MINING SECTOR PERFORMANCE REPORT
2008–2017

Energy and Mines Ministers' Conference

Cranbrook, British Columbia
July 2019

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Preface

The 2019 edition of the *Mining Sector Performance Report* examines the economic, social, and environmental performance of the Canadian minerals industry from 2008 to 2017 and benefits from the insights, comments, and review from a multi-stakeholder external advisory committee, the provinces and territories, industry associations, and industry members. The report was prepared by the Intergovernmental Working Group on the Mineral Industry for submission to the 2019 Energy and Mines Ministers' Conference in July 2019 in Cranbrook, British Columbia.

It is important to note that the 10-year period focused on in this edition of the report differs slightly compared with previous editions. By focusing on calendar years 2008–2017 instead of 2009–2018, a more complete set of finalized data could be captured, vetted, and analyzed by the authors and reviewers. Additionally, it allows for a final comparison on a decade-long horizon with important economic anomalies from the 2008 downturn that would not have been captured by using the status quo.

The report focuses on:

- The sector's domestic activities;
- National-level indicators and, when possible and relevant, data by jurisdiction; and
- Articulating performance trends rather than determining causality among metrics.

For the purpose of this report, the terms *minerals sector* and *minerals industry* are used interchangeably and comprise the following North American Industry Classification System (NAICS) codes:

  - NAICS 212 – mining and quarrying (excluding oil and gas);
  - NAICS 327 – non-metallic mineral product manufacturing;
  - NAICS 331 – primary metal manufacturing; and
  - NAICS 332 – fabricated metal product manufacturing.

For some indicators (i.e., Gross Domestic Product, employment, investment), additional data related to the mineral exploration subsector are available and included in sector totals.[1] In these cases, this is highlighted in the text.

The data exclude oil sands activity. In addition, data and analysis considerations are explained where applicable to provide the reader with an understanding of specific data constraints.[2] Relevant data are complete to year-end 2017.

[1] Within Statistics Canada's *System of National Accounts*, data related to a special tabulation titled NAICS 21311B – *Support activities for mining* are available. This special classification is an aggregation of NAICS 213117 – Contract drilling (except oil and gas) and NAICS 213119 – Other support activities for mining, and captures establishments engaged in mineral exploration and drilling, and service companies operating on a fee or contract basis. This subsector does not include mining industry suppliers that service multiple sectors (e.g., transportation, construction, finance, legal).

[2] For example, nominal values are used for most indicators as data in real terms are unavailable due to the lack of a mineral-specific deflator. As such, trends highlighted in the report for some indicators (i.e., production and exports) reflect price fluctuations.

Introduction

Natural resources have long shared an important connection with the history of the Canadian economy, its development, and its social fabric. The minerals industry is unique among the natural resource sectors in that it is present in each region of the country and touches each of us in our daily lives. It supports the well-being and independence of many rural, remote, and northern communities and is an important driver of economic activity. It would be impossible for our modern 21st century society to sustain itself without the contribution of minerals and minerals products, particularly in areas such as electronics, transportation, and energy, among many others. As new technology emerges in areas such as non-emitting renewable power, electric vehicles, and advanced energy storage, the Canadian minerals industry is well positioned to be a world leader in providing the raw materials required for their construction, deployment, and adoption.

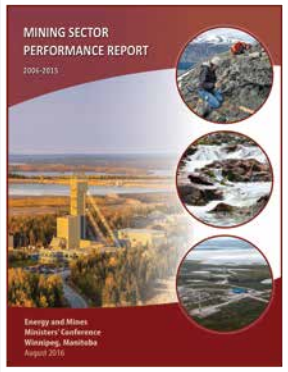
Canada's abundant mineral reserves place it among the world's richest in terms of natural resource wealth, with its mines producing more than 60 minerals and metals and its minerals sector ranking among the world leaders in the production of key commodities such as potash, uranium, gold, primary aluminum, nickel, and diamonds. In addition to these natural resources, Canada's storied history in the sector has led to the nation becoming a world leader in the knowledge, skills, and innovation that have facilitated the prosperity it enjoys.

With the economic prosperity that mining continues to bring to Canadians comes a responsibility to continue to enhance efforts in advancing sustainability while maintaining and improving the sector's economic competitiveness. To measure progress and identify gaps in these areas, federal, provincial, and territorial governments have collaborated with academia, industry, Indigenous organizations, and non-governmental organizations to produce this report.

The *Mining Sector Performance Report* (MSPR) is presented to federal, provincial, and territorial Mines Ministers every three years and has three objectives:

1. To provide Canadians with a common understanding of the sector's performance based on credible and reliable data;
2. To identify areas where improvements have taken place and where progress is still needed; and
3. To help inform the development of priorities for the collaborative work being carried out by the federal-provincial/territorial Energy and Mines Ministers' Conference and the Intergovernmental Working Group on the Mineral Industry.

Box 1: Mining Sector Performance Report, 2006–2015



Presented to Canada's Mines Ministers at their annual conference in August 2016, the report examined the economic, social, and environmental performance of the minerals sector from 2006 to 2015.[3]

To achieve these objectives, the current report measures the performance of 22 indicators over the period from 2008 to 2017.[4] The indicators are intentionally similar to those used in previous editions so that the reader can see and compare trends over time on the most consistent basis possible. Where data sources differ from previous reports, it is highlighted in the text.

In general, the performance indicators were selected on the basis of (i) international minerals sector performance reporting practices; (ii) input from provinces and territories; (iii) consultation with an external advisory committee composed of individuals from academia, industry, Indigenous organizations, and non-governmental organizations; and (iv) data availability.

[3] https://www.nrcan.gc.ca/mining-materials/publications/18912.

[4] The period for which data were collected for this report was shifted back by one year as compared with previous editions. This decision was taken based on feedback from the committees involved to reduce the chance of error based on late data, and so that the 2008 recession information could be included for comparison.

Drawing from the Whitehorse Mining Initiative,[5] the Mining, Minerals and Sustainable Development North America initiative,[6] and the UN Sustainable Development Goals,[7] several desired performance outcomes were identified to complement the conceptual framework for the MSPR with assessable goals (Box 2). Both government and industry have a role to play in improving the sector's performance, which is why government actions are included in the report.

The report is organized into four sections:

- **Section I** provides an overview of the key **global trends** and developments currently shaping the operating context of the minerals sector; and
- **Sections II, III, and IV** present the minerals sector's **economic, social, and environmental** performance based on the selected indicators, respectively.

This report is designed to present readers with the long-term trends of selected indicators so that they may observe the economic, social, and environmental performance of the industry over time and draw their own conclusions about its overall performance. Given the scope of the work contained herein, it is inevitable that the distinction between what constitutes an economic versus social indicator may seem somewhat arbitrary.

Box 2: Desired Performance Outcomes

Economic

Maintain and enhance the vitality of the sector, ensuring its long-term viability and competitiveness so that it can make an economic contribution to the local, regional, national, Indigenous, and global economies of the future.

Social

Develop Canada's mineral resources in order to provide tangible benefits for current and future generations, including local and Indigenous communities in proximity to exploration and mineral activities.

Conduct engagement processes to ensure that local, Indigenous, and affected communities have the opportunity to participate in the development of resources that could influence their future.

Environmental

Practise responsible mineral exploration, development, and mine operation, and support public policies that are predicated on maintaining a healthy environment and, upon closure, returning mine sites and affected areas to viable self-sustaining ecosystems.

Ensure that institutional governance frameworks are in place to provide certainty and confidence that mechanisms exist to protect governments, industry, Indigenous peoples, communities, and individuals from any adverse environmental effects.

This simply points to the need for the reader to bear in mind that the three pillars are interconnected, and that one must consider the data and the indicators contained on the following pages as a whole to arrive at a more complete picture of the performance of the Canadian minerals industry.

Finally, the reader should note that this report was developed in collaboration with federal, provincial, and territorial governments as well as in consultation with an external multi-stakeholder advisory committee.[8] As such, all data, findings, and broad conclusions contained in this report have been reviewed by a range of stakeholders.

[5] At the 1992 Mines Ministers' Conference in Whitehorse, Yukon, ministers agreed to become co-sponsors and trustees of a process called the Whitehorse Mining Initiative. This multi-stakeholder process included representatives from five sectors of society: the mining industry, senior governments, labour unions, Aboriginal peoples, and the environmental community. The initiative concluded with the Leadership Council adopting a signed Accord on September 13, 1994, which expressed a vision of "a socially, economically, and environmentally sustainable, and prosperous mining industry, underpinned by political and community consensus."

[6] The Mining, Minerals and Sustainable Development (North America) initiative was established by the World Business Council for Sustainable Development as one of a number of projects being supported by the Global Mining Initiative. It was formed as an independent process of multi-stakeholder engagement and analysis with the objective of "identifying how mining and minerals can best contribute to the global transition to sustainable development."

[7] The United Nations' Sustainable Development Goals are a collection of 17 global goals set by the United Nations General Assembly in 2015. The SDGs are part of Resolution 70/1 of the United Nations General Assembly: "Transforming our World: the 2030 Agenda for Sustainable Development."

[8] External Advisory Committee membership: Ben Chalmers and Charles Dumaresq (Mining Association of Canada), Hevina Dashwood (Brock University), Ugo Lapointe (MiningWatch Canada), Shirley Neault (Hudbay Minerals Inc.), Lesley Williams (Prospectors and Developers Association of Canada), and Alan Young (Materials Efficiency Research Group).

SECTION 1: Canada's Minerals Industry Operates in a Dynamic and Evolving Global Context

Global Economic Trends Influence Canada's Minerals Industry

The minerals and metals sector is highly cyclical in nature. Following the global financial crisis of 2008–2009 and the sharp drop in the prices for many of Canada's commodities, mineral and metals prices quickly rallied over the next two years, reaching a peak in 2011.[9] Between 2011 and 2015, a secular decline set in with prices easing back towards their 2008–2009 lows before displaying a partial recovery in 2016 and 2017. This cyclical nature of commodity prices means that the value of the Bank of Canada's annual Metals and Minerals Index that tracks the prices of Canada's most important commodities for 2017 was roughly equivalent to that for 2009.

More recently, this recovery in prices faces growing threats from trade tensions and tightening global monetary policy that could restrict global economic growth—particularly in the emerging economies and China—along with the demand for minerals and metals. Recent changes in the Purchasing Managers' Index (PMI), an important indicator of global manufacturing activity, show a downwards trend across economic groupings (advanced, emerging, and developing economies), but remain in expansionary territory. As global investor confidence dampened, especially through the fourth quarter of 2018, prices for many important industrial minerals and metals declined.

Looking ahead, major multilateral organizations expect global economic growth to weaken amidst escalating risks. The International Monetary Fund, Organization for Economic Cooperation and Development, and World Bank forecast that trade disputes will continue to disrupt supply chains and slow growth. Emerging economies will remain susceptible to rising U.S. interest rates and increasing capital outflows.

All this suggests that the near-term outlook for Canada's minerals sector is likely to be mixed. Despite China's slowing economic growth, other economies will continue to expand at a rapid pace, most notably India. The World Bank estimates that India's real Gross Domestic Product (GDP) will expand at a rate of 7.5% in 2019 and 7.5% in 2020, well above China's rate of 6.5% in 2018, 6.2% in 2019, and 6.2% in 2020—the lowest levels since 2001, when China joined the World Trade Organization. In recent years, India has become a major consumer of bulk commodities like steel, metallurgical coal, iron ore, and potash and will be moving on to other metals as they continue to advance in economic terms.

Over the longer term, many analysts believe that minerals and metals prices are likely to increase due to supply-side constraints arising from current underinvestment in exploration, new mines, and existing facilities. Demand is forecast to rally due to the adoption of clean technologies that reduce the global carbon footprint. By the middle of the next decade, the increasing adoption of electric vehicles is expected to have a significant impact on the demand for minerals and metals produced in Canada. Battery manufacturers around the world are seeking reliable sources of cobalt in politically stable jurisdictions like Canada. Canada's traditional metals have been forecasted to benefit as well, since copper is critical for electric motors and charging infrastructure. Electric-vehicle batteries require nickel, of which Canada is a leading source.

Expectations for Socially Conscious and Environmentally Responsible Mining Continue to Rise

The minerals and metals sector continues to progress in performing resource development activities in an increasingly responsible and sustainable manner. Industry associations have established principles, standards, programs, and guidelines to support companies in their efforts to engage in a meaningful manner with host communities, to contribute to community development and social well-being, to apply ethical business practices, to respect human rights, to protect the environment, to adopt responsible governance and management systems, to commit to project due diligence and risk assessment, and to safeguard the health and safety of workers and

[9] See: http://www.bankofcanada.ca/rates/price-indexes/bcpi/.

local populations.[10] There is also substantial and growing pressure from manufacturers desiring responsibly sourced metals and minerals for use in their products and facilities. Experience shows that employing responsible and respectful business practices, such as engaging local and Indigenous communities in early and meaningful collaboration and incorporating traditional and community knowledge into project design, can facilitate a more effective review process and support sustainable resource development, including maximizing benefits to local and Indigenous communities.

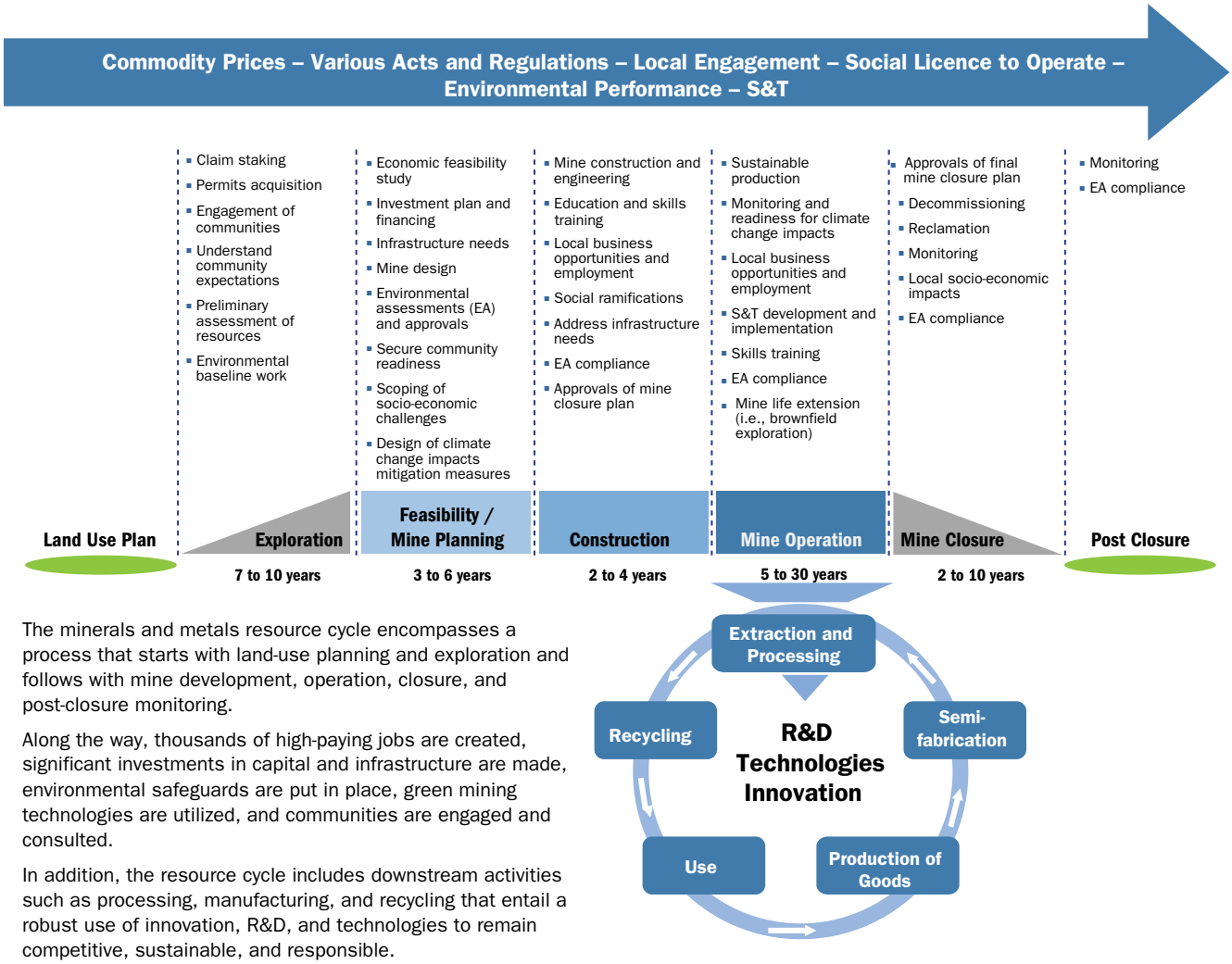
Societal expectations are also increasing when it comes to the way that Canadian companies are operating abroad. *Building the Canadian Advantage* is one example of the efforts to ensure corporate social responsibility of Canadian minerals sector companies engaging in operations overseas.[11] As manufacturers place greater importance on sustainably sourced materials for their products, this places Canada in a position to leverage the "Canada brand" as a sustainable provider of mineral products, especially those required to support the transition to a low carbon economy.

The mineral development continuum is dynamic (Figure 1); as such, a responsible and sustainable development life-of-project approach to mineral development has become an essential condition for companies and host governments at all stages to avoid project delays and disruptions, to create supportive conditions for the minerals sector's long-term socio-economic benefits, and to maintain investor interest.

[10] See: http://www.nrcan.gc.ca/mining-materials/policy/government-canada/8698; https://www.nrcan.gc.ca/mining-materials/mining/minerals-and-metals-policy/8688; http://www.pdac.ca/programs/e3-plus; and http://mining.ca/towards-sustainable-mining.

[11] https://www.nrcan.gc.ca/mining-materials/publications/8776.

Figure 1. Mineral Development Sequence



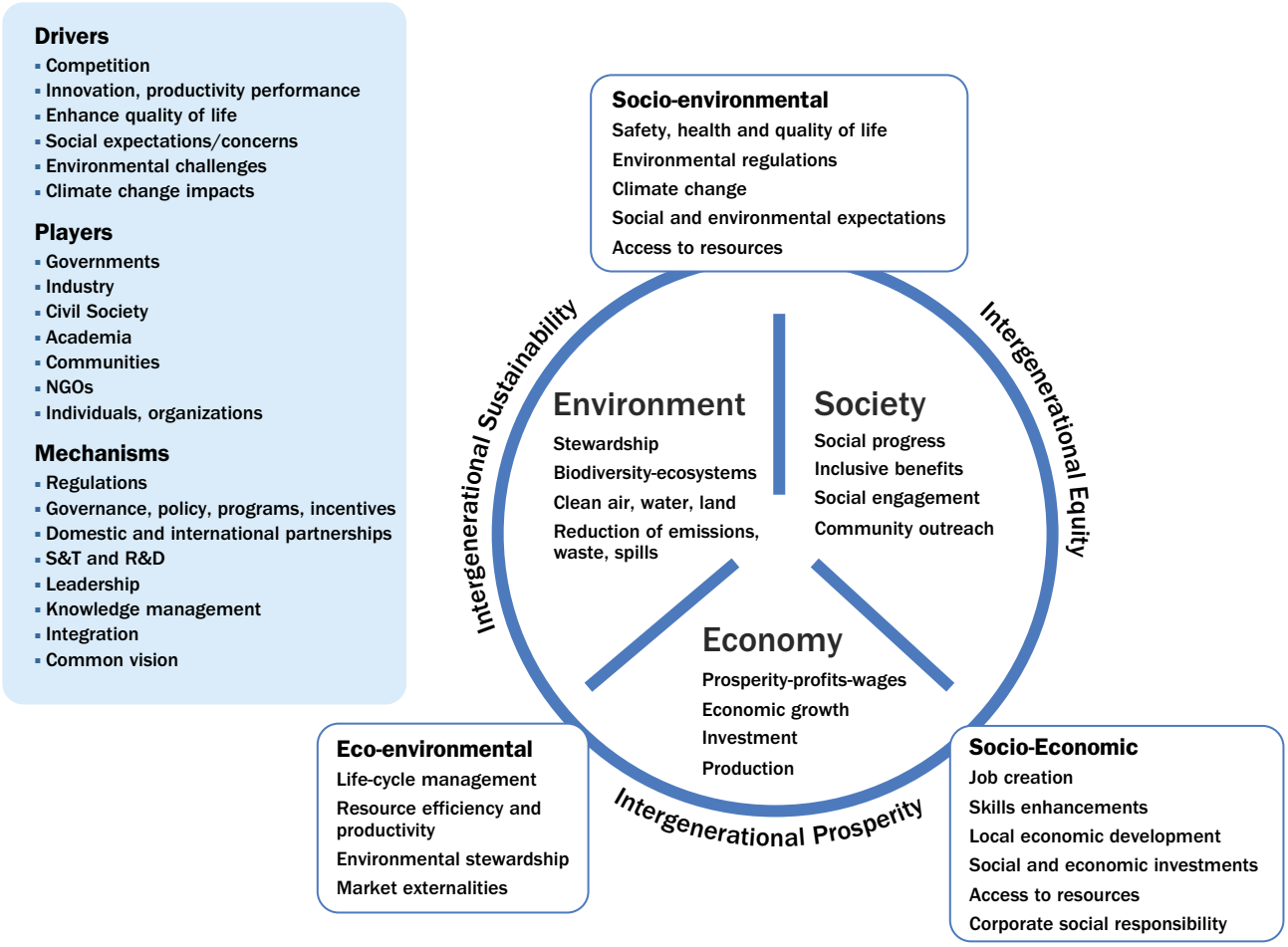
The minerals and metals resource cycle encompasses a process that starts with land-use planning and exploration and follows with mine development, operation, closure, and post-closure monitoring.

Along the way, thousands of high-paying jobs are created, significant investments in capital and infrastructure are made, environmental safeguards are put in place, green mining technologies are utilized, and communities are engaged and consulted.

In addition, the resource cycle includes downstream activities such as processing, manufacturing, and recycling that entail a robust use of innovation, R&D, and technologies to remain competitive, sustainable, and responsible.

In addition, increasing concern over costs related to climate change will continue to have profound impacts on societies, economic growth, and the way natural resources are developed in new and more environmentally sensitive areas. Societal concerns regarding water availability and quality, greenhouse gas (GHG) emissions, and climate change are some of the challenges. However, these challenges also present opportunities that will fuel innovations and leverage of emerging technologies to improve the exploration, development, extraction, processing, and marketing of mineral resources. By continually ensuring that the Canadian industry remains competitive and demonstrates the ability and willingness to produce these materials responsibly, the country will be well positioned to realize long-term economic, social, and environmental goals (Figure 2).

Figure 2. Elements of a Responsible and Sustainable Approach

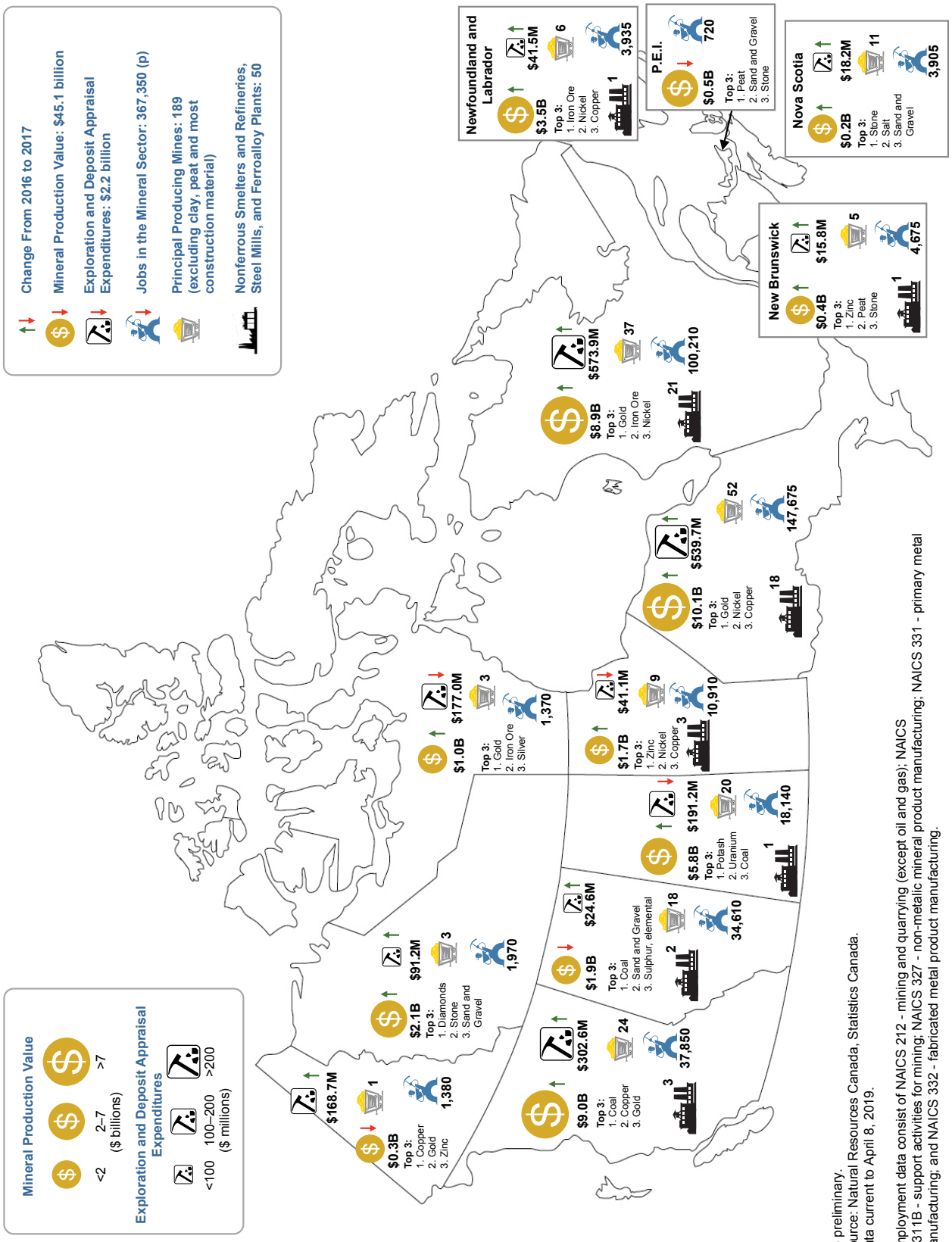


The Minerals Industry Within the Canadian Economy

Canada's minerals industry is a crucial contributor to Canada's economic health (Figure 3). In 2017, the sector:

- Accounted for $58.4 billion in nominal Gross Domestic Product (GDP) (3.4% of total Canadian GDP);
- Directly employed approximately 382,290 workers, with a presence in every region of the country; and
- Contributed $19.9 billion to Canada's trade balance.

