

Project Order

Proforma 2021

1. Short Project Title

Baseline seismic monitoring of the Canning Basin

Long Project Title

Establishment of data processing and dissemination platforms for baseline seismic monitoring of the Canning Basin before commencement of hydraulic fracturing

GISERA Project Number

W.25

Start Date

01/07/2021

End Date

30/06/2025

Project Leader

Erdinc Saygin

2. GISERA State/Territory

- | | | |
|---|--|---|
| <input type="checkbox"/> Queensland | <input type="checkbox"/> New South Wales | <input type="checkbox"/> Northern Territory |
| <input type="checkbox"/> South Australia | <input checked="" type="checkbox"/> Western Australia | <input type="checkbox"/> Victoria |
| <input type="checkbox"/> National scale project | | |

3. Basin(s)

- | | | | |
|--|---|--|--------------------------------------|
| <input type="checkbox"/> Amadeus | <input type="checkbox"/> Beetaloo | <input checked="" type="checkbox"/> Canning | <input type="checkbox"/> Carnarvon |
| <input type="checkbox"/> Clarence-Morton | <input type="checkbox"/> Cooper | <input type="checkbox"/> Eromanga | <input type="checkbox"/> Galilee |
| <input type="checkbox"/> Gippsland | <input type="checkbox"/> Gloucester | <input type="checkbox"/> Gunnedah | <input type="checkbox"/> Maryborough |
| <input type="checkbox"/> McArthur | <input type="checkbox"/> North Bowen | <input type="checkbox"/> Otway | <input type="checkbox"/> Perth |
| <input type="checkbox"/> Surat | <input type="checkbox"/> Other (please specify) | | |

4. GISERA Research Program

- | | | |
|---|--|--|
| <input checked="" type="checkbox"/> Water Research | <input type="checkbox"/> Greenhouse Gas Research | <input type="checkbox"/> Social & Economic Research |
| <input type="checkbox"/> Biodiversity Research | <input type="checkbox"/> Health Research | <input type="checkbox"/> Agricultural Land Management Research |
| <input type="checkbox"/> Other | | |

5. Project Summary

Objective

The primary aim of this project is to establish a long-term baseline seismic monitoring catalogue that will characterise the current natural seismic activity and cultural seismic noise e.g., quarry blasts within the Canning Basin. This baseline will be used to distinguish any potential increase in seismic activity due to planned gas extraction operations. This will be done by deploying and operating a dense seismic monitoring array and providing near real-time analysis of the records with state-of-the-art seismological techniques. This project will provide important information to the community and regulators of the baseline seismic activity, and subsurface imaging for understanding the regional underlying geology of the Canning Basin in a way that is transparent and available to the public.

Description

Background

The Canning Basin, in northwest Western Australia, is the largest sedimentary basin in Australia, aside from the Eromanga Basin (subdivision of the Great Artesian Basin) and it contains potential opportunities for developing shale and unconventional gas. Exploration and investigations across large parts of the basin have to date focussed on the prospectivity for oil and gas for which licences for development of facilities have been granted. The regional geology and structure of the basin has been reviewed and summarised in numerous publications by the Western Australia Government Department of Mines, Industry Regulation and Safety.

As shown in Figure 1, the western and north-western margins of the Australian continent show a moderate amount of long-term seismic activity, with most of the events lying close to the continental margin (Kennett et al., 2018). Particularly notable is the cluster of earthquakes off Broome which produced the magnitude 6.6 in 2019 which was felt as far away as Perth (Geoscience Australia Earthquake Portal).

The origin of the natural seismicity in the Canning Basin is associated with the ongoing deformation at the north-eastern margin of the basin. However, the past and current seismic activity within the basin is poorly constrained due to the lack of seismic monitoring stations in the region. Currently, only four permanent seismic stations exist within the basin (AUBRM, CAAN, FITZ and TEFOZ) (Figure 1).

