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Petroleum Technology
Research Centre

EXPERIENCE COLLABORATION IMPACT

Petroleum Technology Research Centre
2013/2014 Annual Report



Index

About the PTRC	1
Letter from the Chair	2
Letter from the CEO	3
Board of Directors and Structure	4-5
Our Work	
PTRC and Meeting the Challenges of Oil Recovery	6-7
From STEPS to HORNET	8
Portable Water Treatment in the Oil Industry	9
Building on PTRC's Extensive CO₂-EOR and Storage Research Capacity	
Disseminating Results to a Global Audience	10
SaskCO₂USER	11
Aquistore	12
PTRC in the Community	13
Financials	
Auditor's Report	14
Condensed Statement of Financial Position	15
Condensed Statement of Operations and Unrestricted Net Assets	16
Condensed Statement of Cash Flows	17



About the PTRC

About the PTRC

The Petroleum Technology Research Centre (PTRC), a not-for-profit corporation founded in 1998 by the Government of Saskatchewan, Natural Resources Canada, the University of Regina and Saskatchewan Research Council, is located in the Innovation Place Research Park in Regina, Saskatchewan, adjacent to the University of Regina campus. Its diverse portfolio of research projects is funded through contributions from several federal, provincial and private sector partners, including direct funding in fiscal year 2013-14 from:

- Government of Canada: Western Economic Diversification; Business-Led Networks of Centres of Excellence.
- Saskatchewan Government: Ministry of the Economy, Ministry of Environment, Innovation Saskatchewan.
- Private Sector: Canadian and internationally based oil and gas companies, utilities and technology providers.
- Sustainable Development Technology Canada (SDTC).

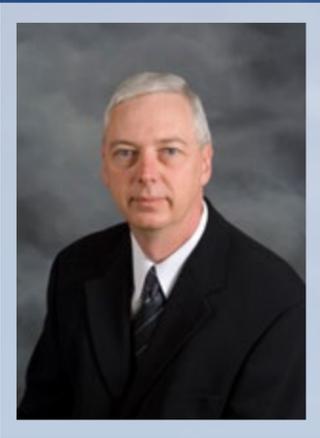
In addition, in-kind research support is provided by the University of Regina's Petroleum Systems Engineering program and the Energy Division of the Saskatchewan Research Council – both of which are housed in the PTRC building. Additional research partners include organizations and universities from across Canada, the United States and the world.

The PTRC is governed by a Board of Directors comprising representatives of the founding partners and industry leaders operating in western Canada.

Vision and Mission

The vision of the PTRC is to be the organization of choice for collaborative petroleum research in Saskatchewan and Canada. Its mission is to initiate and deliver research programs to enhance the efficiency of oil and gas production. PTRC will achieve this vision by leveraging governmental support with industry expertise, harnessing the capability and capacities of research providers. To do this efficiently, PTRC will focus on research themes that serve as the foundation for a series of research initiatives and projects. These themes include:

- Heavy oil
- CO₂ storage and CO₂-EOR
- Light oil/tight oil



LETTER FROM THE CHAIR

The year 2013-14 proved to be transformative and transitional for the PTRC. With the completion of the final few projects in the STEPS Business-Led Networks of Centres of Excellence program, the company moved on with industry and Government of Saskatchewan funding partners to develop the new Heavy Oil Research Network (HORNET) with projects moving forward in enhanced waterflooding, solvent injection and other areas key for improving heavy oil recovery in Canada. This renewed industry focus by the PTRC bodes well for a planned future research program into light and tight oil – directed to recovery from the Bakken and other tight oil formations in the province.

