arrow energy
go further

7 August 2025

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GPO Box 2454
Brisbane QLD 4001

Via email: EnergyandExtractive@detsi.qld.gov.au

Subject: **SGP South EA (EA0001613) major amendment application response to the Request for Further Information (RFI) (reference A-EA-AMD-100835294)**

Arrow CSG (Australia) Pty Ltd (Arrow Energy) is responding to a request for further information (RFI) issued by the Department of Environment, Tourism, Science, and Innovation (DETSI) on 11 June 2025 in relation to its application to amend Environmental Authority (EA) EA0001613 (SGP South EA) for the already approved scope of the Surat Gas Project (SGP) South development. The application considers the first three development areas on petroleum leases (PL) 493 and PL1040 which includes 84 wells of a total of 715 already approved wells and associated gas and water gathering pipelines, infrastructure, and incidental activities.

Arrow's responses to the items as per the RFI are provided in **Table 1**. This response also includes appendices containing the following supporting information:

- Appendix A: Biodiversity Impact Assessment SGP South EA (EA0001613) (Rev 3, 30/07/2025)
- Appendix B: SGP South Stage 1 Maximum Boundary Spatial data
- Appendix C: SGP South Groundwater Assessment - Response to EA Amendment 20250319 Information Request
- Appendix D: Draft marked-up SGP South EA (EA0001613) (07-AUG-2025)
- Appendix E: Latest monitoring results – Groundwater Exceedance Investigation Report, Hopeland (PL253), Reporting Period: 1 April 2025 to 30 June 2025

Arrow Energy would like to note that **Appendix A** has been updated from the original EA amendment submission and replaced with this updated revision (Revision 3) to reflect changes in biodiversity impact data.

Should you require further information or wish to discuss, please do not hesitate to contact Tyson Croll on 07 3012 4417 or via email to tyson.croll@arrowenergy.com.au

Yours sincerely

Matthew Jeffries
Vice President External Affairs

Table 1 SGP South EA amendment - Request for Further Information (RFI) and response from Arrow Energy

<table>
<tr><th>Item</th><th>Issue/Observation</th><th>Action required</th><th>Arrow Energy's response</th></tr>
<tr><td colspan="4">Biodiversity</td></tr>
<tr><td>1.</td><td>A contemporary assessment of impacts to Environmentally Sensitive Areas (ESA) and Prescribed
Environmental Matters (PEM) are required for the two proposed Kogan Creek well site locations. This should include quantified impacts for matters currently listed as protected wildlife.</td><td>Provide a breakdown of all contemporary impacts to ESA and PEMS for the area containing the Kogan Creek well sites and associated infrastructure. Include in this breakdown the quantity of impacts, a likelihood of occurrence assessment and a cumulative significant residual impact assessment, where necessary.</td><td>The ESAs for the two proposed Kogan Creek well pads and associated gas spur line disturbances are mapped in Figure 3.2, Figure 3.3 and Figure 3.4 of the Biodiversity Impact Assessment (BIA) report (refer to Appendix A). Detailed breakdowns of impacts to ESAs are provided in Section 5.1 of the BIA (refer to Appendix A).

Specifically for the two Kogan Creek well pads and associated gas spur line disturbances on PL493 the ESA impacts are presented in the table below.

Disturbance area per ESA type – Two planned Kogan Creek Well pads
<table>
<tr><th>ESA Type</th><th>Detail</th><th>Area (ha)</th></tr>
<tr><td colspan="3">Category B ESAs</td></tr>
<tr><td>Category B</td><td></td><td>0.0</td></tr>
<tr><td>Category B PPZ</td><td></td><td>0.0</td></tr>
<tr><td>Category B SPZ</td><td></td><td>0.0</td></tr>
<tr><td colspan="3">Category C ESAs</td></tr>
<tr><td>Category C</td><td></td><td>0.0</td></tr>
<tr><td>Category C PPZ</td><td>Of concern RE (disturbed RE 11.3.4)</td><td>2.07</td></tr>
<tr><td colspan="3">Category C ESAs – Protected wildlife habitat</td></tr>
<tr><td>Protected wildlife habitat</td><td></td><td>0.08</td></tr>
</table>
The BIA (refer to Appendix A) documents the ecological surveys that have been undertaken in Section 2.2, and includes a likelihood of occurrence assessment in Section 2.1.2 and SRI assessments in Section 4.5, where required.

Ecological surveys are contemporary and were undertaken in 2022 and again in late July 2024. There is a small patch of RE 11.5.1 (0.08 ha) that has been ground-truthed as habitat for koala (Phascolarctos cinereus). The BIA (refer to Appendix A) identifies this area of koala habitat in the PEMs table (Table 5.5 of Appendix A). There are no other PEMs for the Kogan Creek wells.</td></tr>
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<table>
<tr><th>Item</th><th>Issue/Observation</th><th>Action required</th><th>Arrow Energy's response</th></tr>
<tr><td>2.</td><td>DETSI requires further information to consider an alternative approach to conditioning larger well pad sizes, relevant to ESA limitations, to allow for flexibility for Arrow to incorporate a required number of wells on multi-well pads and to allow for more space when constructing on slopes. The solution to this approach needs to be informed by Arrow's requirements when designing and installing well pads in sloped areas and collocating multiple wells to ensure the most efficient use of space is achieved.</td><td>To allow DETSI to make an informed decision and to achieve the best environmental outcome, provide details on specific requirements when designing and installing well pad infrastructure including but not limited to the following:</td><td>Arrow Energy utilises a site assessment process for defining infrastructure layouts. This is carried out by a multidisciplinary team and involves the physical mapping of cultural heritage, ecological, landholder, and other third-party entities plus the constructability constrains to determine the final location of all infrastructure. Ideally, a detailed survey sketch is produced during this phase so that minimal changes occur later on during detailed engineering design phases.

