EMISSIONS REDUCTION ALBERTA
Final Outcomes Report
**** FOR PUBLIC DISCLOSURE ****

1.0 – Title Page

Project Title	**Effective monitoring of long-term site stability for transparent carbon capture and storage hazard assessment (ENSURE)**
ERA Project ID	E0161579
Name of Project Investigators	**Mirko van der Baan** Professor, Department of Physics University of Alberta Mirko.vanderBaan@ualberta.ca **Sven Anders** Professor, Department of Resource Economics & Environmental Sociology University of Alberta anders1@ualberta.ca
ERA Project Advisor	Jonathan Matthews
Start Date	October 15, 2024
Completion Date	September 30, 2024
TRL at Project Initiation	Level 5
TRL at Project Completion	Level 7
Total Actual ERA Fund	CAD $1,014,816.00
Total Actual Cost	CAD $1,014,816.00
Submission Date	January 23, 2025
Short Project Description	Microseismic monitoring represents a key surveillance technology to verify the integrity of any large-scale CO2 storage, since microseismic events provide direct evidence of CO2 migration within the storage reservoir and of potential caprock failure within the overburden. Verification of seal integrity is a major challenge of CCS technology as it requires the recognition of tiny precursor movements as indicators of injection-related reservoir and caprock dynamics before potential seal failure. Optimally designing cost-efficient fit-for-purpose monitoring systems for this purpose has been identified as a critical knowledge

	gap. At the same time, public acceptance of CCS technology hinges on the ability of the general public to differentiate between harmless microseismic deformations (perceived risks) and earthquakes with damaging potential (actual risks). To avoid the pitfall that improved microseismic monitoring and thus enhanced operational safety, is perceived as an increased threat due to a larger number of registered events, we see the need for a more effective communication strategy to establish trust and transparency between CO2 storage operators and the public. The project goal is to advance microseismic monitoring technology to become an accepted tool for seal integrity verification in large-scale CO2 sequestration operations.

2.0 – Table of Contents

3.0 – List of Tables

None

4.0 – List of Figures

None

5.0 – Executive Summary

Please include a high-level summary of the Project Implementation, the technology, and the outcome of the Project relative to expectations at the approval stage. Please also include a high-level discussion of the environmental benefits outcomes.

Microseismic monitoring is a key technology for long-term surveillance of underground CO2 storage projects. This project demonstrated that (i) advanced data processing methods can significantly improve event detection and location, thereby providing additional data for conformance and containment monitoring; and (ii) findings from the CCS survey on public perception and acceptance will inform the development of strategies for external communication and stakeholder engagement.

6.0 – Project Description

Introduction

Including an outline of technology of process that is the focus on the project

The goal of the proposed project is to advance microseismic monitoring technology to become an accepted tool for seal integrity verification in large-scale CO2 sequestration operations. This requires a robust determination of microseismic detection thresholds, novel microseismic processing tools for long-term seal stability assessment, as well as analyzing differences in public views and perceived risks towards CCS-induced seismicity. We reach this goal through developing advanced analysis tools and comparing existing and new data from a variety of sensor types and networks at various sites in several project countries, including fiberoptic sensors and partly new data acquisition. This will lead to design recommendations for cost-effective fit-for-purpose networks and provide a strategy for the translation of seismological observables into traffic-light-system threshold values. Public perceptions, preferences, and alternative means of communication of CCS technology will be assessed by state-of-the-art empirical socio-economic survey methods using scenarios and parameters provided by the seismological analysis. This will result in recommendations on effective communication strategies for advancing public trust in CCS technology.

Background of the Project

*Description of the general problem or opportunity area that is **the focus of the Project**, **the history behind the Project, team, and partners involved**, etc.*

This project falls under the scope of the ENSURE Consortium, with partners the University of Alberta, Canada; the National Institute for Geophysics and Volcanology (INGV), Italy; TotalEnergies OneTech, France; Shell Global Solutions Inc, The Netherlands; Shell Canada, Canada; Midwest Regional Carbon Initiative (MRCI) operated by Battelle Memorial Institute, USA; BP International Ltd, UK; and Alcatel Submarine Networks Norway AS, Norway. The consortium was created under an ACT (Accelerating CCS Technologies) call for proposals (Round 3).

