Submission

2016 National Research Infrastructure Roadmap Capability Issues Paper

General Comments:

We thank the Department and the Taskforce for the opportunity to comment on the National Research Infrastructure Roadmap. I write on behalf of the Sydney Institute of Marine Science (SIMS), a multi-university marine facility based in Mosman (Sydney), NSW. Commonwealth investments in research infrastructure over the past 10 years have been integral to the development of SIMS. This is both via our ongoing role as the operator of the NSW Node of Australia's Integrated Marine Observing System (IMOS), and as the recipient of an Education Investment Fund (EIF) grant in 2009 which contributed substantially towards the building of our Institute.

Before responding in more detail to the questions below, we make two general comments:

1) The marine science community in Australia is well integrated, and after extensive consultation with that community in 2015 we released our decadal plan for marine science, *the National Marine Science Plan 2015-2025 Driving the development of Australia's blue economy*. The Plan details the key research infrastructure needs for marine science into the next decade, which will support the research that underpins Australia's economic and societal needs. These include a national fleet of research vessels funded for full use, observing systems including *in situ* and remote monitoring capacity built around the current IMOS program, experimental systems such as research aquaria and research stations, and e-research infrastructure ranging from integrated modelling capacity to online integrated data access.

2) One aspect of the 2015-25 plan not featured in previous similar documents from the marine community is a more explicit mention of urban and coastal needs. Australia's population is one of the most heavily urbanised and coastally based populations in the world. Thus an increased focus on research infrastructure which supports science for coastal (and urban) Australia will have very substantial benefit to our economy and the broader community. Such infrastructure ranges from a better integration/enhancement of coastal vessels and coastal research stations, to novel molecular based technologies for (e.g.) the detection of human pathogens in coastal waters.

Question 1: Are there other capability areas that should be considered?

The capability areas are appropriately broad, but there is a danger that research infrastructure will be pigeonholed into particular areas. This would be unfortunate in an era in which science is increasingly multidisciplinary. For example, while characterisation of microbial communities in estuaries is fundamental to assessing the environmental health of those systems, it is also fundamental to human public health for identification of water borne pathogens. Similarly, in the context of data management and eResearch, it will be important (for example) to integrate with infrastructure initiatives by other organisations such as the digitisation of museum records by the ABRS.

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure?

Section 3.2 highlights the emerging theme of leadership. In this context it would be useful to more clearly identify whether particular models for organisational leadership and structure are associated with highly performing existing NCRIS facilities, and then implement those models.

Question 3: Should national research infrastructure investment assist with access to international facilities?

Yes, but in a targeted manner and as driven by the science needs. In some areas of science – marine, atmospheric – the issues are by their very nature international and indeed global, and coordination with international efforts is desirable. Assistance with access to international facilities is important if it adds value to data being collected by an infrastructure program in Australia, or when the resources at overseas facilities are beyond the scope available in Australia. However, assistance is often required to access overseas facilities that are funded by large international consortia. The leverage provided by Australian national facilities is often very helpful in this regard.

More specifically, in the context of Australia's marine environment, investment in ocean observing should be made in consultation and collaboration with international activities, such as the new Tropical Pacific Observing System (http://tpos2020.org), the Ocean Tracking Network (http://oceantrackingnetwork.org/), the Southern Ocean Observing System (http://www.soos.aq/) and the Global Ocean Observing System (http://www.ioc-goos.org). These activities are good fits for international collaboration in that they comprise large international consortia with existing contributions from Australian institutions, or they have the capacity to add significant value to data already collected by Australia's Integrated Marine Observing System (IMOS). Access to these international facilities is presently, and should remain, co-ordinated by IMOS.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

Where there are international facilities that Australia has access to and which serve our needs, and for which the cost of investing in an Australian specific facility is very high. An example would be the Ocean Drilling Project, for which building Australian specific vessels and infrastructure would be challenging.

Question 5: Should research workforce skills be considered a research infrastructure issue?

Yes. It is important that Australian science is funded in a way that allows research infrastructure to produce knowledge and products that address our National Research Priorities. Often, this will require funding for a research workforce and not just the infrastructure that they utilise. This investment in the research workforce is particularly important in the context of product development and the enhancement of data streams flowing from research infrastructure. For instance, assimilating the wealth of data collected by IMOS requires a dedicated team of highly skilled people to allow access to the data, and to build more accurate models of our oceans which are critical to our future management of climate impacts, fisheries, tourism, international trade and other key factors affecting Australia. It is however reasonable to expect institutions to co-invest in that workforce (Q6, 7).

