



OUT18/6607

Mr Steven O'Donoghue
Resource Assessments
NSW Department of Planning and Environment
Email: Steven.O'Donoghue@planning.nsw.gov.au

Dear Mr O'Donoghue

**Santos Narrabri Gas Project (SSD6456)
Comment on the Response to Submissions (RTS)**

I refer to your email of 23 April 2018 to the Department of Industry in respect to the above matter. Comment has been sought from relevant branches of Lands and Water and Department of Primary Industries.

Any further referrals to Department of Industry can be sent by email to landuse.enquiries@dpi.nsw.gov.au.

As discussed in the Department's response to the EIS, the groundwater model is indicative only in terms of magnitude and timing of impacts, and cannot be relied upon for detailed impact prediction. The RTS has not demonstrated an adequate understanding of baseline information and has not proposed a suitable approach to monitoring, modelling and management should the project be approved.

This submission reiterates the requests for further information from the Department's response to the EIS to better understand the baseline conditions and risks related to water modelling and impact prediction. This submission also provides a detailed recommended approach to mitigate risk and to ensure appropriate management measures are in place should the project be approved.

Information required to determine the project application

The Department of Industry (DoI) recommends the Department of Planning and Environment (DP&E) request the following to inform determination of the project:

1. Analysis of data presented in the Water Baseline Report in accordance with Attachment A to improve the understanding of the baseline conditions and inform monitoring and modelling programs.
2. A Groundwater Monitoring and Management Plan, including a Groundwater Dependent Ecosystem (GDE) Monitoring Plan should be prepared in consultation with Lands and Water in accordance with the requirements specified in Attachment B. The plans will provide a clear direction on the scale and approach of monitoring and management required should the project be approved.

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3. A Groundwater Modelling Plan prepared in consultation with Lands and Water in accordance with the requirements specified in Attachment B. The plan will clearly map out how the groundwater model will be redeveloped for the specific purpose of predicting impacts to surrounding water sources, users and the environment should the project be approved.
 4. Prior to consultation regarding the Groundwater Monitoring and Management Plan the proponent should submit to Lands and Water detailed cross sections of the whole geological/hydrogeological profile from the geological model and groundwater model. The cross sections must extensively cover the project area from multiple orientations and also cover the alluvium to the north and east of the project area as well as the Great Artesian Basin (GAB) to the west and south outside of the project area. This should include localised maps showing the thicknesses of each geological unit.
 5. A plan of when and how the proponent intends to acquire the necessary water entitlements from relevant water sources if the project is approved. This must include an analysis of availability and potential to purchase in the water sources that are fully allocated and therefore require entitlement to be purchased from the open market.
 6. A Government Stakeholder Consultation Plan to ensure appropriate consultation with Lands and Water on water-related matters, including ongoing modelling and monitoring updates and reporting should the project be approved.

Recommended measures should the project be approved

Should the project be approved, the following management approach should be implemented to ensure robust modelling, monitoring and management to protect impacted water sources and their dependent assets and communities.

Groundwater Modelling and Impact Assessment

1. Update the groundwater model in consultation with Lands and Water by year three post project determination. Sufficient data should be available by year three to update to a confidence level classification Class 2 (Australian Modelling Guidelines).
2. Update the groundwater model in consultation with Lands and Water by year 6 post project determination. Sufficient data, including production and water level data, and hydraulic parameter information should be available by year six to update to a confidence level classification Class 3 (Australian Modelling Guidelines). If by year 6 post determination, insufficient data is available, the requirement and timing of delivery of a Class 3 model may be negotiated with Lands and Water.
3. Regularly update the groundwater model to quantify induced impact during the project's operation and impacts post production. Updated models and associated peer reviews should be made publicly available.
4. Update the groundwater impact assessment at each stage of model re-development including an assessment against the NSW Aquifer Interference Policy (AIP) and updates to the management response triggers. This must be completed in consultation with Lands and Water.

Groundwater Monitoring and Management Triggers

5. Install additional monitoring bores and make operational within the timeframes identified in Attachment B.

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6. The tiered Management Response Triggers should apply to the project as detailed in Attachment B.
 7. Update the Groundwater Monitoring Plan every 3 years and as required by Management Response Triggers. This will include updating the Management Response Triggers where appropriate once model updates have been approved.
 8. Update the groundwater dependent ecosystem (GDE) impact assessment including the HEVAE data provided for all GDE's. A GDE monitoring plan is to be implemented as defined in Attachment B.
 9. All monitoring, modelling and management plans and relevant monitoring data be made available on the proponent's website and reported to Lands and Water on a quarterly basis in a format that can be uploaded to the relevant databases (i.e. GIS, excel or text file).
 10. Prepare a monitoring and mitigation plan to address ecological and water quality impacts to Bohena Creek and other surface water sources. This should address water quality monitoring at the treatment plant.
 11. Investigate upgrading the Bohena Creek gauging station in consultation with Lands and Water and WaterNSW to accurately detect the discharge volumes proposed from the water treatment plant. Prior to a suitable gauging site being operational, discharge of waste water is not recommended. Should this investigation find gauge 419905 inappropriate the proponent is to identify and install a suitable gauging site closer to the discharge point in consultation with WaterNSW and Lands and Water.
 12. Implement the following plans once approved:
 - a. Groundwater Monitoring and Management Plan which incorporates the Groundwater Modelling Plan and Groundwater Dependent Ecosystem Monitoring Plan prepared in accordance with Attachment B
 - b. Surface water and Ecological Monitoring and Management Plan
 - c. Construction Environmental Management Plan

