

Advice to decision maker on coal seam gas project

IESC 2017-088: Spring Gully North-West and North-East CSG Project (EPBC 2017/7881) – Expansion

Requesting agency	The Australian Government Department of the Environment and Energy
Date of request	6 September 2017
Date request accepted	6 September 2017
Advice stage	Assessment

Summary

The Spring Gully North-West and North-East CSG Project (the proposed project) is a proposed coal seam gas extension of 114 wells and associated infrastructure with a development footprint of approximately 601 ha. The project is located approximately 70 km north-east of Roma and 30 km east of Injune in southern central Queensland. The existing operation has been in production since 2005. The proposed project's lifespan is projected to be 30 years.

The proposed project will cause depressurisation within the Bandanna Formation. The IESC considers that groundwater drawdown and aquifer reinjection of co-produced water could result in changes to the volume of water available to ecosystems that rely on groundwater.

The proponent's environmental assessment does not meet the information standard set out in the IESC Information Guidelines (IESC 2015). The environmental assessment requires further baseline information to determine the potential for impacts to surface water and ecosystems that depend on surface and/or groundwater. Additional site-specific groundwater modelling is required to understand groundwater impacts as the regional scale Office of Groundwater Impact Assessment (OGIA) modelling is not suitable for local-scale impact assessment. The proponent has not conducted numerical groundwater modelling, and their analytical modelling is not fit for purpose. There is potential for environmental impacts from salt, hydrocarbons or other contaminants from unintended releases, seepage from water storages and from proposed onsite water use. These have not been adequately considered by the proponent.

The IESC has identified several key deficiencies in the assessment. To address these deficiencies and reduce uncertainty in the assessment, the proponent should provide:

- a more site-specific hydrogeological conceptualisation as this strongly affects the risk assessment. This applies especially to springs and groundwater-dependent ecosystems (GDEs) relying on groundwater from the Hutton and Evergreen Formations;

- an alternative approach to groundwater modelling is required in order to provide a robust risk assessment (including cumulative impacts) to support adaptive management. The proponent's site-specific model needs to be integrated with the results of the regional-scale OGIA model to assess cumulative impacts and will need to be periodically updated as development progresses;
- a broader assessment of potential GDEs to include ecosystems that rely on groundwater intermittently and the potential impacts due to higher pressures related to aquifer injection;
- details of water balance modelling to allow independent verification that discharges to Eurombah Creek will no longer be required. The modelling should clearly separate the water inflows, outflows and management measures of the proposed project at multiple stages over its full life from the existing approved operations;
- a surface water assessment of the Spring Gully Water Treatment Facility (WTF) at the discharge point and along Eurombah Creek to determine potential impacts to environmental values of Eurombah Creek including the White-throated Snapping Turtle (listed as Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*, (*EPBC Act*)), particularly if releases will occur as part of the overall water management;
- plans to deal with legacy issues associated with brine and salt storage after the project is completed to demonstrate that their management is feasible and low-risk; and
- an updated geochemical assessment of potential impacts of the aquifer injection scheme.

Monitoring, mitigation and management plans should be refined to clearly show how water specifically produced from this project will be managed under the current water management plans. These revised plans should be independently reviewed prior to site development and implementation.

Specific details on the above matters are discussed within this advice in the responses to the questions posed by the Commonwealth regulator.

Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and Energy to provide advice on the Australia Pacific LNG Pty Ltd's (the proponent) Spring Gully North-West and North-East CSG Project in Queensland.

This advice draws upon aspects of information in the preliminary documentation together with the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The Spring Gully North-West and North-East CSG project is an extension to the existing Spring Gully CSG project located approximately 70 km north-east of Roma and 30 km east of Injune in southern central Queensland. The proposed project will disturb an area of approximately 601 ha over its 30-year life with the installation of 114 wells and associated infrastructure including gas and water-gathering flowlines, access roads, power and communication systems, temporary accommodation camps, laydowns, stockpiles etc. The proponent does not propose to undertake any hydraulic fracturing as part of this project (PD, p. 144). Therefore, the IESC has not considered any potential impacts from hydraulic fracturing.

The proposed project is located in the Surat Cumulative Management Area (CMA) in Queensland. The Surat CMA contains a number of existing and proposed large-scale CSG developments. Modelling of cumulative groundwater impacts within the Surat CMA is undertaken by the Office of

Groundwater Impact Assessment (OGIA) who publish their findings in the Underground Water Impact Report (UWIR). The proposed project and its aquifer reinjection have not been assessed in the latest Surat CMA UWIR.

