Project Order
Proforma 2011

1. Short Project Title

Towards an integrated study of the Gladstone marine system

Long Project Title	Towards an integrated study of the Gladstone marine system
GISERA Project Number	M1 1214
Proposed Start Date	May 2012
Proposed End Date	June 2014
Project Leader	Russ Babcock

2. GISERA Research Program

☐ Biodiversity Research ☒ Marine Research ☐ Land Research
☐ Water Research ☐ Social & Economic Research

3. Research Leader, Title and Organisation

Dr Russell Babcock
Principal Researcher
CSIRO Marine and Atmospheric Research

4. Summary (less than 300 words)

Port Curtis lies within the Great Barrier Reef Marine Park World Heritage Area and the region supports considerable areas of mangroves, seagrasses and saltmarsh. These vegetated habitats contribute to the high productivity of the area, in particular supporting commercially and recreationally important fisheries for crabs, prawns and finfish. The seagrasses also provide critical foraging grounds for turtles and dugongs. The residents of

the region also use the waters in the Port Curtis area for recreational purposes, including fishing, sailing and access to the nearby southern reaches of the Great Barrier Reef.

Australia Pacific LNG's project proposes to develop more than 35,000 km^2 of coal seam gas (CSG) acreage in southeast Queensland. The whole CSG industry will be considerably larger. The projects consist of 3 main elements:

- The gas fields themselves
- A high pressure gas pipeline from the gas fields to Gladstone
- LNG processing and ship-loading facilities on Curtis Island in Gladstone harbour.

While the major impacts of the project will be on the terrestrial environment, impacts on the inter- and sub-tidal environments of Gladstone harbour will also be significant.

The goal of the marine research program is to understand the vulnerable components of the marine ecosystem surrounding Gladstone with a view to minimising these impacts or identifying appropriate offsets. This project will provide initial data on the distribution and abundance of seagrasses, movement patterns of turtles and dugongs and a coastal hydrodynamic/biogeochemical model for Port Curtis. This will make possible more accurate prediction and understanding of impacts and trends in water quality as well as ecological responses in primary producers (seagrass) and grazers. It will also provide information that may lead to the reduction of impacts on these key ecological assets in the future, well beyond the current phase of development.

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	Total
Labour	652,892	261,646	474,414		1,388,952
Operating	204,250	95,497	4,500		304,247
Total Costs	**857,142**	**357,143**	**478,914**		**1,693,19**
CSIRO	857,142	357,143	478,914		1,693,199
Total Expenditure	**857,142**	**357,143**	**478,914**		**1,693,199**

Expenditure per Task	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	Total
Sub-Project 1: Sustaining turtles and dugongs and their habitat – an integrated marine observation system					
Task 1.1	142,857				
Task 1.2	142,857				
Task 1.3	193,431				
Task 2.1	71,429				
Task 2.2	71,429				

Task 2.3	71,429				
Task 3.1		110,515			
Task 3.2		71,429			
Task 3.3		71,429			
Task 4.1			71,429		
Task 4.2			71,429		
Task 5.1			185,822		
Total	693,432	253,373	328,680		1,275,485
Sub-Project 2: Integrated modelling					
Task 1.4	92,281				
Task 2.4	71,429				
Task 3.4		71,429			
Task 3.5		32,341			
Task 4.3			71,429		
Task 5.1			78,805		
Total	163,710	103,770	150,234		417,714
Total Expenditure	**857,142**	**357,143**	**478,914**		**1,693,199**

Cash Funds to Project Partners	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	Total
CSIRO	599,999	250,000	335,240		1,185,239
Total Cash to Partners	**599,999**	**250,000**	**335,240**		**1,185,239**

Source of Cash Contributions	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	Total
Australia Pacific LNG	599,999	250,000	335,240		1,185,239
Total Cash Contributions	**599,999**	**250,000**	**335,240**		**1,185,239**

In-Kind Contribution from Partners	2012/13 Year 1	2013/14 Year 2	2014/15 Year 3	2015/16 Year 4	Total
CSIRO	257,143	107,143	143,674		507,960
Total In-Kind Contribution from Partners	**257,143**	**107,143**	**143,674**		**507,960**

	Total funding over all years	Percentage of Total Budget
Australia Pacific LNG Investment	1,185,239	70%
CSIRO Investment	507,960	30%
Total Other Investment		
TOTAL	**1,693,199**	**100%**

