Project Order, Variations and Research Progress

Project Title: Regional Methane Emissions in NSW CSG Basins

This document contains three sections. Click on the relevant section for more information.

1 Original Project Order

Project Order
Proforma 2016

1. Short Project Title (less than 15 words)

Regional Methane Emissions in NSW CSG Basins

Long Project Title	Regional Methane Emissions in NSW CSG Basins
GISERA Project Number	G4
Proposed Start Date	1 July 2016
Proposed End Date	30 June 2017
Project Leader	Stuart Day

2. GISERA Region

☐ Queensland ☒ New South Wales ☐ Northern Territory

3. GISERA Research Program

☐ Water Research ☒ GHG Research ☐ Social & Economic Research
☐ Biodiversity Research ☐ Agricultural Land Management Research

4. Research Leader, Title and Organisation

Stuart Day
Research Team Leader
CSIRO Energy

5. Project Description

The CSG industry in NSW is currently much smaller than in Queensland, with only one commercial gas field in operation in Camden south of Sydney. However, there is a proposal to develop the Pilliga gas field in the state's north into a major commercial operation over the coming years. It is therefore important to understand the magnitude of emissions of greenhouse gasses from this development. However, to properly account for emissions from CSG operations, it is essential to understand the contribution from other sources in the region, particularly if top-down atmospheric methods are used for monitoring industry emissions.

In this project we propose to deploy methodology developed during the Queensland GISERA Surat Basin methane study. This approach includes mobile surveys of the entire gas region to locate methane emission sources. These surveys have proved to be extremely effective at locating even small sources over very wide areas. Sources that are located will be quantified using surface flux chambers and tracer gas techniques, which have also been proven in the Queensland gas fields. The results of this phase of the work will produce a detailed map of significant methane sources within the proposed gas production development region. More importantly, the results of this study will be a step towards building a robust inventory of methane sources and provide the basis for longer term baseline atmospheric monitoring currently under development in the Surat Basin.

While the mobile surveying is a versatile and reasonably rapid method for locating methane sources, it is usually limited to areas with vehicle access. Complementary technologies such as remote sensing from satellites or other platforms offer the possibility of much more rapid spatial coverage of very large areas and the potential for routine monitoring. A limitation identified from previous work within the GISERA methane study related to the low spatial resolution of the space-borne sensors available at the time. Recently, a new Canadian satellite (GHGSat) has been launched with a ground resolution of 50 m, which is a vast improvement over previous sensors. The operators of the satellite also claim that methane emission rates can be determined from the data sets. We therefore propose to conduct a small scale trial of the GHGSat system by acquiring data for a CSG region in Australia. A small scale target observation region (approximately 12 x 12 km in area) will be selected for the trial to include a range of methane sources such as CSG infrastructure, underground coal mine vents, etc. A range of different sources with varying emission levels will assist in evaluating the sensor's capability in relation to measuring methane emissions within a CSG field and assessing where such technology may be usefully deployed in the future.

Research context

Greenhouse gas emissions from unconventional gas production have been the subject of considerable public and scientific interest for a number of years. Initial reports from the United States suggested that methane emissions from the onshore gas industry were much higher than previously estimated. However, more recent work in Australia suggests that emissions from Australian CSG production facilities are much lower than the early U.S. estimates. For example, leakage rates from well pads have been shown to be relatively low (Day et al., 2014), although the measurements were restricted to a small sample of wells. A large project within GISERA is also currently underway in the Surat Basin in Queensland to better understand landscape scale emissions from the gas fields in that region (Day et al., 2015).

To date there is relatively little public information on methane emissions from CSG activities in NSW. Some industry funded research into emissions within the Pilliga gas field has been undertaken by the University of Adelaide but the results of this work have not been made public as yet. However, initial discussions have been held with the company that sponsored this work regarding how the results may be incorporated into the study proposed here. Another study funded by the NSWEPA also included a series of measurements within the Pilliga region but this too is not in the public domain at this stage, although it is anticipated that both studies will be available in due course and we will endeavour to connect the findings.

