SUMMARY OF ADVICE IN RELATION TO THE POTENTIAL IMPACTS OF COAL SEAM GAS EXTRACTION IN THE SURAT AND BOWEN BASINS, QUEENSLAND

Phase One Report Summary

for

AUSTRALIAN GOVERNMENT

DEPARTMENT OF SUSTAINABILITY, ENVIRONMENT, WATER, POPULATION AND COMMUNITIES

provided by

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Geoscience Australia (GA) and Dr M.A. Habermehl were contracted by the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) to provide expert advice in relation to the likely groundwater impacts of proposed and potential future Coal Seam Gas (CSG) extraction activities in the Surat and Bowen Basins in Queensland by Australia Pacific (APLNG), Queensland Gas Company/British Gas (Queensland Curtis LNG - QCLNG) and Santos Limited (Gladstone LNG - GLNG).

We have reviewed the content of the Environmental Impact Statements (EIS) and supporting documentation submitted by the three proponents, along with subsequent additional data and information, supplemented by discussions with the proponents. Based on this information, we consider that, while the EIS identify and assess a number of potential local scale (project area) groundwater related impacts, there are some matters which require further consideration under the *Environment, Protection and Biodiversity Conservation (EPBC) Act 1999*.

We recognise that some of these matters can be addressed through the provision of information and modelling developed by the proponents subsequent to the submission of the EIS, as well as through the collection of further information and data in the context of an adaptive management approach. However, we consider that the overriding issue in CSG development is the uncertainty surrounding the potential cumulative, regional scale impacts of multiple developments. The information provided in the assessed EIS documents is not fully adequate for understanding the likely impacts of widespread CSG development across the Surat and Bowen Basins; nor will any level of information or modelling that can be provided by individual proponents. We consider that a regional-scale, multilayer groundwater flow model which incorporates data from both private and public sector sources is necessary to inform this understanding. We emphasise, however, that no matter how thorough a model or detailed the underlying data, any modelled outcomes will be accompanied by high inherent uncertainties until sufficient CSG production data is available to calibrate the groundwater model.

The following summarises our assessment of the proposed projects according to the issues requested by DSEWPC for specific evaluation. We emphasise that this assessment relates to the potential impacts of individual operations on the identified issues and does not consider the likely impacts of multiple CSG operations.

The adequacy of the proponent's hydrogeological models for estimating hydrogeological impacts on and within the Great Artesian Basin (GAB) and other affected surface and groundwater systems (this would include an initial assessment of the potential of one or more aquifers to depressurise and dewater and the likely impacts).

- Within the limitations of available data, the 'project-scale' models produced by all the proponents are generally suitable as a preliminary basis for estimating hydrogeological impacts on and within the GAB and other potentially affected surface and groundwater systems within the influence of the proposed operations.
- The modelling results reported require further work to fully establish the uncertainties and sensitivity of the models to the large variability in the possible range of hydraulic characteristics of aquifers and aquitards, and to demonstrate the appropriate level of confidence that can be placed in the model outputs and the conclusions drawn from them.
- A 'cumulative' model presented by one of the proponents represents a useful preliminary assessment of potential regional hydrogeological impacts resulting from a range of groundwater extraction activities and provides a good starting point for the development of a regional cumulative effects model to underpin groundwater impact prediction and management.
- Whilst the project and regional scale models presented provide useful preliminary assessments of potential hydrogeological impacts resulting from a range of groundwater extraction activities, we understand that the proponents are in the process of developing new models or refining the existing models and consider that these should assessed as to their appropriateness as a basis for further decision making.

Potential impacts of groundwater extraction on aquifer interaction (e.g. water flow, cross contamination), vertical recharge, structural integrity and artesian pressure as a result of the CSG activities. This applies to both quantity and quality of groundwater.

The potential impacts of groundwater extraction on aquifer interaction have, in general, been adequately addressed, although there is scope for further elaboration regarding some aspects.

- The modelled vertical recharge and groundwater pressure changes resulting from coal seam depressurisation are reasonable and likely to result in groundwater flow into the coal measures from adjacent aquifers.
- We consider that these changes are likely to be reversible over medium to long term timeframes (decades to centuries), depending on the specific aquifer and the management strategies applied.
- There is insufficient information to assess the impacts of these changes on artesian pressure, although this is not likely to be evident in bores within the

immediate surrounds of the CSG tenements, as most groundwater here is subartesian.

- There is a low likelihood of cross-contamination, as the majority of inter-aquifer transfer will involve the migration of higher quality water from adjacent underlying and overlying sandstone aquifers into coal measures containing lower quality water.
- The structural integrity of aquifers in relation to groundwater transmission is unlikely to be significantly impacted by the proposed groundwater extraction. We note that groundwater extraction may cause some aquifer compaction that is likely to result in a degree of subsidence (discussed below).

