Australia's National
Science Agency

GISERA | Gas Industry Social and Environmental Research Alliance

Project Order

Short Project Title

Beneficial reuse and disposal options for brine from the Surat and Bowen basins

Long Project Title	Evaluation of beneficial reuse and disposal options for brine from the Surat and Bowen basins
GISERA Project Number	W.37
Start Date	01/07/2024
End Date	30/06/2026
Project Leader	Prashant Srivastava

GISERA State/Territory

- [x] **Queensland**
- [ ] New South Wales
- [ ] Northern Territory
- [ ] South Australia
- [ ] Western Australia
- [ ] Victoria
- [ ] National scale project

Basin(s)

- [ ] Adavale
- [ ] Amadeus
- [ ] Beetaloo
- [ ] Canning
- [ ] Western Australia
- [ ] Carnarvon
- [ ] Clarence-Morton
- [ ] Cooper
- [ ] Eromanga
- [ ] Galilee
- [ ] Gippsland
- [ ] Gloucester
- [ ] Gunnedah
- [ ] Maryborough
- [ ] McArthur
- [x] **North Bowen**
- [ ] Otway
- [ ] Perth
- [ ] South Nicholson
- [x] **Surat**
- [ ] Other (please specify)

GISERA Research Program

- [x] **Water Research**
- [ ] Health Research
- [ ] Biodiversity Research
- [ ] Social & Economic Research
- [ ] Greenhouse Gas Research
- [ ] Agriculture Research
- [ ] Land and Infrastructure Management Research
- [ ] Other (please specify)

1. Project Summary

South-east Queensland hosts the largest coal seam gas (CSG) producing fields in Australia. The CSG fields in Surat and Bowen basins generate large volumes of produced water rich in various chemicals and salts. The predominant management option for this produced water is treatment through the reverse osmosis (RO) process that produces treated water for beneficial reuse along with a highly saline brine by-product. The brine is considered a waste product with no current beneficial reuse identified. Over the life of CSG activities in Queensland, the total volume of brine produced is expected to contain approximately 5 million tonnes of solid salt.

Local communities have concerns about these large volumes of brine and how they will be managed. To address the community concerns, all the potential options for the beneficial reuse, disposal and management of brine need to be evaluated appropriately and presented to stakeholders.

The aim of this project is to review the beneficial reuse and disposal of brine from the Surat and Bowen basins. The project objectives are to:

1. collate existing data and information on produced water and brine generated due to CSG activities in the Surat and Bowen basins,
2. conduct sampling and characterisation of brine from Surat and Bowen basins,
3. undertake a review of existing and emerging innovative technologies and solutions for beneficial reuse, disposal and management options for brine from Surat and Bowen basins, and
4. conduct a techno-economic analysis (pros and cons) for the options identified.

2. Project description

Introduction

The Bowen and Surat basins in southern Queensland host the largest CSG-producing fields in Australia, with production commencing in the Bowen Basin in the 1990s and from the overlying Surat Basin in 2006. The majority of CSG production is from the Surat Basin, with production extending from Dalby in the southeast to about 80km south of Rolleston. Production from the Bowen Basin extends from Moura north to Glendon.

Gas in coal seams is adsorbed to the surface area of the coal and held in place by groundwater pressure. Therefore, the gas reservoir of the coal seam is ‘capped’ by the pressure of groundwater, which must be reduced (by pumping water out of the coal seam) to reach critical desorption pressure and allow gas to flow. This means that significant volumes of water are extracted, with the current rate of 54,000 ML/year (45,000 ML/year from the Surat and 9,000 ML/year from the Bowen).

The produced water has high concentrations of salt and other components. The chemicals in produced water are predominantly naturally occurring salts, but may also contain a small amount of chemicals used in drilling and hydraulic fracturing.

The predominant management option for this produced water is treatment through the reverse osmosis (RO) process, which is highly effective in removing salt from solutions with up to 99% reduction in total dissolved solids (TDS) concentrations. The RO treatment includes forcing solution under pressure through a membrane to remove ions from the solution with the formation of a purified permeate solution and a concentrated brine solution, containing the membrane-rejected salts. The brine is considered a waste product with no current beneficial reuse identified. The brine can vary in concentrations/composition of salts, metals, TDS, and other contaminants that will influence its reuse and other end-use options, which are socially, environmentally and economically acceptable. Over the life of CSG activities in Queensland, the total volume of brine produced will contain approximately 5 million tonnes of solid salt, which is significantly less than originally estimated for the industry (Queensland Government, 2023).

