Australian Government
Geoscience Australia

Cnr Jerrabomberra Avenue
and Hindmarsh Drive,
Symonston ACT 2609

GPO Box 378,
Canberra ACT 2601
Australia

+61 2 6249 9111
www.ga.gov.au

ABN 80 091 799 039

Justice Rachel Pepper
Chair
Scientific Inquiry into Hydraulic Fracturing in the Northern Territory
GPO Box 4396
DARWIN NT 0821
Email: fracking.inquiry@nt.gov.au

Dear Justice Pepper

Geoscience Australia thanks the Independent Expert Scientific Panel for the opportunity to provide a submission to the *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*.

Geoscience Australia is an Australian Government entity within the Industry, Innovation and Science Portfolio, and is Australia's national geoscience agency. Geoscience Australia provides geoscientific advice and information to the Australian Government to support its priorities. The focus of our work at Geoscience Australia enables us to provide data and information on Northern Territory's energy and groundwater resources set in a national context. It is in this context that we provide the attached submission to support the work of the Inquiry.

The Department of Industry, Innovation and Science has recently made a submission to the Inquiry, and it provided introductory information on some of the work being undertaken by Geoscience Australia. This submission builds on their submission to provide detail of work being conducted and planned in the Northern Territory.

Geoscience Australia's Acting Chief Scientist, Ms Jane Coram, is a member of your scientific panel. Please note Geoscience Australia's submission has been prepared independently to Ms Coram's representation.

If you wish to obtain more information on Geoscience Australia's submission, please contact Mr Andrew Barrett, Branch Head, Resources Advice and Promotion, [redacted]
or [redacted]

We look forward to a successful outcome for your Inquiry.

Yours sincerely

Dr Andrew Heap
A/g Chief
Resources Division

16 June 2017

Australian Government
Geoscience Australia

Geoscience Australia submission to the

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

June 2017

1 Introduction

Geoscience Australia provides a broad range of scientific information and advice to assist governments, industry and the community with making decisions about the management of Australia's natural resources and the built environment both now and into the future. Geoscience Australia has expertise in geology, geophysics, geodesy, satellite imagery, groundwater, natural hazard analysis and impact assessment, and topographic mapping.

Geoscience Australia plays a lead role in maintaining Australia's competitive advantage in the global resources sector by:

- Acquiring pre-competitive data and developing new scientific concepts;
- Undertaking regional geological and geophysical studies to develop foundational understanding of energy, minerals and groundwater systems; and
- Capturing, storing, managing and delivering geoscientific data and information.

Geoscience Australia's submission addresses issues identified by the Inquiry's Terms of Reference and expands on components of the submission made by the Department of Industry, Innovation and Science.

If you wish to obtain more information on Geoscience Australia's submission, please contact Mr Andrew Barrett, Branch Head, Resources Advice and Promotion [redacted] or [redacted]

2 Geoscience Australia

Geoscience Australia is Australia's pre-eminent public sector geoscience organisation and the nation's trusted adviser on the geology and geography of Australia. We apply science and technology to describe and understand the Earth for the benefit of Australia.

Geoscience Australia is wholly government-funded and is an entity within the Department of Industry, Innovation and Science portfolio.

It delivers a wide range of products and services that address important and significant national issues to assist government and the community to make informed decisions about the use of natural resources, the management of the environment, and community safety.

Geoscience Australia contributes to Australian Government priorities through six strategic priorities:

- Building Australia's Resource Wealth—to maximise benefits from Australia's minerals and energy resources, now and into the future
- Ensuring Australia's Community Safety—so that Australian communities are more resilient to natural hazards
- Securing Australia's Water Resources—to optimise and sustain the use of Australia's water resources
- Managing Australia's Marine Jurisdictions—to maximise benefits from the sustainable use of Australia's marine jurisdiction
- Providing Fundamental Geographic Information—to understand the location and timing of processes, activities and changes across Australia to inform decision making for both natural and built environments
- Maintaining Geoscience Knowledge and Capability—to maintain an enduring and accessible knowledge base and capability to enable evidence-based policy and decision making by government, industry and the community.

Geoscience Australia works in partnership with a wide range of Australian and State/Northern Territory Government departments and entities to provide geoscience services and information to government, industry, research institutions and the wider public.

3 The Inquiry's Terms of Reference

Two of the Inquiry's Terms of Reference align directly with work currently undertaken within Geoscience Australia.

The **first Term of Reference** assesses "the scientific evidence to determine the nature and extent of the environmental impacts and risks, including the cumulative impacts and risks, associated with hydraulic fracturing of unconventional reservoirs and the Associated Activities in the Northern Territory".

