Arrow CASS Tie-in

Regional Planning Interests Act 2014
Requirement Notice Response
Lot 3 RP77715
RPI25/004

May 2025

1. Introduction

Arrow submitted a Regional Interests Development Approval (RIDA, RPI25-004) application to the Department of State Development, Infrastructure and Planning (the Department) on 19 March 2025 (the Application). The Application is for development of a Tie-in valve in a treated water pipeline in an area mapped as Priority Agricultural Area (PAA) and Strategic Cropping Area (SCA) on the Condamine floodplain.

Arrow received a Requirement Notice (the Notice) on 2 April 2025. This Report provides further information requested in the Notice.

The Notice also requires Arrow to publicly notify the application. This will be complied with separately, and in accord with the Public Notification requirements of the RPI Act.

1.1 Document contents

Section 2 of this document provides a detailed response to each of the 18 issues listed in the Requirement Notice.

Section 3 of this document has the following Attachments.

- Attachment 1 – Arrow Theten CASS Tie-in Restoration Plan (Issue 2, 3 & 8)
- Attachment 2 – Farm Manager confirms the land is operated as a single agricultural enterprise (Issue 6 and 10c iii.)
- Attachment 3 – Farm Manager endorses the methodology used to determine the shadow area and its extent (Issue 7)
- Attachment 4 – Impacts to overland flow (Issue 8)
- Attachment 5 – Minimised impacts to agricultural activities from proposed CSG activities (Issue 10a)
- Attachment 6 – Leased Areas (Issue 10a & 10c iii.)
- Attachment 7 – Dryland Cropping Land Use (Issue 10b & 10c ii.)
- Attachment 8 – Extent of PAA (Issue 12)
- Attachment 9 – Construction and Operation Direct Impact and Impact Shadow Areas (Issue 13)
- Attachment 10 – Tie-In Value Impact Area Calculations (Issue 16)

2. Response to Requirement Notice – RPI25-004 Arrow Theten CASS Tie in – RIDA application.

Item	The Department of State Development, Infrastructure and Planning Requirement Notice	Arrow Response
1	**Issue:** The application indicates the land in this application within SCA overlaps with land used for a Priority Agricultural Land Use (PALU) in a PAA. As per RPI Act Statutory Guideline 03/14, the assessor must ensure that the activity complies with the applicable PAA assessment criteria when deciding on the application relevant to the overlapping land. **Actions:** Please confirm whether all of the disturbance footprint is within the mapped Priority Agricultural Land Use area.	All of the disturbance footprint is within the mapped Priority Agricultural Area (PAA). Further, the Priority Agricultural Land Use (PALU) Assessment (Appendix D of the RIDA supporting document) confirms that all of the disturbance footprint is within areas of the PAA and which are PALU.
2	**Issue:** The assessment application form lodged in support of the application states that 0.3ha of Strategic Cropping Area (SCA) is to be disturbed. However, the supporting report (page 23) states that the expected area of impact to SCA is: • 1.38 ha during construction • 0.82 ha during operation • 0.3 ha during decommissioning and restoration **Actions:** Clarify the total footprint of disturbance within mapped SCA for which the approval is required and the total extent will be restored to pre-activity condition through a restoration plan.	The 0.3ha is the total footprint area that will be disturbed during construction. The entirety of that area will be restored to pre-activity condition through the Restoration Plan (see Attachment 1). The Restoration Plan allows for restoration of 0.3 hectares of direct impact to PAA/SCA land. This is very conservative, given that the valve fenced out area (direct impact at operational phase) is only 0.0016 ha. This ensures that there is room available to follow the restoration plan requirements to remove imported material, stockpile the various soil horizons separately and carry out de-compaction as required.
3	**Issue:** The application supporting material states (at page 4), 'The scale of impact is	Plate 3- 1 (page 8) is a work in progress photo and is not intended to demonstrate the re-instatement phase at the end of construction. It is therefore not 'evidence' of the quality of work at the end of the construction phase. Areas adjacent to the valve and within the fenced-out area will be

Item	The Department of State Development, Infrastructure and Planning Requirement Notice	Arrow Response
	0.3 hectares during the construction phase and 0.0016 hectares during operation, and the activities can be fully restored when the tenure expires and the broader coal seam gas (CSG) activities in the area cease.' However, the above statement is contradicted by evidence provided by Plate 3- 1 (page 8), where during construction, the soil horizons were not returned in the same order as extraction. The report states, 'The proposed work activities will be in operation for approximately 12 years, prior to being decommissioned and rehabilitated in accordance with the conditions of the Petroleum Lease, the Environmental Authority and relevant legislation.' The supporting report also states (at page 24), 'The land will be returned to its previous general state'. "Previous general state" is not "pre-activity condition" and does not constitute restoration as required by the Statutory Guidelines 09/14. In this regard, Statutory Guideline 09/14 states: For land to be restored to pre-activity condition, it will require an adequate restoration to the former or original condition of the land, including the productive capacity of the land. It does not simply mean 'revegetated,' 'rehabilitated' or 'reclaimed' which are all commonly used terms under other state government permit and approval processes.	constructed according to industry guidelines including using any imported material that is required to safely stabilize the valve installation. A site-specific Restoration Plan (See Attachment 1) has been developed and provides details of proposed actions to reinstate land to original PALU. There are no non-PALU areas associated with the application. The plan is: • Independently prepared • Includes sufficiently conservative cost estimates • Considers available soil test results in nearby areas and showing similar soil characteristics to the area of direct impact • Includes requirements for additional soil testing prior to disturbing the ground and again during restoration. This before and after soil testing approach is standard procedure for Arrow in agricultural land, to ensure the return of conditions that are favourable for restoring the previous level of agricultural productivity • Considers how the re-instatement of the disturbance area at the end of the construction phase contributes to good final restoration outcomes • Ensures oversight by suitably qualified people and that laboratory results are suitably endorsed (standards) • Details the process of establishing performance criteria for final restoration, and • Details the appropriate validation of the restoration effort.

Item	The Department of State Development, Infrastructure and Planning Requirement Notice	Arrow Response
	Guideline 09/14 also states, '…information requirements for demonstrating land will be restored to pre-activity condition will be best presented through a detailed restoration plan'. Restoration requirements have not been formalised in a restoration plan (as required by the Statutory Guideline 09/14) to support that the land can be restored to its pre-activity condition at the end of the proposed activities, as required by prescribed solution (d)(i). The supporting report states in Table 3-2 that they will establish pre-activity soil condition. The establishment of pre-activity condition is a key component of a restoration plan. It is not to be established at some undefined point of time in the future. There are no requirements in Table 3-1 for the soil horizons to be returned in the same order as extraction. Appendix F- Restoration Plan (within the supporting report) is stated as a Land Rehabilitation Plan. "Restoration" has a specific meaning for the purposes of impacts to SCA and is not the same as "rehabilitation." Sections 3.2 and 7.3 of the supporting report state that construction activities include undertaking the reinstatement and rehabilitation of the balance of the disturbance area. Proposed work activities do not provide details of the reinstatement to the original land use (i.e., replanting, fallowing, revegetating).	

Item	The Department of State Development, Infrastructure and Planning Requirement Notice	Arrow Response
	Actions: Please provide further information to address requirements of the Prescribed Solution (d)(i), including a fully costed and peer reviewed restoration plan for any non-PALU areas of the PAA; and Please provide details of proposed actions to reinstate land to original PALU following construction activities.	
4	Section 3.1 of the supporting report states, 'The valve, a single l12m length of pipe (capped at this stage) and supporting pipeline form the entirety of the activity to be considered under this application.' It is unclear what this section references as the "supporting pipeline", noting that the Executive Summary, Scope and Definition of Work Activities do not include any references to a supporting pipeline. Further, the application material states, 'tie-in valve in treated water pipeline.' **Actions:** a) Clarify that the application involves a 'tie-in valve and treated water pipeline', given the above; and b) Please clarify the reference to "supporting pipeline" within the report, and provides details relating to the purpose, location and depth of the supporting pipeline.	The application involves a tie-in valve (installed in a pre-existing pipeline) and a single length (12 m) of pipe attached to the tie in valve. The existing pipeline is part of Arrow's Beneficial Use Network which is intended to carry treated water for agricultural users.
5	**Issue:**	The standard valve fence is a 2-metre by 2-metre enclosed area. The 0.0016 ha (4-metre by 4-metre) allowance ensures that we can carry out the

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	Section 3.2, Table 3-1 of the supporting report identifies the installation of a two- by-two meter fenced-out area to facilitate valve operation (0.0004 ha). This appears inconsistent with Section 8 of the supporting report, where the operational direct disturbance area for the valve (the fenced-out area) is shown as 0.0016 ha. **Actions:** Please provide clarification regarding this apparent inconsistency with the operational direct disturbance area.	necessary operational maintenance around the enclosure (e.g. prevention of weed spreading).
6	**Issue:** Section 3.3 of the supporting report states land and subject land are operated as a single enterprise, with the remainder of the original “Theten” leased for cattle grazing. **Actions:** Please provide evidence from the Farm Manager or landowner that the land is operated as a single agricultural enterprise.	The Farm Manager confirms the land is operated as a single agricultural enterprise. See Attachment 2.
7	**Issue:** Section 6 of the supporting report provides minimal details regarding the methodology used to calculate the extent of shadow effects/areas with work activities. **Actions:** Please provide information regarding the determination of shadow effects/areas during work activities, including any relevant advice provided by the Farm Manager or landowner.	The Farm Manager endorses the methodology used to determine the shadow area and its extent. See Attachment 3.
8	**Issue:** Section 7.3 of the supporting report notes the intention for	Due the limited extent of the construction footprint, Arrow does not expect any impact to overland flow conditions. The operational phase has a limited disturbance footprint involving only the above ground section of the valve. The

Item	The Department of State Development, Infrastructure and Planning Requirement Notice	Arrow Response
	reinstatement and rehabilitation work activities to maintain the original overland flow conditions. Insufficient detail has been provided of anticipated impacts to overland flow from installed infrastructure and methods use to mitigate impacts to surrounding PALU and properties. **Actions:** Please provide information of anticipated impacts to overland flow from installed infrastructure and methods use to mitigate impacts to PALU on the property, as well as PALU on surrounding properties. This includes any impacts to future PALUs undertaken in the area.	valve enclosure can be installed to ensure there is no change to volume, direction, quality or destination of overland flow water. The operational phase includes ongoing monitoring to ensure that any localised subsidence or other impact to overland flow conditions is reported and repaired quickly. The final Restoration Plan (Attachment 1) also ensures there is no change to overland flow when the CSG activity is decommissioned at end of life. Attachment 4 for further clarification of the Section 7.3 actions that are part of Arrow's standard approach to managing impact to and maintain overland flow conditions.
9	**Issue:** Section 10.1 of the supporting report states that the applicant is not the owner of the land and there is a voluntary agreement with the landowner with respect to CSG activities on the property. No evidence has been provided of a voluntary agreement (or consultation) with the landowner within the application. **Actions:** Please provide evidence of a voluntary agreement (or extract) with the landowner, including relevant parties, date entered and currency of agreement.	Commercial-in-Confidence documentation.
10	**Issue:** Section 10.1 (and Appendix D) of the supporting report states that the Farm Manager is consulted regularly to ensure CSG activities do not adversely impact agricultural activities. No evidence has been provided of consultation conducted with the	a) See Attachment 5 for consultation with Farm Manager on minimising impacts to agricultural activities. The leased area is not part of the RIDA application and is not directly impacted by the proposed activities (See Attachment 6). b) See Attachment 7. The current land use within the impacted area is dryland cropping.

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	Farm Manager. **<u>Actions:</u>** a) Please provide advice from the Farm Manager/ landowner supporting consultation conducted to minimise impacts to agricultural activities from proposed CSG activities. If the leased area is impacted, please provide evidence that the party that operates the other agricultural enterprise has been notified of this application; and b) Please provide information relating to the current land use within the impacted area, and the last 10 years (2015-2024 inclusive). c) Specifically, please provide advice on the following matters: I. Has the impacted area on Lot 3 RP77715 (including shadow effect areas) been used for irrigated cropping from the centre pivots identified? If so, what years was this conducted in the period 2015-2024? II. <u>If not,</u> has the impacted area on Lot 3 RP77715 (including shadow effect areas) been used for dryland cropping (or another PALU)? If so, what years was this conducted in the period 2015- 2024? **III.** Is any part of Lot 3 RP77715 currently leased to a third party? Where is this land in relation to the impacted areas (including shadow effect areas)?	c) i. No. Trials were performed from the centre pivots for the purposes of irrigation trials, not for the purpose of producing commercial crops. ii. Yes. See Attachment 7. iii. No. See Attachment 2 (subject land operates as a single agricultural enterprise) and Attachment 6 (the leased areas on the Theten property, note Lot 3 RP77715 is not on the leased areas list).
11	**<u>Issue:</u>**	Arrow confirms that the ALUM land uses Cropping (Class 3.3) and Irrigated Cropping (Class 4) have been used to determine PALUs on the Subject

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	Appendix D of the report states: *The Subject Land is located within the Darling Downs Regional Plan and the Western Downs Planning Scheme. The PALUs specific to the PAAs mapped in the Darling Downs regional plan are largely land uses and practices associated with Class 2 (Production from Relatively Natural Environments, to the west of Wilkie Creek) and Class 4 (Production from Irrigated Agriculture and Plantations to the East of Wilkie Creek) in accordance with the Australian Land Use Management (ALUM) classification Version 8 (October 2016).* It is unclear how the applicant determined ALUM Schedule 2 grazing from natural environments as PALU, noting that the Darling Downs Regional Plan 2013 defines PALU as land uses included in class 3.3 (cropping), 3.4 (perennial horticulture), 3.5 (seasonal horticulture), 4 (production from irrigated agriculture and plantations) or 5.1 (intensive horticulture) under the ALUM Classification Version 7 (2010). **Actions:** Please clarify which ALUM Classifications have been used to determined PALU on the land, relevant to the previous statement above.	Property, with both Class 3.3 and 4 making up the entirety of the Subject Property. As seen in Figure D3 in Appendix D of the report, the subject property only intersects with ALUM land uses Cropping (Class 3.3) and Irrigated Cropping (Class 4) which are both defined as PALUs by the Darling Downs Regional Plan 2013. Reference to Class 2 (Production from Relatively Natural Environments, to the west of Wilkie Creek (e.g. grazing)) being included as a PALU is in error and, as seen in Figure D3, Class 2 does not occur inside the subject property. Arrow notes the PALU Assessment (Appendix D) of the supporting report states: “The predominant agricultural land uses in the area are dryland cropping, irrigated cropping and cattle grazing. Dryland and irrigated cropping are defined as a PALU. The predominant cattle grazing in the area is on native grasses and is not defined as PALU.”
12	**Issue:** Figure D1 of the supporting report does not identify PAA relevant for a PALU trigger. **Actions:**	See Attachment 8.

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	Please update Figure D1 to demonstrate the extent of PAA.	
13	**Issue:** Figure E1 of the supporting report includes construction phase impact area but does not clearly define the shadow effect areas in the figure's legend. **Actions:** Please update Figure E1 legend to clearly define shadow effect area.	See Attachment 9.
14	**Issue:** Figure E1 of the supporting report demonstrates the shadow effects during construction. No shapefile of shadow effect impact area has been provided with the report. **Actions:** Please provide relevant shapefile of shadow effects during construction and operational phases.	See shapefile attached inside response email.
15	**Issue:** Appendix H of the supporting report provides no information regarding the depth of the tie-in valve and associated pipe to establish it will not impact PALU. **Actions:** Please update the supporting report to include the indicative depth of the tie-in valve and pipeline.	The pipeline has a nominal 900 mm depth of cover. The tie-in valve depth is not material because it is fenced out within the operational disturbance area.
16	**Issue:**	See Attachment 10 for the calculation of impact restricted to this application (the tie in valve and a single length of pipe) on Lot3 RP77715 only.

Item	The Department of State Development, Infrastructure and Planning Requirement Notice	Arrow Response
	The supporting report uses varying terms and figures to demonstrate various areas of impact during work activities, which impact the review of the report. **Actions:** Please provide a single table that clearly sets out all of the areas of impact, including direct disturbances and associated shadow impacts during each work activity.	
17	**Issue:** Section 2 of the supporting report identifies the disturbance area, including shadow effect areas, as 1.38 hectares during construction. This is inconsistent with the Assessment Application Form, which identifies that the disturbance to 0.3 hectares of PAA. **Actions:** Please update the Assessment Application Form to reflect the extent that the carrying out of PALU is precluded within the PAA.	See response to Issue 2. For the benefit of clarity, see also Appendix E of the supporting report.
18	**Issue:** The declaration in Section 10 of the supporting report does not identify the relevant company name of the authorised signatory, noting the two applicants, Arrow CSG (Australia) and Arrow Energy, and the Circulating Resolution provided. **Actions:** Please confirm the relevant company name within Section 10 of the Assessment Application Report.	Arrow can confirm that the applicant companies are Arrow CSG (Australia) Pty Ltd and Arrow Energy Pty Ltd in this instance. These companies are the relevant tenure holders for PL252.

3. Attachments

Attachment 1 - Arrow Theten CASS Tie-in Restoration Plan (Issue 2, 3 & 8)

REPORT

ARROW THETEN CASS TIE IN - RPI25/004 –RESTORATION MANAGEMENT PLAN

ARROW ENERGY

CLIENT DOC. NO.

TBA

land and water stewardship

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PROJECT

Arrow Theten CASS Tie in - RPI 25/004

DOCUMENT

Plan

Arrow Theten CASS Tie in - RPI 25/004

AUTHOR(S) Stewart Anderson

BeneTerra	PROJECT NO.	DISC	TYPE	DOC NO.
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A	30/04/2025	IFR	SA	SA	SW	AE
0	2/05/2025	IFU	SA	SA	SW	AE

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AUTHORISATION

The delivery of this report to the Client has been authorised by and on behalf of BeneTerra Pty Ltd.

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APPENDIX

ABBREVIATIONS

ASPAC	Australasian Soil and Plant Analysis Council
BT	BeneTerra
bgs	below ground surface
CEC	cation exchange capacity
cm	centimetre
CSG	coal seam gas
CPESC	certified professional erosion and sediment control
CPSS	certified professional soil scientist
dS/m	deciSiemens per meter
EA	Environmental Authority
$EC_{1:5}$	electrical conductivity (measured by mixing 1 part soil to 5 parts water)
EC_{se}	electrical conductivity of saturated soil extract
EGE	effective gypsum equivalent
ESI	electrochemical stability index
ESP	exchangeable sodium percentage
ha	hectare
IECA	International Erosion Control Association
ITP	inspection test plan
m	metre
mS/cm	milliSiemens per centimetre
NATA	National Association of Testing Authorities
$pH_{1:5}$	negative logarithm of hydrogen ions (measured by mixing 1 part soil to 5 parts water)
RoW	right of way
RPEQ	registered professional engineer Queensland
RUSLE	revised universal soil loss equation
SCL	strategic cropping land
t	tonnes
µS/cm	microSiemens per centimetre
yr	year

1 INTRODUCTION

Arrow Energy Pty Ltd (AE) commissioned BeneTerra Pty Ltd (BT) to develop a restoration plan for submission to the Department of State Development, Infrastructure, Local Government and Planning to obtain approval under the Regional Planning Interests Act 2014. The approval relates to construction and operation of a tie in valve and associated gathering pipeline over Priority Agricultural Area and Strategic Cropping Area. Arrow Energy has an existing Environmental Authority EPPG00972513.

