Submission
2016 National Research Infrastructure Roadmap Capability Issues Paper

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Questions

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

Griffith University is mindful that the purpose of this Issues Paper to ensure that the proposed capability areas are the right ones. This will entail consolidation of successful existing infrastructures to build on what we already do well (e.g. ANFF and AURIN), a re-focus where existing ones have fallen short, and potential expansion where others have become more prominent as a national priority – this will inhibit the scope for a grab bag of new capabilities.

With this in mind Griffith registers its commitment to the following emerging directions:

- National health and medical big data capability covering infectious diseases, bioinformatics, glycomics and indigenous research;
- Advanced manufacturing in micro/nanoscale for biomedical applications
- Climate and water resources (notably water security and sediment management);
- Precision measurement (quantum enabled technologies and atom trapping);
- Chemistry and high throughput processes;
- Digital humanities;
- Social and behavioural science innovation;
- National research data (including eResearch) infrastructure.

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

The optimal governance model as set down in the Issues Paper is entirely appropriate and based on a decade of experience – after all, the NCRIS roadmap model has been adopted by nations across the EU. In addition, Griffith University suggests that the assessment of benefits and outcomes should rest more on research outcomes, including the development of innovative capacity, and less on nation-building as the driver. Governance structures should ensure that user representation is achieved from a broad range of researchers as possible to meet the skills needs of academic and industry.

In addition, Australia has learned valuable lessons about the economics of research infrastructure which should allow the development of realistic business and cost recovery plans based on experience rather than courageous projections.

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

Yes.

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

Like other industries and sectors, the higher education and research communities need to face economic reality that major facilities have become increasingly unattainable for a nation of our size. Development of research infrastructure in Australia will not provide the most cost-effective solution in all cases, nor will it lead to the most productive research collaborations. Where research excellence, international collaboration and cost-effectiveness are key drivers then consideration should be given to Australian membership of, or in rare circumstances contributing towards construction of overseas facilities. Programs should also provide allowances for Australian researchers to submit requests for access to overseas facilities.

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

On the basis that research infrastructure comprises the assets, facilities and services then the answer is an emphatic 'yes'. The university sector has in recent years emphasised the need to embrace research workforce skills as a research infrastructure investment principle. This includes: 1) technical support to maintain and manage the facilities; and 2) training for researchers to make the most of the facilities. Broadening of the user groups, especially to support more PhD candidates, postdoctoral researchers and early career academics is essential as part of this next phase in the evolution of NCRIS.

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

Training and capability/capacity development are integral to any strategy in relation to infrastructure investment, and this should be reflected in the activities and performance evaluation of national research infrastructure facilities. For example, infrastructure facilities could be required to develop a national training stream of activity as part of the agreement and on-going contractual arrangements associated with the investment in the creation and maintenance of particular facilities.

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

Universities have a major role to play in this as the channel through which early-career researchers acquire the basic tools-of-the trade that will equip them to access national infrastructure facilities.

There is a skills gap at the interface of undergraduate and doctoral studies with many undergraduates insufficiently equipped with analytic skills spanning statistics and/or maths, infographics and communications, scientific/grant writing, ICT (esp. human-computer interfaces, databases, prototyping) - all skills that underpin the application of leading edge research infrastructure, and which at the same time are of great interest to innovative employers. The need to address this research skills gap for HDR students is widely recognised within the University sector, and, as amply reflected in the responses to the ACOLA review, there are many excellent developments in train across the sector to address these capability needs.

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

Griffith University supports retention of the broad principle that national research infrastructure should be widely accessible (including proactive dissemination of infrastructure locations, availability and cost) to publicly funded and other end-use researchers. The guiding principles to achievement of this include ensuring optimum use for the public benefit, support for local and international collaboration, and opportunities for research trainees and early career researchers (and inhibitors such as travel costs) – all of this based on transparent pricing policies that ensure high quality research is not priced out of the market.

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

Nil response

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

Existing models of co-funding across national/state agencies would seem to lead to funding models with a complexity that does not necessarily add value or ensure value for money for the tax-payer. It would seem advisable to adopt a model that 'national' infrastructure is best funded at national/commonwealth level. As a model from overseas from which to learn, it could be that the UK's Science & Technology Facilities Council is worth a close inspection - http://www.stfc.ac.uk

Is philanthropy the answer? Probably not for infrastructure of this scale; the majority of the philanthropy dollar tends to be directed to scholarships. Similarly it is doubtful that the private sector could be persuaded to invest in large research infrastructure given the likely rate of return. According to various sources, not a single synchrotron in the world is industry funded although there are industry funded beam lines. Even the Large Hadron Collider draws 94 per cent of its income from the public purse.

