hydraulic impact zone during and upon completion of the trial;

iii. hydraulic gradient of the target formation within the hydraulic impact zone upon completion of the trial;

iv. the effectiveness of aquitards (including the stability of the aquitard) and aquicludes of confining the injected fluid within the target formation; and

v. a detailed interpretation of the logs and other tests conducted during the injection trial against their specific objectives;

vi. validation of conceptual framework for injection; and

vii. additional hazards that were not identified earlier;

(g) the results of the REMP for Injection Activities;

(h) analysis of monitoring and operational data in terms of:

i. validation of conceptual framework for injection; and

ii. additional hazards that were not identified earlier;

(i) a revised risk analysis that identifies all potential hazards, likelihood of various risk elements and associated consequences;

(j) a revised water quality compatibility assessment which demonstrates that the injection fluid has inconsequential reactivity with the target formation and native groundwater it will come into contact with;

(k) a re-evaluation of the hydraulic impact zone; and

(l) a re-evaluation of the water quality impact zone.

* Inferred lithology means the best available description of the lithology based upon historical drilling records, interpretation of logs and any other information that the suitably qualified person may have discovered.

BE21 Following completion of the injection trial, a fluid injection cessation report which has been certified by a suitably qualified person must be submitted to the administering authority within two (2) months of completion of the injection trial's recovery period.

BE22 The fluid injection cessation report must include, but not necessarily be limited to:

(a) volumes of fluid injected at each well;

(b) a risk assessment statement providing details on identified hazards including their inherent risk, summary of the results from the verification monitoring, preventative measures and the residual risk; and

(c) a monitoring report outlining the methods and results of verification monitoring undertaken to assess the performance of the injection activities and preventative measures for identified hazards.

Schedule C – Regulated Dams

Dams 1 The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* at the following times:

(a) prior to the design and construction of the structure, if it is not an existing structure; or

(b) prior to any change in its purpose or the nature of its stored contents.

Dams 2 A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.

Dams 3 Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)*.

Dams 4 Conditions (Dams 5) to (Dams 9) inclusive do not apply to existing structures.

Dams 5 All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338)*.

Dams 6 Construction of a regulated structure is prohibited unless:

(a) the holder of this environmental authority has submitted a consequence category assessment report and certification to the administering authority; and

(b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority.

Dams 7 Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338)*, and must be recorded in the Register of Regulated Structures.

Dams 8 Regulated structures must:

(a) be designed and constructed in compliance with the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338)*;

(b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of:

i. floodwaters from entering the regulated dam from any watercourse or drainage line; and

ii. wall failure due to erosion by floodwaters arising from any watercourse or drainage line.

(c) have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.

Dams 9 Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that:

(a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure;

(b) construction of the regulated structure is in accordance with the design plan.

Dams 10 All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure

(a) for existing structures that are regulated structures, within 10 business days of this condition taking effect;

(b) prior to the operation of the new regulated structure; and

(c) if the emergency action plan is amended, within 5 business days of it being amended.

Dams 11 Operation of a regulated structure, except for an existing structure, is prohibited.

Dams 12 For existing structures that are regulated structures:

(a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder of this environmental authority must submit to the administering authority within 12months of the commencement of this condition a copy of the certified system design plan including that structure; and

(a) there must be a current operational plan for the existing structures.

Dams 13 Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in compliance with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.

Dams 14 Conditions Dams 15 to Dams 18 inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.

Dams 15	The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
Dams 16	The holder of this environmental authority must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.
Dams 17	The holder of this environmental authority must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
Dams 18	The holder of this environmental authority must record any changes to the MRL in the Register of Regulated Structures.
Dams 19	The holder of this environmental authority must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.
Dams 20	By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems).
Dams 21	The holder of this environmental authority must, as soon as possible and within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, notify the administering authority.
Dams 22	The holder of this environmental authority must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
Dams 23	Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
Dams 24	At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required.

Dams 25 The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).*

Dams 26 The holder of this environmental authority must, within 20 business days of receipt of the annual inspection report, provide to the administering authority:

(a) The recommendations section of the annual inspection report; and

(b) If applicable, any actions being taken in response to those recommendations; and

(c) If, following receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a copy of the annual inspection report from the holder of this environmental authority, provide this to the administering authority within 10 business days of receipt of the request.

Dams 27 The holder of this environmental authority must provide a copy of any reports, documentation and certifications prepared under this environmental authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this environmental authority.

Dams 30 A Register of Regulated Dams must be established and maintained by the holder of this environmental authority for each regulated dam.

Dams 31 The holder of this environmental authority must provisionally enter the required information in the Register of Regulated Dams when a design plan for a regulated dam is submitted to the administering authority.

Dams 32 The holder of this environmental authority must make a final entry of the required information in the Register of Regulated Structures once compliance with conditions Dams 11 and Dams 12 has been achieved.

Dams 33 The holder of this environmental authority must ensure that the information contained in the Register of Regulated Dams is current and complete on any given day.

Dams 34 All entries in the Register of Regulated Dams must be approved by the chief executive officer for the holder of this environmental authority, or their delegate, as being accurate and correct.

Dams 35 The holder of this environmental authority must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Dams, in the electronic format required by the administering authority.

Dams 36 All existing structures that have not been assessed in accordance with either the Manual or the former *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* must be assessed and certified in accordance with the Manual within 6 months of amendment of the authority adopting this schedule.

Dams 37 All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in *Schedule C, Table 1 – Transitional requirements for existing structures*, depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.

Dams 38 *Schedule C, Table 1 – Transitional requirements for existing structures* ceases to apply for a structure once any of the following events has occurred:

(a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or

(b) it has been decommissioned; or

(c) it has been certified as no longer being assessed as a regulated structure.

Dams 39 Certification of the transitional assessment required by conditions Dams 36 and Dams 37 (as applicable) must be provided to the administering authority within 6 months of amendment of the authority adopting this schedule.

Schedule C, Table 1 - Transitional hydraulic performance requirements for existing structures

Transition period required for existing structures to achieve the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Dams*			
Compliance with criteria	**High**	**Significant**	**Low**
>90% and a history of good compliance performance in last 5 years	No transition required	No transition required	No transitional conditions apply. Review consequence assessment every 7 years.
>70% - ≤90%	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50 -≤70 percent	Within 5 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50%	Within 5 years or as per compliance requirements (e.g. TEP timing)	Within 5 years or as per compliance requirements (e.g. TEP timing)	Review consequence assessment every 5 years.
Regulated levee designed to prevent the ingress of clean flood water <100% compliant[1]	Within 5 years unless otherwise agreed with the administering authority.		

[1] Levees designed for the diversion of contaminated waters or protection of the structural integrity of a dam are not to be considered as part of this provision. These levees are considered a key design element of the relevant dam and transitional periods should as such align to that relevant compliance criteria and consequence category.

Schedule D – Land

Land 1	Contaminants must not be directly or indirectly released to land except for those releases authorised by this environmental authority.
Land 2	Top soil must be managed in a manner that preserves its biological and chemical properties.
Land 3	Land that has been significantly disturbed by the petroleum activities must be managed to ensure that mass movement, gully erosion, rill erosion, sheet erosion and tunnel erosion do not occur on that land.
Land 4	Acid sulfate soils must be treated and managed in accordance with the latest edition of the *Queensland Acid Sulfate Soil Technical Manual*.
Land 5	Chemicals and fuels stored, must be effectively contained and where relevant, meet Australian Standards, where such a standard is applicable.
Land 6	Pipeline operation and maintenance must be in accordance, to the greatest practicable extent, with the relevant section of the *APGA Code of Environmental Practice: Onshore Pipelines (2017)* (or more recent editions).
Land 7	Pipeline trenches must be backfilled and topsoils reinstated within three months after pipe laying.
Land 8	Reinstatement and revegetation of the pipeline right of way must commence within 6 months after cessation of petroleum activities for the purpose of pipeline construction.
Land 9	Backfilled, reinstated and revegetated pipeline trenches and right of ways must be: (a) a stable landform; (b) re-profiled to a level consistent with surrounding soils; (c) re-profiled to original contours and established drainage lines; and (d) vegetated with groundcover which is not a pest species, and which is established and growing.
Biodiversity 1	Prior to undertaking activities that result in significant disturbance to land in areas of native vegetation, confirmation of on-the-ground biodiversity values of the native vegetation communities at that location must be undertaken by a suitably qualified person.
Biodiversity 2	A suitably qualified person must develop and certify a methodology so that condition (Biodiversity 1) can be complied with and which is appropriate to confirm on-the-ground biodiversity values.

Biodiversity 3 For conditions (Biodiversity 4) to (Biodiversity 9), where mapped biodiversity values differ from those confirmed under conditions (Biodiversity 1) and (Biodiversity 2), petroleum activities may proceed in accordance with the conditions of the environmental authority based on the confirmed on-the-ground biodiversity value.

Biodiversity 4 The location of the petroleum activity(ies) must be selected in accordance with the following site planning principles:

(a) maximise the use of areas of pre-existing disturbance;

(b) in order of preference, avoid, minimise or mitigate any impacts, including cumulative impacts, on areas of native vegetation or other areas of ecological value;

(c) minimise disturbance to land that may result in land degradation ;

(d) in order of preference, avoid then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation; and

(e) in order of preference, avoid then minimise clearing of native mature trees.

Biodiversity 5 Linear infrastructure construction corridors must:

(a) maximise co-location;

(b) be minimised in width to the greatest practicable extent; and

(c) for linear infrastructure that is an essential petroleum activity authorised in an environmentally sensitive area or its protection zone, be no greater than 40m in total width.

Biodiversity 6 Despite Biodiversity 5 (c), Should the quality of protection zone land be deemed historically disturbed (subject to assessment by a suitably qualified person), or of low environmental value, then Biodiversity 5 (c) is silent.

Biodiversity 8A Where petroleum activities are to be carried out in environmentally sensitive areas or their protection zones, the petroleum activities must be carried out in accordance with *Schedule D, Table 1— Authorised petroleum activities in environmentally sensitive areas and their protection zones*.

Biodiversity 8B The petroleum activities authorised under condition (Biodiversity 8A) must not exceed the maximum footprint for the activities specified in *Schedule D, Table 2 – Maximum significant disturbance in environmentally sensitive areas and their protection zones*.

Schedule D, Table 1— Authorised petroleum activities in environmentally sensitive areas and their protection zones

Environmentally sensitive area	**Within the environmentally sensitive area**	**Primary protection zone of the environmentally sensitive area**	**Secondary protection zone of the environmentally sensitive area**
Category A environmentally sensitive areas	No petroleum activities permitted.	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.
Category B environmentally sensitive areas that are other than 'endangered' regional ecosystems	Only low impact petroleum activities permitted.	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.
Category B environmentally sensitive areas that are 'endangered' regional ecosystems	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.	Only essential petroleum activities permitted.
Category C environmentally sensitive areas that are 'nature refuges' or 'koala habitat'	Only low impact petroleum activities permitted.	Only low impact petroleum activities permitted.	
Category C environmentally sensitive areas that are 'essential habitat', 'essential regrowth habitat', or 'of concern' regional ecosystems	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.	
Category C environmentally sensitive areas that are 'regional parks' (previously known as 'resources reserves')	Only essential petroleum activities permitted.	Only essential petroleum activities permitted.	
Category C environmentally sensitive areas that are 'state forests' or 'timber reserves'	Only essential petroleum activities permitted.	Petroleum activities permitted.	
Areas of vegetation that are 'critically limited'	Only low impact petroleum activities permitted.	Only essential petroleum activities permitted.	

Schedule D, Table 2 – Maximum significant disturbance in environmentally sensitive areas and their protection zones

Activity	Maximum Footprint
Ground disturbance within a Category B Environmentally Sensitive Area	0 ha
Ground disturbance within a protection zone of a Category B Environmentally Sensitive Area	6 ha
Ground disturbance within a Category C Environmentally Sensitive Area	14 ha
Ground disturbance within a protection zone of a Category C Environmentally Sensitive Area	70 ha

Biodiversity 9 A report must be prepared for each annual return period for all petroleum activities that involved clearing of any environmentally sensitive area or protection zone which includes:

(a) records able to demonstrate compliance with conditions (Biodiversity 4), (Biodiversity 5), (Biodiversity 8A) and (Biodiversity 8B);

(b) a description of the works;

(c) a description of the area and its pre-disturbance values (which may include maps or photographs, but must include GPS coordinates for the works); and

(d) based on the extent of environmentally sensitive areas and primary protection zones on the relevant resource authority(ies), the proportion of native vegetation cleared per environmentally sensitive area and primary protection zone, including regional ecosystem type, over the annual return period.

Biodiversity 10 Significant residual impacts to prescribed environmental matters (other than if the impacts were authorised by an existing authority issued before the commencement of the *Environmental Offsets Act 2014*) are not authorised under this environmental authority or the *Environmental Offsets Act 2014* unless the impact(s) is specified in *Schedule D, Table 3 — Significant residual impacts to prescribed environmental matters.*

Biodiversity 11 Records demonstrating that each impact to a prescribed environmental matter not listed in *Schedule D, Table 3 — Significant residual impacts to prescribed environmental matters* did not, or is not likely to, result in a significant residual impact to that matter must be:

(a) completed by an appropriately qualified person; and

(b) kept for the life of the environmental authority.

Protecting biodiversity values, Table 3 — Significant residual impacts to prescribed environmental matters

Prescribed environmental matter	Location of impact	Maximum extent of impact
REGULATED VEGETATION		
Endangered regional ecosystem		
RE 11.3.21	PL260	3 ha
RE 11.4.2	PL194	2 ha
Of concern regional ecosystem (not within an urban area)		
RE 11.3.2	PL194, PL198, PL230, PL238, PL260	20 ha
RE 11.3.4	PL194, PL198, PL230, PL238, PL252, PL260	18 ha
RE 11.3.17	PL252, PL260	15 ha
Regional ecosystems (not within an urban area) that intersect a wetland on the vegetation management wetlands map		
RE 11.3.4	PL260	1 ha
RE 11.3.27	PL260	2 ha
Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map		
RE 11.3.2 (BVG 17a)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	1 ha
11.3.4 (BVG 16c)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	5 ha
11.3.18 (BVG 17a)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	3 ha
11.3.25 (BVG 16a; 22c)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	15 ha
11.4.12 (BVG 17a)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	1 ha
11.5.1 (BVG 17a; 18b)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	5 ha

Prescribed environmental matter	Location of impact	Maximum extent of impact
11.7.4 (BVG 12a)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	0.5 ha
11.7.7 (BVG 12a)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	1 ha
Essential habitat (not in an urban area) for endangered wildlife		
Hemiaspis damelii	PL230, PL260	6 ha
Essential habitat (not in an urban area) for vulnerable wildlife		
Calyptorhynchus lathami	PL260	1 ha
Jalmenus eubulus	PL260	0.5 ha
CONNECTIVITY AREAS		
Connectivity area that is a regional ecosystem (not in urban area)		
PL194	PL194	6.7 ha
PL198	PL198	2.3 ha
PL230	PL230	1.3 ha
PL260	PL260	1 ha
WETLANDS AND WATERCOURSES		
A wetland in a wetland protection area shown on the Map of referable wetlands (HES wetlands in GBR)	PL198, PL238, PL260	2.5 ha
A wetland of high ecological significance shown on the Map of referable wetlands	PL260	1.5 ha
PROTECTED WILDLIFE HABITAT		
An area shown as a high risk area on the flora survey trigger map that contains plants that are endangered or vulnerable wildlife		
Picris barbarorum	PL260	2.5 ha
Solanum papaverifolium	PL260	3 ha
Habitat for an animal that is vulnerable wildlife		

Prescribed environmental matter	Location of impact	Maximum extent of impact
Acanthophis antarcticus	PL194, PL198, PL230, PL238, PL252, PL258, PL260	370 ha
Calyptorhynchus lathami	PL194, PL198, PL230, PL238, PL252, PL258, PL260	110 ha
Jalmenus eubulus	PL194, PL198, PL230, PL238, PL252, PL258, PL260	20 ha
Tachyglossus aculeatus	PL194, PL198, PL230, PL238, PL252, PL258, PL260	67 ha
Habitat for an animal that is endangered wildlife		
Hemiaspis damelii	PL194, PL198, PL230, PL238, PL252, PL258, PL260	255 ha
FISH HABITAT AREAS		
Fish passage (not in an urban area)	PL194, PL198, PL230, PL238, PL252, PL258, PL260	7 ha

Biodiversity 12 An environmental offset made in accordance with the *Environmental Offsets Act 2014* and Queensland Environmental Offsets Policy, as amended from time to time, must be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in *Schedule D, Table 3— Significant residual impacts to prescribed environmental matters*, unless a lesser extent of the impact has been approved in accordance with condition (Biodiversity 14).

Biodiversity 13 The significant residual impacts to a prescribed environmental matter authorised in condition (Biodiversity 10) for which an environmental offset is required by condition (Biodiversity 12) may be carried out in stages. An environmental offset can be delivered for each stage of the impacts to prescribed environmental matters.

Biodiversity 14 Prior to the commencement of each stage, a report completed by an appropriately qualified person, that includes an analysis of the following must be provided to the administering authority:

(a) for the forthcoming stage—the estimated significant residual impacts to each prescribed environmental matter; and

(b) for the previous stage, if applicable—the actual significant residual impacts to each prescribed environmental matter, to date.

Biodiversity 15 The report required by condition (Biodiversity 14) must be approved by the administering authority before a notice of election for the forthcoming stage, if applicable, is given to the administering authority.

Biodiversity 16 A notice of election for the staged environmental offset referred to in condition (Biodiversity 15), if applicable, must be provided to the administering authority no less than three months before the proposed commencement of that stage, unless a lesser timeframe has been agreed to by the administering authority.

Biodiversity 17 Within six months from the completion of the final stage of the project, a report completed by an appropriately qualified person, that includes the following matters must be provided to the administering authority:

(a) an analysis of the actual impacts on prescribed environmental matters resulting from the final stage; and

(b) if applicable, a notice of election to address any outstanding offset debits for the authorised impacts.

D17 Despite (Biodiversity 8A), the Daandine Brine Dam 2 with its associated activities necessary for construction, operation, maintenance and monitoring of the dam, are permitted to be located within the area bound by the coordinates prescribed in *Schedule D, Table 4 - Coordinates Enclosing the Disturbance Area for Daandine Brine Dam 2*.

D18 Despite (Biodiversity 8A), the water release outlet and pipeline, with its associated activities necessary for construction, operation, maintenance and monitoring for the release of treated CSG water to Wilkie Creek, are permitted to be located within the area bound by the coordinates prescribed in *Schedule D Table 5 - Coordinates Enclosing the Disturbance Area for the Water Release Outlet and Pipeline*.

D19 The construction of the water release outlet and pipeline must be located within the area bound by the coordinates prescribed by *Schedule D Table 5 - Coordinates Enclosing the Disturbance Area for the Water Release Outlet and Pipeline*.

D20 Despite (Biodiversity 8A), the Tipton Treated Water Pipeline, with its associated activities necessary for construction, operation, maintenance, are permitted to be located within the area bound by the coordinates prescribed in *Schedule D, Table 6 – Coordinates Enclosing the Disturbance Area for Tipton Treated Water Pipeline*.

D21 Despite (Biodiversity 8A), the disturbance footprints for the 'Longswamp 31 monitoring bore' and the 'Tipton 253 gas well' are permitted to be located within the areas prescribed in *Schedule D, Table 7 – Authorised footprint for disturbance to environmentally sensitive areas*.

D22 Condition D21 does not authorise clearing of vegetation and requires that all waste, including residual drilling material, must be removed from the site.

Schedule D, Table 4 – Coordinates Enclosing the Disturbance Area for Daandine Brine Dam 2

Point	Northing (GDA94, Zone 56)	Easting (GDA94, Zone 56)
1	7001708	297524
2	7001153	297384
3	7001051	298345
4	7001418	298444
5	7001601	298406
6	7001620	298190

Schedule D Table 5 – Coordinates Enclosing the Disturbance Area for the Water Release Outlet and Pipeline

Point	Northing (GDA94, Zone 56)	Easting (GDA94, Zone 56)	Area of disturbance
Valve Pit	6995424	302897	0.18 ha
High Point on Bank	6995460	302991	
Outlet at Creek	6995465	303004	

Schedule D, Table 6 – Coordinates Enclosing the Disturbance Area for Tipton Treated Water Pipeline

Point	Easting (GDA94 Zone 56)	Northing (GDA94 Zone 56)
Section 1	310653	6969687
	310656	6969747
	310696	6969745
	310661	6970448
	310621	6970453
	310651	6970652
	310611	6970657
	310642	6970846
	310602	6970846
	310707	6971627
	310667	6971630
	310659	6972161
	310618	6972167
	310621	6973392
	310581	6973399
	310613	6973550
	310573	6973550

Point	Easting (GDA94 Zone 56)	Northing (GDA94 Zone 56)
	310639	6973650
	310539	6973550
	310608	6973650
	310568	6973650
	310639	6973550
	310539	6973650
Section 2	310617	6973719
	310577	6973724
	310722	6974060
	310682	6974065
	310717	6974172
	310677	6974177
	310714	6974221
	310675	6974217
	310692	6974378
	310654	6974365
	310692	6974378
	310567	6974521
	310617	6974514
	310563	6974528
	310613	6974522
	310499	6974536
	310594	6974610
	310497	6974636
Section 3	310534	6974847
	310494	6974835
	310534	6974857
	310494	6974862
	310528	6975192
	310488	6975197
	310526	6975351
	310486	6975347

Schedule D, Table 7 – Authorised footprint for disturbance to environmentally sensitive areas

Activity	Latitude	Longitude	Maximum operational footprint	ESA Type
Longswamp 31 shallow monitoring bore	151.095733°E	-27.343471°S	9 m^2	Category A ESA
Tipton 253 gas well	151.13539°E	-27.36818°S	19600 m^2	Primary protection zone of Category C ESA

Schedule E – Acoustic

Noise 1 Notwithstanding condition (General 21), emission of noise from the petroleum activity(ies) at levels less than those specified in *Schedule E, Table 1—Noise nuisance limits* are not considered to be environmental nuisance.

Noise 2 If the noise subject to a valid complaint is tonal or impulsive, the adjustments detailed in *Schedule E, Table 2—Adjustments to be added to noise levels at sensitive receptors* are to be added to the measured noise level(s) to derive $L_{Aeq,\ adj,\ 15\ min}$.

Schedule E, Table 1—Noise nuisance limits[1]

Time period	Metric	Short term noise event	Medium term noise event	Long term noise event
7:00am—6:00pm	$L_{Aeq,adj,15\ min}$	45 dBA	43 dBA	40 dBA
6:00pm—10:00pm	$L_{Aeq,adj,15\ min}$	40 dBA	38 dBA	35 dBA
10:00pm—6:00am	$L_{Aeq,adj,15\ min}$	28 dBA	28 dBA	28 dBA
	Max $L_{pA,\ 15mins}$	55 dBA	55 dBA	55 dBA
6:00am—7:00am	$L_{Aeq,adj,15\ min}$	40 dBA	38 dBA	35 dBA
Drilling activities undertaken from 10:00pm – 7:00am[2]	$L_{Aeq,\ adj,\ 15min}$	28 dBA (measured indoors) 33 dBA (measured outdoors)		

[1] The noise limits in *Schedule E, Table 1 – Noise nuisance limits* have been set based on the following deemed background noise levels (LABG)*:*

7:00am—6:00 pm: 35 dBA

6:00pm—10:00 pm: 30 dBA

10:00pm—6:00 am: 25 dBA

6:00am—7:00 am: 30 dBA

[2] Drilling activities (e.g. drilling, workover, completion activities) undertaken from 10:00 pm – 7:00 am must be temporary and mobile in nature, and must not contribute to long-term background noise creep.

Schedule E, Table 2—Adjustments to be added to noise levels at sensitive receptors

Noise characteristic	Adjustment to noise
Tonal characteristic is just audible	+ 2 dBA
Tonal characteristic is clearly audible	+ 5 dBA
Impulsive characteristic is detectable	+ 2 to + 5 dBA

Noise 3 Notwithstanding condition (Noise 1), emission of any low frequency noise must not exceed either (Noise 3(a)) and (Noise 3(b)), or (Noise 3(c)) and (Noise 3(d)) in the event of a valid complaint about low frequency noise being made to the administering authority:

(a) 60 dB(C) measured outside the sensitive receptor; and

(b) the difference between the external A-weighted and C-weighted noise levels is no greater than 20 dB; or

(c) 50 dB(Z) measured inside the sensitive receptor; and

(d) the difference between the internal A-weighted and Z-weighted (Max $L_{pZ, 15\ min}$) noise levels is no greater than 15 dB.

E10 Within 12 months of commissioning the units listed in Schedule E, Table 3 – Tipton Expansion Project units, the EA holder must, conduct noise monitoring under worst case noise propagation conditions to validate the pre-commissioning noise predictions at sensitive receptors.

E11 The holder of this environmental authority must provide the administering authority with a report of the monitoring results required under condition (E10) that evaluates the accuracy of the pre-commissioning model predictions at sensitive receptors.

Schedule E, Table 3 – Tipton Expansion Project units

Resource Authority	Field	Facility	Unit Description
PL198	Tipton	Tipton Central Gas Processing Facility	K-0007 Compressor 7
			K-0007 Compressor 8
			K-0007 Compressor 9
			K-0007 Compressor 10
			K-0015 Inlet Fuel Gas Compressor Engine
		Tipton Water Treatment Facility	Generator 1
			Generator 2
			Generator 3
			Generator 4

Resource Authority	Field	Facility	Unit Description
			Generator 5

Noise 4 A Blast Management Plan must be developed for each blasting activity in accordance with Australian Standard 2187.

Noise 5 Blasting operations must be designed to not exceed an airblast overpressure level of 120 dB (linear peak) at any time, when measured at or extrapolated to any sensitive place.

Noise 6 Blasting operations must be designed to not exceed a ground-borne vibration peak particle velocity of 10mm/s at any time, when measured at or extrapolated to any sensitive place.

Schedule F – Air

Air 1 Unless venting is authorised under the *Petroleum and Gas (Production and Safety) Act 2004* or the *Petroleum Act 1923*, waste gas must be flared in a manner that complies with all of (Air 1(a)) and (Air 1(b)) and (Air 1(c)), or with (Air 1(d)):

(a) an automatic ignition system is used, and

(b) a flame is visible at all times while the waste gas is being flared, and

(c) there are no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours, or

(d) it uses an enclosed flare.

Air 2A A fuel burning or combustion facility must not be operated unless it is listed in *Schedule F, Table 1– Authorised point sources*.

Air 2B If a fuel burning or combustion facility is listed in *Schedule F, Table 1—Authorised point sources*, the fuel burning or combustion facility must be operated so that the releases to air do not exceed the limits specified in *Schedule F, Table 1—Authorised point sources* at the specified release point reference.

Air 3 Point source air monitoring for each fuel burning or combustion facility listed in *Schedule F, Table 1– Authorised point sources* must:

(a) be undertaken:

i. once in the first three months after each facility is first commissioned, and then

ii. annually or biennially thereafter at the frequency specified in *Schedule F, Table 2 – Annual Air Quality Monitoring*

(b) be carried out when the facility the subject of the sampling is operating under maximum operating conditions for the annual period; and

(c) demonstrate compliance with the limits listed in *Schedule F, Table 1– Authorised point sources* at each release point reference.

Schedule F, Table 1 — Authorised point sources

Tenure	Facility	Release Point Reference	Unit Description	Minimum Release Height (m)	Minimum Efflux Velocity (m/sec)[1]	NO_x as Nitrogen Dioxide	Carbon Monoxide
						Maximum Mass Emission Rate (g/sec)[1]	Maximum Mass Emission Rate (g/sec)[1]
PL 230	Daandine Central Gas Processing Facility	A1	K-0001 Compressor 1	10	30	3.0	5.5
		A2	K-0002 Compressor 2				
		A3	K-0003 Compressor 3				
		A4	K-0004 Compressor 4				
		A5	K-0005 Compressor 5				
		A6	K-0006 Compressor 6				
		A7	K-0007 Compressor 7				
		A8	K-9008 Compressor 8	17	17	1.4	4.8
		A9	K-9009 Compressor 9				
		A10	K-9010 Compressor 10				
		A11	K-9011 Inlet Fuel Screw Compressor Engine 11	8.5	30	1.5	1.0
PL 198	Tipton West Central Gas Processing Facility	A14	K-0001 Compressor 1	7.6	30	6.8	5.5
		A15	K-0002 Compressor 2				
		A16	K-0003 Compressor 3				
		A17	K-0004 Compressor 4				

Tenure	Facility	Release Point Reference	Unit Description	Minimum Release Height (m)	Minimum Efflux Velocity (m/sec)[1]	NO_X as Nitrogen Dioxide	Carbon Monoxide
						Maximum Mass Emission Rate (g/sec)[1]	Maximum Mass Emission Rate (g/sec)[1]
		A18	K-0005 Compressor 5				
		A19	K-0006 Compressor 6				
		A20	K-0007 Compressor 7	17	17	1.4	4.8
		A21	K-0008 Compressor 8				
		A22	K-0009 Compressor 9				
		A23	K-0010 Compressor 10				
	Tipton Water Treatment Facility[2]	A24	K-0015 Inlet Fuel Gas Compressor Engine	8.5	38	1.5	1.0
		A25	Generator 1	7.5	27	1.5	1.5
		A26	Generator 2				
		A27	Generator 3				
		A28	Generator 4				
		A29	Generator 5				

[1] Minimum efflux velocity, maximum mass emission and maximum concentration limits relate to plant maximum continuous ratings.
[2] The Water Treatment Facility's aggregated fuel consumption exceeds the 500 kg per hour threshold when all five generators are in simultaneous operation.

Schedule F, Table 2 – Annual Air Quality Monitoring

Release Point	Parameter[1]		Minimum Monitoring Frequency
	Mass emission rate (g/s)	Concentration (mg/Nm^3)	
A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25[2], A26[2], A27[2], A28[2], A29[2]	oxides of nitrogen (measured as NO_2) carbon monoxide	oxides of nitrogen (measured as NO_2) carbon monoxide	Biennial from commission

[1] Measured in flue gas at the 5% oxygen reference level
[2] Biennial monitoring is not required until at least four of the five generators are commissioned.

Schedule G – Waste

Waste 1 Measures must be implemented so that waste is managed in accordance with the waste and resource management hierarchy and the waste and resource management principles.

Waste 2 Waste, including waste fluids, but excluding waste used in closed-loop systems, must be transported off-site for lawful re-use, remediation, recycling or disposal, unless the waste is specifically authorised by conditions of this environmental authority to be disposed of or used on site.

Waste 3 Waste fluids, other than flare precipitant stored in flare pits, or residual drilling material or drilling fluids stored in sumps, must be contained in either:

(a) an above ground container; or

(b) a structure which contains the wetting front.

Waste 4 Green waste may be used on-site for either rehabilitation or sediment and erosion control, or both.

Waste 5 Vegetation waste may be burned if it relates to a state forest, timber reserve or forest entitlement area administered by the *Forestry Act 1959* and a permit has been obtained under the *Fire and Rescue Service Act 1990*.

Waste 6 Pipeline waste water may be released to land provided that it:

(a) can be demonstrated it meets the acceptable standards for release to land; and

(b) is released in a way that does not result in visible scouring or erosion or pooling or run-off or vegetation die-off.

Waste 7 Produced water may be re-used in drilling and well hole activities.

Waste 8 Produced water may be used for dust suppression provided the following criteria are met:

(a) The amount applied does not exceed the amount required to effectively suppress dust; and

(b) The application:

i. Does not cause on-site ponding or runoff;

ii. Is directly applied to the area being dust suppressed;

iii. Does not harm vegetation surrounding the area being dust suppressed; and

iv. Does not cause visible salting.

Waste 9 Produced water may be used for construction and operation purposes provided the use:

(a) Does not result in negative impacts on the composition and structure of soil or subsoils;

(b) Is not directly or indirectly released to waters;

(c) Does not result in runoff from the construction site; and

(d) Does not harm vegetation surrounding the construction site.

Waste 10 If there is any indication that any of the circumstances in condition (Waste 8)(b)(i) to (Waste 8(b)(iv)) or (Waste 9)(a) to (Waste 9(d)) is occurring, the use must cease immediately and the affected area must be remediated without delay.

Waste 11 Treated sewage effluent or greywater can be released to land provided it:

(a) meets or exceeds secondary treated class B standards for a treatment system with a daily peak design capacity of between 150 EP and 1500 EP; or

(b) meets or exceeds secondary treated class C standards for a treatment system with a daily peak design capacity of less than 150 EP.

Waste 12 The release of treated sewage effluent or greywater authorised in condition (Waste 11) must:

(a) be to a fenced and signed contaminant release area(s);

(b) not result in pooling or run-off or aerosols or spray drift or vegetation die-off;

(c) be to a contaminant release area(s) that is kept vegetated with groundcover, that is:

i. not a pest species;

ii. kept in a viable state for transpiration and nutrient uptake; and

iii. grazed or harvested and removed from the contaminant release area as needed, but not less than every three months.

Waste 13 Notwithstanding condition (Waste 11), treated sewage effluent that meets or exceeds secondary treated class A standards may be used for dust suppression or construction activities, provided the use meets the criteria in condition (Waste 8) or (Waste 9), as relevant to the use.

Waste 14 Sewage pump stations must be fitted with a:

(a) stand-by pump; and

(b) high level alarm to warn of imminent pump station overflow, that operates without mains power or with a back-up power source that starts automatically in the event of a power failure.

Waste 15 If sumps are used to store residual drilling material or drilling fluids, they must only be used for the duration of drilling activities.

Waste 16 Residual drilling material can only be disposed of on-site:

(a) by mix-bury-cover method if the residual drilling material meets the approved quality criteria; or

(b) if it is certified by a suitably qualified third party as being of acceptable quality for disposal to land by the proposed method and that environmental harm will not result from the proposed disposal.

Waste 17 Records must be kept to demonstrate compliance with condition (Waste 15) and (Waste 16).

G12 Coal seam gas water may be transferred to a third party to be used for the following purposes subject to compliance with conditions (G13) and (G14):

(a) dust suppression if the coal seam gas water quality complies with the limits specified in *Schedule G, Table 1 – Water Contaminant Release Limits*;

(b) construction and operational purposes if the coal seam gas water quality complies with the limits specified in *Schedule G, Table 1 – Water Contaminant Release Limits*;

(c) irrigation and livestock watering purposes;

(d) the following industrial purposes:

i. coal washing;

ii. power stations; and

iii. water treatment facilities.

G13 Any coal seam gas water supplied to a third party for irrigation and/or livestock watering purposes in accordance with Condition (G12)(c) must comply with the relevant trigger values contained in ANZECC and ARMCANZ Water Quality Guidelines 2000, or subsequent versions thereof.

Schedule G, Table 1 – Water Contaminant Release Limits

Water Quality Characteristics	Unit	Limit	Limit Type
pH	pH units	6.0 to 9.0	Range

Water Quality Characteristics	Unit	Limit	Limit Type
Sodium Adsorption Ratio	ratio	6	80th Percentile
		12	Maximum
Total Dissolved Solids	mg/L	1500	Maximum
Total Petroleum Hydrocarbons	mg/L	10	Maximum

G14 If the responsibility of coal seam gas water is given or transferred to a third party in accordance with Condition (G12), the holder of environmental authority must ensure that:

(a) the responsibility of the coal seam gas water is given or transferred in accordance with a written agreement (the third party agreement); and

(b) the third party is made aware of the General Environmental Duty under section 319 of the *Environmental Protection Act 1994*.

Schedule H – Rehabilitation

Rehabilitation 1

A Rehabilitation Plan must be developed by a suitably qualified person and must include the:

(a) rehabilitation goals; and

(b) procedures to be undertaken for rehabilitation that will:

i. achieve the requirements of conditions (Rehabilitation 2) to (Rehabilitation 8), inclusive; and

ii. provide for appropriate monitoring and maintenance.

Rehabilitation 2

Significantly disturbed areas that are no longer required for the on-going petroleum activities, must be rehabilitated within 12 months (unless an exceptional circumstance in the area to be rehabilitated (e.g. a flood event) prevents this timeframe being met) and be maintained to meet the following acceptance criteria:

(a) contaminated land resulting from petroleum activities is remediated and rehabilitated;

(b) the areas are:

i. non-polluting;

ii. a stable landform;

iii. re-profiled to contours consistent with the surrounding landform;

(c) surface drainage lines are re-established;

(d) top soil is reinstated; and

(e) either:

i. groundcover, that is not a pest species, is growing; or

ii. an alternative soil stabilisation methodology that achieves effective stabilisation is implemented and maintained.

Rehabilitation 3

All significantly disturbed areas caused by petroleum activities which are not being or intended to be utilised by the landholder or overlapping tenure holder, must be rehabilitated to meet the following final acceptance criteria measured either against the highest ecological value adjacent land use or the pre-disturbed land use:

(a) greater than or equal to 70% of native ground cover species richness

(b) greater than or equal to the total per cent of ground cover

(c) less than or equal to the per cent species richness of plant pest species; and

(d) where the adjacent land use contains, or the pre-clearing land use contained, one or more regional ecosystem(s), then at least one regional ecosystem(s) from the same broad vegetation group, and with the equivalent biodiversity status or a biodiversity status with a higher conservation value as any of the regional ecosystem(s) in either the adjacent land or pre-disturbed land, must be present.

Rehabilitation 4 — Where significant disturbance to land has occurred in an environmentally sensitive area, the following final rehabilitation criteria as measured against the pre-disturbance biodiversity values assessment (required by conditions (Biodiversity 1) and (Biodiversity 2)) must be met:

(a) greater than or equal to 70% of native ground cover species richness;

(b) greater than or equal to the total per cent ground cover;

(c) less than or equal to the per cent species richness of plant pest species;

(d) greater than or equal to 50% of organic litter cover;

(e) greater than or equal to 50% of total density of coarse woody material; and

(f) all predominant species in the ecologically dominant layer, that define the pre-disturbance regional ecosystem(s) are present.

Rehabilitation 5 — Conditions (Rehabilitation 2), (Rehabilitation 3) and (Rehabilitation 4) continue to apply after this environmental authority has ended or ceased to have effect.

Rehabilitation 8 — Where there is a dam (including a low consequence dam) that is being or intended to be utilised by the landholder or overlapping tenure holder, the dam must be decommissioned to no longer accept inflow from the petroleum activity(ies) and the contained water must be of a quality suitable for the intended on-going uses(s) by the landholder or overlapping tenure holder.

Schedule I – Definitions

Words and phrases used throughout this environmental authority are defined below except where identified in the *Environmental Protection Act 1994* or its Regulations and Environmental Protection Policies. Where a word or term is not defined, the ordinary English meaning applies, and regard should be given to the Macquarie Dictionary.

Word or Phrase	Definition
acceptable standards for release to land	means wastewater of the following quality as determined by monitoring results or by characterisation: a) electrical conductivity (EC) not exceeding 3000µS/cm; b) sodium adsorption ratio (SAR) not exceeding 8; c) pH between 6.0 and 9.0; d) heavy metals (measured as total) meets the respective short term trigger value in section 4.2.6, Table 4.2.10—*Heavy metals and metalloids in Australian and New Zealand Guidelines for Fresh and Marine Water Quality;* e) does not contain biocides.
acid sulfate soil(s)	means a soil or soil horizon which contains sulfides or an acid soil horizon affected by oxidation of sulfides.
adjacent land use(s)	means the ecosystem function adjacent to an area of significant disturbance, or where there is no ecosystem function, the use of the land. An adjacent land use does not include an adjacent area that shows evidence of edge effect.
administering authority	means: a) for a matter, the administration and enforcement of which has been devolved to a local government under section 514 of the *Environmental Protection Act 1994*—the local government; or b) for all other matters—the Chief Executive of the Department of Environment and Science; or c) another State Government Department, Authority, Storage Operator, Board or Trust, whose role is to administer provisions under other enacted legislation.
alternative arrangement	means a written agreement about the way in which a particular environmental nuisance impact will be dealt with at a sensitive place, and may include an agreed period of time for which the arrangement is in place. An alternative arrangement may include, but is not limited to, a range of nuisance abatement measures to be installed at the sensitive place, or provision of alternative accommodation for the duration of the relevant nuisance impact.
analogue site(s)	means an area of land which contains values and characteristics representative of an area to be rehabilitated prior to disturbance. Such values must encompass land use, topographic, soil, vegetation, vegetation community attributes and other ecological characteristics. Analogue sites can be the pre-

<table>
<tr><th>Word or Phrase</th><th>Definition</th></tr>
<tr><td></td><td>disturbed site of interest where significant surveying effort has been undertaken to establish benchmark parameters.</td></tr>
<tr><td>annual return period</td><td>means the most current 12-month period between two anniversary dates.</td></tr>
<tr><td>appraisal well</td><td>means a petroleum well to test the potential of one (1) or more natural underground reservoirs for producing or storing petroleum. For clarity, an appraisal well does not include an exploration well.</td></tr>
<tr><td>appropriately qualified person / suitably qualified person</td><td>means a person who has professional qualifications, training or skills or experience relevant to the nominated subject matters and can give authoritative assessment, advice and analysis about performance relevant to the subject matters using relevant protocols, standards, methods or literature.</td></tr>
<tr><td>Approved quality criteria</td><td>for the purposes of residual drilling materials, means the residual drilling material meet the following quality standards:

Part A In all cases:

<table>
<tr><th>Parameter</th><th>Maximum concentration</th></tr>
<tr><td>pH</td><td>6 to 10.5 (range)</td></tr>
<tr><td>Electrical Conductivity</td><td>20 dS/m (20,000 µS/cm)</td></tr>
<tr><td>Chloride*</td><td>8000 mg/L</td></tr>
</table>
*Chloride analysis is only required if an additive containing chloride was used in the drilling process The limits in Part A must be measured in the clarified filtrate of oversaturated solids prior to mixing.

Part B If any of the following metals are a component of the drilling fluids, then for that metal:

<table>
<tr><th>Parameter</th><th>Maximum concentration</th></tr>
<tr><td>Arsenic</td><td>20 mg/kg</td></tr>
<tr><td>Selenium</td><td>5 mg/kg</td></tr>
<tr><td>Boron</td><td>100 mg/kg</td></tr>
<tr><td>Cadmium</td><td>3 mg/kg</td></tr>
<tr><td>Chromium (total)</td><td>400 mg/kg</td></tr>
<tr><td>Copper</td><td>100 mg/kg</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Word or Phrase</th><th>Definition</th></tr>
<tr><td></td><td>
<table>
<tr><td>Lead</td><td>600 mg/kg</td></tr>
</table>

The limits in Part B and Part C refer to the post soil/by-product mix.

Part C If a hydrocarbon sheen is visible, the following hydrocarbon fractions:
<table>
<tr><th>TPH</th><th>Maximum concentration</th></tr>
<tr><td>C6-C10</td><td>170 mg/kg</td></tr>
<tr><td>C10-C16</td><td>150 mg/kg</td></tr>
<tr><td>C16-C34</td><td>1300 mg/kg</td></tr>
<tr><td>C34-C40</td><td>5600 mg/kg</td></tr>
<tr><td>Total polycyclic aromatic hydrocarbons (PAH)</td><td>20 mg/kg</td></tr>
<tr><td>Phenols (halogenated)</td><td>1 mg/kg</td></tr>
<tr><td>Phenols (non-halogenated)</td><td>60 mg/kg</td></tr>
<tr><td>Monocyclic aromatic hydrocarbons (total sum of benzen, toluene, ethyl benzene, xylenes (includes ortho, para, and meta xylenes) and styrene)</td><td>7 mg/kg</td></tr>
<tr><td>Benzene</td><td>1 mg/kg</td></tr>
</table>
</td></tr>
<tr><td>areas of pre-existing disturbance</td><td>means areas where environmental values have been negatively impacted as a result of anthropogenic activity and these impacts are still evident. Areas of pre-disturbance may include areas where legal clearing, logging, timber harvesting, or grazing activities have previously occurred, where high densities of weed or pest species are present which have inhibited re-colonisation of native regrowth, or where there is existing infrastructure (regardless of whether the infrastructure is associated with the authorised petroleum activities). The term ‘areas of pre-disturbance’ does not include areas that have been impacted by wildfire/s, controlled burning, flood or natural vegetation die-back.</td></tr>
<tr><td>associated water</td><td>means underground water taken or interfered with, if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity under a petroleum authority, such as a petroleum well, and</td></tr>
</table>

Word or Phrase	Definition
	includes waters also known as produced formation water. The term includes all contaminants suspended or dissolved within the water.
associated works	in relation to a dam, means: • operations of any kind and all things constructed, erected or installed for that dam; and • any land used for those operations.
Australian Standard 3580	means any of the following publications: • AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter—Gravimetric method. • AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM10 high volume sampler with size-selective inlet— Gravimetric method • AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter— PM10 low volume sampler—Gravimetric sampler.
background noise level	means the sound pressure level, measured in the absence of the noise under investigation, as the $L_{A90,T}$ being the A-weighted sound pressure level exceeded for 90% of the measurement time period T of not less than 15 minutes (or $L_{A\ 90,\ adj,\ 15\ mins}$), using Fast response.
bankfull	means the channel flow rate that exists when the water is at the elevation of the channel bank above which water begins to spill out onto the floodplain. The term describes the condition of the channel relative to its banks (e.g. overbank, in-bank, bankfull, low banks, high bank).
bed	of any waters, has the meaning in Schedule 12 of the *Environmental Protection Regulation 2008* and— a) includes an area covered, permanently or intermittently, by tidal or non-tidal waters; but b) does not include land adjoining or adjacent to the bed that is from time to time covered by floodwater.
being or intended to be utilised by the landholder or overlapping tenure holder	for significantly disturbed land, means there is a written agreement (e.g. land and compensation agreement) between the landholder or the overlapping tenure holder and the holder of the environmental authority identifying that the landholder or the overlapping tenure holder has a preferred use of the land such that rehabilitation standards for revegetation by the holder of the environmental authority are not required. For dams, means there is a written agreement (e.g. land and compensation agreement) between the landholder or the overlapping tenure holder and the holder of the environmental authority identifying that the landholder or the overlapping tenure holder has a preferred use for the dam such that rehabilitation standards for revegetation by the holder of the environmental authority are not required.

Word or Phrase	Definition
biodiversity values	for the purposes of this environmental authority, means environmentally sensitive areas, prescribed environmental matters and wetlands.
BTEX	means benzene, toluene, ethylbenzene, ortho-xylene, para-xylene, meta-xylene and total xylene.
Category A Environmentally Sensitive Area	means any area listed in Schedule 19, Section 3 of the Environmental Protection Regulation 2019.
Category B Environmentally Sensitive Area	means any area listed in Schedule 19, Section 3 of the Environmental Protection Regulation 2019.
Category C Environmentally Sensitive Area	means any of the following areas: • nature refuges as defined in the conservation agreement for that refuge under the Nature Conservation Act 1992 • koala habitat areas as defined under the Nature Conservation (Koala) Conservation Plan 2006 • state forests or timber reserves as defined under the Forestry Act 1959 • regional parks (previously known as resource reserves) under the Nature Conservation Act 1992 • an area validated as 'essential habitat' from ground-truthing surveys in accordance with the Vegetation Management Act 1999 for a species of wildlife listed as endangered or vulnerable under the Nature Conservation Act 1992 • 'of concern regional ecosystems' that are remnant vegetation and identified in the database called 'RE description database' containing regional ecosystem numbers and descriptions.
certified or certification	in relation to any matter other than a design plan, 'as constructed' drawings or an annual report regarding dams means, a Statutory Declaration by a suitably qualified person or suitably qualified third party accompanying the written document stating: • the person's qualifications and experience relevant to the function • that the person has not knowingly included false, misleading or incomplete information in the document • that the person has not knowingly failed to reveal any relevant information or document to the administering authority • that the document addresses the relevant matters for the function and is factually correct; and • that the opinions expressed in the document are honestly and reasonably held.

Word or Phrase	Definition
clearing	has the meaning in the dictionary of the *Vegetation Management Act 2000* and for vegetation— a) means remove, cut down, ringbark, push over, poison or destroy in any way including by burning, flooding or draining; but b) does not include destroying standing vegetation by stock, or lopping a tree.
closed-loop systems	means using waste on site in a way that does not release waste or contaminants in the waste to the environment.
coal seam gas water	means underground water brought to the surface of the earth, or moved underground in connection with exploring for, or producing coal seam gas.
control measure	has the meaning in section 47 of the *Environmental Protection Regulation 2008* and means a device, equipment, structure, or management strategy used to prevent or control the release of a contaminant or waste to the environment.
critically limited regional ecosystem	means the regional ecosystems defined and listed in Appendix 5 of the Queensland Biodiversity Offset Policy.
daily peak design capacity	for sewage treatment works, has the meaning in Schedule 2, section 63(4) of the *Environmental Protection Regulation 2008* as the higher equivalent person (EP) for the works calculated using each of the formulae found in the definition for EP.
dam(s)	means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.
design storage allowance or DSA	means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/19337)*, published by the administering authority, as amended from time to time, that must be provided in a dam to an annual exceedance probability specified in that Manual.
designated precinct	has the meaning in Part 5 section 15(3) of the *Regional Planning Interests Regulation 2014* and means: • for a strategic environmental area mentioned in section 4(1) – the area identified as a designated precinct on the strategic environmental area map for the strategic environmental are; or • if a strategic environmental area is shown on a map in a regional plan – the area identified on the map as a designated precinct for the strategic environmental area
development wells	means a petroleum well which produces or stores petroleum. For clarity, a development well does not include an appraisal well.

Word or Phrase	Definition
document	has the meaning in the *Acts Interpretation Act 1954* and means: • any paper or other material on which there is writing; and • any paper or other material on which there are marks; and • figures, symbols or perforations having a meaning for a person qualified to interpret them; and • any disc, tape or other article or any material from which sounds, images, writings or messages are capable of being produced or reproduced (with or without the aid of another article or device).
ecologically dominant layer	has the meaning in the *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Version 5.1 March 2020) and means the layer making the greatest contribution to the overall biomass of the site and the vegetation community (National Land and Water Resources Audit 2001). This is also referred to as the ecologically dominant stratum or the predominant canopy in woody ecosystems.
ecosystem function	means the interactions between and within living and nonliving components of an ecosystem and generally correlates with the size, shape and location of the vegetation community.
enclosed flare	means a device where the residual gas is burned in a cylindrical or rectilinear enclosure that includes a burning system and a damper where air for the combustion reaction is admitted.
environmental harm	has the meaning in section 14 of the *Environmental Protection Act 1994* and means any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance. Environmental harm may be caused by an activity— a) whether the harm is a direct or indirect result of the activity; or b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.
environmental nuisance	has the meaning in section 15 of the *Environmental Protection Act 1994* and means unreasonable interference or likely interference with an environmental value caused by— a) aerosols, fumes, light, noise, odour, particles or smoke; or b) an unhealthy, offensive or unsightly condition because of contamination; or c) another way prescribed by regulation.
environmental offset	has the meaning in section 7 of the *Environmental Offsets Act 2014.*
environmentally sensitive area	means Category A, B or C environmentally sensitive areas (ESAs)
equivalent person or EP	has the meaning under section 3 of the *Planning Guidelines For Water Supply and Sewerage*, 2005, published by the Queensland Government. It is

Word or Phrase	Definition
	calculated in accordance with Schedule 2, Section 63(4) of the *Environmental Protection Regulation 2008* where: • EP = V/200 where V is the volume, in litres, of the average dry weather flow of sewage that can be treated at the works in a day; or • EP = M/2.5 where M is the mass, in grams, of phosphorus in the influent that the works are designed to treat as the inlet load in a day.

essential petroleum activities	means activities that are essential to bringing the resource to the surface and are only the following:
	• low impact petroleum activities
	• geophysical, geotechnical, geological, topographic and cadastral surveys (including seismic, sample / test / geotechnical pits, core holes)
	• single well sites not exceeding 1 hectare disturbance and multi-well sites not exceeding 1.5 hectare disturbance
	• well sites with monitoring equipment (including monitoring bores):
	  ○ for single well sites, not exceeding 1.25 hectares disturbance
	  ○ for multi-well sites, not exceeding 1.75 hectares disturbance
	• well sites with monitoring equipment (including monitoring bores) and tanks (minimum 1 ML) for above ground fluid storage:
	  ○ for single well sites, not exceeding 1.5 hectares disturbance
	  ○ for multi-well sites, not exceeding 2.0 hectares disturbance
	• well sites with slope considerations (>2% slope) for cut and fill earthworks and drainage:
	  ○ for single well sites, not exceeding 1.5 hectares disturbance
	  ○ for multi-well sites, not exceeding 2.5 hectares disturbance
	• swell sites including a Communications Tower:
	  ○ for single well sites, not exceeding 1.5 hectare disturbance
	  ○ for multi-well sites, not exceeding 3.0 hectare disturbance
	• associated infrastructure located on a well site necessary for the construction and operations of wells:
	  ○ water pumps and generators
	  ○ flare pits
	  ○ chemical / fuel storages
	  ○ sumps for residual drilling material and drilling fluids
	  ○ tanks, or dams which are not significant or high consequence dams to contain wastewater (e.g. stimulation flow back waters, produced water)
	  ○ pipe laydown areas
	  ○ soil and vegetation stockpile areas
	  ○ a temporary camp associated with a drilling rig that may involve sewage treatment works that are no release works
	  ○ temporary administration sites and warehouses

Word or Phrase	Definition
	○ dust suppression activities using water that meets the quality and operational standards approved under the environmental authority • communication and power lines that are necessary for the undertaking of petroleum activities and that are located within well sites, well pads and pipeline right of ways without increasing the disturbance area of petroleum activities • on site disposal of residual drilling material as per condition (Waste 16) • communications towers, not exceeding 1.0 hectares disturbance • supporting access tracks • gathering / flow pipelines from a well head to the initial compression facility • activities necessary to achieve compliance with the conditions of the environmental authority in relation to another essential petroleum activity (e.g. sediment and erosion control measures, rehabilitation).
existing authority	has the meaning in section 94 of the *Environmental Offsets Act 2014.*
exploration well	means a petroleum well that is drilled to: • explore for the presence of petroleum or natural underground reservoirs suitable for storing petroleum; or • obtain stratigraphic information for the purpose of exploring for petroleum. For clarity, an exploration well does not include an appraisal or development well.
flare pit	has the meaning in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/19338*), and means containment area where any hydrocarbon that is discovered in an over-pressured reservoir during a drilling operation is diverted to, and combusted, The flare pit is only used during the drilling and work over process on a petroleum well.
flare precipitant	means waste fluids which result from the operation of a flare.
floodplains	has the meaning in the *Water Act 2000* and means an area of reasonably flat land adjacent to a watercourse that— • is covered from time to time by floodwater overflowing from the watercourse; and • does not, other than in an upper valley reach, confine floodwater to generally follow the path of the watercourse; and • has finer sediment deposits than the sediment deposits of any bench, bar or in-stream island of the watercourse.
flowable substance	means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can

Word or Phrase	Definition
	include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.
fuel burning or combustion facility	means a permanent fuel burning or combustion equipment which in isolation, or combined in operation, or which are interconnected, is, or are capable of burning more than 500 kg of fuel in an hour.
GDA	means Geocentric Datum of Australia.
Great Artesian Basin (GAB) spring	means an area protected under the *Environment Protection and Biodiversity Conservation Act 1999* because it is considered to be a Matter of National Environmental Significance and identified as a: • community of native species dependent on natural discharge of groundwater from the Great Artesian Basin; or • Great Artesian Basin spring; or • Great Artesian Basin discharge spring wetland. A GAB spring includes a spring vent, spring complex or watercourse spring and includes the land to which water rises naturally from below the ground and the land over which the water then flows. *Note: The Australian Government's Protected Matters Search Tool should be used to get an indication of whether the area of interest may contain an MNES spring.* *Note: The GAB springs dataset can be requested from the Queensland Government Herbarium*
green waste	means waste that is grass cuttings, trees, bushes, shrubs, material lopped from trees, untreated timber or other waste that is similar in nature but does not include pest species.
greywater	means wastewater generated from domestic activities such as laundry, dishwashing, and bathing. Greywater does not include sewage.
groundwater dependent ecosystem (GDE)	means ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. For the purposes of the environmental authority, groundwater dependent ecosystems do not include those mapped as "unknown".
growing	means to increase by natural development, as any living organism or part thereof by assimilation of nutriment; increase in size or substance.

Word or Phrase	Definition
hydraulic integrity	refers to the capacity of a dam to contain or safely pass flowable substances based on its design.
impulsive (for noise)	means sound characterised by brief excursions of sound pressure (acoustic impulses) that significantly exceed the background sound pressure. The duration of a single impulsive sound is usually less than one second.
LA 90, adj, 15 mins	means the A-weighted sound pressure level, adjusted for tonal character that is equal to or exceeded for 90% of any 15 minutes sample period equal, using Fast response.
LAeq, adj, 15 mins	means an A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within a 15 minute period has the same square sound pressure as a sound level that varies with time.
land degradation	has the meaning in the *Vegetation Management Act 1999* and means the following: • soil erosion • rising water tables • the expression of salinity • mass movement by gravity of soil or rock • stream bank instability • a process that results in declining water quality.
landholder's active groundwater bore	means bores that are able to continue to provide a reasonable yield of water in terms of quantity for the bores authorised purpose or use. This term does not include monitoring bores owned by the administering authority of the *Water Act 2000*.
linear infrastructure	means powerlines, pipelines, roads and access tracks.
liquid	means a substance which is flowing and offers no permanent resistance to changes of shape.
long term noise event	means a noise exposure, when perceived at a sensitive receptor, persists for a period of greater than five (5) days, even when there are respite periods when the noise is inaudible within those five (5) days.
low consequence dam	means any dam that is not classified as high or significant as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*, published by the administering authority, as amended from time to time.
low impact petroleum activities	means petroleum activities which do not result in the clearing of native vegetation, cause disruption to soil profiles through earthworks or excavation or result in significant disturbance to land which cannot be rehabilitated immediately using hand tools after the activity is completed. Examples of such activities include but are not necessarily limited to soil surveys (excluding test

Word or Phrase	Definition
	pits), topographic surveys, cadastral surveys and ecological surveys, may include installation of monitoring equipment provided that it is within the meaning of low impact and traversing land by car or foot via existing access tracks or routes or in such a way that does not result in permanent damage to vegetation.
Map of referable wetlands	has the meaning in Schedule 12 of the *Environmental Protection Regulation 2008* and means the 'Map of referable wetlands', a document approved by the chief executive on 4 November 2011 and published by the department, as amended from time to time by the chief executive under section 144D.
Max $L_{pA, 15\ min}$	means the absolute maximum instantaneous A-weighted sound pressure level, measured over 15 minutes.
Max $L_{pZ, 15\ min}$	means the maximum value of the Z-weighted sound pressure level measured over 15 minutes.
maximum extent of impact	means the total, cumulative, residual extent and duration of impact to a prescribed environmental matter that will occur over a project's life after all reasonable avoidance and reasonable on-site mitigation measures have been, or will be, undertaken.
medium term noise event	is a noise exposure, when perceived at a sensitive receptor, persists for an aggregate period not greater than five days and does not re-occur for a period of at least four weeks. Re-occurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a difference source or source location.
methodology	means the science of method, especially dealing with the logical principles underlying the organisation of the various special sciences, and the conduct of scientific inquiry.
mix-bury-cover method	means the stabilisation of residual drilling solids in the bottom of a sump by mixing with subsoil and which occurs in accordance with the following methodology: - the base of the subsoil and residual solid mixture must be separated from the groundwater table by at least one metre of a continuous layer of impermeable subsoil material (kw=10-8m/s) or subsoil with a clay content of greater than 20 percent; and - the residual solids is mixed with subsoil in the sump and cover; and - the subsoil and residual solids is mixed at least three parts subsoil to one part waste (v/v); and - a minimum of one metre of clean subsoil must be placed over the subsoil and residual solids mixture; and - topsoil is replaced.

Word or Phrase	Definition
month	has the meaning in the *Acts Interpretation Act 1954* and means a calendar month and is a period starting at the beginning of any day of one (1) of the 12 named months and ending— • immediately before the beginning of the corresponding day of the next named month; or • if there is no such corresponding day—at the end of the next named month.
NATA accreditation	means accreditation by the National Association of Testing Authorities Australia.
notice of election	has the meaning in section 18(2) *Environmental Offsets Act 2014.*
pest	Means a plant or animal, other than a native species of plant or animal, that is – a) an ***Invasive biosecurity matter*** under the *Biosecurity Act 2014** b) a Controlled biosecurity matter or regulated biosecurity matter under the *Biosecurity Act 2014* or c) a Locally significant invasive species declared under *Local Government Act 2009* as local law. *See Biosecurity Act 2014, schedule 1, part 3 or 4 or schedule 2, part 2. See also the notes to the Biosecurity Act 2014, schedules 1 and 2. ***Invasive biosecurity matter*** is defined to include invasive plants and animals as listed as prohibited and restricted matter in schedules 1 and 2 of the *Biosecurity Act 2014*.
pipeline waste water	means hydrostatic testing water, flush water or water from low point drains.
pre-disturbed land use	means the function or use of the land as documented prior to significant disturbance occurring at that location.
predominant species	has the meaning in the *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Version 5.1 March 2020) and means a species that contributes most to the overall above-ground biomass of a particular stratum
prescribed contaminants	has the meaning in section 440ZD of the *Environmental Protection Act 1994*.
prescribed environmental matters	has the meaning in section 10 of the *Environmental Offsets Act 2014*, limited to the matters of State environmental significant listed in schedule 2 of the *Environmental Offsets Regulation 2014*.

Word or Phrase	Definition
primary protection zone	means an area within 200m from the boundary of any Category A, B or C ESA.
produced water	has the meaning in Section 15A of the *Petroleum and Gas (Production and Safety) Act 2004* and means CSG water or associated water for a petroleum tenure.
protection zone	means the primary protection zone of any Category A, B or C ESA or the secondary protection zone of any Category A or B ESA.
regional ecosystem	has the meaning in the *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (Version 5.1 March 2020) and means a vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform and soil. Regional ecosystems of Queensland were originally described in Sattler and Williams (1999). The *Regional Ecosystem Description Database* (Queensland Herbarium 2013) is maintained by Queensland Herbarium and contains the current descriptions of regional ecosystems.
regulated dam	means any dam in the significant or high consequence category as assessed using the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/19339)*, published by the administering authority, as amended from time to time.
rehabilitation or rehabilitated	means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with acceptance criteria and, where relevant, includes remediation of contaminated land. For the purposes of pipeline rehabilitation, rehabilitation includes reinstatement, revegetation and restoration
reinstate or reinstatement	for pipelines, means the process of bulk earth works and structural replacement of pre-existing conditions of a site (i.e. soil surface typography, watercourses, culverts, fences and gates and other landscape(d) features) and is detailed in the *Australian Pipeline Industry Association (APIA) Code of Environmental Practice: Onshore Pipelines* (2013).
reporting limit	means the lowest concentration that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. For many analytes, the reporting limit is selected as the lowest non-zero standard in the calibration curve. Results that fall below the reporting limit will be reported as “less than” the value of the reporting limit. The reporting limit is also referred to as the practical quantitation limit or the limit of quantitation. For polycyclic aromatic hydrocarbons, the reporting limit must be based on super-ultra trace methods and, depending on the specific polycyclic aromatic hydrocarbon, will range between 0.005 µg/L–0.020 µg/L.

Word or Phrase	Definition
residual drilling material	means waste drilling materials including muds and cuttings or cement returns from well holes and which have been left behind after the drilling fluids are pumped out.
restoration	means the replacement of structural habitat complexity, ecosystem processes, services and function from a disturbed or degraded site to that of a pre-determined or analogue site. For the purposes of pipelines, restoration applies to final rehabilitation after pipeline decommissioning.
restricted stimulation fluids	has the meaning in section 206 of the *Environmental Protection Act 1994* and means fluids used for the purpose of stimulation, including fracturing, that contain the following chemicals in more than the maximum amount prescribed under a regulation— a) petroleum hydrocarbons containing benzene, ethylbenzene, toluene or xylene b) chemicals that produce, or are likely to produce, benzene, ethylbenzene, toluene or xylene as the chemical breaks down in the environment.
revegetation or revegetating or revegetate	means to actively re-establish vegetation through seeding or planting techniques in accordance with site specific management plans.
secondary protection zone	in relation to a Category A or Category B ESA means an area within 100 metres from the boundary of the primary protection zone.
secondary treated class A standards	means treated sewage effluent or greywater which meets the following standards: • total phosphorous as P, maximum 20mg/L • total nitrogen as N, maximum 30mg/L • 5-day biochemical oxygen demand (inhibited) (e.g. release pipe from sewage treatment plant), maximum 20mg/L • suspended solids, maximum 30mg/L • pH, range 6.0 to 8.5 • e-coli, 80th percentile based on at least 5 samples with not less than 30 minutes between samples, 100cfu per 100mL, maximum 1000cfu per 100mL.
secondary treated class B standards	means treated sewage effluent or greywater which meets the following standards: • total phosphorous as P, maximum 20mg/L • total nitrogen as N, maximum 30mg/L • 5-day biochemical oxygen demand (inhibited) (e.g. release pipe from sewage treatment plant), maximum 20mg/L • suspended solids, maximum 30mg/L • pH, range 6.0 to 8.5

Word or Phrase	Definition
	• e-coli, 80th percentile based on at least 5 samples with not less than 30 minutes between samples, 1000cfu per 100mL, maximum 10000cfu per 100mL.
secondary treated class C standards	means treated sewage effluent or greywater which meets the following standards: • total phosphorous as P, maximum 20mg/L • total nitrogen as N, maximum 30mg/L • 5-day biochemical oxygen demand (inhibited) (e.g. Release pipe from sewage treatment plant), maximum 20mg/L • suspended solids, maximum 30mg/L • pH, range 6.0 to 8.5 • e-coli, 80th percentile based on at least 5 samples with not less than 30 minutes between samples, 10 000cfu per 100mL, maximum 100000cfu per 100mL.
sensitive place	means: • a dwelling (including residential allotment, mobile home or caravan park, residential marina or other residential premises, motel, hotel or hostel) • a library, childcare centre, kindergarten, school, university or other educational institution • a medical centre, surgery or hospital • a protected area • a public park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment • a work place used as an office or for business or commercial purposes, which is not part of the petroleum activity(ies) and does not include employees accommodation or public roads • for noise, a place defined as a sensitive receptor for the purposes of the *Environmental Protection (Noise) Policy 2008*.
sensitive receptor	is defined in Schedule 2 of the *Environmental Protection (Noise) Policy 2008*, and means an area or place where noise is measured.
short term noise event	is a noise exposure, when perceived at a sensitive receptor, persists for an aggregate period not greater than eight hours and does not re-occur for a period of at least seven (7) days. Re-occurrence is deemed to apply where a noise of comparable level is observed at the same receptor location for a period of one hour or more, even if it originates from a different source or source location.
significant residual impact	has the meaning in section 8 *Environmental Offsets Act 2014.*

Word or Phrase	Definition
significantly disturbed or significant disturbance or significant disturbance to land or areas	has the meaning in Schedule 12, section 4 of the *Environmental Protection Regulation 2008*. Land is significantly disturbed if— (a) it is contaminated land; or (b) it has been disturbed and human intervention is needed to rehabilitate it— I. to a condition required under the relevant environmental authority; or II. if the environmental authority does not require the land to be rehabilitated to a particular condition—to the condition it was in immediately before the disturbance.
species richness	means the number of different species in a given area.
stable	has the meaning in Schedule 5 of the *Environmental Protection Regulation 2008* and, for a site, means the rehabilitation and restoration of the site is enduring or permanent so that the site is unlikely to collapse, erode or subside.
statement of compliance	for a condition in an environmental authority has the meaning in section 208 of the *Environmental Protection Act 1994* and is a condition that requires the holder to give the administering authority a statement of compliance about a document or work relating to a relevant activity. The condition must also state— (a) the criteria (the compliance criteria) the document or work must comply with; and (b) that the statement of compliance must state whether the document or work complies with the compliance criteria; and (c) the information (the supporting information) that must be provided to the administering authority to demonstrate compliance with the compliance criteria; and (d) when the statement of compliance and supporting information must be given to the administering authority.
stimulation	means a technique used to increase the permeability of natural underground reservoir that is undertaken above the formation pressure and involves the addition of chemicals. It includes hydraulic fracturing / hydrofraccing, fracture acidizing and the use of proppant treatments.
stimulation fluid	means the fluid injected underground to increase permeability. For clarity, the term stimulation fluid only applies to fluid injected down well post-perforation.
stimulation impact zone	means a 100m maximum radial distance from the stimulation target location within a gas producing formation.
strategic environmental area	has the meaning in section 11(1) of the *Regional Planning Interest Act 2014*.
structure	means dam or levee.

Word or Phrase	Definition
subterranean cave GDE	• means an area identified as a subterranean cave in the mapping produced by the Queensland Government and identified in the Queensland Government Information System, as amended from time to time; and • means a cave ecosystem which requires access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain its communities of plants and animals, ecological processes and ecosystem services. Subterranean cave GDEs are caves dependent on the subterranean presence of groundwater. Subterranean cave GDEs have some degree of groundwater connectivity and are indicated by either high moisture levels or the presence of stygofauna, or both, referred to in the Queensland Government WetlandsInfo mapping program, as amended from time to time. *Note: the Subterranean GDE (caves) dataset can be displayed through the Queensland Government WetlandInfo mapping program.* *Note: the Subterranean GDE (caves) dataset can be obtained from the Queensland Government Information System.*
suitably qualified third party	means a person who: (a) has qualifications and experience relevant to performing the function including but not limited to: i. a bachelor's degree in science or engineering; and ii. 3 years' experience in undertaking soil contamination assessments; and (b) is a member of at least one organisation prescribed in Schedule 8 of the *Environmental Protection Regulation 2008*; and not be an employee of, nor have a financial interest or any involvement which would lead to a conflict of interest with the holder(s) of the environmental authority.
sump	means a pit in which waste residual drilling material or drilling fluids are stored only for the duration of drilling activities.
synthetic based drilling mud	means a mud where the base fluid is a synthetic oil, consisting of chemical compounds which are artificially made or synthesised by chemically modifying petroleum components or other raw materials rather than the whole crude oil.
top soil	means the surface (top) layer of a soil profile, which is more fertile, darker in colour, better structured and supports greater biological activity than underlying layers. The surface layer may vary in depth depending on soil forming factors,

Word or Phrase	Definition
	including parent material, location and slope, but generally is not greater than about 300mm in depth from the natural surface.
total density of coarse woody material	means the total length of logs on the ground greater than or equal to 10cm diameter per hectare and number of logs on the ground greater than or equal to 10cm diameter per hectare.
valid complaint	means all complaints unless considered by the administering authority to be frivolous, vexatious or based on mistaken belief.
void	means any constructed, open excavation in the ground.
waste and resource management hierarchy	has the meaning provided in section 9 of the *Waste Reduction and Recycling Act 2011* and is the following precepts, listed in the preferred order in which waste and resource management options should be considered— a) AVOID unnecessary resource consumption b) REDUCE waste generation and disposal c) RE-USE waste resources without further manufacturing d) RECYCLE waste resources to make the same or different products e) RECOVER waste resources, including the recovery of energy f) TREAT waste before disposal, including reducing the hazardous nature of waste g) DISPOSE of waste only if there is no viable alternative.
waste and resource management principles	has the meaning provided in section 4(2)(b) of the *Waste Reduction and Recycling Act 2011* and means the: a) polluter pays principle b) user pays principle c) proximity principle d) product stewardship principle.
waste fluids	has the meaning in section 13 of the Environmental Protection Act 1994 in conjunction with the common meaning of “fluid” which is “a substance which is capable of flowing and offers no permanent resistance to changes of shape”. Accordingly, to be a waste fluid, the waste must be a substance which is capable of flowing and offers no permanent resistance to changes of shape.
watercourse	has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means: a) a river, creek or stream in which water flows permanently or intermittently— i. in a natural channel, whether artificially improved or not; or ii. in an artificial channel that has changed the course of the watercourse. b) Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

Word or Phrase	Definition
waters	includes all or any part of a creek, river, stream, lake, lagoon, swamp, wetland, spring, unconfined surface water, unconfined water in natural or artificial watercourses, bed and bank of any waters, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and underground water.
well integrity	the ability of a well to contain the substances flowing through it.
wetland	for the purpose of this environmental authority, wetland means: • areas shown on the Map of referable wetlands which is a document approved by the chief executive on 4 November 2011 and published by the department, as amended from time to time by the chief executive under section 144D of the *Environmental Protection Regulation 2008*; and • areas defined under the Queensland Wetlands Program as permanent or periodic / intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six (6) metres, and possess one or more of the following attributes: o at least periodically, the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle, or o the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers, or o the substratum is not soil and is saturated with water, or covered by water at some time. The term wetland includes riverine, lacustrine, estuarine, marine and palustrine wetlands; and it does not include a Great Artesian Basin Spring or a subterranean wetland that is a cave or aquifer.
wetland of high ecological significance	means a wetland that meets the definition of a wetland and that is shown as a wetland of 'high ecological significance' or wetland of 'high ecological value' on the Map of referable wetlands.
wetland of other environmental value	means a wetland that meets the definition of a wetland and that is shown as a wetland of 'general environmental significance' or wetland of 'other environmental value' on the Map of referable wetlands.

