Summary Technical Report - Part 1

Condamine River Gas Seep Investigation

December 2012
Version 1.0

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Executive summary

The LNG Enforcement Unit (LNGEU) was contacted by a landholder on 17 May 2012, regarding the observation and possible causes of bubbling in the Condamine River approximately six kilometres downstream of Chinchilla Weir. Preliminary investigations indicated that the bubbling was unlikely to be caused by coal seam gas (CSG) activities in the region. However, in anticipation of further sites or incidences being discovered, including further information provided by Origin (on behalf of Australia Pacific LNG) indicating that gas bubbling in the Condamine River was occurring at additional sites, the government implemented a two-phase multi-agency investigation.

Coordinated by the LNGEU, the government's Condamine River gas seep investigation comprises an immediate focus on ensuring public safety, assessing environmental harm and the extent of gas seeps (Phase 1); and a long-term investigation involving a technical program that will allow government experts to verify the information it receives from Origin (Phase 2). Concurrently, Origin has adopted a three-phase long-term investigative approach.

The following report provides a summary of the government's activities regarding its Condamine River gas seep investigation up until 1 October 2012, which incorporates the entirety of Phase 1 and initial activities for Phase 2 of government's investigation.

Phase 1 Investigation Activities
As a priority, the Petroleum and Gas Inspectorate has undertaken gas safety site inspections at key gas seep sites and adjacent areas, in order to ensure public safety. Results indicate that that there is no 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 at targeted seeps and background sites. Results were assessed by government ecotoxicologists and showed no evidence of environmental harm.

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, in detail, the location, extent and occurrence of four key seep sites, developing an empirical spatial-temporal record of gas seep activity and a detailed channel cross-section of a key seep site.

Phase 2 Investigation Activities
Desktop reviews have been undertaken for an extensive area around the gas seeps, focussing on coal seam gas activities and tenure, groundwater and geology. This has been supported with targeted ground verification and will assist in the revision of the geological mapping of the affected area in the Surat Basin. Historical government records of gas seeps in the region have also been examined alongside international evidence of gas seeps and related investigations. 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.

Gas has been sampled for compositional and isotopic analysis at selected key river gas seeps and local groundwater bores, in order to enhance understanding of the seep gas and to explore potential sources. Results indicate that the gas is predominantly composed of biogenic methane, likely formed through a CO_2 reduction pathway, which is consistent with gas originating from Surat Basin geological formations. However, these results do not provide definitive evidence of the source or cause of the Condamine River gas seeps.

Communication and verification of Origin data

The investigation of gas bubbles in the Condamine River by government is independent to that being undertaken by Origin. Nevertheless, the LNGEU is heavily engaged with Origin to ensure that their investigation of the Condamine River gas seeps is rigorous and is independently assessed. To this end, government is providing key input into the development of Origin's gas seep investigation, involving both critical reviews of plans, methodologies and results, and field-based appraisals of Origin's applied study methods. Government input is being coordinated through the LNGEU. A protocol has been developed to ensure that data gathered as part of Origin's project is shared with government.

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

Future directions

It is recommended that government undertake the following future activities regarding the Condamine River gas seeps:

- 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 DNRM Petroleum and Gas Inspectorate, in order to ensure public safety.
- Geological Survey of Queensland will revise the geological mapping of the affected area in the Surat Basin.
- Government will keep landholders updated on investigation activities relating to the Condamine River gas seeps.
- Further in-depth review of historical groundwater data of nearby gassy bores, utilising all available departmental records.
- Government will continue to verify Origin’s investigation of the gas seeps, in order to make sure that their investigation is rigorous and is independently assessed.
- Assisted by the Chief Scientist to the Queensland Government, advanced scientific reviews will ensure that Origin’s investigation, and verification actions by government, achieve a high scientific standard and integrity. It is anticipated that his will commence in the first quarter of 2013.

It is recognised that the source and 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.

1 Introduction

1.1 Background

The LNG Enforcement Unit (LNGEU) was contacted by a landholder on 17 May 2012, regarding the observation and possible causes of bubbling in the Condamine River approximately six kilometres downstream of Chinchilla Weir.

The Unit's preliminary investigations showed that the tenure is held by Origin (on behalf of Australia Pacific LNG) with four Origin coal seam gas (CSG) wells positioned within a five kilometre radius of the reported bubbling location; the closest being approximately 1.4 kilometres from the reported bubbling location (Appendix A). All of the nearby Origin wells are cased and are not part of a producing field. Further, there are no CSG pipelines in the immediate vicinity, while the nearest production fields are approximately 10 kilometres away from the location. Additionally, there was no evidence of hydraulic fracturing having occurred within 40 kilometres of the reported bubbling.

Based on this information, the Unit advised the landholder that the cause of the bubbles appeared unlikely to be CSG activities. Subsequently, additional information was provided to government by Origin indicating that gas bubbling in the Condamine River was occurring at additional sites. Media coverage of the Condamine River gas seeps simultaneously increased. In anticipation of further sites or incidences being discovered, government implemented an initial investigation (Phase 1) focussed on ensuring public safety, assessing for environmental harm and determining the extent of gas seeps.

Simultaneously, the LNGEU coordinated a Department of Environment and Heritage Protection (DEHP) and Department of Natural Resources and Mines (DNRM) review of Origin's proposed program to investigate the gas seeps. This review highlighted opportunities for government to work independently on some projects and collaboratively with Origin on others. As a result, government developed the second, long-term phase of its gas seep investigation (Phase 2), which involves a technical program that will allow government experts to verify the information it receives from Origin.

1.2 Role of Government

Complex issues such as the gas seeps in the Condamine River often require a multi-agency response by government. To this end, the LNGEU is coordinating government's two-phase investigation, which principally involves both DNRM and DEHP.

The two-phase investigation comprises an immediate focus on ensuring public safety, assessing environmental harm and the extent of gas seeps; and a long-term investigation involving a technical program that will allow government experts to verify the information it receives from Origin.

Concurrently, Origin has adopted a three-phase long-term investigative approach that comprises:

- Phase 1 - issue background, safety and extent of gas seep
- Phase 2 - technical studies to enhance understanding of the gas seeps
- Phase 3 - ongoing monitoring program and additional investigation.

Origin is currently engaged in Phase 2 of their investigation, having completed their Phase 1 component in late August 2012.

2. Methodology

2.1 Phase 1 Investigation Activities

On the commencement of government's Phase 1 investigation, the main focus of government was to ensure public safety and assess for environmental harm. Environmental Officers from the DEHP undertook assessment for environmental harm, while officers from the DNRM focussed on gas safety.

2.1.1 Gas safety

An initial gas safety site inspection was undertaken by the Petroleum and Gas Inspectorate on 31 May 2012 at the site of the initial gas seep enquiry, thereafter termed 'Campground' gas seep site (Appendix B). Gas sampling was undertaken for methane at points of constant bubble discharge using a collection cup attached to a GMI Gasurveyor 500R and Gasalert Microclip XT.

Additional sampling was completed at approximately 30 sampling points at the effervescent locations at gas seeps and on selected depressions and cracks in dry ground within 10 metres of the waters edge and for a lateral distance of approximately 200 metres. A follow-up inspection was undertaken on the 19 and 20 June 2012, incorporating approximately 6 kilometres downstream of Chinchilla Weir, and involving sampling for methane, hydrogen sulphide and carbon monoxide (Plate 1).

Results relating to gas safety are reported in section 3.1.1.

2.1.2 Environmental harm

On 31 May 2012, Environmental Officers from DEHP undertook a preliminary environmental site inspection at the Campground gas seep location (Appendix B).

Water and sediment samples were retrieved from a point of elevated effervescent bubbling at Campground; a seep subsequently named 'Campground 1'. For comparison, an additional water sample was retrieved from immediately adjacent (downstream) of effervescent gas seep activity ('Seep 2'), approximately 50 metres downstream the initial Campground 1 sample location ('Seep 1'). In addition, an upstream water sample was retrieved (immediately downstream from Chinchilla Weir) in order to provide a measure of background water quality.

Standard water sampling methods were employed for water quality sampling, in accordance with the Monitoring and Sampling Manual 2009 and Environmental Protection (Water) Policy 2009 (Department of Environment and Resource Management, 2009). Standard sampling and analysis procedures and field quality assurance measures were applied in the field, as appropriate.

Sample analysis included the following analytical parameters:

- Physical parameters (i.e. electrical conductivity, total dissolved solids etc.)

- Ionic components and heavy metals
- Organics (i.e. nitrogen, phosphorous etc.)
- Dissolved gases (i.e. dissolved methane)
- Hydrocarbons (i.e. BTEX, total petroleum hydrocarbons, poly- and mono-cyclic aromatic hydrocarbons etc.)

Several of the physical water quality parameters, such as pH, temperature and dissolved oxygen etc. were additionally analysed *in situ* using a calibrated YSI-556 multi-probe. Retrieved water samples were sent to NATA certified Australian Laboratory Services (ALS) in Brisbane for laboratory analysis.

Results relating to environmental harm are reported in section 3.1.2.

Plate 1: Gas seep compositional analysis undertaken by an Officer of DNRM Petroleum and Gas Inspectorate.