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

Nil response

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

The scan of recent strategies by Griffith suggests the Finnish Strategy and Roadmap is probably leading edge. For a nation of 5.3 million people, the Finnish government has allocated approximately 260 million euros per annum (AUD $370 million) in 2014-2018 for the NCRIS equivalent. The funding is not necessarily tied to one government ministry and attempts to present all research infrastructure funding opportunities available within Finland, the European community and internationally. It systematically assesses the current infrastructure across "Finland's Research Infrastructure Ecosystem" and then maps this by discipline.

The Finnish strategy started from the ground up by first identifying 344 research infrastructures denoted as significant within 14 universities, 15 government research institutes, 17 polytechnics and the National Archives. These continue to be funded by the regular means such as host institutions and ministries. The next step involved evaluations of proposals for 31 projects selected for the roadmap identified as international-level "research infrastructures that support the attainment of Finland's research and innovation policy goals".

The potential each of these 31 projects to become involved in European research infrastructure projects was then mapped and followed by an assessment of international opportunities beyond Europe to access infrastructures which Finland has joined through State agreements. This holistic and strategic view of infrastructure investment in Finland provides research managers at all levels with a straightforward understanding of the available infrastructure and its place in the Finnish research system.

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?

Nil response

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?

Griffith University strongly endorses **'Big Health Data'** as the emerging direction capable of providing significant national benefit once properly linked. One example is the **My Health Record** data which should provide substantial de-identified information – approximately 98% of Australians are expected to have a My Health Record by the end of 2017. To make use of these data will require robust interfaces and systems for extracting data for linking to individuals and registries for analysis.

The University also supports existing infrastructure with the following additions:

- Expansion of Bioplatforms Australia to include Glycomics as a national resource; The Institute for Glycomics at Griffith University is unique in the Southern Hemisphere and one of only a few Institutes world-wide focusing on "omics" approaches to the study of carbohydrates in biological systems. The Institute has significant glycomics capacity that is currently being harnessed by academic and commercial, national and international

collaborators. The Institute and Griffith University are ideally placed to provide new capacity in glycomics as a partner with Bioplatforms Australia, or as a separate entity.

- Drug discovery within Australia is rapidly maturing, with an increasing number of academic groups establishing diverse screening capabilities to facilitate the discovery of new therapeutics for a wide variety of diseases. While research activity and biological technological expertise has proliferated, there is only one facility providing the essential industry standard compound management to drive and support small molecule drug discovery nationwide – **Compounds Australia**. The recognition of Compounds Australia as Australia's only integrated compound management facility to drive and support small molecule drug discovery Australia-wide is critical. Expansion of Compounds Australia – potentially as a node of Therapeutics Innovation Australia – is timely to enable Australian drug discovery to keep pace with global developments and to remain internationally competitive. More Australian health and medical researchers will be positively impacted by the acceleration, optimisation and collaboration afforded by Compounds Australia.
- Expansion of ANFF micro/nanomachining facility at Griffith to support health and medical sciences, in area such as organ-on-a-chip for high throughput drug screening, 3D tissue printing and lab-on-a-chip for quick disease detection.

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

Yes.

There is global interest in the use and integration of electronic clinical registries, not only enabling access for clinical trial units for common diseases but also saving duplication of effort in updating contact details. The development of a list of registries by the NIH in USA that is easily accessible appears as a good starting point for compilation and integration of registries not only of diseases and conditions but also of interventions (new devices, procedures, pharmaceuticals etc.).

National and regional registries for rare diseases are also emerging and Australia needs to develop a nation-wide initiative. The project 'Rare Disease Registry Framework' (RDRF) developed at the Centre for Comparative Genomics, Murdoch University, in partnership with the Dept. of Health WA, is an example of potential development of nation-wide implementation of web-based patient registries following models from programs run by the National Center for Advancing Translational Sciences USA. Another model worth exploring is the European Union one (see RD-CONNECT). These are integrated platforms connecting databases, registries, biobanks and clinical bioinformatics for rare disease research.

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?

