Project Order, Variations and Research Progress

Project Title: Better understanding and managing weed and erosion risks from coal seam gas access tracks

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

1 Original Project Order

Project Order
Proforma 2011

1. Short Project Title (less than 15 words)

Project 4 – Making tracks, treading carefully

Long Project Title	Better understanding and managing weed and erosion risks from coal seam gas access tracks.
GISERA Project Number	A4 1215
Proposed Start Date	July 2012
Proposed End Date	June 2015
Project Leader	Neil Huth

2. GISERA Research Program

☐ Biodiversity Research ☐ Marine Research ☒ Land Research

☐ Water Research ☐ Social & Economic Research

3. Research Leader, Title and Organisation

Dr Neil Huth
Senior Research Scientist
CSIRO Ecosystem Sciences

4. Summary (less than 300 words)

Incorporation of coal seam gas wells into agricultural landscapes requires the construction of many kilometres of access tracks. Tracks will be required to cross cultivated, grazing or forested land. Roadways are known to have impacts on the lands they traverse, including possible increased weed and erosion risks. The diffuse nature of networks of access tracks means that risks will be distributed across the wider landscape. The activities in this project will aim to gain a better understanding of weed and erosion risks and provide guidelines that help to monitor and manage them.

5. Budget Summary (From Excel Budget Pack worksheet "Project Plan Summary")

Expenditure	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
Labour	128,086	182,681	153,322			464,089
Operating	55,000	35,000	10,000			100,000
Total Costs	**183,086**	**217,681**	**163,322**			**564,089**
CSIRO	183,086	217,681	163,322			564,089
Total Expenditure	**183,086**	**217,681**	**163,322**			**564,089**

Expenditure per Task	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
Task 1 Task 2 Task 3 Task 4 Task 5	183,086	217,681	163,322			564,089
Total Expenditure	**183,086**	**217,681**	**163,322**			**564,089**

Cash Funds to Project Partners	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
CSIRO	137,320	163,200	126,240			426,760
Total Cash to Partners	**137,320**	**163,200**	**126,240**			**426,760**

Source of Cash Contributions	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
Australia Pacific LNG	137,320	163,200	126,240			426,760
Total Cash Contributions	**137,320**	**163,200**	**126,240**			**426,760**

In-Kind Contribution from Partners	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	2016/17 Year 5	Total
CSIRO	45,766	54,481	37,082			137,329
Total In-Kind Contribution from Partners	**45,766**	**54,481**	**37,082**			**137,329**

	Total funding over all years	Percentage of Total Budget
Australia Pacific LNG Investment	426,760	75.7%
CSIRO Investment	137,329	24.3%
Total Other Investment		
TOTAL	**564,089**	**100%**

Task	Mile-stone Number	Milestone Description	Funded by	Participant Recipient	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Initial Team Meeting	GISERA	CSIRO	Jul-12	Sep-12	12/13	1st	34,330
Task 2	2.1	Engage Stakeholders	GISERA	CSIRO	Oct-12	Dec-12	12/13	2nd	34,330
Task 3	3.1	Initial Literature Review	GISERA	CSIRO	Jan-13	Mar-13	12/13	3rd	34,330
Task 4	4.1	Monitoring Design	GISERA	CSIRO	Apr-13	Jun-13	12/13	4th	34,330
Task 5	5.1	Monitoring Implementation	GISERA	CSIRO	Jul-13	Sep-13	13/14	1st	40,800
Task 6	6.1	Monitoring Continued	GISERA	CSIRO	Oct-13	Dec-13	13/14	2nd	40,800
Task 7	7.1	Internal progress report to other projects for feedback	GISERA	CSIRO	Jan-14	Mar-14	13/14	3rd	40,800
Task 8	8.1	Annual Team Meeting	GISERA	CSIRO	Apr-14	Jun-14	13/14	4th	40,800
Task 9	9.1	Monitoring Continued	GISERA	CSIRO	Jul-14	Sep-14	14/15	1st	31,560
Task 10	10.1	Monitoring Evaluation	GISERA	CSIRO	Oct-14	Dec-14	14/15	2nd	31,560
Task 11	11.1	Final Analysis	GISERA	CSIRO	Jan-15	Mar-15	14/15	3rd	31,560
Task 12	12.1	Draft Publications	GISERA	CSIRO	Apr-15	Jun-15	14/15	4th	31,560