In the May 2017 Budget, the Federal Government announced a new Geological and Bioregional Assessment Programme to support world class independent scientific analysis of the potential impacts of tight and shale gas extraction on waterways and aquifers. These assessments will commence in 2017-18.

The Bioregional Assessment Programme is being managed by the Department of the Environment and Energy and Geoscience Australia has been a significant contributor to the programme. The programme was established to provide transparent scientific information to better understand the potential impacts of tight and shale gas extraction on water resources and water-dependent assets such as wetlands and groundwater bores. The assessments will provide a baseline level of information on the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts on water resources. This information can be used by government to inform decision making on the potential water-related impacts based on best available science and independent expert knowledge.

The **second Term of Reference** seeks advice on "the nature of any knowledge gaps and additional work or research that is required to make the determination in Item 1, including a program for how such work or research should be prioritised and implemented, that includes (but is not limited to):

a. baseline surface water and groundwater studies,

b. baseline fugitive emissions data,

c. geological and fault line mapping, and

d. focus areas for baseline health impact assessment"

For surface water information, Geoscience Australia is the custodian for two national products:

1. drainage and catchment datasets, and hydrologically enforced elevation models which show the location and extent of Australia's river systems, and where water flows across the landscape; and

2. *Water Observations from Space* (WOfS), which depicts observed surface water across the Australian continent using satellite imagery from the Digital Earth Australia (DEA)[1] platform. The composite product depicts observed surface water for the entire time period, 1987 to present[2], thereby providing a baseline of information and insights about the changing Australian landscape and coastline through time.

[1] http://www.ga.gov.au/about/projects/geographic/digital-earth-australia
[2] http://www.ga.gov.au/interactive-maps/#/theme/earthobservation/map/wofs

National-scale groundwater and energy studies are discussed in more detail in Section 5: Pre-competitive programs.

In addition, Geoscience Australia understands the importance of baseline environmental data. Geoscience Australia was involved in a four year project with CSIRO measuring atmospheric concentrations of carbon dioxide and methane in central Queensland in an area considered potentially suitable for the geological storage of carbon dioxide at the time[3]. The impact of the project was a clear understanding of the atmospheric variability of carbon dioxide and methane atmospheric concentrations, and what modelling could achieve in identifying variations from background due to anthropogenic influence. This project touched on fugitive methane emissions as an adjunct to the carbon dioxide work. The monitoring station has now been incorporated into the Gas Industry Social and Environmental Research Alliance (GISERA) in southeast Queensland. Geoscience Australia has no involvement in GISERA.

A report on the Great Artesian Basin[4] released by Geoscience Australia in 2015 is another demonstration of data and information providing baseline knowledge Australia's most significant groundwater system. This publication provides a snapshot on the current status of the water resources and geological processes in the basin and provides a basis for assessing and monitoring changes due to water usage and natural variation.

The Department of Industry, Innovation and Science's submission to the Inquiry discusses the COAG Energy Council's Gas Supply Strategy (section 3.1). "Improving information on gas reserves and production potential" is an important change required to provide more transparency and certainty to all stakeholders on the activities of both industry and regulators. To assist this, for the last four years Geoscience Australia has compiled a report[5] on behalf of the Upstream Petroleum Resources Working Group (a working group of the COAG Energy Council) on the status of unconventional gas reserves, resources, production and drilling rates[6]. This report uses data provided by all jurisdictions and provides a valuable national overview total reserves and resource base.

The 2016 report highlights that Northern Territory did not report any reserves or contingent resources, but did demonstrate a best estimate of 275 211 PJ of unconventional prospective resources (shale and basin-centred gas). Prospective resources are not discovered resources: they are estimates of what could be present. Exploration for these resources is at a very early stage and more geological information will change this volume. Exploration companies will assess geological and commercial risks to eventually define a potentially much smaller recoverable volume with a greater chance of recovery.