Griffith believes that the need for infrastructure to support **translational bioinformatics** could be better articulated under the emerging direction of Big Health Data and structured within the current and emerging capabilities 'Biobanking and Population Genomics' and 'National health and medical data capabilities'. Opportunities for linking knowledge across biological and clinical realms have been rapidly increasing. On the biological side molecular advances result in the availability of large datasets of human genomes combined with clinical, phenotype and environmental information; on the clinical side this is a new era of data acquisition and decision support driven by electronic health records and flowing exchange of information. Countries around the world are proposing strategies and redirecting funding to cover the need for translational bioinformatics (see NHGRI, Parelsnoer Institute, proposed framework for an EU action plan, Genome Med, June 2016).

Australia needs to actively address the opportunities and challenges for working with 'large data sets' (lots of similar data) and using 'big data' (where associations can be made between previously unrelated observations); this is from the technical and systems complexity perspective but also the legal, regulatory and ethical aspects.

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?

Griffith agrees with the identified directions and infrastructure in particular the data integration and the expansion of modelling capabilities nationally and globally. Griffith as leader in water research agrees with the need to target water sustainability and the management and conservation of aquatic systems as top priorities under desired new capabilities. It is clear that Australia requires continuing collection of environmental data, including satellite based and large scale observations as well as localised, in situ observational data especially in regions of development and areas of high ecological importance or highly susceptible to climatic events.

The conservation and management of the Great Barrier Reef (GBR) is a national priority, and as such, it is Griffith's view that concerted efforts to collect, analyse and integrate research data across different domains are to be supported by a national infrastructure system. The Terrestrial Ecosystem Research Network (TERN) as a current capability of NCRIS offers the ideal opportunity to enhance integration of freshwater, land and coastal ecosystems information with particular focus to the management of the GBR. A redirection of TERN to question-based approaches with expanded capabilities for integration of marine and terrestrial data from all domains (geomorphological, soils, water quality and biological) and compatible temporal and spatial scales is in agreement with the expansion proposed in the TERN Strategic framework 2016-2025.

Griffith's Australian Rivers Institute which includes research expertise in all the relevant domains and has long standing partnerships with key stakeholders in Queensland is in an ideal position to contribute with the reshaping of TERN towards the delivery of knowledge to science and policy for the conservation and management of the GBR. In fact, the Queensland government, supports the need for better integration of terrestrial and marine data as an opportunity to maximise the value of all environmental monitoring and modelling frameworks for decision making and environmental risks assessments.

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

The National Ecological Observatory Network (NEON) in the USA is the first life science project to be constructed solely with National Science Foundation (NSF) Major Research Equipment and Facilities Construction (MREFC) funding. NEON is currently in the construction phase, in which it will build out all 81 field sites as well as the information infrastructure needed to gather data and metadata from sensors and field sampling, ensure data quality, process the information into data products, and deliver those products to users via an online portal. NEON is scheduled to enter full operations in 2018. This is a major infrastructure initiative that Australia could learn from and engage with.

There are global initiatives Australia needs to be aware of and take advantage of infrastructure data and expertise given the existing international infrastructures and capabilities in fields such as deep sea and polar explorations. Multi-national expeditions and research consortia allow cost sharing and exchange of expertise, and multiply outcomes and impact of the research while

benefiting the training of young researchers. Examples of global initiatives are the Global Ocean Observing System (GOOS) and its nascent component, the Deep Ocean Observing Strategy (DOOS).

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?

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?

In addition to its strong endorsement of the ANFF, Griffith supports the identified Emerging Directions of:

- Chemistry and high throughput processes; and
- Precision Measurement

Chemistry and high throughput processes

The provision of swift and reliable access to high quality compounds in reproducible assay-ready formats is essential to facilitate therapeutic drug discovery and translational research in Australia. The national compound collection maintained by Compounds Australia comprises >670,000 samples, including >55,000 academic compounds and >50,000 natural product fractions that are not available in commercial collections and are unique to Compounds Australia. The academic compounds are made openly available to research members, offering the bioscience research community a unique compound set, with enormous scope for novel discoveries. Compounds Australia has a well-established, comprehensive and growing network base, including Medical Research Institutes, not-for-profit entities, international and national companies and Universities. This network has grown 5-fold in the period 2008 to 2016 and Compounds Australia has reached a critical point. The growing client base, leading to increasing demand and greater complexity of requests, requires a bold expansion of capacity and capability. Expansion is timely to enable Australian researchers to keep pace with global developments in small molecule drug discovery and to remain internationally competitive.

