IMOS Integrated Marine Observing System

Call for Proposals under the IMOS (EIF) Five Year Strategy: Enhancement or extension of IMOS – July 2009 to June 2013

Facility Project Plan template

Proposals should be submitted by 30 October 2009 to:
Tim Moltmann, IMOS Director, University of Tasmania
email: tim.moltmann@imos.org.au

Background:
This template has been provided to allow Facility and Sub-Facility Leaders, and other interested parties to prepare a Facility Project Plan following a call for proposals announced on 18 September 2009, with a closing date of 30 October 2009.

Prior to completing this template, please read the IMOS Five Year Strategy (the 'Strategy'), and Detailed Guidelines for Proposal Development (the 'Guidelines') – see the IMOS website at: http://imos.org.au/eif.html.

The Facility Project Plan must be in the following template and contain the information set out below:

Overview:

Proposed Infrastructure Investment:	Extension of the existing FAIMMS Facility through to 2012/2013.
IMOS Facility:	Facility for the Automated Intelligent Monitoring of Marine Systems (FAIMMS)
Operating Institution:	Australian Institute of Marine Science (AIMS)
Facility Leader (for this Proposal):	Mr Scott Bainbridge, AIMS, s.bainbridge@aims.gov.au, 07 4753 4377
Other(s) key people involved:	Dr. Peter Doherty, AIMS Mr. David Harris, University of Queensland Prof. Marimuthu Palaniswami, Melbourne University Prof. Michael Kingsford, James Cook University Dr. Maria Byrne, University of Sydney Mr. Lyle Vail, Australian Museum Dr Stephen Giugni, CISRO ITC Hobart Dr. Matt Dunbabin, CSIRO ITC Brisbane Mr. Stuart Kininmonth, AIMS Dr. Scarla Weeks, University of Queensland Ass. Prof. Ian Atkinson, James Cook University Dr. William Skirving, NOAA Dr. Bronte Tilbrook, CSIRO Dr. Mal Heron, James Cook University

Collaborating Institutions:	University of Melbourne, James Cook University, University of Sydney, Australian Museum, University of Queensland, NOAA

Please attach:

- Letter from senior person in Operating Institution, confirming that the proposed infrastructure can be developed and operated within that institution - attached
- Resume of Facility Leader - attached
- Letters received from Collaborating Institutions, detailing their support to the Proposal, and indicative level of co-investment – on their way.

Nature of Investment:

The Facility requests funding to extend the current investment for an additional two years from 2010/11 through to 2012/13. FAIMMS was set up as a test case for deploying new types of observing systems ('smart' sensor networks), so far four sites have been successfully set up and in doing so the Facility has created the worlds first coral reef wireless sensor network. The network has captured some 4.8 million observations including information on Tropical Cyclone Hamish as it went past One Tree and Heron Islands (see Figure One).

The Facility has demonstrated the capacity and feasibility of this new technology and much of what the Facility has developed is now trickling down to the other components of IMOS. This includes real time communications using the nextG system, the data systems and infrastructure for dealing with real time data (such as the DataTurbine middleware and the QC systems being developed) and the use of traditional oceanographic instruments in shallow systems. Data from events such as cyclone Hamish and the lagoons of the southern GBR are opening up new understandings and as we move into an El-Nino weather pattern this year the data will be critical in measuring and monitoring this event as it unfolds.

The extension will be used to optimise the systems and deployments but importantly to generate data to feed into modelling work on the southern GBR being undertaken at the University of Queensland (Dr. Scarla Weeks), to monitor cross shelf warming events in the central GBR (Dr. Ray Berkelmans, AIMS) and to understand environmental clues to spawning events, such as fish and coral spawning, in the northern GBR at Lizard Island. Additional sensors will be added to the system through collaborations with NOAA (William Skirving, light), AIMS (Dr. Ray Berkelmans, underwater PAR), CSIRO (pCO2 through Bronte Tilbrook) and Queensland surf lifesaving (video via Dr. Lyndon Llewellyn, AIMS).

