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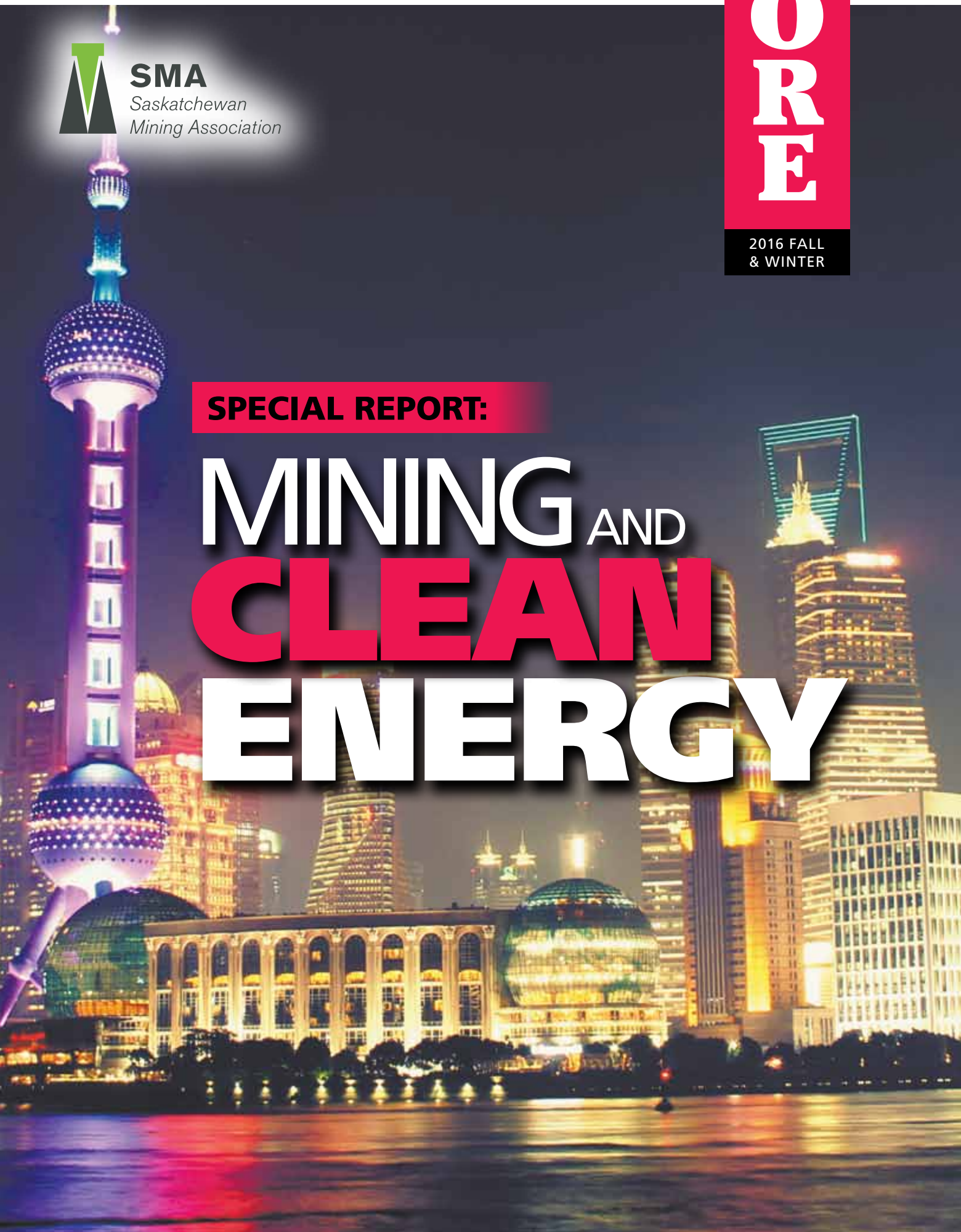

SPECIAL REPORT:

MINING AND CLEAN ENERGY

AREVA Resources Canada's McClean Lake operation.

ORE is produced solely by the Saskatchewan Mining Association.

HEAD OFFICE
Suite 1500
2002 Victoria Avenue
Regina, Saskatchewan
S4P 0R7

Telephone: (306) 757-9505
Fax: (306) 569-1085

www.saskmining.ca

COVER PHOTO
It takes vast amounts of electricity to light up just one city at night, not to mention provide power to industry and run the economy. In this edition of ORE, we investigate the energy contributions – and emission reductions – provided by the Saskatchewan mining industry.

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A MESSAGE FROM SMA PRESIDENT, PAM SCHWANN

MINING AND CLEAN ENERGY

How Saskatchewan's natural resource based economy addresses the climate change reality is literally a billion-dollar question. However, it's one that Saskatchewan is uniquely positioned to respond to.

As global citizens we must all be engaged in addressing climate change and reducing GHG emissions. The reality is that Canada contributes 1.6 per cent of global GHG emissions. The federal government's response to addressing climate change is focused on further reducing Canada's relatively small proportion of GHG emissions by re-engineering our resource-based economy via regulatory, carbon tax and policy directives.

What if, rather than disrupting our existing economy, we were encouraged to leverage our natural resource advantage while at the same time reducing global GHG emissions? This would strengthen our economy and retain the economic and social benefits in our communities that result from mineral resource and related supply chain development. It would also ensure resource development occurs in Saskatchewan and Canada, where there are mature and robust environment and safety regulatory frameworks, rather than shifting development to other global jurisdictions that are less stringently regulated.

Coal-fired power plants currently provide 41 per cent, and uranium-fueled nuclear power plants contribute over 11 per cent, of the world's electricity. Additional nuclear power and coal-fired plants are being constructed. Increasing the proportion of renewable energy is part of the climate change solution. Our moral obligation to contribute to reducing GHG emissions is also accomplished by continuing to safely and responsibly mine the world's highest grade uranium to fuel clean nuclear energy, and by continuing to develop and evolve carbon capture and storage (CCS) technology so that communities can utilize their local, readily-accessible coal deposits.

With a growing population that has increasing food and energy needs, the demand for our resources won't decrease, but the wealth creation opportunities for Saskatchewan and Canada will if our governments fail to complement Canada's natural resource advantage with a competitive regulatory and policy climate change framework.

Read on to learn how mining is adopting innovative technology to reduce GHGs, and how Saskatchewan is poised to be part of the solution in meeting the ambitious targets Canada agreed to at the 2015 United Nations Paris Climate Change Conference (COP21).

PARTNERS IN CLEAN ENERGY

SaskPower's Boundary Dam Carbon Capture and Storage facility.

Saskatchewan mining contributes to clean energy and technology at home and abroad

In Paris last year, countries from around the world agreed that it was time to tackle climate change head on.

Canada was among the signatories to the climate conference, or COP 21, agreement, representing a collective vision to keep global temperature increases to below 2 degrees Celsius by 2100.

According to data from Environment Canada, Canada contributed 1.6 per cent of the global GHG emissions in 2012.

Canada followed up on COP 21 when the prime minister and provincial and territorial leaders agreed in Vancouver to create a framework on clean growth and climate change.

Then in June, Canada co-created the North American Climate, Clean Energy and Environment Partnership with its partners, Mexico and the United States.

Under that agreement, the three countries agreed to work toward 50 per cent clean power generation by 2025, including renewable, nuclear and carbon capture and storage technologies.

With Canada and Saskatchewan's resource-based economies, the ability to grow the economy while significantly decreasing GHG emissions poses some challenges. According to the Government of Canada's National Inventory Report 1990-2014, Greenhouse Gas Sources and Sinks in Canada, Saskatchewan was the fourth highest GHG emitting province in 2014,

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Saskatchewan mining operations account for just over three per cent of the province's greenhouse gas emissions (GHGs); but they contribute a substantial amount to clean energy through the supply sector.

(76 Mt CO2 eq) behind Alberta (274 Mt CO2 eq), Ontario (170 Mt CO2 eq), and Quebec (83 Mt CO2 eq).

However, Saskatchewan is, in fact, well-positioned to be part of the solution to climate change and contribute to the transition to a low-carbon economy that is required under COP21. A report for the federal government by the consulting firm McKinsey & Co. identifies that a key to creating and sustaining an advantage in energy technologies is understanding where Canada has the potential to be an international leader and to leverage these areas.

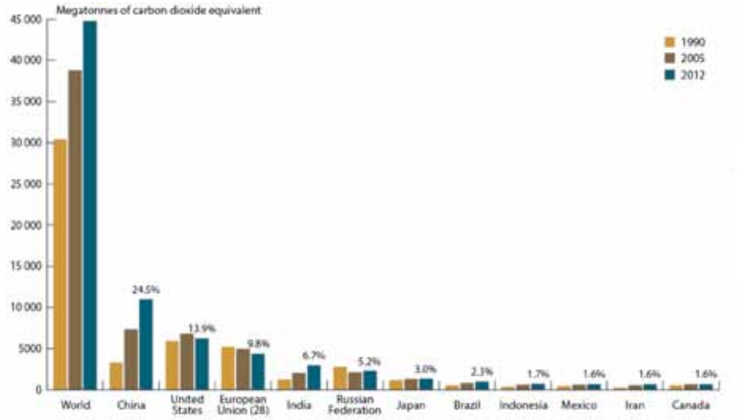
The report, "Opportunities for Canadian energy technologies in global markets," identifies both carbon capture and storage (CCS) and uranium mining as opportunities where Canada, and notably Saskatchewan, has clear strategic advantages in supporting a low-carbon economy.

The Fifth Assessment Report of Intergovernmental Panel on Climate Change identifies the energy supply sector as the largest contributor to global greenhouse gas emissions, contributing 35 per cent of man-made global GHG emissions in 2010. The study identifies multiple options to reduce energy supply sector GHG emissions including low-GHG energy supply technologies such as renewable energy (RE), nuclear power, and CCS.

Reducing the carbon intensity of electricity generation is therefore a key component of cost-effective mitigation strategies. This report identifies that in most integrated modelling scenarios, the electricity generation sector is an early adopter of decarbonization, and predicts that the share of low-carbon electricity supply from renewables, nuclear and CCS will increase from the current share of 30 per cent to more than 80 per cent by 2050.

This means that uranium mined from Saskatchewan and CCS technology developed in Saskatchewan in concert with thermal coal generation have the opportunity to play an increasingly critical role in reducing global GHG emissions.

Saskatchewan mining operations account for just over three per cent of the province's greenhouse gas emissions (GHGs); but they contribute a substantial amount to clean energy through the supply sector.



Natural Resources Canada Energy Fact Book 2016 – 2017
www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf

"The Saskatchewan mining industry is a key link in the clean energy supply chain through the mining of uranium, coal, gold, silver and copper," said Pamela Schwann, SMA president.