A site based Survey Lead is responsible for obtaining detailed survey data of the physical site features in line with the requirements for the location of well pads, and determines the best location of the well pad considering minimal disturbance and other known constraints.

Location of well pads takes into consideration the following aspects:
• distance from tenure boundaries;
• applicable exclusion zones;
• well centre location;
• orientation of the well pad;
• Third-party requirements; and
• feasibility of well pad and access tracks development with minimal disturbance.

The well pad size is dependent on topography and the number of wells nominated for the well pad. The following table provides the estimated areas of disturbance depending on the number of well per well pad on well pads built on terrain with a maximum slope of 2%.

Well pad dimensions on levelled terrain (maximum 2% slope)
<table><tr><th># wells / well pad</th><th>Length (m)</th><th>Width (m)</th><th>Area of disturbance (ha)</th></tr><tr><td>1</td><td>100</td><td>100</td><td>1.00</td></tr><tr><td>2</td><td>100</td><td>115</td><td>1.15</td></tr><tr><td>3</td><td>100</td><td>130</td><td>1.30</td></tr><tr><td>4</td><td>100</td><td>145</td><td>1.45</td></tr><tr><td>5</td><td>100</td><td>160</td><td>1.60</td></tr><tr><td>6</td><td>100</td><td>175</td><td>1.75</td></tr><tr><td>7</td><td>100</td><td>190</td><td>1.90</td></tr><tr><td>8</td><td>100</td><td>205</td><td>2.05</td></tr></table></td></tr>
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- minimum slope angle that triggers the need for installation of batters or other slope design features which require a larger well pad footprint;

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Regarding locating well pads on sloping terrain (i.e., greater than 2% slope), the general guideline is to orientate the well pad in a way that it:

- minimises 'cut and fill';
- avoids steep slopes as much as possible; and
- avoids aligning gathering and access across side slopes.

The table below provides the standard disturbance areas when requiring 'cut and fill' depending on slope (in ranges) and on the number of wells to be installed. Any well pad that has greater than 2% slope may require 'cut and fill' earthworks to enable a levelled well pad, and the construction of slope design features such as, for example, batters and also include provisions for management of overland flow and stormwater I, e. swale drains.

Well pad maximum disturbance areas(*) vs well pad slope (range)

	0 - 2% Slope		2-4% Slope		4-6% Slope		6-8% Slope		8-10% Slope	
Number of wells	Length	Width	Length	Width	Length	Width	Length	Width	Length	Width
1	100	100	115	115	120	120	125	125	130	130
2	100	115	115	130	120	135	125	140	130	145
3	100	130	115	145	120	150	125	155	130	160
4	100	145	115	160	120	165	125	170	130	175
5	100	160	115	175	120	180	125	185	130	190
6	100	175	115	190	120	195	125	200	130	205
7	100	190	115	205	120	210	125	215	130	220
8	100	205	115	220	120	225	125	230	130	235

(*): Length and width in metres.

From the above table, the maximum estimated disturbance area for an 8-10% sloping terrain and 8 wells on a multi-well pad would be 2.35 ha.

It is important to note that these areas are further refined during detailed engineering design, but the standard as presented in the above table is used for well pad maximum disturbances until the refined design data is available.

Changes during engineering design optimisation will include:

- well centre and corner coordinates and elevation(**); and
- extra workspace for well pads on slopes greater than 2% to allow for 'cut and fill'.

(**): elevation help Engineering to determine the orientation of the well pad for drainage and 'cut and fill' requirements.

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- estimated maximum size required for a well pad footprint to safely install on any sloped area;

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The table below provides the maximum well pad footprint size required to safely install a well pad on a sloping terrain depending on the number of wells planned on the well pad and the percentage of slope in the planned well pad location.

Well pad maximum disturbance areas(*) vs well pad slope (range)

	0 - 2% Slope		2-4% Slope		4-6% Slope		6-8% Slope		8-10% Slope	
Number of wells	Length	Width	Length	Width	Length	Width	Length	Width	Length	Width
1	100	100	115	115	120	120	125	125	130	130
2	100	115	115	130	120	135	125	140	130	145
3	100	130	115	145	120	150	125	155	130	160
4	100	145	115	160	120	165	125	170	130	175
5	100	160	115	175	120	180	125	185	130	190
6	100	175	115	190	120	195	125	200	130	205
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(*): Length and width in metres.

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- a scale of well pad size requirements per number of collocated wells (e.g. four collocated wells require a 1.5 hectare well pad, six collocated wells require 2 hectares);

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The table below provides the standard well pad sizes (in m^2) depending on the number of collocated wells within the same well pad.

