EIS Information Guideline

Groundwater dependent ecosystems

This guideline informs proponents about the matters to be addressed in relation to groundwater dependent ecosystems (GDEs) when preparing an environmental impact statement (EIS).

DELIVERING FOR QUEENSLAND

Queensland Government

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February 2026

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1 Introduction

The Department of the Environment, Tourism, Science and Innovation (the department) has published separate, but related, EIS information guidelines that provide additional and more detailed information about assessing terrestrial ecology, aquatic ecology, matters of national environmental significance, coastal, and biosecurity (e.g. weeds and pests).

1.1 What are groundwater dependent ecosystems?

The *Queensland groundwater dependent ecosystem mapping method* (DSITI 2015a) defines GDEs as:

> 'ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services'.

Also, in relation to GDEs, the Queensland Government (WetlandInfo: Glossary of technical terms (DETSI 2021)) defines groundwater as:

> 'water that is present in the pores and cracks of the saturated or capillary zone and water that has been present in caves'.

1.2 What types of GDEs are there?

Current practice recognises the three following main types of GDEs (Eamus 2009); (Eamus et al. 2006).

1. **Aquifer and cave ecosystems**—such as karst aquifer systems, fractured rock, or saturated sedimentary rock that may host stygofauna, troglofauna or other biota.

2. **Ecosystems dependent on the surface expression of groundwater**—such as wetlands, lakes, seeps, springs, mound springs, river baseflow, coastal areas and estuaries and marine ecosystems where pressure brings groundwater above the surface of rocks, soils or sediments.**Ecosystems dependent on the subsurface presence of groundwater**—groundwater is not visible on the surface at these locations; however, the water table is permanently or episodically within the root zone of plants.

Both the second and third types of GDEs may involve perched aquifers. Depending on the depth of the saturate zone, GDEs may have shallow and/or deep-rooted vegetation.

The *Queensland groundwater dependent ecosystem mapping method* (DSITI 2015a) divides the three main types into the subtypes listed in Table 1.

Table 1 Types and subtypes of GDEs

Type	Subtype
Aquifer and cave ecosystems	Wetland system (subterranean wetland–aquifer)
	Wetland system (subterranean wetland–cave)
Ecosystems dependent on the surface expression of groundwater	Wetland system (lacustrine)
	Wetland system (palustrine)
	Wetland system (riverine water body)
	Wetland system (estuarine)
	Wetland system (near-shore marine)
Ecosystems dependent on the subsurface presence of groundwater	Regional ecosystem
	Wetland system (riverine regional ecosystem)

1.3 Addressing GDEs

The EIS must distinctly address GDEs in a separate subsection of the terrestrial or aquatic ecology chapter. The EIS must specifically identify and describe the existing GDEs, assess potential impacts on GDEs, and propose measures to avoid or mitigate the impacts. The following sections of this guideline provide advice on how to achieve those requirements.

Where the impacts on GDEs might occur as an indirect consequence of impacts on water resources, the EIS must cross-reference between the chapters that assess GDEs and water resources so that the EIS deals holistically with the impacts and mitigation measures.

2 Identifying and assessing GDEs

Identify, and assess impacts on, the existing GDEs using current best practice with a combination of desktop research and field studies. Advice on best practice is available from the following sources:

- Information guidelines explanatory note: Assessing groundwater-dependent ecosystems (Doody et al. 2019)
- Australian groundwater-dependent ecosystems toolbox part 1: assessment framework (Richardson et al. 2011a)

- Australian groundwater-dependent ecosystems toolbox part 2: assessment tools (Richardson et al. 2011b)
- Guideline for the environmental assessment of subterranean aquatic fauna (DSITI 2015b)
- Groundwater dependent ecosystem (GDE) mapping method (DSITI 2015a)
- Groundwater dependent ecosystem FAQs (DETSI 2015).

Integrate the identification of GDEs with information from the water resources studies for the EIS. Use knowledge about the local and regional hydrology and hydrogeology to identify where ecosystems that potentially use groundwater are located. The water resources studies must have sufficient field data from bores to adequately model the groundwater depth in areas where GDEs might exist.