Water Licensing

13. Acquire sufficient water access licence/s to account for the maximum predicted take for each water source prior to production. The rules of the relevant water sharing plans must be complied with.
14. For groundwater sources at risk of a reduction in Available Water Determination into the future (including the Lower Namoi, Upper Namoi Zones 2, 4 and 5) the proponent should hold more water entitlement than has been predicted by the model to provide a buffer against reduced AWDs should the Long Term Average Annual Extraction Limit compliance rules be breached. The total entitlement required to be held should be described in the Groundwater Management Plan and approved by Lands & Water.
15. Keep continuous logging of active groundwater extracted volumes, either on a per bore basis (preferably) or jointly for a number of bores (for example at compressor station level).
16. If exceedance of the licensed water take from the Gunnedah-Oxley Basin Groundwater Source occurs, or is predicted to occur as a result of model updates, the proponent is required to:
 - a. Reduce or stop water extraction as required to ensure licensed take is not exceeded and consult with Lands and Water.

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- b. If the proponent wishes to increase the extracted volume predicted at project approval a revised assessment will be required. This would need to be based on an updated model and reviewed against the Aquifer Interference Policy (AIP). It is recommended consultation occur with DP&E as to the requirement to reapply for project approval in this scenario.
 - c. Acquire additional water entitlement to ensure all take is appropriately licensed prior to recommencing extraction.
17. If groundwater model updates and/or observed impacts indicate water take is greater than expected from connected water sources the proponent must:
- a. Re-assess water impacts based on the higher volumes and review against the AIP. If this assessment indicates impacts greater than those predicted at project approval it is recommended consultation occur with DP&E as to the requirement to reapply for project approval, and
 - b. Acquire additional water entitlement to ensure all take is appropriately licensed.
18. Assess the impacts of irrigating treated water on designated disposal areas within or outside of the project area and develop adequate mitigating and management measures.
19. Works within waterfront land are to be in accordance with the guideline "*Guidelines for Controlled Activities on Waterfront Land* (NRAR, 2018)".
20. Provide a Site Water Balance to be updated yearly and made available via annual reporting.

Reporting

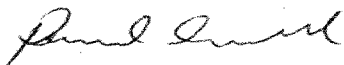
The following are recommended to be integrated into relevant management plans and reporting for the project.

- 21. Update all usage data in all documents and address the incorrect assumption that usage from 1996 - 2000 is representative.
- 22. Present all hydrographs in future reporting with water intake information i.e. screened intervals and screened formation and/or water source on the hydrograph.
- 23. The conceptual model must be updated as new data becomes available and documented in the annual report. The report must be made available to Lands and Water.

Access to crown land

Occupation, access or disturbance to Crown Land must only be carried out with the prior consent of the Minister.

Yours sincerely



Rachel Connell
Executive Director Water
LANDS & WATER DIVISION
Encls
9 October 2018

Attachment A

Santos Narrabri Gas Project (SSD6456) Request for Input into Response to Submissions Requirements for baseline data analysis

Requirements for Baseline Data Analysis

1. Provide an analysis of the adequacy of the data in the Water Baseline Report in characterising typical temporal and spatial variations (water level/pressure and quality) including comprehensive identification of all stressors and existing trends for each individual groundwater source (or geological formation).

This analysis will assist in identifying any limitations of existing data sets and aid in the development of a comprehensive understanding of baseline conditions against which to compare any potential future impacts as a result of the development. This analysis must include:

- a. Explanation on how the Water Baseline Report will be used to identify any potential impacts as a result of the proposed development.
 - b. A comprehensive analysis of the error bands of the pressure sensors used in the monitoring bores including explanation of instrument "aberration", this is to ensure the monitoring data can be trusted as accurate.
 - c. The baseline assessment must be done on quality assured data which has had "aberration" removed so representative water level/pressure data is analysed. The baseline data must inform on quality assurance/quality controls associated with the data.
 - d. All pipes at government monitoring bores sites with multiple depths (identified by the same 'GW' number) must be included in the baseline analysis and monitoring network.
 - e. Clarification of the discrepancy between the number of Gunnedah-Oxley Basin monitoring sites reported in the Water Baseline Report compared to the sites identified in the Water Monitoring Report and justification of why not all existing Gunnedah-Oxley Basin bores were used in the Water Baseline Report.
 - f. All hydrographs presented must have the water intake depth and formation and/or water source monitored displayed on the hydrograph.
 - g. Further water quality analysis from the existing monitoring sites especially in the Great Artesian Basin (GAB) and Gunnedah-Basin, is required to address the issues with the water quality data presented in the EIS and its appendices, specifically:
 - The variances in pH and potassium as a result of inadequate bore development.
 - The general lack of interpretation of water quality data in the report.
2. Provide all information for review from the appraisal well including test duration, distribution and monitored flow and pressures within the coal seams, and drilling and extraction that has occurred to date. Include all data and its interpretation from the drill stem testing sites identified in Figure 5-7 of Appendix F of the EIS as well as any other data collected during the testing phase.