2.1.3 Extent of gas seeps

To obtain a clear understanding of the extent and nature of the seeps, government implemented a gas seep mapping program, which comprised:

- Longitudinal Mapping Transects
- Detailed Profile Mapping

A combined land-based and water-based longitudinal survey of the Condamine River has been completed by the LNGEU, incorporating approximately 60 kilometres downstream of the Chinchilla Weir, and an additional 10 kilometres of Charley's Creek tributary.

Specific mapping transects were established and gas seep activity was empirically assessed at regular temporal intervals by the LNGEU (Plate 2). Potentially affected landholders were contacted prior to and after the surveys and were updated on occurrences on their properties.

Plate 2: Mapping transects focussing on gas seep activity were recorded regularly by government officers.

Information recorded about the gas seep activity during mapping transects typically includes the following:

- GPS coordinates or in-channel location
- General observations such as weather, relative streamflow velocity, features and height, site access etc.
- Observational evaluation of gas seep patterns
    - Effervescence
    - Size
    - Frequency of bubbling
    - Spatial distributions of bubbling
- Photographs of gas seep activity at set transect locations
- Additional notes on riverine geomorphology, riparian features etc.

In June 2012, the LNGEU also undertook a comprehensive profile transect of Campground, which had been identified as a key gas seep location. Channel cross sections were developed by measuring channel depth at two metre intervals between river banks. This process was completed at approximate 20 metre longitudinal intervals throughout an approximate 200 metre stretch of Campground seep site where gas seep activity was elevated, termed Campground 1 (Appendix B: Plate 3).

Results relating to mapping of gas seep activity are reported in section 3.1.3.

Plate 3: Foreground - regular channel depths being measured as part of a detailed profile transect of Campground seep site. Background - water quality sampling of Condamine River by government officers of the Geological Survey of Queensland.

2.2 Phase 2 Investigation Activities

2.2.1 Literature reviews

A review of regional and international information regarding gas seeps has been completed. On a regional scale, government archives were examined in order to explore whether similar occurrences have been recorded in the past. Informal anecdotal accounts from local landholders and departmental groundwater experts were also considered in the review process.

An international perspective on gas seeps has been sought by government in order to enhance understanding of gas seep occurrences, common parameters (geology, trigger mechanisms etc.), and lessons learned from associated investigations, with the aim of optimising government's ensuing gas seep investigation.

Results relating to regional and international gas seep literature reviews are reported in section 3.2.1.

2.2.2 Database reviews

Augmenting the literature reviews, desktop reviews have been undertaken for an extensive area around the gas seeps, including industrial activities (e.g. CSG), tenure, and groundwater bores.

In order to provide an understanding of the groundwater usage within a 5 kilometre and 10 kilometre radius of the reported gas seeps in the Condamine River, departmental groundwater databases have been reviewed. Similarly, available geophysical data has been examined within a 10 kilometre radius from the reported gas seeps, and supported by ground verification of shallow regolith/geology in the vicinity of the gas seeps.

Collectively, these studies build an historical, geographical and hydrogeological context to inform ongoing investigations, and are further complimented by the desk-based review information generated during the preliminary investigation by government.

Results relating to database reviews are reported in section 3.2.2.

2.2.3 Seep gas characterisation

A branch of enquiry has focussed on the characterisation of seep gas, in order to enhance understanding of the nature of the seep gas, and to explore potential sources.

Scientists from the Geological Survey of Queensland (GSQ) Energy Geoscience Unit collected gas samples from three locations (two samples from Campground and one sample from Pumphole: refer to Appendix B) on the Condamine River where outgassing was occurring. This was achieved using tedlar gas sample bags under the supervision of LNG EU officers. Water samples were also taken at two gas seep locations (Campground and Pumphole) and upstream of any observed bubbling (Chinchilla Weir) to characterise the river water possibly entrained in the gas samples (Refer to Plate 3).

Standard water sampling methods were employed for this activity, in accordance with the Monitoring and Sampling Manual 2009 (Department of Environment and Resource Management, 2009) and Environmental Protection (Water) Policy 2009. Standard sampling and analysis procedures and field quality assurance measures were applied in the field, as appropriate.

The gas samples were dispatched to CSIRO in Sydney for compositional and isotopic analysis to assist in determining the source and migration history of the gas. The water samples were sent to NATA certified ALS in Brisbane for compositional analysis and to determine the presence of hydrocarbon gases.

Results relating to gas seep characterisation are reported in section 3.2.3.

2.2.4 Environmental Monitoring

Environmental Officers from DEHP have a regular ongoing sampling and analysis program for the water at the methane seeps and adjacent sites in the Condamine River (Table 1). Monitoring is undertaken to determine the impacts on the quality of water as a result of seepage of methane gas (Plate 4).

Standard water sampling methods are employed for water quality sampling, in accordance with the Monitoring and Sampling Manual 2009 (Department of Environment and Resource Management, 2009) and Environmental Protection (Water) Policy 2009.

Table 1: Water quality sampling dates for DEHP's regular ongoing sampling and analysis program

Sampling Location	Date of Sampling			
	31/05/2012	10/08/2012	5/09/2012	27/09/2012
Upstream	✓	×	✓	✓
Seep 1	✓	×	×	×
Seep 2	✓	✓	✓	✓
Downstream	×	×	✓	✓

Plate 4: Water quality sampling being undertaken by DEHP Environmental Officers at the 'upstream' sampling location, as part of a regular ongoing environmental sampling and analysis program.

The water quality monitoring program has included the following analytical parameters:

- Physical parameters (i.e. pH, electrical conductivity, total dissolved solids, dissolved oxygen etc.)
- Ionic components and heavy metals
- Organics (i.e. nitrogen. phosphorous etc.)
- Dissolved gases (i.e. dissolved methane)
- Hydrocarbons (i.e. BTEX, total petroleum hydrocarbons)

Several of the physical water quality parameters, such as pH, temperature and dissolved oxygen etc. are additionally analysed *in situ* using a calibrated YSI-556 multi-probe. Retrieved water samples are sent to NATA certified ALS in Brisbane for laboratory analysis. Standard sampling and analysis procedures and field quality assurance measures are applied in the field, as appropriate.

Results from the preliminary site assessment are assessed by Environmental Officers from DEHP and compared with available historical flow and water quality data for the study area to assist in benchmarking any measured changes in environmental quality. It is anticipated that repeated assessment will enable a trend analysis of the water quality at the sampled sites in relation to environmental variables (e.g. gas seep activity).

Results relating to environmental monitoring are reported in section 3.2.4.

2.3 Communication and verification

It is important to note that throughout this investigation, a key activity of government has been to keep potentially affected landholders updated on investigation activities relating to the Condamine River gas seeps. Government has endeavoured to do so both by liaising directly with landholders and engaging closely with land advisors and experts in Origin to ensure common and significant information is communicated in an effective and courteous manner.

The investigation of gas seeps in the Condamine River by government is independent to that being undertaken by Origin. The LNGEU has been coordinating a multi-disciplinary management group consisting of government experts in fields relevant to the Condamine River gas seeps, such as gas safety, environmental science, groundwater and gas characterisation.

Origin has committed to a long-term plan to study the occurrence of the gas seeps in the Condamine River. In this regard, the LNGEU is heavily engaged with Origin to ensure that their investigation of the Condamine River gas seeps is rigorous and is independently assessed.

To this end, government has provided key input into the development of Origin's gas seep investigation, involving critical reviews of plans, methodologies and results, and field-based appraisals of Origin's applied study methods. Government input has been coordinated through the LNGEU.

In summary, critical reviews by government have been undertaken on the following Origin documents:

- Proposed program for investigating gas seeps in the Condamine River
- Proposed Terms of Reference for a Principal Consultant to manage the Phase 2 Technical Program portion of their investigation into the Condamine River gas seeps
- Proposed methodologies for the Phase 2 Technical Program portion of Origin's investigation into the Condamine River gas seeps, comprising:

- Bathymetric Survey
- Aquatic Ecosystem Survey
- Soil Gas Flux Survey
- River Flux Survey

Where logistically feasible, government experts are augmenting desk-based critical reviews with field-based appraisals of Origin's applied study methods. To this end, government experts have attended the following fieldwork for Origin's gas seep investigation:

- Longitudinal mapping surveys of the extent and occurrence of gas seeps in the Condamine River
- Testing of local groundwater bores for water quality and gas
- Mapping of geological outcrops
- Isotopic sampling at river seep sites and local water bores
- Soil gas surveys
- River gas flux surveys

Further, government experts are verifying technical data generated by Origin as part of their ongoing investigation into the Condamine River gas seeps, including:

- Gas characterisation data (isotopes and compositional)
- Groundwater testing (water quality, gas)
- Gas seep mapping data.

A protocol has been developed to ensure that data gathered as part of Origin's gas seep investigation is shared with government.

It is also important to note that the all desk-based and field-based evaluation of Origin's gas seep investigation by government is complimented by regular meetings with Origin, which facilitates a transparent investigative framework. Moreover, this degree of collaboration with Origin has also aimed to minimise the impact of project investigation activities on potentially affected landholders by coordinating fieldwork with government units and Origin wherever appropriate, and pursuing practical measures in the field where effective.