Task	Mile-stone Number	Milestone Description	Funded by	Participant Recipient	Start Date	Delivery Date	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Report on project establishment and set up of reference panel.	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	142,857
	1.2	Deploy acoustic receiver array	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	142,857
	1.3	Complete initial seagrass field surveys	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	193,431
	1.4	Assemble underpinning data sets for Port Curtis model parameterization	GISERA	CSIRO	1.7.2012	1.10.2012	12/13	1st	92,281
Task 2	2.1	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
	2.2	Dual GPS and acoustic tagging of turtles	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
	2.3	Complete analysis of seagrass surveys	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
	2.4	Revise existing Port Curtis model grid and implement optics and biogeochemical component	GISERA	CSIRO	1.10.2012	1.3.2013	12/13	3rd	71,429
Task 3	3.1	Complete turtle tagging, download acoustic receivers	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	110,515
	3.2	Complete assessment of dugong tagging feasibility	GISERA	CSIRO	1.3.2013	1.10.2013	13/14	1st	71,429
	3.3	Complete yr 2 seagrass field surveys	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	71,429
	3.4	Compare Port Curtis model	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	71,429

		output with: i) existing mooring data, ii) new and existing optical and biogeochemical data, in Port Curtis area							
	3.5	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model	GISERA	CSIRO	1. 3.2013	1.10.2013	13/14	1st	32,341
Task 4	4.1	Final download of acoustic receiver data	GISERA	CSIRO	1.10.2013	20.12.2014	14/15	2nd	71,429
	4.2	Analysis and modeling of turtle movement	GISERA	CSIRO	1.10.2013	20.12.2014	14/15	2nd	71,429
	4.3	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules	GISERA	CSIRO	1.10.2013	20.12.2014	14/15	2nd	71,429
Task 5	5.1	Final report			1.3.2014	20.12.2014	14/15	2nd	264,627

6. Other Researchers (include organisations)

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Russ Babcock	0.40 FTE	Project management, animal tracking	>20	CSIRO
Richard Pillans	0.60 FTE	Field ecology, animal tracking	6	CSIRO
Gary Fry	0.50 FTE	Field ecology	10	CSIRO
Mick Haywood	0.60 FTE	Field ecology, GIS	>20	CSIRO
Matthew Dunbabin	0.10 FTE	AUV design and operation	>15	CSIRO
Toby Patterson	0.30 FTE	Analysis of animal movement data	10	CSIRO
Chris Wilcox	0.15 FTE	Analysis of animal movement data	>20	CSIRO
Karl Forcey	0.20 FTE	Electronics	>15	CSIRO
Bee Morello	0.30 FTE	Data analysis, scientific writing	10	CSIRO
Khadija Oubelkheir	0.30 FTE	Seagrass physiology	10	CSIRO
Philip Gillibrand	0.25 FTE	Hydrodynamic modelling	>20	CSIRO
Karen Wild-Allen	0.55 FTE	Biogeochemical & optical modelling	>20	CSIRO
Nugzar Margvelashvili	0.45 FTE	Sediment modelling	>20	CSIRO
John Andrewartha	0.10 FTE	Hydrodynamic modelling	>30	CSIRO
Farahan Rizwi	0.10 FTE	Technical programmer	>15	CSIRO

7. GISERA Objectives Addressed

The proposed development by Australia Pacific LNG and others will constitute one of the largest industrial infrastructure investments in Australia over the next decade. This will take place within a region which still enjoys high value marine environmental assets and amenity, and provides a jumping off point to the southern Great Barrier Reef. The challenge is to realise the economic benefits of the proposed industrial development, while maintaining and indeed growing the marine environmental assets and amenity of the region. The proposed marine research program will begin to address this challenge by improving the scientific knowledge base needed to anticipate and mitigate impacts, and to identify opportunities for trade-offs and offsets.

The study will have a high level of impact through a variety of outputs such as peer reviewed publications, presentations, reports, and through direct requests for information from government agencies, industry and the community. The uptake of information from the project will be facilitated by relationships built both before and during the project with key staff from organisations such as the QLD Department of Environment and Heritage Protection (EHP) (formerly DERM), Gladstone Port Authority, as well as a range of industry stakeholders and their consultants. The information provided by these projects will assist agencies in evaluating and refining environmental trigger levels for water quality parameters

and determining options for management of the iconic fauna such as turtles. Refinement of information such as this will increase the level of confidence around environmental decision making processes in Port Curtis (and potentially more widely), with potential savings in time and resources devoted to marine environmental approvals and licensing activities.