End Attachment A

Attachment B

Santos Narrabri Gas Project (SSD6456) Request for Input into Response to Submissions Minimum Requirements for Groundwater Water Modelling, Monitoring and Management Plans, Surface Water Monitoring and Site Water Balance

Minimum Requirements for the Groundwater Monitoring and Management Plan

A Groundwater Monitoring and Management Plan (GWMMP) should be developed prior to project determination in consultation with Lands and Water to manage the risk associated with the low confidence in the modelled impacts, to inform development of a new groundwater model, and to ensure sufficient management responses and monitoring are in place. The minimum requirements for the GWMMP are as follows:

- Provision of a groundwater specific monitoring plan (including groundwater dependant ecosystems) to be developed as a standalone document.
- Updating the management response triggers and response actions for each water source.
- Specific requirement for model updates.
- Provision of a plan for adding the additional monitoring sites proposed in this document. This will include a schedule of sites to be installed and operational by set dates post approval as a condition of consent.

To determine minimum monitoring requirements, Lands and Water has assessed the monitoring sites included in the existing Water Monitoring Plan in the EIS against the maximum predicted impacts from modelled scenario Base Case Sensitivity S5 (BC-S5) which simulates the most impact of all the model scenarios presented as a conservative approach.

In order to manage the risk of potential water level drawdown and propagation of impact, strategic additional groundwater monitoring locations are recommended to assist in monitoring changes in both horizontal and vertical water level pressures. These are recommended for installation post determination should the project be approved. The intent is to develop a comprehensive groundwater monitoring plan to ensure that groundwater extraction for the proposed development is managed within the predictions of the existing model if the project is approved.

The data obtained throughout time should assist in the development of a further refined model leading to refined impact predictions.

Management response triggers must be re-developed in consultation with Lands and Water as part of the development of the GWMMP and to include triggers for the proposed additional monitoring sites identified in this document following installation.

It is noted a number of the sites currently included in the proposed management response trigger network for the Great Artesian Basin (GAB) and the Gunnedah-Oxley Basin (GOB) were assigned to the incorrect formation as identified in the Department's comments on the EIS.

Access agreements should be sought from WaterNSW for any government monitoring bores proposed to be used as part of the GWMMP. Any water level measuring equipment used within Government owned bores shall be supplied by the proponent.

1. Minimum requirements for groundwater trigger response management

The Management Response Triggers (MRTs) are to monitor and manage impact propagation based on groundwater impacts (drawdown and timing) being no greater than those predicted from the 'Base Case' modelling scenario as documented in the EIS. The triggers and responses are grouped into three tiers, with each tier referring to a connected or group of connected water sources as described below.

The monitoring program and responses will be reviewed and updated once the groundwater model has been updated. All bores proposed for MRTs must be equipped with telemetry.

Tier 1 Sites:

MONITORING

- A set number of sentinel monitoring sites located within the Porcupine Formation to be linked to rules around changes in pressure.
- The trigger values are to be based on the 'Base Case' modelled prediction of impact on pressure in the targeted formation.

RESPONSE PLAN

- If observed impacts in any of the sentinel monitoring bores located in the Porcupine formation are greater than those predicted or occur faster than those predicted or are likely to, the Proponent will be required to as a minimum:
 - Confirm the validity of the observed data within one month;
 - a) If the data is false; address the issue with the sensors, in the event of sensor failure alternate sentinel sites will have to be adopted. Reaching a trigger would need to be documented in the annual report, and the review process and conclusions detailed.
 - b) Where the data is confirmed to be real the proponent must consult with Lands and Water and proceed with the following which must be completed within six months – noting in the Porcupine Formation, any impacts can only be as a result of this development as no other extraction is occurring from the Bohena trough.
 - Re-assess impacts (update the model) and predicted take volumes taking the observed data into consideration.
 - Re-assess impacts against the Aquifer Interference Policy (AIP).
 - Acquire additional water entitlement if the assessment identifies take from any impacted water sources exceeds entitlement held.
 - Review the adequacy of the triggers and update as required.
 - If re-assessment shows impacts are greater than the Level 1 minimal impact considerations in the AIP it is recommended the proponent consult with DP&E as to the requirement to re-apply for project approval.

Tier 2 Sites:

MONITORING

- A set number of sentinel monitoring sites located within the Napperby/Digby Formation to be linked to rules around changes in pressure.
- The trigger rules are to be based on the 'Base Case' modelled prediction of impact on pressure in the targeted formation.

RESPONSE PLAN

- If observed impacts in strategic monitoring bores located in the Napperby/Digby Formation are greater than those predicted or occur faster than those predicted or are likely to, the proponent will be required to as a minimum:
 - Confirm the validity of the observed data within one month;
 - a) If the data is false - address the issue with the sensors, in the event of sensor failure alternate sentinel sites will have to be adopted. Reaching a trigger would need to be documented in the annual report, and the review process and conclusions detailed.
 - b) Where the data is confirmed to be real the proponent must consult with Lands and Water and proceed with the following which must be completed within six months – noting in the Napperby/Digby Formation any impacts at these sites are highly likely to be as a result of this development.
 - Reduce production while further assessment is carried out. This is required due to the proximity of this formation to the shallower productive aquifers.
 - Re-assess impacts (update the model) and predicted take volumes taking the observed data into consideration.
 - Re-assess impacts against the AIP.
 - Acquire additional water entitlement if the assessment identifies take from any impacted water sources exceeds entitlement held.
 - Review the adequacy of the triggers and update as required.
 - If re-assessment shows impacts are greater than the Level 1 minimal impact considerations in the AIP it is recommended the proponent consult with DP&E as to the requirement to re-apply for project approval.