END OF PERMIT

Australian Government
Department of Agriculture, Water and the Environment

VARIATION OF CONDITIONS ATTACHED TO APPROVAL

Surat Gas Expansion Project (EPBC 2010/5344)

This decision to vary conditions of approval is made under section 143 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

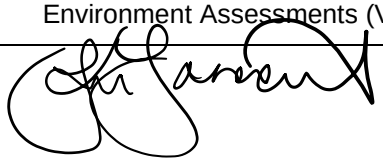
Approved action

Approval holder	Arrow Energy Pty Ltd ABN: 73 078 521 936
Approved action	To expand coal seam gas operations in the Surat Basin, Queensland, as described in the referral received under the EPBC Act on 2 February 2010; and as described in the Surat Gas Project Environmental Impact Statement (March 2012) and Supplementary Report to the Environmental Impact Statement (June 2013).

Variation

Variation of conditions attached to approval	The variation is: Delete conditions 5 and 6 attached to the approval and substitute with conditions 5 and 6 specified in the table below.
Date of effect	This variation has effect on the date the instrument is signed

Person authorised to make decision

Name and position	Kim Farrant Assistant Secretary Environment Assessments (Vic, Tas) and Post Approvals Branch
Signature	
Date of decision	29 March 2022

<table>
<tr><th>Date of decision</th><th>Conditions attached to approval</th></tr>
<tr><td>Original dated 19/12/2013</td><td>1. The Minister may determine that a plan, strategy or program approved by the Queensland Government satisfies a plan required under these conditions.</td></tr>
<tr><td>Original dated 19/12/2013</td><td><u>Disturbance Limits</u>
2. For the purpose of the action, the approval holder must not take any action outside the project area.</td></tr>
<tr><td>Original dated 19/12/2013</td><td>3. The action is limited to a maximum of 6,500 coal seam gas production wells and associated infrastructure.</td></tr>
<tr><td>Original dated 19/12/2013</td><td>4. The approval holder must not undertake hydraulic fracturing.</td></tr>
<tr><td>As varied on the date this instrument was signed</td><td>5. To protect EPBC listed species and EPBC communities within the project area the maximum disturbance limits in Table 1 apply to the project. The approval holder must not exceed these disturbance limits.
Table 1: Whole of project maximum disturbance limits
<table>
<tr><th>Terrestrial species</th><th>Maximum disturbance (hectares) to core habitat</th></tr>
<tr><td>Curly-bark Wattle, Acacia curranii</td><td>1210</td></tr>
<tr><td>Hando’s Wattle, Acacia handonis</td><td>1210</td></tr>
<tr><td>Belson’s Panic, Homopholis belsonii</td><td>140</td></tr>
<tr><td>Prostanthera sp Dunmore</td><td>380</td></tr>
<tr><td>Small-leaved Denhamia, Denhamia parvifolia</td><td>50</td></tr>
<tr><td>Calytrix gurulmundensis</td><td>1210</td></tr>
<tr><td>Ooline, Cadellia pentastylis</td><td>No disturbance</td></tr>
<tr><td>Austral Toadflax, Thesium australe</td><td>160</td></tr>
<tr><td>Acacia lauta</td><td>990</td></tr>
<tr><td>Xerothamnella herbacea</td><td>110</td></tr>
<tr><td>Hawkweed, Picris evae</td><td>120</td></tr>
<tr><td>Austral Cornflower, Rhaponticum australe</td><td>160</td></tr>
<tr><td>Eucalyptus virens</td><td>170</td></tr>
<tr><td>King Blue-grass, Dichanthium queenslandicum</td><td>160</td></tr>
<tr><td>Queensland White-gum, Eucalyptus argophloia</td><td>10</td></tr>
<tr><td>Macrozamia machinii</td><td>No disturbance</td></tr>
<tr><td>South-eastern Long-eared Bat, Nyctophilus corbeni</td><td>4 080</td></tr>
<tr><td>Dunmall’s Snake, Furina dunmalli</td><td>4 400</td></tr>
<tr><td>Five-clawed Worm-skink, Anomalopus mackayi</td><td>560</td></tr>
<tr><td>Squatter Pigeon (Southern), Geophaps scripta scripta</td><td>3261</td></tr>
<tr><td>Regent Honeyeater, Anthochaera phrygia</td><td>20</td></tr>
<tr><td>Collared Delma, Delma torquata</td><td>90</td></tr>
<tr><td>Yakka Skink, Egernia rugosa</td><td>310</td></tr>
<tr><td>Australian Painted Snipe, Rostratula australis</td><td>5</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Date of decision</th><th>Conditions attached to approval</th></tr>
<tr><td></td><td>
<table>
<tr><th>EPBC Communities</th><th>Maximum disturbance (hectares)</th></tr>
<tr><td>Brigalow (Acacia harpophylla dominant and co-dominant)</td><td>106</td></tr>
<tr><td>Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions</td><td>8</td></tr>
<tr><td>Weeping Myall Woodlands</td><td>1</td></tr>
<tr><td>Natural Grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland</td><td>No disturbance</td></tr>
<tr><td>White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland</td><td>No disturbance</td></tr>
<tr><td>Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions</td><td>No disturbance</td></tr>
</table>
</td></tr>
<tr><td>As varied on the date this instrument was signed</td><td>6. To protect EPBC listed species and communities within the project area the maximum disturbance limits in Table 2 apply to Stage 1. The approval holder must not exceed these disturbance limits.

Table 2: Maximum disturbance limits for Stage 1
<table>
<tr><th>Terrestrial species</th><th>Maximum disturbance (hectares) to core habitat</th></tr>
<tr><td>South-eastern Long-eared Bat, Nyctophilus corbeni</td><td>225</td></tr>
<tr><td>Dunmall’s Snake, Furina dunmalli</td><td>300</td></tr>
<tr><td>Five-clawed Worm-skink, Anomalopus mackayi</td><td>2</td></tr>
<tr><td>Squatter Pigeon (Southern), Geophaps scripta scripta</td><td>203</td></tr>
<tr><td>Regent Honeyeater, Anthochaera phrygia</td><td>1</td></tr>
<tr><td>Collared Delma, Delma torquata</td><td>11</td></tr>
<tr><td>Yakka Skink, Egernia rugosa</td><td>19</td></tr>
<tr><th>EPBC Communities</th><th>Maximum disturbance (hectares)</th></tr>
<tr><td>Brigalow (Acacia harpophylla dominant and co-dominant)</td><td>39</td></tr>
<tr><td>Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions</td><td>8</td></tr>
</table>
</td></tr>
<tr><td>Variation dated 31/10/2018</td><td>7. Revoked</td></tr>
<tr><td>Variation dated 31/10/2018</td><td>7A. Prior to the commencement of Stage 1, the approval holder must prepare and submit an EPBC Species Impact Management Plan for the Minister’s written approval. The EPBC Species Impact Management Plan must include:

a. measures that will be taken to avoid, mitigate and manage impacts to EPBC listed threatened species and their habitat during clearance of vegetation, including the involvement of a suitably qualified ecologist at all times during clearance of vegetation;</td></tr>
</table>

Date of decision	Conditions attached to approval
	b. measures that will be taken to avoid and mitigate impacts to **EPBC listed threatened species** and their habitat and to **EPBC communities** during construction, operation and decommissioning of the action; c. a monitoring program to determine the success of impacts avoidance and mitigation measures and that will inform adaptive implementation of the action for the duration of this approval; and d. a description of how measures proposed in the EPBC Species Impact Management Plan are consistent with the measures in relevant **conservation advice, recovery plans** and **threat abatement plans**.
Variation dated 31/10/2018	7B. The approval holder must not **commence Stage 1** until an EPBC Species Impact Management Plan has been approved by the **Minister** in writing. The approved EPBC Species Impact Management Plan must be implemented by the **approval holder**.
Variation dated 31/10/2018	8. Revoked
Variation dated 31/10/2018	**Offsets** 8A. If the **approval holder** has provided an offset in respect of **impacts** predicted for a **development stage** of the project which subsequently are not realised, such parts of the offset in excess of the obligation for that **development stage** can be applied towards offsets required for the **impacts** of subsequent **development stages**.
Variation dated 31/10/2018	8B. The Offset Strategy may be prepared and submitted to the **Minister** for approval in stages. Each stage of the Offset Strategy must provide information in respect of the subsequent **development stage** to commence and all earlier **development stages**. A **development stage** must not **commence** until an Offsets Strategy addressing offset obligations for that **development stage** has been approved by the **Minister**.
Variation dated 31/10/2018	8C. The Offset Strategy must: a. include a strategy to secure the offsets proposed for the residual significant **impacts** to the **EPBC listed species** and **EPBC communities** for the subsequent **development stage;** b. include a map of the location of each **EPBC listed threatened species** and its habitat and **EPBC community** in relation to infrastructure for the subsequent **development stage**; c. describe potential risks to the successful implementation of the Offset Strategy, and the contingency measures that would be implemented to mitigate against these risks; d. detail how the **approval holder** will address any residual significant impacts to any **EPBC listed threatened species** and its habitat and/or **EPBC communities** not identified in Table 1, in accordance with the **EPBC Act Offsets Policy;** and e. specify the proposed legal mechanism and timeframe for securing the offset(s).
Variation dated 31/10/2018	8D. The **approval holder** must not **commence** the action until the Offset Strategy for **Stage 1** has been approved by the **Minister** in writing. The approved Offset Strategy must be implemented by the **approval holder**.
Variation dated 31/10/2018	9. Revoked

Date of decision	Conditions attached to approval
Variation dated 31/10/2018	9A. At least 3 months prior to the **commencement** of any **development stage** after **Stage** 1, the **approval holder** must submit a revised Offset Strategy for approval by the **Minister**. The updated Offset Strategy must include: a. a strategy to secure the minimum offsets proposed for the residual significant **impacts** to the **EPBC listed species** and **EPBC communities** for the subsequent **development stage**; b. a map of the location of each **EPBC listed threatened species** and its habitat and **EPBC community** in relation to infrastructure for the subsequent **development stage**; c. the information required for the Offset Strategy at conditions 8Ca to 8Ce for the subsequent **development stage**; d. demonstration of how any proposed offset builds on offsets already secured and will contribute to a larger strategic offset for whole of project **impacts**; e. performance and completion criteria for evaluating the management of offset areas. f. reconciliation of **impacts** predicted in the subsequent **development stage** and actual disturbance in preceding **development stages** against the maximum disturbance limits set out in Table 1.
Variation dated 31/10/2018	10. Revoked
Variation dated 31/10/2018	10A. Offsets for **development stages** must be provided in accordance with the mechanism identified in the approved Offset Strategy and must be registered and legally secured in accordance with Queensland legislation prior to **commencement** of any subsequent **development stage.**
Variation dated 31/10/2018	10B. Within 12 months of project commencement or the **Minister** approving the Offset Strategy for a subsequent **development stage**, the **approval holder** must submit for the approval of the **Minister** an Offset Area Management Plan which includes: a. a description of the management measures that will be implemented to protect of **EPBC listed threatened species** and **EPBC communities** in each offset area, b. details of how the proposed offset/s and Offset Area Management Plan are consistent with the principles of the **EPBC Act Offsets Policy**; c. a field validation survey and baseline description of the current condition (prior to any management activities) of the offset area/s, including existing vegetation; d. a description and map (including **shapefile/s**) to clearly define the location and boundaries of the offset area/s, accompanied by the **offset attributes**; e. information about how the offset area/s provide connectivity with other relevant habitats and biodiversity corridors including a map depicting the offset areas in relation to other habitats and biodiversity corridors; f. details of how proposed management measures take into account relevant **approved conservation advices** and are consistent with the measures contained in relevant **recovery plans** and **threat abatement plans**;

Date of decision	Conditions attached to approval
	g. completion criteria and performance targets for evaluating the effectiveness of Offset Area Management Plan implementation, and criteria for triggering corrective actions (if necessary); h. a program to monitor, report on and review the effectiveness of the Offset Area Management Plan; i. a description of potential risks to the successful implementation of the offset/s and Offset Area Management Plan, and contingency measures that would be implemented to mitigate against these risks.
Variation dated 31/10/2018	11. Revoked
Variation dated 31/10/2018	11A. The **approval holder** must not commence the subsequent **development stage** until the Offset Area Management Plan for the current **development stage** has been approved in writing by the **Minister**.
Variation dated 29/3/2017	12. Revoked
Variation dated 31/10/2018	12A. Revoked
Variation dated 31/10/2018	12B. Revoked
Variation dated 31/10/2018	12C. Revoked
Original dated 19/12/2013	*Note 1: The Minister may determine that a plan, strategy or program approved by the Queensland Government satisfies the requirements for the EPBC Species Impact Management and Offset Plan under these conditions.*
Original dated 19/12/2013	*Note 2: Offsets for some species may be accommodated within ecological communities or overlap State approval requirements or other species habitat requirements, as long as they meet the requirements of these conditions of approval in respect of each individual species being offset.*
Original dated 19/12/2013	**Coal Seam Gas Water Monitoring and Management Plan** *Stage 1 CSG Water Monitoring and Management Plan* 13. Prior to **commencement**, the proponent must submit a Stage 1 Coal Seam Gas Water Monitoring and Management Plan (Stage 1 CSG WMMP) for the approval of the **Minister,** who may seek the advice of an **expert panel**. The Stage 1 CSG WMMP must include: a. an analysis of the results of the most recent **OGIA model** (built or endorsed by **OGIA**), relevant to all of the project's tenement areas; b. a fit for purpose numerical simulation to assess potential impacts on water resources arising from the action in the project area, subsequent surface water-groundwater interactions in the Condamine Alluvium and impacts to dependent ecosystems; c. an assessment of potential **impacts** from the action on non-spring based groundwater dependent ecosystems through potential changes to surface-groundwater connectivity and interactions with the sub-surface expression of groundwater; d. an assessment of predicted project wide groundwater drawdown levels and pressures from the action, together with confidence levels;

Date of decision	Conditions attached to approval
	e. parameters and a sampling regime to establish baseline data for surface and groundwater resources that may be impacted by the action, including: surface water quality and quantity in the **project area**, and upstream and downstream of potential impact areas; groundwater quality, levels and pressures for areas that may be **impacted** by the project; and for determining connectivity between surface water and groundwater that may be **impacted** by the project; f. a best practice baseline monitoring network that will enable the identification of spatial and temporal changes to surface water and groundwater. This must include a proposal for aquifer connectivity studies and monitoring of relevant aquifers to determine hydraulic connectivity (including potential groundwater dependence of Long Swamp and Lake Broadwater) and must also enable monitoring of all aquatic ecosystems that may be **impacted** by the action; g. a program to monitor subsidence **impacts** from the action, including trigger thresholds and reporting of monitoring results in annual reporting required by condition 28. If trigger thresholds are exceeded, the **approval holder** must develop and implement an action plan to address impacts within 90 calendar days of a trigger threshold being exceeded; h. provisions to make monitoring results publicly available on the **approval holder's** website to facilitate a greater understanding of cumulative **impacts**; i. a discussion on how the **approval holder** is contributing to the **Joint Industry Plan,** including its periodic review. The **approval holder** must contribute to the **Joint Industry Plan** and comply with any part of the **Joint Industry Plan**, or future iterations of the **Joint Industry Plan**, that applies to the **approval holder**; j. a groundwater early warning monitoring system, including: i. groundwater drawdown limits for all consolidated aquifers potentially impacted by the action, excluding the Walloon Coal Measures; ii. for the Condamine Alluvium, appropriate triggers and groundwater limits and a rationale for their selection; iii. early warning indicators and trigger thresholds, including for Lake Broadwater, Long Swamp and other groundwater dependent ecosystems that may potentially be impacted by the action, including those that may occur outside the project area and may be impacted by the action; and iv. investigation, management and mitigation actions, including substitution and/or groundwater repressurisation, for both early warning indicators and trigger thresholds to address flux impacts on the Condamine Alluvium. k. early warning indicators and trigger thresholds, including corrective actions for both early warning indicators and trigger thresholds, for aquatic ecology and aquatic ecosystems; l. a CSG water management strategy for produced salt/brine, which discusses how co-produced water and brine will be managed for the action, including in the context of other coal seam gas activities in the Surat Basin; m. an analysis of how the **approval holder** will utilise beneficial use and/or groundwater repressurisation techniques to manage produced CSG water from the action, and how any potential adverse **impacts** associated with groundwater repressurisation will be managed;

Date of decision	Conditions attached to approval
	n. a discharge strategy, consistent with the recommendations and requirements of the Department of the Environment and Heritage Protection in its **Assessment Report** (pages 94 to 95 and pages 254 to 255) and that includes scenarios where discharge may be required, the quality of discharge water (including water treated by reverse osmosis), the number and location of monitoring sites (including upstream and downstream sites), frequency of monitoring and how the data from monitoring will be analysed and reported, including recommendations on any changes or remedial actions that would be required; o. a flood risk assessment for processing facilities and any raw co-produced water and brine dams, which addresses flood risks to the environment from the action in the case of a 1:1000 ARI event. The risk assessment should estimate the consequences if major project infrastructure was subject to such an event, including release of brine and chemicals into the environment; p. a cumulative **impact** assessment based on the outputs of the **OGIA model** which integrates groundwater model outputs with known and potential groundwater dependent ecosystems and presents the outputs in map form. Contribute to investigations coordinated through the OGIA to assess hydrological and ecological characteristics of **impacted** groundwater dependent ecosystems; q. details of performance measures; annual reporting to the **Department**; and publication of reports on the internet; and r. an explanation of how the Stage 1 CSG WMMP will contribute to work undertaken by other CSG proponents in the Surat Basin to understand cumulative **impacts**, including at the local and regional scale, and maximise environmental benefit.
Original dated 19/12/2013	14. The Stage 1 CSG WMMP must be peer reviewed by a **suitably qualified water resources expert/s** approved by the **Minister** in writing. The peer review must be submitted to the **Minister** together with the Stage 1 CSG WMMP and a statement from the **suitably qualified water resources expert/s** stating that they carried out the peer review and endorse the findings of the Stage 1 CSG WMMP.
Original dated 19/12/2013	15. The **approval holder** must not exceed the groundwater drawdown or groundwater limits for each aquifer specified in the Stage 1 CSG WMMP.
Original dated 19/12/2013	16. Unless otherwise agreed in writing by the **Minister**, the **approval holder** must not **commence** the action until the Stage 1 CSG WMMP is approved in writing by the **Minister**. The approved Stage 1 CSG WMMP must be implemented.
Original dated 19/12/2013	*Note 3: to ensure efficiency the approval holder may prepare and align the Stage 1 WMMP with the requirements of the Queensland Government, as long as the relevant matters under the conditions of this approval are clearly and adequately addressed.*
Variation dated 2/7/2019	*Updated CSG Water Monitoring and Management Plan* 17. The **approval holder** must submit an updated CSG Water Monitoring and Management Plan (Updated CSG WMMP) for the written approval of the **Minister**. The Updated CSG WMMP must: a. include all matters in the Stage 1 CSG WMMP, and discuss how the Stage 1 CSG WMMP is informing adaptive management for the Updated CSG WMMP; b. include any updated modelling for the project, including in respect of the **OGIA model** or any updates to the **OGIA model** by **OGIA**;

Date of decision	Conditions attached to approval
	c. include an explanation of how the **approval holder** will contribute to the **Condamine Interconnectivity Research Project**. The Updated CSG WMMP must present the findings of the Condamine Interconnectivity Research project and any modelling done by the **OGIA** to validate predicted drawdown and a review of trigger thresholds and corrective activities for the action; d. report on the potential for flow reversal from the Condamine Alluvium to underlying aquifers, based on data obtained during the Stage 1 CSG WMMP; e. review and update the monitoring network in Stage 1 WMMP to reflect changes in understanding of **impacts** to water resources, including from baseline monitoring and relevant research; f. identify any predicted changes in stream connectivity due to groundwater drawdown from the action and assess potential impacts to groundwater dependent ecosystems due to any predicted changes in stream connectivity, including to water quality, quantity and ecology; g. address any uncertainty in the groundwater-dependency of ecosystems and springs with supporting evidence from field-based investigations for any groundwater-dependent ecosystems and springs confirmed in the **OGIA model**; h. provide details of an ongoing monitoring plan that: i. sets out the frequency of monitoring and rationale for the frequency; ii. includes continued collection of baseline data for each monitoring site over the life of the project; iii. outlines the approach to be taken to analyse the results including the methods to determine trends to indicate potential impacts; and iv. builds on the groundwater early warning system required at condition 13 (j) and sets out early warning indicators and trigger thresholds and limits for groundwater and surface water. i. include a risk based exceedance response plan that details the corrective activities the **approval holder** will take and the timeframes in which those activities will be undertaken if: early warning indicators and trigger threshold values contained in the Updated CSG WMMP are exceeded, or there are any emergency discharges.
Variation dated 2/7/2019	18. The Updated CSG WMMP must be peer reviewed by a **suitably qualified water resources expert/s** approved by the **Minister** in writing prior to the plan being submitted to the **Minister** for approval. The **approval holder** must, at the same time as the Updated CSG WMMP is submitted for approval, provide to the **Minister**: a. a copy of the peer review; and b. a statement from the **suitably qualified water resources expert/s** stating that they carried out the peer review and endorse the findings of the Updated CSG WMMP.
Variation dated 2/7/2019	19. The **approval holder** must not exceed the groundwater drawdown or groundwater limits specified in the approved Updated CSG WMMP.
Variation dated 2/7/2019	20. The **Minister** may direct, in writing, that the **approval holder** cease water or gas extraction from one or more coal seam gas production wells, or water discharge or use, if:

Date of decision	Conditions attached to approval
	a. an early warning indicator, trigger threshold or limit is exceeded, and b. the **Minister** is not satisfied that the corrective activities proposed or taken by the approval holder will reduce likely impacts on **matters of national environmental significance** (**MNES**) to acceptable levels.
Variation dated 2/7/2019	20A. If condition 20 applies, the **Minister** may direct the **approval holder** to implement alternative corrective activities at the expense of the **approval holder,** provided those corrective activities are unlikely to have a significant impact on **MNES**.
Variation dated 2/7/2019	20B. If condition 20 applies, the **approval holder** must not recommence such extraction or discharge or use until the **Minister** has given approval in writing for the recommencement of that extraction, discharge or use. a. Approval to recommence such extraction, discharge or use may be subject to such conditions as the **Minister** considers reasonably necessary to ensure that impacts on **MNES** will be acceptable. b. If the **Minister** approves the recommencement of extraction, discharge or use subject to conditions, the **approval holder** must comply with such conditions.
Variation dated 2/7/2019	*Note 4: The proponent will be provided with a reasonable opportunity to comment on any such direction from the **Minister** before it is required to be implemented.*
Variation dated 2/7/2019	21. The **approval holder** must not commence the extraction of gas from any coal seam gas production wells unless the Updated CSG WMMP has been approved by the **Minister** in writing. The approved Updated CSG WMMP must be implemented. The Stage 1 CSG WMMP will apply until the commencement of the approved Updated CSG WMMP.
Variation dated 2/7/2019	21A. If the **Minister** has approved the Updated CSG WMMP, the **approval holder** may commence extraction of gas from: a. 250 coal seam gas production wells b. a larger number of coal seam gas production wells as specified by the **Minister** if he or she is satisfied that: i. the **approval holder** has commenced gas extraction from at least 125 coal seam gas production wells; ii. the **approval holder** has requested an increase in the number of wells from which gas can be extracted under the approved Updated CSG WMMP; and iii. extraction of gas from the additional number of coal seam gas production wells will not have an unacceptable impact on **MNES**.
Variation dated 2/7/2019	*Note 5: to ensure efficiency the approval holder may prepare and align the Updated CSG WMMP with the requirements of the Queensland Government, as long as the relevant matters under the conditions of this approval are clearly and adequately addressed.* *Note 5A: The number of additional coal seam gas production wells requested under condition 21A(b) will be at least 200.*
Variation dated 2/7/2019	22. Revoked
Variation dated 2/7/2019	23. If the **OGIA model** ceases to exist, the **approval holder** must:

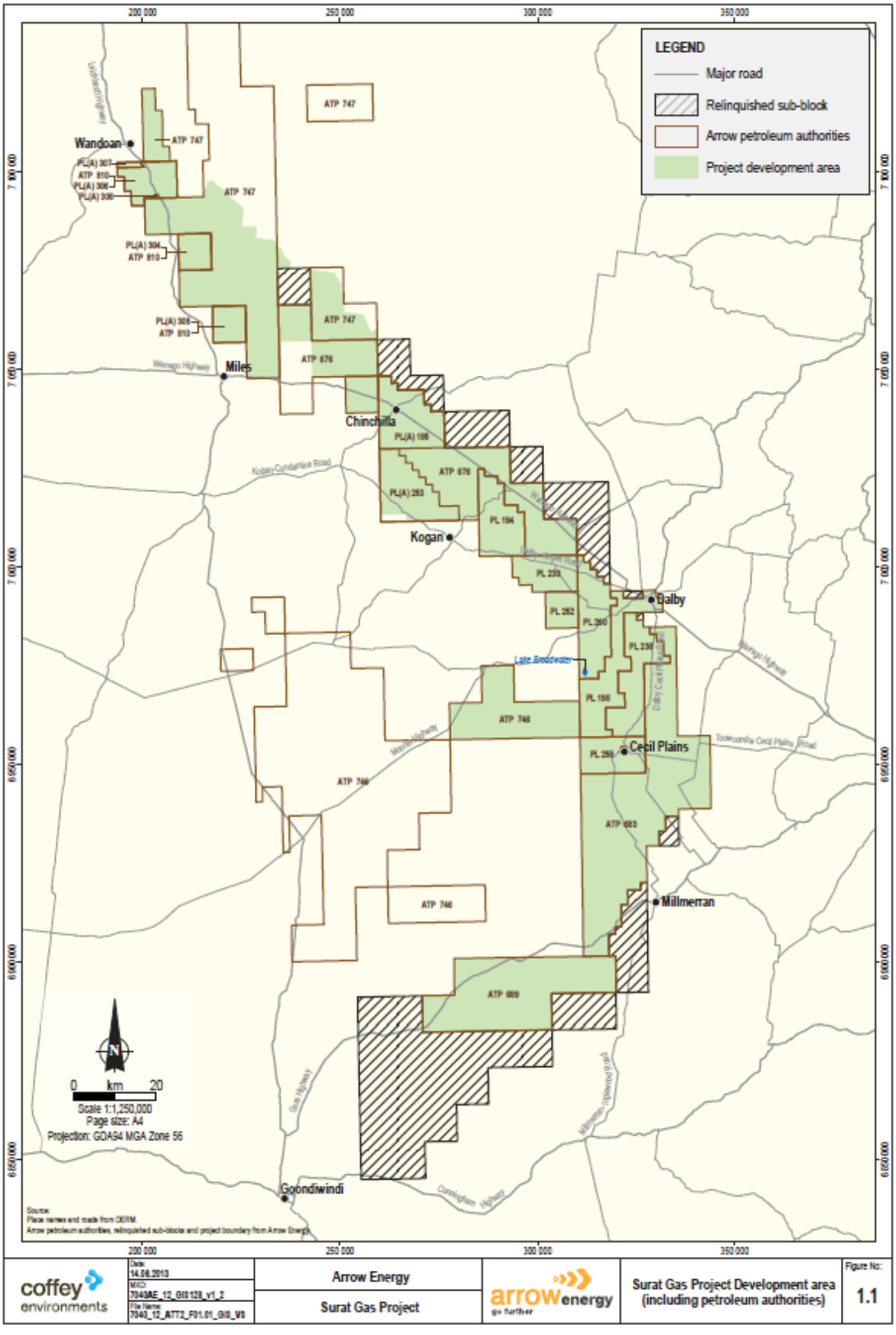
Date of decision	Conditions attached to approval
	a. submit an alternate model that replaces the **OGIA model** for the approval of the **Minister**; b. revise the Updated CSG WMMP to incorporate the approved alternate model, and submit the revised plan to the **Minister** for approval; and c. implement the approved revised plan.
Variation dated 2/7/2019	24. Revoked
Variation dated 2/7/2019	25. The **Minister** may, by written request to the **approval holder**, require the Stage 1 CSG WMMP or the Updated CSG WMMP to be revised, including to address expert advice. Any request must be acted on by the **approval holder** within the timeframe specified in the request.
Variation dated 2/7/2019	*Note 6: The Minister may throughout the life of the project life seek advice from experts, or an expert panel. As a consequence specific matters identified through such advice may need to be addressed in the CSG WMMP. Where such advice is sought the approval holder would be provided with opportunity to submit information and respond to the specific matters identified, in order to ensure the CSG WMMP is based on the best available information. Review requirements will facilitate adaptive management, align with Queensland Government approval requirements, and account for potential cumulative impacts as new scientific information becomes available over the life of the project.*
Original dated 19/12/2013	**General** 26. Within 20 business days after the **commencement** of the action, the **approval holder** must advise the **Department** in writing of the actual date of **commencement.**
Original dated 19/12/2013	27. The **approval holder** must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement the management plans, reports or strategies required by this approval, and make them available upon request to the **Department**. The annual report (condition 28) must state all confirmed cases of non-compliance along with details of any remedial actions. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act,** or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.
Original dated 19/12/2013	28. Within three months of every 12 month anniversary of the **commencement** of the action, the **approval holder** must publish a report on its website for the life of the approval outlining how they have been compliant with the conditions of this approval over the previous 12 months, including implementation of any management plans as specified in the conditions. The **approval holder** must also report against disturbance limits. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published.
Variation dated 2/7/2019	29. The **approval holder** must notify the **Department** in writing of potential non-compliance with any condition of this approval as soon as practical and within no later than ten business days of becoming aware of the potential non-compliance. The notice provided to the **Department** under this condition must specify: a. the condition which the **approval holder** has potentially breached; b. the nature of the potential non-compliance;

Date of decision	Conditions attached to approval
	c. when and how the **approval holder** became aware of the non-compliance; d. how the non-compliance will affect the approved action; e. how the non-compliance will affect the anticipated **impacts** of the approved action, in particular how the non-compliance will affect the **impacts** on the **MNES**; f. the measures the approval holder will take to address the **impacts** of the non-compliance on the **MNES** and rectify the non-compliance; and g. the time by when the approval holder will rectify the non-compliance.
Original dated 19/12/2013	30. Upon the direction of the **Minister**, the **approval holder** must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister.**
Original dated 19/12/2013	31. If the **approval holder** wishes to carry out any activity other than in accordance with the management plans as specified in the conditions**,** the **approval holder** must submit to the **Department** for the **Minister's** written approval a revised version of that management plan. The approval holder must not **commence** the varied activity until the **Minister** has approved the varied management plan. The **Minister** will not approve a varied management plan unless the revised management plan would result in an equivalent or improved environmental outcome over time. If the **Minister** approves the revised management plan, that management plan must be implemented in place of the management plan originally approved.
Original dated 19/12/2013	32. If the **Minister** believes that it is necessary or convenient for the better protection of listed threatened species, listed migratory species or water resources to do so, the **Minister** may request that the **approval holder** make specified revisions to the management plans specified in the conditions and submit the revised management plan for the **Minister's** written approval. The **approval holder** must comply with any such request within the timeframe specified by the **Minister**. The revised approved management plan must be implemented. Unless the **Minister** has approved the revised management plan, then the person taking the action must continue to implement the management plan originally approved, as specified in the conditions.
Variation dated 29/5/2018	33. If at any time after seven years from the date of this approval, the **approval holder** has not commenced the action, then the **approval holder** must not **commence** the action without the written agreement of the **Minister**.
Original dated 19/12/2013	34. Unless otherwise agreed to in writing by the **Minister**, the **approval holder** must publish all management plans referred to in these conditions of approval on their website. Each management plan must be published on the website within 1 month of being approved and remain available on that website for the life of the approval.

Date of decision	Definitions attached to approval
Original dated 19/12/2013	**Approval holder:** means the person to whom the approval is granted.
Original dated 19/12/2013	**Assessment Report:** means the Queensland Department of Environment and Heritage Protection's report under the *Environmental Protection and Biodiversity Conservation Act 1994* for the action.
Variation dated 29/3/2017	**Commence/commencement:** means any physical disturbance, including clearance of native vegetation, new road work and the establishment of well sites to develop the gas field project area. Commencement does not include: a. minor physical disturbance necessary to undertake pre-clearance surveys or establish monitoring programs or geotechnical investigations; or b. activities that are critical to commencement that are associated with mobilisation of plant and equipment, materials, machinery and personnel prior to the start of development only if such activities will have no adverse impact on matters of national environmental significance, and only if the proponent has notified the Department in writing before an activity is undertaken.
Original dated 19/12/2013	**Core habitat:** means core habitat known and core habitat possible as defined in the rules for habitat mapping for each individual species in the *Supplementary Report to the Surat Gas Project EIS (March 2012), Attachment 1 – Matters of National Environmental Significance.*
Original dated 19/12/2013	**Conservation advice:** means an approved conservation advice under the EPBC Act for an EPBC Act listed species or community.
Original dated 19/12/2013	**Core habitat known:** means habitat where a spatially accurate confirmed record of a particular species exists (e.g. Herbrecs or survey record). Core habitat known is attributed to the particular habitat polygon in which it occurs, based on either regional ecosystem (RE) mapping provided by the Queensland Department of Environment and Heritage Protection (or successor agency) or high resolution habitat mapping developed for a specific purpose. Core habitat known also means a 1 km buffer around all spatially accurate (< 400 metres accuracy) species records.
Original dated 19/12/2013	**Condamine Interconnectivity Research Project:** means the Condamine Interconnectivity Research Project being undertaken by the Queensland Office of Groundwater Impact Assessment as part of the implementation of the Surat Underground Water Impact Report (UWIR), which was prepared by the Queensland Water Commission (QWC) in 2012.
Original dated 19/12/2013	**Core habitat possible:** means an area where previous records of a particular species are not known to occur within a given area or habitat, although specific habitat features are present which are known to be favoured by the species and the habitat occurs within the species known geographic range.
Original dated 19/12/2013	**Department**: means the Australian Government Department administering the *Environment Protection and Biodiversity Conservation Act 1999*.
Original dated 19/12/2013	**Department's survey guidelines:** means: Matters of National Environmental Significance, Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999 - http://www.environment.gov.au/epbc/publications/nes-guidelines.html. Survey Guidelines for Australia's Threatened Frogs, Threatened Birds, Threatened Fish, Threatened Mammals, Threatened Reptiles and Threatened Bats: http://www.environment.gov.au/epbc/guidelines-policies.html.
Variation dated 29/3/2017	**Development stage:** means Stage 1, Stage 2, Stage 3 or Stage 4 of project development, as defined in these conditions.
Original dated 19/12/2013	**EPBC/ EPBC Act:** means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

Date of decision	Definitions attached to approval
Original dated 19/12/2013	**EPBC Act Offsets Policy:** means the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (October 2012) including the Offsets Assessment Guide.
Original dated 19/12/2013	**EPBC community:** means an endangered ecological community listed under the EPBC Act.
Original dated 19/12/2013	**EPBC listed threatened species:** means a threatened flora or fauna species listed under the EPBC Act.
Original dated 19/12/2013	**Expert panel:** means an expert panel appointed by the Minister.
Original dated 19/12/2013	**Fitzroy River Turtle:** means the Fitzroy River Turtle, *Rheodytes leukops*, listed as vulnerable under the EPBC Act.
Original dated 19/12/2013	**General habitat:** means where a species has not been recorded in a given location and habitat accounts for some of the features favoured by a particular species. The habitat occurs on the margins of a species known geographic range. Otherwise, the habitat is suitable for the species
Variation dated 29/3/2017	**Impact/s:** has the definition assigned to it in section 527E of the **EPBC Act**.
Original dated 19/12/2013	**Joint Industry Plan:** means the *Joint Industry Plan for an Early Warning System for the Monitoring and Protection of EPBC Springs* established with other coal seam gas proponents operating within the Surat Cumulative Management Area.
Variation dated 2/7/2019	**Matters of National Environmental Significance (MNES):** means matters protected by a provision of Part 3 for which the approval has effect.
Original dated 19/12/2013	**Minister:** means the Minister administering the *Environment Protection and Biodiversity Conservation Act 1999* and includes a delegate of the Minister.
Original dated 19/12/2013	**Murray Cod:** means the Murray Cod, *Maccullochella peelii*, listed as vulnerable under the EPBC Act.
Variation dated 31/10/2018	**Offset attributes** means the offset title, status, EPBC referral number, land parcel details and relevant protected matters.
Original dated 19/12/2013	**OGIA:** means the Office of Groundwater Impact Assessment or its successor body
Original dated 19/12/2013	**Pre-clearance surveys:** means surveys that are undertaken for EPBC species and EPBC communities for all areas of the project area that may be disturbed by project activities.
Original dated 19/12/2013	**Project area:** means the area identified as the project area in Attachment A.
Variation dated 29/3/2017	**Recovery plan/s:** means an approved recovery plan under the **EPBC Act** for an **EPBC listed species** or **EPBC community**.
Variation dated 31/10/2018	**Shapefile** means an ESRI Shapefile containing '.shp, '.shx' and '.dbf' files and other files capturing attributes including the shape, the EPBC Act reference. ID number and EPBC Act protected matters present at the relevant site. Shapefile files must also include either a '.prj' file or specification of the projection/geographic coordinate system used.
Original dated 19/12/2013	**Stage 1:** means year 1 to 3 (inclusive) of the action, starting at the date of commencement.
Original dated 19/12/2013	**Stage 2:** means year 4 to 11 (inclusive) of the action.
Original dated 19/12/2013	**Stage 3:** means year 12 to 20 (inclusive) of the action
Original dated 19/12/2013	**Stage 4:** means year 21 to decommissioning (inclusive) of the action

Date of decision	Definitions attached to approval
Original dated 19/12/2013	**Suitably qualified ecologist:** means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis to performance relative to the subject matter using relevant protocols, standards, methods and literature.
Original dated 19/12/2013	**Suitably qualified water resources expert/s**: means a natural person with at least a postgraduate degree (or equivalent) in a suitable area (such as hydrology or hydrogeology) and a minimum of 10 years relevant experience in water resources assessment, including at least one year of experience in Australia.
Variation dated 29/3/2017	**Threat abatement plan/s:** means an approved threat abatement plan under the **EPBC Act**.

Date of decision	Attachment A
Original dated 19/12/2013	

Appendix 2: Title Searches

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**16558189**	**Search Date:**	06/04/2022 12:29
Date Title Created:	10/01/1984	**Request No:**	40694307
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:**	06/04/2022 12:29
Date Title Created:	18/01/1991	**Request No:**	40694303
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:**	06/04/2022 12:29
Date State Tenure Created:	21/10/1995	**Request No:**	40694300
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:**	06/04/2022 12:29
Date Title Created:	24/01/1977	**Request No:**	40694308
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:**	06/04/2022 12:32
Date Title Created:	30/06/1999	**Request No:**	40694353
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:**	06/04/2022 12:29
Date Title Created:	10/05/1971	**Request No:**	40694299
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: 721451218 02/02/2022

WARAKIRRI ASSET MANAGEMENT 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)

2. MORTGAGE No 721475986 14/02/2022 at 10:53
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:	**15689193**	**Search Date:**	06/04/2022 12:32
Date Title Created:	16/09/1977	**Request No:**	40694354
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:**	06/04/2022 12:32
Date Title Created:	30/06/1999	**Request No:**	40694355
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:**	06/04/2022 12:29
Date Title Created:	03/11/2006	**Request No:**	40694302
Previous Title:	40052662		

ESTATE AND LAND

Estate in Fee Simple

LOT 12 SURVEY PLAN 193328
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 721451218 02/02/2022

WARAKIRRI ASSET MANAGEMENT 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)

2. MORTGAGE No 721475986 14/02/2022 at 10:53
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:	**13047163**	**Search Date:**	06/04/2022 12:29
Date Title Created:	08/08/1957	**Request No:**	40694305
Previous Title:	11192119		

ESTATE AND LAND

Estate in Fee Simple

LOT 36 CROWN PLAN DY45
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 721451224 02/02/2022

WARAKIRRI ASSET MANAGEMENT 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)

2. MORTGAGE No 721475986 14/02/2022 at 10:53
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:	**50634411**	**Search Date:**	06/04/2022 12:29
Date Title Created:	03/11/2006	**Request No:**	40694304
Previous Title:	40052661		

ESTATE AND LAND

Estate in Fee Simple

LOT 57 SURVEY PLAN 193329
Local Government: WESTERN DOWNS

REGISTERED OWNER

Dealing No: 721451224 02/02/2022

WARAKIRRI ASSET MANAGEMENT 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)

2. MORTGAGE No 721475986 14/02/2022 at 10:53
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:	**13883004**	**Search Date:**	06/04/2022 12:29
Date Title Created:	18/05/1966	**Request No:**	40694306
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:**	06/04/2022 12:29
Date Title Created:	08/09/1983	**Request No:**	40694301
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

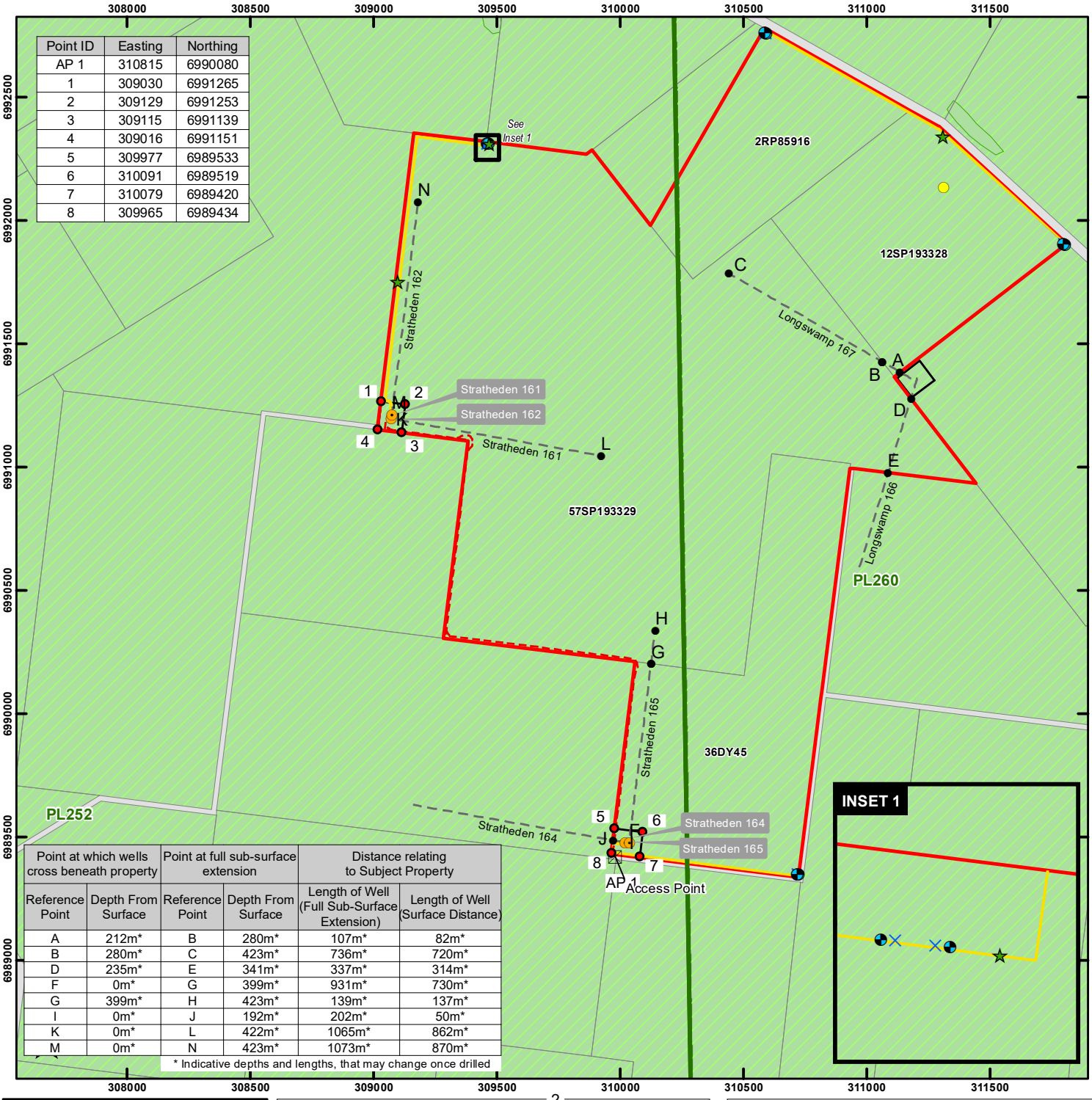
Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

Requested by: D-ENQ CITEC CONFIRM

Appendix 3: Land Parcel and Property Details

CCA Map

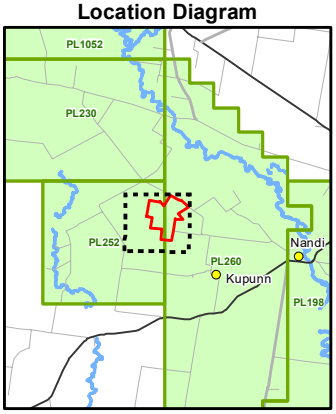


Point ID	Easting	Northing
AP 1	310815	6990080
1	309030	6991265
2	309129	6991253
3	309115	6991139
4	309016	6991151
5	309977	6989533
6	310091	6989519
7	310079	6989420
8	309965	6989434

Point at which wells cross beneath property		Point at full sub-surface extension		Distance relating to Subject Property	
Reference Point	Depth From Surface	Reference Point	Depth From Surface	Length of Well (Full Sub-Surface Extension)	Length of Well (Surface Distance)
A	212m*	B	280m*	107m*	82m*
B	280m*	C	423m*	736m*	720m*
D	235m*	E	341m*	337m*	314m*
F	0m*	G	399m*	931m*	730m*
G	399m*	H	423m*	139m*	137m*
I	0m*	J	192m*	202m*	50m*
K	0m*	L	422m*	1065m*	862m*
M	0m*	N	423m*	1073m*	870m*

* Indicative depths and lengths, that may change once drilled

Location Diagram



2

Tenement: PL252, PL260

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

Well/s: Longswamp 166, Longswamp 167, Stratheden 161, Stratheden 162, Stratheden 164 & Stratheden 165

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

- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- HPV
- Tie-in
- Proposed RoW – 23m wide
- Well Path
- Access Track
- Well Area
- Subject Property
- Property Boundary
- Strategic Cropping Area
- Priority Agricultural Area
- PL (Arrow)

Rev	Date	Revision Description	Drn	Chk	Eng	QA	Appr
5	07/07/2022	Issued for Use - IFD	CO	AH	_	_	AH
4	06/04/2022	Issued for Use - IFD	CO	AH	_	_	AH
3	05/04/2022	Issued for Use - IFD	CO	AH	_	_	AH
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

arrow energy go further

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

Surat Basin

(5)

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Land_Access\Conduct_and_Compensation\MXDs\SB_CCA_WARAKIRRI_57SP193329_RITM0326633_5.mxd

Print Date: 7/07/2022

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 all four parcels (57SP193329, 36DY45, 12SP193328 and 2RP85916).
- There are two well pad on this property, with two deviated wells on each. One located in a corner of the paddock on Lot 57SP193329 and one located in the corner of 36DY45.
- All access and gathering lines have been located adjacent property boundaries. The previous layout involved gathering traversing the middle of the paddock across 57SP193329 and access traversing the .
- middle of the paddock across 36DY45.
- Gathering lines are located along the north eastern boundary of 12SP193328 and 2RP85916, adjacent Daandine Naandi Road
- Two additional deviated well trajectories enter 57SP193329 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

- Arrow will utilise existing landholder access tracks to infrastructure and will upgrade existing tracks as necessary (see below).
- The proposed gathering and access tracks have all been located to be adjacent property boundaries and minimise impacts to farming activities as much as possible.
- Justification /reasoning for the layout.

Infrastructure summary

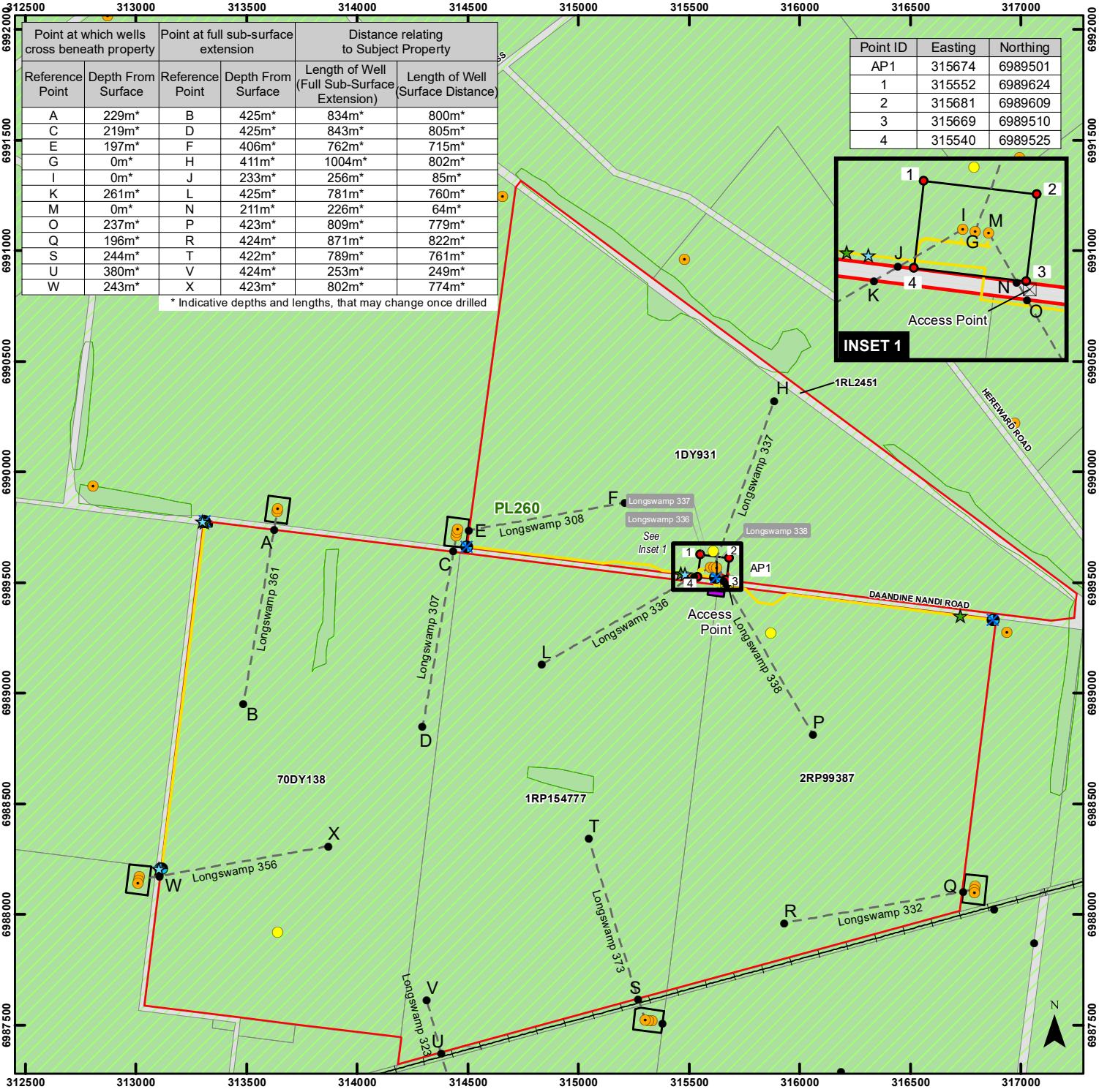
- 2 x 2-well multi-well pads (1.15 ha each during construction & reducing to 0.17 ha each during operation) & associated 4 sub-terranean deviated well trajectories
- Pipeline Right of Way – 8.19 ha (during construction)
- Buried gas and water gathering lines – 3.92km of restored ROW
- Access track – 2.74km of upgraded access track plus 350m (0.350 ha) of new access track
- 3 x high point vents – 0.01 ha (operational footprint)
- 8 x isolation valves – 0.03 ha (operational footprint)
- 8 x future service connections – 0.03 ha (operational footprint)
- 2 x tie-in valves – 0.01 ha (operational footprint)
- 2 x additional subterranean deviated well trajectories

CCA Map

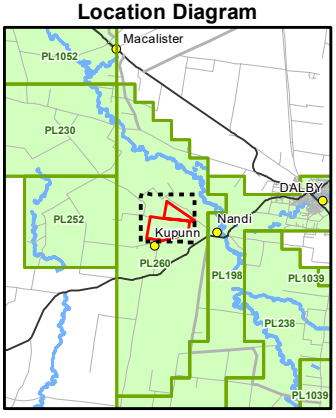
Point at which wells cross beneath property		Point at full sub-surface extension		Distance relating to Subject Property	
Reference Point	Depth From Surface	Reference Point	Depth From Surface	Length of Well (Full Sub-Surface Extension)	Length of Well (Surface Distance)
A	229m*	B	425m*	834m*	800m*
C	219m*	D	425m*	843m*	805m*
E	197m*	F	406m*	762m*	715m*
G	0m*	H	411m*	1004m*	802m*
I	0m*	J	233m*	256m*	85m*
K	261m*	L	425m*	781m*	760m*
M	0m*	N	211m*	226m*	64m*
O	237m*	P	423m*	809m*	779m*
Q	196m*	R	424m*	871m*	822m*
S	244m*	T	422m*	789m*	761m*
U	380m*	V	424m*	253m*	249m*
W	243m*	X	423m*	802m*	774m*

* Indicative depths and lengths, that may change once drilled

Point ID	Easting	Northing
AP1	315674	6989501
1	315552	6989624
2	315681	6989609
3	315669	6989510
4	315540	6989525



Location Diagram



Tenement: PL260

LotPlan: 1DY931, 1RL2451, 1RP154777, 2RP99387, 70DY138

Well/s: Longswamp 307, Longswamp 308, Longswamp 323, Longswamp 332, Longswamp 336 - 338, Longswamp 356, Longswamp 361, Longswamp 373

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 225 450 675 900

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:25,000

Legend

- Reference Point (depth)
- Arrow Well (Proposed)
- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- LPD
- HPV
- Proposed RoW – 23m wide
- Well Path
- Access Track
- Well Area
- Subject Property
- EWA
- Property Boundary
- PL (Arrow)
- Road

Rev	Date	Revision Description	Dft	Chk	Eng	QA	Appr
6	07/07/2022	Issued for Use - IFD	CO	AH	_	_	AH
5	24/06/2022	Issued for Use - IFD	JJ	AH	_	_	AH
4	06/04/2022	Issued for Use - IFD	CO	AH	_	_	AH
3	05/04/2021	Issued for Use - IFD	CO	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

Data Source: Arrow Energy Limited, QSpatial

arrow energy go further

Status: IFU
Issued To: A Hall
Author: coellermann

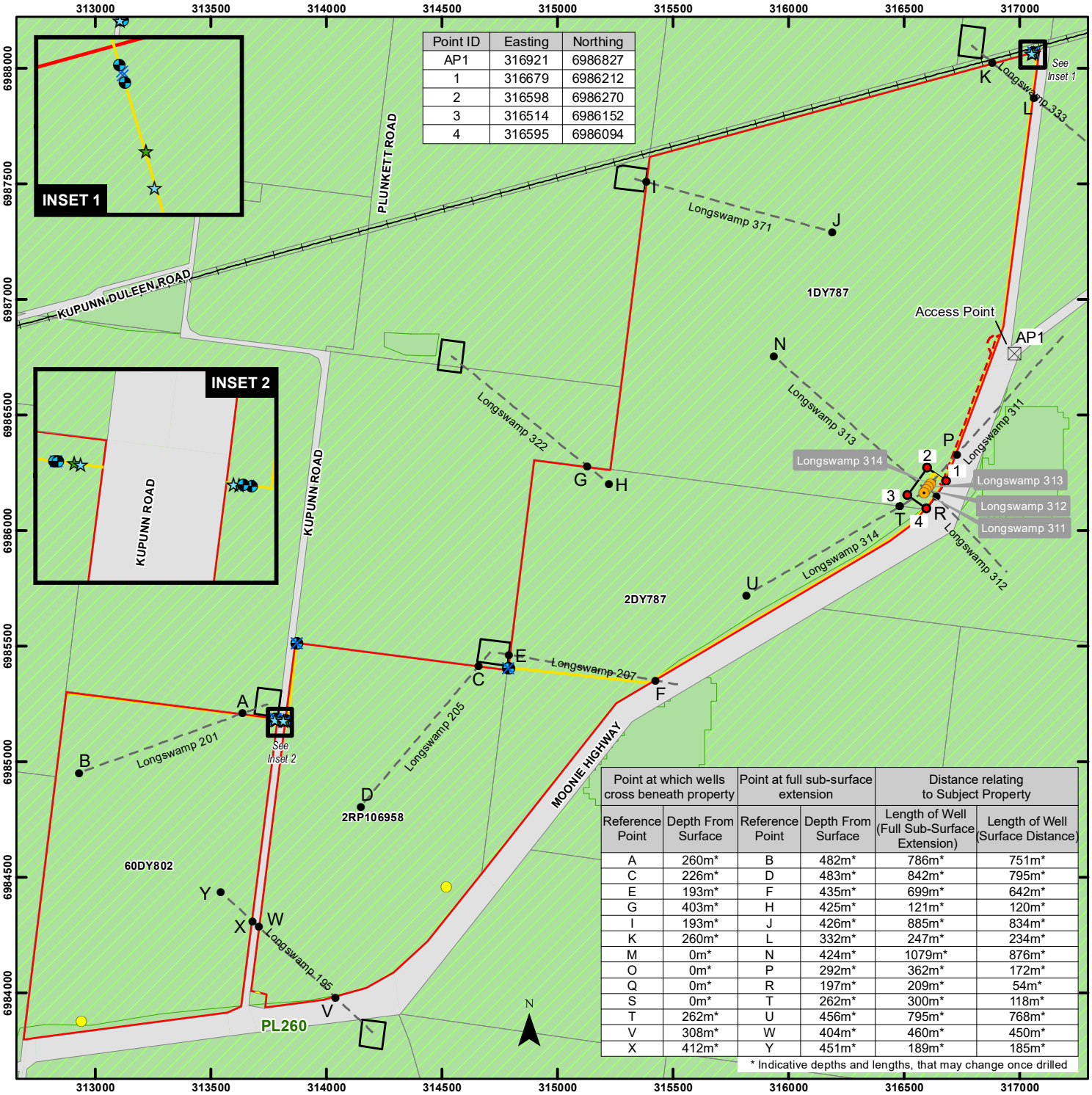
Surat Basin

(6)

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Land_Access\Conduct_and_Compensation\MXDs\SB_CCA_Warakirri_1DY931_1RL2451_1RP154777_2RP99387_70DY138_RITM0422592_6.mxd

Print Date: 7/07/2022

CCA Map

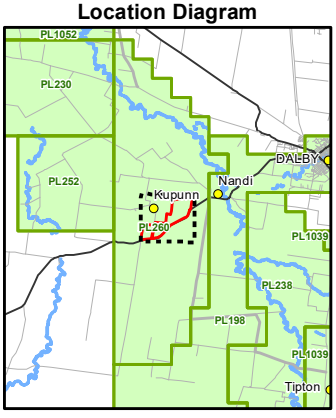


Point ID	Easting	Northing
AP1	316921	6986827
1	316679	6986212
2	316598	6986270
3	316514	6986152
4	316595	6986094

Point at which wells cross beneath property		Point at full sub-surface extension		Distance relating to Subject Property	
Reference Point	Depth From Surface	Reference Point	Depth From Surface	Length of Well (Full Sub-Surface Extension)	Length of Well (Surface Distance)
A	260m*	B	482m*	786m*	751m*
C	226m*	D	483m*	842m*	795m*
E	193m*	F	435m*	699m*	642m*
G	403m*	H	425m*	121m*	120m*
I	193m*	J	426m*	885m*	834m*
K	260m*	L	332m*	247m*	234m*
M	0m*	N	424m*	1079m*	876m*
O	0m*	P	292m*	362m*	172m*
Q	0m*	R	197m*	209m*	54m*
S	0m*	T	262m*	300m*	118m*
T	262m*	U	456m*	795m*	768m*
V	308m*	W	404m*	460m*	450m*
X	412m*	Y	451m*	189m*	185m*

* Indicative depths and lengths, that may change once drilled

Location Diagram



Tenement: PL260

LotPlan: 1DY787, 2DY787, 2RP106958, 60DY802

Well/s: Longswamp 195, Longswamp 201, Longswamp 205, Longswamp 207, Longswamp 311, Longswamp 312, Longswamp 313, Longswamp 314, Longswamp 322, Longswamp 333, Longswamp 371

Project Name: Duleen Kupunn Part 3

Owner: WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE

Metres 0 210 420 630 840

Coordinate System: GDA 1994 MGA Zone 56

Scale @ A4: 1:24,000

Legend

- Reference Point (depth)
- Arrow Well (Proposed)
- Sensitive Receptor
- Future Service Connection
- Isolation Valves
- Access Point
- LPD
- HPV
- Proposed RoW – 23m wide
- Well Path
- Access Track
- Well Area
- Subject Property
- EWA
- Property Boundary
- PL (Arrow)

Rev	Date	Revision Description	Drn	Chk	Eng	QA	App
6	07/07/2022	Issued for Use - IFD	CO	AH	_	_	AH
5	24/06/2022	Issued for Use - IFD	JJ	AH	_	_	AH
4	06/04/2022	Issued for Use - IFD	CO	AH	_	_	AH
3	05/04/2022	Issued for Use - IFD	CO	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

Data Source: Arrow Energy Limited, QSpatial

arrow energy go further

Status: IFU
Issued To: A Hall
Author: coellermann

Surat Basin

(6)

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Land_Access\Conduct_and_Compensation\MXDs\SB_CCA_Warakirri_1DY787_2DY787_2RP106958_60DY802_RITM0422592_6.mxd

Print Date: 7/07/2022

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, parcels 2RP99387 and 2DY787. No infrastructure is proposed to be located on 1RL2451.
- There are two well pads proposed to be located on this property.
- There is a proposed 3-well multi-well pad to be located on 1DY931 along the southern boundary adjacent Daandine Nandi Road. There is also gathering proposed to be located along the western portion of southern boundary of this lot along with access from Daandine Nandi Road and 0.05km of upgraded access track.
- 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 an access new track proposed to run parallel to the Moonie Highway.
-
- Gathering lines on all parcels has been aligned to the parcel boundaries, apart from a section on 2DY787 which unavoidably crosses a small section of cropping to meet the northern boundary of 2RP106958.
- Temporary Extra Work Areas (EWA's) are located on 2RP99387, 1RP154777, 70DY138, 1DY787 & 2RP106958 to facilitate the construction of gathering crossings of roads and rail lines adjacent these parcels.
- There are an additional14 deviated well trajectories proposed to enter this property from neighbouring lots at a subterranean depth of at least 190 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

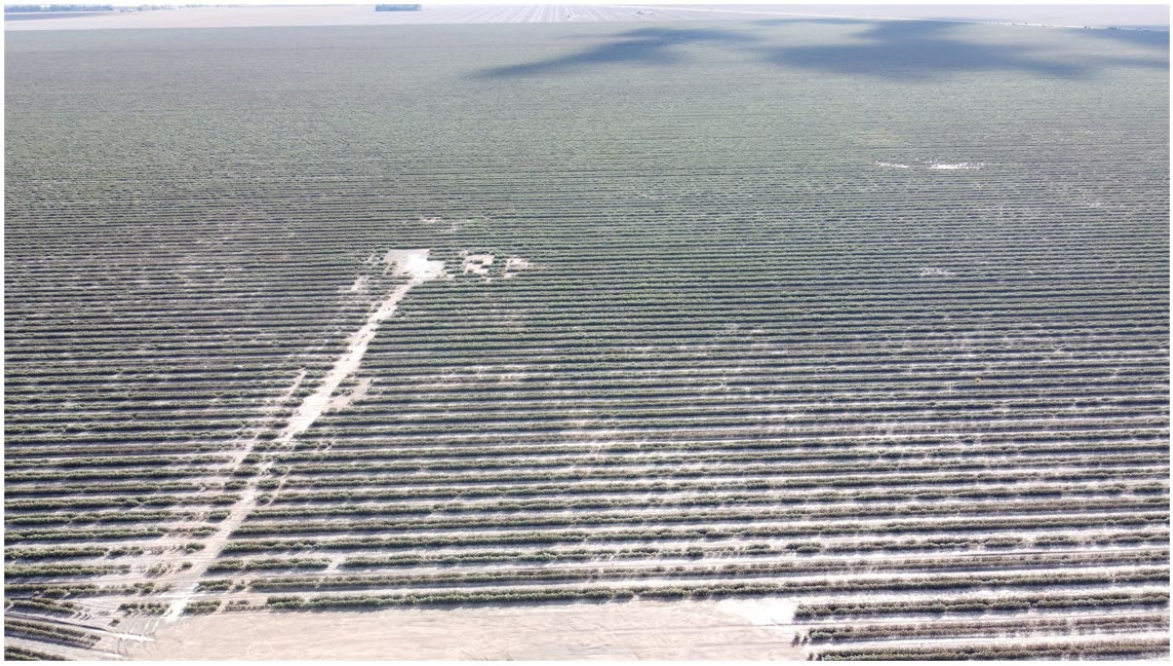


Image of Lot 1DY787

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

- Arrow will utilise existing landholder access tracks to access infrastructure and will upgrade existing tracks as necessary.
- The proposed infrastructure on 1DY931 is located adjacent Daandine Nandi Road, the provide direct access and minimise additional access.
- The section of gathering proposed to be located on 2RP106958 is adjacent Kupuun 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 to follow the eastern boundary.
  The proposed gathering on 2DY787 is located adjacent to the Moonie Highway and then heads west across a cropped area. This section of cropping cannot be avoided, as this location provides the best connection to additional gathering located further west, which has been aligned to property boundaries.

- The proposed infrastructure on 60DY802 is directly adjacent the northern boundary of the property to minimise impacts to farming activities.
- 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

- 1 x 3-well multi-well pad & associated sub-terranean deviated well trajectories– 1.3 ha (during construction) - reducing to 0.17 ha (during operation)
- 1 x 4-well multi-well pad & associated sub-terranean deviated well trajectories – 1.45 ha (during construction) - reducing to 0.27ha (during operation)
- Pipeline Right of Way – 29.37 ha (during construction)
- Access track – 0.05km of upgraded access track and 0.83km of new access track (0.83 ha (footprint)
- 6 x high point vents – 0.02 ha (operational footprint)
- 6 x low point drains – 0.002 ha (operational footprint)
- 20 x isolation valves – 0.07 ha (operational footprint)
- 20 x future service connections – 0.07 ha (operational footprint)
- 14 x additional subterranean deviated well trajectories
- 5 x Extra Work Areas (0.23 ha)

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

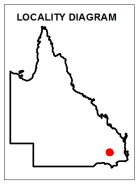
Queensland Land Use Mapping Program

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

LOCALITY DIAGRAM



N

0 680 1360 2040 2720 3400 m

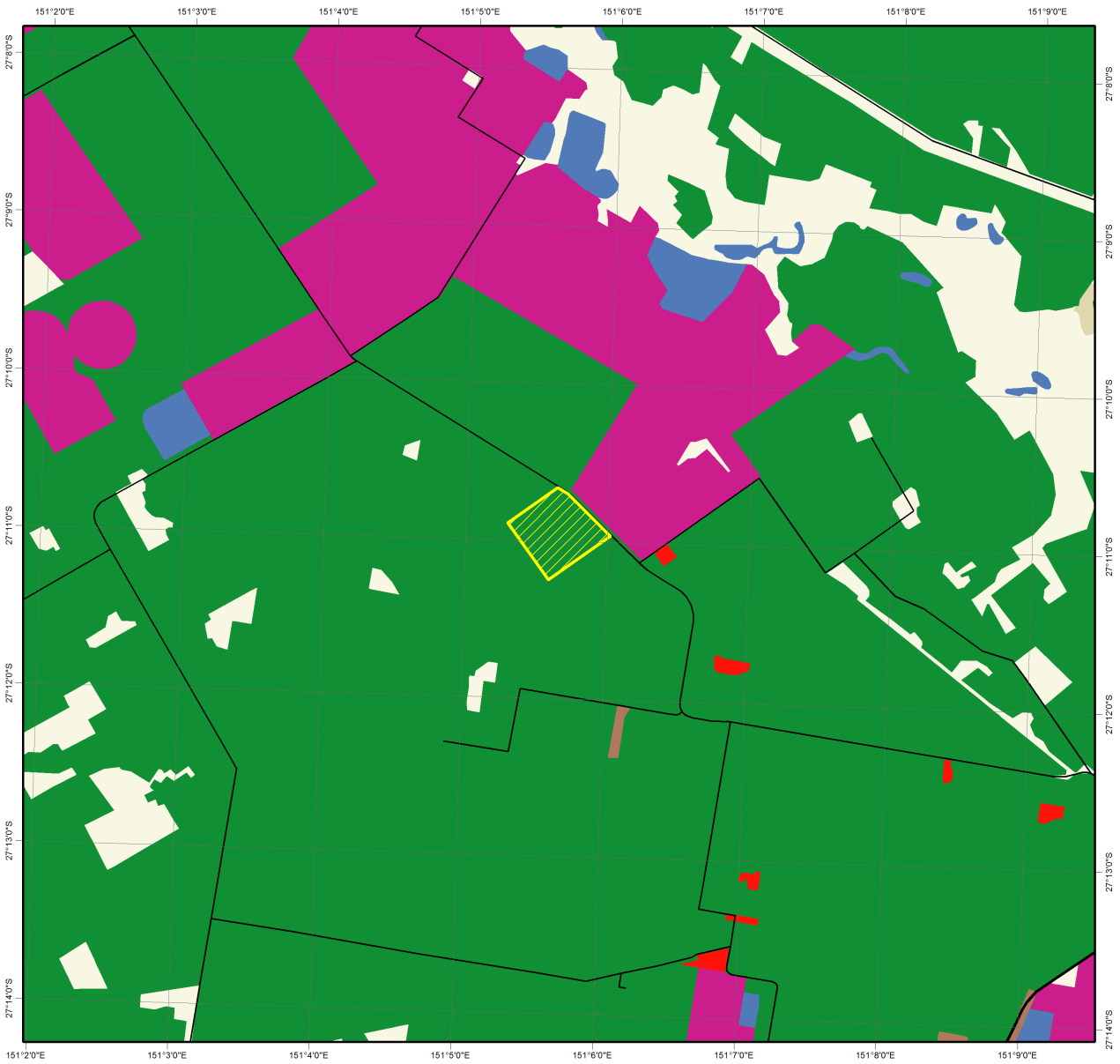
This product is projected into GDA 1994 Queensland Albers

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.

Land use is classified according to the Australian Land Use and Management Classification (ALUMC) Version 8, October 2016. Primary and secondary levels relate to land use (i.e. the principal use of the land in terms of the objectives of the land manager), the tertiary level further discriminate land use, eg. commodity/intensity. Where required and possible, attribution is performed to tertiary level. QLUMP maps the land use classes of sugar and cotton consistently to tertiary level. The minimum attribution level for land use mapping in Queensland is secondary land use, as presented in this map.

Refer to the contact position for additional information regarding source data. Further information relating to land use mapping can be found at http://www.qld.gov.au/environment/land/vegetation/mapping/qlump/ and http://www.agriculture.gov.au/abares/aclump/land-use/

While every care is taken to ensure the accuracy of this information, the Department of Environment and Science makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which might be incurred as a result of the information being inaccurate or incomplete in any way and for any reason.