The CSG developments and the associated activities/processes including the generation of large quantities of brine as a result of CSG extraction activities have been a cause for concern in the local community. To address the community concerns, a thorough assessment including the pros and cons of all potential options for the beneficial reuse and management of brine needs to be conducted and shared with the community.

The Queensland Government's Coal Seam Gas Water Management Policy (DESI, 2012) sets out a prioritisation hierarchy for managing saline waste from CSG activities:

> **Priority 1** – Brine or salt residues are treated to create useable products wherever feasible.
>
> **Priority 2** – After assessing the feasibility of treating the brine or solid salt residues to create useable and saleable products, disposing of the brine and salt residues in accordance with strict standards that protect the environment.

Priority 2 can only be considered once priority 1 has been fully evaluated and determined not to be feasible. This policy emphasizes the need to explore beneficial reuse options for brine or salt.

The CSG Brine Management Action Plan 2023-2033 (Queensland Government, 2023) also recognises the need for further research into alternative options for brine management. The CSG Brine Management Action Plan recognises that while the most feasible option is currently the encapsulation of brine waste, research and investigation of alternative options for brine management must be continued in keeping with circular economy principles within the CSG resources sector.

The key principles for CSG brine management (Queensland Government, 2023) identified within this action plan are to:

- ensure a robust regulatory framework;
- promote a circular economy;
- invest in research and development; and
- increase transparency and stakeholder engagement.

These principles are supported by seven actions to be carried out by the department and industry. The actions include:

- regular reporting of brine volumes;
- review and analysis of the existing regulatory framework for brine management;
- updated departmental guidance on CSG brine management;
- investigating options for providing public access to data relating to environmental impacts of brine management;
- coordinated approach to the consideration of brine management options;
- investing in research and development; and
- publicly reporting on the application of learnings from research and development.

This action plan will be periodically reviewed to ensure currency, taking into account emerging research and development including advancements in technological capability and scientific knowledge.

A key consideration in examining beneficial reuse and disposal options for brine are the characteristics of the brine. While the bulk composition of brine is reasonably well understood as it reflects the composition of the produced water that has been treated, there are additional complexities that will influence beneficial reuse and disposal options. These include:

- spatial variability in composition across Queensland's CSG developments and the two geological basins that have been developed,
- temporal variations as different parts of the resource have been developed,
- ingress of material into brine storage ponds (dust),
- biological processes in brine storage ponds (algae and microbial activity),
- concentration processes in brine storage ponds and the balance between water inflow (rain, addition of brine) and evaporation,

- chemical speciation processes in concentrated brine and precipitating solids,
- compositional variation within brine storage ponds.

These processes will influence the physical and chemical characteristics of brine. Brine has been generated from CSG activities in Queensland for over a decade, with around 13,000 ML of brine stored in 36 brine ponds (Queensland Government, 2023). Additional brine will be produced for the foreseeable future. Understanding the characteristics of brine and the variability will be critical in evaluating the viability of beneficial reuse and disposal options. Laboratory analyses of brine samples is also a challenge because of the high salt concentrations, which effect many of the standard analytical approaches.

Prior Research

Previous GISERA research found that perceptions of community resilience to CSG development were relatively low - 60% of respondents indicated that they believed their community would adapt or transform into something better (Walton et al., 2018). To help maintain the well-being and function of communities, it is important to provide impacted communities with information on the environmental impacts associated with gas extraction.

The brine produced through the RO process can be diverted to storage ponds, concentrated via passive evaporation through to salt crystallisers or enhanced evaporation systems, which require additional energy inputs. Brine can be used as a feedstock for chemical production, such as sodium hydroxide. The concentration of brine to produce salt containing minimal to no liquid can make it considerably easier for beneficial reuse opportunities arising from a solid salt material. The primary salts present in produced water include sodium bicarbonate ($NaHCO_3$), sodium carbonate (Na_2CO_3) and sodium chloride (NaCl) and each of these can be used for a range of industrial applications, such as the production of glass, detergents, animal feeds and sodium hydroxide through to mine site rehabilitation (Hayes, 2020).