Tier 3 Sites:

MONITORING

- A set number of sentinel monitoring sites located within the Purlawaugh and GAB and Namoi Alluvial formations to be linked to rules around changes in water level/pressure.
- The trigger rules are to be based on the 'Base Case' modelled prediction of impact on pressure/water level in the targeted formations.

RESPONSE PLAN

- If observed impacts in strategic monitoring bores located in these formations are greater than those predicted or occur faster than those predicted or are likely to, the proponent will be required to:
 - Confirm the validity of the observed data within one month;
 - a) If the data is false - address the issue with the sensors, in the event of sensor failure alternate sentinel sites will have to be adopted. Reaching a trigger would need to be documented in the annual report, and the review process and conclusions detailed.
 - b) Where the data is confirmed to be real the proponent must consult with Lands and Water and proceed with the following which must be completed within six months. Any impacts within the Purlawaugh Formation at these sites are highly likely to be as result of this development. Impacts on the GAB and alluvium may require further assessment to confirm impacts are due to the development – noting impact propagation up the geological profile will have been observed in the sentinel monitoring sites for a Tier 3 management response to occur.

- Stop production while further assessment is carried out. This is required due to the proximity of the Purlawaugh Formation to the shallower productive aquifers or that impact to the GAB or alluvium has already occurred much faster than predicted.
- Re-assess impacts (update the model) and predicted take volumes taking the observed data into consideration.
- Re-assess impacts against the AIP.
- Acquire additional water entitlement if the assessment identifies take from any impacted water sources exceeds entitlement held.
- Review the adequacy of the triggers and update as required.
- If re-assessment shows impacts are greater than the Level 1 minimal impact considerations in the AIP it is recommended the proponent consult with DP&E as to the requirement to re-apply for project approval.

2. Minimum Requirements for Groundwater Modelling Plan

The groundwater modelling plan must include specific detail regarding updating and/or remaking the groundwater model to improve the confidence in the model's ability to predict impacts on surrounding water sources, other users and the environment.

The plan must include detail on how:

- The model will be updated by year 3 post project commencement - it is acknowledged this will be dependent on the data available by this time – given the requirements for additional monitoring and data collection detailed in this document sufficient data should be available to achieve a confidence level classification Class 2 (Australian Modelling Guidelines).
- The model will be updated to a confidence level classification Class 3 (Australian Modelling Guidelines) by year 6 of approval.

The intention is that at least two years of production data and multiple years of groundwater monitoring data, additional local hydraulic parameter information will be included in the development of the Class 3 model.

The modelling plan must also include as a minimum:

- Data requirements
- Model update and impact assessment update requirements
- Model review requirements
- Plan review requirements
- Provision of model reports to agencies and the public
- Stakeholder consultation

Model updates should include the following:

- Model development completed by a suitably qualified and experienced groundwater modeller with experience in building complex models utilising the most suitable code applicable at the time.
- Transient calibration to water levels/drawdowns and volumes in all main groundwater systems.
- All available drilling, pumping and monitoring data.
- An independent peer review by a suitably qualified modelling expert.

- A range of sensitivity scenarios both including and excluding cumulative impacts of other mining development in the area. These scenarios to be agreed to in consultation with Lands and Water.
- The provision of modelling reports developed for each stage of the model development to Lands and Water for review.
- The groundwater impact assessment updated against the AIP. If impacts are predicted greater than those predicted at project approval and/or the Level 1 minimal impact considerations of the AIP the proponent will need to consult with DP&E as to the requirement to reapply for project approval.
- Review the suitability of existing trigger levels and response actions and the adequacy of water entitlements held in each water source.

3. Minimum Additional Monitoring Sites

The proposed additional monitoring sites required for the development are shown in Figure 1 and listed in Table 1.

- At identified Government monitoring sites currently included in the WMP with multiple pipes at different depths identified by the same 'GW' number; all pipes must be included in the monitoring network.
- Consideration can be made for using existing Government alluvial monitoring bores at the recommended locations.

Timing of Installation of the Monitoring Bores

- As a minimum all identified sentinel monitoring bores specified in Table 1 shall be in place and equipped with appropriate water level measuring devices to enable collection of data for a minimum of 1 year:
 - prior to the commencement of any production or
 - prior to the requirement for the model to be updated by year 3 post project approval.

Whichever comes first.

- All additional bores specified in Table 1 shall be in place and equipped with appropriate water level measuring devices to enable collection of data for a minimum of 1 year prior to updating the model to a Class 3 model by year 6.
- All existing Santos monitoring sites are to be included in the monitoring network.

Monitoring bore Infrastructure

- All monitoring bores, where practical, shall be constructed as cased / screened bores to enable water quality sampling to be undertaken as detailed in the Water Monitoring Plan.
 - Where this construction is not considered practical, monitoring infrastructure shall be constructed based on industry best practice to obtain water levels, pressures, and/or water quality.
 - Confirmation of successful bore construction is required to be provided to DoI Water together with all bore construction information. This is to include as a minimum: surveyed bore data, lithostratigraphy information, interpreted stratigraphy, geological log, geophysical log, bore construction information.
- All monitoring bores constructed within the Gunnedah Oxley Basin shall be constructed in accordance with the NSW Government's Code of Practice for Coal Seam Gas Well

Integrity, September 2012, as well as the Minimum Construction Requirements for Water Bores in Australia, February 2012.