The purpose of the proposed project is to build on and complement these other studies by charaterising methane emissions (both natural and anthropogenic) within the Pilliga ahead of large scale development. This will provide important baseline information for the region. A second component of the project will investigate a new satellite sensor specifically designed for measuring methane, which has the potential to be applied across Australian CSG sites for ongoing monitoring.

Please see table below that summarises overall emissions in the region and where this project will focus its efforts (shaded cells). While the project will be largely aimed at understanding methane emissions from ill-defined sources such as seeps, it is also intended to estimate emissions from other known large sources such as coal mining and agriculture. This will allow CSG emissions to be placed in context across the region.

Regional GHG Emissions			
Activity	Potential sources	Methane Released?	Current Estimate Uncertainty
CSG	Fugitives	Yes	High
	Fuel usage	minor	Low
Coal Mining	Fugitives	Yes	Low to moderate
	Fuel usage	Minor	Low
Transport	Fuel usage	Minor	Low
Agriculture, Forestry and Other Landuse	Ruminant animals	Yes	High
	Manure management	Yes	High
	Fertiliser	Minor	High
	Landclearing	Minor	High
	Biomass Burning	Some	High
Natural	Wetlands	Yes	Very high
Other	Seeps – natural, caused or affected by CSG and mining?	Yes	Unknown
	Legacy bores	Yes	Unknown
	Water bores	Yes	Unknown

6. Budget Summary

Expenditure	2015/16	2016/17	2017/18	2018/19	Total
Labour		166,910			166,910
Operating		20,000			20,000
Subcontractors		15,000			15,000
Total Expenditure		**201,910**			**201,910**

Expenditure per Task	2015/16	2016/17	2017/18	2018/19	Total
Task 1		20,000			20,000
Task 2		60,000			60,000
Task 3		40,000			40,000
Task 4		20,000			20,000
Task 5		61,910			61,910
Total Expenditure		**201,910**			**201,910**

Source of Cash Contributions	2015/16	2016/17	2017/18	2018/19	Total
GISERA Industry Partners (25%)		50,477.50			50,477.50
- Santos (12.5%)		25,238.75			25,238.75
- AGL (12.5%)		25,238.75			25,238.75
NSW Government (25%)		50,477.50			50,477.50
Federal Government (25%)		50,477.50			50,477.50
Total Cash Contributions		**151,432.50**			**151,432.50**

In-Kind Contribution from Partners	2015/16	2016/17	2017/18	2018/19	Total
CSIRO (25%)		50,477.50			50,477.50
Total In-Kind Contribution from Partners		**50,477.50**			**50,477.50**

	Total funding over all years	Percentage of Total Budget
GISERA Investment	$50,477.50	25%
NSW Government Investment	$50,477.50	25%
Federal Government Investment	$50,477.50	25%
CSIRO Investment	$50,477.50	25%
Total Other Investment	-	-
TOTAL	**$201,910**	**100%**

Task	Milestone Number	Milestone Description	Funded by	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Formation of Technical Reference Group	GISERA	1 July 2016	1 Aug 2016	16/17	1	15,000
Task 2	2.1	Ground surveys	GISERA	1 July 2016	31 Dec 2016	16/17	2	45,000
Task 3	3.1	Satellite trial	GISERA	1 Jan 2017	30 June 2017	16/17	4	30,000
Task 4	4.1	Interim report	GISERA	1 Dec 2016	31 Dec 2016	16/17	2	15,000
Task 5	5.1	Final report	GISERA	1 June 2017	30 June 2017	16/17	4	46,432.50

7. Other Researchers (include organisations)

Researcher	Time Commitment (project as a whole)	Principal area of expertise	Years of experience	Organisation
Stuart Day	0.05	Atmospheric emissions	>25	CSIRO Energy
Brendan Halliburton	0.05	Atmospheric emissions	>20	CSIRO Energy
Stephen White	0.15	Atmospheric emissions	10	CSIRO Energy
Paul Marvig	0.15	Technical support	>30	CSIRO Energy
Cindy Ong	0.15	Remote sensing	>20	CSIRO Minerals

8. Subcontractors

Subcontractors (clause 9.5(a)(i))	Subcontractor	Role
	GHGSat Inc.	Acquisition of satellite imagery of selected area.