A number of reviews have been undertaken to assess various options for brine/salt management, that have highlighted both beneficial reuse and disposal options. Previous studies have considered the beneficial reuse and disposal of CSG brines in Australia, with a number of technically viable options identified (Hayes 2020, Khan and Kordek 2014, Ly 2013). Recent studies by the University of Queensland (2020) have indicated that long-term storage by salt encapsulation was the most viable brine management option at this point. Both studies were used to inform the Coal Seam Gas Brine Management Action Plan 2023-2033 (Queensland Government 2023). These studies considered selective salt recovery as the only beneficial reuse option, and injection, ocean outfall and encapsulation as disposal options, whereas other potential beneficial reuse options could also be considered along with their site-specific techno-economic feasibility.

A current GISERA project exploring the beneficial reuse options for brine at Narrabri Gas Project has considered options such as selective salt recovery, high-value algae cultivation, acid mine drainage neutralisation, recovery of critical raw minerals and other important metals, and harvesting and storing energy (Srivastava et al 2024).

Since these recent assessments of brine reuse and management, likely, some of the options that were previously not considered commercially viable have become feasible in the last 12 months. For example, carbonates can be used for renewable energy storage or synthetic production of nitrates for renewable energy heat transfer applications (Geyer et al. 2022, Bell et al. 2019). In addition, there is a general policy push towards including circular economy issues in all areas of the economy and management of wastes, which is likely to increase the feasibility of beneficial reuse options.

There is a limited amount of data in the public domain on the characteristics of brine derived from CSG activities in the Surat and Bowen basins.

Need & Scope

There is increasing interest from Oil and Gas stakeholders in beneficial reuse options for brines due to their large production volumes that can be difficult to treat and manage in a cost-efficient and sustainable manner. Brine reuse and recycling strategies can provide several benefits, such as reducing wastewater discharge volumes or allowing facilities to increase production volumes while staying within discharge permit limitations. Additionally, some facilities have seen net cost savings by supplementing freshwater demand with waste brine, especially in regions where access to source water may be costly and unreliable.

The production of brine from water treatment must meet the environmental, social, and economic needs of the projects and therefore must ensure community concerns are addressed, environmental harm is minimised, and technical and economic feasibility is achieved. As highlighted by the CSG Brine Management Action Plan 2023-2033 (Queensland Government, 2023), the options available for brine reuse and management must be explored.

An important precursor to the analysis of brine management options is a proper characterisation of the physical and chemical properties of brine and the variability in these properties. This information is needed to allow consideration if the brine characteristics will impact the performance of various reuse and disposal technologies and whether industry wide options are viable or that bespoke solutions are needed for certain brines.

Aims and Objectives

The aim of this project is to review the beneficial reuse of brine from the Surat and Bowen basins. The project objectives are to:

1. Charactise the physical and chemical properties of brines generated through CSG activities in Queensland, including;
    a. Development of brine parameters from brine characterisation;
    b. collation of existing data and information on produced water and brine;
    c. additional sampling and characterisation of brine from Surat and Bowen basins
2. undertake a review of existing and emerging innovative technologies and solutions for beneficial reuse, disposal and management options for brine from Surat and Bowen basins, and
3. conduct a high-level techno-economic analysis (pros and cons) for the options identified.

Methods

Tasks 1 and 2 of this project will collate all relevant literature relating to brine and salt management in the Surat and Bowen basins. Task 1 will focus on the acquisition of existing data from various sources and identifying any data gaps. CSIRO has discussed data availability with some CSG industry partners and will engage with other relevant stakeholders as part of this data collation task. Key brine characteristics will be identified during this task, and are likely to include:

- locations and volumes of brine storage ponds
- composition
- mineralogy
- age, and
- saturation state and level of crystallisation

Relevant information relating to technical, regulatory, economic and environmental aspects of brine reuse will also be considered in Task 1. In addition, an assessment of existing and emerging technological innovations that can be applied to brine or salt for future management strategies, particularly in the context of the identified salt composition in brine samples collected from the Surat and Bowen basins, will be conducted.