Question 6: How can national research infrastructure assist in training and skills development?

It is sensible and desirable to provide national research infrastructure that will underpin research training, and failure to match training and skills to our national research infrastructure would threaten Australia's ability to compete in rapidly developing technologies, leaving our research infrastructure redundant. Given these threats, it will be important to identify and fill training gaps for skills that are required to fully utilise infrastructure capabilities.

In some cases (see Q5) it will be appropriate for investment in training and skills to be made directly through investment in infrastructure. However, the bulk of training and skills development is still likely – and appropriately - to be made v*ia* other mechanisms such as postgraduate training at universities. Here the central challenge is to align processes for training & education and infrastructure investment. Possibilities for encouraging alignment include:

• formal engagement between the Taskforce and other sections of the Department or Government to specifically focus on this issue;

• making training resources (eg. postgraduate scholarships) available that are tied to infrastructure investments;

• support for training courses for use of the infrastructure, and;

• programs such as the Super Science Fellowships that are specifically designed to align national research infrastructure, use of the infrastructure and training.

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

Research institutions remain the most suitable places to train infrastructure-ready researchers and technical specialists, and the contribution of students and researchers to the use of national infrastructure represents a very substantial co-investment in that infrastructure. The longer term time horizons for research infrastructure investment now also means that this co-investment can be planned for in a sensible way, and provides a much more predictable pathway for employment.

As per our response to Q6, the challenge is to align infrastructure and educational/training processes, and where possible to incentivize training providers to use the infrastructure. A specific challenge here is the time course of infrastructure investment vs. research training programs. Time lags for significant shifts in direction for the later can be substantial. There thus are shortfalls in the integration of training between universities and custodians of the national research infrastructure, and addressing this will require national coordination and arguably a formal integrating process at the Commonwealth level.

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

National research infrastructure should be operated wherever possible on an open access basis for the benefit of the entire Australian community, subject to appropriate governance structures established by that facility. The data generated should be freely available, and there should be investment in tools which allow access by the general community to that data.

Exceptions to these general principles include:

• Where there are issues of national security, and;

• Where assets are owned and have been funded outside of Commonwealth funding but brought into an infrastructure facility as part of an integrating process. For example, a national coastal vessel fleet will include vessels which are owned by non-Commonwealth entities. It is reasonable for the owners to maintain some level of control over the use of the vessels.

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

Two key criteria are 1) the success of the facility/infrastructure based on defined metrics, and 2) life cycle analyses of the cost/benefits of the infrastructure investment and its decommisioning.

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

The general model of co-investment of people, assets or cash under which many NCRIS facilities operate has risks, because of the inevitable fluctuations in the level of co-investment. However, in our view this remains the most appropriate model. Other options, in which for example commercial entities co-invest, are possible in some instances but in general are difficult to reconcile with the broad mandate for free access to data. We also note that not all research infrastructures will initially attract substantial co-investment, even though they may directly speak to Australia's National Research Priorities and make long term contributions to national productivity.

Question 11: When should capabilities be expected to address standard and accreditation requirements?

We view this as a relatively organic process that varies according to different areas or disciplines. In some capability areas adherence to standards and accreditation are essential for the uptake of products and services, or to meet international treaty and domestic regulatory requirements. However, other capabilities do not typically operate in areas that have widely recognised standards and accreditation requirements. In these cases, internal quality assurance processes and benchmarking against defined national and international performance criteria will be important, and their adequacy a reasonable criteria for assessing the performance of the facility.

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

In the marine area, the Integrated Marine Observing System (IMOS), a current NCRIS facility, is widely recognised as an effective model for the development of national research infrastructure. IMOS has become one of the global leaders in assessment of the marine environment, and it now works closely with its national (IOOS, www.ioos.org & OTN, http://oceantrackingnetwork.org/) or global (GOOS) counterparts. An important lesson from IMOS' US counterpart is that infrastructure is defined to include non-physical assets such as models and data. That is, the model itself is considered research infrastructure, rather than just the equipment used to run the model (supercomputing) or take measurements. As recognised in the Paper, the massive databases derived from our rapidly emerging capacity to capture, store and model data, are as much critical

national infrastructure as physical assets. These databases include biological (eg. gene sequences) as well as physical parameters.