Figure 3. The Minerals Sector in 2015 – A Pan-Canadian Industry



(p) preliminary.
Source: Natural Resources Canada, Statistics Canada.
Data current to April 8, 2019.

Employment data consist of NAICS 212 - mining and quarrying (except oil and gas); NAICS 21311B - support activities for mining; NAICS 327 - non-metalic mineral product manufacturing; NAICS 331 - primary metal manufacturing; and NAICS 332 - fabricated metal product manufacturing.

In addition, the sector:

- Contributes directly to the economic vitality of local and Indigenous communities, especially in remote and northern communities with few alternative economic drivers, and remains an important employer of Indigenous Canadians, employing approximately 11,000 Indigenous workers in 2017;
- Is capital-intensive and highly technical, which plays an important part in Canada's role in advanced technology development;
- Is one of the few industrial sectors that consistently add to Canada's balance of trade, contributing nearly $172 billion over the past 10 years; and
- Produces more than 60 minerals and metals and ranks among the top producers of many key commodities such as potash, uranium, nickel, aluminum, and cobalt (Table 1).

With its massive land area and diverse geological settings, Canada has a strong foundation to support prosperity based on the minerals industry. Canada is a global leader in mining, including its economic, cultural, social, political, environmental, and ecological aspects with world-class geoscience knowledge and education systems, a public policy framework that supports responsible mineral development, a skilled labour force, and an ecosystem for innovation in the sector. These attributes provide Canada with immense possibilities to meet future global commodity demand and to strengthen its international standing as a major producer of minerals and mineral products.

Table 1. Manufacturing Sector's Energy Use by Canadian Global Production Ranking, by Volume, 2017

Commodity	Global Rank	2016 Report Rank	2013 Report Rank
Potash	1st	1st	1st
Uranium	2nd	2nd	2nd
Diamonds	2nd	4th	4th
Aluminum (primary)	3rd	3rd	3rd
Cobalt	4th	3rd	3rd
Salt	4th	4th	Not Included
Platinum group metals	3rd	3rd	4th
Gold	5th	5th	7th
Nickel	5th	2nd	5th
Iron ore	9th	8th	9th
Zinc	9th	9th	6th
Copper	12th	8th	9th

Sources: Natural Resources Canada; U.S. Geological Survey.

SECTION 2: Economic Performance

The Canadian mineral industry makes an important contribution to the country's economy. Mining and mineral processing operations contribute directly to the Canadian economy's GDP, and the supply chain and network of service providers have placed Canada among the world leaders in the sector. Many of Canada's rural, remote, and northern communities rely on mining as the primary economic activity.

Drawing from the Whitehorse Mining Initiative (1993) and the Mining, Minerals and Sustainable Development (2002) multi-stakeholder frameworks, the Intergovernmental Working Group committee responsible for the development of this report chose the following desired outcome to frame the economic performance of the sector:

> *Maintain and enhance the vitality of the sector, ensuring its long-term viability and competitiveness, so it can continue to make an economic contribution to the local, regional, national, and global economies.*

The indicators chosen to measure the sector's performance related to these outcomes are:

- **Value of mineral production –** This indicator measures the value of commodities produced using current market prices. It helps determine the vitality of the sector, as it is linked to the revenues and incomes generated.
- **Real Gross Domestic Product (GDP) –** Nominal GDP measures the market value of all final goods and services produced by a sector. It is one of the primary indicators used to measure economic performance and the contribution of a sector to the economy. Real GDP is adjusted for inflation. This indicator measures the sector's direct contribution to the economy's total GDP.
- **International trade –** International trade is the exchange of capital, goods, and services across international borders or territories. Trade is critical to Canada's minerals sector (with the majority of production being exported) and to the country's prosperity, fuelling economic growth, supporting jobs, raising living standards, transferring technologies, and providing affordable goods and services.
- **Public geoscience –** Public geoscience broadly refers to geological, geophysical, and geochemical data, information, and knowledge provided by governments as a public good. The availability of such data and information is widely acknowledged as one of Canada's competitive advantages in attracting mineral exploration, as it enables grassroots exploration companies to make informed decisions regarding their exploration activity. Assessing public geoscience expenditures provides an indication of government efforts to support early-stage mineral exploration.
- **Exploration and deposit appraisal expenditures –** As mines have a finite life, exploration activity is necessary to find mineral deposits that support future mining developments and downstream production in Canada. Exploration spending is the key barometer of the health of the sector, and measuring spending levels in exploration and deposit appraisal activity provides an indication of the future potential for mineral production and downstream activities.
- **Capital expenditures –** Capital expenditures are made by companies to purchase or upgrade physical assets such as property, equipment, or buildings. They help improve an industry's productivity performance, and measuring trends in capital expenditures helps provide an indication of the future competitiveness of a sector.
- **Research and development (R&D) –** Innovation helps improve the productivity and competitiveness of firms and the minerals sector overall. R&D expenditures indicate the extent to which firms are committed to improving production processes and are pivotal to the innovation performance of any industry.
- **Government revenues –** Government revenues from the mining sector are collected through taxes and royalties. Measuring these payments to governments helps determine the direct contribution of the sector to government finances.

Synopsis

The economic performance of Canada's minerals sector over the 10-year period from 2008 to 2017 shows mixed results. Following the recession of 2008–2009, some economic indicators steadily recovered, while others continued to lag behind their pre-recession levels. As this section describes, many economic indicators declined over this 10 year period, although more recently, many of them have started trending upward over the short term. Looking forward, the sector shows some optimistic signs that these upward trends may continue.

Highlights

- In 2008, the mining sector's **value of mineral production** was $46.9 billion and reached a record high of $50.9 billion in 2011. The value of production subsequently declined to $43.9 billion in 2017.

- **GDP** in Canada's minerals sector is currently similar to that of 2008 ($58.5 billion), declining by only 0.2% over the 10 year period ending in 2017 ($58.4 billion). There was a sharp decline during this period between 2008 and 2009 from $58.5 billion to $46.1 billion, followed by a gradual recovery to its 2017 level.

- The value of Canada's **mineral and metal exports** increased 9.2% from $93.0 billion to $101.5 billion between 2008 and 2017.
  - Gold has become Canada's leading mineral export, more than doubling its value since 2008 from $8.9 billion to $18.6 billion due to higher prices and increased production.
  - Iron and steel together represented the second leading export in 2017 at $14.9 billion, which represented a 7.5% decrease from $16.1 billion in 2008.
  - Aluminum was third in terms of export value at $12.7 billion up 8.5% from $11.7 billion in 2008.

- **Government expenditures on public geoscience** grew 3.5% to $161.2 billion from 2004-2005 to 2012–2013. However, there was a 9.7% decrease from a $178.5 billion peak in 2010–2011 to 2012–2013's figure of $161.2 billion.

- In 2017, **exploration and deposit appraisal expenditures** in Canada increased by 29.6% compared to 2016, the first year-over-year increase in 5 years, reaching $2.2 billion.
  - Gold led the recovery in exploration activity in Canada during 2017. Precious metals accounted for 65% of total exploration spending, the highest ratio in over 25 years.
  - Canada remains in first place on a global scale, with its exploration budgets representing 14% of global exploration spending.

- **Capital investment** in the minerals sector increased 10.1% over the past decade. Capital expenditures steadily rose from $10.8 billion in 2008 to $16.6 billion in 2012, then steadily declined year over year to $11.9 billion in 2017.

- Canada's mining, support services, and mineral processing industries' **business expenditures on research and development (BERD)** totalled $524 billion in 2017, representing a decline of 26.2% over the 10 year period.

- Between 2007 and 2016, the minerals sector generated $13.8 billion in corporate **income tax revenue** for Canadian governments with annual revenues ranging from $718 billion (2013) to $2.5 billion (2007). **Resource royalties and taxes** paid to the provinces and territories declined by 39.0% over the last 10 years; in 2016–2017, they generated a total of $1.1 billion compared to $1.8 billion in 2007–2008.

Indicator (2008–2017) (unless otherwise specified)	
Mineral Production Value	●
Gross Domestic Product	●
International Trade	●
Public Geoscience Expenditures (2004–2005 to 2012–2013)	●
Exploration and Deposit Appraisal Expenditures	●
Capital Expenditures	●
Research and Development (2007–2017)	●
Government Revenues (2005–2014)	●

● Improved Performance ● Limited Change ● Decline in Performance

Value of Mineral Production

Highlights

- Canada's mineral production recovered from the impact of the global economic recession in 2008 and 2009, with the value of production reaching an all-time high of $50.9 billion in 2011. The value of production declined in subsequent years, falling by $7 billion between 2011 and 2017. However, the value of production rose in 2017, indicating a potential reversal of this trend.
- Nonetheless, the total value of Canadian mineral production in 2017 was $43.9 billion, 6.5% below 2008 levels. The mining industry has continued to face headwinds in recent years, including slower global growth and excess supply for most minerals, which were partly offset by favourable exchange rates.
- Ontario is the perennial leader in terms of value of mineral production in Canada, accounting for between 20.4% (2008) and 23.3% (2013) of total value over the last 10 years, and still accounting for almost a quarter of total value in 2017 (22.5%), despite a slight decrease relative to 2013.
    - Ontario was closely followed by British Columbia (15.8% to 20.1%) and Quebec (13.2% to 19.6%).

Definition

The value of mineral production is measured by multiplying the volume of extracted commodities by the current price of the commodity.[12] It includes metallic and non-metallic minerals as well as coal.

Rationale

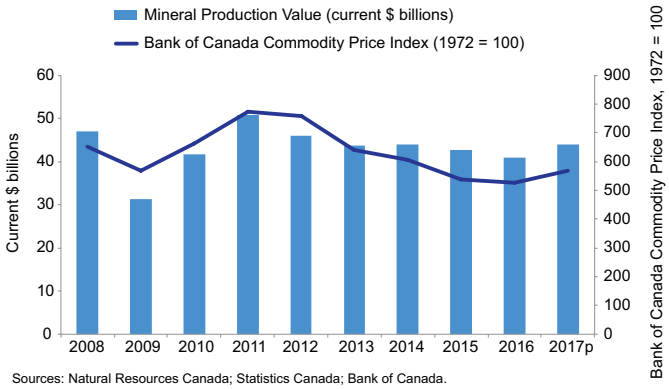
Monitoring the value of mineral production over time helps determine the vitality of the mineral extraction sector, as it is linked to the revenues generated by both companies and governments. Furthermore, production value provides insight to commodity price fluctuations and their impact on production, necessity of discoveries to sustain production levels, potential value of trade, and employment.

[12] Details regarding the methodology used in computing the mineral production of Canada can be located at https://www.nrcan.gc.ca/our-natural-resources/minerals-and-mining/minerals-metals-facts/20507.

Analysis

In 2017, the value of mineral production in Canada was $43.9 billion. While this represents a 6.5% decline in value since 2008, it fluctuated considerably during this 10-year period as shown in Figure 4. In 2008 and 2009, the economic recession and lower commodity prices contributed to a downturn in the minerals sector. In 2011, the value of mineral production peaked at $50.9 billion due to a wide variety of factors including strong economic growth in countries like China and Southeast Asian nations in the wake of the recession. Between 2011 and 2016, there was a 14% decline in the value of mineral production, as the prices for many of Canada's major commodities fell due to slower growth and reduced expectations about growth in future demand. As prices and production recovered, the value of production rose between 2016 and 2017.

Figure 4. Value of Canadian Mineral Production, 2008–2017 (p)



Sources: Natural Resources Canada; Statistics Canada; Bank of Canada.
(p) Preliminary.

In response to these changing economic circumstances over this 10 year period, the Bank of Canada's Metals and Minerals Commodity Price Index [1] (BCPI) showed considerable fluctuations as commodity prices varied widely. The recession at the beginning of the decade led to a drop in the BCPI of 12.8% between 2008 and 2009. This decline quickly turned around and by 2011 the BCPI had increased by 36.3% to reach its highest level during this period. From 2011 onward, the BCPI steadily declined until 2016, representing a drop of 36.3% and falling to pre-2011 levels. Although the BCPI increased slightly in 2017 from 2016, it remained 12.8% below its 2011 level.

The value of individual commodities also varied widely during this period. The value of production of gold, coal, diamonds, and copper increased significantly by 206.5%, 25.1%, 10.5%, and 7.9%, respectively. In addition, the production volume for gold and diamonds

increased by 73.1% and 56.5%, respectively since the beginning of the decade. The value of production for potash peaked in 2011 but declined steadily until 2016. While the value of production rose slightly in 2017, it remained almost 41% lower than its peak in 2008 due to lower prices. Other commodities that experienced the most significant price declines during the period include lead, nickel, and silver. Lead and zinc experienced some of the largest reductions in both value and volume of production for the period due to mine closures and curtailments. During this period, the decline in value of the Canadian dollar relative to the U.S. dollar has helped domestic producers because most raw mineral products are priced in U.S. currency.

The value of production of iron ore has declined nearly two thirds since its peak in 2011 due to lower prices resulting from oversupply and declining Chinese demand. However, there was evidence of a recovery underway in 2017, when the value of production increased by 20.5%. For the two most recent years, the value of Canada's coal production rose as spot prices for metallurgical coal increased. Coal remains an important commodity in Canada with $6.2 billion worth of it produced in 2017, making it the second-most valuable commodity mined in the country. While Canada produces both thermal and metallurgical coal, the latter had the largest impact on total value of production. Since its high in 2011, the effective export price of metallurgical coal had declined by over 55% by 2016. However, in 2016, there was a rally during which the price partially recovered due to mine disruptions in Australia and various cutbacks in production in China.

Ontario maintained its rank as the largest commodity producer in Canada for every year from 2008 to 2017. On average, it accounted for 20.4% of the value of minerals produced in the country. In 2017, the province posted a value of $9.9 billion, which represents 22.5% of the total Canadian value. British Columbia, Quebec, and Saskatchewan were the next largest contributors to the value of production. Together, these four jurisdictions accounted for over three quarters of Canada's value of mineral production in 2017 (Table 2).

Table 2. Value of Mineral Production, by Jurisdiction, 2008, 2013, and 2017 (p)

Province or Territory	Unit	2008	2013	2017 (p)
Alberta	Value of production ($000)	3,952,089	2,662,414	2,443,925
	% of total	8.4%	6.1%	5.6%
British Columbia	Value of production ($000)	7,402,675	7,111,670	8,835,810
	% of total	15.8%	16.2%	20.1%
Manitoba	Value of production ($000)	1,686,975	1,306,192	1,655,679
	% of total	3.6%	3.0%	3.8%
New Brunswick	Value of production ($000)	1,536,973	597,580	392,775
	% of total	3.3%	1.4%	0.9%
Newfoundland and Labrador	Value of production ($000)	5,315,760	4,078,547	2,926,590
	% of total	11.3%	9.3%	6.7%
Northwest Territories	Value of production ($000)	2,123,469	1,658,958	2,070,157
	% of total	4.5%	3.8%	4.7%
Nova Scotia	Value of production ($000)	357,314	220,783	237,376
	% of total	0.8%	0.5%	0.5%
Nunavut	Value of production ($000)	12,654	629,041	844,426
	% of total	0.0%	1.4%	1.9%
Ontario	Value of production ($000)	9,561,159	10,205,284	9,862,475
	% of total	20.4%	23.3%	22.5%
Prince Edward Island	Value of production ($000)	3,230	3,627	6,013
	% of total	0.0%	0.0%	0.0%
Quebec	Value of production ($000)	6,162,506	8,095,196	8,992,882
	% of total	13.2%	18.4%	19.6%
Saskatchewan	Value of production ($000)	8,603,948	6,858,339	5,718,178
	% of total	18.3%	15.6%	13.0%
Yukon	Value of production ($000)	207,644	466,905	300,860
	% of total	0.4%	1.1%	0.7%
Total	**Value of production ($000)**	**46,955,870**	**43,860,914**	**43,903,755**

Sources: Natural Resources Canada; Statistics Canada.
(p) Preliminary.

Data Considerations
It is important to note that the value of mineral production is displayed in current dollars (not adjusted for inflation). Given this, the BCPI is included on the graphs and the volume and value produced are noted to highlight the impact commodity price fluctuations have on the value of mineral production.

Gross Domestic Product

Highlights

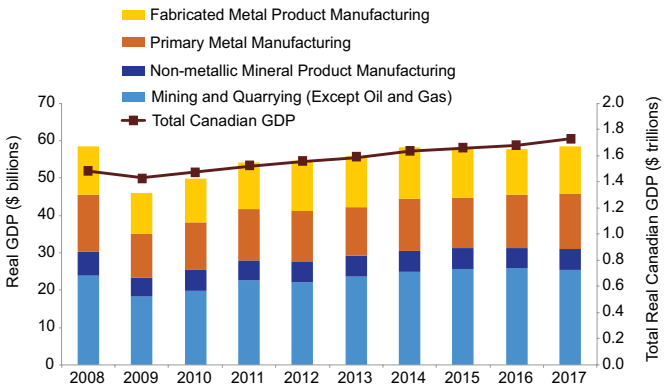
- Real GDP of the minerals sector between 2008 and 2017 was largely unchanged, declining by only 0.2% over the period from $58.5 billion to $58.4 billion.
- A sharp decrease of 21.2% in real GDP between 2008 and 2009 from $58.5 billion to $46.1 billion reflected a decline across all four subsectors within the minerals sector (mining and quarry except oil and gas, non-metallic mineral product manufacturing, primary metal manufacturing, and fabricated metal product manufacturing).
- Real GDP displayed a strong recovery after its 10 year low in 2009, increasing 26.6% to $58.4 billion from 2009 to 2017, but has yet to return to peak levels experienced in 2011.
- The improvement was driven by the mining and quarrying (except oil and gas) subsector as output grew nearly 40% from its 10-year low in 2009.
- Over the last five years, the minerals sector's direct contribution to Canada's total GDP has remained steady at approximately 3.5%, ranging between $55.8 billion (2013) and $58.4 billion (2017), with Canada's total GDP between $1.6 trillion (2013) and $1.7 trillion (2017).

Definition
GDP represents the total dollar value of all finished goods and services produced by a given jurisdiction or industry. GDP includes only final goods and services; it does not include the value of intermediate goods and services used to make another product. Real GDP is adjusted for inflation whereas nominal GDP is expressed in current dollars.

Rationale
GDP and its change over time is a widely used economic indicator to evaluate the size and health of an economy and to measure the relative economic contribution of an industry sector or subsector. Real GDP data remove the effects of price variations and inflation over time to measure the extent of output gains or losses within an industry.

Analysis
In 2017, the minerals sector's real GDP was $58.4 billion, representing a 0.2% decline from the 2008 value of $58.5 billion (Figure 5). The sector experienced a significant year-over-year decline (21.2%) from 2008 to 2009 resulting from the global economic recession with GDP dropping from $58.5 billion in 2008 to a low of $46.1 billion in 2009. Since then, it has grown to $58.4 billion (+26.6%), largely recovering from its recession-driven low in 2009. The sector's share of Canada's total GDP declined from 4.0% in 2008 to 3.4% in 2017, which is higher than the 2009 low of 3.2%. Since 2013, the sector's contribution to Canada's total GDP has remained stable at an average of 3.5% since 2013.

Figure 5. Mineral Industry Real Gross Domestic Product, 2008–2017



Source: Statistics Canada.

At the subsector level, mining and quarrying (except oil and gas) experienced a moderate 5.9% increase in real GDP from 2008 ($23.9 billion) to 2017 ($25.3 billion). This subsector was hit particularly hard by the economic downturn in 2009, with output falling 23.8% on a year-over-year basis from $23.9 billion in 2008 to $18.2 billion in 2009. The subsector subsequently rebounded, with real GDP increasing by 39.3% since 2009 and reaching $25.3 billion in 2017, accounting for 43.4% of the sector's total value added. This share is up from 40.9% in 2008 and a low of 39.5% in 2009. However, the 2017 contribution of the mining and quarrying (except oil and gas) subsector was down slightly to 43.4%, below its high of 44.8% reached in 2016 (a 3.0% decrease).

International Trade

Highlights

- Between 2008 and 2017, exports from Canada's minerals sector increased by 9.2% from $93.0 billion to $101.5 billion in 2017, which represents a 10 year high.
  - This overall growth hides a substantial decrease in export value from $93.0 billion in 2008 to $65.0 billion in 2009 resulting from the sector's downturn.
- The sector routinely makes a positive contribution to Canada's overall trade balance, contributing a surplus of nearly $172 billion over the last 10 years or an average of $17.2 billion per year.
- Gold has become Canada's leading mineral export with a value of $18.6 billion in 2017 (19.1% of the top five mineral commodities), more than double its 2008 value (9.9% of the top five mineral commodities), as a result of rising prices and increased production over that period.
  - Iron and steel was the sector's second-highest export in terms of value, but decreased 7.5% from $16.1 billion in 2008 to $14.9 billion in 2017.
  - Aluminum was third, having increased 8.5% from $11.7 billion (2008) to $12.7 billion (2017).
  - Together, gold, iron and steel, and aluminum constitute almost half of Canada's top five mineral commodity exports.
- Other leading exports for 2017 included copper and coal, which together contributed 14.7% of total commodity exports.

Definition

International trade is a measurement of the exchange of capital, goods, and services across international borders or territories. Trade indicators include *domestic exports* (goods grown, extracted, or manufactured in a territory, including goods of foreign origin that have been materially transformed in the territory); *imports* (all goods that have crossed into a territorial boundary, whether for immediate use or to be stored in bonded Customs warehouses); *re-exports* (the export goods of foreign origin that have not been materially transformed in a territory); and *total exports* (the sum of domestic exports and re-exports). The balance of trade is measured by subtracting imports from total exports.

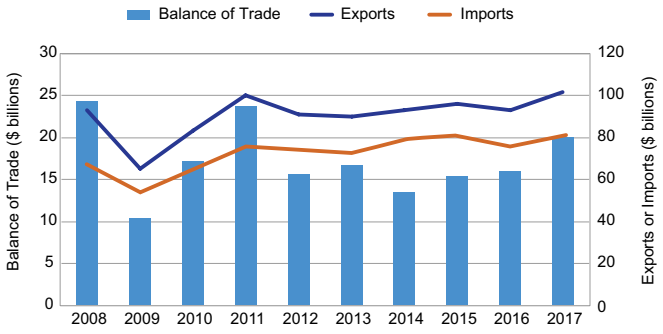
Rationale

Canada is an open economy that depends heavily on foreign markets and international trade to support the nation's economic activity and help sustain a high standard of living for its citizens. A positive trade balance contributes to Canada's prosperity, as it fuels economic growth, creates jobs, supports high living standards, fosters the adoption of innovation and new technologies, promotes trade, and provides affordable goods and services.

Analysis

In 2017, the value of Canada's minerals and metals exports,[13] which include ores, concentrates, and semi- and final-fabricated mineral products, reached a 10 year high of $101.5 billion, or 19.4% of the country's total value of merchandise exports. Over the last decade, the value of mineral exports has increased 9.2%. As with many other economic indicators, exports fell dramatically in 2009 to $65.0 billion from $93.0 billion in 2008, before rebounding in 2010 and 2011, during which they reached a high of $100.3 billion in 2011. In 2012 and 2013, exports declined from 2011 levels and reached a low of $90.0 billion (2013) before steadily increasing through to 2015, largely due to the depreciation of Canada's currency against the U.S. dollar. Exports decreased slightly in 2016 to $92.9 billion before rebounding into 2017 to $101.5 billion. The substantial increase in 2017 can be partially attributed to higher commodity prices for copper, aluminum, iron ore, gold, and coal (Figure 6).

Figure 6. Minerals Sector Trade, 2008–2017



Sources: Natural Resources Canada; Statistics Canada.

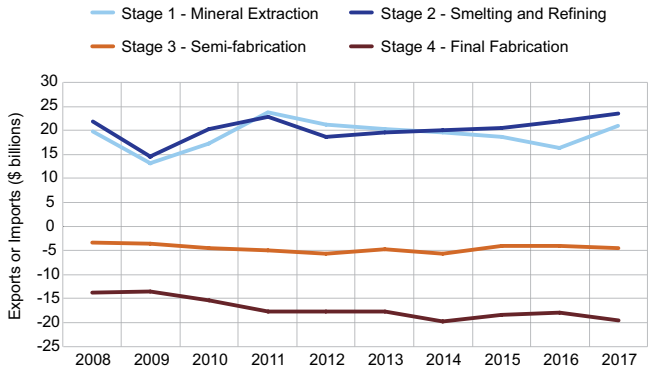
The minerals sector is one of the few industrial sectors that consistently make a positive contribution

[13] For this section, "exports" refer to domestic exports. Total exports, which include re-exports, is used only when calculating the balance of trade.

to Canada's overall balance of trade, totalling nearly $172 billion since 2008. Following the global recession of 2008 and 2009, the sector's trade surplus fell 57.8% to $10.3 billion in 2009, before rebounding to a near record of $23.6 billion in 2011. The balance of trade then fell, overall, over the next three years beginning in 2012, with a small peak of $16.6 billion in 2013, before growing in 2015 and 2016, capping off by a 25% increase in 2017 to $19.9 billion.

A closer examination at the subsector level reveals Canada's relative strength in mineral extraction and smelting and refining. In terms of stages in the production side of the mineral development sequence, Canada traditionally runs large, positive trade balances in *Stage 1 – Mineral extraction* and *Stage 2 – Smelting and Refining*. Trade balances in *Stage 3 – Semi-fabrication* tend to be slightly negative while trade balances for *Stage 4 Final Fabrication* are usually large and negative (Figure 7). This reflects Canada's natural resource wealth, its comparative advantage in mineral extraction, and changing geographic patterns with respect to manufacturing locations.

Figure 7. Minerals Sector Balance of Trade, by Subsector, 2008–2017



Sources: Natural Resources Canada; Statistics Canada.

Table 3 shows Canada's top five mineral commodity exports by value from 2008 to 2017. During this period, the value of gold exports more than doubled. As a result, gold is now Canada's most valuable mineral commodity export. Over two thirds of Canada's gold exports are destined for the United Kingdom, as London is the centre for the global gold trade.

Table 3. Top Five Mineral Commodities Exported by Canada, by Value, 2008 and 2017

2008		2017		
Commodity	**($ billions)**	**Commodity**	**($ billions)**	**Main Destination (2017)**
Iron and steel	16.1	**Gold**	18.6	U.K. (66.9%)
Aluminum	11.7	**Iron and steel**	14.9	U.S. (86.9%)
Gold	8.9	**Aluminum**	12.7	U.S. (87.2%)
Nickel	7.4	**Copper**	7.2	U.S. (53.3%)
Copper	6.6	**Coal**	7.1	Japan (23.9%)
Total exports	**90.2**		**97.5**	**n.a.**

Sources: Natural Resources Canada; Statistics Canada.
n.a. Not applicable; U.K. United Kingdom; U.S. United States.