Land Use

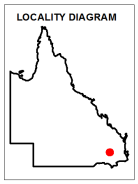
Queensland Land Use Mapping Program

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

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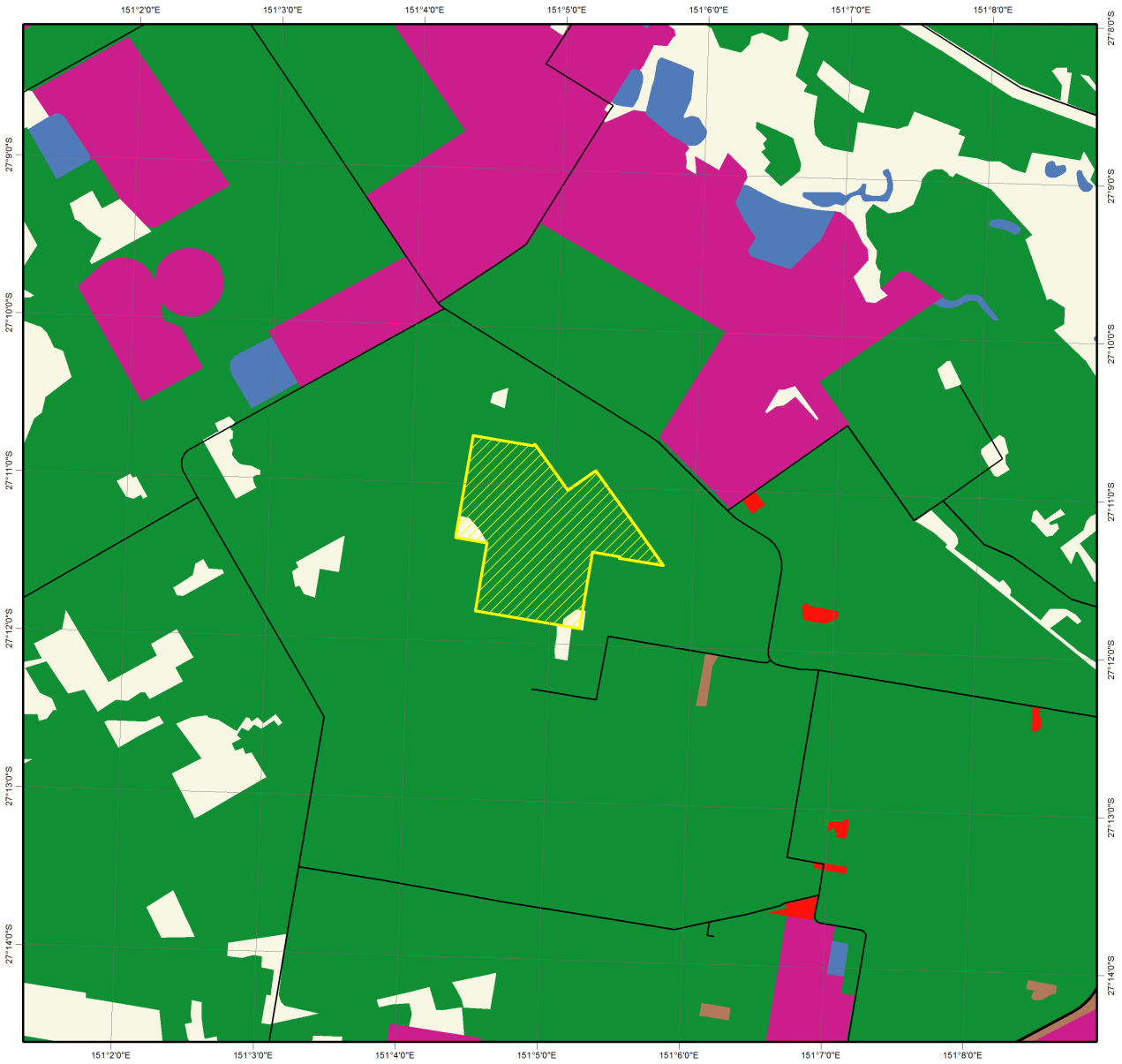


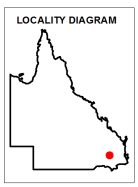
Land Use

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



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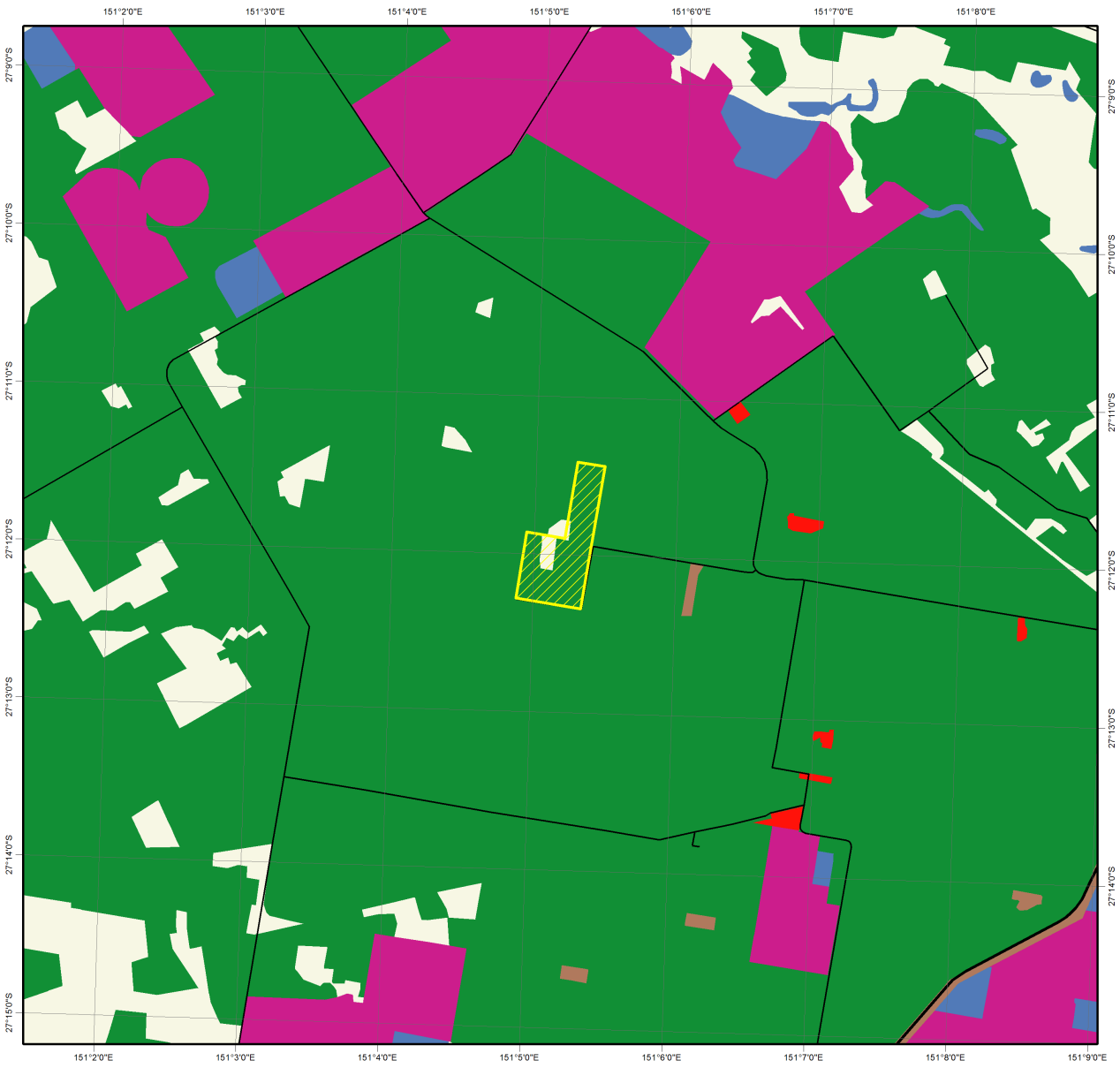


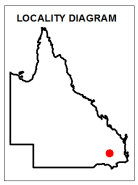
Land Use

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



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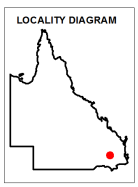
Land Use

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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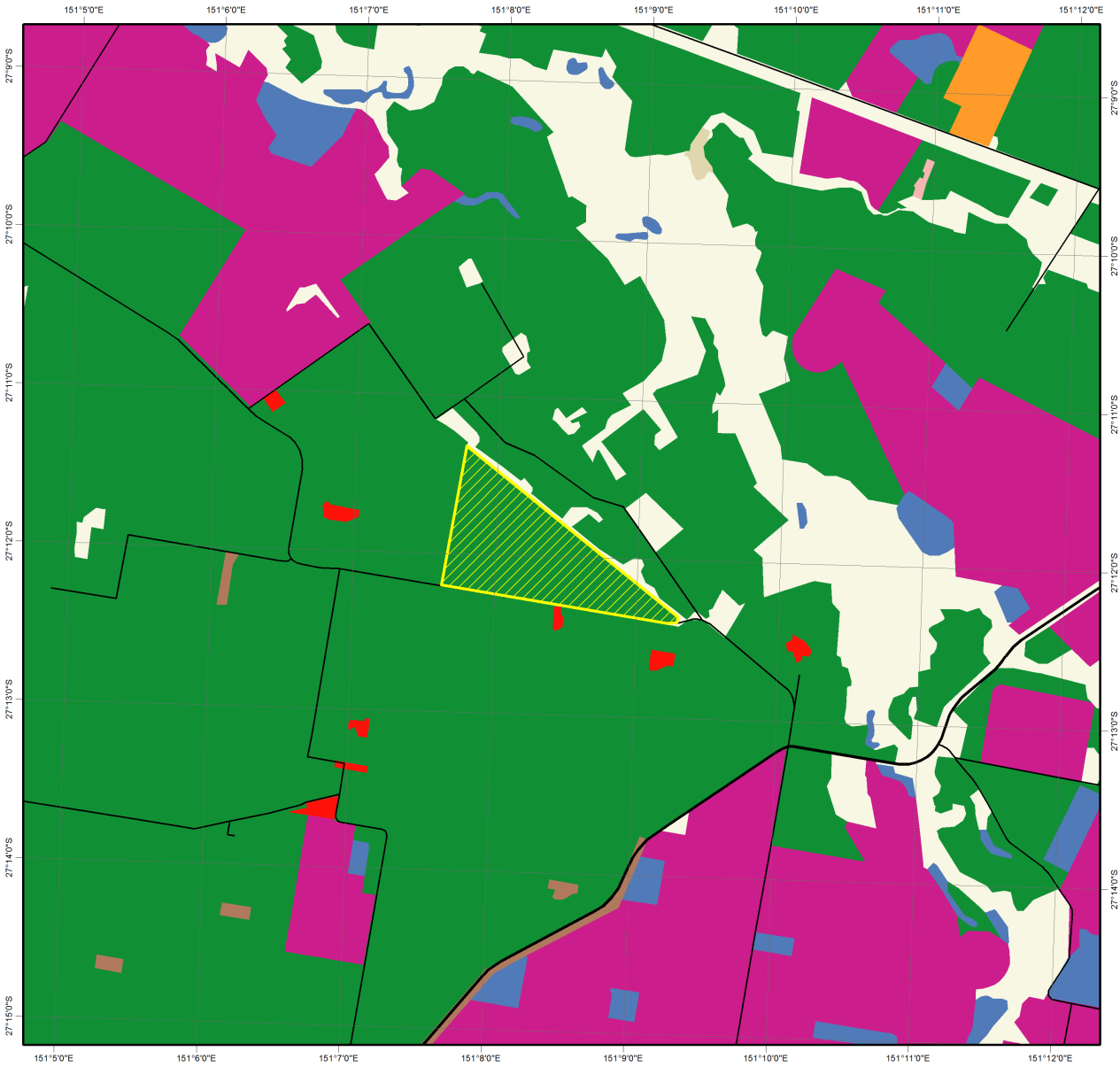

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

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- Nature conservation
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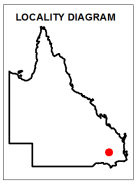
LOCALITY DIAGRAM



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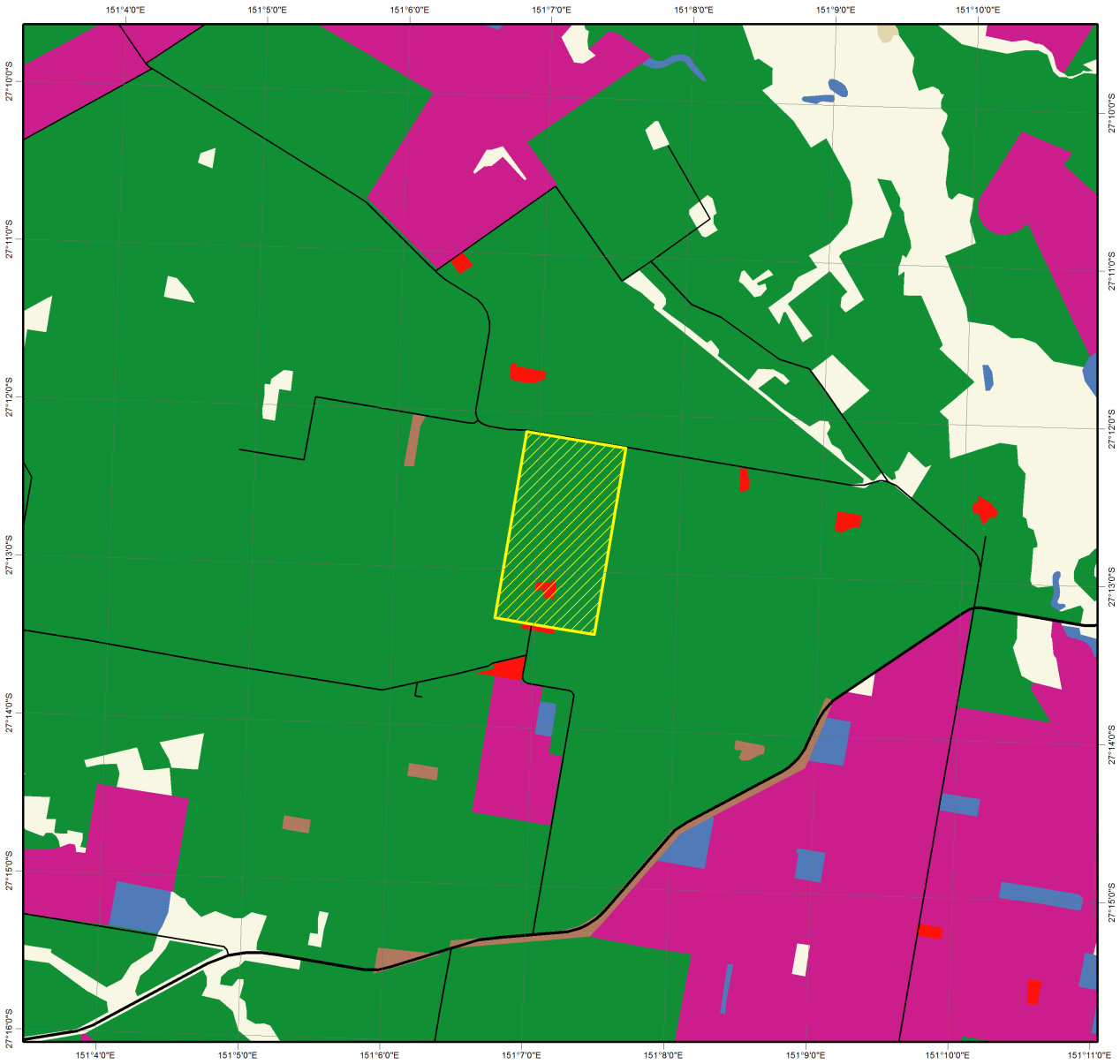

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

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- Nature conservation
- Other minimal use
- Grazing native vegetation
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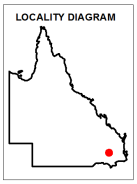
LOCALITY DIAGRAM



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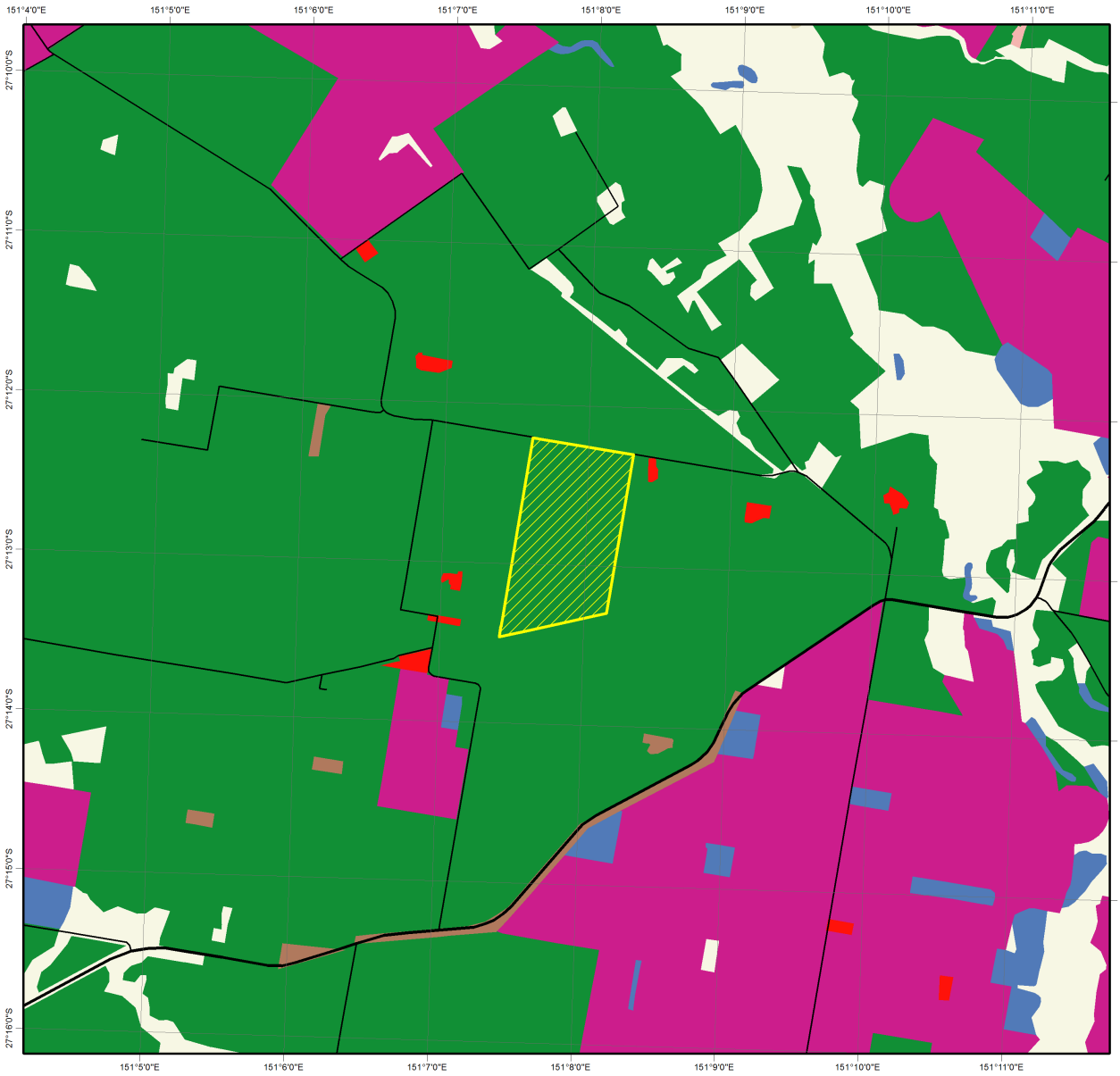

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

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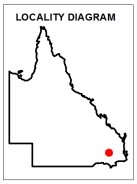

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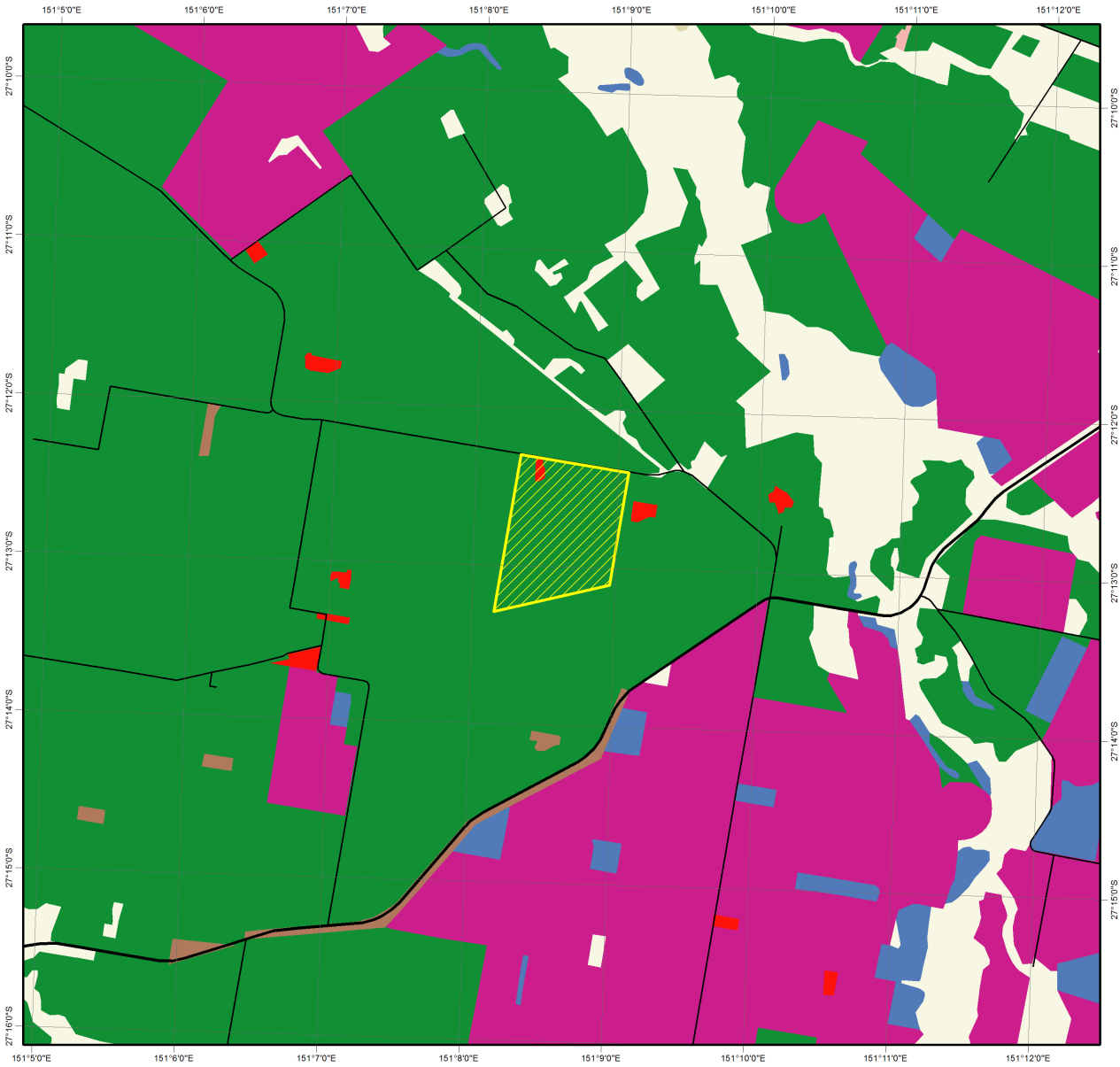

Land Use

Queensland Land Use Mapping Program

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ALUM v8 Secondary level

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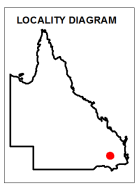

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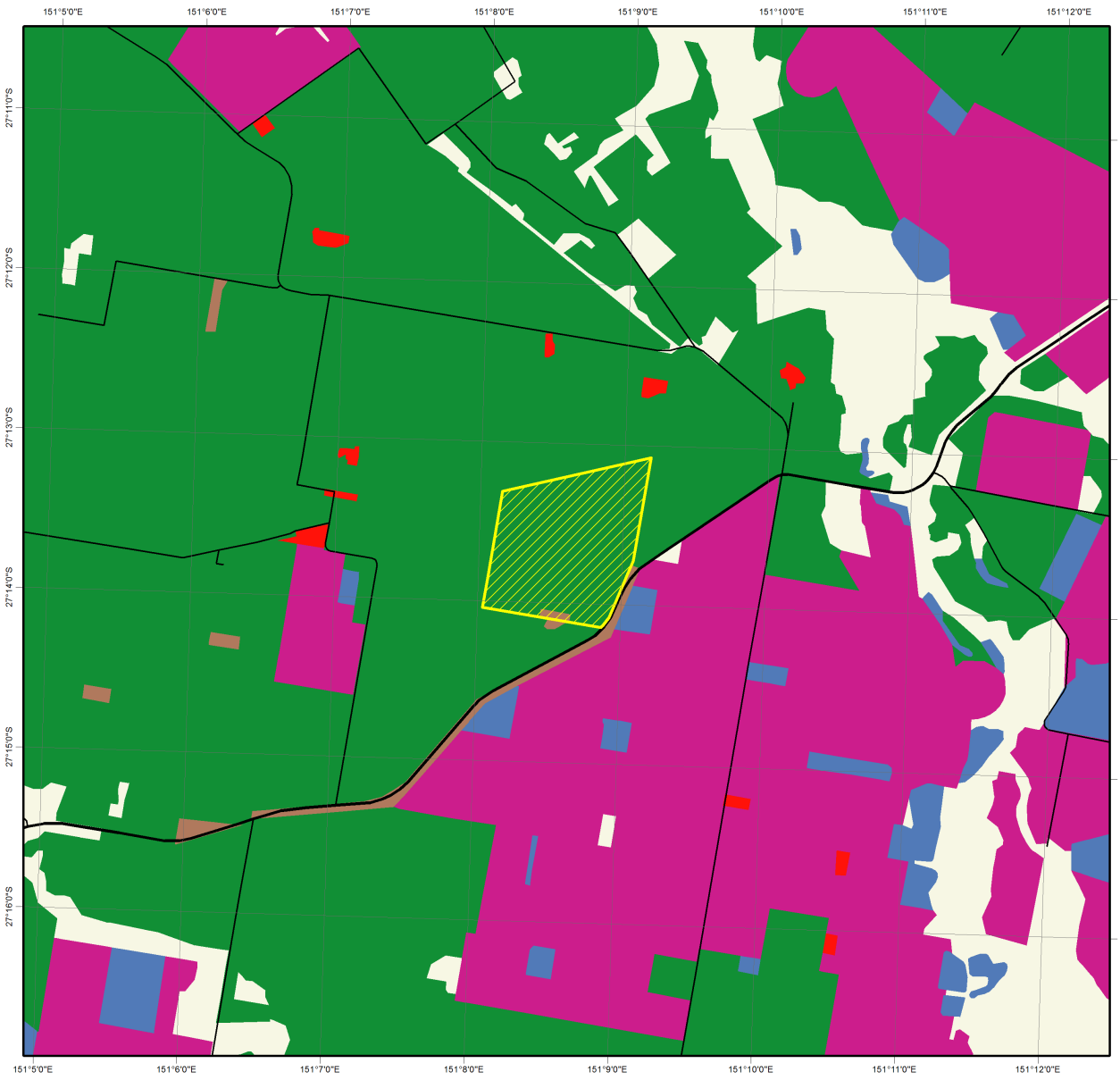

Land Use

Queensland Land Use Mapping Program

Legend

ALUM v8 Secondary level

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- Other minimal use
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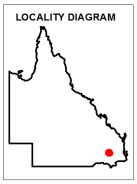

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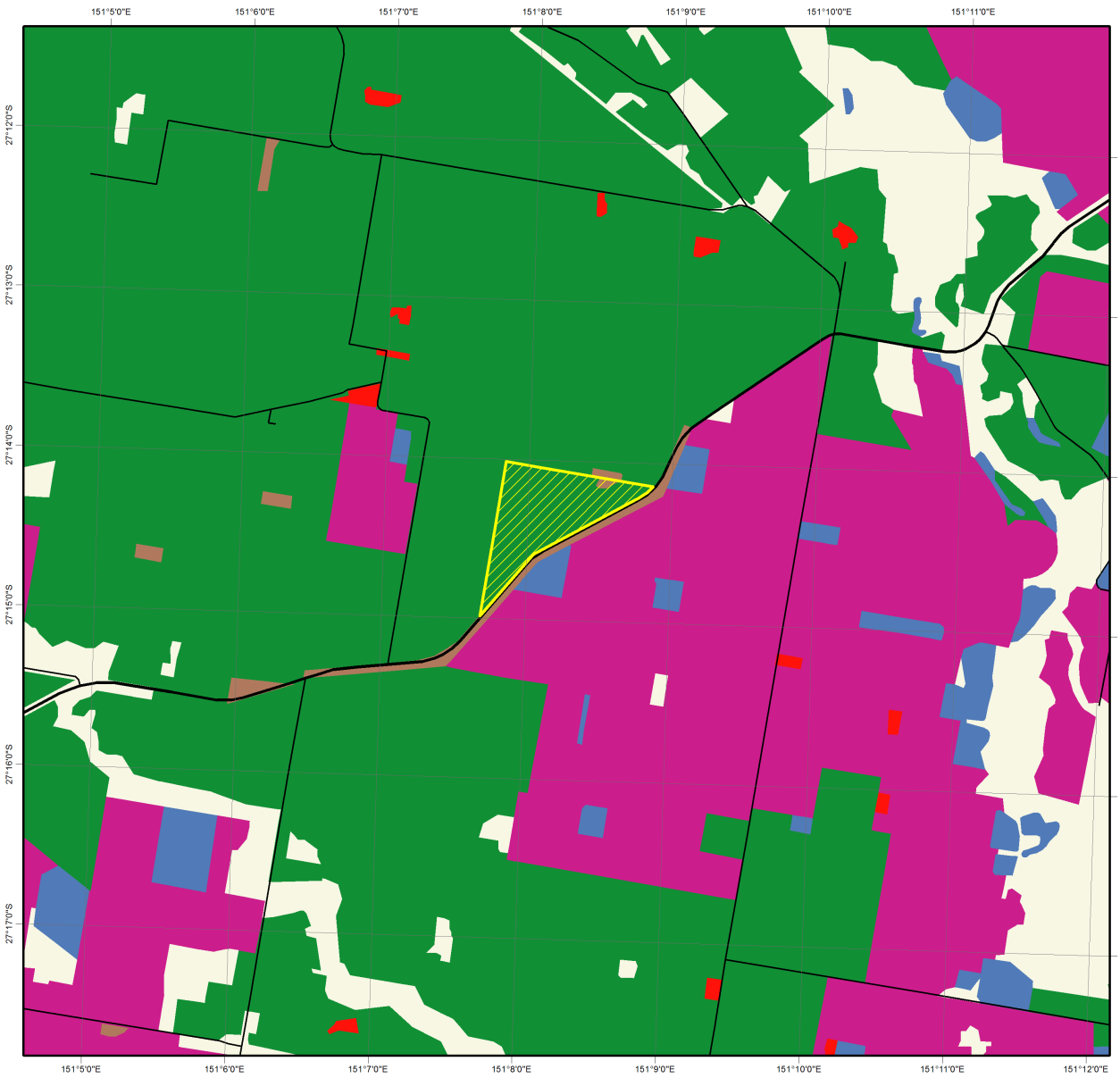

Land Use

Queensland Land Use Mapping Program

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ALUM v8 Secondary level

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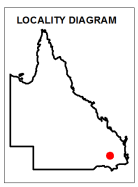

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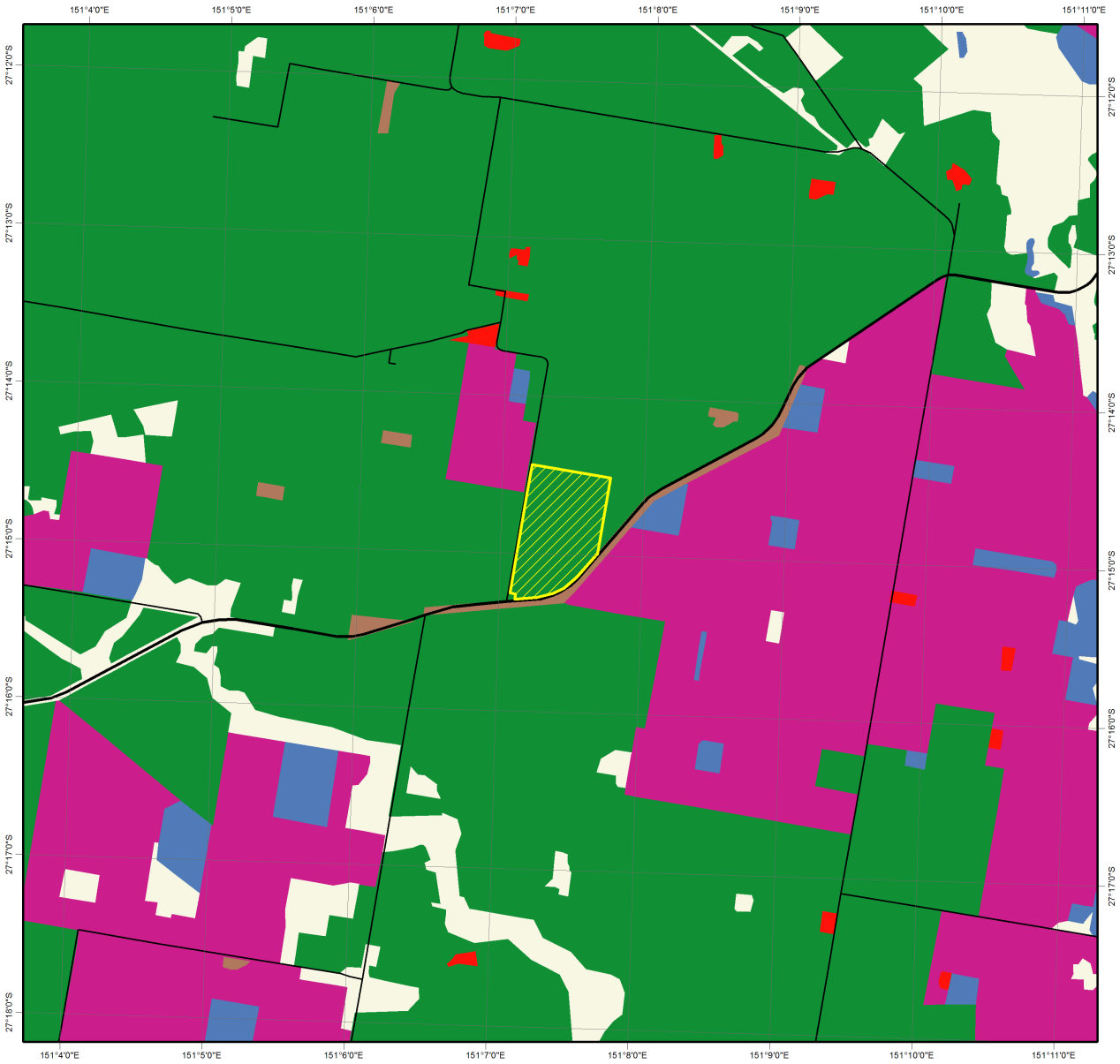

Land Use

Queensland Land Use Mapping Program

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ALUM v8 Secondary level

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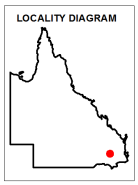

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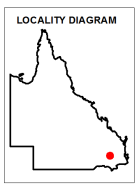

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Land use is classified according to the Australian Land Use and Management Classification (ALUMC) Version 8, October 2016. Primary and secondary levels relate to land use (i.e. the principal use of the land in terms of the objectives of the land manager), the tertiary level further discriminate land use, eg. commodity/intensity. Where required and possible, attribution is performed to tertiary level. QLUMP maps the land use classes of sugar and cotton consistently to tertiary level. The minimum attribution level for land use mapping in Queensland is secondary land use, as presented in this map.

Refer to the contact position for additional information regarding source data. Further information relating to land use mapping can be found at http://www.qld.gov.au/environment/land/vegetation/mapping/qlump/ and http://www.agriculture.gov.au/abares/aclump/land-use/

While every care is taken to ensure the accuracy of this information, the Department of Environment and Science makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which might be incurred as a result of the information being inaccurate or incomplete in any way and for any reason.

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

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FORAGE REPORT: CROP FREQUENCY

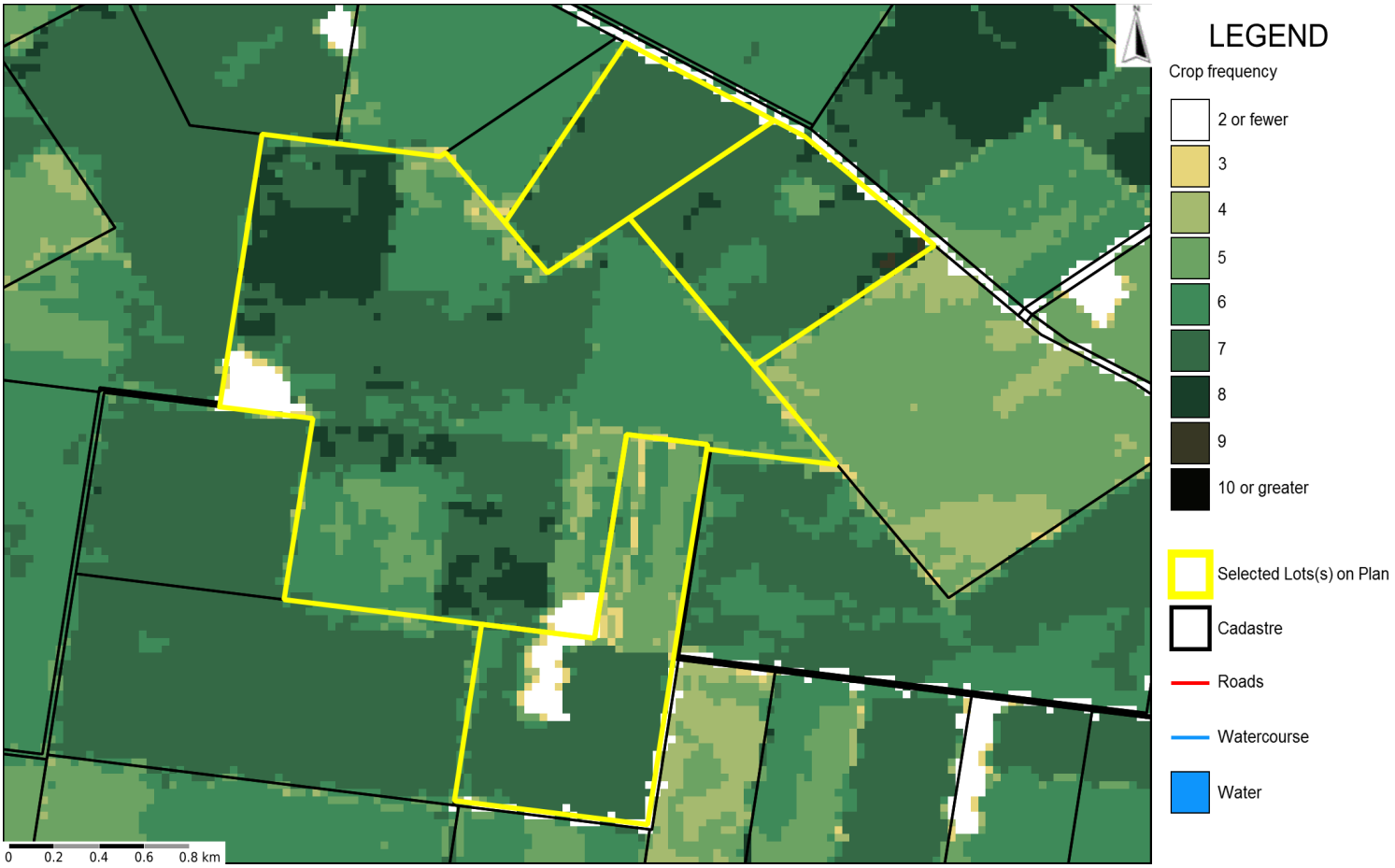
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

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.

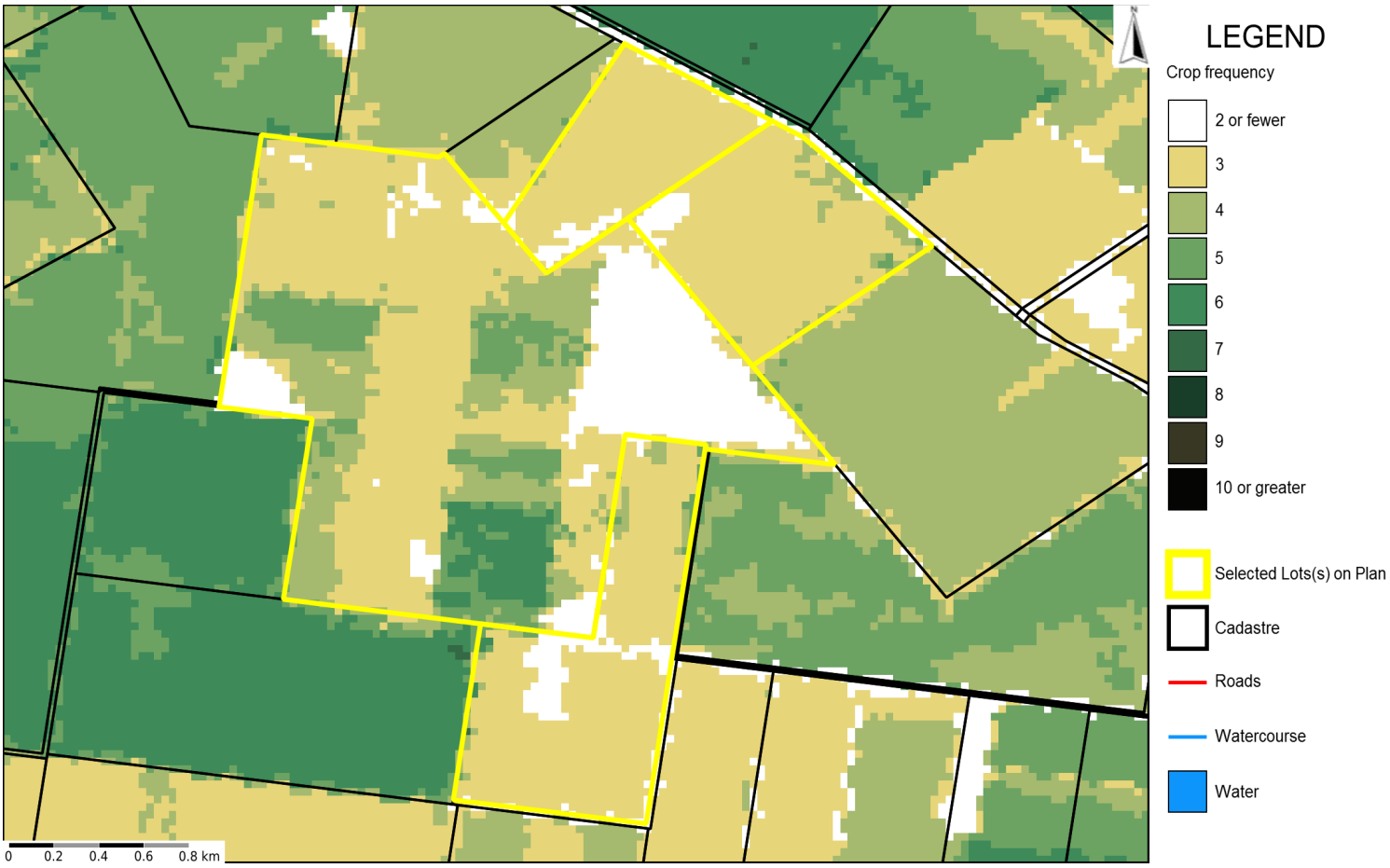
Composite satellite imagery: Due to the limitations of the automated method used to detect active cropping, it is recommended to view the seasonal composite images (pages 5 onward), compiled to represent the maximum greenness (per pixel) within a growing season. Cropped areas will generally appear bright 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

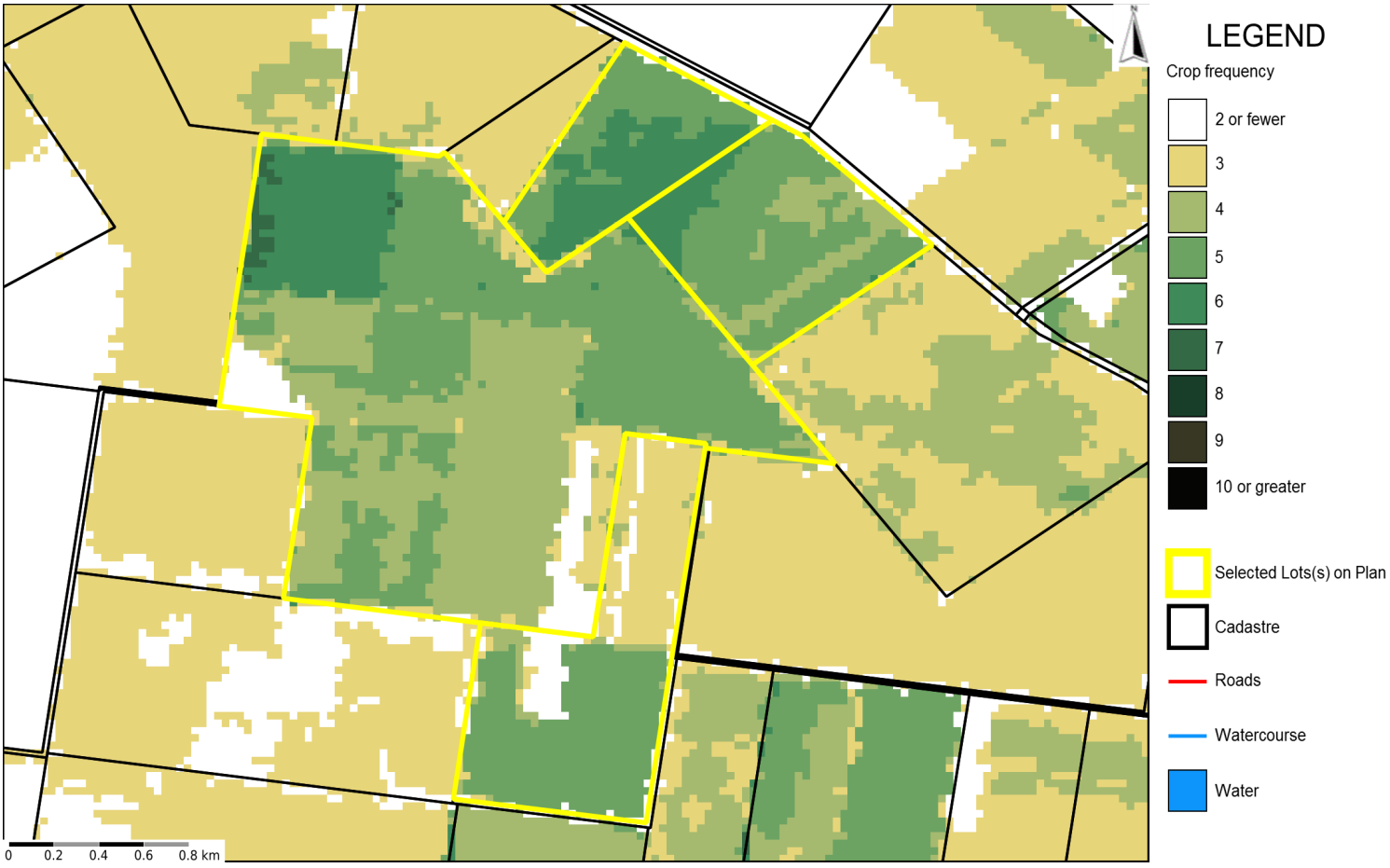
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

Queensland Government

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



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

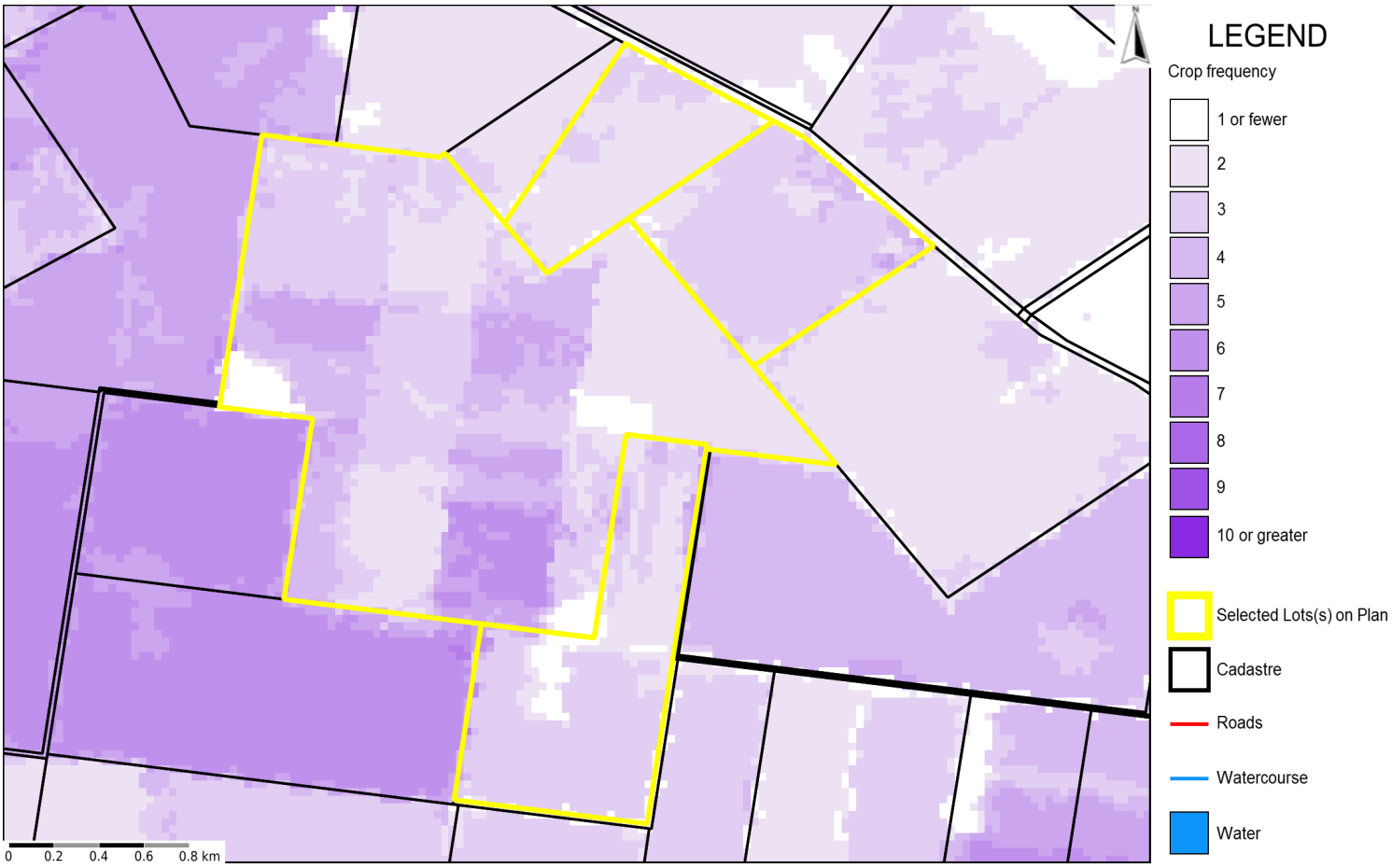


FORAGE REPORT: CROP FREQUENCY

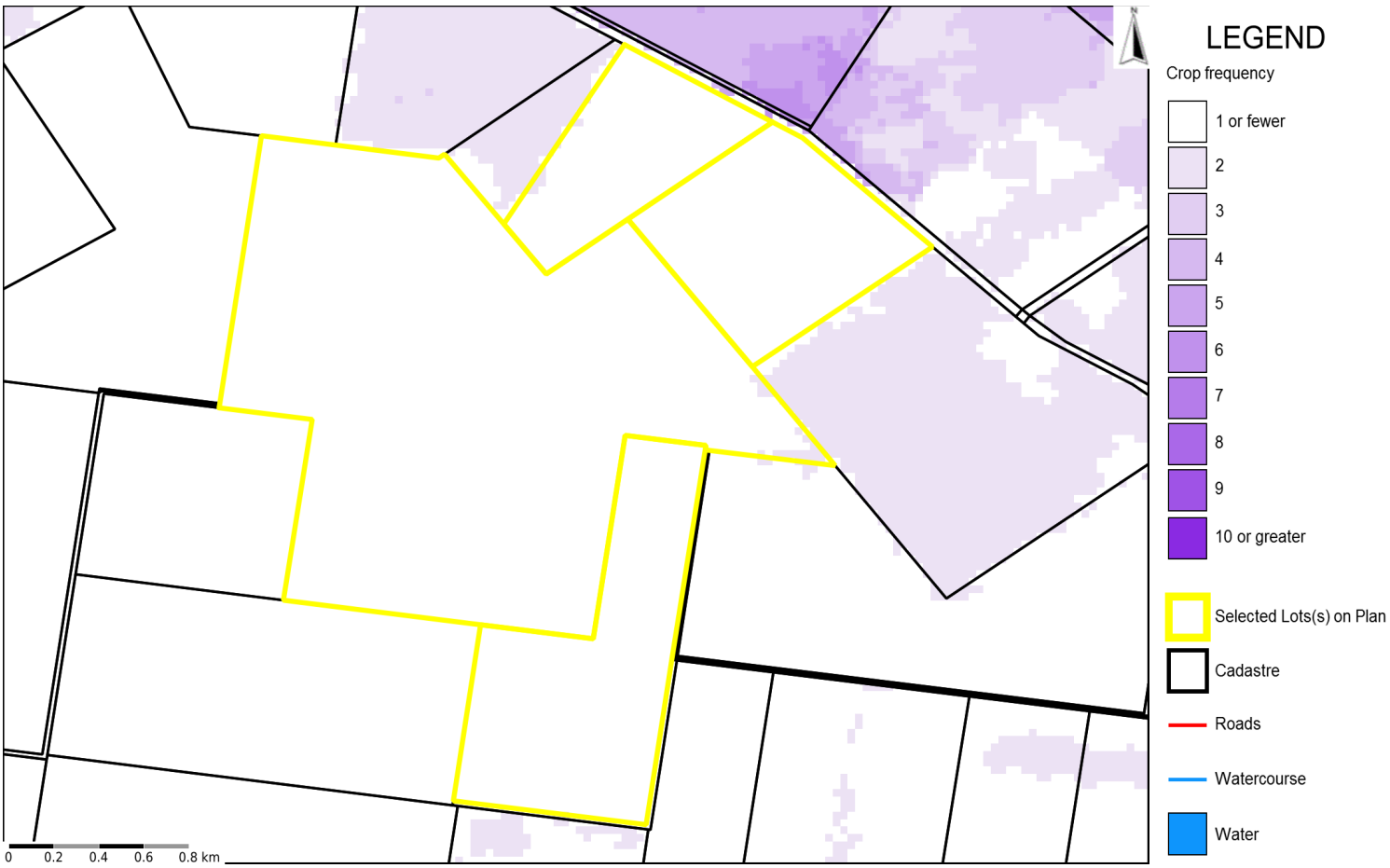
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

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)

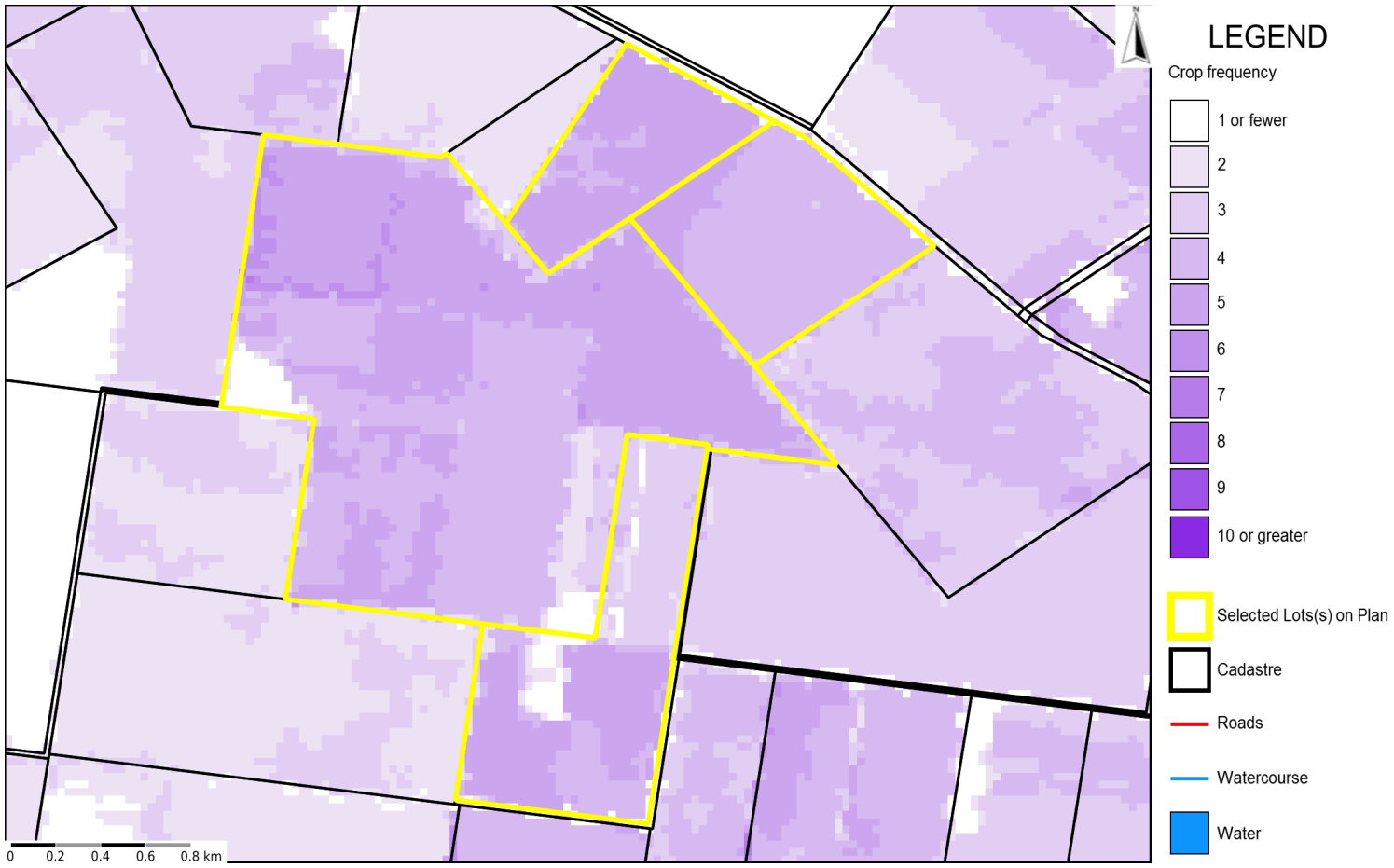


FORAGE REPORT: CROP FREQUENCY

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

Queensland Government

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



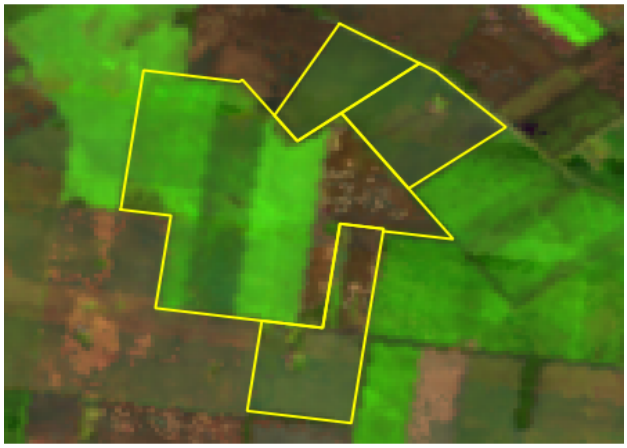
Estimated frequency map for winter (September) pulse crops (2011 - 2020)

FORAGE REPORT: CROP FREQUENCY

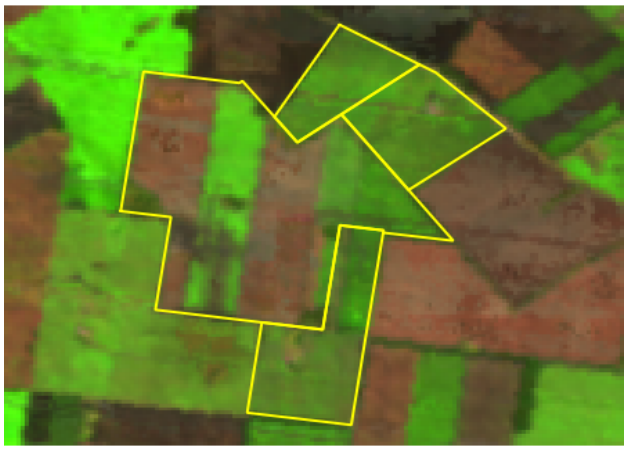
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

Queensland Government

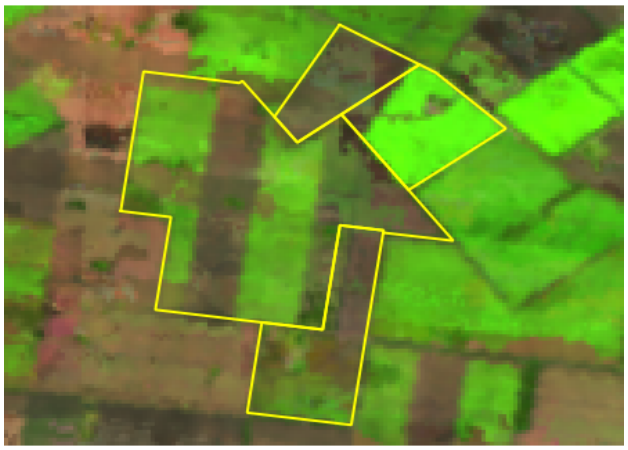
February (left) and September (right) images for 2011

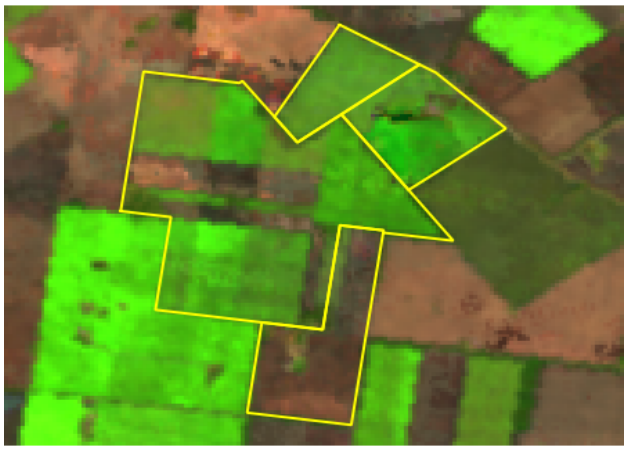


February (left) and September (right) images for 2012



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



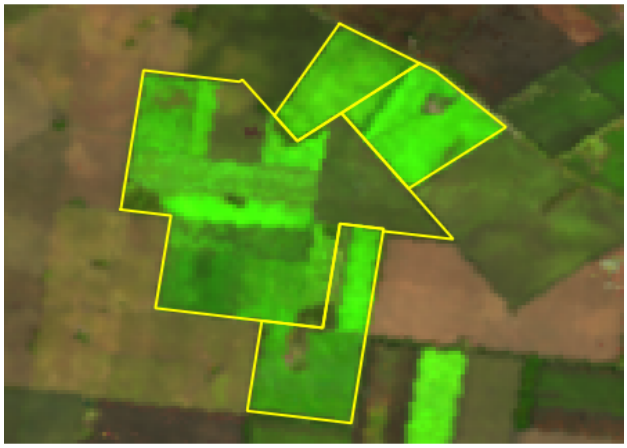


FORAGE REPORT: CROP FREQUENCY

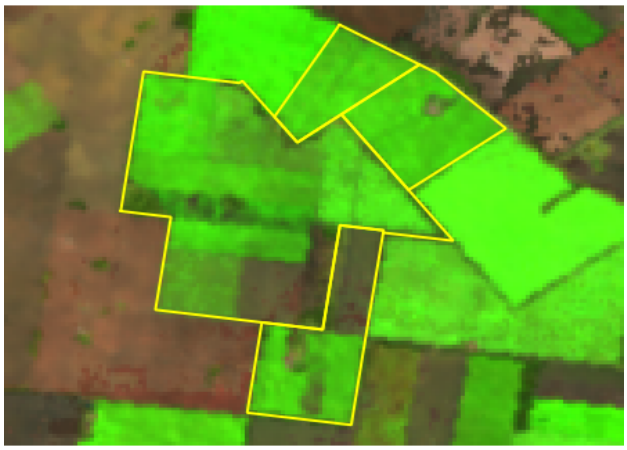
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 2RP85916,12SP193328,57SP193329,3 etc.* *Label: noLabel*

Queensland Government

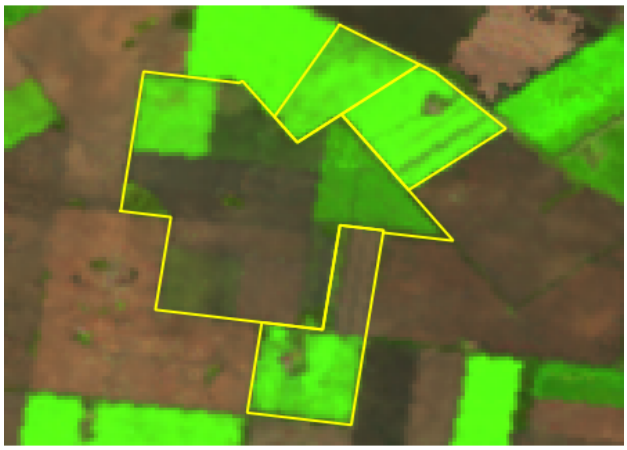
February (left) and September (right) images for 2014



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



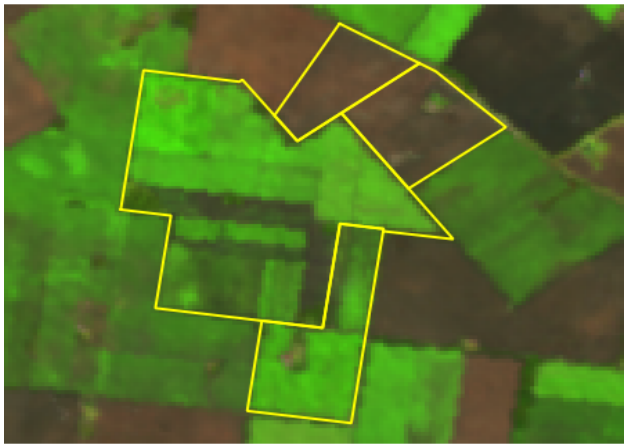
February (left) and September (right) images for 2016



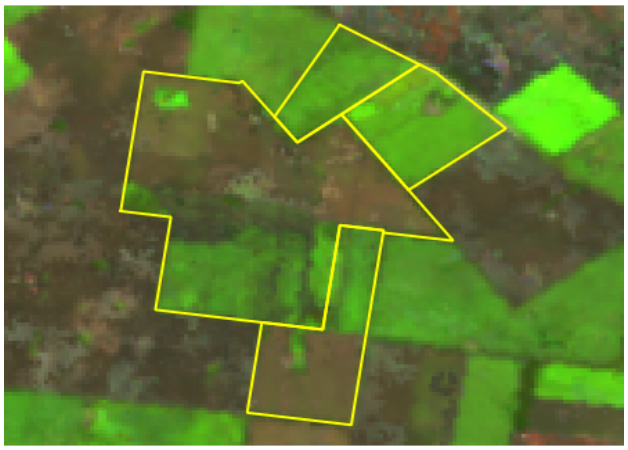
FORAGE REPORT: CROP FREQUENCY

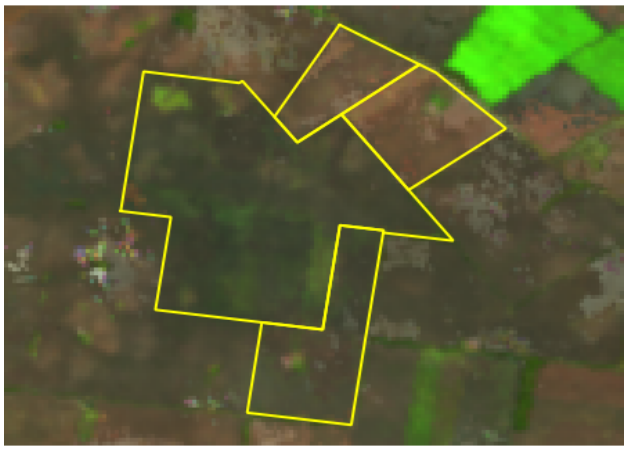
Queensland Government

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



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





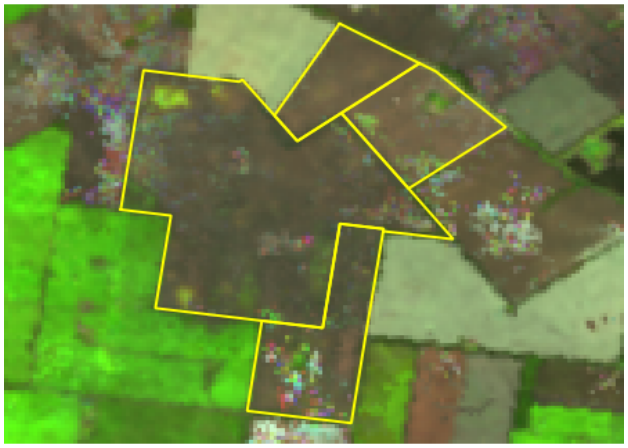
February (left) and September (right) images for 2019

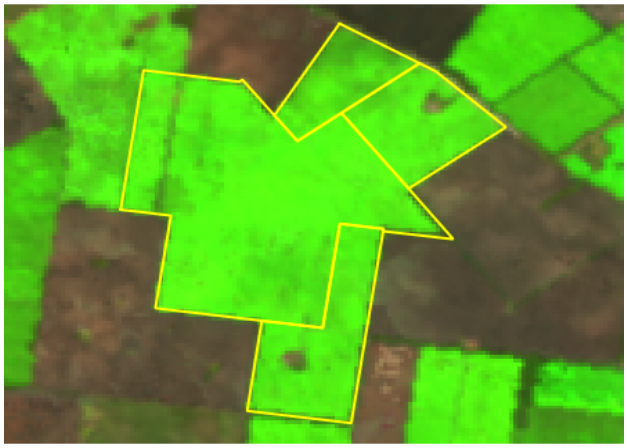
FORAGE REPORT: CROP FREQUENCY

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 2020





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http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 1DY931,2RP99387,1RP154777,70DY13 etc.* *Label: noLabel*

Queensland Government

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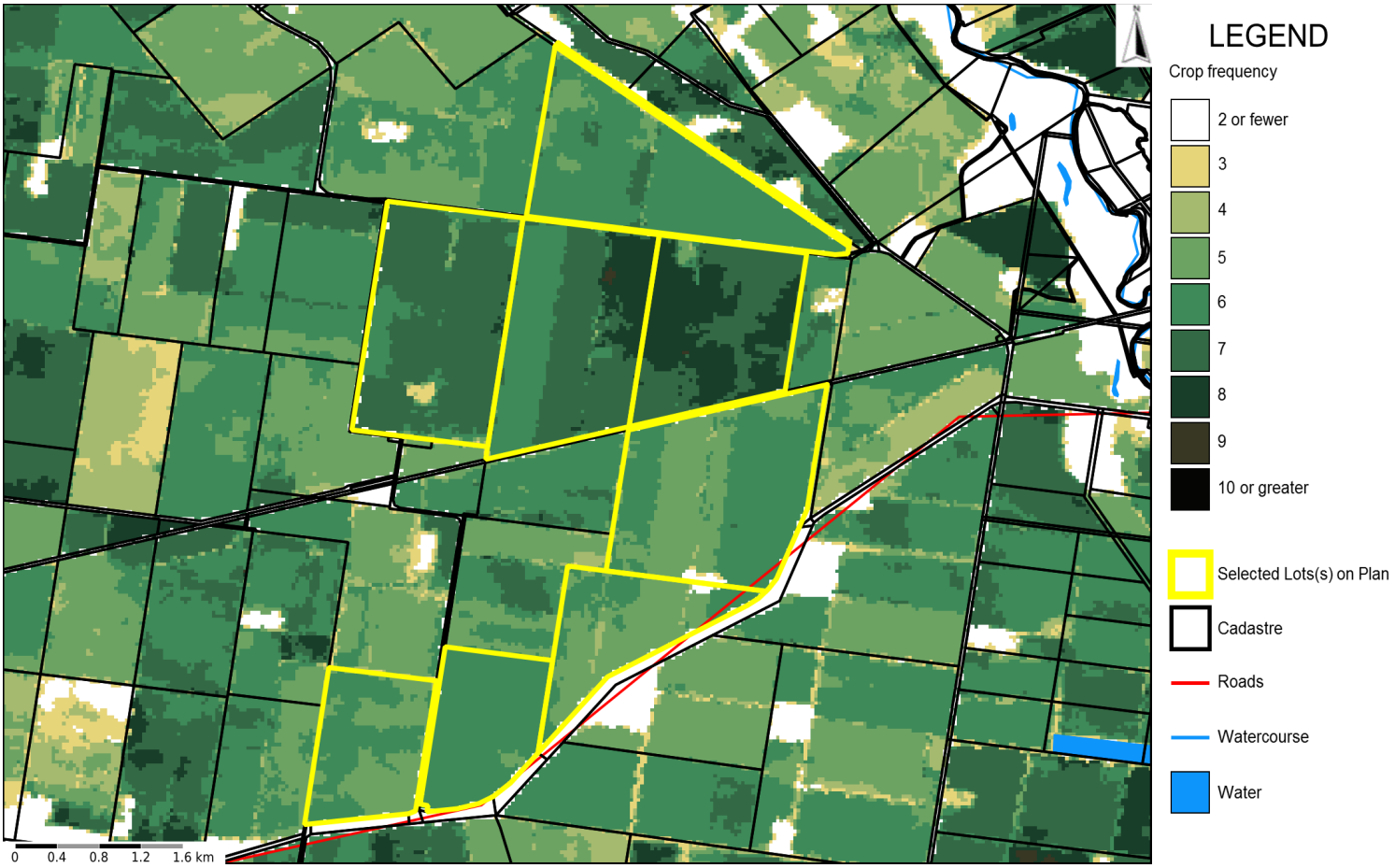