PTRC also continued to receive international attention in 2013-2014 for its CO₂ storage research. The United States Department of Energy, partnering with the Saskatchewan Government, provided funding for a further seven research projects to follow up on the wealth of data and findings from the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project. The new program, called Saskatchewan CO₂ Oilfield Use for Storage and EOR Research (SaskCO₂USER) is looking into applied research for the recognition of commercial CO₂-EOR operations as storage sites. This is a logical and important outgrowth of the measurement, monitoring and verification work done at the Weyburn and Midale fields. The project will help better inform prospective CO₂-EOR operators, regulators and service providers on how to maintain safety and integrity of CO₂ storage, improve the recovery rates and efficiencies of EOR operations, and reduce potential risks of such operations.

This annual report will provide many more details of the rich work currently underway at the PTRC, as well as outline the company's commitment to improving the economic and environmental aspects of petroleum recovery, and to supporting the community in which it operates. The PTRC is justly proud of its funding of the Educating Youth in Engineering and Science (EYES) program, which enrolls thousands of elementary school students in science camps each summer; the company is also a very big supporter of the engineering students at both the province's major universities, offering scholarships and the chance to participate in one of many funded research projects.

I'd also like to take this opportunity to personally thank the members of the PTRC Board of Directors for their continued hard work and support. This past year we welcomed three new members to the Board - Dr. Esam Hussein, the new Dean of Engineering and Applied Sciences at the University of Regina; Martin Aube, Director General of Energy Innovation at Natural Resources Canada; and, Michael Crabtree, the Vice President of Energy at the Saskatchewan Research Council. We also welcomed a new Chief Executive Officer, Mr. Ken From, who brings with him a wealth of industry experience and knowledge that should prove invaluable.

Finally, I'd like to thank the PTRC staff members themselves, for their expertise and commitment displayed in the workplace.

Sincerely,

Brian Watt
Chair



LETTER FROM THE CEO

This is my first public letter as the head of PTRC. Like most first time authors – and as a new CEO taking over from different predecessors stretching back to 1998 – I need to tap into what has happened historically, while shaping a future that responds to new business realities and challenges. For 2013-2014, the PTRC has renewed its vigor in engaging with our industry partners – fostering new connections, developing new areas of research, and drawing from our past strengths. Our core business has always been in two main areas – enhanced oil recovery (EOR) and CO₂ storage – and the company saw the successful completion of some projects as it moved in new directions.

The IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project came to an end in 2012 with the publication of a Best Practices Manual that continues to disseminate important CO₂ monitoring and storage knowledge to a worldwide audience. The Joint Implementation Vapour Extraction field trials (JIVE) were completed in 2010 and have provided invaluable data for companies using solvent injection methods to increase oil production from Saskatchewan's heavy oil fields. These successes were well communicated in previous annual reports.

The 2013-14 year proved to be one of transition and change for the company. This year marked the conclusion of Government of Canada funding for the Sustainable Technologies for Energy Production Systems (STEPS) Business-Led Network of Centres of Excellence, a five year enhanced oil recovery research program that saw advances in the areas of reservoir characterization, wormhole research, enhanced waterflooding, and solvent extraction. Our new program to emerge out of STEPS – the Heavy Oil Research Network, or HORNET – renews our focus on industry-driven research. Fourteen new projects were approved by our Technical Advisory Group made up of representatives from sponsoring oil companies.

PTRC's past research successes in CO₂ monitoring and storage were also rewarded in 2013 with additional funding from the United States Department of Energy and the Government of Saskatchewan for our new SaskCO₂USER project. Using the Weyburn-Midale research as a foundation, this project will expand research into storage, wellbore integrity, predicting CO₂ migration underground, and the identification of effective monitoring techniques.

Aquistore also advanced its research into deep saline CO₂ storage with ongoing seismic, soil gas and ground water monitoring ahead of the arrival of CO₂ from the Boundary Dam Integrated Capture Facility. PTRC successfully completed the transfer of ownership for the wells and permanent seismic array to SaskPower in November, 2013. PTRC will continue to manage the research side of CO₂ injection as it occurs in the coming years.