Metals such as gold, silver and copper are used as components in batteries, windmills and solar panels. However, Schwann notes that both nuclear and CCS will have an increasingly important global role in providing low GHG-emitting energy supplies, uranium mining and clean coal technologies, truly positioning the Saskatchewan mining sector as part of the solution to the transition to a clean economy.

The Benefits of Nuclear

Nuclear power generation creates virtually no GHGs. Indeed, the Intergovernmental Panel on Climate Change (IPCC) has determined that nuclear power's emissions are similar to wind, and lower than hydro, solar and coal.

Today, electricity generated by nuclear power plants provides 11.5 per cent of the world's electricity, while saving about 2.5 billion tonnes of greenhouse gases per year, as compared to fossil fuel sources. In fact, one 20-gram uranium pellet is equivalent to the energy provided by 410 litres of oil, or 350 metres of natural gas, says the Canadian Nuclear Association (CNA).

"Our greenhouse gas reduction targets cannot be reached without nuclear energy," according to the IPCC.

Since 1996, all Canadian uranium production has been from northern Saskatchewan, so Saskatchewan is uniquely positioned to provide the fuel for those plants, through the operating mines in the Athabasca Basin.

McArthur River and Cigar Lake, both operated by Cameco Corp. along with the recently scaled-down Rabbit Lake, produced 22 per cent of world production in 2015. McArthur River, which began production in 1999, is the world's largest uranium mine. Cigar Lake's grade averages 20.7 per cent U3O8, unheard of elsewhere.

"Saskatchewan has the highest grade uranium in the world, and the emissions from uranium mining in Canada are very, very low when compared to extracting fossil fuels," said David Parker, a co-researcher who produced a study on nuclear power supported by the Sylvia Fedoruk Canadian Centre for Nuclear Innovation.

Uranium mined in Saskatchewan is helping Ontario to meet its climate change plan as nuclear power provides approximately 60 per cent of the province's electricity needs, said John Barrett, President and CEO of the CNA.

The technology behind the use of uranium, as with coal, has also played roles in Canada, said Barrett.

The Canadian-built Candu reactors have been used in several countries, including Romania, China, India, Pakistan, Argentina and South Korea where they have been lessening the impact of CO2 emissions over the years.

In the future, small and very small reactors may also become part of the electrical grid,

Uranium mined from Cameco Corporation's McArthur River Operation is used to fuel clean nuclear energy.

although they are still in the development phase. SaskPower, the Saskatchewan power utility, has said small modular nuclear reactors are being considered as part of future power generating sources in Saskatchewan.

While Candu reactors can generate 700 to 900 megawatts, small reactors, by comparison, would generation 200 to 300 megawatts, said Barrett. Small reactors would be linked into an electrical grid system that already exists.

"The idea of these reactors is to line them up – a six pack or eight pack – you can add as you need them. They can be manufactured in a shorter time period and deployed to where they are needed."

Very small reactors may generate three to 15 megawatts, a reasonable amount of electricity for perhaps a small community or a mine site.

These would be very useful for small remote communities requiring, for example, water purification, he said.

Nuclear reactors and cyclotrons are also used to generate isotopes, crucial for medical imaging, among other uses. The global market for medical isotopes is about $4 billion USD, and is expected to grow to $7 to $8 billion by the end of the decade. Canada is the world's leading supplier of medical isotopes, adding $200 million to the economy.

All the while, nuclear reactors are extremely safe, creating only 0.07 per cent of the radiation Canadians are exposed to annually. Medical procedures, food and beverages, and external sources make up more than 99 per cent.

The Benefits of CCS

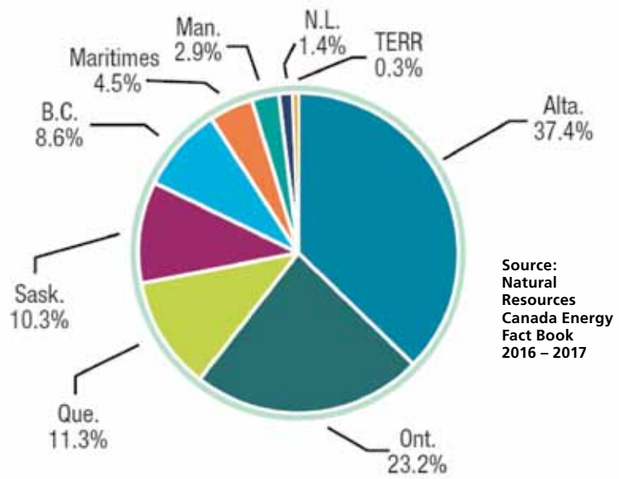
In Saskatchewan, coal-fired electrical power provides 34 per cent of our available power-generating capacity and almost 50 per cent of its baseload capacity. Federal regulations introduced in 2011 to reduce GHG emissions require that all coal-fired units built before 1975 must close by 2020, and units built after 1975 will close by 2030, unless they have CCS technology.

As coal is a reliable, affordable and accessible resource, the Saskatchewan and federal governments have invested in CCS technology at the Boundary Dam Power Station near Estevan so that coal can continue to be utilized for power generation beyond 2030. SaskPower is also partnering with BHP Billiton to establish a CCS knowledge centre in Saskatchewan.

The Boundary Dam CCS facility, which fired up in 2014, allows the power station's Unit No. 3 to generate up to 115 megawatts of baseload electricity while reducing GHGs by up to a million tonnes of carbon dioxide (CO_2) annually. That is the equivalent of taking more than 250,000 cars off Saskatchewan roads.

The captured CO_2 is sold and transported by pipeline to nearby oil fields in southern Saskatchewan where it is used for enhanced oil recovery (EOR).

GHG emissions by province, 2014



Source: Natural Resources Canada Energy Fact Book 2016 – 2017

As over 40 per cent of the world's electrical generation is from coal, CCS technology can also contribute to the global reduction in GHG emissions. Juho Lipponen, the head of the International Energy Agency (IEA) Carbon Capture and Storage Technology Unit, has also examined CCS - Enhanced Oil Recovery Plus and says this technology offers a win-win solution.

It offers the opportunity to continue to develop locally available coal deposits and provides commercial opportunities for oil producers while also ensuring permanent storage of large quantities of CO_2 underground and overall reduction in GHG emissions.

When the managing director of the Pembina Institute, Chris Severson-Baker, toured the Boundary Dam CCS facility after its opening, he called it "a precedent setting project."

"Climate change represents the greatest threat, environmental threat, that we are faced with today," he said in a videotaped release. "It represents a threat to human health and economic prosperity throughout the world. And CCS is one of the solutions to reducing greenhouse gas emissions at the scale that's needed to address what scientists are saying what's needed to address climate change."

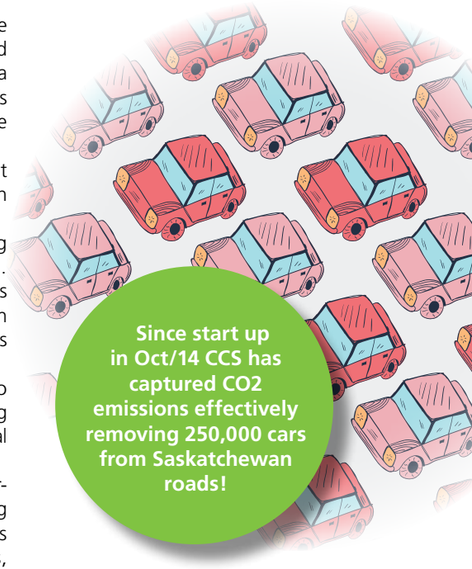
Severson-Baker warned that no single solution or technology is enough to respond to that challenge, "and therefore we need a portfolio approach, and because fossil fuels are going to be part of that mix for some time," he said.

The world really needs a technology that reduces emissions from coal plants, both new and existing, he said.

"CCS is that solution. There's nothing quite like seeing that project being built… I'm walking away with the sense that this is something that will be part of the solution for dealing with greenhouse gas emissions in the future."

As the world moves to take action to support COP 21, Saskatchewan is punching well above its weight in contributing to global clean energy solutions, says Schwann,.

"Through the development and commercialization of CCS technology and producing over 20 per cent of the world's requirements for uranium that fuels nuclear reactors, Saskatchewan mining and related innovation will lead to a cleaner energy future for the world."



Study finds GHG emissions from uranium mining, milling very low

Earlier this year, three researchers from the University of Saskatchewan undertook a daunting project.

They set out to determine the level of GHG emissions emitted by uranium mining and milling operations in Saskatchewan. While it's well-understood that nuclear power creates very low amounts of GHGs, people have questioned emissions from the mining sector – and there was little easily-accessible data on the subject.

"This is the first rigorous look at GHG emissions from uranium mining and milling in Saskatchewan, and is more detailed and transparent than the few studies that have been done before," said David Parker, a graduate student in the U of S Department of Civil and Geological Engineering, who worked with adjunct professor Cameron McNaughton (also with Golder Associates Ltd.) and professor emeritus Gordon Sparks.

The study, supported by the Sylvia Fedoruk Canadian Centre for Nuclear Innovation, was published in the journal Environmental Science and Technology.

It found that the mining and milling of uranium contributes about a gram of greenhouse gases as CO_2 equivalents per kilowatt-hour of electricity generated by uranium.

The UN Intergovernmental Panel on Climate Change says about 12 grams of CO_2-equivalent gases are generated by nuclear power per kilowatt hour, about the same level as wind power.

The study included all potential emissions generated in mining and milling uranium at three Saskatchewan operations: fuel used in heavy machinery and to power the mine and mill, the concrete and steel used in construction, and emissions generated by flying workers in and out of the sites. They even included emissions from the mining companies' head offices.

Neil Alexander, executive director of the Fedoruk Centre, said they funded the project not to promote nuclear power or to lead to this outcome, although the results do support nuclear being a tool to reduce GHG emissions.

"We wanted to support academic research to provide information to Saskatchewan people about their uranium," he said in an interview. "But we do think the outcome suggests the people of Saskatchewan should be very proud of the contribution our uranium makes to avoiding greenhouse gases elsewhere in the world. That's a point that's often lost. Saskatchewan gets beaten up for having a fossil-fuel based electricity system.