Collaboration with Central Queensland University (CQU) to have a PhD student participate in the Marine Research Program will add value and increase the capacity building component of the program. Government agency experts, such as a turtle expert will be fully engaged in the turtle tagging and tracking program, bringing their own capability and resources to the Marine Program. Discussions have occurred between CSIRO, QLD DEHP, Australian Institute of Marine Science (AIMS) and James Cook University (JCU) in relation to this work.

The significant resources and experience of the CSIRO will ensure sound and efficient operational management of the Marine Program, with accurate reporting and on-time, on-budget delivery on milestones.

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 research outputs derived from this project will (i) increase our understanding of the impacts of the Gladstone CSG-LNG projects on turtles and potentially dugongs, leading to opportunities for Harbour managers and DEHP to minimise impacts on these species (for example by fine-tuning harbour shuttle services) and (ii) develop integrated hydrodynamic, sediment transport and light models that will improve our understanding of the local effects of discharges and dredging associated with CSG projects on the optical and seagrass ecosystems in the region. The project will provide significantly more accurate models through locally tuned parameter values and process understanding. This improved information will be made available through a range of approaches including reports and publications.

11. How will these Research outputs and outcomes be used by State Government and other water managers to achieve Adaptive Management of Coastal Resources?

The outputs from this project will help to inform government, regulators and policy-makers on key issues regarding the impacts of CSG-related port developments, namely seagrasses, turtles and potentially dugongs. The information will feed into an adaptive management process enabling regulators to assess the effectiveness of decisions and actions, and to design more effective management actions in the future. These might include decisions such as varying trigger or compliance levels for water quality, or implementing spatial or temporal zoning of boating activity.

12. Project Development (1 page max.)

The projects were developed according to the GISERA's nine-stage research project development process (http://www.gisera.org.au/documents/research-development-process.pdf).

13. Project Objectives and Outputs

The goal of the marine research program is to understand the vulnerable components of the marine ecosystem surrounding Gladstone with a view to minimising these impacts. It is proposed that the program be conducted in 2 phases. Phase 1 (years 1 & 2 (May 2012 to June 2014)) will provide initial data on the distribution and abundance of seagrasses, movement patterns of turtles and dugong, and a coastal model for Port Curtis. Phase 2 will rely on future funding and it is proposed that this will comprise further development and integration of the models.

Sub-project 1: Sustaining turtles, dugongs and their habitat – an integrated marine observation system

The acoustic tracking array will span the Port Curtis project area with a series of curtains to the north of the development extending south to Gladstone Harbour. The array will be deployed in year one following site investigations to determine receiver range in the Port Curtis environment. Five turtles will be tagged simultaneously with GPS satellite and acoustic tags as a means of calibrating the accuracy of the acoustic tracking network. The double tagging will also allow us to construct a model of animal habitat use, permitting interpolation of animal positions between acoustic receptions with high accuracy. Acoustic systems have the advantage that tags are relatively inexpensive and large numbers of animals across a wide size range can be easily tagged and tracked for periods much longer (up to 8-10 yr) than the life of a GPS tag. Installation of the acoustic monitoring arrays and tagging of turtles will be completed between 6 and 12 months of project commencement. Receivers will be downloaded 6 monthly for the first year and every 8-12 months thereafter. Tagging trials with dugongs will be attempted within the second year and dugongs will be included in the program if this proves to be ethically and logistically possible.

Seagrass will be surveyed initially in winter to document the extent of key habitat using the Starbug AUV. The AUV allows transects to be accurately and repeatedly positioned, with data collected in the form of continuous geo-located stereo images that can subsequently be quantified to determine the extent, cover and composition of seagrass meadows. Data collected by the AUV includes depth and other water column parameters. Information collected on seagrass community dynamics will provide estimates of parameters for the seagrass process model being developed in sub-project 2: Integrated modelling.

Collaboration with DEHP and JCU will bring decades-worth of experience to this project and will be key to developing an acceptable method of acoustic tagging of dugongs.

