

Condamine River Gas Seep Investigation

January 2013 update

Overview

The Queensland Government has implemented a multi-agency investigation into the Condamine River gas seeps, coordinated by the LNG Enforcement Unit (LNGEU). This investigation comprises of:

Phase 1: an immediate focus to ensure public safety, assess potential environmental harm and the extent of gas seeps.

Phase 2: ongoing water quality monitoring and periodic gas safety assessments of the river and water bores on adjacent properties.

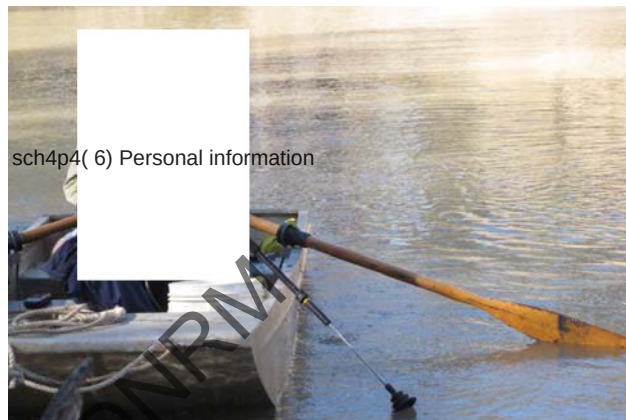
Concurrently, Origin (on behalf of Australian Pacific LNG) has adopted an independent three-phase long-term investigative approach.

Phase 1 Investigation Activities

The Petroleum and Gas Inspectorate has conducted gas safety site inspections at key gas seep sites and adjacent areas in order to ensure public safety. Results indicate that there is no evidence of safety risk in the immediate area from the gas seeps.

A preliminary environmental site inspection and water and soil sampling was undertaken by the Department of Environment and Heritage Protection (DEHP) at targeted seep and background sites. Results were assessed by government ecotoxicologists and showed no evidence of environmental harm or water quality risks to the community.

The LNGEU has undertaken a longitudinal survey incorporating approximately 60 kilometres of the Condamine River downstream of the Chinchilla Weir and an additional 10 kilometres of Charley's Creek tributary. As a result the LNGEU has verified and mapped the location, extent and occurrence of five gas seeps located at key sites along the river.



Gas seep compositional analysis undertaken by DNRMP Petroleum and Gas Inspectorate.

Phase 2 Investigation Activities

Desktop and field-based reviews and testing have commenced over an extensive area surrounding the gas seeps focussing on coal seam gas activities and tenures, groundwater and geology. This has been supported with verification and examination of regional and international evidence of gas seeps.

Gas has been sampled for compositional and isotopic analysis at selected key river gas seep sites and local groundwater bores in order to enhance understanding of the nature of the gas seeps and to explore potential sources.

Results indicate that the gas is predominantly composed of biogenic methane. This is consistent with gas originating from Surat Basin geological formations.

While these results do not provide definitive evidence of the source or cause of the Condamine River gas seeps, the investigation is taking a long-term approach to find science-based answers to this phenomenon.





Water quality sampling being undertaken by EHP Environmental Officers as part of a regular ongoing environmental sampling and analysis program.

Verification of Origin data

The investigation of bubbling gas seeps in the Condamine River by the Queensland Government is independent to that being undertaken by Origin.

The LNGEU will continue to work in partnership with industry and local landholders to determine the source or cause of gas seeps and is heavily engaged with Origin to ensure that their investigation is rigorous and independently assessed.

The technical review and validation process involves providing input into the development of Origin's gas seep investigation, including critical reviews of plans, methodologies and results together with field-based appraisals of Origin's applied study methods.

Communication

Throughout the investigation, government has endeavoured to keep potentially affected landholders updated on government studies and monitoring relating to the Condamine River gas seeps. This has been achieved by liaising directly with landholders and engaging with Origin to ensure common and significant information is communicated in an effective and professional manner.

Next steps

The next phase of the investigation for Queensland Government agencies will focus on the following:

- Ongoing water quality monitoring in the Condamine River by DEHP, in order to assess for potential environmental harm.
- Periodic gas safety assessments of nearby landholder water bores by the Petroleum and Gas Inspectorate.
- Geological Survey of Queensland will revise the geological mapping of the affected area in the Surat Basin.
- Regular updates for landholders on investigation activities and findings.
- Further in-depth review of historical groundwater data of nearby gassy bores, utilising all available departmental records.
- Continued verification and monitoring of Origin's investigation of the gas seeps to ensure that the investigation is rigorous and is independently assessed.
- Assisted by the Government's Chief Scientist, an independent scientific review will ensure that Origin's investigation and the verification actions by government achieve a high scientific standard and integrity. This will commence first quarter of 2013.

Conclusions

Anecdotal accounts would appear to support the regional incidence of gas migrating to the surface, although the current activity would appear to be more vigorous than previously observed.