Key potential impacts

The key potential impacts of the proposed project include:

- changes in groundwater level and pressure in landholder bores as a result of groundwater depressurisation;
- changes to water volumes available at springs and other GDEs as a result of groundwater depressurisation and drawdown;
- changes to water volumes discharged at springs and other GDEs as a result of the aquifer injection scheme; and
- possible discharges of co-produced water to Eurombah Creek which may change its water quality and flow regime with associated impacts on downstream environmental values, noting that this discharge is already occurring under the current Environmental Authority (EA).

Response to questions

The IESC's advice, in response to the requesting agency's specific questions, is provided below.

Question 1: Can the Committee provide comment on whether the information provided in the draft PD (including baseline and modelled data), and the conclusions drawn by the proponent, is adequate to assess the project's impacts, including groundwater drawdown impacts on GDEs?

1. Given that this project is an extension, substantial data that have already been collected to satisfy conditions of approval for current operations have not been presented and it is not clear if the data have been used to inform the impact assessment.

Groundwater

2. Refined geological conceptualisations need to be considered to improve the modelling of local scale impacts. Natural systems have complexities that, depending on the scale of the study, may be important for the determination of impacts yet violate the simplifying assumptions of models. Geological conceptualisations should be consistent with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). The hydrogeological heterogeneity within the Rewan Formation, Precipice Sandstone, Evergreen Formation and the Hutton Sandstone is considered to be important for impacts of interest. This should include the two distinct facies in the Precipice Sandstone identified by the proponent. The analytical modelling presented is too simplified to capture processes important for impacts. Further, the assumption of constant parameters within the Precipice Sandstone will affect outcomes. The project has the potential to impact the Hutton Sandstone aquifer. This aquifer provides groundwater resources to landholder bores and GDEs such as terrestrial vegetation, springs and baseflow to surface water. The proponent states that there are no impacts to the Hutton Sandstone and associated watercourse springs due to the presence of the Evergreen Formation restricting the propagation of groundwater depressurisation and drawdown. (PD, 2017, App. 12, p. 58, Table 11). However, the information provided is insufficient to demonstrate no potential links between the Precipice and Hutton Sandstones.
3. Uncertainty in how effective the Evergreen Formation is in restricting groundwater drawdown and depressurisation arises from both the regional and local variation in facies within this unit. The IESC notes that hydraulic conductivity within the Evergreen Formation is variable. These

variations in measured horizontal (10^{-5} to 10^{-2} m/day) and vertical (10^{-5} to 10^{-3} m/day) hydraulic conductivity are shown in the OGIA report (State of Queensland 2016a, Figures 6-5, 6-6). Such variations have the potential to create preferential groundwater flow paths. To address this, updated modelling should be informed by detailed site-specific hydrogeological conceptualisation(s) and associated representative hydrogeological parameterisation.

4. The proponent has also considered regional numerical groundwater modelling undertaken by OGIA but this does not include the proposed project or reinjection into the Precipice Sandstone. The use of a regional groundwater model that does not include the proposed project fundamentally weakens the proponent's ability to predict impacts. Therefore, the magnitude, extent, severity and timing of groundwater impacts of the proposed project are not able to be determined. The IESC suggests an approach to modelling for the project in paragraph 5 below and in response to Question 2.
5. A numerical model or a number of smaller site-specific models is needed to represent the spatial heterogeneity and temporal detail to adequately describe the processes and features of this hydrogeological system. This is important given the scale and complexity of the project and the presence of sensitive groundwater receptors in the region. In this instance, a site specific 3D transient model incorporating key units, for example the Rewan Formation, Bandanna Formation, Precipice Sandstone, Evergreen Formation and Hutton Sandstone, would provide a more realistic representation of the project area and associated activities (see response to Question 2). The project's potential long-term impacts and groundwater recovery following the end of operations should be represented in the model. A thorough sensitivity and uncertainty analysis is required to test the range of outcomes due to groundwater properties and behaviours within and between aquifers.
6. The proponent has been operating in the region since 2005. However, the proponent has provided limited groundwater monitoring data in the assessment. For example, the Groundwater Management Plan shows several bores screened within the Hutton Sandstone (PD, App. 14, p. 63). Further, the groundwater quality summary (PD, p. 82) does not include any data for metals and only gives averages (no ranges) for the other chemical and physical parameters measured in the Bandanna and Precipice Formation only.
7. Cumulative groundwater impacts to Spring Rock (5-6 m max), Yebna 2 (1-1.5 m) and 311 spring complexes (1 m) are reported in the 2016 UWIR (State of Queensland 2016b). The magnitude and extent of impacts due to the proposed project are unclear, as reinjection and extraction are not captured in the current 2016 UWIR. It is also not clear how these impacts will be considered through the Joint Industry Plan (JIP).