9. Project Objectives and Outputs

The aim of the project proposed here is to investigate potential land seeps of methane, including leaking legacy boreholes and other sources (e.g. agriculture, coal mining, natural sources) in the Pilliga gas field, which is the most likely region in NSW to see CSG development over the next few years. Emissions from other significant methane sources such as intensive feedlots and coal mining operations will also be estimated to develop a detailed emission inventory for the region. Such a project will provide a baseline for the industry and other stakeholders against which to compare any emissions once large scale gas extraction commences.

A second objective is to evaluate a new satellite-based sensor designed to monitor atmospheric methane levels. If successful, the technology has the potential to provide rapid and cost-effective routine monitoring at gas fields across Australia.

10. GISERA Objectives Addressed

Natural seeps of methane and other hydrocarbons are well known in gas fields but once major development has occurred it can be much more challenging to assess whether seeps are natural or caused by gas production activities (e.g. the Condamine River seep still remains a controversial issue despite considerable research into the phenomenon). Detection and quantification of landscape methane sources (either natural or anthropogenic such as legacy boreholes, abandoned oil and gas wells or water bores) ahead of development is essential for establishing a credible baseline. Understanding the contribution from other sources such as coal mining and agriculture is also important.

Government departments within NSW (OEH, NSWEPA) are already considering future regulatory programmes regarding atmospheric emissions from CSG activities in NSW. For example, the NSWEPA recently commissioned a study of methane emissions across NSW to better understand current levels of fugitive methane emissions associated with CSG production and other sources in NSW. The project presented here would complement and build upon the recent work conducted on behalf of the NSWEPA.

11. Project Development

Previous research in Queensland funded by GISERA has developed the methodology necessary to detect and quantify methane emissions from a diverse range of sources. As a result of that work, an advanced method utilising a network of fixed monitoring stations for accurately monitoring emissions is now under development in the Surat Basin. That work will continue until at least the end of 2017 and will provide regional scale monitoring of methane fluxes across one of the main CSG production areas of the Surat Basin. Although this work is essential for assessing and quantifying changes in emissions as production increases to supply the export LNG market, the study only commenced at a comparatively late stage of gas field development; there are no 'greenfield' monitoring data available. In NSW, on the other hand, the gas industry is much less mature and hence there is a unique opportunity to establish a programme to establish baseline conditions ahead of large scale gas development. As noted above, the NSWEPA has recently sponsored research to better understand baseline methane emissions across the state for the purpose of informing future government policy in relation to CSG operations.

During the Queensland GISERA greenhouse study in the Surat Basin a number of legacy exploration boreholes were found to be leaking methane. Given the large number of such boreholes in Queensland they represent a potentially significant source of methane in the region. As a result of that work, further research is currently underway in collaboration with the industry to locate and remediate leaking boreholes. NSW also has large numbers of abandoned exploration wells in coal basins but at present there is no information on emissions (if any) from these wells. It is anticipated that this project will provide a first step in understanding and quantifying any methane emissions from legacy wells in NSW.

The Queensland GISERA methane project also demonstrated the value of remote sensing technology for methane detection. While the results were promising, it was clear that there were certain limitations with the systems available at the time. Satellite sensors have the advantage of providing rapid regional coverage but the spatial resolution is usually very coarse. However, a Canadian company has recently deployed a new satellite (GHGSat) that is claimed to be capable of monitoring surface methane emissions to 50 x 50 m. This fine resolution potentially has wide application in the gas industry. The opportunity now exists to acquire data over a gas producing region in Australia, which will allow detailed evaluation of the sensor's capability and to determine if it has application to the Australian industry.