Well pad maximum disturbance areas(*) vs well pad slope (range)

	0 - 2% Slope		2-4% Slope		4-6% Slope		6-8% Slope		8-10% Slope	
Number of wells	Length	Width	Length	Width	Length	Width	Length	Width	Length	Width
1	100	100	115	115	120	120	125	125	130	130
2	100	115	115	130	120	135	125	140	130	145
3	100	130	115	145	120	150	125	155	130	160
4	100	145	115	160	120	165	125	170	130	175
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- the considerations made to the protection zones and ESAs when selecting appropriate locations for well pads.

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Arrow Energy uses an internal impact assessment process as a guide which outlines the mandatory requirements for conducting ecological impact assessments (EIA) in support of petroleum development activities that involve disturbance to land.

These assessments are necessary to:

- establish the ecological and biodiversity characteristics of areas that may be disturbed (including Environmentally Sensitive Areas (ESAs));
- identify site-specific ecological constraints; and
- identify management requirements to avoid, minimise, or mitigate environmental harm associated with land disturbance activities, which are the '*guiding*

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Item	Issue/Observation	Action required	Arrow Energy's response
			hierarchy principles for biodiversity' (guiding principles) and to be used to plan and implement works before any decision to clear or disturb native vegetation is taken. EIAs consist of the following three phases: Planning and design, on-ground assessments, and internal approvals. Planning and design considers preliminary site selection, ecological desktop assessment, and constraints analysis (including topography and slope). On-ground assessments include field verification of the previously conducted desktop assessment, site selection review (if required), ecological survey, reporting and data supply to GIS system, and the identification of offsets. Finally, internal approvals are sought to be able to disturb matters that trigger environmental offsets. Well pad site selection incorporates the guiding principles and, where possible, the proposed location shall not be placed in an area that will involve clearing vegetation or placing a fill in a way that significantly isolates, fragments, or dissects tracts of native vegetation resulting in a reduction of the current level of ecosystem functioning and connectivity, or results in an increase in threatening processes. The ecological desktop assessment is completed using the relevant GIS layers. The location and distance of the proposed site to ecological features are considered, including, but not limited to, Environmentally Sensitive Areas (ESAs) and their associated protection zones. Online database searches are undertaken which are then included in the desktop assessment, ecological constraints mapping, and reports. The ecological constraints map includes ESAs and their associated protection zones and is incorporated to the desktop assessment for later field verification if required. This map provides preliminary understanding at a broad scale of: • the impact locating infrastructure at a particular site; • whether it is permissible with the constraints of the current environmental authority or other planning approvals specific to the activity; • the distance to protection zones relating to ESAs and their protection zones, wetlands, and watercourses; and • whether offsets are likely to be triggered at the proposed location. Following planning, ecological field validation is done. Ecological constraints to be surveyed and documented include: • habitat trees; • animal breeding places; • protected plants;

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			• watercourses and wetlands; • weeds and pests; • distance of proposed infrastructure to a Category A, B, or C Environmentally Sensitive Area (ESA) and their protection zones; • Regional Ecosystems (REs) and Threatened Ecological Communities (TECs) – where field assessment determines that there is a discrepancy with Arrow Energy field validated mapping, or, if field validated mapping is not available and there is a discrepancy with State regional ecosystem mapping; and • any other relevant ecological constraints. Information obtained during the ecological field survey include the validation of ESAs. If the proposed area for any activity is unsuitable, potential new areas are assessed to determine a more suitable location. Where the field assessment results indicate that an ESA is incorrectly mapped for a particular location, or unmapped, these are mapped using a mapping methodology appropriate to the value. When determining the final location *following the field validation process, Arrow look to* avoid, minimise, or mitigate environmental harm associated with land disturbance activities, and it covers vegetation clearing where possible. Arrow Energy's first guiding principle used for land disturbance is to '***avoid disturbing sensitive environmental values (e.g., ESAs, flora, fauna, watercourses, and wetlands), and disturbing land outside the approved area***'. The processes as described above were used for determining the locations of the proposed activities for the SGP South EA amendment well pads locations.
3.	SGP South Stage 1 Maximum Boundary (Schedule F, Figure 1) has been provided to assist with defining the area in which biodiversity impacts are limited. This figure does not provide the detail required to adequately define the stage 1 boundary.	Provide alternative spatial information in one of the two following forms: • two high-resolution pdf maps, zoomed into the areas applicable for stage 1 development, with coordinates detailing the proposed boundary; or • spatial data of the proposed boundary	Spatial data of the proposed boundaries for the SGP South Stage 1 development within PL493 and PL1040 are provided in **Appendix C**.
4.	DETSI requires a complete understanding of impacts to ESAs to authorise disturbance limits within these specific areas and their primary and secondary protection zones.	Provide a breakdown and quantify the proposed impacts to each Category B ESA and Category C ESA matter and their primary and secondary protection zones. For completeness, the Category C ESA definition is provided as follows: means any of the following areas: • nature refuges as defined in the conservation agreement for that refuge under the *Nature Conservation Act 1992*;	The BIA (refer to **Appendix A**) includes a complete assessment of the ESAs for the Project with: • ESA definitions in Section 3.1.1 that are consistent with the RFI; • Maps of each type of ESA are provided in Figure 3.2, Figure 3.3, and Figure 3.4; and • An indicative quantification and breakdown of the planned impacts based of a proposed footprint by each type of ESA, Category B and C and their primary

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- state forests or timber reserves as defined under the *Forestry Act 1959*;
- Resources Reserve under the *Nature Conservation Act 1992*;
- an area validated as from ground-truthing surveys as 'essential habitat' on the Queensland Government Essential Habitat Map in accordance with section 20AC of the *Vegetation Management Act 1999* for a species of wildlife listed as critically endangered, endangered, vulnerable under the *Nature Conservation Act 1992*;
- an area validated from ground-truthing surveys as 'protected wildlife habitat' that is category A, B or C on the Remnant Vegetation Management Map, in accordance with section 20A of the *Vegetation Management Act 1999*, for a species of wildlife listed as critically endangered, endangered or vulnerable under the *Nature Conservation Act 1992*;
- 'of concern regional ecosystems' that are remnant vegetation and identified in the database called 'RE description database' containing regional ecosystem numbers and descriptions.

