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Attention: Hydrogeologist, EPA

Re: Questions regarding EPL 20350

There are 86 monitoring points on Licence 20350. Of these 86 points, monitoring has been reduced to 28 in the latest Quarterly results. The NSW Government Coal Basins Monitoring Strategy is still not operational and is years behind schedule. The Santos gas field is ageing and the public seeks reassurance that any problems will be revealed by the regulator. In order for problems to be revealed there is a need for data.

NWPA QUESTION

1. Monitoring Point 13

We are aware that there has been a self-reported non-compliance at Monitoring Point 13 for the past 2 years and it is over 2 years since data has been published.

- a) Do Santos have any other monitoring bores in the Purlewaugh formation besides Monitoring Point 13? There seems to be contradictory information around this. (*The EPA have previously indicated in correspondence: DOC17/228961 Date: 13 April 2017 "Santos has no other monitoring bores installed in the Purlewaugh Formation."*)
- b) When will we see publicly available data for this monitoring point? Will it follow the same pattern as previous reporting or will it be 2023 until we see data? Please consider asking Santos to provide data for this bore in the 2nd Quarter.

NWPA are concerned about what appears to be a downward trend in pH in this monitoring bore. The results spanning from 2015 through to 2019 indicate some unusual activity for the Purlewaugh formation which underlies the Pilliga Sandstone. Significant changes have occurred in the pH over the years.

Location Report for:

Santos Reference: DWH14PRPUR03
 Local Name: EPL Monitoring Point 13
 Sample Point Type: Groundwater Monitoring
 Monitoring Program: Groundwater Level Monitoring

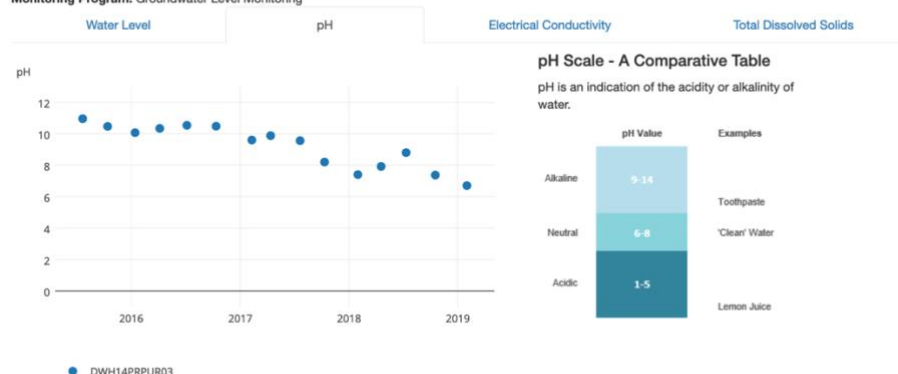


Figure 1 Historical pH levels from the Santos Water Monitoring portal

Santos EIS states the mean pH of the Purlawaugh is 9.2 The stated EC and TDS do not correlate with data displayed on the Santos Water Monitoring Portal – consistently testing much lower over the years.

Table 11-6 Regional groundwater quality

Hydrostratigraphic unit	Mean EC ^a (µS/cm)	Equivalent TDS ^b (mg/L)	Mean pH
Namoi Alluvium	697	446	7.9
Bohena Creek Alluvium	559	358	6.8
GAB – Orallo Formation	1,030	659	7.4
GAB – Pilliga Sandstone	402	257	6.2
GOB – Digby, Napperby and Purlawaugh Formations	4,785	3,062	9.2
GOB - Black Jack Group	14,158	9,061	8.2
GOB - Maules Creek Formation	14,134	9,046	7.9

^a Electrical conductivity – a measure of water salinity

^b Total dissolved solids – an alternative measure of water salinity

Figure 2 Chapter 11 Santos EIS Groundwater & Geology page 40

In the latest quarterly monitoring report, the pH is recorded at 5.41.

		EPA Identification No	13
		Location	DWH14PRPUR03
		Date	15/06/2021
		Sample Method	in situ
Parameter	Units	LOR	RESULT
Dissolved Oxygen	mg/L	-	0.54
Electrical Conductivity	µS/cm	-	568
pH	pH Unit	-	5.41
Redox Potential	mV	-	-97
Standing Water Level	mTOC	-	52.14

Can the EPA please explain why the pH is much lower now? Is this unit receiving inflow from elsewhere? We were under the impression that the Purlawaugh impeded vertical flow of groundwater.