Canning Basin Seismic Monitoring Array

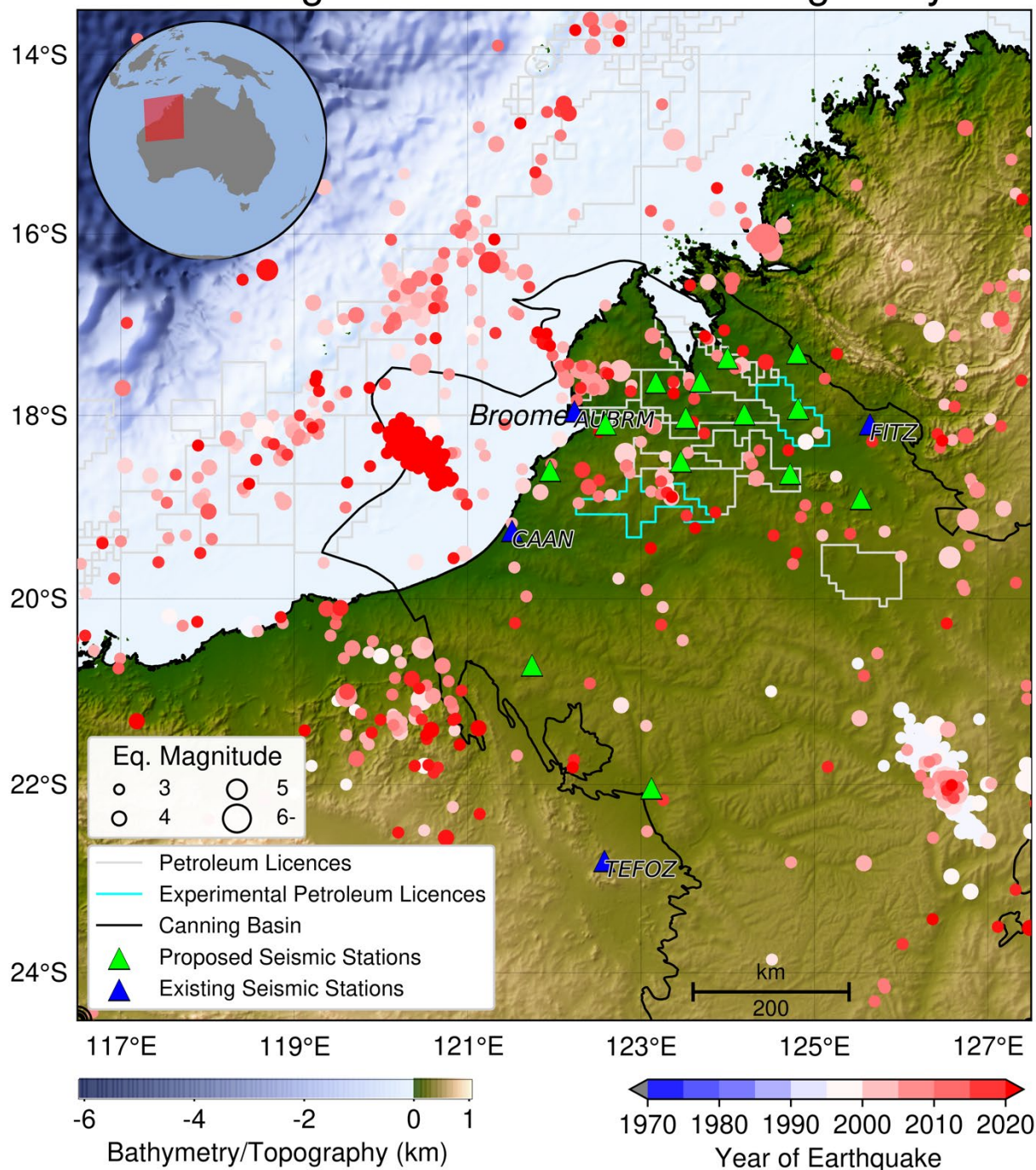


Figure 1: Proposed seismic array (green triangles) across Canning Basin along with the existing seismic stations (blue triangles). The distribution of the historical seismicity in the last 50+ years is shown with filled circles. Note the relative increase of the seismicity after 1990s, which is a function of the installation of the first digital seismic station in the region in Fitzroy Crossing (FITZ).

The historical seismic events shown in Figure 1 are generally of magnitudes greater than 2.5. It is known that where there are moderately sized events, there will be many more, smaller earthquakes. These currently go undetected and unreported.

The low detection rate is a product of the sparse distribution of monitoring stations. The low reporting rate is because the catalogue published by Geoscience Australia (GA) in Canberra only reports events with magnitudes greater than 2, as detected on the Australian National Seismic Network (ANSN). To accurately form a baseline of current seismicity that will be useful for comparing against seismic events originating from industry activities, seismic events of magnitudes as low as 1.5 will be needed. The proposed seismic array is expected to have a sensitivity range of magnitudes as low as 1 and potentially lower after refining the subsurface velocity model by applying seismic imaging with the new array data.

Project outline

The Geological Survey of Western Australia (GSWA) are planning on installing seismic monitoring stations in the Canning Basin. GSWA will be responsible for the deployment and operation of this dense seismic monitoring array (this represents GSWA in-kind investment >\$1M and dependency for CSIRO delivery to the project).

The objectives of this GISERA project are to:

- (a) process and disseminate seismic baseline data (from the GSWA seismic monitoring stations):
- (b) develop additional understanding of structure and geology in areas where only sparse surveys have occurred previously to aid the interpretation of the detected seismic activity.

The Canning Basin is a site of conventional hydrocarbon (mainly gas) production. However, applications for experimental extraction by unconventional methods are under consideration (See Environmental Protection Authority).

The key objective is to start building a baseline seismic activity catalogue within the Canning Basin. To do this, we need to increase the seismic monitoring capabilities and to disseminate these seismic event locations on a regular basis. The proposed approach is based on other monitoring networks such as that planned for the Beetaloo Basin ([Beetaloo Sub-basin Seismic Monitoring Project | Geoscience Australia \(ga.gov.au\)](#)) and that operating in Texas (<https://www.beg.utexas.edu/texnet-cisr/texnet/earthquake-catalog>). TexNet directly contributes to the safety and prosperity of Texas. The TexNet Earthquake Catalog has become the primary source for critical seismic information for decision-making by researchers, by state regulators making policy decisions, and by operators, thus maximising industry best practices in the United States (see Figure 2 for a view of the current information portal). Whilst the proposed program will not directly monitor the effects of unconventional extraction methods in the Canning Basin, any changes in the seismicity pattern (within the detection threshold of the network) which correlate with the onset of new industrial activities, would be detected.