Work will begin in developing management and forecasting products for the Great Barrier Reef Marine Park Authority so that the real–time data can be used to assess current situations and to develop management strategies to best deal with events such as coral bleaching and cyclones. The synergy between the data systems being deployed by FAIMMS and the management capacity of GBRMPA, linked into forecast models under development by MTSRF, will deliver a new capacity in the management of the GBR.

The extension will allow for the network to be maintained so that it continues to deliver quality scientifically valid data (which requires instruments to be serviced and maintained), it will allow for new sensors to be deployed in conjunction with a number of other agencies and it will allow for a series of summer events to be fully observed so that the scientific purpose that the network was built for (coral bleaching and other warm water events) can be realised. No IMOS/EIF funds have been asked to enhance the Facility; this will come through funds generated by the Facility as opportunities arise.

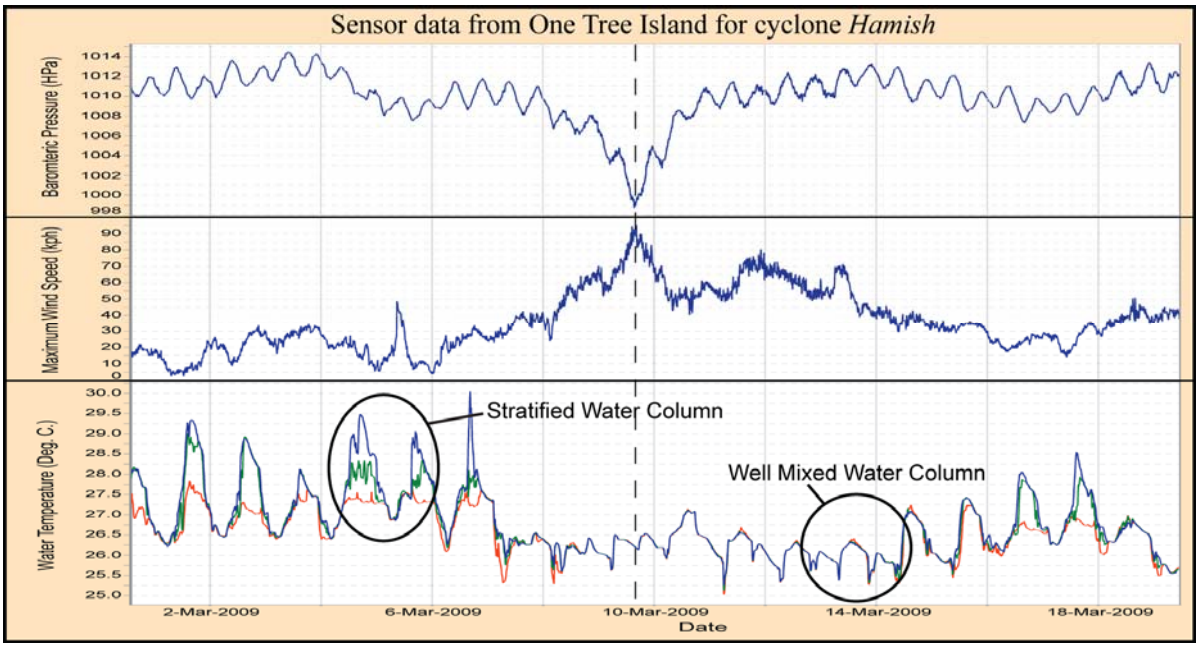

Figure One. Real time sensor network data showing the impact of cyclone Hamish at One Tree Island. Top graph is atmospheric pressure, middle graph is wind speed, bottom graph is a temperature profile showing how the stratified lagoon becomes well mixed.

Implementation Strategy:

- Summary

The implementation builds on the current implementation plan that will see all systems installed by the end of the 2009/10 financial year. The plan for the additional two years is to maintain the deployed equipment through the planned six month service visits, to work with other agencies in increasing the types of sensors to be installed and to work to make the data available and usable through a range of data and knowledge products developed in direct consultation with users such as the modelling group at UQ and Climate Change group at GBRMPA.