I joined the PTRC early in 2014, and would like to take this opportunity to thank employees for their support and hard work in my early days here. I'd also like to take this opportunity to commend the members of our Board, who have offered invaluable direction in my first year, and been open to the renewal of the PTRC as a world-leader in EOR and CO₂ storage research. I look forward to new and exciting research possibilities for the company, with a commitment to our industry sponsors, and to our research providers.

Ken From
Chief Executive Officer

Board of Directors and Structure 2013-2014

Brian Watt, Chair
Manager, EOR Planning and Land
Heavy Oil & Gas Business Unit
Husky Energy Inc.

Randy Brunet
Partner
MacPherson, Leslie and Tyerman

Michael Crabtree
Vice-President, Energy
Saskatchewan Research Council

Esam Hussein
Dean of Engineering and Applied Sciences
University of Regina

Bill Jackson
Independent Director

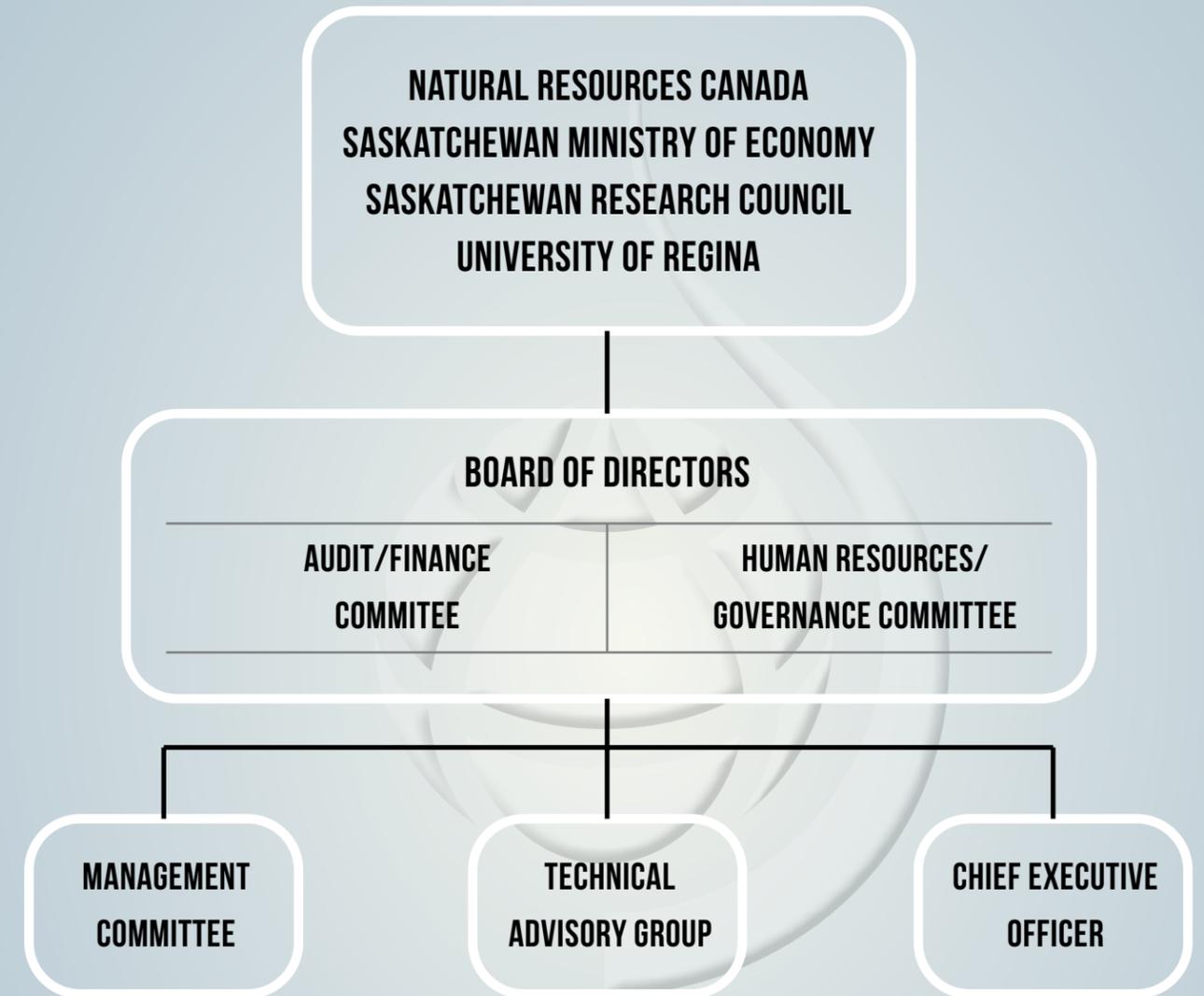
David Payne
Vice-President, Exploitation East
Canadian Natural Resources Limited