Sedimentary basins cover about 75% of the Northern Territory, but many of these are not prospective for gas resources. The prospective Beetaloo Basin only covers 2% of the Northern

[3] https://d28rz98at9flks.cloudfront.net/73714/Rec2012_054.pdf

[4] https://d28rz98at9flks.cloudfront.net/79790/79790_GAB_Atlas.pdf

[5] http://www.coagenergycouncil.gov.au/publications/report-coag-energy-council-unconventional-reserves-resources-production-forecasts-and

[6] The terms **reserves**, **contingent resources**, and **prospective resources** are defined by the Society of Petroleum Engineer's Petroleum Resources Management System.
"Reserves represent that part of resources which are commercially recoverable and have been justified for development, while contingent and prospective resources are less certain because some significant commercial or technical hurdle must be overcome prior to there being confidence in the eventual production of the volumes."
"**Contingent resources** are less certain than reserves. These are resources that are potentially recoverable but not yet considered mature enough for commercial development due to technological or business hurdles."
"**Prospective resources** are estimated volumes associated with undiscovered accumulations. These represent quantities of petroleum which are estimated, as of a given date, to be potentially recoverable from oil and gas deposits identified on the basis of indirect evidence but which have not yet been drilled."
http://www.spe.org/industry/docs/PRMS_guide_non_tech.pdf

Territory's landmass while the Amadeus Basin covers 10%. Even within these basins potential hydraulic fracturing operations will potentially only cover a fraction of this.

4 Australia's energy resources

Australia is rich in accessible energy resources. Australia is at or near the top of world rankings for coal (black and brown), uranium and gas, but has only limited domestic oil currently identified.

The resources information is updated on an annual basis by Geoscience Australia with the coal and uranium information available through the *Australia's Identified Mineral Resources*[7] publication and oil and gas information available through the *Australian Energy Resources Assessment*[8].

Australia has substantial gas resources and ranks 13th in the world for gas reserves.

Most of the conventional gas resources (around 95 per cent) are located in the Carnarvon, Browse and Bonaparte basins off the north-west coast of Australia, and the Gippsland Basin off the south-east coast (Figure 1). These resources have been progressively developed for domestic use and liquefied natural gas (LNG) export.