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protection zones (PPZ) and secondary protection zones (SPZ)) and project activity are provided in Section 5.1, which each ESA category broken down in and Table 5.1 and Table 5.2.

Details of impacts to ESAs are provided in table below. It should be noted that these are proposed impacts to determine the maximum allowance of ESAs, and that the final layout and impact will be subject to detailed design and landholder sign-off.

Proposed disturbance to ESAs and their protection zones

<table>
<tr><th>ESA Type</th><th>Allowable activities</th><th>Disturbance by proposed activities</th><th>Total proposed disturbance</th></tr>
<tr><td colspan="3">Category B</td><td>0.3 ha</td></tr>
<tr><td>Endangered RE (RE 11.3.1)</td><td>Low impact petroleum activities only</td><td>Right of Way (Row) - 0.3 ha</td><td>0.3 ha</td></tr>
<tr><td colspan="3">Category B PPZ (PPZ - within 200 m)</td><td>9.5 ha</td></tr>
<tr><td>Endangered RE</td><td>Only essential petroleum activities</td><td>Extra Work Areas (EWAs) – 1.3 ha
Well pads – 2.9 ha
RoW – 5.3</td><td>9.5 ha</td></tr>
<tr><td colspan="3">Category B SPZ (SPZ - within 300 m)</td><td>3.4 ha</td></tr>
<tr><td>Endangered RE</td><td>Only essential petroleum activities</td><td>EWAs – 0.1 ha
Well pads – 0.9 ha
RoW – 2.4 ha</td><td>3.4 ha</td></tr>
<tr><td colspan="3">Category C</td><td>137.5 ha</td></tr>
<tr><td>Of concern RE (RE 11.3.25)</td><td>Only low impact petroleum activities</td><td>RoW – 0.2 ha</td><td>0.2 ha</td></tr>
<tr><td>'State forests' or 'Timber reserves'</td><td>Only essential petroleum activities</td><td>Access track - 16.2
Comms tower - 0.5 ha
EWAs -0.9 ha
Well pads – 43.0 ha
RoW – 76.7 ha</td><td>137.3 ha</td></tr>
<tr><td colspan="3">Category C PPZ (PPZ - within 200 m)</td><td>58.8 ha</td></tr>
<tr><td>Essential habitat for 'endangered or vulnerable wildlife. 'Of concern REs', and 'State forests'</td><td>Only essential petroleum activities</td><td>Access track – 3.48 ha
Mobile drilling area – 0.877 ha
EWAs – 1.686 ha
Laydown – 2.56 ha
Roads – 23.0 ha
Well pads – 8.27 ha
RoW – 18.95 ha</td><td>58.8 ha</td></tr>
</table>

The following table provides the proposed biodiversity impacts from the SGP South Stage 1 activities in relation to the maximum significant disturbance footprint allowed under the SGP South EA.

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<tr><th>Item</th><th>Issue/Observation</th><th>Action required</th><th>Arrow Energy's response</th></tr>
<tr><td></td><td></td><td></td><td>
Total proposed SGP South Stage 1 footprint by ESA vs SGP South EA Maximum allowed footprint
<table>
<tr><th>Project Activities</th><th>Location</th><th>Total proposed disturbance SGP South Stage 1</th><th>Maximum allowed footprint by petroleum lease (PL)</th><th>Maximum allowed footprint under SGP South EA by ESA type</th></tr>
<tr><td rowspan="2">Ground disturbance to Category B ESAs</td><td>PL493</td><td>0.3 ha</td><td>6 ha</td><td rowspan="2">17 ha</td></tr>
<tr><td>PL1039</td><td>0 ha</td><td>11 ha</td></tr>
<tr><td rowspan="6">Ground disturbance to Category C ESAs</td><td>PL185</td><td>0 ha</td><td>0.5 ha</td><td rowspan="6">1,657 ha</td></tr>
<tr><td>PL493</td><td>0.2 ha</td><td>5 ha</td></tr>
<tr><td>PL1039</td><td>0 ha</td><td>10 ha</td></tr>
<tr><td>PL1040</td><td>137.3 ha</td><td>1,640 ha</td></tr>
<tr><td>PL1041</td><td>0 ha</td><td>0.5 ha</td></tr>
<tr><td>PL1043</td><td>0 ha</td><td>1 ha</td></tr>
</table>
As per the above table, Arrow Energy can confirm that the total proposed disturbance from the SGP South Stage 1 activities are well under the already approved maximum disturbance limits for Category B and Category C ESAs under the SGP South EA and no amendment to the SGP South is required to this regard.
</td></tr>
<tr><td>5</td><td>Where impacts are determined to be relevant to the same/substantially the same matter and the same/substantially the same impact, the offset delivery may be satisfied through obligations under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). This is confirmed through the assessment of a Notice of Election. The EA must still identify and authorise the impacts to PEMs.</td><td>Identify and quantify impacts to all PEMs that are MSES regardless of whether approval is held under the EPBC Act. Specifically, for any matters on the proposed EA listed as MNES, please quantify these.</td><td>The BIA (refer to Appendix A) identifies and quantifies all impacts to PEMs regardless of whether approval is held under the EPBC Act.