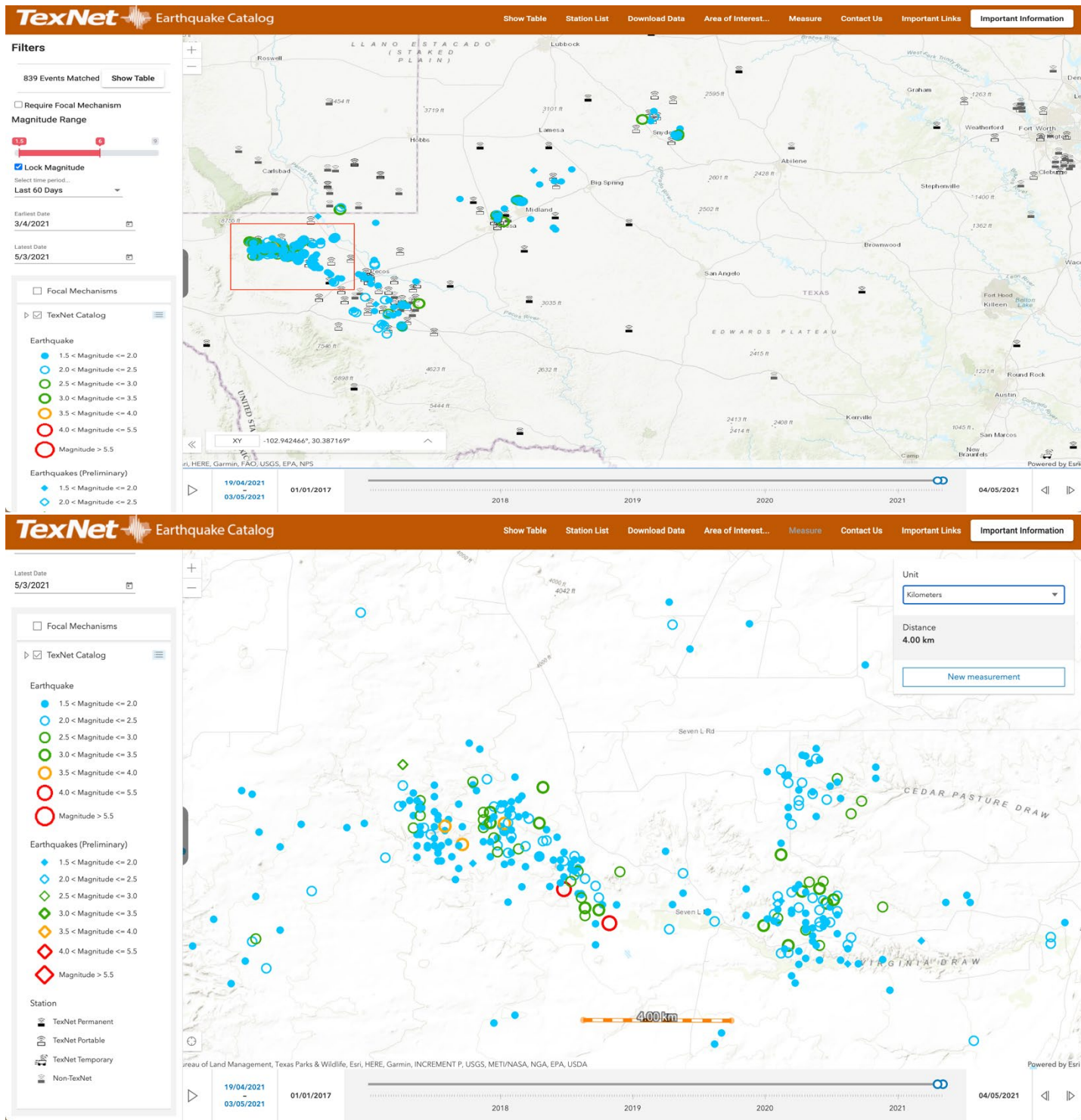


Figure 2: A screenshot of the current TexNet Seismic Monitoring Program information portal. Coloured circles indicate the location of the detected local seismic events with magnitudes between 1.5 and 4 during the last one month. Seismic instruments are marked with rectangles with wave symbol. The interface can show the location of seismic events as well as the magnitudes and their depths on a map and also as a text-based catalogue. The second map is the zoomed version of the first screenshot for the zone highlighted with a red rectangle.

Seismic monitoring stations

The Geological Survey of Western Australia (GSWA) has received equipment funding to instrument a section of the Canning Basin adjacent to a series of permits for oil and gas exploration, including experimental licenses. The funding, installation and operation of the seismic network represent the GSWA in-kind investment in this project.

CSIRO has the expertise to set up the necessary software and algorithms to produce timely reports of seismic activity recorded by the seismic network, as well as evaluate the data for structural/stratigraphic information. This GISERA project will integrate the data generated from GSWA's soon to be installed seismic stations and four existing stations to provide the first baseline data for any naturally induced seismic events in the region.

The installation of a network of 14 seismic monitoring stations with real-time data telemetry systems which will feed the data real-time directly into the ANSN, will be completed by GSWA in 2021. Hence the potential for detecting much smaller seismic events in the Canning Basin is greatly increased.

From the seismic activity detected by this array we can start to form a pattern of earthquakes and man-made seismic activity such as quarry blasting. In the first instance, clusters of events can be correlated with either geology or surface infrastructure to distinguish between natural and anthropogenic events. This map will be continuously updated so that when new industrial activities start up e.g., unconventional gas extraction, any increase in seismic activity in that particular area can be noted. The long-term seismic baseline monitoring also provides information about seismic activity patterns, often following a 'power-law' type relation. The number of events for a given period decreases exponentially as their earthquake magnitudes increase exponentially (Atkinson et al., 2020). From this relationship, one can predict the number of expected seismic events to occur in the region of interest. In contrast, any increase due to man-made activities can be detected by analysing the established catalogues as a part of the baseline monitoring activities. The estimated statistical relation with the collection of sufficiently long-term baseline data will set the foundation for the commonly used risk mitigation strategies such as 'traffic light protocol' in hydraulic fracturing operations.

The mapping of the subsurface structure of the Canning Basin is important to aid the interpretation of the seismic activity happening in this region, and also increase our fundamental understanding of the region. The same seismic data that will be recorded at the array can be used for this purpose by using modern seismological subsurface imaging techniques. We will use the continuously recorded ambient vibrations of the Earth and also seismic activities to illuminate the subsurface physical structure. Another aspect of the outputs of this activity will be providing outputs to guide interpretation of the detected seismicity if any. The

seismic waves that will be recorded continuously at this array is also sensitive to any physical changes in the subsurface in real-time. For example, the change in the groundwater table levels in aquifers will affect the propagation of seismic waves in a measurable way as demonstrated in He et al. (2021).

Need & Scope

The background seismic activity of the region is largely unknown. The Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia (2018) stated that it is important to have a baseline of natural seismic activity before unconventional gas extraction activities are started to ensure that any industrial activities are not seen to be producing excessive seismic activity. This project will provide important information to the community and regulators of the baseline seismic activity in the Canning Basin in a way that is transparent and available to the public.

As mentioned in the previous section, GA only reports events of magnitude 2 or above. This network is aiming to detect much smaller events. A data centre is needed with processing capability using advanced detection algorithms to look specifically at issues pertaining to the Canning Basin.

The scope of this project includes:

- Identification of the potential sources of seismic activity using the existing datasets and maps within a desktop study.
- Development and application of state-of-the-art algorithms for detecting and discriminating smaller natural and induced seismic events which do not fall into the remit of the ANSN.
- Developing a platform to publish a seismic activity catalogue and generating seismicity maps of smaller events in the Canning Basin and relating these to geological features or surface infrastructure.
- Further seismological research with the aim of increasing the geological knowledge of the Canning Basin to aid interpretation of the seismic activity and increase fundamental understanding.