Groundwater in the Pilliga Sandstone flows primarily from outcrop in the east towards the north west and then west. The Purlawaugh Formation and Keelindi Beds are understood to comprise aquitards, impeding the vertical flow of groundwater. Hence groundwater infiltrating the Pilliga Sandstone outcrop in the east and south east of the Field Area is prevented from percolating into the Purlawaugh and may be confined in the north west by the Keelindi Beds. Locally, groundwater in the Pilliga Sandstone in the northern part of the NGP area may flow northwards, drawn by hydraulic gradients in the Namoi Alluvials (Gunnedah & Narrabri Formations).

EPA ANSWER

Monitoring Point 13

The neutralizing trend of pH observed at Monitoring Point 13 is **not clearly conclusive**. Observations of standing groundwater levels at Monitoring Point 13 show no significant variations indicating hydraulic changes are not occurring at the location. Electrical conductivity remains stable.

Monitoring Point 11 and Monitoring Point 12 – respectively known as Dewhurst 14A and Dewhurst 14B – exist at the same location and monitor groundwater in the Pilliga Sandstone. Summary graphs have been provided for pH, electrical conductivity and standing water level for the nested site at Tab 1 for your information. Note there is 44m of vertical separation between the screen intervals of Dewhurst 14B and Dewhurst 14C.

The low permeability of the Purlawaugh formation is conceptually identified as a barrier to regional groundwater flow. The bore known as Dewhurst 14C is constructed to monitor the Purlawaugh formation with a screen interval depth of 263-269 meters below ground level.

Monitoring point 13 is the only monitoring point on EPL 20350 that samples this stratigraphic unit. Monitoring point 49 also records groundwater pressures for the Purlawaugh formation but is not constructed to yield a sample.

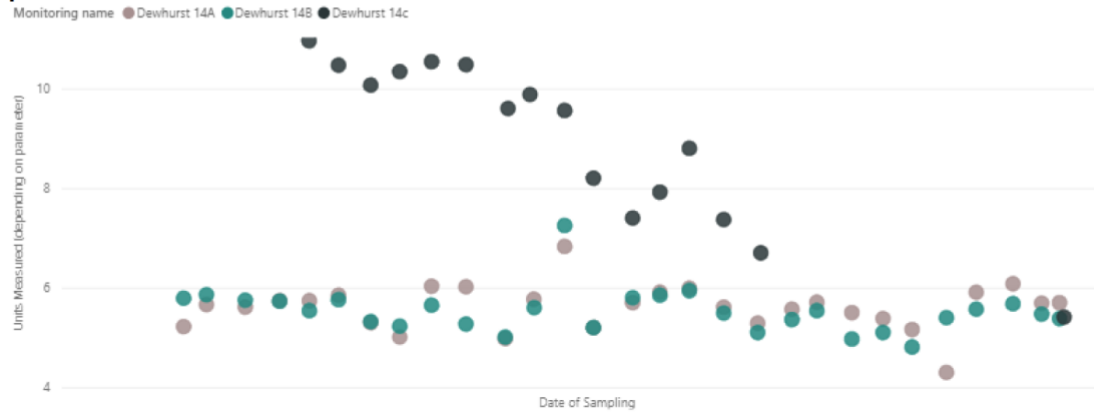
TAB 1 Dewhurst 14 Summary

Dewhurst 14 Site monitoring bores

EPL Monitoring Point No.	Bore name	Santos nomenclature	Screen Interval (mbgl)	Target lithology
11	Dewhurst 14A	DWH14PRUPS01	63-69	Pilliga Sandstone
12	Dewhurst 14B	DWH14PRLPS02	213-219	Pilliga Sandstone
13	Dewhurst 14C	DWH14PRPUR03	263-269	Purlawagh formation

An obstruction occurred at Monitoring Point 13 following sampling on 31/1/19, sampling recommenced on 15/6/21. Water level only was reportable during this period.