Task 2 will focus on the collection of additional data to fill the gaps identified to allow characterisation of brine from CSG activities in Queensland. Given the complexity and variability of brine characteristics, CSIRO will first develop a detailed sampling and analytical quality plan (SAQP) in consultation with industry and other stakeholders via a workshop. The SAQP will take into consideration all the factors to reduce any uncertainties and ensure that the samples collected truly represent the Surat and Bowen basins. Once the SAQP is finalised, brine samples will be collected from different ponds in Bowen and Surat basins and analysed as per the SAQP. To facilitate brine sampling and access any existing characterisation data for brine, CSIRO will engage with the CSG industry. Initial discussions during the development of this proposal have been positive. The SAQP will collect brine samples from the Surat and Bowen basins to cover the spatial and compositional

variability between sites, within individual ponds, and between the bulk composition of brine outflow from treatment plants and brine stored in ponds. CSIRO will also review the geochemical processes (e.g. changes in mineralogy or precipitation) that might occur due to the dehydration of brine.

Task 3 will be to conduct a techno-economic (pros and cons) analysis, with a broad economic viewpoint, of identified promising technology/management interventions/options for the beneficial reuse options for brine from the Surat and Bowen basins. This will involve an assessment of the technical merits and demerits, and impact of each option including a broad economic analysis. The physical and chemical properties of brine and their variability will be an input into this analysis, allowing a high level assessment of how the brine characteristics may impact the performance of the reuse and disposal technologies identified. This work will build on the recently completed studies by the Queensland Government (2023) and the University of Queensland (2020), which considered selective salt recovery as the only beneficial reuse option, and injection, ocean outfall and encapsulation as disposal options.

A face-to-face or virtual workshop will take place at the beginning of the project (within the first 3 months), to discuss with selected industry and key stakeholders about the project aim, scope, methods, timing and expected outcomes. Discussion on brine characterisation and sampling and analytical quality plan will also be held at this workshop. A second workshop will discuss the proposed technical and economic frameworks that will be used to evaluate each of the potential beneficial reuse options for brine. This workshop will be undertaken within the first six-twelve months of the project and the feedback from stakeholders will be used to refine the technical and economic assessment frameworks.

A third and final engagement with industry and key stakeholders will then be organised at project completion. This will cover the communication of project outcomes and key messages, with potential for discussion around any ongoing or future work.

Quarterly progress reports, fact sheets, and a final report will be produced. Presentations will be made at the workshops, and a Knowledge Transfer Session involving government and industry representatives will also be held prior to project completion. The findings of the research will be published in peer-reviewed research journals and national and international conferences subject to GISERA approval.

Sampling and Analytical Quality Plan

A sampling and analytical plan (SAQP) will be prepared in consultation with industry and other stakeholders. Freshly produced brine from the reverse osmosis plants and aged/concentrated brine from evaporation ponds located at different sites will be collected. At this stage, we envisage collecting enough representative brine samples from the Surat and Bowen basins. The samples will then be analysed at the CSIRO analytical laboratory facilities and/or a commercial NATA-accredited analytical laboratory. To facilitate brine sampling and accessing any existing characterisation data for

brine, CSIRO has liaised with some industry partners and will continue engaging with other relevant stakeholders. These data may need to be deidentified for their location and sample IDs for commercial reasons.

Task 1 will define the important characteristics of CSG brine when considering long-term disposal or beneficial use options. These could include, but are not limited to the following:

> TDS, anions/cations, metals and heavy metals, organics (including residual treatment chemicals and those in the water), microbiology, speciation of solids, saturation/solids content, fractionation between liquid and solid phases.