12. Project Plan

To assist in developing a comprehensive inventory of methane sources within the Pilliga region, all known sources aside from CSG activities (feedlots, landfills, coal mines, etc.) will be identified and estimates of emissions made. In addition, state government and other databases will be examined to locate boreholes (exploration, abandoned oil and gas wells, agricultural bores), which may have associated methane emissions. These tasks would largely be desktop studies that will guide the ground based field measurements.

Over the last two years, there have been other studies in the Pilliga region examining fugitive methane emissions (e.g. University of Adelaide conducting surveys on behalf of Santos; CSIRO performing measurements on and around Santos facilities for the NSW EPA). In addition, we understand that researchers from the University of NSW have been investigating methane levels in the area. To ensure that effort is not duplicated and to maximise the value of the proposed project, the CSIRO research team will coordinate efforts with these groups and industry as appropriate.

The ground measurements will comprise mobile surveys through the Pilliga gas field at various times of the year, specifically to measure ambient methane concentrations within the gas fields and in areas without CSG activities or infrastructure. The surveys would include areas where non-CSG methane sources and potential legacy boreholes were located. There are several large coal mines (both underground and open-cut) within the Narrabri region and attempts would be made to include these mines in the ground surveys. Where possible, methane emission rates would be measured using various plume dispersion methods. Surface gas emissions would also be measured throughout the region to establish background soil methane emissions. These measurements would also be concentrated near identified boreholes to determine whether or not there was any methane leakage, and if so, to quantify the emission rate.

Satellite imagery of a 12 x 12 km area will be acquired for a region selected to include CSG infrastructure but also other significant methane sources such as underground coal mine vents or landfills. This will provide a range of source strengths and spatial distribution so that the performance of the satellite sensor can be properly assessed. Although larger areas can be acquired, the cost of the data increases substantially. Hence for this trial, we propose to target a region in the Camden gas field south of Sydney where multiple sources (gas compression plant, CSG wells, underground coal mine vent and landfill) are located within the smaller footprint. Ground truthing using mobile surveys would be conducted at the time of the satellite data acquisition throughout the target area and will provide a direct comparison of the two methods.

An interim report will be prepared at the end of six months. This will detail the results of the satellite trial and an assessment of its applicability or otherwise for monitoring methane emissions in Australian gas fields. Recommendations on future remote sensing research will be provided if appropriate. The report would also include a summary of progress in relation to the ground based field measurements and may include preliminary emission flux results for some sources.

The results of the entire project will be presented in the final report at the end of the project.

		Q1	Q2	Q3	Q4
Task 1	**Formation of Technical Reference Group**				
Task 2	**Ground Surveys**				
2.1	Desktop study to identify location of all major sources in Pilliga region				
2.2	Survey of geological/government databases for locations of known boreholes (agriculture, oil and gas, coal exploration)				
2.3	Field measurements				
Task 3	**Satellite Trial**				
3.1	Identify target area				
3.2	Acquire satellite imagery for target area				
3.3	Analyse data				
Task 4	**Interim Report**				
Task 5	**Final Report**				

A Technical Reference Group will be established for this project similar to that which is in place for the current Queensland GISERA GHG project. The Technical Reference Group would likely comprise some members from the current Queensland GISERA GHG project but with some additional members from NSW. It is anticipated that the makeup of the Technical Reference Group would be finalised within the first month of the project with the first meeting shortly afterwards.

12.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Formation of Technical Reference Group		1 July 2016	1 August 2016	
Task 2	Ground surveys	Stuart Day	1 July 2016	30 June 2017	
Task 3	Satellite trial	Cindy Ong	1 July 2016	30 June 2017	
Task 4	Interim report	Stuart Day	1 Dec 2016	31 Dec 2016	
Task 5	Final report	Stuart Day	1 June 2017	30 June 2017	

Task 1

TASK NAME: Formation of Technical Reference Group

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 2 months

BACKGROUND: Establishing an effective Technical Reference Group is an important foundation for this project. The value of detailed technical input from industry representatives has been clearly demonstrated throughout the Surat Basin methane study.