Potential impacts of groundwater extraction on the EPBC Act listed endangered ecological community *'The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.'*

Based on consideration of the hydrogeological, environmental and management information provided, we agree with the assessments of two of the proponent that the risk of impact from groundwater extraction in individual operations to the EPBC Act listed endangered ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin*' is low, based on the following:

- With one exception, documented and/or surveyed natural discharge sites (springs) are located outside the CSG fields and the modelled zones of groundwater drawdown.
- Proposed monitoring programs are likely to enable the timely detection of potentially deleterious changes to groundwater level or quality, and the implementation of proactive responses.
- Proposed controls on the location and construction of infrastructure are likely to avoid physical impacts on environments suitable for hosting EPBC Act listed communities.
- A small number of additional natural discharge sites proximal to the CSG fields should be investigated and assessed to determine their EPBC Act significance.

Based on consideration of the hydrogeological, environmental and management information provided, we suggest that the third proponent consider further investigations to fully assess the risk of impact from groundwater extraction to the EPBC Act listed endangered ecological community '*The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin*'. Our assessment is based on the following:

- A number of surveyed and unsurveyed natural groundwater discharge sites (springs) proximal to the proponents' CSG fields should be assessed to determine their EPBC Act significance.

- Proposed monitoring programs do not state how trigger levels will be acted on with regard to mitigating changes to groundwater flow or quality in springs.

Potential for recharge into the GAB to be impacted in these areas as a result of CSG activities and the likely long term impact(s).

Although we consider that the proponents have provided sufficient information to assess the impacts of CSG activities on recharge processes at the ground surface, we do not consider that there is sufficient information with which to fully assess the long impacts of CSG activities on recharge into the GAB. On this basis we conclude:

- Proposed infrastructure located within the intake beds of the GAB is unlikely to significantly reduce the volume of groundwater recharge at the ground surface.
- A reduction in pressure as a result of water extraction down-gradient of the GAB aquifer intake beds is not likely to affect the rate of recharge.
- There is insufficient information currently to understand the relative significance of the proposed CSG activities in proportion to recharge to individual GAB aquifers. We consider that the total proposed annual extraction volumes may represent a moderate proportion of annual recharge to the GAB in the project areas, but that this represents a relatively small proportion of total recharge to the GAB. Detailed water balance modelling is required to quantify these relative volumes.
- We note however, that while individual operations may not represent a significant potential impact to overall GAB recharge, if similar extraction volumes were to occur from a number of CSG developments, GAB recharge could be significantly impacted. In such a scenario, we consider that a reduction in recharge flows basinward of the CSG developments could result in reduced artesian pressures and potential impacts on EPBC Act significant spring communities further afield from the developments.
- We are unaware of any existing data or modelling results which would be suitable for assessing the likelihood or potential timeframes for such impacts, although groundwater movement rates in deeper GAB aquifers suggest that any impact (and subsequent recovery) would be extremely long term (i.e. occurring over many thousands of years or more).

Potential impacts of hydraulic fracturing (fraccing) on the structural integrity of aquifers and aquitards, and on existing groundwater flow processes.

Based on the geological and technical information provided by the proponents with regards to the potential impacts of fraccing, we consider that the potential risks posed by fraccing are low. We conclude that:

- Fraccing will fundamentally alter the structural integrity of the targeted coal seam aquifers. These represent a relatively small proportion of the total thickness of the Walloon Coal Measures.
- While the potential for fraccing activities to impact on the structural integrity of other aquifers and aquitards, and on existing groundwater flow processes, can

never be completely eliminated, the competent application of industry standard technologies, techniques, and monitoring/mitigation measures proposed by each proponent are considered appropriate for minimising the risk.

- All proponents have adequately assessed any potential risks associated with fraccing activities and have proposed appropriate monitoring and mitigation measures.

Initial advice on the likelihood and materiality of subsidence as the result of the proposals.

Based on our assessment of the geological and geotechnical information provided, and relevant information from other sources, we consider that there is a likelihood of subsurface subsidence, and that this could result in surface subsidence.

- Based on the estimated magnitude of the subsidence (in the order of centimetres to tens of centimetres), and with reference to subsidence assessments for CSG activities in similar geological environments elsewhere, we consider that the risk of impacts to surface water and shallow groundwater systems is very low.
- We suggest that the monitoring activities currently proposed by two of the proponents should be strengthened by assessing deformation at the land surface as well as in the aquifers and coal seams.
- We suggest that the monitoring activities currently proposed by the other proponent, which assess both surface and sub-surface deformation, are appropriate.
- We consider that monitoring activities could be value-added by linking into a regional program of monitoring led by the relevant State Government agency.

Initial advice on the likelihood and materiality of any impact on Murray-Darling Basin (MDB) groundwater or connected surface water resources.