Relevant State/Territory Government independent reviews

The Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia (2018) has concluded that for Western Australia, there are no seismic monitoring arrays regularly deployed in a closely spaced configuration so as to enable good baseline of seismic activity to be obtained. The timeliness of this project is related to the granting of the first experimental unconventional gas extraction license within the Canning Basin (see Figure 1). Concerns about the effects of these unconventional methods on the rocks in the vicinity of hydrocarbon extraction projects are a very real environmental consideration.

This project will contribute to **Finding 2** of Hydraulic Fracture Stimulation in Western Australia (2018): “Given the paucity of studies on tectonics and seismic hazard in the Canning Basin, further data collection, permanent monitoring stations and independent studies of the stress state and neotectonic activity, such as those undertaken by Geoscience Australia, are warranted.”.

The recorded seismic data will also be used to map the subsurface in more detail to understand the regional underlying geology and benchmarked against any publicly available seismic data for tie ins for future interpretation and mapping as well providing input to the interpretation of the detected baseline seismic activity.

Methodology

Stage 1 Desktop study to identify the potential location of natural and man-made seismic sources: Existing seismic catalogues, location of quarries or mines, and any other exploration activities will be investigated to identify the potential location of seismic activity and also assessing the sensitivity of the proposed seismic array.

Stage 2 Establishing a data processing framework for the automatic detection, location and discrimination of any seismic events: Establish data workflows for the implementation of the following:

- automatic retrieval of data from GA,
- scanning and detection of seismic activity, using parameters suitable for the study area,
- locating and discrimination of seismic events in the Canning Basin using geological models refined for the study area which will be a product of Stage 3,
- timely production of catalogue and maps of locations of seismic activity.

This will start as soon as the project is funded using data from the four existing stations and will add the new stations into the algorithms as they come online.

Stage 3 Developing a reporting protocol for public dissemination of information: The catalogue (with regular automatic updates and maps) will be published through a publicly accessible online platform with interactive capabilities.

Stage 4 Enhancement of the geological knowledge using the recorded seismic data: The recorded seismic waveforms from this dense network will allow more detailed imaging of the geological structure. The results will contribute to the interpretation of the recorded seismic activity and also increase our general knowledge. The recently developed methods by team members (Chen&Saygin, 2020; Chen&Saygin, 2021; Tork-Qashqai et al. 2019; Tork-Qashqai & Saygin, 2021) will be applied to the recorded data to image the subsurface.

It is important to note there are activities that will be conducted by GSWA and GA that represent in-kind investment and dependency for CSIRO delivery to the project:

GSWA Activity 1:

Public Engagement is being conducted before July 2021 and before the installation of the monitoring network): to increase community knowledge on natural and human induced seismic activity in the Canning Basin and surrounds and show the results of previous work done in the area. GSWA will also locate sites for the installation where the security of the instrumentation can be guaranteed and that there is 4G communications available.

GSWA Activity 2:

Procurement, installation and operation of the real-time seismic monitoring network in the Canning Basin (between August - November 2021): GSWA will install 14 seismic stations across the Canning Basin in 2021 (for locations see Figure 1). GSWA will use the existing infrastructure of the ANSN at GA to receive and archive data and will also perform an initial screening of the data as per their normal operations. This ensures that the waveforms will be publicly accessible immediately.

GSWA Activity 3:

IT Infrastructure and Support: GSWA will organise the procurement of a high-end workstation and sufficiently large storage space for facilitating the data hosting and also operation of the background processes such as seismic event location.

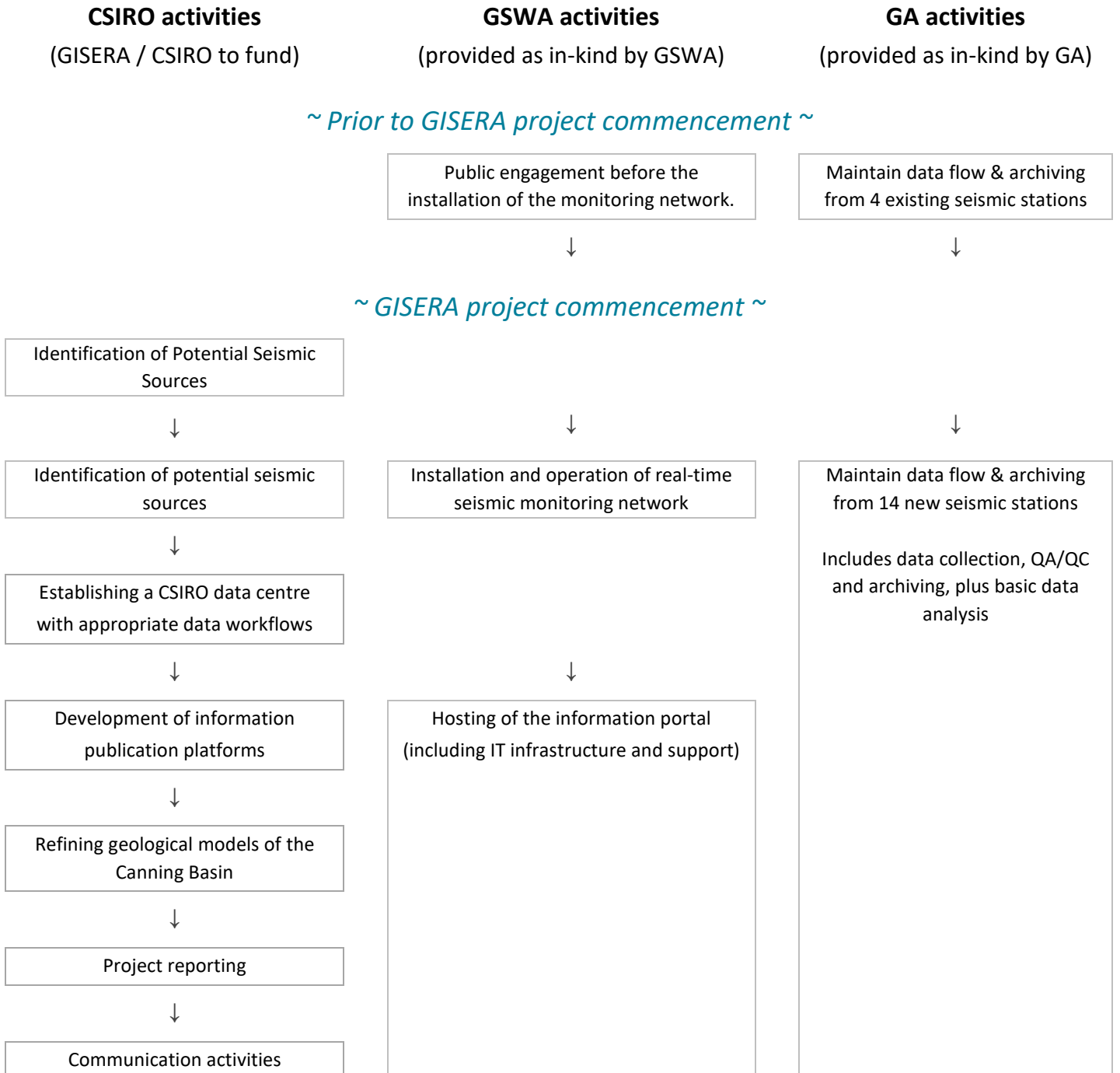
GSWA In-kind investment: Totals \$1,154,800 over 4 years (includes \$1M for purchase of 14 seismic stations, staff to deploy and maintain monitors, IT support and infrastructure).