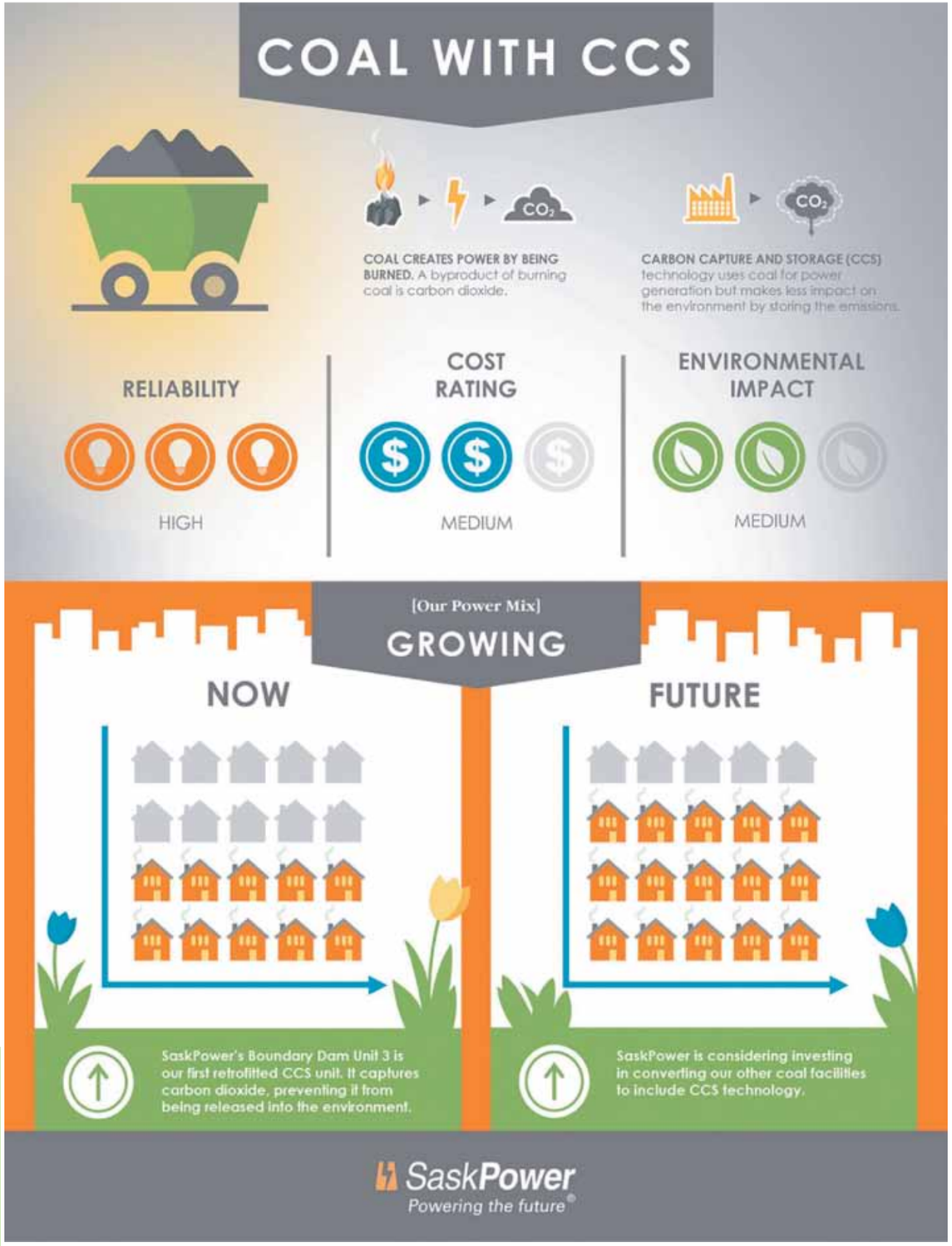
"But actually, we offset a huge amount of greenhouse gases elsewhere in the world – particularly Ontario. It's a large quantity of nuclear power in Ontario, being largely supplied by Saskatchewan.

"The fact that Ontario has a green electricity system is a result of the contribution Saskatchewan makes to it."

The high ore grade of Saskatchewan uranium contributes to its low GHG footprint, he added.

"In amongst the facts that the nuclear industry avoids the production of greenhouse gases because it is a clean way of producing electricity, Saskatchewan's uranium is a very good way because it minimizes the amount of greenhouse gases that arise from its production.

"One of the greatest contributions to that is the fact that our uranium ores are quite rich, and therefore the amount you need to dig up to get a good quantity of energy out of is much less. If you're going to mine uranium for avoiding greenhouse gases, Saskatchewan is the place to do it."



http://www.saskpower.com/our-power-future/our-electricity/supply-options/coal-with-ccs-technology/

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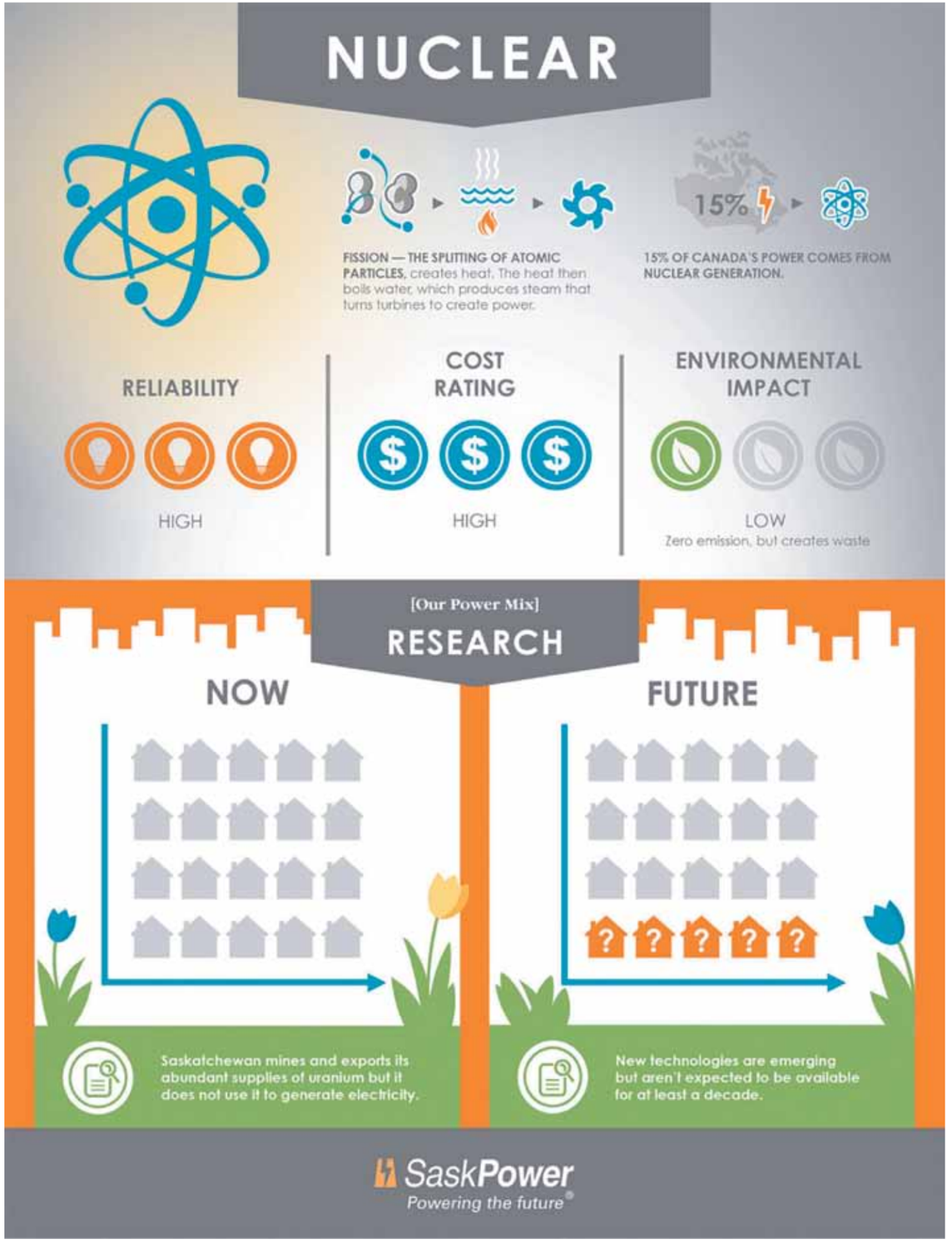

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Reducing the carbon footprint

Experts say it's crucial to design a policy that mitigates carbon but supports industry

Mining in Saskatchewan creates only a little more than three per cent of the province's greenhouse gas emissions (GHGs), while in many ways its products support global carbon reduction through nuclear power and carbon capture and storage technology at SaskPower's Boundary Dam.

Mining is a vital industry to not just the province, but the world. Yet in the wake of the global Paris agreement on climate change, and the more recent North American Climate, Clean Energy and Environment agreement, mining along with other industries are being called upon to reduce a disproportionate amount of GHGs. Canada's federal government has agreed to cut emissions by 30 per cent by 2030.

But what's the right approach to encouraging industry to reduce GHGs? A carbon tax? A cap and trade system?

The answer may be both, neither, or a mixture of several policies, says a Saskatchewan policy expert.

"There's no one size fits all," said Peter Phillips of the Johnson-Shoyama Graduate School of Public Policy in an interview.

"If the objective is to have a lower carbon footprint we have to tailor the mechanism to the market structures.

"The export dependence and volatility of some of our sectors means that neither a carbon tax nor cap and trade are overly effective in terms of managing and incentivizing firms to invest in carbon mitigating mechanisms."

After consulting with the Saskatchewan mining sector, Phillips and Victoria Taras explored the issue in a paper entitled The challenge of managing carbon emissions in Saskatchewan's mining and mineral sector. *(http://www.schoolofpublicpolicy.sk.ca/research/publications/jsgs-policy-brief.php).*

They make the argument that carbon taxes, cap and trade, or "implicit" carbon pricing operating alone "are likely to be insufficient to meet Paris Agreement carbon levels because they each have their faults.

"When two or all three are used together, along with perhaps other carbon management options, there is great potential for mitigating carbon emissions."

However, say the authors, carbon management risks destabilizing mining, "which is one of Saskatchewan's and Canada's most competitive and important revenue-generating industries. New technologies could make it easier to balance these environmental and economic concerns, but the policy system will need to adapt.

"A partnership between Canada's federal and provincial jurisdictions, that includes consultation with the minerals and mining sector, offers real hope for discussion grounded in facts and realities."

How would carbon management destabilize the industry? Phillips explained that a large part of Canada's carbon footprint is traded internationally.

"Unit per unit, our carbon footprint is lower for what we're exporting than for what a lot of other people are producing in other parts of the world," he said. "If we shut down our operations, we just ramp up production in some other part of the world – consumption isn't going to change."

And, he points out, reducing GHGs is not just a provincial or national concern: it's a global one. That must be taken into account with any national carbon policy.

"I think the evidence is still fuzzy on how

CONTINUED ON PAGE 14

GLOSSARY

CARBON TAX: A tax based on greenhouse gas emissions (GHG) generated from burning fuels. In British Columbia, for example, the carbon tax rate is $30 for each tonne of CO2 emissions.

CAP AND TRADE: A cap on carbon sets a limit on emissions, while carbon trade allows companies to sell their unused limits to other producers.

IMPLICIT CARBON PRICING: Expenditures on direct or indirect carbon mitigation, such as a tax exemption on biofuels or subsidies to buy electric vehicles.