Table 4 shows the value of Canadian minerals sector exports by commodity group and jurisdiction. By value, metal ores and manufactured products comprise by far the majority of Canada's mineral exports (74.3% to 78.1% from 2008 to 2017). Since their high in 2011, the values of coal and coke exports have fallen 15.2%.

Table 4. Canada's Mineral Exports, by Jurisdiction and Commodity Group,* 2008 and 2017**

Province/Territory	Coal and Coke Products		Metallic Ores and Manufactured Products		Non-metallic Ores and Manufactured Products		Total	
	2008	2017	2008	2017	2008	2017	2008	2017
	(current $000)							
Alberta	724,015	205,252	2,928,082	1,976,750	2,159,901	539,257	5,811,998	2,721,260
British Columbia	5,437,279	6,616,834	4,887,621	6,961,907	977,398	830,252	11,302,298	14,408,994
Manitoba	74	43	2,363,661	1,246,207	237,030	270,469	2,600,765	1,516,719
New Brunswick	-	-	563,192	358,343	570,782	214,841	1,133,973	573,184
Newfoundland and Labrador	20,390	0	2,564,310	2,619,261	16,468	34,924	2,601,168	2,654,185
Northwest Territories	-	-	54,447	720	2,281,997	2,024,487	2,336,444	2,025,207
Nova Scotia	14	2,387	207,301	246,616	112,938	61,960	320,253	310,963
Nunavut	-	-	17,097	319,965	47	52	17,144	320,017
Ontario	278,133	267,148	34,205,903	40,391,972	2,569,486	3,048,020	37,053,522	43,707,139
Prince Edward Island	25	6	5,932	12,509	4,075	6,597	10,033	19,112
Quebec	703	1,770	17,655,836	20,694,568	1,784,843	2,043,015	19,441,383	22,739,353
Saskatchewan	56	679	1,521,184	1,210,658	5,996,947	5,156,084	7,518,187	6,367,422
Yukon	-	-	126,782	101,874	73	990	126,855	102,864
Canada	**6,460,689**	**7,094,120**	**67,101,350**	**76,141,352**	**16,711,984**	**14,230,948**	**90,274,023**	**97,466,419**

Sources: Natural Resources Canada; Statistics Canada.
- Nil.
Exports are recorded under the jurisdiction where the commodity exits the country. As such, they may not correlate with where the commodity was mined. At this disaggregated level, the tracking of inter-provincial/territorial transactions is more difficult and may result in misallocation among jurisdictions.
* Natural Resources Canada's Trade Retrieval and Aggregation System allows for aggregation by Harmonized System (HS) codes (HS 8 for exports and HS 10 for imports). The advantage to aggregating by HS code is that it captures specific products, providing more complete data across all NAICS codes.
** Some provincial and territorial export numbers may include the value of raw materials imported from other provinces as products are only captured once they cross international boundaries. For example, a Stage 1 product (nickel concentrate from Newfoundland and Labrador) is transported to Ontario for smelting. In Ontario, it is transformed into a Stage 2 product and exported. Because the final stage of manufacturing occurred in Ontario, the product would be captured as a Stage 2 product originating in Ontario.

The majority of Canada's mineral trade flows to and from Ontario, Quebec, and British Columbia. In 2017, Ontario accounted for 44.8% of exports, Quebec for 23.3%, and British Columbia for 14.8%. Mineral and metal exports also represent a sizable proportion of total exports from many provinces and territories. For instance, minerals and metals accounted for 99.9%, 97.8% and 95.1% of the total value of exports of the Northwest Territories, Nunavut and Yukon, respectively.

Data Considerations

Trade data at Natural Resources Canada are collected and disseminated using stages that differ slightly from the NAICS codes. *Stage 1 – Mineral Extraction* involves the discovery of ore, ore extraction, and processing to the concentrate stage. Scrap material, ash, and tailings are included in this category. *Stage 2 – Smelting and Refining* refers to the metallurgical extraction process, the product of which is a relatively pure mineral, metal, or alloy. Some of the activities related to this stage are smelting and refining, roasting, calcining, direct reducing, and leaching. Products classified under this stage include powders, flakes, dusts, cathodes, ingots, pig, blocks, and plates. *Stage 3 – Semi-fabrication* involves the manufacturing or processing steps required to bring products to a semi-finished or semi-fabricated stage or form, or to a state for use as input in other industries. Products related to Stage 3 include rods, plates, sheets, thin strips, pipes, rails, wires, metal-based structural forms, and a number of chemicals and compounds. Ingot moulds are also included. *Stage 4 – Final Fabrication* includes products of Stage 3 that have undergone further processing, such as elements produced by the metal framing industry, hardware items, tools, and cutlery. This stage includes products such as pipe fittings, forged and cast parts, grinding balls, and rail parts.

Public Geoscience Expenditures

Highlights

- Government expenditures on geoscience in 2017–2018 were $161.7 billion, a 4.6% decrease over 2008–2009, and a 17.3% decline since a peak of $195.4 billion in 2009–2010.
- Federal government expenditures on geoscience account for approximately 43.2% of total expenditures in 2017–2018, with the provinces and territories accounting for the remainder of this investment.
- Both British Columbia and the Northwest Territories experienced notable expenditure increases of 246.9% and 78.7%, respectively, from 2008–2009 to 2017–2018.

Definition

Public geoscience broadly refers to geological, geophysical, and geochemical data, information, and knowledge provided by governments as a public good. The availability of such data and information has long played an important role in fostering a strong mineral investment climate in Canada and is widely acknowledged to be one of Canada's competitive advantages in attracting mineral exploration, which has contributed to the country's standing as a leading exploration target and mineral producer.

Rationale

The availability of public geoscience data and analyses enables exploration companies to make informed decisions regarding their exploration plans. With a better understanding of geological environments through pre-competitive maps, databases, tools, and models, mineral exploration can focus on areas of higher prospectivity and reduced investment risk. Assessing public geoscience expenditures provides an indication of government efforts to support mineral exploration.

Analysis

In 2017–2018, total public geoscience expenditures were $161.7 billion, a 4.6% decrease over the $169.5 billion reported in 2008–2009. Federal government expenditures in 2017–2018 totalled $69.8 billion, representing 43.2% of total expenditures. On average, the federal government usually accounts for approximately one half of total expenditures (Table 5).

Table 5. Public Geoscience Expenditures, 2008–2009 to 2017–2018 ($000s)

Jurisdiction	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Alberta	11,691	11,327	7,257	7,124	7,870	7,156	7,462	7,495	7,970	7,570
British Columbia	4,040	4,310	14,929	2,754	3,946	3,973	6,234	8,645	8,932	14,015
Manitoba	5,685	6,067	5,912	5,635	5,365	5,944	4,802	4,814	4,908	5,005
New Brunswick	2,389	2,397	2,214	2,200	2,188	2,000	3,163	2,755	2,757	2,680
Newfoundland and Labrador	5,088	5,734	5,721	6,128	6,062	5,688	5,477	5,535	5,180	4,908
Northwest Territories	3,640	2,340	2,640	2,279	5,179	4,171	7,013	10,215	6,966	6,503
Nova Scotia	2,385	2,385	2,498	2,498	3,053	2,523	2,570	2,464	2,672	2,571
Nunavut	2,506	2,690	2,586	2,136	2,822	2,361	3,181	2,978	2,351	3,028
Natural Resources Canada	85,759	113,482	93,641	82,091	73,811	70,933	83,098	88,683	88,923	69,846
Ontario	18,700	18,900	19,300	19,300	19,336	18,412	17,816	16,825	18,058	17,838
Quebec	16,783	14,397	18,821	18,695	15,341	15,315	14,916	18,256	15,909	17,525
Saskatchewan	4,828	4,478	4,026	4,407	4,413	4,457	4,325	4,580	4,517	4,882
Yukon	5,997	6,925	6,409	5,194	5,162	4,920	4,957	4,957	4,807	5,289
Total	**169,491**	**195,432**	**185,954**	**160,441**	**154,548**	**147,853**	**165,114**	**178,202**	**173,950**	**161,660**

Sources: Natural Resources Canada; Committee of Provincial and Territorial Geologists.

Public geoscience expenditures in British Columbia and the Northwest Territories climbed significantly during the period from 2008–2009 to 2017–2018. In British Columbia, expenditures in 2017–2018 were $14.0 million, 246.9% higher than in 2008–2009. Similarly, in the Northwest Territories, expenditures in 2017–2018 were $6.5 million, 78.7% higher than in 2008–2009. While spending for many of the jurisdictions has been relatively flat or downward trending since 2013–2014, Natural Resources Canada expenditures increased through 2017.

Exploration and Deposit Appraisal Expenditures

Highlights

- In 2017, exploration and deposit appraisal expenditures in Canada increased 29.6%, the first year-over-year increase in 5 years, to reach $2.2 billion and end a long period of decline.
- On a global scale, Canada remains in first place with respect to non-ferrous exploration expenditures, representing 14% of global exploration spending in 2017.
- In 2017, Quebec was the leading jurisdiction in terms of spending, followed by Ontario and British Columbia. These three jurisdictions accounted for 64.4% of Canada's total exploration and deposit appraisal expenditures in Canada.
- Gold remains the leading commodity for exploration, but exploration companies are increasingly investing in the search for metals such as lithium and cobalt.

Definition

Exploration expenditures refer to the investments made by prospectors and mineral companies in the discovery of a previously unknown mineral deposit or to re-evaluate a sub-marginal or neglected mineral deposit. Deposit appraisal expenditures refer to investments involved in determining the economic viability of a mineral deposit. Exploration and deposit appraisal activities range from regional reconnaissance to the delimitation and definition of specific mineral deposits using a number of tools such as prospecting, mapping, geochemical and geophysical surveys, drilling, and deposit modelling.

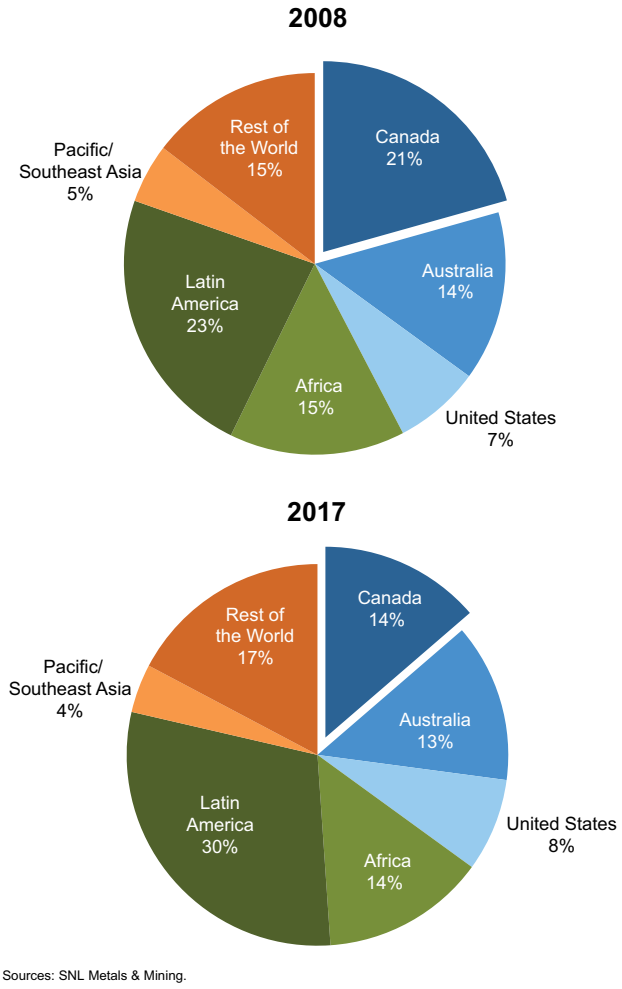
Rationale

Mineral exploration activity to discover new mineral deposits and to advance the development of known deposits is vital in sustaining the production of minerals to meet the future needs of society. It is also the foundation of a mineral industry and is necessary for it to remain an important engine of economic growth in many regions of Canada. Without sufficient levels of investment in exploration and deposit appraisal, mine development and production and the downstream activities of the mine life cycle (smelting, refining, and manufacturing) could be jeopardized.

Analysis

A diverse and rich endowment of mineral resources has helped make Canada the world's leading exploration target throughout the past decade, with an estimated US$1.1 billion budgeted for exploration in 2017. This represents a 14% share of global spending (Figure 8). However, its share of global exploration budgets has declined since 2008, when the share of the country as a whole was 21%.

Figure 8. Canada's Share of Global Exploration Spending, 2008 and 2017

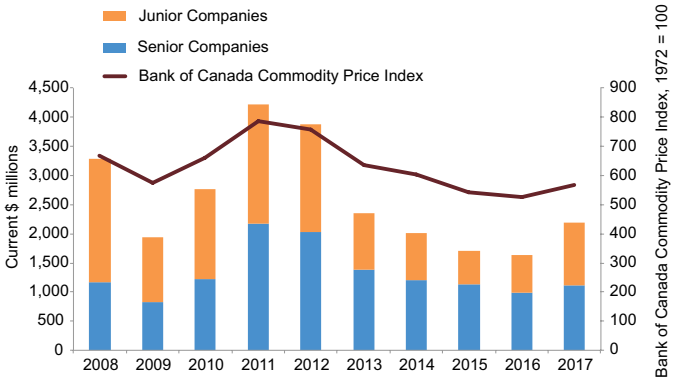


Sources: SNL Metals & Mining.

Trends in exploration and deposit appraisal expenditures provide a barometer of the health and the future potential success of the mineral industry.[14] As shown in Figure 9, Canada's mineral exploration sector experienced significant instability and challenges over the past 10 years. Expenditures showed a sharp decline in 2009 in the immediate aftermath of the global recession. In its wake, companies reduced investment in mineral exploration and delayed investment plans for advanced projects. However, spurred by mineral and metal price increases in 2010 and 2011, exploration expenditures recovered rapidly, surpassing the $4 billion spending mark in 2011. This period of recovery was short-lived, as spending began a drastic and prolonged decline starting in 2012. This decline followed on from falling prices for major Canadian minerals and metal products, slower growth in China's economy, shifts in capital markets making it more difficult for companies to secure funding, and the shifting focus—particularly in the gold sector—away from exploration activity to focus on developing their core assets.

The decline in exploration expenditures stopped in 2016 when there was a year-over-year increase of nearly 30% to 2017. A small increase of 6.0%, to $2.3 billion, occurred in 2018 (not shown on the graph).

Figure 9. Exploration and Deposit Appraisal Expenditures, by Company Class, With Bank of Canada Metals and Minerals Commodity Price Index, 2008–2017



Sources: Natural Resources Canada; Bank of Canada.

Mineral exploration activity is highly correlated with commodity prices (Figure 9). Over the last decade, the prices of Canada's most important minerals and metals fluctuated significantly, reaching historic highs in 2011, followed by a period of persistent decline that ended in 2016. Figure 9 also underlines the important role that junior mining companies[15] play in the discovery and development of mineral deposits in Canada. Total junior company expenditures exceeded the $2 billion level in 2008 and 2011. In 2013, spending fell below the $1 billion mark, and only began to recover in 2016 after reaching its lowest level in 12 years. This trend continued into 2017, which saw spending rise by 50% to almost $1 billion.

In terms of the share of total exploration and deposit appraisal expenditures, junior companies spending peaked in 2007 at 67.3%. It decreased in subsequent years and has remained below 50% since 2011, accounting for 45% in 2017. Expenditures by senior mining companies surpassed the $2 billion level in 2011 and again in 2012.

However, their spending decreased in subsequent years, falling below the $1 billion mark in 2016, a level not seen since the global economic crisis in 2009.

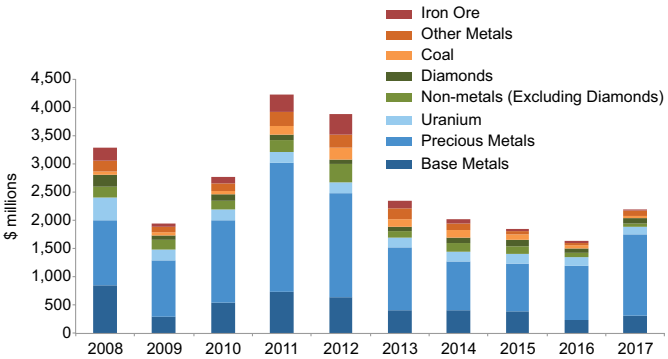
[14] *Exploration* is defined as the search for, discovery, and first delimitation of a previously unknown mineral deposit or the re-evaluation of a sub-marginal or neglected mineral deposit in order to enhance its potential economic interest based on delimited tonnage, grade, and other characteristics. *Deposit appraisal* reflects the steps undertaken to bring a delimited deposit (by definition drilling, comprehensive tests, and planning) to the stage of detailed knowledge required for an exhaustive and complete feasibility study that will fully justify and support a production decision and the investment required (Source: Natural Resources Canada, http://sead.nrcan.gc.ca/expl-expl/RG-GR-eng.aspx).

[15] *Junior companies* are neither a producing company (a senior company) nor the recipient of operating income from production or from some other business segments. Their principal business is mineral exploration, for which they are required to raise funds through the issuance of treasury shares. *Senior companies* normally derive their operating income from mineral extraction or other business segments (they need not be mining companies) rather than from the issuance of shares. (Source: Natural Resources Canada, http://www.nrcan.gc.ca/mining-materials/statistics/8854)

In 2017, the Fraser Institute's Annual Survey of Mining Companies[16] ranked Canada first in the world as the most attractive region for investment based on the combined ranking of all provinces and territories, beating out Australia for the top spot. Three Canadian jurisdictions ranked among the top ten globally: Saskatchewan (second), Quebec (sixth), and Ontario (seventh). However, there are indications that permitting times have increased in a number of jurisdictions over the past 10 years[17].

Exploration and deposit appraisal expenditures between 2008 and 2017 are summarized in Figure 10 according to commodity groups. Gold led the recovery in exploration activity in Canada during 2017. In terms of spending, precious metals accounted for 65% of total exploration expenditures, the highest ratio in over 25 years. As can be expected, jurisdictions with well-known gold camps or gold belts, like Quebec, Ontario, British Columbia, Nunavut, and Yukon were the main beneficiaries of this increase in exploration for precious metals. Base metals were the second most attractive commodity group, accounting for 13.9% of the total. Spending for the other metals group, which includes lithium and cobalt, experienced the largest increase in percentage terms in 2017, rising 85.2% to $88.9 billion. Interest in these metals is driven by new technologies and increased production of electric vehicles.

Figure 10. Exploration and Deposit Appraisal Expenditures, by Commodity Group, 2008–2017



Source: Natural Resources Canada.

In terms of regional distribution of spending over the decade, exploration and deposit appraisal expenditures are concentrated in Ontario, Quebec, and British Columbia (Table 6). Saskatchewan displaced British Columbia within the top three in 2009 and by 2017, Quebec took the lead and accounted for 27% of total expenditures. Adjusted for inflation, every jurisdiction except Alberta and Yukon experienced negative growth in exploration and deposit appraisal spending from 2008 to 2017. In 2017, exploration spending showed signs of recovery from the downturn and all jurisdictions experienced an increase in expenditures year over year except Manitoba, Saskatchewan and Nunavut. It is important to note that, although there has been recovery, expenditure levels seen in 2008 and 2011 have yet to be re-attained.

Table 6. Exploration and Deposit Appraisal Expenditures, by Province and Territory, 2008, 2013, and 2017

Province/ Territory	2008	2013	2017
	(constant 2017 $millions)		
Canada	3,632	2,441	2,186
Alberta	23	40	25
British Columbia	482	512	303
Manitoba	168	63	41
New Brunswick	36	29	16
Newfoundland and Labrador	162	122	42
Northwest Territories	163	81	91
Nova Scotia	24	13	18
Nunavut	479	267	177
Ontario	885	583	540
Quebec	526	382	574
Saskatchewan	477	230	191
Yukon	148	104	169

Sources: Natural Resources Canada.

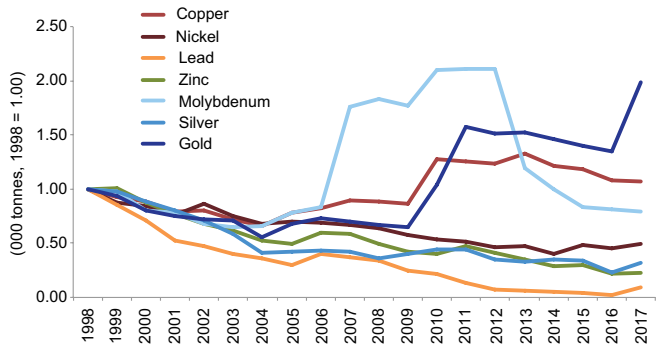
[16] https://www.fraserinstitute.org/studies/annual-survey-of-mining-companies-2017

[17] "Permit Times for Mining Exploration in 2017," Fraser Institute, 2018

Reserves

Mineral exploration and deposit appraisal activities are critical to the identification of Canada's mineral resources, which provide a pipeline of potential reserves for future mines to exploit. Reserves are indicators of the short-term potential supply of metals, as well as an important indicator of the diversity and strength of the extractive sector. Canadian base-metal reserves had been declining on a long-term basis for nearly three decades, but began to increase in 2004 as prices rose on strong Asian demand. This drove steady increases and additions to some of Canada's mineral reserves well into 2011. Copper, molybdenum and gold saw the most increases, with nickel, zinc and lead continuing to decline (Figure 11).

Figure 11. Canadian Reserves of Select Metals, 2000–2017



Source: Natural Resources Canada.

Robust demand and high metal prices leading into the late 2000s led to the development of new mines or the expansion of existing mines, fuelling additions to Canada's metal reserves. In the 10-year period from 2008 to 2017, gold reserves doubled, copper reserves increased by 20% and all other metals generally declined to 2016 levels. Favourable prices brought increases for reserves in 2017 for nickel, lead, zinc, silver, and gold. The robust increase in gold reserves is due to the opening of seven new mines in 2017.

Economic uncertainty due to trade conflicts could mean a slump in demand and slowdown in mineral project advancement. Metal reserve gains made over the last few years may erode if the economic cycle moves into decline but could continue to improve if metal demand increases.

Box 3: Mineral Resources vs. Reserves

Resources: A concentration or occurrence of solid material of economic interest in such form, quality, and quantity that it has a reasonable prospect of economic extraction. Resources are classified as inferred, indicated, or measured.

Reserves: The economically mineable portion of a measured and/or indicated resource demonstrated by at least a prefeasibility study. Reserves are classified as probable or proven.[18]

Looking ahead, for Canada to remain a leading destination for global exploration investment and mineral production, bottlenecks in the development process will need to be recognized and reconciled. Remote and northern regions contain significant mineral potential; however, working in these areas presents a number of challenges, such as infrastructure connectivity, climate, and relatively sparse populations (Box 6).

[18] Canadian Institute of Mining, Metallurgy, and Petroleum Standards on Mineral Resources and Reserves. http://web.cim.org/standards/menupage.cfm?sections=177&menu=178.

Box 4: Enabling Infrastructure in Northern and Remote Regions

Canada's transportation infrastructure lags in relation to other northern countries, according to Transport Canada's 2016 *Canada Transportation Act Review*.[19] Development of the north in particular is constrained by a lack of road, rail, and other critical infrastructure including port facilities, housing, and energy.

Realizing the considerable mineral potential of northern and remote regions means that existing infrastructure gaps—in transportation, power, and communications—will need to be addressed. Otherwise, companies operating in these regions will continue to face cost premiums estimated at 6 times higher for exploration projects and 2.5 times higher for mines than at similarly sized projects in the South,[20] which are almost entirely attributable to these increased infrastructure costs. These additional expenses inhibit mineral development and can make otherwise economically viable projects cost-prohibitive.

Capital Expenditures

Highlights

- Capital expenditures in the minerals sector, including support activities for mining, experienced a 10.1% increase between 2008 ($10.8 billion) and 2017 ($11.9 billion).
- Since reaching a record high of $16.9 billion in 2012, capital expenditures in the minerals sector experienced a subsequent decline to $11.9 billion in 2017.
- In the mining and quarrying subsector, which on average accounts for 70% of total investment in the sector, spending increased 11.6% between 2008 ($7.35 billion) and 2017 ($8.20 billion) but has declined since reaching a record high in 2012.
- Preliminary intentions for 2018 show a modest further decrease in capital expenditures in the minerals sector ($11.5 billion).

Definition

Capital expenditures include costs associated with procuring, constructing, or upgrading physical assets such as property, buildings, and machinery and equipment.[21]

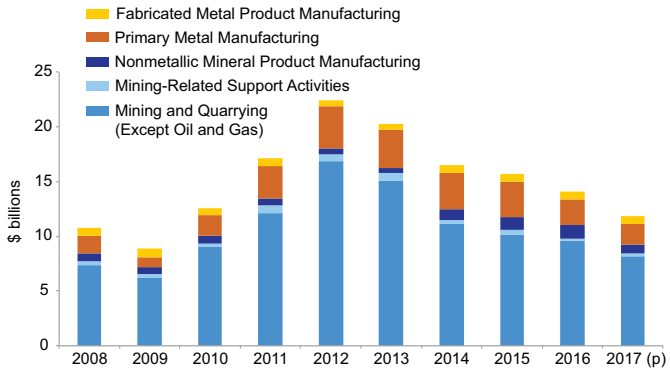
Rationale

Information on capital spending provides a useful indicator of market conditions in the economy as a whole and in particular industries. In addition, information on the relative size of planned expenditure programs, particularly for industrial sectors, indicates the views held by management on future market demand in relation to present productive capacity.

Analysis

Capital investment in the minerals sector, including support activities for mining, dropped by 18% in 2009 compared to 2008, due to the global recession. It quickly rebounded to reach a record high of $22.5 billion by 2012 (Figure 12) but has since declined in successive years to $14.1 billion in 2016. This was in reaction to global economic conditions, falling demand, and oversupply of some commodities. Preliminary results for 2017 show a further reduction to $11.9 billion, representing 5.2% of Canada's total capital investment intentions. Preliminary spending intentions for 2018 indicate continued reductions in minerals sector investment to an estimated $11.5 billion.

Figure 12. Minerals Sector Capital Expenditures, by Subsector, 2008–2017



Sources: Natural Resources Canada; Statistics Canada.
(p) Preliminary

[19] *Canada Transportation Act* Review 2016, https://www.tc.gc.ca/eng/ctareview2014/canada-transportation-act-review.html

[20] Association of Consulting Engineering Companies of Canada et al., 2015, *Levelling the Playing Field: Supporting Mineral Exploration and Mining in Remote and Northern Canada*, https://mining.ca/documents/levelling-playing-field/.

[21] Detailed information regarding the compilation and dissemination of capital investment data can be located at http://www.statcan.gc.ca/pub/61-205-x/2014000/technote-notetech2-eng.htm.