The Independent Expert Scientific Committee on Unconventional Gas Development and Large Coal Mining Development (IESC) guidelines (Doody et al. 2019) provide a framework to be used by a proponent when preparing a section of an EIS that describes and assesses potential impacts, risks and mitigation options of unconventional gas or large coal mine activities on GDEs. The framework is divided into six stages:

1. Determine the spatial extent of impact
2. Identify GDEs in the impact area
3. Assess groundwater dependence
4. Determine baseline ecological condition
5. Assess impacts
6. Develop avoidance and mitigation measures.

Those stages are outlined in the following sections of this guideline. However, also refer to the best practice publications mentioned above for the detail of how to assess impacts on GDEs for the EIS.

2.1 Determine the spatial extent of impact

Determine and describe the potential spatial extent of impacts on GDEs. The assessment must not be limited to the project site – it must cover the whole area on and off the site that might experience changes to surface water and groundwater due to the project. Surface water is relevant as a source of recharge for groundwater. The EIS must explain how knowledge of the regional geology, topography, aquifers and hydrology were used to decide on the area covered by the assessments.

Include the full extent of groundwater drawdown and changes to surface and subsurface flow in channels and wetlands.

2.2 Identify GDEs in the impact area

Undertake a desktop assessment to obtain information about potential GDEs in the impact area from all available sources including the following sites:

- Aquatic conservation assessments (ACA) and AquaBAMM
- Biodiversity planning assessments
- National groundwater dependent ecosystems atlas

- Queensland groundwater dependent ecosystem mapping
- Queensland springs database
- Regional ecosystem mapping
- Wetland*Maps*.

Search for previous field studies in the project area, such as those produced for academic research or for industrial projects.

Assign the identified GDEs to one of more of the subtypes listed in Table 1 above and identify their regional ecosystem as described in the Regional ecosystem description database (DETSI 2024). Provide a detailed description of each GDE's attributes and environmental values. Illustrate the description of GDEs with maps, photographs, and aerial photographs/satellite images.

Describe the habitat value of each GDE with particular reference to any critical habitat or any habitat that might support threatened or near threatened wildlife.

Assess whether any of the GDEs are matters of state environmental significance and/or matters of national environmental significance.

2.3 Assess groundwater dependence

If the desktop assessment indicates that one or more GDEs may be present, develop for each GDE a conceptual model that describes the ecosystem's hydrology and hydrogeology, and its biotic components and processes (Wetland*Info*, and (Richardson et al. 2011a). Provide spatial datasets of the relevant GIS layers (e.g. topography, groundwater depth, ecosystems, etc.) and any associated attribute data. Describe the results of each model, showing where it predicts GDEs would occur.

Describe the methods and results of any initial field surveys and assessments for potential GDEs.

Where GDEs are likely to occur, the EIS must answer the following key questions (Richardson et al. 2011a):

- Is groundwater part of the ecosystem?
- How reliant is the system on groundwater?

Use current knowledge of local and regional surface and groundwater hydrology (water levels, hydraulic gradients and fluxes) to identify any GDE that might be impacted by the project. Take account of seasonal and climatic cycles.

Develop and describe a water balance model and estimate the ecological water requirements (EWRs) for each GDE with particular regard to quantity and timing (e.g. seasonal) of water availability. Assess the likely reliance of each GDE on groundwater.

2.4 Determine baseline ecological condition

Undertake field studies to examine in detail what GDEs are present in locations and areas that could potentially be impacted by the project. Address both direct impacts (e.g. by excavation) and indirect impacts (e.g. by altering groundwater levels or availability). Extend the studies to areas beyond the project site that might be impacted.

The field studies must be adequate for not only establishing the presence or absence of GDEs, but also the ecological condition of any GDEs present. Ensure the studies are conducted with sufficient replication and over sufficient time to establish seasonal effects on the ecological condition of identified GDEs. Ensure sites that are sampled for baseline assessment include those that would be suitable for ongoing monitoring for impact assessment during operations. Make every effort to identify locations with the same or similar GDEs to use as control or reference sites that can be compared with impacted sites if the project progresses.