GREENHOUSE GAS EMISSIONS: Greenhouse gases trap heat in the atmosphere. The main GHGs are carbon dioxide, methane, and nitrous oxide.

INTENSITY-BASED EMISSIONS: Most discussion about carbon reduction refers to absolute reduction of the total quantity of GHGs being emitted. Intensity compares the amount of emissions to some unit of economic output. Saskatchewan miners work toward reducing the emission intensity per unit of the commodity mined.

> If we shut down our operations, we just ramp up production in some other part of the world – consumption isn't going to change.
>
> **PETER PHILLIPS**
> **THE JOHNSON-SHOYAMA GRADUATE SCHOOL OF PUBLIC POLICY**

CONTINUED FROM PAGE 12

much we can lower Saskatchewan's carbon footprint and still have a modern resource economy. You can reduce dramatically, but that means you stop doing certain things. Those certain things aren't going to stop worldwide; the activities just stop here and move somewhere else. That's not always good."

Multiple strategies will likely be needed to support industry and reduce emissions. Some provinces have instituted various carbon mitigating policies, Phillips noted.

"We have a series of regions pricing through tax, some are pricing through cap and trade, and some have something else. (Some have) said we're going to get out of producing electricity through coal. That's an implicit carbon pricing, getting out of coal, because the next cheapest source of energy is more expensive."

Phillips gives the example of B.C., which has gone with a carbon tax. The province produces very little carbon per capita, but is a heavy consumer of carbon. By contrast, in Saskatchewan, we have three per cent of Canada's population but produce 17 per cent of the carbon.

"We're producing carbon for other people, we're not consuming it," said Phillips.

"In agriculture and probably some of our more modern mining enterprises, a lot of our firms are as good as it gets in their industry. They may still be carbon emitters, but these are products important in the food system or transportation system or home heating system."

Principles for Policy Design

The Mining Association of Canada recently published a document entitled Principles for Climate Change Policy Design with seven recommendations, of which Saskatchewan Mining Association members are generally supportive. They are:

- Establish a broad-based carbon price that is applicable to all sectors of the Canadian economy.
- Be revenue neutral by investing revenues generated through carbon pricing into the development of lower emission technologies to manage the transition to a lower carbon future, including climate adaptation, and to ensure a level playing field for trade-exposed industries that are emission intensive.
- Address competitiveness and carbon leakage concerns across all sectors to prevent declines in investment, employment, tax revenues and trade.
- Be predictable, flexible and sensitive to changing economic conditions and geographic circumstances, to enable consumers and industry to adapt and to treat regions fairly.
- Be simple, complementary and effective to ensure that a national climate change regime works in tandem with existing provincial schemes, avoids duplication, and is simple to understand and administer.
- Support investments in the development and implementation of technologies that lower emissions through capital investments, which could include public-private partnerships.
- Recognize early action, acknowledging that some companies have been proactive in reducing their climate footprints and that several provinces have already established climate change mitigation regimes.

Mosaic's plan to save energy

A unique partnership between The Mosaic Company and Yara has resulted in significant reductions of water and energy use.

Mosaic's Belle Plaine mine, originally constructed in 1964, is a solution mine requiring water and energy to recover potash. In 2007, an expansion of the mine was completed and integrated with the neighbouring ammonia fertilizer plant owned by Yara.

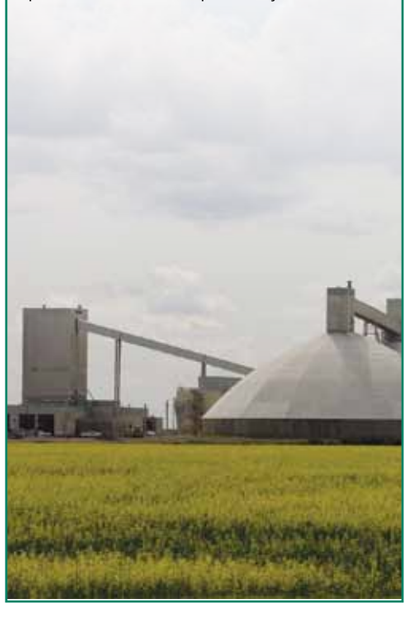
The two operations collaborated to install equipment that allows Mosaic to recover both waste water and waste heat from the Yara plant. At the time, Mosaic reduced its fresh water intake by about 131 million litres, and its energy consumption by 700,000 gigajoules, per year.

A second Belle Plaine expansion several years later increased the energy savings by another 1.132 million gigajoules annually.

For perspective, Mosaic has reduced its fresh water consumption by 52 Olympic-sized swimming pools every year, and its energy consumption reduction is equal to the energy use of 19,600 North American homes.

This energy reduction has cut Mosaic's greenhouse gas emissions by 99,400 tonnes of CO_2 per year, equivalent to removing just over 21,000 cars off the road annually.

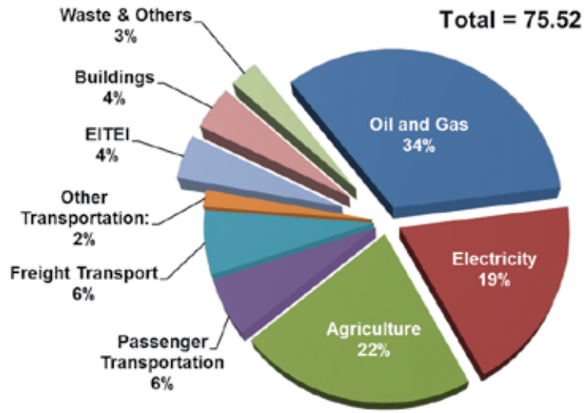
Mosaic's stated commitment is to reduce company-wide energy consumption by at least 10 per cent, water consumption by 10 per cent, and greenhouse gas emissions by 10 per cent per finished tonne of potash by 2020.



How Saskatchewan mining companies are working to reduce GHGs

SMA member companies continuously strive to identify opportunities to improve their energy use and lower their emissions footprint. Here are some examples of what they are doing.

- Cameco Corporation significantly reduced its GHG emissions in 2015 over 2014 by reducing the consumption of propane at Key Lake and McArthur River, and natural gas at its Saskatoon offices. Consumption of diesel and gasoline for mobile vehicles was also lower in 2015 as compared with previous years.
- The Mosaic Company replaced nearly 200 lights with LED fixtures, reducing its GHGs by 97 metric tonnes of C02e.
- BHP Billiton has invested $20 million over five years into the creation of a global centre for carbon capture and storage (CCS) knowledge at the Innovation Place Research Park in Regina.
- PotashCorp and Mosaic Co. use highly-efficient, electricity-powered vehicles underground at their mines. The vehicles significantly improve not just carbon release, but also underground safety.
- K+S Potash Canada has a 15-megawatt, natural gas-fired turbine with exhaust flow to an un-fired heat recovery steam generator which provides about 20 per cent of the site's energy needs. The assembly is called co-generation and combines heat and power generation.
- AREVA Resources Canada renovated its dorm rooms at the McClean Lake Operation camp 10 years ago to include Styrofoam block design, geothermal and radiant heating, and other features that ensure heating and energy requirements are minimal. Within the mill itself, AREVA switched to LED lights and ensured that compressor systems are efficient, leading to lower power usage.



Source: Environment Canada NIR 1990-2014 and Saskatchewan Ministry of the Environment

Rare Earth Elements

Provided by Saskatchewan Geological Survey, Ministry of the Economy

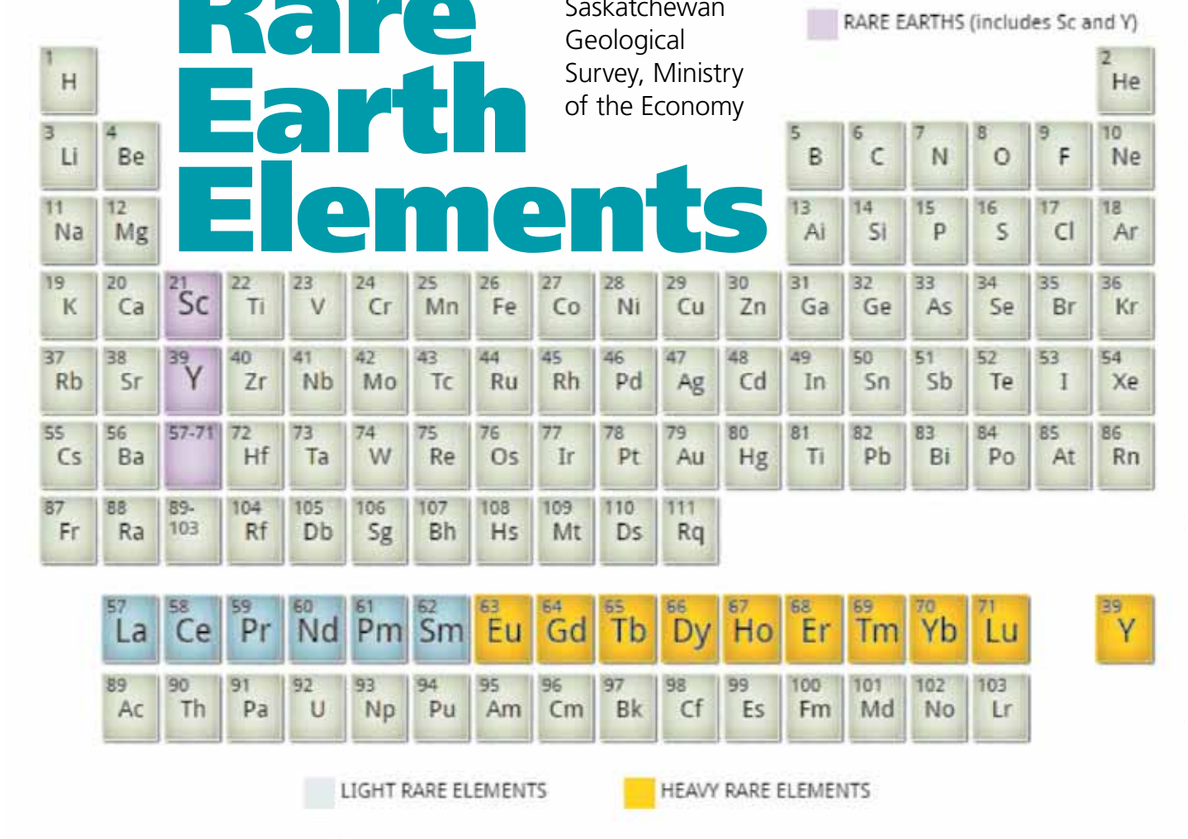


FIGURE 1: REE in the periodic table: < *http://etn-demeter.eu/what-are-rare-earth-elements-rees/*> September 14, 2016

What Are Rare Earth Elements (REE)?