3 Results

3.1 Phase 1 Investigation Activities

3.1.1 Gas safety

The Petroleum and Gas Inspectorate assessment of the gas seep areas indicates that there is no safety risk in the immediate area from the seeps.

Assessing gas flux at set distances from the river surface, the initial gas seep analysis at Campground 1 seep (31 May 2012) (Appendix B) produced methane readings of approximately 80% of the lower explosive limit (LEL) (at river surface), which equates to 4% methane gas in air. LEL is the measure of methane to air mixture at which ignition will occur. Positioning the collection cup approximately 50mm above the escaping bubbles resulted in a reduction of captured methane to 35-85 parts per million (ppm), significantly lower than the LEL of 50,000 ppm. No readings were detected at 100mm and 150mm from the gas seep location.

Similar gas concentration readings were recorded on gas bubbles discharging from the river bank sediments (‘weep holes’), exhibiting 20% LEL. A 20% LEL reading for methane would be equivalent to 1% methane by volume in air. At approximately 30 sampling points on selected depressions, cracks and ravines in dry ground within 10 metres of the river channel and for a lateral distance of approximately 200 metres, the maximum gas reading observed was 15ppm.

A subsequent inspection of Campground 1 gas seep (19-20 June 2012) resulted in similar methane concentrations being detected. Campground 1 seep also exhibited minor traces of hydrogen sulphide (15-17ppm).

Seep gas analysis of discharging gas seeps at Pumphole (Appendix B) provided reasonably constant readings of 40% LEL, which equates to 2% gas (in air).

Government’s gas seep investigation remains strongly focussed on ensuring public safety. To this end, government will be periodically reassessing risks to public safety with regard to the Condamine River gas seeps.

3.1.2 Environmental harm

Results from DEHP’s preliminary site assessment (Appendix C) of the Condamine River gas seeps were analysed by Environmental Officers, and subsequently verified by government ecotoxicologists.

Results did not indicate any environmental harm at the targeted seep area when compared to background sample locations.

3.1.3 Extent of gas seeps

As a result of the longitudinal survey, the location, extent and occurrence of five key seeps at four main locations in the Condamine River, south-west of Chinchilla, have been verified and mapped (Table 2).

Table 2: Gas seep activity mapping events at the four key seep locations.

Seep Location	Date of Sampling			
	19/06/2012	25/06/2012	11/07/2012	25/07/2012
Campground	✓	✓	✓	✓
Pumphole	✓	×	✓	✓
Fenceline	✓	×	✓	✓
Rockhole	×	×	✓	✓

The resulting mapping dataset provides a spatial-temporal record of gas seep activity at the four key gas seep locations. The dataset was subsequently transferred to Google Earth in order to illustrate the spatial and temporal patterns in gas seep activity (see Appendix D). The spatial record of gas seeps was broadly consistent over time, although distinct spatial-temporal trends in seep activity were difficult to distinguish, partly due to subjectivity of the assessment.

Nevertheless, the longitudinal transect mapping provides key information that has allowed government to focus its subsequent gas seep investigations.

A series of detailed channel cross-sections were generated from the profile mapping dataset, which illustrates channel morphology throughout Campground 1, a key gas seep (See Appendix E). It is anticipated that this data may provide useful information regarding potential associations between channel morphology, flow regime and gas seep activity.

3.2 Phase 2 Investigation Activities

3.2.1 Literature review

Regional Evidence of gas seeps
A review of the Queensland Government Mining Journal (QGMJ) archives produced limited recorded examples of gas seeps in the region. However, an example of a water 'blow out' reaching 30 feet in the air was located, occurring during a water bore being drilled in the Hopeland area, south of Chinchilla (Gray, 1967).

This documented account of gassy bores in the region is supported by historical government records, such as borecards and drilling logs, which report the presence of gas in water bores drilled into the Great Artesian Basin (GAB). Anecdotal accounts would appear to support the regional incidence of gas migrating to the surface, both through gassy water bores and the Condamine River. However, some long-term landholders that adjoin the present gas seep sites in the Condamine River have indicated the current activity appears more vigorous than previously observed.

International evidence of gas seeps
International case studies were considered in order to develop a wider understanding of any common circumstances surrounding the occurrence of gas seeps and to verify the effectiveness of investigation and mitigation strategies implemented elsewhere.

A review of online material indicated that information on gas seeps could be broadly separated into the following categories:

- Hydrocarbon seeps used to identify potential conventional resource reservoirs
- Gas seep/stray gas case studies.

The review focussed on gas seep/stray gas case studies, with the majority of documented gas seeps largely confined to the following sedimentary basins in the US:

- San Juan Basin (Colorado and New Mexico)
- Powder River Basin (Wyoming and Montana)
- Black Warrior Basin (Alabama)
- Appalachian Basin (particularly New York, Ohio, Pennsylvania, Virginia and West Virginia)
- Raton Basin (Colorado, New Mexico)

The majority of information regarding US gas seeps predominantly lies within technical documents by regulatory and research bodies, and anecdotal accounts by advocacy groups and media.

Nevertheless, common themes are apparent in the gas seep literature, with a significant portion of examples of gas seeps active where methane-bearing sediments outcrop at the surface. Similarly, gas migration has commonly been linked with natural and man-made structures that can act as conduits for gas migration from regions of high pressure (source area) to low pressure (land surface). As such, natural pathways such as faults and dykes, and man-made structures such as poorly completed wells, groundwater bores and mineral exploration holes are frequently cited.

At the extreme, negative impacts of gas seeps can be dramatic. Methane is a colourless, odourless and highly flammable (at approximately 5% - 15% methane in air) asphyxiant gas, which has the capacity at sufficiently elevated concentrations to impact on public health, fauna and flora. Similarly, typically minor constituent gases, such as hydrogen sulphide and hydrocarbons, have the potential to generate a range of detrimental impacts on public health, fauna, flora and water quality at elevated levels. However, as stated in 3.1.1 and 3.1.2, results indicate that there is no safety risk or evidence of environmental harm occurring in the immediate area from the Condamine River gas seeps.

3.2.2 Database reviews

Tenure is held by Origin with four Origin CSG wells positioned within a five kilometre radius of the initially reported gas seep location; the closest being approximately 1.4 kilometres from the reported gas seep location. All of the nearby Origin wells are cased and are not part of a producing field. Further, there are no CSG pipelines in the immediate vicinity, while the nearest production fields are approximately 10 kilometres away from the location (Appendix A). Additionally, there was no evidence of hydraulic fracturing having occurring within 40 kilometres of the reported bubbling.

Results of the groundwater data review indicate that, of the bores within 10 kilometres of the reported bubbling activity that are not abandoned and destroyed and have sufficient information to determine an aquifer, 26 are in the Walloon Coal Measures (WCM). Using the information available, only three bores located in the WCM are equipped with a pump (two with gas, one without gas). Results were plotted on a map to assist analysis of the data (Appendix F).

Government analysis of groundwater data has been complimented by subsequent field assessments of local water bores undertaken by Origin as part of their gas seep investigation. This has comprised the testing of 21 water bores in the area surrounding the reported gas seep sites. Government groundwater experts have accompanied Origin for a portion of their water bore testing program, in order to verify their applied field methods.

Results of the geophysical data review provide a limited dataset (Appendix G), due to the lack of detailed borehole data in the area. The resulting gas well stratigraphic cross section is based on three CSG wells (Darvall 1, Orana 10 and Xyloleum 1) and provides an indication of geological strata around the gas seep sites. Results suggest that the geology dips towards the south-east, with the Walloon Coal Measures closer to the surface at the Darvall 1 CSG well, in the immediate vicinity of the main gas seep sites. Ground verification of the area undertaken independently by government and Origin representatives appears broadly consistent with this desk based study.

3.2.3 Seep gas characterisation

Gas compositional results from gas seep sites Campground (CG1 and CG2) and Pumphole (PH) show that the seep gas is generally consistent between seep sites (Table 3). Seep gases are dominated by methane (94.4 – 96.8%) supported by smaller amounts of nitrogen (3.0 – 4.5%) and carbon dioxide (0.2 – 1.1%). Gas composition from the river seeps appears to differ slightly from the gas composition measured at a historically gassy local water bore (Dairy), with the water bore exhibiting a relatively increased concentration of nitrogen (8%) to methane (90.9%). No other constituent gases, such as hydrocarbons, were evident in the samples tested.

Table 3: Relative composition of free gas samples retrieved from Condamine River gas seep sites Campground (CS1 and CG2) and Pumphole (PH), in addition to a local 'gassy' water bore (Dairy). Sample date: 19 June 2012.

Sample Reference	% Methane (CH_4)	% Nitrogen N_2	% Carbon Dioxide (CO_2)	% Other	Total (%)
CG1	94.4	4.5	1.1	0	100
CG2	96.8	3.0	0.2	0	100
PH	95.8	3.6	0.6	0	100
Dairy	90.9	8.0	1.1	0	100

Individual isotopic results for carbon composition (Table 4) and methane composition (Table 5) appear broadly consistent with each other and with historical gas isotopic records. The information has been forwarded on to Origin to assist in their own seep gas characterisation study.