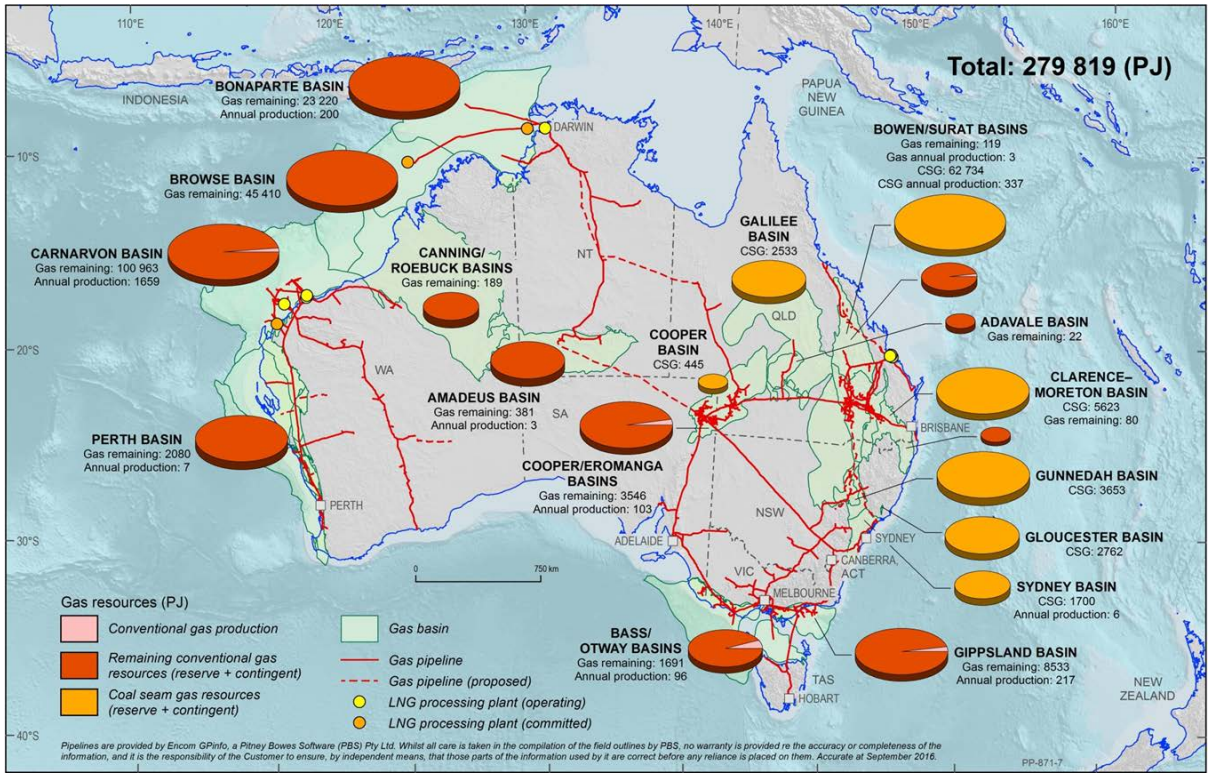

Figure 1: Australia's identified gas resources

Coal seam gas (CSG) is expected to remain the most important resource of the unconventional gas industry for the foreseeable future. It is already a significant source of domestic gas and liquefied natural gas (LNG) exports in eastern Australia. Australia's identified CSG reserves have grown substantially in recent years. In 2014, the CSG reserves in Australia were 45 520 PJ (43 tcf) and accounted for about 38 per cent of the total gas reserves. More than 93 per cent of the reported CSG reserves are in Queensland; the remainder are in New South Wales. In addition to reserves, Australia has substantial contingent resources (33 920 PJ; 32 tcf) of CSG.

[7] http://www.ga.gov.au/scientific-topics/minerals/mineral-resources/aimr
[8] www.ga.gov.au/aera

No reserves have been reported from deep coal gas exploration, although Tri-Star (http://www.tri-starpetroleum.com.au/) has reported on exploration for coal in the Pedirka Basin in southeastern Northern Territory:

> *Exploration to date indicates the presence of several coal seams in an area 70 kilometres by 30 kilometres wide, with thick sections of coal at depths of approximately 200 metres.*
>
> *Further investigation is warranted and may eventually lead to significant thermal coal mining operations in the future, comparable to projects proposed for Queensland's Galilee Basin.*[9]

Currently, production of CSG is mostly from the Bowen and Surat basins in Queensland, with some production from the Sydney Basin in New South Wales. CSG production in Queensland has increased dramatically during the past 17 years; from 4 PJ in 1998-99 to 979 PJ in 2015-16[10].

Further opportunities for large conventional and unconventional gas discoveries remain across Australia, with the development of new technologies and play concepts, and the advance of exploration into proven basins and frontier areas, including the Northern Territory. Figure 2 summarises Australia's prospective gas resources.