Refer to Section 1.4.1 that discusses the relevance of the EPBC Act and the MNES species that were included in the BIA. A likelihood of occurrence (refer to Section 2.1.2.1 of Appendix A) was undertaken and any impacts to MNES species or MSES were assessed in Section 4, including an SRI where required.
Section 5.2 and Table 5.5 of Appendix A identifies all PEMS that are MSES regardless of whether they are matters under the EPBC Act.</td></tr>
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Waste			
6.	Inclusion of condition Waste 5 relating to the management of vegetation waste requires site-specific information of the impacts to environmental values that may occur should the activities be authorised. Note: the intention of the use of this condition is to be used in conjunction with Waste 4 (listed below) with the first preference for this waste to be beneficially reused. ***Waste 4**: Green waste may be used on-site for either rehabilitation or sediment and erosion control, or both.*	Provide the following:	Arrow Energy uses its internal processes for the management of cleared vegetation, or 'green waste' in accordance with current applicable legislation. Activities undertaken by Arrow Energy, including those undertaken by contractors engaged directly or indirectly by Arrow Energy are likely to produce Green waste, or 'cleared vegetation', due to the clearing of land. The inclusion of condition Waste 5 in relation to vegetation waste is to be used in conjunction with condition Waste 4 to align the SGP South EA with the *Streamlined model conditions for petroleum activities* Guideline (ESR/2016/1989, Version 2.04 of 13 May 2024) (condition Waste 5), **with Arrow Energy's preferred first option for the management of this type of waste to be beneficially re-used as stipulated in condition Waste 4 (i.e., re-used)**. Arrow Energy's internal processes stipulate that **vegetation shall not be burnt unless within areas covered by the *Forestry Act 1959* and only with correct permits in place,** and that **no onsite burning of waste is not allowed unless permitted under the EA**.
		(i) Risk assessment that identifies the possible impacts due to the proposed activities and all associated risks to environmental values;	**(i) Risks associated with the generation of green waste can include:** • blocking of stock, wildlife, or water movement; and vehicles for access and maintenance activities (e.g., erosion repairs, weed control, etc.); • loss of hollow bearing logs or other fauna habitat features (e.g., large rocks/rock piles, hollow bearing limbs); • potential shelter attraction for fauna; • bushfire risk from stockpiled cleared vegetation; and • reduction of vegetation regrowth.
		(ii) Strategies to mitigate identified risks to environmental values;	**(ii) Arrow Energy's management measures for the storage and handling of Green waste include:** • Re-use on site where possible (e.g., use in land rehabilitation and/or in erosion and sediment control activities); and • Mulching of any vegetation not specified to be stockpiled or retained[1]. Onsite re-use of Green waste is Arrow Energy's preferred reuse/disposal method. **Strategies identified to mitigate Green waste's identified risks are:** • stockpiling of cleared vegetation in a manner that facilitates respreading for future land rehabilitation activities or salvaging, and does not impede vehicle, stock, wildlife, or water movement.

[1] The depth of mulch and method of application may impact its effectiveness for erosion and sediment control and vegetation re-establishment.

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			• retaining all hollow bearing logs and stockpiling them within the project's battery limits;
			• including a spotter catcher or ecology representative to be present when any piles of timber or vegetation stockpiled for greater than 24 hours or a period to be determined through specialist ecology advice are required to be moved;
			• managing bushfire risks from stockpiled green waste accordingly by:
			  ○ calculating safe vegetation management buffer distances;
			  ○ reducing the size of the stockpiles by using a mixture of timber stockpiles and mulch; and
			  ○ placing mulch at a depth not greater than 50 mm due to the increased risk of prolonging fire where a bushfire may have occurred and reducing vegetation regrowth due to high ground temperatures as a result of burning.

		(iii) An assessment against the waste management hierarchy to demonstrate that all other options have been considered.	**(iii) Application of the waste hierarchy**: Arrow Energy utilises the mandatory requirements for managing wastes generated from its operations in accordance with the 'waste hierarchy' as contained in the *Waste Reduction and Recycling Act 2011* (section 9), which establishes the preferred order in which waste and resource management options should be applied. This is the guiding principle for waste management at all Arrow Energy sites, and are: 1. AVOID unnecessary resource consumption 2. REDUCE waste generation and disposal 3. RE-USE waste resources without further manufacturing 4. RECYCLE waste resources to make the same or different products 5. RECOVER waste resources, including the recovery of energy; 6. TREAT waste before disposal, including reducing the hazardous nature of waste; and 7. DISPOSE of waste only if there is no viable alternative. Arrow Energy's ensures that the elements of the waste hierarchy are considered in project activity planning and design, particularly identifying opportunities or waste management practices for avoiding and minimising waste during all stages of the project, including construction, operations, and decommissioning. With regards to the generation of cleared vegetation, or Green waste, the clearing of vegetation for the development of the project activities will be avoided to the extent it is practicable before any decision to clear or disturb vegetation is taken, and it will be limited to the minimum necessary for safe construction and operation of infrastructure. Minimal disturbance site preparation methods are utilised whenever possible for well pads and associated access tracks. As such, the first three principles of the waste hierarchy are applied to the management of green waste.