Research aim	Research methods	Outcomes
Year 1		
Deploy and calibrate acoustic array, and tag accuracy.	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	Comprehensive tracking array able to provide high levels of confidence around positions of tagged animals.
Download initial datasets.	Deploy acoustic receiver array, download at 6 and 12 months. Dual GPS and acoustic tagging turtles for tag comparison and acoustic tag modelling.	
Establish seagrass baseline.	Deploy Starbug AUV, analysis of seagrass data sets.	Accurate quantitative and repeatable baseline of seagrass habitats in the region encompassed by the array.
Year 2		
Turtle tagging to provide information on statistically significant number of individuals across populations of turtles using habitats in the region.	Externally attached V16 tags on turtles captured in Port Curtis, using standard techniques. Regular download of acoustic receiver array data.	Large sample size of turtles able to provide a better picture of behavioural variability than small numbers of GPS tagged animals.
Determine the feasibility of dugong tagging and tracking using acoustic technology.	Dugongs internally tagged, several methods may be trialled and will require appropriate involvement of skilled veterinary staff.	Large sample size of dugongs able to provide a better picture of behavioural variability than small numbers of GPS tagged animals.
Ongoing seagrass measurement.	AUV deployments annually in winter.	Ability to relate animal movements to variation in food source.

Sub-project 2: Integrated modelling

The aim of this integrated modelling task is to establish a coastal model for Port Curtis, nested within regional Great Barrier Reef models, that allows improved understanding of the local effects of discharges and dredging associated with LNG projects on the optical and seagrass ecosystems in the region.

This project will proceed through a series of staged tasks:

1. A pilot fine-scale 3D hydrodynamic, sediment, biogeochemical & optical model will be implemented on a revised Port Curtis model grid based on Herzfeld et al. (2004), augmented with the current coastline and bathymetry. The model will be used to simulate a seasonal cycle, which will form the basis for exploration of seagrass growth dynamics. The development of the Port Curtis optical model and seagrass interactions will have the potential to link with eReefs modelling and assist the development of similar capability in the larger scale model.

2. Temperature, salinity and turbidity data from 16 moorings in the Port Curtis area (maintained/supplied by 'Vision Environment Queensland') will be used to assess the skill of the hydrodynamic and sediment models.

3. New biogeochemical, optics and seagrass data will be collected by Russ Babcock & Kadija Oubelkheir. This data will be used to assess the skill of the biogeochemical and spectral optics model.

4. A review of seagrass process understanding and existing seagrass models will be completed. The primary drivers of seagrass growth and bed dynamics will be identified and prioritised for inclusion in the seagrass process model. In particular, options for enhanced coupling of seagrass dynamics across the hydrodynamic, sediment and optical models will be explored. Possible updates to the current model include:

- Inclusion of bottom current velocities and bed erosion into seagrass loss terms
- Adding sediment deposition/burial of seagrass beds to the optics terms for attenuation of light
- Parameterisation of grazing impacts in the seagrass loss term
- Improved model for seagrass photosynthesis and growth possibly including partitioning of biomass between roots/shoots/leaves
- Parameterisations of dynamic seagrass bed processes (likely as a function of bed substrate, sediment consolidation & hydrodynamics) e.g. formation/recovery of 'blow outs', expansion of bed areas, repopulation of previous areas, new colonisation.
- Note that some of these enhancements are dependent upon the delivery of the light transfer efficiency model from the University of Technology Sydney that is being developed for the Queensland Department of Employment, Economic Development and Innovation.

5. Delivery of an improved seagrass model demonstrated across a range of plausible water quality scenarios, for example elevated sediment and/or nutrient loads associated with flood events. Peer reviewed publication of the model.

Research aim	Research methods	Outcomes
Year 1		
Pilot fine-scale 3D hydrodynamic, sediment, optics and biogeochemical model for Port Curtis region.	Revise existing Port Curtis model grid and implement optics and biogeochemical component.	Pilot model of seasonal cycle.
Skill assessment of hydrodynamic and sediment models.	Compare model output with existing mooring data in Port Curtis area.	Assessment of pilot hydrodynamic and sediment models as 'fit for purpose'.
Year 1-2		
Skill assessment of biogeochemical and spectral optics models.	Compare model output with new and existing optical and biogeochemical data in Port Curtis area.	Assessment of pilot optical and biogeochemical models as 'fit for purpose'.
Review of seagrass process understanding and existing seagrass models; prioritise primary drivers of seagrass growth and bed dynamics.	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model.	Primary drivers of seagrass dynamics and growth prioritised for inclusion in the model.
Year 2		
Update seagrass process model including improved growth, partitioning of biomass and enhanced coupling across hydrodynamic, sediment and optical models.	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules.	Seagrass process model capable of capturing the effect of sediment transport and water quality disturbance on seagrass meadows.
Demonstration of improved seagrass model over a range of plausible environmental scenarios; peer reviewed publication(s).	Exercise seagrass process model across a range of environmental scenarios; draft manuscript(s).	Peer reviewed model demonstrates the spatial and temporal response of seagrass in the Port Curtis region under a range of contrasting environmental scenarios.