The REE comprise 17 chemical elements in the periodic table that include scandium, yttrium, and the lanthanides series (Figure 1). Despite their name, REE are not exceptionally rare and occur in low concentrations throughout the earth's crust, with some elements, like cerium, nearly as abundant as copper. However, unlike other common metals, REE are usually more dispersed, often occurring in concentrations of ten to a few hundred parts per million by weight, making it more difficult to find concentrations great enough to be economically viable mineral deposits.

REE are a unique group of metallic elements that exhibit a range of special magnetic, electromagnetic, optical and catalytic properties. REE are commonly subdivided based on their atomic weights into light rare earths, which comprise lanthanum to samarium (blue in Figure 1), and heavy rare earths; europium to lutetium plus yttrium (yellow in Figure 1). The heavy REE are scarcer than light REE and are thus more valuable.

Where Do They Come From?

Currently China produces about 95 per cent of the world's REE, with Australia, USA and Russia contributing smaller amounts to the global supply. It's estimated that approximately 124,000 tonnes of rare earth oxide were mined in 2015. Although Saskatchewan has no current production, there are numerous REE occurrences.

In Saskatchewan three main types of REE deposit types are recognized:

- light REE-bearing veins to the north and east of the Athabasca Basin;

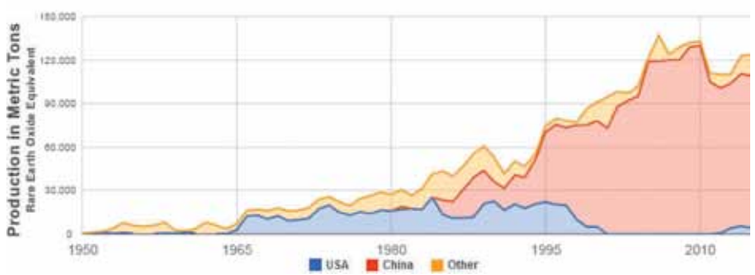


FIGURE 2: Global REE production: <*http://geology.com/articles/rare-earth-elements/*> September 14, 2016

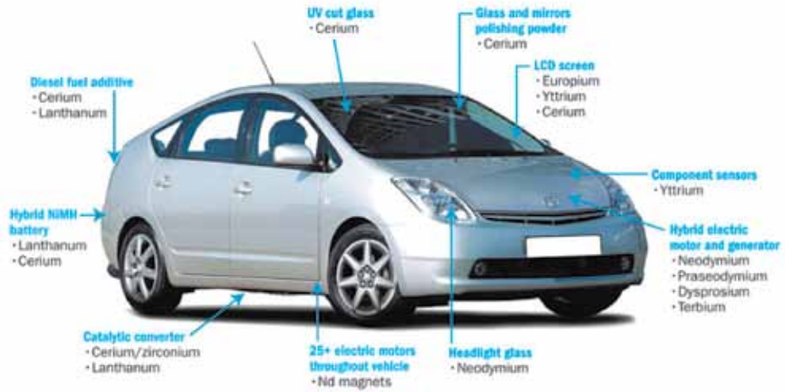


FIGURE 3: REE used in hybrid cars < *http://www.outsidethebeltway.com/hybrid-cars-rare-earth-elements-and-supply/*> September 14, 2016

- mixed light and heavy REE associated with the uranium deposits in the Athabasca Basin; and

- heavy REE occurrences associated with deposits of the mineral xenotime in and around the Athabasca Basin.

The various REE have similar chemical properties, which is why they are usually found together in geologic deposits of rare earth oxides. The complex mineral assemblages hosting these deposits can make it difficult to extract the REE. In Saskatchewan, uranium and thorium often accompany REE, adding additional metallurgical challenges.

What Are They Used For?

Technological innovations, and the push toward more clean energy products, have driven demand for REE to all-time highs over the past number of years. In addition to their industrial applications in polishing compounds, chemical catalysts, permanent magnets, and metal alloys, REE are essential components of high technology and clean energy products. Mobile phones, tablets, hard drives, and flat screen displays are just a few of the items we use daily that contain these elements. REE are sometimes referred to as "green elements" because they are critical components in energy efficient technologies like: catalytic converters, wind turbines, compact fluorescent light bulbs, rechargeable batteries and hybrid cars. It is estimated that 20 kilograms of rare earth oxide ore will be required for each hybrid car produced (Figure 2). REE are also invaluable to the medical industry in equipment such as X-ray machines, MRIs and high precision lasers.

Clearing the Air

Underground mines reap the benefits of electric vehicles

While the race is on above ground to develop mass market electric vehicles by automotive and IT giants including Toyota, Ford, Tesla, and Google, a Saskatoon-based company, Prairie Machine & Parts is leading the race underground.

The use of electric vehicles in underground mines is a growing trend, and Saskatchewan mining companies are among the early adopters. Many factors are driving the move from diesel to electric, but it all comes down to emissions or, more accurately, the lack thereof. Electric vehicles produce zero emissions.

"Air quality is definitely the number one factor behind the growing use of electric vehicles in underground mining operations. PotashCorp, Mosaic and Agrium all currently use our electric vehicles at their mine sites," said Kipp Sakundiak, general manager of PMP.

PapaBravo electric vehicles save energy and improve air quality underground.

"Using electric vehicles instead of diesel improves underground air quality, reduces greenhouse gas emissions, lowers noise levels; they even generate less heat. They help reduce operating and ventilation costs. They're also quiet; you can be driving along and having a conversation with the guy beside you."

PMP is a Saskatchewan-based, internationally recognized manufacturer of heavy industrial machinery and machine components that's been serving the mineral mining, steel production and oil and gas industries for over 35 years.

In 2015, PMP acquired PapaBravo Innovations, a leading designer and manufacturer of electric vehicles and electric drive systems.

PMP's PapaBravo Electric Vehicles are designed specifically for rugged underground potash mining conditions, with robust automotive grade chassis and parts, reliable, low maintenance operation and minimal downtime.

They also have great names. PapaBravo's first machines were, appropriately for the mining industry, named for burrowing mammals – including the marmot and badger. Indeed, the prototype was the Gofer.

The full line of vehicles includes two to 12-passenger transports, 4×4 electric trucks and 4×4 electric vehicles. Vehicles and trucks can travel from 100 to 120 km on a single charge unloaded and from 65 to 90 km carrying a payload. Hauling capacity ranges from 3,500 lbs for personnel carriers, to 4,000 lbs for the 4x4s, to 7,200 lbs for heavy duty trucks. Depending on the charging option, vehicles can recharge to 65 per cent in an hour and fully recharge in two hours.

"The units being provided by PMP are just as capable as many of the diesel machines we've been using in mining for years without the downside that comes with burning diesel. It's been very beneficial to have a progressive

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Saskatchewan-based partner who understands the unique needs in a potash mine," said Matt Johnson, Mine Manager, Esterhazy K1 facility with The Mosaic Company. "The technology is getting to the point where we don't have to make a compromise in performance to utilize the electric vehicles."

"We build all of our vehicles from ground up in our Saskatoon facility," Sakundiak said. "Every vehicle is made to order—we pride ourselves on being able to customize to specific client needs and configurations. For example, the way we kit out a welder's truck for one client will be different from that of another, everything from equipment brackets to customized toolboxes and tank mounts. And our engineers work with clients to develop the best vehicle charging strategy for their particular situation."

It takes eight to 10 weeks for PMP to build a custom electric vehicle. Standard features include 4-wheel drive, soft riding coil-over suspension, patented modular drive system, certified roll over protection and lithium iron phosphate (LiFePo) batteries. Optional features include fall protection, LED lighting, back-up cameras, spring applied hydraulic released brakes and vehicle diagnostic tools.

There's also growing industry interest in the software capabilities of electric vehicles, whether it's being able to collect detailed, day-to-day data on vehicle use for use in asset management plans, or being able to control how fast a new employee drives a vehicle and which areas specific vehicles are allowed to access.

> "We build our vehicles from scratch onsite in our Saskatoon facility."
>
> **KIPP SAKUNDIAK, PRAIRIE MACHINE & PARTS MFG**

Zero emissions, quiet ride, rugged construction, reduced maintenance and operation costs, flexible configurations — there are good reasons Saskatchewan mining companies are going electric.

PapaBravo's first machines were named for burrowing mammals – including the marmot, badger and even the gopher!

ORE | THE OFFICIAL PUBLICATION OF THE SASKATCHEWAN MINING ASSOCIATION FALL/WINTER 2016

Environmental stewardship a key part of new agreement with northern partners

Vincent Martin, President and CEO of AREVA Resources Canada, Diane McDonald, lead negotiator, and Cameco President and CEO Tim Gitzel (front row, left to right) join Hatchet Lake First Nation residents at the announcement of the Lands of the North agreement.

A new, ground-breaking agreement between Saskatchewan's two largest uranium companies and seven northern communities will strengthen open communications, spur economic development and ensure environmental sustainability for generations to come

Cameco Corporation and AREVA Resources Canada signed the new collaboration agreement June 21 to solidify their partnerships in the Athabasca Basin.

"It has been 17 years since the last agreement, and this new agreement is more reflective of the current mining industry and the needs of the communities," said Alice Wong, Cameco senior vice-president and chief corporate officer.

Entitled Ya'Thi Néné, or Lands of the North in the Dene language, the agreement was built on the historical relationship between the Athabasca people and the Cigar Lake, McClean Lake and Rabbit Lake operations. It connects Cameco and AREVA with the First Nations of Black Lake, Fond du Lac and Hatchet Lake, and the communities of Stony Rapids, Wollaston Lake, Uranium City and Camsell Portage.

The agreement covers important considerations including workforce development, business development and community investment, as well as community engagement and environmental stewardship.

Its intent is to ensure a strong future for mining in the north, for years to come.

"These agreements give communities a strong voice in their relationship with industry and more certainty and predictability in the benefits they receive, whether it be employment, business opportunities or community investment," said Wong.

"The renewed partnership agreement gives the Athabasca communities certainty, to help ensure that the companies operate sustainably, bringing positive changes for the future generation," agreed Diane McDonald, lead negotiator for the Athabasca communities, at the time. McDonald has also been named the primary contact person with the new Land and Resource Office.

"By working with industry, people living in the north have found ways to enhance the capacity and vitality of their communities while protecting their traditional values and lands. This agreement assures that strong partnership will continue," said Tim Gitzel, president and CEO of Cameco.

Building on the impact agreement signed in 1999, the environmental segment of the agreement commits to:

- Establishing new structures, in consultation with communities, to engage and inform

Signatories to the Lands of the North agreement pause for a post-signing photograph.

the Athabasca residents on environmental and operational matters related to Cameco and AREVA operations.

• Sustaining and enhancing the community-based environmental monitoring program previously overseen by the long-time Athabasca Working Group, the primary avenue of information to the community, and

• Providing annual funding to support the new Ya'Thi Néné Land and Resource Office, which will serve as a point of contact for the companies on environment-related matters.