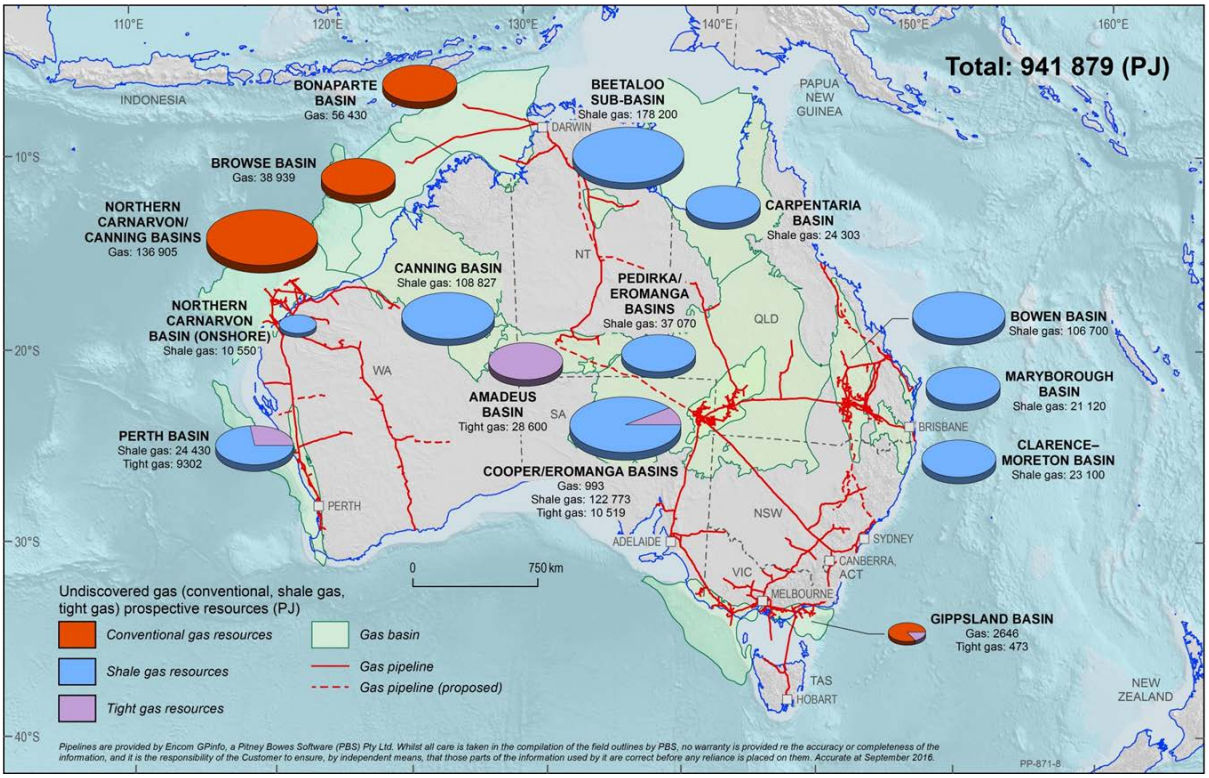

Figure 2: Summary of Australia's prospective gas resources

Geoscience Australia has assessed the potential for unconventional gas and oil in the onshore Gippsland, Otway, Perth, Cooper and Canning basins. This is a desktop assessment, using only publicly available data and a probabilistic assessment methodology designed to capture the uncertainty in the input parameters.

[9] http://www.tri-starpetroleum.com.au/index.php/about-coal

[10] https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0008/1237742/qld-petroleum-coal-seam-gas-2017.pdf

Not all of the gas is extractable, and an estimate of 5 per cent recovery from the in-place volumes was made. This recognises two factors. Firstly, with few exceptions, there is no experience of how productive these reservoirs will be in Australia. Secondly, in the medium term (10-15 years), only a small amount of the gas-in-place could be extracted because of the very early stage of exploration, the time needed to better define resources prior to production, and the limited existing infrastructure (for example, roads, pipelines and towns). The assessments indicate large volumes of gas-in-place, but with a high degree of uncertainty.

The preliminary results from the assessments indicate the potential for a total of 416 tcf (457 600 PJ) of recoverable shale gas resources with associated liquids of 48.5 billion barrels, and a total of 120 tcf (132 000 PJ) of recoverable tight gas resources with associated liquids of 24.9 billion barrels across the five basins.

Geoscience Australia has yet to undertake resource assessments of basins in the Northern Territory. However, Origin Energy's drilling program in the Beetaloo Basin has highlighted the potential of the basin with the company declaring a contingent resource of 6.6 tcf in its media release of 15 February 2017[11].

It is important to note that the discovery of potentially commercial hydrocarbon resources does not lead to immediate production, apart from in basins that have a highly developed infrastructure already in place in areas such as the Cooper and Eromanga basins.

In areas of little or no infrastructure it can take many years to see first production. As an example, although offshore, the Blacktip gas field that feeds into the Northern Territory domestic gas market, took eight years from discovery (2001) to first gas production (2009). Onshore discoveries can likewise take many years to develop. In an area with very limited infrastructure, Buru Energy discovered the Ungani oil field in 2011 in the Canning Basin, Western Australia. It took until July 2015 to be awarded production licences over the field[12]. This four year gap highlights what is possible with a high value product (oil) and emphasises that a lower value product (gas) will take longer.

Origin Energy entered a Joint Venture in 2014 in the Beetaloo Basin and ultimately declared the contingent resource mentioned above. Origin Energy saw this opportunity as the quickest path to commercialisation, however, there are still many obstacles and challenges to overcome before commercial production may commence. The contingent resource categorisation suggests that there is a minimum of five years prior to Origin Energy declaring a reserve indicating that any production from the basin is still many years away.

[11] https://www.originenergy.com.au/about/investors-media/media-centre/beetaloo-basin-drilling-results-indicate-material-gas-resource.html

[12] http://www.dmp.wa.gov.au/Documents/Petroleum/PD-RES-PUB-135D.pdf, p.14

5 Geoscience Australia's Pre-competitive programs

The provision of pre-competitive geoscience information by Geoscience Australia is fundamental to attracting the exploration investment needed to ensure the discovery and sustainable development of the next generation of energy, minerals and groundwater resources.

Pre-competitive data and information are non-rivalrous goods. There is no economic barrier to anyone being able to access and use the data and information, although some of the data require specialist tools to view and analyse.

Energy Resources

Acquisition of pre-competitive data is vital to helping secure Australia's resources future, significantly lowering the costs for companies entering into Australia and enhancing Australia's reputation as an attractive destination for resources investment in a globally competitive market. Pre-competitive data also assist in building our knowledge of groundwater systems.

It is important to note that the pre-competitive work is undertaken by Geoscience Australia at regional or basin level scale. The data and information de-risk exploration and support explorers in focussing in on prospective targets.