- Objectives

The objectives of the work to be undertaken with the extension money include:

1. Completion of the process of making operational the equipment deployed including fine-tuning designs, locations and sensors;
2. Servicing and maintenance of the equipment to continue and expand the current data streams;
3. Continue to work with existing partners to deploy new types of sensors including light and PAR (William Skirving, NOAA), pCO2 (Bronte Tilbrook, CSIRO), video (Lyndon Llewellyn, AIMS), etc;
4. Continue to support the SEMAT work being undertaken by the University of Queensland;
5. Continue to build the expertise in sensor networks through partnerships with the University of Melbourne (ISSNIP) and with the general IMOS community to allow the work done to be applied to other areas and systems;
6. Continue to work at an International level to facilitate the development of new technologies for ocean observations.

- Addressing the IMOS Five Year Plan

The following items have been extracted from the IMOS Five Year Plan to address the strategic importance of continued funding for the FAIMMS Facility.

- ***allow oceanographic and associated biological phenomena to be investigated at a geographic and temporal scale that has hitherto been extremely limited. (page 6)***

  The FAIMMS infrastructure is a generic platform that can be adapted to accommodate a range of sampling techniques including still photographs, video, and in fact any sensing system that has a data interface. This uniquely positions the FAIMMS systems as general purpose tools and opens up their use to a range of observations including biological ones. Possible applications include video for behavioural studies (a trial is currently underway looking at jellyfish identification for Qld Surf lifesaving), image systems for plankton counts (image based plankton recorders are currently under development), nutrient analysers and even biochemical samplers that are able to sample for pesticides and biological wastes such as vitamins and hormones.

  The FAIMMS infrastructure is also unique in being able to be deployed in intensive spatial deployments and to be able to alter the temporal sampling rates based on event detection. This uniquely allows new levels of sampling, both in time and space, that have not been available with existing technologies. Adaptive sampling using smart controllers means it becomes possible to intensively sample events while conserving battery and power and so the system is able to intelligently manage issues such as power and battery life along with sampling rates.

The need for a coastal component integrated via a national backbone & regional nodes

The FAIMMS infrastructure and systems are easily deployed in a range of environments including coastal and shallow water system such as lagoons, bays and even rivers. The FAIMMS approach has been to nest the infrastructure into the mooring infrastructure using the same instruments (although wrapped with smart controllers) to deliver data that has the same level of robustness as the deep water data. At Heron Island we now have equivalent sensors inside the lagoon and outside the lagoon and so we can look at how these systems interconnect. Figure Two shows the temperature from the sensor network inside the lagoon (green line) and a deep water mooring (GBR Mooring Array) outside the lagoon (blue line), the patterns have a degree of similarity but the lagoons are more variable due to the shallow nature of the environment.

Providing a national backbone for observing boundary currents

The FAIMMS sensor networks provide the ultimate link between the coastal boundary currents and the impacts on the reefs on the Great Barrier Reef. The detection and monitoring of the gross large scale currents is important but so is understanding how the larger scale processes actually impact at the local level, in this case on the corals themselves.

For example initial evidence from the sensors on Heron Island show that some reefs are reasonably independent from ocean processes and in fact are driven more from atmospheric processes, which of course, are linked to ocean processes, but via a more complex pathway. The FAIMMS network provides the fine scale temporal and spatial information required to link these multi-scale processes together and so is a critical part of understanding how systems respond to changes in the boundary current conditions.