Project Objectives

Including the objectives from the contribution agreement and any evolution/revision made to the objectives over the course of the project

This project consists of seven objectives; they are:

1. Demonstration of suitability of Distributed Acoustic Sensing (DAS) and surface node acquisition for CCS monitoring.
2. Development of processing tools able to handle integrated datasets.
3. Determination of relative value of down-hole/DAS/surface acquisition for CCS monitoring.
4. Accelerated and improved interpretation of microseismic data, suitable for real-time application.
5. Design case-site specific economic survey experimental studies to quantify public preferences for alternative CCS technology scenarios.
6. Investigate specific impacts of public knowledge, understanding of CCS, risk perceptions, information uncertainty, trust and transparency in current seismic monitoring approaches on CCS acceptance.

Performance/success Metrics identified in the Contribution Agreement

Include a discussion of any evolution/revision made over the course of the project, i.e., the KPI.

Success Metric	***Project target***
Practices informed/influenced	*Validation of the suitability of data acquisition using fiber-optic cables for detecting acoustic emissions and microseismic events during underground CCS experiments*

Publications	*Progress and final reports to ERA, covering all milestones. Scientific presentations at national and international scientific conferences, ACT3 workshops and Consortium workshops. Publication of peer-reviewed academic journals. If warranted, media (print/online) outreach to larger non-scientific community*
Technology development	*Development of processing strategies to deliver induced (micro)earthquake event catalogues (locations, times, magnitudes). Public and scientific dissemination will ensure these can be integrated into commercial products provided by existing service companies*
Monitoring, measuring and verification	*Development and evaluation of cost-effective, geophysical techniques for monitoring, measuring and verification programs for CCS storage sites.*
Identification of appropriate communication strategies	*Recommendations on effective communication strategies for advancing public trust in and transparency of CCS technology to help differentiate between perceived and actual risks.*

No changes occurred to the performance metrics.

Discussion on any changes

Including any changes to corporate structure of the company / Or project consortium since commencement of the project

No changes

Technology risk

Discussion of the technology risks, and how they evolved from the beginning of the Project to Project conclusion. Please include a discussion of all identified risks and whether mitigation strategies worked, and whether challenges arose that were not identified risks.

This project comprises a mix of geophysical research and social perception studies, and as such does not have specific technology risks but is exploratory by its very nature. Geophysical data analysis and software development had initially some startup delays due to backlogs in work permit processing by Immigration, Refugees and Citizenship Canada due to the Covid19 pandemic. Initial hiring delays were overcome by employing additional researchers. Data acquisition proceeded as planned. All milestones were completed at the project end date.

7.0 – Project Work Scope

The project was divided into ten milestones with specific tasks:

1. Data collection by Shell Canada
    a. Installation of a DAS interrogator
    b. DAS data acquisition at Quest
    c. Data validation by an external vendor
2. Data analysis by Shell Canada
    a. Calculation of absolute event locations
    b. Calculation of source mechanisms if sufficient receiver coverage
    c. Comparison of located seismicity to injection parameters
3. Literature review of observed microseismicity in existing CCS sites
    a. Report describing observed microseismicity patterns at existing CCS sites
4. Software development
    a. Development of microseismic location software for absolute hypocenters
    b. Development of microseismic location software for relative hypocenters
    c. Development of software for analysis of source mechanisms
5. Parallel processing of Quest Data by the University of Alberta
    a. Calculation of absolute event locations
    b. Calculation of source mechanisms if sufficient receiver coverage
    c. Comparison of located seismicity to injection parameters
6. Comparison of Shell and Univ of Alberta microseismic results
    a. Exchange of independent processing results from Milestones 2 and 5
    b. Comparative study of independent processing results
    c. Examination of causes underlying any differences in processing results
7. Recommendations for cost-effective monitoring and seal verification
    a. Final report on recommended strategies for data processing, cost-effective monitoring, and seal verification
8. Effective communication strategies: Literature review and survey design
    a. Preparatory literature review on survey design
    b. Design of country-specific surveys

    c. Questionnaire development and translation
9. Effective communication strategies: Survey implementation and initial analysis
    a. Implementation of surveys, conducted by market research providers
    b. Initial analysis of country-specific surveys
10. Effective communication strategies: Survey analysis and synthesis
    a. In-depth analysis of country-specific surveys
    b. Comparison of common and contrasting public perceptions across all countries.
    c. Preparation of final report on survey outcomes per country

8.0 – Commercialization

8.1 – *Discussion of any advancements made toward commercialization, commercial deployment or market adoption*

Participation in external collaborative R&D projects plays an important part in the development of the technologies required to support CCS. In the area of induced seismicity monitoring, ENSURE has provided the opportunity to participate in and learn from trials of a number of key MMV technologies. Working with a diverse group of partners makes the best use of available resources, bringing in fresh insights and complementary expertise.