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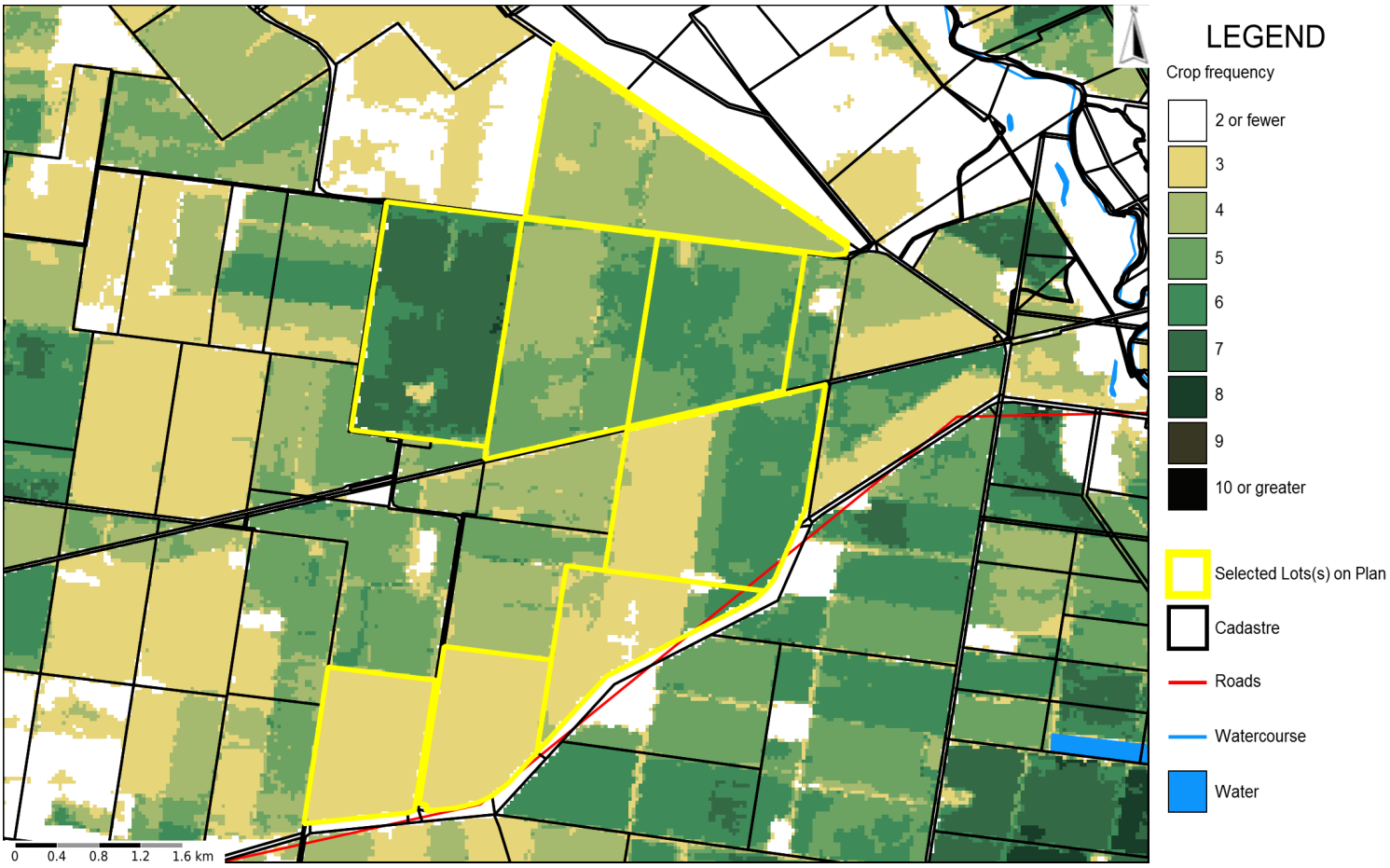
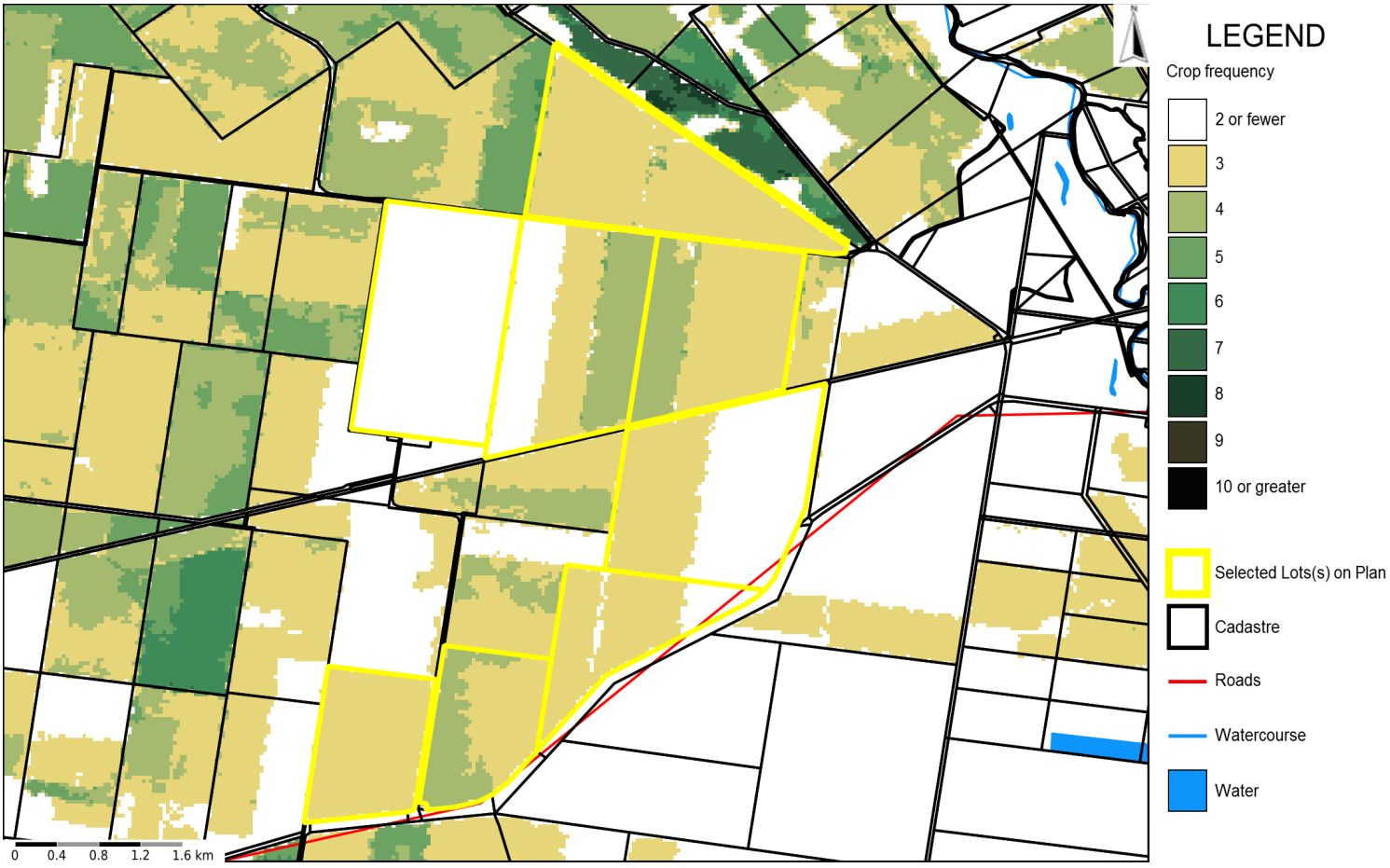
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 1DY931,2RP99387,1RP154777,70DY13 etc.* *Label: noLabel*

Queensland Government

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



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

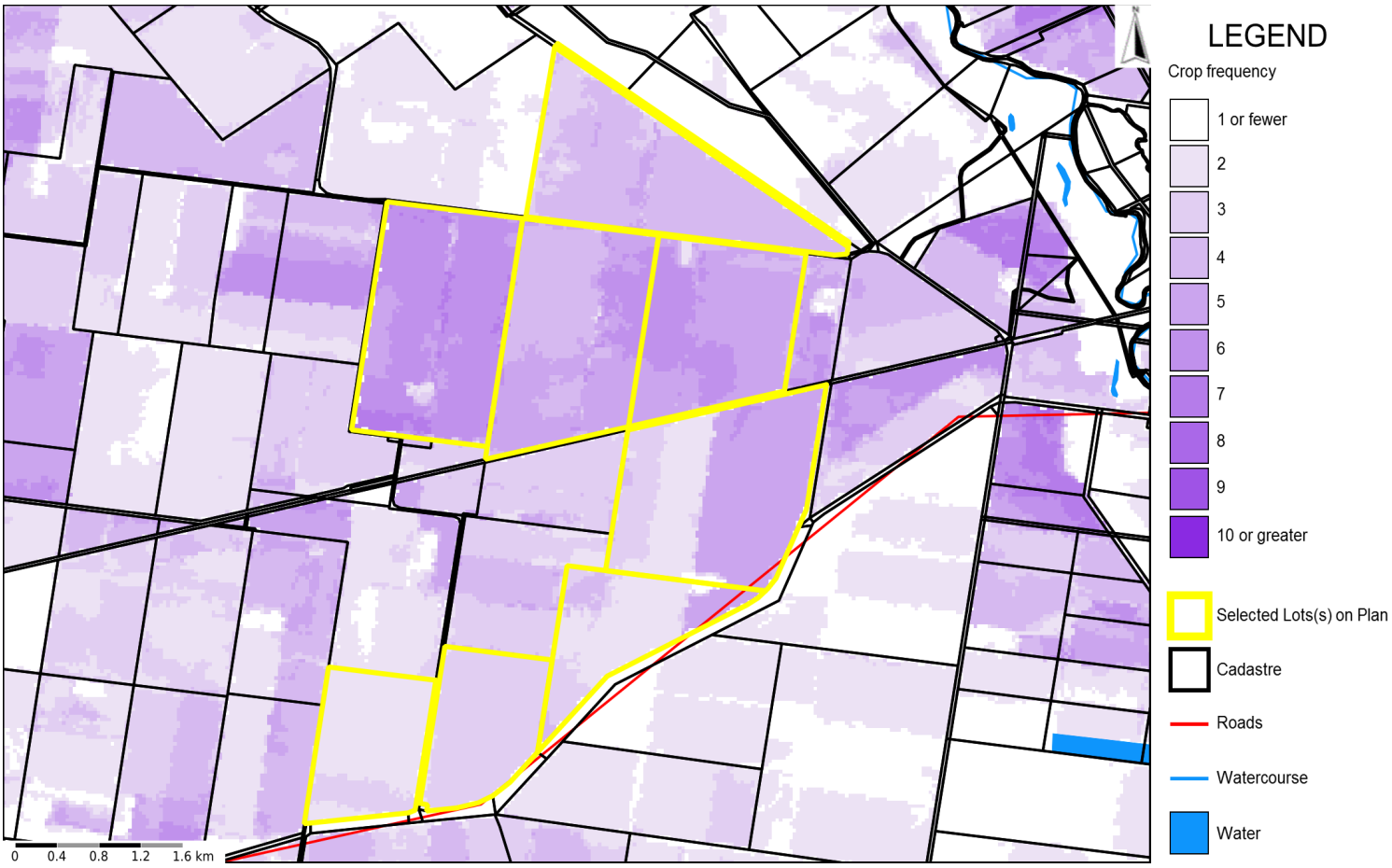


FORAGE REPORT: CROP FREQUENCY

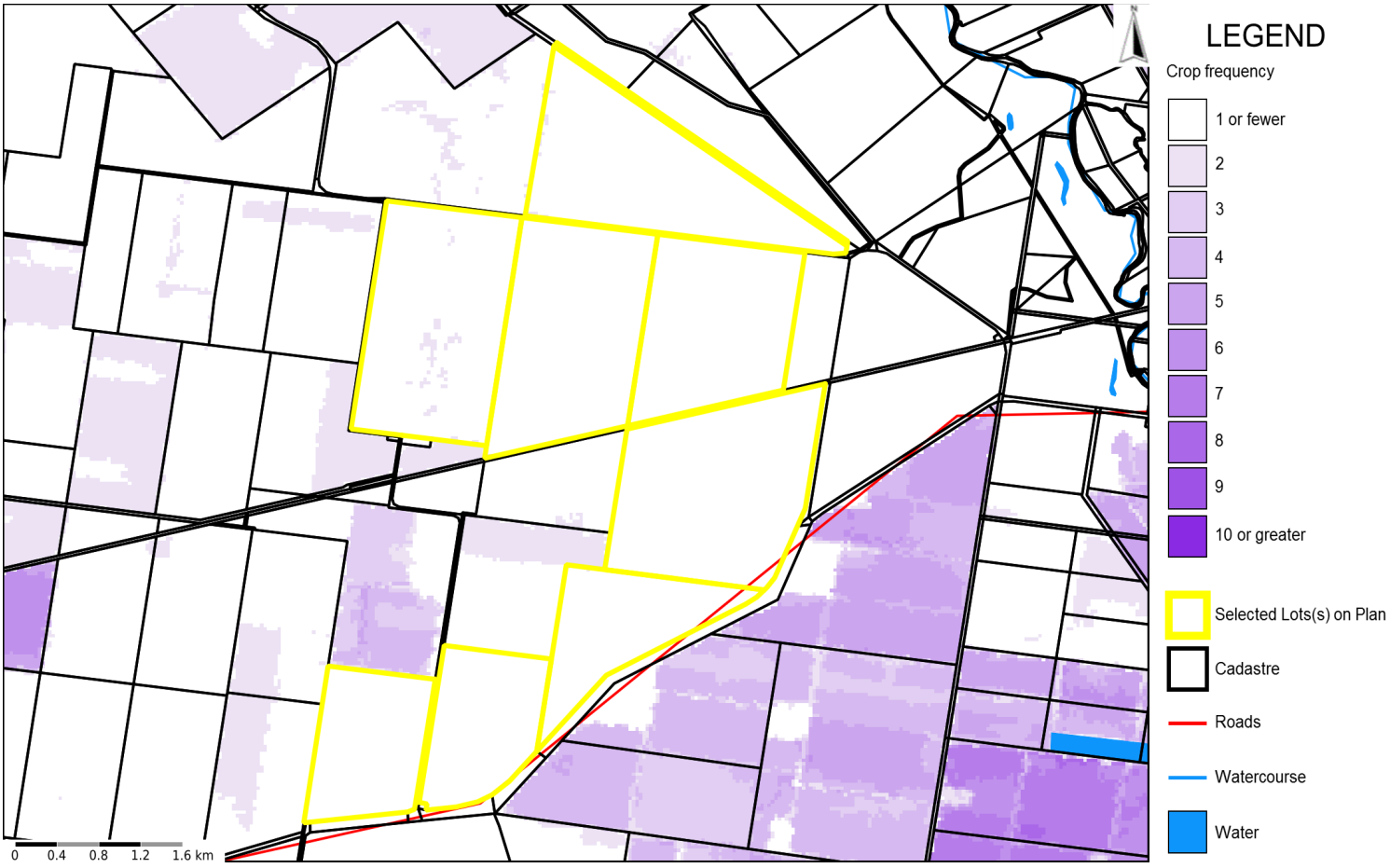
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 1DY931,2RP99387,1RP154777,70DY13 etc.* *Label: noLabel*

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)

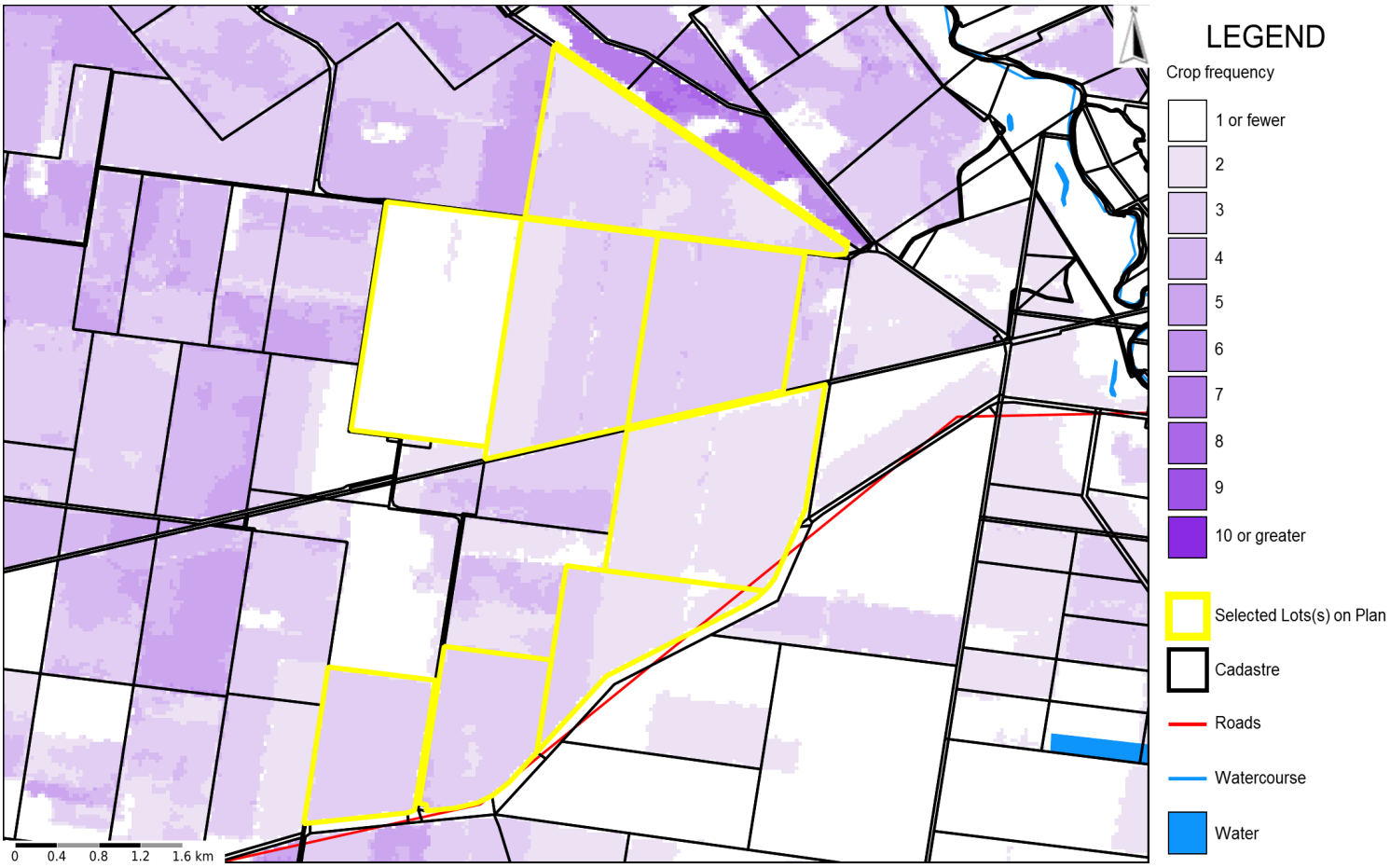


FORAGE REPORT: CROP FREQUENCY

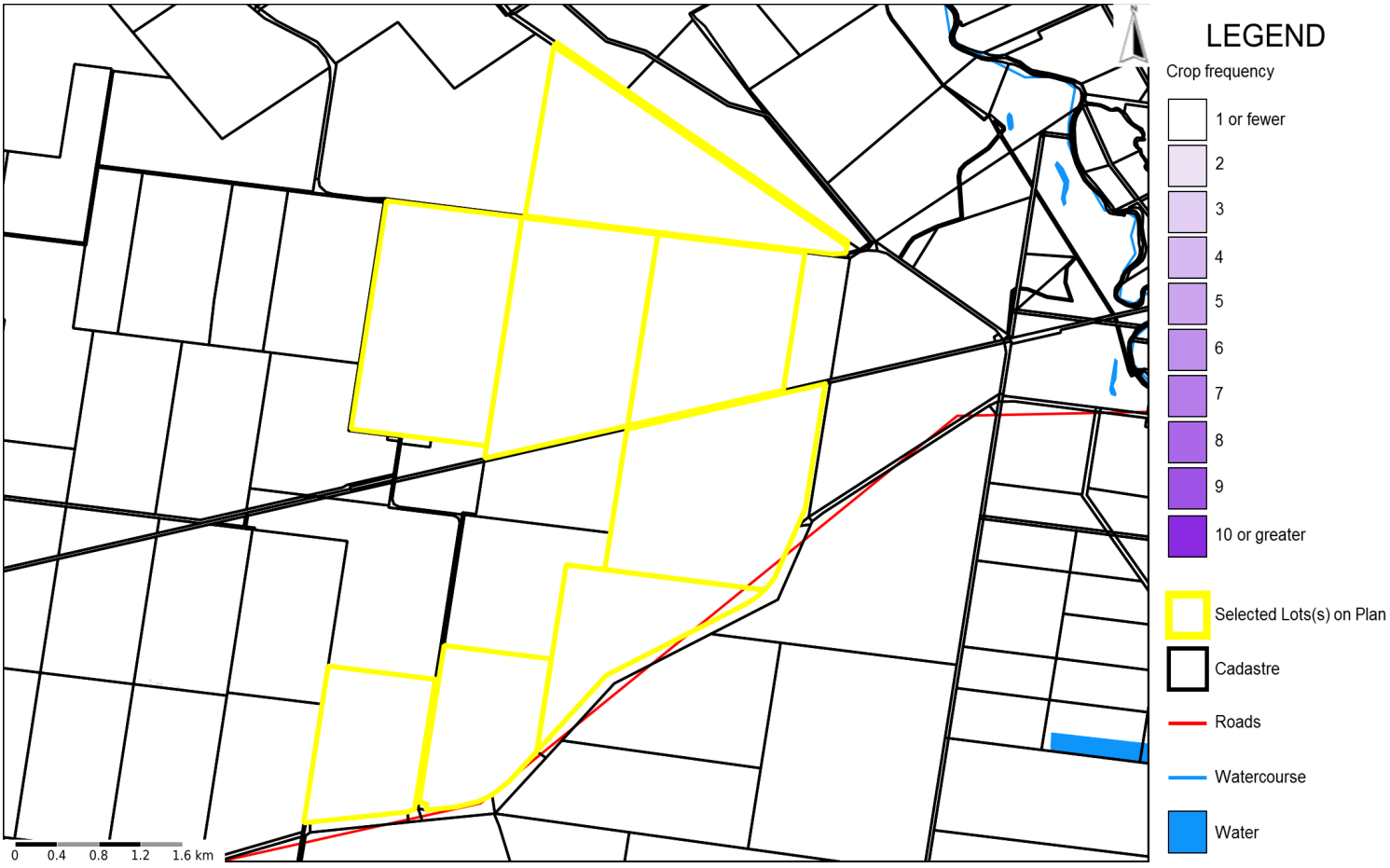
http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 1DY931,2RP99387,1RP154777,70DY13 etc.* *Label: noLabel*

Queensland Government

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



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

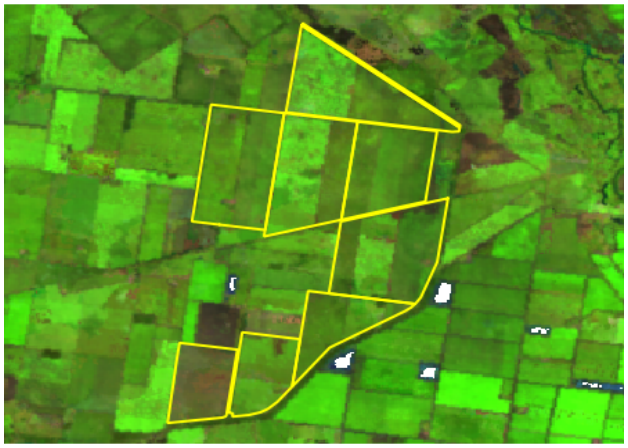


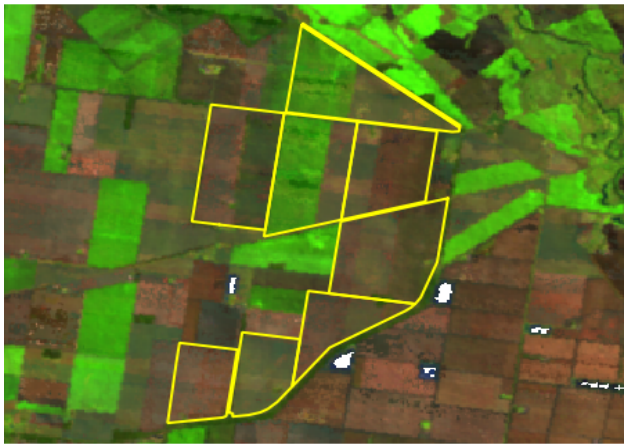
FORAGE REPORT: CROP FREQUENCY

http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 1DY931,2RP99387,1RP154777,70DY13 etc.* *Label: noLabel*

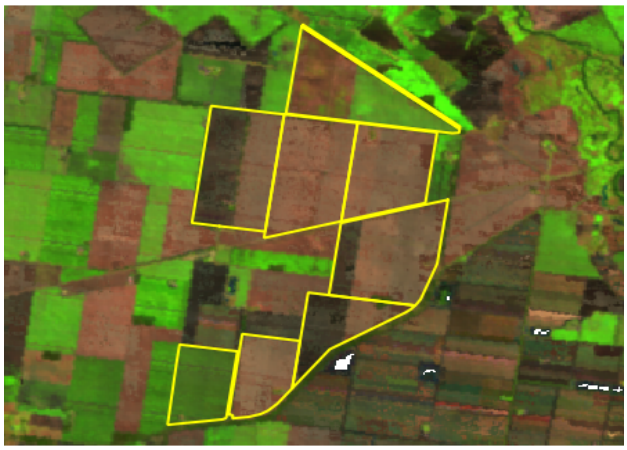
Queensland Government

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

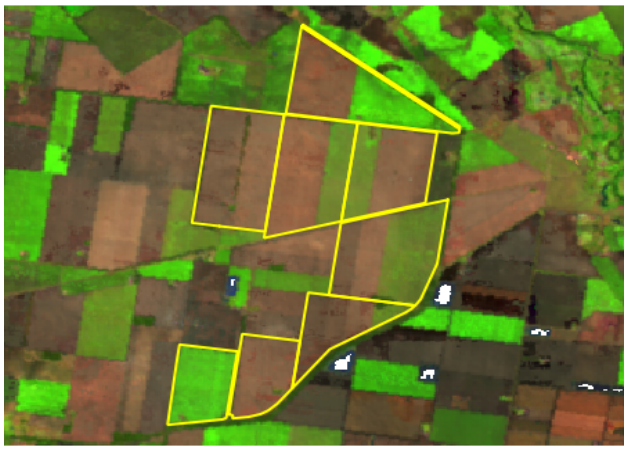




February (left) and September (right) images for 2012



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



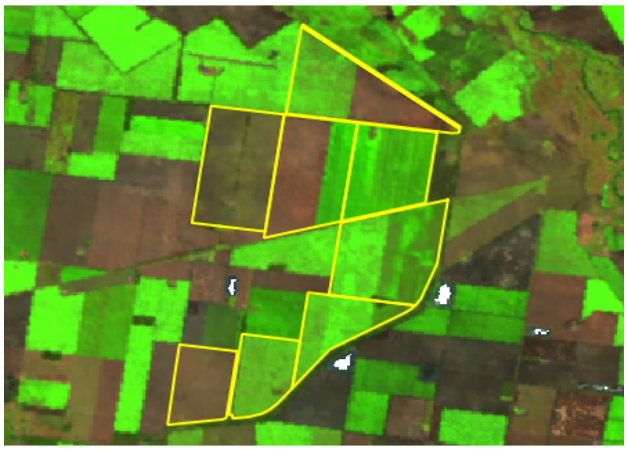
FORAGE REPORT: CROP FREQUENCY

http://www.longpaddock.qld.gov.au/forage *June 25, 2021* *Lot on Plan: 1DY931,2RP99387,1RP154777,70DY13 etc.* *Label: noLabel*

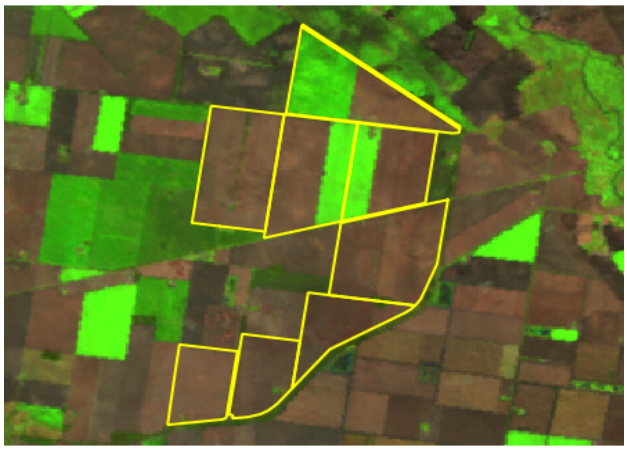
Queensland Government

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

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



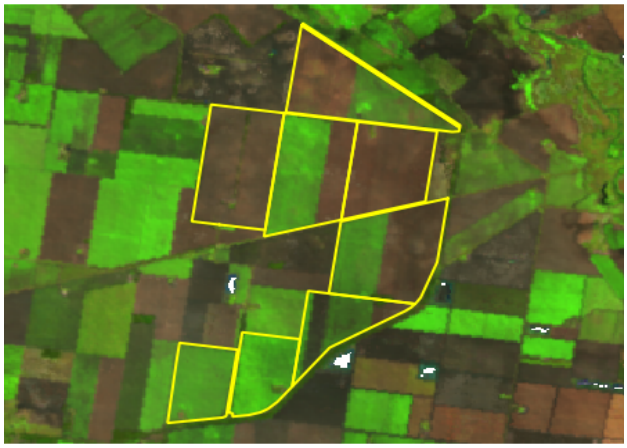
February (left) and September (right) images for 2016



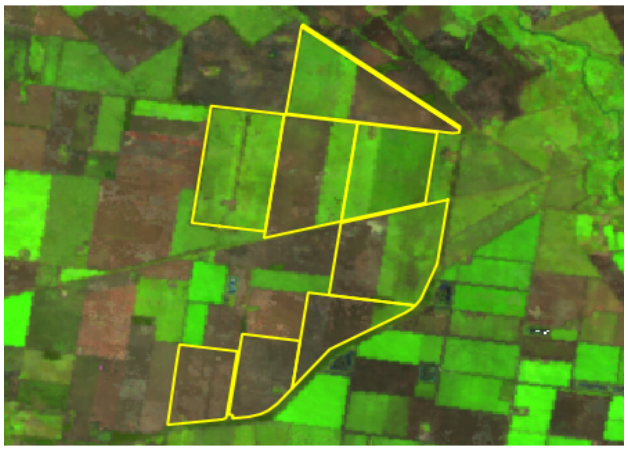
FORAGE REPORT: CROP FREQUENCY

Queensland Government

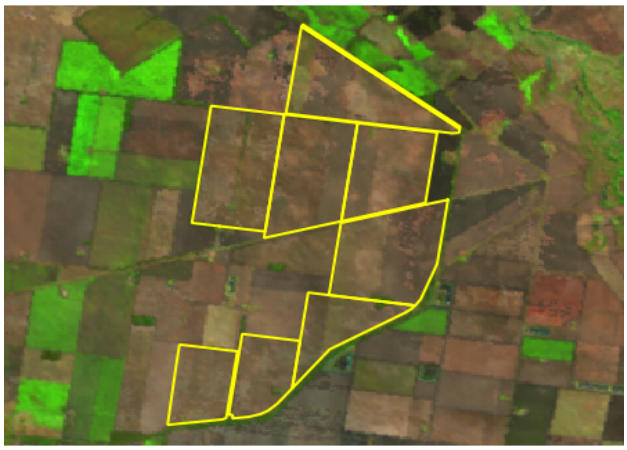
February (left) and September (right) images for 2017



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



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



FORAGE REPORT: CROP FREQUENCY

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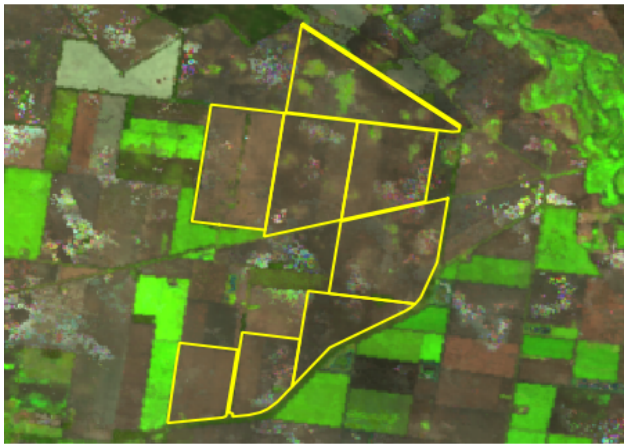
Queensland Government

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



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Appendix 7: Topography Map Series

arrow energy
go further

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

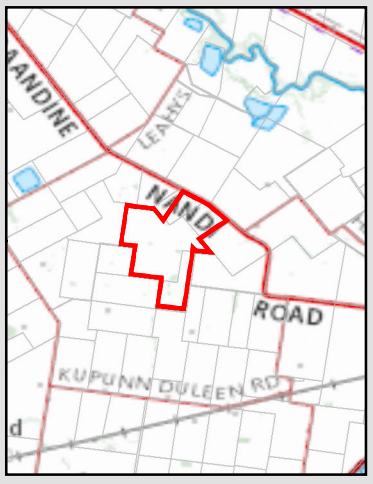
331m
330m
331m
331m
332m

HOADLEYS ROAD

Legend

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

Location Diagram



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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

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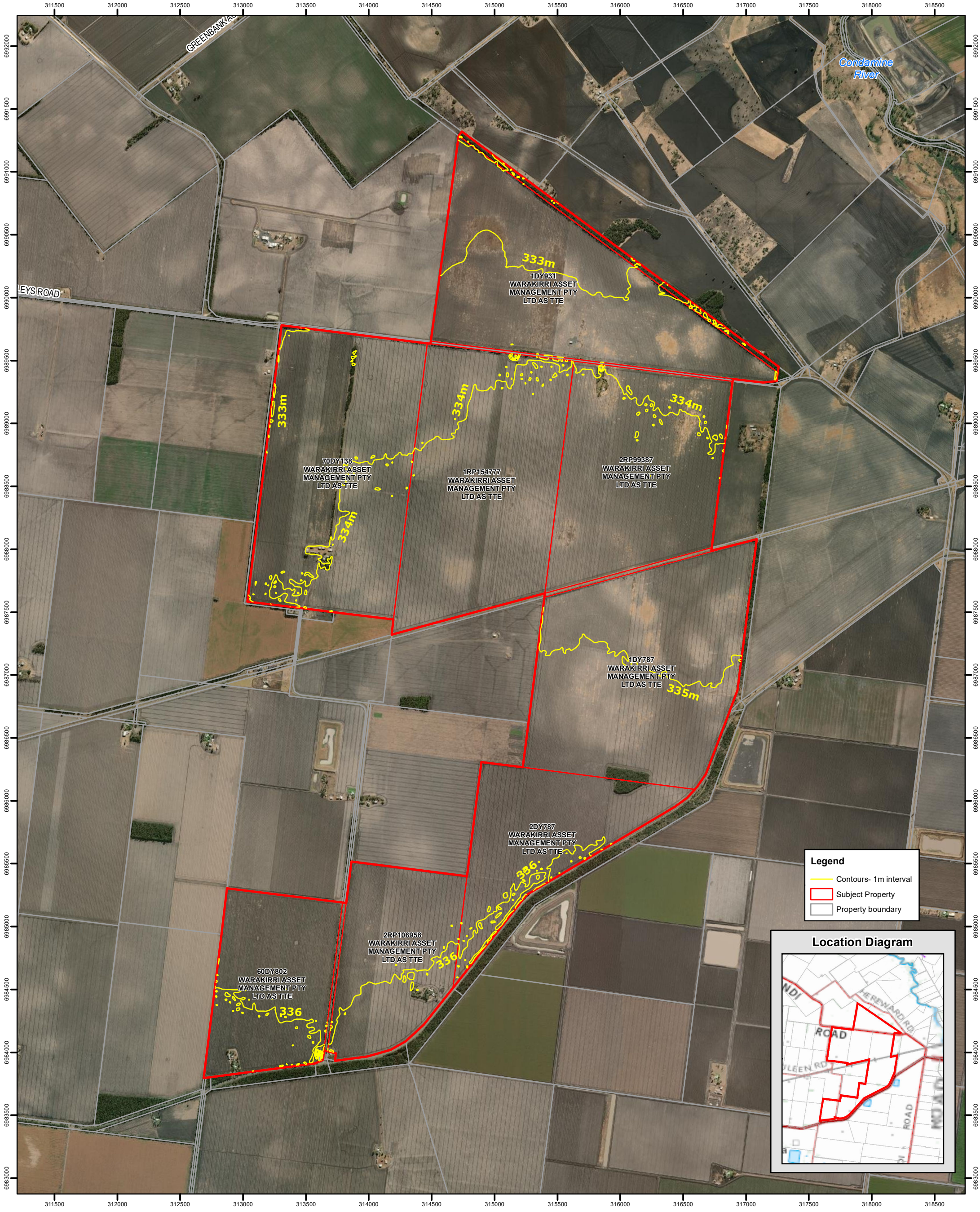

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Rev	Date	Revision Description	Orig	Chk'd	Eng	QA	App
0	20/09/2021	Initial issue.	AW	AH	--	--	AH

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Author: awolhuter

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Surat Basin
Warakirri Asset Management Property 2

- Topography

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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

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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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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.

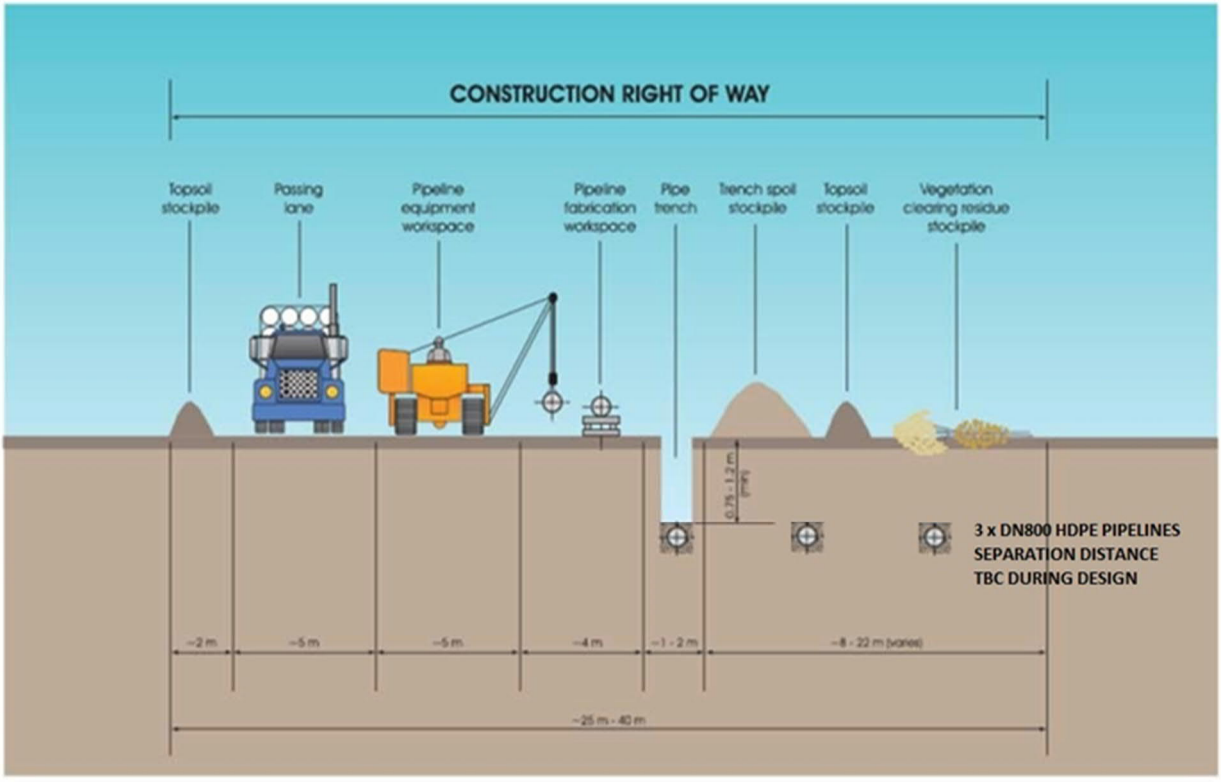
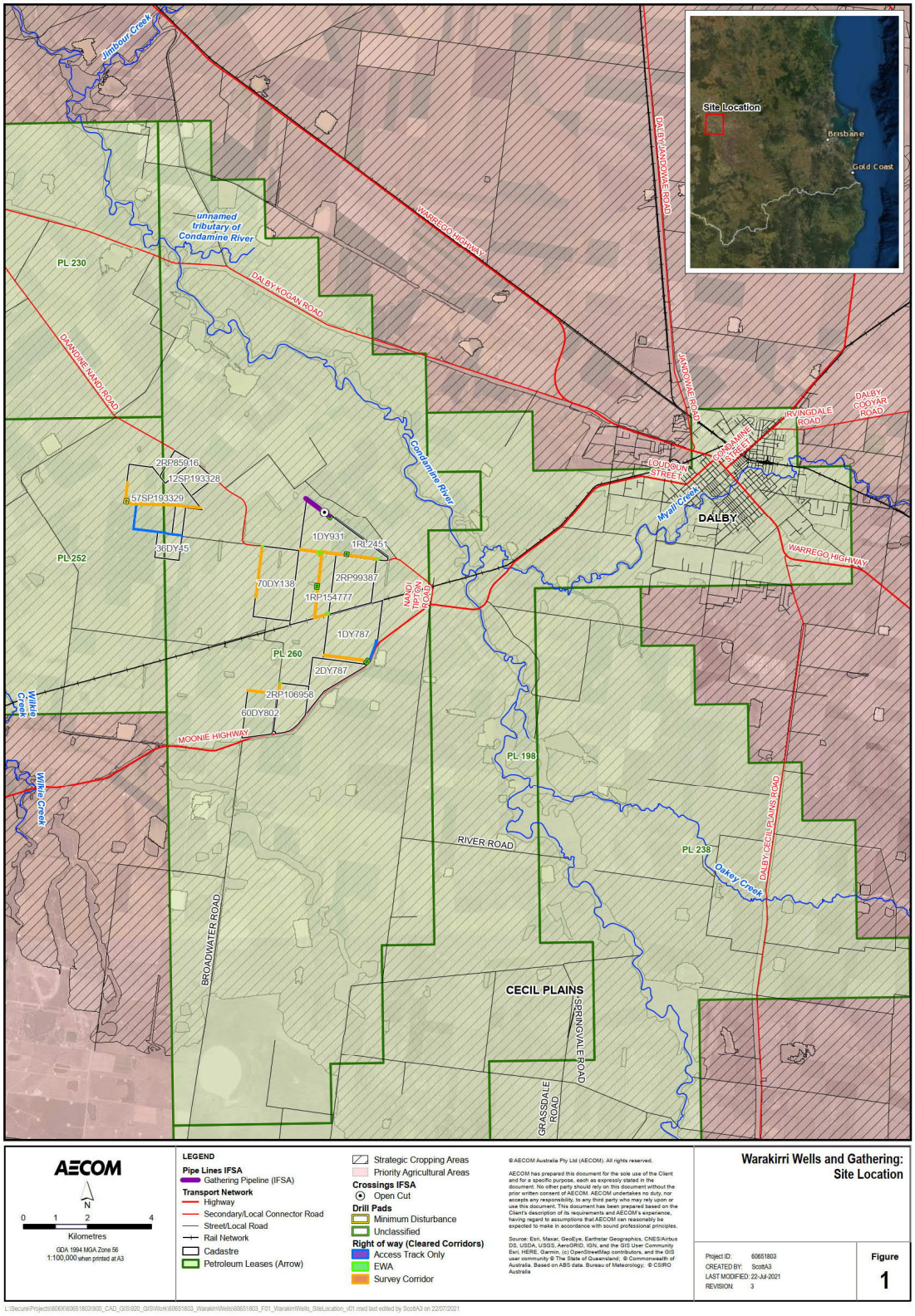


Plate 1 Typical Pipeline ROW Layout

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

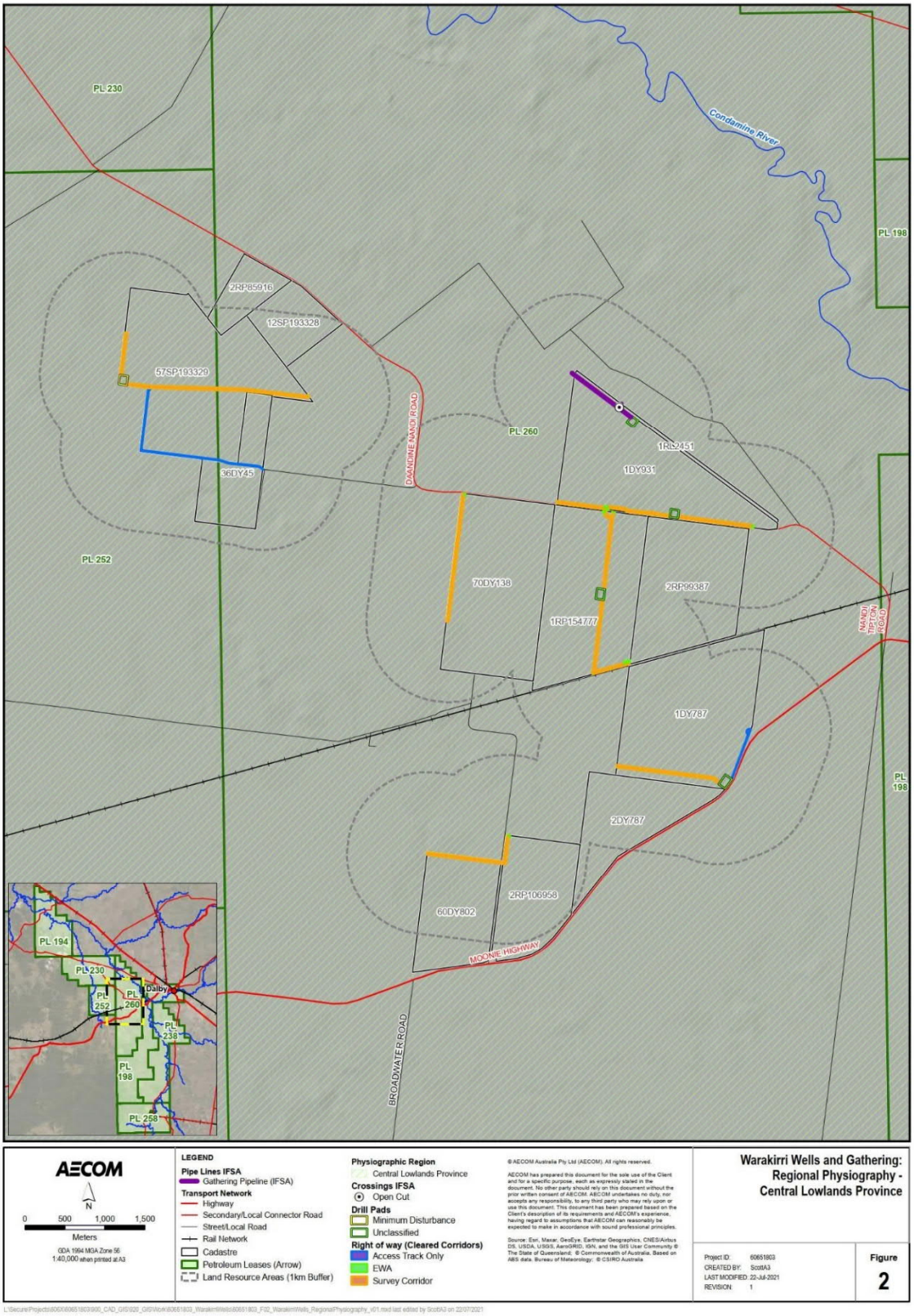


Figure 3 Slope Class and Slope Range (%)

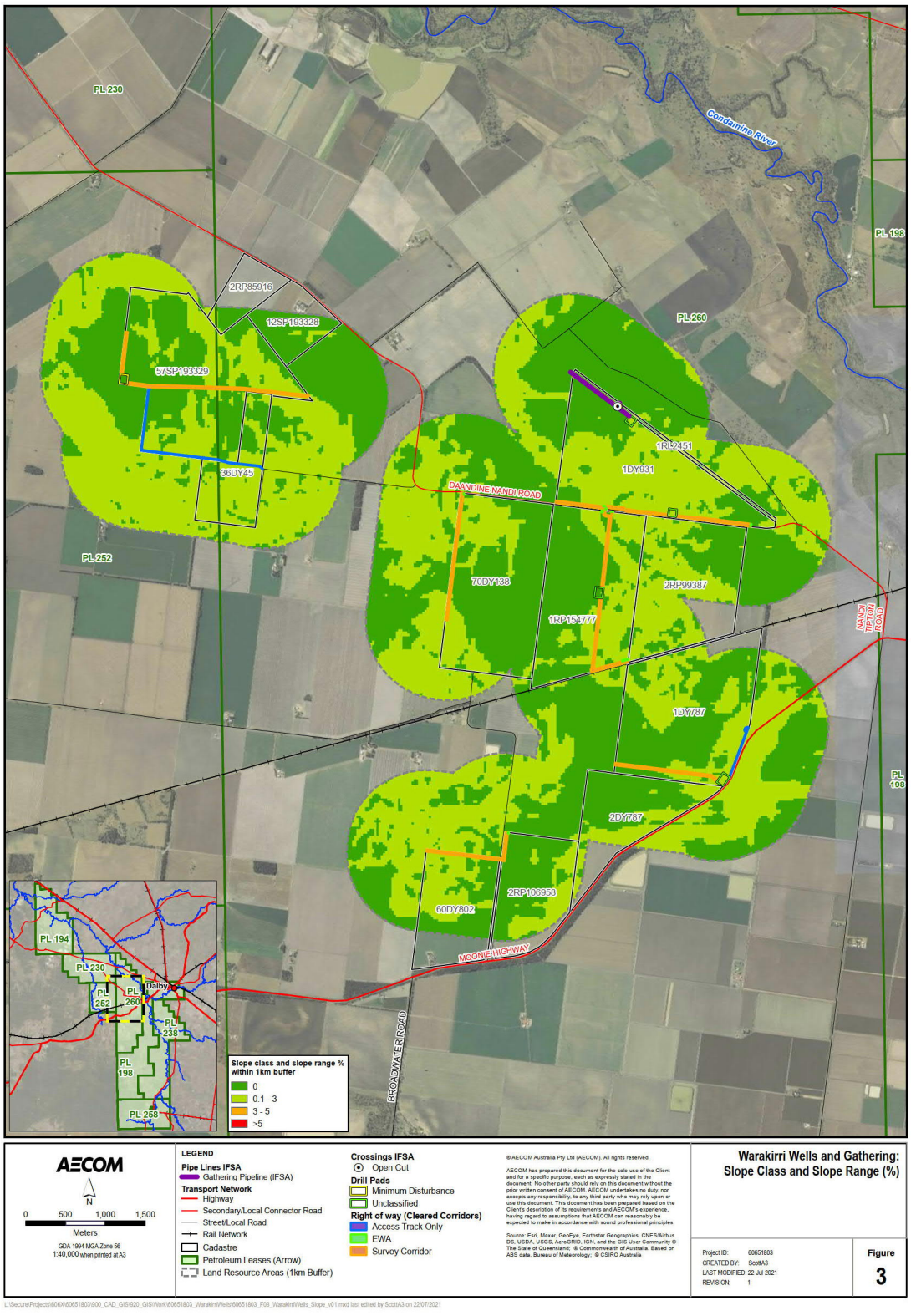
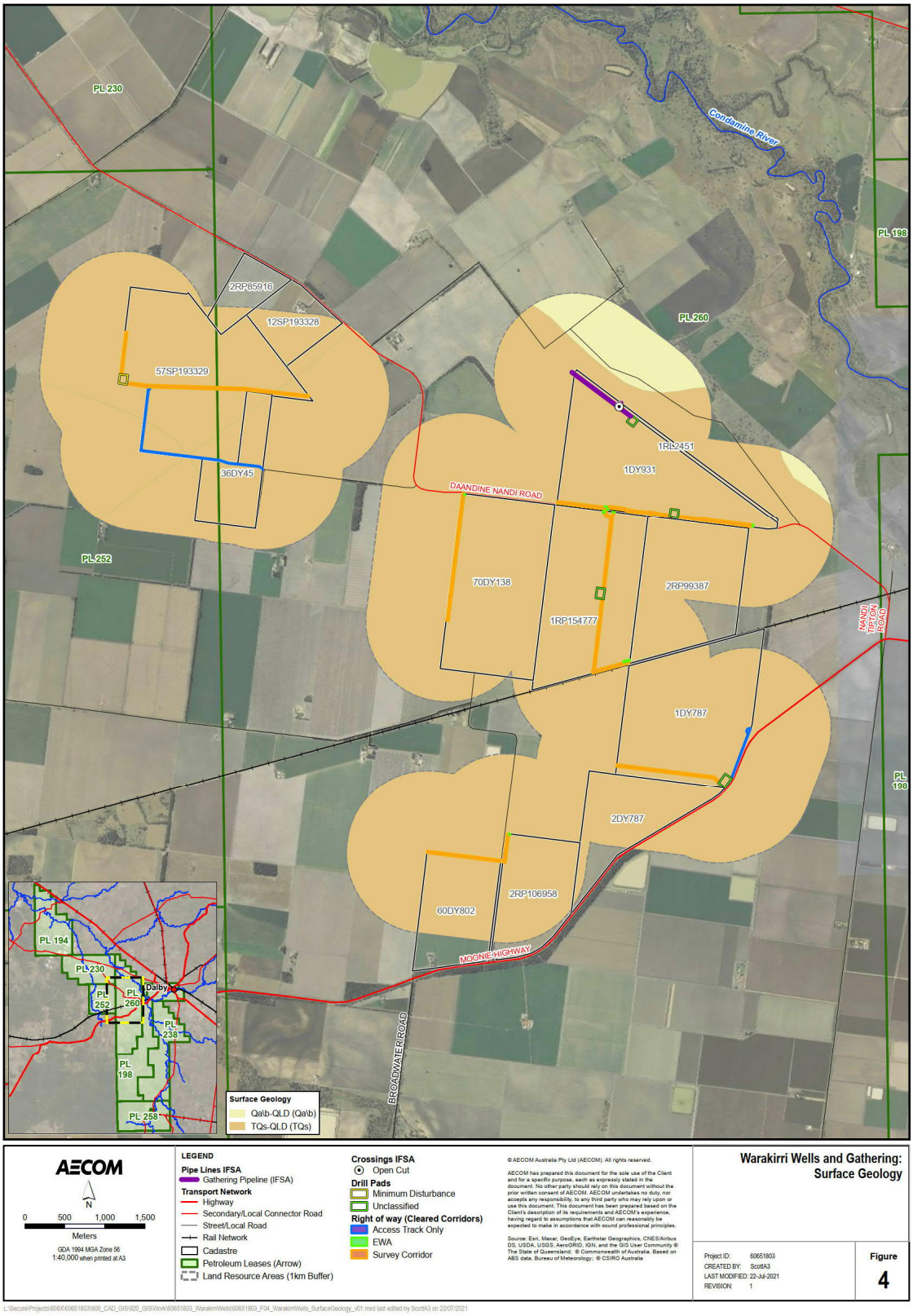


Figure 4 Surface Geology



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).

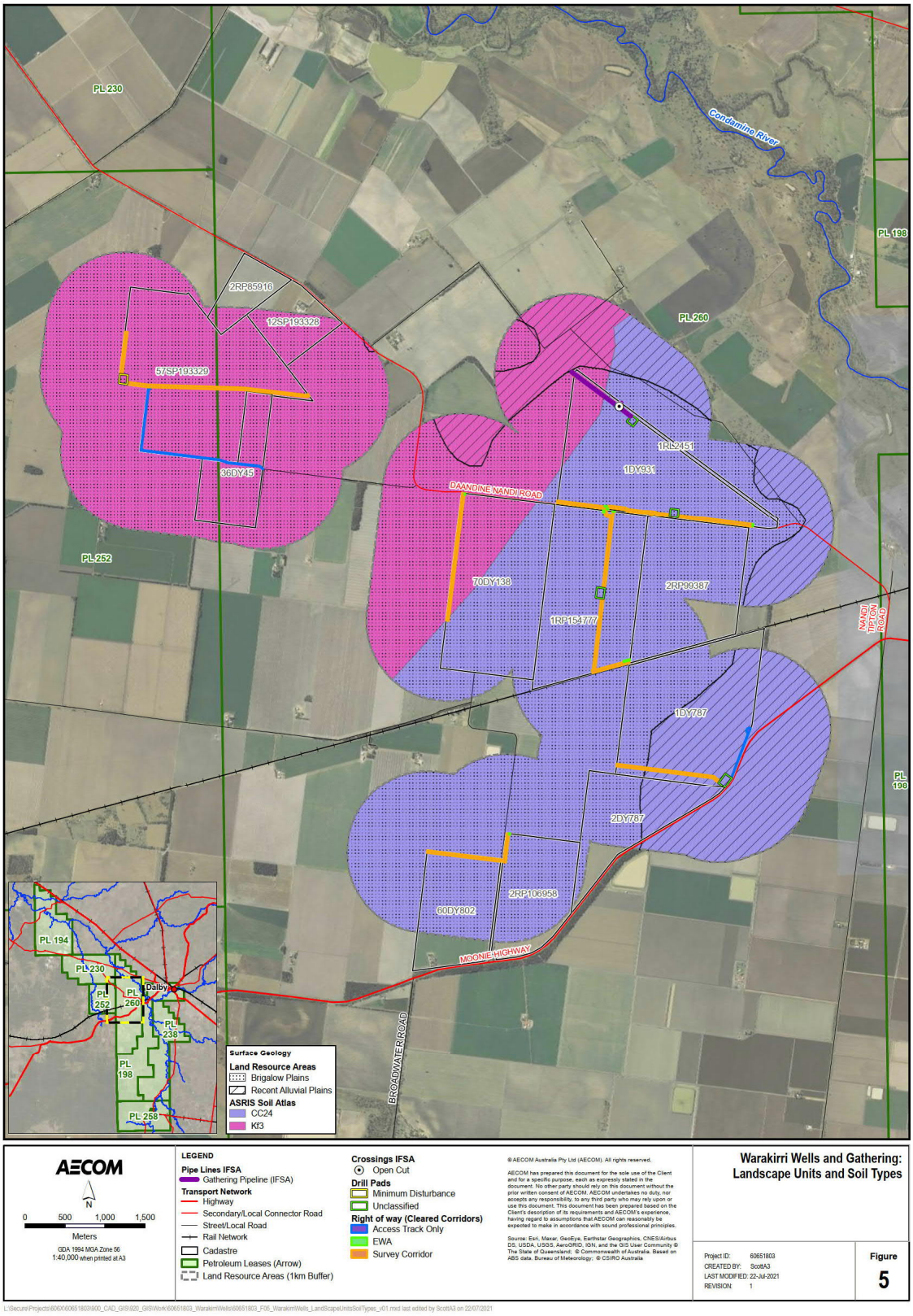
Table 2 Soil landscapes which intersect the Project

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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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

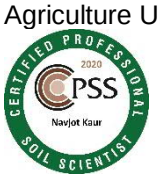
2001 - 2003
Coffey Geosciences Pty Ltd
Environmental Scientist

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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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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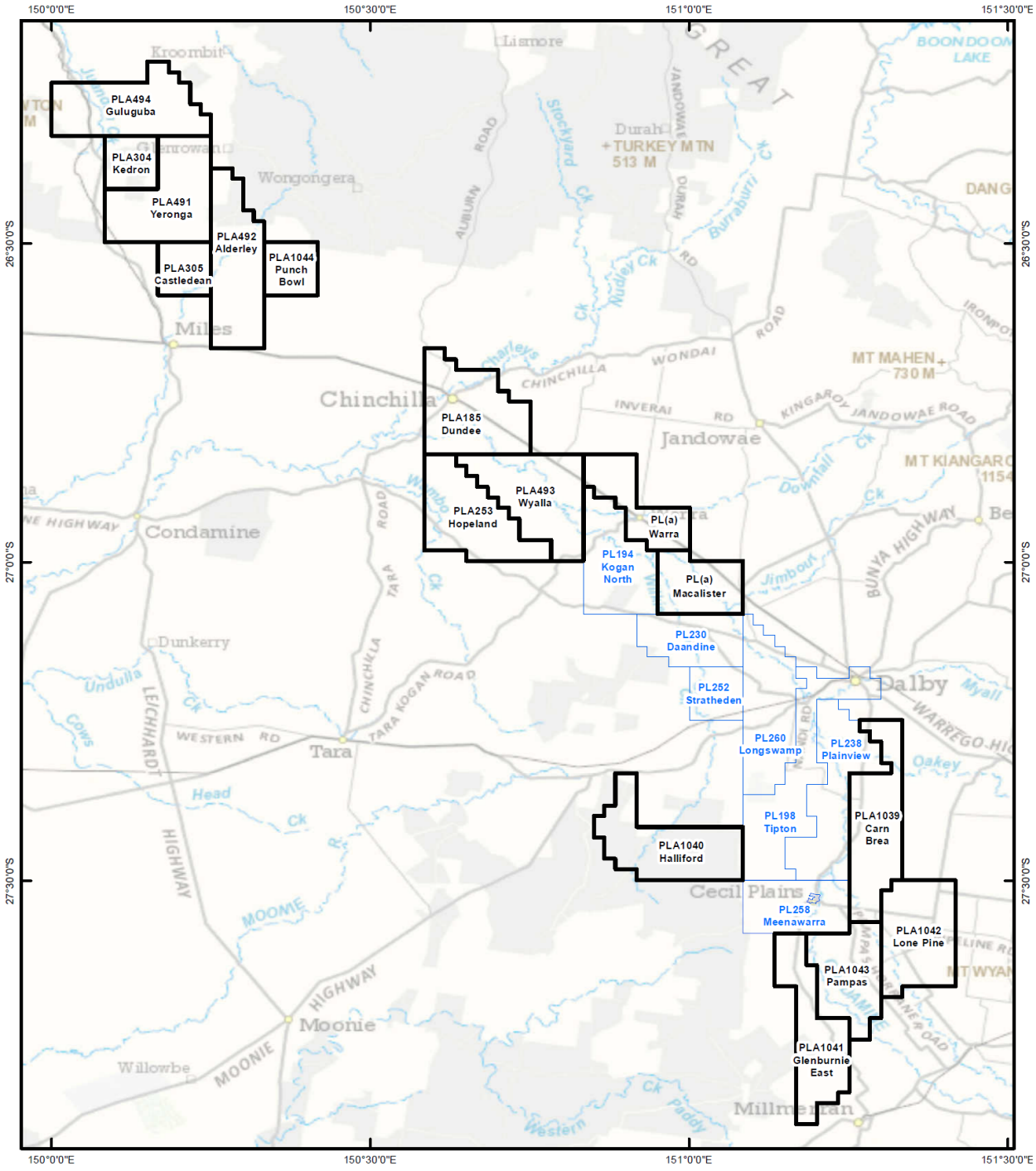

N

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.

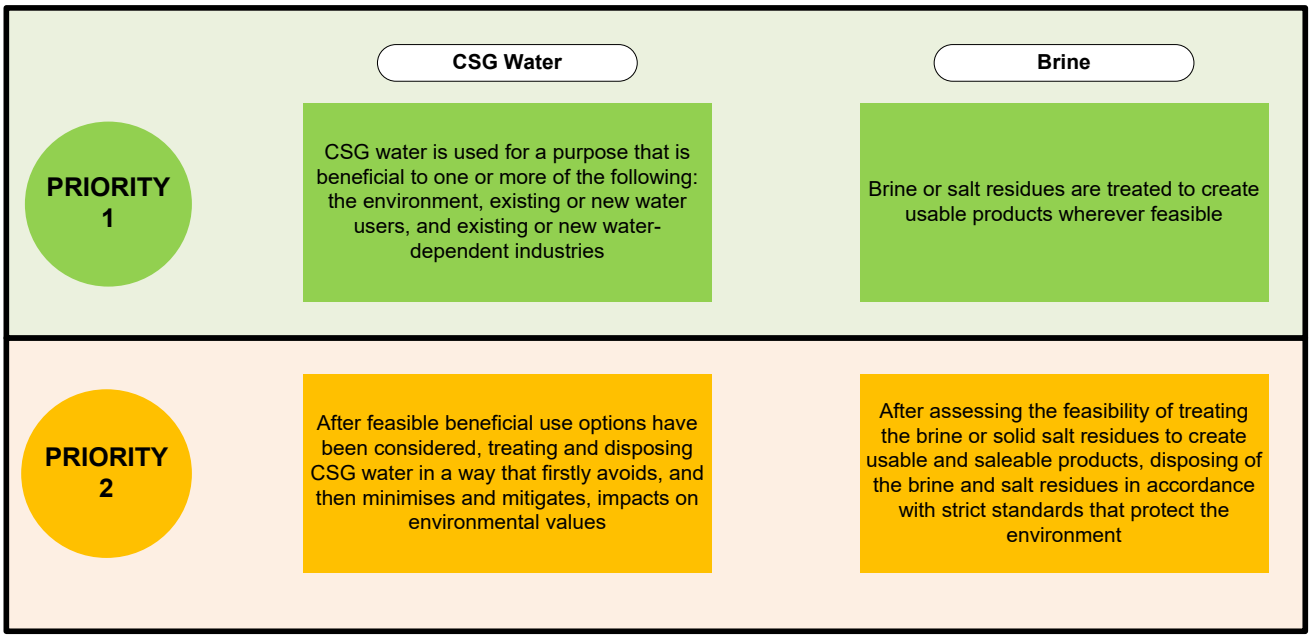


Figure 1-2 DES Prioritisation Hierarchies for CSG Water and Brine Management

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.

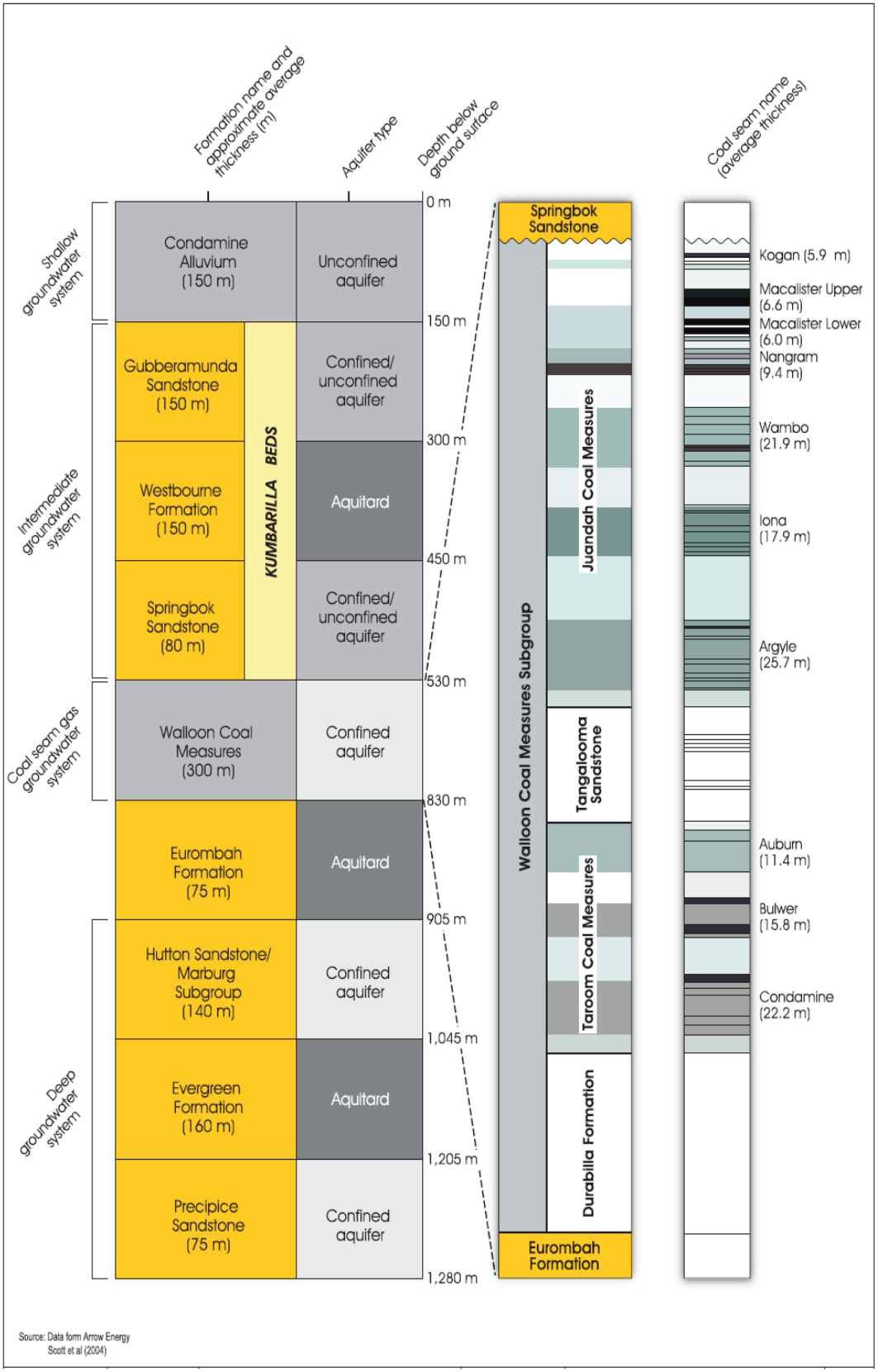
2.3 Groundwater

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.

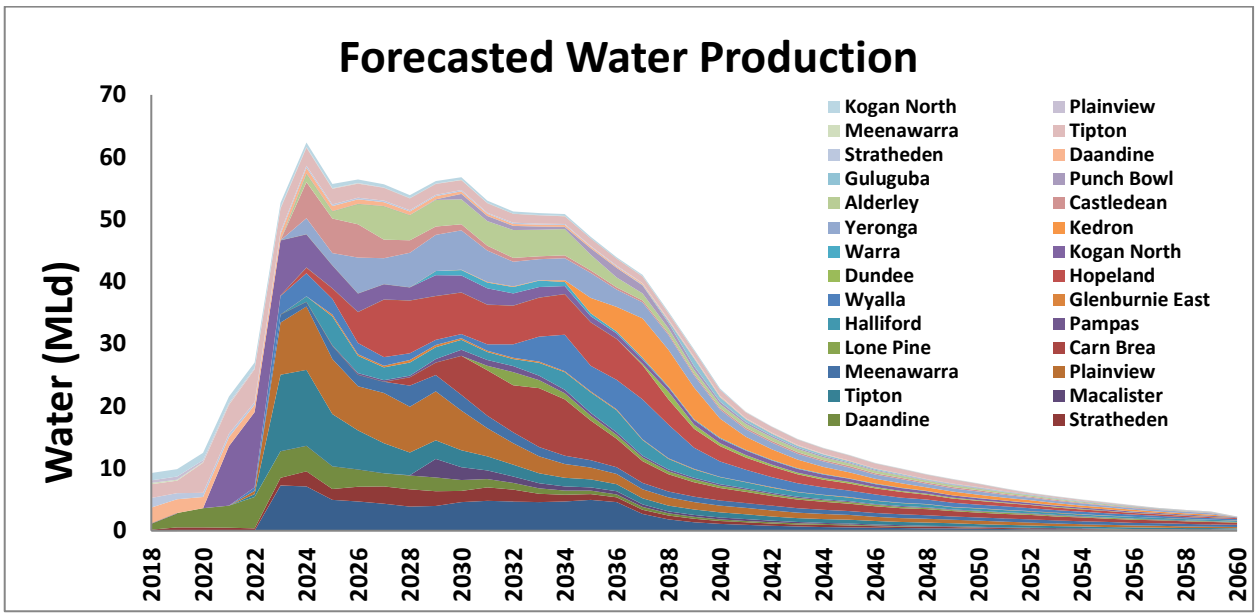
3.1 CSG Water Quantity

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.