- All monitoring bores constructed within the Great Artesian Basin shall be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia, February 2012.

Monitoring Frequency – pressure/level monitoring

- All sentinel sites must be installed with automatic water level recorders and telemetry.
- All other bores should be installed with water level loggers.

Figure 1 Map of Recommended Locations

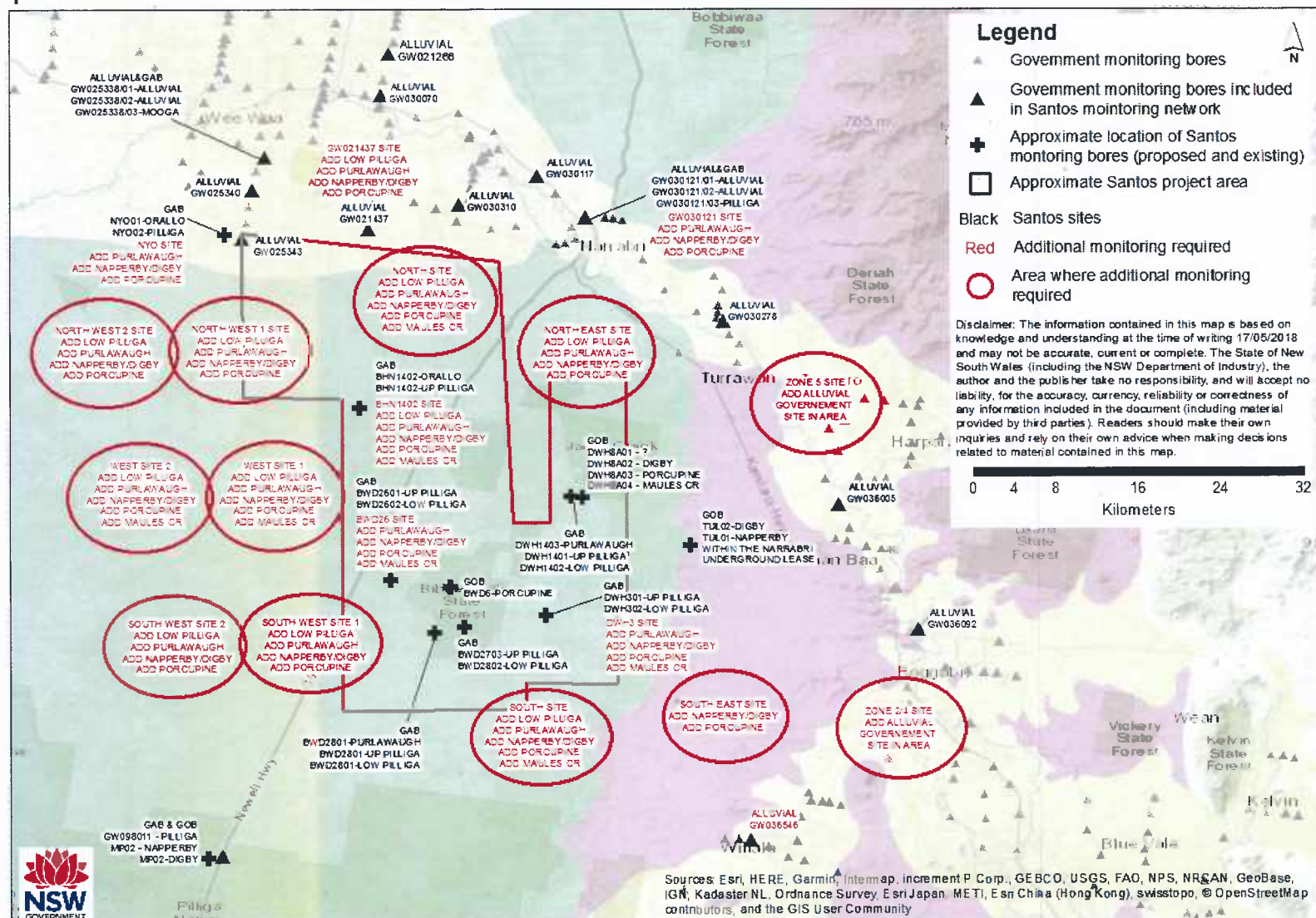


Table 1. Requirement for sentinels and additional groundwater monitoring sites

Note: existing Santos monitoring sites not specified in this table will form part of the broader monitoring network.