3. Project Inputs

Resources and collaborations

Researcher	Time Commitment (project as a whole)	Principal area of expertise	Years of experience	Organisation
Dr Prashant Srivastava	110 days	Soil and water chemistry, risk assessment and remediation	>20	CSIRO Environment
Dr John Awad	19 days	Water science, civil engineering	>5	CSIRO Environment
Dr Mutah Musa	30 days	Techno-economic analysis	>2	CSIRO Energy
Dr Nawshad Haque	1 day	Techno-economic analysis	>20	CSIRO Energy
Timothy Lai	5 days	Techno-economic analysis	>3	CSIRO Energy
Dr Tara Hosseini	1 day	Techno-economic analysis	>10	CSIRO Energy
Dr Ramesh Thiruvenkatachari	20 days	Water and wastewater treatment	>20	CSIRO Mineral Resources
Dr Se Gong	12 days	Organic geochemistry	>10	CSIRO Energy
Dr David Midgley	10 days	Biogeochemistry and microbiology	>15	CSIRO Energy
Ms Carla Mariani	2 days	Biogeochemistry and microbiology	>5	CSIRO Energy
Mr Kyle Gavrily	8 days	Biogeochemistry and microbiology	>5	CSIRO Energy

Subcontractors (clause 9.5(a)(i))	Time Commitment (project as a whole)	Principal area of expertise	Years of experience	Organisation
Paul Holper	10 days	Scientific writing and editing	>20	Scientell
Analytical laboratory	15-20 days	Analysis of brine samples	Many. Commercial laboratory	TBD

Budget Summary

Source of Cash Contributions	2023/24	2024/25	2025/26	2026/27	% of Contribution	Total
GISERA	$0	$241,198	$72,687	$0	70.1%	$313,886
- Federal Government	$0	$186,253	$56,129	$0	54.13%	$242,381
- APLNG	$0	$25,257	$7,611	$0	7.34%	$32,869
- Origin	$0	$25,257	$7,611	$0	7.34%	$32,869
- QGC	$0	$4,432	$1,336	$0	1.29%	$5,767
Total Cash Contributions	**$0**	**$241,198**	**$103,691**	**$0**	**70.1%**	**$313,886**

Source of In-Kind Contribution	2023/24	2024/25	2025/26	2026/27	% of Contribution	Total
CSIRO	$0	$102,879	$31,004	$0	29.9%	$133,883
Total In-Kind Contribution	**$0**	**$102,879**	**$31,004**	**$0**	**29.9%**	**$133,883**

TOTAL PROJECT BUDGET	2023/24	2024/25	2025/26	2026/27	-	TOTAL
All contributions	**$0**	**$344,078**	**$103,691**	**$0**		**$447,769**
TOTAL PROJECT BUDGET	**$0**	**$344,078**	**$103,691**	**$0**		**$447,769**

4. Communications Plan

Stakeholder	**Objective**	**Channel** (e.g., meetings/media/factsheets)	**Timeframe** (Before, during at completion)
Regional community stakeholders / wider public including landholders and traditional owners	To communicate project objectives and key messages from the research	A fact sheet at the commencement of the project explaining in plain English the objectives of the project. Project progress report on the GISERA website to ensure transparency for all stakeholders including regional communities.	At the commencement of the project Ongoing
Gas Industry	Industry adopts methods for improving understanding of the options for brine beneficial reuse or end-use	A workshop with industry and key stakeholders to discuss project aim, scope, methods, timing and expected outcomes. Discussion on brine characterisation and sampling and analytical quality plan will also be held at this workshop. A second workshop will discuss the proposed technical and economic frameworks that will be used to evaluate each of the potential beneficial reuse options for brine. The feedback from stakeholders will be used to refine the technical and economic assessment frameworks. A third and final engagement with industry and key stakeholders to present research results, with potential for discussion around any ongoing or future work. Fact sheet and project report Presentation of findings at joint Gas Industry/Government Knowledge Transfer Session	Within 3 months of the commencement of the project Within the first six-twelve months of the project At the completion of the project At project completion
Government	The advice provided to senior bureaucrats/ministers/ policymakers	Fact sheet and project report Presentation of findings at joint Gas Industry/Government Knowledge Transfer Session	At project completion
Regional community/wider public, government, scientific community and industry	To report on key findings	Public release of the final report Plain English factsheet summarising the outcomes of the research. Preparation of a news article for GISERA newsletter and other media outlets, as advised by GISERA's communication team.	At project completion At project completion

Stakeholder	**Objective**	**Channel** (e.g., meetings/media/factsheets)	**Timeframe** (Before, during at completion)
Scientific Community	Provide scientific insight into the latest opportunities for brine and salt management	Manuscripts for submission to journals Presentations at national/international conferences in Australia and/or overseas	At project completion

In addition to project-specific communications activities, GISERA has a broader communications strategy. This strategy incorporates activities such as webinars, workshops, newsletters and the development of other communications products.