2 SCOPE OF REPORT

The department provided a response to RPI25/004 application dated 28 March 2025, requesting a Restoration Plan, Table 1.

Table 1. Extract from RIDA25-004 Requirement Notice Arrow CASS Tie-in

Issue	*The application supporting material states (at page 4), 'The scale of impact is 0.3 hectares during the construction phase and 0.0016 hectares during operation, and the activities can be fully restored when the tenure expires and the broader coal seam gas (CSG) activities in the area cease.' However, the above statement is contradicted by evidence provided by Plate 3- 1 (page 8), where during construction, the soil horizons were not returned in the same order as extraction. The report states, 'The proposed work activities will be in operation for approximately 12 years, prior to being decommissioned and rehabilitated in accordance with the conditions of the Petroleum Lease, the Environmental Authority and relevant legislation.'* *The supporting report also states (at page 24), 'The land will be returned to its previous general state'. "Previous general state" is not "pre-activity condition" and does not constitute restoration as required by the Statutory Guidelines 09/14.* *In this regard, Statutory Guideline 09/14 states:* *For land to be restored to pre-activity condition, it will require an adequate restoration to the former or original condition of the land, including the productive capacity of the land. It does not simply mean 'revegetated,' 'rehabilitated' or 'reclaimed' which are all commonly used terms under other state government permit and approval processes.* *Guideline 09/14 also states, '…information requirements for demonstrating land will be restored to pre-activity condition will be best presented through a detailed restoration plan'.* *Restoration requirements have not been formalised in a restoration plan (as required by the Statutory Guideline 09/14) to support that the land can be restored to its pre-activity condition at the end of the proposed activities, as required by prescribed solution (d)(i).* *The supporting report states in Table 3-2 that they will establish pre-activity soil condition. The establishment of pre-activity condition is a key component of a restoration plan. It is not to be established at some undefined point of time in the future. There are no requirements in Table 3-1 for the soil horizons to be returned in the same order as extraction.* *Appendix F- Restoration Plan (within the supporting report) is stated as a Land Rehabilitation Plan. "Restoration" has a specific meaning for the purposes of impacts to SCA and is not the same as "rehabilitation."* *Sections 3.2 and 7.3 of the supporting report state that construction activities include undertaking the reinstatement and rehabilitation of the balance of the disturbance area. Proposed work activities do not provide details of the reinstatement to the original land use (i.e., replanting, fallowing, revegetating).*

Action	*Please provide further information to address requirements of the Prescribed Solution (d)(i), including a fully costed and peer reviewed restoration plan for any non-PALU areas of the PAA; and please provide details of proposed actions to reinstate land to original PALU following construction activities.*

2.1 RESTORATION PLAN REQUIREMENTS

As per *RPI Act Statutory Guideline 09/14 How to determine if an activity has a permanent impact on Strategic Cropping Land,* demonstrating land will be restored to pre-activity condition will be via a Restoration Plan. The criteria for a Restoration Plan is displayed in Table 2 - Assessment criteria stepsTable 2.

Table 2 - Assessment criteria steps

Assessment criteria	Plan section
1) Information on the nature of impact on the land and methods used to determine impact	Section 3.
2) Characterisation of the pre-activity (current) condition of the land and soils	Section 4.
3) Evaluation of the nature and risk of any predicted impacts on the land	Section 3 and 4.
4) Evidence that scientifically proven and practical methods do exist for restoring the land	Section 5.
5) Detail on the application of the restoration methods including timeframes	Section 5 and 6.
6) A monitoring program including benchmarking and progress milestones	Section 5.4
7) A fully-costed estimate of identified restoration works	Section 7.
8) Restoration criteria against which successful restoration can be demonstrated	Section 5.3

3 PROPOSED WORKS AND IMPACT

3.1 SITE DETAILS

The Restoration Management Plan is specific to the proposed tie in valve and associated gathering on Lot3 RP77715. The site is located 22 kilometres west of Dalby in Queensland.

The proposed works consist of a total disturbance of approximately 0.3 hectares of land, which is a right of way (RoW) below ground pipeline and a valve pit, Figure 1.

The initial earthworks require a total area of 0.3 hectares for a period of less than three months, to install the underground assets. Once the gathering pipeline and valve is installed, an above ground valve pit riser will remain to operate the valve. Once the pipeline ceases operations, the valve pit will be decommissioned.

The site is mapped as priority agricultural land use (PALU) and Strategic Cropping Area (SCA). The project area is predominately flat, with a slope < 1%, and commonly <0.5%. The landowner and farming operator is Arrow Land Holdings Pty Ltd, who have conducted irrigation trials within the project area in recent years, Figure 2. The current PALU is dryland broad acre cropping of corn, chickpea, wheat, sorghum, mung beans and barley, since 2019. The farming in the vicinity of the proposed tie-in valve is dryland due to no permanent water source to enable ongoing irrigation.

NOTE: the '*Construction Footprint/ Disturbance Footprint*' symbol in Figure 1 displays the proposed earthworks.

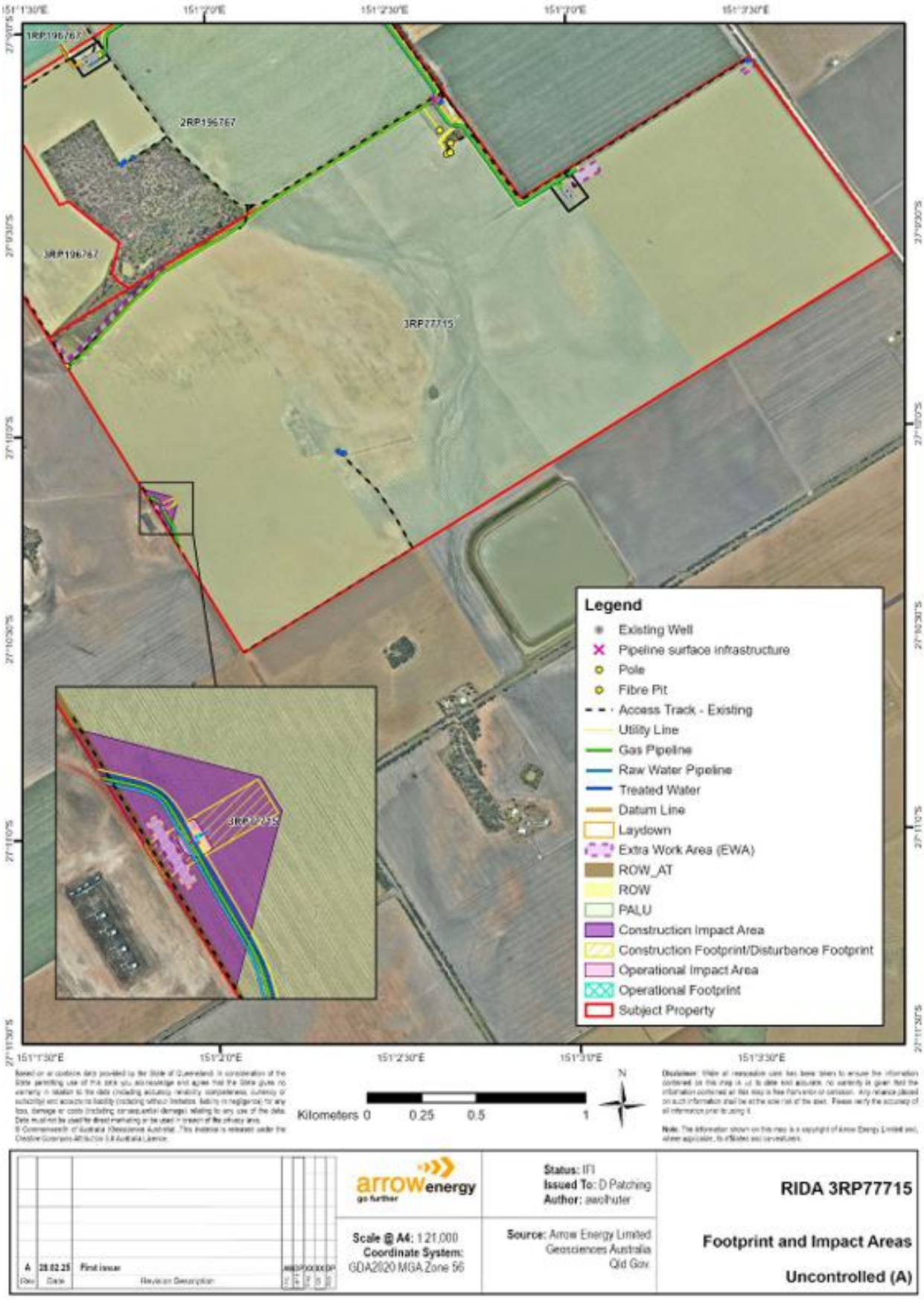

Figure 1 Overview of the project area (source: Arrow Energy).

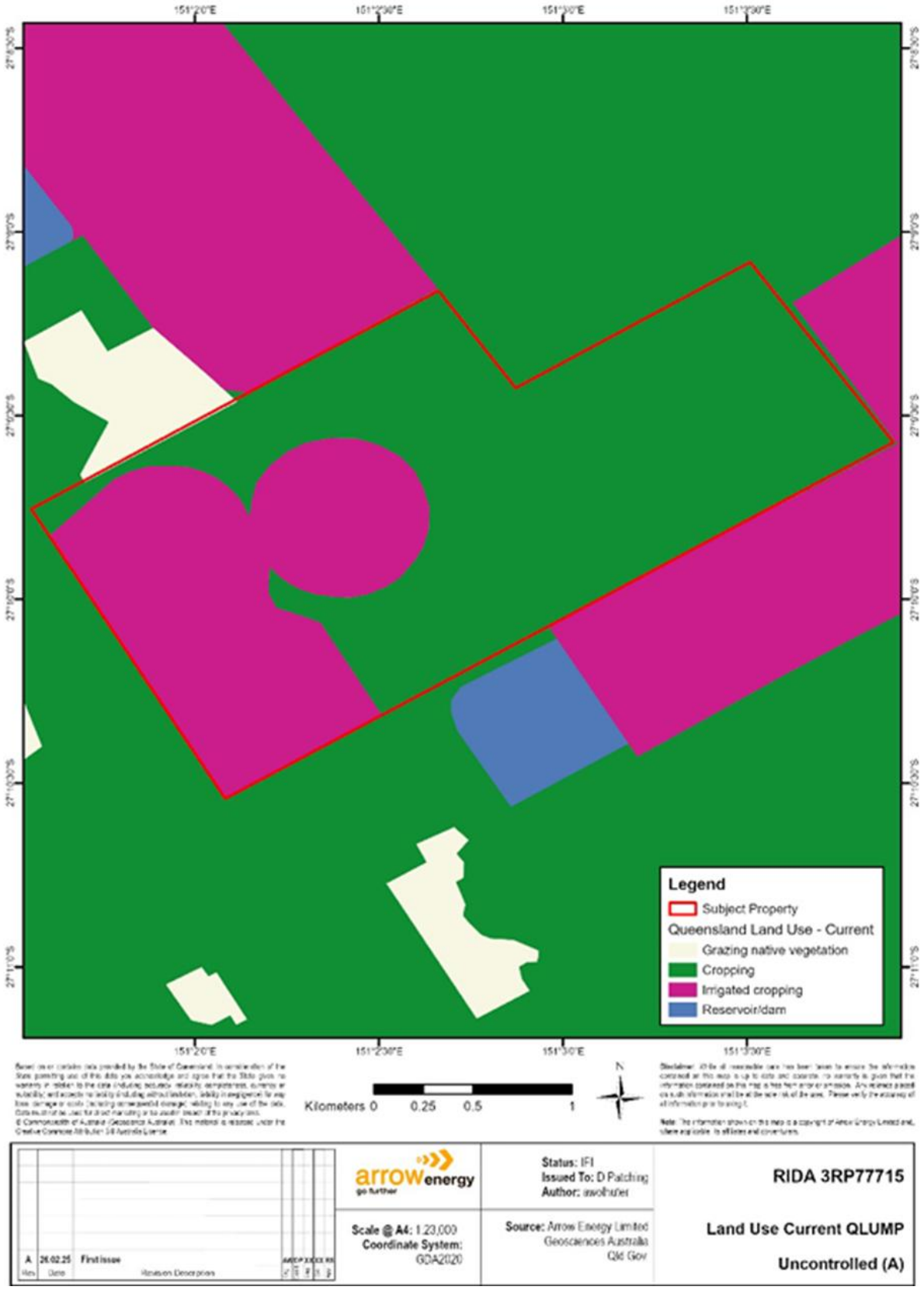

Figure 2 Agricultural land use (source: Arrow Energy)

3.2 IMPACTS

Arrow Energy propose to construct a valve and an adjoining single length of new pipe for this project. This will require trenching works to install an underground pipeline, with an above ground riser to operate the valve. Table 3 displays the activities associated with the asset type and the potential risk to soil resources. Similar impacts are identified in a study conducted by the *CSIRO, GISERA, 2014*.

Table 3 - Gathering pipeline and valve

Activity	Potential risk to soil resources
Clearing	• Low risk to soil resources, previously cleared area on PALU.
Topsoil removal	• Mixing topsoil with subsoil. • Loss of nutrients, mainly nitrogen. • Exposure of subsoil and soil erosion. • Erosion of stockpiles.
Trench excavation to a depth of 2 m.	• Mixing subsoil horizons. • Potential saline, sodic and/or alkaline properties placed above background levels.
Pipe installation	• Displacement of soil. • Compaction (this risk also relates to multiple activities).
Backfill	• Potential for voids to be left around pipe. • Backfill trench bulk density does not match surrounding terrain. • Mixed lower profile soil backfilled into upper profile (inverted).
Topsoil reinstatement	• Mixing topsoil with subsoil. • Lack of topsoil. • Interrupt the overland flow.

3.3 RISKS AND CONTROLS

Table 4 identifies project specific soil attributes that are detrimental to crop growth and identifies project activities that have potential expose these risks.

Table 4 – Project specific soil risks

Activity	Risk	Potential harm	Control
Clear n grade, topsoil removal and stockpiling.	Loss of nutrients Mixing soil horizons.	Disturbance to topsoil results in potential loss of nitrogen, and diluting nutrients with stripping depth. Risk of losing phosphorus with soil erosion.	Identify and reinstate soil horizons. Stockpile controls.
Trenching or excavation and backfilling.	Mixing soil horizons. Soil structural decline.	Reinstatement of layers incorrectly, resulting in salinity, sodicity, alkalinity etc. within root zone. Mixing soil layers impacts structure and texture class, impacting permeability and soil water.	Identify and reinstate soil horizons. Add amendments if required.
Pipe installation.	Displaced subsoil spread over site.	Lower subsoils cannot be reinstated to original depth, impacting root zone.	Removal of subsoil from site that cannot be reinstated to original depth.

Machinery movement	Compaction.	Compacting upper and lower layers to a bulk density > 1.5 or above background.	Add amendments if required. Compaction relief.
Rainfall and wind.	Loss of soil to erosion.	Soil loss due to inadequate drainage or wind.	Implement soil erosion controls during construction.
Topsoil reinstatement.	Soil structural decline.	Worked topsoil becoming hard set. Loss of surface roughness. Dilution of organic matter.	Add amendments as required. Compaction relief with tracked machinery.
Reinstatement.	Surface drainage.	Reinstatement levels above or below predevelopment, causing ponding or diverting flows.	Pre-disturbance survey and post disturbance survey validation.

4 PREDEVELOPMENT SOIL ATTRIBUTES

The Central Darling Downs Land Resource Area Map defines this area as Land Resource Area (LRA) 1a soil landscape, which is broad level plains of mixed basaltic and sandstone alluvium, *Maher, et.al 1998*. LRA 1a has two major soil groups, being either, black and grey cracking clays or bleached sands or loams over brown or black clays. The common local named soils that match this description is either; Condamine, Haslemere, Mywybilla or Anchorfield.

Condamine, Mywybilla and Anchorfield are variations (different suborders/subgroups) of Vertosol. This soil group has a high clay content, vertic properties, abundant cations, high water holding capacity, all of which have agricultural benefit.

Figure 3, Figure 4 and Figure 5 are different suborders/subgroups of Vertosol, each with slightly varying properties and constraints. However, each has the following main limitations of, increasing salinity, alkalinity and sodicity with depth. Each soil sub-order has favourable A-horizontal and upper B-horizon, with adverse properties mentioned above impacting plant root growth becoming evident within the lower B-horizon.

Horizon	Depth	Description
A1	0 to 0.02 m	Brownish grey (10YR4/1) moist; medium heavy clay; strong 2-5mm granular; field pH 8; sharp to-
A12	0.02 to 0.15 m	Brownish grey (10YR4/1) moist; heavy clay; strong 100-200mm prismatic; dry, very strong; field pH 9; abrupt to-
B21	0.15 to 0.30 m	Black (10YR2/1) moist; heavy clay; strong 20-50mm angular blocky; clear to-
B22	0.30 to 0.60 m	Black (10YR2/1) moist; heavy clay; strong 20-50mm lenticular; field pH 8; gradual to-
B23	0.60 to 1.00 m	Brownish grey (10YR4/1) moist; heavy clay; strong 20-50mm angular blocky; very few, coarse 6-20mm calcareous nodules; field pH 8.5; gradual to-
B24	1.00 to 1.40 m	Greyish yellow-brown (10YR5/2) moist; medium heavy clay; strong 50-100mm lenticular, strong 10-20mm angular blocky; very few, medium 2-6mm calcareous nodules; moderately moist, very firm; field pH 8.5.

Analytical Data:

Depth	1:5 soil/water			Particle size				pH 8.5 Alcoholic Cations					BAR	D.R	Total Element					
		dS/m	%	%				meq%					%		%	%	%	%		
(cm)	pH	EC	Cl	CS	FS	SI	CL	CEC	Ca	Mg	Na	K	15*	R1	P	K	S	ESP	Ca/Mg	B.S
0-10	7.5	0.09	0.002	6	14	9	69	47.0	29.0	16.0	1.4	0.60	29	0.65	0.062	1.100	0.018	3	1.81	68
20-30	7.4	0.13	0.010	5	12	13	69	47.0	28.0	16.0	2.4	0.39	29	0.63	0.062	1.030	0.019	5	1.75	68
50-60	6.7	0.56	0.058	3	9	17	70	48.0	25.0	18.0	4.8	0.19	31	0.64	0.053	0.990	0.024	10	1.38	69
80-90	7.3	0.53	0.060	3	10	18	69	42.0	20.0	17.0	5.0	0.23	29	0.76	0.062	1.130	0.025	12	1.17	61
110-120	7.9	0.56	0.066	4	10	11	73	46.0	22.0	18.0	5.4	0.18	N/A	N/A	0.086	1.250	0.016	12	1.22	62
150-160	8.3	0.76	0.074	5	10	10	72	45.0	22.0	17.0	5.7	0.29	N/A	N/A	N/A	N/A	N/A	13	1.29	62

Figure 3 – Condamine soil. (Source: Extract from Soil Chemical Data Book, *Biggs, et. al. 1999*)

Profile Morphology:

Horizon	Depth	Description
Ap1	0 to 0.12 m	Brownish black (10YR3/1) moist; medium heavy clay; strong 5-10mm granular; dry, moderately strong; field pH 9; abrupt to-
Ap2	0.12 to 0.27 m	Brownish black (10YR3/1) moist; medium heavy clay; dry, moderately strong; field pH 8.7; clear to-
B21	0.27 to 0.90 m	Brownish black (10YR3/1) moist; medium heavy clay; moderate 10-20mm lenticular, moderate 20-50mm lenticular; moist, moderately weak; field pH 9; gradual to
B21	0.90 to 1.20 m	Brownish grey (10YR5/1) moist; few medium prominent brown mottles; medium heavy clay; strong 20-50mm lenticular; few medium 2-6mm calcareous nodules; moist, moderately weak; field pH 9; gradual to-
B22	1.20 to 1.70 m	Brownish grey (10YR5/1) moist; very few coarse prominent brown mottles; medium heavy clay; strong 10-20mm lenticular, strong 20-50mm lenticular; few medium 2-6mm calcareous nodules; moist, moderately weak; field pH 9.