Seismicity data was acquired in field trials. Advanced data processing methods were shown to significantly improve the performance of event detection (template matching, machine learning, and frequency domain cluster analysis), and location (double-differencing).

Moreover, an extensive survey of the public understanding and acceptance of CCS was run in five countries. The findings from the survey of the public understanding and acceptance of CCS were compiled, published and summarized to inform the development of strategies for external communication and stakeholder engagement.
The close collaboration between academia and industry stakeholders within the project provided an ideal test bed for technology development and data processing advancements and helped to develop new ideas for all partners. In particular the work package on communication research showed that (independent) microseismic monitoring can play a pivotal role in enhancing public acceptance of CCS through its unique capability towards both seal integrity verification and seismic early warning for risk mitigation. This will in particular foster commercialization as it gives operators some hands-on guidelines for embedding microseismic monitoring into their long-term MMV strategies.

8.2 – Description of technology advancement over the course of the Project

- *Provide an update on the achievement of performance/success metrics outlined in the Contribution Agreement*
    - Validation of the suitability of data acquisition using fiber-optic cables for detecting acoustic emissions and microseismic events during underground CCS experiments
        - *Outcome*: An in-well DAS system was used at Quest to acquire microseismic data. Results showed that DAS data acquisition and event detection capabilities have now improved to the point at which DAS can be considered as a complement to conventional seismometer recordings.
    - Progress and final reports to ERA, covering all milestones. Scientific presentations at national and international scientific conferences, ACT3 workshops and Consortium workshops. Publication of peer-reviewed academic journals. If warranted, media (print/online) outreach to larger non-scientific community
        - *Outcome*: See list of publications below under point 12
    - Development of processing strategies to deliver induced (micro)earthquake event catalogues (locations, times, magnitudes). Public and scientific dissemination will ensure these can be integrated into commercial products provided by existing service companies
        - *Outcome*: Advanced data processing methods were shown to significantly improve the performance of event detection and location algorithms. The interactions and collaborations with all ENSURE partners has facilitated commercial and industrial uptake of developed algorithms.
    - Development and evaluation of cost-effective, geophysical techniques for monitoring, measuring and verification programs for CCS storage sites.
        - *Outcome*: As indicated, the developed techniques provide means of increasing the information content and business value of acquired data: data processing techniques which reduce event detection thresholds result in a greater volume of usable data from a given acquisition system; reduced event location uncertainties result in more confident interpretations of data; hybrid networks integrate multiple data types to extend coverage and reduce ambiguities.
    - Recommendations on effective communication strategies for advancing public trust in and transparency of CCS technology to help differentiate between perceived and actual risks.
        - *Outcome*: The findings from the survey of the public understanding and acceptance of CCS were compiled, published and summarized to inform the development of strategies for external communication and stakeholder engagement

- *Provide an update on the technology readiness level (TRL) advancement from the beginning of the Project to completion*

  Because of the scope of the research program and its interdisciplinary nature, the results span a large range of Technology Readiness Levels (TRLs).

  - Milestones 1 and 2 (data acquisition and operator/vendor-based processing): TRLs 3-7, possibly 3-9, ranging from basic research to field-scale testing. The large range occurs because these milestones involved novel analysis techniques (e.g., noise assessments), compared different sensor technologies and network setups using existing and new data, thus spanning multiple TRLs. Notably, the deployment and evaluation of fibre-optic cables for monitoring of induced seismicity in a commercial setting (Shell Quest) involves feasibility research through to technology development and demonstration.
  - Milestones 3 - 7 (Advanced microseismic processing and interpretation): TRLs 1-7. These milestones cover fundamental research, yet their applicability and testing on field data remains at the forefront of the research objectives.
  - Milestones 8 - 10 (Effective communication strategies) have no associated technology readiness level; yet we believe that may help in generating a social license to operate by the general public in multiple jurisdictions, thereby aiding in the scale up of existing and planned CO2 sequestration projects.

9.0 – Lessons Learned

Discussion of any challenges, delays, or obstacles encountered during the Project

Since this project was kicked off during the COVID-19 pandemic, delays were encountered in hiring research personnel. This challenge was overcome by hiring additional people

Important lessons learned, including learnings around business, government policy, regulation, commercialization, technology development, etc.