5. Project Impact Pathway

Activities	Outputs	Short term Outcomes	Long term outcomes	Impact
Review of literature and existing and emerging innovative technologies and solutions for beneficial reuse options for brine	A review of and potential approaches to brine or salt beneficial reuse, disposal and end-use, applicable to the Surat and Bowen basins. Scientific journals will also be reviewed to find technologies for brine and salt management that may not have been previously considered. A review of existing and emerging innovative technologies and solutions for beneficial reuse, disposal or end-use options for brine will be undertaken.	Greater awareness of beneficial reuse or end-use options for brine from the Surat and Bowen basins Satisfied and confident stakeholders	This project will assist the stakeholders in the decision-making with respect to the beneficial reuse or end-use options for brine from the Surat and Bowen basins. A cost-effective, socially acceptable and environmentally-friendly solution to the brine issue. Satisfied and confident stakeholders	Environmental impacts: • Reduction of salt entering the environment Social impacts: • Community confidence in appropriate reuse options for a waste product • Providing opportunities for employment in beneficial reuse Economic impacts: • Cost-effective solution • Ongoing savings or profits from brine
Brine characterisation	Collation of existing data and acquisition of new data on the characteristics of brine. The data will help in the characterisation of brine and understand the variability in key characteristics. CSIRO will liaise with the CSG industry and other relevant stakeholders for this purpose.			
Techno-economic analysis	A techno-economic assessment of identified options for brine reuse and end-use will be undertaken.			
Information sharing with industry and key stakeholders	Up to 3 workshops to be organised to inform and engage industry and key stakeholders to: • discuss project aim, scope, methods, timing, expected outcomes, brine characterisation and SAQP • discuss proposed technical and economic frameworks (feedback from stakeholders will be used to refine the technical and economic assessment frameworks) • present project outcomes and key messages, with potential for discussion around any ongoing or future work.			

Activities	Outputs	Short term Outcomes	Long term outcomes	Impact
Communication	• GISERA Communications will develop a plain English fact sheet at project commencement. • Completed fact sheet with key findings for distribution via the GISERA website. • Final report with detailed outcomes will be prepared. • Manuscripts/abstracts will be prepared for submission to journals/conferences.			

6. Project Plan

Project Schedule

ID	Activities / Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Review of literature and existing and emerging innovative technologies and solutions for beneficial reuse or end-use options for brine	Prashant Srivastava	1 July 2024	30 December 2024	None
Task	Brine characterisation	Prashant Srivastava	1 July 2024	31 March 2025	None
Task 3	Techno-economic analysis	Prashant Srivastava	1 February 2025	30 September 2025	Tasks 1, 2
Task 4	Communication and engagement with industry and key stakeholders (up to 3 workshops)	Prashant Srivastava	1 July 2024	30 June 2026	Tasks 1, 2
Task 5	Communication and reporting of project progress and findings	Prashant Srivastava	1 July 2024	30 June 2026	Tasks 1, 2, 3

Task description

Task 1: Review of literature and existing and emerging innovative technologies and solutions for beneficial reuse options for brine and collation of existing data

OVERALL TIMEFRAME: 6 months (1 July 2024 – 30 December 2024)

BACKGROUND: Task 1 will involve two components. The first a detailed review of the literature and existing and emerging approaches to beneficial reuse and end-use of brine, which could apply to the Surat and Bowen basins. This will build on the work already conducted for the NSW CSG project in Narrabri (Srivastava et al, 2024). A wide range of recent literature including publicly accessible reports and web-based resources related to CSG extraction in Surat and Bowen basins and other sites in Australia or globally will be reviewed. Scientific journals will also be reviewed to find potential options for brine reuse that may not have been previously considered. The second component is the collation and review of existing data on CSG derived brine generated and stored in Queensland. This will allow key characteristics of the brine to be determined and any data gaps to be identified.