Analytical data:

Depth	1:5 soil/water			Particle size %				pH 8.5 Alcoholic Cations meq%					BAR %	D.R	Total Element %			%		
(cm)	pH	dS/m EC	% Cl	CS	FS	SI	CL	CEC	Ca	Mg	Na	K	15*	R1	P	K	S	ESP	Ca/Mg	B.S
0-10	7.3	0.28	0.001	8	24	29	38	51.5	26.3	17.9	1.0	1.47	24	N/A	N/A	N/A	N/A	2	1.50	123
10-20	7.5	0.23	0.001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20-30	7.7	0.26	0.001	11	22	30	37	50.5	22.1	21	1.8	0.76	22	N/A	N/A	N/A	N/A	4	1.10	123
30-40	7.9	0.29	0.002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A
40-50	7.9	0.31	0.002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50-60	8.1	0.35	0.003	7	19	31	43	54.1	21.2	25.5	3.5	0.81	24	N/A	N/A	N/A	N/A	7	0.80	119
60-70	8.3	0.43	0.004	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
70-80	8.4	0.50	0.006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
80-90	8.6	0.63	0.009	9	18	31	42	52.6	18.9	26.3	4.9	1.03	24	N/A	N/A	N/A	N/A	9	0.72	122
90-100	8.7	0.61	0.013	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-110	8.6	0.63	0.017	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27	N/A	N/A	N/A	N/A	N/A	N/A	N/A
110-120	8.7	0.62	0.026	9	18	30	43	50.9	17.0	26.5	5.3	1.27	27	N/A	N/A	N/A	N/A	10	0.64	116
120-130	8.7	0.60	0.030	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	29	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130-140	8.6	0.69	0.034	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
140-150	8.6	0.63	0.041	5	16	31	45	55.6	17.1	28.9	5.6	1.28	28	N/A	N/A	N/A	N/A	10	0.59	117
150-160	8.6	0.64	0.042	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
160-170	8.7	0.69	0.045	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
170-180	8.7	0.69	0.047	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
180-190	8.6	0.69	0.045	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
190-200	8.7	0.68	0.043	5	15	14	65	53.5	26.7	33.1	5.1	1.07	27	N/A	N/A	N/A	N/A	10	0.81	102

Figure 4 – Mywybilla soil. (Source: Extract from Soil Chemical Data Book, *Biggs, et. al. 1999*)

Profile Morphology:

Horizon	Depth	Description
A1	0 to 0.05 m	Black (10YR2/1) moist; heavy clay; few, medium 6-20mm angular chert pebbles; moderate 2-5mm granular; field pH 6.5; clear to-
B21	0.05 to 0.30 m	Black (10YR2/1) moist; heavy clay; moderate 10-20mm sub-angular blocky; field pH 8.5; gradual to-
B22k	0.30 to 0.80 m	Brownish black (10YR3/1) moist; heavy clay; strong 10-20mm lenticular; few, medium 6-6mm calcareous concretions; field pH 8.5; diffuse to-
B23k	0.80 to 1.10 m	Brownish black (10YR3/1) moist; heavy clay; moderate 10-20mm lenticular; few, coarse 6-20mm soft calcareous segregations, few, medium 2-6mm calcareous concretions; field pH 9.

Analytical Data:

Depth	1:5 soil/water			Particle size %				pH 7.0 Aqueous Cations meq%					BAR %	D.R	Total Element %			%		
(cm)	pH	dS/m EC	% Cl	CS	FS	SI	CL	CEC	Ca	Mg	Na	K	15*	R1	P	K	S	ESP	Ca/Mg	B.S
0-10	8.3	0.17	0.007	8	11	16	60	62.5	27.5	21.2	2.5	2.12	29	0.63	0.140	1.100	0.038	4	1.30	89
10-20	8.7	0.17	0.004	7	12	16	63	66.8	29.7	24.4	3.2	1.91	27	0.64	0.130	1.030	0.022	5	1.20	94
20-30	9.0	0.23	0.007	6	10	24	60	68.8	32.2	29.0	4.3	1.03	29	0.59	0.120	0.950	0.016	6	1.10	111
50-60	9.2	0.41	0.019	5	9	16	68	70.2	22.7	36.7	9.4	1.03	31	0.79	0.120	0.983	0.015	13	0.60	103
80-90	9.2	0.68	0.046	5	9	15	69	65.1	17.1	38.4	12.8	1.07	33	0.93	0.130	1.020	0.019	20	0.44	101
110-120	9.3	0.71	0.051	4	9	17	67	66.1	13.9	36.2	13.8	1.07	32	0.98	0.134	1.070	0.017	N/A	N/A	N/A

Figure 5 – Anchorfield soil. (Source: Extract from Soil Chemical Data Book, *Biggs, et. al. 1999*)

The Haslemere is described as a texture-contrast soil, likely either a Chromosol or Sodosol. The description and chemistry for the Haslemere is displayed in Figure 6.

This landscape occurs on slight rises with LRA 1a adjacent to Vertosol. It has lower agricultural values compared to Vertosol, as the water holding capacity is lower, surface soils tend to erode via wind and water post cultivation and hard setting surface.

The topsoil is approximately 20 cm and has a slightly favourable upper B-horizon to a depth of 55 cm, whilst sodic, the electrical conductivity and pH is satisfactory. The lower B-horizon (below 55 cm) is highly sodic, highly alkaline and becoming poorly drained.

Profile Morphology:

Horizon	Depth	Description
A1	0 to 0.15 m	Very dark greyish brown (10YR3/2) moist; coarse sandy clay loam; moderately moist, very weak; field pH 6; clear to-
A2e	0.15 to 0.20 m	Grey (10YR6/1) dry, very dark grey (10YR3/1) moist; sandy loam; moderately moist, very weak; field pH 6; clear to-
B21t	0.20 to 0.50 m	Very dark greyish brown (10YR3/2) moist; medium heavy clay; moderate 100-200mm columnar, moderate 20-50mm angular blocky; moderately moist, very firm; field pH 6 to 8.5; gradual to-
B22t	0.50 to 0.80 m	Very dark greyish brown (10YR3/2) moist; medium clay; few coarse 6-20mm soft calcareous segregations; dry, moderately strong; field pH 8.5 to 9; clear to-
B23t	0.80 to 1.20 m	Brown (10YR5/3) moist, very dark greyish brown (10YR3/2) moist; few very coarse 15-30mm distinct orange mottles; medium clay; very few coarse 6-20mm soft calcareous segregations; dry, moderately strong; field pH 9.

Analytical data:

Depth	1:5 soil/water			Particle size				pH 8.5 Alcoholic Cations					BAR	D.R	Total Element					
		dS/m	%	%				meq%					%		%	%	%	%		
(cm)	pH	EC	Cl	CS	FS	SI	CL	CEC	Ca	Mg	Na	K	15*	R1	P	K	S	ESP	Ca/Mg	B.S
B0-10	7.0	0.08	0.002	N/A	N/A	N/A	N/A	16.0	6.2	4.9	0.4	0.80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0-10	6.9	0.07	0.002	54	16	8	21	18.3	7.3	5.7	0.4	0.86	11	0.99	0.101	1.380	0.042	2	1.30	68
20-30	7.8	0.16	0.008	37	12	5	45	34.8	13.3	12.3	4.1	0.28	21	0.89	0.059	0.903	0.033	12	1.10	67
55-65	9.3	0.28	0.016	54	14	7	25	19.3	7.3	9.0	3.9	0.16	13	0.99	0.028	1.280	0.040	20	0.80	81
90-100	9.4	0.40	0.018	N/A	N/A	N/A	N/A	26.0	9.3	12.0	5.8	0.35	N/A	N/A	N/A	N/A	N/A	22	0.80	N/A

Figure 6 – Haslemere soil. (Source: Extract from Soil Chemical Data Book, *Biggs, et. al. 1999*)

The Central Darling Downs Land Management Manual, *Harris, et.al 1999,* was developed from a 1:250,000 survey scale, with no corresponding bore holes located with close (<500 m) vicinity of site. This scale is appropriate for landscape and catchment management, however, inappropriate to determine a land restoration method for bulk earthworks.

AECOM 2021 performed a soil survey for a pipeline alignment adjacent to the CASS tie and described the soil landscape as a Vertosol. The soil survey site of SS03 (surface site) is approximately 230 m north of the proposed CASS tie in, and DS04 (field testing site) is approximately 750 m south, Figure 7.

Figure 7 does highlight the variability in colour of the surface, light coloured soils intersecting with the dark coloured soils, there is a possibility that the soil survey did not identify a Chromosol/ Sodosol (likely the light colour) or transitional soil landscape due to the scale of survey.

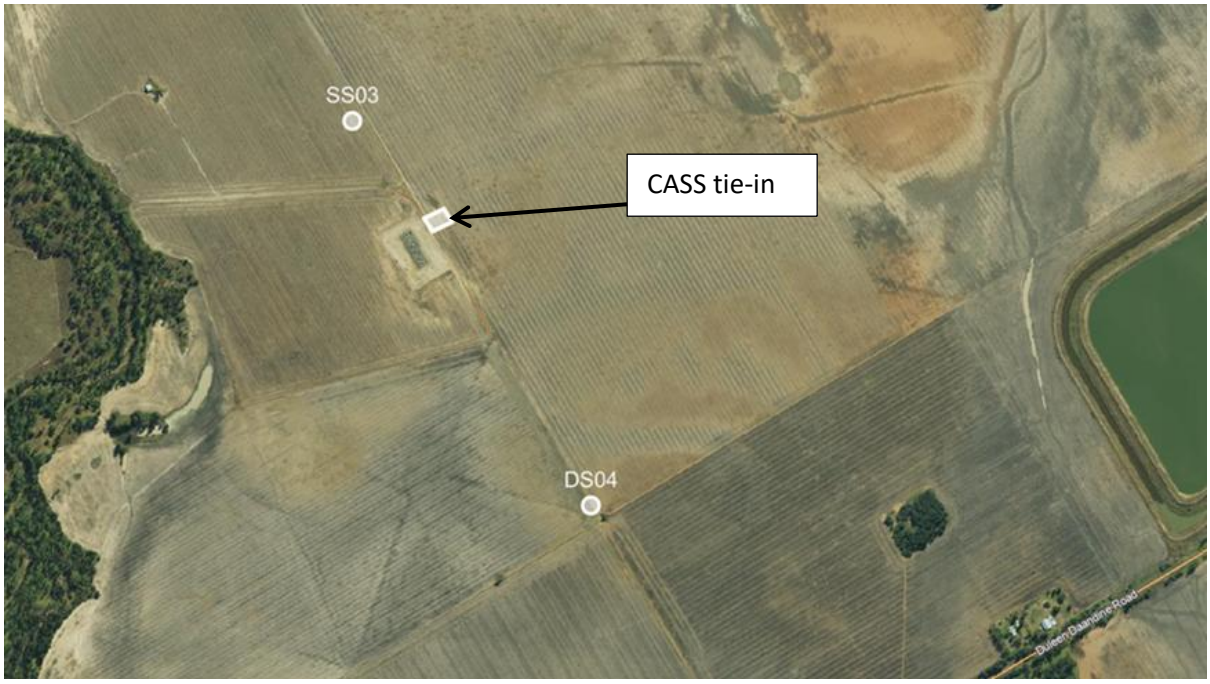

Figure 7 – Soil sites in relation to proposed CASS tie in. (Source: QLD Globe at 1:5,000 Scale)

SS03 (Figure 8) and DS04 (Figure 9) soil sites did not have corresponding laboratory data, as the data displayed in Table 5 is derived from soil sites DS08, which is located 8 km to the south. However, the *AECOM 2021* soil survey provides a degree of confidence that three general soil horizons exist, (topsoil, upper B and lower B), the exact depth of excavation need to be confirmed as varying suborders of Vertosol exist. There is a possibility of an isolated patch of Chromosol/Sodosol within the project location that would not have been identified during soil surveys due to survey scale.

AECOM 2021 described the general Vertosol soil landscape as a well-structured cracking clay soil, with a self-mulching surface and topsoil depth of approximately 20-30 cm. The topsoil is strongly alkaline, non-sodic to sodic and non-saline. The upper B horizon extends to 100 cm bgs. This horizon, despite being sodic and strongly alkaline, has low salinity and will support root growth of common tolerant crops of the region. Below 100 cm the lower B horizon is sodic to strongly sodic and moderately saline.

SOIL LOGGING SHEET — **SS03**

Project: Surat LPH Pipeline Soil Survey	**Project No:** 60651803
Observation Type: Surface Site	**Date:** 22 July 2021
Easting / Northing: 304716 / 6993456	**Topography:** Flat, level plain
Drainage: Poorly to imperfectly drained	**Disturbance:** Cultivation, irrigated, past or present
Land use: Cultivation, wheat	**Surface condition:** Cracking clay

Horizon Type	Depth	Boundary	Colour	Mottles	Texture	Consistency	Structure	Coarse Fragments	Segregations/ Inclusions	Roots	pH	EC (µS/cm)
A1	0.0-0.2	-	10YR3/2	Common mechanical mixing	Light clay	Dry	Strong, angular blocky	<5%	5-10% calcareous and gypseous soft segregations and concretions	No roots		
-	-	-		-			-		-	-	-	-
-	-	-		-			-		-	-	-	-

Existing soil mapping:
Vertosol

Soil Survey:
Well-structure cracking clay soils

Remarks:
Sample collected from the topsoil stockpiled on the side of cleared road. No access to nearby paddocks. Assuming 0-0.2.

Figure 8 – SS03 soil survey site. (Source: Extract from AECOM 2021)

SOIL LOGGING SHEET — **DS04**

Project: Surat LPH Pipeline Soil Survey	**Project No:** 60651803
Observation Type: Detailed Site	**Date:** 14 July 2021
Easting / Northing: 305263 / 6992607	**Topography:** Flat, level plain
Drainage: Poorly drained	**Disturbance:** Cultivation, irrigated, past or present
Land use: Cultivation, wheat	**Surface condition:** Cracking clay

Horizon Type	Depth	Boundary	Colour	Mottles	Texture	Consistency	Structure	Coarse Fragments	Segregations/ Inclusions	Roots	pH	EC (µS/cm)
A1	0.0-0.3	Abrupt	7.5YR3/2	Few mottles	Sandy clay	Moderately moist	Angular blocky	10-20%	5% organic root linings	-	8.8	-
B1	0.3-1.2	Clear	7.5YR4/3	Mottles common	Heavy clay	Moderately moist	Angular blocky	20-50%	5% soft carbonate segregations	-	9.5	-
B2	1.2-2.0	-	7.5YR3/4	Few mottles	Heavy clay	Moderately moist	Angular blocky	20-50%	5% soft carbonate segregations and ferromanganiferous nodules	-	9.5	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

Existing soil mapping:
Vertosol

Soil survey:
Well-structured cracking clay soils

Remarks:
Site located within ROW, adjacent to cropping

Figure 9 – DS04 soil survey site. (Source: Extract from AECOM 2021)

Table 5. Vertosol soil data summary. (Source: Extract from AECOM 2021).

Analysis	Sample Depth						
Units	0.0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2	1.5-1.6	1.9-2.0
Soil pH	9.1	8.7	8.6	8.7	8.8	8.8	8.7
Soil EC (µS/cm)	109	232	332	316	246	623	680
PSA-Sand (0.06-2m%)	31	-	-	-	-	-	-
PSA-Fine Silt (2-60µm%)	21	-	-	-	-	-	-
PSA-Clay (<µm%)	47	63	42	46	54	67	80
Moisture content FC (%)	46.4	-	-	-	-	-	-
Moisture content WP (%)	19.9	-	-	-	-	-	-
CEC (meq/L)	34.8	20.2	26.1	28.5	31.3	26.2	38.4
Phosphate Buffering Index	110	-	-	-	-	-	-
Ca/Mg (ratio)	3.5	3.2	2.8	2.1	2.4	1.4	1.3
ESP (%NaCEC)	4.6	6.4	6.9	8.5	7.5	13.2	15.2

The *AECOM 2021* soil survey was conducted at a survey scale of 1:50,000, appropriate for long distance pipelines, however inappropriate for classification of bulk earthworks for a small (<1 ha) site. A soil survey is required to close the data gaps and identify the soil horizonal boundaries, confirming management techniques.

4.1 DATA GAP CLOSURE

A soil survey shall be conducted by a suitably qualified person, to confirm pre-activity soil characteristics, as per Table 11. The survey and sampling methodology will follow standards set out by the National Committee on Soil and Terrain (NCST 2009) and (McKenzie et al. 2008). Agronomic soil analysis techniques will follow the standards set out in Rayment & Lyons 2011. The aim of the soil survey is to confirm the following pre-activity soil characteristics, and set performance criteria for reinstatement of soil horizons:

- A-horizon depth and amelioration (topsoil).
- Upper B-horizon depth and amelioration.
- Lower B-horizon depth.

The following Table 6 provides a guide of planned site survey data collection. This will be adapted where appropriate as determined by the suitably qualified person upon site survey.

Table 6. Summary of planned site data collection.

Item	Requirement
Soil survey intensity	• 1:5,000 (2 samples per ha) • For the 0.3 ha site a total of 2 boreholes (assuming 1 soil type is identified). *If melon holes are present or levelled, shallow field measurements and/or electromagnetic scanner may help locate appropriate location for lab sampling points.*
Profile description	• Surface condition, horizon, boundary distinctness, texture, colour, mottles, coarse fragments, structure, degradation. • Photo of soil profile. • Field testing; $pH_{1:5}$ and $EC_{1:5}$ can guide sampling depths.
Profile sampling depths	• Uniform sample depths (cm): 0-10, 20-30, 50-60, 80-90, 110-120, 140-150. These depths shall be varied based on observed soil horizons.
Laboratory testing	• $pH_{1:5}$, $EC_{1:5}$ • Exchangeable cations (Ca, Mg, K, Na, Al) • Soluble cations (Ca, Mg, K, Na, Al) • Anions (Cl, So4, Co3, etc.) • Major nutrients (N,P,K,S) • Calculation; Ca/Mg, ESP, SAR.

5 REINSTATEMENT FOR RESTORATION

The pipeline methods implemented by Arrow Energy are contained within the pipeline specification ORG-ARW-PPL-SPR-00005_3.0_1_publication_SPECs_PE. These methods are adapted from APIA code of practice for onshore pipelines and Australian Standard 2885. These general methods specify topsoil to be removed and reinstated and backfilling controls. In addition to implementation of this specification, reinstatement of soil horizons in order of extraction and soil amelioration will achieve restoration.

Reinstatement of the soil horizons in order of extraction is a proven and a practical method of reinstatement, for pipeline construction. Each soil landscape identified within the desktop assessment can be managed appropriately by reinstating soil horizons in order of extractions. Field investigation shall classify the soil type and suborder and soil horizon boundaries.