It is recognised that the source or cause of the Condamine River gas seeps is unlikely to be determined in the short-term and that a long-term approach to find more science-based answers to the phenomenon is needed.

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3 May 2013

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Dear Mr Kernke

Re: Review of Aquatic Ecology Assessment of the Condamine River Gas Seeps conducted by Origin

Department of Environment and Heritage Protection (EHP) has reviewed the frc report; "*Aquatic Ecology Assessment of the Condamine River Gas Seeps*" which details an investigation of the incidence of gas seepage into the Condamine River at sites southwest of Chinchilla (downstream of the Condamine Weir).

EHP's comments (incorporating comments from DSITIA) on this report are attached to this letter. EHP would like Origin to consider these comments before a final report on the Aquatic Ecology Assessment of the Condamine River Gas Seeps is released.

Should you have any further enquiries, please contact Tariq Khan of this Department on (07) 4699 4343.

Yours sincerely

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Attachment

EHP's Review of Aquatic Ecology Assessment of the Condamine River Gas Seeps

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Subject: Review of Aquatic Ecology Assessment of the Condamine River Gas Seeps conducted by Origin

EHP has reviewed the frc report; "*Aquatic Ecology Assessment of the Condamine River Gas Seeps*" which details an investigation of the incidence of gas seepage into the Condamine River at sites southwest of Chinchilla (downstream of the Condamine Weir). EHP's comments on this report are provided below.

Comments overall

The stated aims of the study were to "to determine whether aquatic ecology in the Condamine River was impacted by the methane gas seeps within the immediate vicinity of the gas seeps, and if impacts were observed in the immediate vicinity of the gas seeps, whether these impacts extended downstream".

The study appears to lack a strong causal framework and does not provide a robust basis for determining whether environmental harm has been caused by these methane seeps. It is unclear how the indicators that were assessed are specifically linked to the hazard posed by the methane. Without this any "positive results" do not have strong inferential power. The chance of missing an effect is just as strong as recording a false positive. The need for a clear causal framework is particularly important in such an agricultural setting where multiple confounding stressors are likely to be present.

At present there would appear to be insufficient data with which to clearly determine impacts, hence further monitoring is recommended. However, no ongoing monitoring be undertaken until a robust causal framework is developed, indicators sensitive to the hazard are chosen, and a study design developed (including spatial and temporal replication) which provides strong inferential power. Without this EHP will not have a clear basis for decision making going forward, and resources may be wasted on inappropriate monitoring in the interim.

The data collected from an initial round of monitoring may provide useful data to perform power studies and inform future designs.

Comments on specific elements of the study

Overall the study appears to have applied sampling methods that are aligned with standard practices and the statistical approaches used are appropriate for the study design. However, as the study is based on one sampling occasion with sometimes highly variable data, reflective of a highly variable system, the predictive capability of the study is limited. Although qualifying statements are generally made, care should be exercised when drawing conclusions, for example the statement - "The gas seeps do not appear to have negatively impacted the macroinvertebrate and fish communities" requires some clarification such as 'based on the available data'.

There would not appear to be a description of the stressor in terms of the measures or quantities of methane, bubble velocities or the some metric of the stressor. If possible to quantify, this would allow a determination of what methane exposure is/was being experienced by the ecosystem and allow comparisons of the effects for any future studies.

Study design

Ideally this type of study would include a comparison of data from the current study with data from before the 'impact' as such a design would improve predictive capability though it is recognised that as this study is occurring in response to the seepage, this was not possible. However, there are studies such as the Talinga REMP report and the water monitoring undertaken by government agencies that may provide background information that could be used to assist interpretations. It is recommended that existing background information from government and non-government sources of data be considered in the report.

There is a possibility that natural longitudinal changes in streams may cause differences between sites. These factors do not appear to have been considered in the assessment.

The plant indicators appeared to be altered at some downstream sites, though effects were attributed to cattle access and impacts to edge habitat. If the data cannot be interpreted, such sites should not be included. Where possible such sites should be avoided *a priori* to allow data from all sites and indicators to provide meaningful comparisons.

Sampling frequency and predictive power

The study includes only one sampling event that was undertaken post gas seepage. One sampling occasion is not likely to detect chronic biological impacts in the absence of a robust spatial sampling design.

Indicators of impacts

The tolerant, generalist nature of the aquatic plants, invertebrates and vertebrates found in the region mean that they may be resilient to the changes in habitat conditions associated with gas seeps. However, these characteristics along with the relatively low diversity mean that measures of community composition may not be a sensitive indicator of chronic impacts. While the metrics used in the study are well-established and commonly used, the conceptual links between the likely effects of methane gas seeps outlined and the expected response of the biological and chemical indices used are often unclear. The small number of control sites, single sampling occasion, and in the case of fish, unequal sampling effort, also makes interpretation of results difficult.