pH



Monitoring name	Parameter	Date	pH
Dewhurst 14c	pH	15/6/21	5.41
Dewhurst 14c	pH	31/1/19	6.7
Dewhurst 14c	pH	17/10/18	7.37
Dewhurst 14c	pH	11/7/18	8.8
Dewhurst 14c	pH	18/4/18	7.92
Dewhurst 14c	pH	30/1/18	7.4
Dewhurst 14c	pH	10/10/17	8.2
Dewhurst 14c	pH	20/7/17	9.56
Dewhurst 14c	pH	12/4/17	9.88
Dewhurst 14c	pH	8/2/17	9.6
Dewhurst 14c	pH	11/10/16	10.48
Dewhurst 14c	pH	5/7/16	10.54
Dewhurst 14c	pH	5/4/16	10.34
Dewhurst 14c	pH	13/1/16	10.07
Dewhurst 14c	pH	13/10/15	10.47
Dewhurst 14c	pH	21/7/15	10.96
Average		16 samples	8.98

NWPA QUESTION

2. Shallow Aquifer Monitoring Bores

We know that de-pressurizing coal seams leads to leakage of water from overlying aquifer systems and that “Hydraulic fracturing can unintentionally cause fracture penetration to shallower strata. This creates hydraulic connections (groundwater flow paths) between the target coal seams and

shallower formations. Such connections may drain groundwater from shallower aquifers when coal seams are dewatered for gas production. This increases the amount of produced water without additional gas extraction, thereby reducing the efficiency of gas production. The influence on shallow aquifers and their ability to recover from groundwater drawdown/leakage due to coal seam gas production depends on the individual setting.” See report:

<http://environment.gov.au/system/files/resources/ee38b672-6faa-452e-979f-d97b7d425333/files/csg-modelling-groundwater-impacts.docx>

Over the past few years we have seen many of the Shallow Aquifer Monitoring Bores (SAMBs) in the project area return ‘Dry results’. The latest Groundwater Monitoring Report from Santos confirms that nearly all of the SAMBs in EPL 20350 are not functioning.

- a) Can the EPA provide detail of SAMBs that measure to a depth of 50m that are still returning results.
- b) Can the EPA provide an explanation for why these SAMBs are no longer providing data and detail how they intend to ensure that no harm to the environment is occurring?

In their Groundwater Monitoring Report Santos fail to mention that they have not been able to take water levels. These points measure the groundwater in the Pilliga sandstone and the Purlawaugh.

- c) Can the EPA provide an update on Monitoring points 47, 48 and 49: Santos have indicated “no water level results available, repairs and maintenance being investigated” in their latest Quarterly Monitoring.

EPA ANSWER

Monitoring Points 47, 48 and 49

These monitoring points are known as Bibblewindi 28A, 28B and 28C and monitor groundwater pressures at depths of 81, 247 and 293 meters below ground level in the Pilliga Sandstone (28A & 28B) and the Purlawaugh formation (28C).

They are a type of bore construction known as Vibrating Wire Piezometers (VWP). These monitoring bores are designed to provide continuous measurement of groundwater pressure from sealed transducers installed at depth. This sealed design prevents the collection of groundwater samples.

The Santos 2021-2022 Q1 NSW Water Portal Report reports that no water level results are available at these points, and that repairs and maintenance are being investigated. Faults and errors are not uncommon with water or barometric logging equipment used in continuous groundwater monitoring due to the corrosive operating environment. The EPA is currently liaising with Santos about the implications of this fault and its proposed repairs.

Other groundwater monitoring points on EPL20350 including 44, 45 and 46 are the same type of VWP type bore construction reporting water pressure only.

Shallow Aquifer Monitoring Bores

Within the group of monitoring bores identified as shallow aquifer monitoring bores (SAMB), there are shallow piezometers for monitoring potential perched water tables. These bores monitor the unsaturated profile above the regional water table and were mostly drilled from legacy investigations at the Tinsfield and Bibblewindi sites. You may notice in the bore nomenclature for these shallow piezometers that they terminate in either S – shallow, I- intermediate, or D – deep. All these piezometers are a SAMB where D – deep exist up to 38 metres below ground level at these produced water facilities.

These shallow bores have become dry following the decommissioning of Bibblewindi Pond 3 and upgrades to water management at the Narrabri Gas Project including construction of the Leewood Produced Water Management Facility. As expected, the perched groundwater has fallen below the screen interval of the S – shallow, and I – intermediate, piezometers in these locations.