The value delivered by ENSURE lies in the testing and further development of a suite of techniques which specifically address the needs of CCS projects for cost-effective monitoring.

ENSURE has shown which methods work and how these can be implemented. Key high-level findings are the value of hybrid networks, and a much-improved understanding of the utility of DAS for seismicity monitoring.

The ERA-funded component demonstrated that (i) advanced data processing methods can significantly improve event detection and location, thereby providing additional data for conformance and containment monitoring; and (ii) findings from the CCS survey on public perception and acceptance will inform the development of strategies for external communication and stakeholder engagement.

10.0 – Environment Benefits

10.1 – Emissions Reduction Impact

For Projects that result in future and indirect GHg emissions reductions, o.e., after subsequent market adoption or future commercialization,

- *Please provide a forecast of the estimated annual GHG reductions in Alberta from commercial roll out of the technology in Alberta by the years 2030 and 2050, and thereafter*
- *The expected start date of commercialization and level of market saturation and speed of market adoption should be described. This can be presented as a year-over-year commercial rollout, or it can be in reference to a published reference market size and anticipated % of adoption*

Discussion regarding how the completed Project may help facilitate a low-carbon economy and secure Alberta's success in a GHG-constrained future should be included.

The project goal is to advance microseismic monitoring technology to become an accepted tool for seal integrity verification in large-scale CO2 sequestration operations. This requires a robust determination of microseismic detection thresholds, novel microseismic processing tools for long-term seal stability assessment, as well as analyzing differences in public views and perceived risks towards CCS-induced seismicity. We reached this goal through developing advanced analysis tools and comparing existing and new data from a variety of sensor types and networks at various sites in several project countries, including fiberoptic sensors and partly new data acquisition. This will lead to design recommendations for cost-effective fit-for-purpose networks and provide a strategy for translation of seismological observables into traffic-light-system threshold values.

Public perceptions, preferences, and alternative means of communication of CCS technology were assessed by state-of-the-art empirical socio-economic survey methods using scenarios and parameters provided by the seismological analysis. This will result in recommendations on effective communication strategies for advancing public trust in CCS technology.

Given the research-intensive nature of this project, developed insights have long-term impacts on monitoring of underground CO_2 storage, thus facilitating the transition to a low-carbon economy. Application to the Quest site located in Alberta demonstrates its value to the CCUS objectives of the Province of Alberta in particular.

10.2 – Other Environmental Impacts

No other direct environmental impacts are anticipated.

11.0 – Economic and Social Impacts

11.1 – Description of the projected economic impacts in Alberta, including revenues, cost savings, job creation, investment attraction, economic diversification, tax revenue, etc., based on the outcomes of the Project

Hires as part of this project exceeded 9.5 person years. Other long-term impacts are described under point 10.1.

11.2 – Description of how the Project has resulted in ***increased innovation capacity*** *in the province* ***through training of highly-skilled personnel****,* ***knowledge development****,* ***postsecondary partnerships****,* ***research organizations****,* ***startup companies****, etc.*

This project was an academia-industry collaboration. As such multiple highly-skilled personnel were hired and trained at MSc, PhD and postdoctoral level (see team list under point 6) with knowledge development and transfer as a primary objective.

11.3 – Discussion of how the Project impacted local communities, underserved communities, and/or indigenous groups

Work predominantly occurred in offices in Calgary and Edmonton, and as such had little impact on local communities.

11.4 – Discussion of any other equity, diversity and inclusion related Project work and outcomes

Participation in external collaborative R&D projects plays an important part in the development of the technologies required to support CCS. Working with a diverse group of partners makes the best use of available resources, bringing in fresh insights and complementary expertise. EDI is strongly considered in the selection and hiring of involved research personnel, who represent multiple visible minorities.

12.0 – Scientific Achievement

Knowledge transfer via public dissemination of research results was an important performance metric (see sections 6 and 8.2). Work conducted during the project led to the following publications:

Conference publications and presentations:

1. Mohammed, Abdul-Hamid, Anders, Sven & Lokuge, Nimanthika. Heterogeneity in Public Perceptions of Hydraulic Fracturing. National Canadian Agricultural And Resource Economics Conference. Whistler, BC, Canada. 2023-07-17.