6. Other Researchers

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Neil Huth	0.38 FTE	Farming Systems Research, Modelling, Trade-off Analysis	>20	CSIRO
Oswald Marinoni	0.37 FTE	Spatial analysis and modelling of geo-data, Informing land management decision processes	>15	CSIRO
Brett Cocks	0.4 FTE	Field operations, soil characterisation, farmer engagement, agronomic technical support	>15	CSIRO
Xiaoliang Wu	0.3 FTE	Terrestrial Mapping and Monitoring	>20	CSIRO
Kassel Hingee	0.3 FTE	Terrestrial Mapping and Monitoring	>5	CSIRO

7. GISERA Objectives Addressed

Research that improves and extends knowledge of environmental risks from weeds and erosion caused by CSG-LNG projects, enabling the agricultural and CSG-LNG industries to better manage impacts of widespread access track development.

GISERA performance indicators addressed in this work include:

- Publication of results
- Conference invitations and presentations
- Industry (CSG and Agriculture) participation
- Engagement with local gas and agricultural industries.

8. Program Outcomes Achieved

Details are provided in *Section 13. Project Objectives and Outputs.*

9. Program Outputs Achieved

Details are provided in *Section 13. Project Objectives and Outputs.*

10. What is the knowledge gap that these research outputs will address?

The risk from invasive weeds and soil erosion caused by the extensive network of gas well access tracks is not well understood. The research outputs derived from this project will provide information on techniques for ongoing monitoring across very large areas and any

existing and emerging signs of weed invasion and erosion damage. This information will then be used to inform guidelines for managing these risks via improved design, management and monitoring.

11. How will these Research outputs and outcomes be used by government, agriculture or the CSG-LNG industry?

The research outputs and outcomes will help to inform farmers, CSG developers and policy makers on the nature of weed and erosion risks and means for managing them. If successful, the monitoring approaches developed during this project may provide ongoing support for risk management. The design and management guidelines developed in this project will complement those developed as part of the *Gas Farm Design* project and so could share a similar pathway to adoption.

12. Project Development (1 page max.)

The project was developed in consultation between Australia Pacific LNG staff. The proposed activity was discussed with members of various farmer/stakeholder groups and was endorsed as an important research need.

The spread of weeds is an ongoing concern for cropping farmers and graziers. There is wide-spread adoption of integrated weed management approaches in the Darling Downs region (Streit 1996) and farm hygiene is an important practice for most producers. The construction of access roads, and the ensuing traffic, will be a major concern for many farmers who would see these tracks as likely sources of weed infestation. The same issues will be observed in the grazing and rangeland systems. Preece et al (2010) showed that the number of weed species observed at individual sites across extensive transects in Australia's Northern Territory was heavily influenced by the length of roads or fence line in the local area. Road developers may assist with reducing the likelihood and extent of weed infestation by seeking to ensure that weeds are neither introduced nor spread by their activities, assisting with the surveillance of weed infestations (possibly drawing on resident local expertise) and helping to eliminate weeds when identified.

Similarly, erosion has been managed in the subtropical cereal belt via various control structures or farming methods (Titmarsh and Stone 1997). Soil conservation practices have developed over a long period of time and are now employed extensively (Thomas et al 2007). Incorporation of roadways and tracks across farming land will likely impact on erosion losses and sediment transport into streams as observed in other regions. Motha et al (2004) found, in a study in Southern Australia, that the contributions from unsealed roads exceeded those from other land uses and suggested that emphasis should be placed on such roads when sediment control measures are planned for agricultural catchments. Sediment transport control measures have been designed for roadways (e.g. Croke and Hairsine 2001) and similar approaches should be evaluated for the various land management types where gas well access tracks are employed.

Both weed and erosion are distributed across the landscape and so will require considerable effort for monitoring and intervention. Such an approach has already been suggested for weed management in rangelands (Martin et al 2006). Modern technology, including simple tools such as GPS-enabled cameras and phones, are making collection of spatial data more efficient.

A coordinated approach including CSG company monitoring efforts and landholder involvement to proactively identify and document risks, leading to early intervention, could be investigated for the wider coal seam gas industry. Similarly, approaches using airborne imagery have developed to such an extent that very fine scale identification of soil disturbance or weed presence may soon be possible. If successful, these methods would allow rapid surveys of thousands of square kilometres. A mixture of ground-based and airborne methods for widespread monitoring will be evaluated as part of this project.