It is imperative that the curation of the national compound collection is supported by state-of-the-art infrastructure. This will enhance access to compounds, provide confidence in compound integrity and ensure reproducibility of research data in the nation's drug discovery and development projects. An integrated **Compound Management and Drug Discovery facility** does not exist in Australia, but would further reduce equipment and personnel duplication, while facilitating a seamless workflow from compound storage through to biological profiling. Specifically, the co-location of compound management with high throughput screening/high content imaging would have enormous impact on drug discovery, unlocking the value in the nation's compound collections.

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Precision measurement

The Centre for Quantum Dynamics at Griffith University has acquired a single-photon detector from the National Institute of Standards and Technology (NIST) in Boulder, Colorado. Detecting individual photons with near perfect reliability is formidably difficult. Attaining 100% consistency remains the greatest challenge but once achieved, it opens up the possibility of use in quantum information science and data encryption and the creation of unbreakable codes. The two-way benefit is that Australia cannot currently 'build' a detector while NIST is seeking partners, like Griffith, to explore the potential of this device. For the cost of a mid-scale infrastructure grant, Australian researchers are using very expensive equipment right in our own laboratories. What NIST asks for in return is acknowledgement on publications and information sharing about how we configured and operated the device.

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

Compounds Australia already has linkages with several international organisations including EU-OPENSCREEN. There is potential to provide reciprocal access to expansive novel compound collections BETWEEN Australia and Europe. The expansion of capacity and capability afforded by an integrated *Compound Management and Drug Discovery* facility will enable further broadening and deepening of Compounds Australia national and international networks.

Refer response to previous question relating to partnering with the National Institute of Standards and Technology, USA. NIST utilises the science of measurement for applications across a diverse range of scientific fields including bioscience and health, electronics and telecommunications, cybersecurity, energy, environment and climate, materials science, nanotechnology and quality.

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?

Linking up existing infrastructures across disciplines (for instance ANFF and Compound Australia) to develop next-generation high-throughput screening technologies. Considering the amount of compounds available, suitable micro technologies should be developed to enable high-throughput screening and interfacing with existing robotic systems.

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?

Yes, although the reference to Trove unfortunately skirts around what has become a very pressing national infrastructure issue. If ever there was a piece of infrastructure that served a wide array of disciplines in the HASS sector and beyond (e.g. a wide range of sciences involving Australian data) it is Trove. But this world-leading infrastructure has been funded internally by the National Library of Australia (NLA), and continual budget cuts have brought to a halt many of the innovations tied to Trove. A priority of the Roadmap should be to expedite a solution to this problem in order to ensure that Trove thrives as a critical resource in the 'understanding cultures and communities' space.

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

None specifically that we are aware of, although we see considerable value in Australia taking the lead in promoting an Asia-Pacific framework/approach that enables regional international collaborations to those that sign up to it, similar to how the EU funds European infrastructure collaborations.

There is a particular concern about the constrained LOTE capability within the Australian research community and as a consequence its ability to access datasets, materials and knowledge in languages other than English, something which is widely believed to be a significant gap in national capability more generally – see for example, http://dassh.edu.au/resources/uploads/publications/submissions/DASSH_Asian_Century_Submission_2012.3_.2_.pdf

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?

It is important to highlight data storage and access issues – slow broadband is now widely discussed as a major problem for Australia in all sorts of areas. The Roadmap could very importantly highlight the significant IT requirements of HASS disciplines – their computing requirements can be very data hungry; and access and communication issues will continue to hamper research collaboration where they cannot benefit from the best possible internet infrastructure. This also leads into a need to emphasise the sustainability of AARNET and related computing infrastructure (e.g. QCIF locally).

With much of the discussion in the document being about big data, security, and commercial exploitation of data, there is very little on what will be the legal, ethical, IP issues that arise from these, or about the challenges for researchers in resourcing pre-existing datasets from across the range of publicly funded organisations. It is critical that there is investment in training people on how to address these issues.

National Security

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

Nil response

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

Nil response

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

Nil response

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?