2. Lokuge, Nimanthika, Nimanthika, Phillips, Jordan, Anders, Sven, van der Baan, Mirko. Induced Seismicity and Public Perception of Hydraulic Fracturing: A Vignette Experiment. National Canadian Agricultural And Resource Economics Conference. Whistler, BC, Canada. 2023-07-18.

3. Anders, Sven. Public perceptions and preferences for Carbon Capture and Storage in Europe and Canada. University of Calgary. 2023 ABBY-Net Research Consortium Member Workshop. 2023-08-04.

4. Anders, Sven. Canada is going on Carbon Removal Do Canadians agree? . Sustainability Council Lecture Series at the University of Alberta. 2023-10-30.

5. Fadil, Wardah, Grubas, Serafim & van der Baan, Mirko. Improved microseismic event detection with CATS: A case study of the Quest CO2 storage facility, GeoConvention 2024, Calgary AB, Canada. 2024-06-17.

6. Anders, Sven, Jürgen Meyerhoff, Ulf Liebe, Nimanthika Lokuge, & Abdul-Hamid Mohammed. Public Support for Carbon Removal and the Issue of Cross-border Transport of CO2. Huazhong Agricultural University, Wuhan, China. 2024-06-18.

7. Lokuge, Nimanthika, Anders, Sven & van der Baan, Mirko. Are Canadians willing to fund Carbon Capture and Storage? Finding the balance between climate benefits and deployment costs. 2024 CAES Annual Meeting. Winnipeg MB, Canada. 2024-07-07.

8. Mohammed, Abdul-Hamid & Anders, Sven. Public Perceptions and Preferences for CCS Development in Canada. 2024 CAES Annual Meeting. Winnipeg MB, Canada. 2024-07-07.

9. Mohammed, Abdul-Hamid, Anders, Sven , & van der Baan, Mirko. Public Perceptions and the Acceptance of CCS Development In Canada – A Vignette Experiment. The 17th Greenhouse Gas Control Technologies Conference (GHGT-17). Calgary AB, Canada. 2024-11-05.

10. Lokuge, Nimanthika, Nimanthika, Anders, Sven, van der Baan, Mirko. What CCS Should Look Like in Canada? Trade-offs Between Climate Benefits, Seismic Risks and Deployment Costs. The 17th Greenhouse Gas Control Technologies Conference (GHGT-17). Calgary AB, Canada. 2024-11-05.

11. Goertz-Allmann B, Baird A, Fadil W, Kuehn D, Langet N, Oates S, Rebel E, Van der Baan M, Vernier J, Wienecke S, Yang X, Oye V, Winsor J and Rowe C. (2024) *Optimized microseismic detection and source analysis at the Quest CCS site, Alberta, Canada.* 17th International Conference on Greenhouse Gas Control Technologies, GHGT-17, Calgary. 2024-11-05

Invited Talks:

1. Anders, Sven, N. Lokuge, A.H. Mohammed, J. Meyerhoff, U. Liebe, & M. van der Baan. Public Perceptions and the Acceptance of Storing Carbon Underground. ENSURE Fall Consortium Meeting 2024. Shell Headquarters, Amsterdam, The Netherlands. 2023-11-15.

2. Fadil, Wardah, Grubas, Serafim & van der Baan, Mirko. Improving microseismic event detection at Quest with Cluster Analysis of Trimmed Spectrograms (CATS). ENSURE Fall Consortium Meeting 2024. Amsterdam, The Netherlands. 2023-11-16.

3. Fadil, Wardah, Hazra, Somak, Yang, Xu & van der Baan, Mirko. ENSURE WP2 at University of Alberta: Induced seismicity monitoring at Quest, source parameter estimations, subspace event detection and relative relocations. ENSURE Fall Consortium Meeting 2024. Amsterdam, The Netherlands. 2023-11-16.

4. Anders, Sven, N. Lokuge, A.H. Mohammed, J. Meyerhoff, U. Liebe, M. van der Baan. Public Acceptance of CCS - Dutch Citizen Perspectives. The Hague, Netherlands. 2024-04-11.

Journal Articles:

1. Mohammed, Abdul-Hamid, Sven Anders & Nimanthika Lokuge. Public Perceptions and Acceptance of Carbon Capture and Storage for Greenhouse Gas Mitigation. Working Paper, Department of Resource Economics and Environmental Sociology. 2023-10-24.
2. Anders, Sven, Jürgen Meyerhoff & Ulf Liebe,. Public Support for Carbon Removal and the Issue of Cross-border Transport of CO2. Nature Climate Change. 2024-05-21.
3. Lokuge, Nimanthika, Jordan Phillips, Sven Anders & Mirko Van Der Baan. "Human-induced seismicity and the public acceptance of hydraulic fracturing: A vignette experiment", The Extractive Industries and Society. 2023-09-01.