References

Croke JC, Hairsine PB (2001) Management of road runoff: A design approach. In 'Soil Erosion Research for the 21st Century, Proceedings'. (Eds JC Ascough, DC Flanagan) pp. 249-252. (Amer Soc Agr Engineers: St Joseph).

Martin TG, Campbell S, Grounds S (2006) Weeds of Australian rangelands. *Rangeland Journal* **28**, 3-26.

Motha JA, Wallbrink PJ, Hairsine PB, Grayson RB (2004) Unsealed roads as suspended sediment sources in an agricultural catchment in south-eastern Australia. *Journal of Hydrology* **286**, 1-18.

Preece N, Harvey K, Hempel C, Woinarski JCZ Uneven distribution of weeds along extensive transects in Australia's Northern Territory points to management solutions. *Ecological Management & Restoration* **11**, 127-134.

Streit L (1996) Perceptions and attitudes towards integrated weed management in the intensive broadacre cropping region of the Darling Downs in Southern Queensland. In 'Proceedings of the 11th Australian Weeds Conference, Melbourne, Australia, 30 September - 3 October, 1996.' pp. 39-41. (Weed Science Society of Victoria Inc.).

Thomas GA, Titmarsh GW, Freebairn DM, Radford BJ (2007) No-tillage and conservation farming practices in grain growing areas of Queensland - a review of 40 years of development. *Australian Journal of Experimental Agriculture* **47**, 887-898.

Titmarsh GW, Stone BJ (1997) Runoff management: techniques and structures. In 'Sustainable crop production in the sub-tropics: an Australian perspective.' pp. 181-194. (Queensland Department of Primary Industries, Information Centre: Brisbane Australia).

13. Project Objectives and Outputs

The aim of this project is to explore and develop monitoring and management options for the joint risk of weeds and erosion arising from a wide network of access tracks.
By understanding the existing risks, and likely processes by which these risks will play out in the future, we will map out a process for the monitoring and timely intervention of each risk. In some agricultural systems, a significant number of farm tracks already exist, allowing an evaluation of risk via assessment of impacts on existing farms. This will be achieved via farm visits/surveys which investigate impacts of current traffic on farms. This will provide an understanding of existing erosion and weed risks in farming systems prior to development.

Project outputs include:

- Information on possible existing or emerging weed invasion and erosion damage
- An evaluation of processes for monitoring future weed and erosion risks

- A previously unavailable documented history of erosion and weed occurrence during a period of extensive land use change that will extend scientific understanding of important natural processes
- Reports
- Scientific papers
- Popular précis of research findings and implications.

14. Project Plan

14.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Initial Team Meeting	Neil Huth	Jul-12	Sep-12	
Task 2	Engage Stakeholders	Neil Huth	Oct-12	Dec-12	Task 1
Task 3	Initial Literature Review	Neil Huth	Jan-13	Mar-13	Task 2
Task 4	Monitoring Design	Neil Huth	Apr-13	Jun-13	Task 3
Task 5	Monitoring Implementation	Neil Huth	Jul-13	Sep-13	Task 4
Task 6	Monitoring Continued	Neil Huth	Oct-13	Dec-13	Task 5
Task 7	Internal progress report to other projects for feedback	Neil Huth	Jan-14	Mar-14	Task 6
Task 8	Annual Team Meeting	Neil Huth	Apr-14	Jun-14	
Task 9	Monitoring Continued	Neil Huth	Jul-14	Sep-14	Task 7
Task 10	Monitoring Evaluation	Neil Huth	Oct-14	Dec-14	Task 9
Task 11	Final Analysis	Neil Huth	Jan-15	Mar-15	Task 10
Task 12	Draft Publications	Neil Huth	Apr-15	Jun-15	Task 11

Task 1.

TASK NAME: Initial team meeting

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

TASK OBJECTIVES:

- Establish a project team
- Establish contact with GISERA collaborators
- Gather background information for methodology
- Inform literature research
- Refine work plan.

SPECIFIC DELIVERABLE: Short report providing information about initial team meeting, established relationships and lists of proposed methodologies and key stakeholders with whom to establish contact.

Task 2.

TASK NAME: Engage stakeholders

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: This project investigates widely-spread and potentially regionally-specific issues of erosion and weed threats. To do this effectively, the project will have to engage with a range of local gas and agricultural industry people.

TASK OBJECTIVE: To identify and build links with key gas and agricultural industry operators with whom issues will be identified and effective monitoring approaches will be developed and tested.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A short report listing the stakeholders approached and linkages developed.