Tammy Van Lambalgen, Vice-President, Corporate Affairs and General Counsel for AREVA, said the agreement was innovative and enhances the environmental side of community engagement.

"What I am really proud of in this agreement is that it is truly collaborative," she said. "It is an improvement over the 1999 Impact Management Agreement. It has a strong reliance on sharing of information and is definitely more two-way. The whole tone of the agreement emphasizes working together."

It's also a progression from the Athabasca Working Group as it existed under the 1999 IMA. The group handled all aspects of the IMA as one entity; the new agreement breaks out the key pillars into subcommittees, and goes more deeply into each of the key pillars of the relationships between AREVA, Cameco and the communities and the First Nations.

One of the subcommittees is the Athabasca Joint Engagement and Environmental Subcommittee (AJES), which will be focused on "anything we need to engage the community on, and environmental stewardship," said Van Lambalgen.

The AJES, which will now also review the community-based environmental monitoring program that has been in place for 17 years, will have an office dedicated to environmental stewardship.

"If people have concerns about our activities or operations, they can always go directly to the companies. But if they want, they now have someone within their communities appointed as a point of contact."

It's very important for the communities to have a place to weigh in on environmental issues, said Wong.

"We have a shared interest in protecting the environment. With local people involved we can make sure that the communities are aware and engaged in our activities. They can see first-hand how the environment is monitored and cared for."

> "The whole tone of the agreement emphasizes working together."
>
> **TAMMY VAN LAMBALGEN**
> **AREVA**

The agreement will undergo five-year reviews, but will extend to the length of the operations.

As Van Lambalgen pointed out, AREVA and Cameco have been engaged in corporate social responsibility "long before it was even a term."

"We always were, for a variety of reasons, looking to include our neighbours in our activities right from the get-go. We enjoy really strong Aboriginal employment at our mine sites – at AREVA's McClean we are at 47 per cent Aboriginal employees, and have over 50 per cent that are residents of Saskatchewan's north.

"Hopefully it will give the communities more power and a stronger say," Van Lambalgen added, referring to the agreement. "When you empower people, they thrive."

eARTh

The art of mining

James M. Clow creates remarkable potash paintings

James Clow has invented a method of mixing potash with paint for his unique works of art.

They said it couldn't be done.

"They" were the chemists at Golden Artist Colors, a United States paint and art supply company. "It" was combining potash – real potash – with their products.

Mixing the pink gold of Saskatchewan with paint, and applying the mixture to canvas, was the brainchild of Saskatoon artist James M. Clow. The miner at Mosaic's Colonsay mine – who has been an artist longer than he has been a miner – began studying how to turn potash into art not long after he joined Colonsay.

He was thunderstruck the first time he went underground; he couldn't believe the beauty and the deep, long history of the province's geology.

"That really sparked my imagination," said the former animator (yes, as in animated movies.) "I saw the rotor grooves left in the walls where the guys had been cutting…and took it out of the context of a blue collar job site and into a modern art gallery. I wanted to bring the two worlds together."

He started taking home small amounts of potash, and mixing them with acrylic paints. It took him three months of experimenting, every single day, but he finally figured it out.

It shouldn't have worked. Potash is salt; acrylic paint is, essentially water. "Apparently, I am the only one in the world who has done it," said Clow, who researched extensively before experimenting himself.

Then one day, when he tried to buy more of the Golden Artist Colors paint he had been using in the mixture, he was told they were out and the paint was on back order.

He had ordered quite a lot.

"I got a call from New York – the international representative (for Golden) – and he asked, 'what are you using this for?' Nobody buys this much of this product."

Clow told him.

"He told me, you can't do that. It's not possible. I said, yes it is."

It is, however, a proprietary process. The representative hooked Clow up with one of the company's chemists, who promised a confidential conversation.

The chemist first agreed with the rep: what Clow said he was doing was impossible. Once the process was explained, though, the chemist changed his mind.

"The end of the conversation was "at first I thought you were an idiot,'" Clow remembers the chemist saying. "Now I think you are a genius."

Clow, today, produces several potash canvases during the summer.

Sometimes he adds gold, sterling silver

and copper to the potash and acrylic mixture, as well.

Many of them depict the rotor grooves, in raised paintings that look quite incredibly identical to the underground grooves themselves. Other paintings include sky, earth, crops and potash underneath, in homage to the Saskatchewan landscape – above and below ground. He produces them in various sizes, and they have been selling rather well.

Mosaic Co. and others have purchased paintings, which now hang in offices around the province and as far away as Florida and Mexico. He has also sold "a lot" to private collectors.

Clow, who started drawing as a small child, originally became an animator. Taking a bachelor of fine arts at the University of Regina, he majored in drawing and minored in print making, while also taking classes at Sheridan College in the summer months. In 1988, he graduated from both schools

> "I wanted to bring the two worlds together."
>
> **JAMES M. CLOW**

– "seven years of education wrapped up in four."

He was hired even before he graduated, and went to work in Germany before going to Universal Pictures in London, England. He helped create two features there before the studio was closed, and all work was moved to Los Angeles under the Dreamworks name.

Returning to Canada, Clow worked in Vancouver for many years, but eventually came back to Saskatchewan to be closer to family. However, Clow said, "you can be an animator from Saskatchewan, but you can't be an animator in Saskatchewan," so he began looking for other work.

That's when a friend took him on a tour of the Colonsay mine, and the rest is history.

"When I went underground, to me, it was art, what they were doing."

Clow's work can be seen, and he can be reached, through his website: *http://jamesmclow.ca/*.

In each edition of ORE, we go beyond the official bios to give our readers insight into the leaders of Saskatchewan's mining and exploration companies.

Beyond the Bio:

BRUCE BODINE
SENIOR VICE PRESIDENT, POTASH, THE MOSAIC COMPANY

Bruce Bodine spent much of his life in Florida, land of sunshine and beaches. You might think moving to Saskatchewan would have been a bit trying, considering the winters, but Bodine really took it in stride.

"I moved to Esterhazy in September, 2012, from Florida, and it wasn't a shock," he says in an interview. "People probably overtalk it – I thought it would be much more of a shock. Yes, the winters are cold…but you wear the right gear and it's not so bad.

"Florida was just as miserable, in a different way. Living there for that long, 35 years – it just got so hot in July and August, it's like you can't escape it. You can't breathe outside."

That was the first Saskatchewan stint for the new senior vice president, potash, for The Mosaic Co. At the time, his predecessor, Walt Precourt, called Bodine and asked if he would be interested in an opportunity.

"And I said, 'always interested, what do you have in mind?' And he said, 'I'd like you to come up here and run our Esterhazy operation.'

"I didn't expect that. I thought about it long and hard. Esterhazy is a flagship operation for Mosaic in many ways. I ultimately said yes, and moved up here in 2012."

He ran Esterhazy for a year as general manager, and in July 2013, he also took on the Colonsay operation and was promoted to vice president, operations for the two facilities.

Then in August, 2014, he was offered a corporate role at Mosaic's office in Minneapolis. Mosaic had just purchased Archer Daniels Midland (ADM) distribution assets in Brazil and Paraguay. He ran those operations for about seven months, and then became vice president of supply chain. Bodine added oversight of China and North American Midwest assets including warehouses, ports and the operations groups to his portfolio.

"It was quite a large job as well as strategic sourcing. We're the largest ammonia and sulphur procurer in the world, and that responsibility fell within my organization.

"I got to travel to Brazil quite a bit and to Paraguay, to China, and a really fascinating part of my job for me personally was to experience different cultures, different operations. It really gave me a good perspective on all that Mosaic encompasses."

But Saskatchewan was again looming in his future. In early 2016, Mosaic's CEO asked Bodine if he would be interested in moving back to Saskatchewan to lead the potash business. "We had a colleague of mine (in Florida) with 45 years of experience who expressed a desire to retire, and rightfully so," said Bodine, referring to Bo Davis, former senior vice president of phosphates, a role Precourt has now taken over.

"I don't think I could say yes fast enough."

The new role, he says, is very different from his other positions. He is deeply involved in representing Mosaic to various stakeholder groups, including government and Saskatchewan communities.

"As a kind of figurehead for this business, that is something that has really been quite the change. But it's something I was really looking forward to," he said.

"It's really about the depth and breadth of how we are involved and how Mosaic is a partner in the community, participating and helping shape policy on how, in this province, to move things forward for the benefit of citizens."

Bodine, who moved to Lakeland, Fla., at the age of seven, earned his Bachelor of Science degree in environmental engineering from Florida State University at Gainesville.

Out of school, he started work with a smaller, family-owned engineering firm in his hometown. His primary responsibility was supporting the fertilizer industry in Florida, which is largely phosphate.

He was a seconded engineer working for IMC Fertilizer at the time, a predecessor company to Mosaic.

"I reported into a legacy Mosaic company more than I reported into the engineering company's office. I got to know a lot about the industry, and a lot about the company."

Mosaic soon offered Bodine a job, and he liked working for the bigger company. He worked at the New Wales facility in Florida, and then in 2004, moved into operations when IMC and Cargill merged into Mosaic, eventually becoming general manager at the largest phosphate mining operation in central Florida. He was there for several years, until the call from Walt Precourt came in 2012.

Despite his senior position, Bodine is not resting on his engineering laurels. He is pres-

ently in his second year of taking an MBA in Chicago at the Kellogg School of Management.

"I can do the financial stuff, but only enough to support the roles I was in," he explains. "This is a deeper dive. The reason Kellogg was a good choice in my mind is they believe strongly in the power of the network and the value you get in interfacing with a cohort.

"I have been in this industry my whole career. It probably limits the perspective that I have. To hear and discuss with and learn from my fellow students who are in totally different industries, and have faced similar strategic challenges…just further broadens my perspective. That's been the rewarding part of that experience for me."

When not working or studying, Bodine returns to Minneapolis regularly to visit his family. With three daughters, one of them finishing high school, he and his wife decided the family would remain in Minneapolis until the school year is over.

The remaining few moments in his schedule are spent cheering for the Saskatchewan Roughriders: After all, they play football in Mosaic Stadium. Asked if he has adopted them, he says, "I can, with good conscience, say yes. They are my favourite Canadian football team, by far. It really is an amazing experience to be a part of that.

Bruce Bodine has adopted the Saskatchewan Roughriders – "the best brand in the CFL."

"Rider Nation – I think it's the best brand in the CFL. When you go to a game, you see why. It rivals anything that I've witnessed in the United States, with the fan dedication.

"It's contagious; it's pulled me right in. We are proud to have our name on the stadium. It's been a great relationship with the organization."

Tagging along

DEVIN KOPP
ENVIRONMENTAL ENGINEER
POTASHCORP

Some people see an engineering career as a desk job, surrounded by complex drawings and reports, and interrupted by the occasional meeting.