Geoscience Australia's role is to:

- Continue to acquire and make available pre-competitive data and information that improves knowledge of Australia's prospectivity and resources, both offshore and onshore.
- Address the most critical geological and exploration issues to make the biggest material difference in the understanding of Australia's energy and minerals prospectivity.
- Regularly engage with the petroleum and minerals industries to ensure the pre-competitive program is aligned with their needs. The program is designed to augment industry activities by undertaking work that companies do not and cannot undertake themselves.
- Continue to provide leadership when collaborating with state and territory government organisations to undertake pre-competitive energy, minerals and groundwater assessments for onshore.

To assist in directing Geoscience Australia's pre-competitive energy program an inventory of Australia's frontier basins is being compiled. To date the inventory for offshore basins has been completed[13] as has the first volume for onshore basins[14]. Volume 1 for the onshore basins focussed on the Northern Territory and provides a comprehensive inventory of the geology, petroleum systems, exploration status and data coverage for the McArthur (including Beetaloo), South Nicholson, Georgina, Wiso, Amadeus and Warburton basins as well as the Cooper and Galilee basins in South Australia and Queensland (Figure 3).

The assessment includes an analysis of the critical science questions and exploration uncertainties for each basin. The results of each basin assessment are summarised in a prospectivity ranking. The availability of data and level of knowledge in each area is reflected in a confidence rating for that ranking.

[13] https://d28rz98at9flks.cloudfront.net/79058/Rec2014_009.pdf
[14] https://d28rz98at9flks.cloudfront.net/84587/Rec2016_004.pdf