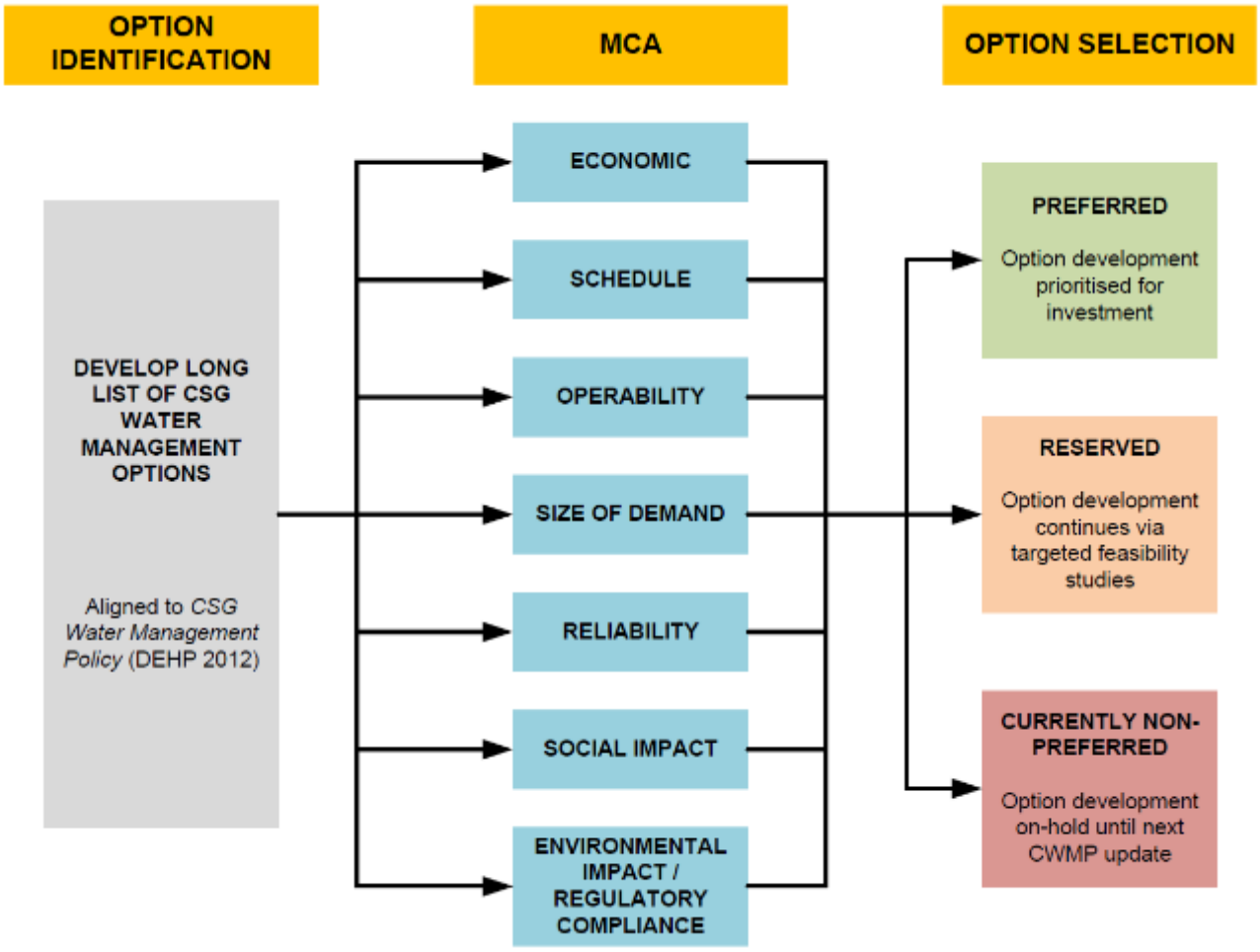


Figure 3-2 Option Selection and MCA Framework

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.

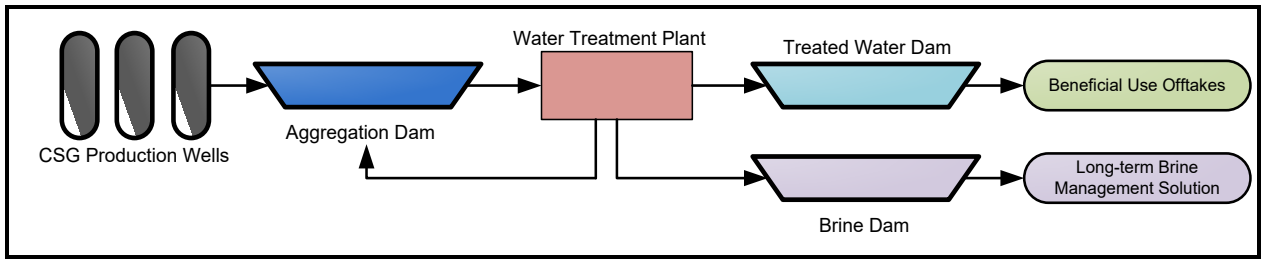
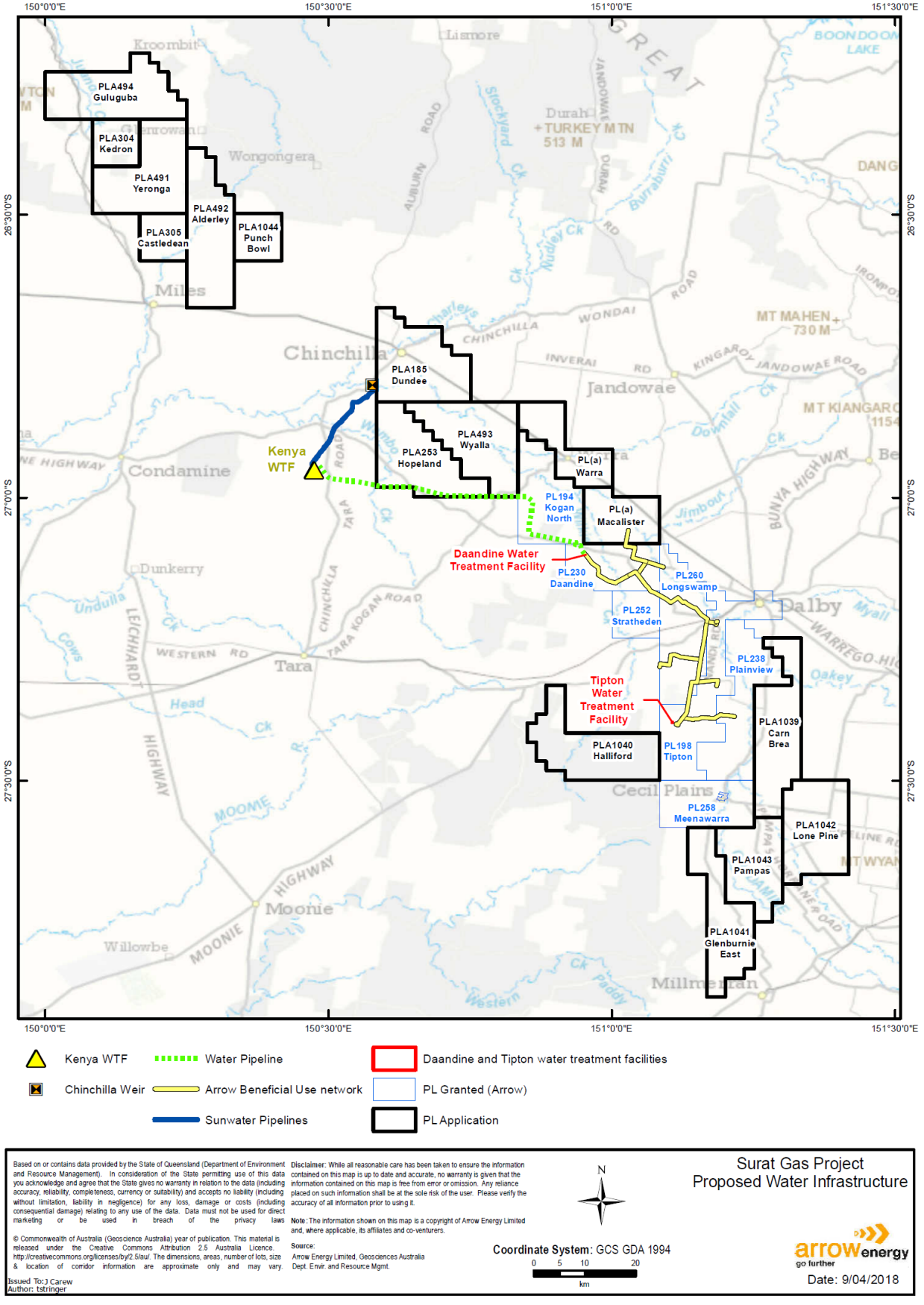


Figure 4-1 Conceptual Diagram of CSG Water Management



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Surat Gas Project
Proposed Water Infrastructure

arrow energy go further

Date: 9/04/2018

Figure 4-2 Proposed SGP CSG Water Management Network

arrow energy go further

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.

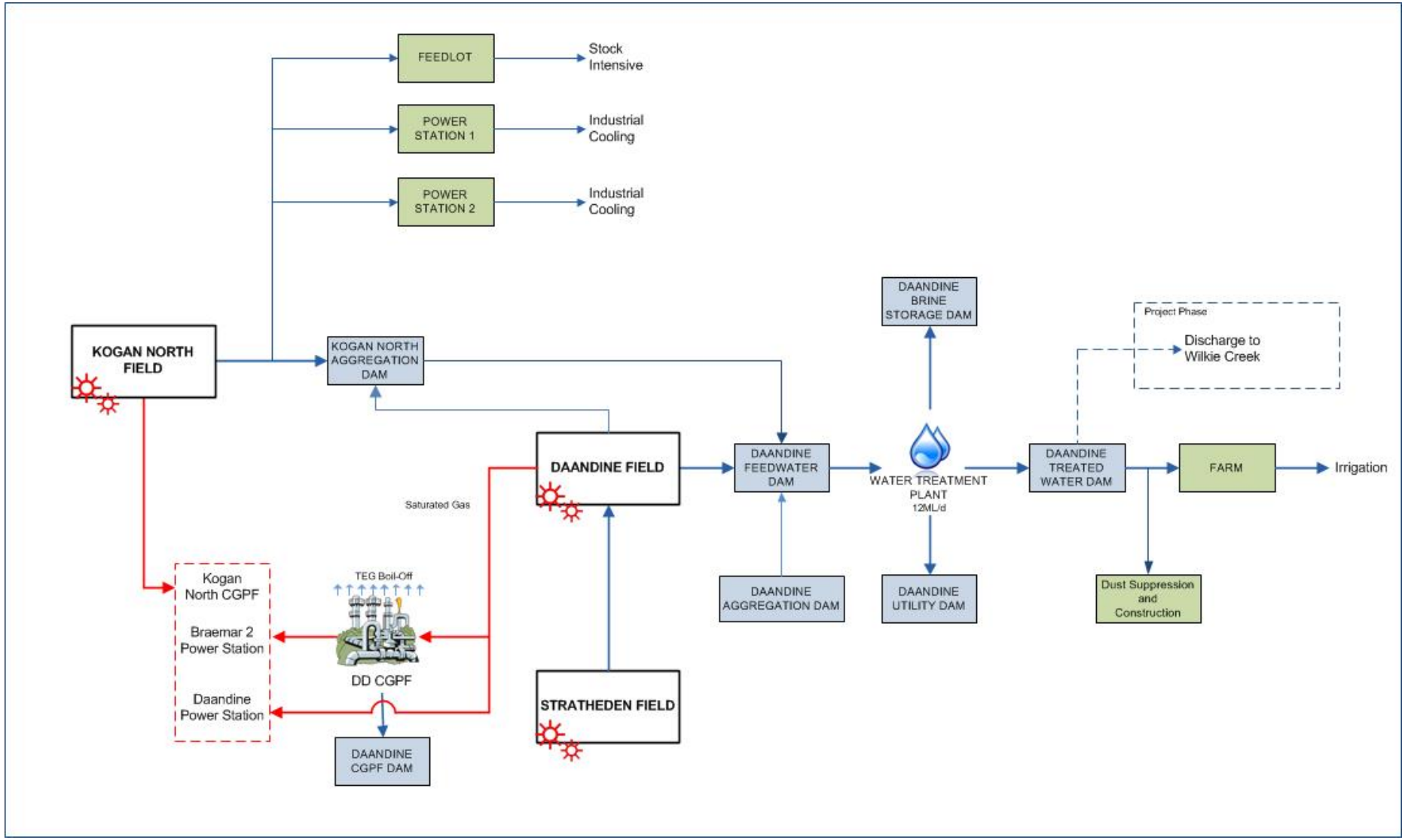

Figure 4-3 **Schematic diagram of the Daandine Water Management Network**

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

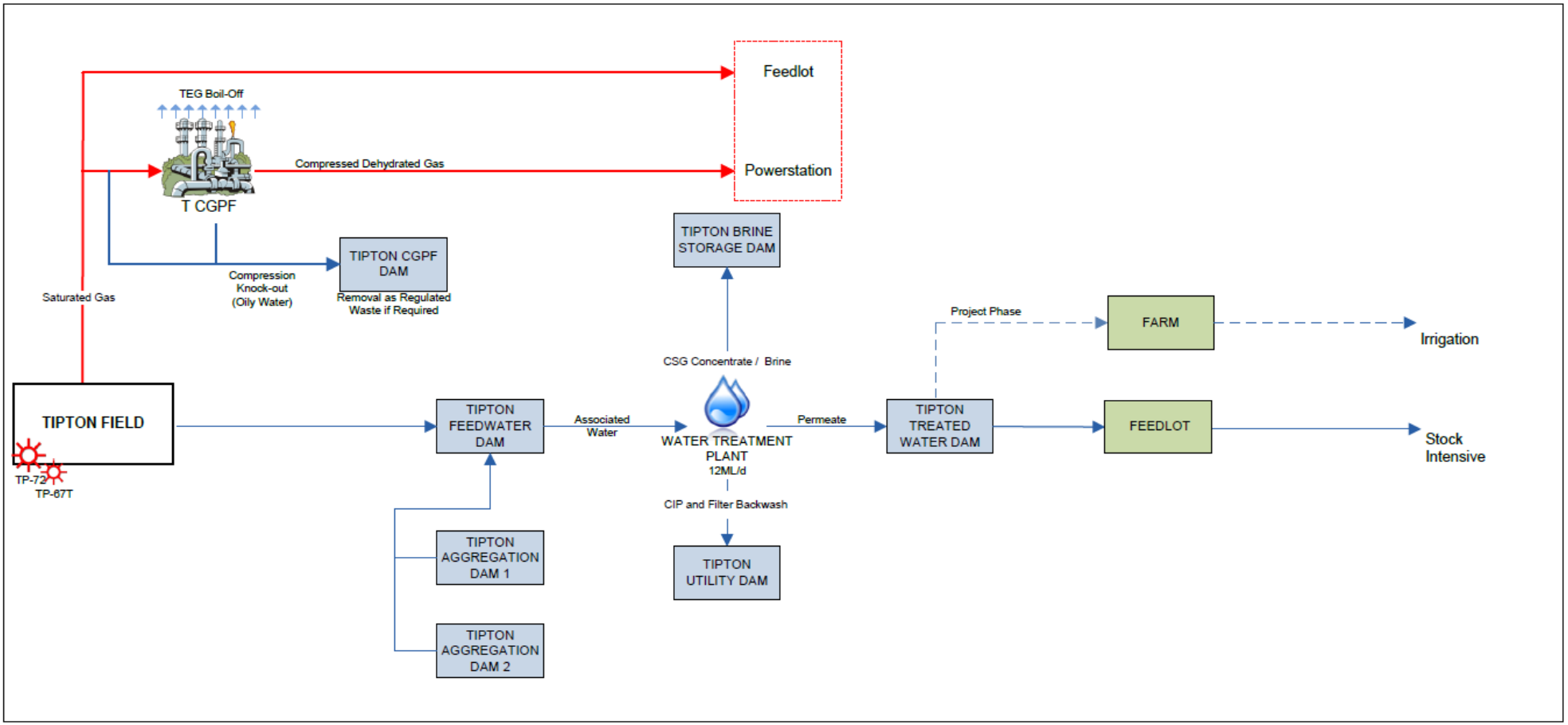

Figure 4-4 **Schematic diagram of the Tipton Water Management Network**

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

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Baseline Report

Surface Elevation Data – Warakirri Holdings

12SP193328, 2RP85916, 57SP193329, 36DY45, 1RL2451, 1DY931, 70DY138, 1RP154777, 1DY787, 2DY787, 60DY802 and 2RP106958.

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 Warakirri Holdings, lots on plans, 12SP193328, 2RP85916, 57SP193329, 36DY45, 1RL2451, 1DY931, 70DY138, 1RP154777, 1DY787, 2DY787, 60DY802 and 2RP106958. :

- 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.

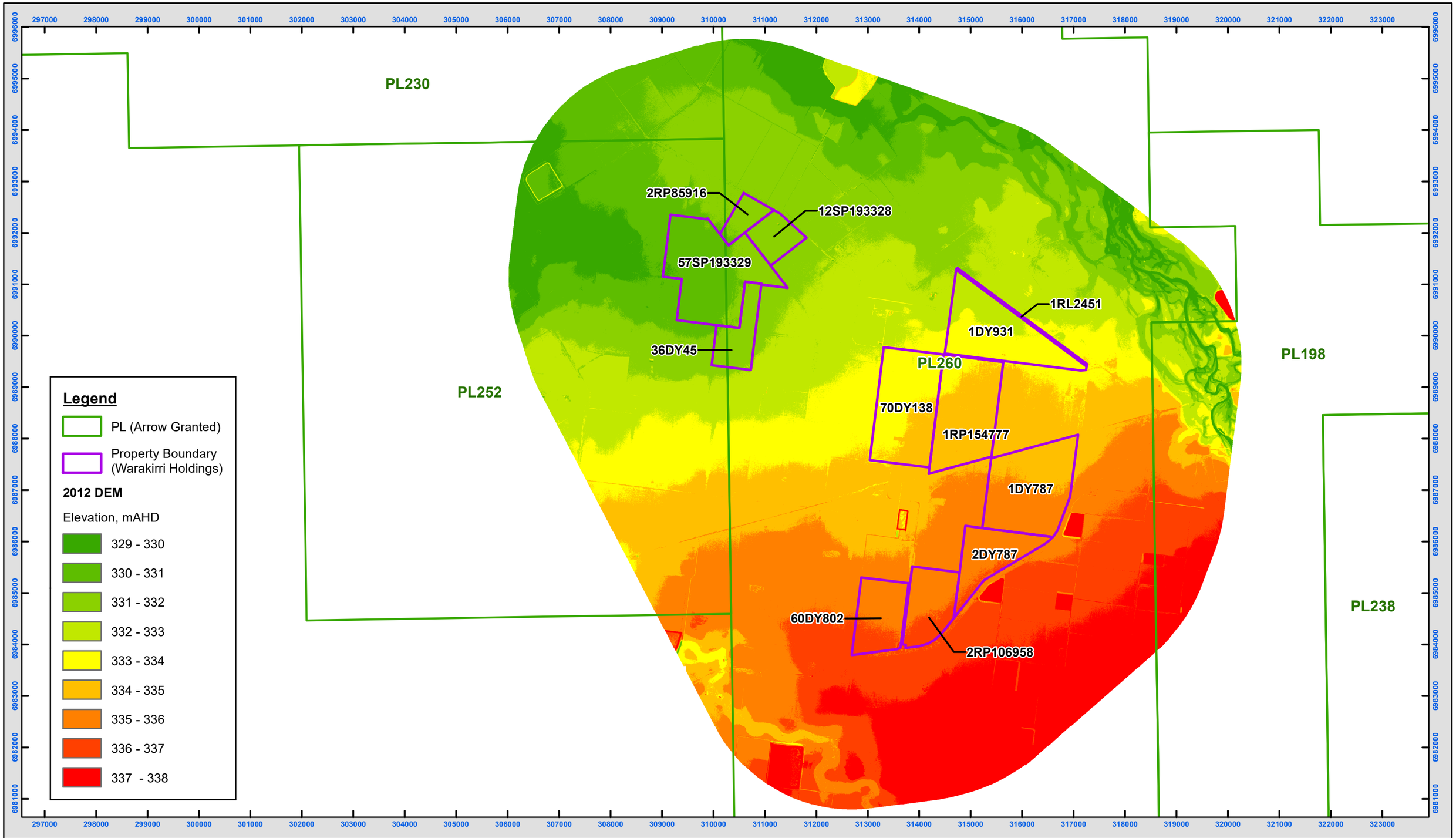

Figure 1 : 2012 DEM

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

2 1 0 2 Kilometres

Scale: 1:70,000 @ 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

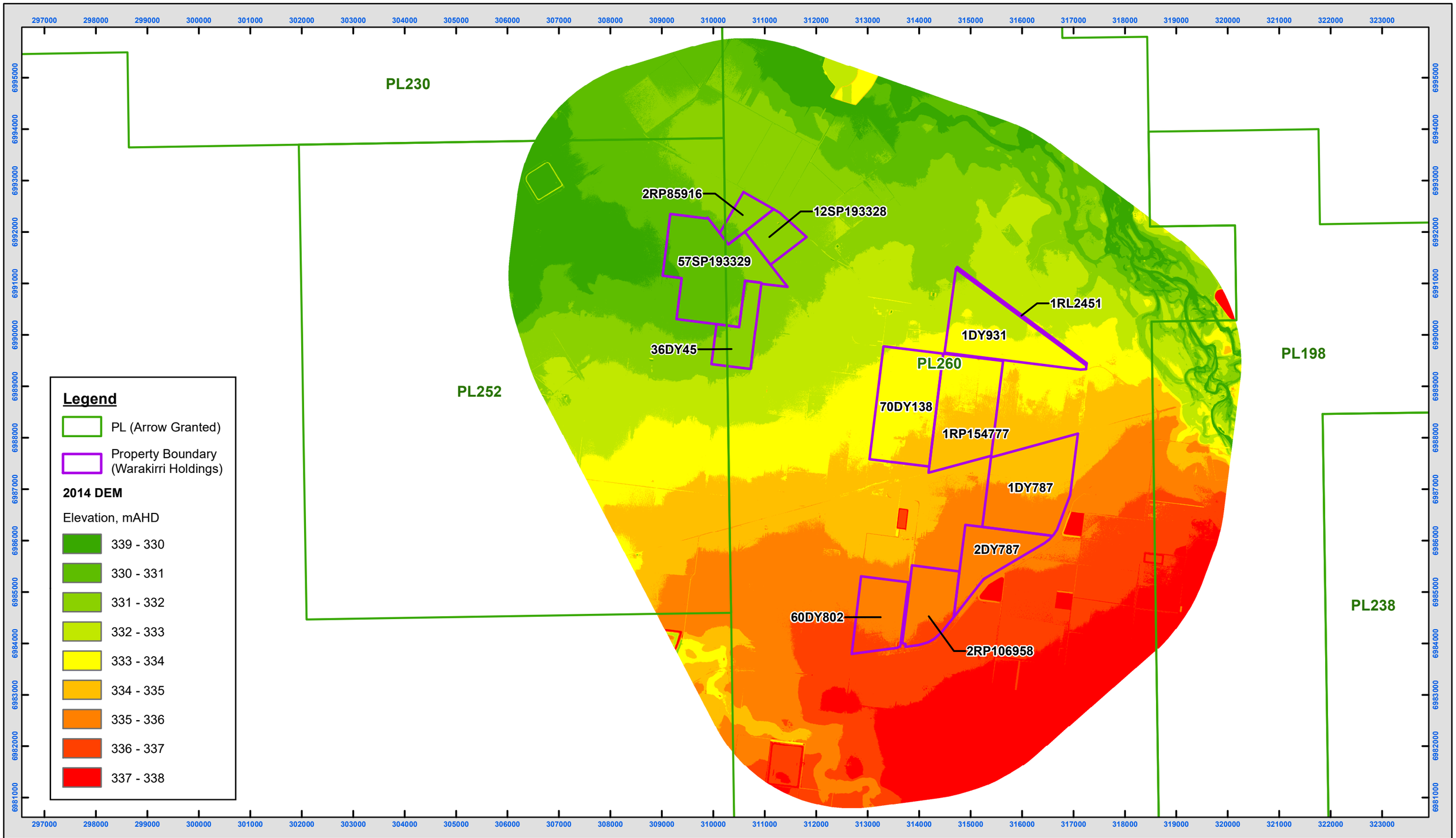

Figure 2 : 2014 DEM

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

2 1 0 2 Kilometres

Scale: 1:70,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

NOT FOR CONSTRUCTION

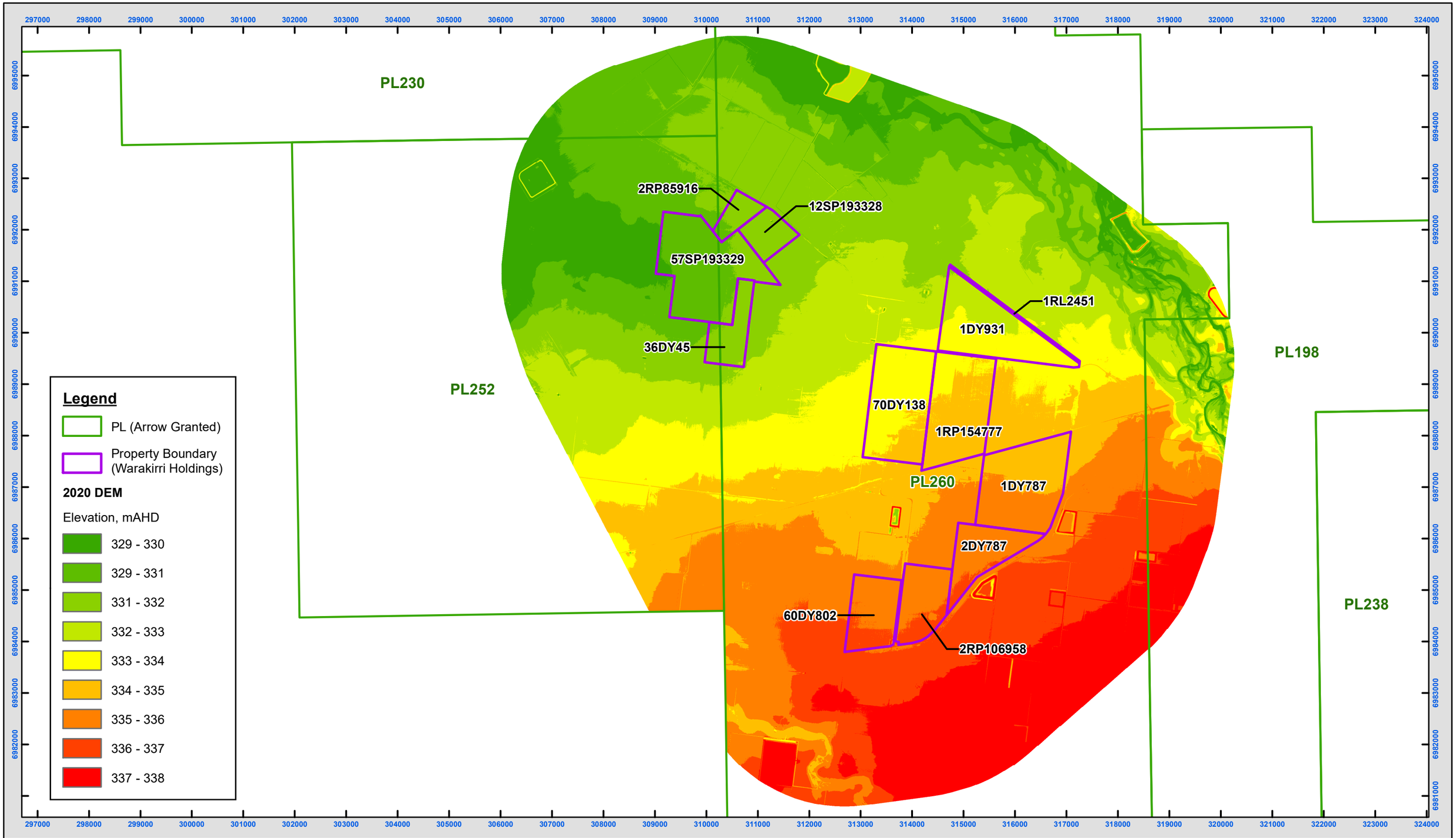

Figure 3 : 2020 DEM

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

2 1 0 2 Kilometres

Scale: 1:70,000 @ A3

Coordinate System: GDA2020 MGA Zone 56

GDA

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The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

NOT FOR CONSTRUCTION

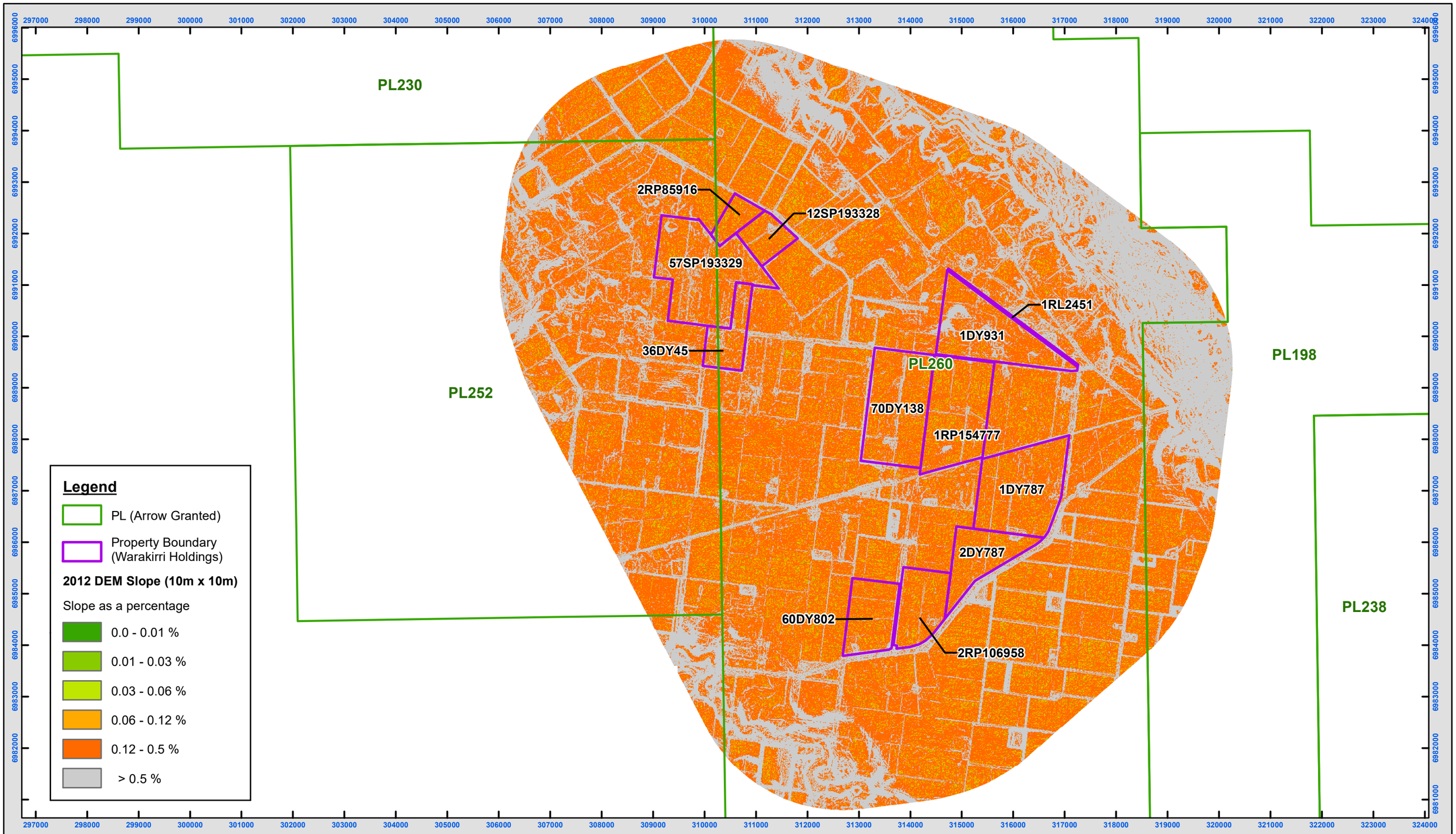

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

2 1 0 2 Kilometres

Scale: 1:70,000 @ 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

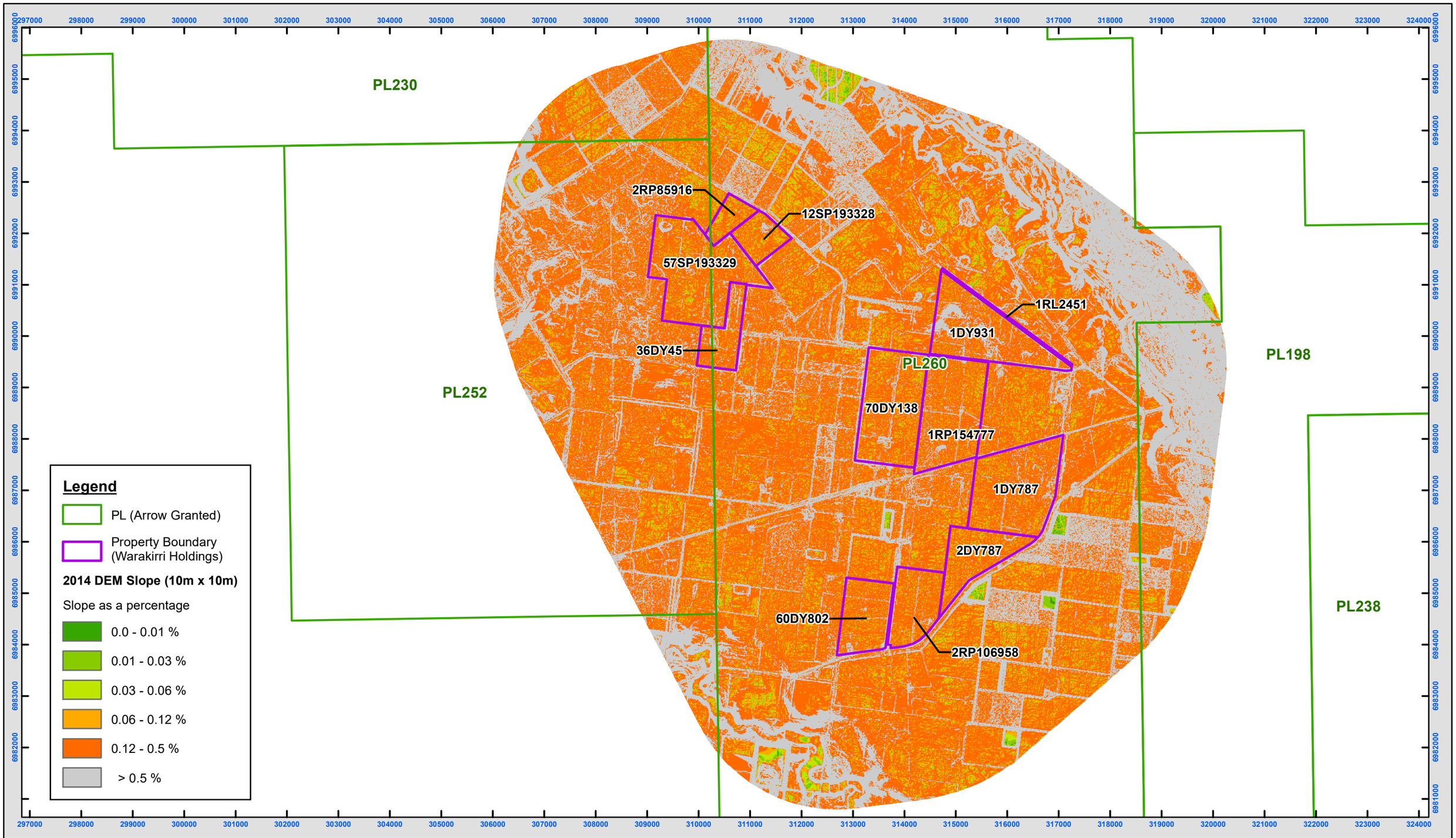

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

2 1 0 2 Kilometres

Scale: 1:70,000 @ 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

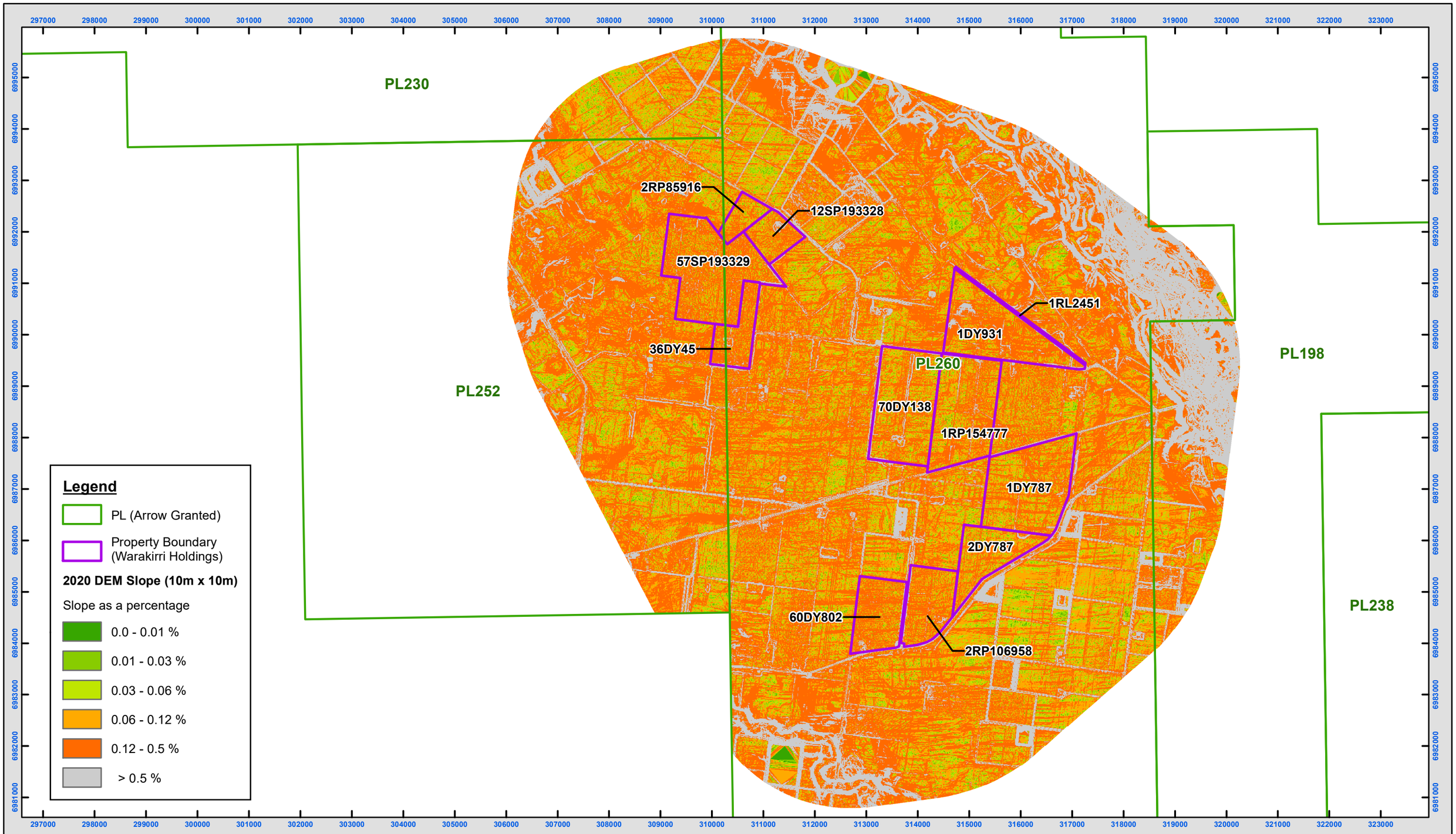

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

2 1 0 2 Kilometres

Scale: 1:70,000 @ A3

Coordinate System: GDA2020 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

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Report

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Baseline Report

Surface Elevation Data – 70DY138 & 1RP154777

Version	1
Released	19/07/2021

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Contents

List of Figures

1. Purpose

This Report provides the following surface elevation datasets overlaid on lots on plans 70DY138 & 1RP154777 :

- 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.

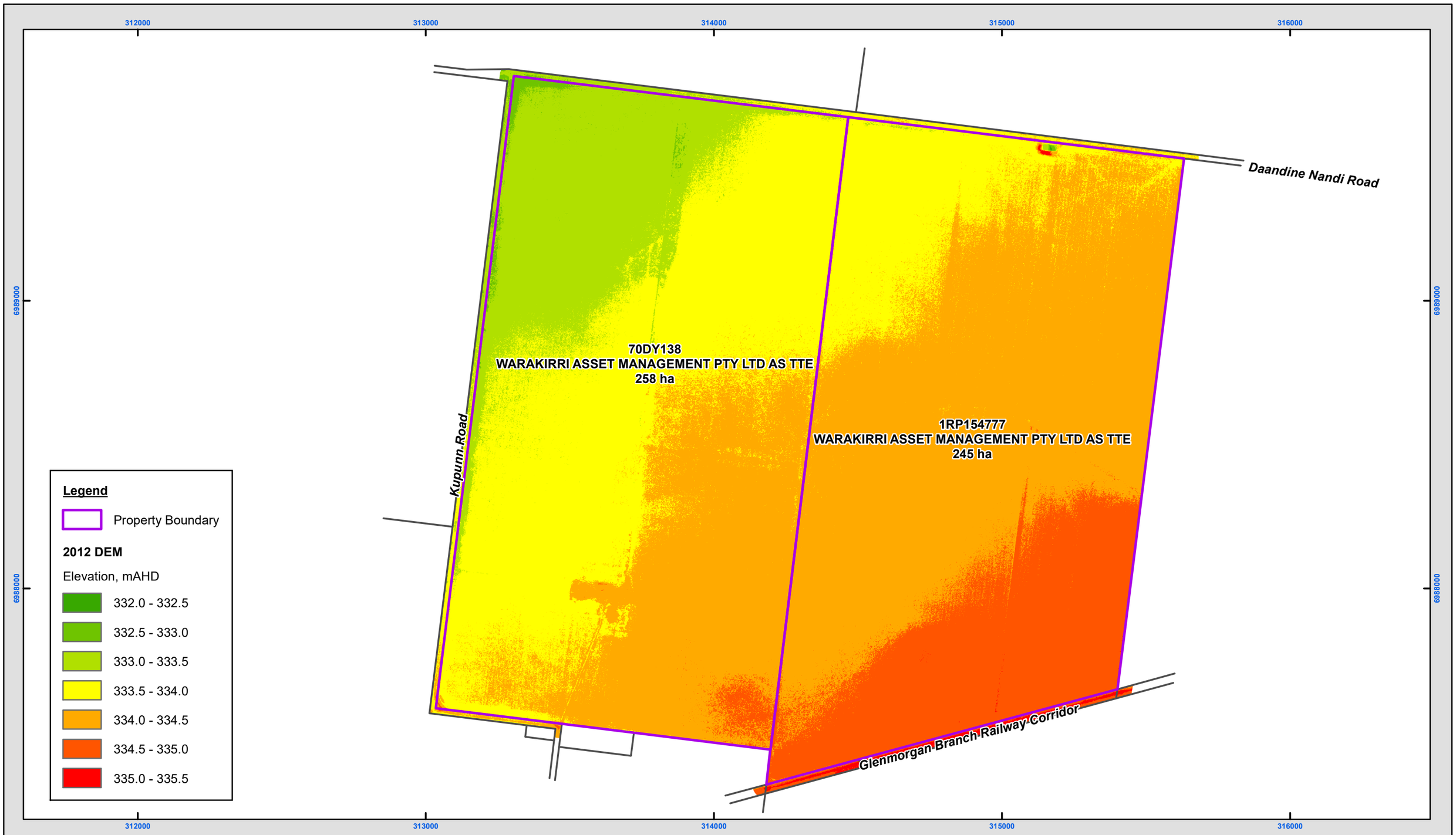

Figure 1 : 2012 DEM : Lots on Plans 70DY138 & 1RP154777

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:12,500 @ 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

312000 313000 314000 315000 316000

6989000

6988000

Daandine Nandi Road

Kupunn Road

70DY138
WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE
258 ha

1RP154777
WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE
245 ha

Glenmorgan Branch Railway Corridor

Legend

Property Boundary

2014 DEM

Elevation, mAHD

- 332.0 - 332.5
- 332.5 - 333.0
- 333.0 - 333.5
- 333.5 - 334.0
- 334.0 - 334.5
- 334.5 - 335.0
- 335.0 - 335.5

Figure 2 : 2014 DEM : Lots on Plans 70DY138 & 1RP154777

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35
Kilometres

Scale: 1:12,500 @ 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

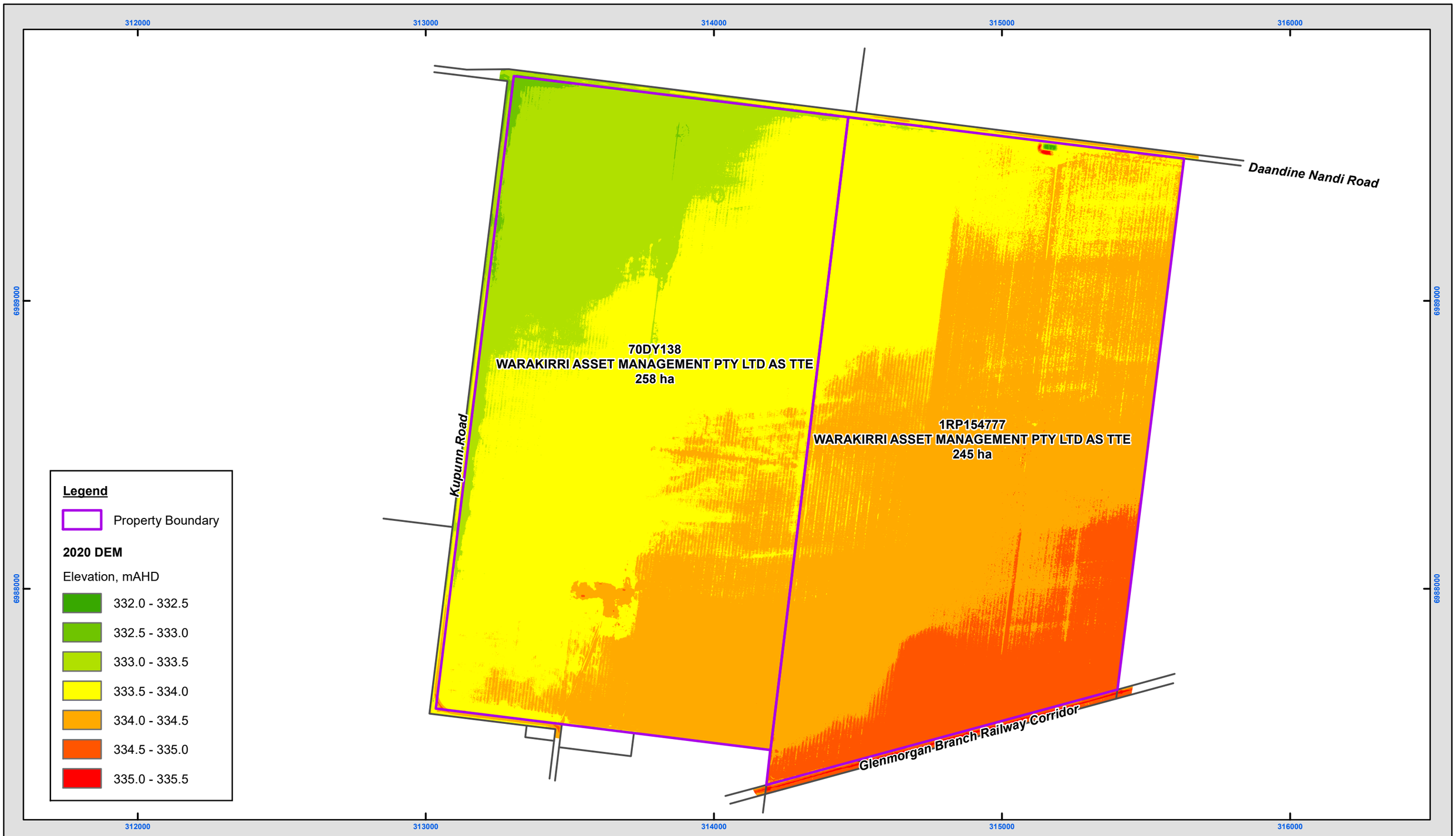

Figure 3 : 2020 DEM : Lots on Plans 70DY138 & 1RP154777

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:12,500 @ 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

312000 313000 314000 315000 316000

6988000

Daandine Nandi Road

Kupunn Road

70DY138
WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE
258 ha

1RP154777
WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE
245 ha

Glenmorgan Branch Railway Corridor

Legend

Property Boundary

2012 DEM Slope (10m x 10m)

Slope as a percentage

- 0.0 - 0.01 %
- 0.01 - 0.03 %
- 0.03 - 0.06 %
- 0.06 - 0.12 %
- 0.12 - 0.5 %
- > 0.5 %

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM : Lots on Plans 70DY138 & 1RP154777

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:12,500 @ 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

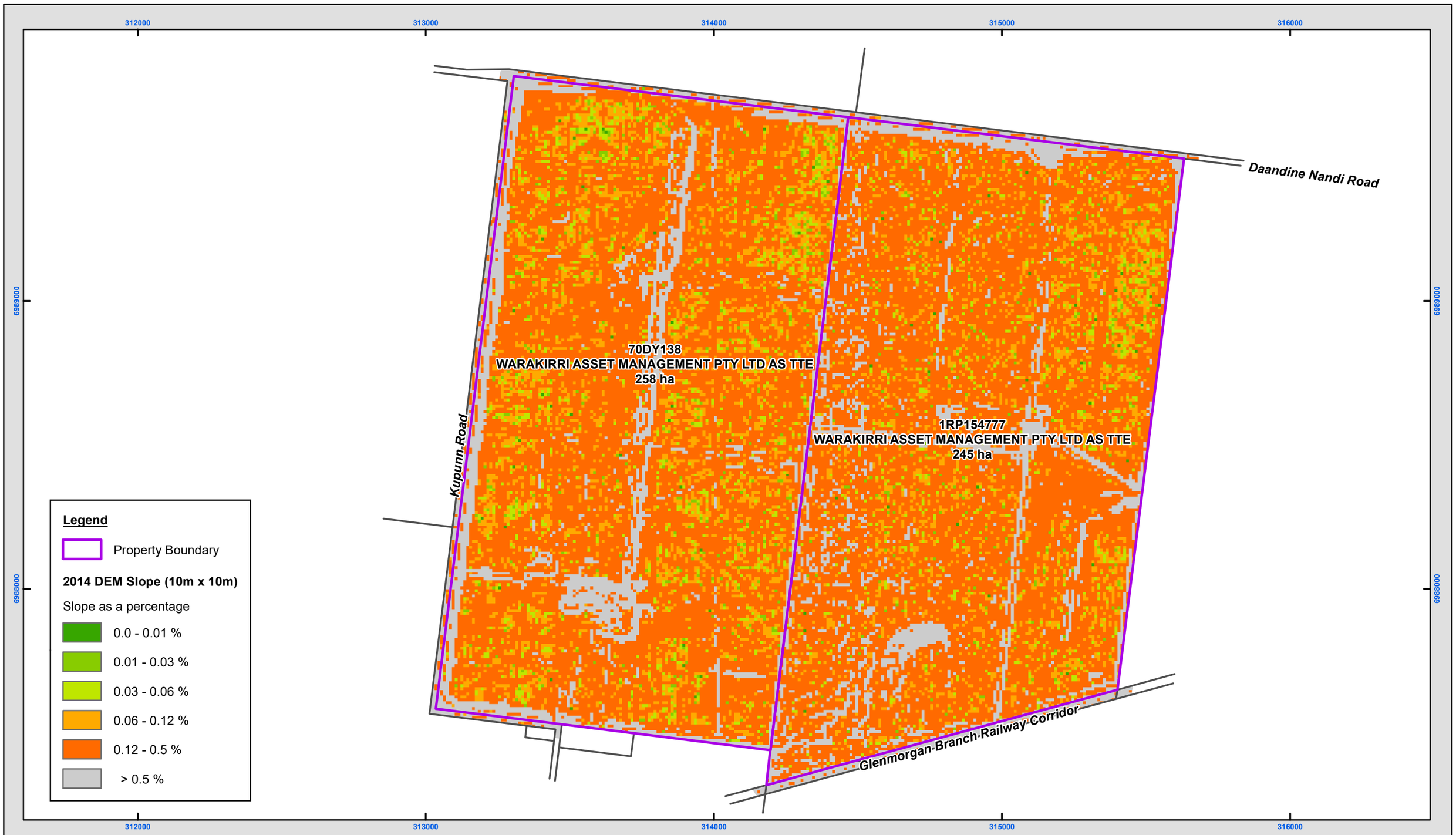

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM : Lots on Plans 70DY138 & 1RP154777

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:12,500 @ 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

312000 313000 314000 315000 316000

6988000

70DY138
WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE
258 ha

1RP154777
WARAKIRRI ASSET MANAGEMENT PTY LTD AS TTE
245 ha

Kupunn Road

Daandine Nandi Road

Glenmorgan Branch Railway Corridor

Legend

Property Boundary

2020 DEM Slope (10m x 10m)

Slope as a Percentage

- 0.0 - 0.01 %
- 0.01 - 0.03 %
- 0.03 - 0.06 %
- 0.06 - 0.12 %
- 0.12 - 0.5 %
- > 0.5 %

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM : Lots on Plans 70DY138 & 1RP154777

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:12,500 @ 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

Report

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Baseline Report

Surface Elevation Data – 57SP193329, 36DY45, 12SP193328 & 2RP85916

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 on lots on plans 57SP193329, 36DY45, 12SP193328 & 2RP85916 :

- 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.

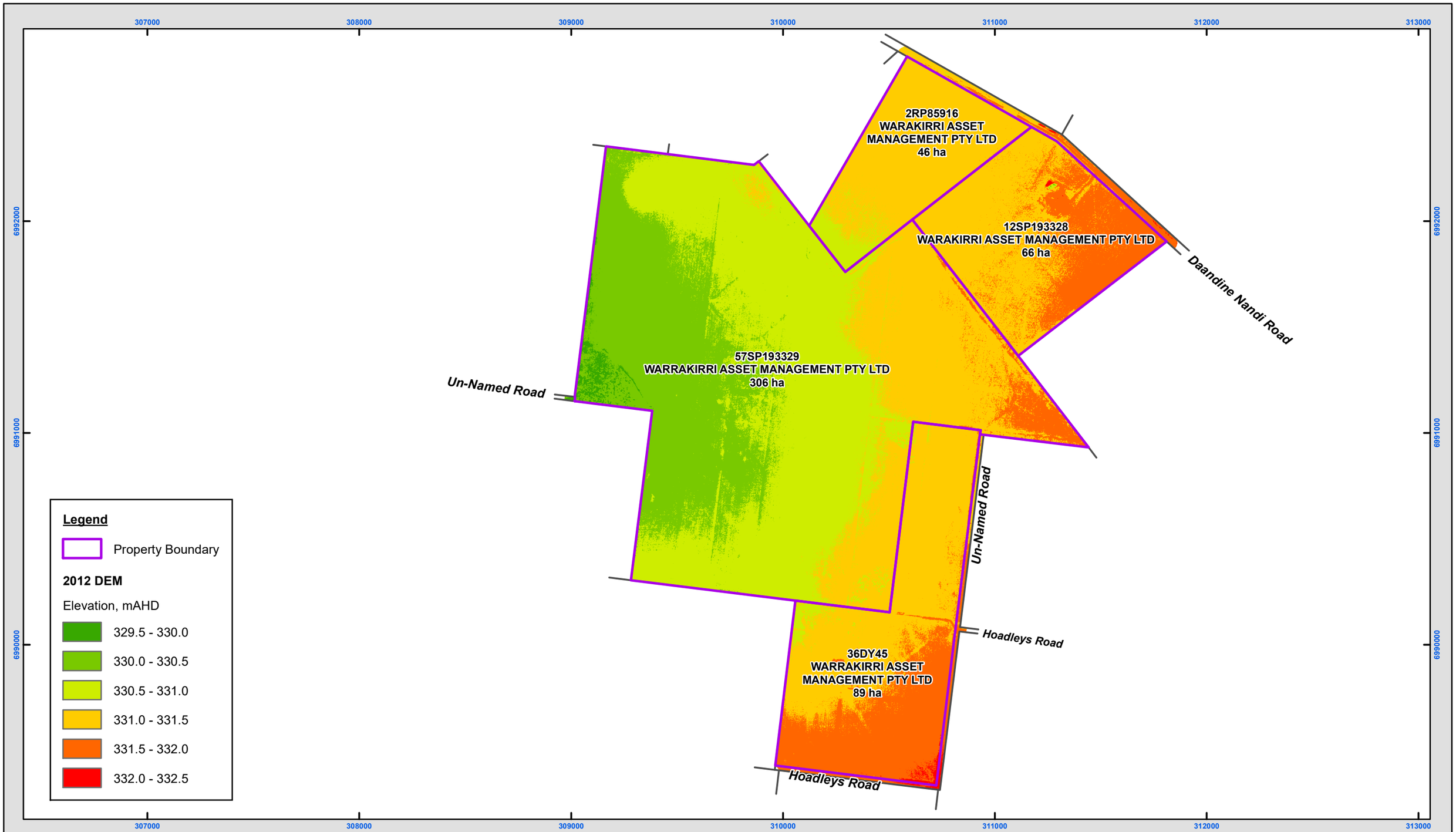

Figure 1 : 2012 DEM : Lots on Plans 57SP193329, 36DY45, 12SP193328 & 2RP85916

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 20/07/2021

Author: Arrow Energy

0.5 0.25 0 0.5 Kilometres

Scale: 1:17,000 @ 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

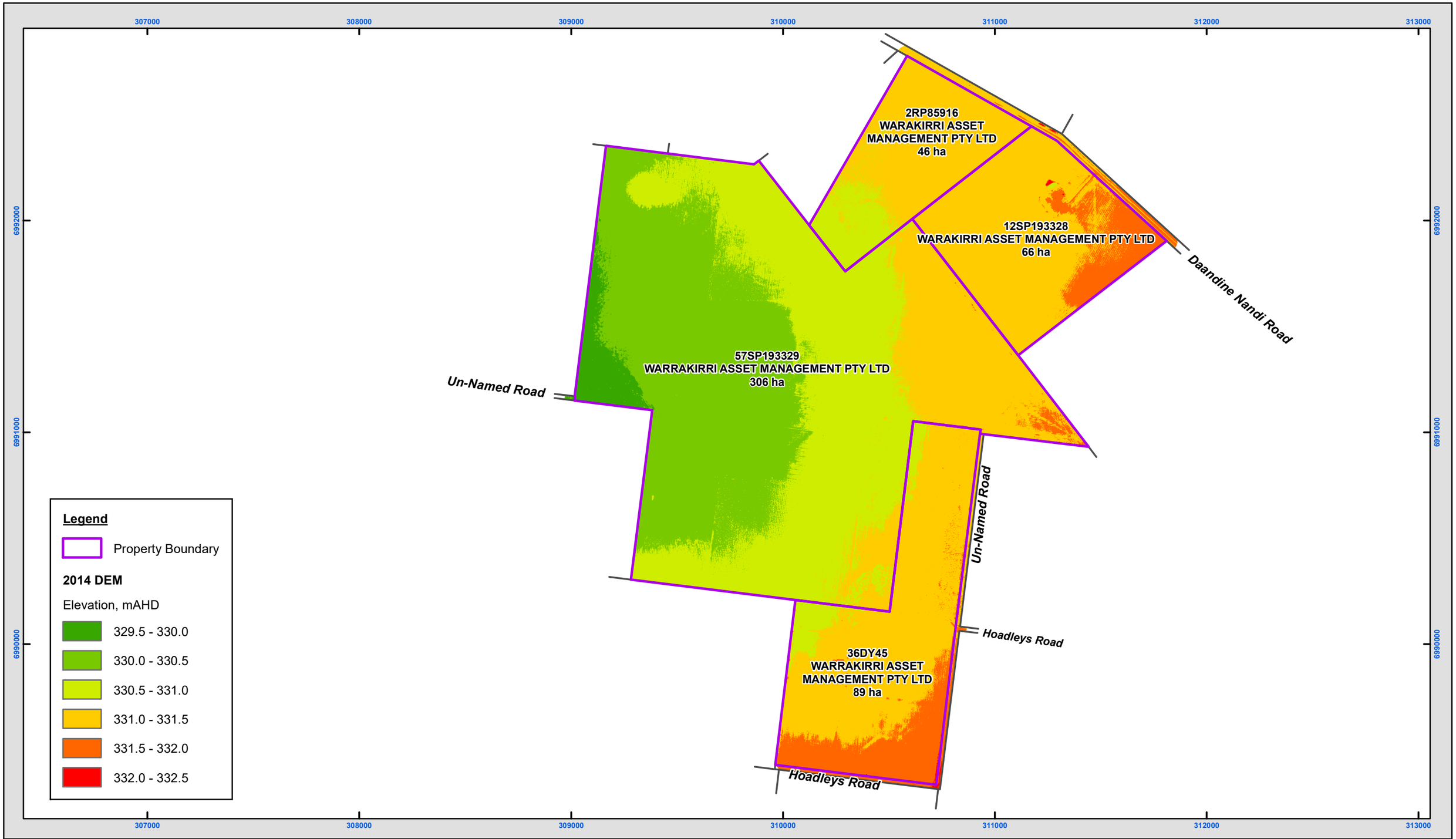

Figure 2 : 2014 DEM : Lots on Plans 57SP193329, 36DY45, 12SP193328 & 2RP85916

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 20/07/2021

Author: Arrow Energy

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Scale: 1:17,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

NOT FOR CONSTRUCTION

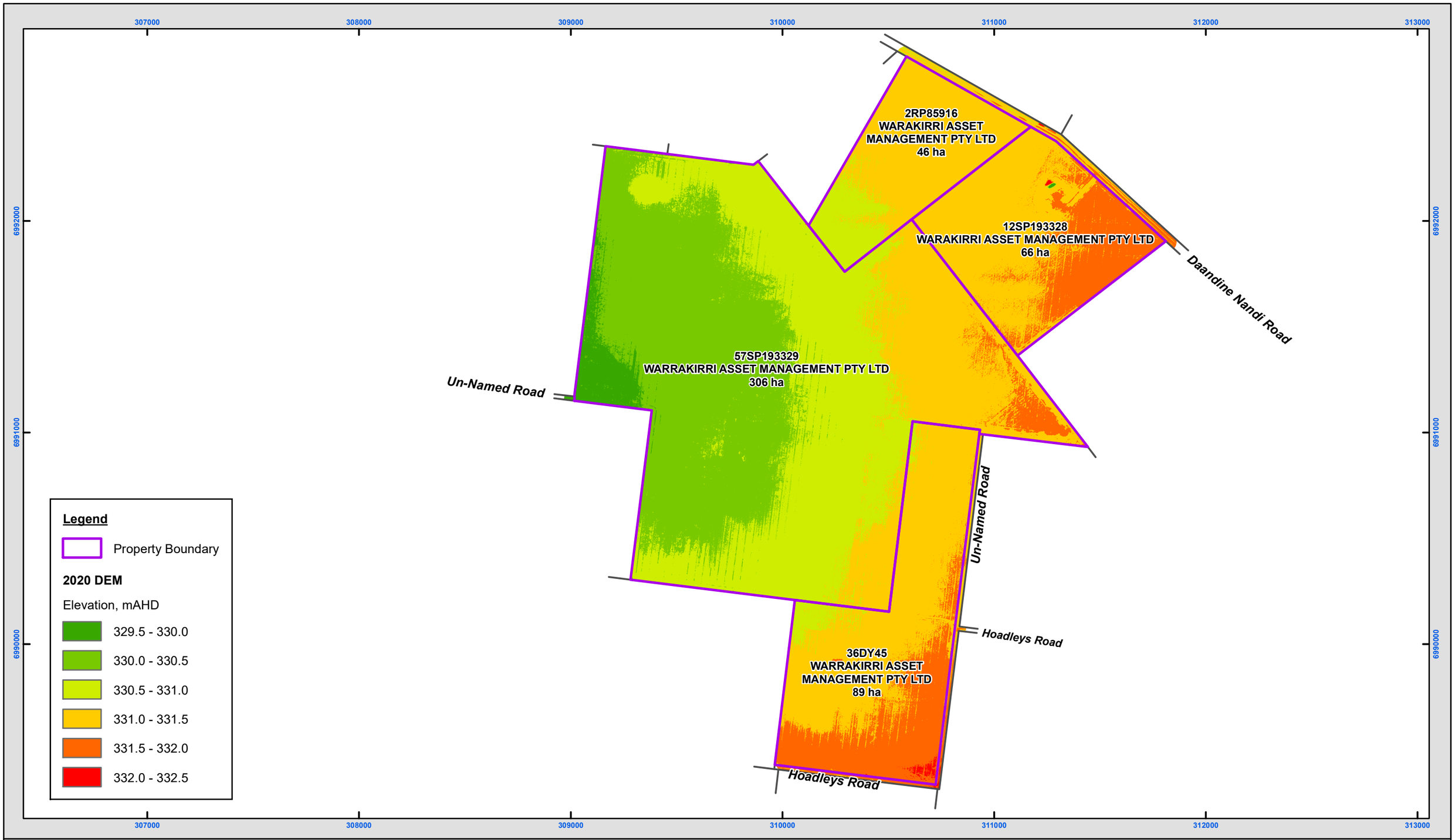

Figure 3 : 2020 DEM : Lots on Plans 57SP193329, 36DY45, 12SP193328 & 2RP85916

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 20/07/2021

Author: Arrow Energy

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Scale: 1:17,000 @ 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

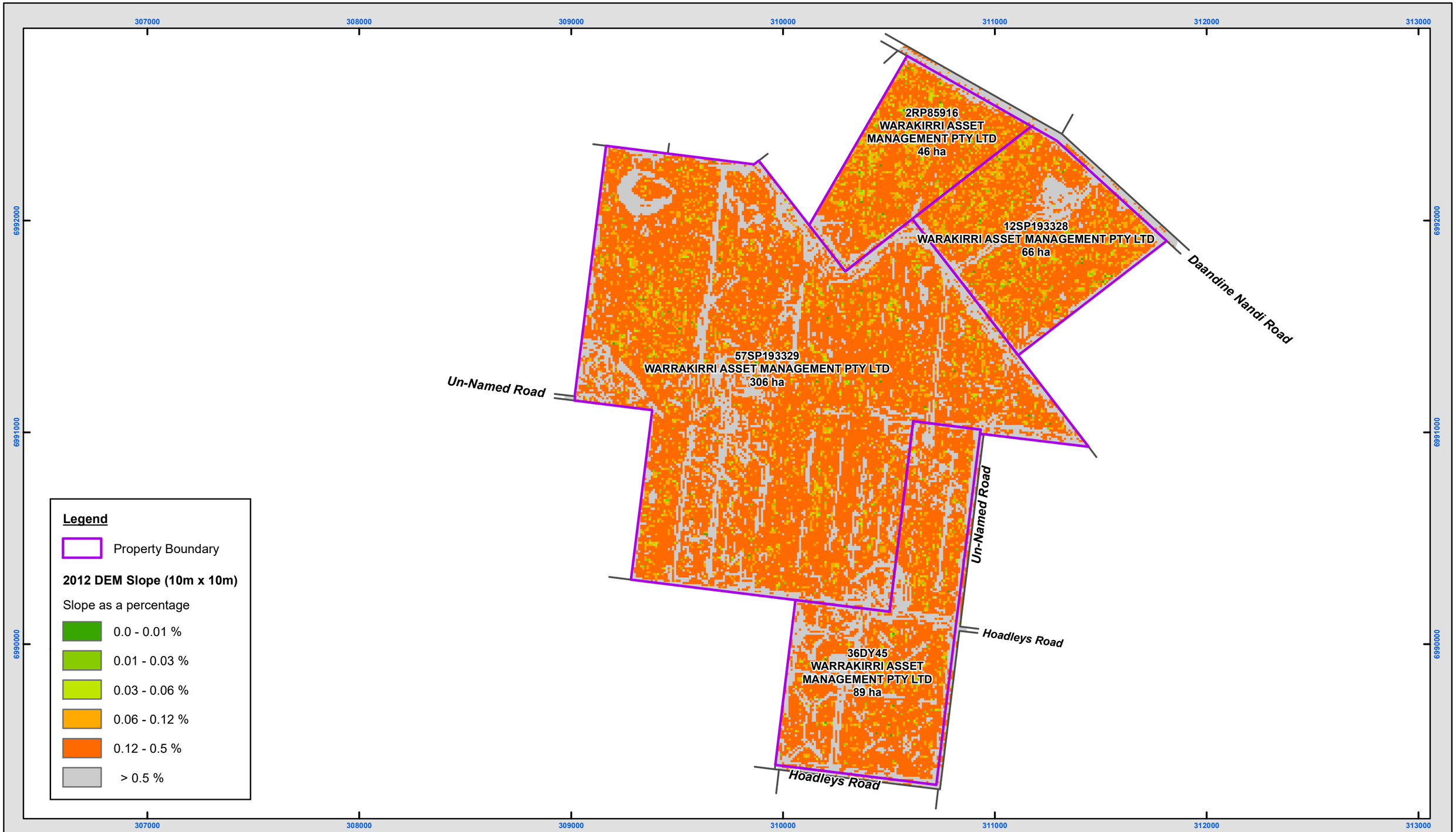

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM : Lots on Plans 57SP193329, 36DY45, 12SP193328 & 2RP85916

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 20/07/2021

Author: Arrow Energy

0.5 0.25 0 0.5 Kilometres

Scale: 1:17,000 @ 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

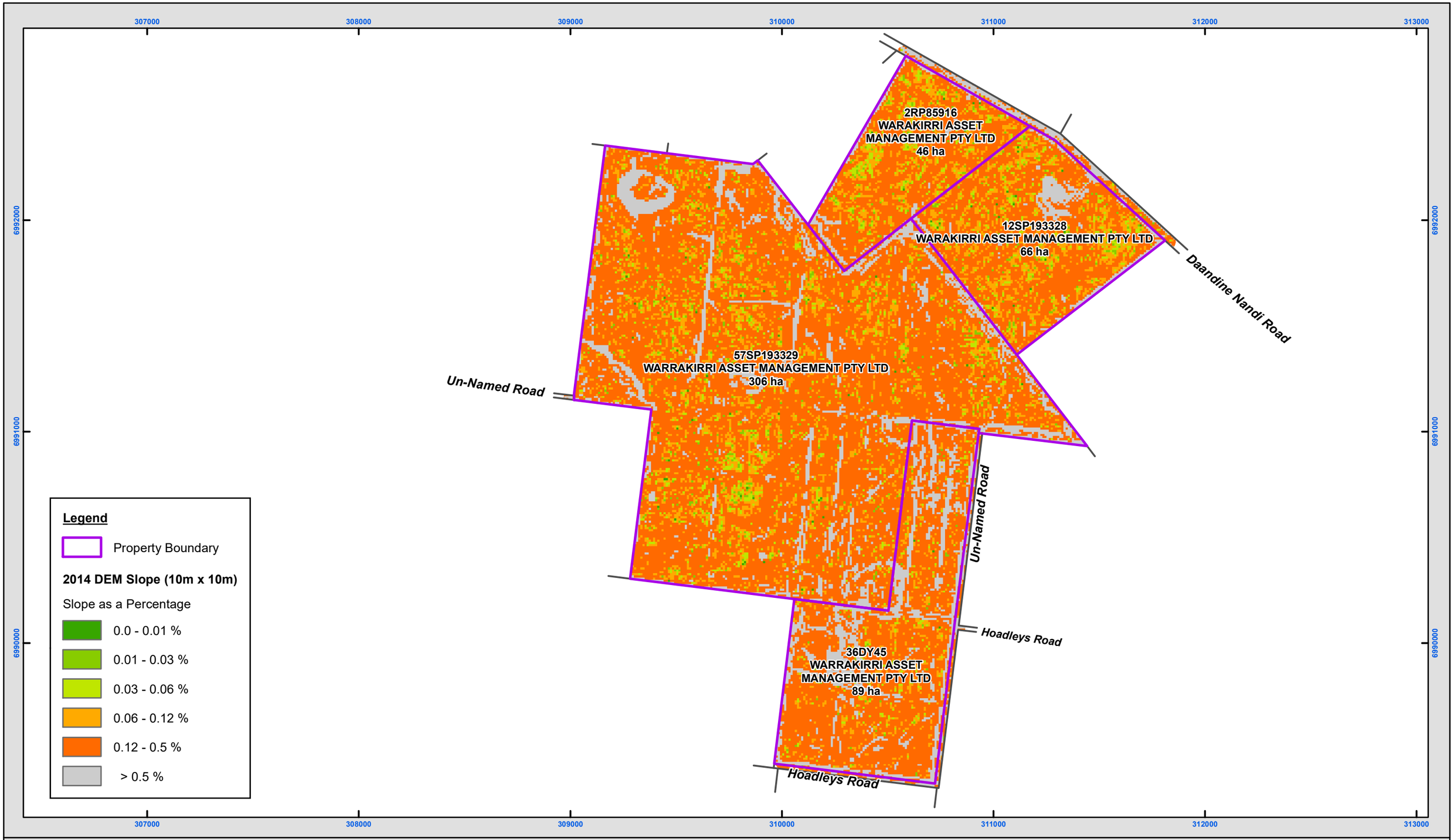

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM : Lots on Plans 57SP193329, 36DY45, 12SP193328 & 2RP85916

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 20/07/2021

Author: Arrow Energy

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Scale: 1:17,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

NOT FOR CONSTRUCTION

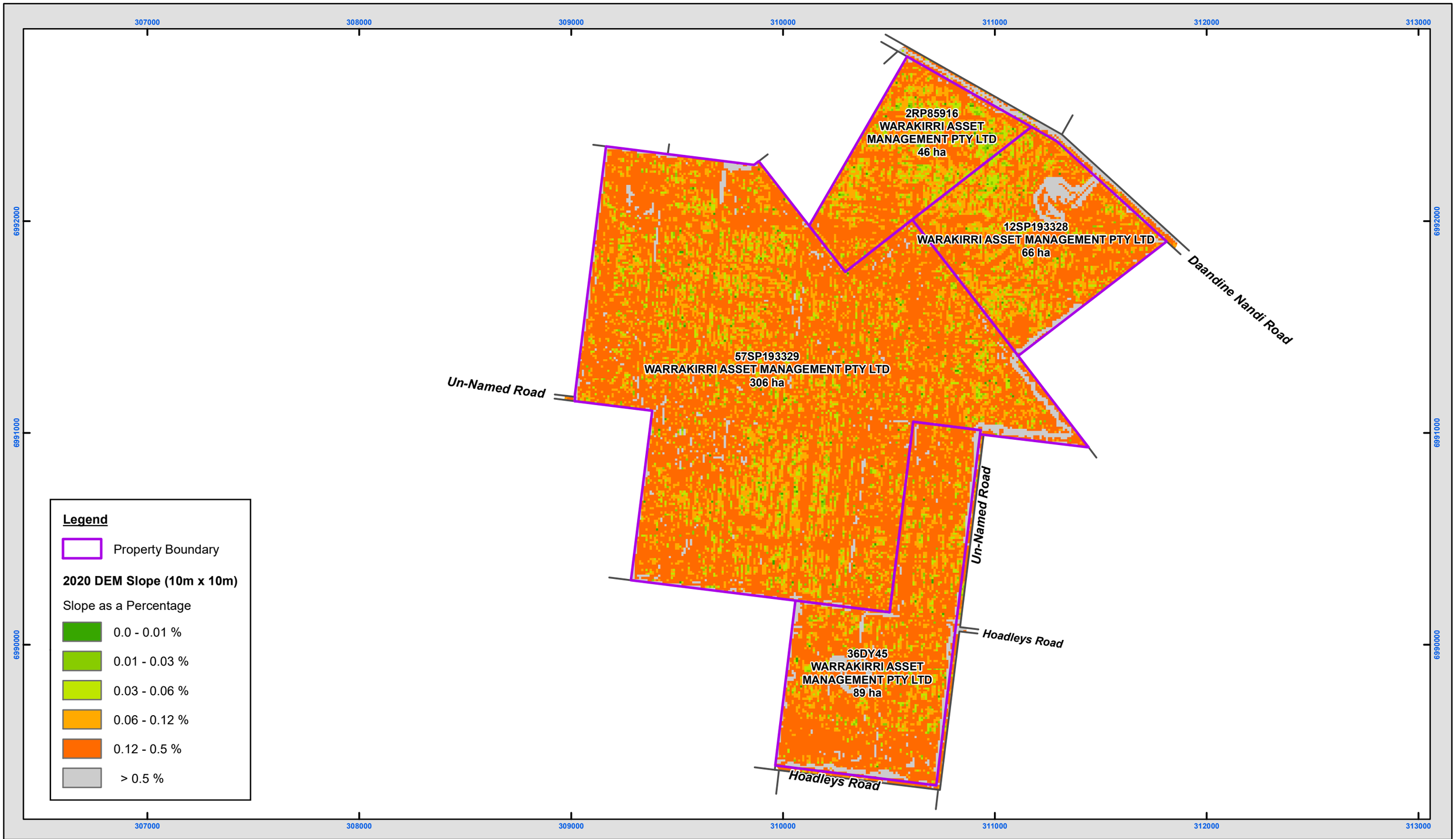

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM : Lots on Plans 57SP193329, 36DY45, 12SP193328 & 2RP85916

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 20/07/2021

Author: Arrow Energy

0.5 0.25 0 0.5 Kilometres

Scale: 1:17,000 @ A3

Coordinate System: GDA2020 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

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Baseline Report

Surface Elevation Data – 1DY931 & 1RL2451

Version	1
Released	20/07/2021

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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.