It depends on the kind of engineer.

When Devin Kopp was contemplating his own career future, being at a desk more or less constantly did not appeal to him. He did want to be an engineer, but he also wanted to be active; so he chose to become an environmental engineer.

"I enjoy being outdoors, and the field of environmental engineering can be broad and exciting," he said. "This may or not be true, but my vision of other engineering is that you can be very focused on a narrow scope.

"The field of environment can encompass a lot of things – air quality, water quality, earthworks projects, those kinds of things. That's what interested me."

Kopp, who is from North Battleford, graduated from the University of Saskatchewan in geological engineering in 2006. He started his career working in environmental consulting, largely in Alberta's oil and gas industry.

After about a year, he moved back to Saskatoon but stayed with the same company for another one and a half years before deciding to change his direction. He started at PotashCorp's Cory mine in March 2009, and just moved to the Saskatoon head office in May.

"PotashCorp is one of the best employers, top employers, in Saskatchewan, and I had some friends and family that had worked for the company too. I always heard good things. I just knew it was a great company; their reputation kind of pulled me in."

> "PotashCorp's goal is to go above and beyond regulation requirements."
>
> **DEVIN KOPP**

At Cory, Kopp oversaw responsible tailings management and ensured government compliance with environmental regulations.

"Cory was a great place, close to Saskatoon. I got to live in Saskatoon and still be at an operating site. It was a good fit there.

"Because I've been at the corporate office for a short amount of time, I'm still working with the new hire at Cory to ensure a responsible turnover of duties. I'm still spending part of my time at Cory, but I've also been going to other sites as part of my new role.

"Part of my role is to provide technical support on some of the larger site projects. Each site has environmental capital projects, so for some of the larger ones I would be there for technical support, if needed, help with design review, help with environmental approvals, those types of processes.

"I've also been helping conduct environmental audits."

So far, since moving to head office, his work has been equally divided between office time and travelling to all the potash mine sites. As time goes on, Kopp says he may be in the office a bit more.

"It does also depend on the time of the year, because summer is a busy season for the sites," he explained.

"With the capital projects, the majority of the work happens in the summer. There are a lot of approvals, earthworks, those types of things we are trying to fit into our narrow construction season. My time in the field will be more in the summer months, and time in the office in the winter months when reports tend to be due.

"We are required to complete numerous reports for Environment Canada, Saskatchewan Environment, and other regulators."

At Cory, Kopp wrote a lot of reports; his new job entails reviewing reports.

"Those could be reports from sites or reports from consultants. Also, I'm always working to stay at the forefront of federal and provincial regulations. It's also a time now where there are a lot of changes happening with both federal and provincial environmental regulations.

"Just last year, the new Saskatchewan Environmental Code was implemented for the province. I'm trying to stay on top of what those new regulations mean for our sites, and ensure that our sites are equipped to meet those new regulations."

One of the largest recent changes is the federal government's commitment to reduce greenhouse gas emissions by 30 per cent by 2030, in the wake of the agreement signed at the Paris global climate change conference in May.

That commitment may affect potash companies on the operational side, said Kopp.

"Our sites are well within regulatory standards for emissions," he said. "Potash dryers, for example, which operate on natural gas, are equipped with the best available technology. We are always seeking new technology to reduce emissions and increase efficiency.

"Our corporate philosophy plays a part in how we operate our sites. PotashCorp's goal is to go above and beyond regulation requirements."

He's also constantly evaluating best practices and technologies in environmental management.

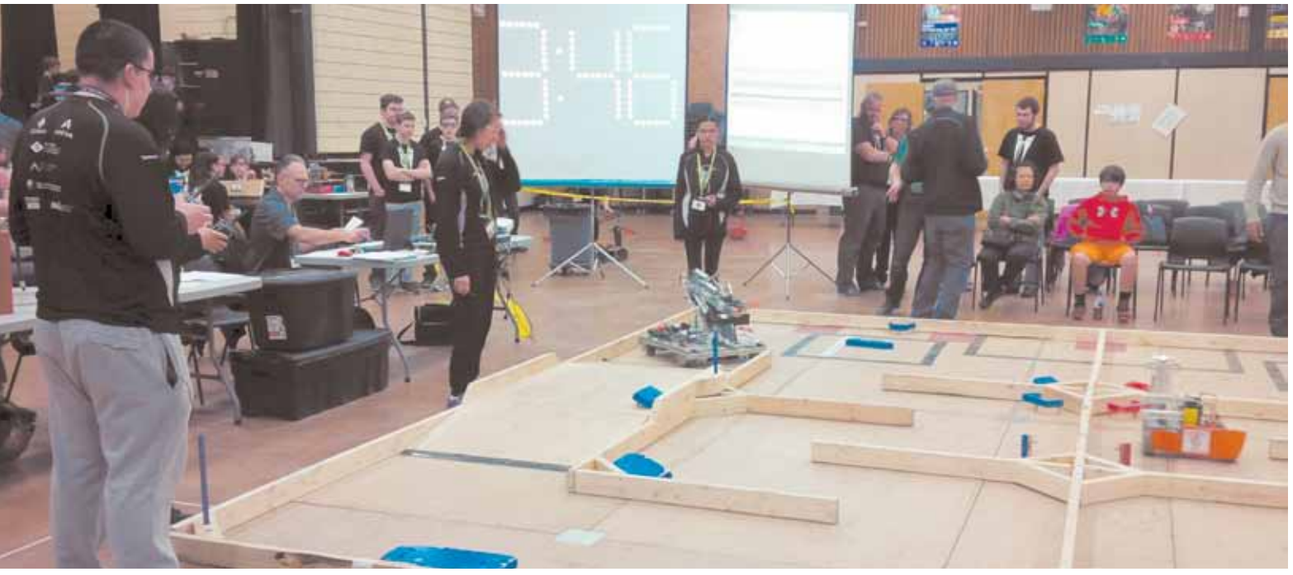
For example, PotashCorp is always seeking new ways to deliver environmental awareness and training to operational teams.

"There are interactive online learning systems we can use to develop training packages, as opposed to the old book and paper way to deliver information. We are developing interactive digital solutions to enhance environmental awareness and training."

Kopp does have work-life balance in his own environment. He and his wife Jaclyn (they've been married for less than a year) frequently visit her family's cabin, where Kopp likes to go fishing. He plays golf in the summer and basketball in a city men's league in the winter. He was also in a band during his university years, and he continues to play drums for the physical and mental workout.

"It's a good way to relax after work."

ROBOTICS CLUBS



Students at Rossignol High School in Ile-a-la-Crosse are learning robotics, and having a lot of fun at the same time.

The New Woodshop?

For high school students, participating in robotic competitions like myRobotRumble SUMOBot Challenge at Saskatchewan Polytechnic is a fun way to earn extra credit and meet new people.

For the Saskatchewan mining industry, the stakes are higher. Robotic equipment is currently used in underground uranium mining operations and will continue to be a growing trend in the mining industry, which means tomorrow's miners are going to need a new skill set. That's what makes programs like the Rossignol High School Robotic Huskie Squad so important.

Throughout the school year, club members meet after school to work on their robots. In March 2016, club members made the five-hour drive from the village of Ile-a-la-Crosse to compete at the annual Sask-Polytechnic myRobotRumble in Saskatoon. A month later, they made the seven-hour trip to compete in the Skills Canada Saskatchewan competition in Regina, placing sixth in mobile robotics.

"Thanks to our generous sponsors, including the Saskatchewan Mining Association, we were able to purchase more robots, more parts, build a larger robot and afford our trips to both competitions this year," said Dave Dalton, a math and science teacher at Rossignol as well as coach of the robotics club. Dalton launched the club six years ago with four students. Last year, 10 to 15 students were regular participants; this year, he expects that number to be closer to 20.

Why are students so attracted to robotics?

"I think the chance to do something new, something hands-on appeals to kids. The students had a lot of fun at both competitions, but the club meets all year and most of the time we just play around—designing, building, tweaking, planning. It's fun," Dalton said.

Rossignol entered five teams in the 2016 myRobotRumble: Blitz (Noah Dubrule and Lance Belanger), Butch (Terrance Daigneault), R (Mason Desjarlais and Trinity Morin), Shay-Shay (Shayna Burnouf and Shanelle Kenny), and The Doctors (Leon Iron). The teams battled small SUMOBots, which are provided by Saskatchewan Polytechnic.

"Our five teams were all in different pools, and three of the five finished in the top three of their pool, advancing to the semi-final round. We were close to having all five teams advance to the semi-finals, but we ran into some issues with our bots, including one that completely fried," Dalton said.

For the Skills Canada competition, schools are limited to a single team of four: SUMOBot veterans Shayna, Shanelle, Terrance and Trinity made up Rossignol's team.

"The Skills Canada competition is very different than battling the little SUMOBots," Dalton said. "It involves building a large 100 to 150 pound custom robot to compete in a game, which changes every year. This year, the robots had to pick up and assemble the pieces of a 'boat,' which was comprised of 11 wooden blocks that had to be stacked together in the right order and location. Each part you delivered to the building area earned your team one point, and each part you correctly assembled gained another point."

This year marked only the school's second appearance at the Skills Canada competition, making the sixth place finish a remarkable achievement.

While Dalton recognizes the value of school robotics clubs in giving students hands-on experience building, programming and using technology, he believes the main benefit is "seeing students gain experience and confidence, and seeing them learning and growing."

> "Robots are the future. In schools, I think building robots is going to be like woodshop was in past generations."
>
> **DAVE DALTON, COACH ROSSIGNOL HIGH SCHOOL ROBOTIC HUSKIE SQUAD**

FIRST MINE SAFETY SUMMIT: Asking the BIG Question

PotashCorp Lanigan Emergency Response Team competes at the 2016 Emergency Response/Mine Rescue Skills Competition.

What do we need to do to get to zero fatalities?

That was the question asked at the Mine Safety Summit - Technical Aspects of Mine Safety hosted by the Saskatchewan Mining Association (SMA) in February. Safety is not a new topic for the SMA or its member companies; what made this event unique, and filled the room to capacity, was the approach.

"We wanted to kick the discussion of mine safety up to the next level, and to do that, we needed to drill down to a detailed technical level," said Arnfinn Prugger, PotashCorp's Vice President, Technical Services. He and Liam Mooney, Cameco's VP SHEQ and Regulatory Relations, co-chaired the summit.

"When there's an accident in the airline industry, for example, they go into great detail about what went wrong and why," Prugger said. "They really drill down to get those answers, and they publicly share what they know. We don't have that tradition in mining."

The Mine Safety Summit is a step in that direction. The Summit presented case studies from SMA member companies on safety issues that related to activities and conditions that have been, or have the potential to have been, associated with serious injury and/or fatality.

Eighteen presentations on six themes (ground control, structural integrity, mobile equipment/personnel interaction, falling/dropped objects, fires and best practices in safety) shared insights on reviews of incident investigations, equipment/procedure evaluations, corrective actions and best practices.