Hal Sanders
Assistant Deputy Minister, Minerals, Lands and Policies
Saskatchewan Ministry of the Economy

Robert Scammell
Independent Director

Chantal Abou Debs
(Non-voting Observer)
Senior Program Manager
Networks of Centres of Excellence Secretariat

Martin Aube
(Non-voting Director)
Director General, Energy Innovation
Natural Resources Canada



PTRC AND MEETING THE CHALLENGES OF OIL RECOVERY - IN SASKATCHEWAN, CANADA AND AROUND THE WORLD

Improving oil recovery from Saskatchewan's reserves has never been without challenges. Most of the province's oil is in technically complex formations.

With fully 20 billion barrels of heavy oil in place along the Alberta-Saskatchewan border, and the Bakken formation (which runs below southeastern Saskatchewan, southwestern Manitoba, North and South Dakota and Montana) containing an economic prize of potentially 500 billion barrels, the development of technologies to better produce from these two main regions is vital.

Heavy oil production in Saskatchewan recovers about 8% of the original oil-in-place. No less challenging is the province's tight oil reservoirs, most of which are contained in the Bakken formation and have thin pay zones (sometimes only 2 or 3 metres thick). Such deposits require expensive horizontal drilling and hydraulic fracturing. These wells typically experience rapid drop-off in production and are currently recovering about 10% of original oil-in-place.

From PTRC's inception, overcoming industry challenges and improving efficiencies of production were understood to have a cascading effect on the provincial economy – on jobs, the environment and royalties paid – and the fact that PTRC's enhanced oil recovery research has been directed by an advisory board made up of industry sponsors has helped push the program into new and exciting areas.

Photo credit:
http://eoimages.gsfc.nasa.gov/images/imagerecords/55000/55167/earth_lights_lrg.jpg

Our industry partners offer testimonials to the impact of PTRC, and point the company's way to an improved energy future fostered by leading research.

"Involvement in the PTRC's programs has provided us with data and understanding that is directly applicable to the Manatokan formation. In addition, we have enjoyed participating and learning about some of the other active areas of research, such as the joint initiative to develop wormhole sensors, and the work that was run through several researchers studying techniques for modeling of sand production during CHOPS."

Jon Bryan, Devon Energy

"PTRC has an impressive collection of research that is often referred to by engineers. The value of the research conducted is often not immediately appreciated, yet when the area of research does become a hot topic in the industry or in a particular operating company, the value of the research is often realized."

David Payne, CNRL

"PTRC's enhanced oil recovery program in conjunction with the Saskatchewan Research Council has given BP an opportunity to collaborate directly with the researchers working on their 3-D physical model and the heavy/viscous oil waterflood database. These projects have been important in increasing our understanding of the waterflood mechanisms and how to improve the recovery from such projects."

Bradley Brice, BP Exploration

From STEPS to HORNET



The first full year of research began in the PTRC's new Heavy Oil Research Network (HORNET) in 2013-14, with 14 projects approved in Post-CHOPS (cold heavy oil production with sand) research such as solvent application, water and chemical flood optimization, thermal technologies and microbial EOR. Reservoir characterization work was also approved in the areas of computer modelling and characterization of wormholes (channels created in the CHOPS process).