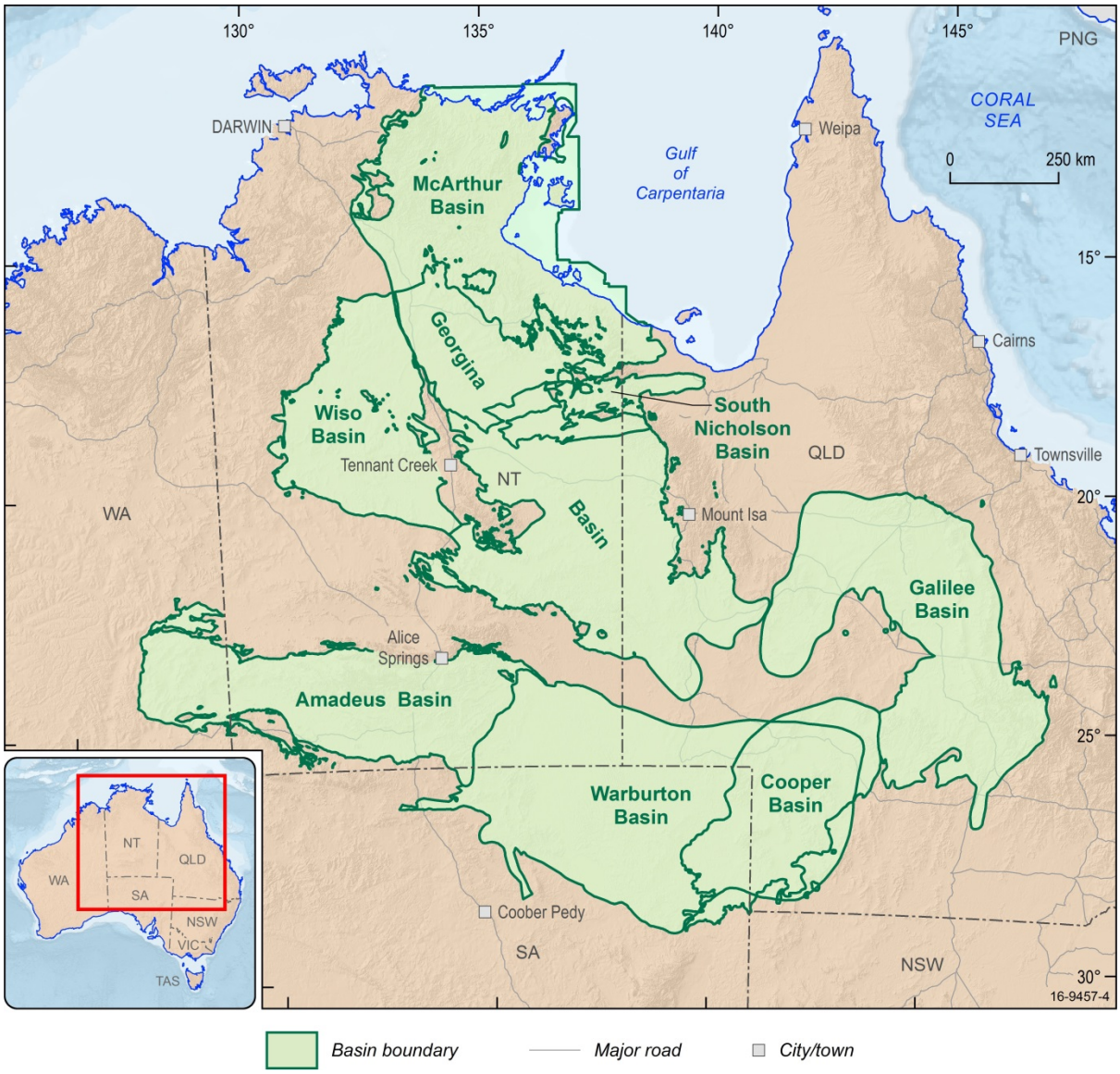

Figure 3: Location map of basins assessed for the Australian Onshore Basin Inventory Volume 1.

While the prospectivity of some areas is widely acknowledged to be high (for example, the Cooper Basin), the perception of prospectivity in many basins is negatively affected by the amount or quality of data available. In these basins, the acquisition of new data or targeted research could make a significant difference to the understanding of petroleum potential and likelihood of exploration success. Therefore, recommendations for future work that could assist in addressing key knowledge or data gaps are included in each basin assessment.

The Amadeus Basin was assessed to have high prospectivity with high confidence. The McArthur and Georgina basins were assessed to have moderate prospectivity with high confidence. The remaining Northern Territory basins were assessed to have lower prospectivity, lower confidence, or both.

Groundwater Resources

Australia is the driest inhabited continent on Earth by land area and, on a per capita basis, is one of the largest users of water in the world. Australians consume 20 000 billion litres of water every year,

with households spending $5.1 billion and industry spending $2.9 billion on water each year. Groundwater is a critical component of the water resources available to the nation.

Securing and sustaining water supplies is a significant challenge for Australia. Our health, lifestyle, agriculture, industry and environment are increasingly in competition for the same limited resource.

Geoscience Australia's work informs effective and responsible decision making about groundwater, and is fundamental to addressing our nation's critical water security challenges, our national interest and our future prosperity.

5.1 Exploring for the Future Programme

In the 2016 Federal Budget, the then Minister for Resources and Energy and Northern Australia, announced funding of $100.5 million over four years for the *Exploring for the Future* Programme.

The programme is delivering a resource prospectus for minerals, energy and groundwater aimed at attracting industry investment through the delivery of a suite of new pre-competitive geoscience data and knowledge for targeted areas of northern Australia and parts of South Australia. The programme is delivering a vastly improved understanding of the potential mineral, energy and groundwater resources where current knowledge is limited or unknown.

New data and information are currently being acquired to aid decision making by all levels of government, industry and communities about the best way to utilise resources to encourage the long-term economic prosperity and sustainability of northern Australia.