Task 3.

TASK NAME: Initial literature review

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: An extensive search of the existing literature is always required to avoid duplication of previous work and to accelerate progress.

TASK OBJECTIVE: To collate as much relevant background information on weed and erosion risks for the study area. Information should include existing knowledge, previous results in the international scientific literature, prior application of the techniques to be used, and background information on the agricultural systems of the case study regions.

SPECIFIC DELIVERABLE: A document describing and analysing the relevant findings of the literature review.

Task 4.

TASK NAME: Monitoring design

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

TASK OBJECTIVE: Based upon the input of stakeholders and the literature review, to develop a methodology for implementing the different monitoring programs with weeds and erosion.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Draft documentation of the methodologies for monitoring weed and erosion risks to be implemented during the monitoring phase of the project.

Task 5.

TASK NAME: Monitoring implementation

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Monitoring methodologies will have been developed as part of the previous project milestones. This milestone will document progress made in implementing these approaches.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document briefly describing progress in implementing the monitoring program. Reference should be made back to the original methodology document.

Task 6.

TASK NAME: Monitoring continued

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Monitoring approaches will have been implemented in previous project tasks. This milestone will document progress made in employing these methodologies. Some results may be available. Technical problems may have been identified and where possible, rectified.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document briefly describing progress in operating the monitoring program. Reference should be made back to the original methodology document. Any technical problems and resolutions should be clearly described.

Task 7.

TASK NAME: Internal progress report to other projects for feedback

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Approximately six months of data collection should be available by this milestone. Knowledge gained from this project will be valuable for parallel projects within the GISERA agricultural land management portfolio. Information from the stakeholder engagement, literature review, and initial monitoring attempts in this project will be provided to staff in the other GISERA land management projects to allow them to provide feedback and to guide them in how they will best make use of the information gathered in this project.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document or verbal presentation of progress within this project provided to all staff in the GISERA agricultural land management portfolio.

Task 8.

TASK NAME: Annual team meeting

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Recent progress within the project will include feedback from the internal project progress report and results from nearly one year of data collection.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Brief progress report documenting the outcomes, responses by the team, and the latest progress in the monitoring program.

Task 9.

TASK NAME: Monitoring continued

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Monitoring methodologies will have been developed, trialled and discussed with relevant scientific staff. Any necessary adaptation or improvement will be tested during these later phases of monitoring.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the on-going trial of the monitoring methodologies.

Task 10.

TASK NAME: Monitoring evaluation

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Monitoring will be almost complete and data will be available for evaluation of the methodologies developed within this project. The data will be analysed and the methodologies evaluated.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the success of the methodologies and the lessons learned regarding their effectiveness and application.

Task 11.

TASK NAME: Final analysis

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: The data gathered from the monitoring efforts will be used to identify the key issues of weed and erosion risks from gas well access tracks. This final analysis will centre more on the lessons from the data rather than the effectiveness of the methodologies.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the data and knowledge gathered on weed and erosion risks from these results. The main messages emerging from these analyses will likely form the basis for subsequent publication of the results of this project.

Task 12.

TASK NAME: Draft publications

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Communication of findings to the scientific community.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Draft manuscript(s) prepared for journal(s) and/or conference proceedings.

15. Budget Justification

The budget for this project has been approved by GISERA's Research Advisory Committee and Management Committee.

16. Project Governance

Project management tasks and dissemination activities are specified *Section 14. Project Plan.*

17. Communications Plan

General communication will be managed by GISERA.

18. Risks

At this stage no major risks particular to this project are foreseen.

Capacity to deliver: Two staff members have sufficient experience to lead and supervise the various technical activities and ascertain the research outcomes. Close collaboration with other GISERA agricultural land management projects will provide opportunity for project awareness by other CSIRO researchers who could assume extra responsibilities in the event of unplanned staff departures. The impact of key staff departure is low and could be mitigated.

There is some risk that adverse weather conditions may impact the ability to monitor weeds and erosion. This is managed within the project design by trialling multiple techniques based upon very different approaches and by involving monitoring over very large areas.

There is some risk involved in accessing appropriate airborne imagery. This risk includes technological constraints as well as logistical constraints in obtaining the data for defined points in space and time. The use of experienced CSIRO staff will minimise this risk.