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7.	The inclusion of condition Waste 12 requires further information to confirm whether the proposed activities trigger the requirement for ancillary ERA 63(1)(a) either (i) or (ii).	Please provide sufficient information relating to any proposed STP operations to allow for this determination.	The proposed EA amendment does not seek authorisation for any additional Sewage Treatment Plant (STP) operations. The SGP South EA already authorises the release of treated sewage effluent or greywater to land through existing condition Waste 11, this is, STPs with release limits defined for camp sizes up to 1500EP. As such, Arrow Energy believes that ERA 63(1)(a) either (i) or (ii) should already be listed in the EA to ensure consistency with existing conditions. Arrow Energy proposes to add ERA 63(1)(a) (refer to **Appendix D**, Draft marked-up EA (EA0001613)). Notwithstanding, Arrow Energy's proposed amendment to Waste 12 (i.e., a new modified condition Waste 14) is to authorise temporary drilling camps which may be up to a max 50EP, to be able to release treated sewage or grey water to land for irrigation as long as they comply with the conditions in this new proposed condition Waste 14. As it is currently under the SGP South EA, STPs with less than 21EP are authorised to release these type of effluents to land without any release limits due to the low risk nature based on the DETSI risk assessment for petroleum activities and the short term duration of the release (i.e. drilling campaign for a few weeks or workover rig), before they are demobilised to another site. Arrow Energy proposes to increase this from 21EP to 50EP through this new condition Waste 14, consistent with the recently approved SGP North EA conditions (EA0001399), only for temporary drilling camps to allow for operational flexibility whilst reducing HSSE exposure from increased driving from rig camps to another rig camp or towns because of the restriction on the maximum camp EP for the duration of the drilling campaign.
8.	Applications should identify the environmental values likely to be affected by the proposed amendment, the nature and extent of any impacts, and the management practices proposed to be implemented to prevent or minimise adverse impacts.	Please address these areas in relation to changes proposed in the submitted EA relating to management and beneficial use of produced water.	The proposed activities will comply with existing SGP South EA conditions regarding water and wetlands environment, and the EA amendment will not result in changes to the management of Coal Seam Gas (CSG) water (i.e., produced water). Refer to Section 6.3.1 and Table 6-4 of the SGP South EA Amendment Supporting document, in response to the statutory requirements for CSG Activities under s227 (1)(b) of the *Environmental Protection Act 1994*). The EA amendment proposes to include conditions regarding the use of produced water for irrigation activities to align the EA with *Streamlined model conditions for petroleum activities* (SMC) Guideline (ESR/2016/1989, Version 2.04 of 13 May 2024): • SMC Guideline condition Waste C1 – resulting in the inclusion of condition Waste 11 to the SGP South EA (refer to marked-up EA, **Appendix D** of this RFI);

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			• SMC Guideline condition Waste C2 – resulting in the inclusion of condition Waste 12 to the SGP South EA (refer to marked-up EA, **Appendix D** of this RFI); and • SMC Guideline Waste management schedule, Table 1 – Assessment procedures for water quality criteria) – resulting in the inclusion of Schedule B, Table 1 to the SGP South EA (refer to marked-up EA, **Appendix D** of this RFI). The EA amendment also proposes to include conditions to authorise the transfer of CSG water to third parties for its beneficial use with the inclusion of new condition Waste 18, for its use for the following purposes: • dust suppression; • construction and operational purposes; • irrigation and livestock watering; • industrial use such as coal washing, power stations, and water treatment facilities. The above beneficial uses of CSG water apply providing they also comply with new proposed condition Waste 18 (a) to (d), new table Schedule B, Table 2 – Water Contaminant Release Limits, new condition Waste 19, and new condition Waste 20. The proposed conditions Waste 18, Waste 19, and Waste 20 are also in line with the Standard Conditions for Petroleum Exploration Activities. Arrow Energy's CSG Water Management Plan is consistent with the above changes and inclusions proposed in the EA amendment.
Groundwater			
9.	To support the proposed amendments to water conditions in this application, a groundwater assessment, including modelling, is required to understand the extent of risks on EA0001613 associated with the historical underground coal gasification (UCG) activities on Lot 40 DY85.	a) Provide an in-depth assessment, including groundwater modelling, that identifies potential influences and risks associated with Lot 40 DY85 on the land and activities subject to EA0001613. b) Provide supporting information that justifies the relevant inputs for the groundwater modelling and what process was applied to confirm an acceptable and unbiased outcome to the modelling results. c) Prove a discussion with evidence on how reservoir pressure has been considered and accounted for in the model to determine groundwater flow direction at Lot 40 DY85.	Through Arrow Energy's conditioning for the Hopeland EA (PL253) (EA0001401),, we have undertaken extensive investigations in relation to the historical underground coal gasification (UCG) site activities on Lot 40 DY85 operated by the former Linc Energy. PL253 is located directly adjacent to Lot40 DY85 (and encompasses Lot40 DY85). Through the Hopeland EA, granted in 2023, risks relating to natural gas product have been addressed through these investigations and supporting conditions. The 10km exclusion zone contained within the existing SGPS EA does not exist in the Hopeland EA. In addition to available historical data from the time of the UCG activities which ceased in 2013, 32 purpose-drilled groundwater monitoring bores were installed in and around the site by the Queensland Government and Arrow Energy, with data extending as far back as 2018. Arrow Energy has supported these investigations since 2019 through