Capital expenditures in the mining and quarrying subsector account for the bulk of total sector investment expenditures, averaging around 70% of total mineral investment expenditures. Investment in this sector is closely linked to current mine capacity to produce a given mineral and expectations for future demand, which, in turn depends on various factors.[22] Factors that tend to reduce capacity include permanent closures, temporary shutdowns or closures, and ore depletion. Elements leading to an increase in capacity are reopenings of mines that were temporarily closed, expansion of existing capacities, and new mines reaching production. Mining company executives make decisions on these factors based on their estimates of future commodity prices and supply and demand conditions. Firms tend to curtail expenditures when market conditions are unfavourable and accelerate investment plans when there are expectations of economic growth.

As shown in Figure 12, capital expenditures in the mining and quarry subsector increased 11.6% from 2008 to 2017. This overall increase occurred in spite of a decrease from $7.4 billion in 2008 to $6.2 billion in 2009. The 10-year low in 2009 was followed by increasing expenditures, which reached $16.9 billion in 2012, before trending downwards again to $8.2 billion in 2017.

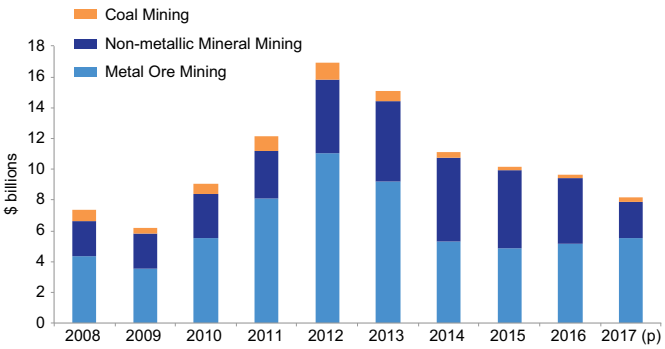
In the non-metallic ore extraction subsector, capital investment spending increased by 5.0% (Figure 13). Spending trends in the non-metallic ore extraction subsector can largely be explained by capital expenditures in Canadian potash mining, as it represents almost 60% of the subsector. Potash mining spending decreased 23% between 2009 and 2017, the earliest year for which data are available. This decrease was partly offset by substantial increases in capital expenditures in stone mining and quarrying (+95%) and salt mining (+116%) over the same period.

Expenditures in the metallic ore extraction subsector increased by 25.9% between 2008 and 2017, led by a substantial capital spending increase of 195% in precious metals mining, which represents 65% of the total subsector. In the coal subsector, capital investment in 2017 was $335 billion, 54.0% lower than it was in 2008 ($728 billion). However, there were strong signs of recovery underway in 2017 as expenditures increased 62.5% over 2016, rising from $206 billion to $335 billion.

[22] Crowson, Phillip, 2008, *Mining Unearthed*, United Kingdom: Aspermont.

Comparisons between 2008 and 2017 overlook the substantial increase in spending that occurred from 2009 to 2012, followed by a downward trend from 2012 onwards. Since this 2012 peak, capital expenditures in the mining and quarrying subsector have fallen 51.5% to $8.20 billion. Figure 13 shows this trend peaking in 2012, further separated by commodity group.

Figure 13. Mineral Extraction Expenditures, by Commodity Group, 2008–2017



Source: Statistics Canada.
(p) Preliminary

The downstream mineral processing and manufacturing industries contributed $4.27 billion (30.3%) to the minerals sector capital investment in 2016, while preliminary results show a contribution of $3.46 billion in 2017 (29.1%). Over half of this investment (55.0% or $1.90 billion) is attributable to primary metal manufacturing. From 2008 to 2017, investment in the primary metal manufacturing and the non-metallic mineral product manufacturing subsectors experienced growth of 16.7% and 23.7%, respectively. Investment in the fabricated metal product manufacturing subsector experienced a decrease of 4.14% during the same period.

Capital expenditures in mining-related support activities saw a substantial decrease of 43.0% between 2008 and 2017 from $382 billion to $218 billion.

Data Considerations

As of 2015, Statistics Canada updated its methodology related to the capital investment account system. As a result, expenditures related to mineral exploration are no longer classified under “capital investment, construction,” but instead under “intellectual property.” Historical data have been updated to reflect this change. Additional information regarding Statistics Canada’s methodological updates is available at http://www23.statcan.gc.ca/imdb-bmdi/document/2803_D16_T9_V1-eng.htm.

Business Expenditures on Research and Development

Highlights

- Business expenditures on research and development (BERD) within Canada's mining, support services, and mineral processing industries totalled $524 billion in 2017.
- While the sector's level of BERD declined by 26.2% between 2008 ($710 billion) and 2017 ($524 billion), preliminary data for 2018 show an increase of 8.8% ($46 billion) compared to 2017.
- In comparison to the minerals sector as a whole, BERD in the mining and related support activities subsector increased and was 1.5 times higher in 2017 compared to 2008.
- Research and development (R&D) personnel in the minerals sector numbered 4,033 employees in 2016, which represents a decrease of 47.5% from a peak of 7,687 in 2009.

Definition

Business expenditures on research and development (BERD) encompass all activities undertaken to discover or develop new processes or products. BERD is defined as spending on research and development (R&D) work performed within the company, including work financed by others. BERD is often used as a proxy to measure innovation, which is essential to the long-term competitiveness of the sector.

Rationale

BERD plays a key role in innovation. It is pivotal to the innovation performance of an industry and demonstrates firms' commitment to new or improved production processes. BERD is important for a company and industry to remain competitive as it helps to minimize costs, reduce environmental footprints, enhance efficiency, and improve profitability in the long term.

Analysis

Constantly evolving conditions in mineral exploration and mining drive innovation by leveraging emerging technologies to meet long-term economic, social, and environmental goals. Collaboration and forward thinking are required to respond appropriately to the challenges faced by the natural resource sectors.

Economic innovation is an important use of resources that can enhance productivity, address skilled labour shortages, solidify global competitiveness, and develop the technologies necessary to explore for and extract mineral resources in more technically challenging conditions.

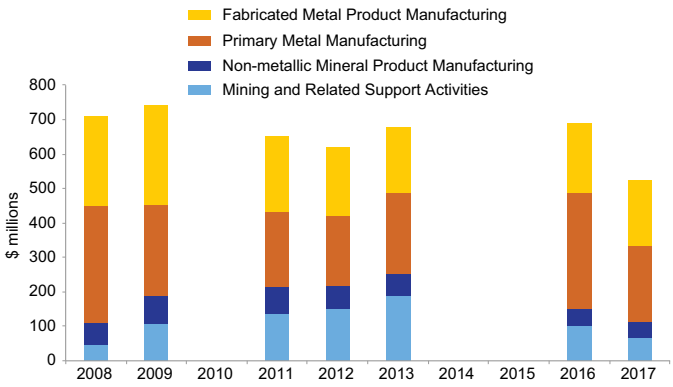
Socially, innovation is important to obtain and maintain social licences to operate; minimize community disruption or opposition; improve sustainability performance through the adoption of green technologies, practices, and processes; and establish early engagement of communities with a goal of achieving mutually beneficial relationship.

Environmentally, innovation is important to support efforts to minimize and mitigate the environmental footprint of the minerals sector, including developing new technologies and materials that are safer; promoting energy efficiency and reducing greenhouse gas emissions; and better managing the resources required to operate.

Canada's minerals sector BERD totalled $524 billion in 2017 (Figure 14), the latest year for which reliable statistics are available.[23] Data are also not shown for 2010, 2014, and 2015 because it was either unavailable, incomplete, or withheld for those years for confidentiality reasons. The primary metal manufacturing subsector accounted for 42.2% of total BERD in 2017, reaching $221 billion. BERD in the mining and related support activities subsector was comparatively weak, contributing to 12.8% of total BERD in 2017. This represents a substantial change from the period between 2011 and 2013 when mining and related support activities contributed between 21.2% and 28.2% of total BERD.

[23] Statistics Canada's dataset groups NAICS codes 212 – Mining and quarrying (except oil and gas), 213117 – Contract drilling (except oil and gas), and 213119 – Other support activities for mining, including exploration (excluding surveying for oil and gas).

Figure 14. Minerals Sector Business Expenditures on Research and Development, by Subsector, 2008–2017



Source: Statistics Canada.

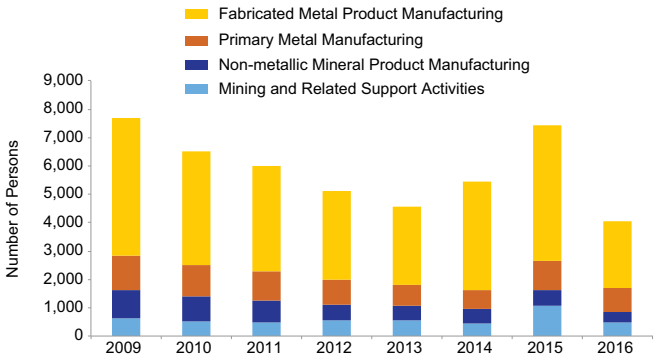
With the exception of non-metallic mineral product manufacturing (which remained relatively constant at approximately $48 billion between 2016 and 2017), total BERD as well as that of all the individual subsectors demonstrated a decline in value in 2017 relative to past years. The minerals sector's 2017 BERD decreased 29.3% relative to a peak reached in 2009.[24]

With respect to longer-term trends, BERD in the fabricated metal product manufacturing subsector declined from $260 billion to $189 billion between 2008 and 2017. BERD in primary metal manufacturing fluctuated between $260 billion and $202 billion. BERD in mining and related support activities increased 45.7% or $21 billion between 2008 and 2017. Finally, BERD in non-metallic mineral product manufacturing decreased 28.8% between 2008 and 2017 from $66 billion to $47 billion.

Although Statistics Canada indicates that some subsector data for the mineral sector are unreliable for the most recent year (i.e. 2018), preliminary values point towards a slight increase of 8.8% in total BERD compared to 2017.

In 2016, the most recent year for which data are available, a total of 4,033 R&D employees were working in Canada's minerals sector (Figure 15). This represents a decrease of 47.5% from the 7,687 people employed in 2009 and a 45.9% decrease from a peak of 7,449 in 2015.[25] Employment of R&D personnel is concentrated in the fabricated metal product manufacturing subsector, contributing around 60% of total personnel.

Figure 15. Minerals Sector Research and Development Personnel, by Subsector, 2009–2016



Source: Statistics Canada.

Data Considerations

Statistics Canada's data for BERD and R&D personnel contain several years with gaps because of the application of confidentiality rules and/or data quality issues. Data contained in this section are only presented for years where the data were available for all subsectors.

Government Revenues

Highlights

- Between 2007 and 2016, the minerals sector generated $13.8 billion in corporate income tax revenue for Canadian governments ($8.1 billion to the federal government and $5.6 billion to provincial/territorial governments). The lowest annual government revenue over the decade was $718 million in 2013, and the highest was $2.5 billion in 2007.
- Mining taxes and royalties paid to governments by the mineral extraction industry have declined 39% over the last 10 years with $1.1 billion generated in 2016–2017 compared to $1.8 billion in 2007–2008; this trend is similar and related to the overall decline in the sector's expenditures, investment, and production.

[24] For a number of years, Statistics Canada's data on BERD are either unavailable or too unreliable to be published, hence the comparison between select years where data are available.

[25] Data for 2008 for the primary metal (ferrous) subsector are unavailable.

Definition
Government revenues from the minerals sector include corporate income taxes, mining taxes, and royalty payments to provincial and federal governments. Corporate income tax data in this section are from 2007 to 2016 while provincial mining and royalty tax data were reported on a fiscal year basis, covering the period from 2007–2008 to 2016–2017.

Rationale
Taxes and royalties paid to governments are a significant part of the sector's contribution to the national, provincial, and territorial economies and a way for Canadians, present and future, to receive revenue from the extraction of mineral resources and to benefit from the country's mineral wealth.

Analysis
The minerals sector in Canada benefits from one of the most internationally competitive and attractive tax regimes for mining and mineral exploration companies. The Canadian statutory corporate income tax rate consists of profit-based royalty systems, carry-forward and carry-back provisions, and mineral and exploration tax incentives such as flow-through shares (FTS) and the mineral exploration tax credit (METC).[26] As shown in Table 7, the federal statutory corporate income tax rate was 19.5% in 2008 and 15% in 2018. This change occurred in 2012 and has been stable at this rate since January of that year. Four provinces and territories reduced their corporate income tax rates while five have increased them since 2008.

Table 7. Canadian Federal and Provincial/Territorial Corporate Income Tax Rates, 2008 and 2018

Jurisdiction	Tax Year 2008	Tax Year 2018
Federal	19.50%	15.00%
Alberta	10.00%	12.00%
British Columbia	11.00%	11.00%
Manitoba	14.00%	12.00%
New Brunswick	13.00%	14.00%
Newfoundland and Labrador	14.00%	15.00%
Northwest Territories	11.50%	11.50%
Nova Scotia	16.00%	16.00%
Nunavut	12.00%	12.00%
Ontario	14.00%	11.50%
Prince Edward Island	16.00%	16.00%
Quebec	11.40%	11.80%
Saskatchewan	13.00%	12.00%
Yukon	15.00%	12.00%

Source: Natural Resources Canada.

Generally, mining taxes and royalties in Canada are based on the net income of a mining operation rather than its revenue, although six provinces[27] have a two-tier system in which a small percentage of operating income is taxed before taxing the net income.

Also of note is Canada's unique mechanism of flow-through shares (FTS) that allows a principal business corporation to obtain financing for certain expenditures on mineral exploration and development in Canada. FTS investors can receive a 100% tax deduction for the money invested in FTS for exploration activity and 30% for development activity. This incentive is enhanced by the 15% Mineral Exploration Tax Credit on eligible expenses (for example, costs related to prospecting and carrying out geological, geophysical or geochemical surveys conducted from or above the surface of the earth). Furthermore, several provinces (British Columbia, Manitoba, Ontario, and Saskatchewan)

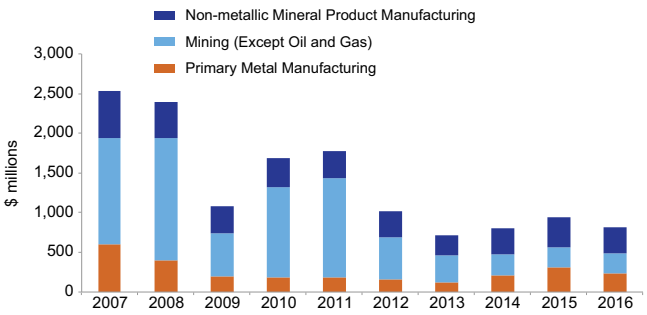
[26] http://www.nrcan.gc.ca/mining-materials/taxation/mining-taxation-regime/8892#lnk16.

[27] Alberta, British Columbia, New Brunswick, Newfoundland and Labrador, and Nova Scotia currently have a two-tier mining royalty system. In May 2013, the Government of Quebec announced a new mining tax regime effective January 1, 2014. Companies will pay the higher of a minimum mining tax on value of production, which will vary from 1% to 4%, or a tax on profits ranging from 16% to 22.9%.

also offer additional tax credits or deductions to FTS investors to encourage exploration investment in their jurisdictions.

Corporate income tax paid to governments by the minerals sector in Canada fluctuated significantly between 2007 and 2016, reaching a high in 2007 of $2.5 billion (Figure 16).[28] This high is consistent with peak activity levels and the value of production for the industry. Corporate taxes paid dropped substantially in 2009 and 2012, reaching the lowest point in 10 years in 2013 at $718 billion. This drop is linked to the downturn faced by the sector as a whole. While the levels have recovered from this low, corporate income tax recoveries have remained below $1 billion since 2012. It is important to note that taxes and royalties paid to government are related to and influenced by the economic performance of the sector as a whole.

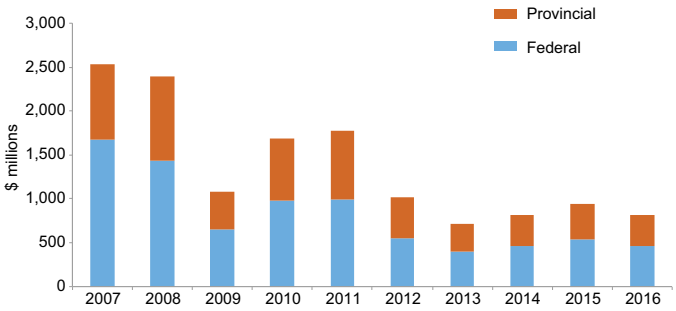
Figure 16. Minerals Sector Corporate Income Tax Paid to Governments in Canada, by Subsector, 2007–2016



Source: Statistics Canada.

Between 2007 and 2016, the minerals sector generated $13.8 billion in corporate income tax revenue for Canadian governments ($8.1 billion to the federal government and $5.6 billion to provincial/territorial governments) (Figure 17). With federal corporate income tax rates holding steady at a low of 15% over the last 6 years, the provinces and territories share of corporate income tax revenues have been at their highest in recent years for all mineral subsectors. For instance, overall, the share of provincial/territorial corporate income tax to total corporate income tax increased from 34.1% in 2007 to 42.8% in 2016.

Figure 17. Minerals Sector Corporate Income Tax Paid to Federal-Provincial Governments, 2007–2016



Source: Statistics Canada.

However, mining taxes and royalties paid to governments by the mineral extraction industry have declined by 39% over the last 10 years (Table 8). These payments reached a peak of $2.7 billion in 2008–2009, at the height of a commodity price cycle, before receding in the wake of the global recession. Payments rebounded in subsequent years but were at a near low of $1.1 billion in 2016–2017 due in part to a significant reduction in royalties/taxes from Saskatchewan. Lower potash prices in 2016–2017 were responsible for Saskatchewan's 48% drop in payments from the previous year.

[28] Data for NAICS 332 – Fabricated metal product manufacturing are not available in a disaggregated manner.

Table 8. Royalties, Mining Taxes, and Similar Payments to Provinces and Territories, 2007–2008 to 2016–2017

Province/ Territory	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017
	(current $ billions)									
Alberta (coal)	14.0	36.0	31.0	31.0	29.0	-3.0	16.0	16.0	14.0	26.2
British Columbia	202.5	324.4	292.1	364.5	358.3	150.2	106.5	89.7	103.1	258.7
Manitoba	104.1	49.7	14.6	45.9	66.8	42.4	13.0	7.1	14.2	5.2
New Brunswick	133.9	37.2	43.0	44.4	66.0	31.0	22.7	36.3	20.3	2.7
Nova Scotia	2.3	2.6	1.7	1.4	2.5	1.6	1.3	1.3	1.4	1.2
Newfoundland and Labrador	276.6	216.9	84.8	228.1	317.4	136.0	160.4	95.4	70.0	60.0
Northwest Territories and Nunavut	64.0	112.7	91.5	108.9	132.2	58.1	28.3	127.8	76.5	64.1
Ontario	236.7	79.8	20.5	176.1	213.4	117.5	18.6	159.0	69.1	60.4
Quebec	59.8	5.7	116.3	323.6	352.2	207.3	56.8	90.1	172.2	100.4
Saskatchewan	714.0	1,797.2	113.0	626.0	858.7	742.0	667.0	910.2	1,009.6	523.6
Yukon	1.9	2.0	2.3	4.2	5.4	4.0	2.4	3.0	1.6	1.5
Canada	**1,809.7**	**2,664.2**	**810.9**	**1,954.2**	**2,401.9**	**1,487.0**	**1,093.1**	**1,536.0**	**1,552.0**	**1,104.0**

Source: Natural Resources Canada.

Data Considerations

Although it is not captured within the statistics in this section, it is important to note that the minerals sector's contributions to government revenues extend beyond corporate income tax and royalties. Minerals sector activity drives economic activity in other sectors that contribute to government revenue, including sales taxes on goods and services purchases, employee income taxes, contributions to the Canada Pension Plan and the Quebec Pension Plan, and property taxes to municipalities.

Box 5: The Extractive Sector Transparency Measures Act

The *Extractive Sector Transparency Measures Act* (ESTMA; "the Act"), which came into force on June 1, 2015, delivers on Canada's international commitment to support global efforts to strengthen transparency and accountability in the extractive sector. The Act requires certain entities that are engaged in the commercial development of oil, gas, or minerals to annually report specific payments made to all governments in Canada and abroad. The payments reported are those of C$100,000 or more that fall within specific categories of revenue streams commonly associated with exploration and extraction of oil, gas, or minerals (e.g., taxes, royalties, fees). Since June 1, 2017, the Act includes payments made to Indigenous governments in Canada.

The purpose of the ESTMA is to deter corruption in the global extractive sector by making government revenues from natural resources transparent to the public. The Act was developed in response to a commitment that Canada made at the 2013 G8 Leaders' Summit, where leaders agreed to raise global standards of transparency in the extractive sector, reduce the potential for corruption, and ensure that citizens benefit fully from the extraction of natural resources. Since 2013, NRCan has engaged with stakeholders for input on how best to implement the Act.

Canada's reporting requirements are broadly aligned with similar transparency measures implemented in the EU and Quebec and substitution has been put in place to enable companies operating in more than one of these jurisdictions to prepare one report. Canada is recognized as a leader in promoting transparency and accountability in the extractive sector both at home and around the world. As of November 1, 2018, approximately 950 individual, consolidated, and substituted reports are linked on the NRCan website at: https://www.nrcan.gc.ca/mining-materials/estma/18198.

SECTION 3: Social Performance

As an industrial activity, the minerals sector can have a tremendous impact on local communities and on Canadian society as a whole. Outputs of the sector are often key components in the production of goods and services that benefit Canadians on a daily basis. Mineral exploration, development, and production provide direct and indirect economic and social benefits. This economic activity can improve quality of life through direct and indirect employment, education and training, improved access to infrastructure, and other community development projects.

Mineral projects can also bring change to a community's identity and can lead to increases in undesirable outcomes such as increased cost of living.[29] Additionally, communities that become reliant on exploration and mining as economic drivers can be especially vulnerable to adverse impacts once operations close. Major adverse social impacts following closure could include loss of employment and income; reductions in tax revenues and associated funding decreases for infrastructure and social programs; population flight; and declining local secondary economic activity, including services that support of the local minerals sector and its employees

The outcomes and indicators in this section of the report were developed to help assess the minerals sector's social performance. Based on a review of various multi-stakeholder frameworks, the overall desired outcomes chosen to frame social performance are:

Develop Canada's mineral resources in order to provide tangible benefits for current and future generations, including local communities in the proximity to mineral activities such as prospecting and exploration, development, extraction, and closure and reclamation.

Conduct engagement processes to ensure local and affected communities have the opportunity to participate in the development of resources that could influence their future.

The indicators[30] chosen to measure the sector's performance related to these outcomes are:

- **Employment –** Employment in the mineral industry provides income security through wages and salaries, an improved standard of living, and the acquisition of transferable skills. Measuring the sector's employment level helps assess one of the most important socio-economic contributions provided to communities located in all regions of the country, from large urban centres to rural, northern, and remote areas.
- **Agreements between mineral companies and Indigenous communities or groups –** Agreements, which can range from a Memorandum of Understanding (MoU) to an Impact Benefit Agreement (IBA), have helped secure benefits for local Indigenous communities and businesses, and provide clarity and certainty for exploration and mining companies. Monitoring the number of agreements is one possible metric of the mineral industry's efforts to develop partnerships with communities and earn and maintain the positive relationship with local stakeholders needed to operate. However, while increasing the number of agreements over time is beneficial, the nature and magnitude of benefits will be different in each case.
- **Government funding for public participation in environmental assessments –** Environmental assessments examine a comprehensive list of potential impacts in natural resource development, including the cumulative effects of a proposed project, measures to mitigate those effects, and concerns and comments raised by the public. Funding to support participation by the public and Indigenous communities in environmental assessments is one potential indicator in gauging efforts to ensure concerns are considered during regulatory processes.

[29] Natural Resources Canada, 2003, *The Social Dimension of Sustainable Development and the Mining Industry*, http://www.publications.gc.ca/site/eng/9.686723/publication.html.

[30] The authors acknowledge the indicators presented in the report are not currently sufficient to measure all of the social impacts of the minerals sector, positive or negative. The continued search for relevant data and new indicators for subsequent editions is an ongoing priority.

- **Gender diversity –** Gender diversity is the measurable representation of women and men employed within the sector. It is an important indicator for assessing the effectiveness of industry efforts to remove unintended barriers that prevent increased female representation in the sector's labour force.
- **Workplace health and safety –** Workplace health and safety is measured as the occupational injury rate, both fatal and non-fatal. Monitoring it helps determine the minerals sector's level of performance in ensuring safe and healthy work environments.
- **Mine openings and closures –** Mine openings and closures can result in significant socio-economic impacts, both positive and negative, including changes in employment, government revenues, population, and socio-economic activity in the local area.
- **Strikes and lockouts –** Strikes and lockouts are the result of friction between employees and the employer. Regardless of the reason for the labour disruption, they can have a negative impact on the industry, the workers, and the local community.

Synopsis

Overall, the mineral industry's social performance has been variable between 2008 and 2017. While total employment has fallen nearly 4% over this period, this longer-term trend was heavily influenced by the protracted economic downturn in 2008–2009, which saw operation closures, exploration declines, and other negative impacts. In contrast, Indigenous employment remained stable over the same period. During the same period (2008–2017), workplace health and safety improved, showing lower rates of both fatal and non-fatal worker injuries. The last decade also saw fewer labour disputes, and positive trends in mine openings and closures.

Highlights

- In 2017, 382,220 people were directly **employed** in mining, mining-related support activities, and the mineral processing sector in Canada, a decrease of 3.2% over 2008 levels. Average employment was 376,545 per year in the sector.
- **Indigenous employment** in the minerals industry decreased 0.9% between 2008 and 2017. However, Indigenous employment in the mining and quarrying subsector increased from 34.2% to 55.5% of total Indigenous employment between 2008 and 2017.
- While the number of **women employed in the sector** declined over the past 10 years, the proportion of women employed has remained constant at approximately 14%.
- Since 1974, more than 500 **agreements between companies and Indigenous communities or groups** have been signed, covering over 300 projects. Over 400 of these agreements remain active. A total of 340 agreements have been signed over the last 10 years.
- In terms of **government funding for public participation in the environmental review process** in 2017–2018, the Canadian Environmental Assessment Agency's Participant Funding Program (PFP) disbursed more than $1.4 billion to projects from a range of sectors. It provided $141,000 to 22 recipients to facilitate public participation in the environmental assessments (EA) of 12 projects and $1.3 billion to 47 recipients to facilitate Indigenous participation in the environmental assessments of 21 mining projects [31]
- **Workplace health and safety** improved with injury rates for both fatal and non-fatal occupational incidents in the minerals sector, respectively, decreasing from 3.9 to 2.8 per 10,000 employees (29.2% decrease) and from 429.8 to 254.0 per 10,000 employees (40.9% decrease) between 2008 and 2016 – the last year for which data are available.
- Between 2008 and 2017, 60 new **mines opened**, and 31 mines **reopened**. During this same period, 35 mines closed and 83 operations were **suspended**.
- Between 2008 and 2017, the total number of **strikes and lockouts** decreased from 16 to 8 (50%). The resulting total person-days not worked as a result of them increased 53.3% from 67,170 (2008) to 102,950 (2017); however, this overall trend misses a peak of 574,090 days in 2009 and subsequent decrease to a low of 20,250 days in 2016 (-69.9%).