Site Name as per map	Target Formations for Screen	Sentinel	Purpose
NYO	Purlawaugh Napperby / Digby Porcupine	No	A site located to the north west of the lease area, this site is proposed to monitor any radiating water level fluctuations within 3 of the main aquitards between the main production zone and higher formations. These additional proposed bores will complement the proponents proposed bores at this site being within the Pilliga and Orallo formations
GW021437	Purlawaugh Napperby / Digby Porcupine	Tier 2 and Tier 3	A site located to the north of the lease area, this site is proposed to monitor any radiating water level fluctuations within 3 of the main aquitards between the main production zone and higher formations. These additional proposed bores will complement the existing bores at this site monitoring the Lower Namoi alluvium.
GW030121	Purlawaugh Napperby / Digby Porcupine	No	A site located to the north east of the lease area, this site is proposed to monitor any radiating water level fluctuations within 3 of the main aquitards between the main production zone and higher formations. These additional proposed bores will complement the existing bores at this site monitoring the Lower Namoi alluvium and Pilliga Sandstone.
North West 1	Lower Pilliga Purlawaugh Napperby / Digby Porcupine	No	A site located to the north west of the lease area, this site is proposed to monitor any north westerly radiating water level fluctuations / impacts. Monitoring targets the 3 main aquitards between the production formation and the main stock and domestic access aquifer being the Pilliga Sandstone. This site also includes strategic monitoring of the Pilliga Sandstone in a north westerly direction.
North West 2	Lower Pilliga Purlawaugh Napperby / Digby Porcupine	No	A site located to the north west of the lease area, this site is proposed to provide a transect away from the lease area to monitor the degradation of any north westerly radiating water level fluctuations / impacts. Monitoring targets the 3 main aquitards between the production formation and the main BLR aquifer being the Pilliga Sandstone. This site also includes monitoring of the Pilliga Sandstone.
West 1	Lower Pilliga Purlawaugh Napperby / Digby Porcupine Maules Creek	Tier 2 and Tier 3	A site located to the west of the lease area, this site is proposed to monitor any westerly radiating water level fluctuations / impacts. Monitoring targets the main production formation as well as 3 aquitards between the production formation and the main BLR aquifer being the Pilliga

Site Name as per map	Target Formations for Screen	Sentinel	Purpose
			Sandstone. This site also includes strategic monitoring of the Pilliga Sandstone in a westerly direction.
West 2	Lower Pilliga Purlawaugh Napperby / Digby Porcupine Maules Creek	No	A site located to the west of the lease area, this site is proposed to provide a transect away from the lease area to monitor the degradation of any westerly radiating water level fluctuations / impacts. Monitoring targets the main production formation as well as 3 aquitards between the production formation and the main stock and domestic access aquifer being the Pilliga Sandstone. This site also includes monitoring of the Pilliga Sandstone.
South West 1	Lower Pilliga Purlawaugh Napperby / Digby Porcupine	No	A site located to the south west of the lease area, this site is proposed to monitor any south westerly radiating water level fluctuations / impacts. Monitoring targets the 3 main aquitards between the production formation and the main stock and domestic access aquifer being the Pilliga Sandstone. This site also includes strategic monitoring of the Pilliga Sandstone in a south westerly direction.
South West 2	Lower Pilliga Purlawaugh Napperby / Digby Porcupine	No	A site located to the south west of the lease area, this site is proposed to provide a transect away from the lease area to monitor the degradation of any south westerly radiating water level fluctuations / impacts. Monitoring targets the 3 main aquitards between the production formation and the main stock and domestic access aquifer being the Pilliga Sandstone. This site also includes monitoring of the Pilliga Sandstone.
North	Lower Pilliga Purlawaugh Napperby / Digby Porcupine Maules Creek	Tier 1, Tier 2 and Tier 3	Considered a sentinel location within the northern end of the lease. Monitoring of direct vertical impacts between the main extraction zone, 3 highlighted aquitards, and the main regional stock and domestic access aquifer being the Pilliga Sandstone.
BH14	Lower Pilliga Purlawaugh Napperby / Digby Porcupine Maules Creek	Tier 1, Tier 2 and Tier 3	Considered a sentinel location in the north west area of the lease. Monitoring of direct vertical impacts between the main extraction zone, 3 aquitards, and the main regional stock and domestic access aquifer being the Pilliga Sandstone. These additional proposed bores complement the existing site bores being within the Upper Pilliga and Orallo formations
BWD26	Purlawaugh Porcupine Napperby / Digby Maules Creek	Tier 1, Tier 2 and Tier 3	Considered a sentinel location in the south west area of the lease. Monitoring of direct vertical impacts between the main extraction zone, 3 highlighted aquitards, and the main regional stock and domestic access aquifer being the

Site Name as per map	Target Formations for Screen	Sentinel	Purpose
			Pilliga Sandstone. These additional proposed bores complement the existing site bores being within the Upper and Lower Pilliga Sandstone.
North East	Lower Pilliga Purlawaugh Napperby / Digby Porcupine	Tier 1, Tier 2 and Tier 3	A site located to the north east of the lease area, this site is proposed to monitor any north easterly radiating water level fluctuations / impacts. Monitoring targets 3 highlighted aquitards between the production formation and the main stock and domestic access aquifer being the Pilliga Sandstone. This site also includes strategic monitoring of the Pilliga Sandstone in a southerly direction.
South	Lower Pilliga Purlawaugh Napperby / Digby Porcupine Maules Creek	Tier 1, Tier 2 and Tier 3	A site located to the south of the lease area, this site is proposed to monitor any southerly radiating water level fluctuations / impacts. Monitoring targets the main production formation as well as 3 aquitards between the production formation and the main stock and domestic access aquifer being the Pilliga Sandstone. This site also includes strategic monitoring of the Pilliga Sandstone in a southerly direction.
DWH3	Purlawaugh Porcupine Napperby / Digby Maules Creek	Yes	Considered a sentinel location in the south east area of the lease. Monitoring of direct vertical impacts between the main extraction zone, 3 highlighted aquitards, and the main regional stock and domestic access aquifer being the Pilliga Sandstone. These additional proposed bores complement the existing site bores being within the Upper and Lower Pilliga Sandstone
South East	Napperby / Digby Porcupine	No	A site located to the south east of the lease area, this site is proposed to monitor any radiating water level fluctuations within the main aquitard between the main production zone higher formations.
Zone 5	Alluvial	No	Monitoring of alluvial bores within Namoi Zone 5 to assess long term trends and provided strategic alluvial data for modelling.
Zone 2/4	Alluvial	No	Monitoring of alluvial bores within Namoi Zone 2/4 area to assess long term trends and provided strategic alluvial data for modelling
GW036546	Alluvial	No	Monitoring of alluvial bores within Namoi Zone 2 to assess long term trends and provided strategic alluvial data for modelling
DHW14-2	Lower Pilliga	Tier 3	Santos existing monitoring site in key location
DHW14-3	Purlawaugh	Tier 3	Santos existing monitoring site in key location
DHW8A-2	Digby	Tier 2	Santos existing monitoring site in key location
DHW8A-3	Porcupine	Tier 1	Santos existing monitoring site in key location