TASK OBJECTIVE: Establish a highly functioning Technical Reference Group.

TASK OUTPUTS: This task will be to establish the project, develop professional working relationships amongst the project team and with industry representatives to facilitate exchange of information and uptake of findings.

SPECIFIC DELIVERABLES: Technical Reference Group established.

Task 2

TASK NAME: Ground surveys

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 12 months

BACKGROUND: This is a development of the Queensland GISERA greenhouse gas study.

TASK OBJECTIVE: Identify and quantify methane emission sources, apart from CSG activities, within the Pilliga gas field.

TASK OUTPUTS: Inventory of methane sources within the Pilliga gas field.

SPECIFIC DELIVERABLES: Interim and final reports (see Tasks 4 and 5).

Task 3

TASK NAME: Satellite trial

TASK LEADER: Cindy Ong

OVERALL TIMEFRAME: 6 months

BACKGROUND: This is a development of the Queensland GISERA greenhouse gas study.

TASK OBJECTIVE: To assess the GHGSat platform for application to Australian CSG monitoring

TASK OUTPUTS: An understanding of the capabilities of the sensor and the extent to which it can be applied for greenhouse gas monitoring of Australian gas fields.

SPECIFIC DELIVERABLES: Interim and final report (see Tasks 4 and 5).

Task 4

TASK NAME: Interim report

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 6 months

BACKGROUND: It is important to make the results of the project available as soon as possible.

TASK OBJECTIVE: To provide a preliminary assessment of the satellite's capability

TASK OUTPUTS: An initial assessment of the GHGSat application to Australian gas production regions.

SPECIFIC DELIVERABLES: Interim report

Task 5

TASK NAME: Final report

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 12 months

BACKGROUND: This task is the final deliverable of the project.

TASK OBJECTIVE: To clearly present the findings of the project.

TASK OUTPUTS: A detailed report that provides an assessment of the GHGSat for greenhouse monitoring in Australian gas fields. The report will also present the findings of the ground based measurements including a preliminary inventory of methane sources in the Pilliga gas field.

SPECIFIC DELIVERABLES: Final report

13. Communications Plan

Communication of the results of the project will be managed in accordance with GISERA's communication strategy. This may include presentations at community and industry meetings, conferences and publication of reports and scientific articles. In addition, communication with relevant state and federal government departments (e.g. NSWEPA, Department of the Environment) will be maintained to ensure that they are aware of the outcomes of the research and possible policy implications. Other means of communicating the project outcomes may be recommended by the GISERA RAC.

14. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
				$
				$
Ownership of Non-Derivative IP (clause 12.3)	CSIRO			
Confidentiality of Project Results (clause 15.6)	Project results are not confidential.			
Additional Commercialisation requirements (clause 13.1)	Not Applicable			

2 Variations to Project Order

Changes to research Project Orders are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

The table below details variations to research Project Order.

Register of changes to Research Project Order

Date	Issue	Action	Authorisation
14/6/17	There are outstanding measurements required to be collected in order to fill gaps within ground measurements.	Milestone 5.1 will be pushed back to Aug 17	

3 Progress against project milestones

Progress against milestones are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

Progress against project milestones/tasks is indicated by two methods: Traffic Light Reports and descriptive Project Schedule Reports.

1. Traffic light reports in the Project Schedule Table below show progress using a simple colour code:
   - Green:
     - Milestone fully met according to schedule.
     - Project is expected to continue to deliver according to plan.
     - Milestone payment is approved.
   - Amber:
     - Milestone largely met according to schedule.
     - Project has experienced delays or difficulties that will be overcome by next milestone, enabling project to return to delivery according to plan by next milestone.
     - Milestone payment approved for one amber light.
     - Milestone payment withheld for second of two successive amber lights; project review initiated and undertaken by GISERA Director.
   - Red:
     - Milestone not met according to schedule.
     - Problems in meeting milestone are likely to impact subsequent project delivery, such that revisions to project timing, scope or budget must be considered.
     - Milestone payment is withheld.
     - Project review initiated and undertaken by GISERA Research Advisory Committee.