[31] This date were not disaggregated, and some of these projects fell outside of the mining and quarrying space.

Indicator (2008–2016) (unless otherwise specified)	
Employment	●
Indigenous Employment	● ●
Indigenous Agreements	●
Public Funding for Participation	●
Gender Diversity	●
Workplace Health and Safety	●
Mine Closures and Openings	●
Strikes and Lockouts	●

● Improved Performance ● Limited Change ● Decreased Performance

Refer to Data Considerations in Indigenous Employment for important limitations in this indicator.

Employment

Highlights

- There were a total of 382,220 people directly employed in mining, mining-related support activities, and the mineral processing sector in Canada in 2017, which represents a decrease of 3.2% over 2008. The downstream subsectors such as metal manufacturing and mineral product manufacturing were most affected, whereas mining and quarrying saw increases.
- Employment numbers rose in mining and quarrying, as well as in support activity sectors.
- Average total direct employment in the minerals sector was 376,545 employees per year (2008–2017).
- Average annual compensation increased on a year-over-year basis and reached $99,117 on average compared to the national average of $60,130.[32]

Definition

Employment is the number of individuals directly employed by establishments classified within the mining and exploration, mining-related support activities, and mineral processing subsectors.[33]

Rationale

Employment provides income security that can result in improved quality of life and the acquisition of transferable skills. Compensation in the minerals sector remains among the highest in the Canadian economy. Employment can lead to higher consumption and spending in the local community or regions (usually in services and retail), which drives local economic development and improved quality of life, often resulting in better health. As well, there is a positive correlation between employment and growth in Gross Domestic Product, which can lead to increased living standards.[34]

Analysis

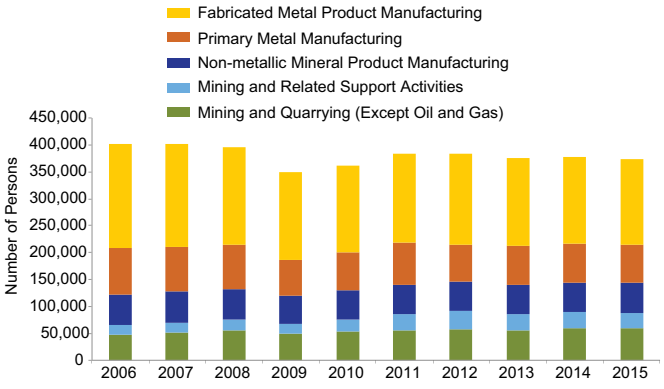
In Canada, direct employment in mining and exploration, mining-related support activities, and mineral processing totalled 382,220 people in 2017. This represents one in every 52 Canadian jobs or 2% of the national working population. Average direct employment per year in the minerals sector was 376,545 employees. Between 2008 and 2017, the total number of people employed in this sector was at its highest level in 2008 with 394,690 individuals. The 2008–2009 global recession saw the sector lose 44,57 jobs but experience a partial recovery by 2011, reaching 384,250 employees. Since 2011, employment levels in mining and mining-related support activities have trended negatively and by 2016 had decreased by nearly 17,000 jobs. This can be attributed to a prolonged industry downturn from 2012/13 to 2015/16 or approximately half of the period covered. A slight increase in jobs was recorded in 2017, but the figure remains lower than 2008 levels (Figure 18).

[32] The total annual compensation per job for the minerals sector is a weighted average of NAICS 212 – Mining and quarrying (except oil and gas); NAICS 21311B – Mining-related support activities; NAICS 327 – Non-metallic mineral product manufacturing; NAICS 331 – Primary metal manufacturing; and NAICS 332 – Fabricated metal product manufacturing.

[33] Statistics Canada's Labour Statistics within the Canadian System of National Accounts provide aggregated data for NAICS 213117– Contract drilling (except oil and gas) and NAICS 213119 – Other support activities for mining, which taken together, comprise activities related to mineral exploration and development.

[34] Daly, Mary C., et al., 2014, *Interpreting Deviations from Okun's Law*, Federal Reserve Bank of San Francisco: Economic Letters, http://www.frbsf.org/economic-research/publications/economic-letter/2014/april/okun-law-deviation-unemployment-recession/.

Figure 18. Mining, Mining-related Support Activities, and Mineral Processing Employment, 2006-15



Source: Statistics Canada.

The decline in employment in the Canadian minerals sector has been concentrated in downstream manufacturing activity. The largest decline occurred in primary metal manufacturing where employment fell by almost 22%, or about 18,000 jobs. Smaller declines occurred in the manufacturing of non-metallic mineral products and fabricated metal products, where employment fell by 5.5% and 5.2%, respectively. The downstream subsectors of Ontario and Quebec experienced the largest employment losses with a total reduction of 27,170 jobs. In contrast, employment in mining and quarrying, as well as mining-related support activities (which includes mineral exploration activities) saw employment growing 29.6% and 7.2%, respectively, during the 10 year period.

A number of factors are responsible for these fluctuations. The cyclical nature of commodity markets will drive changes in mining and quarrying activity along with consolidation in the industry. Employment in the manufacturing industries have been correlated with competition in international markets from Southeast Asian countries. Additionally, variability in the methods of reporting employment numbers will create some inconsistency in the results.[35] The influence of the prolonged industry downturn from 2012–2013 to 2015–2016 must also be kept in mind as it affected the minerals sector for approximately half of the period covered in the current report.

Compensation in the minerals sector remains among the highest in the Canadian economy. In 2017, the average annual earnings for all industries in Canada was $60,330. Average annual earnings for the mining and exploration subsector was $99,117,which is 64% higher than the national average. Compensation has risen in the sector by nearly 17% and has trended positively year-over-year during this decade.

The Canadian Mining Labour Market Outlook 2019 produced by the Mining Industry Human Resources Council (MiHR) estimates that the mining sector would need some 97,000 new workers over the next decade in a baseline market status scenario. In a scenario estimated with a market upswing, this number rises to 135,230, but falls to 49,890 in a pessimistic scenario. The report forecasts that the number of people retiring from this industry will rise and account for most of the departing workforce. Projections indicate that the largest gaps in employment occur in mine production roles, followed by supervisory, support workers, and tradespeople. In addition, with advances in technology and a move towards zero-emission technologies, there will be an increased need for personnel with advanced science, technology, engineering and mathematics (STEM) expertise. However, the number of new students enrolling in mine engineering at the undergraduate level fell by 12% from 2015 to 2016, the steepest decline of all engineering programs in Canada.[36]

In the Mining Association of Canada's Facts and Figures 2017 report, four measures to address these employment gaps were identified:

- Promote employment in the minerals sector to all areas of the population such as women, youth, and Indigenous peoples
- Create initiatives that encourage retired workers to return to the workforce and in addition increase mentoring activities
- Increase education programs and promote in-house training
- Develop a set of standards for critical jobs to ease the transfer from one job to another

MiHR has developed several programs towards achieving these goals, which are found in Box 6.

[35] The Mining Association of Canada, 2018, *Facts and Figures 2017*, https://mining.ca/documents/facts-and-figures-2017/.

[36] Mining Industry Human Resources Council, 2018, *Canadian Mining Labour Market Outlook 2019*, http://www.mihr.ca/pdf/NationalOutlook2019_EN_Final.pdf.

Box 6: MiHR Initiatives to Promote Careers and Diversity in Mining

MiHR has secured federal funding to develop several initiatives to address the issue of labour shortages in the minerals sector:

- **Mining Essentials –** A program focused on developing the non-technical skills and readiness of Indigenous peoples interested in entering the workforce. This program is coordinated in conjunction with the Assembly of First Nations and features a 70% employment rate of participants within six months of graduation.
- **Green Internship Program –** Over the next two years, 120 internships will be offered to qualified post-secondary graduates to provide them with on-the-job experience in STEM fields in the natural resources sector. MiHR will provide up to $12,000 of the intern's salary with funding from Natural Resource Canada's Green Jobs – Science and Technology Internship Program. Past minerals sector placements have included work as an environmental technician or energy project manager.
- **Gearing Up –** In an effort to create 850 work-integrated learning prospects over the next four years. MiHR will provide up to $7,000 towards wages to companies who take on interns, co-ops, field placements, capstone projects, or case competitions. The program is run in consultation with a National Consortium of companies from the minerals sector, service industries, associations and post-secondary institutes.
- **Canadian Mining Certification Program –** A national program that is designed to recognize and certify the skills and competencies of workers in currently undesignated occupations in four key jobs: underground miner; surface miner; minerals processing operator; and diamond driller. This certification would be recognized throughout the industry as it demonstrates transferable skills for use in many areas of mining.
- **Gender Equity in Mining –** A 12-month program that provides coaching and resources to employers to remove barriers of gender inequality for career progression.
- **Workforce Transition Resources –** In recognition of the large number of retiring senior level workers, MiHR has created a list of non-technical transferable management skills and an occupational matrix indicating where these skill sets are found. Companies in need may access this information to fill vacancies within their organizations.

Data Considerations

Data for this section were obtained from Statistics Canada through the *North American Industry Classification System*. This dataset reconciles information from the Survey of Employment Payroll and Hours and the Labour Force Survey (LFS), along with information from the census and administrative data sources (i.e., Canada Revenue Agency T4 tax slips). This allows for the capture of categories such as self-employment, which in turn allows for a more accurate and complete estimate of employment value.

This dataset also disaggregates industry categories in a manner that enables the reporting of employment for the mining-related support activities subsector, which includes select mineral exploration activities like contract drilling. It is important to note, however, that this industry category is not inclusive of all mineral exploration employment as it is unable to adequately capture the numerous professional services (i.e., geological, financial,

legal, construction) associated with the mineral exploration industry that are spread across other industry classifications.

Indigenous Employment

Highlights

- Indigenous employment in the minerals sector decreased 0.9% from 2008 to 2017, a decrease at least partially influenced by a prolonged industry downturn from 2012–2013 to 2015–2016.
- In 2017, over half of Indigenous minerals sector employment was concentrated in the mining and quarrying subsector at 55.5% of the total jobs held by Indigenous people in the mineral industry, up from 34.2% in 2008.

Definition

The Labour Force Survey (LFS) measures the Indigenous population using the concept of Indigenous identity. A person has an Indigenous identity if he or she reports as identifying with at least one Indigenous group, for example, First Nations, Métis, or Inuit. This is based on the individual's own perception of his/her Indigenous identity.[37]

Rationale

Governments and the mineral industry have recognized the potential for greater Indigenous participation in the industry's labour force. Canada's Indigenous population is younger and growing at a faster rate than its general population, and a number of Indigenous communities are located in close proximity to exploration projects and producing mines. This makes local hiring an attractive solution to sourcing human resources. A company's relationship with local stakeholders is intrinsically linked to its ability to hire and train local people, which provides an avenue to increase the employment participation of Indigenous people. It is worth noting that the location of a mine opening or closure may affect Indigenous employment, as Indigenous population locations and densities can differ dramatically across jurisdictions. Opening and closing of mines may disproportionately influence Indigenous employment relative to the overall population depending on the location under consideration.

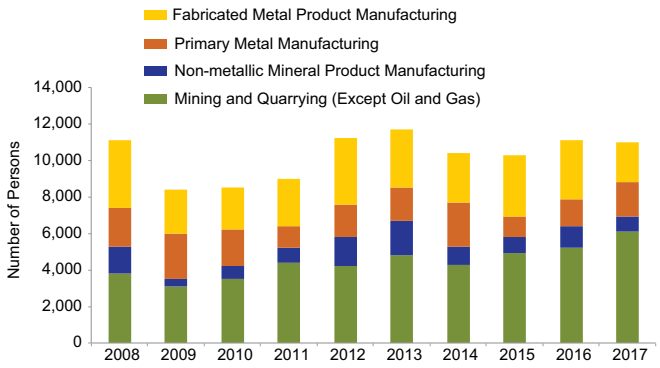
[37] www.statcan.gc.ca/pub/71-588-x/71-588-x2011003-eng.htm.

Analysis

The number of Indigenous peoples employed in the minerals sector fluctuated considerably between 2008 and 2017, from a low of 8,400 in 2009 to a high of 11,700 in 2013 in just five years (Figure 19). Employment levels declined to 10,300 in 2015, as the industry was in the midst of a protracted downturn and as companies recalibrated and refocused activities in light of the dire economic conditions. Total minerals sector Indigenous employment began to rebound in 2015 and 2016 and remained stable year over year to 2017.

Potential for increased Indigenous employment remains strong. Many Indigenous communities are located within 200 km of approximately 180 producing mines and more than 2,500 exploration properties. Many mines and projects are located on traditional lands. Therefore, Indigenous peoples across the country are ideally placed to access the employment opportunities and other benefits of the minerals sector. Involvement of Indigenous peoples and communities in the sector plays an important role in the means to advancing Indigenous economic reconciliation.

Figure 19. Indigenous Employment in the Minerals Sector, 2008–2017



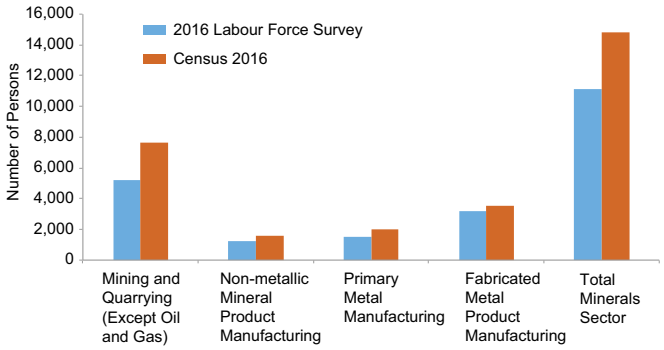
Source: Statistics Canada.

In 2017, Indigenous employment in the minerals sector was mostly concentrated in the mining and quarrying subsector, representing 55.5% of total Indigenous employment in the sector, up from 34.2% in 2008. The slight decrease in employment between 2008 and 2017 was largely due to decreases in employment in non-metallic mineral product manufacturing and fabricated metal product manufacturing. This may have been influenced by the prolonged downturn in the minerals sector between 2012–2013 and 2015–2016.

Employment decreases in these two subsectors were partially offset by an increase in employment in the mining and quarrying subsector.

Data from the 2016 census provide an even better employment picture for Indigenous people in the minerals sector (Figure 20). According to that source, total employment of Indigenous people in Canada's minerals sector amounted to 14,800 individuals, 33% higher than figures from the Labour Force Survey. Employment levels are also higher in each of the subsectors, with the largest difference in the mining and quarrying subsector. The reasons for these discrepancies are described in the Data Considerations section below.

Figure 20. Comparison of Census and LFS Minerals Sector Indigenous Employment Results, 2016



Source: Statistics Canada.

Box 7: CanNorth

Supporting Indigenous businesses makes the mining business better as a whole. Canada North Environmental Services (CanNorth) is an Indigenous-owned company, established through the support of Cameco and other uranium mining companies in northern Saskatchewan. For nearly two decades, CanNorth has overseen independent and community monitoring programs that protect the environment for future generations.

CanNorth is 100% owned by Kitsaki Management Limited Partnership, the business arm of the Lac La Ronge Indian Band. The company provides employment opportunities for Indigenous people, and all profits directly benefit Indigenous people.

CanNorth is an active participant in the Eastern Athabasca Regional Monitoring Program (EARMP), which was established in 2011 under the Province of Saskatchewan's Boreal Watershed Initiative. They work directly with Indigenous residents from the seven Athabasca-based communities to collect both the technical and community samples for the EARMP. In addition to environmental services, CanNorth also provides services related to communication between Indigenous and local communities and mining developments.

Canada's mining industry is a major customer of Indigenous businesses and a top employer of Indigenous talent.

Data Considerations

The Indigenous employment numbers presented throughout this section are primarily sourced from Statistics Canada's Labour Force Survey (LFS). Although the LFS produces employment estimates for Canada's three territories and includes Indigenous identity questions, it employs a different methodology than the one used for the provinces. The LFS also excludes persons living on reserves and settlements. As such, the data included in this section are not as comprehensive as those provided by the census and appear to underestimate the number of Indigenous peoples employed in the minerals sector. Moreover, owing to changes in the survey's methodologies over time, data prior to 2007 are not included in this section as they cannot be compared with more recent data.

Gender Diversity

Highlights

- The number of women employed in the minerals sector totalled 50,800 in 2017, a decrease of nearly 9,000 employees from its 2008 level. However, the proportion of women employed in the sector has remained relatively consistent, declining less than 1% over the same period.
- In the mining and quarrying (excluding oil and gas) subsector, the number of women in the workforce has increased from 10,000 in 2008 to 10,700 in 2017. The percentage of women employed in the subsector has remained at just under 14%.
- Further effort is required, and underway, to reduce the barriers for women's recruitment, retention, and career advancement in the sector's labour force and to improve gender equality in the sector.

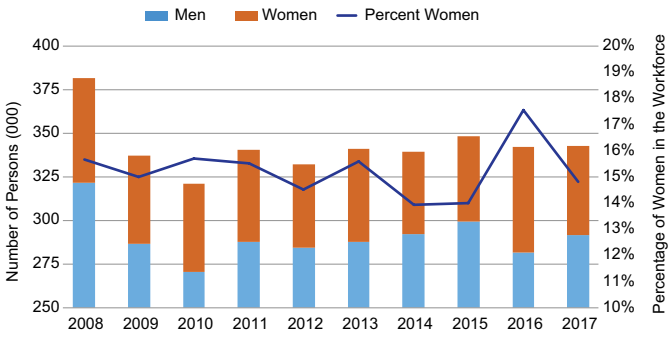
Definition
Gender diversity is the measurable representation of women employed in a given industry.

Rationale
Gender diversity is a key measure of the minerals sector's social performance. The higher participation rate of women in the workforce has multiple positive socio-economic impacts including poverty reduction, health, and child development. Low employment levels for women can have a negative impact on economic growth and gender equality.

Several studies have identified positive correlations between women employed at all levels of an organization and better organizational performance,[38] as well as positive correlations between gender diversity on boards of directors and in senior executive positions and better financial performance,[39] decision-making[40] and governance.[41] Furthermore, research shows that lack of gender diversity could have an impact on a firm's productivity and profitability. Companies in the lowest quartile of measures on gender diversity are more likely to underperform their industry peers on profitability.[42]

Analysis
Figure 21 shows employment trends by gender for the total minerals sector from 2008 to 2017.[43] This sector comprises four subsectors under the North American Industry Classification System (NAICS 2012): mining and quarrying (excluding oil an gas), non-metallic mineral manufacturing, primary metal manufacturing, and fabricated metal product manufacturing.

Figure 21. Mining and Quarrying and Oil and Gas Employment, by Gender, 2008–2017



Source: Statistics Canada.

The total number of women employed in the minerals sector declined slightly over the 10-year period shown, from a peak of 59,700 in 2008 to 50,800 in 2017. However, the proportion of women employed in the sector remained stable throughout the decade, with the exception of a spike in 2016, which indicates the decline in women's employment in the sector is largely due to the general trend of declining employment overall.

[38] Women in Mining Canada. 2010. *Ramp-UP: A Study on the Status of Women in Canada's Mining and Exploration Sector*, https://wimcanada.org/wimc-ramp-up-report/.

[39] See: WIM (U.K.) and PwC. 2015. *Mining for Talent 2015: A Review of Women on Boards in the Mining Industry 2012–2014*, www.pwc.co.uk/industries/mining/insights/mining-for-talent-2015.html.

[40] See: Women in Mining Canada. 2016. Welcoming to Women. An Action Plan for Canada's Mining Employers, http://wimcanada.org/wp-content/uploads/2017/01/WIM-NAP-book-full.pdf

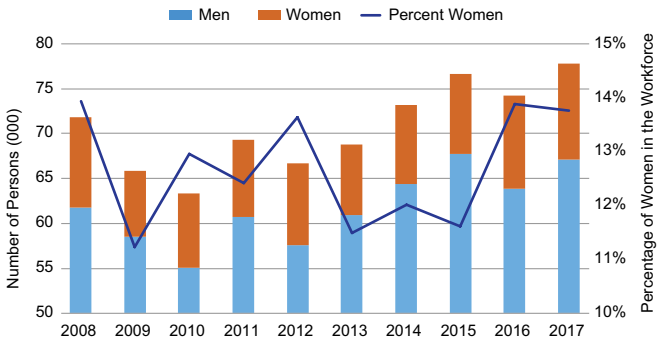
[41] See: Hunt, Vivian, et al. 2018. *Delivering through Diversity*. McKinsey & Company, https://www.mckinsey.com/~/media/mckinsey/business%20functions/organization/our%20insights/delivering%20through%20diversity/delivering-through-diversity_full-report.ashx; Hunt, Vivian, et. al., 2015, Why Diversity Matters, France: McKinsey & Company, https://www.mckinsey.com/~/media/mckinsey/business%20functions/organization/our%20insights/why%20diversity%20matters/diversity%20matters.ashx.

[42] Hunt, Vivian, et al. 2018. Delivering through Diversity. McKinsey & Company.

[43] Statistics Canada's custom tabulation for gender employment in the minerals sector.

If attention is restricted to the mining and quarrying subsector (excluding oil and gas), the number of women employed rose from 7,700 in 2007 to 10,700in 2017, representing a 39.0% increase. Figure 22 shows the employment trends by gender for this subsector.

Figure 22. Mining and Quarrying (Excluding Oil and Gas) Employment, by Gender, 2008–2017



Sources: Statistics Canada.

The proportion of women employed in the mining and quarrying (excluding oil and gas) subsector remained slightly below 14% from 2008 to 2017. This figure dipped below 12% from 2013 to 2016 before recovering to its previous levels. It is important to note that due to the smaller sample size, the variability in this figure is higher than that of the total minerals sector, which is explained further in the Data Considerations section below.

Relative to other sectors of the Canadian economy, the minerals sector as a whole had a lower participation of women in the workforce throughout the reference period. In 2015, for example, women represented 23% of the labour force in utilities and 28% in manufacturing.[44]

With respect to senior management positions, the minerals industry ranked in the lowest quartile for the number of women in director and executive officer positions. In 2017,[45] just 9% of directors were women, compared to 13% in 2016. Between 2016 and 2017, the percentage of women executive officers in mining companies remained at 13%, and the percentage of women on the boards of mining companies declined from 13% to 9.4%.[46]

A 2016 study conducted by the Peterson Institute for International Economics analyzed the impact of gender diversity on the corporate performance of nearly 22,000 companies across the globe and showed that companies with 30% female corporate leadership could lead to an increase in net profit for the firm.[47] Recent qualitative research on women's employment in natural resources sectors confirms that establishing a 30% critical mass of women in executive roles and board representation are essential in establishing supportive institutional environments.[48] Progress is required to reduce the barriers for women's recruitment, retention, and career advancement to achieve a more diverse workforce in the sector.

A number of organizations, such as the Mining Industry Human Resources Council (MiHR), Women who Rock, and Women in Mining (WIM) Canada, are making efforts to increase career awareness in order to attract women to the industry, particularly in the Science-Technology-Engineering-Mathematics (STEM) fields. They are also working to change workplace culture to retain female talent and to create mentorship and networking opportunities to support the advancement of female employees.

In 2016, Women in Mining (WIM) Canada, with the support of Status of Women Canada, developed the National Action Plan for Canada's Mining Employers.[49] The National Action Plan was informed by leading mining organizations that established a Gender Advisory Committee. The Plan is a resource for employers to help them transform their workplaces and challenges industry to take meaningful efforts to actively include women in the workplace and achieve new business benefits.

Natural Resources Canada, in partnership with provinces, territories, and Indigenous peoples and in collaboration with industry, has developed the Canadian Minerals and Metals Plan to bolster competitiveness and reaffirm Canada's position as a leading mining nation. The Plan's Action Plan will provide an opportunity to further develop and enhance the opportunities for women in the Canadian minerals sector.

[44] Women in Mining Canada. 2016. *Welcoming to Women. An Action Plan for Canada's Mining Employers*.

[45] Since 2014, Canadian provinces and territories (except Alberta, Prince Edward Island and Yukon) introduced "comply or explain" legislation requiring publicly traded companies to report on their gender diversity policies and the representation of women in board or senior executive positions (Baruah, Bipasha. (2018). *Barriers and Opportunities for Women's Employment in Natural Resources Industries in Canada)*.

[46] MacDougall, A., et al. (2018). *Diversity Disclosure Practices: Women in leadership roles at TSX-listed companies*. Osler, Hoskin & Harcourt LLP.

[47] Noland, M., et al. (2016). *Is Gender Diversity Profitable? Evidence from a Global Survey*. Peterson Institute for International Economics.

[48] Baruah, Bipasha. (2018). *Barriers and Opportunities for Women's Employment in Natural Resources Industries in Canada*.

[49] https://wimcanada.org/wim-canada-national-action-plan/.

Box 8: Gender-Based-Analysis Plus

As part of ratifying the United Nations Beijing Declaration and Platform for Action in 1995, the Government of Canada committed to using Gender-Based-Analysis Plus (GBA+) to assess the gender impacts of government policies, programs, and services. In 2015, GBA+ became a key analytical tool used across the Government of Canada to assess these impacts. While its main purpose is to advance gender equality, the framework goes beyond gender and includes the examination of identity factors, such as age, education, language, cognitive or physical disabilities, geography, culture, and income.

Over the last three years, increasing workforce diversity and equality in the workplace has been a priority of the Federal government, which has committed to a number of key actions with significant policy and data implications. These outcomes include:

- The first 2017 Gender Budget Statement championing the systematic use of GBA+ across government, including the first GBA+ federal budget.
- The 2018 Gender Budget introducing the Gender Results Framework to monitor and evaluate progress on key performance indicators.
- The proposal to establish in law the Department for Women and Gender Equality (WAGE), with an extended mandate and resources to promote the full participation of diverse Canadians in the economic, social and democratic life of Canada.

The Government's GBA+ requirements and the introduction of the Gender Results Framework have increased the need for disaggregated data for all federal departments and agencies. To support the data needs of federal departments and agencies, Budget 2018 provided funding to Statistics Canada to create the Centre for Gender, Diversity and Inclusion Statistics.[50] Over the last year, the centre has worked closely with Status of Women Canada to establish a data hub aligned with the six pillars of the Gender Results Framework. The main objective of the hub is to help users find the information that Statistics Canada publishes. At the same time, Statistics Canada analyzes the differential impacts of programs, policies, and other initiatives from a gender, diversity, and inclusion perspective.