Isotopic results for carbon composition exhibited a $\delta^{13}CH_4$ (‰ VPDB) range of -59.3 to 63.4 at Campground 1 (Isobottle) and Fenceline (Flexfoil bag) respectively. A wider range in $\delta^{13}CO_2$ (‰ VPDB) was exhibited at Pumphole (Flexfoil bag) and Fenceline (Flexfoil bag), displaying -1.7 and -25.0 respectively.

Similarly, isotopic results for methane composition appear consistent with each other, exhibiting a $\delta D\ CH_4$ (‰ VSMOW) range of -188.0 to 202.4 at Pumphole (Isobottle) and Campground 1 (Flexfoil bag) respectively.

Table 4: Carbon isotopic composition (‰) of gas seeps in the Condamine River measured against a VPDB (Vienna Pee Dee Belemnite) standard. Sample date: 20 June 2012.

Sample Site	Date of Analysis	$\delta^{13}CH_4$ (‰ VPDB)	$\delta^{13}CO_2$ (‰ VPDB)
Campground 1 - Isobottle	28/06/12	-61.5	-16.3
		-59.3	-16.7
Campground 1 – Flexfoil bag	28/06/12	-60.0	-10.9
		-60.1	-10.7
Fenceline – Flexfoil bag	28/06/12	-63.4	-25.0
		-63.0	-25.0
Pumphole - Isobottle	28/06/12	-62.0	-15.8
		-62.5	-13.7
Pumphole – Flexfoil bag	28/06/12	-61.9	-1.7
		-61.6	-1.7

Table 5: Methane isotopic composition (‰) of gas seeps in the Condamine River measured against a VSMOW (Vienna Standard Mean Ocean Water) standard. Sample date: 20 June 2012.

Sample Site	Date of Analysis	δD CH_4 (‰ VSMOW)
Campground 1 - Isobottle	18/07/12	-193.1
		-197.7
Campground 1 – Flexfoil bag	18/07/12	-201.7
		-202.4
Fenceline – Flexfoil bag	18/07/12	-193.2
		-195.6
Pumphole - Isobottle	18/07/12	-198.2
		-188.0
Pumphole – Flexfoil bag	18/07/12	-197.1
		-198.2
		-196.3

These results suggest a predominantly biogenic methane isotopic signature formed through a CO_2 reduction pathway, which is consistent with gas originating from Surat Basin geological formations. However, these results do not provide definitive evidence of the source or cause of the Condamine River gas seeps.

3.2.4 Environmental monitoring

Results to date from DEHP's regular ongoing water quality sampling and analysis program do not indicate any significant deterioration in water quality and subsequent environmental harm (Appendix C). Similarly, DEHP's water quality results remain generally consistent with historical water quality information for this segment of the Condamine River.

Electrical conductivity (EC) values are similar for upstream, downstream and Seep 1 and 2 sites, displaying a range of 283 to 645 µS/cm. The recorded EC values appear inversely related to flow conditions in the Condamine River, with low EC values recorded during elevated flows and high EC values exhibited during low or no flow conditions (Figure 1).

Dissolved Oxygen (DO) levels remained relatively stable at all sampling sites for the first three sampling runs (May – September 2012; 72 - 95% saturation). However, a decrease in DO level was recorded during the late September sampling run and was more prominent at the gas seep site 'Seep 2' (52.4%) compared to upstream and downstream sites (72 - 77%).

Dissolved methane levels have been elevated at the gas seep site (97 – 558 µg/L) compared to background levels at upstream and downstream sites (<10 µg/L).

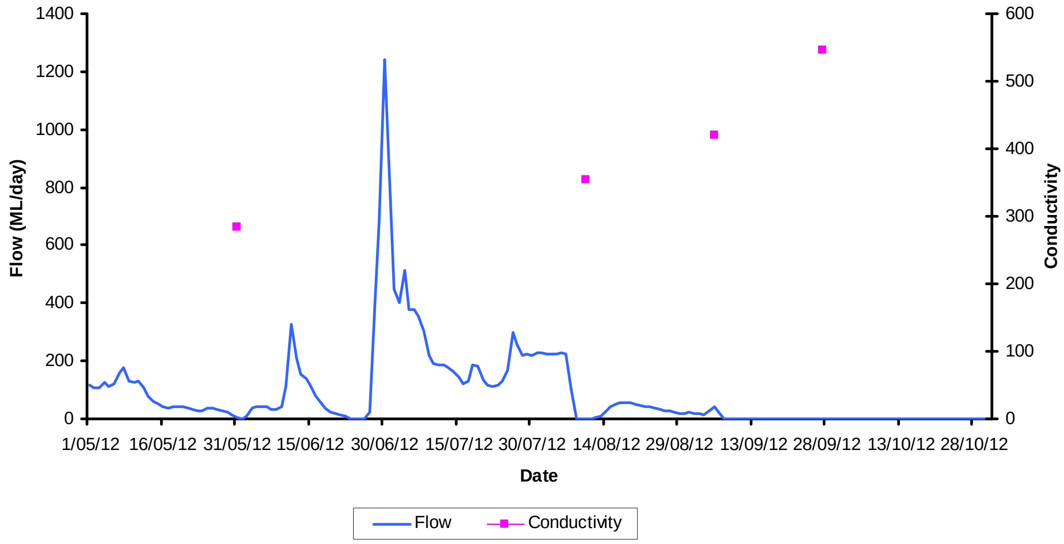

Figure 1: Relationship between flow (ML/day) and electrical conductivity (µS/cm) recorded at Seep 2 site. Flow data is from Stream Gauging Station 422308C. Note an increase in EC levels as flows started receding.

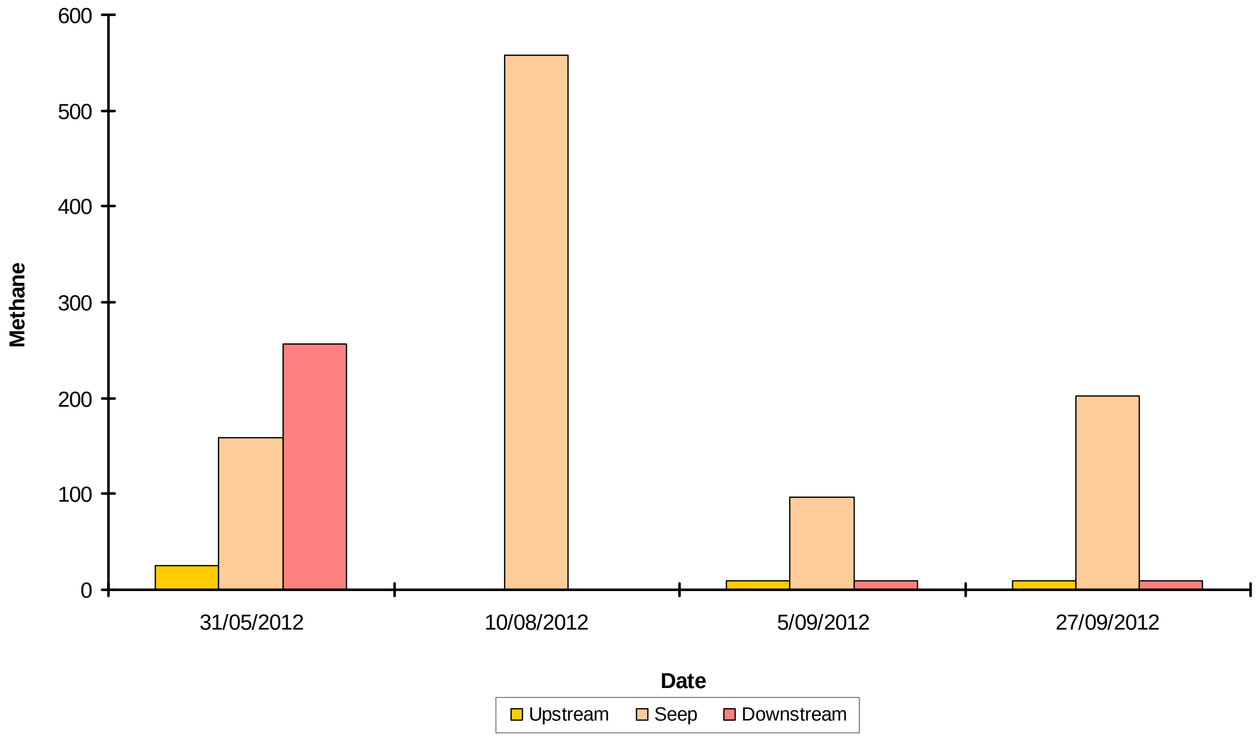

Figure 2: Dissolved methane levels (µg/L) recorded at Seep 1 and 2 sample sites and two background sites (upstream and downstream sites). Seep 2 site was located approximately 50 metres downstream of Seep 1 site, immediately adjacent (downstream) of effervescent gas seep activity.