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			conditions of its EA for PL253 including the installation of 12 monitoring bores and sampling up to five (5) landholder bores in the area. The monitoring and modelling for these investigations was reviewed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2023 and with the (completed) additional 4 bores, was considered acceptable to support the approval of the PL253 Environmental Authority EA0001401. Ongoing data collection has facilitated Arrow Energy's update of the conceptual site model (SCM), encompassing the historical UCG operations by the former Linc Energy, which were the source of the residual contamination; the degradation of contaminant concentrations with time; and the potential contaminant mobilisation pathways and groundwater flow regime around the site. The SCM and data collected are used in a 3D numerical groundwater model (incorporating groundwater flow as well as contaminant fate and transport) which is history matched to the available data and provides for quantitative uncertainty analysis in predictions of potential impacts from Arrow Energy's proposed operations. A groundwater assessment is provided in **Appendix C**. This assessment is in line with best practice and the latest numerical modelling techniques including for groundwater flow, contaminant transport, and particle tracking. The models were developed using MODFLOW 6 which is the industry-standard code for numerical modelling. The groundwater flow and contaminant transport, and particle tracking models were developed by INTERA who contributed to development of this code through the creation of advanced modelling tools and packages (USGS, 2024). It draws on extensive groundwater monitoring and modelling conducted by Arrow Energy and others within the vicinity of Lot40 DY85, as summarised above, including quarterly groundwater sampling and the 3D groundwater model developed under the conditions of EA0001401. a) The groundwater assessment was carried out using numerical groundwater flow, contaminant transport, and particle tracking modelling, based on the most recent Field Development Plan (FDP) for PL253 and PL493. Predictive modelling scenarios were developed to assess and quantify the risk of contaminant migration from Lot 40 DY85. Further details are provided in **Appendix C**. b) Supporting information that justifies the relevant inputs for the model (i.e., model grid and stratigraphy, boundary conditions, Arrow Energy and non-Arrow Energy CSG wells, contaminant source, initial contaminant distribution, sorption and decay [degradation] approaches) are presented in Section 2.1.3.1 of **Appendix C**, with processes applied to confirm an acceptable and unbiased outcome provided in Section 2.1.3.2.

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			c) Section 2.1.4 of **Appendix C** provides a discussion with evidence on how reservoir pressure has been considered and accounted for in the model, with additional information provided in Section 2.2.2.3.
10.	The following issues may impact the monitoring of groundwater levels and quality and determining groundwater flow directions and trends at Lot 40 DY85: • limited data points resulting in simplification of contours and flow direction • groundwater quality being highly variable spatially • reservoir pressure variations as a result of venting • issues as a result of kill water introduced at some bores Additionally, DETSI requires a complete understanding of the limitations of the groundwater modelling, to understand any uncertainty in the influence of the gasifiers on groundwater levels and reservoir pressure flow patterns, and conversely the risk of migration off-site.	a) Relevant to the required groundwater modelling and results, provide an assessment with details on any limitations and uncertainty associated with the abovementioned issues and how these have been addressed. b) Where relevant, such as for reported recharge rates, provide a comparison with OGIA conceptualised and/or modelled rates to support values applied in the groundwater modelling.	In line with best practice, the SGP South EA groundwater assessment was undertaken using advanced numerical modelling techniques based on an ensemble of history-matched datasets aligned with the latest proposed development plan for PL253 and PL493. The groundwater flow, contaminant transport, and particle tracking models were developed using MODFLOW 6, the industry-standard code for simulating groundwater systems. The models were developed by INTERA, who have contributed to MODFLOW's development through the creation of advanced modelling tools, including the adjoint capture function for MODFLOW-2005 and the Contaminant Treatment System (CTS) package for MODFLOW 6, which enhance its capabilities in capture zone analysis and contaminant transport (USGS, 2024). Methods employed to account for uncertainty in the data used in the groundwater model (refer to **Appendix C**) include using a quantitative uncertainty analysis approach, history matching using different types of data to avoid bias, reviewing groundwater monitoring data collected by the third-party contractor and excluding the data that likely represent conditions affected by venting-related pressure changes and the introduction of kill water, and using geostatistics to generate stochastic distributions of initial contaminant concentrations. a) Section 2.2.2 of **Appendix C** provides an assessment of the limitations and uncertainties associated with the availability of limited data points, which can lead to simplified contour mapping and flow direction interpretation, as well as the high spatial variability of groundwater quality, and reservoir pressure variations caused by venting and the introduction of kill water at some bores. It also investigates the potential impacts of these issues on monitoring groundwater levels and quality, and on determining groundwater flow directions and trends at Lot 40 DY85. The section concludes by explaining how these limitations and uncertainties have been addressed. b) Section 2.2.3 of **Appendix C** provides the recharge ranges and their comparison with OGIA (2019, 2021) values. This section also compares the modelled flow rate estimates for the relevant layer in which historical UCG activities occurred (the Macalister coal seam) with those from the OGIA (2021) model.
11.	Provide additional information.	If available, provide the following additional information: • The year in which the hydraulic gradient at Lot 40 DY85 inverts;	The simulated drawdown and associated flow fields demonstrate that the proposed five CSG wells on PL493 do not induce hydraulic gradients that would increase the risk of contaminant migration, therefore showing that the operation of these five wells wouldn't have any impact on the migration of contaminants on Lot 40 DY85.