The likely soil types described in 4.3 can be broken up into three main horizons, A-horizon, upper B-horizon and lower B-horizon, Figure 10 provides an example of grouped soil horizons. The lower B-horizon has adverse properties, where if placed higher in the soil profile can impact plant root growth, therefore has potential to impact non-tolerant crops.

During excavation it is practical to excavate and stockpile these soil horizons separately. Returning specific subsoil horizons within the trench line in order of extraction will eliminate risk.

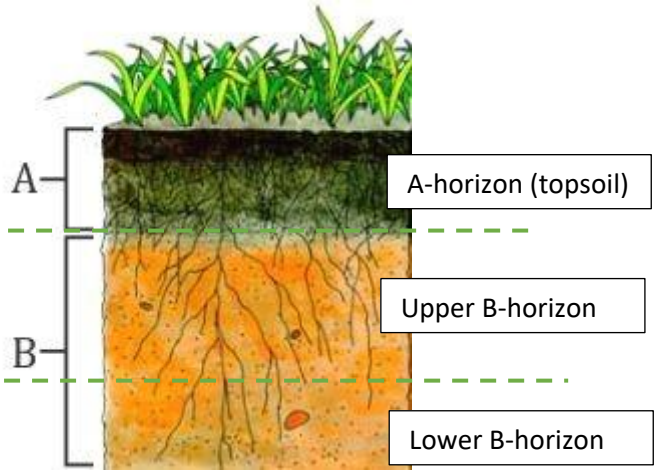

Figure 10 – Example of Pre-development depth and soil horizon reinstatement

Soil management techniques will be confirmed during detailed field investigation; however, the following is expected to be required:

A-horizon (topsoil)

- Stripped and stockpiled separately.
- Reinstated to pre-disturbance horizon.
- Apply amelioration (gypsum and potentially compost).

Upper B-horizon

- Stripped and stockpiled separately.
- Reinstated to pre-disturbance horizon.
- Apply amelioration (gypsum).

Lower B-horizon

- Stripped and stockpiled separately.
- Reinstated to pre-disturbance horizon.

- Remove surplus material, if required.

Each soil landscape has dispersive properties (sodicity, low Ca/Mg ratio, low ESI, etc.) occurring within the profile at varying depths. To reduce the risk of soil dispersion and improve soil structure, from pre-activity baseline, it is recommended that gypsum be applied to the project area in two split application rates. One on the topsoil and one under the topsoil (on top of upper B-horizon) within the excavation.

The topsoil application rate is to be based on exchangeable sodium (using below calculation) and increasing soil salinity over the ESI dispersive threshold. The subsoil application rate is to be based on sodicity within the upper B-horizon.

The following can be used to calculate a gypsum rate:

(ESP-5) *CEC*BD*depth = pure gypsum application rate (kg/ha) * EGE.

NOTES:

ESP = exchangeable sodium percentage

CEC = cation exchange capacity (meq/100g)

BD = soil bulk density

Depth = depth of soil profile to be ameliorated in cm

EGE = effective gypsum equivalent %

Where carbonate is identified and pH >9 is encountered gypsum rate is to be increased, based on carbonate equivalent measurement, to displace sodium-carbonate and form calcium-carbonate.

Once a gypsum source has been selected, lab analysis is required to understand the EGE (effective gypsum equivalent percentage).

The Haslemere (texture-contrast) landscape will likely require gypsum and the addition of compost, to overcome the risk of hard setting surface and potential hydrophobic properties of the light textured surface. This in turn will improve water holding capacity, permeability and nutrient retention.

An indicative fertilizer rate is given only, as 150 kg/ha nitrogen and phosphorus fertilizer; 18% N, 20 %P; with Zn blend. This should be discussed and amended based on advice from the land manager, as the fertilizer needs to be based on the next proposed crop. Generally, potassium is within the adequate range within the clay soil of the Darling Downs Region.

Compaction relief of subsoil once prior to reinstated is recommended to occur over the entire area impacted by heavy equipment. A bulk density < 1.5 is required to prevent restriction to root growth and aid profile leaching. A depth of at least 30 cm prior to topsoil reinstatement is required.

5.1 CONSTRUCTION REINSTATEMENT METHOD FOR RESTORATION

The key methods and techniques to prevent the degradation of the soil profile during and post construction are displayed in Table 7.

Table 7 – Construction restoration techniques

Attribute	Requirement	Example rates*
Pre-disturbance soil characteristics.	Perform soil survey prior to disturbance, as per section 4.1.	Confirm soil properties.
Topsoil stripping depth. (A-horizon)	Remove topsoil prior to excavation and stockpile in a windrow as per standard drawing ORGP01-ARW-HSM-LAY-00001-002.	Depth to be confirmed.
Upper B-horizon stripping depth.	Remove this depth post topsoil removal, stockpile separately and reinstate in order of extraction.	Depth to be confirmed.
Lower B-horizon excavation to depth for pipeline valve.	Remove this depth to desired depth of excavation. Stockpile separately and reinstate in order of extraction.	Depth to be confirmed.
Soil amendment *	Topsoil gypsum application. Provisional compost application.	To be confirmed. *Assume 5 t/ha (EGE)*
	Gypsum application over B-horizon prior to topsoil application.	To be confirmed. *Assume 5 kg/m^3 (EGE)*
	Fertilizer application mixed into topsoil. Nitrogen and phosphorus fertilizer, with Zn blend: N: 17 | P: 18.9 | S: 2.5 | ZN: 1.88 *Fertilizer type and rate are indicative only. Seek advice from the land manager about the next crop.*	150 kg/ha
Stockpiling and earthworks.	Arrow Energy have a standard layout and detail for construction of pipelines. These drawings specify standard topsoil stockpiling requirements and soil conservation techniques, in general: • Separation of topsoil, mid-horizon and lower horizon (no mixing). To be reinstated in order or extraction. • Limiting height of stockpiles to 2 m, with gradient >1:3 (v:h) • Reinstate topsoil ASAP post works. • No stockpiles in drainage lines. • Avoid excessive compaction of topsoil stockpiles. • Stabilize stockpiles appropriately prior to rainfall. • Gaps left in stockpiles. Refer to Appendix B, drawings: • ORGP01-ARW-HSM-LAY-00001-001 • ORGP01-ARW-HSM-LAY-00001-002 • ORGP01-ARW-HSM-LAY-00001-003 • ORGP01-ARW-HSM-LAY-00001-004	Validation and quality assurance to ensure adherence to specification.

Backfill of pipeline excavation	Specific controls for backfill of the pipeline trench are within document pipeline engineering specification *ORG-ARW-PPL-SPR-00005_3.0_1_publication_SPECs_PE Gathering Network*, with the following specific inclusions: • Backfill pipeline in order of soil horizon extraction.	Validation and quality assurance to ensure adherence to specification.
Surplus backfill material (surplus fill)	Remove excess material from site, if required.	Removal of material from site.
Relieve compaction	Ripping compacted subsoil to a minimum depth of 30 cm to pre-development bulk density. Only ripping when soil is at or similar to air dry moisture content (dry and cannot mold). Ripping works shall shatter soil.	Bulk density < 1.5
Reinstate topsoil to predevelopment level	Reinstating topsoil to predevelopment level, by re-spreading all stockpiled windrows.	No ponding and topsoil reinstated.
Validation soil testing as per section 5.4.	Soil testing and quality assurance specifically to ensure conditions can be met for a return to the agricultural productivity pre-disturbance, refer to section 5.4.	Validation report prepared by suitably qualified person as per section 5.4, confirming restoration to pre-disturbance conditions.

**Assumed rates and measurements have been specified only. Actual rates will be determined once soil survey has been completed.*

5.2 DECOMMISSIONING REINSTATEMENT METHODS FOR RESTORATION

At present, Arrow Energy is expected to operate this pipeline asset for approximately 10 to 15 years. During this time, an above ground valve pit riser is required to operate the pipeline valve. When operations are complete pipeline abandonment will comply with requirements of *Code of Environmental Practice: Onshore Pipelines, Australian Standard 2885,* which require above ground assets to be removed. Further restoration requirements within Table 8.

Table 8 – Final decommissioning (post operations) restoration techniques

Attribute	Requirement	Example rates*
Removal of imported material and surface pipework.	Post operation, removal of all imported material such as gravel, above ground valve and riser pipes.	Removal of gravel and riser pipe work.
Topsoil stripping depth. (A-horizon)	Remove topsoil prior to excavation and stockpile in a windrow as per standard drawing ORGP01-ARW-HSM-LAY-00001-002.	Depth to be confirmed.
Upper B-horizon stripping depth	Remove this depth post topsoil removal and reinstate in order of extraction.	Depth to be confirmed.
Lower B-horizon excavation to depth for pipeline valve.	Remove this depth to desired depth of excavation. Stockpile separately and reinstate in order of extraction.	Depth to be confirmed. *To excavation extent.*
Soil amendment *	Topsoil gypsum application. Provisional compost application.	To be confirmed. *Assume 5 t/ha (EGE)*

	Gypsum application over B-horizon prior to topsoil application.	To be confirmed. *Assume 5 kg/m^3 (EGE)*
	Fertilizer application mixed into topsoil. Nitrogen and phosphorus fertilizer, with Zn blend: N: 17 | P: 18.9 | S: 2.5 | ZN: 1.88 *Fertilizer type and rate are indicative only. Seek advice from the land manager for the next crop.*	150 kg/ha
Stockpiling and earthworks	Arrow Energy have a standard layout and detail for construction of pipelines. These drawings specify standard topsoil stockpiling requirements and soil conservation techniques, in general; • Separation of topsoil, mid-horizon and lower horizon (no mixing). To be reinstated in order or extraction. • Limiting height of stockpiles to 2 m, with gradient >1:3 (v:h) • Reinstate topsoil ASAP post works. • No stockpiles in drainage lines. • Avoid excessive compaction of topsoil stockpiles. • Stabilize stockpiles appropriately prior to rainfall. • Gaps left in stockpiles. Refer to Appendix B, drawings: • ORGP01-ARW-HSM-LAY-00001-001 • ORGP01-ARW-HSM-LAY-00001-002 • ORGP01-ARW-HSM-LAY-00001-003 • ORGP01-ARW-HSM-LAY-00001-004	Validation and quality assurance to ensure adherence to specification.
Backfill of pipeline excavation	Specific controls for backfill of the pipeline trench are within document pipeline engineering specification *ORG-ARW-PPL-SPR-00005_3.0_1_publication_SPECs_PE Gathering Network*, with the following specific inclusions: • Backfill pipeline in order of soil horizon extraction.	Validation and quality assurance to ensure adherence to specification.
Surplus backfill material (surplus fill)	Remove excess material from site, if required.	Removal of material from site.
Relieve compaction	Ripping compacted subsoil to a minimum depth of 30 cm to pre-development bulk density. Only ripping when soil is at or similar to air dry moisture content (dry and cannot mold). Ripping works shall shatter soil.	Bulk density < 1.5
Reinstate topsoil to predevelopment level	Reinstating topsoil to predevelopment level, by re-spreading all stockpiled windrows.	No ponding and topsoil reinstated.

Validation soil testing as per section 5.4.	Soil testing and quality assurance specifically to ensure conditions can be met for a return to the agricultural productivity pre-disturbance, refer to section 5.4.	Validation report prepared by suitably qualified person as per section 5.4, confirming restoration to pre-disturbance conditions.

**Assumed rates and measurements have been specified only. Actual rates will be determined once soil survey has been completed.*

5.3 PERFORMANCE CRITERIA

The restoration performance criteria are displayed in Table 9 measure restoration success (to pre-development conditions).

Table 9 - Restoration performance criteria

Aspect	Criteria
Land use altered	• Land has not been altered and can still sustain dryland intense cropping for; cotton, wheat, barley, chickpeas, mung beans etc. • No yield reduction.
Topsoil reinstated	• Seed strike zone reinstated not impacting on future crop strikes that are suited to soil landscape. • No evidence of subsoil on surface.
Timeline for restoration post construction.	• Pipelines - as soon as reasonably practicable post pipeline trench backfilling.
Timeline for final decommissioning of pipeline above ground assets.	• Pipelines – as soon as soon as reasonably practicable post operations.
Predevelopment depth reinstated	• Root zone reinstated not impacting on water holding capacity
Bulk density reinstated	• Bulk density < 1.5.
A-horizon (topsoil) measurements: • pH • Electrical conductivity • Chloride • ESP • Texture • Colour	Specific performance criteria to be set post pre-disturbance soil characterization.
Upper B-horizon measurements: • pH • Electrical conductivity • Chloride • ESP • Texture • Colour	Specific performance criteria to be set post pre-disturbance soil characterization
Lower B-horizon measurements: • pH • Electrical conductivity • Chloride • ESP • Texture • Colour	Specific performance criteria to be set post pre-disturbance soil characterization.

No rockiness	• No rock > background.
Terrain reinstated	• No ponding or diverting water. • No permanent drainage structures causing erosion offsite. • Overland flow as per predevelopment.

5.4 VALIDATION AND QUALITY ASSURANCE OF PERFORMANCE CRITERIA

The project manager is responsible for project implementation and quality assurance. Project responsibilities may be delegated through the project, however ultimate responsibility lies with the project manager / budget holder. The project manager shall be responsible for:

Site Inspections

- Visual daily inspections during construction
- Post rainfall inspection during construction
- Weekly inspections during construction
- Client (Arrow Energy) inspection

Assurance and Monitoring

The following requirements are recommended to be undertaken to assure performance criteria. An assurance plan should identify:

- Construction activity being monitored
- Method of inspection or testing standard
- Frequency or timing of inspection
- Performance criteria
- Required documentation
- Corrective actions management

Table 10 provides overview of data capture requirements to assure soil management techniques comply with performance criteria. This data is required for the validation report, which specifically addresses and confirms the performance criteria have been achieved.

Table 10 - Assurance requirements for reinstatement

Activity	Confirmation	Requirement
Topsoil management (A-horizon).	• Depth removed and replaced.	• Confirmation of depth. • 2 soil samples for 0.3 ha, with photo. • Samples analyzed for field parameters by suitably qualified person for; $pH_{1:5}$, $EC_{1:5}$, field texture, colour, exchangeable cations, ESP, SARe and chloride, or as required by suitably qualified person. NOTE: $EC_{1:5}$ will be elevated post gypsum application. Gypsum solution saturation is 2.2 dS/m. Gypsum portion of $EC_{1:5}$ needs to be explained if samples contain applied gypsum
Backfill operations for Upper B-horizon.	• Depth removed and replaced.	• Confirmation of depth. • 2 soil samples for 0.3 ha, with photo. • Samples analyzed for field parameters by suitably qualified person for; $pH_{1:5}$, $EC_{1:5}$, field texture, colour, exchangeable cations, ESP, SARe and chloride, or as required by suitably qualified person. NOTE: $EC_{1:5}$ will be elevated post gypsum application. Gypsum solution saturation is 2.2 dS/m. Gypsum portion of $EC_{1:5}$ needs to be explained if samples contain applied gypsum.

Backfill operations for Lower B-horizon.	• Depth removed and replaced.	• Confirmation of depth. • 2 soil samples for 0.3 ha, with photo. • Samples analyzed for field parameters by suitably qualified person for; $pH_{1:5}$, $EC_{1:5}$, field texture, colour, exchangeable cations, ESP, SARe and chloride, or as required by suitably qualified person.
Compaction relief.	• Ripping soil layers.	• Photo monitoring and visual inspection.
Soil amelioration.	• Rates applied and locations.	• Photo monitoring, delivery dockets and locations.
Terrain reinstated.	• Landform reinstated to predevelopment	• As-build survey of surface conditions.

NOTE: *the method to determine sufficient soil sample validation is derived from Table 1, within Soil Science Australia, Guideline for Soil Survey along Linear Infrastructure, 2015. This intensity is representative of The Department of Resources Queensland Soil and Land Resource Survey Information Guideline, Table 1 – Site density for different survey scales. It aligns with a 1:5,000 mapping scale.*

Validation Report

It is recommended a validation report is prepared by a suitably qualified person to summarise the quality assurance data captured during the project. This report will satisfy any future query regarding construction process and methods utilised to achieve the performance criteria.

The report is recommended to contain:

- Summary of key dates and milestones.
- Summary of the soil management method.
- Evidence of as per Table 10 - Assurance requirements for reinstatementTable 10.
- Analysis of quality assurance data collated, soil samples, soil test results and photos.
- Statement addressing performance criteria.
- Summary of monitoring post reinstatement.

6 STANDARD

Table 11 recommends measuring and monitoring standards for the restoration management plan.

Table 11 – Standards for measuring and monitoring success of reinstatement

Aspect	Requirement
Suitably qualified person (SQP).	All plans shall be developed by an SQP. A CPSS, RSP or CPESC (CPESC will need to display experience in soil chemistry and morphology) is an example of a suitably qualified person. As a minimum, SQP shall have 5 years of experience in soil chemistry, soil morphology, and soil survey with particular focus in land restoration.
Soil sampling.	All soil sampling shall be overseen by an SQP.
Soil testing (field testing).	All field testing shall be conducted by an SQP.
Soil testing laboratory.	Laboratories engaged to perform soil testing shall be NATA and ASPAC certified.
Gypsum.	• Calcium sulphate $CaSO_4\,2H_2O$.

	• Test supplied for gypsum purity
	• Weed seed free and documented evidence of compliance with *Queensland Biosecurity Act 2014*.
	• Moisture content < 15%, air dried at 40°C
	• If manufactured
	  ○ < 0.001% cadmium, and
	  ○ < 0.01% lead, and
	  ○ < 0.0005% mercury.
	
	The application rate shall be adjusted based on effective gypsum equivalent (EGE) calculation;
	
	(PF % x FF %)/100 = EGE%
	
	EGE x 1 ton = application rate for gypsum source per ton
	
	Purity factor (PF);
	Lab analysis of calcium and sulphate (CaSO42H2O) content and any neutralizing potential. The lab analysis will provide a purity percentage.
	Fineness factor (FF), is the percentage passing through a sieve, based on the following;
	• 0% if > 6mm
	• 75% if < 6mm but > 3mm
	• 100% if < 3mm
	
	<u>Example equation</u>
	PF = 90%
	FF = 80%
	
	(0.8 x 0.9)/100 = 72% EGE
	
	Calculated rate to displace excess sodium off exchange site is 10 ton per ha.
	
	10 / 0.72 = 13.8 t/ha EGE actual application rate.

Compost.	Composted to Australian Standard AS4454-2012, and free from all contaminants of concern (low ash content, no PFAS or other by-products that maybe accepted by compost facility). Weed seed free and documented evidence of compliance with *Queensland Biosecurity Act 2014*.
Fertilizer.	N: 17 | P: 18.9 | S: 2.5 | ZN: 1.88 or approved equivalent as specified by land manager.

7 COST OF REINSTATEMENT METHOD

Table 12 provides an overview of cost for specified reinstatement methods and techniques. Some methods are just displayed and not costed, as these for part of general construction method. Costs associated *Arrow Energy Specification for PE Gathering Networks (Gas and Water)*, are included but not costed, as these techniques form part of general construction technique, called 'construction works' in table.