Question 13: In considering whole of life investment including decommissioning or defunding for national research infrastructure are there examples domestic or international that should be examined?

Question 14: Are there alternative financing options, including international models that the Government could consider to support investment in national research infrastructure?

Health and Medical Sciences

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

Integrating environmental data with public health data is critical, as is a coordinated approach to facilities for molecular analysis (gene sequencing and related tools) across environmental and biomedical science. Also see response to Q20.

Question 16: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 17: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Health and Medical Sciences capability area?

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

The issues paper captures a number of the key needs for marine research infrastructure. This includes sustaining and expanding the Integrated Marine Observing System to support critical climate change and coastal systems research, including coverage of key estuarine systems, and funding national research vessels (e.g., the Marine National Facility) for full use.

Integration and enhancement of various existing systems is mentioned in the Paper, and this should be an important focus for the Roadmapping process. In marine systems, both coastal research vessels and coastal research facilities represent very substantial investments in sea going or land-based infrastructure. They are well placed to address the strong need to focus more strongly on coastal systems. Integration, harmonisation and targeted enhancement of these facilities would substantially increase the contribution of research infrastructure nationally to our coasts.

Similarly, a National Ocean Modelling System, recognized as infrastructure, would supply defence, industry and government with accurate, detailed knowledge and predictions of ocean state. Emerging directions in this space include an emphasis on downscaling climate forecasts for the coastal region. The Roadmapping process also needs to integrate as appropriate with efforts by museums and related institutions to continue to document and digitize the biodiversity of ecosystems and how they are changing with increasing urbanisation, climate change, invasive species.

Beyond integration, strategic investment in the continuing revolution in technology for molecular

monitoring ('omics, etc.) of ecosystems should be a priority. These technologies are rapidly advancing in the environmental arena as well as in biomedical science. Here the key challenge is not just integration across facilities, but to move to *in situ* molecular tools, prototypes of which are now emerging. These approaches also span different capability areas, merging environmental needs with health and broader community issues.

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

IMOS in particular is well integrated into other international ocean observing or related programs, such as the Global Ocean Observing System (GOOS) or the Ocean Tracking Network (OTN). International collaborations specifically in the coastal and urban areas are less well developed, but are likely to emerge strongly in the coming years. Participation in such programs should be anticipated by the Roadmap.

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

While recognising the need for categorisation, there is a danger that by focusing strongly on infrastructure needs within each capability area - in this case the Environmental area – we will artificially segregate research infrastructure. For example, estuarine and urban water quality is very relevant to other capability areas in this paper. Environmentally distributed and dispersed pathogens are fundamental to public health (Health and Medical Science Area) and planning around waterways, including management of terrestrial runoff, is critical for Understanding Cultures and Communities. Formally considering needs across capability areas will increase the efficiency and use of our research infrastructure.

Integration across capability areas does emerge in some areas in the Paper, such as the emerging trend of eResearch for improved linkage of environmental and societal data in the Cultures and Communities section, but in our view is not considered sufficiently in the Paper.

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Understanding Cultures and Communities

Question 24: Are the identified emerging directions and research infrastructure capabilities for Understanding Cultures and Communities right? Are there any missing or additional needed?

Management of the environment has moved very strongly to "triple bottom line" approaches, integrating environmental, societal and economic issues. Thus (for example), infrastructure to

monitor human use patterns needs to be integrated with environmental monitoring. Please also see response to Q20.

Question 25: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 26: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Understanding Cultures and Communities capability area?

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

Question 28: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 29: Is there anything else that needs to be included or considered in the 2016 Roadmap for the National Security capability area?

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

Question 31: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 32: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Underpinning Research Infrastructure capability area?

Data for Research and Discoverability

Question 33 Are the identified emerging directions and research infrastructure capabilities for Data for Research and Discoverability right? Are there any missing or additional needed?

Question 34: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 35: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Data for Research and Discoverability capability area?

Other comments

If you believe that there are issues not addressed in this Issues Paper or the associated questions, please provide your comments under this heading noting the overall 20 page limit of submissions.