Item	Issue/Observation	Action required	Arrow Energy's response
		• The vertical gradient between Springbok Sandstone and WCM Macalister; • The maximum particle migration distance from the boundary of Lot 40 DY85 over the simulation period; • The particle locations at the end of the simulation period; • Forecasted contaminant concentrations around Lot 40 DY85; • Predictive year at which the hydrocarbon plume would deplete. Additionally provide the latest monitoring results report Arrow has completed for the historic UCG site.	The following summary has been drawn from the groundwater assessment provided in **Appendix C**: • The median year in which the hydraulic gradient in the Macalister coal seam at Lot40 DY85 inverts is late 2025, with a range up 2035. This change to groundwater movement is slow and gradual and does not indicate that any remaining contaminants will move offsite (see points below). Further detail is provided in Section 2.3.2.1. • The vertical gradient between Springbok Sandstone and WCM Macalister remains downwards (i.e., from the Springbok Sandstone to the Macalister coal seam) in all model realisations, with no reversal in gradient direction during the simulation period. Refer to Section 2.3.2.2 for additional details. • The maximum particle migration distance from the Lot40 DY85 boundary was 2432 m over the entire simulated period (over 200 years) for the most sensitive realisation of the model, while the median distance was less than 25 m over 200 years. Table 1-2 provides summary statistics of simulated particle distances from Lot40 DY85 boundary for all realisations. Refer to Section 1.4.4 for further detail. • Maps showing the particle locations at the end of the model simulation period are presented in Section 2.3.2.4. • The UCG by-products that are identified as contaminants for consideration (e.g., benzene and naphthalene) have been modelled, with predicted concentrations around Lot40 DY85 discussed in Section 1.4.3 and Section 2.3.2.5, with further figures presented in an appendix of the report. It is important to note that the concentration of contaminants has been either below the limit of reporting (LOR) or showing an overall declining trend since 2018 as observed in most of the monitoring bores (further information below). • Table 2-4 summarises the model-predicted years when indicators of the hydrocarbon plumes (e.g., naphthalene and benzene concentrations) are predicted to completely attenuate (break down). Of particular note, these indicators in the Macalister coal seam degrade the fastest, with the mean depletion in this formation occurring by 2032, while in the earliest case all indicators may have broken down by 2028. Naphthalene was predicted to deplete earlier than benzene across all modelled scenarios, with mean depletion years of 2027–2028 in the Springbok Sandstone and 2021 in the Macalister coal seam for naphthalene. Early depletion (P5) was predicted as early as 2018–2020, while later estimates (P95) extended to 2040 in the Springbok and 2032 in the Macalister. Benzene showed greater persistence, with mean depletion predicted around 2042–2043 in the Springbok and 2032 in the Macalister. P5

Item	Issue/Observation	Action required	Arrow Energy's response

			values for benzene ranged from 2026–2032, while P95 extended to 2049 in the Springbok and 2045 in the Macalister.
			
			The latest monitoring results for the historic former Linc Energy UCG site (Lot40 DY85) are provided in the Investigation Report for PL253 in **Appendix E**. No widespread or consistent increasing concentrations of the typical UCG contaminants were detected. The analysis of the monitoring results indicates that the contaminants detected are consistent with UCG activities on Lot 40 DY85. Arrow Energy has not undertaken production activity on PL253 and based upon the monitoring results, has not caused migration of the contaminants.
			
			The Investigation Report found:
			• No significant change in groundwater flow direction and level has been observed.
			  ○ Groundwater flow in all aquifers and coal seams continues to follow the regional east-to-west gradient, consistent with historical patterns and regional geological dip (as per OGIA's UWIR 2021).
			  ○ Local depressions in groundwater levels and reservoir pressures remain present in the vicinity of the former UCG area, particularly within the Macalister coal seam and Springbok Sandstone. These features are consistent with historical monitoring and are not new developments. This suggests that any existing site contamination in this area is not currently migrating off-site via groundwater.
			
			Groundwater quality results indicate that contaminants dissolved in groundwater are primarily concentrated near the former gasifiers within Lot40 DY85. These concentrations are aligned with the known UCG legacy footprint and do not suggest new or increasing contamination, but show decreasing concentration of contaminants with time.
			
			The investigation limits contained in Arrow Energy's PL253 EA conditions are very low, for example even though natural groundwater is not considered suitable for drinking, the Australian Drinking Water Guidelines limit for benzene has been prescribed.

APPENDICES

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Appendix A. Biodiversity Impact Assessment SGP South EA (EA0001613) (Rev 3, 30/07/2025)

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Appendix B. SGP South Stage 1 Maximum Boundary Spatial data

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Appendix C. SGP South Groundwater Assessment – Response to EA Amendment 20250319 Information Request

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Appendix D. Draft marked-up SGP South EA (EA0001613) (07-AUG-2025)

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Appendix E. Latest monitoring results – Groundwater Exceedance Investigation Report, Hopeland (PL253), Reporting Period: 1 April 2025 to 30 June 2025

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