Table 12 – Cost of restoration methods

Activity	Price assumptions	Cost
Pre-disturbance soil survey.	Assume 1 day onsite. 2 sample points (with 5 samples each) to lab. Collation of data and reporting.	$26,750
Topsoil removal.	Construction works*	NA
Soil erosion control	Construction works*	NA
Quality assurance and soil testing for backfill.	Extra works. 3 x soil samples, collection and testing. 1 x technician required to collect these samples, assume 3 days work at $1500 per day (this task can be performed by personnel already onsite).	$4,500
Provisional sum for extra stockpiling (excavation in layers).	Provisional sum (extra machine time for stockpile separation and handling) A large portion of this excavation is 'construction works'*	$10,000
Compaction relief.	Construction works*	NA
Removal of displaced trench soil.	The quantity is unknown. Provision sum.	$10, 000
Application of ameliorants Total disturbance estimated at 0.3 ha. *1.5 tons gypsum (pure gypsum) required for topsoil. * 1.5 tons gypsum (pure gypsum) for subsoil. Increase gypsum by 30% for EGE = 4 tons (approximately). Compost rate based on 6 ton provision.	Gypsum material cost $400/ton landed onsite (high rate for small volume), plus 2 days spreading at 2000 per day = $4,000 Gypsum material 4 x 400 = $ 2,400 Plus loading = $1,000	$7,400
	Compost material cost $400/ ton, plus (high rate for small volume), 1 days spreading at 2000 per day. 6 t x 400 = $2,400 1 x 2000 = $2, 000	$4,400
	Fertilizer material cost (small quantity). Total fertilizer required 50 kg = $200 Plus 1 days spreading at 2000 per day.	$2,200

Topsoil reinstatement.	Construction works*	NA
Removal of imported materials.	Construction works*	NA
Removal of surface facilities.	Construction works*	NA
Validation report.	1 technician required to perform a project quality assurance report. $1500 per day for 3 days and lab cost.	$32,000
Total cost estimate of site-specific reinstatement method.		$97,250

**Construction works – defines works that are already priced within project budget, under existing construction specification.*

8 CONCLUDING STATEMENT

Proven practical reinstatement methods exist to achieve the restoration performance criteria. These methods consist of identifying soil horizons, laboratory testing of the soil samples, excavating soil horizons separately and reinstating in order of extraction. Application of soil amelioration (gypsum, fertilizer and compost) will improve the soil structure and fertility above that of pre-development. Finally, post restoration soil testing to confirm suitable conditions exist for a return to the previous productive agricultural land use.

These methods combined with robust quality assurance techniques and method validation will assure the land is reinstated to pre-disturbance or better, therefore not impacting future agricultural land use.

7 REFERENCES

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APPENDIX A – GENERAL PIPELINE ARRANGEMENT DRAWING

EROSION AND SEDIMENTATION CONTROL

GENERAL

1. THIS GENERIC EROSION AND SEDIMENT CONTROL PLAN HAS BEEN PREPARED IN ACCORDANCE WITH THE INTERNATIONAL EROSION CONTROL ASSOCIATION (IECA)'S BEST PRACTICE EROSION AND SEDIMENT CONTROL GENERAL GUIDELINES (2009) AND APPENDIX P - PIPELINE CONSTRUCTION (2015).
2. THIS PLAN IS TO BE READ IN CONJUNCTION WITH LAND DISTURBANCE GUIDELINE (ORG-ARW-HSM-GUI-00094) AND ANY OTHER PLANS OR WRITTEN INSTRUCTION THAT MAY BE ISSUED BY ARROW ENERGY RELATING TO LINEAR INFRASTRUCTURE AT THE SUBJECT SITE.
3. SOIL AND EROSION CONTROL MEASURES ARE INDICATIVE ONLY AND APPLICABLE WITHIN IDENTIFIED LIMITATIONS, REFER LIMITATIONS SECTION. THE APPOINTED CONTRACTOR IS TO REVIEW AND ASSESS THE SUITABILITY OF THE MEASURES INDICATED ON THE DRAWINGS AND DEVELOP TO SUIT ITS CONSTRUCTION PROGRAM AND METHODOLOGY. THE CONTRACTOR IS TO ENSURE RUNOFF FROM ALL AREAS WHERE THE NATURAL SURFACE IS DISTURBED BY CONSTRUCTION, INCLUDING ACCESS ROADS, PLATFORMS AND STOCKPILE SITES, SHALL BE TREATED BY SUITABLE EROSION AND SEDIMENT CONTROL MEASURES BEFORE IT IS EITHER DISCHARGED TO STABLE AREAS OR DIRECTED TO NATURAL WATERCOURSES.
4. AN ON-SITE MEETING IS TO BE HELD WITH THE CONTRACTOR AND THE SUPERINTENDENT PRIOR TO ANY SITE WORKS COMMENCING. ALL ENVIRONMENTAL ASPECTS OF THE PROJECT WILL BE DISCUSSED, INCLUDING STAGING OF CONSTRUCTION WORKS, STOCKPILE SITES, AND PROPOSED VEHICULAR AND PLANT ACCESS.
5. BEFORE EARTHWORKS BEGIN IN AN AREA, ALL CONTROL WORK, INCLUDING DIVERSION BANKS AND BERMS, SHOULD BE COMPLETED AND FUNCTIONAL FOR THE DISTURBED AREA WHERE PRACTICAL.
6. THE ENTIRE DISTURBED AREA (INCLUDING TOPSOIL/MULCH BERMS AND DIVERSION BUNDS) ARE TO BE MACHINE COMPACTED AND STABILISED WITH AN EROSION CONTROL PRODUCT (e.g. VITAL BON-MATT HR OR SIMILAR APPROVED PRODUCT) WITH A DEMONSTRATED COVER FACTOR OF 90% OF MORE WITHIN 10 DAYS OF DISTURBANCE. PRODUCT IS TO BE PREPARED AND APPLIED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND MUST BE RE-APPLIED AS REQUIRED.
7. IF ON-SITE WORK IS SUSPENDED FOR GREATER THAN 10 DAYS, THEN DISTURBED AREAS MUST BE COVERED IN ACCORDANCE WITH GENERAL NOTE 6.
8. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING AND PROVIDING ONGOING ADJUSTMENT TO EROSION CONTROL MEASURES TO SUIT THE CONTRACTOR'S PROGRAM OF WORKS, AS REQUIRED DURING CONSTRUCTION.

SITE ACCESS AND CLEARING

1. ALL VEHICLES ARE TO BE PARKED WITHIN THE RIGHT OF WAY ONLY, UNLESS ALTERNATIVE PARKING AREA IS APPROVED IN THE AAP AND ESTABLISHED READY FOR USE.
2. AS MUCH AS POSSIBLE, EXISTING VEGETATION COVER (INCLUDING GRASS) IS TO BE LEFT INTACT.
3. MINIMAL SOIL DISTURBANCE TO OCCUR DURING VEGETATION CLEARING.
4. CLEARING AND STRIPPING SHALL NOT OCCUR MORE THAN 4 WEEKS PRIOR TO COMMENCING TRENCH EXCAVATIONS, UNLESS THE ENTIRE SITE IS SPRAYED WITH AN EROSION CONTROL PRODUCT SUCH AS VITAL BON-MATT HR (OR SIMILAR APPROVED PRODUCT) WITH A DEMONSTRATED COVER FACTOR OF 90% OR MORE FOLLOWING SITE PREPARATION.
5. AT TRACK ENTRY POINT, INSTALL EARTHEN BUND/HUMP TO DIVERT CLEAN WATER AWAY (FOR UPSLOPE ENTRY POINT) OR DIVERT DIRTY WATER TO SEDIMENT CONTROL (FOR DOWNSLOPE ENTRY POINT).
6. ALL DISTURBANCE, INCLUDING SOIL STRIPPING, VEGETATION CLEARING, BUNDS, STOCKPILES AND OTHER CONTROLS ARE TO BE LOCATED WITHIN THE APPROVED BOUNDARIES DEFINED IN THE AAP.

SOIL/MULCH MANAGEMENT (INCLUDING DUST SUPPRESSION)

1. WINDROWS ARE TO BE SEPARATED INTO SOIL AND USE TYPES, E.G. TOPSOILS ARE NOT TO BE MIXED WITH SUBSOILS.
2. IF DISPERSIVE SOILS ARE ENCOUNTERED, THEY MUST BE STABILISED IN ACCORDANCE WITH THE REQUIREMENTS OF THE REHABILITATION PLAN AND AAP.
3. TOPSOIL STOCKPILES ARE TO BE NO MORE THAN 2.0m HIGH (SHAPED & LIGHTLY COMPACTED TO REDUCE RUNOFF).
4. STOCKPILES ARE TO BE PROVIDED WITH PROTECTIVE GROUND COVER USING A SPRAY-ON EROSION CONTROL PRODUCT (APPLIED IN ACCORDANCE WITH GENERAL NOTE 6). IF A STORM OR RAIN EVENT IS IMMINENT, STOCKPILES ARE TO BE COVERED WITH IMMEDIATE EFFECT.
5. STOCKPILES ARE TO BE LOCATED FURTHER THAN 100m FROM TOP OF WATERWAY EMBANKMENTS WHERE PRACTICAL.
6. AVOID EXCESSIVE SOIL COMPACTION, WHICH CAN DESTROY SOIL STRUCTURE AND IMPACT REHABILITATION.
7. KEEP SOIL SURFACES MOIST (NOT WET) TO MANAGE DUST.
8. DIVERSION BUNDS ARE TO BE CONSTRUCTED FROM TOPSOIL, NOT SUBSOILS.
9. MULCH MUST BE GREEN WASTE WON FROM ON-SITE CLEARING AND GRUBBING
10. MULCH MUST BE GENERATED THROUGH EITHER HORIZONTAL OR TUB GRINDING
11. GRADE 3 MULCH IS RECOMMENDED, THAT BEING, MULCH CONTAINING 90% BY MASS OF MATERIAL WITH A MAXIMUM SIZE OF 150mm.

RAINFALL PREPARATION

1. VIEW SITE SPECIFIC WEATHER FORECASTS FOR UPCOMING WEEK AND ENSURE ALL ESC (EROSION AND SEDIMENT CONTROL) MEASURES ARE OPERATIONAL IF THERE IS GREATER THAN 50% CHANCE OF RAINFALL GREATER THAN 10mm.
2. UNFINISHED EARTHWORKS AND UNCOVERED STOCKPILES ARE TO BE COVERED AND/OR PROTECTED WITH EROSION CONTROL PRODUCT WITH IMMEDIATE EFFECT IF GREATER THAN 50% CHANCE OF RAINFALL OVER 10mm.
3. INSPECT THE WHOLE SITE AND IDENTIFY AREAS OF EXPOSED SOIL WHERE EROSION MIGHT OCCUR. CONSIDER TREATING WITH SOIL BINDER OR COVERING AREAS (E.G. WITH GEOFABRIC/BUILDER'S PLASTIC).

SEDIMENT CONTROLS

1. THE REQUIRED SEDIMENT CONTROL LEVEL IS 3 (REFER SECTION 4.5.1, BOOK 1, IECA (2009))
2. THE SELECTED SEDIMENT CONTROL(S) ARE: MULCH BERM OR FIBRE ROLL; OR TOPSOIL BERM.
3. THESE CONTROLS ARE TO BE PROPERLY INSTALLED AROUND THE LOWER EDGE OF THE DISTURBED AREA. THE LOCATIONS OF SEDIMENT CONTROLS SHOWN IN THIS ESCP ARE INDICATIVE ONLY.
4. REFER TO BEST PRACTICE EROSION & SEDIMENT CONTROL (IECA, 2008 OR LATEST EDITION AND UPDATES) FOR TYPICAL DETAIL FOR INSTALLING SEDIMENT CONTROLS.
5. FIBRE ROLLS (FR) SHALL BE RECESSED AND APPROPRIATELY ANCHORED TO THE SOIL SURFACE TO REDUCE RISK OF UNDER-MINING.
6. FIBRE ROLLS MUST OVERLAP AT LEAST 450mm, NOT ABUTTED, AND THE OUTER ENDS ARE TURNED UPSLOPE TO ALLOW WATER VELOCITY TO SLOW AND MINIMISE FLOW BYPASSING.
7. FLOW DIVERSION BERMS SHOULD BE POSITIONED ALONG THE CONTOUR AT 1% FALL (WHERE POSSIBLE) TO MAINTAIN FREE DRAINAGE.
8. MULCH BERMS MUST COMPLY WITH THE REQUIREMENTS IN AS4454.

TRENCH MANAGEMENT

1. DIVERT STORMWATER FROM EXCAVATIONS USING FLOW DIVERSION BERMS ON THE UPHILL SIDE OF EXCAVATION.
2. FOR TRENCHES WITH A GRADE RUNNING PERPENDICULAR TO THE SURFACE CONTOURS, TRENCH STOPS SHOULD BE INSTALLED EVERY 50m FOR FLAT TRENCHES OR 15m FOR TRENCHES WITH A GRADE TO LIMIT FLOW LENGTH AND VELOCITY. THIS CAN BE ACHIEVED THROUGH SANDBAGS RUNNING PERPENDICULAR TO THE DIRECTION OF THE TRENCH.
3. EXCAVATIONS SHOULD BE DEWATERED BY PUMPING STORMWATER UPSLOPE OF THE NEAREST DIRTY WATER CONVEYANCE BERM (TOPSOIL OR MULCH) WHICH SHOULD DIRECT THIS WATER TO THE NEAREST SEDIMENT TRAP.

WATER QUALITY RELEASE LIMITS

1. REFER TO ENVIRONMENT ADVISOR WATER QUALITY RELEASE LIMITS FROM CONSTRUCTION AND MAINTENANCE OF LINEAR INFRASTRUCTURE. IN THE ABSENCE OF ENVIRONMENT ADVISOR RELEASE LIMITS, THE FOLLOWING RELEASE LIMITS SHOULD BE ADOPTED FOR RELEASES TO WATERS:
   - MAXIMUM 55 NEPHELOMETRIC TURBIDITY UNITS (NTU) FOR BACKGROUND VALUES OF BELOW 45 NTU OR FOR BACKGROUND VALUES ABOVE 45 NTU. USE A MAXIMMUM OF BACKGROUND PLUS 25%. TURBIDITY IS TO BE MEASURED WITHIN A 50m RADIUS OF THE CONSTRUCTION OR MAINTENANCE WITHIN A WETLAND OF OTHER ENVIRONMENTAL VALUE.
   - NO VISIBLE OIL OR GREASE
   - PH BETWEEN 6.5 AND 9
2. IF WATER DISCHARGING FROM SEDIMENT TRAPS DO NOT ACHIEVE THE DESIRED WATER QUALITY TARGETS APPROPRIATE FLOCCULATION MAY BE REQUIRED.
3. DEWATERING ACTIVITIES SHALL DIRECT WATER THROUGH OPERATIONAL DIRTY WATER CONTROLS WHERE POSSIBLE. ALTERNATIVE DEWATERING TO LAND LOCATIONS SHALL BE IN ACCORDANCE WITH APPROVED CONTRACTOR DOCUMENTS.

SITE MANAGEMENT AND MAINTENANCE

1. ENSURE SETTLEMENT TANKS, SKIPS OR PITS MAINTAIN A FREEBOARD OF AT LEAST 300mm AT ALL TIMES. ANY DIRTY SURFACE WATER RETAINED ON SITE IS TO BE TESTED (AND TREATED IF REQUIRED) AND MUST MEET DISCHARGE QUALITY LIMITS BEFORE BEING RELEASED TO GROUND. HOWEVER, IT IS PREFERABLE TO REUSE WATER ON SITE (E.G. FOR DUST SUPPRESSION).

OTHER CONSIDERATIONS

1. THE CONTRACTOR MUST BE AWARE OF ALL RELEVANT CONDITIONS, WHETHER KNOWN OR LATENT, REGARDING: HEALTH AND SAFETY; ENVIRONMENTAL (FLORA, FAUNA, NOISE, DUST, VIBRATION, ETC.); CULTURAL (INDIGENOUS AND NON-INDIGENOUS); NATIVE TITLE; CONTAMINATION/CONTAMINATED LAND AND/OR ACID SULFATE SOILS.
2. IF THE CONTRACTOR ENCOUNTERS ANY CONDITIONS THAT ARE NOT IDENTIFIED IN THE AAP, NOT EXPECTED, SEEM OUT OF THE ORDINARY OR ARE OF ANY CONCERN, THE CONTRACTOR SHALL STOP WORK AND CONSULT WITH THE APPROPRIATE PROFESSIONALS/REPRESENTATIVES TO RESOLVE THE CONCERN ABOUT THE REAL OR PERCEIVED CONDITIONS SO THAT WORK CAN RESUME SAFELY IN ALL ASPECTS.

LIMITATIONS

1. THIS EROSION AND SEDIMENT CONTROL PLAN IS SUITABLE FOR SLOPE GRADES OF UP TO 5% WITH NO NATURAL WATER COURSE CROSSINGS. FOR SITES OUTSIDE OF THESE PARAMETERS ALTERNATIVE EROSION AND SEDIMENT CONTROLS ARE REQUIRED IN CONSULTATION WITH THE ENVIRONMENTAL ADVISOR.
2. RUSLE CALCULATIONS MUST BE PERFORMED FOR EACH SITE TO CHECK THAT THE SITE -SPECIFIC SOIL LOSS ESTIMATE IS 48 t/ha/year OR LESS. IF SOIL LOSS ESTIMATE IS GREATER THAN 48 t/ha/year, RE-ASESSMENT OF PLAN SUITABILITY AND APPROPRIATE REVISIONS TO ESC MEASURES WILL BE REQUIRED FOR THAT PARTICULAR SITE. REFER TO TABLE 1 FOR CALCULATION PARAMETERS.

TABLE 1 - RUSLE CALCULATION PARAMATERS

PARAMATER	SURAT BASIN	BOWEN BASIN	COMMENTS
RAINFALL EROSIVITY FACTOR (R) (YEARLY)	2012	2495	CALCULATED USING RAINFALL AT DALBY AND MORANBAH LOCATIONS.
SOIL ERODIBILITY FACTOR (K)	0.066	0.066	TABLE E5 IECA - INORGANIC SILTS, FINE SANDS OR SILTY SOILS, ELASTIC SILTS.
SLOPE-LENGTH FACTOR (LS)	1.010	1.010	TABLE E3 IECA - 5% SLOPE GRADIENT WITH A 60m SLOPE LENGTH. SLOPE LENGTH BASED ON CONTOURS AT 45 DEGREES RELATIVE TO A 40m ROW.
COVER FACTOR (C)	0.220	0.220	TABLE E9 IECA - ASSUMED NEWLY ESTABLISHED GRASS WITH 40% GROUND COVER.
PRACTICES/METHOD FACTOR (P)	1.300	1.300	TABLE 11 IECA - COMPACTED AND SMOOTH (DEFAULT CONSTRUCTION PHASE CONDITION).
SOIL LOSS (t/ha/year)	38	47.600	BOWEN BASIN SITE IS WORST CASE DUE TO HIGHER RAINFALL INTENSITIES.

REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	ORIG	CHK	QA	APP
		0	26.11.21	ISSUED FOR CONSTRUCTION	AR	KP	MH	RB
ORG-ARW-HSM-GUI-000094	LAND DISTURBANCE GUIDELINE	A	12.10.21	ISSUED FOR CLIENT REVIEW	AR	KP	MH	RB

RPEQ CERTIFICATION
Signature
Name: MARK F. HARGRODER
RPEQ No.: 094.16
Date: 26.11.21

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

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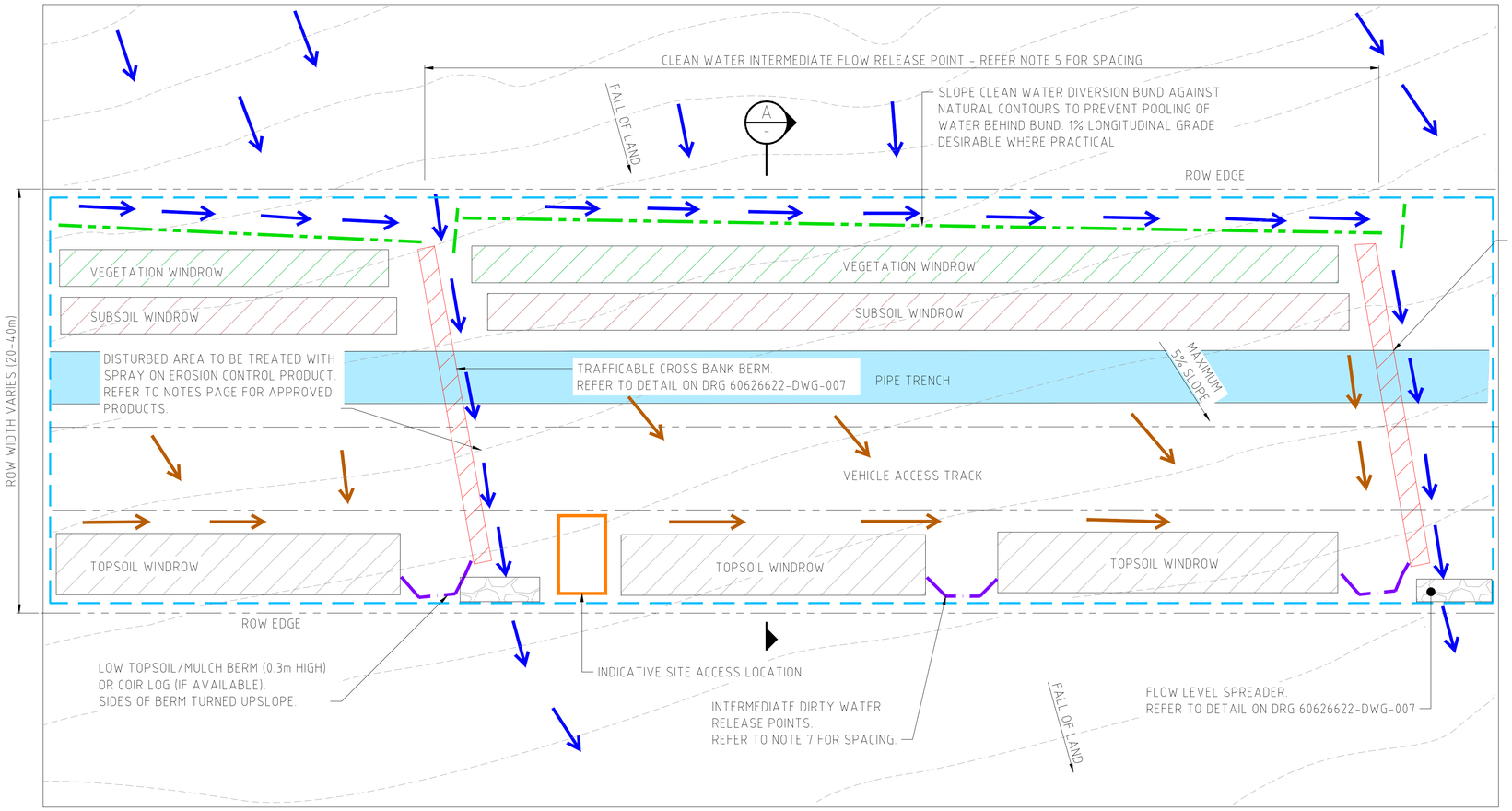
SITE	PLANT	PROJECT CODE
ORG	P01	A201

SECURITY CLASSIFICATION: RESTRICTED

ARROW ENERGY
GATHERING AND PIPELINE NETWORKS
EROSION AND SEDIMENT CONTROL GENERAL NOTES
LAYOUT SHEET 1

STATUS	CONTRACTOR DRAWING NUMBER	ARROW ENERGY DRAWING NUMBER	SCALE	REV	SIZE
IFC	60626622-DWG-004	ORGP01-ARW-HSM-LAY-00001-001	NTS	0	A1



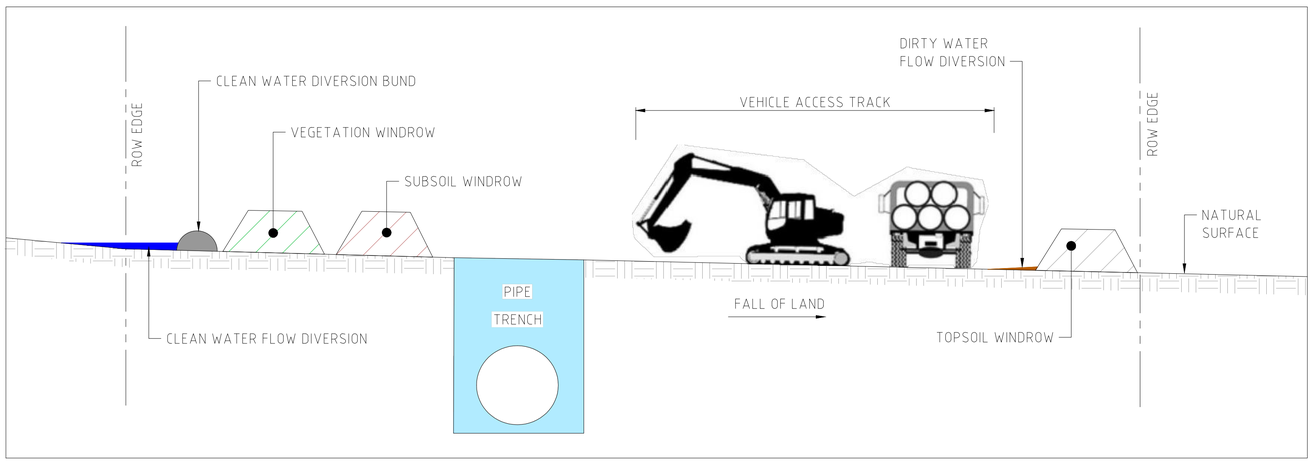
PLAN A - EROSION AND SEDIMENT CONTROL PLAN - TRENCH UPSLOPE OF ACCESS TRACK

LEGEND

- DISTURBANCE AREA
- DIVERSION BUND (DB)
- TOPSOIL/MULCH BERM/COIR LOG
- RIGHT OF WAY (ROAD) EDGE
- STABILISED SITE ACCESS
- CLEAN WATER FLOW ARROW
- DIRTY WATER FLOW ARROW
- WATER COURSE
- FLOW LEVEL SPREADER
- TRAFFICABLE CROSS BANK BERM
- TOPSOIL WINDROW
- SUBSOIL WINDROW
- VEGETATION WINDROW
- ACCESS TRACK
- INDICATIVE SITE CONTOURS

NOTES

1. EROSION CONTROL LAYOUT SHOWN ON PLAN IS BASED ON EXISTING SURFACE AND PROPOSED PAD FALL DIRECTIONS. CONTRACTOR TO APPLY EROSION CONTROL TREATMENTS TO SUIT INDIVIDUAL SITE CONDITIONS.
2. FOR EROSION AND SEDIMENT CONTROL NOTES REFER DRG 60626622-DWG-004.
3. FOR TYPICAL DETAILS REFER DRG 60626622-DWG-007.
4. FOR EROSION AND SEDIMENT CONTROL PLAN FOR VEHICLE ACCESS TRACK ON UPSLOPE SIDE OF PIPE TRENCH REFER DRG 60626622-DWG-006.
5. SPACING OF THE CLEAN WATER INTERMEDIATE FLOW RELEASE POINTS TO BE DETERMINED BASED ON THE PEAK FLOW FROM THE UPSTREAM CATCHMENT IN THE 1 IN 2-YEAR AVERAGE RECURRENCE INTERVAL (ARI) STORM EVENT.
6. EXCAVATION OF TRENCHES TO BE STAGED TO ENSURE THAT THERE REMAINS A SUFFICIENTLY WIDE SECTION OF UNOPENED TRENCH ON THE SURFACE TO DIVERT CLEAN WATER THROUGH THE RIGHT OF WAY.
7. INTERMEDIATE DIRTY WATER RELEASE POINTS ARE TO BE PROVIDED FOR EVERY 2500m^2 OF DISTURBED AREA UPSLOPE.
8. THIS EROSION AND SEDIMENT CONTROL PLAN IS SUITABLE FOR SLOPE GRADES UP TO 5% WITH NO NATURAL WATER COURSES AND A SOIL LOSS OF LESS THAN 48 t/ha/year.



TYPICAL ROW WITH TRENCH UPSLOPE OF ACCESS TRACK

SECTION A

REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	ORIG	CHK	QA	APP
60626622-DWG-007	TYPICAL DETAILS				AR	KP	MH	RB
60626622-DWG-006	LAYOUT PLAN - TRENCH DOWNSLOPE OF ACCESS TRACK	0	26.11.21	ISSUED FOR CONSTRUCTION	AR	KP	MH	RB
60626622-DWG-004	GENERAL NOTES	A	12.10.21	ISSUED FOR CLIENT REVIEW	AR	KP	MH	RB

RPEQ CERTIFICATION
Signature
Name: MARK F. HARGRODER
RPEQ No.: 09416
Date: 26.11.21

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

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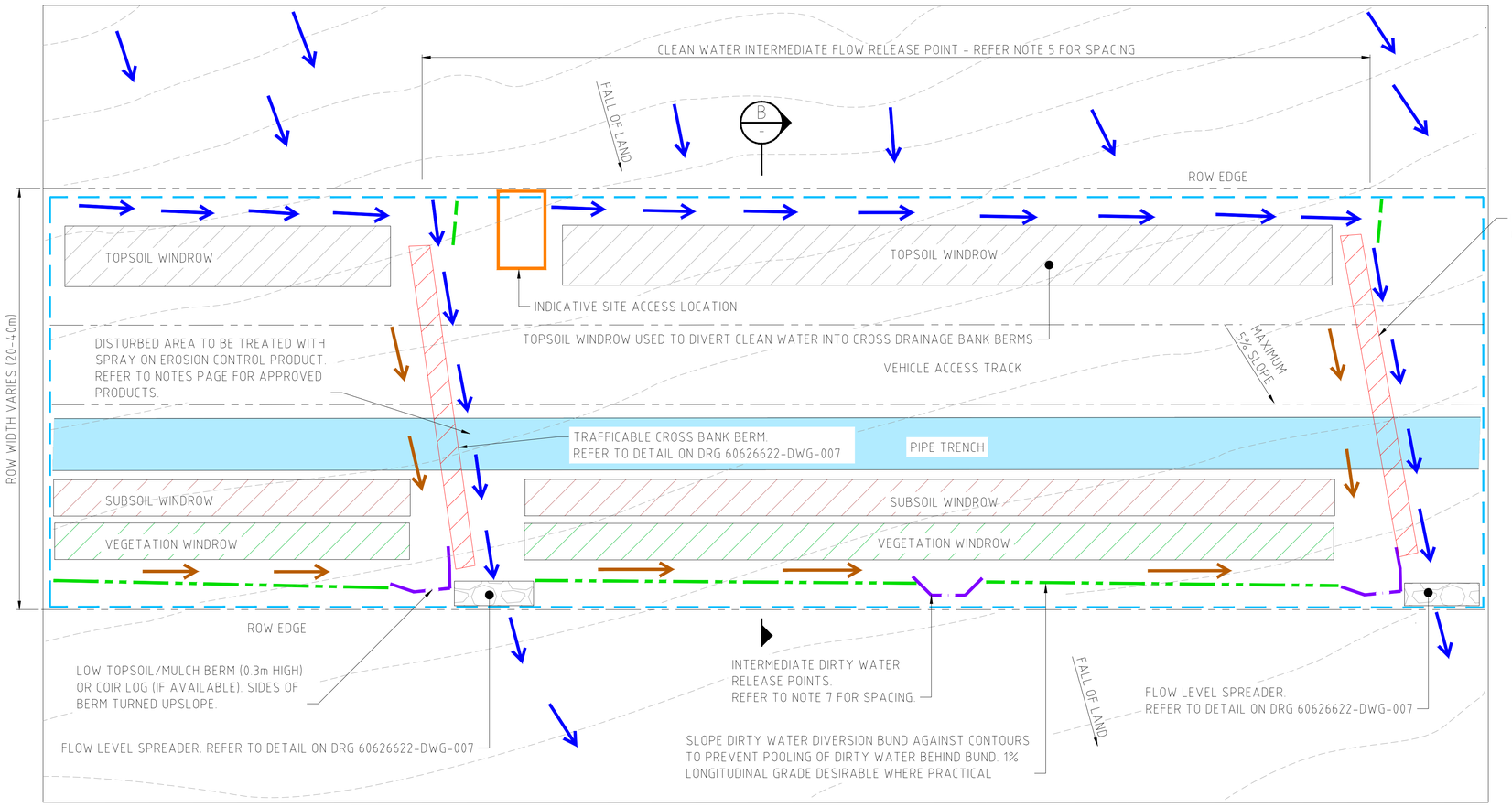
SITE	PLANT	PROJECT CODE
ORG	P01	A201

SECURITY CLASSIFICATION: RESTRICTED

ARROW ENERGY
GATHERING AND PIPELINE NETWORKS
EROSION AND SEDIMENT CONTROL TRENCH UPSLOPE OF ACCESS TRACK
LAYOUT SHEET 2

STATUS	CONTRACTOR DRAWING NUMBER	ARROW ENERGY DRAWING NUMBER	SCALE	REV.	SIZE
IFC	60626622-DWG-005	ORGP01-ARW-HSM-LAY-00001-002	NTS	0	A1



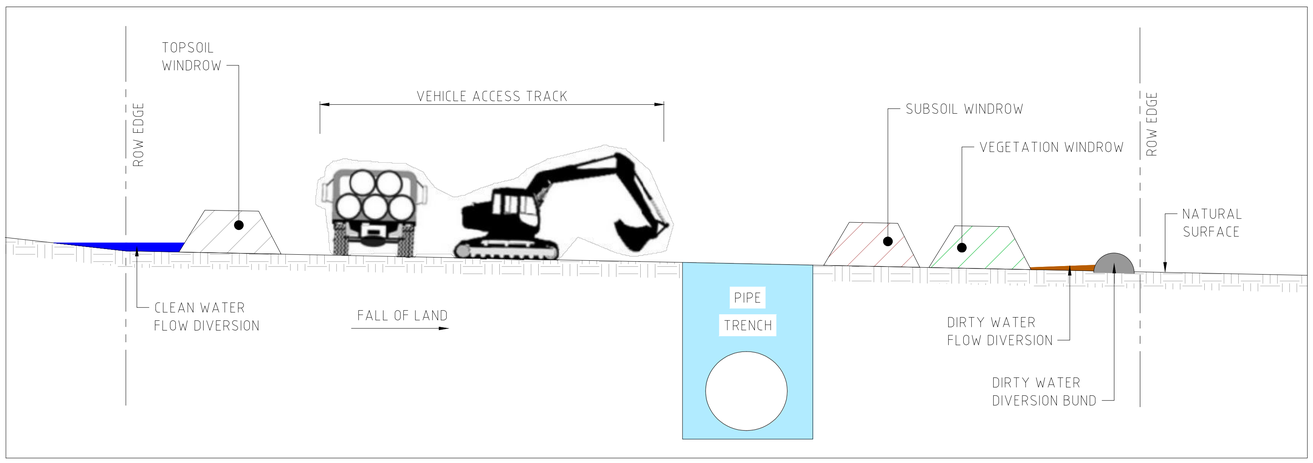
LEGEND

- DISTURBANCE AREA
- DIVERSION BUND (DB)
- TOPSOIL/MULCH BERM/COIR LOG
- RIGHT OF WAY (ROAD) EDGE
- STABILISED SITE ACCESS
- CLEAN WATER FLOW ARROW
- DIRTY WATER FLOW ARROW
- WATER COURSE
- FLOW LEVEL SPREADER
- TRAFFICABLE CROSS BANK BERM
- TOPSOIL WINDROW
- SUBSOIL WINDROW
- VEGETATION WINDROW
- ACCESS TRACK
- INDICATIVE SITE CONTOURS

NOTES

1. EROSION CONTROL LAYOUT SHOWN ON PLAN IS BASED ON EXISTING SURFACE AND PROPOSED PAD FALL DIRECTIONS. CONTRACTOR TO APPLY EROSION CONTROL TREATMENTS TO SUIT INDIVIDUAL SITE CONDITIONS.
2. FOR EROSION AND SEDIMENT CONTROL NOTES REFER DRG 60626622-DWG-004.
3. FOR TYPICAL DETAILS REFER DRG 60626622-DWG-007.
4. FOR EROSION AND SEDIMENT CONTROL PLAN FOR VEHICLE ACCESS TRACK ON UPSLOPE SIDE OF PIPE TRENCH REFER DRG 60626622-DWG-005.
5. SPACING OF THE CLEAN WATER INTERMEDIATE FLOW RELEASE POINTS TO BE DETERMINED BASED ON THE PEAK FLOW FROM THE UPSTREAM CATCHMENT IN THE 1 IN 2-YEAR AVERAGE RECURRENCE INTERVAL (ARI) STORM EVENT.
6. EXCAVATION OF TRENCHES TO BE STAGED TO ENSURE THAT THERE REMAINS A SUFFICIENTLY WIDE SECTION OF UNOPENED TRENCH ON THE SURFACE TO DIVERT CLEAN WATER THROUGH THE RIGHT OF WAY.
7. INTERMEDIATE DIRTY WATER RELEASE POINTS ARE TO BE PROVIDED FOR EVERY 2500m^2 OF DISTURBED AREA UPSLOPE.
8. THIS EROSION AND SEDIMENT CONTROL PLAN IS SUITABLE FOR SLOPE GRADES UP TO 5% WITH NO NATURAL WATER COURSES AND A SOIL LOSS OF LESS THAN 48 t/ha/year.