2. Progress Schedule Reports outline task objectives and outputs and describe, in the 'progress report' section, the means and extent to which progress towards tasks has been made.

GISERA
Gas Industry Social and Environmental Research Alliance

Project Schedule Table

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish
Task 1	Formation of Technical Reference Group		1-Jul-16	1-Aug-16
Task 2	Ground surveys	Stuart Day	1-Jul-16	31-Dec-16
Task 3	Satellite trial	Cindy Ong	1-Jan-17	30-Jun-17
Task 4	Interim report	Stuart Day	1-Dec-16	31-Dec-16
Task 5	Final report	Stuart Day	1-Jun-17	31 Aug-17

GISERA
Gas Industry Social and Environmental Research Alliance

Project Schedule Report

Task 1

TASK NAME: Formation of Technical Reference Group

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 2 months

BACKGROUND: Establishing an effective Technical Reference Group is an important foundation for this project. The value of detailed technical input from industry representatives has been clearly demonstrated throughout the Surat Basin methane study.

TASK OBJECTIVE: Establish a highly functioning Technical Reference Group.

TASK OUTPUTS: This task will be to establish the project, develop professional working relationships amongst the project team and with industry representatives to facilitate exchange of information and uptake of findings.

SPECIFIC DELIVERABLES: Technical Reference Group established.

PROGRESS REPORT:

A technical reference group comprising representatives from AGL (Aaron Clifton), Santos (Joshua Gilroy) and the NSW Office of Environment and Heritage (John Klepetko) has been established. Informal discussions have been held with two of the group members regarding the aims and timeline of the project. We anticipate that the first face-to-face meeting will be held with all of the group members and key CSIRO staff during early October. In the meantime, a desktop survey of the main methane sources in the Pilliga area has been commenced and mapping of the sources (coal mines, intensive agricultural facilities, sewage treatment plant, landfills and boreholes) is currently underway for Task 2. An initial survey of some of these sources and background regions is planned for the last week of September. Planning for the satellite trial (Task 3) is currently well advanced.

Task 2

TASK NAME: Ground surveys

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 12 months

BACKGROUND: This is a development of the Queensland GISERA greenhouse gas study.

TASK OBJECTIVE: Identify and quantify methane emission sources, apart from CSG activities, within the Pilliga gas field.

TASK OUTPUTS: Inventory of methane sources within the Pilliga gas field.

SPECIFIC DELIVERABLES: Interim and final reports (see Tasks 4 and 5).

PROGRESS REPORT:

Ground surveys have been conducted within the Pilliga region as well as areas outside the gas production areas. A number of methane sources have been located and identified including coal mines (open-cut and one underground), landfill, wastewater treatment facility and CSG production infrastructure. In some cases, emission rates have been measured directly from these sources. In others, especially the coal mines, we have used publicly available data to estimate emission rates from these sources. A preliminary inventory of the main methane sources within the study region has been prepared and has allowed the relative contribution from each source to be ranked.

Task 3

TASK NAME: Satellite trial

TASK LEADER: Cindy Ong

OVERALL TIMEFRAME: 6 months

BACKGROUND: This is a development of the Queensland GISERA greenhouse gas study.

TASK OBJECTIVE: To assess the GHGSat platform for application to Australian CSG monitoring

TASK OUTPUTS: An understanding of the capabilities of the sensor and the extent to which it can be applied for greenhouse gas monitoring of Australian gas fields.

SPECIFIC DELIVERABLES: Interim and final report (see Tasks 4 and 5).