To reflect these changes in the next edition of the *Mining Sector Performance Report*, NRCan will consider redefining the Gender Diversity indicator to reflect these broader definitions of diversity in the workforce in light of the Canadian Minerals and Metals Plan.

Data Considerations

Data for this section were obtained from Statistics Canada using a custom data filter on the Labour Force Survey (LFS) in order to disaggregate employment in the mining industry from the oil and gas sector. The LFS estimates are based on a sample drawn from the Canadian labour force, and the results are therefore subject to sampling variability. As a result, estimates for smaller sectors and subsectors drawn from the LFS can display a higher degree of variability than the numbers drawn from the survey overall.

[50] https://www.statcan.gc.ca/eng/topics-start/gender_diversity_and_inclusion.

Agreements Between Mineral Companies and Indigenous Communities or Groups

Highlights

- More than 500 agreements have been signed in Canada since 1974 for over 300 projects, and over 400 of these agreements remain active.
- A total of 340 agreements have been signed over the last 10 years (2008–2017).
- More than half of the active agreements are in Ontario and British Columbia.

Definition

Agreements between mining companies and Indigenous communities or groups are, for the most part, privately negotiated agreements that typically contain provisions for employment and training, business opportunities through set-aside contracts and joint ventures, social and cultural considerations, environmental monitoring, funding arrangements, and other provisions. These can be negotiated at multiple stages of the mineral development sequence (i.e., exploration, mine development) and can be revisited as a project advances.

Rationale

Agreements between mining companies and Indigenous communities or groups at the exploration and development stages (i.e., construction, operation, closure, and post-closure) play an important role in shaping the terms by which mineral activity can occur within the traditional territory of a First Nation, Inuit, or Métis group, and/or when such activities may have an impact on Indigenous or treaty rights. Partnerships between mining companies and Indigenous communities have become the preferred practice for mining companies operating in Canada and often establish, among other things, economic benefits for the community, such as preferential employment and procurement contracts, training and skill-building opportunities, and profit sharing. Meanwhile, they provide exploration and mining proponents with increased certainty through a framework and tools for engagement and relationship building (Box 10). Failure to reach an agreement, or the lack of an agreement, can have adverse impacts on the development of a project, the sustainability of an exploration or mining company, and on socio-economic opportunities for local communities and their residents.

Box 10: Importance of Meaningful Partnerships With Indigenous Communities

Teck's Elk Valley Operations

Teck's commitment to environmental and social best practices is exemplified by the Line Creek Operations, one of its five steelmaking coal operations in the Elk Valley region of southeastern British Columbia. In 2016, the Ktunaxa Nation Council and Teck signed an Impact Management and Benefits Agreement that creates numerous long-term benefits for the Ktunaxa people and increased certainty around future sustainable mining development in the Elk Valley region. Spanning approximately 40 years and all five steelmaking operations, it is one of the most comprehensive agreements of its kind in place in Canada. It sets out commitments for both parties in the areas of consultation and engagement, environmental and land stewardship, employment and business opportunities for Ktunaxa citizens, and cultural resource management. Teck also works with a number of local partners and organizations on economic, social and environmental initiatives. Line Creek Operations received a Mining Association of Canada (MAC) Towards Sustainable Mining Leadership Award in 2015 for its outstanding performance. Dedication to working collaboratively with local communities and sharing best practices across the company helps ensure that short- and long-term environmental and social goals are met and that a net positive impact is achieved in the operating area.

Analysis

Over 500 agreements have been signed in Canada since 1974 for over 300 projects. Over the years, there has been a notable increase in the number of agreements. A total of 340 were signed between 2008 and 2017 compared to 168 prior to 2008, as these have become a common practice in the Canadian mineral sector. However, not all of these signed agreements remain active as replacement agreements are signed, operations end, or a decision is made to end the agreement. As of December 31, 2017, there were over 400 active agreements across Canada.

Agreements are increasingly being signed earlier in the mining sequence. For example, the proportion of exploration agreements has increased between 2008 and 2017 when compared to those signed before 2008. That is because exploration-stage agreements establish positive working relationships and build mutual understanding between communities and the

exploration company. These agreements can provide a framework for negotiating more detailed agreements as the project advances through the development stage towards production (i.e., an operating mine).

Natural Resources Canada has produced and disseminated guides, toolkits, and information products to promote partnerships and dialogue among Indigenous communities, the mineral industry, and governments to facilitate mutual understanding and benefits. These can be found at http://www.nrcan.gc.ca/mining-materials/aboriginal/bulletin/7817.

Data Considerations
These data were collected through a systematic search through public records, including company and community websites, and should be viewed as approximations. They do not include oil and gas operations.

Funding for Public Participation in Environmental Review Processes

Highlights

- In 2017/18, the Canadian Environmental Assessment Agency's Participant Funding Program (PFP) disbursed a total of $1,435,550. The program provided $140,666 to 22 recipients to facilitate public participation in the environmental assessments (EA) of 12 projects and $1,294,884 to 47 recipients to facilitate Indigenous participation in the environmental assessments of 21 projects.
- Between April 2017 and March 2018, 27 projects were supported by PFP of which 12 were related to the mining industry. These 12 mining projects generated $638,719 in funding from the CEAA.

Definition
Environmental assessments (EAs) examine a comprehensive list of potential factors in natural resource development, including the cumulative environmental effects of a proposed project, measures to mitigate those effects, and concerns and comments raised by the public.

The PFP, administered by the Canadian Environmental Assessment Agency (the Agency),[51] is designed to support public participation by providing financial support to individuals, non-profit organizations, and Indigenous communities to participate in the federal EA process. It is used in this section as a proxy to measure efforts in encouraging public participation in the regulatory process.

Rationale
The public's participation in the EA process helps ensure the views of Canadians are meaningfully considered in the planning of natural resource development projects. It also increases the inclusion of local and traditional knowledge in environmental studies and improves knowledge and understanding of the public's concerns and potential issues. Sections 57 and 58 of the *Canadian Environmental Assessment Act, 2012* required that a funding initiative be established to facilitate the public's participation in consultation activities.

Analysis
The PFP consists of two funding components: the Regular Funding (RF) and the Indigenous Funding (IF). While the RF provides financial assistance to individuals and organizations, including Indigenous groups, to participate in public participation opportunities, the IF is meant specifically for Indigenous groups, which triggers the duty to consult from the Government of Canada for IF participation and provides funding to "prepare for and participate" in Indigenous consultation activities.

In 2017–2018, the Agency's PFP disbursed a total of $1,435,550. It provided $140,666 to 22 recipients to facilitate public participation in the environmental assessments of 12 projects and $1,294,884 to 47 recipients to facilitate Indigenous participation in the EAs of 21 projects. In total, there were 27 funded projects in 2017–2018, 12 of which were mining-related. These 12 mining projects generated $638,719 in EA participation funding (Table 9). In addition, the Policy Dialogue Program (introduced in 2016–2017) disbursed a total of $2,146,110 to support Indigenous participation in the review of environmental and regulatory processes, which involved a total of 63 recipients.

Along with the PFP, the *Canadian Environmental Assessment Act, 2012* requires the Canadian Nuclear Safety Commission and the National Energy Board to establish participant funding programs that provide opportunities for the public, Indigenous groups, and other stakeholders to participate in regulatory processes under their respective authority.

[51] www.ceaa.gc.ca/default.asp?lang=En&n=8A52D8E4-1.

Table 9. CEAA Funding for Participation in the EA Process, 2009–2018[a]

Fiscal year	Regular Funding[b]			Indigenous Funding[b]			Mining-related	
	Funding	Projects	Recipients	Funding	Projects	Recipients	Funding	Projects
2008/09	$532,631	n.a.	32	$484,821	8	21	n.a.	n.a.
2009/10	$300,000	n.a.	30	$1,200,000	n.a.	24	n.a.	n.a.
2010/11	$300,000	15	35	$1,900,000	13	67	n.a.	n.a.
2011/12	$1,100,000	18	59	$4,300,000	24	140	n.a.	n.a.
2012/13	$381,197	23	50	$1,612,471	27	90	n.a.	n.a.
2013/14	$517,555	22	51	$2,000,768	27	91	n.a.	n.a.
2014/15	$162,990	14	32	$1,595,464	27	74	$741,487	18
2015/16	$124,875	13	30	$1,203,775	25	59	$598,790	19
2016/17	$231,114	13	38	$1,771,808	20	59	$697,607	10
2017/18	$140,666	12	22	$1,294,884	21	47	$638,719	12

[a] Source: Canadian Environmental Assessment Agency
[b] These values represent **all** projects funded through the CEAA, e.g., mining, hydro, oil and gas, and marine
n.a. Not applicable

Provinces and Territories

All provinces and territories allow for public participation in their respective EA processes. Given that the environment is a shared jurisdiction, the federal government has signed bilateral agreements with Alberta, British Columbia, Manitoba, Newfoundland and Labrador, Ontario, Quebec, Saskatchewan, and Yukon for the coordination of the EA processes for projects that are subject to the environmental assessment legislation of both jurisdictions. To the extent possible, these agreements contain commitments to facilitate public participation in the EA processes. In the case of coordinated EA processes, the public may access funding from both the PFP and, if available, equivalent provincial/territorial programs, to support their participatory activities related to the project review.

In addition to government efforts to promote public participation in the EA process by administering PFPs, mineral companies are important facilitators in enabling public participation in the review of their projects. Fostering participation is a critical step towards achieving public confidence in a given project as it enables a better understanding of concerns and issues related to the project and allows for the opportunity to take those issues into account to develop a more environmentally and socially responsible project.

Data Considerations

Data from government PFPs and similar programs provide only a partial perspective of funding for public participation in environmental review processes for the mineral sector. Mineral company efforts to solicit and incorporate public feedback into project design are critical components to obtaining public acceptance of a project and allow for the development of a more responsible mineral project. However, aggregate funding provided by companies is not currently available.

Workplace Health and Safety

Highlights

- Fatal injuries decreased from 3.9 to 2.8 per 10,000 employees (-29.2%) between 2008 and 2016, despite a 38.1% increase between 2008 and 2010.
- Non-fatal injuries showed a steady and largely uninterrupted decline between 2008 and 2016, falling from 430 to 254 per 10,000 employees (-40.9%).

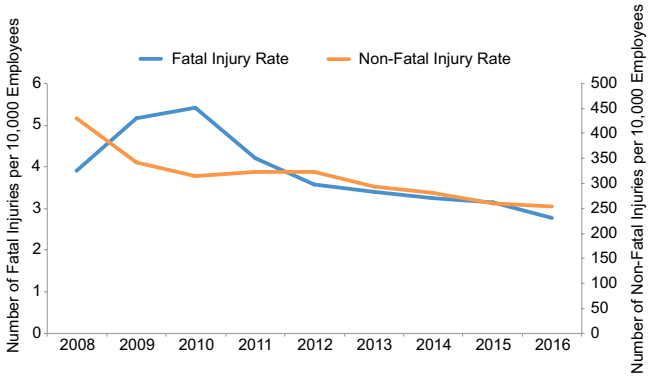
Definition
Workplace health and safety is expressed as either the fatal or non-fatal injury rate per 10,000 workers in the minerals sector. The rate is calculated by dividing the count of fatal or non-fatal injuries by the number of employees in each sector and then multiplying by a factor of 10,000.

Rationale
A safe and healthy work environment is an important social issue for workers and local communities.

Analysis
The minerals sector in Canada has shown continual improvement in its performance in providing a safe work environment with a decrease in rates of injury, both fatal and non-fatal, over the nine-year period between 2008 and 2016 (the most recent year for which data are available).

The rate of fatal injuries per 10,000 employees fell by 29.2% from 3.9 in 2008 to 2.8 in 2016 (Figure 23). During this same period, the non-fatal injury rate also dropped, decreasing 40.9% from 429.8 to 254.0 per 10,000 employees.

Figure 23. Total Compensated Fatal and Non-fatal Injury Rate in the Minerals Sector, 2008–2016



Sources: Natural Resources Canada; Association of Workers' Compensation Boards of Canada; Statistics Canada.

At the subsector level, performance improvements are also apparent. The mineral extraction subsector has made substantial improvements in health and safety as demonstrated by decreasing fatal injury rates, which fell 53.8% from 12.4 per 10,000 employees in 2008 to 5.7 in 2016. The mineral processing subsector includes the primary metal, fabricated metal products, and non-metallic mineral products industries. The subsector's fatal injury rate decreased by 15.5% between the years 2008 and 2016 from 2.5 to 2.1. For non-fatal injury rates, both the mining and quarrying and mineral processing subsectors saw their rates fall by 43.4% and 39.3% between 2008 and 2016, respectively. Non-fatal injury rates for the mining and quarrying subsector decreased from 286.8 to 162.4 injuries per 10,000 workers between 2008 and 2016 (-43.4%). The rate for the mineral processing subsector decreased from 454.4 to 275.7 over the same period (-39.3%).

Labour unions and industry associations have played an important role in improving worker health and safety by encouraging the sharing of best practices, developing industry standards, and providing third party auditing and external verification.

One example includes the efforts of the Saskatchewan Mining Association (SMA). SMA held its 50th Annual Emergency Response Mine Rescue Skills Competition in June 2018. The event hosts teams that participate in a range of mine rescue scenarios. The event highlights and reinforces the skills required to perform rescue operations in a mining environment; motivates participants to train intensively so that rescue operations become ingrained; encourages teamwork in such environments; enables the evaluation of the effectiveness of emergency response programs;

and allows the sharing of best practices among participants. This improving of mine rescue technique and execution is just one way that efforts can be taken within the industry to improve worker health and safety by reducing the incidence rates of fatal and non-fatal on-the-job injuries.

Governments also have a critical role to play in promoting and improving worker health and safety in the mineral industry. In January 2014, Ontario's Chief Prevention Officer (CPO), working in collaboration with an advisory panel and six working groups, launched a comprehensive review of the health, safety, and prevention issues related to underground mining in the province. As of March 2018, the Prevention Office under the CPO's direction has implemented most of the 18 recommendations tabled in the Mining Health, Safety and Prevention Review (2015).[52]

The Prospectors and Developers Association of Canada (PDAC) runs a comprehensive health and safety program in support of improving safety in the exploration industry. Detailed guidance is provided in the comprehensive Health & Safety toolkit in PDAC's sustainability toolkit, *e3 Plus: A Framework for Responsible Exploration*. PDAC offers a short course on health and safety at its annual convention and performs outreach at industry conferences to promote exploration health and safety. The program also includes an annual survey in collaboration with the Association for Mineral Exploration, compiling health and safety statistics provided by companies and publishing an annual safety report and set of guidelines. The most recent report, published in 2018,[53] indicated a record low incident frequency of 0.3 per 200,000 hours in 2016 compared to a previous record of 0.87 per 200,000 hours in 2015. The report suggested that there is still room for improvement with 95% of companies discussing safety at worker meetings, but only 74% claiming that they always do so. According to the report, "Discussing safety at all board and worker meetings is an important leading indicator of a commitment to a culture of safety within a company."

Data Considerations

The data from the Association of Workers' Compensation Boards of Canada's National Work Injury/Disease Statistic Program report lost-time claims and fatalities accepted for compensation by one of the 12 Canadian Workers' Compensation Boards or Commissions. This does not include all worker compensation claims, as claims with no lost time as a result of the incident are not included.[54]

Mine Openings and Closures

Highlights

- Between 2008 and 2017, 60 mines opened and 31 reopened.
- During this same period, 35 mines closed, and 83 operations were suspended.

Definition

This indicator is defined as the number of mines that close, suspend, open, or reopen their operations during a given time frame.

[52] Office of the Chief Prevention Officer, 2015, *Final Report: Mining Health, Safety, and Prevention Review*, http://www.labour.gov.on.ca/english/hs/pubs/miningfinal/.

[53] Prospectors & Developers Association of Canada, 2018, *Canadian Mineral Exploration Health & Safety Annual Report 2016*, https://amebc.ca/wp-content/uploads/2018/03/2016EHSAnnualReport-web.pdf.

[54] See: http://awcbc.org/?page_id=4025.

Mine Opening

A mine is considered open when the operating company announces it has achieved commercial production or when it is reported as such by the regulating jurisdiction. Commercial production can be defined as the point when the mine's development phase is complete and production begins.[55]

Mine Reopening

A mine reopening refers to the opening of a mine that had previously been closed or suspended.

Mine Suspension

A mine is considered suspended when its extraction operations have indeterminately ceased for reasons such as production no longer being economically viable due to commodity price fluctuations or the depletion of higher-grade ore, with a reasonable probability that operations will resume once the situation is resolved. Also, in rare instances, a mine may be considered suspended due to safety issues. Strikes and lockouts are excluded because of their unpredictable nature.

Mine Closure

A mine is considered closed when its extraction activities have ceased indefinitely, and there is no clear intention of resuming operations in the foreseeable future. A mine is considered closed when the operating company announces its closure or when it is reported by the regulating jurisdiction as closed. Mine closure carries with it the responsibility of remediation.

Mine Reclamation

Mine reclamation is a term used to describe the process of restoring land that has been impacted from mining to a natural or economically usable purpose. Although the process of mine reclamation occurs at the end of the mining cycle,[56] the planning of mine reclamation activities occurs prior to a mine being permitted or started.

The framework for site reclamation and remediation includes a requirement that companies provide full funding of their future obligations up front. This reduces the likelihood of future insolvency and the negative impact mine failures have on the economy.

[55] Chartered Professional Accountants Canada, 2011, *Viewpoints: Applying IFRSs in the Mining Industry – Commencement of Commercial Production,* p. 3, https://www.cpacanada.ca/-/media/site/business-and-accounting-resources/docs/viewpoints-commencement-of-commercial-production-mining-july-2011.pdf?la=en&hash=21C96F2898E0A72A050F2908C261AC332277FCDB.

[56] Reclamation also takes place following cessation of exploration project activities, but this aspect is not included in this section's data.

Rationale

Mine openings and closures generate both positive and negative socio-economic impacts, including changes in employment, population, and economic activity in the local area. Governments may also see fluctuations in revenues. Monitoring is important given the potential impacts on local communities.

Analysis

Mining operations including extraction are dynamic, with new operations opening and existing ones closing or suspending production as a result of constantly evolving economic circumstances and commodity price fluctuations. Successful exploration campaigns resulting in increased reserves can extend a mine's life beyond the original mine plan. In contrast, market fluctuations and other external factors can result in a shortened mine operation.

Between 2008 and 2017, 60 new mines opened and 31 reopened, while approximately 35 closed and 83 suspended their operations (see Table 10).[57] Of these 60 new mines, 8 are precious metals mines that opened between 2015 and 2017. Strong gold and silver markets with expected future gold prices forecasted to remain above $1,200/oz and lower corporate taxes (see Section 2) created ideal conditions for a resurgence of precious metal exploration.[58]

[57] Natural Resources Canada. Note: These figures are additive and do not exclude operations that may have reopened in later years.

[58] Wood Mackenzie Ltd, Dataset: 2017 Q1.

Table 10. Mine Openings and Closings in Canada, 2008–2017

Year	Precious Metals				Base Metals				Other Minerals or Metals			
	Opening	Reopening	Suspension	Closing	Opening	Reopening	Suspension	Closing	Opening	Reopening	Suspension	Closing
2008	4	-	3	1	3	-	10	-	1	-	1	3
2009	3	1	1	1	1	3	11	1	-	-	1	2
2010	2	4	1	1	1	4	1	-	1	1	3	2
2011	7	1	2	1	2	3	2	-	1	1	5	1
2012	5	1	3	-	1	3	4	2	-	-	1	1
2013	3	1	2	-	2	-	2	3	1	-	1	2
2014	1	-	3	3	4	1	1	-	1	-	7	-
2015	3	-	4	2	1	1	2	3	1	1	3	-
2016	1	2	1	-	1	-	2	-	1	1	3	5
2017	5	-	-	1	-	-	2	-	3	2	-	-
Total	**34**	**10**	**20**	**10**	**16**	**15**	**37**	**9**	**10**	**6**	**25**	**16**

Source: Natural Resources Canada.

- Nil.

Strikes and Lockouts

Highlights

- Between 2008 and 2017, the total number of strikes and lockouts decreased by 50% from 16 to 8.
- The number of person-days not worked as a result of strikes or lockouts increased 53.3% from 67,170 to 102,950 during this period, but this ignores significant labour disruptions in 2009 (574,090 days) and 2010 (567,790 days) at select mineral processing facilities.
  - The 2009 peak in person-days not worked decreased towards a low of 20,250 days in 2016 representing a 69.9% decrease.

Definition

The International Labour Organization defines a strike as a temporary work refusal or slowdown by employees designed to limit production to attain key demands from employers. A lockout is defined as a total or partial temporary closure of places of employment or the hindering of the normal work activities of employees, by employers, to resist key demands from employees.[59]

Rationale

Strikes and lockouts can occur for a variety of reasons, including disagreements over wages, benefits, social programs, or work conditions. Regardless of the reason for the strike or lockout, it has an impact on the industry, workers, and the local community. Strikes and lockouts threaten the stability of the relationship between labour and industry and have the potential to affect both investment and employees' decisions to remain in the sector. As well, they may have an impact on the public image of the company and industry.

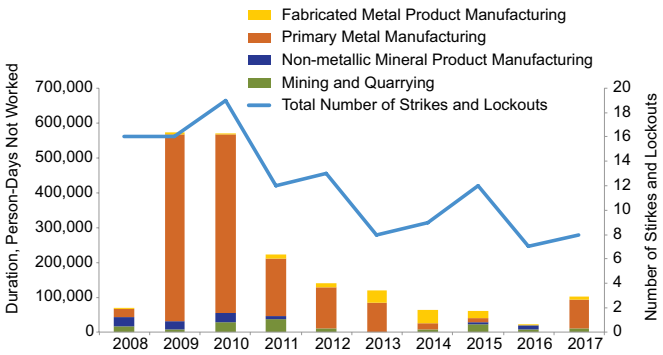
Analysis

According to data from Employment and Social Development Canada, the total number of strikes and lockouts in the minerals sector decreased between 2008 and 2017 from 16 to 8, respectively (Figure 24). A peak of 19 strikes and lockouts was reached in 2010 before following an overall decreasing trend towards 2017. The lowest annual total of strikes and lockouts was seven in 2016.

[59] International Labour Organization, 1993, *Resolution Concerning Statistics of Strikes, Lockouts and Other Action Due to Labour Disputes*, http://www.ilo.org/global/statistics-and-databases/standards-and-guidelines/resolutions-adopted-by-international-conferences-of-labour-statisticians/WCMS_087544/lang–en/index.htm.

There was a slight overall increase in person-days lost due to strikes and lockouts during the 2008 to 2017 period. In 2008, there were 67,170 person-days not worked compared to 102,960 days in 2017. This represents a 53.3% increase. However, only comparing endpoints of the 2008–2017 time range overlooks large labour disputes that occurred in 2009 and 2010 at smelting, refining, and steel manufacturing facilities. There were 574,090 person-days not worked in 2009 and 567,790 in 2010 due in large part to these large disputes. A general decreasing trend in person-days not worked took place following 2009's peak towards a low of 20,250 days in 2016 (-69.9%). Person-days not worked then increased in 2017, reaching the above-mentioned figure of 102,960 days.

Figure 24. Minerals Sector Labour Stoppages, 2008–2017



Source: Employment and Social Development Canada, Workplace Information Directorate, Labour Program.

SECTION 4: Environmental Performance

Previous sctions in this report have explored how the minerals sector contributes to Canada's well-being through improvements in its economic and social performance. This can occur via many aspects, including GDP growth, better availability of public geoscience, and investments in research and development, as well as through increased employment opportunities and benefits secured for Indigenous communities through agreements with mineral companies. Trends within the mining industry such as improved workplace health and safety, greater transparency via the *Extractive Sector Transparency Measures Act*, and increased numbers of partnerships including those with MiHR to offer on-the-job training and internships can also contribute to better well-being for Canada and Canadians. However, these economic and social benefits can be accompanied by challenges resulting from environmental impacts on local and regional ecosystems that can occur during any phase of a minerals sector operation from exploration, extraction, closure, or manufacturing.

Minimizing and mitigating these environmental impacts continue to be a central focus for the minerals sector.

The public image and reputation of the minerals sector are closely linked to its environmental performance as a result of legacy issues related to orphaned and abandoned mines and as societal concerns over water, air, mine waste, and greenhouse gas (GHG) emissions continue to grow. In Canada, the mining industry is subject to various federal, provincial, and territorial legislation in order to set a minimum standard of environmental performance. Over and above this, the Mining Association of Canada's *Towards Sustainable Mining*® (TSM®) initiative lays out a set of principles and performance indicators governing the key activities of any company operating in the sector as a step towards responsible environmental practices. The Prospectors & Developers Association of Canada's *e3 Plus: A Framework for Responsible Exploration* provides guidance for exploration companies to enhance their performance, including in the area of environmental stewardship. Sustainability in mining practices has become increasingly relevant for companies seeking to operate in Canada and globally. TSM, *e3 Plus*, and similar sustainability initiatives can help the minerals sector maintain its position as an important economic contributor in Canada while also protecting the environment and remaining responsive to societal expectations. These and other initiatives represent the efforts being undertaken within the sector to set an example globally of what can be achieved in terms of environmental sustainability and responsible development. They build from and attempt to move beyond the standards set by federal, provincial, and territorial legislation, and thereby assure Canadians that real progress in environmental protection is being made.

This section will examine a set of indicators and outcomes to better understand and quantify the sector's[60] performance in addressing these environmental challenges. An examination of the various multi-stakeholder frameworks used in developing this report led to the following statement of desired environmental performance outcomes:

> *Practise responsible mineral exploration, development, and operations, and support public policies that are predicated on maintaining a healthy environment and, upon closure, returning mine sites and affected areas to viable self-sustaining ecosystems.*
>
> *Ensure institutional governance frameworks are in place to provide certainty and confidence that mechanisms exist for governments, industry, communities, and residents to avoid or mitigate adverse environmental effects.*

[60] It is important to differentiate between mineral exploration impacts, which tend to be less invasive, and those of mineral development, extraction, and processing activities, which are typically more substantial. The indicators within this section are weighted towards mining activities due to 1) the less intrusive nature of mineral exploration activities, and 2) data availability. Guidance such as the Prospectors & Developers Association of Canada's e3 Plus has been developed to assist mineral exploration companies minimize their environmental footprint and impact on the environments in which they explore.