Hydrocarbon levels, including BTEX and Total Petroleum Hydrocarbons (TPH), are below respective limit of reporting (LOR) (1 to 2 µg/L for BTEX, and 20 to 100 µg/L for TPH). Total metals at all sites sampled provide similar results across sampling events. Copper (LOR – 0.0014mg/L), Beryllium (0.00013mg/L), Cobalt (0.0014mg/L), Chromium (0.0033 LR H (CrIII); 0.001 (CrVI)), Vanadium (LOR - 0.006mg/L) exceed their respective guideline trigger levels, although are generally consistent with historical water quality values.
All sediment analytes for the river bank immediately adjacent to gas bubbling were either less than LOR, or marginally elevated above LOR. None of the sediment results appear indicative of detrimental environmental impact.

4 Conclusions

This is a technical report summarising government activities up to 1 October 2012 on its Condamine River gas seep investigation. Key conclusions are outlined in the following sections.

4.1 Phase 1 Investigation

The investigation has completed its initial phase, with the key results being:

- No apparent safety risk in the immediate area of the seeps
- No apparent evidence of environmental harm that can be attributed to the present gas seeps

4.2 Phase 2 Investigation and future directions

Government's long-term technical program is in progress, with important advances already achieved with regard to understanding the extent and nature of the gas seeps, such as characterising the seep gas composition and generating a regional and an international context for the occurrence that will help inform governments ensuing operations in the matter.

It is recommended that government undertake the following future activities regarding the Condamine River gas seeps:

- 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 DNRM Petroleum and Gas Inspectorate, in order to ensure public safety.
- Geological Survey of Queensland will revise the geological mapping of the affected area in the Surat Basin.
- Government will keep landholders updated on investigation activities relating to the Condamine River gas seeps.
- Further in-depth review of historical groundwater data of nearby gassy bores, utilising all available departmental records .
- Government will continue to verify Origin's investigation of the gas seeps, in order to make sure that their investigation is rigorous and is independently assessed.
- Assisted by the Chief Scientist to the Queensland Government, advanced scientific reviews will ensure that Origin's investigation, and verification actions by government, achieve a high scientific standard and integrity. It is anticipated that his will commence in the first quarter of 2013.

However, it is recognised that the source and 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.

5 Publications of note

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US Environmental protection Agency (2004). Evaluation of Impacts to Underground Sources of Drinking Water by Hyadrulic Fracturing of Coalbed Methane Reservoirs, Chapter 6 - Water Quality Incidents, pp.6-1 – 6-16, June 2004.
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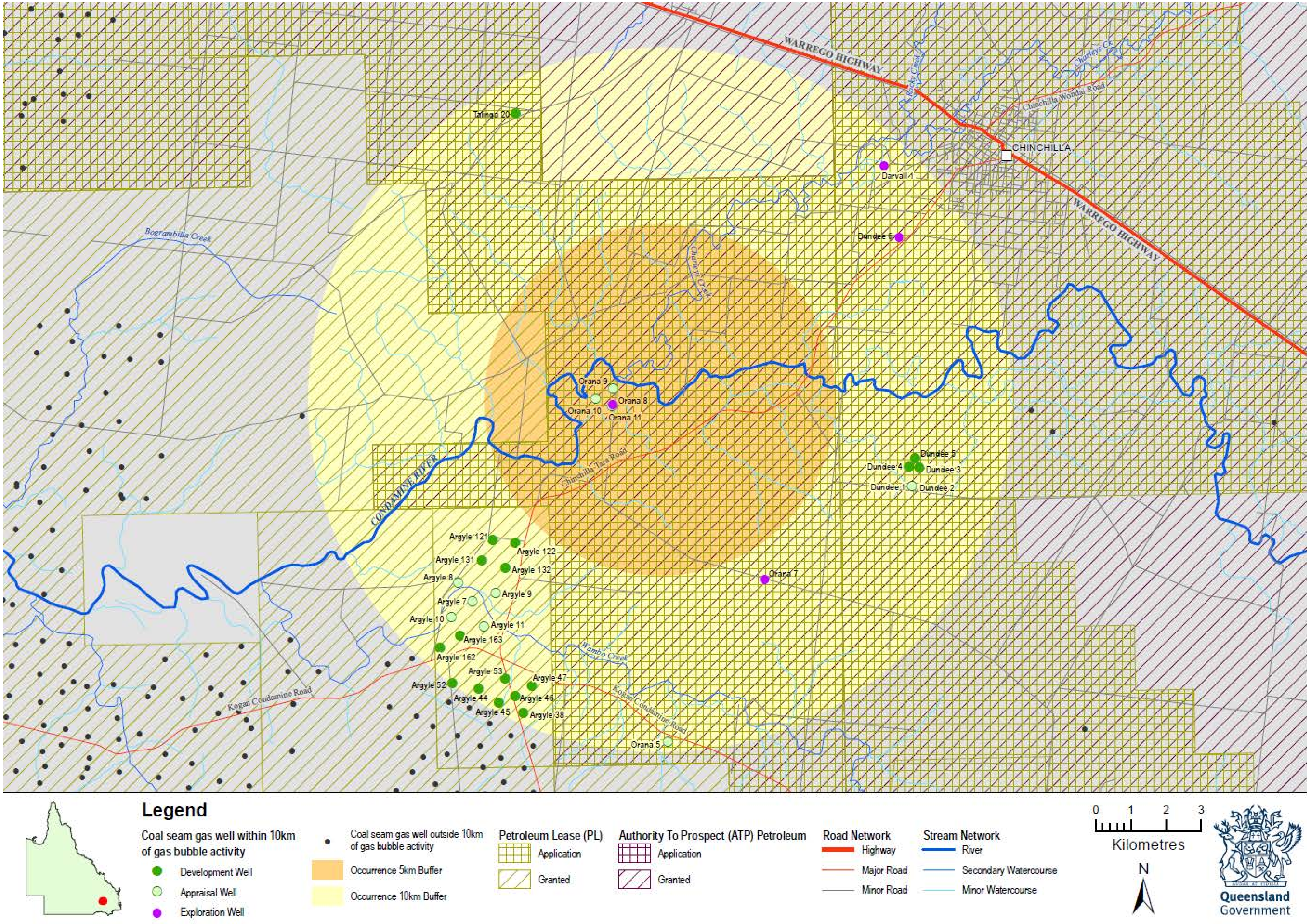
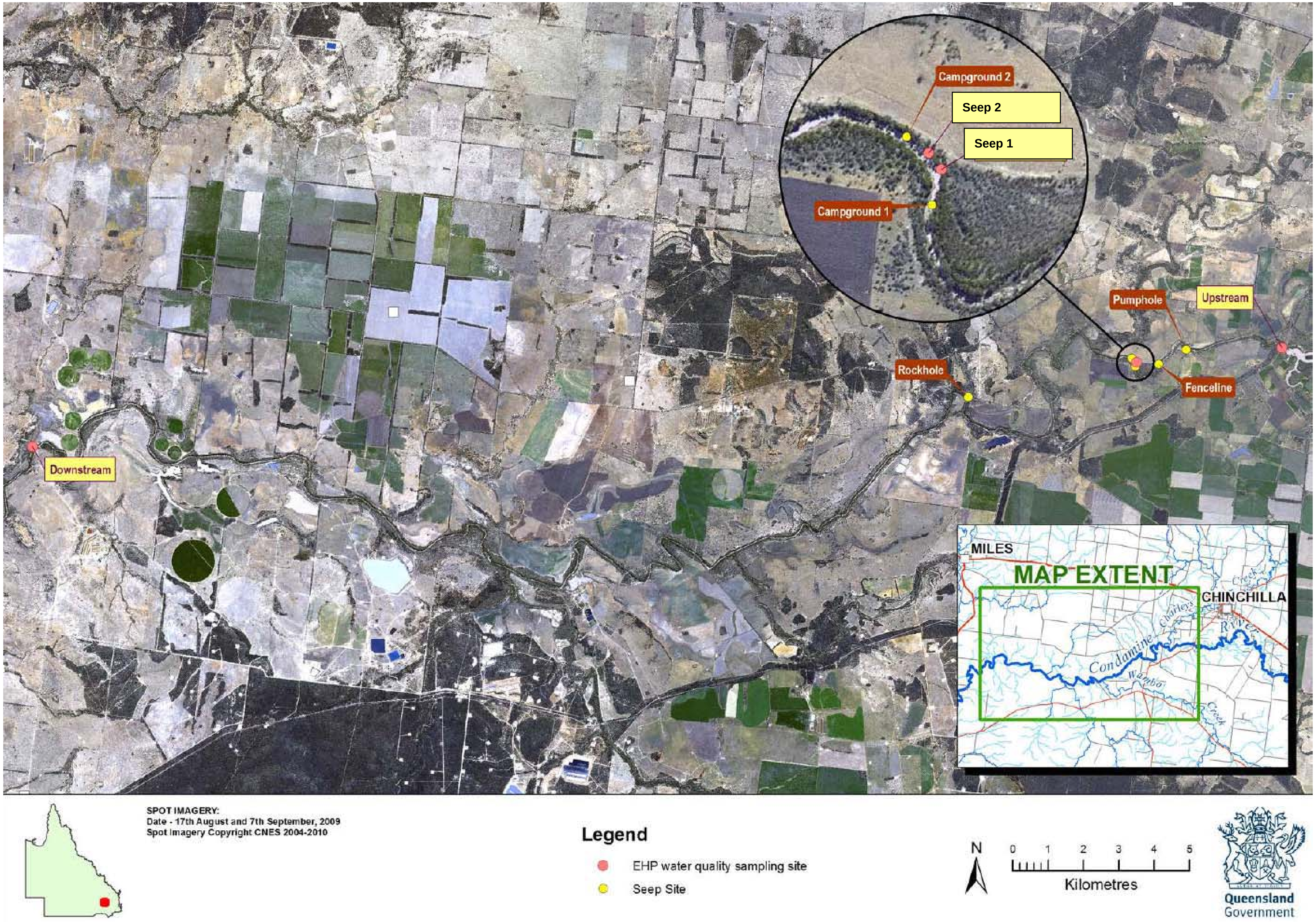
http://ipec.utulsa.edu/Conf2002/viellenave_fontana_gorody_114.pdf