TASK OBJECTIVES:

1) Review previous work as published in reports, journals, and web-based resources;
2) Collate and review existing data on the characteristics of brine in ponds in Queensland; and
3) Use this information to inform Tasks 3, 4 and 5.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A draft report that comprehensively reviews previous work will be prepared. This information will feed into later tasks and the results will be discussed in detail in the final report.

Task 2: Brine characterisation

OVERALL TIMEFRAME: 6 months (1 July 2024 – 31 March 2025)

BACKGROUND: Task 2 will focus on the characterisation of brine samples from different sites to address data gaps identified in Task 1. CSIRO will collect brine samples from Bowen and Surat basins and analyse them for various characteristics of brine as prescribed in the (to be) developed Sampling and Analytical Plan. To facilitate brine sampling and accessing any existing characterisation data for brine, CSIRO will liaise with the three industry partners and any other relevant stakeholders. Any data collected or sourced will be deidentified for their location and sample IDs. This task will also review the geochemical processes that occur in brine ponds as they dehydrate, either through laboratory experiments or speciation modelling.

TASK OBJECTIVES: The objectives of the project report will be to:

1) Collect brine samples from existing reverse osmosis plants from Bowen and Surat basins
2) Collect brine samples from existing evaporation ponds from Bowen and Surat basins

3) Analyse brine samples for various parameters
4) Review geochemical processes that occur in brine ponds

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A draft report detailing the brine composition and variability across sites that will feed into the final report. This report will combine the newly-acquired data with existing data obtained in Task 1.

Task 3: Techno-economic analysis

OVERALL TIMEFRAME: 6 months (1 February 2025 – 30 September 2025)

BACKGROUND: A techno-economic analysis (pros and cons) of identified technology/management interventions/options for the beneficial reuse or end-use options for brine from the Surat and Bowen basins will be conducted. This will involve an assessment of the technical merits and demerits of each identified option. In addition, the economic impact, including broad economic analysis of each option will be evaluated. The physical and chemical properties of brine and their variability will be an input into this analysis, allowing a high level assessment of how the brine characteristics may impact the performance of the reuse and disposal technologies identified.

TASK OBJECTIVES: The objectives of the project report will be to:

1) Provide an overview of the technical merits and demerits of current and emerging technologies and their sensitivities to the characteristics of the brine
2) Conduct a techno-economic assessment (pros and cons) of identified technology/management interventions/options

TASK OUTPUTS AND SPECIFIC DELIVERABLES: A draft report detailing the techno-economic assessment of identified technology/management interventions/options; that will feed into the final report.

Task 4: Communication and engagement with industry and key stakeholders

OVERALL TIMEFRAME: Full duration of project (1 July 2024 – 30 June 2026)

BACKGROUND: Up to three workshops will be organised to engage with industry and key stakeholders to elicit existing knowledge and to understand priorities in relation to produced water and brine about CSG brine. The workshops will also be used to develop and refine a sampling and analytical quality program for brine sampling and characterisation.

TASK OBJECTIVES:

- The first workshop aims at engagement with selected industry and key stakeholders and discussing the project aim, scope, methods, timing and expected outcomes, and engaging with stakeholders around their perceived information and communication needs. A discussion on

brine characterisation and sampling and analytical quality plan will also be held at the workshop.

- The second workshop will discuss and refine the proposed technical and economic frameworks that will be used to evaluate each of the potential beneficial reuse options for brine.
- The third engagement will communicate project outcomes and key messages.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: The feedback from the workshops will be considered and incorporated into the final report. Ethics approval for seeking feedback from stakeholders will be obtained prior to engagement.

Task 5: Communication and reporting of project progress and findings

OVERALL TIMEFRAME: Full duration of project (1 July 2024 – 30 June 2026)

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

TASK OBJECTIVES: Communicate project objectives, progress and findings via factsheet(s), reports, presentations and journal article(s), in consultation with GISERA Communications officers. A knowledge transfer session will be organised with key stakeholders at the completion of the project.