19. Intellectual Property and Confidentiality

Background IP (clause 10.1, 10.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
				$
				$
Ownership of Non-Derivative IP (clause 11.3)	CSIRO			
Confidentiality of Project Results (clause 15.6)	Project results are not confidential.			

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
19/04/13	Research project start date delayed; milestone dates require rescheduling	All milestone dates rescheduled to reflect later project start date; timing of milestones relative to start date not altered.	Peter Stone
16/06/16	Due to significant amount of engagement work undertaken, additional time is required to complete milestone 12.	Milestone 12 will be pushed back to July 2016.	

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.

Project Schedule Table

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Initial Team Meeting	Neil Huth	Oct-12	Dec-12	
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Task 9	Monitoring Continued	Neil Huth	Oct-14	Dec-14	Task 7
Task 10	Monitoring Evaluation	Neil Huth	Jan-15	Mar-15	Task 9
Task 11	Final Analysis	Neil Huth	Apr-15	Jun-15	Task 10
Task 12	Draft Publications	Neil Huth	Jul-15	Jul-16	Task 11

Project Schedule Report

Task 1.

TASK NAME: Initial team meeting

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

TASK OBJECTIVES:

- Establish a project team.
- Establish contact with GISERA collaborators.
- Gather background information for methodology.
- Inform literature research.
- Refine work plan.

SPECIFIC DELIVERABLE: Short report providing information about initial team meeting, established relationships and lists of proposed methodologies and key stakeholders with whom to establish contact.

PROGRESS REPORT:

An initial team meeting was held in Toowoomba with Perth-based staff joining by video link. Perth-based researchers were introduced to staff from Queensland, as well as staff involved in the other GISERA agriculture projects with whom they will interact, including sharing of field case study sites. Several very relevant recent publications on similar work from the Marcellus Shale Gas fields in the United States were shown to the team and discussed. The skills mix, and capabilities of staff in this GISERA project should allow us to expand on the methods used overseas. A range of remote sensing techniques were discussed, including technologies that ranged from hand-held devices through to airborne or satellite imagery. These will be evaluated further in response to project needs.

Task 2.

TASK NAME: Engage stakeholders

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: This project investigates widely-spread and potentially regionally-specific issues of erosion and weed threats. To do this effectively, the project will have to engage with a range of local gas and agricultural industry people.

TASK OBJECTIVE: To identify and build links with key gas and agricultural industry operators with whom issues will be identified and effective monitoring approaches will be developed and tested.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A short report listing the stakeholders approached and linkages developed.

PROGRESS REPORT:

A range of agricultural stakeholders (Roma, Dalby, and Chinchilla) have been consulted as part of Project 1 – *A Shared Space*. The issues of weeds and erosion threats have been discussed as part

of these proceedings. Gas company staff (Origin, Chinchilla and Arrow, Cecil Plains) have also been approached for input. The issues of both weeds and erosion were highlighted in broader discussions of the impacts of CSG gathering systems and gas pipelines. For example, both gas company staff and farmers have raised the issue of subsidence along larger gas pipelines and the risk of further damage from overland flow due to these changes in surface topography. Monitoring techniques using satellite and aerial imagery used within this project could potentially also identify areas currently showing these issues and sites likely to develop as high risk areas. Therefore, case study regions in this project, and Project 3 – *Gas-Farm Design*, have been chosen to be broad enough to include areas containing networks of larger gas and water pipes and the Dalby case study farm has been chosen in part because of a history of this issue. Farmer discussions in Project 1 – *A Shared Space* highlighted dust as a major concern for land holders. Whilst this issue was also not included in the original project plan, it is clear that some focus needs to be given within the *Making Tracks* project. This will be achieved via another link with the *Gas-farm Design* project where data on dust emissions may be gathered and this information will be used by this project in a broader analysis of the impacts of road networks on erosion, weeds and dust.

Task 3.

TASK NAME: Initial literature review

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

BACKGROUND: An extensive search of the existing literature is always required to avoid duplication of previous work and to accelerate progress.

TASK OBJECTIVE: To collate as much relevant background information on weed and erosion risks for the study area. Information should include existing knowledge, previous results in the international scientific literature, prior application of the techniques to be used, and background information on the agricultural systems of the case study regions.

SPECIFIC DELIVERABLE: A document describing and analysing the relevant findings of the literature review.