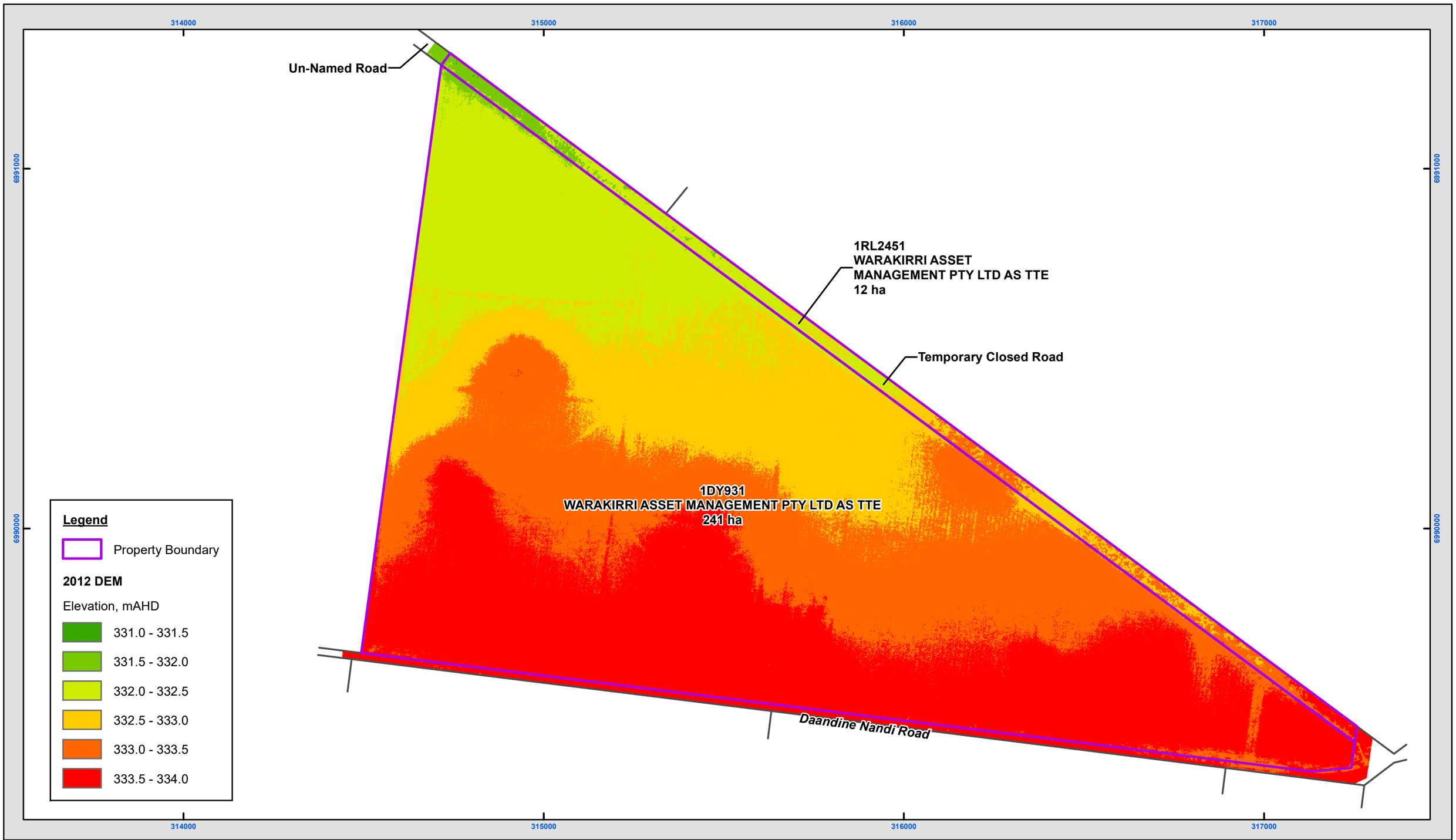

Figure 1 : 2012 DEM : Lots on Plans 1DY931 & 1RL2451

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

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Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

NOT FOR CONSTRUCTION

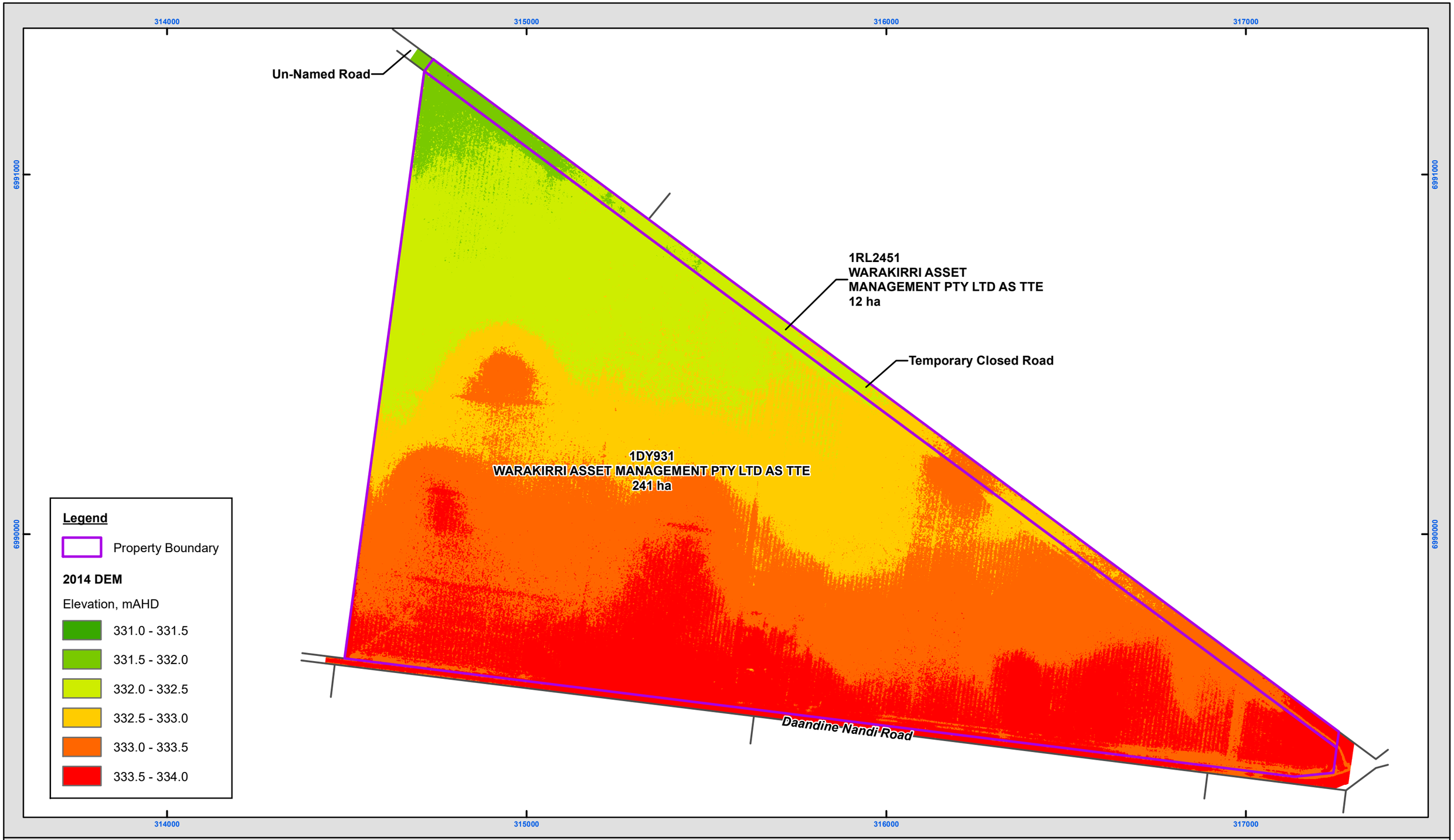

Figure 2 : 2014 DEM : Lot on Plan 1DY931 & 1RL2451

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

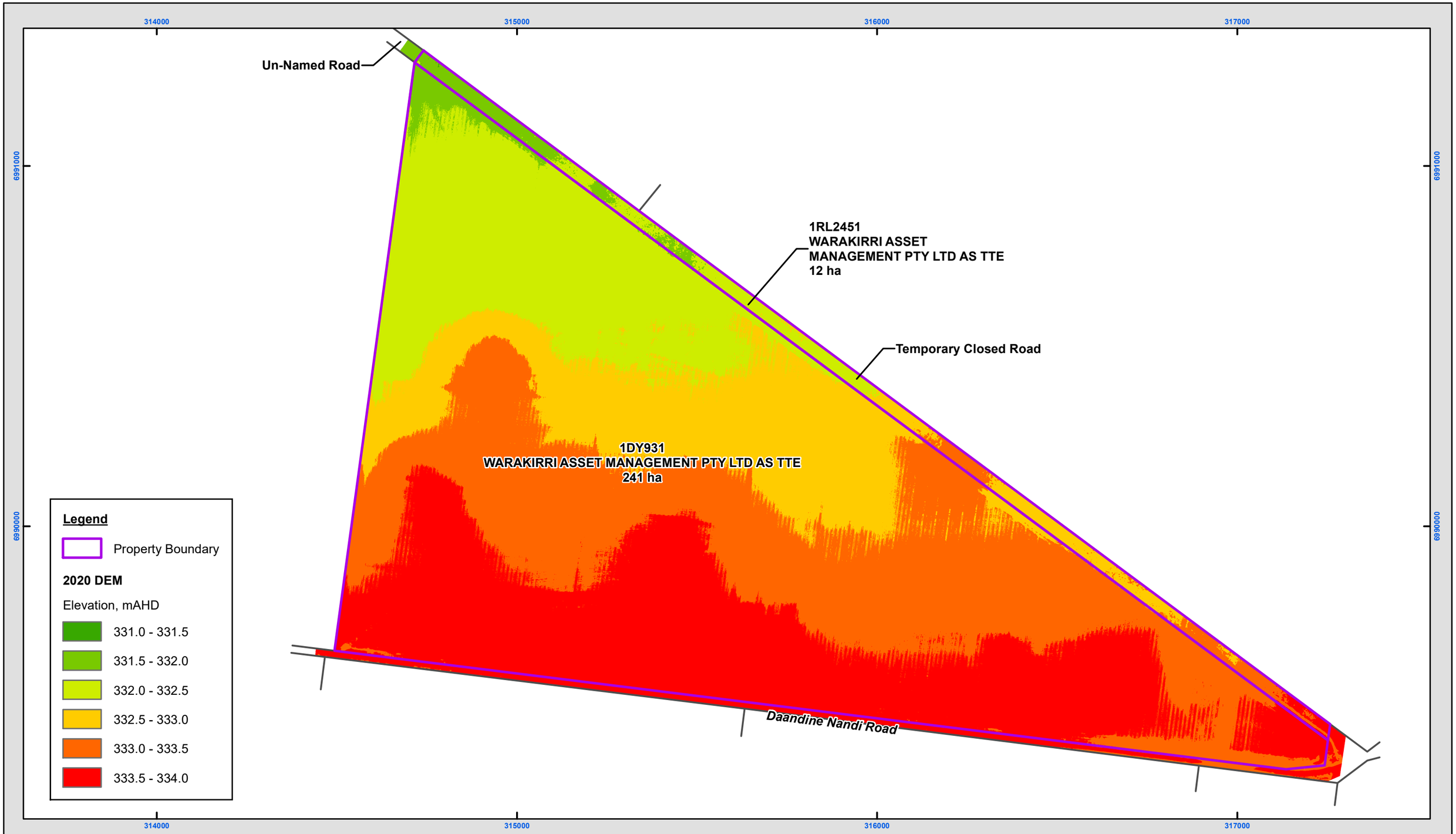

Figure 3 : 2020 DEM : Lot on Plan 1DY931 & 1RL2451

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

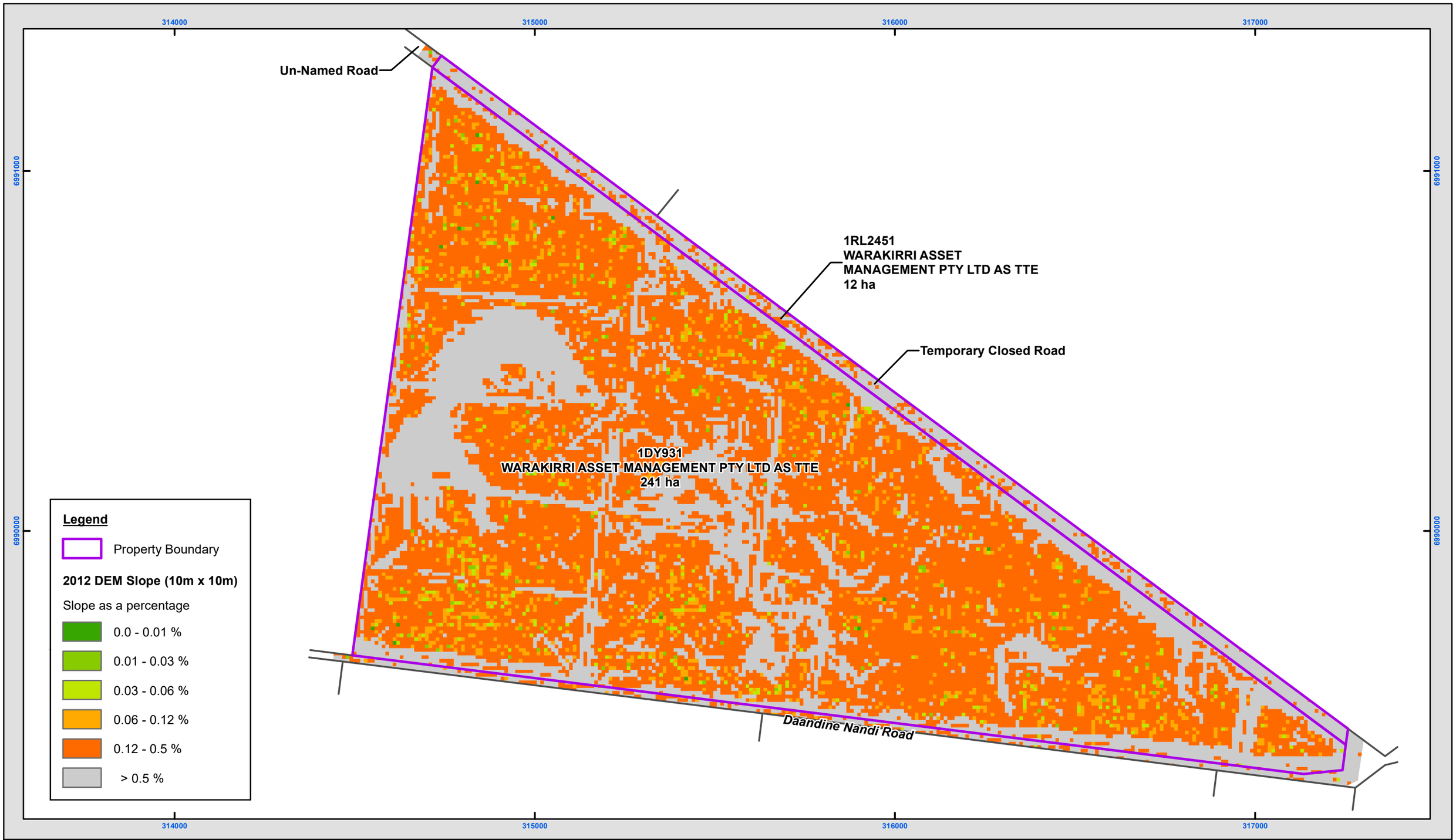

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM : Lot on Plan 1DY931 & 1RL2451

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.

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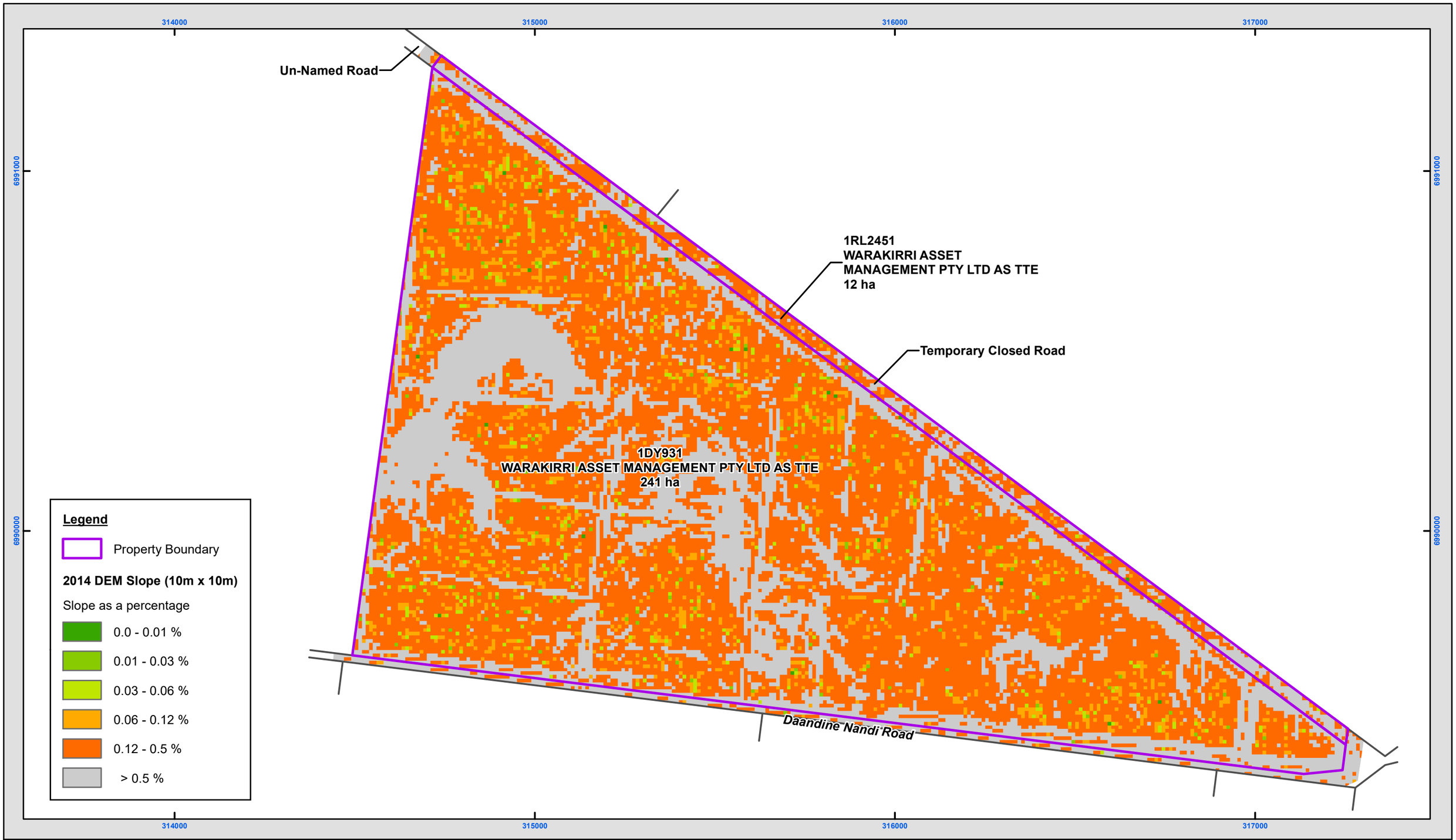

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM : Lot on Plan 1DY931 & 1RL2451

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

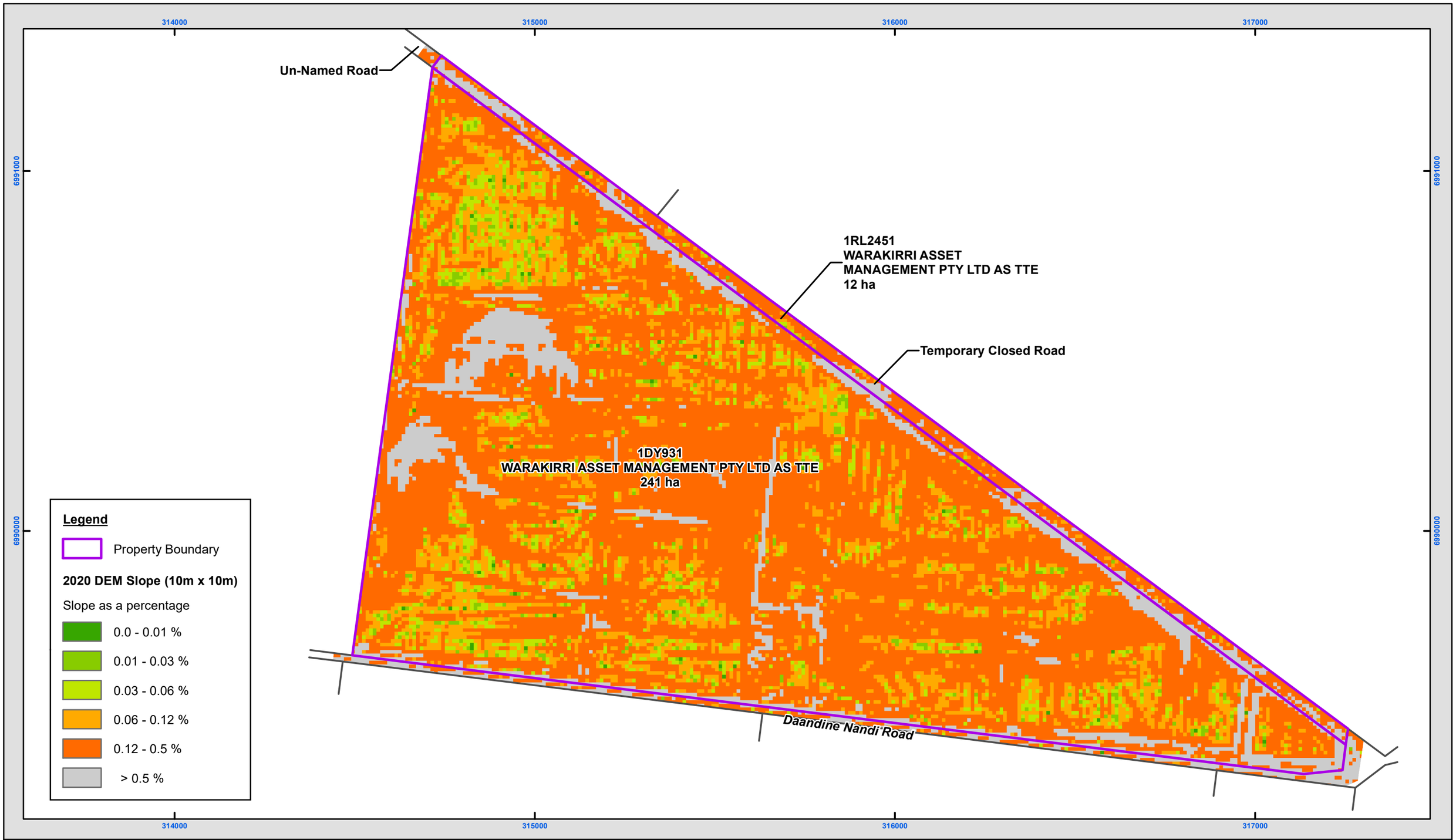

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM : Lot on Plan 1DY931 & 1RL2451

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.

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Baseline Report

Surface Elevation Data – 60DY802, 2RP106958 & 2DY787

Version	1
Released	19/07/2021

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1. Purpose

This Report provides the following surface elevation datasets overlaid on lots on plans 60DY802, 2RP106958 & 2DY787 :

- 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.

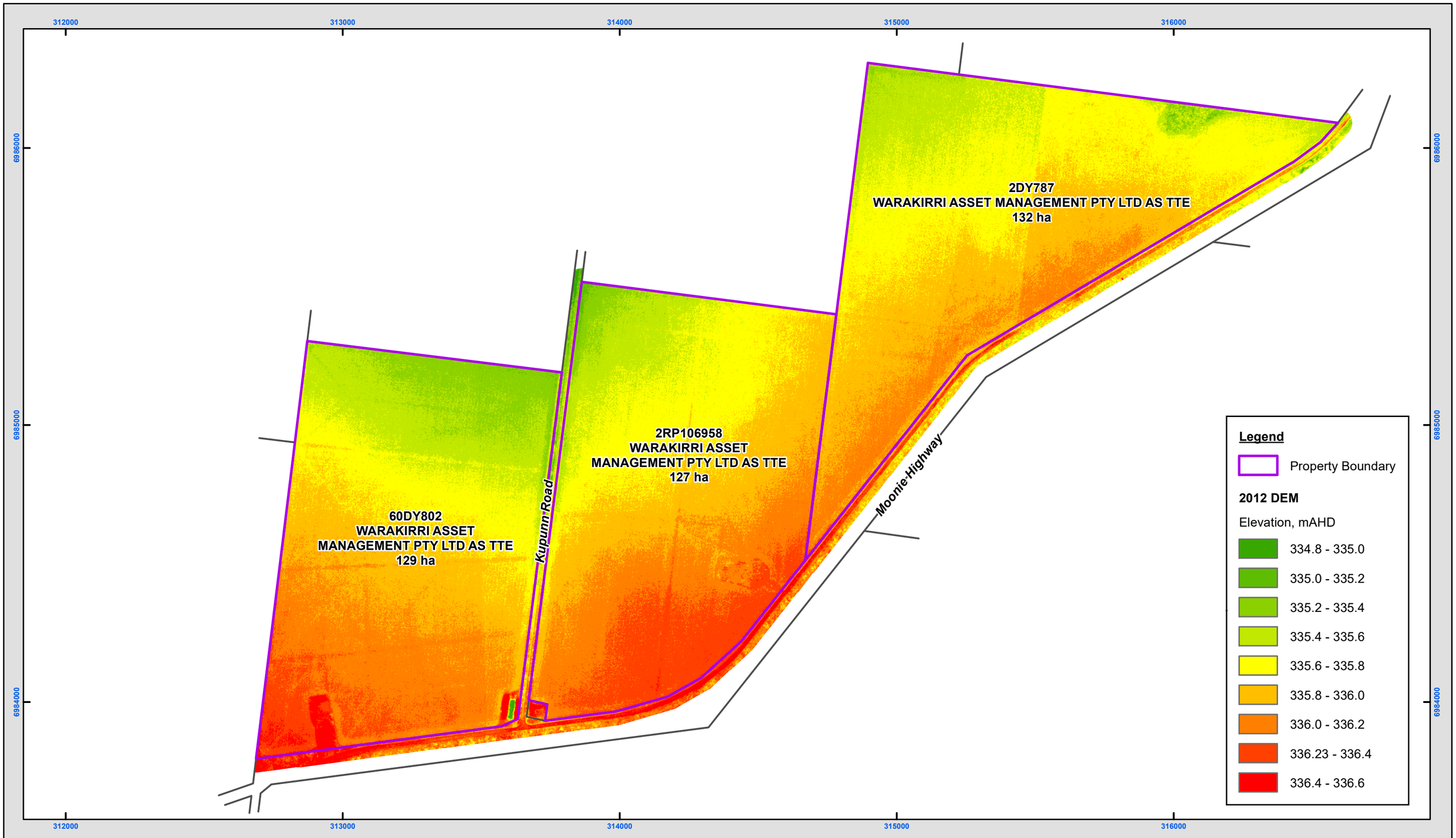

Figure 1 : 2012 DEM : Lots on Plans 60DY802, 2RP106958 & 2DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35
Kilometres

Scale: 1:13,000 @ 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

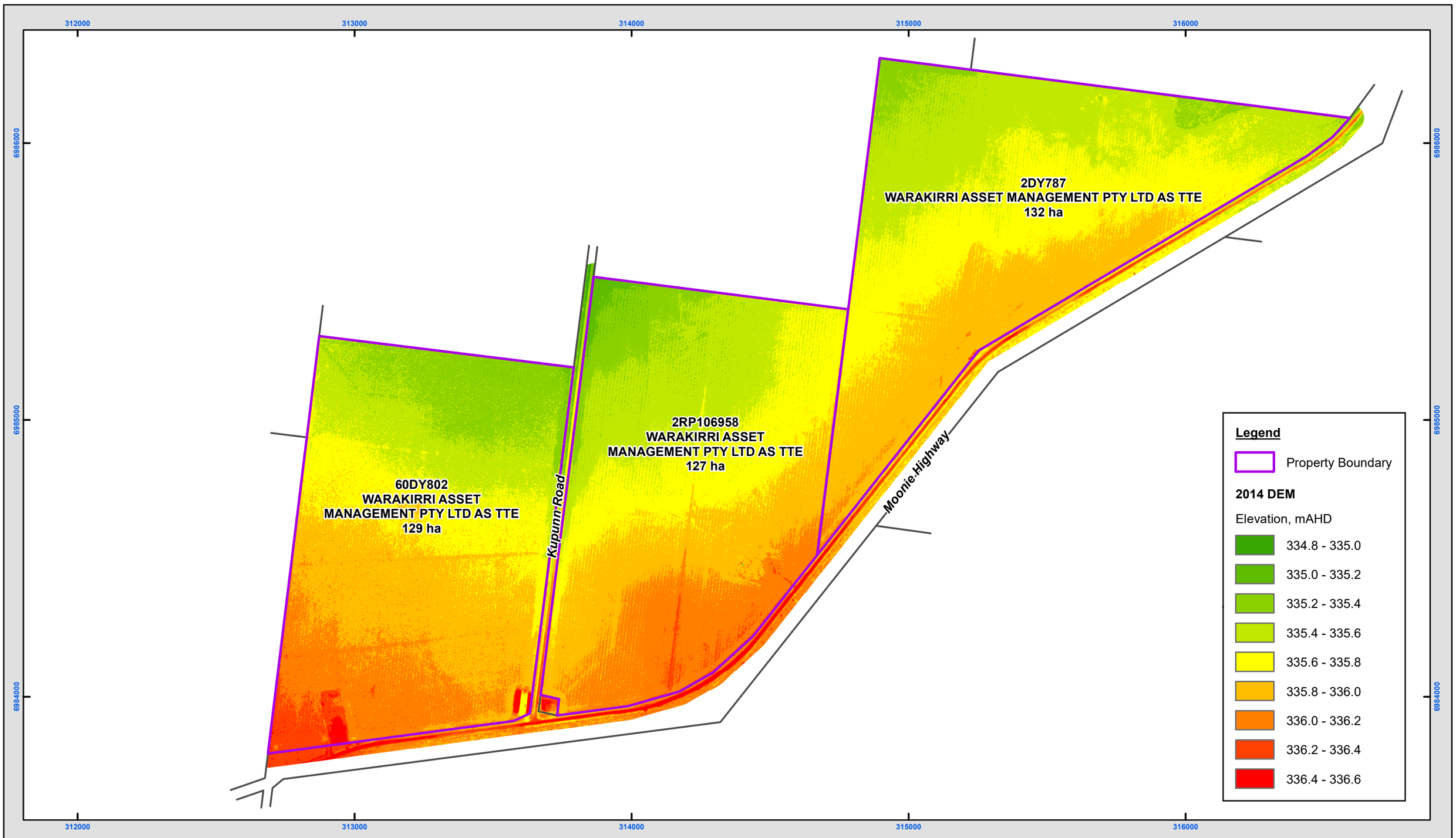

Figure 2 : 2014 DEM : Lots on Plans 60DY802, 2RP106958 & 2DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:13,000 @ 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

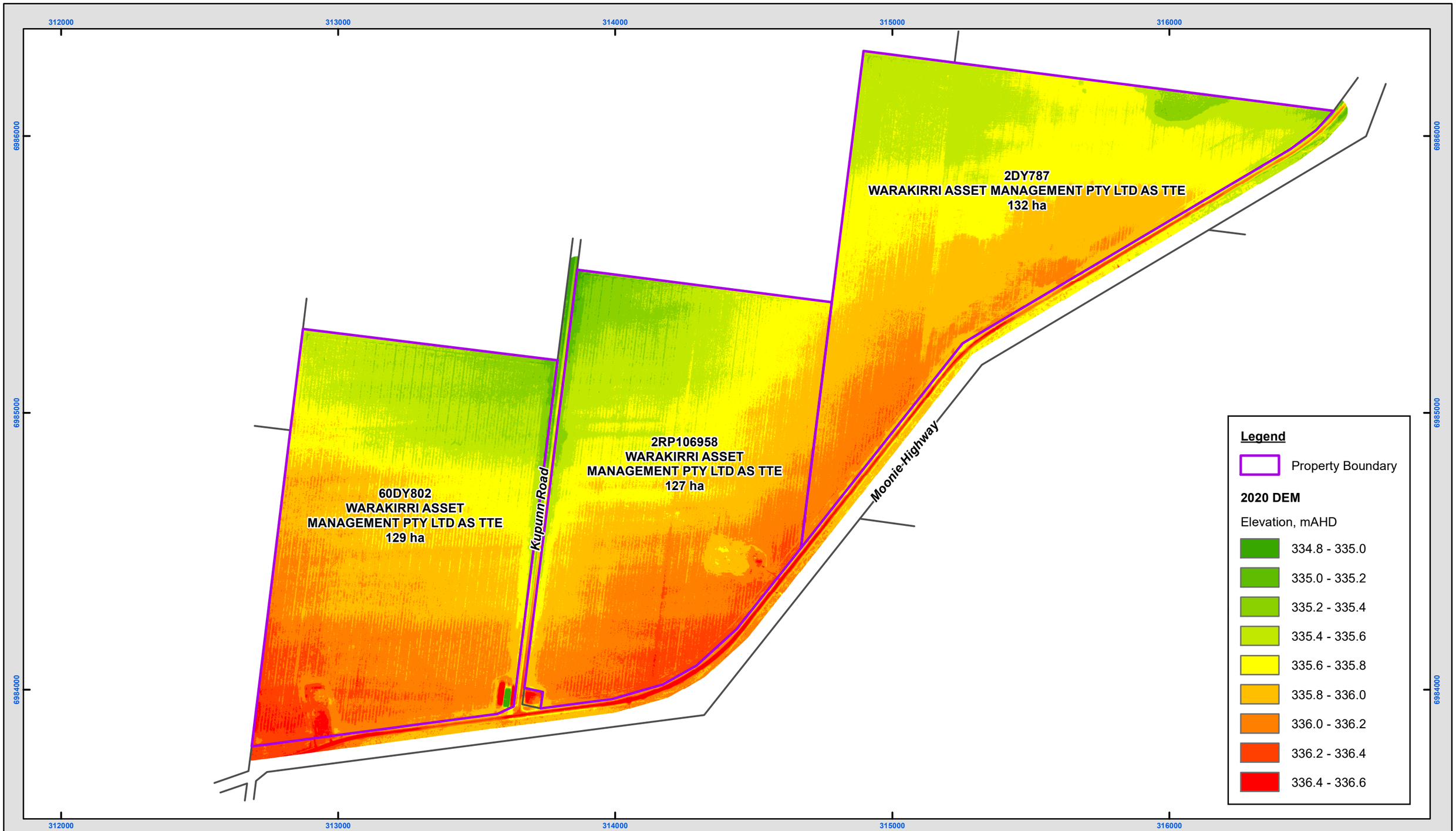

Figure 3 : 2020 DEM : Lots on Plans 60DY802, 2RP106958 & 2DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:13,000 @ 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

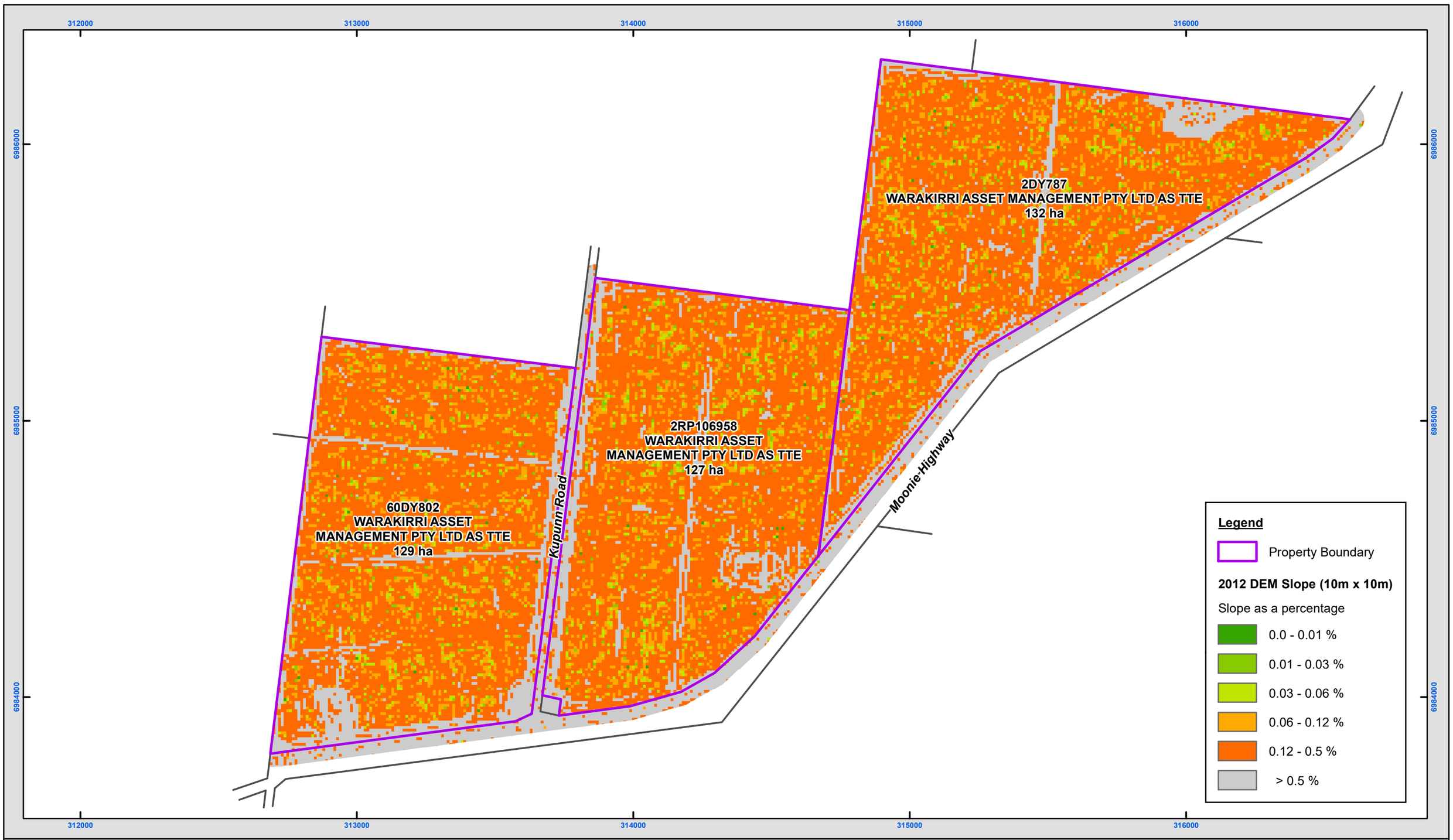

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM : Lots on Plans 60DY802, 2RP106958 & 2DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:13,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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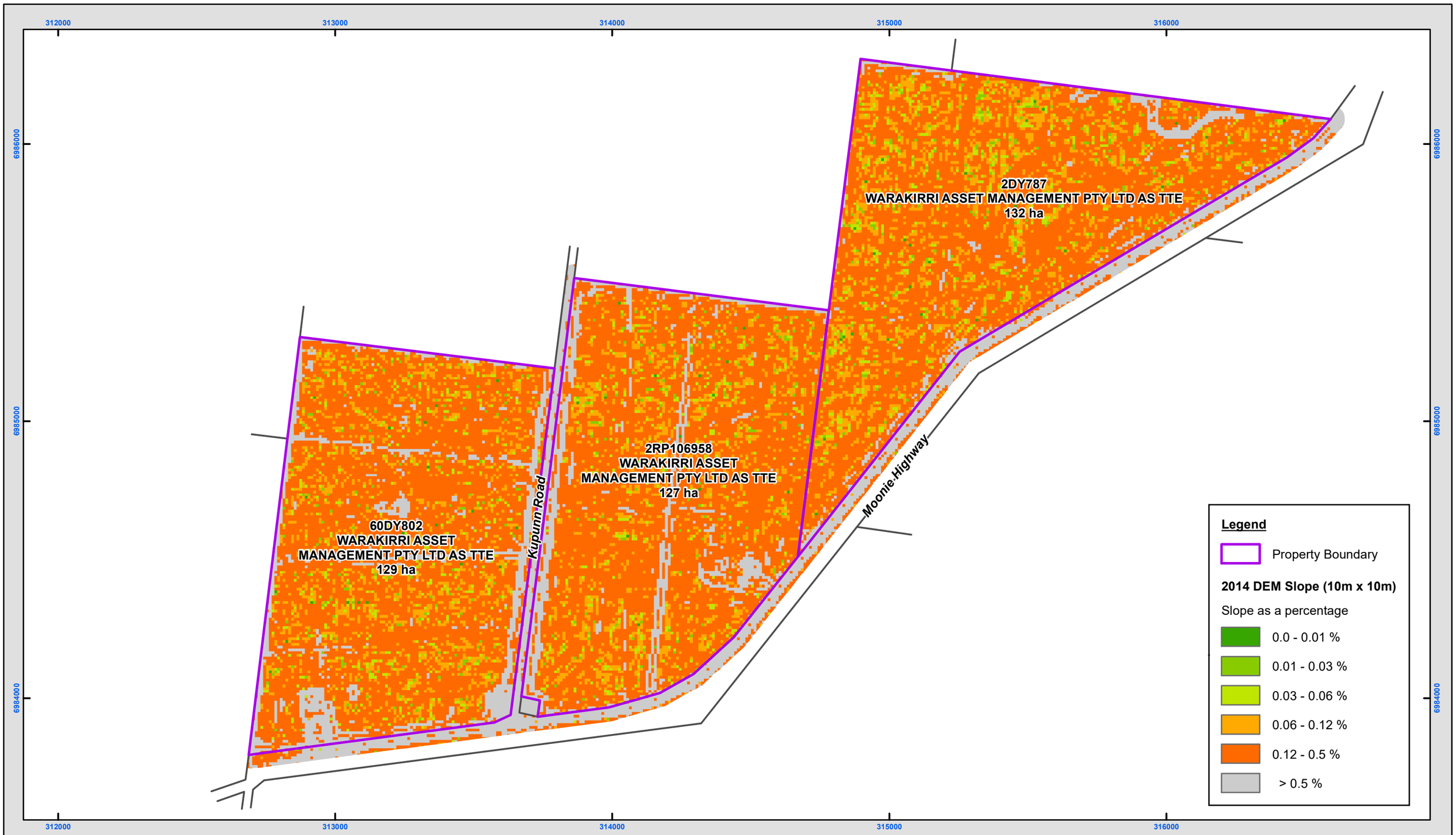

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM : Lots on Plans 60DY802, 2RP106958 & 2DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:13,000 @ 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.

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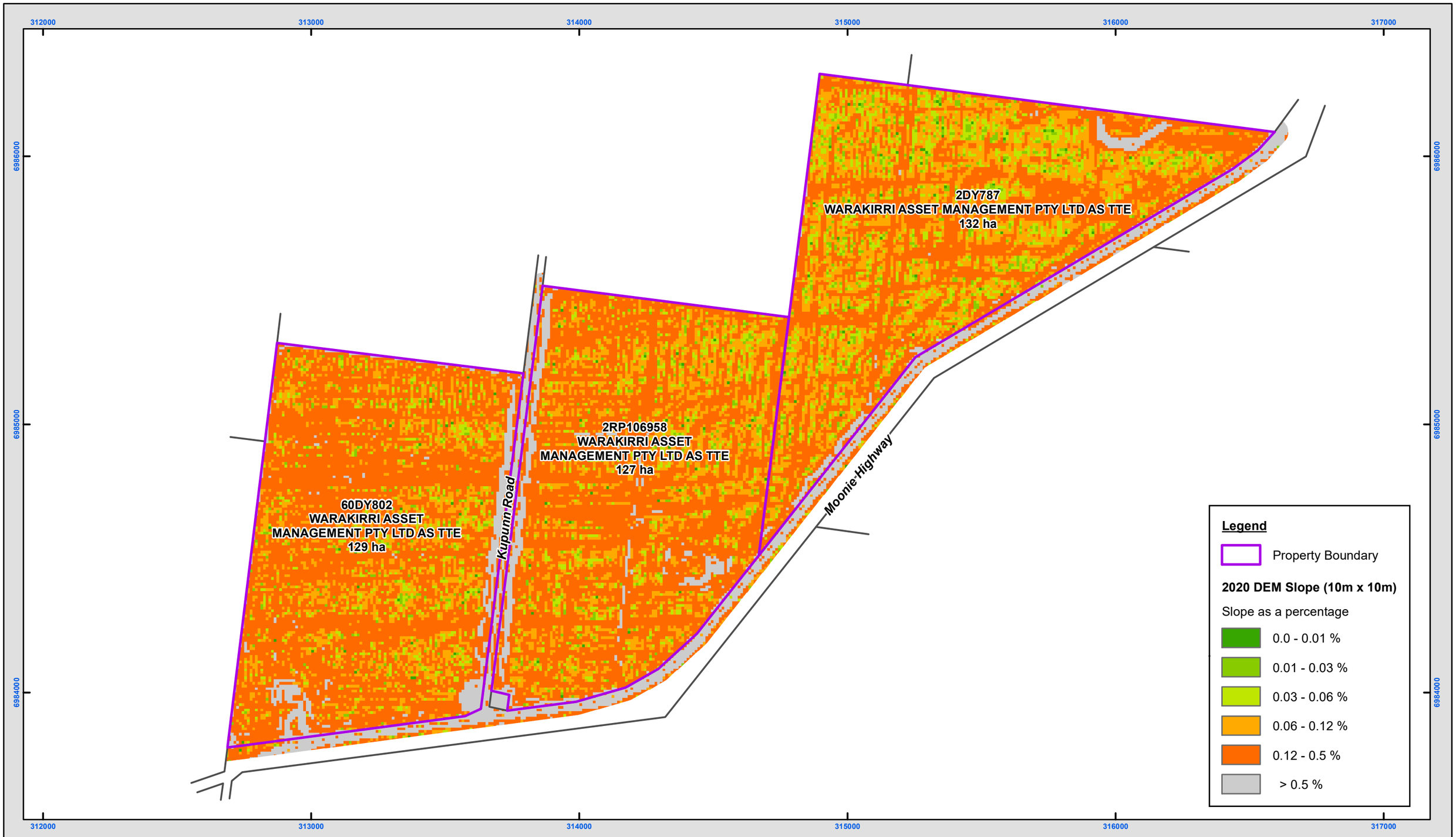

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM : Lots on Plans 60DY802, 2RP106958 & 2DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 21/07/2021

Author: Arrow Energy

0.35 0.175 0 0.35 Kilometres

Scale: 1:13,433 @ A3

Coordinate System: GDA2020 MGA Zone 56

The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.

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Baseline Report

Surface Elevation Data – 1DY787

Version	1
Released	19/07/2021

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1. Purpose

This Report provides the following surface elevation datasets overlaid on lot on plan 1DY787 :

- 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),
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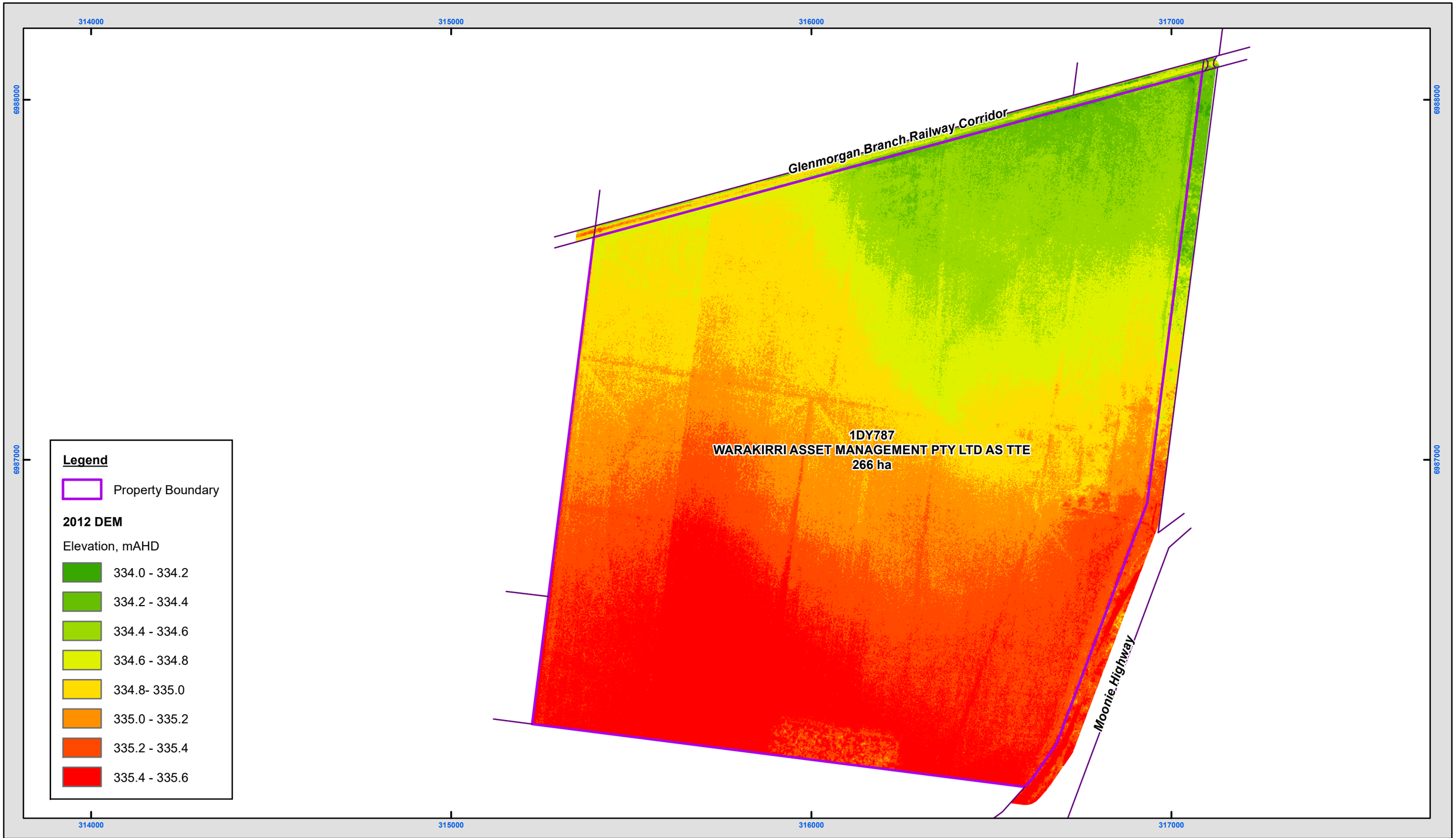

Figure 1 : 2012 DEM : Lot on Plan 1DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

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

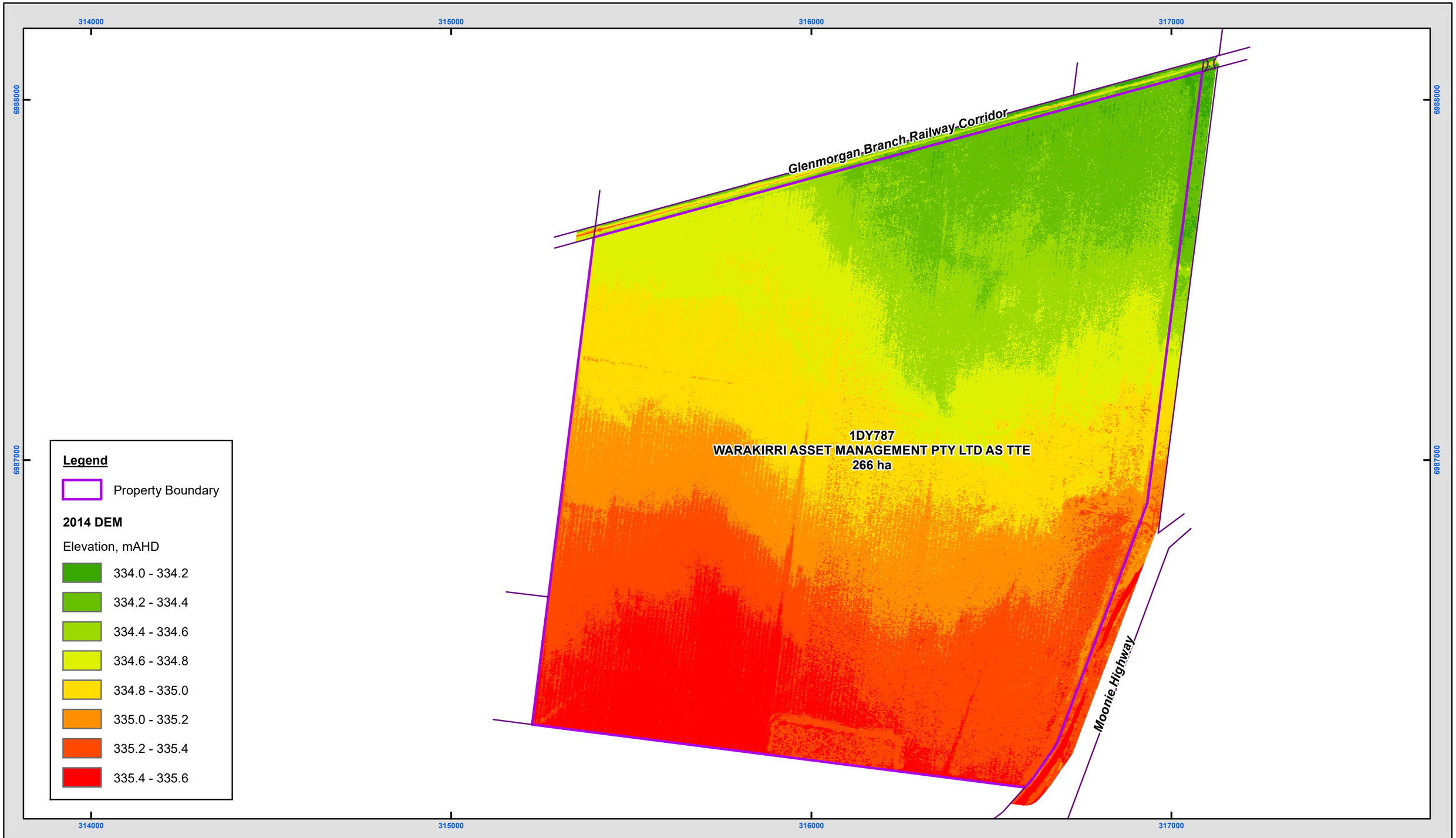

Figure 2 : 2014 DEM : Lot on Plan 1DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

0.25 0.125 0 0.25 Kilometres

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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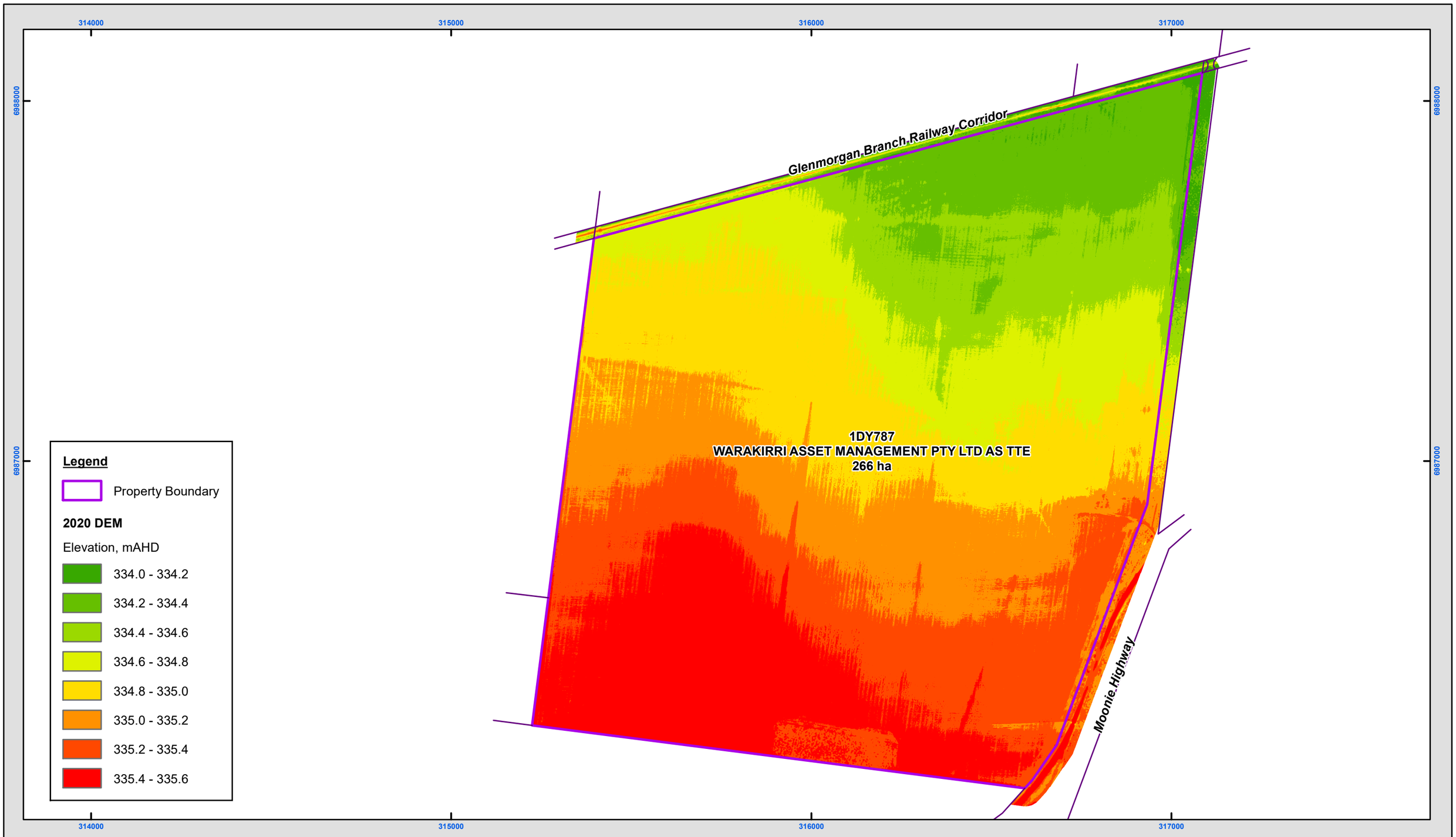

Figure 3 : 2020 DEM : Lot on Plan 1DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

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

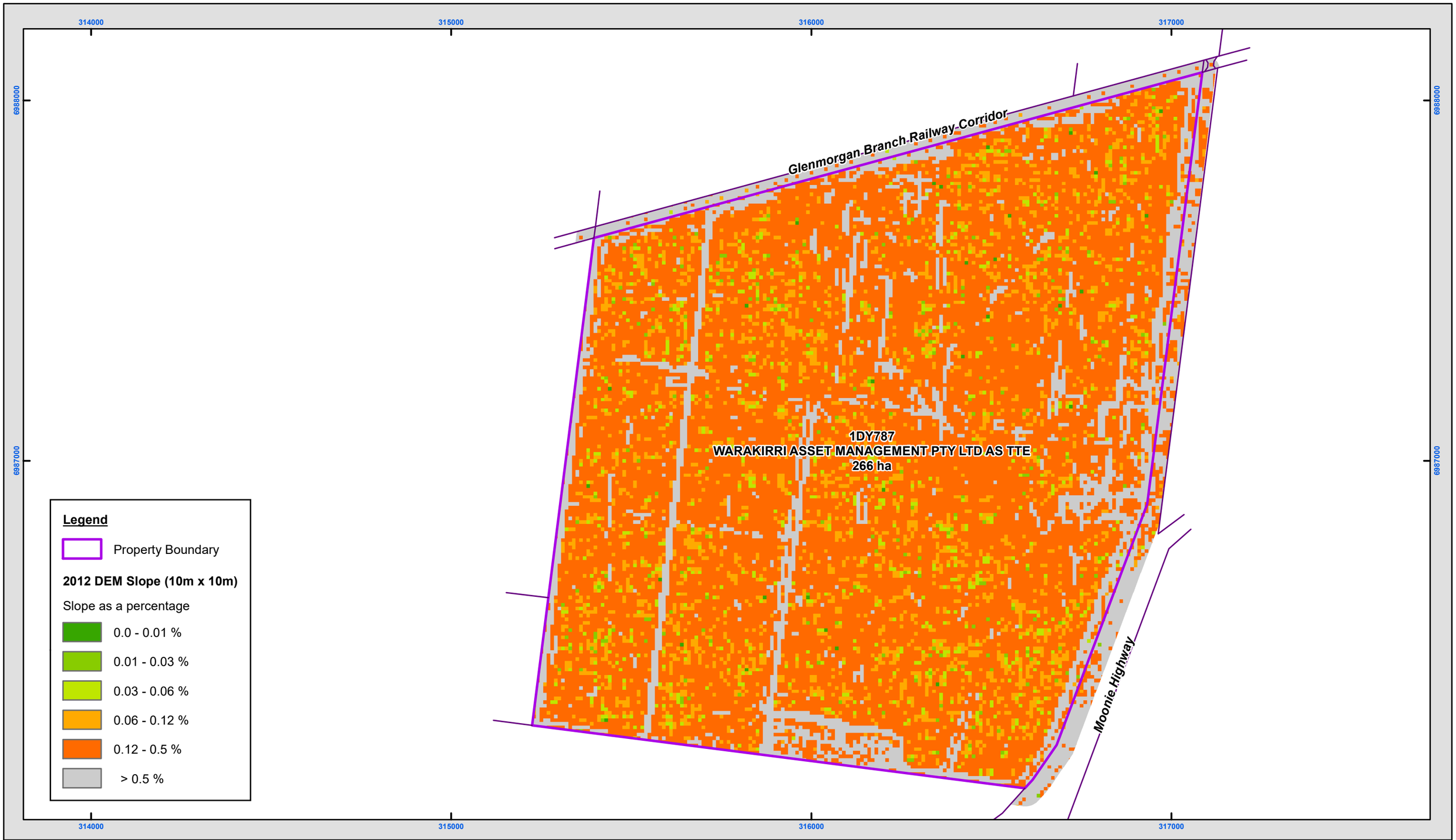

Figure 4 : Slope Analysis (10m x 10m squares) of 2012 DEM : Lot on Plan 1DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

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

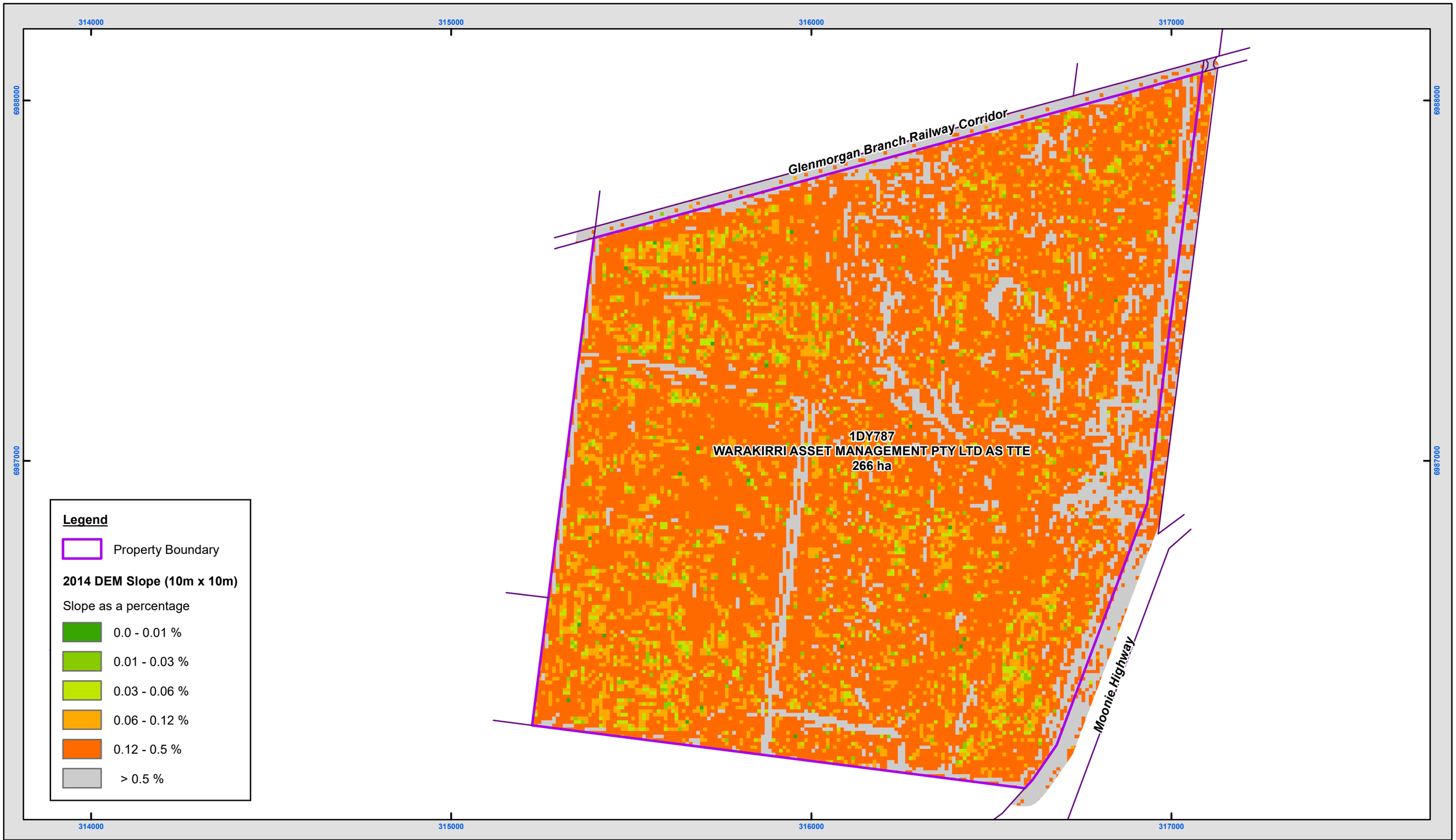

Figure 5 : Slope Analysis (10m x 10m squares) of 2014 DEM : Lot on Plan 1DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

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Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

NOT FOR CONSTRUCTION

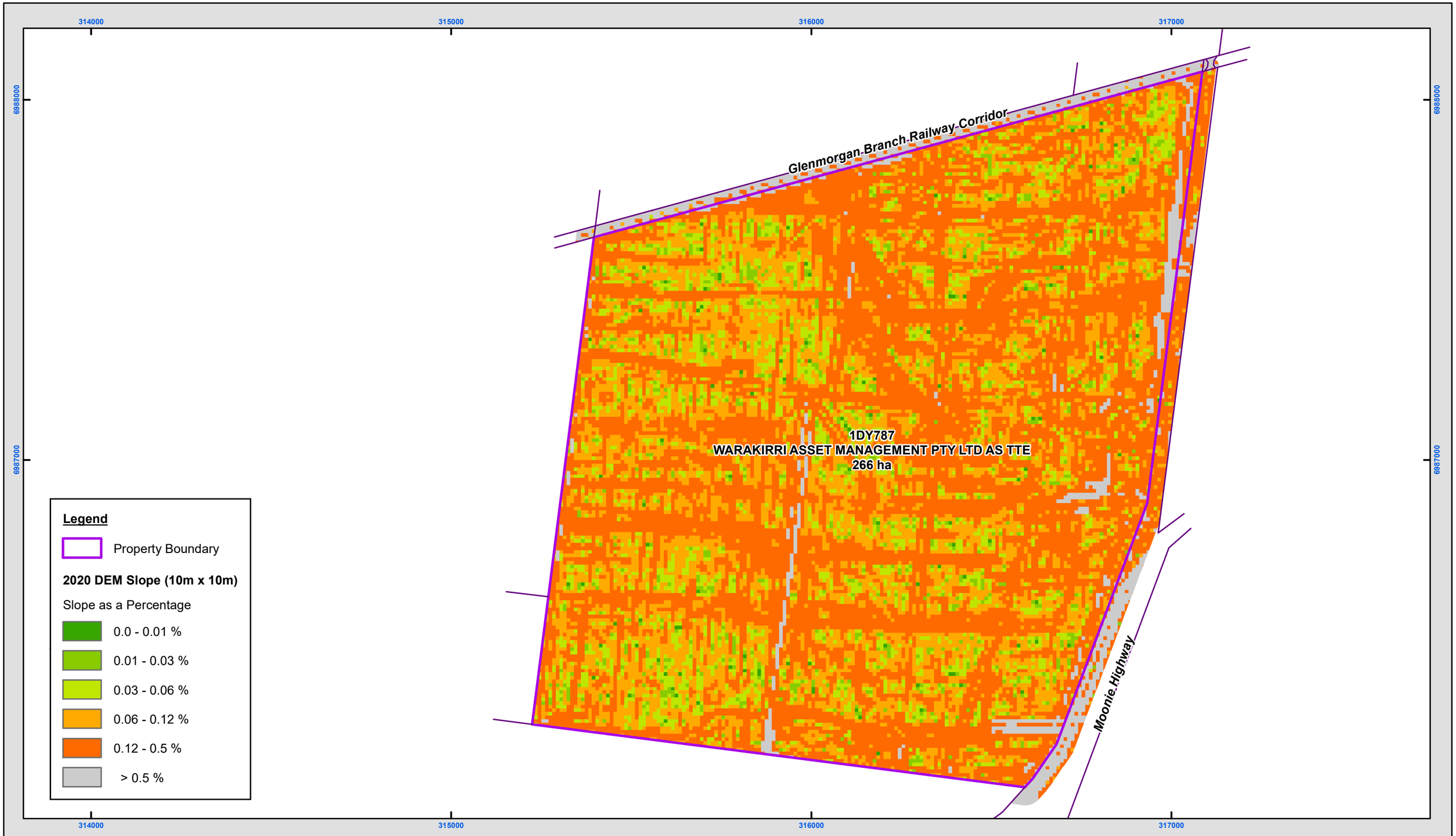

Figure 6 : Slope Analysis (10m x 10m squares) of 2020 DEM : Lot on Plan 1DY787

Source: Arrow Energy Pty Ltd
Geosciences Australia
Dept. Natural Resources and Mines

Date: 19/07/2021

Author: Arrow Energy

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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.