- On the basis of the available information, we consider that there is a limited likelihood of impact on MDB groundwater or connected surface water resources as a result of any of the proposed individual operations.

- This assessment is based primarily on information suggesting that only a small number of the proposed CSG tenements are proximal to the Condamine River Valley and are located in an area where there is no demonstrated hydraulic connection between the Walloon Coal Measures and MDB alluvial aquifers.

- However we consider that additional data from drilling and pumping tests is critical for confirming the potential for GAB aquifers to be connected with MDB groundwater or river systems.

Initial advice on potential cumulative impacts on the issues above

While all proponents identify the issue of cumulative impacts of groundwater extraction activities in the region, only two of the proponents have attempted to quantify this.

We consider that these cumulative impact assessments are unavoidably inadequate because of the inability of individual proponents to access commercial-in-confidence data from a number of sources. We do not consider that individual proponents can be in a position to develop regional scale models which incorporate confidential drilling and production data from other sources.

We consider that the successful long term monitoring and management of groundwater resources and groundwater-dependent EPBC Act communities dependent on natural discharge of groundwater from the GAB requires a comprehensive regional groundwater simulation model developed using all available data.

Recommendations

Although we consider that a number of the issues requested by DSEWPC have not been fully addressed by the material within the various EIS, we note that in many cases the necessary information associated with the impacts of individual operations has either been developed since the submission of the EIS, or can be acquired in the course of subsequent development under an explicit adaptive management strategy. We have noted that the current groundwater modelling is inadequate in terms of scale and detail to identify the impacts of multiple CSG developments on groundwater interactions in the GAB and hence on EPBC Act listed discharge springs communities in the GAB. However, if the following recommendations are implemented, it should be possible to manage the potential groundwater impacts of proposed and potential future CSG extraction activities in the Surat and Bowen Basins and minimise the risk of unintentional outcomes for EPBC Act communities dependent on natural discharge from the GAB.

We thus make the following key recommendations for a staged process of adaptive management of CSG development.

1. Management of uncertainty

Given the resulting levels of uncertainty in relation to cumulative impacts at the regional scale of a number of CSG developments, a precautionary approach should be taken in relation to approving proposed and potential CSG developments, recognising the fundamental principle that excessive rates of groundwater extraction will have impacts on groundwater and connected surface water systems, and on groundwater dependent values such as EPBC Act listed discharge springs communities in the GAB.

In the absence of sufficient evidence to characterise and quantify these potential impacts or to define excessive rates of extraction, we recommend that proposed and potential CSG development should be undertaken with an explicit requirement to minimise and mitigate any impacts during production.

2. Refinement of existing models as an initial basis for development

We have noted a number of shortfalls in the models presented in the various EIS, but consider that overall these models provide useful preliminary assessments of potential hydrogeological impacts resulting from a range of groundwater extraction activities.

We recommend that the predictions of these models could serve as a preliminary basis for informing initial decisions about the approval of the CSG developments, pending a positive assessment of the validity and implications of the new models we understand have been developed by the proponents since the submission of their EIS.

3. Modelling regional scale impacts of cumulative CSG developments

We consider that the proponents have, for the most part, proposed appropriate mitigation measures to address the short term, local scale impacts of groundwater extraction on groundwater users. However, it is not clear that the measures proposed in the individual proponent's proposals will be adequate to fully address regional scale impacts on EPBC Act values or aquifer interactions.

We recommend that a regional-scale, multi-state and multi-layer model of the cumulative effects of multiple developments, and a regional-scale monitoring and mitigation approach will be developed to assess and manage these impacts. Such a model could be used to set the parameters for an adaptive management framework in which monitoring and mitigation strategies can be developed and be applicable at both the project and regional scale. We consider that concerted Commonwealth and State action will be necessary to develop such a model as a high priority.

4. Management of long term water balance impacts

We emphasise that any groundwater model, no matter how well-parameterised, calibrated and validated, is an interpretation of a groundwater system and therefore subject to uncertainty. Given that there are shortfalls in the parameterisation and calibration of the models presented in the EIS, we consider that there are high levels of uncertainty in the accuracy of the predicted impacts of CSG development on groundwater behaviour and on EPBC Act listed ecological communities dependent on discharge from the GAB.

For this reason, **we recommend that measures to mitigate the potential impacts of proposed operations on water balances, such as the re-injection of treated associated water back into appropriate permeable formation(s) to re-establish pre-development pressure levels, be explored as an option and considered as a condition for approval of any development activities.** This needs to be undertaken in conjunction with appropriate measures to forecast and proactively manage any short term impacts, and should enable the reversal of any medium to long term changes in artesian groundwater pressures before they could impact on EPBC Act listed discharge communities. The design of and volumes involved in these activities should be informed by a regional-scale groundwater model.