PROGRESS REPORT:

Review of the literature has found that there is very little information on the impacts of CSG road networks on farms in Australia. There are studies on sediment export from unsealed road networks in agricultural and forestry catchments in Australia and overseas. Parallel literature review undertaken as part of Project 5 – *Without A Trace*, demonstrates that the understanding and engineering requirements for erosion control from unsealed roads is well known. Studies in broader grazing systems in Northern Australia impacted by mining development has shown that weed species richness increases with intensity of road and fence line networks. However, well developed agricultural areas already have levels of disturbance several magnitudes greater than this and weed control is widespread. Trends in Northern Australia are unlikely to extend to farming systems in southern Queensland. Recent publications from North America demonstrate the use of airborne survey methods to identify hydrological impacts of shale gas well access road networks. This demonstrates the value of the techniques chosen for this project. Review of recent publications describing emerging satellite products and analysis techniques has identified a suite of products that will be evaluated at the various case study sites chosen for this project.

Task 4.

TASK NAME: Monitoring design

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2012/13

TASK OBJECTIVE: Based upon the input of stakeholders and the literature review, to develop a methodology for implementing the different monitoring programs with weeds and erosion.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Draft documentation of the methodologies for monitoring weed and erosion risks to be implemented during the monitoring phase of the project.

PROGRESS REPORT:

The main areas of focus for this project involve weed and erosion threats. Appreciation for weed threats within the CSG industry and the broader community generally is quite high resulting in extensive weed management policies and practices already in use (e.g. vehicle wash down, tracking and regulation). As such, monitoring design will be biased more toward the erosion issues. Though weeds and other risks will still be considered, runoff and erosion will be the primary focus. The monitoring design developed during this project will rely heavily on remote sensing and its ability to detect and quantify damage and threats from CSG infrastructure, in this case, roads. In doing this, efficacy for other risks such as damage from subsidence along pipelines and impacts of compaction will also be evaluated. Whilst not monitoring the key drivers of weed dispersion, remote sensing is regularly used for detecting weed dispersion.

Three potential data sources have been chosen for monitoring. These are:

1) High resolution aerial imagery:

   Aerial images are going to be captured around November this year. Survey area is a 34 km by 34 km block near Miles, Condamine, Wieambilla and Chinchilla west. The image has the resolution of 20cm per pixel for panchromatic bands (nadir, backward and forward views), 4 multispectral bands (red, green, blue and near infrared) and 12bit dynamic range. The pan images will be used to reconstruct detailed digital surface models (DSM) at a resolution of 20cm, and the multispectral images will be used for analysing many land and cover indicators.

2) 3D Mapping satellite imagery:

   Chinese ZY-3 satellite data will be used for broad scale monitoring purposes. ZY-3 has similar imagery to aerial imagery but with resolutions of 2m for panchromatic bands and 6m for 4 multispectral bands (red, green, blue and near infrared) and 10bit dynamic range. The pan images will be used to reconstruct DSM (5m resolution) models, and the multispectral images will be used for analysing many land and cover indicators in a broad scale.

3) TanDEM-X satellite imagery:

   A data acquisition request has been submitted to DLR (German Space Centre) for the Monreagh Case Study Site. The following data takes have been commanded: 22 July, 20 August, 22 September, and 3 October, 2023. More data takes will be commanded in Nov-Dec 2013 and March-April 2014. These images have pixel resolution of 5m, and provide HH + VV

polarisation bands, the single-pass interferometric data will be used to generate the DSM of the test site and detect the surface changes over time.

Task 5.

TASK NAME: Monitoring implementation

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Monitoring methodologies will have been developed as part of the previous project milestones. This milestone will document progress made in implementing these approaches.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document briefly describing progress in implementing the monitoring program. Reference should be made back to the original methodology document.

PROGRESS REPORT:

Aerial survey of the Chinchilla-Miles-Condamine area is now complete. Data is now being processed by the contractor and will be further processed by CSIRO staff in Perth during early 2014. A fine scale resolution digital elevation model (DEM) will be created from this imagery. To test this DEM, and hydrological models derived from it, a detailed survey of various land disturbance features has been undertaken. Surveys include roadways, pipelines and pads and have been undertaken at approximately 2cm resolution. Vegetation surveys have also been conducted for testing of airborne estimates of vegetation structure. Finally, various hydrological features, such as contour banks or erosion gullies have been located in the field for comparison to predicted flow networks. Testing of the DEM and hydrological models derived from aerial and satellite imagery will commence in March 2014.

Task 6.