Aquifer injection scheme

8. Known and expected operating pressures in the Precipice Sandstone and overlying formations should be discussed further and compared to the current EA limits and observed pressures within the aquifer (regionally as well as locally) both currently and prior to reinjection.
9. The proponent's aquifer injection scheme is not represented in a numerical groundwater model. As discussed in response to Question 2, the proponent should develop a local-scale numerical groundwater model. This should incorporate the aquifer injection scheme.
10. The Spring Gully aquifer injection scheme has been operational since late 2015 and data from the operating period are likely to exist. The information outlined below should be provided as it is needed for assessing the likely impacts of this scheme and should be used to support the proponent's conclusions.

- a. The geochemical modelling provided was undertaken prior to the aquifer injection trial and therefore included an assessment of multiple pressure and mixing ratio scenarios. The known range of operating pressures and mixing ratios should be used to constrain this modelling with updated results provided.
 - b. Geochemical modelling should include the possibility of discharge pathways from the reinjection point to the ground surface. When groundwater discharges to the surface, pressure is reduced and the water enters an oxygenated environment. Both of these processes affect mineral solubility and physico-chemical water quality parameters (e.g. pH, oxidation reduction potential and dissolved oxygen). These changes could impact flora and fauna which use this water. Predicted water quality should be compared to the appropriate level of ecosystem protection as outlined in ANZECC/ARMCANZ (2000) not just the Australian Drinking Water Guidelines.
 - c. Due to the lack of available data the reported geochemical modelling used a number of assumptions (PD, App. 9, p. 36). These assumptions should be validated including temperature, oxidation/reduction potential and aquifer mineral phases (through further analysis of the amorphous material).
 - d. There is potential for iron speciation to affect mineral precipitation and cause fouling which could limit functionality of the aquifer injection scheme, resulting in the need to periodically discharge to Eurombah Creek. Further investigations of iron speciation could be considered.
 - e. The geochemical modelling provided was identified as an initial assessment with a recommendation that it be linked to a mass transport numerical groundwater model (PD, App. 9, App. B, p. 27). The proponent should undertake this work, using a more detailed model, or provide reasons to the regulator for why it is no longer considered necessary.
 - f. Geochemical modelling should be conducted to examine potential changes to water quality in the Evergreen Formation and the Hutton Sandstone should injectate-affected Precipice Sandstone groundwater enter these formations. This would facilitate an assessment of the potential risk to these formations and associated groundwater receptors including landholder bores and GDEs.
11. The proponent should undertake the following additional monitoring to identify and then address potential impacts to groundwater quality from the aquifer injection scheme.
- a. Monitor the oxidation/reduction potential of the injected water on a continuous basis as is currently done for pH and dissolved oxygen.
 - b. It is likely that native microbial communities promote groundwater quality within the Precipice Sandstone. Baseline surveys of the main functional groups of native groundwater microbes will allow the proponent to assess risks associated with injectate containing disinfectant.

Surface water

12. The proponent states that reinjection or beneficial re-use are the preferred co-produced CSG water disposal methods. The proponent also states the project has been changed and will not require releases of treated co-produced CSG water to Eurombah Creek. The IESC supports alternative approaches to disposal of co-produced water in order to avoid impacts from surface water discharge on Eurombah Creek. However, the proponent proposes to use the existing CSG Water Management Plan which allows for such discharges. Given the volume and regularity of contingency discharges identified by the water balance predictions (discussed below) the proponent needs to provide justification for their claim that the proposed project will not discharge to Eurombah Creek.