14. Project Plan

14.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor(s)
Task 1.1	Deploy acoustic receiver array.	Russ Babcock	21.07.2012	01.10.2012	Task 1.2
Task 1.2	Complete initial seagrass field surveys.	Russ Babcock	01.07.2012	01.10.2012	Task 1.3
Task 1.3	Assemble underpinning data sets for Port Curtis model parameterization .	Karen Wild-Allen	01.07.2012	01.10.2012	Task 1.4
Task 2.1	Range testing of receivers at locations throughout the array in order to ensure array effectiveness.	Russ Babcock	01.10.2012	01.03.2013	Task 2.1
Task 2.2	Dual GPS and acoustic tagging of turtles.	Russ Babcock	01.10.2012	01.03.2013	Tasks 1.1, 2.1
Task 2.3	Complete analysis of seagrass surveys.	Russ Babcock	01.10.2012	01.03.2013	Tasks 1.2
Task 2.4	Revise existing Port Curtis model grid and implement optics and biogeochemical component.	Russ Babcock	01.07.2013	01.03.2013	
Task 3.1	Complete turtle tagging, download acoustic receivers.	Russ Babcock	01.03.2013	01.10.2013	Task 1.1, 2.1, 2.2
Task 3.2	Complete assessment of dugong tagging feasibility.	Russ Babcock	01.03.2012	01.10.2013	Task 1.1, 2.1, 2.2
Task 3.3	Complete yr 2 seagrass field surveys.	Russ Babcock	01.03.2013	01.10.2013	Tasks 1.2, 2.3
Task 3.4	Compare Port Curtis model output with: i) existing mooring data, ii) new and existing optical and biogeochemical data, in Port Curtis area.	Karen Wild-Allen	01.01.2013	01.10.2013	Tasks 1.3, 2.4
Task 3.5	Workshop with seagrass experts; interact with seagrass sampling program to constrain parameters for process model.	Karen Wild-Allen	01.03.2013	01.10.2014	

Task 4.1	Final download of acoustic receiver data.	Russ Babcock	01.10.2013	20.12.2014	Tasks 1.1, 2.1, 2.2, 3.1
Task 4.2	Analysis and modeling of turtle movement.	Russ Babcock	01.10.2013	20.12.2014	Tasks 1.1, 2.1, 2.2, 3.1, 3.2, 4.1
Task 4.3	Seagrass model code augmented with additional process resolution and coupling to hydrodynamic, sediment and optics modules.	Karen Wild-Allen	1.10.2013	20.12.2014	Tasks 1.4, 2.4, 3.4, 3.5
Task 5.1	Final report.	Russ Babcock and Karen Wild Allen	1.3.2014	20.12.2014	All previous tasks

15. Budget Justification

The budget for both sub-project 1 and 2 have been approved by GISERA's Research Advisory Committee and Management Committee.

16. Project Governance

Project management tasks are specified in *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: the project draws upon significant contributions from a wide range of highly experienced staff; the impact of key staff departure could be mitigated by existing project staff covering gaps as required.

19. Intellectual Property and Confidentiality

Background IP (clause 10.1, 10.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
Not applicable				
Ownership of Non-Derivative IP (clause 11.3)	Models developed will remain as a property of CSIRO, however model concepts and outputs will be published.			
Confidentiality of Project Results (clause 15.6)	Project results are not confidential.			
Additional Commercialisation requirements (clause 12.1)	Not applicable.			
Distribution of Commercialisation Income (clause 1.1)	Not applicable.			
Commercialisation Interest (clause 1.1)	**Party**		**Commercialisation Interest**	
	Australia Pacific LNG			
	CSIRO			