TASK NAME: Monitoring continued

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Monitoring approaches will have been implemented in previous project tasks. This milestone will document progress made in employing these methodologies. Some results may be available. Technical problems may have been identified and where possible, rectified.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document briefly describing progress in operating the monitoring program. Reference should be made back to the original methodology document. Any technical problems and resolutions should be clearly described.

PROGRESS REPORT:

Testing and evaluation of the high resolution aerial imagery has commenced as specified in the previous milestone report (see Task 4). Statistical comparison of surface elevation measured during the detailed survey with the digital surface model (20cm pixel) generated from the aerial survey is showing promise. These efforts may provide the first ever testing of such a dataset at this level of spatial resolution. Initial high resolution (1m pixel) maps of water flow networks

across the study area have been developed and products for use in ground-based testing and evaluation are currently being evaluated and finalised with staff in Perth. A detailed digital elevation model (1m pixel) for use in other land management projects is almost complete. A comparison of alternative satellite-derived digital surface models has commenced. These will be compared to two airborne techniques (DEM generated in this project and LiDAR-derived surfaces provided by Origin). Initial investigations are commencing to explore an alternative method for studying landscape change using historical airborne images held by the Queensland government. This new approach, not in the initial plan (Task 4), is being investigated because it may provide a means to rapidly create better land surface datasets across a large area using existing and historical information. Such data will be of great value to Project 3 (Gas-Farm Design) in exploring historical and CSG-related land use change and would allow the use of spatial tools and analyses used by CSIRO in monitoring of oil well networks elsewhere in Australia. The addition of this capability will greatly benefit the land management portfolio of projects. Collation of high resolution (5m pixel) satellite imagery for studying cropping impacts is almost complete.

The project is on-track to provide an internal progress report, as required by the next project milestone, outlining the testing of the various techniques. Datasets required by other projects will also be available at this time.

Task 7.

TASK NAME: Internal progress report to other projects for feedback

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Approximately six months of data collection should be available by this milestone. Knowledge gained from this project will be valuable for parallel projects within the GISERA agricultural land management portfolio. Information from the stakeholder engagement, literature review, and initial monitoring attempts in this project will be provided to staff in the other GISERA land management projects to allow them to provide feedback and to guide them in how they will best make use of the information gathered in this project.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A document or verbal presentation of progress within this project provided to all staff in the GISERA agricultural land management portfolio.

PROGRESS REPORT:

A presentation of progress and developing datasets and capability has been communicated to relevant GISERA project staff and stakeholders. This includes presentations to GISERA team staff in Brisbane, relevant CSIRO Flagship Theme Leader and Origin collaborators in Brisbane. A presentation showing current progress was also provided to key government, industry and environmental groups during a seminar in Toowoomba. Groups include the Gasfields commission, DAFF, DNRM and Queensland Murray Darling Basin Commission. A formal report of the detailed testing of the high resolution Digital Surface modelling is under preparation.

Task 8.

TASK NAME: Annual team meeting

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2013/14

BACKGROUND: Recent progress within the project will include feedback from the internal project progress report and results from nearly one year of data collection.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Brief progress report documenting the outcomes, responses by the team, and the latest progress in the monitoring program.

PROGRESS REPORT:

An annual team meeting was held on 19th September via video conference to include staff from Toowoomba and Perth. Toowoomba staff described the positive response from landholders in exploring the impact of access roads on water flow using the flow model maps for the aerial survey area. Perth staff provided information on latest ZY3 imagery obtained for the study area on 6th August. Full resolution data will become available in the near future. Two main decisions were made. 1) Because testing to date has proven the digital elevation model to be very accurate, and with such a positive response from landholders, the team will now attempt to take the water flow modelling one step further and investigate the provision of a very fine scale erosion map which could indicate the likely location of individual erosion rills or likely points of road damage from overland flow. Toowoomba staff will take the lead with data collection for model evaluation. Perth staff will undertake the model development. 2) To obtain a further satellite image from late September to complement the August image. Impacts of infrastructure on crops was becoming apparent at this stage during the winter growing season and the team will attempt to demonstrate the utility of fine scale satellite imagery for ongoing monitoring of on-the-ground impacts. To date, drought has made such work difficult but the current growing season may yet provide an adequate case study. The team has decided to make every effort toward a successful result. Key Toowoomba staff will visit Perth early in the new year, once the latest data is available, to make progress on the two objectives outlined above.

Task 9.