13. The IESC notes that untreated co-produced water may be used for project activities such as dust suppression. The proponent should demonstrate that the quality of this water will not degrade the environmental values of nearby water resources or groundwater-dependent terrestrial vegetation.
14. The water balance results presented (PD, App. 8) show the minimum volume of treated co-produced CSG water required to be discharged to Eurombah Creek is approximately 310 ML/yr (PD, App. 8, p. 37). The worst-case model predicts discharges of just under the proponent's EA maximum allowance of 700 ML/yr. In a median-weather year, releases are predicted to be necessary every month.
15. To address uncertainties in the water balance modelling and its results and to demonstrate that discharges to Eurombah Creek would not occur, the proponent needs to:
 - a. provide the supporting documentation for the water balance modelling to allow an independent assessment of the methods, data and veracity of the model results;
 - b. provide the data and methods used to determine the irrigation water volumes, soil water capacity properties and evapo-transpiration conditions at sites to be irrigated; and
 - c. provide water balance model predictions for the duration of peak years of water production for the existing and proposed project.
16. A surface water assessment downstream of the Spring Gully WTF discharge point and Eurombah Creek should be provided if the updated water balance modelling shows that discharges to Eurombah Creek will be necessary, even as a contingency. The surface water assessment should determine potential impacts to the environmental values of the receiving environment. This assessment would need to include:
 - a. an ecological assessment of Eurombah Creek downstream of the discharge point, as discussed under "Water-dependent ecosystems" below; and
 - b. any studies or monitoring data that the proponent can provide to support the above assessments.

Salt and brine management

17. Management of brine and salt solids is proposed to use existing management processes and facilities at the Spring Gully WTF. Salt solids are proposed to be stored until they can be encapsulated in two regulated waste facilities, to be located within the footprint of decommissioned brine ponds outside the Spring Gully Regional Area (PD, p. 44).
18. Permanent storage facilities are not anticipated to be operational for approximately 20 years (PD, p. 44). Storage of brine and salt solids for 20 years could impact on the environment if spills, leaks or seepages occur, particularly as brine may also include other contaminants, such as metals, hydrocarbons and radionuclides.
19. Large-scale CSG extraction has been occurring in the region surrounding the project area for approximately five years but a strategy for brine and salt disposal has not yet been determined. Without a long-term plan for permanent disposal, this remains an unmitigated risk. The IESC considers that if the plan is for long-term storage, a strategy should be developed and implemented now to prevent long-term legacy impacts.

Water-dependent ecosystems

20. The information provided is insufficient to assess potential cumulative impacts to GDEs. The proponent attempts to determine the magnitude of cumulative drawdown by using the OGIA

modelling in combination with estimates from an analytical groundwater model. However, the reliability of the predictions is affected by the limitations of the proponent's analytical groundwater model and the assumption that hydraulic connectivity between aquifers is limited (see paragraph 28). Consequently, impacts on springs sourced by groundwater from the Boxvale and Hutton Sandstones are not considered.

21. Limited ecological surveying data have been presented. The following information should be provided to facilitate assessment of potential impacts to water-dependent ecosystems.
 - a. Aquatic ecological surveys should be undertaken as discussed in the response to Question 2. These surveys should include surface water features within the proposed project sites and Eurombah Creek. If these surveys are currently underway as implied (PD, p. 32), then the final reports should be provided before the project commences.
 - b. An assessment of all potential GDEs, including ecosystems that rely on groundwater intermittently, should be undertaken. This assessment should include ecological surveys of riparian vegetation and an assessment of which threatened ecological communities (TECs) could be groundwater-dependent. Further details are described in the response to Question 2.
 - c. Stygofauna sampling should be conducted as discussed in the response to Question 2.

Drilling chemicals

22. The proponent has provided useful information on drilling chemicals. The IESC considers that risks to water resources from the drilling chemicals are likely to be low, noting concerns regarding disposal of drilling chemicals discussed in paragraph 25 below.
23. The proponent has listed chemicals (including CAS numbers) to be used and provided information on quantities. They have also undertaken analytical tracer modelling which gives an indication of the potential migration and dilution of chemicals away from the well sites. This is valuable in evaluating the potential environmental risks from the chemicals.
24. A small number of chemicals have limited or no information, yet they are presented as not persistent, bioaccumulative or toxic in the final analysis. This means that risks arising from use of potentially hazardous chemicals have not been fully assessed.

