# Weyburn-Midale $CO_2$ Project

## *Best Practices Manual*

The Weyburn-Midale $CO_2$ Project has produced one of the most extensive, peer reviewed data sets in the world regarding $CO_2$ geological storage. As a major product of the Project, involved researchers will contribute toward developing a manual to address major aspects associated with the transition of $CO_2$-EOR operations into long-term $CO_2$ storage sites.

The Best Practices Manual will focus on the technical strengths of the Weyburn-Midale Project which include:

***Technical Components***

- Seismic monitoring
- Geochemical monitoring
- Well-database
- Geological framework/characterization
- Rich dataset

***Non-technical components***

- Regulatory issues
- Public communication and outreach
- Business environment

**Industry Participation Key to Success**

Continued funding from industry partners will result in scientific and policy/regulatory guidance for $CO_2$ geological storage projects anywhere they are being considered.

**Cost to Buy In**

Participation in this multi-million dollar project secures access to world-leading results and produces tremendous leverage regarding all aspects of $CO_2$ geological storage.

A one-time fee of $700,000 (US Funds) is required for new funders to buy into the full research reports, database and current on-going research results.

**"Cenovus is pleased to be participating in this international research project, which will provide guidance for future enhanced oil recovery and carbon sequestration operations for years to come."**

Don Swystun,
President of Cenovus Energy's Canadian Plains Division

**"Apache continues to identify efficient, cost-effective solutions to reduce greenhouse gas emissions. The research and knowledge amassed by the PTRC is integral to understanding $CO_2$ geological storage. Being able to leverage that information through our partnership with the PTRC has been a keystone in Apache's success."**

*John Crum, Co-Chief Operating Officer and President – North America*
*Apache Corporation*

*Internationally recognized leader*

*in $CO_2$ geological storage research*

Research from the Weyburn-Midale $CO_2$ Project, conducted in the world's largest natural laboratory, is leading the development of $CO_2$ geological storage as an economically viable global climate change strategy.

***Key Contacts:***

The Project Integrator, on behalf of the Leading Sponsors, will ensure the integration between the Project's technical and policy research activities. For more information, please contact:


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# I E A G H G
# Weyburn-Midale
# $CO_2$ Monitoring
# and Storage Project

*The World's First $CO_2$ Measurement, Monitoring & Verification Initiative*

**"The continued success of this Project will have incredible implications for reducing $CO_2$ emissions throughout the world."**

John Gale, General Manager
International Energy Agency, Greenhouse Gas R&D Programme

IEA GHG
Weyburn-Midale
$CO_2$ Monitoring
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# IEA GHG Weyburn-Midale $CO_2$ Monitoring and Storage Project

IEA GHG Weyburn-Midale $CO_2$ Monitoring and Storage Project

Recognized and endorsed by:

- The International Energy Agency Greenhouse Gas R&D Programme (ensuring technical excellence)
- The Carbon Sequestration Leadership Forum (ensuring sound policy and regulatory development)

Launched in 2000, this 11-year, $80 million initiative studies carbon dioxide ($CO_2$) injection and storage underground in depleted oil fields.

## World's Largest Natural Laboratory

The Weyburn-Midale Project is conducted in conjunction with two billion-dollar commercial $CO_2$ floods in Saskatchewan, Canada (Weyburn and Midale) where huge volumes of the gas are injected to revive oil production.

- As of June 2010, more than 18 million tonnes of $CO_2$ have been injected and stored, with approximately 3 million tonnes injected annually
- Phase 1 results (2000-2004) indicated that the natural geological setting is highly suitable for long-term $CO_2$ storage
- Final Phase results (2005-2011) aim to address long-term monitoring and storage, and provide best practices for transitioning to $CO_2$ storage from enhanced oil recovery operations globally

## Addressing Climate Change

The effects of climate change are becoming all too evident. That's why it is crucial to validate the potential of $CO_2$ geological storage technology to reduce global atmospheric greenhouse gas concentrations right now.

- In one oilfield alone, the Weyburn $CO_2$ flood operated by Cenovus will store 30 million tonnes of $CO_2$
  - Equivalent to removing 6.8 million cars off the road for a year
- 10,000 billion tonnes of $CO_2$* could potentially be kept out of the atmosphere if the technology proven in this project is applied on a worldwide scale
  - That's like eliminating 425 years' worth of global $CO_2$ emissions

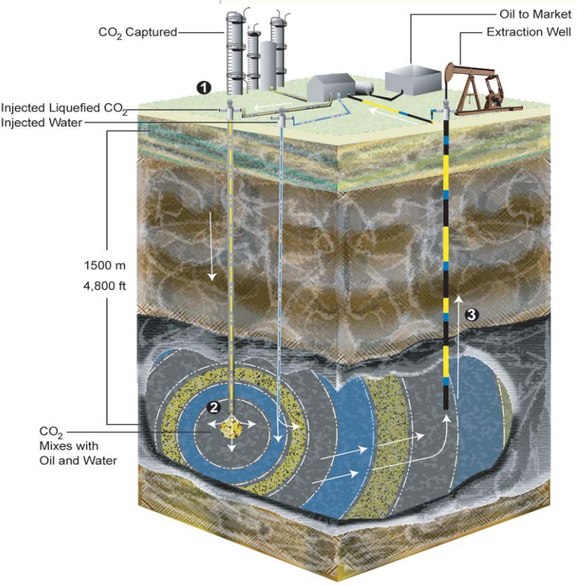
* Intergovernmental Panel on Climate Change (includes saline aquifer storage potentials)

## Profit Boosting Technology

The Weyburn-Midale Project is applying a rigorous scientific approach to the injection and storage of $CO_2$ from industrial sources – a technique that's proving to be good for both the environment and the bottom line.