Appendix A Coal Seam Gas operations within a 5 kilometre and 10 kilometre radius of the reported gas bubbling in the Condamine River



Appendix B Condamine River gas seep sites (x4) and corresponding gas seeps (x5)



Appendix C Preliminary results of the water quality recorded at the Campground seep and background sites

Analyte		Sample Site			Sample site	Sample Site			Sample Site		
	Units	Upstream	Seep 1	Seep 2	Seep 2	Upstream	Seep2	Downstream	Upstream	Seep 2	Downstream
Sample date		31/05/2012	31/05/2012	31/05/2012	10/08/2012	5/09/2012	5/09/2012	5/09/2012	27/09/2012	27/09/2012	27/09/2012
Latitude		26.7987	26.804	26.8022	26.804	26.79966	26.80292	26.81842	26.79966	26.80292	26.81842
Longitude		150.575	150.5333	150.5332	150.5333	150.57501	150.53383	150.21915	150.57501	150.53383	150.21915
In Situ											
Water temperature	Degrees C	16.1	15.41	15.31	15.3	17.4	17.11	16.01	24.1	24.8	22.6
Electrical Conductivity	µS/cm	295	285	283	335	429	420	375	645	547	578
pH	pH units	7.83	8.27	8.04	8.38	9.4	9.35	8.8	8	7.8	8
DO%	%	72.4	80	80	80.3	76	92.7	95.2	72.1	52.4	77.1
Laboratory											
Electrical Conductivity	µS/cm	362	350	349	398	501	486	455	632	551	591
Total Dissolved Solids @180°C	mg/L	244	200	228	255	278	263	258	411	399	410
Alkalinity											
Hydroxide Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	5	18	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	109	106	106	98	119	100	110	167	142	117
Total Alkalinity as CaCO3	mg/L	109	106	106	98	124	118	110	167	142	117
Sulfate											
Sulfate as SO4 2-	mg/L	<1	<1	<1	6	8	8	7	8	4	10
Chloride											
Chloride	mg/L	39	39	40	64	80	79	73	104	88	116
Dissolved Major Cations											
Calcium	mg/L	20	21	21	21	27	26	22	31	31	27
Magnesium	mg/L	14	13	13	14	20	19	15	23	21	17
Sodium	mg/L	26	24	25	37	43	43	44	63	44	66
Potassium	mg/L	4	4	4	4	4	4	4	4	4	4
Total Metals											
Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001		0.002	
Barium	mg/L	0.072	0.075	0.075	0.086	0.070	0.069	0.081		0.097	
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		0.004	
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		0.0008	
Cobalt	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	<0.001		0.003	
Chromium	mg/L	0.005	0.006	0.006	0.005	0.003	0.002	0.002		<0.001	
Copper	mg/L	0.002	0.003	0.004	0.007	0.004	0.004	0.003		0.002	
Manganese	mg/L	0.063	0.076	0.068	0.074	0.115	0.123	0.063		0.584	
Nickel	mg/L	0.007	0.008	0.008	0.008	0.005	0.005	0.004		0.007	
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	
Vanadium	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	<0.01		<0.01	
Zinc	mg/L	0.006	0.007	0.007	0.011	0.009	0.007	<0.005		<0.005	
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	
Ammonia as N											
Ammonia as N	mg/L				0.03	0.04	0.05	0.03	0.12	0.12	0.16
Nitrite plus Nitrate as N (NOx)											
Nitrite + Nitrate as N	mg/L				0.85	0.06	0.02	0.02	0.08	0.06	0.08
Total Kjeldahl Nitrogen											
Total Kjeldahl Nitrogen as N	mg/L				0.6	1.0	1.0	0.7	1.0	0.8	0.6

Analyte		Sample Site			Sample site	Sample Site			Sample Site		
	Units	Upstream	Seep 1	Seep 2	Seep 2	Upstream	Seep2	Downstream	Upstream	Seep 2	Downstream
Sample date		31/05/2012	31/05/2012	31/05/2012	10/08/2012	5/09/2012	5/09/2012	5/09/2012	27/09/2012	27/09/2012	27/09/2012
Latitude		26.7987	26.804	26.8022	26.804	26.79966	26.80292	26.81842	26.79966	26.80292	26.81842
Longitude		150.575	150.5333	150.5332	150.5333	150.57501	150.53383	150.21915	150.57501	150.53383	150.21915
Total Phosphorus as P											
Total Phosphorus as P	mg/L				0.13	0.14	0.15	0.08	0.22	0.20	0.05
Fluoride											
Fluoride	mg/L	0.2	0.1	0.1							
Ionic Balance											
Total anions	meq/L	3.28	3.22	3.25	3.89				6.44	5.40	5.82
Total cations	meq/L	3.38	3.26	3.31	3.91				6.28	5.29	5.72
Ionic balance	%	1.58	0.71	0.93	0.30				1.22	1.04	0.86
C1-C4 Hydrocarbon Gases											
Methane	µg/L	25	158	257	558	<10	97	<10	<10	202	<10
BTEX											
Benzene	µg/L	<1	<1	<1	<1	<1	<1	<1		<1	
Toluene	µg/L	<2	<2	<2	<2	<2	<2	<2		<2	
Ethylbenzene	µg/L	<2	<2	<2	<2	<2	<2	<2		<2	
meta- & para-Xylene	µg/L	<2	<2	<2	<2	<2	<2	<2		<2	
ortho-Xylene	µg/L	<2	<2	<2	<2	<2	<2	<2		<2	
Total Xylenes	µg/L	<2	<2	<2	<2	<2	<2	<2		<2	
Sum of BTEX	µg/L	<1	<1	<1	<1	<1	<1	<1		<1	
Naphthalene	µg/L	<5	<5	<5	<5	<5	<5	<5		<5	
Total Petroleum Hydrocarbons											
C6 - C9 Fraction	µg/L	<20	<20	<20		<20	<20	<20			
C10 - C14 Fraction	µg/L	<50	<50	<50		<50	<50	<50			
C15 - C28 Fraction	µg/L	<100	<100	<100		<100	<100	<100			
C29 - C36 Fraction	µg/L	<50	<50	<50		<50	<50	<50			
C10 - C36 Fraction (sum)	µg/L	<50	<50	<50		<50	<50	<50			
Polynuclear Aromatic Hydrocarbons											
Naphthalene	µg/L	<1.0	<1.0	<1.0							
Acenaphthylene	µg/L	<1.0	<1.0	<1.0							
Acenaphthene	µg/L	<1.0	<1.0	<1.0							
Fluorene	µg/L	<1.0	<1.0	<1.0							
Phenanthrene	µg/L	<1.0	<1.0	<1.0							
Anthracene	µg/L	<1.0	<1.0	<1.0							
Fluoranthene	µg/L	<1.0	<1.0	<1.0							
Pyrene	µg/L	<1.0	<1.0	<1.0							
Benz(a)anthracene	µg/L	<1.0	<1.0	<1.0							
Chrysene	µg/L	<1.0	<1.0	<1.0							
Benzo(b)fluoranthene	µg/L	<1.0	<1.0	<1.0							
Benzo(k)fluoranthene	µg/L	<1.0	<1.0	<1.0							
Benzo(a)pyrene	µg/L	<0.5	<0.5	<0.5							
Indeno(1.2.3.cd)pyrene	µg/L	<1.0	<1.0	<1.0							
Dibenz(a.h)anthracene	µg/L	<1.0	<1.0	<1.0							
Benzo(g.h.i)perylene	µg/L	<1.0	<1.0	<1.0							
Sum of polycyclic aromatic hydrocarbons	µg/L	<0.5	<0.5	<0.5							