Theses:

1. Mohammed, Abdul-Hamid. "The Nexus of Public Perceptions of Contemporary Energy Technologies in the Face of Climate Change". Master's Thesis. Defended on September 27, 2023.

Awards:

1. Best Oral Presentation, Honorable Mention in GeoConvention 2024. Calgary AB. Wardah Fadil for Improved microseismic event detection with CATS: A case study of the QUEST CO2 storage facility.

13.0 – Overall Conclusions

Summary of the Project outcomes and resulting GHG emissions reductions attributed to this Project in Alberta and/or abroad.

Microseismic monitoring is a key technology for long-term surveillance of underground CO2 storage projects. This project demonstrated that (i) advanced data processing methods can significantly improve event detection and location, thereby providing additional data for conformance and containment monitoring; and (ii) findings from the CCS survey on public perception and acceptance will inform the development of strategies for external communication and stakeholder engagement.

14.0 – Next Steps

Discussion about the next steps for the technology/process/innovation, including potential follow-up Projects. Long-term plan for commercialization of the Project technology/learnings. Commercialization-related actions to be undertaken within two years of Project completion. Potential partnerships under development with technology integrators, adopters, etc.

The collaboration between Shell Canada and the University of Alberta continues within the Consortium of Distributed and Passive Sensing, with dedicated research topics on long-term monitoring of underground CO2 storage. Knowledge and technology transfer are core pillars of the Consortium.

15.0 – Communications Plan

The project has been actively engaging in knowledge sharing with the public. The project has had media outreach and extensive scientific knowledge sharing.

- **Summary of the knowledge sharing activities**

The research outcomes were presented at various national and international events, including GHGT-17, GeoConvention, and the National Canadian Agricultural And Resource Economics Conference. In summary, knowledge-sharing activities include 11 conference presentations, 3 articles, 4 invited presentations, and 1 thesis. One of the conference presentations was awarded Best Oral Presentation, Honorable Mention in GeoConvention 2024.

- **Communications Plans for the Future**

(1) Active engagement in knowledge dissemination events within academic settings
Several conference publications have been submitted and presented. At least three scientific papers are in preparation. Knowledge dissemination will also occur within the annual meetings of the Consortium for Distributed and Passive Sensing, an industry-sponsored research consortium.

Materials in Preparation with Current Titles:

1. Fadil, Wardah & van der Baan, Mirko. Improved Microseismic Monitoring at the Quest CO2 Storage Facility with Cluster Analysis of Trimmed Spectrograms (CATS). Abstract submitted to Carbon Capture, Utilization, and Storage Conference 2025. Houston TX, The United States. *2025-03-05*.
2. Fadil, Wardah & van der Baan, Mirko. Improved microseismic event detection and classification based on time-frequency analysis with CATS: A case study of the Quest CO2 storage facility, Alberta. Abstract to be submitted to GeoConvention 2025. Calgary AB, Canada. *2025-01-20*.
3. Yang, Xu & van der Baan, Mirko. Enhanced microseismic event detection via template matching and PhaseNet at the Quest CCS site, Alberta, Canada. Abstract to be submitted to GeoConvention 2025. Calgary AB, Canada. *2025-01-20*.
4. Lokuge, N., S. Anders, J. Meyerhoff & U. Liebe. How does the public perceive CCS deployment within a broader portfolio of decarbonization strategies? Exploring within- and cross-country acceptance using a best-worst scaling approach. Working paper to be submitted to a journal publication in June 2025.

(2) Public outreach
Apart from dissemination of our knowledge through academic events, we have raised awareness of this project through online and print interviews. Professor Sven Anders **has**

done a podcast on Spotify, one of the largest providers of music streaming services, in collaboration with the **Alberta Land Institute** on the public perception of CCS to raise public awareness. Another print interview was published in **Folio**: Researchers and industry team up to assess long-term effectiveness and public perceptions of carbon storage technology, as well as an associated media release of Emissions Reduction Alberta, featuring the ENSURE project.

16.0 – Literature reviewed / Works Cited

None in this report. A full list can be found in the individual scientific publications.