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Communicate project objectives, progress and results to GISERA stakeholders according to standard GISERA project procedures which may include, but not limited to:

1) Knowledge Transfer session with Government/Gas Industry.
2) Two project factsheets: A factsheet developed at the commencement of the project, and a second that will include peer-reviewed results and implications developed at the completion of the project, both to be published to the GISERA website.
3) A quarterly report.
4) A consolidated report (from tasks 1, 2, 3 and 4) outlining the scope, methods, findings and any suggestions/options for future research.
5) Following the CSIRO ePublish review, the consolidated report will be submitted to the GISERA Director for final approval.
6) Following the CSIRO ePublish review, a manuscript/abstract based on the report will be submitted to an appropriate journal/conference.

Project Gantt Chart

		2024/25												2025/26											
Task	**Task Description**	**Jul 24**	**Aug 24**	**Sep 24**	**Oct 24**	**Nov 24**	**Dec 24**	**Jan 25**	**Feb 25**	**Mar 25**	**Apr 25**	**May 25**	**Jun 25**	**Jul 25**	**Aug 25**	**Sep 25**	**Oct 25**	**Nov 25**	**Dec 25**	**Jan 26**	**Feb 26**	**Mar 26**	**Apr 26**	**May 26**	**Jun 26**
1	Review of literature and existing and emerging innovative technologies and solutions for beneficial reuse options for brine																								
2	Brine characterisation																								
3	Techno-economic analysis																								
4	Communication and engagement with industry and key stakeholders (up to 3 workshops)																								
5	Communication and reporting of project progress and findings																								

7. Budget Summary

Expenditure	2023/24	2024/25	2025/26	2026/27	Total
Labour	$0	$285,078	$83,691	$0	$368,769
Operating	$0	$37,000	$16,000	$0	$53,000
Subcontractors	$0	$22,000	$4,000	$0	$26,000
Total Expenditure	**$0**	**$344,078**	**$103,691**	**$0**	**$447,769**

Expenditure per task	2023/24	2024/25	2025/26	2026/27	Total
Task 1	$0	$71,812	$0	$0	$71,812
Task 2	$0	$183,564	$0	$0	$183,564
Task 3	$0	$33,430	$37,504	$0	$70,934
Task 4	$0	$36,136	$35,465	$0	$71,601
Task 5	$0	$19,136	$30,722	$0	$49,858
Total Expenditure	$0	**$344,078**	**$103,691**	**$0**	**$447,769**

Source of Cash Contributions	2023/24	2024/25	2025/26	2026/27	Total
Federal Govt (54.13%)	$0	$186,253	$56,129	$0	$242,381
APLNG (7.34%)	$0	$25,257	$7,611	$0	$32,869
Origin (7.34%)	$0	$25,257	$7,611	**$0**	$32,869
QGC (1.29%)	$0	$4,432	$1,336	$0	$5,767
Total Cash Contributions	**$0**	**$241,198**	**$72,687**	**$0**	**$313,886**

In-Kind Contributions	2023/24	2024/25	2025/26	2026/27	Total
CSIRO (29.9%)	$0	$102,879	$31,004	$0	$133,883
Total In-Kind Contributions	**$0**	**$102,879**	**$31,004**	**$0**	**$133,883**

	Total funding over all years	Percentage of Total Budget
Federal Government investment	$242,381	54.13%
APLNG investment	$32,869	7.34%
Origin investment	$32,869	7.34%
QGC investment	$5,767	1.29%
CSIRO investment	$133,883	29.9%
Total Expenditure	**$447,769**	**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	Review of literature and existing and emerging innovative technologies and solutions for beneficial reuse options for brine	GISERA	Jul-24	Dec-24	2024/2025	$50,340
Task 2	2.1	Brine characterization	GISERA	Jul-24	Mar-25	2024/2025	$128,678
Task 3	3.1	Techno-economic analysis	GISERA	Jan-25	Sep-25	2025/2026	$49,725
Task 4	4.1	Communication and engagement with industry and key stakeholders	GISERA	Jul-24	Jun-26	2025/2026	$50,192
Task 5	5.1	Communication and reporting of project progress and findings	GISERA	Jul-24	Jun-26	2025/2026	$34,950

8. 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)	Not Applicable			
Distribution of Commercialisation Income (clause 13.4)	Not Applicable			
Commercialisation Interest (clause 13.1)	**Party**		**Commercialisation Interest**	
	CSIRO		Not Applicable	
	APLNG		Not Applicable	
	Origin Energy		Not Applicable	
	QGC		Not Applicable	

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