HORNET began after the conclusion of Government of Canada funding of the STEPS Business-Led Networks of Centres of Excellence Program in 2013-14. The final few research projects funded under that program were completed in October, 2013, and a new website giving STEPS sponsors and industry participants direct access to all final reports went live in January 2014. In the coming years, this website will allow broader access to reports that are outside the two-year confidentiality period, and better allow the PTRC to showcase the breadth and depth of research conducted in enhanced oil recovery since 1998.

HORNET, like past enhanced oil recovery programs, continues to be driven by a Technical Advisory Group made up of industry sponsors that contribute funds to the program. This model helps HORNET remain focused on the real-world technical challenges faced by industry in their operations, and assures that innovations move quickly to field trials and broader applications.

We thank our industry funders in 2013-14, including Devon Energy, Husky Canada, British Petroleum (Alaska) and Canadian Natural Resources Limited (CNRL). The ongoing financial contributions of the Saskatchewan Ministry of the Economy are also crucial to the PTRC's development of new technologies to ensure prudent development of Saskatchewan's oil and gas resources.

Portable Water Treatment in the Oil Industry

A Standout Success from STEPS Research



Untreated water in the right glass container, with treated water on the left. The pipe shows full production of treated water from the ERIN field trials.

One of the greatest challenges facing the oil industry globally is the amount of water used during oil operations. In Saskatchewan, this is a particularly acute problem because so many of the oil companies operating in the southeast of the province are small-to-medium sized enterprises that require cost-effective, small-scale applications for dealing with the cleaning and disposal of water.

During the final years of research in the STEPS Business-Led Networks of Centres of Excellence program, the PTRC (along with our private sector partners, Western Economic Diversification and the provincial and federal governments) invested in research into portable, in-situ water treatment technologies that provide cost-effective means of cleaning water. Field trials of one of the new technologies in the United States – where a 500 barrel per day unit was placed at an operating oil well site – proved that the new nano-polymer dispersion technology (developed by a Canadian company and adapted for oilfield use by Regina-based Erin Consulting) could effectively clean up to 700 barrels of produced water per day at significant cost savings to other processes.

Three portable units, containing different water treatment and oil-water separation technologies, were developed in the PTRC's water treatment program. The University of Regina also received funding to develop enhanced membranes for field water treatment, and the Saskatchewan Research Council is continuing to develop an in-situ unit for improving produced water.



Left: *Best Practices for Validating CO₂ Geological Storage – Observations and Guidance from the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project.*
Right: *What Happens When CO₂ is Stored Underground? Questions and Answers from the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project*

Disseminating Results to a Global Audience

2012-13 saw the completion of research in the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project, and the publication of a special supplement of the International Journal of Greenhouse Gas Control dedicated to the technical findings of the program. The PTRC also brought out the final deliverable for the project – a book titled *Best Practices for Validating CO₂ Geological Storage – Observations and Guidance from the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project.*

Despite the conclusion of this important twelve year program, 2013-14 continued to see significant interest expressed nationally and internationally in the research conducted at Weyburn. The PTRC was approached in late 2013 by the Global Carbon Capture and Storage Institute (based in Melbourne, Australia) to use the research findings from the project to answer the most commonly asked questions the general public has about carbon capture and storage. The completed booklet – entitled *What Happens When CO₂ is Stored Underground? Questions and Answers from the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project* – has seen wide distribution amongst teachers, researchers and project proponents and is currently in its second print run of 500 copies.

As well, PTRC's expertise in CO₂ measurement, monitoring and verification (MMV) led to an Environment Canada contract to produce a report assessing Saskatchewan's potential for acid gas injection and CO₂ sequestration by the upstream sector. In collaboration with the Saskatchewan Geological Survey, which contributed analysis and geological maps, the PTRC's report concluded that there is significant potential for both the injection and storage of CO₂ and/or acid gas disposal.