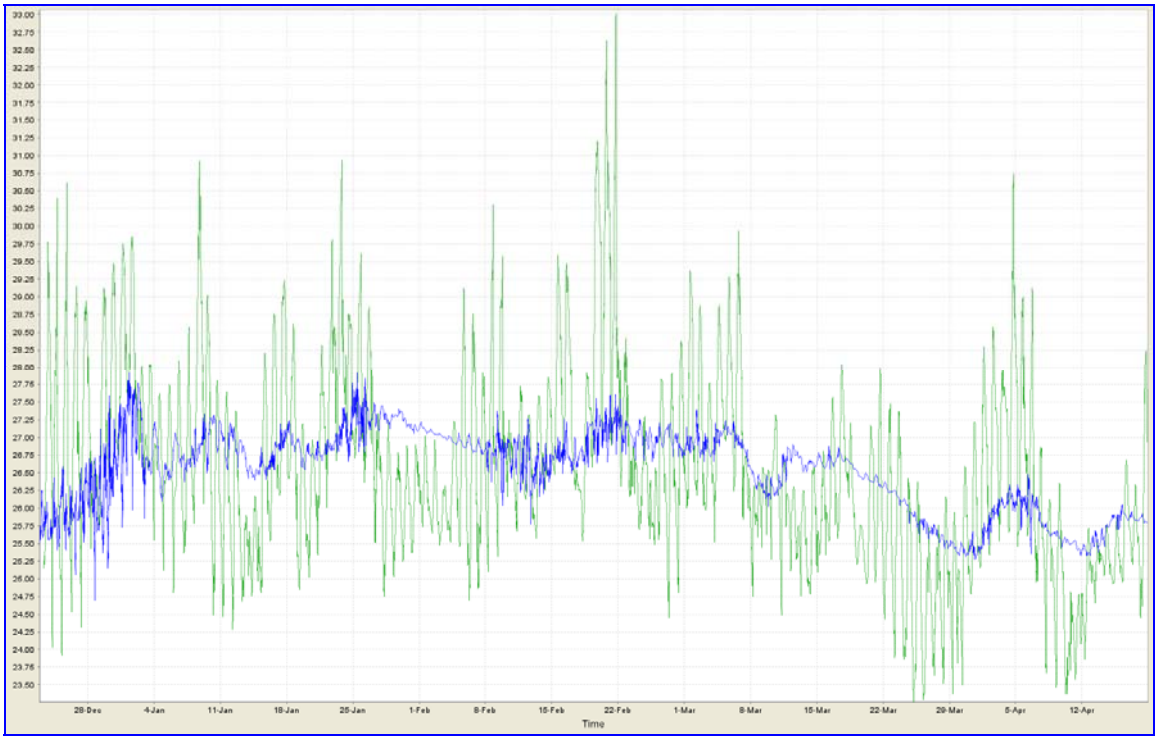

Figure One. Sensor network data (green) for Heron Island lagoon compared to the GBR Heron East mooring (blue).

Continuing to build institutional strengths into national capability

Sensor Networks are a new technology that have not previously been trialled in an operational manner in the marine environment in Australia. As such the project, which now has four operational deployments, has resulted in a new set of capacities within IMOS and, through the extension of the Facility, into the general marine community. FAIMMS is acknowledged as being a leader in coral reef sensor networks as demonstrated by the number of presentations and talks given over the last year remembering that it has only been one year since the first deployments were completed and we are only half way through the original project plan.

The facility has also driven capacity into other areas such as the work with eMII to develop real time data systems such as automatic metadata generation and the DataTurbine middleware originally used by FAIMMS and now used operationally by eMII. This is continuing with work underway on the OGC set of protocols including the development of an Sensor Observation Service (SOS) client to make time series data easily accessible in the way that the portal currently makes map based data available.

The FAIMMS Facility is working with the ISSNIP project run by the University of Melbourne on two project looking at the development of a new generation of across water high speed networking protocols as well as working with the SEMAT project at the University of Queensland on underwater RF communications and with the University of Maryland on the application of underwater laser communications.

Finally the FAIMMS project is building capacity in real-time data including the use of nextG communications (used extensively for the sensor network deployments), system monitoring in real time, database schemas and systems to accommodate real time data, data access systems (web services, DataTurbine, SOS), quality control of real time data (web based rules system currently deployed at AIMS) and event detection and reporting systems.