The indicators chosen to measure the sector's performance as it relates to this statement are:

- **Waste rock and tailings management –** Effective management of waste rock and tailings at mining operations is an important environmental and safety consideration in safeguarding the long-term health of local and regional ecosystems. Monitoring and assessing the sector's efforts in waste management provides a measure of its performance in maintaining healthy environments and minimizing any negative environmental effects associated with its operation.
- **Mine effluent and discharges to surface water –** The extraction and processing of minerals create substantial quantities of waste materials that must be carefully and responsibly managed to avoid discharge of contaminants and other undesirable substances to surface waters. Unintended discharges to surface water can occur in a number of ways, including seepage through mine wastes, containment breaches, and the release of uncontrolled storm water. Monitoring discharges to surface water yields insight to the sector's performance in limiting its impact on local aquatic ecosystems. This indicator tracks performance using the *Metal Mining Effluent Regulations* (MMER) and the National Pollutant Release Inventory (NPRI).
- **Air emissions –** Pollution from the emission and interaction of substances including nitrogen oxide (NO_x), sulphur oxide (SO_x) and particulate matter (PM_{10} and $PM_{2.5}$) can affect local, regional, and national ecosystems. These air pollutants contribute to smog, acid rain, and poor air quality, and may influence human and ecosystem health. Analyzing air emission trends provides an indication of how the minerals sector is performing with respect to reducing air pollution.
- **Energy consumption and efficiency –** Energy costs have a strong influence on business performance and global competitiveness in the energy-intensive minerals sector. There are economic, social, and environmental incentives to improve energy efficiency, lower energy-related operating costs, and reduce environmental impacts including greenhouse gas (GHG) emissions and other contributors to climate change.
- **Greenhouse gas emissions –** Greenhouse gases (GHG) trap heat in the Earth's atmosphere, contributing to climate change. Climate change presents both risks such as flooding and increased incidence of forest fires and opportunities such as reduced snow and ice cover in exploration areas. Monitoring changes in the minerals sector management of GHG emissions demonstrates the sector's efforts to mitigate any potential current and future impacts of climate change.
- **Environmental expenditures –** Measuring the level of environmental expenditures in the minerals sector gives an indication of the level of capital that has been committed to complying with Canadian or international environmental regulations, agreements, and voluntary commitments.
- **Orphaned and abandoned mines –** Canada faces the legacy and liability of environmental impacts, human health concerns, and cleanup costs that result from orphaned and abandoned mines. Current provincial and territorial legislation puts the onus on developers to submit mine closure plans describing decommissioning, site rehabilitation, and financial surety for any proposed operation; however, many legacy sites remain. Legislation, financial securities for site remediation for future rehabilitation costs, and assessment initiatives and programs to remediate and rehabilitate orphaned and abandoned mine sites can demonstrate the sector's commitment to ensuring healthy ecosystems are maintained following closure of an operation.

Synopsis

Environmental performance of the minerals sector has generally undergone continual improvement between 2008 and 2017.

Measures of discharges to surface water, air emissions, and greenhouse gas emissions all showed marked improvement over this period. Generally speaking, discharges to water, energy consumption and intensity, and environmental expenditures showed modest improvements. Where there were suggestions of stagnation in performance of specific parameters within an indicator, these were often offset by substantial improvements in most other parameters.

The analysis of this section also revealed areas where there remains room for improvement in the environmental performance of the minerals sector. Discharges to water of manganese and selenium increased over the period studied. While the release of greenhouse gas emissions has improved over the last 10 years, emissions have largely remained stable since 2013. Improvements in other emissions such as nitrogen oxides and PM_{10} were modest.

There are data limitations in assessing environmental performance in areas such as orphaned and abandoned mines and protected areas. However, governments have been working in collaboration with communities to expand and strengthen programs that address the environmental performance of the minerals sector.

Highlights

- Between 2008 and 2017, an increase of 83.7% was reported in the reported total amount (mass) of all NPRI substances in **tailings and waste rock** produced each year, from 524,324 t in 2008 to 963,256 t in 2017, and an increase of 35.2% between 2014 (712,716 t) and 2017. Manganese and its compounds are the most abundant substances measured in tailings and waste rock, comprising almost 35% of the total mass of substances reported in 2008 and almost 40% in 2017. The number of mines reporting to NPRI also increased during this time.

- In terms of **effluent discharge**, the number of mines subject to Metal Mining Effluent Regulations (MMER) increased 85.1% from 74 to 137 operations between 2007 and 2016. The number of exceedances for regulated parameters decreased 49.5% from 103 to 52 during the same period.

- Fourteen indicator metals measured by NPRI showed there was a 26.5% reduction in total mass released to **surface water** between 2008 and 2017 in the mineral sector. Decreases in tonnage released were recorded for arsenic, lead, nickel, and zinc discharges. However, amounts increased for manganese and selenium.[61]

- **Air emissions**, which were measured in tonnes for four criteria, decreased between 2008 and 2017. Specifically, emission of SOx (sulphur oxides), NO_x (nitrogen oxides), PM_{10}, and PM2.5 (particulate matter less than 10 and 2.5 micrometres in diameter) decreased by 45.8%, 3.2%, 7.0%, and 16.9%, respectively.

- The minerals sector used 9.7% of Canada's total energy in 2017 compared to 9.2% in 2014. Sector **energy consumption** decreased 3.6% between 2008 and 2017 from 828.7 petajoules (PJ) to 798.8 PJ; however, energy consumption increased 6.1% between 2014 and 2017. **Energy intensity**—which describes how much energy is consumed to produce one unit of output and expressed as terajoules (TJ) per dollar—decreased 6.8% from 14.24 TJ/$million to 13.27 TJ/$million between 2008 and 2017 compared to a decrease of 11.9% across all Canadian industries (A decrease in energy intensity represents an improvement in efficiency as less energy is needed to produce the same output.

- The minerals sector released almost 45.0 billion tonnes (Mt) of **greenhouse gas (GHG) emissions** in 2017, which was 16.7% lower than the approximately 54.0 Mt emitted in 2008. Quantities of emitted GHGs have remained relatively steady at an average of 45.0 Mt per year since 2013.

- A large increase of almost 34% from $453.6 million to $607.2 billion in **environmental capital expenditures** was noted between 2006 and 2016. Environmental operating expenditures increased 15.5% from $1.029 billion to $1.189 billion during the same period. However, a recovery of capital and operating expenditures in 2012 was followed by a 28.2% decline in total environmental expenditures by 2016.

- Federal, provincial, and territorial governments in Canada continue to allocate and expand funds devoted to contingency, cleanup, and monitoring for **orphaned and abandoned mines** in Canada. Examples in the last few years include the Northern Contaminated Sites Program that made a $408 billion commitment for rehabilitation and monitoring of sites in Canada's northern territories. In Quebec, the Ministère de l'Énergie et des Ressources naturelles invested $1.2 billion in contingency funds in 2017 to cover environmental liability relating to mining activities.

[61] In 2011, the reporting thresholds for selenium (and its compounds) were modified to 100 kg with a 0.000005% (0.05 ppm) concentration threshold for quantities that are manufactured, processed or otherwise used, from the original 10 t and 1% concentration thresholds. As a result of this change, the number of facilities reporting selenium releases to water jumped after this amendment. In 2008 only 17 facilities reported releases, and this jumped to 62 in 2011 as a result of this amendment. Since then, the number has increased to 78 in 2017. Variances in this value as well as the total selenium released over the 10 year period are subject to this reporting artifact.

Indicator (2008–2017) (unless otherwise specified)	
Waste and Tailings Disposal	Incomplete Assessment *
Mine Effluent and Discharges to Surface Water	●
Air Emissions (2008, 2013, 2017)	●
Energy Consumption and Intensity	●
GHG Emissions (2008–2017)	●
Environmental Expenditures (2006–2016)	●
Orphaned and Abandoned Mines	●

● Improved Performance ● Limited Change ● Decreased Performance

* The waste rock and tailings indicator has been marked with "incomplete assessment" with regard to the industry's environmental performance in this area. While there are data available for the 10 year horizon on the quantities of certain materials deposited in waste rock and tailings, it was noted in discussions with the advisory committees for this report that these quantities do not directly translate into a valid assessment of environmental performance. Please refer to the *Data Considerations* subsection of this indicator for important limitations in this analysis.

Waste Rock and Tailings Disposal

Highlights

- Reported tonnage of tailings and waste rock disposal of NPRI's 300 measured substances and substance groups by mining facilities in 2017 were 35.2% higher than 2014, increasing from 712,716 t to 963,256 t. Reported tonnage excludes unconsolidated overburden, stable/inert constituents of tailings, and inert waste rock.
- Manganese and its compounds are the most abundant substances measured in tailings and waste rock in 2017, comprising almost 40% of **all** measured substances. It is important to note here that the number of mines reporting to NPRI for manganese has also increased, from 61 in 2008 to 77 in 2017.

Definition

There are two major forms of solid waste that are generated by mines: tailings and waste rock. Waste rock is removed in order to access ore and is not processed.[62] Tailings are the residual material that remains after economic minerals have been recovered by physical or other methods. They consist of a mixture of finely ground sand- to silt-sized waste minerals, water, residual reagents, and degradation products.[63]

Rationale

Mineral extraction and processing generate significant volumes of materials that must be effectively managed, including tailings, waste rock, and water. If waste materials are not contained and managed properly, water that is acidic or contaminated with metals, or both, may be discharged to surface and groundwater. Various disposal methods can be used to mitigate releases from mine wastes such as subaqueous, dry covers, waste segregation, and using elevated water tables within tailings facilities.

Analysis

In 2009, the National Pollutant Release Inventory (NPRI) began collecting information on the amount of NPRI substances deposited in tailings management facilities and waste rock piles. Reporting requirements for tailings and waste rock were applied retroactively to 2006 for certain types of mining operations. NPRI requires reporting of the total mass of 300 substances and substance groups present in tailings and waste rock produced each year. The NPRI is a key tool for identifying and monitoring pollution sources in Canada and can be a starting point for better understanding how pollutants are entering the Canadian environment. The general NPRI reporting requirements are designed to capture the most significant point sources and relate to the quantity of the specific substance(s) manufactured, processed, used, or released at the facility during the year. Data users are encouraged to consider relevant contextual information to avoid misinterpreting perceived risk from NPRI data alone since NPRI data are not an indication of whether a facility is in compliance with regulatory or other requirements. In addition, the requirement to report on substances contained in tailings and waste rock does not include the reporting of any information on:

- the chemical form in which NPRI substances occur in tailings and waste rock;

[62] Environment Canada and Climate Change Canada, 2017, *National Pollutant Release Inventory*, www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=4A577BB9-1.

[63] See: http://www.nrcan.gc.ca/mining-materials/publications/13924.

- the potential risks posed by the occurrence of NPRI substances in tailings and waste rock; and
- how tailings, waste rock, and associated water are managed to prevent or control any releases from tailings and waste rock, either to air in the form of dust or to surface water.

A review of the data considerations at the end of this section further outlines the potential limitations of the NPRI data. Ongoing discussions with respect to this indicator will attempt to improve the way in which this data are presented in future editions of the MSPR.

Under the NPRI, pits and quarries with production of <500,000 t are exempt from reporting. Open pit mines are not included in the definition of a pit or quarry and are subject to reporting requirements. Exclusions apply to unconsolidated overburden, inert waste rock and stable/inert constituents of tailings. NPRI reporting requirements focus attention on the quantity and content of residual materials that merit closer attention, due to their potential to react and to mobilize contaminants that could affect the quality of surface water or groundwater resources. As a result, the NPRI excludes or excerpts certain mineral materials from reporting.

The guidance document titled *Environmental Code of Practice for Metal Mines* recommends environmental management practices to mitigate identified environmental concerns associated with the management of waste rock and tailings at each stage of the mine life cycle.[64] Risks can be eliminated or reduced by pollution prevention and environmental management planning and by implementation of management programs for water quality, tailings, and waste rock.

The NPRI lists 300 substances and substance groups to be reported in disposal and transfers of material for recycling. The substances of focus in this section are the same substances reported for discharges to surface water (including cyanide) in an effort to maintain consistency throughout this section. However, this information is based on reported amounts (mass in kilograms or tonnes) of NPRI substance in tailings and waste rock produced each year (Table 11).

[64] *Environmental Code of Practice for Metal Mines*, Environment Canada, 2009.

Table 11. Total Reported Mass (in tonnes) of Selected NPRI Substances in Tailings and Waste Rock Produced Annually From 2007 to 2017

Substance	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Antimony	432	405	550	355	297	368	243	131	92	162	236
Arsenic	13,883	15,758	14,096	17,633	22,089	19,269	19,472	18,372	22,714	21,358	22,320
Cadmium	248	283	218	201	186	224	172	207	193	173	192
Chromium	12,601	12,159	12,218	13,069	15,336	21,031	20,830	22,813	26,254	29,956	44,811
Cobalt	3,461	3,733	3,068	3,753	3,617	4,063	5,589	5,959	5,436	8,945	10,141
Copper	50,633	62,423	58,161	62,613	52,913	67,701	94,085	93,696	85,853	102,406	128,476
Cyanides	-	-	-	16	263	707	946	768	840	1,009	1,077
Lead	25,660	26,539	23,385	22,261	22,105	26,453	16,169	9,631	11,624	16,019	16,217
Manganese	154,436	186,979	168,998	227,116	215,624	247,148	329,163	297,491	332,567	356,081	378,234
Mercury	23	19	15	15	15	8	14	27	8	11	10
Nickel	52,780	53,236	37,225	36,677	43,599	45,588	51,146	52,150	49,850	52,512	57,671
Selenium	486	503	310	413	746	681	1,198	1,050	957	1,026	1,190
Thallium	-	-	-	-	-	-	-	42	103	98	132
Vanadium	6,618	6,661	6,776	7,522	9,051	11,575	18,876	21,923	21,747	29,890	30,981
Zinc	50,677	64,442	55,758	53,063	72,509	53,835	50,515	36,650	42,344	48,711	51,692
No. of Facilities	**292**	**266**	**251**	**254**	**270**	**262**	**256**	**264**	**251**	**230**	**223**

- NIL
Please refer to Data Considerations below for important information on NPRI data.

Between 2014 (the last year reported in the 2016 MSPR) and 2017, an increase of 35.2% occurred in NPRI's reported substances of concern in tailings and waste rock disposal from 712,716 t to 963,256 t. During this same period, the number of facilities reporting dropped 15.5% from 264 to 223. Manganese and its compounds were the most abundant substances reported in tailings and waste rock in 2017, comprising almost 40% of all measured substances while copper and its compounds, the second most abundant substance in this list, represented over 13.0%. From 2014 to 2017, the total mass of many of the metallic substances gradually increased, mimicking production volumes for many of the metals over the same period. Cyanide amounts have also been increasing steadily since 2014, reaching 1,077 t in 2017, a 40% increase from 2014 values. This aligns with the increase in tailings from gold and silver mines. While most substances have seen an increase in tonnage, the amounts of mercury and cadmium have declined, with mercury dropping 63% in mass from its high of 27 t in 2014. Since 2014, chromium and antimony have seen the largest increases in mass of 96% and 80%, respectively. Conversely, the amount of mercury has declined by 63% while cadmium measurements were 7% lower from 2014 to 2017. It is important to understand that these are absolute quantities reported and will fluctuate greatly with changes in mining tonnages and ore types year to year, as explained in the Data Considerations section.

Within the mining and quarrying subsector, metal ore mining accounted for at least 93% of all reported tailings and waste rock disposal in each year between 2013 and 2017. Gold and silver ore mining produced the majority of reported substances in waste rock and tailings, followed by iron ore mining and copper-zinc ore mining. Diamond mining accounted for the majority of reported substances in tailings and waste rock disposal from non-metal mining, while the disposal tonnage of NPRI substances from coal mining represented less than 2.3% of all mining activity.

To assist mining companies in evaluating and managing their environmental and social responsibilities, the Mining Association of Canada (MAC) established the Tailings Management Protocol under the Towards Sustainable Mining® (TSM®) initiative in 2004. The Protocol assesses MAC members on their level of management system implementation using the following performance indicators: (1) Tailings management policies and commitments; (2) Tailings management systems; (3) Assigned accountability and responsibility for tailings management; (4) Annual tailings management reviews; and (5) Operation, maintenance, and surveillance manuals. Member performance is based on the systems and targets in place, with performance levels ranging from "C" (no systems in place) to "A" (comprehensive systems developed and implemented) to "AAA" (excellence in leadership). The percentage of facilities with a performance rating of A or higher has decreased since 2014 in three of the management assessment indicators. The percentage of facilities with a performance rating of A or higher in *Assigned accountability and responsibility for tailings management* dropped from 94% in 2014 to 77% in 2017. Similarly, *Annual tailings management review* dropped from 90% in 2014 to 71% in 2017 and *Operation, maintenance, and surveillance manuals* fell from 98% compliance in 2014 to 91% in 2017.[65] These drops are due in part to the addition of new MAC member facilities that are still working to align their systems with TSM requirements. Seven facilities (including six closed facilities) that previously reported Level A performance for indicators 3 and 4 were downgraded to Level C and B during external verification this year.

A more detailed explanation of the new tailings management guide can be found in Box 13.

[65] The Mining Association of Canada, 2018, *Towards Sustainable Mining Progress Report 2018*, https://mining.ca/towards-sustainable-mining/tsm-progress-report/.

Box 11: Towards Sustainable Mining Update – Waste and Tailings Management

Towards Sustainable Mining® (TSM®), a program first established by the Mining Association of Canada (MAC) in 2004, focuses on providing the tools to enable mining companies to meet society's needs for minerals, metals, and energy products in the most socially, economically, and environmentally responsible way. TSM provides the tools to drive performance and ensure that key mining risks are being managed responsibly. The program is mandatory for all MAC members for their Canadian operations and requires participants to report on eight performance elements, including responsible tailings management.

Immediately following the Mount Polley tailings dam breach in 2014,[66] MAC launched a thorough review of the TSM Tailings Management Protocol (the Protocol) and associated guidance documents. As part of this review, MAC commissioned an independent TSM Tailings Management Review Task Force to review the TSM requirements and guidance for tailings management. In November 2015, the Task Force provided MAC with its final report containing 29 recommendations to enhance the Protocol and guides.

MAC and its members have been working since the release of the Task Force report to implement the recommendations, which resulted in an updated Protocol and the third edition of *A Guide to the Management of Tailings Facilities* (the Tailings Guide), released in late 2017. MAC subsequently made additional enhancements to the Tailings Guide to provide more detailed and comprehensive guidance on emergency preparedness. MAC has also strengthened a second guidance document entitled *Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities* (the OMS Guide).[67] The OMS Guide has been substantially reworked and modernized, responding to the Task Force recommendations and building on lessons learned over the last 15 years of developing and implementing site-specific OMS manuals. The second edition of the OMS Guide integrates a risk-based approach and emphasizes the critical role that operating, maintenance, and surveillance activities play in the management of risk. The Protocol has also been updated to ensure alignment with these changes to the Tailings Guide and OMS Guide. The updated versions of all three documents were released in early 2019.

[66] Independent Expert Engineering Investigation and Review Panel, *Report on Mount Polley Tailings Storage Facility Breach*, 2015, https://www.mountpolleyreviewpanel.ca/sites/default/files/report/ReportonMountPolleyTailingsStorageFacilityBreach.pdf.

[67] http://mining.ca/oms-guide.

Data Considerations

NPRI information is a starting point for identifying and monitoring sources of pollution in Canada. The information collected by qualified mining facilities is reported to the NPRI and is used to help determine if regulatory or other action is necessary to ensure reductions. Although NPRI reviews data for inconsistencies and errors, some inaccuracies and reporting errors may occur, such as reporting quantities manufactured, processed or otherwise used instead of quantities released and, reporting inappropriate units and decimal errors. The NPRI provides Canadians with annual information on industrial, institutional, commercial and other releases and transfers in their communities.

NPRI reporting requirements for on-site waste rock and tailings disposal came into effect in 2009. Facilities were asked to report retroactively for 2006 through 2008, and there may be some errors in the estimation of historical levels. There have also been several changes in reporting requirements. The 2006–2008 requirements were applicable only to mining and oil sands facilities that generated or disposed of tailings and/or waste rock from the processing of bitumen, coal, diamonds, potash, or metals. The 2009–2010 requirements applied to all facilities that generated or disposed of tailings and waste rock, subject to certain exemptions and exclusions. In addition, some facilities do not meet any threshold that would trigger tailings and waste rock reporting requirements for an NPRI substance (e.g., certain potash and coal mines).

While every effort was made to clean and vet this data, it is apparent that some of the anomalous data points could be due to a number of reporting artifacts, changes in reporting methodologies, or changes in compliance rates with NPRI requirements, both positive and negative. Ongoing work in this area will result in the continuous improvement of the NPRI as a data source to provide credible trends over time.

Mine Effluent and Discharges to Surface Water

Highlights

- The number of mines subject to the Metal Mining Effluent Regulations increased from 74 in 2007 to 137 in 2016, an increase of 85%, while the number of exceedances of a regulated parameter declined by 49.5% from 103 to 52.
- Decreases in total discharged amounts were noted for arsenic, lead, nickel, and zinc from 2008 to 2017, while increases in tonnage were recorded for manganese and selenium discharges.
- The amount of direct releases from 14 indicator metals to surface water decreased 26.5% from 2008 to 2017 in the mineral sector.

Definition

An on-site release that may be reportable to the National Pollutant Release Inventory (NPRI) is a discharge of a substance to the environment within the physical boundaries of the facility. It includes releases to air, surface water and land.[68] Routine releases and accidental or non-routine releases (e.g., spills and leaks) are included. This section focuses on discharges to surface water of arsenic, cadmium, lead, nickel, selenium, and nine other metals.[69]

Rationale

Mineral extraction and processing generate significant volumes of material that must be effectively managed, including tailings, waste rock, water, and effluent treatment plant sludge. Water originates from precipitation, fresh water supply, and mine dewatering. If waste materials are not contained and managed properly, water that is acidic or contaminated with metals, or both, may be discharged to surface and groundwater. Clean water is generally diverted and monitored, while water that could be contaminated by contact with ore, concentrates, mineral wastes, fuel, or reagents is collected. This water may be reused for ore processing or other uses on site, such as dust suppression, or it may be discharged to surface water. Water is treated as appropriate prior to discharge to meet federal (e.g., MMER) and any provincial or territorial legal requirements. Monitoring of discharges to surface water provides insight into the industry's performance in limiting the impact of its activities on aquatic ecosystems.[70]

Mine effluent is one of many factors affecting downstream water quality. The Metal Mining Effluent Regulations (MMER) authorize the deposit of certain substances into waters frequented by fish, specifying the maximum concentration for several parameters and both upper and lower limits for pH found in mine effluent. Measuring compliance with the MMER provides some insight on the industry's performance in maintaining healthy ecosystems. Consistent compliance requires that measured levels rarely approach a limit, while exceedances trigger corrective actions.

Groundwater protection and monitoring is an important consideration, but discharges to groundwater are not reported to the NPRI and are not regulated under the MMER. The *Environmental Code of Practice for Metal Mines* guidance document recommends environmental management practices to mitigate identified environmental concerns, including potential impacts on groundwater resources.[71] Risks can be eliminated or reduced by pollution prevention and, environmental management planning and by implementation of management programs for water quality, tailings, and waste rock.

Analysis

Environment and Climate Change Canada (ECCC) is responsible for administration and enforcement of the MMER[72] under the *Fisheries Act*.[73] These regulations require effluent quality limits to be met and that effluent not be acutely lethal to prescribed test species.[74,75] The regulations can provide for the deposit

[68] *Guide for Reporting to the National Pollutant Release Inventory (NPRI) 2016 and 2017*, Environment and Climate Change Canada, 2016.

[69] Other metals include antimony, chromium, cobalt, copper, manganese, mercury, thallium, vanadium, and zinc.

[70] Crowe, Allan S., et al., 2015, *Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada, Environment and Climate Change Canada*, http://www.ec.gc.ca/inre-nwri/default.asp?lang=En&n=235D11EB-1&offset=13&toc=sh.

[71] *Environmental Code of Practice for Metal Mines*, Environment Canada, 2009.

[72] The MMER set out effluent quality limits for arsenic, copper, cyanide, lead, nickel, zinc, radium-226, and total suspended solids. The regulations apply to all metal mines, except placer mines. Coal and diamond mines were excluded in 2016 and prior years.

[73] Government of Canada, 1985, *Fisheries Act*, https://laws-lois.justice.gc.ca/eng/acts/f-14/.

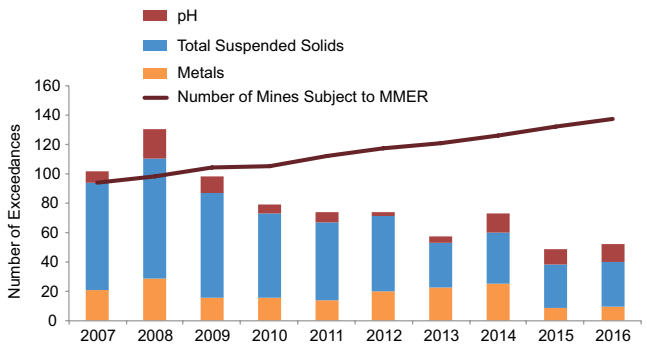
[74] The MMER require effluent monitoring, reporting, and environmental effects monitoring.

[75] Environment and Climate Change Canada completed a multi-stakeholder 10-year review of the MMER and developed proposed amendments that include more stringent effluent limits for several substances, including technology-based limits for new mines, and streamline environmental effects monitoring requirements. The amendments would expand the scope of the regulation to diamond mines, providing regulatory certainty to that sector. A separate regulatory approach is under development for the coal mines.

of tailings and waste rock in a designated tailings impoundment area, in a water body frequented by fish, through an amendment to add a facility and water body to Schedule 2 of the MMER.

From 2007 to 2016, the total number of exceedances declined from 103 in 2007 to 52 in 2016, a decrease of 49.5%, while the number of mines subject to the MMER rose from 94 to 137,[76] an increase of 45.7%. The total number of exceedances and the contribution of different parameters varied from year to year. Total suspended solids (TSS) accounted for the highest proportion of non-compliance in each year (Figure 25).

Figure 25. Distribution of MMER Exceedances by Substance, 2007–2016



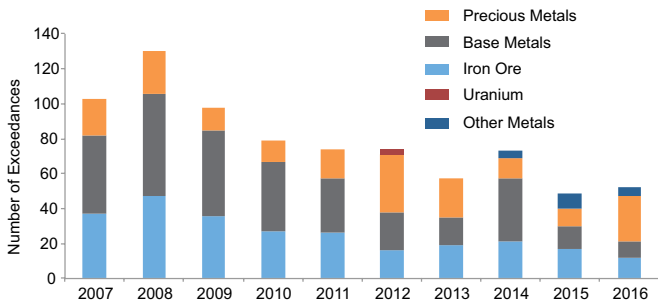
Source: Environment and Climate Change Canada. *Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations.*

The number of TSS exceedances declined by 58.9%, from 73 exceedances in 2007 to 30 in 2016, while the TSS compliance rate increased from 93.7% in 2007 to 98.0% in 2016. Most TSS exceedances occurred at a limited number of facilities, where technological solutions were or are being examined and/or implemented. TSS accounted for 30 of the 52 exceedances reported in 2016. Between 2007 and 2016, the mining sector achieved a compliance rate of over 99% for all parameters other than TSS and fish toxicity.