GA Activity:

Data collection, QA/QC and archiving: GA will collect and store data from the seismic stations and perform a basic data analysis to rectify any anomalies.

GA In-kind investment: Totals \$300,000 over 4 years

The diagram below outlines the various activities to be undertaken by CSIRO, Geological Survey of Western Australia and Geoscience Australia.



6. Project Inputs

Research

There is a significant information gap about the background seismic activity of the Canning Basin due to the sparse coverage of the seismic sensors (only four) in the region. This sparse network of stations cannot detect and locate events small enough (less than 2.5), which is critical for identifying the baseline activity patterns. As outlined by the Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia (2018), it is important to establish a baseline of natural seismic activity before unconventional gas extraction activities are started, which may produce sufficiently large induced seismic events.

We will use the publicly accessible free data from the new seismic network installed and operated by the Geological Survey of Western Australia (GSWA) to provide a near real-time analysis of the records with state-of-the-art seismological techniques. The routine analyses of the data coming from this network aim to detect much smaller events than is currently captured by Geoscience Australia (GA). The results will be communicated through a publicly accessible data information platform that will be listing the locations of detected seismic events, their magnitudes in near real-time.

The software would all be open-source licences.

Computing hardware of the information platform will be funded through GSWA.

Historic and larger seismic events (magnitude greater than 2.5) will be taken from the GA catalogue and incorporated into the Canning Basin seismicity maps and catalogue.

Geological and geophysical maps and data will be sourced from the GSWA product range (at no cost to GISERA).

Resources and collaborations

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Dr Erdinc Saygin	129	Geophysics/Seismology	18	CSIRO
Dr Mehdi Qashqai	140	Geophysics/Seismology	7	CSIRO
Dr Peng Guo	65	Geophysics/Seismology	7	CSIRO
Dr Yuqing Chen	119	Geophysics/Seismology	6	CSIRO
CSIRO Software Engineer	28	Software Engineering	5+	CSIRO

Subcontractors (clause 9.5(a)(i))	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Nil				

Budget Summary

Source of Cash Contributions	2021/22	2022/23	2023/24	2024/25	% of Contribution	Total
GISERA	\$49,445	\$175,471	\$76,000	\$67,741	17.1%	\$368,656
- Federal Government	\$49,445	\$175,471	\$76,000	\$67,741	17.1%	\$368,656
Total Cash Contributions	\$49,445	\$175,471	\$76,000	\$67,741	17.1%	\$368,656

Source of In-Kind Contribution	2021/22	2022/23	2023/24	2024/25	% of Contribution	Total
CSIRO	\$43,847	\$155,606	\$67,396	\$60,072	15.2%	\$326,922
Geological Survey of WA	\$1,051,600	\$34,400	\$34,400	\$34,400	53.7%	\$1,154,800
Geoscience Australia	\$75,000	\$75,000	\$75,000	\$75,000	14.0%	\$300,000
Total In-Kind Contribution	\$1,170,447	\$265,006	\$176,796	\$169,472	82.9%	\$1,781,722

TOTAL PROJECT BUDGET	2021/22	2022/23	2023/24	2024/25	-	TOTAL
All contributions	\$1,219,892	\$440,477	\$252,796	\$237,213	100%	\$2,150,378
TOTAL PROJECT BUDGET	\$1,219,892	\$440,477	\$252,796	\$237,213	100%	\$2,150,378

7. Project Impact Pathway

Activities	Outputs	Short term Outcomes	Long term outcomes	Impact
Identification of potential sources	Location of existing & potential seismic activity due to man-made activities.	Provides input to the location of the planned seismic array. Refinements will be done to the location of sensors where necessary.	Will improve community, government and community knowledge on baseline seismic activity in the Canning Basin.	Increased sensitivity of the seismic array, and better discrimination of sources such as earthquakes vs. man-made activities.
Establishment of a data centre	A working system that receives data on a real-time basis from the ANSN network to be operated by GSWA	Building a catalogue of detected natural and human induced seismic events. Establishment of initial processing parameters, which will be refined as more knowledge is gained.		1. A baseline of seismic activity in an area to be opened up for exploration.
Definition of parameters and automation	An automated process stream that receives data, detects events, filters non-seismic events, and produces event locations.			2. Ability to locate additional seismic activities (within the limitations of the network) caused by new industrial activities.
Dissemination	Daily publication of seismic activity locations and magnitudes of the Canning Basin events	Publicly accessible seismic activity locations in the region with some interrogation capabilities.		
Refining geological models of the Canning Basin	Updated and new geological models that give more detailed understanding of the geological structure of the Canning Basin	Reports on the models produced (this is in the latter part and after the completion of this project)	Aid interpretation of the seismic activity and increase fundamental knowledge.	3. Potential to provide baseline seismic activity information for guidelines of the operation of extraction industries within the appropriate Codes of Practice and Legislation.
Reporting	Interim and final reports	Progress tracking along the way	A final report on the completion of the project detailing the system put in place and the products released.	