PROGRESS REPORT:

Evaluation of data provided by GHG Sat is now complete. Processed data consisting of derived CH4 and CO2 column concentration maps and an albedo map produced from "Claire" data onboard GHGSat acquired on 30.10.2016 has been delivered to CSIRO. These data were among the first acquired by "Claire" and consequently experienced some teething issues related to new sensors. Specifically, the data were partially overexposed. Despite this, the data showed some interesting results.

A large region of high CH4 concentrations was detected and this appear to coincide with an area where gas wells (vents) associated with underground coal mining were located. The data collected from the ground truthing survey close to this area also recorded some of the highest methane concentrations in the target region. This indicates that "Claire" may be able to detect large emitters such as underground coal mine vents.

Overall, at this stage, there remain important uncertainties associated with the quantitative use of the CH4 concentration map delivered so far. Specifically, the level of instrument noise/artefacts as indicated by diagonal striping across the imagery remains a concern. The image can potentially be improved with noise removal techniques such as fast Fourier transform. While the application of such techniques provide better definition and highlight other anomalous regions, it will not improve the accuracy of the data.

Additional data of the target region are currently being acquired by "Claire" and GHGSat hopes to provide these data for further evaluation in future.

Some recent staff changes within CSIRO have resulted in a delay to the ground measurements planned within the Narrabri gas field region. However, we anticipate that these measurements will be completed by the end of June.

Task 4

TASK NAME: Interim report

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 6 months

BACKGROUND: It is important to make the results of the project available as soon as possible.

TASK OBJECTIVE: To provide a preliminary assessment of the satellite's capability

TASK OUTPUTS: An initial assessment of the GHGSat application to Australian gas production regions.

SPECIFIC DELIVERABLES: Interim report

PROGRESS REPORT:

An interim report of progress to date has been completed and submitted. The report details work relating to the development of a methane inventory and the remote sensing trial. This can be found on the GISERA website Regional Methane Emissions in NSW CSG Basins Interim Report.

Task 5

TASK NAME: Final report

TASK LEADER: Stuart Day

OVERALL TIMEFRAME: 12 months

BACKGROUND: This task is the final deliverable of the project.

TASK OBJECTIVE: To clearly present the findings of the project.

TASK OUTPUTS: A detailed report that provides an assessment of the GHGSat for greenhouse monitoring in Australian gas fields. The report will also present the findings of the ground based measurements including a preliminary inventory of methane sources in the Pilliga gas field.

SPECIFIC DELIVERABLES: Final report

PROGRESS REPORT:

The final report for this project has now been completed. The report documents and provides the findings of the research completed as part of this project.

An inventory of the major methane sources in the study area has now been established providing a strong foundation for a methane emission baseline for the study area. The data collected as part

of this project indicated that the largest source of methane is the Narrabri underground coal mine, followed by livestock, CSG in the mid levels, and, no boreholes were found to be leaking. However, there remains quite a high level of uncertainties with some of the estimates. For example, the methane levels for CSG wells were estimated using emissions rates obtained from previous NSWEPA work. Moreover, emissions from other production facilities have not been included. The collection of more comprehensive data over the CSG wells and other CSG infrastructure is warranted to reduce the uncertainties. Furthermore, although none of the bores measured were found to be leaking, only 2% of the total number of bores have been examined to date. Because of this low number and other researchers from University of Adelaide have found leaks in some of the bores they measured in region, the collection of more data from this source would be warranted. However, with the current figures of 3380 bores, a more efficient method or sampling strategy for collecting more spatially and statistically representative data in a timely manner would be required.

The evaluation of the column methane data provided by GHGSat indicate the potential for remote sensing to provide spatial data but the results were inconclusive. The data provided were compromised by to modelling errors, image alignment errors and the effect of uncorrected instrument imperfections. Overall, at this stage, there remains important uncertainties associated with the quantitative use of the methane concentration map derived from "Claire" as delivered from GHGSat. Specifically, the level of instrument noise/artefacts remains a concern and there appears to be influences of the local geology, landforms and/or compositional material that may require to be accounted for in the retrieval of the methane products.