Left: *researchers from the University of Bristol install passive seismic monitoring stations outside of Weyburn, Saskatchewan.*
Right: *a seismic station, installed.*

Beneficial results from Weyburn-Midale have led to the development of a new research program funded by the United States Department of Energy and the Saskatchewan Ministry of the Economy. This program – Saskatchewan CO₂ Oilfield Use for Storage and EOR Research, or SaskCO₂USER – received approval in concept just as 2013-14 came to an end. The new project proposes to advance the rich datasets from the Weyburn and Midale fields to better inform prospective CO₂-EOR operators, government regulators and service providers on how to maintain the integrity of CO₂ storage, improve the efficiency of CO₂-EOR operations, and limit liabilities and risks during operations.

Going forward, the PTRC will continue to work on new and innovative methods of using CO₂ in enhanced oil recovery operations, expanding not just into potential uses for heavy oil recovery, but also for use during tight oil recovery in the Bakken and like formations.



Aquistore



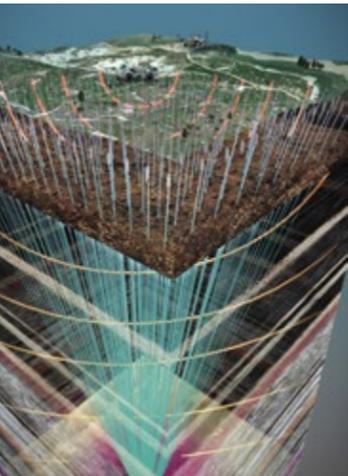
2013 was a quiet but critical year for Aquistore. The project's two state-of-the-art wells (injection and observation) were approved for use by the Ministry of Environment, which signaled the start of the successful asset transfer and service agreement with SaskPower. While SaskPower now manages these assets and operations, PTRC will continue to provide research and monitoring, oversight and project management, and public outreach and stakeholder engagement.

The project has completed a number of collaborative projects such as an electromagnetic survey, and a 3D/VSP/DAS seismic survey – conducted jointly with universities, USDOE national labs, Chevron, and British Petroleum. These and other research collaborations amounted to over \$3M of in-kind work and/or direct research contributions in 2013-2014.

The installation of Aquistore's surface and shallow-sub-surface monitoring equipment was also completed in the fiscal year. In addition to piloting a number of innovations, Aquistore's program seeks to provide future CCS projects with an efficient and economical suite of proven technologies to choose from. With the installation of equipment completed, baseline monitoring work continued and processing of data and results is underway.

Aquistore continues to attract worldwide attention as a leading industrial laboratory. The Global CCS Institute contracted the PTRC to produce a summary report on the work performed specific to the Aquistore project. This document focused on activities to date with special attention paid to issues and decision points relevant to similar and/or developing projects.

The number of visitors to the PTRC and the Aquistore site remained at 225 individuals this past year, for a total of over 500 since the project's launch. From reporters to international geologists, engineers and policy makers - the world is watching this important project.



PTRC in the Community



Supporting a Natural Curiosity in Science

The PTRC continued its funding of Educating Youth in Engineering and Science (EYES) in 2013-14. This excellent educational program – which provides summer camps and educational programs for youth from grades 2 through to 9 – reaches over 15,000 students a year in Regina and southern Saskatchewan.

“The funding provided by PTRC has helped our group expand its reach over the past few years,” noted Ben Freitag, the Coordinator of the EYES program. “We’ve been able to hire instructors from universities to host the experiments and camps in the summer, and provided a great program for so many kids!”

EYES ensures that kids with an early interest in science and engineering – and even those who might have a predilection against it – learn through engaging and entertaining experiments under the watchful gaze of enthusiastic volunteers. PTRC is proud to be a continuing sponsor of a program that will help provide the scientists of the future.