A dry bore still provides useful information that indicate the presence or absence of groundwaters. Low permeability stratigraphy, those that restrict regional groundwater flow, might not have sufficient permeability to yield a sample to a monitoring well. Reporting a dry well remains relevant to environmental conditions, particularly these shallow piezometer type monitoring sites at produced water management facilities.

Regional SAMB include those targeting depths at or below the regional water table in the Namoi Alluvium and Pilliga Sandstone are operational and reporting results throughout the Santos and NSW government monitoring network.

NWPA QUESTION

3. Cumulative impacts with Narrabri Coal Mine

It has been repeatedly stated by Santos and the EPA that there is no possibility of cumulative impacts between the Narrabri Gas Project and the Narrabri Coal Mine. However, Whitehaven Coal appears to contradict this in its submission to the NGP. No mention of Narrabri Mine's submission was made in Santos Response to Submissions. Since then, Narrabri Mine proposes a further expansion, Stage 3, which has updated its groundwater assessment.

Has the EPA considered the Narrabri Underground mine latest modelling, and in particular the potential of cumulative groundwater impacts arising therefrom?

4. Condition B37 accordance

You will note the comments of the NSW Independent Planning Commission during the Narrabri Gas Project Public Hearing (1 August 2020) concerning the importance of baseline data, where the Commissioners stressed that adequacy of baseline data is critical and questioned the Department of Planning as to whether the current PESA network is sufficient, either in plan position or vertically, to provide data for groundwater flow models in order to predict future impacts.

We understand that at the present time, the Narrabri Gas Project Model has yet to satisfy Condition B37(e) of SSD 6456, which requires that the groundwater model update must *"include all reasonable and feasible measures to improve the model to meet the requirements of a Class 2 and Class 3 confidence level model (as per the Australian Groundwater Modelling Guidelines) as soon as is reasonable and feasible"*, and lists under Condition B37(f)(i)-(v) matters that must be considered as per the Australian Groundwater Modelling Guidelines.

Is the EPA in agreement that at the present time, Santos has yet to satisfy the Australian Groundwater Modelling Guidelines as required by B37?

As the lead regulator of the Narrabri Gas Project, is the NSW EPA satisfied that the reduction of groundwater monitoring points from 86 to 28 is consistent with Condition B37(e) and B37(f)? If Santos and the EPA have deemed the large majority of the monitoring points in EPL 20350 redundant, why are they not being replaced with monitoring points which do provide relevant data to ensure confidence?

We are asking these questions as we are aware that Environmental Protection Licence Conditions are required to be consistent with Planning Approvals. We have concerns that changes to EPL 20350 are not consistent with the requirements of B37.

We would like to thank the EPA for their work in regulating coal seam gas in NSW and express our gratitude for your open and transparent approach in answering our queries.

EPA ANSWER

Regional Groundwater Monitoring and Modelling – SSD 6456 Condition B39

The Water Management Act 2000 governs the extraction of groundwater in NSW. It is administered by DPIE Water, who provide technical advice and assessment of groundwater impacts. The NSW Aquifer Interference Policy (2012) ensures that potential impacts on groundwater sources from CSG and other mining activities are subject to comprehensive assessment and licensing requirements including cumulative assessments.

The groundwater monitoring required by EPL 20350 aims to align with monitoring requirements of the NSW Code for Produced Water Management Storage and Transfer. The groundwater monitoring network on EPL 20350 is limited to the premises boundaries and its scope does not include the regional monitoring required to meet the conditional modelling consent. The Narrabri Gas Project model geometry presented in the Environmental Impact Statement covers regional groundwater sources, including cumulative impacts from coal mining in the Gunnedah Oxley Basin. Further reporting on a refined groundwater model, including its calibration to baseline groundwater monitoring, is required to meet Condition B39.

Other publicly available groundwater monitoring is available through the “NSW Water Monitoring Strategy for Coal Basins” available at <https://realtimedata.waternsw.com.au/>. The monitoring locations identified as Plumb Rd, Scratch Rd and Pilliga South monitor nested groundwater sites nearby the proposed Narrabri Gas Project and the Narrabri Underground Mine.