8. Project Plan

Project Schedule

ID	Activities / Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Identification of Potential Seismic Sources	Mehdi Qashqai	1 July 2021	31 August 2021	
Task 2	Establishing a CSIRO data centre with appropriate data workflows	Mehdi Qashqai	1 September 2021	31 August 2024	Task 1
Task 3	1 st Interim Report	Erdinc Saygin	1 April 2022	30 June 2022	Task 1
Task 4	Publication platform development	Mehdi Qashqai	1 November 2022	28 February 2025	Task 3
Task 5	Refining geological models	Yuqing Chen	1 November 2022	31 October 2024	Task 3
Task 6	2nd Interim Report	Erdinc Saygin	1 April 2023	30 June 2023	
Task 7	3rd Interim Report	Erdinc Saygin	1 April 2024	30 June 2024	
Task 8	Final Report	Erdinc Saygin	1 March 2024	30 April 2025	Task 6
Task 9	Communicate findings to stakeholders	Erdinc Saygin	1 May 2025	30 June 2025	Task 8

Task description

Task 1

TASK NAME: Identification of Potential Seismic Sources

TASK LEADER: Mehdi Qashqai

OVERALL TIMEFRAME: 1 July 2021 – 31 August 2021

BACKGROUND: The identification of existing seismic sources including man-made ones prior to the installation of the network is critical in discrimination in later stages.

TASK OBJECTIVES: Conduct desktop study to identify and map existing seismic sources from legacy data.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: 2D maps of seismic sources and their potential impact on the planned seismic array. It will provide input to the fine tuning on the location of the planned seismic array.

Task 2

TASK NAME: Establishing a CSIRO data centre with appropriate data workflows to detect and locate seismic activity.

TASK LEADER: Mehdi Qashqai

OVERALL TIMEFRAME: 1 September 2021 – 31 August 2024

BACKGROUND: It is vital to establish a fully operational data centre that will capture near real-time data from seismic stations, apply several workflows in an automated fashion to streamline the detection and location of seismic activity within the Canning Basin. Several workflows will be tested and fine-tuned over time with the inclusion of inputs from other tasks.

TASK OBJECTIVES: To develop and maintain system that is operational within the restrictions of the GSWA IT security, that can receive and process seismic data and produce a location and magnitude for each event using the state of the art detection and location algorithms and workflows.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: The system should be able to:

- a) Retrieve data from the GA open access repository including the GSWA new stations, and from the Seismometers in Schools server (and possibly any other local real-time network) into a temporary CSIRO data centre.
- b) Set up and refine triggering algorithms specific to the stations in this study with the aim of capturing magnitude 1.5 events and larger
- c) To automate location and magnitude calculations of seismic activity from the triggered events
- d) Incorporate outputs from Task 4 to refine the depth and magnitude estimates. Consider relocation of historic events using the refined velocity model
- e) To allow operator review and intervention into the automation on an ad hoc basis
- f) Produce a listing of the seismic activity details suitable for publication

Task 3

TASK NAME: 1st Interim Report

TASK LEADER: Erdinc Saygin

OVERALL TIMEFRAME: 1 April 2022 – 30 June 2022

BACKGROUND: The desktop study regarding the potential seismic sources aims to determine the location of existing sources, classify them, and provide input to the network design. The data centre will automatically retrieve the data from Geoscience Australia and will apply many processing steps in the background to the raw data to detect and locate earthquakes.

TASK OBJECTIVE: Provide a general outline of the potential seismic sources, and provide input to the seismic network design (GSWA Task). Provide a preliminary assessment of the data centre's capabilities and core functions.

TASK OUTPUTS: A detailed report showing the results of the desktop study of seismic sources through maps and digital datasets. Assessment of the capabilities of the data centre with the first batch of the data coming from the seismic network.

SPECIFIC DELIVERABLES: Interim report

Task 4

TASK NAME: Development of information publication platforms

TASK LEADER: Mehdi Qashqai

OVERALL TIMEFRAME: 1 November 2022 – 28 February 2025

BACKGROUND: The whole aim of this task is to make publicly available the baseline seismicity of the Canning Basin as outlined in Task 2. The information produced in the previous step need to be shared with the public in a transparent and accessible way. Ideally the information portal will regularly publish a daily listing and map of the seismic activity of the Canning Basin and follows the format and standards of the other international published seismic event catalogues as well as maintaining an easy-to-understand interface for the public. This activity will proceed through the following stages:

Stage 1 - Determine the minimum viable product in collab with GSWA.

Stage 2 - Development / Implementation of information portal

Stage 3 - Deliver the information portal software and processing workflows to GSWA.

TASK OBJECTIVES: Publish locations and magnitudes of seismic activity in the Canning Basin

TASK OUTPUTS AND SPECIFIC DELIVERABLES:

- a) Identify and document and agreement between GSWA and CSIRO on minimum viable product
- b) Delivery of beta information portal for acceptance testing by CSIRO and GSWA on GSWA IT infrastructure

- c) Completion of acceptance testing and formal handover of information platform to GSWA by CSIRO.
- d) CSIRO staff to train GSWA staff in the operation and maintenance of the software

Task 5

TASK NAME: Refining geological models of the Canning Basin

TASK LEADER: Yuqing Chen

OVERALL TIMEFRAME: 1 November 2022 – 31 October 2024

BACKGROUND: The science of seismic activity location strongly relies on having earth models with strong a priori knowledge. In general, for 'poor' earth models, the estimated depths and location of events can be off by several km, which will bias baseline monitoring operations. The same data collected in the array can be used to improve the Earth models to refine the spatial location of the detected seismic events.

TASK OBJECTIVES: To conduct advanced seismological research using the seismic data to investigate the geological structure of the Canning Basin. The results will contribute to new geological information to discriminate natural and man-made seismic events.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Methods such as receiver function analysis and ambient noise tomography will be used to gain a better geological insight into the structure of the Canning Basin. Geological models will be published via open access platforms including social media and academic publications. Implementation of updated velocity models into GSWA information portal by CSIRO.