Exploring the potential for whole-of-system approaches

The FAIMMS sensor network provides the 'last-mile' in linking what occurs in the oceans with the impacts and events we are actually interested in. Climate change really only has meaning at the point where changes occur to biological systems and so being able to measure these directly, as changes to fish movements, spread of species, impacts to humans, is essential in delivering a system that has real societal benefits. The FAIMMS technologies allow for very specific areas to be monitored and observed at high temporal and spatial scales and so represents a logical end point from large scale systems such as satellite remote sensing and ocean moorings. As such, it sits logically within a hierarchy of space and time, from daily large scale satellite images down to ten minute centimetre scale sensor observations.

Driving down the cost per observation.

The FAIMMS Facility is an infrastructure facility and as such one main goal is to lower the cost of future work. FAIMMS has installed complete platforms and communications systems at seven sites and so the cost for additional observations from those sites is just the cost of any additional sensors. FAIMMS includes the servicing deployment, communications, data management and data access so that these are not costs that any additional observations need to carry. For example to add a light sensor to the existing deployments would now just entail the cost of the sensor itself (hundreds of dollars) rather than the tens of thousands of dollars that would be required to do this from scratch.

Another area where FAIMMS has worked to drive down the costs of observations is with communications. The nextG solutions developed by the FAIMMS Facility can reduce the costs of real-time communications from the $15,000 per annum for the proposed Iridium based moorings to under $1,500 – that is one tenth. The work that FAIMMS has done with Telstra and other companies in this are has been recognised world wide through the promotional work undertaken.

8. Creating and developing the information infrastructure

- List of major activities – including major party(s) involved, duration, start, finish

The following activities are proposed:

Activity	*Timing*	*Party*
Servicing of Equipment	Every six months	AIMS
Optimisation of the deployed infrastructure	On-going	AIMS
Support for the SEMAT Project	Every six months	AIMS/UQ
Addition of Ambient Light Sensors	Project Start	AIMS
Addition of other sensors	As required	AIMS/Other
Data Use Workshops / Community Meetings	Annually	IMOS/Other

- List of major equipment to be purchased / developed

There are no major capital items to be purchased, capital items in the budgets are for spares / replacement items.

Access, pricing regimes:

- How will data access be provided?

Data access will be via the current set of methods, these include:

1. Metadata will be harvested off the AIMS MEST into the eMII MEST as per the current arrangement;
2. Real-time data will be made available from the AIMS DataTurbine which is synchronised into the eMII DataTurbine
3. All data will be made available via the current set of web service interfaces for access by eMII in their systems such as the Oceans Portal
4. The current web site will be continued and expanded as required, access to this is via the INOS web site
5. The IMOS web site will be added to and enhanced as required
6. Ad-hoc requests for data will be dealt with as required.

New methods such as SOS and so on will be investigated and deployed during the life of the project allowing the FAIMMS data to be part of a number of international sensor projects including the CREON project and the OOS-Tethys Project.

- How will data and products be managed?

The existing systems for data management will be continued and expanded under the new funding, products will be delivered via using the web and innovative platforms such as the iPhone. Products will be developed in conjunction with key stakeholders (such as the Tropical Marine Network and GBRMPA). Work will begin to make the sensor observations available via the GTS and to the modelling groups at UQ and the Navy. The Facility already has strong links to eMII and these will be used to continue to deliver compliant data products to eMII.

- What are the dependencies on external / other facilities (national and international)?

The Facility has no direct dependencies on other IMOS Facilities although ideally the FAIMMS Facility sits within the GBROOS Node to give it the context of linking the larger scale observations, such as the mooring network, with the finer scale FAIMMS observations to provide measures of how the larger scale processes act at the reef and coral scale.

FAIMMS has formal links to the University of Melbourne ISSNIP project and is using the technical IT expertise of this group to develop new solutions to issues such as the management of power budgets in remote equipment, communications protocols for interrupted systems and so on.