To build more robust, seamless and trusted infrastructure, additional focus needs to be placed on the following areas to increase interoperability between institutions, facilities and applications (national and international):

- Network Integration and Management
- Information Security Management
- Identity Management
- Application Integration

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

Nil reponse

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

Technical and data science skills

The development and maintenance of underlying infrastructure is only valuable if the people who manage it have the requisite skills and capability to use the latest technologies, methods and techniques, collaborating nationally and internationally. This will be necessary to maximise capabilities to stay at the forefront of new technology innovation while utilising commodity services like Amazon Web Services. Both the Australian government and research institutions need to actively invest in addressing skills shortage in advanced technical and data science skills at a national level.

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?

The current national research infrastructure governance model has not delivered coherent approaches to the long-term development of nationally significant research data standards, processes, tools and assets. Discipline-specific and project-based approaches to funding elements of the research data infrastructure, coupled with separately governed national agencies managing elements of the infrastructure, have allowed a focused development but at the expense of maximising the value of the research outputs that are created.

Griffith University strongly endorses support for National data platforms (e.g. health bioinformatics, resilient cities and regions, environmental, social resilience) **with a shift in direction from a project base (previous ANDS approach) to large scale national platforms.**

Griffith supports the proposed characteristics for a new governance model (section 3.2); the commitment to establishing a more integrated, coherent and reliable platform to deal with data-intensive, cross-disciplinary and global collaborative research, and the focus on partnerships.

It will be important that such a governance group focuses on critical emerging issues such as:

- the establishment of **seamless integration** between articles, data, and researchers across the research lifecycle as part of the international research ecosystem, and
- the opportunities to put in place national policies, standards and processes to create **a national research information ecosystem** which leverages all potential research data assets across government, industry and research entities.

A major focus to date has been on data produced by research institutions (e.g. genomics, urban research). However, many of the complex problems (e.g. combating terrorism, climate change adaption, health services reform) require not only integrating diverse data but also obtaining data from other sources such as government agencies. There needs to be a national approach to work with the key organisations to facilitate access to data for research.

Immediate opportunities include use of research infrastructure as a platform for supporting data interchange and collaboration in analytics and the application of research to large national and regional planning and policy development. By integrating access to a broad range of environmental (e.g. climate change response), ecological (e.g. Great Barrier Reef), terrestrial, regional, urban, social and population data (e.g. resilient and innovative regions), significant advances in research, management and policy making and researcher benefits can be gained.

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

This more holistic, cross discipline approach to complex problems immediately offers benefits to international collaborators. For example, the existing national investment in repositories (e.g. Terra Nova), TERN and ALA facilities, and BCCVL (NeCTAR Virtual Laboratory) provides an exciting building block from which to start. This work would also be of immediate benefit to international activities focussing on similar problems (e.g. the DFAT $800m investment in climate change adaptation in the Pacific, i.e. the iCLIM Pacific Project).

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?

Specific recommendations:

<u>Standardisation</u>

1. Given that research data, in many cases, lies in trusted sources that are not managed by research institutions, such as federal, state and local government departments, state archives and the National Library of Australia (Trove), and each agency has its own standards, methods and governance, the following key national challenges to be addressed include:
    a. a lack of appropriate national policies, standards, or inconsistent implementation of policy (e.g. lack of agreed best practices to underpin policy on sharing of data);
    b. technical aspects (e.g. data movement, incompatible IT systems between institutions, thereby limiting interaction);
    c. data not being delivered to the end-user by methods, processes and interfaces that are fit-for-purpose (e.g. open APIs, visualisation and mapping tools), and
    d. lack of bidirectional movement of data to enrich the source data.

Reliability and support

2. If we are to build a trusted national research data platform, this implies it comprises more than just "trusted data". The platform must be reliable and supported, and the methods and processes used must be quality assured. Building trust in our data and platforms will require the adoption of international certification, accreditation and standards to identify trusted sources.

Seamless Access

3. Current methods of access underpinning infrastructure are not seamless across the whole research ecosystem. For example, there are still instances in which the researcher has to create separate accounts and, in some cases, more than one account in addition to their Australian Access Federation account. These barriers need to be removed to allow more seamless access and improve automated methods of accessing national platforms.

Data Management Skills

4. Research data infrastructure is only valuable if people have the skills and capability to use it well. To fully leverage the value data can provide, Australian government and research institutions need to actively invest in addressing skills shortage around data management at a national level.

Increasing Uptake

5. A national approach needs to be taken to increase the uptake and use of NCRIS-funded facilities, services and data. This applies to various communities across research, industry, higher and secondary education, broader community groups, and citizen scientists.