Task 6

TASK NAME: 2nd Interim Report

TASK LEADER: Erdinc Saygin

OVERALL TIMEFRAME: 1 April 2023 – 30 June 2023

BACKGROUND: The data centre will automatically retrieve the data from Geoscience Australia and will apply a number of processing steps in the background to the raw data to detect and locate seismic activity. The publication platform is for disseminating information about detected seismic events to the public.

TASK OBJECTIVE: Provide an update of the data centre functionality supported with real data examples. Initial assessment of the publication platform.

TASK OUTPUTS: Examples of detected local seismic activity: location maps, magnitude information. Demonstration of the publication platform through screenshots as given in the report.

SPECIFIC DELIVERABLES: Interim report

Task 7

TASK NAME: 3rd Interim Report

TASK LEADER: Erdinc Saygin

OVERALL TIMEFRAME: 1 April 2024 – 30 June 2024

BACKGROUND: The publication platform is for disseminating the information about detected seismic activity to the public. The refinement of the geological models will be achieved using the raw data with the state-of-the-art seismic imaging methods.

TASK OBJECTIVE: The demonstration of the publication platform with its full functionality. Demonstration of the impact of the updated subsurface models in seismic event location estimates.

TASK OUTPUTS: Demonstration of the publication platform through screenshots as given in the report. Calibrated and updated seismic event locations after the refinement of the subsurface model. Magnitude-Frequency plots for establishing the statistical seismic activity patterns.

SPECIFIC DELIVERABLES: Interim report

Task 8

TASK NAME: Final Report

TASK LEADER: Erdinc Saygin

OVERALL TIMEFRAME: 1 March 2024 – 30 April 2025

BACKGROUND: Information from this project is to be made publicly available after completion of standard CSIRO publication and review processes.

TASK OBJECTIVES: To ensure that the information generated by this project is documented and published after thorough CSIRO Internal review.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: 1) Preparation of a final report outlining the scope, methodology, findings and any recommendations for future research; 2) Following CSIRO Internal review, the report will be submitted to the GISERA Director for final approval; and public release.

Task 9

TASK NAME: Communicate findings to stakeholders

TASK LEADER: Erdinc Saygin

OVERALL TIMEFRAME: 1 May 2025 – 30 June 2025

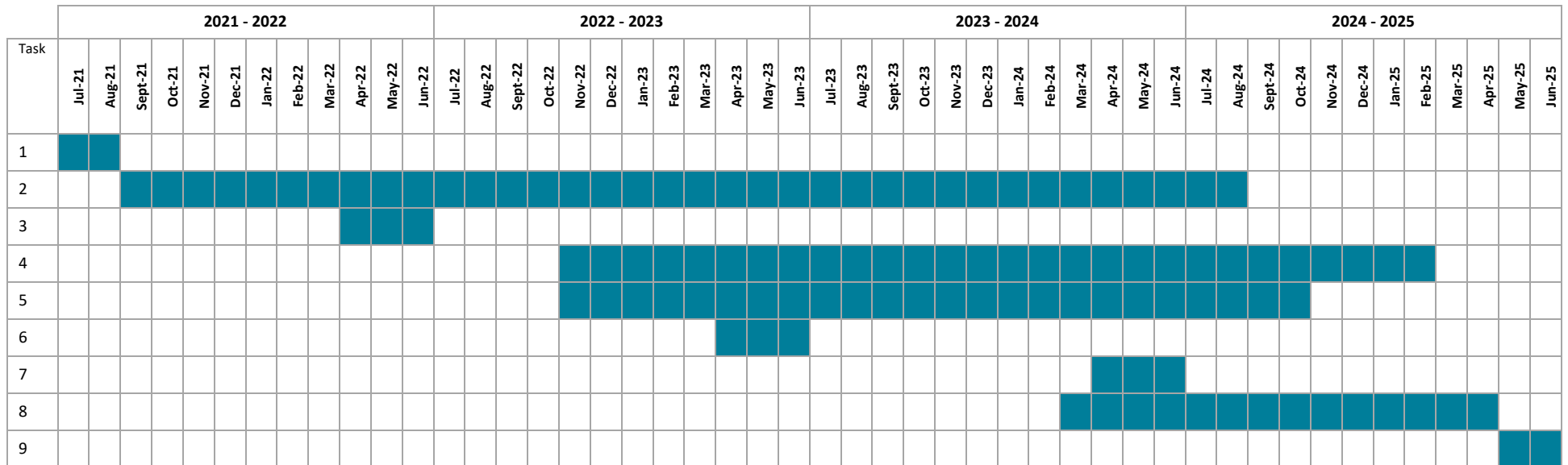
BACKGROUND: Communications of GISERA research are an important component of outreach and dissemination of findings to diverse audiences.

TASK OBJECTIVES: Communicate findings to stakeholders through meetings, knowledge transfer session, factsheet and journal article, in collaboration with GISERA Communications officers.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Communicate results to GISERA stakeholders according to standard GISERA project procedures which will include:

- 1) Knowledge Transfer session with Government/Gas Industry
- 2) Presentation of findings to Community members/groups
- 3) Preparation of article for GISERA newsletter
- 4) Revision of project factsheet to include final results (a factsheet is developed at project commencement and another will be done at completion)
- 5) Peer reviewed scientific manuscript ready for submission to relevant journal

Project Gantt Chart



9. Technical Reference Group

The project will establish a Technical Reference Group (TRG) aimed at seeking peer-to-peer technical advice on contextual matters and to discuss research needs as well as outputs as the project progresses. The TRG will include the project leader and a group of different stakeholders as appropriate which may include:

- Geoscience Australia representative
- Kimberley Land Council representative
- Western Australian Farmers Federation representative
- Department of Fire and Emergency Services (DFES) representative
- Department of Mines, Industry Regulation and Safety (DMIRS) representative
- Gas, petroleum and minerals industries representatives