- Collaborative structures for allocation of priorities

Currently FAIMMS sits wholly within the GBROOS Node and there are no IMOS activities in the other Nodes and so the GBROOS Governance will be used to allocate priorities.

Governance

- Performance indicators

The main performance measure is the uptime and reliability of the deployed systems. This is currently measured by the monitoring systems at AIMS which gives alerts of any failures and outages. For the sensors on One Tree Island the uptime from January to September 2009 was 99.6%, so already the systems are showing a high level of reliability.

The other measure is the uptake and use of the data and this is one area that the Facility recognises the need to focus on. Part of the issue is that the project has only had data flowing for twelve months and that as the data is new there is no pre-existing community of users waiting to utilise the data as there are for other Facilities. The task now is to grow that community outside places like AIMS and that is why the extension of the Facility is important in generating real scientific value for the work under taken so far. At this stage it is hard to put simple numbers to reflect the uptake and use of the data apart from publications and access requests. The delay in getting publications completed and the inability to track all data usage makes this problematic.

- Describe key risks and risk management strategies

The main risks when the project started were that the technologies and approaches being used would not be viable; these have been overcome with operational systems now being deployed. The main risks remaining are common to the marine community and include cyclones, equipment loss (theft or storms) and reliability issues with regards to the communication systems. The other area of risk is lack of uptake of the data and this is one recognised by the Facility and one that it will be focusing on once the initial deployments are completed.

Particular risks include:

1. Loss of equipment due to cyclones or other events:

   All of the FAIMMS equipment is covered by the AIMS insurance policies and so any major equipment lost will be replaced.

2. Loss of major communications links:

   This has already occurred with a number of modems failing. All of the equipment logs the data and so there are multiple fall-backs for the preservation of the data itself so loosing data is not the issue. The island research stations can be serviced by the on-site staff and all of the deployed systems are plug and play so installing new equipment is straightforward. For the reef locations this may need to wait until a service visit but most of the reefs close to Townsville can be done in a day trip so again this risk can be covered.

3. Lack of uptake of the data.

   This is a recognised issue and one that the Facility will be actively addressing (and already is) into the future. As mentioned the Facility is new and does not have a pre-existing user based that is able to immediately use and understand the data, instead the Facility needs to build this community through consultation and the development of tailored projects. As the project has still some sites to complete the focus has been on getting quality data streams, the completion of the deployments will give time for the engagement process to begin in earnest.

   The need to value add to the work done, through additional observations and applications, is key to why the Facility is taking the position of asking for an extension with limited new capital to be deployed, this gives the Facility time to do the value add so that the full

investment is realised. There is the temptation to do more sites and areas but this would only dilute the value-add process that needs to now occur.

- Issues raised in the 2008 IMOS Review

  The following is an exert from the 2008 Review:

5.3.3 Facility for Automated Intelligent Monitoring of Marine Systems (FAIMMS)

Main discussion points of the Panel were

1. FAIMMS implementation is progressing at an impressive pace, is well designed and hitting planned milestones and developing websites and data protocols ahead of the set-up of eMII
2. Suggest link to eMII could be delayed at this stage, as given the status of the other facilities, FAIMMS can continue to develop while eMII concentrates on other data streams. Maybe eMII could allocate funds direct to AIMS to assist with development as this seems to be the best strategy given the capability already developed at AIMS
3. The main research goal of FAIMMS remains unclear since it has had a technology focus – is the key outcome a system to plug sensors into, or a sustained observing system in its own right? – this should be clarified in the plans

Review Panel Recommendations:

31. Identify a common scientific rational for FAIMMS and the GBR mooring network in the next business plan (due February 2009)

The main issue here is that the FAIMMS facility is neither obviously a pure technology development or a pure applied scientific activity but somewhere in-between. This was recognised when FAIMMS was established on the basis that developing a technology without a use was not a good way to proceed but that integrating a technology that was largely untested strongly into a scientific application was also less than ideal.