4. Baseline Data

- Additional baseline data on aquifer and aquitard characterisation and connectivity is required from new monitoring bores. This data should include parameters obtained from drilling of additional monitoring bores, as well as data that will lead to refinement of transmissivity and storage values for future potential model refinement and include field obtained parameters for “Negligibly Transmissive Units”, “Significantly”, and “Less Significantly Transmissive Units”.
- All additional baseline data must be collected at minimum of:
 - 3 monthly intervals for water quality, and
 - Via continual loggers for water level/pressure monitoring.
- All new monitoring bores are to be hydraulically tested and the data made available to Lands and Water. Consultation is required with Lands and Water prior to testing to confirm specific requirements. This data will need to be used to inform the update of the groundwater model.
- Raw data is to be made available for Lands and Water for interpretation.
- The proposed additional sentinel monitoring bores sites are to be constructed first and in sufficient time to allow at least 1 year of additional baseline water level (and quality data where appropriate) to be collected prior to production or updating of the model by year 3, whichever comes first.
 - The full monitoring network should be operational to allow at least 1 year of monitoring data (from all sites) to be collected and included in the update of the model to a confidence level classification Class 3 (Australian Modelling Guidelines) by year 6 of approval.

5. Water Quality

- The proponent is required to update their water quality monitoring network to include the proposed additional monitoring sites.
- The full list of analytes required for baseline and ongoing monitoring to be developed in consultation with Lands and Water and EPA.
- All additional water quality baseline data must be collected for a minimum of a 1 year period prior to production commencing at minimum of 3 monthly intervals.
- The proponent is also required to define what ‘expected change’ is given the existing management objective is ‘No unexpected change in the Gunnedah-Oxley Basin’.
- Noting there is very little existing water quality information presented for the Gunnedah-Oxley Basin, pre development baseline conditions must be established prior to production in order to identify any water quality changes as a result of the development.

6. Other Requirement of the GWMMP

Equipment and data Quality Assurance/Quality Control

- Equipment and data quality assurance/quality control should be undertaken in accordance with Santos Data Management Process as provided in Appendix B of the Water Baseline report.
- All groundwater data should be presented with field measurements to assist in assessment of sample integrity.

Storage and access to data

- The proponent must make the Water Monitoring Plan, Modelling Plan, monitoring data and other relevant data and documents publically available on its website.
- This data must be kept up to date.

- All water quality and water level/pressure data displayed must be quality assured (which has had "aberration" removed), including reporting of any instrument failures or drifting.
- All production data (extraction volumes) and water quality and level/pressure data must be provided to Lands and Water in a format that allows data analysis and storage in a database (data formats such as excel or plain text format).
- Should the proponent consider that specific data is to be treated as "commercial in confidence", Lands and Water must be notified in writing along with the submission of the data to Lands and Water.

Provision of data to governmental agencies as quality coded and quality controlled data in a format as requested by the agencies, and including interpreted data.

- Any water level reporting or hydrographs presented shall be in a corrected format. This includes barometric corrections along with corrections for instrument drift, errors, and obvious instrument malfunctions.
- Water level information shall be provided as "below measuring point" as well as in elevation in metres Australian Height Datum (mAHD).
- Any water quality data shall be presented in its raw form along with milli equivalent values where applicable.
- Any data provided, including in graph format, shall also be provided in Excel file format where possible.

7. Monitoring Requirements for Groundwater Dependant Ecosystems

The establishment of baseline groundwater dependant ecosystem (GDE) conditions is essential to ensure sufficient data is available against which to compare any potential changes.

A GDE monitoring plan must be developed in consultation with Lands and Water and implemented once approved. The monitoring plan will aim at gathering baseline data, characterising each GDE and will provide for management actions and response to potential impact.

Reporting on GDE and provision of data to Lands and Water will follow the same requirements as to the water monitoring plan.

GDE Baseline and characterisation

The GDE monitoring plan must consider all GDEs in and adjacent to the project area (not just those scheduled or proposed to be scheduled in the Water Sharing Plans). As such the baseline must address both terrestrial and aquatic systems (base flow, springs, wetlands, and stygofauna and microbial communities).