10. Communications Plan

Stakeholder	Objective	Channel (e.g. meetings/media/factsheets)	Timeframe (Before, during at completion)
Regional community / wider public	To communicate project objectives and key messages from the research	Fact sheets (including development of one at commencement of project which will explain in plain English the objective of the project – this will be updated periodically as project progresses). Project progress reported on GISERA website to ensure transparency for all stakeholders including regional communities. Media release (optional)	From commencement of project and with updates as they come to hand. As required At completion
Government	Briefing on research being undertaken and progress	Engagement during project	During
Regional community/wider public, government, scientific community and industry	Make publicly available the baseline seismicity of the Canning Basin.	Development of online platform with daily listings and maps of seismic event activity.	During

Stakeholder	Objective	Channel (e.g. meetings/media/factsheets)	Timeframe (Before, during at completion)
Regional community/wider public, government, scientific community and industry	Provide a general outline of the potential seismic sources and provide input to the seismic network design. Provide a preliminary assessment of the data centre's capabilities and core functions.	Public release of 1 st interim report	During
Regional community/wider public, government, scientific community and industry	Provide an update of the data centre functionality supported with real data examples. Initial assessment of the publication platform.	Public release of 2 nd interim report	During
Regional community/wider public, government, scientific community and industry	Demonstration of the publication platform with its full functionality. Demonstration of the impact of the updated subsurface models in seismic event location estimates.	Public release of 3 rd interim report	During
Gas Industry	Improve knowledge on baseline seismic activity in the Canning Basin.	Presentation of findings at joint Gas Industry/Government Knowledge Transfer Session	At Completion
Government	Advice provided to senior bureaucrats / ministers / policy makers	Presentation of findings at joint Gas Industry/Government Knowledge Transfer Session	At Completion
Community stakeholders	Presentation of research findings	Presentation of findings at via workshop/briefing	At Completion
Regional community/wider public, government, scientific community and industry	To report on key findings	Public release of final report	At project completion

11. Budget Summary

Expenditure	2021/22	2022/23	2023/24	2024/25	Total
Labour	\$93,292	\$324,077	\$141,396	\$124,813	\$683,578
Operating	\$0	\$7,000	\$2,000	\$3,000	\$12,000
Subcontractors	\$0	\$0	\$0	\$0	\$0
In-kind	\$1,126,600	\$109,400	\$109,400	\$109,400	\$1,454,800
Total Expenditure	\$1,219,892	\$440,477	\$252,796	\$237,213	\$2,150,378

Expenditure per task	2021/22	2022/23	2023/24	2024/25	Total
Task 1	\$34,879	\$0	\$0	\$0	\$34,879
Task 2	\$38,163	\$35,871	\$22,788	\$13,327	\$110,149
Task 3	\$20,250	\$0	\$0	\$0	\$20,250
Task 4	\$0	\$202,575	\$36,095	\$37,096	\$275,766
Task 5	\$0	\$76,872	\$30,673	\$17,260	\$124,805
Task 6	\$0	\$15,759	\$0	\$0	\$15,759
Task 7	\$0	\$0	\$16,210	\$0	\$16,210
Task 8	\$0	\$0	\$37,630	\$47,627	\$85,257
Task 9	\$0	\$0	\$0	\$12,503	\$12,503
In-kind	\$1,126,600	\$109,400	\$109,400	\$109,400	\$1,454,800
Total Expenditure	\$1,219,892	\$440,477	\$252,796	\$237,213	\$2,150,378

Source of Cash Contributions	2021/22	2022/23	2023/24	2024/25	Total
Federal Govt (17.1%)	\$49,445	\$175,471	\$76,000	\$67,741	\$368,656
Total Cash Contributions	\$49,445	\$175,471	\$76,000	\$67,741	\$368,656

In-Kind Contributions	2021/22	2022/23	2023/24	2024/25	Total
CSIRO (15.2%)	\$43,847	\$155,606	\$67,396	\$60,072	\$326,922
Geological Survey of WA (53.7%)	\$1,051,600	\$34,400	\$34,400	\$34,400	\$1,154,800
Geoscience Australia (14%)	\$75,000	\$75,000	\$75,000	\$75,000	\$300,000
Total In-Kind Contributions	\$1,170,447	\$265,006	\$176,796	\$169,472	\$1,781,722

	Total funding over all years	Percentage of Total Budget
Federal Government investment	\$368,656	17.1%
Geological Survey of WA investment	\$1,154,800	53.7%
Geoscience Australia investment	\$300,000	14.0%
CSIRO investment	\$326,922	15.2%
Total Expenditure	\$2,150,378	100%

Task	Milestone Number	Milestone Description	Funded by	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year Completed	Payment \$ (excluding CSIRO contribution)
Task 1	1.1	Identification of Potential Seismic Sources	GISERA	Jul-21	Aug-21	2021/22	\$18,486
Task 2	2.1	Establishing a CSIRO data centre with appropriate data workflows	GISERA	Sep-21	Aug-24	2024/25	\$58,379
Task 3	3.1	1 st Interim Report	GISERA	Apr-22	Jun-22	2021/22	\$10,733
Task 4	4.1	Publication platform development	GISERA	Nov-22	Feb-25	2024/25	\$146,156
Task 5	5.1	Refining geological models	GISERA	Nov-22	Oct-24	2024/25	\$66,147
Task 6	6.1	2 nd Interim Report	GISERA	Apr-23	Jun-23	2022/23	\$8,352
Task 7	7.1	3 rd Interim Report	GISERA	Apr-24	Jun-24	2023/24	\$8,591
Task 8	8.1	Final Report	GISERA	Mar-24	Apr-25	2024/25	\$45,186
Task 9	9.1	Communicate findings to stakeholders	GISERA	May-25	Jun-25	2024/25	\$6,627

12. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	Party	Description of Background IP	Restrictions on use (if any)	Value
				\$
				\$
Ownership of Non-Derivative IP (clause 12.3)	CSIRO			
Confidentiality of Project Results (clause 15.6)	Project Results are not confidential.			
Additional Commercialisation requirements (clause 13.1)	Offer GSWA non-exclusive royalty free licence of project (CSIRO) IP for the delivery of information portal only. No further distribution rights.			
Distribution of Commercialisation Income (clause 13.4)	All income derived from commercialisation of the project IP is owned by CSIRO.			
Commercialisation Interest (clause 1.1)	Party		Commercialisation Interest	
	CSIRO		100%	

13. References

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