Zooplankton

No significant differences were detected between the seep and no-seep sites, but given the limited mobility of the organisms and the possible sensitivity to increased water movement (p 14) assessment of within-site differences in zooplankton communities (i.e. locations with and without visible bubbling) may be more indicative of the response to gas seeps.

There is little detail on sampling methods for some of the indicators notably zooplankton (and blue-green algae) to assess their effectiveness or relevance to the study. These indicators are patchy in time and space, hence one off sampling such as used in this study are likely to yield naturally variable results with little power to detect significant differences between treatment sites

Fish

Fish abundance in ephemeral rivers is known to be highly variable, and as mentioned in the report, is likely to be driven by changes in habitat availability, quality and connectivity with flow regime. As such, comparison of fish abundance at a single sampling time is unlikely to be a meaningful indicator of potential impacts from gas seeps. This is particularly the case when catch is low and has not been standardised by effort. The distribution of age classes of fish is also likely to be highly influenced by habitat and flow conditions, however over multiple sampling times, measures of breeding and recruitment success may be a useful indicator. Tolerance of a broad range of habitat conditions mean that physiological or biochemical measures of parameters such as body condition and growth rate would provide a better assessment of any chronic effects of gas seeps than broad community metrics.

As the response of fish communities occurs over long time periods (months to years), the collection of fish community data at a single sampling occasion in Oct 2012 after impacts were first detected in May 2012, may not provide sufficient response time to detect impacts. Where the detection of short term impacts to fish is required, the application of biochemical stress indicators that respond over shorter durations may be more appropriate. Collection of community metrics of fish data will be useful over time. Given DO has been identified as a stressor, markers of oxidative stress may be more appropriate.

Aquatic plants

As macrophytes are spatially variable they are not likely to provide a good indicator of "stream health" in a short term study such as that described here. Further, as discussed above, plants at some sites were found to be affected by impacts unrelated to the gas seeps, reducing their usefulness as indicators for the study.

Water and sediment quality

In the report there are some instances where it is difficult to determine any changes to water and sediment quality that may have resulted from the gas seepage because of the high variability in duplicate sampling at each site. Added to this, the proponent has not adequately explained why there is such high duplicate variability in some water and sediment samples; what duplicate sampling variability means for their results and whether including more replicate samples in any future sampling might be necessary. Some further consideration and explanation may also need to be made on sampling technique at the seepage sites and whether sampling at these sites is affected by (more variable) the vigorously bubbling, especially with regard to the partitioning of metals.

One of the most important factors that effects water quality (and influences variability in water quality) is flow. The hydrological conditions of the waterway will also affect biological indicators. Despite acknowledging that flow influences water quality parameters such as dissolved oxygen levels and temperature and can, for example, influence macroinvertebrate communities, the study has not really addressed this factor in the data analysis. Including information on the total and average monthly rainfall is not useful, especially where the stream flow is also highly modified by the Condamine Weir, which is immediately upstream of the study area.

Flow data is essential (including consideration of modification in stream flow due to the Condamine Weir) and should be available from nearby gauging stations.

Flow information at each site on the days of sampling would have been ideal but may not have been possible to collect. Flow information from the nearest upstream and downstream gauging stations may have been helpful to infer flow at the sites. Some information on flow during other times of the year, gathered from nearby gauging stations, could have allowed the proponent to infer how water quality may have varied during the year at different flow. As the Condamine River is a highly modified system immediately upstream on the sampling area (Condamine Weir), it is particularly important to understand how this influences stream flow at the sampling locations. Therefore, we recommend that the proponent supply Chinchilla Weir release dates; times and release volumes around the current sampling time and this information should be supplied with any future sampling.

Dissolved oxygen

The proponent has determined that the DO is generally lower at gas seepage sites, especially more vigorously bubbling seepage sites, compared to sites upstream or downstream of the bubbling. While the study has explained that there could be a number of other reasons for differences in DO between sites (photosynthetic rates; microbe respiration; surface mixing; water depth), it has not investigated these. Regardless of this the study has stated that there *'did not appear to be negatively affecting aquatic flora and fauna in the current survey.'* However, this was based on only one species survey. Added to this, there may be a potential for impacts (*'long term effects may arise in the future that could be associated with the gas seeps'*) but it is not clear when they will occur; what species they will effect; and how they will be monitored. The results of DO analysis at the seepage sites warrants further water quality and biological surveys to determine if the gas seepage is influencing DO levels and what this means for aquatic ecosystem health. The proponent also needs to expand on the following statement - (*'long term effects may arise in the future that could be associated with the gas seeps'*) to include information on when impacts might occur; what species they are likely to effect; and how they will be monitored. Reference to any recommendations made by proponent for further monitoring should be included here.