Analyte		Sample Site				Sample site		Sample Site				Sample Site		
	Units	Upstream	Seep 1	Seep 2		Seep 2		Upstream	Seep2	Downstream		Upstream	Seep 2	Downstream
Sample date		31/05/2012	31/05/2012	31/05/2012		10/08/2012		5/09/2012	5/09/2012	5/09/2012		27/09/2012	27/09/2012	27/09/2012
Latitude		26.7987	26.804	26.8022		26.804		26.79966	26.80292	26.81842		26.79966	26.80292	26.81842
Longitude		150.575	150.5333	150.5332		150.5333		150.57501	150.53383	150.21915		150.57501	150.53383	150.21915
Monocyclic Aromatic Hydrocarbons														
Styrene	µg/L	<5	<5	<5										
Isopropylbenzene	µg/L	<5	<5	<5										
n-Propylbenzene	µg/L	<5	<5	<5										
1.3.5-Trimethylbenzene	µg/L	<5	<5	<5										
sec-Butylbenzene	µg/L	<5	<5	<5										
1.2.4-Trimethylbenzene	µg/L	<5	<5	<5										
tert-Butylbenzene	µg/L	<5	<5	<5										
p-Isopropyltoluene	µg/L	<5	<5	<5										
n-Butylbenzene	µg/L	<5	<5	<5										
Oxygenated Compounds														
Vinyl Acetate	µg/L	<50	<50	<50										
2-Butanone (MEK)	µg/L	<50	<50	<50										
4-Methyl-2-pentanone (MIBK)	µg/L	<50	<50	<50										
2-Hexanone (MBK)	µg/L	<50	<50	<50										
Sulfonated Compounds														
Carbon disulfide	µg/L	<5	<5	<5										
Fumigants														
2.2-Dichloropropane	µg/L	<5	<5	<5										
1.2-Dichloropropane	µg/L	<5	<5	<5										
cis-1.3-Dichloropropylene	µg/L	<5	<5	<5										
trans-1.3-Dichloropropylene	µg/L	<5	<5	<5										
1.2-Dibromoethane (EDB)	µg/L	<5	<5	<5										
Halogenated Aliphatic Compounds														
Dichlorodifluoromethane	µg/L	<50	<50	<50										
Chloromethane	µg/L	<50	<50	<50										
Vinyl chloride	µg/L	<50	<50	<50										
Bromomethane	µg/L	<50	<50	<50										
Chloroethane	µg/L	<50	<50	<50										
Trichlorofluoromethane	µg/L	<50	<50	<50										
1.1-Dichloroethene	µg/L	<5	<5	<5										
Iodomethane	µg/L	<5	<5	<5										
trans-1.2-Dichloroethene	µg/L	<5	<5	<5										
1.1-Dichloroethane	µg/L	<5	<5	<5										
cis-1.2-Dichloroethene	µg/L	<5	<5	<5										
1.1.1-Trichloroethane	µg/L	<5	<5	<5										
1.1-Dichloropropylene	µg/L	<5	<5	<5										
Carbon Tetrachloride	µg/L	<5	<5	<5										
1.2-Dichloroethane	µg/L	<5	<5	<5										
Trichloroethene	µg/L	<5	<5	<5										
Dibromomethane	µg/L	<5	<5	<5										
1.1.2-Trichloroethane	µg/L	<5	<5	<5										
1.3-Dichloropropane	µg/L	<5	<5	<5										
Tetrachloroethene	µg/L	<5	<5	<5										

Analyte	Units	Sample Site			Sample site	Sample Site			Sample Site		
		Upstream	Seep 1	Seep 2	Seep 2	Upstream	Seep2	Downstream	Upstream	Seep 2	Downstream
Sample date		31/05/2012	31/05/2012	31/05/2012	10/08/2012	5/09/2012	5/09/2012	5/09/2012	27/09/2012	27/09/2012	27/09/2012
Latitude		26.7987	26.804	26.8022	26.804	26.79966	26.80292	26.81842	26.79966	26.80292	26.81842
Longitude		150.575	150.5333	150.5332	150.5333	150.57501	150.53383	150.21915	150.57501	150.53383	150.21915
1.1.1.2-Tetrachloroethane	µg/L	<5	<5	<5							
trans-1.4-Dichloro-2-butene	µg/L	<5	<5	<5							
cis-1.4-Dichloro-2-butene	µg/L	<5	<5	<5							
1.1.2.2-Tetrachloroethane	µg/L	<5	<5	<5							
1.2.3-Trichloropropane	µg/L	<5	<5	<5							
Pentachloroethane	µg/L	<5	<5	<5							
1.2-Dibromo-3-chloropropane	µg/L	<5	<5	<5							
Hexachlorobutadiene	µg/L	<5	<5	<5							
Halogenated Aromatic Compounds											
Chlorobenzene	µg/L	<5	<5	<5							
Bromobenzene	µg/L	<5	<5	<5							
2-Chlorotoluene	µg/L	<5	<5	<5							
4-Chlorotoluene	µg/L	<5	<5	<5							
1.3-Dichlorobenzene	µg/L	<5	<5	<5							
1.4-Dichlorobenzene	µg/L	<5	<5	<5							
1.2-Dichlorobenzene	µg/L	<5	<5	<5							
1.2.4-Trichlorobenzene	µg/L	<5	<5	<5							
1.2.3-Trichlorobenzene	µg/L	<5	<5	<5							
Trihalomethanes											
Chloroform	µg/L	<5	<5	<5							
Bromodichloromethane	µg/L	<5	<5	<5							
Dibromochloromethane	µg/L	<5	<5	<5							
Bromoform	µg/L	<5	<5	<5							

Notes:

1. For 31/5/2012 sample run, Seep 2 sample location is located approximately 50m downstream of Seep 1 sample location at the Campground seep site

Appendix D Condamine River gas seep sites and mapping transects

MAIN MAP IMAGERY:
Date - 17th August and 7th September, 2009
Spot Imagery Copyright CNES 2004-2010

INSET MAP IMAGERY:
©2010 Google ©2012 Whereis® Sensis Pty Ltd ©2012 GeoEye

Key:

Shape of marker = Date of Observation
- 16 June 2012
- 25 June 2012
- 1 July 2012
- 25 July 2012

Colour of marker = Bubble Effervescence
- Minor
- Minor/Moderate
- Moderate
- Moderate/Very effervescent
- Very effervescent
- No observation

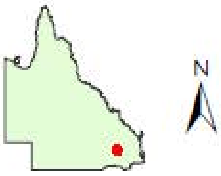
Opacity of marker = Continuity of bubbles
- Continuous
- Intermittent

Size of marker (relative) = Size of bubbles
- Small
- Medium
- Large
- Extra large

AF-MAIN

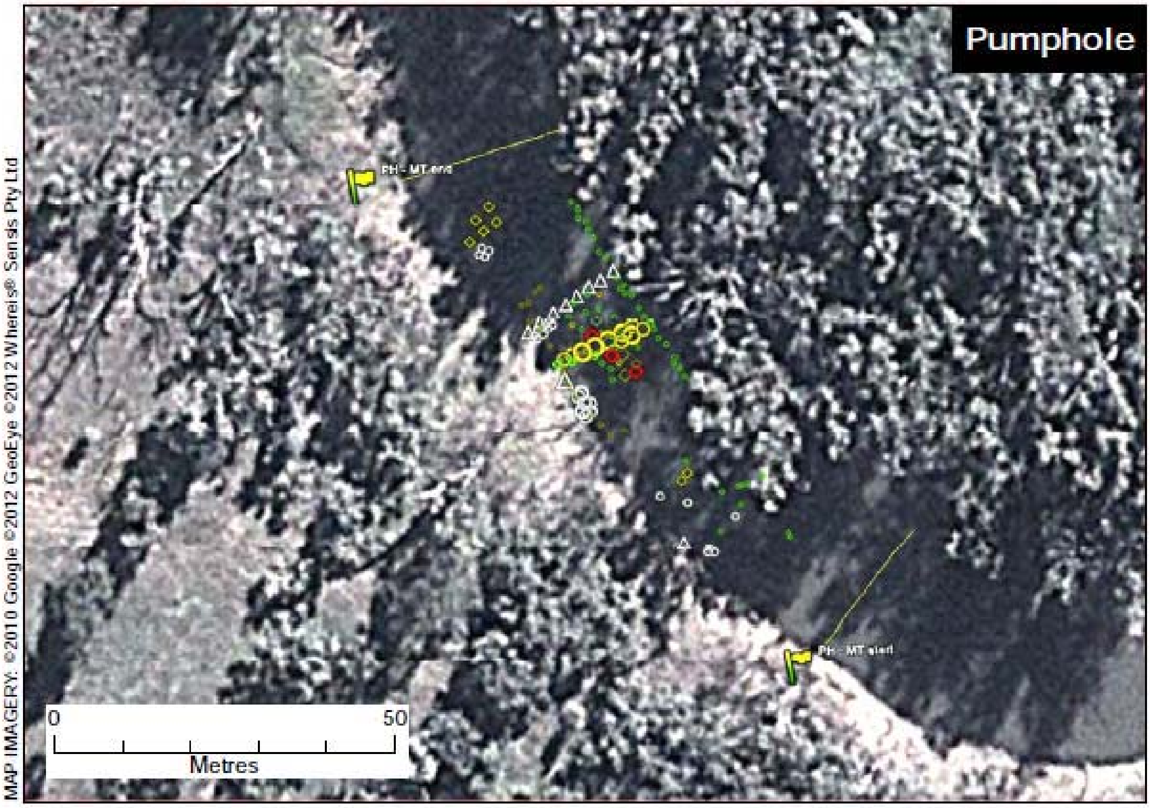
N 0 0.5 1 Kilometres

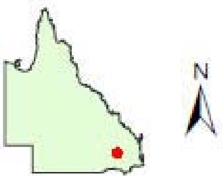
Queensland Government



Note: Refer to map AF-MAIN for mapping transect locations and legend.