Landspray while drilling

25. It is proposed to discard excess drilling fluids using the 'landspray while drilling' (LWD) technique. The proponent has not assessed this exposure pathway in the chemical risk assessment (PD, App. 15)
26. The proponent proposes to use their existing Landspray While Drilling Procedure document. The IESC was not provided this document and is unable to comment on the specific process followed by the proponent except as presented in the Preliminary Documentation (p. 30) and the EA (PD, App. 2, pp. 51 – 52). The proponent estimates about 120m³ of drilling muds from each well will be spread across 4 ha of land. This has been approved already with conditions, including monitoring before spraying to ensure "chemical and toxicity parameters" are within acceptable limits. While monitoring of metals, Total Petroleum Hydrocarbons and electrical conductivity is proposed, other organic contaminants in drilling muds may also leach into soils, surface water and groundwater. These other contaminants should be monitored and included in a formal risk assessment. The IESC considers that, in addition to existing conditions, LWD should not occur in or near native vegetation.

Question 2: Can the Committee identify and discuss what additional information could be provided by the proponent to assist in the assessment of groundwater drawdown impacts on GDEs?

27. The IESC considers that the information outlined below should be provided by the proponent to assist in assessing the potential impacts of groundwater drawdown to GDEs in the vicinity of the proposed project. Some of these issues have also been addressed in the response to Question 1.
28. The proponent states that no impacts are expected at springs sourced from the Hutton Sandstone and the Evergreen Formation due to a presumed lack of hydraulic connectivity with the Precipice Sandstone (PD, pp. 84-85). Further evidence to support a lack of hydraulic connectivity between these aquifers near the project area should be provided as the IESC notes that hydrocarbon shows have been recorded in the Hutton Sandstone in areas of the Surat Basin, indicating some level of connectivity (Cadman et al. 1998). This evidence could be obtained from the existing nested bores screened in the Precipice Sandstone, the Hutton Sandstone and the Evergreen Formation. Additional nested piezometers may be required in the Boxvale Sandstone in the western part of the Evergreen Formation, in order to provide early warning of potential impacts to Lucky Last Spring, a spring complex of high conservation value that provides habitat for the EPBC Act-listed species *Eriocaulon carsonii*. Currently, the proponent relies on conclusions drawn in the 2016 UWIR (State of Queensland 2016b). These conclusions are drawn at a regional scale. Local-scale variability in geology can occur which may allow connectivity between aquifers. Therefore, local-scale data will be required.
29. A groundwater model should be developed consistent with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012) that is tailored to predicting impacts of depressurisation and reinjection on GDEs. Without this modelling, it is difficult to determine the impacts that the proposed project will likely have on GDEs. This modelling should use available monitoring data to provide early warning of potential impacts. Modelling in combination with environmental tracers may also help to confirm source aquifers for GDEs.
30. Drawdown and reduced groundwater discharges are recognised as a key threat to springs. However there are also potential impacts associated with inundation and waterlogging, especially where these conditions favour invasion by exotic vegetation that may outcompete native plants and alter habitat and food supply for native fauna. Rising water tables can result in anoxia within the root zone and stress plants; if the rate of rise exceeds that to which groundwater fauna and flora can adapt, then ecosystem health will be impacted (Dillon et al. 2009). This is why strategies to protect spring ecosystems include specifying the importance of “preserving the natural level of flow variability (daily and longer time scales) in springs” (Department of the Environment and Energy 2017).
31. If head-rise is likely to occur as a result of aquifer injection, springs and other GDEs in the project area should be monitored to measure any change in their biota that may be associated with increased flows. These data would also be essential to assess the success of management strategies implemented to control invasive species favoured by the altered water regime or to conserve native biota impacted by waterlogging and other impacts, such as anoxia (Dillon et al. 2009) associated with raised water levels.
32. The proponent states that severe changes in water availability at springs would be needed to alter ecosystem structure and species composition (PD, App. 9, p. 22). The proponent also states that studies have found “no threshold above which water table increases would cause harm” (PD, App. 9, p. 22). The proponent should provide information to support these statements. The information should focus on the specific species occurring in GDEs potentially impacted by the proposed project.