Given the success of the project at a technical level there is now the need to do this at a scientific level. This is happening as the data accumulates and we start to see how the lagoons of these reefs act but so far we only have a years worth of data from a small number of sites over a time period (the winter) which is scientifically less interesting that the extreme conditions that the summer brings. There are a number of patterns emerging from the data already that will contribute to the science and as the summer of 2009/10 looks to be warmer than average (and may well be an El-Nino year) the data will start to show its value.

One example is with tropical cyclone Hamish that went past the One Tree and Heron Island sites. The real time data gave important data on the conditions experienced within the reef lagoon itself, a publication is underway looking at the data from the external moorings and the radar data to see how conditions outside the reef translated to conditions within the reef. This is a good example of how the sensor network data, when integrated with the mooring, remote sensing and radar data, is giving new understandings of how these systems operate.

Another example comes from looking at the dynamics of the lagoons of these southern reefs. It is normally assumed that these reefs are driven by oceanic water, that is there is a strong connection between the reefs and the water surrounding them. The lagoonal nature of Heron and One Tree Islands means this is not the case and initial analysis of the data shows that the lagoons of these reefs are driven by local atmospheric conditions not ocean processes. This will be different for the outer parts of these reefs but the internal lagoons seem to act as isolated systems for much of the time. This means we may be able to predict the lagoon environment from the atmospheric conditions alone.

Other examples include looking at the impact of the dust cloud that recently covered most of northern Australia. The dust is thought to cause an increase in primary production through iron enrichment and so the satellite, mooring and sensor network data will be analysed to see if this indeed occurred. Such data may throw new light on the impact of events such as dust storms that may become more common with changes in climate.

Budget: Please complete the spreadsheet provided, and detail here any further information you have available on the background to the Budget:

- EIF Funds
  - Extension of existing Facility

    The funds requested and detailed in the budget are for an extension of the Facility for an additional two years from 2010/11 to 2012/13.
  - Expansion of existing Facility / New Facility

    No money to expand the Facility has been requested.
- Co-investments – source and nature

  The main co-investment for FAIMMS is being negotiated at the GBROOS Node level as the focus on co-investment is in the science rather than at the Facility level. Some co-investment is being provided by AIMS in terms of all Salary Overheads, some vessel costs and part of the Facility Leaders salary. These in-kind costs are shown in the budget.
- Staffing details

  The following staff are being proposed (see budget for the overall costs):

  - Technician – 1.0 FTE (existing position)
  - Electronics Technician – 1.0 FTE (existing position)
  - Database Programmer – 1.0 FTE (existing position but increased FTE)
  - Facility Manager – 0.5 FTE (existing position, other 0.5 FTE in-kind from AIMS)

  The Technician and Electronics Technician positions are continuations of the current positions. The Database Programmer position is an extension of a current position and reflects the data intensive nature of the Facility and supports the development of key knowledge products that will be critical in getting the data to end users. This position is therefore the way that we will be able to generate the products our users require to utilise the data collected, such as products suitable for model input, alert and event detection systems, improved bleaching detection and so on.
- Description of proposed new infrastructure for Nodes – please complete the Table on the next page, referring to Attachment 1 to the Guidelines for further information

  There is no new infrastructure proposed.

TABLE: Observations required by the Nodes in relation to this Facility

Facility	**Observations required by the Node**			
	NCRIS Funded (already allocated to Jun11)	EIF first $8M funded (already allocated to Jun10)	Extension of existing facility infrastructure out to 2013.	Enhancements of existing Facilities / new infrastructure required 2010-2013
	(see Appendix 1 of the Guidelines)			
Bluewater & Climate				
WAIMOS				
GBROOS	Observations of temperature and other parameters at a number of reefs along the Great Barrier Reef	Nil	Continuation of the existing systems including servicing and maintaining the deployed equipment.	Nil
NSW-IMOS				
SAIMOS				
Other <enter name>				