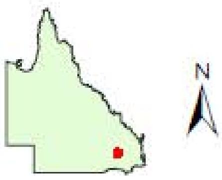
Queensland Government





Note: Refer to map AF-MAIN for mapping transect locations and legend.

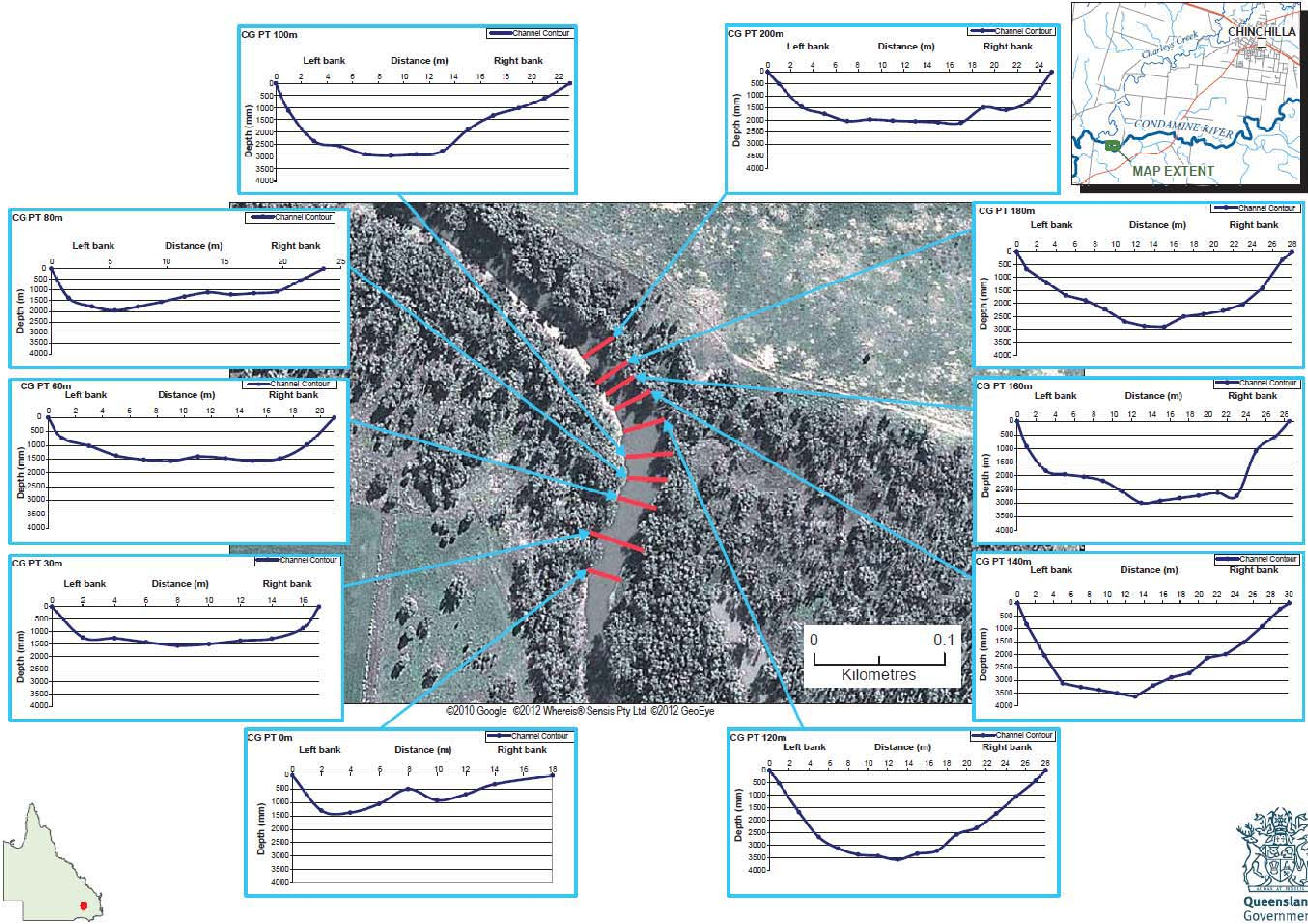
Queensland Government



Note: Refer to map AF-MAIN for mapping transect locations and legend.

Queensland Government

Appendix E Detailed profile transect at Campground 1 seep



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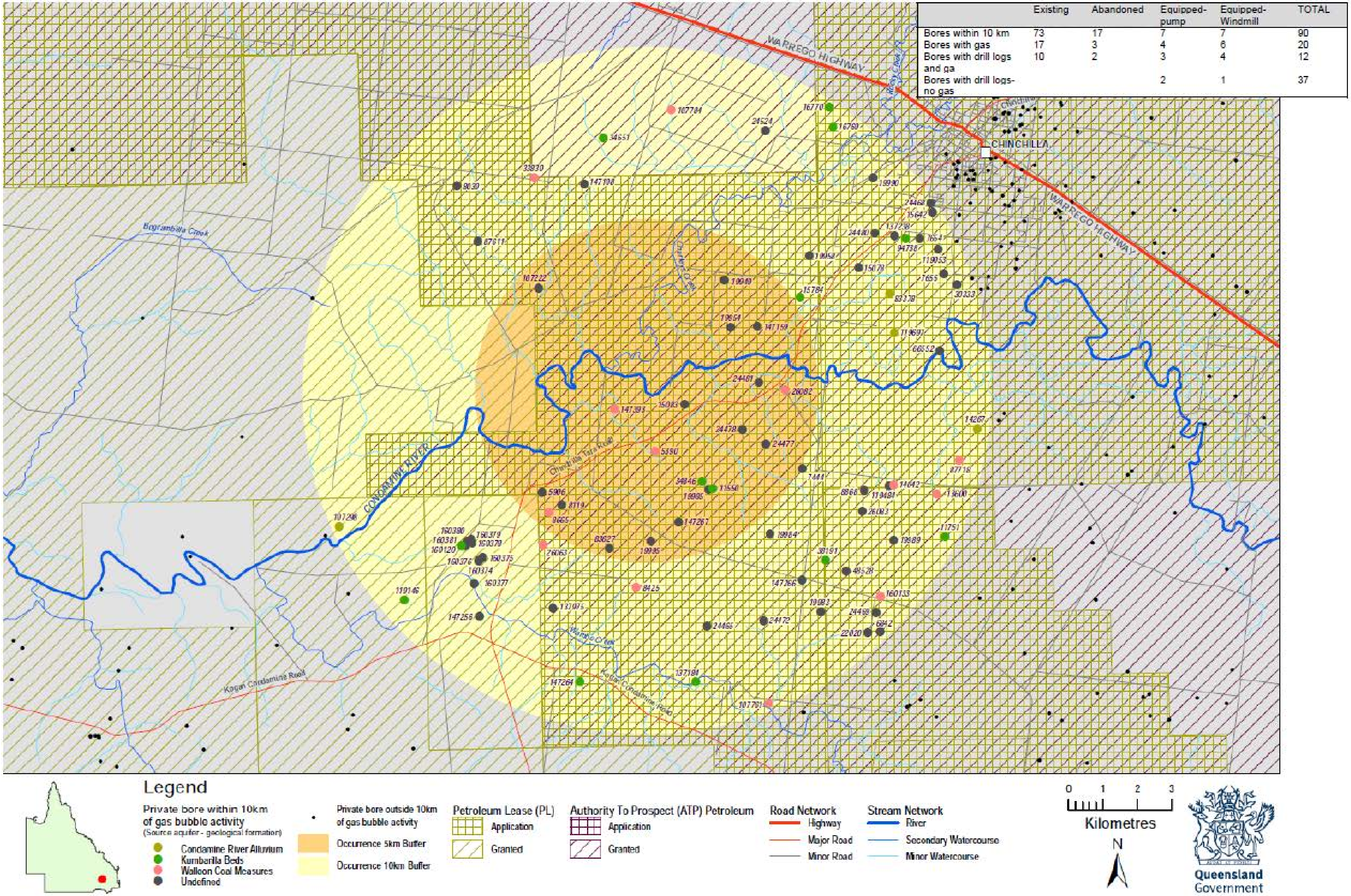
Appendix F Private bores within 5km and 10km radius of gas seeps in the Condamine River



	Existing	Abandoned	Equipped-pump	Equipped-Windmill	TOTAL
Bores within 10 km	73	17	7	7	90
Bores with gas	17	3	4	6	20
Bores with drill logs and ga	10	2	3	4	12
Bores with drill logs-no gas			2	1	37

Appendix G Geophysical database review: (a) Location of wells included in cross section; and (b) stratigraphical logs of Darvall 1, Orana 10 and Xyloleum 1 wells