PLAN B - EROSION AND SEDIMENT CONTROL PLAN - TRENCH DOWNSLOPE OF ACCESS TRACK



TYPICAL ROW WITH TRENCH DOWNSLOPE OF ACCESS TRACK SECTION B

REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	ORIG	CHK	QA	APP
60626622-DWG-007	TYPICAL DETAILS				AR	KP	MH	RB
60626622-DWG-005	LAYOUT PLAN - TRENCH UPSLOPE OF ACCESS TRACK	0	26.11.21	ISSUED FOR CONSTRUCTION	AR	KP	MH	RB
60626622-DWG-004	GENERAL NOTES	A	12.10.21	ISSUED FOR CLIENT REVIEW	AR	KP	MH	RB

RPEQ CERTIFICATION
Signature
Name: MARK F. HARGRODER
RPEQ No.: 09416
Date: 26.11.21

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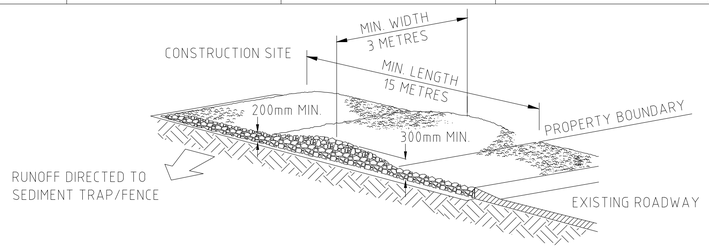
SITE	PLANT	PROJECT CODE
ORG	P01	A201

SECURITY CLASSIFICATION: RESTRICTED

ARROW ENERGY
GATHERING AND PIPELINE NETWORKS
EROSION AND SEDIMENT CONTROL TRENCH DOWNSLOPE OF ACCESS TRACK LAYOUT SHEET 3

STATUS	CONTRACTOR DRAWING NUMBER	ARROW ENERGY DRAWING NUMBER	SCALE	REV	SIZE
IFC	60626622-DWG-006	ORGP01-ARW-HSM-LAY-00001-003	NTS	0	A1

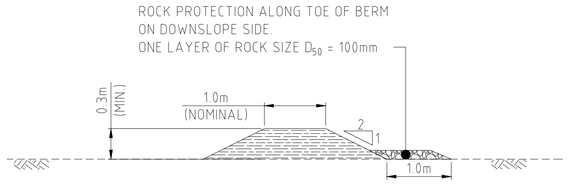


STABILISED SITE ACCESS

NTS

NOTES

1. STRIP THE TOPSOIL, LEVEL THE SITE AND COMPACT THE SUBGRADE.
2. COVER THE AREA WITH NEEDLE-PUNCHED GEOTEXTILE.
3. CONSTRUCT A 200mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 30mm AGGREGATE.
4. ENSURE THE STRUCTURE IS AT LEAST 15 METRES LONG OR TO BUILDING ALIGNMENT AND AT LEAST 3 METRES WIDE.
5. WHERE A SEDIMENT FENCE JOINS ONTO THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT FENCE.
6. GEOTEXTILE TO BE BIDIM A34 OR SIMILAR APPROVED.

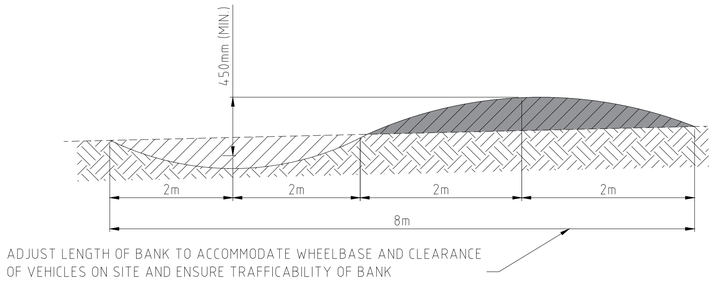


TYPICAL TOPSOIL/MULCH BERM

NTS

NOTES

1. USE MULCH OR TOPSOIL OBTAINED FROM SITE CLEARING FOR CONSTRUCTION.
2. LOCATE 2m FROM EDGE OF EARTHWORKS AND 0.5m IN FROM EDGE OF CLEARING TO AVOID DAMAGE TO TREES, WHERE POSSIBLE.
3. WHERE PRACTICAL, POSITION THE BERM ALONG A LINE OF CONSTANT ELEVATION.
4. ENSURE BOTH ENDS OF BERM ARE TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING THE BERM.

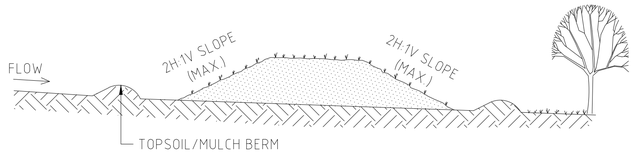


TYPICAL TRAFFICABLE CROSS BANK BERM

NTS

NOTES

1. CROSS BANK BERM IS FORMED FROM EXCAVATED ACCESS TRACK MATERIAL.
2. ENSURE THAT THE BANK IS ADEQUATELY COMPACTED TO WITHSTAND VEHICLE LOADING.
3. CROSS BANK BERM IS TO BE STABILISED AS PER THE NOTES ON DRG 60626622-DWG-004.

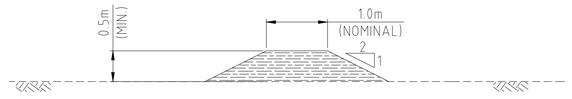


WINDROW

NTS

NOTES

1. PLACE WINDROW MORE THAN 5 METRES FROM EXISTING VEGETATION, CONCENTRATED WATER FLOW, ROADS AND HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS LOW, FLAT, ELONGATED MOUNDS/WINDROWS.
3. WHERE THERE IS SUFFICIENT AREA, TOPSOIL WINDROW SHALL BE LESS THAN 2 METRES IN HEIGHT.
4. WHERE WINDROWS ARE TO BE IN PLACE FOR MORE THAN 10 DAYS, STABILISE BY GRASS SEEDING OR MULCHING.
5. TOPSOIL/MULCH BUNDS ARE NOT REQUIRED FOR ALL WINDROW TYPES. REFER TO EROSION AND SEDIMENT CONTROL PLAN LAYOUTS FOR LOCATIONS OF TOPSOIL/MULCH BUNDS.

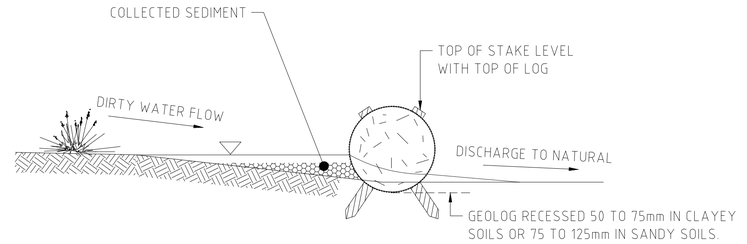


TYPICAL DIVERSION BUND

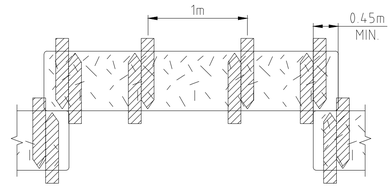
NTS

NOTES

1. USE TOPSOIL/MULCH OBTAINED FROM SITE CLEARING FOR CONSTRUCTION.
2. LOCATE 2m FROM EDGE OF EARTHWORKS AND 0.5m IN FROM EDGE OF CLEARING TO AVOID DAMAGE TO TREES, WHERE POSSIBLE.
3. ENSURE THAT THE BUNDS ARE COMPACTED.
4. COMPLETE PERMANENT OR TEMPORARY STABILISATION WITHIN 10 DAYS OF CONSTRUCTION.
5. CHECK BUND ALIGNMENT TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.



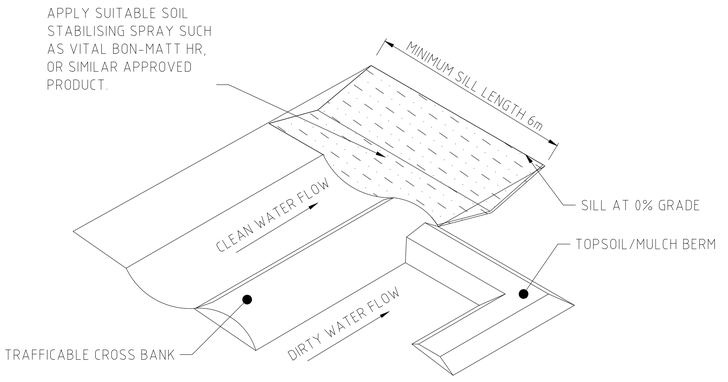
(A) TYPICAL PLACEMENT OF GEO LOG



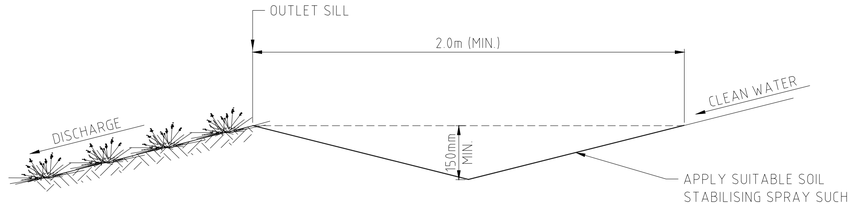
(B) METHODS OF STAKE PLACEMENT

COIR LOG/GEO LOG/FIBRE ROLL

NTS



(A) LEVEL SPREADER WITH CROSS BANK TYPICAL DETAIL



(B) OUTLET WEIR TYPICAL PROFILE

LEVEL SPREADER

NTS

NOTE: ALL DETAILS ARE TYPICAL. MANAGING CONTRACTOR TO PROVIDE SITE SPECIFIC ESC MANAGEMENT LAYOUT PLANS AND DETAILS FOR CONSTRUCTION.

REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	ORIG	CHK	QA	APP
					AR	KP	MH	RB
		0	26.11.21	ISSUED FOR CONSTRUCTION	AR	KP	MH	RB
60626622-DWG-004	GENERAL NOTES	A	12.10.21	ISSUED FOR CLIENT REVIEW	AR	KP	MH	RB

RPEQ CERTIFICATION
Signature
Name: MARK F. HARGRODER
RPEQ No.: 09416
Date: 26.11.21

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

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SITE	PLANT	PROJECT CODE
ORG	P01	A201

SECURITY CLASSIFICATION: RESTRICTED

ARROW ENERGY
GATHERING AND PIPELINE NETWORKS
EROSION AND SEDIMENT CONTROL TYPICAL DETAILS LAYOUT SHEET 4

STATUS	CONTRACTOR DRAWING NUMBER	ARROW ENERGY DRAWING NUMBER	SCALE	REV	SIZE
IFC	60626622-DWG-007	ORGP01-ARW-HSM-LAY-00001-004	NTS	0	A1

Attachment 2 - Farm Manager confirms the land is operated as a single agricultural enterprise (Issue 6 and 10c iii.)

From: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Sent on: Thursday, April 24, 2025 4:46:11 AM
To: Daniel Clarke <Daniel.Clarke@arrowenergy.com.au>
CC: Darryl Patching <Darryl.Patching@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>
Subject: Re: Theten Requirement notice - Issue 6

Hi Daniel. I can confirm the farming country of Arrow Energy is treated as a separate entity to the rest of the company operation. The remainder of the Theten farm is leased out grazing county.

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From: Daniel Clarke <Daniel.Clarke@arrowenergy.com.au>
Sent: Thursday, April 24, 2025 2:39:01 PM
To: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Cc: Darryl Patching <Darryl.Patching@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>
Subject: Theten Requirement notice - Issue 6

Hi Bill,

Thanks for dialling in on the phone today.

As discussed - please confirm the *land (subject to this RIDA) is operated as a single agricultural enterprise, with the remainder of the original "Theten" leased for cattle grazing.*

Cheers,

Dan

Daniel Clarke
Environment Approvals Advisor Projects

Arrow Energy Pty Ltd
Level 39, 111 Eagle St, Brisbane QLD 4000
GPO Box 5262, Brisbane QLD 4001, Australia
T: +61 7 3012 4000
M: +61 478 039 259
F: +61 7 3012 4001
daniel.clarke@arrowenergy.com.au

Attachment 3 - Farm Manager endorses the methodology used to determine the shadow area and its extent (Issue 7)

From: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Sent on: Wednesday, April 30, 2025 2:01:22 AM
To: Daniel Clarke <Daniel.Clarke@arrowenergy.com.au>; Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>
CC: Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Subject: Re: Theten requirement notice - Issue 7

Hi Daniel. Looks fine to me.

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From: Daniel Clarke <Daniel.Clarke@arrowenergy.com.au>
Sent: Wednesday, April 30, 2025 11:53:27 AM
To: Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>; Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Cc: Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Subject: RE: Theten requirement notice - Issue 7

Hi Bill,

Just chasing an update for your confirmation on the below.

Cheers,

Dan

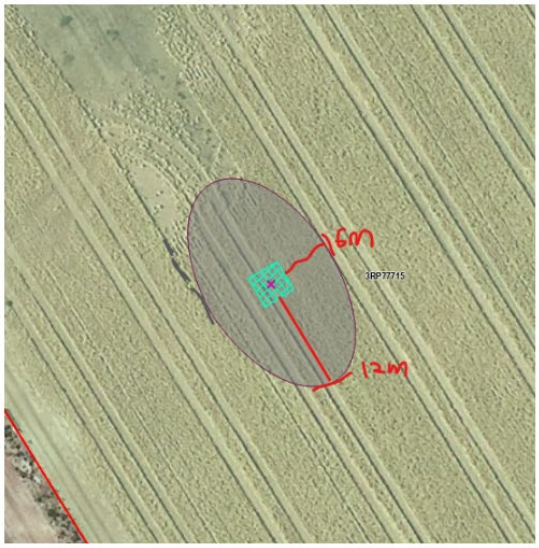
From: Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>
Sent: Thursday, 24 April 2025 4:27 PM
To: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Cc: Daniel Clarke <Daniel.Clarke@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Subject: Theten requirement notice - Issue 7

Hi Bill,

Thanks for the chat this afternoon. I worked with Gav to estimate an "impact shadow" that shows the are of land that wouldn't be cropped anymore because you would have to steer around the valve.
Below is a snip of the area in grey. The blue cross-hatched area would be the fenced area around the valve (pink cross). Length-wise it gives a clearance of 12m from the fence and a width of 6m from the fence, also lining up with existing cropping rows.

Please let me know this this looks about right.

Thanks,
Alex



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Attachment 4 – Impacts to overland flow (Issue 8)

Reinstatement and rehabilitation -RIDA – Condamine Alluvium Substitution Scheme (CASS) Tie-in valve (on RP77715 Lot Plan)

Overland Flow impact mitigation requirements: In response to the Department's **Requirements Notice (RN)**

Anticipated impacts to overland flow from installed infrastructure	***Methods use to mitigate impacts to surrounding PALU and properties***	
	Current RIDA application (section 7.3)	**Response to RN (received from the Department) with additional / clarifying text (in green) in addition to the already provided provisions in section 7.3**
	Reinstatement and rehabilitation measures will be applied to all areas disturbed during construction as soon as practical following the completion of the construction of proposed petroleum activities.	Reinstatement measures will be applied to all areas disturbed during construction as soon as practical following the completion of the construction of proposed petroleum activities. Final Rehabilitation will be commenced to all areas disturbed during construction as soon as practical following the decommissioning of the infrastructure and removal of the above ground infrastructure.
	All reinstatement and rehabilitation will be conducted in accordance with the Environmental Authority requirements. This will include:	All reinstatement and rehabilitation will be conducted in accordance with the Environmental Authority requirements and rehabilitation procedures. This will include:
Stockpiling	• stockpiling of soil into differing horizons after clearing and prior to construction	

	• segregation of topsoil to ensure topsoil integrity when soil clearing is required as part of construction	
Backfilling	• backfilling of pipeline trenches and bell holes once pipelines/valves are installed and constructed	
Re-contouring	• reinstatement of the land contours/land surface and drainage to maintain original overland flow conditions and agricultural production	• The trench and ROW (including the ROW at the gathering network tie-ins) are restored to the natural contours of the ground allowing return to the prior / original overland flow, surface drainage and agricultural production • Excavated areas are backfilled with the original native material and compacted to match the natural contours with sufficient surplus fill to compensate for minor subsidence.
Scarifying		Scarifying operation is used to relieve any unduly compacted surfaces on ROW prior to replacement of topsoil. Ripping or scarifying operation is restricted to a depth of 50mm and follow natural contours to avoid soil erosion.

Establishing overland flow		Overland flow paths are identified by surveying and engineering methods prior to any site activity. Design documentation that is specified to not effect overland flow. Construction work is executed to the approved design documents and with application of tight construction tolerances to finished ground levels, hence ensuring overland flow is maintained. Pre disturbance survey and post disturbance surveys are carried out to ensure the original overland flow conditions are maintained.
Soil Amelioration	• re-test of the soil to establish recommendations for fertiliser and/or ameliorants to re-establish the productivity of the soil	
	• application of ameliorants and fertilisers	
Stabilisation	• implementation of necessary stabilisation measures.	Stabilisation measures are implemented on the disturbed areas required for maintaining the stability of the asset for its operational life, as soon as practical during the construction and/or following the completion of the construction of proposed petroleum activities.

Erosion and Sediment Control	Detailed erosion and sediment control measures will also be implemented and maintained consistent with the Environmental Authority during construction, and as required following construction.	Detailed erosion and sediment control measures will also be implemented and maintained consistent with the Environmental Authority during construction, and as required following construction. Where required, diversion contour banks / berms are 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.
Topsoil Re-spreading		After erosion control works are complete, stockpiled topsoil are evenly respread over the re-contoured surfaces which have been restored to their natural prior contours ground allowing return to the original overland flow and surface drainage.
Monitoring & Maintenance	The land will be returned to its previous general state and use once construction is completed and rehabilitation is undertaken, and the land will be visually consistent with the surrounding land features. Periodic monitoring will be undertaken to ensure integrity of the rehabilitation.	The ROW is regularly inspected and maintained with respect to washout, erosion and subsidence for its operational life.
Other reinstatement activities	Other reinstatement activities will include:	
	• removal of any foreign construction material and waste	

	• restoration of fencing as required	
	• reinstatement of existing access track.	
		• Removal of above ground infrastructure (Tie-in point / fencing) after decommissioning of the pipeline during rehabilitation

Attachment 5 – Minimised impacts to agricultural activities from proposed CSG activities (Issue 10a)

From: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Sent: Thursday, 10 April 2025 12:27 PM
To: Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Cc: Rita Hassan <Rita.Hassan@arrowenergy.com.au>; Suzanne Ferguson <Suzanne.Ferguson@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>
Subject: Re: Theten Requirement notice - Issue 10(a) (farming)

Hi Darryl. Yes that is true we can work around the valve no problem at all.

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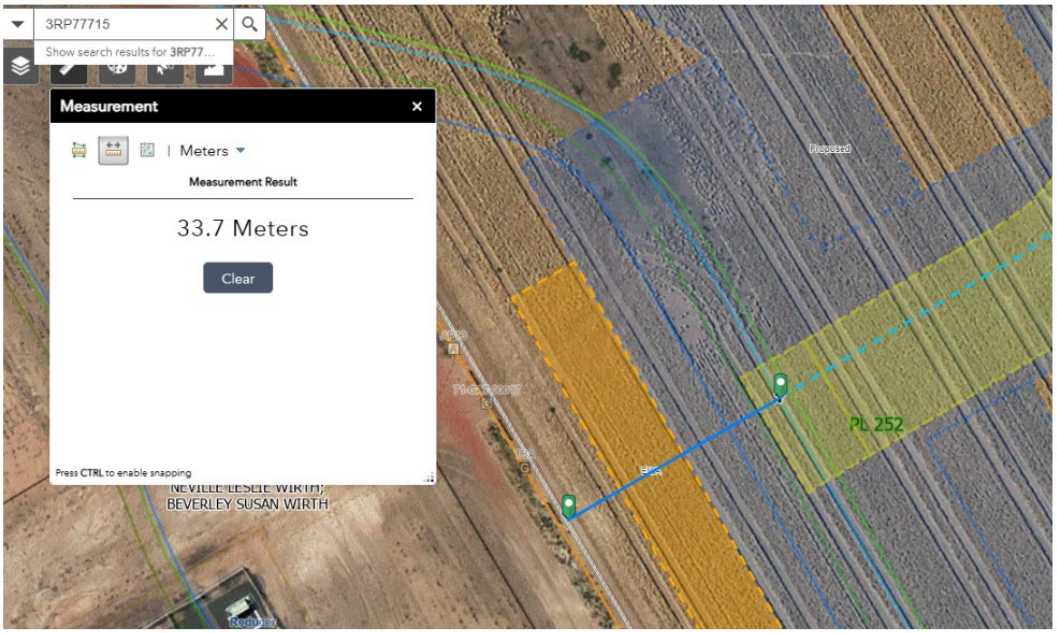
From: Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Sent: Thursday, April 10, 2025 12:16:30 PM
To: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Cc: Rita Hassan <Rita.Hassan@arrowenergy.com.au>; Suzanne Ferguson <Suzanne.Ferguson@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>; Alexandra Wolhuter <Alexandra.Wolhuter@arrowenergy.com.au>
Subject: Theten Requirement notice - Issue 10(a) (farming)

Hi Bill,

I understand from our discussion yesterday that the water valve is located within the property boundary on the third swathe from the property boundary, approximately 34 m from the property boundary. (See snip below) This will allow you to still use farming equipment on the two outer, existing 12 m swathe lines along the property boundary. Additionally, the valve pit position allows a single 36 m boom operation (weed spraying) along the property boundary with minimal disruption to the spray operation. You are expecting to be able to fold in a portion of the boom for a short section of the runs to ensure clearance on the valve fenced out area. The location of the infrastructure will therefore have minimal impact on your operations. Additionally, the construction timeline of late June / July fits in with the fallowing of the land at that period. The operational footprint area that Arrow has estimated (0.82ha) is conservative given the direct and indirect impacts of the infrastructure on your farming operation are minimal.