33. The proponent acknowledges that their ecological surveying did not always meet relevant Commonwealth and State Government standards (PD, p. 54). The IESC suggests that, in addition to following Commonwealth and State Government protocols, improvements to ecological surveying should include:
- a. aquatic ecology surveys are needed to improve the understanding of refuge pools and the importance of these pools to the White-throated Snapping Turtle and other aquatic biota that may be impacted by the proposed project. The proponent acknowledges that the survey for the White-throated Snapping Turtle was constrained by factors limiting detection success (e.g. water temperature, turbidity) and was only done in May 2017 (PD, p. 49). To capture seasonal variability, further surveys of this critically endangered species should be conducted at other times of the year.
 - b. an assessment of how changes to flow regimes and possible water quality changes could impact aquatic flora and fauna, including the White-throated Snapping Turtle, is needed. This assessment should examine potential changes caused by contingency surface water discharges from the WTF, drawdown due to CSG production and potentiometric head rises due to aquifer injection that result in increased groundwater discharges to watercourses.
 - c. ground-truthing of riparian vegetation (likely to be water-dependent) and Threatened Ecological Communities (TECs) is needed prior to any disturbance from proposed construction and operational activities. Further baseline surveying, particularly of refugial pools and GDEs other than listed springs, should be undertaken. As baseline surveying of listed springs is required under the JIP, it is likely that this has been undertaken. The IESC considers that these results should be provided.
 - d. stygofauna surveys of the alluvial/surficial aquifers and the braided stream facies (where reinjection will be targeted) of the Precipice Sandstone should be undertaken in accordance with the Department of Science, Information Technology and Innovation guidelines (DSITI 2015).

Question 3: Can the Committee discuss whether the proposed aquifer reinjection program is adequate to mitigate groundwater drawdown impacts on GDEs? What additional measures would be taken to monitor, mitigate and manage groundwater drawdown impacts on GDEs?

34. The proponent states that aquifer injection is being used as a management method for CSG co-produced water and not primarily as a mitigation method for drawdown (PD, p. 41). The proponent also states that reinjection is a beneficial reuse of CSG co-produced water (PD, Table 18, pp. 113-118) and will reduce the predicted drawdown at the springs.
35. The adequacy of the proposed aquifer reinjection program in mitigating groundwater drawdown impacts on GDEs is unclear from the information provided. This is primarily because of the limitations of the proponent's current groundwater model and assumptions about the lack of hydraulic connectivity between aquifers as discussed in the response to Question 1. Due to these limitations, the IESC believes further information is required to have confidence in the current predictions of drawdown, depressurisation and head-rise. Consequently, no conclusions can be reached about the mitigation capacity of the aquifer reinjection program.
36. The following should be addressed to facilitate an assessment of the adequacy of the aquifer reinjection program as a mitigation measure for groundwater drawdown impacts on GDEs.
- a. A new numerical groundwater model should be constructed as discussed in the responses to Questions 1 and 2 and used to determine impacts from reinjection.

- b. A monitoring program, including triggers and management actions, should be developed to identify when head changes are having negative impacts and how they could be managed. The groundwater exceedance response plan currently requires 100 days exceedance (either drawdown or groundwater quality) before investigation. The IESC believes this is not an early warning mechanism as proposed by the proponent.
 - c. Monitoring should consider using loggers and telemetry (if not already in place) to obtain water level data in real time with reporting that would provide sufficient early warning of impacts for management responses to be enacted. Continued monitoring of the JIP early warning and trigger sites, Spring Gully monitoring bores, aquifer injection scheme monitoring bores, springs and other potential receptors is critical to ensure early identification of the potential for impacts to these assets.
 - d. Water quality triggers should be developed for all monitoring bores and for the springs. These could be used to identify potential water quality changes from the reinjected water and should be able to trigger a management response without an associated level/pressure change.
 - e. A commitment to avoid GDEs, potential habitat of listed species and TECs as well as other native vegetation when undertaking LWD is needed. Additionally, the proponent should identify the extent of the exclusion zone that would be needed to prevent leached LWD materials from reaching surface water features or GDEs via through-flow. This will vary depending on the soil properties and topography of each application site. Site-specific exclusion zones should be implemented.
 - f. The IESC notes that the proponent has developed a hierarchy for locating infrastructure to minimise impacts to higher value ecosystems. The proponent has also avoided placing infrastructure in the southwest of PL417 (North East Development Area) where there are large areas of TECs. However, the following proposed locations should be reviewed to minimise potential impacts to water-dependent ecosystems and TECs.
 - i. In the northeast of PL418 (North West Development Area - NWDA) and the southwest of PL414, the development footprint appears to be located within a riparian corridor, possibly crossing the creek on multiple occasions (Referral, Attachment E, Figure 4.2a).
 - ii. In the northeast of PL414, and the centre of PL415 (NWDA), the development footprint is shown bisecting two areas of ground-truthed Brigalow TEC (Referral, Attachment E, Figure 4.2b).
 - iii. In the northeast of PL417, a well-pad appears to be located within a large area of potential Weeping Myall Woodland TEC. In the central and southern areas of PL417 some well-pads appear to be partially located in potential Brigalow TEC (Referral, Attachment E, Figure 4.2d).
37. The IESC notes that the map provided of the groundwater monitoring network in the Evergreen Formation (PD, App 14, App A, p.63) shows no monitoring bores that can be used to provide an early warning of potential drawdown impacts to the *EPBC Act*-listed Lucky Last spring complex (see paragraph 28). The proponent is not the responsible tenure-holder for this spring complex, and does not anticipate that their activities will cause drawdown at this spring complex. However, monitoring of this spring complex is needed to ensure that potential impacts can be identified and suitable management actions commenced in a timely manner. Nearby tenure-holders should discuss responsibility for the installation, monitoring and management of such a bore.