TASK NAME: Monitoring continued

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Monitoring methodologies will have been developed, trialled and discussed with relevant scientific staff. Any necessary adaptation or improvement will be tested during these later phases of monitoring.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the on-going trial of the monitoring methodologies.

PROGRESS REPORT:

On-ground monitoring of water flow patterns across various landscape elements has continued across the 1156 km2 (34km x 34 km) study area. Water flow maps generated within this project capture flow paths of various sizes across a range of landscape types. Ground surveys have been undertaken to test the flow modelling across this range. This includes small erosion rills forming across farm tracks where the size of the path is small and the ground surface is relatively featureless. Both these aspects would make aerial monitoring difficult. At the other extreme, gullies forming within native forests are larger but potentially difficult to detect from the air due to

obstruction of views of the soil surface by the forest canopy. Actual water flow paths have been mapped using differential GPS (<1m resolution) across this range of landscape types and flow path sizes. These will be compared to water flow modelling.

Furthermore, some of the water flow paths are small and therefore difficult to distinguish using the existing modelling at a resolution of 1m. Aerial data was obtained at 20cm resolution but flow modelling had been conducted at 1m resolution because of the overheads involved in processing data at that scale. Recently, water flow paths have been recalculated at the full resolution of the surface elevation maps in an attempt to test the approach for detecting much smaller water flow paths and therefore the formation of smaller erosion rills.

Task 10.

TASK NAME: Monitoring evaluation

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Monitoring will be almost complete and data will be available for evaluation of the methodologies developed within this project. The data will be analysed and the methodologies evaluated.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the success of the methodologies and the lessons learned regarding their effectiveness and application.

PROGRESS REPORT:

A final ground survey for evaluating modelled water flow paths has been undertaken for water flows under native vegetation. Previous evaluation of similar techniques overseas have shown large errors in heavily forested areas where foliage obstructs the view of the soil surface during aerial surveys. The native open woodlands of the region should pose less of a problem, and modern techniques developed by the CSIRO team in Perth allow very dense sampling of the soil surface. Evaluation of several water flow paths using ground-based measurements using differential GPS units was undertaken during February 2015 within the Condamine State Forest in an area contained in our aerial survey. Comparison of modelled flow paths against manually mapped flow paths showed very close agreement even under native forest cover. This provides confidence in the predicted water flows through native remnant areas within our study area. Further mapping was also taken on Origin's Monreagh farm to evaluate predicted water flows around access tracks, or physical features inserted to protect access tracks. Once again, predictions based on the aerial survey were in close agreement with manually mapped water flows near access tracks. Collation of all these data into a report of model evaluation has commenced, as required for Task11.

Task 11.

TASK NAME: Final analysis

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: The data gathered from the monitoring efforts will be used to identify the key issues of weed and erosion risks from gas well access tracks. This final analysis will centre more on the lessons from the data rather than the effectiveness of the methodologies.

TASK OUTPUTS & SPECIFIC DELIVERABLES: A brief report describing the data and knowledge gathered on weed and erosion risks from these results. The main messages emerging from these analyses will likely form the basis for subsequent publication of the results of this project.

PROGRESS REPORT:

All ground survey and data gathering is complete. A final report/scientific paper is being developed to incorporate the following:

- Aerial survey and methods used to generate the water flow models
- Soil surface survey and statistical comparison of these data against the DEM
- Water flow survey with comparison against predicted water flow paths
- Historical aerial photographs with comparison against predicted water flow paths
- Satellite imagery with comparison against predicted water flow paths
- Examples of use of water flow model to identify probable erosion hot spots, efficacy of water flow control structures, and impacts of CSG infrastructure on over land flow.

Task 12.

TASK NAME: Draft publications

TASK LEADER: Neil Huth

OVERALL TIMEFRAME: 2014/15

BACKGROUND: Communication of findings to the scientific community.

TASK OUTPUTS & SPECIFIC DELIVERABLES: Draft manuscript(s) prepared for journal(s) and/or conference proceedings.

PROGRESS REPORT:

Reporting of project findings has been undertaken. The evaluation of the aerial survey techniques have been reported as follows:

- International Farming Systems Design Conference (Montpellier, France)
- Australian Agronomy Conference (Hobart, Tasmania)
- Australian Modelling and Simulation Society (Gold Coast, Queensland)
- Fact Sheet (Available on GISERA website)

A draft of article for publication in an international scientific journal is under preparation. The publication is expected to be finalised by July 2017.