Could you please confirm I have understood this correctly?

Additionally, I have CCed Alex Wolhuter in to this email and she will prepare a diagram of the expected Operational impact for your review/ approval.



Regards

Darryl Patching
Regulatory Approvals Specialist

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darryl.patching@arrowenergy.com.au

Attachment 6 – Leased Areas (Issue 10a & 10c iii.)

From: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Sent: Thursday, 10 April 2025 12:22 PM
To: Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Cc: Rita Hassan <Rita.Hassan@arrowenergy.com.au>; Suzanne Ferguson <Suzanne.Ferguson@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>
Subject: Re: Theten Requirement notice - Issue 10(a)

Hi Darryl. All the blocks in question have been leased out for many year now some of them close to 10 years.

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From: Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Sent: Thursday, April 10, 2025 11:40:06 AM
To: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Cc: Rita Hassan <Rita.Hassan@arrowenergy.com.au>; Suzanne Ferguson <Suzanne.Ferguson@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>
Subject: Theten Requirement notice - Issue 10(a)

Hi Bill,

Further to our discussions yesterday, please confirm that the Lots listed below, considered part of the original 'Theten' property, have been under lease arrangements for cattle grazing with third parties for quite some time. These blocks are therefore not considered part of the farming operation under your management.

- 109DY344
- 107DY848
- 3RP99604
- 34DY632

Regards

Darryl

Darryl Patching
Regulatory Approvals Specialist

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darryl.patching@arrowenergy.com.au

Attachment 7 – Dryland Cropping Land Use (Issue 10b & 10c ii.)

From: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Sent: Thursday, 10 April 2025 12:25 PM
To: Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Cc: Rita Hassan <Rita.Hassan@arrowenergy.com.au>; Suzanne Ferguson <Suzanne.Ferguson@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>
Subject: Re: Theten Requirement notice - Issue 10 - Cropping history

Hi Darryl. I can confirm all the above is true and correct the soil under the small pivots is very ordinary and not worth spending money watering.

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From: Darryl Patching <Darryl.Patching@arrowenergy.com.au>
Sent: Thursday, April 10, 2025 12:21:59 PM
To: Bill Schloss <Bill.Schloss@arrowenergy.com.au>
Cc: Rita Hassan <Rita.Hassan@arrowenergy.com.au>; Suzanne Ferguson <Suzanne.Ferguson@arrowenergy.com.au>; Gavin Gunther <Gavin.Gunther@arrowenergy.com.au>
Subject: Theten Requirement notice - Issue 10 - Cropping history

Hi Bill,

as discussed yesterday, could you please confirm the following statements:

> *The impacted area is a section of dryland cropping for the farming operation. The soils in that area are not as productive as other parts of the farming operation where the bigger pivots were installed and were more frequently irrigated. The lateral irrigation infrastructure in that area was very rarely used as the investment in irrigation was not worth it on that particular section of the Lot due to the poor soils.*

and

> *The centre pivots have not been used to irrigate commercial crops in this area. The centre pivots were used to carry out irrigation trials involving testing of water quality, soils, crops and groundwater. The irrigated crops were primarily established for the trial, not as part of the normal farming operations. There is also a lateral irrigator in this particular area of the Lot, however the poor soils have meant that the commercial cropping activity over the last 10 years has been associated with Dryland Cropping activity. The block is operated as zero till on 12 m CTF with a maximum 36 m swathe for the boom operations. This has produced varying results in the last 10 years, estimated by the farm manager to be 4 tonnes per hectare (t/ha) in 4 years, 1.5 t/ha for 4 years and two of the poorest years were not cropped at all.*

Thanks in advance,

Darryl Patching
Regulatory Approvals Specialist

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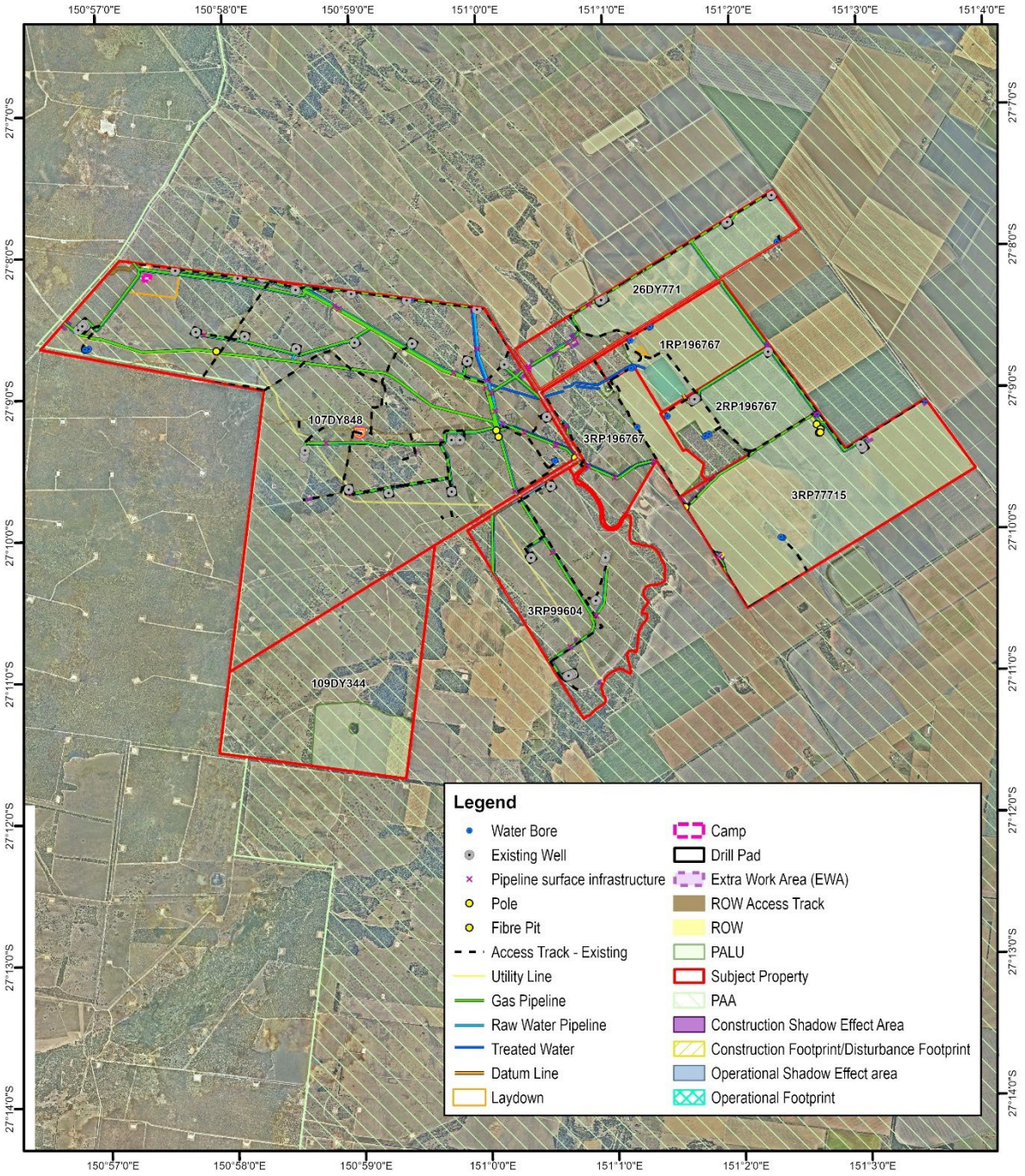
darryl.patching@arrowenergy.com.au

Attachment 8 – Extent of PAA (Issue 12)



Rev	Date	Revision Description	Orig	Chk	Eng	QA	Appr
B	24.04.25	PAA added	AWDP	XXXX	DP		
A	28.02.25	First issue	AWDP	XXXX	DP		

arrow energy go further

Scale @ A4: 1:66,000
Coordinate System: GDA2020 MGA Zone 56

Status: IFI
Issued To: D Patching
Author: awolhuter

Source: Arrow Energy Limited
Geosciences Australia
Qld Gov.

RIDA 3RP77715

Current and proposed infrastructure Whole Property

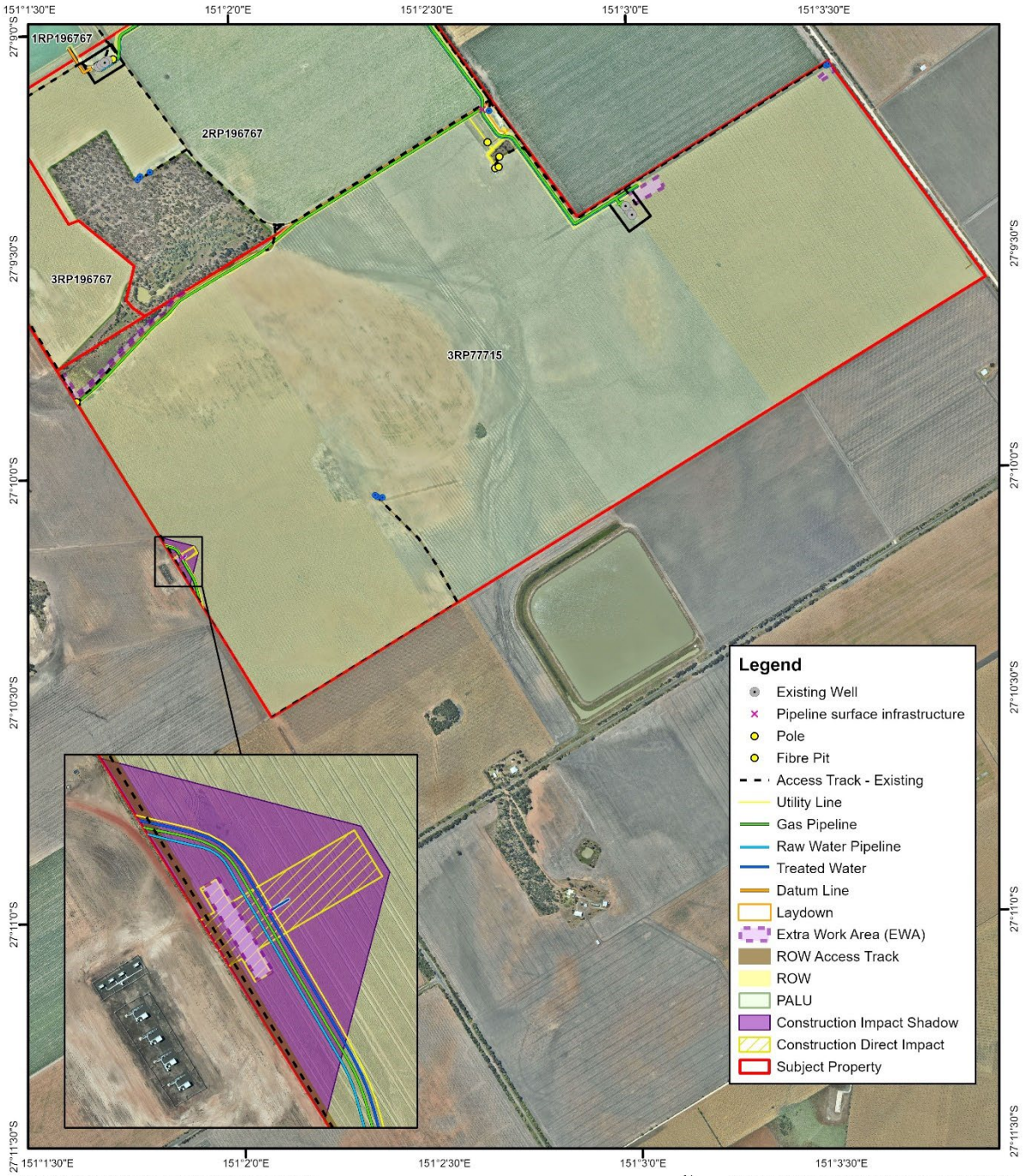
Uncontrolled (B)

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Regional_Planning\250218_RITM0640242_Theten_3RP77715RIDA_DP\RIDA_3RP77715.aprx

NOT FOR CONSTRUCTION

Print Date: 30/04/2025

Attachment 9 – Construction and Operation Direct Impact and Impact Shadow Areas (Issue 13)



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Rev	Date	Revision Description	AW	DP	XX	XX	DP
A	30.04.25	First issue					

arrow energy go further

Status: IFI
Issued To: D Patching
Author: awolhuter

Scale @ A4: 1:21,000
Coordinate System: GDA2020 MGA Zone 56

Source: Arrow Energy Limited Geosciences Australia Qld Gov.

RIDA 3RP77715

Construction Direct Impact and Impact Shadow

Uncontrolled (A)

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Regional_Planning\250218_RITM0640242_Theten_3RP77715RIDA_DP\RIDA_3RP77715.aprx

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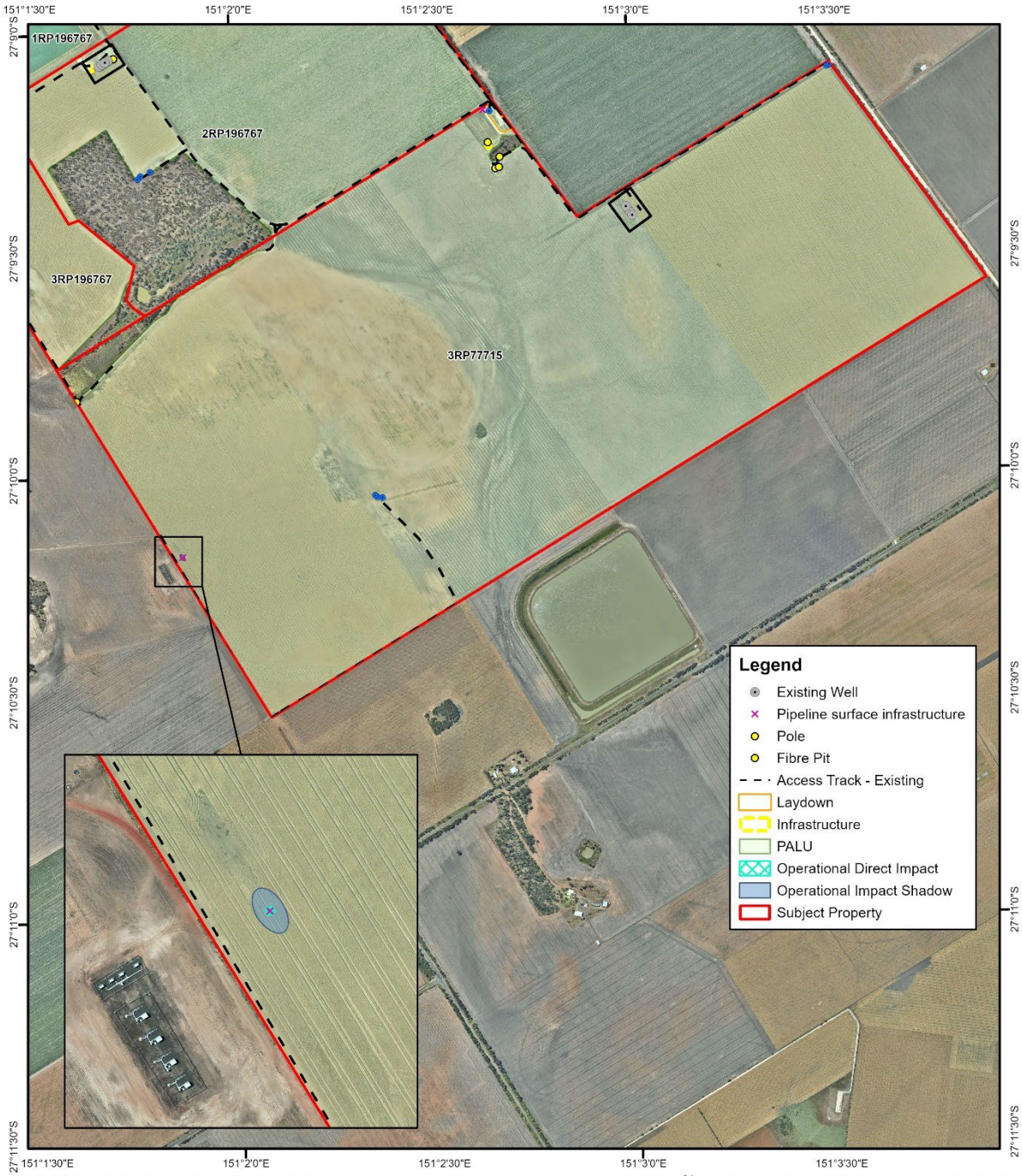
Print Date: 30/04/2025



Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no warranty is given that the information contained on this map is free from error or omission. Any reliance placed on such information shall be at the sole risk of the user. Please verify the accuracy of all information prior to using it.

Rev	Date	Revision Description	Dwg	Chk'd	Eng	QA	App
A	30.04.25	First issue	AW	DP	XX	XX	DP

arrow energy go further

Scale @ A4: 1:21,000
Coordinate System: GDA2020 MGA Zone 56

Status: IFI
Issued To: D Patching
Author: awolhuter

Source: Arrow Energy Limited
Geosciences Australia
Qld Gov.

RIDA 3RP77715

Operation
Direct Impact and Impact Shadow

Uncontrolled (A)

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Print Date: 30/04/2025

Attachment 10 – Tie-In Value Impact Area Calculations (Issue 16)

Proposed new infrastructure on Lot 3 RP77715				1) Construction Footprint (Direct Impact)(1)		2) Construction Impact Area (2)		3) Operational Footprint (Direct Impact)(1)		4) Operational Impact Area (2)		5) Post Restoration Impact Area (3)	
LOTPLAN	**Owner**	**AREA (ha)**	**PALU land on Lot (ha)**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
3RP77715	ALH PTY LTD(4)	508.98	503.00	0.33	0.1%	1.38	0.3%	0.0016	0.0101%	0.0507	0.0003%	0.0000%	0.0000%
Notes	(1) Footprint is defined as the area of Direct Impact												
	(2) Impact Area is defined as the footprint + the Impact Shadow												
	(3) Restoration refers to the process of decommissioning and removing the CSG infrastructure.												
	(4) ALH is ARROW LAND HOLDINGS PTY LTD												