Baseline is required for at least two years to establish presence, characteristics and trends prior to operations commencing. Baseline acquisition must be completed before the start of production.

Monitoring of baseline prior to production and during operation is to follow a statistically valid Before-After-Control-Impact (BACI) design.

GDE monitoring plan should include but is not limited to the following:

- Monitoring of GDEs for condition and water quantity and quality requirements for both terrestrial and aquatic systems as defined above
- Monitoring methodologies of all surface water and groundwater sources and dependent ecosystems within and adjacent to the mining operation area to enable verification of predictive modelling.
- Relevant groundwater pressure/groundwater level data;
- Relevant water quality monitoring for watering regime and assessment of condition, including:

- Physical/chemical - pH, temperature, electrical conductivity, turbidity, dissolved oxygen, total suspended solids, oil and grease, major cations and anions.
- Dissolved metals - iron, manganese, nickel, cobalt and zinc.
- Hydrocarbons
- Determination of ecological watering regime spatially and temporally for all the above mentioned GDE types.
- Stygofauna community and microbial community analysis including DNA analysis and eDNA 16S & 18S sequencing, total cell counts, cellulose degradation).
- Vegetation condition assessment by using ground survey involving the following indicators: crown extent, crown density, new tip growth, epicormic growth, extent of bark cracking and leaf die-off, which may indicate the future direction of tree condition. The tree condition assessment is to also collect contextual information at both the scale of the individual tree and the assessment site scale to aid in the interpretation of the condition assessments.

Upon acquisition of two years of baseline data and prior to production, a GDE characterisation report is to be submitted to Lands and Water. The GDE characterisation report is to include as a minimum:

- A summary of GDE baseline data and findings;
- For each GDE, a review of findings and a characterisation of the attributes of the GDE including a conceptual model;
- For each GDE, the GDE characterisation report is to identify the level of changes to the characteristics of the GDE and/or environment of the GDE which would result into an unacceptable impact to the GDE.

Management of potential impact to GDE

The GDE monitoring plan should include an impact management plan. The management of impacts to GDEs is to be informed by the GDEs baseline data, GDEs characterisation and by the overall propagation of impact. Management of impact to GDEs may also be required due to unexpected impacts from the CSG field activities.

The management of impacts to GDEs must address/include the following:

- Trigger criteria/levels are to be developed based upon ANZECC guidelines prior to project commencement and to be revised once baseline data has been collected and submitted in a report with baseline data for review.
- The management plan must allow in its response time for sufficient time to carry out studies and mitigation before an adverse impact is observed on the GDE. As such early warning triggers are required to define the time where monitoring of GDE behaviour is to be resumed.
- Additional monitoring sites may need to be installed based on the GDE characterisation assessment and management option.
- A timing for the outlining of protective measures that will minimise any impacts on GDEs and their implementation is required.

Note: GDEs will be scheduled in the future Water Sharing Plans and any impacts to these GDEs at any time during or after the project should be monitored and managed. Suitable baseline data collection and ongoing monitoring of these GDEs should be undertaken.

Minimum Requirements for Site Water Balance

A Site Water Balance should be prepared, updated yearly and made available via annual reporting, including details of:

- Methodology to calculate inputs and outputs
- Predictions of future input and output requirements

- Plan review requirements
- Trigger response management
- Stakeholder consultation

Minimum Requirements for Surface Water Monitoring and Management Plan

A Surface Water Monitoring and Management Plan is required to manage impacts on Bohena Creek. This is to expand on elements of the Risk Assessment (Appendix G1 of the EIS – Managed Release Study Bohena Creek).

This plan should include a mitigation plan to address ecological and water quality impacts to Bohena Creek and other surface water sources, as well as water quality monitoring at the treatment. The plan should include the following:

- Water quality monitoring requirements for Bohena Creek and the water treatment plant
- Metering and reporting requirements
- Confirmed method of measuring flows in Bohena Creek
- Impact assessment and management of irrigating treated water on and off the project site
- Monitoring requirements for impacts to all surface water sources.
- Plan review requirements
- Trigger response management
- Stakeholder consultation

Further requirements of the Surface Water Monitoring and management Plan include:

- Regarding Bohena Creek managed release water quality:
 - a. Scheduled review of all data over the life of the project to ensure ANZECC guidelines are met.
 - b. Include early warning systems / protocols to identify contaminants exceeding recommended default triggers (e.g., salinity & mercury).
- Detailed design and construction plan for all gas and water gathering lines to address:
 - a. How the Australian standards quoted will be adhered to,
 - b. Assessment and monitoring of impacts to overland and surface water flows
 - c. Details of the sediment and erosion control to be implemented.
 - d. Assessment and monitoring of impacts to geomorphology.
- Formalise the risk mitigation measures relating to Bohena Creek detailed in Appendix G1 Section 9 of the EIS, specifically under heading 9.3, 9.4 and 9.5; to ensure they are implemented over the life of the project including post operation.
- Increased frequency of event sampling within five days post release (as detailed in Section 9 of the EIS) and in accordance with the ANZECC/ARMCANZ (2000) guidelines requirement "increase the inferential strength of the monitoring program for biological indicators".
- Provide all data collected to the relevant agencies (including Lands and Water) post sampling event. Document the water quality monitoring plan for the Leewood Water and Brine Treatment Plant and maintain all data relating to QA/QC and monitoring results.

End of Attachment B