Date of advice 19 October 2017

Source documentation available to the IESC in the formulation of this advice	<p>PD 2017. Spring Gully North-West and North-East Project – Preliminary Documentation, Australia Pacific LNG, draft dated August 2017.</p> <p>Referral 2017, Spring Gully North-West and North-East Development - Referral, EPBC referral 2017/7881. Referred by Origin Energy on behalf of Asia Pacific LNG, Brisbane.</p>
References cited within the IESC’s advice	<p>ANZECC/ARMCANZ 2000. <i>Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy (NWQMS)</i>. Canberra: Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.</p> <p>Barnett B, Townley LR, Post V, Evans RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A and Boronkay A, 2012. <i>Australian groundwater modelling guidelines</i>. Waterlines Report, National Water Commission, Canberra.</p> <p>Cadman SJ, Pain L, and Vuckovic V, 1998. <i>Bowen and Surat Basins, Clarence-Moreton Basin, Sydney Basin, Gunnedah Basin and other minor onshore basins, Qld, NSW and NT</i>. Australian Petroleum Accumulations Report 11. Department of Primary Industries and Energy. Bureau of Resource Sciences, Petroleum Resources Branch.</p> <p>Department of the Environment and Energy 2017. The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin, in <i>Community and Species Profile and Threats Database</i>. Department of the Environment and Energy, Canberra. Available [online]: http://www.environment.gov.au/sprat.</p> <p>Department of Science, Information Technology and Innovation 2015. <i>Guideline for the Environmental Assessment of Subterranean Aquatic Fauna: Sampling Methods and Survey Considerations</i>. Queensland Government. Available [online]: https://publications.qld.gov.au/dataset/f7e68ccd-8c13-422f-bd46-1b391500423f/resource/ba880910-5117-433a-b90d-2c131874a8e6/download/guideline-subterranean-aquatic-fauna.pdf</p> <p>Dillon P, Kumar A, Kookana T, Leijs R, Reed T, Parsons S and Ingerson G, 2009. <i>Managed Aquifer Recharge – Risks to Groundwater Dependent Ecosystems – A Review</i>. Water for a Healthy Country Flagship, Report to Land & Water Australia, 2009.</p> <p>IESC 2015. <i>Information Guidelines for the Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals</i>. Available [online]: http://www.iesc.environment.gov.au/system/files/resources/012fa918-ee79-4131-9c8d-02c9b2de65cf/files/iesc-information-guidelines-oct-2015.pdf.</p> <p>State of Queensland 2016a. <i>Hydrogeological conceptualisation report for the Surat Cumulative Management Area</i>. Department of Natural Resources and Mines, Office of Groundwater Impact Assessment. August 2016. Available [online]: https://drive.google.com/open?id=0B5u2TKAmnh_iaWsydHlfZVR0VVk</p> <p>State of Queensland 2016b. <i>Underground Water Impact Report for the Surat Cumulative Management Area</i>. The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines, State of Queensland. September 2016. Available [online]: https://www.business.qld.gov.au/industries/mining-energy-water/resources/land-environment/surat-cma/uwir</p>