Consideration of dissolved oxygen may be best evaluated using diurnal measures of DO or measures of whole stream metabolism to better reflect temporal and spatial variability. Measurement of BOD may give an insight into whether the DO sag observed around the bubble plume is a chemical or biological artefact.

Changes to methanogenic bacterial communities may provide a useful indicator of impacts, particularly if leading to localised cascading effects on food webs.

Depth profile analysis

There is too little information on the methodology (to replicate the method) used for the depth profile analysis (depths that the measurements were taken; when the measurements were taken (date and time) and what sites were included). There is only a brief sentence reporting that *'A depth profile was taken at two gas seep sites to assess any variation due to water depth'*. This information is important because it

was used to interpret the results and formulate conclusions in the report. This information should be clearly stated in the methods section.

It is also not clear why a depth profile analysis was not also performed at background or control sites (where no seepage was occurring) or indeed other seepage sites. Control or background site information would allow the proponent to better assess whether the gas seepage in the Condamine is influencing water temperature; pH; electrical conductivity (EC) and DO with depth. Inclusion of these sites might also go some way to proving or disproving the theory that the deep bubbling sites CGS and PHS are low in DO, because the gas bubbles have redistributed poorly oxygenated/stratified water from the stream bed. It may also help determine if this is happening at sites FLS and RHS where the seepage is also occurring but water depths are shallower than CGS and PHS.

Only the EC and DO results from the depth profiles have been presented. Assuming (from information in Section 4.1.1) that depth profile measurements were taken for water temperature; pH; EC and DO, then all of this data should be presented in the Depth Profile results section. The proponent has reported '*substantial temporal variation in dissolved oxygen saturation that was most likely associated with water temperature.*' EHP would not agree with this conclusion. Depth profile DO taken at gas seepage sites CGS and PHS '*measured in the morning*' did not appear to be significantly different to surface DO measurements '*taken the previous afternoon*'. Approximate percent oxygen saturation at different depths was ~2% and 10% for site CGS and PHS respectively, whereas approximate percent oxygen saturation at CSG and PHS were 8 and 20%, respectively. It is also difficult to see the correlation / relationship between temperatures in afternoon and morning surface water sampling when no data is presented on water temperatures at the depth sampling sites.

It is recommended that water temperature and pH data should be presented in the Depth Profile results section. We recommend that where the proponent revises conclusions made regarding '*substantial temporal variation in dissolved oxygen saturation that was most likely associated with water temperature.*' The proponent should include a figure showing a comparison of temperature with depth and temperature at the time of surface sampling. There should also be a figure showing a comparison between surface water DO and temperature against DO and temperature at depth.

Metals

In sediment, metals will partition to organic matter (depending on pH etc.), which makes it important to collect information on the level of organic matter in sediment and even to normalise levels of metals in sediment to levels of organic matter. If possible, include information on total organic carbon levels in sediments sampled and present data for metals normalised to total organic carbon levels. This information will be important in determining whether the seepage may be a source of metals or if sites are just environmental sinks for metals.

Organic compounds

All organic compounds are reportedly below the limits of reporting (LORs) but these values are not reported. It is important to ensure that the analytical techniques are

sensitive enough to detect levels of contaminants for comparison with relevant guidelines to protect or enhance environmental values Provide the LOR values for the compounds listed in Sections 4.2.7; 4.2.8 and 4.2.9.

Groundwater infiltration

Groundwater connectivity could also influence water quality and aquatic ecosystem health in the stream but the proponent has not addressed this. From the current results it does not appear that there has been groundwater infiltration (EC is similar between sites and it would be expected to be higher at seepage sites if there was groundwater infiltration). However, this is only one sampling event. Is it possible that groundwater can infiltrate surface water systems at the seepage sites at different times? Under what circumstance would this happen and what is the likelihood it would occur? If there is a high likelihood of groundwater infiltration then what would be the frequency; period and volume of infiltration? Where there is a potential for groundwater infiltration, the proponent should consider the likely impacts to environmental values in the Condamine River. We recommend that the proponent conduct a risk assessment on the potential for groundwater infiltration from the seepage sites and the likely impacts, particularly if this infiltration is predicted to happen frequently and / or at high volumes.

Presentation of data in summary tables

In a number of instances data has been summarised into tables (e.g. Table 4.4. Water quality at gas seep sites and comparative sites in the 2012 survey, p46) and where upstream and downstream sites have been combined into 'comparative sites'. This is not appropriate because it makes it difficult to determine if there is any difference between water quality at upstream and downstream sites. This pooling of sites is most inappropriate at sites and for parameters where there has been high variability in duplicate analysis. It is more useful to present the data in figures such as Figure 4.1, where there is a bar graph of the mean and standard error of duplicates from surface sampling measurement of pH levels. Any raw data could also be included as an appendix in the report.