Prugger gave the opening address. "I wanted to light a fire," he said. "SMA member companies have all improved the safety culture at our mine sites, as shown by our greatly improved total recordable injury frequency (TRIF) and lost time injury frequency (LTIF) statistics since 2000. However, we have yet to eliminate life-altering injuries/fatalities from our work sites. When you look at the numbers, you see that fatalities have remained the same since 2000 — we haven't made the same progress that we made with decreasing recordable injuries. Why? What do we need to do to get to zero life-altering injuries/fatalities in the future?"

The question was at the heart of his address. Prugger reviewed Saskatchewan mining industry fatalities by injury area (e.g. mine, mill, load-out) and cause (e.g. fall-of-round, fall, electrocution). He provided a brief overview of some of the things PotashCorp is doing to get to zero life-altering injuries/fatalities.

Perhaps the most powerful segment of his presentation was a series of images from a PotashCorp incident. The series begins with a photo of a bolt on a flotation-cell skimmer-paddle. The story unfolds with several shots of the twisted skimmer-paddle after a PotashCorp worker got his shirt caught on the little bolt. The room went still at the image of the worker's torn and ripped shirt; the words "near-miss" led to a collective exhale.

"We now have paddle-guards covering all flotation skimmers. But, why didn't we think of this before the near-miss accident?" Prugger said. "We need to work together to solve this problem — let's start by sharing information about our incidents, as well as our mitigation/elimination strategies."

"The Mine Safety Summit was well attended, with 140 delegates, including representatives of SMA member companies and government officials," said Brad Sigurdson, SMA's manager of environment and safety. "Feedback indicates it was an excellent opportunity for delegates to learn from other SMA members, through the presentations as well as the networking opportunities."

A highlight for many delegates was the Mining CEO Conversations on Safety over lunch, facilitated by Cameco CEO Tim Gitzel and featuring commentary by executive leaderships from Agrium, AREVA Resources Canada, BHP Billiton Canada, K+S Potash Canada, The Mosaic Company, PotashCorp and Thyssen Mining.

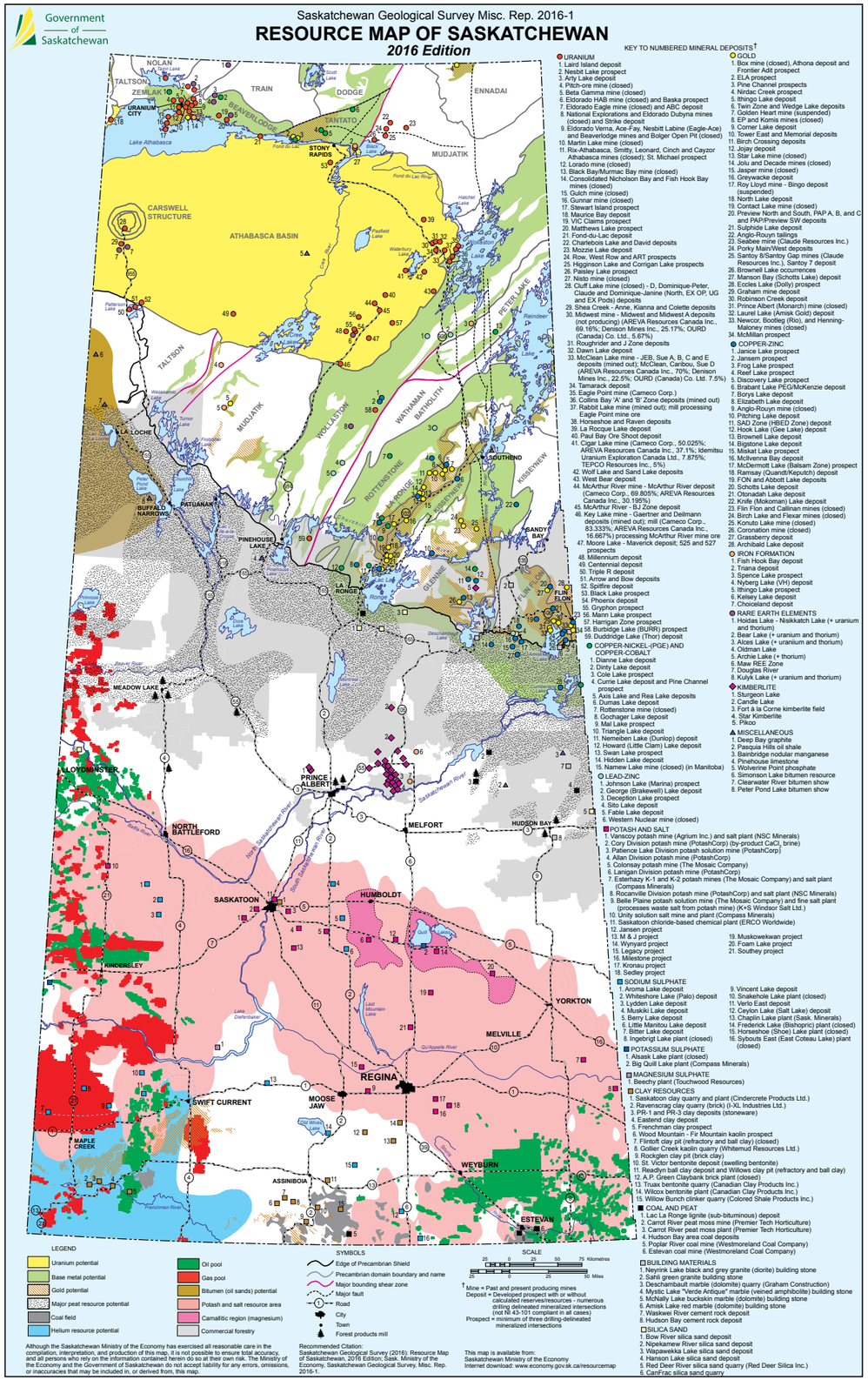
Based on attendance and feedback, the first Mine Safety Summit was a success. It confirmed industry interest not only in discussing the technical details of mine safety incidents, but also in sharing the resulting insights, conclusions, actions and best practices. It's an important step forward in finally answering the big question of how the mining industry gets to Mission Zero — zero injuries, zero fatalities, zero suffering.

Planning is now underway for the second annual Mine Safety Summit in February 2017. Look for details at *saskmining.ca*.

On Monday August 8, 2016, Chad Wiklun, an employee at the Agrium Vanscoy Potash Mine, was crushed between two pieces of mobile equipment. Tragically, he sustained life-threatening injuries and died as a result of those injuries. A trust fund has been set up for Chad's two young daughters, ages six and eight, at the Affinity Credit Union. Donations are greatly appreciated and can be made at any branch of Affinity province wide or through e-transfer to:

Chad Wiklun Trust Fund, Affinity Credit Union, #1619998, Etransfer: *chadwikluntrust-fund@gmail.com*

Please also consider donating blood and or plasma to your local Canadian Blood Services *www.blood.ca*



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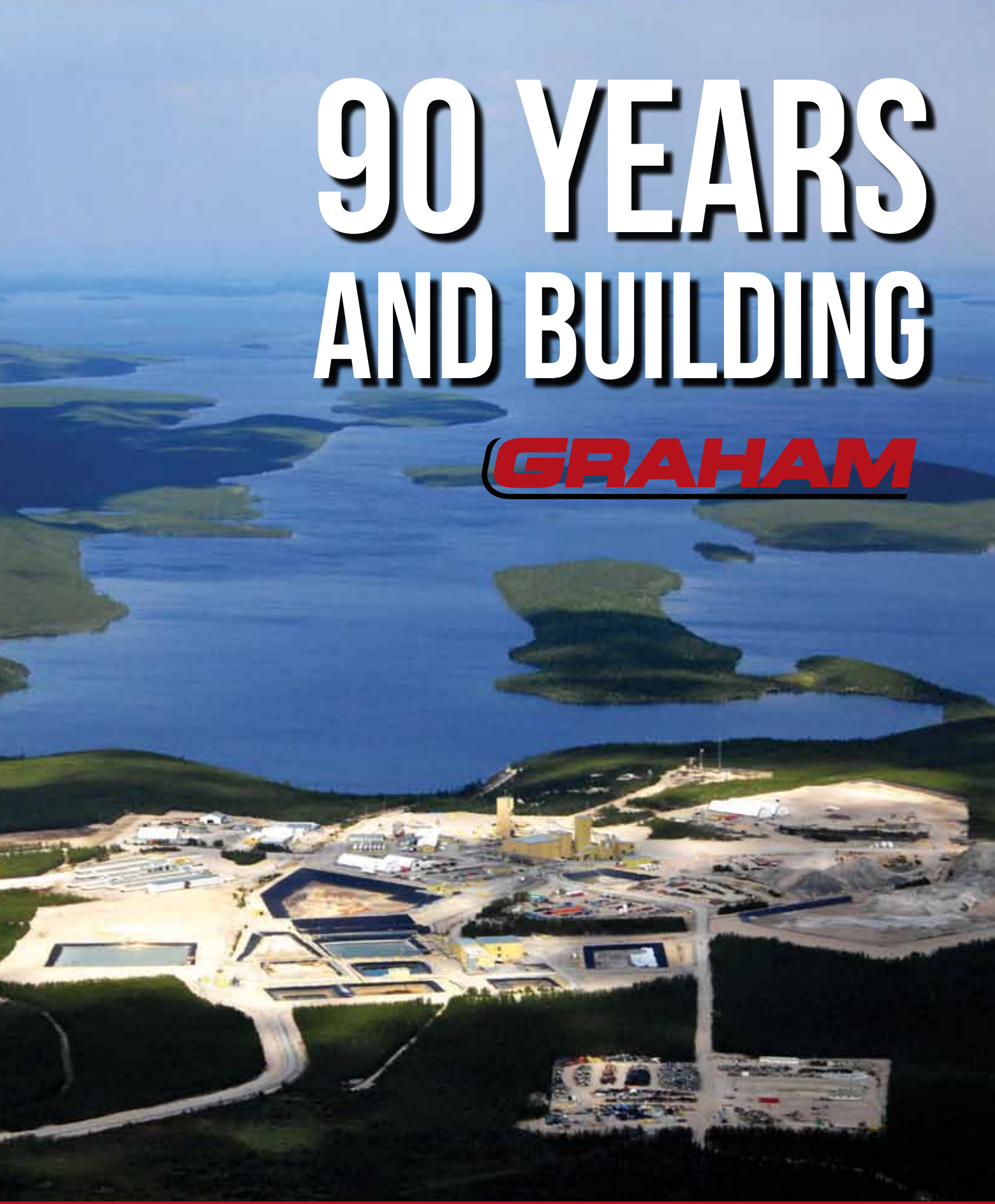

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