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Appendix 12: Arrow Land Procedures

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Procedure
ORG-ARW-HSM-PRO-00146

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Land Disturbance

Version	6.0
Released	February 2022
Document Custodian	Environment Manager Operations and Project Execution
Document Owner	Environment Manager
Review Date	January 2024
Document Status	Issued for Use
Security Classification	Unrestricted
Legacy Document Number	99-V-PR-0038

Please see document administration section for more information

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Contents

1. Purpose and Application

Arrow activities involve constructing and establishing a wide range of petroleum and gas related infrastructure. Installing this infrastructure will cause disturbance to land, vegetation and soil. This procedure outlines mandatory environmental requirements to avoid, minimise or mitigate environmental harm associated with land disturbance activities. It also describes how the land disturbance aspects of the *Arrow Land Management Standard* are met.

This procedure covers vegetation clearing, soil management, site preparation and erosion and sediment control for all Arrow controlled activities during exploration, drilling, construction, and operating phases. This procedure does not cover site stabilisation, final rehabilitation or rehabilitation monitoring (refer to the *Arrow Land Rehabilitation Procedure*).

All Arrow employees and Mode 1 Contractors are required to adhere to the requirements of this procedure and Mode 2 Contractors are required to have an equivalent process that meets or exceeds the requirements of this procedure.

This procedure must be implemented together with any site-specific conditions and approvals (for example – Environmental Authority (EA) conditions, Arrow Access and Approvals Package (AAP), Environmental Impact Statement (EIS) commitments).

Activities must not be carried out if they will cause, or are likely to cause environmental harm, unless all reasonable and practicable measures to prevent or minimise the harm are taken (*s319 of the Environmental Protection Act 1994 (Queensland)*). EA's have specific conditions associated with land disturbance. The EA conditions must be adhered to in order to ensure impacts from land disturbance are minimised to as low as reasonably practicable.

2. Framework

This procedure supports the Standard – Land Management under the Arrow Health Safety Environment Management System (HSEMS. The Land Disturbance Guideline is the primary document supporting this procedure and provides further detail in relation to vegetation clearing, soil management, site preparation and erosion and sediment control.

3. Objectives

3.1 Guiding Principles for Land Disturbance

The guiding principles for land disturbance should be used to plan and implement works; and to develop additional plans and procedures for specific sites.

Avoid

- disturbing sensitive environmental values (for example - flora, fauna, watercourses, wetlands); and
- disturbing land outside the approved area.

Minimise

- the footprint (area) of the site (i.e. the total area of land disturbance within the approved area);

- the duration of soil disturbance;
- water movement across the site; and
- removing vegetation, especially native woody vegetation/grasses (i.e. utilise previously disturbed areas).

Mitigate impacts by

- developing and implementing effective Erosion and Sediment Control Plans (ESCPs) and soil management measures based on anticipated soil type, scale of disturbance, weather and construction conditions, and time/length of disturbance;
- maintaining all erosion and sediment control (ESC) measures in proper working order;
- stabilising and/or rehabilitating sites promptly; and
- providing biodiversity offsets where required.

4. Planning & Design

The hierarchy of avoiding, minimising, and mitigating any proposed disturbance to vegetation shall be followed. This may include environmental offsets; refer to any relevant Environment Protection and Biodiversity Conservation Act (EPBC) approval, the EA and any other relevant environmental approval for specific requirements. This hierarchy shall be applied to the extent practicable before any decision to clear or disturb vegetation is taken.

Minimal Disturbance site preparation methods shall be utilised whenever possible for well pads and associated access tracks. This shall be planned for during the design phase. For further guidance material on Minimal Disturbance, refer to the Arrow *Land Disturbance Guideline*.

Ensure pre-clearance fauna and vegetation surveys are carried out as per Federal and State approval requirements, refer to the Arrow *Ecology Survey Guideline.*

Vegetation clearing shall be limited to the minimum necessary for safe construction and operation of the infrastructure. Avoid impacts to riparian vegetation and where this isn't possible, minimise ROW widths through any watercourse crossings or wetlands. Designs shall comply with any relevant legislation, including EA conditions relating to vegetation disturbance areas, widths, and location. Immediately prior to commencing work on site the EA conditions shall be reassessed to ensure they have not changed since the design and the AAP was completed.

Designs shall assess the alteration of drainage flows in and around site infrastructure and shall ensure that permanent measures are implemented to manage any changes to surface flows once construction is completed.

4.1 Permits

If sensitive species or communities (e.g. Endangered, Vulnerable or Near Threatened or EPBC) are present on the site, any necessary permits shall be obtained prior to commencing land disturbance works and the permit conditions or regulatory approved plans must be implemented for the operational life of the activity, if appropriate.

Where appropriate, permits shall be obtained for traversing watercourses and wetlands.

4.2 Planning for Soil Management

The soil type/s for the site to be disturbed shall be determined. This can be achieved by referring to soils maps or taking soil samples on site. The risks regarding soils for the site and the appropriate management practices shall also be determined. If further guidance is required, refer to the Arrow *Land Disturbance Guideline*. Once the soil type has been determined, refer to *Appendix A* for appropriate topsoil stripping depths for Arrow sites.

An ESCP shall be implemented for all areas of soil disturbance greater than 250 square metres. For soil disturbances greater than 2,500 square metres the ESCP must be prepared by a *suitably qualified and experienced person*[i]. The ESCP shall be approved by Arrow before land disturbance commences. Any material deviation from the ESCP must be managed through a robust, documented management of change process.

Erosion and sediment control measures shall be in accordance, to the greatest extent practicable, with the International Erosion Control Association Best Practice Erosion and Sediment Control document (IECA, 2008), unless more cost-effective practices are proposed that achieve the same or better outcomes.

4.3 Protection Measures for Sensitive Areas

If protection measures (environmental or cultural) are specified in the AAP, Environment/Ecology/Cultural Heritage representatives shall ensure protection measures are accurately located, pegged out and demarcated prior to vegetation clearing. If sites are to be partially prepared using Minimal Disturbance techniques, these areas shall be clearly defined, pegged out and demarcated.

Depending on the category of watercourse crossing, a geotechnical assessment and Aquatic Values Management Plan (AVMP) may be required. These assessments should indicate the appropriate construction methodology. An AVMP may be required under the EPBC Act approval or Environmental Authority and will be identified under the site-specific AAP if required.

Site-specific plans shall be developed for each watercourse crossing based on EA requirements, EIS requirements (if relevant to the particular project), soil type, ecological values, slope, time of year for works and rehabilitation methods (refer to the Arrow *Land Rehabilitation Procedure*). Additional protection measures shall be installed in these areas during construction works.

Where activities have the potential to impact high ecological value waters, monitoring and assurance should be undertaken.

4.4 Fauna and Flora Management

A fauna spotter/catcher shall be on site to supervise woody vegetation removal in accordance with the site AAP. All native vegetation clearing or habitat removal by Arrow and Mode 1 Contractors must adhere to the requirements of the Arrow *Fauna Management Procedure*. Mode 2 Contractors are required to have a fauna management process that meets or exceeds the requirements of Arrow's *Biodiversity Standard*.

If endangered, vulnerable or near-threatened flora species are to be removed, refer to the AAP and referenced relevant species management plans and approval conditions.

Woody native vegetation shall not be removed to create stockpile or laydown areas if previously cleared areas can be utilised.

Cleared vegetation shall not be burnt (unless within areas covered by the *Forestry Act 1959,* and then only with the correct permits and approvals in place).

Once vegetation clearing is complete the area shall be surveyed or GPS coordinates taken to determine the actual extent of clearing (as-built). This information and the clearing dates are required for rehabilitation tracking, and (for Contractors) shall be provided to Arrow in accordance with the contract conditions.

All applicable regulatory permits (e.g. EA and Occupation Permit) shall be checked to ensure any other mandatory requirements for flora and fauna management are identified.

4.5 Weed Management

Refer to Arrow *Weed Management Procedure* for details on the management of weed species. Mode 2 Contractors are required to have a weed management process that meets or exceeds the requirements of the Arrow *Land Management Standard*.

4.6 Fencing

Sites shall be fenced in accordance with the appropriate design, security and landholder requirements. These requirements shall take into consideration the use of fauna friendly designs (refer to the *Arrow Land Disturbance Guideline* if further information is required). All infrastructure associated with well pads shall be fenced to exclude livestock until site stabilisation is complete. Temporary fencing may be required on other sites to re-establish vegetative cover. Temporary pipeline bell holes shall be fenced for safety and to prevent the entry of stock, native species and pest animal species.

4.7 Decommissioning

Following the completion of activities, infrastructure will be decommissioned and removed prior to rehabilitation works commencing. For further information on decommissioning rehabilitation requirements, refer to Arrow's *Rehabilitation Procedure*.

5. Soil and Water Management

Problematic soils, such as sodic/saline or acidic soils shall be managed and ameliorated in line with the results of soil testing. For large-scale sites, soil ameliorants shall be applied prior to topsoil stripping where possible. For soil amelioration specifications refer to *Appendix B*. Product specifications may vary from these as long as there is suitable justification for use and only as agreed with Arrow Environmental Representative.

The top layer of the soil profile shall be removed prior to carrying out land disturbance activities and the material stockpiled to preserve its biological and chemical properties. Refer to *Appendix A* for designated topsoil stripping depths for Arrow sites.

Once construction is complete, site stabilisation is required including topsoil re-spreading across the disturbed area. Compacted sites should be ripped/scarified along the contour to an appropriate depth (~200-300mm depending on soil type). If the site topsoil is not present in

sufficient quantities then substitution with materials such as organic matter or chemical additives may be used if approved by the Arrow Environmental Representative.

Refer to the Arrow *Land Rehabilitation Procedure* for details on site stabilisation requirements.

5.1 Drainage, Erosion and Sediment Controls

Drainage, erosion and sediment control measures shall be installed in parallel with vegetation clearing and grading, so that all disturbed areas have some protection in place until all the erosion and sediment controls identified in the ESCP are installed. All erosion and sediment controls shall be maintained throughout the construction phase. The ESCP shall be modified, updated and approved when required to reflect changes in site conditions or controls.

5.2 Water Management

All water from upslope of the site shall be designated as 'clean' and diverted around areas of disturbed soils or where wastes or contaminants are stored or handled. All water (runoff or rainfall) that has come into contact with disturbed soils or where contaminates are stored or handled on site shall be designated as 'dirty' and re-used, or treated prior to being discharged from site in accordance with the EA conditions and the ESCP.

Water should be discharged from sediment basins in accordance with EA requirements and the objectives identified in the specific ESCP.

Site specific overland flow characteristics and associated downstream usage also require consideration during construction planning. Minimising potential impacts on overland flow should include consideration of construction timing and duration together with identification and incorporation of overland flow paths into site drainage designs.

5.3 Stockpile Management

Topsoil, vegetation and spoil material shall be stockpiled separately.

Topsoil stockpiles shall not be compacted, or driven over and shall be a maximum of 2m in height, unless otherwise stipulated in the EA. All soil stockpiles shall be protected from erosion and sediment loss as identified in the ESCP.

Permanent stockpiles (unsuitable/spoil and topsoil) shall be capped with topsoil, stabilised and revegetated as soon as possible. These stockpiles shall have 4:1 batters and must be free-draining. There are no restrictions on height for permanent stockpiles as long as there are no visual amenity issues with neighbouring landholders, and that they are shaped to minimise erosion and ensure long-term stability.

Cleared vegetation shall be stockpiled in a manner that facilitates respreading or salvaging and does not impede vehicle, stock, wildlife or water movement. The fire risk shall be assessed and managed accordingly. Any piles of timber or vegetation stockpiled for greater than 24 hours (or a period to be determined through specialist ecology advice) will require a fauna spotter catcher or ecology representative to be present when moved.

If identified in the AAP, hollow bearing logs or other fauna habitat features (e.g. large rocks/rock piles, hollow bearing limbs) shall be retained and stockpiled within the battery limits of the site.

Unless otherwise directed, vegetation stockpiles shall not be respread until final rehabilitation phase. This is to ensure that sites are accessible for maintenance (erosion repairs, vegetation slashing or weed control etc.). Refer to the Arrow *Land Rehabilitation Procedure* for further detail regarding stabilisation or final rehabilitation requirements.

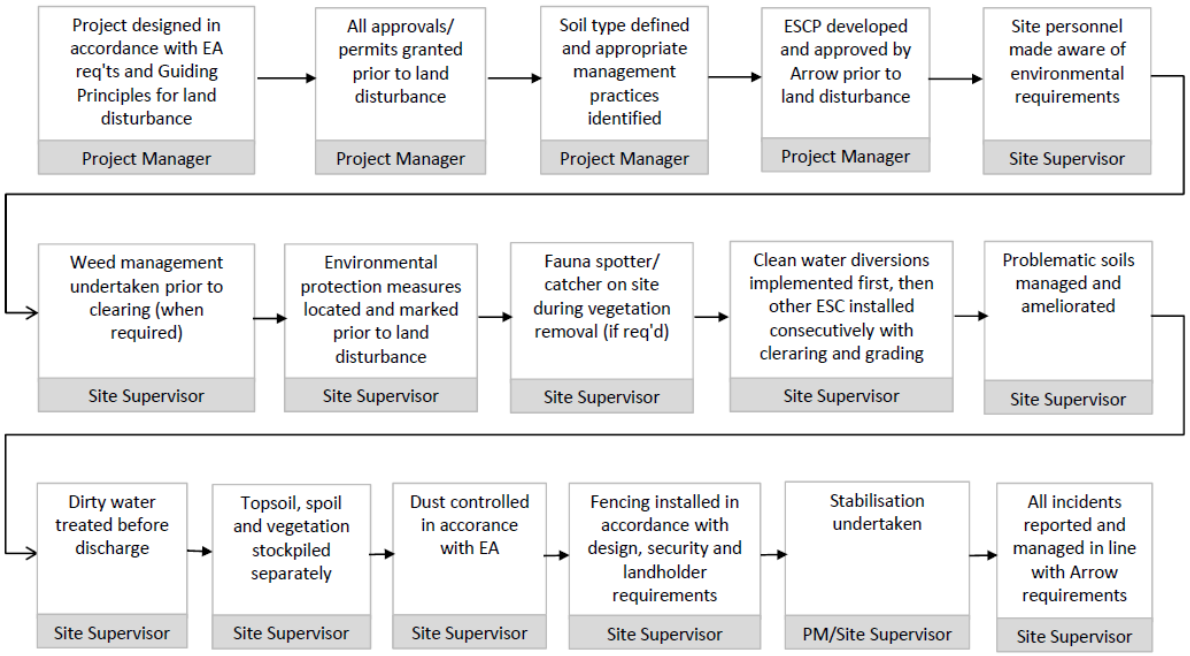
All relevant regulatory permits (e.g. EA and Occupation Permit) shall be checked to ensure any other mandatory requirements for stockpiling are identified.

5.4 Dust Management

Dust shall be managed in accordance with the requirements of the EA and the AAP. Construction activities shall also meet any EIS commitments (if relevant to the specific project) regarding dust generation and control. Refer to the Arrow *Dust Management Guideline* for information relating to the various controls that can be used for dust suppression.

6. Requirements and Responsibilities

The following flowchart shows the key steps required to follow this procedure and the key person responsible for each.



7. Compliance and Assurance

Compliance with the requirements established in this procedure will be reviewed as part of Arrow's assurance activities.

7.1 Monitoring

Monitoring and verification of the key requirements of this procedure will also be included as part of Arrow's environmental reporting requirements. Monitoring must be undertaken at a frequency that is appropriate to demonstrate compliance with Arrow legislative and EA

obligations. Where works have the potential to impact on high ecological value waters, monitoring and assurance should be undertaken.

7.2 Data and record keeping

Land disturbance data and records must be prepared and maintained. As a minimum, the following information shall be prepared and maintained where applicable:

- pre-clearance vegetation survey data
- coordinates and maps of areas that have been cleared
- details of soil ameliorants (specifications/quantities) applied.
- Fauna Spotter Catcher reports for clearing activities

For land disturbance works undertaken by Contractors, as a minimum the above information must be provided to Arrow (electronically).

8. Definitions

Term	Definition
Access and Approvals Package (AAP)	Package issued under Access and Approvals Framework which hosts the access and approval conditions which must be met for activities on a particular site.
AVMP	The Aquatic Values Management Plan (AVMP) describes the values of the watercourses and wetlands intersected by a disturbed area and outlines the mitigation measures to avoid or minimise the impacts during construction.
Decommissioning	When a network is disconnected from all sources of hydrocarbons or water that may be present in other pipelines and other appurtenances. Gas lines are purged of hydrocarbon and vapour with non-flammable fluid. Water lines are purged using compressed air.
Minimal Disturbance	Preparation of a well pad and/or access track with minimal disturbance to soil. Sites are stick raked and slashed only with no bulk earthworks occurring. Shrubs and saplings are mulched only to ground level whilst retaining root stock.
Final Rehabilitation	The process of reshaping and revegetating land to restore it to a stable landform which meets final acceptance criteria in EAs and, where relevant, includes remediation of contaminated land. This is the final phase prior to relinquishment. Refer Procedure – Land Rehabilitation for a more detailed description
Suitably Qualified/ Experienced Person	Formal training and/or qualifications in erosion and sediment control and relevant experience in the management of erosion and sediment control for the scale of disturbance proposed.
Site Stabilisation	Site stabilisation relates to ensuring a site remains stable for its operational life. Typically this will include: removing contaminated soil and wastes from the site unless otherwise authorised to remain, re-establishing the pre-existing landform (including topsoil management and amelioration and backfilling excavations), establishing groundcover, undertaking weed control, monitoring for erosion/subsidence, vegetation establishment and weed germination, and periodic maintenance. Refer Procedure – Land Rehabilitation for a more detailed description. May also be referred to as ‘progressive’, ‘interim’ or ‘transitional’ rehabilitation.

9. Document Control

This document has been created using ORG-ARW-IMT-TEM-00003 v3.0

Revision history

Revision	Revision Date	Revision Summary	Author
2.0	10/02/15	Transferred to new procedure template, addition of transitional rehab requirement, topsoil stripping depths and ameliorant specifications. Consolidated info covered in other critical HSE procedures and minor changes to technical content.	K Sanson
3.0	7/02/17	Minor change increasing flexibility for preparation and approval of ESCPs.	J Flint
4.0	27/11/17	Minor update to reflect change in terminology from transitional rehabilitation to stabilisation to align with Procedure – Land Rehabilitation and supporting documents.	T Jocumsen
5.0	07/02/2019	Update of header to “Safe Work, Strong Business” logo	J Hayes
6.0	06/01/2021	Legislative updates. Section 5.2, update and inclusion of ‘Overland flow’ considerations.	T Riseley

Related documents

Document Number	Document title
ORG-ARW-HSM-STA-00036	Land Management Standard
ORG-ARW-HSM-PRO-00073	Land Rehabilitation Procedure
ORG-ARW-HSM_PLA-00064	Land Rehabilitation Plan
ORG-ARW-HSM-GUI-00094	Land Disturbance Guideline
ORG-ARW-HSM-PRO-00139	Weed Management Procedure
ORG-ARW-HSM-PRO-00067	Fauna Management Procedure
ORG-ARW-HSM-STA-00034	Biodiversity Standard
ORG-ARW-HSM-GUI-00050	Dust Management Guideline
ORG-ARW-HSM-GUI-00070	Ecology Survey Guideline
ORG-ARW-HSM-PLA-00070	Species Management Plan

Acceptance and release

Author

Position	Incumbent	Release Date
Environment Lead Well Delivery	Tarla Jocumsen	November 2017
Senior Environment Advisor	Tim Riseley	February 2022

Stakeholders and reviewers

Position	Incumbent	Review Date
Environment Manager Operations and Project Execution	Jenny Miller	January 2021
Projects Environment Manager	Alison Way	January 2021
Senior Environment Advisor South	Tim Riseley	January 2021
Senior Environmental Advisor South	Arron Gorrie	February 2022

Approver

Position	Incumbent	Approval Date
Environment Manager	Scott Nairn	February 2022

Appendix A - Topsoil Stripping Depths for Arrow Sites

Arrow soil	Maximum stripping depth [1](mm)
Shallow sands and loams	100
Shallow clay loams and clays	100
Shallow medium-heavy clays	200
Deep sands and sandy loams	200
Deep loams and clay loams	200
Deep cracking clays	Variable [2, 3] (maximum 300 mm)
Melonhole clays	200 [4]
Massive earths	300
Structured earths	200
Non-dispersive texture contract (TC) soils	Variable [2] (maximum 400 mm)
Thin-surfaced, dispersive TC soils	Variable [2] (maximum 200 mm)
Thick-surfaced, dispersive TC soils	200

Notes:

1. The recommended maximum stripping depth includes suitable soil material from the surface layer and from the underlying subsurface layer (if present) and subsoil.

2. “Variable” stripping depth needs to be tested by soil survey prior to stripping.

3. Thickness of suitable topsoil in deep cracking clays will depend upon the salinity, pH and capacity for dispersion of underlying soil material.

4. A 200 mm topsoil stripping depth for the Melonhole clays should result in only material from the mounds being stockpiled for topsoil as the vertical interval between the tops of the mounds and bottom of the depressions is at least 300 mm.

Appendix B – Soil Ameliorant Specifications

Material requirements

The soil amelioration agents (lime, gypsum and dolomite) shall comply with the requirements stated below. Documents showing the product analysis shall be provided to Arrow upon request prior to application.

Lime and Dolomite

Lime shall be agricultural lime consisting of natural ground limestone (calcium carbonate - $CaCO_3$). Dolomite shall be agricultural dolomite ($CaMgCO_3$). Both products shall meet the following parameter requirements:

- A neutralising value (NV) of 90 and above determined by using the test method 19A1 from the *Australian Laboratory Handbook of Soil and Water Chemical Methods*
- A pH value of 8.5 +/- 0.5 determined by using the test method identified in Clause 5.5 of AS 4419 – Soils for landscaping and garden use
- Particle size (fineness):
    - 100% by weight to pass a 5 mm sieve
    - 95% by weight to pass a 3.5 mm sieve
    - 40% by weight to pass a 0.15 mm sieve

Gypsum

Gypsum (calcium sulfate $CaSO_42H_2O$) shall be a natural agricultural grade material. Gypsum shall meet the following parameter requirements:

- a minimum 80% of gypsum
- a moisture content of <15%
- have a total content (x-ray fluorescence test) of:
    - > 20% calcium (Ca)
    - > 15% sulphur (S)
    - < 2% sodium chloride (NaCl)
- if manufactured - have a total content of heavy metals:
    - < 0.001% cadmium (Cd)
    - < 0.01% lead (Pb)
- have a particle size distribution of:
    - 100% by weight to pass a 6 mm sieve
    - 80% by weight to pass a 4 mm sieve
    - 50% by weight to pass a 2 mm sieve

[i] Adapted from IECA 2008, Best Practice Erosion and Sediment Control, Book 1, pp. 5.4

Procedure
ORG-ARW-HSM-PRO-00073

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Land Rehabilitation

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Table of Contents

1. Purpose and Application

Many of Arrow's activities involve land disturbance and Arrow has an obligation to ensure disturbed areas are appropriately managed to comply with regulatory requirements, minimise risk of environmental harm and ensure an appropriate land use can be re-established at the end of life of the infrastructure/activity for which land disturbance was required. Dependent on future activities, disturbed areas must be stabilised or rehabilitated to meet regulatory obligations and landholder expectations.

This procedure describes how the rehabilitation aspects of the Arrow *Standard – Land Management* are met. It outlines the steps that must be undertaken when rehabilitating areas of disturbance resulting from Arrow activities in order to maintain stability for its operational life (referred to as stabilisation). It also outlines rehabilitation requirements following infrastructure decommissioning, or completion of exploration, appraisal and production phases, or other short-term activities (referred to as final rehabilitation). Only rehabilitation aspects of land disturbance are covered in this procedure; refer to the Land Disturbance Procedure for other land disturbance requirements.

All Arrow employees and Mode 1 Contractors are required to adhere to the requirements of this procedure and Mode 2 Contractors are required to have an equivalent process that meets or exceeds the requirements of this procedure.

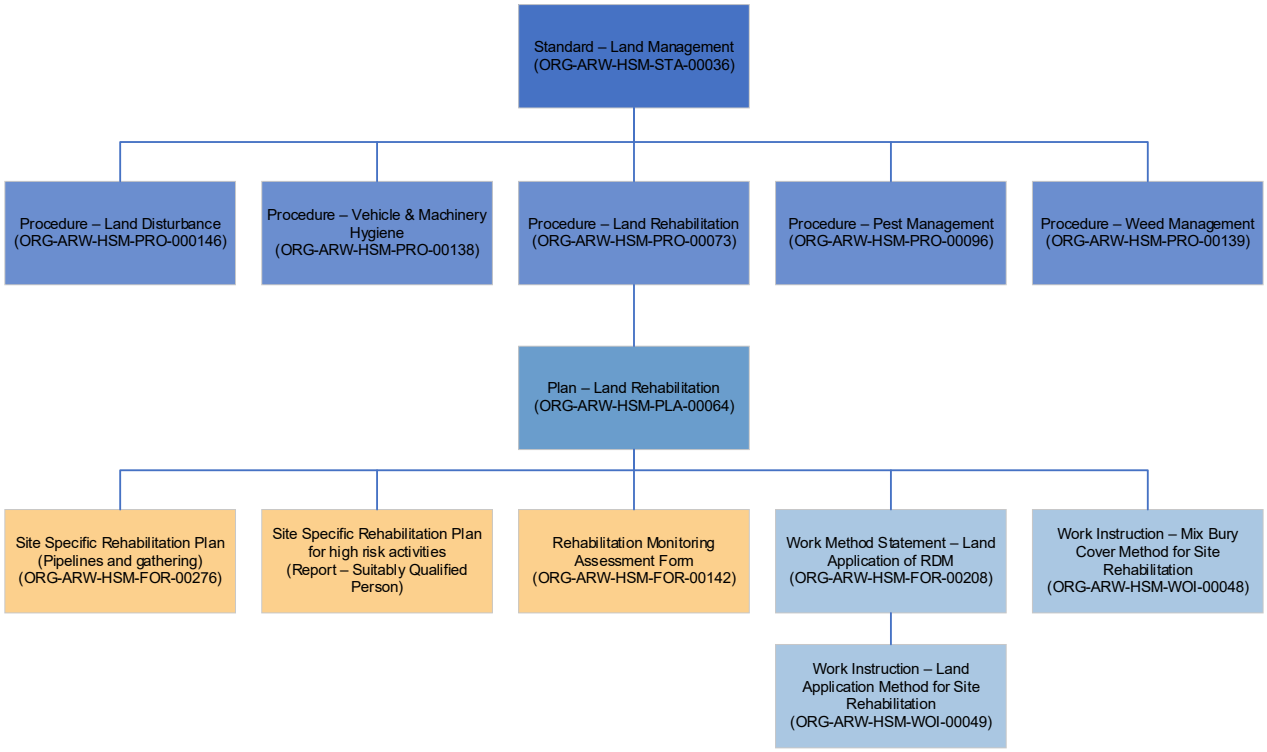
This procedure must be implemented together with any site-specific conditions and approvals (for example - Environmental Authority (EA) conditions, Arrow Access and Approvals Package (AAP), Environmental Impact Statement (EIS) commitments).

Unless authorised, activities must not be carried out if they will cause, or are likely to cause environmental harm, unless all reasonable and practicable measures to prevent or minimise the harm are taken (s319 of the Environmental Protection Act 1994 (Queensland)). EAs have specific conditions associated with rehabilitation.

2. Framework

This procedure supports the *Standard – Land Management* under the Arrow Health Safety Environment Management System (HSEMS). Supporting HSEMS documents to this procedure include the Land Rehabilitation Plan, Rehabilitation Monitoring Assessment Form, Site Specific Rehabilitation Plan and work method and instructions related to onsite disposal of residual drilling material. This framework is represented in Figure 1 below.

Figure 1: HSEMS Framework Supporting *Standard – Land Management*



The Land Rehabilitation Plan contains standard rehabilitation requirements and guides rehabilitation for all sites. Site-specific rehabilitation plans may contain requirements such as rehabilitation target outcomes, seed mixes and management of residual drilling materials.

A site specific rehabilitation plan may be a form completed by an Arrow employee as a requirement for decommissioning of a pipeline or gathering network or a document prepared by a suitably qualified person for high risk areas such as a Dam or large facility.

3. Objectives

3.1 Stabilisation

Areas of land disturbance associated with Arrow activities which are required for ongoing activities need to be maintained in a stable state to meet EA and other regulatory requirements and landholder expectations. Hence, where land disturbance is undertaken, project managers must ensure sites are maintained in an appropriate stable condition following completion of construction activities, e.g. construction works associated with new buildings or facilities, pipeline installation or drilling activities. Stabilisation requirements are based on the pre-disturbance ecological values of the site and surrounding area unless otherwise agreed with the landholder and regulator.

As a minimum, the following objectives must be met for site stabilisation unless otherwise approved by a suitably qualified/experienced person, e.g. Environment team representative, and the asset owner:

- Contaminated land resulting from petroleum activities is remediated and rehabilitated;
- All wastes are removed from site unless otherwise authorised to remain, e.g. residual drilling material;
- Any permitted onsite use or disposal of wastes is executed in accordance with HSEMS, EA and AAP requirements;

- Any excavations not required for ongoing operations are backfilled, e.g. pits/trenches/sumps used for drilling activities;
- Site is re-profiled to contours consistent with the surrounding landform to the extent allowable by the site's operational use;
- Topsoil is reinstated and any amelioration required to support re-establishment of groundcover has been applied; and
- Groundcover is established or another soil stabilisation method that achieves effective stabilisation (e.g. spray on polymer) has been employed.

Stabilisation of disturbed areas must commence as soon as practicable following land disturbance. Sites are to be stabilised to these objectives within 12 months of cessation of activities unless an alternative timeframe is agreed with the regulator and/or permitted in the EA. Staged stabilisation may be appropriate for large projects and/or linear infrastructure to minimise risk of land degradation before stabilisation works are completed.

Ongoing monitoring and maintenance are required to ensure sites remain in a stable condition, i.e.

- Weeds and pests are controlled
- Significant erosion/subsidence is not occurring
- Vegetation has established or other soil stabilisation methods are maintained

Records of stabilised area footprints, volumes, methods and locations of any onsite waste disposal, monitoring and maintenance activities shall be provided to Arrow during site handover processes

3.2 Decommissioning

Following completion of activities, infrastructure will be decommissioned, and above ground infrastructure removed prior to rehabilitation works commencing. For large infrastructure such as dams and CGPFs, a site-specific decommissioning plan will be developed.

For pipeline and gathering networks that are to be decommissioned, a decommissioning plan will be developed to meet the requirements of the latest Australian Pipelines and Gas Association (APGA) Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry, this plan will be supported by a Site Specific Rehabilitation Plan.

The objectives to be achieved for decommissioning include those for stabilisation (Section 3.1) and:

- The infrastructure no longer accepts inflow from the petroleum activities
- Networks will be purged of all hydrocarbons and vapor with a non-flammable fluid. Disposal of the purging fluid will meet all relevant environment and safety requirements.
- Contamination of the soil or groundwater is minimized to an acceptable risk
- Future ground subsidence is minimised to an acceptable risk
- Pipeline and gathering networks should be left in the ground
- For pipelines and gathering, records identifying locations of the networks are to be prepared as part of the relinquishment procedure

3.3 Rehabilitation

Following completion of activities and decommissioning of infrastructure (if applicable), sites shall be rehabilitated to achieve compliance with the final rehabilitation acceptance criteria specified in the relevant EA and/or any commitments made in a site-specific rehabilitation

plan/decommissioning plan and/or any other outcomes agreed with the landholder and/or regulator. This shall be undertaken as soon as practicable and within timeframes specified in EAs.

EAs contain requirements and criteria which must be met in order for sites to be recognised as having achieved final rehabilitation status. The final acceptance criteria are generally measured either against the highest ecological value adjacent land use or the pre-disturbed land use for the site.

Site specific rehabilitation plans are required to support pipeline and gathering network decommissioning plans in accordance with the APGA Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry. Additionally, petroleum pipeline lease EAs require the reinstatement of pipelines in accordance with the APGA Code of Environmental Practice – Onshore Pipelines. Arrow also commits to developing site specific rehabilitation plans for large high risk facilities such as CGPFs and dams.In some instances, where authorised by the relevant EA, agreement may be reached with landholders to handover infrastructure (e.g. dams, fences or tracks) for their ongoing use, or be rehabilitated to an alternative outcome than the pre-disturbance land use (e.g. if surrounding land uses have changed since initial disturbance activities). Any deviation to EA final rehabilitation acceptance criteria must be agreed in writing with both the landholder and the regulator.

Final rehabilitation objectives are determined by considering the EA final rehabilitation acceptance criteria, surrounding land use and landholder preferences. These objectives shall be determined by the Access and Approvals Team in consultation with the landholder and the Asset Manager. As per the Access & Approvals Framework, the relevant environmental representative reviews and approves the content that relates to compliance with EA conditions.

As a minimum, the following is required for final rehabilitation to be achieved:

- Completion of all stabilisation activities (refer to Section 3.1)
- Reinstatement of specific vegetation species to meet final acceptance criteria, e.g. percent groundcover, percent species richness and/or vegetation types in pre-existing or adjacent environmentally sensitive areas
- Weed management to final acceptance criteria, e.g. percent species richness of declared plant species
- Achievement of other criteria which may apply where significant disturbance has occurred in an environmentally sensitive area, e.g. percent organic litter cover or total density of coarse woody material
- Achievement of other objectives agreed with the landholder and/or regulator
- Final acceptance criteria stipulated in the EAs to be achieved

Monitoring and maintenance must occur during final rehabilitation to ensure sites remain stable and are progressing towards final acceptance criteria within the desired timeframes.

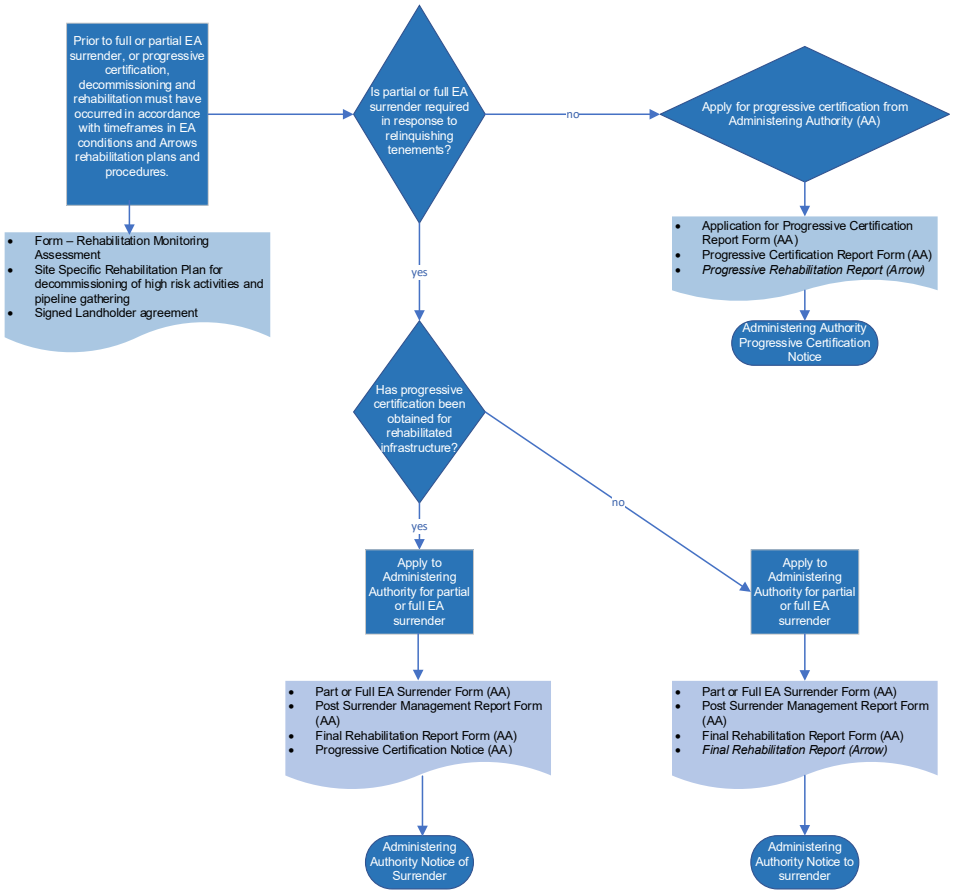
4. Administering Authority Documentation

Upon completion of rehabilitation, Arrow may choose to apply to the Administering Authority for Progressive Certification over parts of an area of the resource tenure. The benefits are: ability to reduce financial assurance payment; no impact to progressively certified areas if there are any changes to rehabilitation conditions in the EA; and reduced survey/reporting requirements when partial or full EA surrender is required at the end of a tenure. Progressive certification applications must include the ‘application for progressive certification form’ and a ‘progressive certification report’, which are both administering authority forms. Additionally, Arrow has developed a template called Progressive Rehabilitation Report to address the detailed information required by the administering authority’s form.

Alternatively, Arrow may decide or be required to surrender all or part of an EA in response to a

full or partial tenure relinquishment. In addition to completing the administering authority's 'surrender application form', which is required for all full or part EA surrenders, a number of other administering authority's forms are required where disturbance and subsequent rehabilitation has occurred on the tenure to be relinquished. These forms are 'final rehabilitation report' and 'post surrender management report'. Additionally, Arrow will prepare a Final Rehabilitation Report to address the detailed information required by the administering authority's forms.

Figure 2: Administering Authority Process



5. Requirements and Responsibilities

Table 1 shows the key actions required under this procedure for different project stages and the responsible party for each.

Table 1 Key rehabilitation-related activities

Project Stage	Key project activities	Key rehabilitation-related activities	Responsibility
Plan	Project scoping and design	Identify stabilisation/rehabilitation requirements.	SMEs through AAP process
		Include requirements in project scopes, budgets and schedules.	Project Manager
Execute/ Construct	Infrastructure construction (land disturbance)	Stabilise disturbed areas in accordance with agreed scope.	Construction Superintendent
		Monitor and maintain stabilised areas to verify stabilisation objectives have been met.	Construction Superintendent
	Handover of infrastructure to operator	Provide records including disturbance footprints, stabilisation activities and any onsite waste management as per Section 3.1.	Project Manager (as built records) Construction Superintendent (other records)
Operate	Operation and maintenance of infrastructure	Prioritise monitoring of stabilised areas and corrective actions where required.	Environment Team
		Monitor and maintain stabilised areas to ensure stabilisation objectives continue to be met. Support site monitoring including record keeping.	Asset Manager Environment Team representative Access and Approvals Team
Project Stage	**Key project activities**	**Key rehabilitation-related activities**	**Responsibility**
Decommission high risk facility e.g. Dam	Infrastructure decommissioning	Identify final rehabilitation objectives and develop a site-specific rehabilitation plan.	Suitably qualified person
		Scope and budget for works to meet rehabilitation objectives.	Asset Manager
		Decommission infrastructure and undertake site works to support final rehabilitation per agreed scope.	Construction Superintendent
		Prioritise monitoring and maintenance of rehabilitated areas.	Environment Team
		Monitor and maintain rehabilitated areas to ensure final rehabilitation objectives are met. Support site monitoring.	Asset Manager Asset environmental representative Access and Approvals Team
Decommission pipeline or gathering	Infrastructure decommissioning	Complete site-specific rehabilitation plan (Arrow form) and identify final rehabilitation objectives.	Asset Manager/Environmental representative
		Scope and budget for works to meet rehabilitation objectives.	Asset Manager
		Decommission infrastructure and undertake site works to support final rehabilitation per agreed scope.	Construction Superintendent
		Prioritise monitoring and maintenance of rehabilitated areas.	Environment Team

		Monitor and maintain rehabilitated areas to ensure final rehabilitation objectives are met. Support site monitoring.	Asset Manager Asset environmental representative Access and Approvals Team
Post-Rehabilitation	Final rehabilitation complete	Prepare Progressive Certification Application or Final Rehabilitation Report.	Environment Team
		Review Reports	Environment Team
		Obtain landholder signoff (and regulator signoff if site not returned to pre-disturbance condition).	Access and Approvals Team (Land Liaison Officer)
		Apply for progressive certification of rehabilitation from regulator.	Environment Team

6. Monitoring

All stabilised or rehabilitated sites require ongoing monitoring to ensure relevant rehabilitation objectives continue to be met during their operational life and decommissioning process.

Any remedial actions and maintenance requirements identified during monitoring activities and incidental observations (e.g. by Operations or land access staff) shall be carried out in a timely manner. The frequency of monitoring and timing of remedial actions or maintenance activities is to be based on the perceived risk of harm to people, the environment or infrastructure posed by the site and/or any regulatory (e.g. EA) or landholder conditions.

The Rehabilitation Monitoring Assessment Form is used to record ecological data and achievement against the EA rehabilitation acceptance criteria conditions. The data collected informs the final rehabilitation report and certified rehabilitation reports to apply to the Administering Authority for EA surrender or certification.

7. Compliance and Assurance

Compliance with the requirements established in this procedure are reviewed as part of Arrow's assurance activities.

Monitoring and verification of the key requirements of this procedure are included as part of Arrow's environmental reporting requirements.

8. Definitions

Term	Definition
Access and Approvals Package (AAP)	Package issued under Access and Approvals Framework which hosts the access and approval conditions which must be met for activities undertaken on a particular site.
Certified rehabilitated area	The area the subject of progressive certification is a certified rehabilitated area for the relevant tenure.
Decommissioning	When a network is disconnected from all sources of hydrocarbons or water that may be present in other pipelines and other appurtenances. Gas lines are purged of hydrocarbons and vapour with non-flammable fluid. Water lines are purged using compressed air.
Final rehabilitation report (FRR)	A final rehabilitation report prepared under chapter 5, part 10, division 3 of the *Environmental Protection Act 1994*. It provides evidence that the land on which activities authorised under an EA have been carried out has been rehabilitated to the required standards, e.g. final rehabilitation acceptance criteria in EA. The FRR is required to accompany an application for surrender of an EA which contains rehabilitation conditions, and to which no progressive rehabilitation and closure applies.
Progressive certification	Certification from the regulator that a particular area within a relevant tenure has been successfully rehabilitated to meet final acceptance criteria in EA.
Progressive rehabilitation report (PRR)	A report prepared to support an application for progressive certification of a particular rehabilitated area within a relevant tenure. It contains the same information as a final rehabilitation report.
Rehabilitation	Rehabilitation is the process of returning the land to a condition that will ensure the ongoing physical integrity and the natural ecosystem values of the site.
Stabilisation	Following land disturbance, the stabilisation of the land to minimise further risk of land degradation, this may include but is not limited to backfilling of excavations, reinstatement of topsoil and amelioration, waste disposal, remediation of contaminated land, re-profiled contours, establishment of groundcover or another soil stabilisation method.
Suitably qualified/ experienced person	A person who has professional qualifications, training or skills or experience relevant to the nominated subject matters and can give authoritative assessment, advice and analysis about performance relevant to the subject matters using relevant protocols, standards, methods or literature.

9. Document Control

This document has been created using ORG-ARW-IMT-TEM-00003 v3.0

Revision history

Revision	Revision Date	Revision Summary	Author
6.0	11/02/15	New procedure template. Moved to new document number from 99-H-PR-0088 Split info into transitional rehab and final rehab sections. Consolidated info covered in other critical HSE procedures and minor changes to technical content and wording around Contractor responsibilities.	K Sanson
7.0	21/09/17	Comprehensive review of procedure, update of rehabilitation requirements for different project stages and responsibilities for each.	Tarla Jocumsen
8.0	08/02/2019	Update of header to "Safe Work, Strong Business" logo.	J Hayes
9.0	12/11/2020	IFU - Alignment with APGA CoP for Upstream Polyethylene Gathering Networks	L Mack

Related documents

Document Number	Document title
ORG-ARW-HSM-STA-00036	Standard - Land Management
ORG-ARW-HSM-PRO-00146	Procedure - Land Disturbance
ORG-ARW-HSM-PRO-00138	Procedure – Vehicle & Machinery Hygiene
ORG-ARW-HSM-PRO-00139	Procedure - Weed Management
ORG-ARW-HSM-PRO-00096	Procedure – Pest Management
ORG-ARW-HSM-PLA-00064	Land Rehabilitation Plan
ORG-ARW-HSM-FOR-00208	Work Method Statement - Land Application of RDM
ORG-ARW-HSM-WOI-00049	Work Instruction - Land Application Method for Site Rehabilitation
ORG-ARW-HSM-WOI-00048	Work Instruction – Mix Bury Cover Method for Site Rehabilitation
ORG-ARW-HSM-FOR-00142	Rehabilitation Monitoring Assessment Form
ORG-ARW-HSM-FOR-00276	Site Specific Rehabilitation Plan

Acceptance and release author

Position	Incumbent	Release Date
Environment Lead Well Delivery	Tarla Jocumsen	21 September 2017
Environment Lead Compliance & Technical	Joe Hayes	08 February 2019
Senior Environment Advisor – Biosecurity & Compliance	Lavinnia Mack	12 November 2020

Stakeholders and reviewers

Position	Incumbent	Review Date
Environment Lead – Compliance and Technical	Georgina Rowe	November 2020
Projects Environment Manager	Alison Way	November 2020
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Approver(s)

Position	Incumbent	Approval Date
Corporate Environment Manager	Scott Nairn	

Specification
ORG-ARW-PPL-SPR-00005

Safe Work. Strong Business.

Specification for PE Gathering Networks (Gas and Water)

Version	3.0
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Document Status	Issued for Use
Security Classification	Restricted

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Contents

1. Introduction

1.1. Purpose

This Specification defines the minimum technical requirements for the design and construction of PE gathering networks associated with Arrow Energy projects.

This definition is derived from key legislative requirements, Australian and International Standards and Arrow Energy Policies.

Additional definition is provided by industry practices and guidelines where relevant.

A risk based approach has been taken for other content/definition provided.

1.2. Intended Use

This Specification applies to all Arrow Energy projects and design modifications to Arrow Energy assets. It is intended for use by Arrow Energy, its Consultants, Contractors and/or Suppliers.

Repairs, modifications or upgrades of existing Arrow Energy assets that have been built prior to publication of this version of this document should endeavour to comply with the requirements specified based on risk assessment.

This document is part of the suite of Arrow Technical Standards which includes Design Criteria, Philosophies, Specifications, Guidelines, Standard Drawings, Templates, and Standard Procedures.

No project or site specific data is included in this document. It is intended that project or site specific requirements are defined specific to each project within applicable project documentation.

1.3. Inclusions

The following are included in this document:

- Gas and water gathering networks.
- Treated and beneficial use water gathering networks.
- Water transfer and brine pipelines.

1.4. Exclusions

Being a general specification, no project or site-specific data is included. This information is contained in project-specific scope of work documents and the site specific documentation.

1.5. Regulatory Framework

1.5.1. Safety

Arrow Energy is required to meet safety obligations under three Acts that interface and overlap:

- Work Health and Safety Act 2011 (WHS Act).

- Petroleum and Gas (Production and Safety) Act 2004 (P&G Act).
- Electrical Safety Act 2002 (ES Act).

The aim of both the WHS Act and the safety aspects of the P&G Act is to eliminate or reduce the risk of injury and illness caused by places of work, to workers and others. It is a requirement of both Acts to systematically manage safety, reduce risk, so far as responsibly practicable and to utilise the hierarchy of control in managing risks.

The WHS Act is the default safety regulation in Queensland – it provides a hazard based framework to protect the health, safety and welfare of all persons in the conduct of a business or undertaking and other personnel who might be affected by the business or undertaking.

The P&G Act uses the term 'Operating Plant', as a legislative trigger for identifying facilities and activities that are subject to its safety jurisdiction (activities outside of the jurisdiction of the P&G Act fall under the WHS act). The P&G Act has specific prescriptive safety management system requirements which are addressed in Arrow Energy's Safety Management System Manual (ORG-ARW-HSM-MAN-00016).

Key parts of the WHS legislation used to set minimum requirements for high risk activities have been adopted by the P&G Act so that the same minimum standards apply. Arrow reflects these requirements in its HSE standards and procedures applicable to key high risk activities.

All of the safety acts impose generalised obligations on engineers and designers:

- To ensure that plant is adequately designed, operated and maintained which is met by following the applicable engineering documentation.
- Ensure that risks to health and safety are managed and minimised so far is reasonably practicable for not only the current configuration or use but also for that which is reasonably foreseeable. This is met by completing the required risk assessments and where necessary following Arrow Energy's Management of Change Procedure (ORG-ARW-HSM-PRO-00002).
- To maintain records including appropriate design documentation. This is met by following the relevant Information management documents particularly the Controlled Documents Standard (ORG-ARW-IMT-STA-00002) and Document Control Information Management Procedure (ORG-ARW-IMT-PRO-00002) where applicable. These documents set the requirements for Arrow Energy controlled documents including retention, revision, approval and review

The Electrical Safety Act (2002) (ES Act) applies specifically to electrical work

1. A person conducting a business or undertaking must ensure the person's business or undertaking is conducted in a way that is electrically safe.

2. With limiting subsection (1) the duty includes:

    a) Ensuring that all electrical equipment used in the conduct of the person's business or undertaking is electrically safe.

b) If the person's business or undertaking includes the performance of electrical work, ensuring the electrical safety of all persons and property likely to be affected by the electrical work.

c) If the person's business or undertaking includes the performance of work, whether or not electrical work involving contact with, or being near to, exposed parts, ensuring persons performing the work are electrically safe.

The ES Act imposes specific competency requirements on all electrical work and stringent documentation requirements for some types of electrical installations. Electrical work at Arrow Energy is conducted under the Electrical Safety Rules (ORG-ARW-ELE-SPR-00020).

1.5.2. Environment

Environmental relevant activities that relate to Arrow Energy's assets fall under the Environmental Protection Act 1994 (EP Act) and are subject to permitting under the relevant Environmental Authority (EA).

Arrow Energy has developed documentation - Environmental Basis of Design (ORG-ARW-ENV-GUI-00002) to provide detailed guidance in relation to environmental aspects and principles for design, planning and construction of Arrow Energy facilities.

1.5.3. Professional Engineers Act 2002

The execution of obligations under S.22 (3) and S.22 (4) of the WH&S Act will require the Designer to be a registered professional engineer in accordance with the Professional Engineers Act 2002 (PE Act). This Act also requires that any non-RPEQ engineer contributing to the design is adequately supervised by a nominated RPEQ.

1.5.4. Discrepancies, Conflicts and Order of Precedence

In circumstances where this Design Criteria poses conflicts with other requirements, the following hierarchy shall apply, in decreasing order with Statutory Regulations and Acts having the highest requirement:

- Statutory Regulations and Acts of Parliament except where the contract documentation imposes more stringent requirements.
- Relevant national standards and codes of practice.
- Relevant international, local government and industry standards and codes of practice.
- Arrow Energy engineering standards (encompassing all corporate Arrow Energy documentation).

Approval from Arrow Energy is mandatory for any deviation from the requirements of this General Specification which is considered to be necessary in order to comply with national and/or local regulations and other Arrow Energy Standards. Deviation requests shall be submitted and processed in accordance with ORG-ARW-PMC-PRO-00010.

1.5.5. Deviations to Regulatory Requirements

Any deviations to Statutory Regulations, Acts of Parliament, National standards and National Codes of Practice are excluded from this procedure and are not permitted.

Should a deviation be sought to requirements listed in Mandatory and preferred standards for safety requirements detailed in the Petroleum and Gas (Safety) Regulation 2018, the express written approval from Arrow's Technical Authority – Level 0 is required to confirm approval has been granted from the Chief Inspector as per section 13(4) of the regulation.

1.6. Definitions

Definitions of terms used in this document are as follows:

Term	Definition
Arrow Energy	The party that initiates the project and ultimately pays for it. Arrow Energy may also include an agent or consultant authorised to act for, and on behalf of, Arrow Energy.
Contractor	The Contractor is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. Arrow Energy may undertake all or part of the duties of the Contractor.
Principal's Representative	Appendix A. Agent or consultant authorised to act for, and on behalf of, the Principal
Package	Means any physically pre-assembled skids, as well as all containerised and equipment supplied in enclosures.
SHALL [PS]	Indicates a mandatory process safety requirement.
Shall	Indicates a requirement
Should	Indicates a recommendation
Vendor / Supplier	The party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.
Work	Design, Procurement, Services, Fabrication, Installation, Inspection, Testing and other activities included in the scope.

1.7. Unit of Measure

All design tasks shall be performed, and deliverables produced in the metric (SI) system in accordance with AS/ISO 1000. Any units of measure that differ from this should be covered in project specific documentation.

1.8. Language

All design tasks, deliverables and documentation shall be in English.

1.9. Abbreviations

Abbreviations used in this document are as follows:

Term	Abbreviation
AAP	Access & Approvals Packages

Term	Abbreviation
AAR	After Action Review
APGA	Australian Pipeline and Gas Association
APGA CoP V4S	APGA Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry Version 4.0 Supplementary
AS	Australian Standards
CCA	Conduct and Compensation Agreement
CEMP	Construction Environmental Management Plan
CSG	Coal Seam Gas
EA	Environmental Authority
EMP	Environmental Management Plan
ES	Electrical Safety
ESCP	Erosion and Sediment Control Plan
HDD	Horizontal Directional Drilling
HPV	High Point Vent
HSE	Health, Safety and Environment
LAR	Land Access Request
LPD	Low Point Drain
MAOP	Maximum Allowable Operating Pressure
MDR	Manufacturer's Data Report
NER	National Engineering Register
NZS	New Zealand Standards
P&G	Petroleum and Gas
PE	Polyethylene
PPE	Personal Protection Equipment
ROW	Right of Way
RPEQ	Registered Professional Engineer of Queensland
WHS	Workplace Health and Safety

2. Reference Documents, Codes and Standards

2.1. Australian and International Standards

Australian and International Standards referenced in this document are listed in .

Table 2-1: Australian and International Standards

Document Number	Title
AS 1100.401	Technical drawing Engineering survey and engineering survey design drawing
AS 1289	Methods of testing soils for Engineering Purposes
AS 1726	Geotechnical Site Investigations
AS 2187	Explosives - Storage and use
AS/NZS 2566.1	Buried Flexible Pipelines Part 1: Structural design
AS/NZS 2566.2	Buried Flexible Pipelines Part 2: Installation
AS/NZS 2648.1	Underground marking tape Part 1: Non-detectable tape
AS/NZS 4129	Polyethylene (PE) Fittings for Pressure Applications
AS/NZS 4130	Polyethylene (PE) Pipes for Pressure Applications
AS/NZS 4131	Polyethylene - PE -Compounds for Pressure Pipes and Fittings
AS 4133	Methods for testing rock for Engineering Purposes
AS 4799	Installation of Underground Utility Services and Pipelines within Railway Boundaries
ISO 13953	Polyethylene (PE) pipes and fittings -Determination of the tensile strength and failure mode of test pieces from a butt-fused joint
ISO 13954	Plastics pipes and fittings Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm
ISO 21307	Plastics pipes and fittings- Butt fusion jointing procedures for PE pipes and fittings used in construction of gas and water distribution systems.

2.2. Reference Codes of Practice and Guidelines

Reference codes of practice and guidelines referenced in this document are listed in Table 2-2.

Table 2-1: Reference Codes of Practice and Guidelines

Document Number	Title
APGA CoEP	APGA Code of Environmental Practice - Onshore Pipelines
APGA CoP V4S	Upstream Polyethylene Gathering Networks – CSG Industry, Version 4.0 Supplementary
MCE-SR-0016	Requirements for Services under the Railway Corridor
PIPA POP 001	Electrofusion Jointing of PE Pipe and Fittings for Pressure Applications
PIPA POP 005	Packaging, Handling and Storage of Polyethylene Pipes and Fittings
WSA PS- 318	Marking Tape, Detectable

2.3. Arrow Energy Governed Documents

Documents that are governed by this document are listed in Table 2-3.

Table 2-3: Arrow Energy Governed Documents

Document Number	Title
N/A	N/A

2.4. Arrow Energy Referenced Documents

Documents that are referenced in this document are listed in Table 2-4.

Table 2-4: Arrow Energy Referenced Documents

Document Number	Title
MCE-SR-0016	Requirements for Services under the Railway Corridor
ORG-ARW-AOP-SPR-00005	Project HFE Screening and Standards Baseline
ORG-ARW-CIV-SPR-00022	Specification for Road Works
ORG-ARW-ELE-SPR-00020	Specification for Electrical Safety
ORG-ARW-ENG-STR-00001	Engineering Design Philosophy
ORG-ARW-ENV-GUI-00002	Environmental Basis of Design
ORG-ARW-ENV-PLA-00003	Environmental Management Plan - Domestic Projects
ORG-ARW-GIS-STA-00001	Spatial Data Transfer
ORG-ARW-GIS-STA-00013	As-Built Geospatial Specification
ORG-ARW-HSM-GUI-00060	Rehabilitation Guideline

Document Number	Title
ORG-ARW-HSM-GUI-00094	Land Disturbance Guideline
ORG-ARW-HSM-MAN-00016	Arrow Energy's Safety Management System Manual
ORG-ARW-HSM-PRO-00002	Arrow Energy's Management of Change Procedure
ORG-ARW-HSM-PRO-00039	Excavation Procedure
ORG-ARW-HSM-PRO-00067	Fauna Management Procedure
ORG-ARW-HSM-PRO-00073	Rehabilitation Procedure
ORG-ARW-HSM-PRO-00138	Vehicle and Machinery Hygiene Procedure
ORG-ARW-HSM-PRO-00139	Weed Management Procedure
ORG-ARW-HSM-PRO-00146	Land Disturbance Procedure
ORG-ARW-IMT-PRO-00002	Document Control Information Management Procedure
ORG-ARW-IMT-STA-00002	Controlled Documents Standard
ORG-ARW-MEC-SPR-00020	Specification for Protective Coatings -Painting and Galvanising
ORG-ARW-PIP-DET-00001	Hot Tap Tie-in Detail General Arrangement
ORG-ARW-PIP-SPR-00005	Piping Specification
ORG-ARW-PMC-PRO-00010	Technical Standards Deviation Procedure
ORG-ARW-PPL-CAL-00004	HDPE Pipe MAOP Calculation
ORG-ARW-PPL-DEC-00002	HDPE Gathering Design Criteria
ORG-ARW-PPL-DET-00002	Protective Slab Details
ORG-ARW-PPL-DET-00003	Pipeline Standard Drawing Marker Post Detail
ORG-ARW-PPL-DET-00004	Pipeline Standard Drawing Marker Sign Details
ORG-ARW-PPL-DET-00006	Pipeline Standard Drawing Aerial Marker Detail
ORG-ARW-PPL-DET-00010	Pipeline Standard Drawing Marker Tape Details
ORG-ARW-PPL-DET-00015	Pipeline Standard Drawing Temporary Fence
ORG-ARW-PPL-DET-00020	Pipeline Standard Drawing Pipeline Trench Detail
ORG-ARW-PPL-DET-00022	Pipeline Standard Drawing Pipeline Trench Barriers
ORG-ARW-PPL-DET-00055	Polyethylene Pipeline Standard Drawing- Branch Tee Cross Section
ORG-ARW-PPL-DET-00062	Squeeze-off Straight Connection
ORG-ARW-PPL-DET-00063	Squeeze-off Tee Connection
ORG-ARW-PPL-GAT-00001	Pipeline Standard Drawing Foreign Service Crossing
ORG-ARW-PPL-GAT-00028	Pipeline Standard drawing –Sealed Road

Document Number	Title
	crossing- Bored/Cased
ORG-ARW-PPL-GAT-00029	Pipeline Standard Drawing Formed Gravel Road Crossing – Open Cut
ORG-ARW-PPL-GAT-00031	Pipeline Standard Drawing Unformed Track Crossing – Open Cut
ORG-ARW-PPL-GAT-00053	Polyethylene Pipeline Standard Drawing Valve Pit – Type 1
ORG-ARW-PPL-GAT-00062	Polyethylene Pipeline Standard Drawing Minor Watercourse Crossing
ORG-ARW-PPL-GAT-00065	Polyethylene Pipeline Standard Drawing Gas Line Single Point Drain
ORG-ARW-PPL-GAT-00067	High Point Vent to Gas Line
ORG-ARW-PPL-GAT-00068	Valve Pit – Type 2
ORG-ARW-PPL-GAT-00069	High Point Vent to Atmosphere
ORG-ARW-PPL-GAT-00070	Pipeline Standard Drawing 20m Right of Way – General Arrangement
ORG-ARW-PPL-GAT-00071	Pipeline Standard Drawing 25m Right of Way – General Arrangement
ORG-ARW-PPL-LAY-00005	Marker Sign Location Plan
ORG-ARW-PPL-PRO-00001	Pipeline Safety Management Study Procedure
ORG-ARW-PPL-SPR-00009	Specification for Procurement of Polyethylene Pipelines
ORG-ARW-PPL-SPR-00011	Excavation of Live Pipeline
ORG-ARW-PPL-SPR-00016	Specification for Polyethylene valves
ORG-ARW-PPL-SPR-00020	Specification for Conditions of Working near Metallic and Non Metallic Pipelines
ORG-ARW-PPL-SPR-00021	Specification for Line Class PA101 (HDPE, SDR 21, WATER GATHERING)
ORG-ARW-PPL-SPR-00022	Specification for Line Class PA201 (HDPE, SDR 17, WATER GATHERING)
ORG-ARW-PPL-SPR-00023	Specification for Line Class PA100 (HDPE, SDR 21, GAS GATHERING)
ORG-ARW-PPL-SPR-00024	Specification for Line Class PA200 (HDPE, SDR 17, GAS GATHERING)
ORG-ARW-PPL-SPR-00025	Specification for Line Class PA300 (HDPE, SDR 13.6, GAS GATHERING)
ORG-ARW-PPL-SPR-00027	General Specification for Coating of High Pressure Steel Pipelines
ORG-ARW-PPL-SPR-00028	Specification for Line Class PA301 (HDPE, SDR 13.6, WATER GATHERING)
ORG-ARW-PPL-SPR-00029	Specification for Line Class PA401 (HDPE, SDR

Document Number	Title
	11, WATER GATHERING)
ORG-ARW-PRS-DEC-00001	Process Design Criteria

3. Design

3.1. General

The requirements for the design of PE gathering networks conveying gas and water that include CSG gathering lines, CSG produced water lines, water flowlines (permeate, saline water, treated water) shall comply with APGA CoP V4S and ORG-ARW-PPL-DEC-00002 HDPE Gathering Design Criteria.

3.2. Design Basis

The design of the PE gathering network shall be documented in an approved (by the Principals Representative) Design Basis, in accordance with APGA CoP V4S.

3.3. MAOP Calculation

The Design Basis shall detail the pressure testing requirements. The APGA CoP in conjunction with HDPE Pipe MAOP Calculation ORG-ARW-PPL-CAL-00004 and the applicable PE 100 Line Class Specifications listed in Section 2.3 define Arrow Energy's MAOP requirements. The testing pressure shall be as high as practical to achieve the PE material limitation pressure to ensure flexibility for future increases in gathering network maximum operating pressure.

3.4. Right of Way Width

For Right of Way (ROW) width selection, refer to Appendix A.

4. General Preparation

4.1. Pre-Planning

4.1.1. General

Preplanning and co-ordination between those involved in pipeline design and construction activities are essential to ensure safety and to protect members of the public.

Particular hazards shall be identified in a formal risk assessment by those people involved in the works, before commencement and during the life of the activity as required, or as site conditions change. As a part of the planning stage, the following steps and information shall be collected:

- Environmental data (of particular significance is the flood (1 in 100 years flood zone) and overland flow information).
- Environmental approvals required (i.e. river crossings, geotechnical activity, vegetation clearing, offsets).
- Any other approvals as required.
- Work method statements.
- Management and control procedures specific to the work.
- HSE procedures specific to the work.
- A fully detailed list of all Plant, Equipment, Instruments, Sign Boards, Warning /Caution measures, overhead services.
- Consultation with land owner in relation to locations for pads and pipeline alignments.
- Land ownership and access requirements/notifications.
- Geotechnical study.
- Water source and required permits for water withdrawal.
- Disposal areas for excavated material.
- Plans for stockpiling on site.
- Contingency plan.
- Other planned work in the area - road works, other utility work, and private construction.
- Presence of underground services (i.e. power, water communications), shafts or other underground structures.
- Characteristics of vehicle loading to be experienced by the proposed pipeline.
- Profile of special crossings, including but not limited to the following: width of flow path, water level, and location of top of banks.

4.1.2. Alignment

Pipeline crossings of roads, railway lines, creeks and underground services shall, as far as practicable, be as perpendicular as practical (e.g. close to 90 degrees). Pipelines should be located and designed to minimise restoration and maintenance requirements. Alignments should be as far as practicable parallel to existing features and as close to boundaries as possible.

The final alignment shall be in accordance to the project specific Routing Philosophy (if applicable), alignment sheets and GIS maps.

4.2. Geotechnical Investigation

The requirement for and the extent, frequency and location of any geotechnical investigation shall be determined during the planning phase based on the level of risk that the project presents. The extent of the investigation shall meet the requirement to address the geological risks anticipated for the project in accordance with AS 1726 Geotechnical Site Investigations.

The need for and the extent of a Geotechnical investigation shall be determined based on the following considerations:

- The complexity and scale of the project.
- Experience working in the specific area.
- The availability of existing geotechnical information.

Notwithstanding the experience, availability, proximity and complexity considerations, geotechnical investigation shall be undertaken for all trenchless pipeline installations including HDD, thrust boring, etc. Geotechnical investigation should be undertaken at all waterway crossing locations. Such investigation shall be undertaken to the required depth and shall include the appropriate tests to minimise the risks to budget, schedule, integrity and the environment.

Geotechnical testing shall be undertaken in accordance with AS1289 Methods of testing soils for Engineering Purposes (series) and AS4133 Methods for testing rock for Engineering Purposes (series).

4.3. Risk Management Assessment

A risk assessment in accordance to the APGA CoP V4S (refer to Pipelines Safety Management Study Procedure (ORG-ARW-PPL-PRO-00001)) shall be completed as part of the design process. The design shall include the risk reduction measures identified in the assessment.

A pre-construction risk assessment study shall be carried out, and the planned ground works and location of services shall be identified before commencing work on site.

5. Clear and Grade

5.1. General

All clearing and grading activities shall comply with following procedures, the specific requirements of the Project and land access conditions/CCA and AAP.

Before commencement of clear and grade activities, the following approval documents must be in place:

a) Work crew inductions into land access requirements.
b) "Dial Before You Dig" clearance report.
c) Relevant easement access agreement with all relevant easement holders on the land.
d) Environmental and Cultural Heritage clearance.
e) Construction Environmental Management Plans (CEMP).
f) Erosion and Sediment Control Plan (ESCP).

The involved stakeholders shall prepare and implement a CEMP and ESCP specific to the project site and be familiar with the above requirements and associated documents. These notices and orders shall be complied with at all times.

All site clearing works and ROW Remediation shall be planned in accordance with the documents nominated in project documents.

The planning process shall include preparation of a CEMP that takes account of the activities described in this Specification.

The ROW shall be cleared and graded only to the extent required for performing the pipeline construction operations efficiently. Any activities conducted outside the ROW shall be pre-approved by Principal's Representative.

5.2. Route of Line and Survey

The coordinate system shall be GDA94 MGA. The construction survey shall adopt the same marks and benchmarks as used in the engineering design.

Stakes maintaining line-of-sight placed along the proposed pipe centreline will delineate the pipeline route as shown on the Drawings. Pipeline centreline stakes shall be placed sufficiently in advance of construction before construction to permit continuity of operations.

The as built data should be loaded into the GIS system. Refer to Section 0 for as constructed data requirements.

5.3. Clearing

5.3.1. General

Clearing of the ROW shall include the removal to ground level as required of trees, shrubs, stumps and other obstacles, and the grubbing, or removal otherwise, of stumps in the way of the trench line. All timber and vegetation shall be stockpiled along the edges and within the ROW. Stacking of vegetation shall comply with the CEMP.

Pipeline clearing preparation shall be conducted in accordance with vegetation clearing Land Disturbance Guideline (ORG-ARW-HSM-GUI-00094) and Land Disturbance Procedure (ORG-ARW-HSM-PRO-00146).

No filling of the ground over the pipeline centreline to achieve the minimum depth of cover shall be permitted.

5.3.2. Riparian Zones

Refer to the requirements of ORG-ARW-HSM-GUI-00094 Land Disturbance Guideline and ORG-ARW-HSM-PRO-00146 Land Disturbance Procedure and the conditions stipulated in the relevant AAP.

5.3.3. Trees and Vegetation Clearing

The extent of tree clearing shall be minimised where possible, particularly for field access roads. This may involve minor realignments to make use of existing cleared areas.

The vegetation clearing must be within the approved battery limit of the access and approvals package (AAP) or within the area indicated on the internal After Action Review (AAR).

The ROW and access roads shall be prepared to allow for the control of erosion and shall be maintained throughout construction.

5.3.4. Grubbing

At no time shall top soil be used to fill holes. After mulching, grubbing of stumps shall be kept to a minimum. Where stumps have been cut off or mulched over as opposed to being grubbed (i.e. in areas other than over the top soil benching and trench line), they shall be left in a state suitable for rubber-tyre vehicle operation.

Following grubbing, but prior to stripping, erosion and sediment controls shall be installed, where practical

5.3.5. Flora and Fauna

All reasonable steps shall be made to prevent unnecessary disturbances to, and destruction of, flora, fauna and other natural resources on the right-of-way, and elsewhere where the works are carried out. Measures shall be taken to reduce the likelihood of trapping fauna or stock in the trench or bell- holes.

Construction management plans shall include a flora and fauna management strategy. If required, this will include a daily inspection of any open trench by suitably qualified personnel to remove any trapped fauna. Open trenches may need to be suitably barricaded at the end of each day's work and have high visibility with warning signs. This shall be the responsibility of the work site permit holder.

Pipeline clearing preparation and remediation shall be conducted in accordance with Arrow Energy's established Fauna Spotter-catcher Program, which includes a register of approved companies providing spotter-catcher services. Fauna spotter-catchers are specialist Contractors who perform fauna welfare activities prior to and during clearing of vegetation and habitats Fauna Management Procedure (ORG-ARW-HSM-PRO-00067).

Management of Fauna and notification of fauna incidents will be implemented as per Arrow's Species Management Program, ORG-ARW-HSM-PLA-00070.

If known weeds or pathogens are encountered, follow Weed Management Procedure (ORG-ARW-HSM-PRO-00139).

5.3.6. Disposal of Materials

Clearing (and subsequent restoration) shall be confined to the ROW. No additional areas of the ROW shall be cleared without pre-approval. Surplus excavated material shall be disposed of to the satisfaction of the landowner and in accordance with the AAP and/or CEMP.

Vegetation and other flammable material shall be managed in accordance with the CEMP. No burning of cleared or grubbed Vegetation material shall be conducted in areas of remnant vegetation.

5.4. Removal of Topsoil

5.4.1. General

Topsoil stripping and stockpiling shall be minimised and shall be carried out in accordance with the requirements of section 12 of Land Disturbance Guideline (ORG-ARW-HSM-GUI-00094) and Land Disturbance Procedure (ORG-ARW-HSM-PRO-00146).

5.4.2. Topsoil Stockpiles

Topsoil shall be removed so as to keep it separate from trenched soil. Handling of topsoil shall meet the requirements of Land Disturbance Guideline (ORG-ARW-HSM-GUI-00094) and Land Disturbance Procedure (ORG-ARW-HSM-PRO-00146).

Topsoil shall not be removed from the ROW, except where required as part of other topsoil conservation work as specified herein.

Topsoil stripping and transportation shall be minimised and shall be carried out in accordance with the CEMP

Stockpiles shall be managed in accordance with document Land Disturbance Guideline (ORG-ARW-HSM-GUI-00094) and Land Disturbance Procedure (ORG-ARW-HSM-PRO-00146).

5.5. Grading

Where grading of the ROW involves removal of surface stones or rock of any dimension greater than 150mm, such stones and rock shall be kept separate from other material.

Regular breaks shall be left in stockpiled soil windrows to avoid impeding on the movement of vehicles, stock or wildlife. Stockpile breaks are to coincide with designated access roads or tracks, fence lines and gaps in stockpiled vegetation windrows.

Surface drainage or surface water drainage lines shall not be blocked as a result of grading activities or soil stockpiles. Appropriate sediment and erosion controls should be maintained throughout the grading operation.

Soil and surface stability shall be maintained at all times through to the final rehabilitation and cut and fill excavations shall be shaped so as to maintain slope stability.