Describe the methods and results of the field studies, including any assumptions, constraints or limitations. Field survey methods should consider multiple lines of evidence including the assessment of leaf-water potential, soil-moisture potential, and stable isotope analysis of xylem water and soil moisture. Describe the ecological condition and ecosystem value of each identified GDE. Integrate information about the existing quality of groundwater when assessing the baseline ecological condition of an identified GDE.

Identify a representative subset of each GDE type that would be used to detect impacts associated with the project's activities and monitor the effectiveness of mitigation strategies. Establish benchmarks for each GDE to be used when assessing the level of impact.

2.5 Assess impacts

Identify and assess the following matters (Doody et al. 2019):

- the threats to the groundwater system and ecosystem
- how the GDE (or one of its components) is likely to respond to changes in groundwater regime and water quality
- the natural range of hydrological conditions under which the GDE persists
- hydrological thresholds that represent the limits of ecosystem persistence and resilience or vulnerability.

Identify the project's activities that would, or might, impact on each GDE. Include not only the extraction but also the storage and disposal/release of mine affected water or coal seam gas water. Use conceptual models for each GDE and the threats to it to predict the likely impacts over the short and long terms, and under differing climate cycles. Threats might include changes to water quality (e.g. through contamination, or changes to salinity) and changes to groundwater availability, quantity or level. Use the models to predict the causal pathways and the spatial extent of likely impacts.

Assess the location and magnitude of the potential impacts and assess the significance of potential impacts at local and regional scales. Assess the sensitivity and resilience of each identified GDE to potential impacts. Estimate the potential loss of any GDE and assess whether the impacts of the project might change the ecosystem from one type to another. Assess any cumulative impacts that might occur in conjunction with other local or regional activities.

Undertake a risk assessment to identify GDEs that have high or medium ecological value and/or are at high or medium risk of impacts from CSG or large mining activities to prioritise management actions. The risk assessments must define relationships for each threat between:

(i) the consequences to the GDE, spatially and temporally, as a function of the severity of the threat

(ii) the likelihood of the threat affecting each GDE

(iii) the significance of impacts in a regional/state/national context.

Assess the type and magnitude of any residual impacts that would persist after operations cease. Describe, quantify, and assess the significance of any potential residual impacts on environmental matters prescribed in the Environmental Offsets Regulation 2014. The Queensland Government's Significant residual impact guideline (DETSI 2014) provides additional information when deciding whether a proposed project might have a significant residual impact on matters of state environmental significance.

2.6 Develop avoidance and mitigation measures

Describe in detail, the mitigation measures that would avoid or minimise all potentially significant impacts on GDEs. Demonstrate that the mitigation measures would avoid impacts to the greatest extent practicable. Where impacts cannot be completely avoided, the mitigation measures must minimise the level of impact. For significant impacts on prescribed environmental matters, assess the offsets requirements in accordance with the *Environmental Offsets Act 2014* and the latest version of the Queensland Environmental Offsets Policy (EPP/2015/1658) (DETSI 2023). Describe in detail how the offsets were determined or justify why no offsets are proposed.

All mitigation measures must be measurable and auditable. Consequently, propose specific environmental indicators with thresholds for corrective actions. Describe the corrective actions that would be taken if thresholds are reached.

Propose a monitoring plan capable of detecting trends in environmental indicators before they reach the threshold values for unacceptable impacts. Propose reference (control) sites with which to compare potentially impacted sites. Reference sites must be independent from the potentially impacted sites and should also be good analogues of those sites with respect to such attributes as geology, hydrology, and biology.

Provide a consolidated description of commitments regarding GDEs. Ensure these commitments integrate with commitments for related matters, such as terrestrial ecology, aquatic ecology, biosecurity, coastal management and protection.

Present the commitments and the avoidance and mitigation measures for GDEs in the form of proposed conditions that may be placed on the environmental authority and any other required approvals or licenses.

3 References and useful resources

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