Supporting Saskatchewan's Universities

PTRC continued its ongoing support of students at Saskatchewan's two universities through the PTRC 10th Anniversary Scholarship – two \$5000 awards. The yearly scholarships support a student entering graduate studies in Petroleum Systems Engineering at the University of Regina and another entering graduate studies in Engineering at the University of Saskatchewan in Saskatoon. Award winners in 2013 included Wahab Olaiya Alabi, working on his Ph.D. at University of Saskatchewan in Chemical and Biological Engineering, and Tayebah Jamshidi working on her Ph.D. at University of Regina in Petroleum Engineering.



PTRC also co-funded the University of Regina Engineering Student Society's first-year reception in September 2013, and supported the U of R's annual President's Breakfast for Athletics by purchasing a table at the event.

**REPORT OF THE INDEPENDENT AUDITOR
ON THE SUMMARIZED FINANCIAL STATEMENTS**

To the Members,
Petroleum Technology Research Centre Inc.

The accompanying summarized financial statements, which comprise the summarized statement of financial position as at March 31, 2014, and summarized statements of operations and cash flow for the year then ended, are derived from the audited financial statements of Petroleum Technology Research Centre Inc. for the year ended March 31, 2014. We expressed an unmodified audit opinion on those financial statements in our report dated July 17, 2014.

The summarized financial statements do not contain all the disclosures required by Canadian accounting standards for not-for-profit organizations. Reading the summarized financial statements, therefore, is not a substitute for reading the audited financial statements of Petroleum Technology Research Centre Inc.

Management's Responsibility for the Summarized Financial Statements

Management is responsible for the preparation of a summary of the audited financial statements in accordance with Canadian accounting standards for not-for-profit organizations.

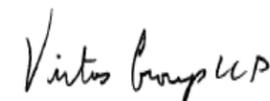
Auditor's Responsibility

Our responsibility is to express an opinion on the summarized financial statements based on our procedures, which were conducted in accordance with Canadian Auditing Standards.

Opinion

In our opinion, the summarized financial statements derived from the audited financial statements of Petroleum Technology Research Centre Inc. for the year ended March 31, 2014 are a fair summary of those financial statements, in accordance with Canadian accounting standards for not-for-profit organizations.

July 17, 2014
REGINA, Saskatchewan


Chartered Accountants

Petroleum Technology Research Centre Inc.
Condensed Statement of Financial Position
For the year ended March 31, 2014

(C\$000s)	2014	2013
Assets		
Cash	\$ 4,623	\$ 8,543
Other assets	4,029	4,350
Total assets	8,652	12,893
Liabilities and net assets		
Deferred revenue	7,564	5,941
Other liabilities	286	12,122
Total liabilities	7,850	18,063
Net assets (deficit)	802	(5,170)
Total liabilities and net assets	\$8,652	\$12,893

Petroleum Technology Research Centre Inc.

Condensed Statement of Operations and Unrestricted Net Assets

For the year ended March 31, 2014

(C\$000s)	2014	2013
Revenue		
Government of Canada funding	\$1,690	\$12,030
Government of Saskatchewan funding	4,108	8,236
Industry funding	7,535	3,975
Other funding	836	1,596
Total revenue	14,169	25,837
Expenses		
Projects	4,942	29,470
Operations	3,255	2,515
Total expenses	8,197	31,985
Excess of revenue (expenses)	5,972	(6,148)
Unrestricted net assets (deficit), beginning of year	(5,170)	701
Unrestricted net assets, transfers	-	277
Unrestricted net assets (deficit), end of year	\$802	\$(5,170)

Petroleum Technology Research Centre Inc.

Condensed Statement of Cash Flows

For the year ended March 31, 2014

(C\$000s)	2014	2013
Net cash from (used in) operating activities	\$(3,920)	\$530
Net cash used in investing activities	-	(66)
Increase (decrease) in cash	(3,920)	464
Cash, beginning of year	8,543	8,079
Cash, end of year	\$4,623	\$8,543

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2013/2014 Annual Report



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