- 18,000 incremental barrels of oil per day produced in Cenovus's Weyburn field as a direct result of $CO_2$ injection
  - 60 % increase
  - 155 million incremental barrels of oil expected by end of $CO_2$ flood
- 1,000 incremental barrels of oil per day produced in Apache's Midale Field as a direct result of $CO_2$ injection, and still rising
- 3.8 billion incremental barrels of oil potential in western Canada using $CO_2$ injection technology
  - The worldwide potential: huge

## How Does Enhanced Oil Recovery by $CO_2$ Injection Work?




1) $CO_2$ is injected, along with water, deep underground (1,500 metres at the Weyburn field) into a depleted oil field. The $CO_2$ used at Weyburn and Midale comes from the Dakota Gasification Plant in Beulah, North Dakota. There, the gas is captured after coal gasification (rather than vented to the atmosphere), liquefied by compression and pipelined 320 km north to the oilfields. It is the first time a man-made source of $CO_2$ has been used for enhanced oil recovery.

2) In an operating strategy that alternates gas and water injection, $CO_2$ injection increases reservoir pressure and oil fluidity, enabling oil to escape from rock pores and flow more readily toward production wells.

3) Much of the injected $CO_2$ is pumped to the surface together with oil and water, then separated and re-injected. At the end of the enhanced oil recovery period, virtually all injected and recycled $CO_2$ is permanently stored.

"The Weyburn-Midale Project is the most exhaustive study of effective, leading-edge technologies for $CO_2$ geological storage."

**Dr. Malcolm Wilson, Lead Author,**
IPCC Special Report on Carbon Dioxide Capture and Storage

## Final Phase* (2005-2011)

An integrated approach between technical and non-technical research will bring the Weyburn-Midale Project's Final Phase to a successful conclusion.

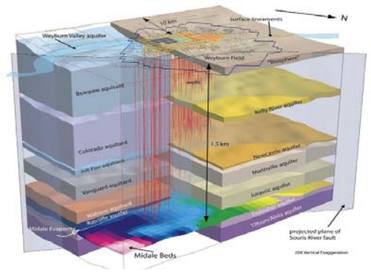
## 4 Technical Themes

*Theme 1: Site Characterization*

Develop geocellular framework models incorporating geotechnical information for simulation work and identify and supply appropriate data requirements for Risk Management studies.

*Theme 2: Wellbore Integrity*

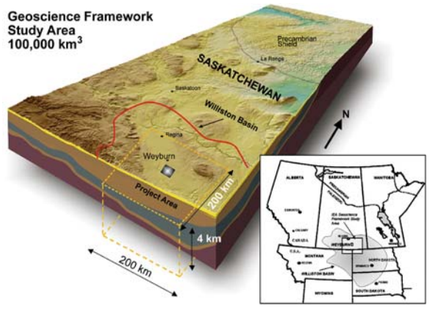
Increase knowledge and assessment of risks associated with leakage from abandoned wells caused by material and cement degradation. This area is among the most critical to resolving questions around long-term CCS security.




A 3D geological model has been constructed from ~1000 wells for an area extending 200 km beyond the limits of the Weyburn field $CO_2$ injection area and 4km deep.

*Business Environment*

Work with key stakeholders and policymakers to influence the development of a large, economic, anthropogenic $CO_2$ supply and infrastructure, along with mechanisms for monetizing credits for $CO_2$ geological storage.




Extensive historical field and well datasets make Cenovus's Weyburn field and Apache's Midale field, located in southeast Saskatchewan, Canada, ideal natural laboratories for $CO_2$ geological storage research.

*Theme 3: Monitoring and Verification*

Field test and assess a range of geochemical and geophysical techniques for monitoring injected $CO_2$.

*Theme 4: Performance Assessment*

Perform simulation studies for containment and performance assessments and contrast risk management methodologies. Engage public stakeholders and experts in the risk assessment process.

## Policy Research

*Regulatory Issues*

Engage regulators and stakeholders to identify and address enhancements to existing regulatory frameworks necessary to ensure long-term safety and security of geologically stored $CO_2$.

*Public Communications and Outreach*

With key stakeholders, develop and deliver a communications plan based on the Weyburn-Midale experience and other major international projects to ensure a more common understanding of $CO_2$ geological storage and associated issues. A public communications and outreach website has been launched: www.ccs101.ca.

* Final Phase project deliverables subject to change