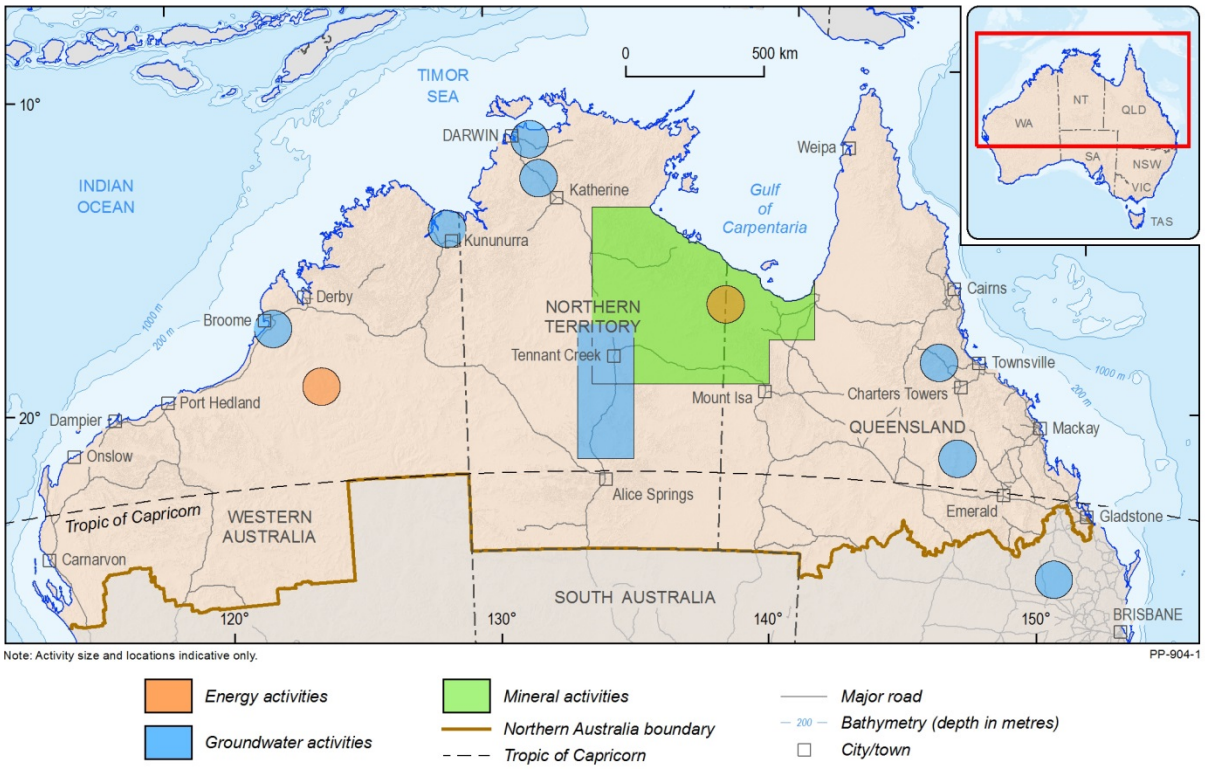

Figure 4: *Exploring for the Future* Programme planned activities

The Geological Surveys for the Northern Territory, Western Australia, Queensland and South Australia are key stakeholders in this programme and Geoscience Australia is working collaboratively

with them. The Northern Territory Department of Environment and Natural Resources is a stakeholder in the groundwater programme.

The *Exploring for the Future* Programme has the following activities planned (Figure 4) in the next 12 months for the Northern Territory, some of which extend into Western Australia and Queensland:

- Four regional scale geophysical (gravity, aerial electromagnetics, magnetotellurics, passive seismic) surveys commencing in June and early July 2017.
- Mineral Hydrogeochemistry Survey: Selected water bores are being sampled to analyse for trace amounts of elements that may indicate groundwater interaction with mineral ore at depth. Work is currently underway and will continue through the dry season.
- North Australia Geochemistry Survey: Over 900 soil samples are being collected between Tennant Creek, Mount Isa and the Gulf of Carpentaria. 65% of the samples have been collected to date with collection continuing through the dry season.
- Isotopic mapping: Selected rock samples are being analysed to build a regional map of crustal age and composition. Fieldwork is planned for later in the dry season.
- South Nicholson Basin Seismic Survey: Seismic reflection data are being collected to assess shape and structure of a poorly explored basin that has potential for hydrocarbon and mineral resources. Acquisition has just commenced on the Queensland side of the basin and will move through to the Northern Territory in late June 2017.
- Stratigraphic drilling: The current field data acquisition will be collated and modelled to build a mineral prospectivity map and target areas for further research will be identified. Stratigraphic drilling will be used to test data modelling and sample material at depth not seen on the surface.
- Groundwater studies: These projects bring together a range of geophysical, hydrological and hydrochemical methods to assess the scale, connectivity and natural parameters of groundwater systems to provide baseline information about natural systems to aid water use decision making. The areas in the Northern Territory being investigated are:
    - Southern Stuart Corridor – between Alice Springs and Tennant Creek;
    - Northern Stuart Corridor – Daly Waters; and
    - East Kimberley.

All activities are being undertaken in close association with the Northern Territory Geological Survey and the Department of Environment and Natural Resources. Any future drilling activity is focussed on scientific research and will follow Northern Territory and Federal Government requirements for land holder consultation, cultural heritage maintenance and environmental protection. None of the drilling will involve hydraulic fracturing.

6 Summary

Geoscience Australia's submission demonstrates the national-scale context that is application to this Inquiry.

Australia is well endowed with abundant energy (unconventional gas) resources to ensure our future energy security. Geoscience Australia regional geological and geophysical studies demonstrate that the Northern Territory has considerable prospectivity that could be developed.

Geoscience Australia's *Exploring for the Future* Programme will provide greater data and information on this potential to support future investment to identify, characterise and develop these resources. Ongoing collaboration with the Northern Territory Geological Survey and the Department of Environment and Natural Resources will ensure the success of the *Exploring for the Future* Programme.

The examples of Geoscience Australia's work provided in this submission could guide future work activities in the Northern Territory in the context of developing its energy and groundwater resources in the long term.