Grading of water body beds and banks shall be minimised to leave an undisturbed organic area within the riparian zone and shall be left until construction of the crossing is to proceed, to avoid erosion and sedimentation risk.

As a minimum, the DMRE publication "Guideline - Activities in a watercourse, lake or spring associated with mining operations" shall be used as part of the risk assessment process for any works in a waterway.

The Contractor is responsible for notification for all works considered to be "Accepted Development" in the Department of Agriculture and Fisheries (DAF) document - Accepted development requirements for operational work that is constructing or raising waterway barrier works, October 2018.

5.6. Protection of Adjacent Work Areas

For protection of areas adjacent to the designated work areas, erosion and sediment control measures shall be implemented as specified by the Land Disturbance Guideline (ORG-ARW-HSM-GUI-00094) and Land Disturbance Procedure (ORG-ARW-HSM-PRO-00146).

6. Purchase, Transportation, Handling, Storage and Stringing of Pipe

6.1. General

Transportation, handling and storage of pipes and fittings shall meet the requirements of this Specification and APGA CoP V4S and PIPA POP 005 – Packaging, Handling and Storage of PE Pipes and Fittings.

6.2. Purchase of Pipe

All PE Pipes shall be purchased in accordance to specification for Procurement of Polyethylene Pipelines (ORG-ARW-PPL-SPR-00009).

6.3. Transporting

Pipe shall be transported in a manner that will prevent damage to the pipe. Pipe can be stacked onto a trailer with bolsters in a nested arrangement.

Pipe shall be supported in a secure manner to prevent damage or excessive distortion of the pipe. Pipe shall not be secured using chains. Pipe transport shall be in accordance with manufacturer's recommendations.

Appropriate headboards shall be installed between the pipe and the vehicle cabin to prevent cabin penetration in the event of pipe movement during a sudden deceleration event.

6.4. Handling

Care shall be taken to avoid rough handling of the pipe. Straight pipe may be lifted by one of the following methods:

- Rated Vacuum lift machine.
- Use of slings with a spreader bar (where required).
- If coils are to be lifted by a fork truck, contact points shall be protected and the lifting shall be performed on the entire coil. Fork tines shall not be inserted between windings in a coil.

Where the pipe is placed directly on the ground during stringing and stockpiling operations, the ground surface shall be clear of sharp rocks and/or other material which could adversely affect the pipe before placement. Pipes shall be layered and stacked in a way that avoids the risk of damage or permanent deformation.

Alternatively, the pipes may be supported on sand or saw dust filled bags and/or timbers. Where more than one layer of pipe is stacked, each layer shall be separated to avoid damage to the pipe and collapse of the stack.

Pipe stack height shall not exceed that allowed by supplier. Stack heights should also give consideration to ground conditions, and the likely hood of livestock pushing the stack over.

6.5. Storage

Storage of PE Pipes and fittings shall be in accordance to Section 5.5.3 of APGA CoP and the supplier's recommendation. Storage locations shall be approved by Principal's Representative, prior to their use.

Any grass and vegetation below and immediately adjacent to the pipe shall be kept trimmed or eradicated by an approved manner to prevent damage to the pipe in the event of fire.

6.6. Pipe Stringing

Pipe diameters 250mm and less may be stockpiled at designated welding stations.

Pipe strings may be welded up and towed up to 150 meters from the weld station.

Pipe diameters greater than 250mm shall be strung individually along the ROW, in preparation for welding activities.

Pipe shall only be strung on to areas of the ROW where clearing and grading are complete.

Pipe shall not be placed or strung in areas where it is known blasting shall be carried out, and any pipe strung out where blasting is found to be necessary, shall be removed prior to blasting. Pipe shall only be placed or strung out provided:

- The pipe is supported and handled in a safe and proper manner and in accordance with this General Specification.
- Normal access along roadways and tracks is maintained at all times.
- Sufficient openings are left for livestock and the landowner(s) to pass through the pipe string where the ROW cuts across known and identifiable stock crossing points.

Coiled pipe, which is re-rounded and straightened for stringing, shall be adequately restrained along its full length to prevent it from tending to spring back into its coiled shape.

Other third party easement access to be maintained eg Ergon, BMA waterline easements, etc.

7. Trench Excavation

7.1. General

Excavation work shall be undertaken such that as to enable the pipe to be laid in conformity with the levels, depths, widths, slopes, curves dimensions and instructions shown on the drawings.

At any time during the progress of the work, there should be no more than 250 meters of trench opened up ahead of pipe laying in any section of the work (unless risk assessed on a project by project basis) and agreed by the principal's representative. Unless they can be adequately secured from livestock, fauna etc. entering or there are sufficient means for animals to escape via exit ramps or escape ladders, the trenches shall be backfilled and made safe prior to the completion of each day's work.

If a contingency arises such as heavy rain, which may detrimentally affect the pipeline or adjoining roads, footpaths or other public or private utilities, the length of trench should be immediately refilled.

7.2. Foreign Services

A "Dial Before You Dig" enquiry shall be undertaken, for the location and protection of all overhead and underground structures and lines. The Contractor needs to comply with any conditions for the third party crossings before commencing any works. It is the Contractor's responsibility to physically locate, identify and physically mark with high visibility all third party services.

Any buried service pipes, underground cables, gas and water mains and other obstructions intersecting or adjacent to the route shall be located in accordance with the procedure for Excavation (ORG-ARW-HSM-PRO-00039).

Prior to excavating in the vicinity of power poles, the poles shall be properly secured and any all appropriate safety measures followed to the satisfaction of the asset owner or relevant authority. No excavation shall be undertaken in the vicinity of pole mounted transformers until the extent of the earth mat around the pole has been marked by the Supply Authority.

7.3. Trenching

7.3.1. General

The trench shall be excavated, trimmed to the required grade and as narrow as practicable, taking into account the native soil type and the need to make joints install fittings and compact the pipe embedment material. Where required, the trench shall be wide enough to allow for jointing, compaction and inspection. Narrow trench may be used where the system design permits, and person access is not required.

Adequate breaks in the spoil pile shall be left to allow run-off to follow natural drainage patterns.

Erosion and sediment controls will be left in place and maintained until the area is stabilised. Disturbance time during construction shall be minimised.

7.3.2. Trench Depth

The trench depth shall be sufficient to allow for the specified grade, the required depth of bedding, and foundation material (if required). This is to be detailed in project specific trench cross section drawing and alignment sheets.

Stockpiles of spoil and backfill materials shall be stored away from creeks and stormwater drains. If necessary, sediment control devices shall be placed on the low side of the stockpiles to prevent sediment from moving off site. Stockpiles shall be inspected regularly and maintained on a regular basis.

Project alignment sheets shall be prepared to ensure the trench is excavated in such a manner as to permit the pipeline to be laid with a cover not less than 900mm for rural-residential locations and 750mm for rural locations in accordance with the APGA CoP V4S. In rock, the minimum cover shall only be reduced at in accordance with the APGA CoP V4S, based on a risk assessment.

Where minimum cover cannot be obtained, a protective concrete slab or sleeve shall be used.

Where over-excavation occurs, the trench bottom shall be re-established with approved materials and compacted prior to placement of bedding material.

7.3.3. Extra Cover Requirements

Extra cover shall be provided as per alignment sheets and standard drawings supplied on a project by project basis.

7.3.4. Separation from other Utility Assets

Separation from other utility assets shall comply with the APGA CoP V4S, AS/NZS 2566.2 and project specific requirements like the AAP.

7.3.5. Covering Ends

Ends of pipelines, mains or services shall not be left open in the trench between working periods but shall be closed with caps or expandable plugs to prevent the entry of animals, water or foreign matter, until work is resumed. Where two or more lengths of main or service are to be jointed together above ground, the ends shall be covered at all times that the job is left unattended. At the conclusion of each day's laying, open ends of gas mains or services shall be sealed and sections being welded shall be covered.

7.3.6. Excavation of Rock

Provision shall be made for the excavation and removal of all materials including rock.

When trench is cut in rock or shale, it shall be excavated deeper than the depth of the gas main or service and this excess depth filled with approved padding material before laying the main or service. Refer to Pipeline Trench Detail drawing ORG-ARW-PPL-DET-00020 for details.

The definition of rock is provided in the Specification for Bulk Earthworks (ORG-ARW-CIV-SPR-00007).

7.4. Blasting

Any blasting to be conducted shall be done in accordance with: AS 2187 Part 1 and 2 -Explosives- Storage, transport and use. Refer to Section 4.14 of APGA CoP V4S for guidance on the effect of seismic loads on adjacent PE pipelines.

Blasting operations shall not commence without first obtaining all required written permissions. A comprehensive blasting procedure shall be submitted as part of the Contractor's Safety Management Plan (SMP).

Prior to commencement of blasting, all buildings and structures adjacent to the site where lasting is to be carried out shall be inspected, to determine existing condition and to confirm evacuation of all personnel.

7.5. Markers, Marker Tape and Tracer Wire

Markers, marker tape and tracer wire shall be supplied and installed in accordance with the requirements of APGA CoP V4S.

7.5.1. Marker Tape

Marker tape shall be located at the top of the embedment zone. The tape shall conform to AS/NZS 2648.1 for non-detectable tape and to WSA PS-318 for detectable tape. Where two pipelines are laid in a common trench, such as gas and associated water, a marker tape that indicates the presence of each of the pipelines is to be installed separately, unless an alternative arrangement is developed and approved by Principal's Representative.

Marker tape shall be installed in accordance to standard drawing for Marker Tape Details ORG-ARW-PPL-DET-00010.

7.5.2. Tracer Wire

When installing a pipeline in an open trench, a detectable wire and marker tape, or a detectable marker tape or a marker board shall be installed above the pipeline, to enable the location of the pipeline to be traced with a pipe locator, and so reduce the likelihood of damage during future excavations in the vicinity of the main or service.

Tracer wire should be durable and connected using an approved technique.

When the pipeline is installed using boring techniques only tracer wire needs to be installed.

Tracer wires shall not be electrically connected to a source of electrical current for which they are not designed. This includes steel pipelines and any earthing or grounding systems and risers.

Tracer wire shall be copper wire, electrically insulated, resistant to corrosion damage and have a minimum diameter of 1.6 mm.

During the lowering in process, trace wire shall be strung along the entire length of the pipe. Trace wire shall be installed in continuous lengths adjacent to the pipe including all existing and future tie in points.

No tracer wire shall be allowed to be connected in any way to steel structures or piping (physically isolated). This is to avoid sacrificial corrosion of steel in preference to the copper wire.

7.5.3. Markers

Pipeline markers shall be supplied and installed as detailed in APGA CoP V4S, standard detail for Marker signs (ORG-ARW-PPL-DET-00004) and the Alignment sheets or construction maps.

8. Trenchless Construction

8.1. Ploughing-In

Ploughing-in is an established method of installing pipes, especially where there are continuous lengths to be buried in open terrain. The process avoids the costs of excavation and reinstatement associated with open trenching. It also avoids the safety risks of having trenches open for extended periods as pits are only required at the start and finish of a run.

The method of ploughing to be used shall feed the pipe directly into the cavity though a chute mounted immediately behind the plough. The ploughing method shall impose no tensile load on the pipe and no abrasion between the pipe wall and the soil. Ploughing techniques that involve attaching the pipe behind the plough and pulling the pipe into the cavity shall not be used. The final installation of any pipeline, including those utilising ploughing methods, shall achieve the degree of compaction around the pipe.

For a new method, the proposed sub-contractor or machine being utilised in the field, a trial shall be conducted to verify that the proposed ploughing method is acceptable and personnel competent. No ploughing for the project shall commence until the trial has been completed and approved by Principal's Representative. The trial shall be managed and reported on by an independent person experienced in similar trial installations. The trial shall be conducted in terrain and ground conditions similar to that found in the project area. The trial shall include the upper and lower range of pipe diameters to be installed by ploughing and shall use multiple pipes where this is proposed. A minimum length of 30 meters of each pipe run shall be installed. Sections of installed pipe shall be exhumed so that the pipe condition can be inspected, and compaction tests conducted on the pipe side support and overlay material. The trial shall verify that the ploughing-in complies with The APGA CoP V4S and industry standards.

Grading and topsoil removal activities are normally not required where ploughing is undertaken, however this is to be assessed on a project by project basis.

8.2. Horizontal Directional Drilling

Horizontal directional drilling (HDD) represents a form of trenchless technology. The equipment and procedures are intended to minimize above and below ground surface damage, restoration requirements, and disruption to traffic, with little or no interruption of existing services.

HDD installation involves four main steps:

- Pre-planning.
- Drilling a pilot hole.
- Expanding the pilot hole by reaming.
- Pull back of fabricated pipe.

8.2.1. Preplanning

8.2.1.1. General

Where HDD is being considered, it is particularly important to identify the geotechnical conditions including the soil rock interface, the presence of zones of alluvial gravels/cobbles/ and boulders, variable ground conditions, assessment of

the rock quality and an understanding of the potential extent of jointing. Drilling in such conditions can add to increased drilling costs or schedule delays due to frequent fluid loss or release of drilling fluids to the environment, damage/excessive wear to drill bits, bore instability or collapse, difficulties in steering or the pilot/reamer may get jammed during piloting or the reaming process.

Geotechnical conditions within and adjacent to watercourse channels can vary significantly both vertically and laterally. As such variable ground conditions should be anticipated along the HDD routes. It is possible that deeper alluvial deposits than encountered may occur along the pipeline route.

As a part of the planning stage, the following information is to be collected:

- Environmental data (of particular significance is the flood and overland flow information)
- Work method statements.
- Management and control procedures specific to the work.
- HSE procedures specific to the work.
- A fully detailed list of all Plant, Equipment, Instruments, Sign Boards, Warning /Caution measures.
- Land ownership and access requirements/notifications
- Geotechnical study.
- Water source and required permits for water withdrawal.
- Disposal areas for excavated material and disposal plan for drilling fluids.
- Stockpiling on site (a site may need to be prepared for temporary stockpiling or stringing for HDD work).
- Contingency plan.
- Other planned work in the area- road works, other utility work, and private construction.
- Presence of underground shafts or other underground structures/utilities.

8.2.1.2. Preliminary Investigation

Prior to the start of an HDD activity, a surface and subsurface investigation to identify any existing underground utilities shall be undertaken. HDD shall be technically and geo-technically determined feasible by studying existing geological data and conducting field investigations to assess the subsurface conditions and characteristics likely to be encountered during the drill.

Qualified geotechnical engineers shall perform the investigation as required, in preparation for planning and designing of the bore route. See also Section 4.2 of this General Specification.

8.2.2. Engineering Design Consideration

8.2.2.1. General

HDD shall meet the requirements of the APGA CoP V4S , AS/NZS 2566.2, AS/NZS 4130, requirements stipulated in the AAP and the proposed installation procedures.

The following requirements apply to HDD installations:

- Crossing route shall be selected to keep it to the shortest reasonable distance.
- The pipeline shall be constructed in one continuous length.
- Drill path should be straight.
- Entry and exit elevation differences should not be in excess of 15 m (both points should be as close as possible to the same elevation).
- All buried structures and utilities should be located outside 3 m of the drill-path for mini-HDD applications and outside 7m of the drill-path for maxi-HDD applications.
- Above ground structures should be avoided, such as power lines, which might limit the height available for construction equipment.

8.2.2.2. Breakout Prevention

Breakout prevention needs to be considered. Drilling mud breakout is dependent upon a number of factors such as subsurface conditions, type of drilling equipment, mud pressure (which is a function of the mud pump capacity), and the difference in elevation between the entry and exit points.

Speciality HDD consultants need to be engaged when required to calculate the risk of breakout for large HDD's with corresponding high mud pressures and major elevation differences.

8.2.2.3. Alignment

Angles in the Right-Of-Way (ROW) alignment approaching and departure the HDD crossing should be minimized. The approach / departure alignment to the HDD crossing needs to allow for the potential need for lengthening of the crossing.

8.2.2.4. Right-of-Way

The drill path should be aligned to lie within the ROW boundaries. If this is not feasible, new ROW must be acquired prior to commencement of the HDD. Temporary workspace is required at the entry and exit points. The pipe string will require additional workspace and, where the alignment on the exit side is not straight, additional workspace, typically referred to as false ROW, maybe required. This area shall be of sufficient length and width to allow the pipe to be welded up and tested along the full length of the pipe string. These requirements shall be stipulated in the AAP.

8.2.3. Pipe Stress

Tensile and bending stresses that are induced on the pipe during an HDD installation shall be analysed to ensure the pipe is suitable for installation.

8.2.4. Buoyancy Control

When a drag section is pulled back through the bore, the buoyant weight of the pipe as well as the resulting drag forces between the pipe (pipe coatings) and the walls of the bore shall act as resisting forces. The drag force can be severe enough to gouge pipe as well as collapse the pipe. Therefore, it is important to determine whether buoyancy control is needed. If buoyancy control is necessary (for long and large diameter drills), a buoyancy control plan needs to be

implemented. Typically, buoyancy control is applied by adding water to the drag section during the pull- back phase.

8.2.4.1. Limits of Curvature

The design of the drill path and selection of pipe shall consider the following:

- The radius of the curves in the drill path.
- The exit and entry angle.

The radius of the arc of the drill path should consider the diameter of pipe to be installed. The minimum radius for most drilling applications is the diameter of the pipe to be installed in meters multiplied by 1200.

This formula is used to ensure a conservative radius of curvature that will allow for the easy installation of the pipe and minimize the bending stresses on the pipe.

8.2.4.2. Reaming Diameter

The drill hole should be reamed to 1.5 times the outside diameter of the pipe to be installed. This diameter shall generally provide for an adequate allowance for the installation of the pipe. The multiplier may be reduced for large pipe diameters

The number of reaming passes required shall be determined by the hardness of the material being reamed and the ability to remove cuttings from the hole.

8.2.4.3. Swivel

In order to prevent the transmission of torsional loads to the pipe(s) due to the rotating drill rods or back-reamer, a swivel should be mounted behind the rods or reamer, to which the pulling line(s) and gripping hardware are connected. The swivel shall be appropriate for drilling operations, compatible for use in soil and slurry. For non-breakaway type swivels the load rating should be at least as large as the total safe pulling loads of the bundle of pipes to be installed, but not excessively greater. Inefficiencies in overly large swivels may impose significant torque on small pipes.

8.2.4.4. Carrier Pipe

Pipes shall be manufactured using PE100 materials. If pipe is provided in short segments, the individual units shall be joined using a butt-fusion technique in accordance with the APGA CoP V4S. This will allow the inherent strength of the PE pipe to be maintained during the placement process and when subjected to other operational stresses. Small diameter pipe of continuous length provided on reels is to be used in preference – where practical.

8.2.4.5. Casing Requirements

The PE carrier pipe should normally be threaded through a casing pipe installed by boring (PE, concrete or steel) and the installation shall include provision of insulators and grouting the space between the casing and the carrier pipe. The insulators are to hold the carrier clear of the casing.

The space between the pipes shall be completely filled with an approved grout that shall comprise a pre- mixed blend of Portland cement, aggregate and

additives. The grout shall be non-shrink, have a minimum strength of 5 MPa and have a low heat of hydration. The grout shall be mixed and applied in accordance with the manufacturer's directions. The grout shall be installed so that no air pockets or voids are created as the casing is filled.

9. Construction

9.1. General

Polyethylene (PE) gathering network construction and installation begins with the arrival and temporary storage of pipe, fittings, and other components required for the network. Assembly and installation follow, then network testing and finally, handover for operation. Throughout the installation process, various inspections and tests are performed to ensure that the installation is in appliance with specification requirements and that the network when completed is capable of functioning according to its design requirements.

PE gathering network construction shall comply with:

- APGA Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry Version 4.0 Supplementary
- AS/NZS 2566.2 Buried Flexible Pipelines Part 2: Installation

9.2. Access and Damage to the Right-of-way

Work shall not encroach outside the ROW width.

All reasonable measures shall be taken to minimise permanent damage and prevent soil erosion to the ROW. Damage to the ROW shall require an immediate notification together with the proposed corrective action and timing. Damage shall be repaired as soon as practicable.

Work shall not encroach outside the ROW width. Any damage made shall be made good as soon as practicable.

9.3. Pre-Installation Inspection

Inspections before construction shall be undertaken to ensure:

- Correct type, size, rating and SDR of pipe and fittings.
- No damage is evident that reduces the wall thickness more than allowed by the APGA CoP V4S.
- Correct identity and traceability markings are present.
- No debris in the pipe.
- Ovality limitation requirements are met.

No pipe shall be used containing damage.

Pipe shall be accepted or rejected in accordance with the provisions stipulated in Specification for Procurement of PE Pipelines (ORG-ARW-PPL-SPR-00009).

9.4. Access Road and Track Crossings

Unless otherwise stipulated by 3rd party in the AAP, all tracks should be open cut and the crossing installed in accordance with this Specification and Arrow Energy pipeline standard drawings. Bitumen road crossings shall be bored. Refer standard drawing ORG-ARW-PPL-GAT-00028.

Trenches shall not be excavated across roads or tracks until a risk assessment for this activity has been completed. Access shall be maintained at all times or alternative access shall be provided around the work area.

Spoil excavated from the trench shall be placed entirely clear of the access routes and shall also be placed away from any surface drainage structures.

Quarry material and compaction used in the backfill of road crossings shall comply with ORG-ARW-CIV-SPR-00022.

9.5. Railway Crossings

Minimum requirements of railway crossing shall be in accordance with AS 4799 "Installation of underground utility services and pipelines within railway boundaries" and in Queensland, work should comply with MCE-SR-0016 "Requirements for Services under the Railway Corridor" and any additional requirements specified by the Rail Line Operator such as Aurizon "Wayleave requirements, Asset Business Procedure, AZN.NA.PRO.04.6150.063".

The CCA/AAP between Arrow Energy and the Rail Line Operator is to document specific crossing requirements.

All design works for the crossing shall be approved by a RPEQ signatory in Queensland and NER Engineer in other states.

The engineering design shall be appropriate to the specific location and shall include provision for the following:

- Traffic in the reserve.
- Effects on the pipeline from an accident involving traffic.
- Effects on the traffic from a puncture rupture or leak from the pipeline.
- Inconvenience to other parties during inspection or repair of the pipeline.
- Risk of external damage to the pipeline.
- Requirements for corrosion mitigation (where applicable).
- Liaison with the authority responsible for the reserve.
- Liaison with authorities responsible for other utilities or infrastructure installed in the reserve.
- Effect on pipeline of maintenance of the reserve.
- Requirement for internal grouting between the carrier pipe and casing shall be determined for each crossing method.

Other minimum requirements to be complied with for railway crossings are as follows:

- The crossing shall be straight and oriented at an angle of 90° +/-5° of the railway centreline. (If crossing depth is more than 4 m or the geotechnical investigations shows that bore can be self-supporting, Railway manager may give the permit to relax the restriction).
- Minimum distance from structure foundations shall be greater than 5 meters.
- Minimum distance from existing utilities shall be greater than 2 meters.

- If the crossing passes above or under an existing utility the vertical clearance shall be in accordance with the standard detail drawing Pipeline Standard Drawing Foreign Service Crossing (ORG-ARW-PPL-GAT-00001) and protecting concrete slabs shall be installed. Slabs details shall be in accordance with the standard detail drawing Protective Slab Details (ORG-ARW-PPL-DET-00002).
- Manholes, Pits, Anchor Blocks and etc. if required shall be installed outside the railway corridor boundary.
- Isolation valves if required shall be installed outside the railway corridor boundary.
- Permanent Pipeline Marker signs shall be installed and positioned 150mm outside the railway corridor boundary.

9.6. Watercourse and Gully Crossings

Watercourse and Gully crossings shall be installed in accordance with Arrow standard drawings listed in Section 2 of this Specification.

9.7. Construction Vehicles over Existing Pipelines

For an existing pipeline, with unknown or inadequate compaction and embedment details, requiring a construction vehicle crossing, a compacted ramp should be constructed over the top. The ramp shall be purpose designed and constructed as an embankment in accordance to AS/NZS 2566.1 and AS/NZS2566.2 to protect the existing pipelines from the expected traffic.

10. Jointing

PE pipe and fittings shall be joined to each other by heat fusion (welding). Fittings shall be in accordance with Arrow Specification for Line Class listed in Section 2 of this Specification.

Preferred method of heat fusion joint should be butt fusion welding.

Prior to any heat fusion/welding it shall be ensured that pipe ends and fittings to be welded are thoroughly cleaned and prepared. Cleaning cloths and solvents shall not be permitted.

Welding equipment is regularly inspected for functionality and maintained in good working order.

10.1. Qualification of Welders

Welders shall hold a competency certificate issued by an approved Registered Training Organisation. Welders undertaking work on the pipeline shall be assessed by performing test welds on the same size groupings according to APGA CoP V4S. Destructive testing shall then be carried out in accordance with ISO 13953 for butt-fused joint and ISO 13954 for electrofusion joint.

10.1.1. General

Written procedures for butt welding of PE Pipe shall be prepared. A procedure shall be written for each individual pipe diameter, pipe grade or SDR number. The procedures shall conform to the requirements of ISO 21307 Plastics pipes and fittings- Butt fusion jointing procedures for PE pipes and fittings used in construction of gas and water systems.

Procedures for electro-fusion jointing shall comply with the manufacturer's recommendations and PIPA POP 001 - Industry Guidelines - Electrofusion Jointing of PE Pipe and Fittings for Pressure Applications.

These procedures shall be reviewed and approved, prior to the commencement of production welding. All welders shall be qualified to the approved procedures. A register of qualified welders shall be maintained. Each welder shall be issued a unique identification number which shall be placed adjacent to all production butt welds. If the welder leaves the project his number shall not be re-used for subsequent welders.

10.1.2. Testing of Welders

The qualification test for each welder shall be carried out on pipe test pieces in accordance with the approved welding procedure.

In the event of a welder's qualification test piece failing to pass visual inspection or destructive testing, a second test will be allowed. Should this test fail, the welder may be retested provided the satisfactory evidence of further training and competence is presented.

10.2. Weld Defects

A weld shall be deemed defective by one of the following criteria:

- Visual defect noted in accordance with Appendix 8 of the APGA CoP V4S.
- Weld not completed in accordance with the approved Weld Procedure.
- Weld defective as assessed in accordance with this specification.
- Defects found using non-destructive examination.

10.3. Pipe Damage Repairs

Sections of pipe containing dents, grooves and scratches deeper than allowed by AS/NZS 4130 and APGA CoP V4S shall be rejected.

10.4. Removal of Production Welds for Testing

Production testing of welds shall be completed in accordance with the APGA CoP V4S .

After intial qualification for both EF and butt welding, one production weld shall be taken within the first 10 welds performed by each welder. If succesfull, the sampling rate of production test welds shall be one on 200 welds for each welded. However, if the work requires less than 100 welds at least one poduction weld shall be perfomed for each welder.

As an example:

- if the work requires a total of 100 welds and welder A performs 10 weld and welder B, 90, a production weld will be required for both welder A and B.

-if the work requires a total of 500 weld and welder A performs 50 weld, welder B performs 250 welds and Welder C performs 600 welds. Then the following sampling rate will be applicable:

+Welder A - one production weld (rate, at least one)
+Welder B - one production weld (rate 1 every 200)
+Welder C - three production welds (rate 1 every 200)

10.5. Pipe Internal Cleanliness

Pipe is to be clean and free of debris at the commencement of pipe jointing. It shall be ensured at all times that no water, dirt or foreign material can enter the pipe.

Before jointing operations commence pipe ends are to be checked for damage at the joint and for entry of water, dirt or other foreign material. If there is evidence of foreign matter entering the pipe, the pipe shall be cleaned before jointing operations commence.

10.6. Wind

Adequate arrangements shall be made to shield the welding operation during periods of high winds. Welding shall not be permitted when, the wind, or dust generated by the wind, is detrimental to the quality of the welds, irrespective of the shielding method used.

10.7. Flood

Adequate arrangements shall be made to ensure construction equipment and pipeline materials are adequately anchored or removed from site in a sufficient timeframe in the event of flood.

10.8. Non-Destructive Inspection of Jointing

Non-destructive inspection of jointing shall comply with the APGA CoP V4S and manufacturers' procedures.

10.9. Tie-Ins

Tie-ins are to be completed in a timely fashion to eliminate as much as possible open bell holes and the risks associated with such activities.

Tie-ins shall be performed in accrordance with Arrow standard drawings squeeze-off connections or hot tap connection.

- Squeeze-off straight connection ORG-ARW-PPL-DET-00062
- Squeeze-off tee connection ORG-ARW-PPL-DET-00063
- Hot tap tie-in detail general arrangement ORG-ARW-PIP-DET-00001

Tie-in shall be performed according to the requirements given in Appendix C of APGA CoP V4S where the tie-in weld is a golden weld. A trial production weld shall be prepared using samples of the pipe being joined and welded using the same parameters and conditions that will be used for the actual tie-in weld, this includes the welder performing the weld. On successful completion of the trail weld and achievement of the required test parameters the tie-in weld can be performed.

All buried future tie-in points shall be marked with an off-cut of PE pipe standing vertically in the trench. This off-cut pipe shall protrude minimum 200mm above ground level. The size and type of line(s) shall be marked on the off-cut pipe. A pipeline sign shall be installed adjacent to the off-cut pipe.

10.10. Flanged Joints

Flanged joints should be avoided for buried service. PE Flanged joints components (stub flange, backing ring, stud bolts, nuts and gaskets) shall be in accordance with the applicable line class specifications. Flanged joints in gathering networks should utilise a gasket joint design.

For PE flanged joints, a flanged joint assembly and torqueing procedure should be prepared during the design phase of the project for each type of specific joint (i.e. for each size, line class and gasket combination) to be installed. PE-to-steel flange joints should be made with the metal flange full face finished to avoid any concentricity or edge bending issued that can occur with raised face flanges (POP 007 for reference).

10.11. Golden Welds

Golden welds shall be adequately verified for integrity prior to energisation.

For important tie in golden welds near high risk areas, the additional precaution of adding a vertical conduit above the tie to act as a "sniffer tube" may be

considered. This requirement shall be reviewed during the project detailed design phase (and confirmed during the SMS). Where the sniffer tube is to be installed, they shall be nominated on construction drawings.

11. Steel Riser and Valve Coating

All above-ground valve assemblies and risers (including High Point Vents or Low Point Drains) shall comply with the requirements of the Piping Specification ORG-ARW-PIP-SPR-00005, designed per B31.3.

Coatings for buried risers shall terminate a minimum of 200 mm above the ground. All pipe and tape wraps for buried steel and below ground/above ground interface sections of gathering networks and risers shall be selected, installed, tested, inspected and repaired in accordance with ORG-ARW-PPL-SPR-00027. Tape wrap products should be linked to the paint coating specification for above ground piping.

12. Above Ground PE Pipe Installations

PE pipes and fittings for gas gathering networks service shall not be installed above ground.

PE pipes and fittings for water systems shall only be used in accordance with Section 4.13.1 of APGA CoP V4S.

13. Lower-In

13.1. General

Procedures shall be developed to ensure that the method of pipe laying shall not damage the pipe or endanger personnel.

13.2. Preparation Prior to Lowering-In

All water in the trench shall be removed except at water crossings, swampy areas, where precautions shall be made to ensure installed pipe is not damaged.

In rock cut, and areas where the trench bed is likely to cause damage to the pipe, sand filled bags and soft padding shall be used in accordance with the backfilling section of this General Specification.

In clay type excavations the pipe may be laid directly onto the trench bottom.

13.3. Lowering-In

Pipes and fittings shall be lifted and lowered with approved belt slings; cradles; or vacuum cranes. After lowering, the slings or cradles shall be removed in such a manner that will prevent pipe damage.

Immediately prior to lowering the pipe into the trench, the trench shall be inspected to ensure that it is free from any material likely to be injurious to the pipe or coating. Where any stones, metal, wood, vegetation, clods of earth or other deleterious material are lying loose on the bottom of the trench, they shall be removed before commencing the lowering-in.

14. Installation of Valves, Drains and Vents

In-Line PE Valves, HPV and LPD are to be installed in the gathering network as per the Process Design Criteria ORG-ARW-PRS-DEC-00001 and as shown on alignment sheets.

Unless otherwise specified, bedding and surrounds of LPD, HPV, PE Valves, risers and the like shall be installed in accordance with the requirements of AS/NZS 2566.2 and tested in accordance with AS1289 (series). Compaction is to be as per section 15 of this Specification and relevant standard drawings. Test results shall form part of the MDR.

14.1. High Point Vents

Two alternative HPV standard designs are available:

- High Point Vent to Gas Line - ORG-ARW-PPL-GAT-00067
- High Point Vent to Atmosphere - ORG-ARW-PPL-GAT-00069

The decision to use the vapor recovery system (vent to gas line) or to atmosphere, will be made on a project by project bases, depending whether the pressure gradient allows vapors to flow from the water to the gas gathering network. This is to be determined by network flow assurance modeling. The selected design shall be nominated on the alignment sheets.

14.2. Low Point Drains

Alternative Low Point Drain (LPD) standard designs exist. The applicable design implemented shall be made during the project design phase and nominated on the alignment sheets.

14.3. Valves

PE ball valves shall be designed, procured and installed in accordance to ORG-ARW-PPL-SPR-00016, PE Ball Valve Datasheets and relevant valve pit drawings.

15. Backfilling, Bedding and Clean-Up

15.1. General

All water in the trench with the exception of stream crossings, swampy areas, or where written exemption has been provided, shall be removed prior to placement of any bedding or backfill. Water disposal shall be in accordance with Rehabilitation Procedure (ORG-ARW-HSM-PRO-00073) and Rehabilitation Guideline (ORG-ARW-HSM-GUI-00060).

No deleterious materials are to be included in the backfill.

Bedding and backfill shall be placed and compacted in a manner that shall ensure that no damage occurs to the pipe and no voids are left around the pipe. Backfilling of the trench has to take place in such a manner that the original design of construction contoured or natural crossings is not disturbed.

Backfilling operations shall be completed in accordance with this specification.

15.2. Soft Padding

The padding material shall be screened backfill or imported fines. Padding shall be in accordance with the requirements of Appendix G of AS2566.2.

15.3. Backfill

15.3.1. General

All backfilling shall be performed in a manner that causes the least damage to the pipe and surrounding environment.

All backfilling shall be well consolidated, to prevent subsequent settlement. Surplus soil and other materials from the excavation shall be spread across the ROW. Larger rock or boulders in excess of 200mm shall not be backfilled into the trench.

15.3.2. Spoil Backfill

The trench shall be backfilled and compacted over its entire length.

Backfill shall be undertaken such that after compaction the following conditions are obtained.

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

15.4. Compaction and Testing of Embedment / Backfill

Bedding and surrounds of trenches, water crossings and the like shall be installed and compacted in accordance with the requirements of AS/NZS 2566.2 and tested in accordance with AS1289 (series).

The minimum compaction is determined based on the soil type and location in accordance with Table 15-2 below. Test results shall form part of the Manufacturer's Data Report (MDR).

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

Trench testing frequency shall comply with the 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.

Bell holes (for example; HPV's, LPD's, valve pits, foreign service crossings, below ground tie-ins, hot taps, squeeze off):

- Compact in 300mm Layers (measured loose/unconsolidated).

- One compaction test per 2 layers per bell-hole – tests shall be conducted at location nominated by the Principals Representative.

For trafficable areas compaction standards for pavement shall be in accordance with Arrow Energy's Specification for Roadworks, ORG-ARW-CIV-SPR-00022. Testing frequency shall be:

- One test in embedment zone.
- One test in every second layer in backfill zone, each backfill layer not to exceed 300mm.
- One test per layer in pavement zone.
- Tests at locations nominated by the Principal's Representative.

The backfilling under Creek/water crossings and embankments shall be placed in layers not exceeding 300mm (measured loose) and, compacted to 95% of Standard dry density (AS1289.5.4.1) for cohesive materials or 70% density index (AS1289.5.6.1) for non-cohesive materials.

15.5. Sign Posting

Permanent pipeline marker signs shall be installed as detailed in Section 7.5.3 of this General Specification and drawing for Pipeline Marker Sign (ORG-ARW-PPL-LAY-00005).

15.6. Contour Banks

Reference shall be made to Land Disturbance Guideline (ORG-ARW-HSM-GUI-00094) for further details concerning contour banks, and the following items:

In undulating or hilly country, the contour banks shall be constructed in order to prevent surface erosion of the ROW, following completion of the works.

In cultivated areas with contour banks or pondage banks, reinstatement of banks shall be at least 30% higher than existing contour banks to allow for settlement. Shallow ripping (200mm deep) shall ensure bonding of the bank to the soil.

The contour banks shall have a minimum fall of 1% in order to prevent excessive sedimentation and a maximum fall of 4% such that scouring does not occur in the channel above the bank.

The contour banks shall be constructed in order to allow the discharge onto an undisturbed area such that water cannot flow onto or across the ROW The spacing of diversion banks shall be as per Diversion Berm Detail (ORG-ARW-PPL-DET-00014).

16. PE Pressure Testing

16.1. General

All elements of the PE gathering network shall be tested after backfilling operations, in accordance with the Section 8 of APGA CoP V4S.

Pneumatic testing shall only be used when suitable exclusion zones can be provided.

A PE pipeline pressure testing procedure and test pack shall be prepared prior to commencing any testing work. The procedure shall be approved by Principal's Representative.

The person(s) conducting the pressure test shall have suitable experience and knowledge to conduct the pressure test.

16.2. Pressure Testing Safety

16.2.1. Testing Method

Liquids such as water are preferred as test fluids because less energy is released if something in the test section fails catastrophically.

Use of any testing method involving fluid other than water shall first be subject to a rigorous risk review and shall be approved by Principal's Representative.

16.2.2. Exclusion Zone

Exclusion zones on either side of the pipeline being tested shall be maintained for the period of pressurisation in accordance with the requirements of the APGA CoP V4S.

Reduction of this exclusion zone may be approved based on a hazard assessment which is includes the Project Manager and project manager, site safety manager and testing supervisor.

Only personnel directly involved in testing operations shall be permitted to enter the exclusion zone. Each entry shall be authorised by the Testing Supervisor.

Personnel shall not enter the exclusion zone whilst the test section is at full strength test pressure unless the hazard has been assessed and/or appropriate controls have been provided to reduce the risk to the testing personnel to an acceptable level.

Personnel not directly involved in the pressurisation procedure shall not enter the exclusion zone during pressurization up to the maximum set test pressure. Once the maximum set test pressure has been achieved each entry into the exclusion zone requires authorisation by the Testing Supervisor.

Where the exclusion zone is not an effective or practical control (e.g. at crossings, and in populated areas), alternative controls shall be identified and applied in hazard assessment including the Project Manager and the Testing Supervisor.

16.2.3. Road Crossings

The exclusion zone should be maintained along the entire length of the pipeline section under test to reduce exposure of people not involved in the procedure.

Where it is not practicable to close a road for the purposes of maintaining the exclusion zone, the following is to be observed:

- The PE pipe utilised in the easement section shall be pre-tested with water for a minimum of 3 hours with the pressure being held at the maximum set test pressure (i.e. make-up water will need to be added during the test to maintain the pressure). This pre-test will be deemed to pass if no visible leaks occurred. The pre-test must be conducted in dry daylight conditions where a small leak would be evident.
- The PE pipe shall be a single section of suitable length to ensure there are no joints within 30m of the road or public access areas (where this is not achievable the joints shall also be subject to pre-testing).
- The pre-tested road crossing section shall then be installed under the road and welded into the total test section.
- The road crossing section shall be backfilled along the pipeline for a minimum of 30m from the road and all public access areas.
- The pipeline shall remain depressurised for a period of at least 8 hours prior to any retesting to enable elastic stabilisation of the pre-test section.
- The total test section including the pre-tested road crossing pipe shall then be tested in accordance with this General Specification.

16.2.4. Network Temperature

Before applying test pressure, allow time for the test fluid and the test section to temperature equalize. The Testing Supervisor, together with the Arrow Energy Representative, is responsible for selecting a suitable reduced test pressure, if required, in the event the test temperatures exceed 25 ºC.

Any reduced test pressure shall be documented and approved by Principal's Representative.

16.3. Hydrostatic Test

16.3.1. General Requirements

Strength testing PE pipes requires special processes since the pipes may continue to expand significantly throughout the test period. When a PE pipe is sealed under a test pressure there may be decay, even in a leak free network, due to the creep response and stress relaxation of the PE material. Due to this material behaviour, standard pipe testing procedures used for other pipe materials such as carbon steel, may not be suitable for PE pipe.

The following factors can affect a PE pipe pressure test:

- Length of section and pipe diameter.
- Test pressure, rate of pressurisation and duration of the test.
- Presence of air.
- Relative movement of mechanical fittings.

- Level of support from pipe embedment.
- Accuracy of test equipment.
- Ambient temperature changes during testing.
- Presence of fittings and other materials in the test section.

The longer the test section the harder it is to locate a leak. Where site or production reasons require longer lengths to be tested, radio links between test operatives to minimise the test duration should be employed.

16.3.2. Filling

Depending on elevation changes and test locations, test water may be transferred directly from an adjoining section, pumped through temporary pipe-work, stored in temporary holding tanks, stored in temporary “Turkey’s Nest” type dams or transported with water tankers.

Filling rates will vary depending on filling method and water supplies.

Filling shall generally be from one low point or from a test header with a fill and vent point attached if the test section does not incorporate section valves. Additional fill points may be used if required to accommodate the water supply points.

Air shall be released from the pipeline high points utilising the high point air valves.

16.3.3. Pressure Test

Where hydrostatic pressure testing is approved for use a detailed project specific procedure shall be approved by Principal’s Representative in accordance with the requirements of Section 8 of APGA CoP V4S.

16.3.4. De-pressurising

Following the successful hydrostatic test, water shall be released in a controlled manner in accordance with the de-pressurising plan.

16.3.5. De-watering

Dewatering shall be carried out where required in accordance with the water management plan. Dewatering operations shall be approved by Principal’s Representative (where required) and shall comply with any statutory regulations before commencing.

Dewatering operations shall take into account the hydraulics of the network. The flow rates, back pressure, elevation and pumping operations shall be in a controlled manner.

Initial test pressure shall be bled off using a needle valve installed for this purpose. When the equivalent pressure has been reduced to high point zero, the highest point air vent shall be opened to atmosphere to prevent a vacuum being pulled. Other air vents will be progressively opened as the water level falls to the level of the vents.

16.4. Pneumatic Test

16.4.1. General Requirements

Pneumatic testing shall only be undertaken where approved by Principal's Representative.

The following factors are to be considered in arriving at a decision:

- Is the gathering network so designed that it is impracticable to test hydrostatically?
- Does the gathering network traverse only low population density areas the entire length?
- Does the gathering network approach any areas where people are likely to gather?
- Does the gathering network cross any third party service or infrastructure?
- Can the Minimum Exclusion Zone be adequately and safely controlled?
- Is the maximum required test pressure too high to safely conduct a pneumatic test?

16.4.2. Test Procedure

Where pneumatic pressure testing is approved for use a detailed project specific pneumatic procedure shall be approved in accordance with the requirements of Section 8 of APGA CoP V4S. The test procedure shall address:

- Installation of test equipment.
- Pneumatic test pressure calculation.
- Exclusion zone calculation.
- Formal risk assessment and mitigation measures.
- Pressure test requirements.
- Pressurisation of the network pipeline.
- Maximum allowable test section inlet temperature.
- Test pressure.
- Strength test pass/fail assessment.
- De-pressurisations of pipeline.
- Fill with tracer gas if gas detection method of leak detection is being utilised.
- Ultrasonic leak detection equipment and methodology if acoustic method of leak detection is being utilised.
- Leakage survey.
- Leak test pass /fail assessment.
- Preparation for recovery in the event of failure; and test records.
- For a pneumatic test the gathering network shall be buried prior to any pneumatic testing and test gas shall be cool (<25°C.) and clean, containing no water or oil.

16.4.3. Leakage Survey Test

Upon successful completion of the strength test a leakage test shall be undertaken. The leakage test shall be conducted in accordance with Section 8.4.2 of APGA CoP V4S.

16.4.4. De-Pressurising

Prior to pressurisation a plan to depressurise shall be prepared to ensure air is released in a controlled manner from nominated points.

The following points shall be observed:

- Only authorised personnel may operate the release valves.
- Valves shall be slowly operated. Do not activate valves quickly.
- Confirmation that the test section is depressurised shall be confirmed by the Testing Supervisor in liaison with all personnel involved.
- Personnel not involved in depressurising shall remain outside the exclusion zone area. Once depressurization is confirmed, personnel shall be allowed to enter the exclusion zone and continue work.

17. Gathering Network Integrity

The PE gathering network integrity shall comply with the requirements detailed in PE Network Integrity Management Plan - Surat Basin (S00-ARW-PPL-PLA-00003) and PE Network Integrity Management Plan - Bowen Basin (BMGP01-ARW-PPL-PLA-00006).

18. Reinstatement

18.1. General

After backfilling has been completed, construction tools, equipment and debris shall be removed. Areas that have been disturbed by the installation shall be reinstated. Appropriate measures shall be taken to prevent erosion (e.g. the construction of contour banks or diversion banks) and to minimise long-term degradation of the environment.

Reserves shall be reinstated in accordance with the requirements of the appropriate authority and CEMP and AAP.

Remediation of the gathering network ROW shall be conducted in accordance with Rehabilitation Procedure (ORG-ARW-HSM-PRO-00073). Reinstatement should be completed as soon as is practicable.

18.2. Restoration of Ground Contours

The trench and ROW shall be restored to the natural contours of the ground and shall allow normal surface drainage. Watercourses, terraces and levees disturbed by construction of the gathering network shall be restored to their original contours. Banks of watercourses shall be restored in a manner that shall resist erosion.

Where erosion control is required, diversion banks shall be constructed across the ROW to divert the flow of water away from the backfilled trench and into natural drainage courses to prevent erosion along the trench line. These banks shall be constructed in accordance with the following requirements:

- Banks shall be constructed across the entire disturbed width of the working area.
- The height of the banks shall be such that they will be capable of retaining a depth of water behind the bank of not less than 150 mm. In areas of steep slopes, the height of bank should be modified to suit the conditions.
- Banks shall be constructed so that water is discharged onto undisturbed land on the lower side of the ROW. The slope along the length of the contour bank channel shall be a maximum of 1 in 35 and a minimum of 1 in 50.

All temporary works provided for construction shall be removed and fences and private roads disturbed by construction of the gathering network shall be restored to their original condition. All terraces, levees and watercourses shall be restored to their former condition.

Where deemed necessary a plough or scarifier shall be used to relieve any unduly compacted surfaces on project areas such as ROW, access roads, camp sites and stockpile sites. Scarifying of areas where topsoil has been conserved shall be carried out prior to replacement of topsoil. Care shall be taken to avoid soil inversion if scarifying is carried out where topsoil has not been removed. Any ripping or scarifying operation shall be restricted to a depth of 50mm and shall follow natural contours to avoid soil erosion.

Where excavation has occurred for side-hill cut or other purposes, the areas shall be backfilled with the original material, and compacted to duplicate the natural contours with sufficient surplus fill to compensate for subsidence. After erosion control works are complete, stockpiled topsoil and vegetation shall be evenly respread over the re-contoured surfaces and loose surface rock shall be removed.

18.3. Adverse Weather

Clean-up operations shall not be undertaken during adverse weather or in wet ground conditions. Such clean-up shall be redone in order to meet the required standard of normal dry weather clean-up.

18.4. Maintenance of ROW

The ROW shall be continually maintained with respect to washout, erosion and subsidence for a period of 5 years (in accordance with EA conditions).

18.5. Disposing of Topsoil

Topsoil which has been stockpiled shall be disposed of in an approved manner. General topsoil shall be evenly spread over areas directed.

Topsoil removed from ROW or lay-down areas during clear and grade operations shall be replaced and spread uniformly over the portions of the ROW from which it was removed.

Note: If additional topsoil is required, topsoil shall be imported subject to the conditions in the CEMP and in consultant with the landowner.

Note: In the event of finishing with excess subsoil, relocation is allowable. However, no topsoil shall be removed from the ROW unless authorised by the landowner and Environmental officers.

The ROW shall be contoured to original landscape. V-drains are to be avoided to improve spreading of run-off water.

The ROW shall be rough tilled or ripped prior to completion and sown with an appropriate pasture mix in consultation with the landowner and the requirements of the Rehabilitation Procedure (ORG-ARW-HSM-PRO-000073). Landowners are to be offered an equal or superior grade of pasture/legume mix of high quality species to assist rehabilitation results if the site was previously disturbed.

Note: Gypsum application shall be considered on areas of unstable or dispersive soils that are subject to erosion, sealing or hard setting to assist with rainfall infiltration and rehabilitation of soil surface.

Work areas compacted due to plant traffic shall be ripped to a depth of 150mm.

ROW rehabilitation shall meet or exceed the requirements of the Rehabilitation Procedure (ORG-ARW-HSM-PRO-000073) within a period of settling, revegetation pasture establishment or re-cropping of not less than 12 months from date of construction clean up and reinstatement completion.

18.6. Grassing

After topsoil has been spread, trimmed and rolled, it shall be fertilised and grass seeded as per the requirements of the Rehabilitation Procedure (ORG-ARW-HSM-PRO-000073).

Weed infestations identified in the areas reinstated with grass shall be treated and controlled in accordance with Weed Management Procedure (ORG-ARW-HSM-PRO-00139) or weed specific guidelines.

18.7. Regenerating Natural Vegetation

After all other earthworks are complete, mulch, shrub and selected tree limbs shall be spread over the ROW for the purpose of preserving and regenerating natural vegetation, erosion control and providing animal habitation.

Vegetation spreading is to be in accordance with the following:

- Shrub and tree limbs and timber fragments along the ROW shall be retained and spread evenly across the ROW during the clean-up operation, except that a track, suitable for 4WD access by ROW patrols, shall be left clear of vegetation and tree limbs.
- Tree trunks and large limbs are to be laid on the ROW so that they lie in a random fashion across the natural slope of the ground. Continuous straight lines shall be avoided.
- Tree trunks, limbs and stumps shall not be placed in watercourses or gullies. Rocks which cannot be buried in the trench shall be dealt with in accordance with the CEMP.
- Vegetation which does not require re-spreading shall be identified in the CEMP and shall be disposed of in accordance with the CEMP.
- Mulched vegetation shall be re-spread across the ROW at a depth of 50 mm (for erosion protection and moisture retention).

Weed infestations in naturally regenerated areas shall be treated and controlled in accordance with the requirements of Weed Management Procedure (ORG-ARW-HSM-PRO-00139).

18.8. Borrow Pits

Borrow areas shall be prepared and then restored as follows:

- Vegetation shall be cleared from the site and placed adjacent to the area to be disturbed.
- Topsoil up to a depth of 100 mm (max 150mm) shall be stripped and stockpiled adjacent to the borrow area.
- Other overburden, if present, shall be stockpiled separately from any topsoil.
- When extraction has been completed; any stockpiled overburden shall be replaced in a manner compatible with the surface contours that existed prior to disturbance. Edges of pits shall be graded to shallow angles to prevent collapse. If the borrow pit is on a hillside, it shall be graded so that it does not pond water.

- The base of the pit shall be scarified and stockpiled topsoil shall be re-spread over it and then seeded and fertilised. Stockpiled vegetation shall also be re-spread over the pit floor.
- The access track to such borrow areas shall also be restored using similar procedures to pipeline easement restoration.

18.9. Final Clean-Up

Final clean-up operations shall be carried out to restore all disturbed areas to a stable, ecologically compatible condition to the satisfaction of the relevant authorities.

Such work is to include but not be limited to the following:

- Restoration of ROW at all gathering network tie-ins.
- Reinstatement of all permanent fences and gates.
- Restoration of roads and tracks affected by gathering network construction to original condition.
- Making good any deterioration following preliminary clean-up operations.

18.10. Fence and Gate Restoration

Temporary fences and gates shall be removed. Fences disturbed or relocated during construction shall be restored to their original location using materials and construction not inferior to the original.

Permanent ROW fence gates shall be installed at fence crossings where nominated on the Construction Drawings. Permanent fence gates shall be in accordance with the Construction Drawings and shall be fitted with a padlock.

All work shall meet the approval of the Landowner in terms of material, workmanship and function.

18.11. Removal of Surplus Material/Recycling

All rubbish and debris resulting from construction activities shall be removed from the ROW. Any rock or surplus spoil which cannot be placed on the ROW shall be disposed of in a location as indicated within the CEMP or approved by Principal's Representative.

Where ever possible any rubbish or surplus material which may include leftover pipe, sleepers, crates, cans, bottles etc. shall be recycled and not disposed of so as to minimise land fill within the region.

18.12. Removal of Temporary Facilities

All temporary facilities (on and off the ROW) installed for the purpose of construction of the gathering network shall be removed.

All services and facilities disturbed by construction (on or off the ROW) shall be restored to a condition similar to or exceeding that which existed prior to the commencement of construction during clean-up of the ROW.

18.13. Removal of Timber

Timber or vegetation felled within road or water supply/drainage reserves shall be removed from site and disposed of in an approved manner.

Timber retained during the Clear and Grade for habitat creation shall be spread appropriately on top of the finished grade.

19. Post Construction ROW Maintenance

Systematic patrolling shall be carried out in accordance with AS 2885.3 to:

- Detect leaks.
- Protect the gathering network from external activities.
- Protect the gathering network from damage caused by natural events such as erosion.

The patrolling schedule shall be made specific to determine any change in the ROW. Monthly patrolling shall be conducted during the Contract maintenance period.

If pavement, topsoil or the ROW final surface has any settlement or erosion damage, the area shall be restored by backfilling to match adjacent levels and repaved or reseeded in accordance with project specifications.

The following issues shall be part of the ROW post construction maintenance:

- Settlement of the pipe trench.
- Re-vegetation.
- Erosion control.

20. Brownfield Design

20.1. General

When working in the vicinity of live pipelines, site activities shall comply with the Specification for Conditions of Working near Metallic and Non Metallic Pipelines (ORG-ARW-PPL-SPR-00020).

20.2. Squeeze off

Squeeze-off is a technique used to temporarily control or stop the flow of gas or liquid in gathering networks by compressing the pipe between parallel bars with a mechanical or hydraulic squeeze-off device until the inside surfaces make contact.

Squeeze off procedures shall be in accordance with below standards:

- APGA CoP V4S and
- ASTM F1041Standard guide for squeeze-off of Polyolefin Gas Pressure Pipe and Tubing, or
- ASTM F1563 Standard Specification for Tools to Squeeze-Off Polyethylene (PE) Gas Pipe or Tubing, or
- ASTM F1734-03 Standard Practice for Qualification of a Combination of Squeeze Tool, Pipe, and Squeeze-Off Procedures to Avoid Long-Term Damage in Polyethylene (PE) Gas Pipe.

Squeeze-off operations shall require pre-qualification on pipe diameters greater than DN315.

In selecting squeeze off locations, confirm no prior squeeze off has been applied within a distance of 5 times the nominal diameter of the pipe in either direction.

On completion of the squeeze off, mark the location and the distance equal to 5 times the diameter on either side of the squeeze off warning to avoid any future squeeze off at that location.

20.3. Hot tap tie-ins

Hot tap to a live gas or water gathering network can occur in a brownfield design where new wells are connected to existing networks. Hot tap procedures are required for review and approval.

The following shall be considered:

- Hot tap activities shall be captured in the safe work method statement.
- Existing pipe and hot tap branch saddle tie-in shall be supported as necessary during installation.
- Prior to hot tap branch saddle tie-in, the operating pressure of the line shall be set below the MAOP of the tapping spool.
- Hot tap assembly including branch saddle tie-in and PE ball valve shall be pressure tested to 1.25 x MAOP of the new designated gathering line after

the welding of the electrofusion saddle to the existing pipe before drilling through live pipe.

- Only tapping spools with MAOP greater than MAOP of the existing pipe shall be used.
- For Bedding, Backfill and Topsoil details refer to Section 15.
- The hot tap tie-in valve shall be supported and backfill material compacted as specified by this General Specification.
- For hot tap details, refer to ORG-ARW-PIP-DET-00001.
- To achieve the hot tap tie in cases where the existing lines are laid at the same depth of cover, the overall depth of the existing gathering shall be adjusted in accordance to ORG-ARW-PPL-DET-00055.

21. As-Built Records and Data

21.1. Construction Data Record

All construction data that is relevant to the verification of work, work standards, clearance/approval to operate the future safe operation, management and development of the pipeline shall be gathered.

This data shall be captured in databases that shall be available to be accessed directly through the Construction Management System (CMS) database, as well as via the project GIS for operational needs.

The data shall include all construction records including but not limited to, drawings, alignment sheets, drawing references, engineering lists, P&ID's, calculations and design determinations, records of prior condition, bend position, size, direction and bend type, wall thickness changes, buoyancy control locations, entry and exit points of all thrust and/or auger bore locations, entry and exit points of all HDD locations, other measurements, monitoring records and recordings associated with design, procurement, construction, PE gathering network installation, performance checks, and manufacturing data and test/measurement for other procured items, all weld records, weld and pipe position, hydrostatic/pneumatic testing, paper and photographic records of construction together with other records including PE linepipe manufacturing data and construction progress and quality data.

Where as-built data is required to be supplied, it shall be supplied in an approved electronic format. Paper copies shall also be provided when the documents are required to be signed as a formal record of an activity.

21.2. As-Built Survey and Records

When carrying out As-Constructed survey, readings shall be taken on the pipe with GPS equipment to accurately reference height and location of points to permanent survey points.

Gathering network elevation and alignment shall be taken at minimum 100m intervals and at point of interest (including but not limited to all bends, tees, valves, special crossings, reducers, LPD, HPV and purge points).

Chainages are to be surveyed as horizontal chainages of the actual gathering network. All surveyed data including locations, features and lengths for all below ground gathering network information shall be referenced by these As Constructed chainages.

For trenched installation, the pipe reading shall be taken after the pipe has been lowered-in and is in its final location within the trench. The points measured shall be top-of-pipe, and this shall be stated on the data output. Further readings shall then be taken after backfill and reinstatement to provide a restored crossing profile.

A drawing shall be produced for each special crossing, showing the pipe as constructed profile, and the restored and reinstated land profile. The drawings shall show weld diameters, locations, and, if applicable, the start and end of any pipe with a different SDR or PN.

Records are to be taken along the length of the gathering network of the location, length and characteristics of the pipe laid. As Constructed survey data and drawings shall be in accordance with the requirements of APGA CoP V4S and AS1100.401. Records to be taken include:

- Identification of sequence of each pipe and pipe off-cut in the gathering network by pipe ID number printed on the PE Pipe.
- String length, diameter and wall thickness.
- Sequence and location of each weld in the gathering network (including Golden Welds), referenced to weld. In locations where the ground conditions permit the coordinates of the intermediate welds to be determined by interpolation, the frequency of weld survey may be extended with approval.
- Depth of cover.
- Placement of bedding and padding, where appropriate.
- Location of sweep bends including angle.
- Location in the trench of buoyancy control measures, concrete slabs, trench breakers and marker tape.
- Location of each facility installed as part of the gathering network, LPDs, HPVs, valves, future off-takes and any other appurtenances.
- Location of each foreign service crossed by the gathering network, including overhead power lines.
- Separation distance from underground facilities and services shall be recorded.
- Topographical features along the gathering network route, including creek crossings, roads, tracks, railways, and foreign services crossed, and their spatial relationship to the gathering network.
- Rock types and method of excavation within the ditch-line.
- Significant features within 50 m of the pipe centreline including dams, windmills, homesteads, mines, and buildings.
- Post construction survey to locate all above ground appurtenances, fence-lines, facility fences, erosion control banks, permanent gates, gathering network markers.
- A profile of the gathering network route suitable for alignment drawings.

21.2.1. Major Creek or River Crossings

Data shall be recorded as follows:

- Crossing identification number (e.g., KP location).
- Measured length of prefabricated crossing string prior to installation.
- Start/end tie in locations.
- Start/end of different SDR or PN pipe.
- Start/end of buoyancy control device.
- Depth of cover.
- At tangent points of all bends and at least two additional readings on each bend.
- Location of trench breakers.

- All weld locations, referring to weld numbers.
- Elevation and location of welds within 100m either side of crossings. After restoration, sufficient shots shall be taken to show the restored natural surface profile including:
  - Lead up to the channel including erosion control banks.
  - Top of banks.
  - Bottom of banks.
  - Additional readings (minimum 4 readings) through the bed of the creek including the low point.

21.2.2. Road and Track Crossings

Data shall be recorded as follows:

- Start and end of different SDR or PN pipe.
- Readings at not more than 5 m intervals across the road.
- Edges of road shoulder.
- Start/finish concrete slabs.
- Centre of road.
- Table drains.
- Name of the Road.

21.2.3. Horizontal Directional Drills

As-Constructed details shall be prepared for all crossings installed by this method.

21.3. As-Built Data Delivery

During construction, an as-built survey with pipe and weld records shall be undertaken.

Refer to the As-Built Geospatial Specification (ORG-ARW-GIS-STA-00013). In addition to the requirements outlined in the above mentioned document, attention is drawn to the following requirements.

Intermediate as-built GIS data supplies shall be provided at the completion of each test section at intervals agreed on a project by project basis.

All vector data must be supplied in ArcGIS native format. The preferred ArcGIS format is File Geodatabase (.gdb).

When supplying CAD files in addition to ESRI compliant .gdb format, layer names should be meaningful and layer definition table should be supplied for easy interpretation. All data should be included in the correct layers. No data to be stored on Layer 0. If a series of drawings are supplied over time, the layer naming convention should remain the same.

All spatial data and/or drawings showing horizontal alignments or layout plans will conform to the Coordinate System and Datum standard. Associated metadata and/or title block that clearly states the Projection and Datum information relating to all data/drawings supplied is required.

Drawings should be purged and clipped so that any unnecessary or irrelevant information is deleted.

External References (x-refs) are acceptable and should follow the convention set out above as per all drawings. If X-refs are supplied, a description should be included as to exact drawing number and revisions of its associated drawing. This can be achieved through file naming conversions or communicated via other means.

Elevation data (contours, spot heights, etc) supplied as CAD should be supplied as either 3D data or with the Z-value as an attribute. Note CAD data containing entities incompatible with ESRI formats will not be accepted.

All data (e.g. aerial or satellite imagery, DEM), must be supplied in an ArcGIS compliant format.

Any spatial data used to create figures in an Arrow Energy sponsored report or other document, a corresponding ESRI Layer File(s) describing the cartographic rendering of the dataset in all figures must be supplied (including source data). The ESRI Layer Files must be named such that they can be easily associated with the relevant dataset. The ESRI Layer Files shall be named such that they can be easily associated with the relevant dataset.

The complete as-built survey including the complete resupply of a complete collated GIS data model shall be submitted within three weeks of completion of the project. The data shall be compiled, verified, and delivered on a non-volatile medium such as a DVD. Three copies shall be supplied.

Hard copies shall be A3, 4D ring lever arch file with concise index divided at each section using commercial numbered dividers. Three copies shall be supplied.

The MDR index format is to be tabled for approval.

21.4. GIS Data Specification

As-built survey GIS data shall be supplied according to the following specifications.

Table 21-1 GIS Data Specification

Accuracy	+/- 50mm
Horizontal Coordinate System / Datum	GDA 94 MGA Zone 55 / 56
Vertical Datum	Australian Height Datum (AHD) using ausgeoid09
Format	ESRI File Geodatabase
Metadata	Refer to document ORG-ARW-GIS-STA-00001 Spatial Data Transfer

Attribute Fields	All feature attribute fields are to be populated in accordance with the data dictionary. If fields are not applicable, they shall be populated with “N/A”.

22. Inspection and Test Plan

Inspection and Test Plans (ITPs) shall be developed and implemented to cover the supply of all products and services associated with this specification. The ITP shall include all the inspection and testing requirements nominated in this specification and related standards; the ITP shall also contain the relevant acceptance criteria for the inspection and testing performed and the records that will be generated as evidence that the tests have been performed and meet requirements. During the review of the ITP, Arrow Energy will indicate Hold and Witness Points – over and above those listed in Table 21.1 – required; the following definitions apply.

22.1. Hold Point (H)

A critical step in fabrication, construction and testing where it is mandatory that Arrow Energy inspect the component/equipment or witness an activity. Activities designated as Hold points shall not proceed unless Arrow Energy or Arrow Energy's appointed representative is present at the Hold point, has approved documentation required as Hold point, or has formally waived the Hold point. The notification period required shall be as detailed in the contract agreed to by Arrow Energy prior to the work proceeding.

Note: Approval of the ITP shall be regarded as a Hold point.

22.2. Witness Point (W)

A critical step in fabrication, construction and testing where it is desirable that Arrow Energy inspect the component/equipment or witness an activity. Arrow Energy shall be notified in advance of the activity taking place, the notice period being as indicated in the contract or the time agreed to by Arrow Energy prior to the work commencing. Once notification has been given, the activity may proceed according to schedule regardless of Arrow Energy's attendance or not. Any step requiring witnessing shall take place at the time and date for which Arrow Energy has been notified, if there are any schedule changes, Arrow Energy shall be advised of these changes. The minimum notification period shall be as agreed by Arrow Energy prior to the start of work.

Check sheets and inspection reports for carrying out the quality control checks shall be prepared in accordance with the technical specifications. All inspection and test forms and records used shall be specific to the activity and the items inspected and referenced in the ITP.

Specific Hold and Witness Points to be observed:

The Hold (H) and Witness (W) points required for this General Specification and to be indicated on the relevant ITP are given in Table 21.1.

Table 22-1: Mandatory Hold and Witness points

Clause	Hold (H) Point	Witness (W) Point
4	Availability of all Approvals	
5	Surveyed Route	
10	Approval of Welding Procedures	
10	• Approval of Welder Qualifications • Golden welds	• Preparation and removal of production welds. • Approval of Welder Qualifications
18	Pressure testing procedure	
18		Pressure testing
21	Review and approval of ITP by Arrow Energy	
		Preparation and removal of production welds
	Golden Welds	

23. Compliance and Assurance

Compliance with the requirements established in this standard will be reviewed as part of Arrow Energy's assurance activities.

Monitoring and verification of the key requirements of this standard will also be included as part of the Arrow Energy key performance indicator reporting requirements.

Appendix A. ROW Width Selection

tem	Description	Minimum Distance	Basis/Justification	Relevant Standards	Reference Notes
A	Between adjacent trenches in parallel	4.0 m	1. To provide working area for construction/maintenance equipment so that not to cause any adjacent trench collapse during construction or to impose direct vehicle load on to pipe at any time. 2. To provide space during construction for pipe preparation area such as stringing & welding.	APIA CoP V4S, AS/NZS 2885.1 AS/NZS 2566.2	• For pipeline trench details refer to Standard Drawing Pipeline Trench Detail ORG-ARW-PPL-DET-00020 • The permissible traffic load on pipeline alignment is subject to project specific SDR ratio • Heavy vehicle/equipment only to cross pipeline at designated crossing locations
B	Center to center between HDPE pipe trench and 11 kV powerline above/below ground infrastructure	4.0 m	1. To provide required clearing distance from 11 kV power pole during pipeline construction/maintenance activities as per drawing 750630-60050-E99-0085. 2.To provide working area for construction/maintenance equipment so that not to cause any adjacent trench collapse or to impose vehicle load on to pipe. 3. Procedures shall be defined and Risk Assessment shall be carried out prior to any work to be done near live powerline. 4. To provide space for pipe preparation area such as stringing & welding.	AS/NZS 7000, APIA CoP V4S, AS/NZS 2566.2	• The 11 kV vegetation clearing width is based on drawing Moranbah Gas Field 11kV Overhead Line – 11kV Corridor Clearing Requirements, 03-E-DWG-2481. • For pipeline trench details refer to Standard Drawing Pipeline Trench Detail - ORG-ARW-PPL-DET-00020 • The permissible traffic load on pipeline alignment is subject to project specific SDR ratio • Heavy vehicle/equipment only to cross pipeline at designated crossing locations • Procedures need to be defined and Risk Assessment shall be undertaken before carrying out any work near the overhead or below-ground powerline. Refer to exclusion zone for authorised person working in close proximity to power lines as defined in Part-2 of QLD Electrical Safety

tem	Description	Minimum Distance	Basis/Justification	Relevant Standards	Reference Notes
					Code of Practice 2010.
C	11 kV powerline above/below ground infrastructure to the nearest ROW corridor boundary (areas not subjected to vegetation growth or traffic way)	2.0 m	1. To provide working area for stockpiling of trench spoil or top soil.		• Procedures need to be defined and Risk Assessment shall be undertaken before carrying out any work near the overhead or below-ground powerline. Refer to exclusion zone for authorised person working in close proximity to power lines as defined in Part-2 of QLD Electrical Safety Code of Practice 2010.
D	11 kV powerline above ground infrastructure to the nearest ROW corridor boundary (areas subjected to vegetation growth)	8.0 m	1. To provide working area for stockpiling of trench spoil or top soil.	AS/NZS 7000	• Procedures need to be defined and Risk Assessment shall be undertaken before carrying out any work near the overhead or below-ground powerline. Refer to exclusion zone for authorised or instructed person working in close proximity to power lines as defined in Section 3 Unsafe distances and Part-2 Overhead uninsulated (exposed) electric lines Division 2 of the QLD Electrical Safety Code of Practice 2010.
E	11 kV powerline pole to the nearest ROW corridor boundary (areas subjected to conductor swing identified as a threat)	5.0 m	1. To provide minimum clearing distance from 11 kV power conductor swing as per drawing 750630-60050-E99-0085.	AS/NZS 7000	• The 11 kV vegetation clearing width is based on drawing Moranbah Gas Field 11kV Overhead Line – 11kV Corridor Clearing Requirements, 03-E-DWG-2481. • Procedures need to be defined and Risk Assessment shall be undertaken before carrying out any work near the overhead or below-ground powerline. Refer to

tem	Description	Minimum Distance	Basis/Justification	Relevant Standards	Reference Notes
					exclusion zone for authorised or instructed person working in close proximity to power lines as defined in Section 3 Unsafe distances and Part-2 Overhead uninsulated (exposed) electric lines Division 2 of the QLD Electrical Safety Code of Practice 2010.
F	Between below-ground powerline and the nearest HDPE pipe trench centreline	4.0 m	1.To provide working area for construction/maintenance equipment so that not to cause any adjacent trench collapse or to impose vehicle load on to pipe. 2. To provide space for pipe preparation area such as stringing & welding.	APIA CoP V4S, AS/NZS 2566.2	• For pipeline trench details refer to Standard Drawing Pipeline Trench Detail ORG-ARW-PPL-DET-00020 • The permissible traffic load on pipeline alignment is subject to project specific SDR ratio • Heavy vehicle/equipment only to cross pipeline at designated crossing locations • Procedures need to be defined and Risk Assessment shall be undertaken before carrying out any work near the overhead or below-ground powerline. Refer to exclusion zone for authorised or instructed person working in close proximity to power lines as defined in Section 3 Unsafe distances and Part-2 Overhead uninsulated (exposed) electric lines Division 2 of the QLD Electrical Safety Code of Practice 2010.
G	Width for track/road	15.0 m (Road) 10.0 m (Track)	1. As per Typical Road/Access Track cross section details in Typical Road Cross Section Details drawing 2. Table drains are allowed		• For pipeline trench details refer to Standard Drawing Pipeline Trench Detail ORG-ARW-PPL-DET-00020 . For typical Road/Access Track cross section details refer to Typical Road Cross

tem	Description	Minimum Distance	Basis/Justification	Relevant Standards	Reference Notes
			within this corridor		Section Details ORG-ARW-CIV-STD-00013 • For Gathering ROW's it is assumed a track not a road will be required.
H	Pipe trench center line to nearest the Road/Access track boundary	2.0 m	1. Road/track table drains are not within 2.0m separation distances	APIA CoP V4S, AS/NZS 2566.2	• For pipeline trench details refer to Standard Drawing Pipeline Trench Detail - ORG-ARW-PPL-DET-00020 • The permissible traffic load on pipeline alignment is subject to project specific SDR ratio • Heavy vehicle/equipment only to cross pipeline at designated crossing locations
I	Installation of Fibre Optic Cable in the same trench with water(gathering)/raw water pipeline	-	1. Fibre optic cable to be laid in between water pipeline and the trench wall.	APIA CoP V4S, AS/NZS 2566.2	• For pipeline trench details refer to Standard Drawing Pipeline Trench Detail - ORG-ARW-PPL-DET-00020

Specification
ORG-ARW-PPL-SPR-00005 Specification

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Related documents

Document Number	Document title
ORG-ARW-PPL-REG-00010	PE Gathering Networks (Gas and Water) - Change Register
ORG-ARW-PPL-DEC-00002	HDPE Gathering Network Design Criteria

Acceptance and release

Author

Position	Incumbent	Release Date
Senior Pipeline Engineer	Yuyu Fang	30/06/2019

Stakeholders and reviewers

Position	Incumbent	Review Date
Principle Pipeline Engineer	Paul Beukelman	29/04/2019
Senior Pipeline Engineer	Yuyu Fang	21/06/2019
Principle Mechanical Engineer	Simon Fogarty	26/05/2019
Environmental Manager	Alison Way	22/05/2019
Quality Manager	Chris Rossel	24/05/2019
Construction Supervisor	Tony Larsen	22/05/2019

Approver(s)

Position	Incumbent	Approval Date
Engineering Technical Authority Level 1	Venkat Ghantala	30/06/2019

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