Occurrence of MMER exceedances by subsector is illustrated in Figure 28. In 2016, the 137 mining facilities subject to the MMER included 68 precious metal mining facilities (49.6%), 47 base metal mining facilities (34.3%), 9 other metal mining facilities (6.6%), 8 iron ore mining facilities (5.8%), and 5 uranium mining facilities (3.6%). In 2016, zero exceedances were reported for arsenic, lead or cyanide.[77]

The majority of exceedances between 2007 and 2016 were in the iron ore and base metal subsectors, except in 2012 and 2016. In those years, the number of exceedances reported by precious metal mining facilities increased sharply.

Figure 26. MMER Exceedances by Subsector, 2007–2016



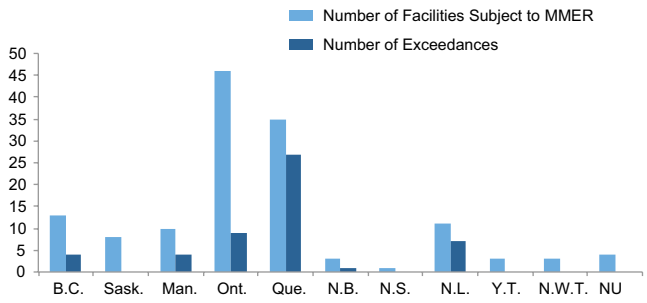
Source: Environment and Climate Change Canada. *Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations.*

Quebec (27), Ontario (9), and Newfoundland and Labrador (7) had the highest number of MMER exceedances in 2016, together accounting for 82.7% of total exceedances (Figure 29). The remaining exceedances were concentrated in British Columbia (4) and Manitoba (4). Most mining facilities have a single final discharge point, but 33% of mines subject to the MMER in 2016 reported more than one final discharge point. (TSS and other exceedances at a few precious metal mining facilities in Quebec and Ontario drove the observed increase in subsector exceedances in 2016, while the total number of exceedances was 10.) Detailed data for every mine that was subject to the MMER in 2016 are provided in the referenced summary review.

[76] It should be noted that this does not equal an increase in the number of operating mines, since the MMER continue to apply for at least three years after the end of commercial operations.

[77] Environment and Climate Change Canada, 2018, *Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations in 2016*. http://publications.gc.ca/collections/collection_2018/eccc/En11-14-2016-eng.pdf.

Figure 27. Regional Distribution of Facilities and Exceedances, 2016

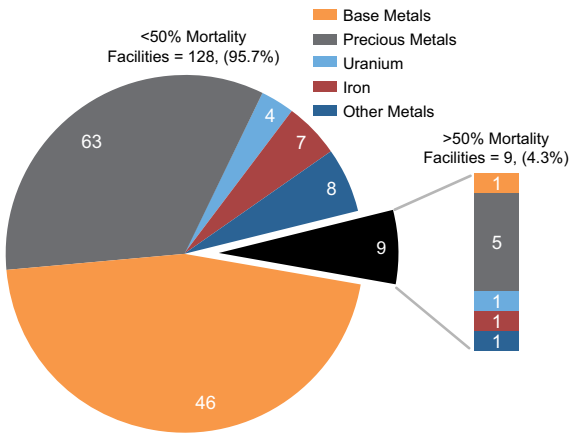


Source: Environment and Climate Change Canada. *Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations.*

Under the MMER, mine effluent is required to be non-acutely lethal to rainbow trout. Figure 30 shows the distribution of facility acute lethality test results for rainbow trout for each subsector where acute lethality is defined as undiluted effluent that results in >50% mortality within 96 hours of exposure.

In 2016, precious metal mines accounted for most failures for trout at 5 of 68 facilities. Other trout failures are widely distributed across other subsectors. Of 137mines, 128 reported no test failures for trout (Figure 28).

Figure 28. 2016: Rainbow Trout Acute Lethality Results



Source: Environment and Climate Change Canada. *Summary Review of Performance of Metal Mines Subject to the Metal Mining Effluent Regulations.*

Data reported to the NPRI for the period between 2008 and 2017 reveal significant variation over time.Total releases for each substance are based on changes in the total discharge volume and concentration of contaminants in water discharged from many sites. Significant variation in local net precipitation at a mine site drives substantial changes in annual discharges. Effluent quality is usually less variable, but total annual discharges can increase due to a major spill over a short period of time or an ongoing leak over a comparatively long time, at one or more sites. The most obvious case was due to the breach of a tailings dam at the Mount Polley mine in 2014 (Table 12). Data for 2014 have been restated to correct errors in discharges from all other mines and total discharges.

Excluding the 2014 Mount Polley incident, key changes include a substantial reduction in arsenic discharges; an increase in nickel discharges between 2008 and 2011 followed by a decrease to levels well below those of 2008; and a substantial increase in selenium discharges in 2011 and 2012, followed by a decrease to levels that were still well above those recorded in 2008. Between 2008 and 2017, discharges of arsenic, lead, and nickel decreased by 90.2%, 57.6%, and 45.3%, respectively. Discharges of cadmium remained similar, while discharges of selenium rose by a factor of 10 (18.6 t). Total discharges of nine other metals increased by 15.5% while the total mineral industry discharges of 14 metals decreased by 27.1%. These aggregate results obscure trends that may reflect changes in product mix, ore types, and regional geology. For example, releases of manganese found in “Other Metals” increased from 56.7 tonnes (t) in 2008 to 76.8 t in 2017. This represents an increase from 22.1% of total discharges in 2008 to 41.0% in 2017. Zinc discharges decreased from 72.7 t in 2008 to 48.6 t in 2017 while decreasing from 28.3% of total discharges in 2008 to 26.0% in 2017 (Table 12).

Table 12. Minerals Industry Discharges to Surface Water, by Substance (Tonnes), 2008–2017

Year	Arsenic	Cadmium	Lead	Nickel	Selenium	Other Metals*	Total Mineral Industry
2008	39.8	0.7	6.7	42.6	1.8	165.0	**256.6**
2009	4.9	1.1	5.3	31	3.2	223.4	**268.9**
2010	4.1	0.7	4.5	23.1	2.2	158.8	**193.4**
2011	4.2	0.6	4.9	75.9	17.9	161.9	**265.4**
2012	4.4	0.6	6.2	50.9	22.9	141.0	**226.0**
2013	5.6	0.7	5.5	27.8	22.6	247.7	**309.9**
2014	264.0	4.4	138.6	253.3	52.3	40,485.0	**41,197.6**
Mount Polley 2014 Subtotal	**259.1**	**3.8**	**134.2**	**223.7**	**33.0**	**40,386.4**	**41,040.2**
All others 2014	**4.9**	**0.6**	**4.3**	**29.6**	**19.4**	**98.4**	**157.2**
2015	3.2	0.4	3.3	28.7	14.5	154.1	**204.2**
2016	4.2	0.5	3.3	25.1	13.6	139.9	**186.6**
2017	3.9	0.6	2.9	23.3	18.6	139.4	**188.7**

Source: Environment and Climate Change Canada, National Pollutant Release Inventory.
*Includes antimony, chromium, cobalt, copper, manganese, mercury, thallium, vanadium, and zinc.

Data Considerations
Monitoring discharges to surface water provides insight on the industry's performance in limiting the impact of its activities on surrounding ecosystems, but does not indicate the presence or absence of risk. Discharges can be underestimated or overestimated as a result of the procedure for estimating discharges when analytical results are below the Method Detection Limit (MDL). Half of the substances included in Table 12 are qualified in terms of their specific physical or chemical form (e.g., antimony, chromium, copper, manganese, nickel, vanadium, zinc).

Effects on the health of fish, other organisms, and aquatic ecosystems depend upon speciation, environmental concentrations, conditions that modify toxicity, and exposure as well as other factors. A great deal of other data and information are available for Canadian mines and used by regulators, businesses, communities, and other stakeholders to assess risks and priorities for action. In some cases, a better understanding of the complex interaction between ecosystems is required to assess long-term, cumulative impacts on local and regional environments.[78]

[78] Bruce, James P., et. al., 2013, *The Sustainable Management of Groundwater in Canada*, http://wedocs.unep.org/handle/20.500.11822/18051.

Air Emissions

Highlights

- Minerals sector air emissions for four criteria air contaminants decreased between 2008 and 2017. Emissions of SO_x (sulphur oxides), NO_x (nitrogen oxides), and PM_{10} and $PM_{2.5}$ (particulate matter less than 10 and 2.5 micrometres) decreased by 45.8%, 3.2%, 7.0%, and 16.9%, respectively.

Definition
Air pollution can affect Canadians' health and the environment. Emissions of sulphur oxides (SO_x), nitrogen oxides (NO_x), particulate matter with a diameter less than 10 micrometres (PM_{10}), and particulate matter with a diameter less than 2.5 micrometres ($PM_{2.5}$) contribute to smog, poor air quality, and acid rain.

Rationale
Air pollution problems result from air pollutants released by human activities and natural processes, and from interactions among pollutants. Air pollutant concentrations in the environment are influenced by the quantity of pollutants released, the distance from sources, and weather. Some pollutants affect air quality hundreds to thousands of kilometres from sources.

The minerals sector is a source of air emissions including sulphur oxides (SO_x), nitrogen oxides (NO_x), PM_{10}, or $PM_{2.5}$. Exposure to SO_x and NO_x can reduce lung function and increase susceptibility to allergens in people with asthma. SO_x and NO_x are precursors of fine particulate matter ($PM_{2.5}$) and contribute to formation of acid rain and smog.

Analysis

A summary of minerals sector air emissions for 2008, 2013, and 2017 is presented below in Table 13.

Base metal smelters process sulphide mineral concentrates and are the largest source of domestic SO_x emissions. Substantial emissions can also emanate from electricity generating plants, refineries, and paper and pulp facilities.[79] In the case of mining operations not connected to an electrical grid—as is the case for many mines operating in northern and remote areas—large quantities of emissions can be output by the diesel generators used to produce electricity. Smaller minerals sector SO_x sources include combustion of fuels that contain sulphur. NO_x is generated by fuel combustion in industrial processes and transportation equipment. Sources of direct PM_{10} and $PM_{2.5}$ emissions include crushing and fragmentation processes and transportation. $PM_{2.5}$ can be transported over long distances, while effects of coarser particles (including most PM_{10}) are local.

Smelter SO_x emission reductions were an early priority to reduce impacts of acid rain. Mineral industries emitted 48.4% of total SO_x emissions in Canada in 1990, and emissions from those industries were cut by 51.6% between 1990 and 2008. SO_2 emission reductions at smelters accounted for most SO_x emission reductions. Between 2008 and 2017, the minerals sector reduced emissions of SO_x (-38.4%), NO_x (17.4%), PM_{10} (-10.7%) and $PM_{2.5}$ (-24.3%).

Smelter emissions and reductions continue to drive SO_x emission trends in the mining and quarrying and primary metal manufacturing subsectors, which together accounted for 93.7% of 2017 minerals sector SO_x emissions.[80] Other subsectors also reduced SO_x emissions, and non-metallic mineral product manufacturing accounted for 6.3% of 2017 SO_x emissions.

Non-metallic mineral product manufacturing was the largest source of NO_x emissions in 2008 (46.2%), followed by mining and quarrying (33.3%), and primary metal manufacturing (20.4%). NO_x emissions from mining and quarrying increased somewhat, but were offset by emission reductions from non-metallic mineral product manufacturing and primary metal manufacturing. Subsector shares of 2017 minerals sector emissions of NO_x, by NAICS subsector were mining and quarrying, 42.3%; non-metallic mineral product manufacturing, 40.1%; and primary metal manufacturing, 17.3%.

SO_x and NO_x emission reductions resulted in part from federal and provincial/territorial government regulatory initiatives, including the implementation of the Canada-Wide Acid Rain Strategy for Post-2000[81] and agreements with the United States. SO_x reductions were realized by mineral processing improvements, commissioning of a new facility with higher efficiency and the latest technology in Newfoundland and Labrador, changes in activity levels at existing smelters, capacity rationalization and smelter closures, reinvestment in technological upgrades at existing smelters and refineries, and continual improvement. The minerals sector is a comparatively small source of NO_x emissions compared to SO_x, with many mobile sources and few large stationary sources. Reported emission increases from mining and quarrying may be due in large part to elimination of exemptions for quarries and open pit mines, changes in responsibility for reporting emissions from off-road vehicles, and methodological changes. Changes in the quantity of NO_x emissions resulted from efforts to reduce fossil fuel combustion through the integration of renewable energy and energy storage to reduce fuel combustion at remote mines that rely on diesel power generation and replacement of diesel equipment by electric vehicles.

Direct emissions $PM_{2.5}$ from mining and quarrying remained stable between 2008 and 2017, while emissions from primary metal manufacturing and non-metallic mineral product manufacturing decreased. Shares of 2017 minerals sector emissions were mining and quarrying, 57.6%; non-metallic mineral product

[79] The Conference Board of Canada, 2016, *Sulphur Oxides Emissions*, https://www.conferenceboard.ca/hcp/provincial/environment/sox.aspx?AspxAutoDetectCookieSupport=1.

[80] Subsectors of the minerals sector in this case are those defined by North American Industry Classification System (NAICS): Mining and quarrying (except oil and gas), non-metallic mineral product manufacturing, primary metal manufacturing, fabricated metal product manufacturing, support activities for mining and quarrying (except oil and gas).

[81] Signed by federal, provincial, and territorial energy ministers in 1998, it provides a framework for the long-term management of acid rain in Canada. Among other things, it requires regular reporting on SO_2 and NO_x emissions and forecasts. See: http://www.ccme.ca/files/Resources/air/acid_rain/1998_acid_rain_strategy_e.pdf.

manufacturing, 7.7%; and primary metal manufacturing, 34.4%. Emission levels and trends reflect the significance of mobile sources for mining and quarrying and stationary sources in downstream product manufacturing subsectors, as well as other factors noted above. Substantial SO_x emission reductions and direct $PM_{2.5}$ emission reductions reduce minerals sector impacts on ambient $PM_{2.5}$ concentrations.

Table 13. Minerals Sector Air Emissions (Tonnes), 2008, 2013, and 2017

Year	SO_x	NO_x	PM_{10}	$PM_{2.5}$
Mining and Quarrying (Except Oil and Gas)				
2008	366,626	30,048	53,323	11,745
2013	170,659	34,850	56,983	11,274
2017	131,391	36,980	55,679	12,161
Non-metallic Mineral Product Manufacturing				
2008	33,580	41,768	5,835	3,084
2013	25,320	33,514	4,669	2,310
2017	24,337	35,054	2,904	1,628
Primary Metal Manufacturing				
2008	316,462	18,426	14,453	10,476
2013	296,436	15,570	12,086	8,309
2017	233,173	15,127	9,980	7,271
Fabricated Metal Product Manufacturing				
2008	607	74	166	98
2013	3	93	262	77
2017	1	235	70	56
Total Sector Emissions				
2008	**717,275**	**90,315**	**73,777**	**25,403**
2013	**492,418**	**84,027**	**74,000**	**21,970**
2017	**388,902**	**87,396**	**68,633**	**21,116**

Source: Environment and Climate Change Canada, National Pollutant Release Inventory.

Energy Consumption and Efficiency

Highlights

- In 2017, minerals sector energy consumption was 798.8 PJ, 29.9 PJ (-3.6%) below 2008 levels. Since 2014, energy consumption has increased 6.1% (8.6 PJ).
- The minerals sector accounted for 9.7% of total Canadian energy use in 2017 and 9.2% in 2014.
- Minerals sector energy intensity decreased 6.8% from 14.24 TJ/$million to 13.27 TJ/$million between 2008 and 2017, while energy intensity for all industries decreased 11.9%.
- Between 2014 and 2017, minerals sector energy intensity rose by 3.8%, while energy intensity for all industries declined by 4.3%.

Definition

Energy consumption is defined as the energy used from all sources in a given year. Energy intensity is the ratio of energy consumption to output. The output measure used to calculate energy intensity is Gross Domestic Product (GDP).

Rationale

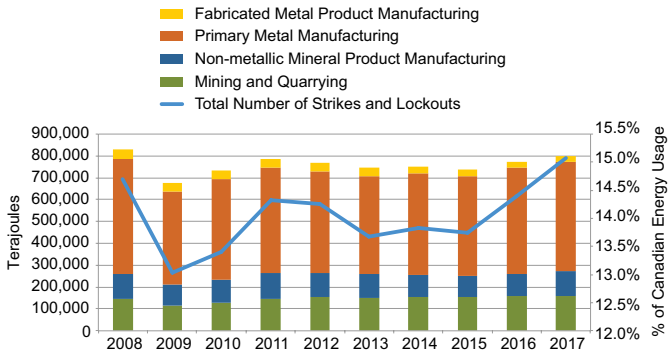
Minerals sector activities are energy-intensive, so energy availability cost is an important determinant of business performance and global competitiveness. Improving energy efficiency reduces operating costs and environmental impacts, including direct and indirect greenhouse gas emissions that contribute to climate change.

Analysis

The minerals sector accounted for 9.7% of total Canadian energy use in 2017, down from 10.8% in

2008. Total 2017 energy use by the minerals sector was 798.8 PJ. Subsector consumption in 2017 is presented in Figure 32 and was primary metal manufacturing, 500.1 PJ (62.6%); mining and quarrying (excluding Oil and Gas Extraction and Coal Mining), 159.4 PJ (20.0%); non-metallic mineral product manufacturing, 112.5 PJ (14.1%); and fabricated metal product manufacturing, 26.8 PJ (3.4%).

Figure 29. Minerals Sector Energy Consumption, 2008–2017



Sources: Canadian Energy and Emission Data Centre, Statistics Canada.

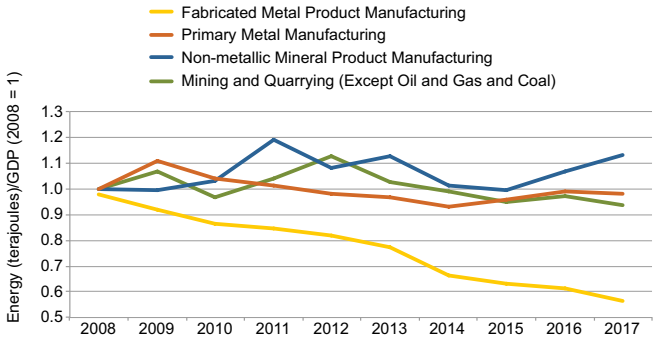
Minerals sector energy intensity decreased from 14.24 TJ/$million to 13.27 TJ/$million (-6.8%) between 2008 and 2017, while energy intensity for all industries decreased from 16.88 TJ/$million to 14.86 TJ/$million (-12.0%). Energy intensity differs widely among subsectors and products; 2017 intensities were 34.30 TJ/$million of 2007$ GDP for primary metal manufacturing, 5.92 TJ/$million of 2007$ GDP for mining and quarrying, 19.40 TJ/$million of 2007$ GDP for non-metallic mineral product manufacturing, and 2.10 TJ/$million of 2007$ GDP for fabricated metal product manufacturing.

Between 2008 and 2017, energy intensity increased in non-metallic mineral product manufacturing and decreased in other minerals subsectors. Over the three-year period from 2014 to 2017, the changes in minerals subsector energy intensity were primary metal manufacturing, +5.5%; mining and quarrying, 5.3%; non-metallic mineral product manufacturing, 11.7%; and fabricated metal product manufacturing, -14.2%. Short-term changes in subsector intensity are influenced by changes in product mix, price, the exchange rate, construction, and capacity additions and closures. Energy intensity for all industries declined by 4.3% over the same period (Figure 30).

Fuel options differ among products, processes, and locations. Electricity is the preferred source of energy where available, affordable, and appropriate. In primary metal manufacturing, electricity is the dominant energy source. Metal recycling is a preferred strategy to minimize energy consumption. Solid fuels are used as reducing agents and electrodes are carbon-based, while natural gas keeps metal liquid and prevents oxidation. In non-metallic mineral product manufacturing, natural gas and solid fuel supply heat needed to produce lime, cement, and other products. In mining and quarrying, current open pit and underground mines use diesel-powered mobile equipment, while electricity is used for underground mine ventilation and ore processing.

Mines in remote regions often lack access to electricity and natural gas. As a result, most remote mines rely on diesel generators to supply heat and electricity. Liquefied natural gas is also used at a new diamond mine with road access, while diesel used at some remote sites is reduced by the integration of wind power and energy storage technologies. Development of new base metal, diamond, iron ore, and gold mines has not resulted in a substantial increase in energy consumption but has increased reliance on diesel to some extent. Mining and quarrying have not had a material effect on the growth of industrial energy use, which has resulted mainly from increased upstream oil and gas activity (notably upstream oil sands development).

Figure 30. Minerals Sector Energy Intensity (GDP), 2008–2017



Sources: Canadian Energy and Emission Data Centre, Statistics Canada.

Governments and industry have identified energy as a key challenge for the industry going forward and have been working together on a variety of initiatives to improve energy-use practices.

Box 12: Glencore's Wind Farm and Industrial Storage Facility, Raglan Mine

Glencore's Raglan Mine is located in Nunavik, at the northern tip of Quebec. Without access to electricity or natural gas, it has relied on diesel to generate electricity and heat and to power vehicles and equipment. Building on efforts to improve energy efficiency through heat and energy recovery in the past, with the support of multiple strategic and financial partners, Raglan has become a clean energy innovator.

The Raglan team won a 2016 Towards Sustainable Mining Excellence Award from The Mining Association of Canada for its wind turbine and micro-grid demonstration project, installed in 2014 by TUGLIQ Energy at a satellite site with the financial support of governments. An Arctic wind turbine and energy storage system were coupled to diesel generators. An innovative foundation design cuts concrete use by 90%, allowing the turbine to withstand 160 km/h wind gusts, and prevents tilting in case ice lenses in the permafrost thaw in the future. Models predict electricity demand and turbine output. A flywheel and lithium ion battery allow time to start a generator when necessary, cutting fuel consumption needed to spin a spare generator. Excess wind power generates hydrogen, which is stored for use in fuel cells that supply clean electricity. The demonstration surpassed 40% penetration of renewable energy relative to installed diesel generation capacity, while documented deployments of hybrid-diesel grids without energy storage reported persistent penetration. While the rated turbine capacity represents less than 20% of total electricity demand at Raglan, such an approach could supply much of the electricity consumed by many northern communities.

The Raglan demonstration project was scaled up to include a second wind turbine and satellite site in August 2018. Relative to the period prior to 2014, wind turbines are expected to supply about 10% of Raglan Mine's energy needs, reduce diesel use by about 4.4 billion L of diesel per year, and cut annual greenhouse gas emissions by about 12,000 t, which is equivalent to taking 2,700 vehicles off the road.

The renewable energy model pursued at Raglan Mine is an international flagship for energy diversification in Arctic regions. It has de-risked integration of clean energy at other mines and for communities, in Nunavik and elsewhere. Experience at Raglan also advances the vision of electrification at off-grid mines, at which electric vehicles may cut fuel consumption and store electricity in the future.

Data Considerations
Two datasets were used to express the minerals sector energy use as a percentage of Canada's overall emissions. Subsector energy use is sourced from the Canadian Energy and Emissions Data Centre. The Statistics Canada "Supply and demand of primary and secondary energy" dataset is the source for total industrial and total Canada energy use.

Greenhouse Gas Emissions

Highlights

- In 2017, the minerals sector emitted almost 45.0 million tonnes (Mt) of greenhouse gases (GHG), 9.0 Mt (-16.7%) below the 2008 level.
- Since 2013, GHG emissions have been relatively flat, averaging just under 45.0 Mt.
- For the past five years, the minerals sector has accounted for, on average, 6.0% of Canada's total GHG emissions.

Definition
Greenhouse gases (GHG) trap heat in the Earth's atmosphere and contribute to climate change. Major sources include fossil fuel combustion and process emissions. Fuel combustion emits carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Process emissions of CO_2 and other gases arise from decomposition of carbonate minerals, use of reducing agents to produce metals from oxides, transformation of iron into steel, and other manufacturing processes.[82]

Rationale
Climate change due to GHG accumulation in the atmosphere is a domestic and international issue. Environmental, economic, and social impacts occur in Canada and at a global scale. Businesses are vulnerable to climate change impacts on transportation, communication, infrastructure, operations, and long-term reclamation.[83]

[82] GHG emissions are expressed in carbon dioxide equivalents (CO_2e). Emissions from industrial processes and product use were excluded in prior reports. Historical data were restated to include all sources. Process emissions are particularly significant sources of GHG emissions for primary metal manufacturing and non-metallic mineral product manufacturing.

[83] Warren, F. J. and Lemmen, D. S. (Eds.), 2014, *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptations*, http://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2014/16309.

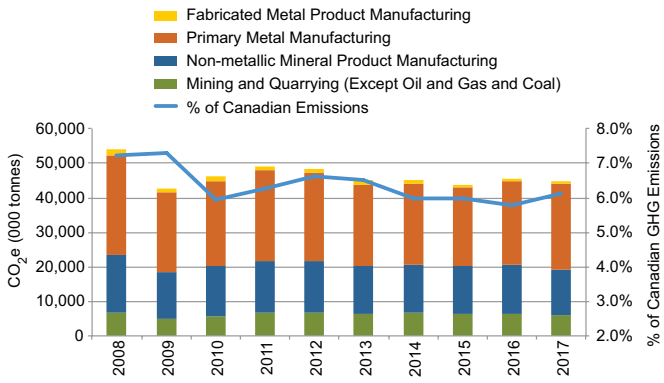
Monitoring the management of GHG emissions is an important component in assessing efforts to mitigate current and future impacts.

Analysis

The minerals sector has represented 6.0% of Canada's total GHG emissions via on-site emissions for the past five years. This does not include indirect emissions associated with on-grid energy use. GHG emissions result mainly from the use of fossil fuel in heavy equipment, for heat and power generation in remote regions, and in industrial processes. Changes over time reflect changes in output, product mix, and the development of new mines in remote regions where electricity is not available. In 2017, mineral industry GHG emissions were 45.0 Mt of GHGs, 9.0 Mt (-16.7%) below 2008 levels (Figure 31).

GHG emission levels in 2017 were primary metal manufacturing, 25.0 Mt; non-metallic mineral product manufacturing, 13.2 Mt; mining and quarrying, 6.0 Mt; and fabricated metal product manufacturing, 0.8 Mt. Sources include reagent and electrode consumption in iron and steel, aluminum, other non-ferrous metals, and ferroalloy production; process heat and decomposition of carbonate minerals in cement and lime production; fuel combustion in heavy equipment; generation of heat and power at remote mines; cogeneration of heat and electricity at a solution mine; drying of mine products; heating of ventilation air at underground mines; and melting, alloying, forming, and joining processes for fabricated metal products.

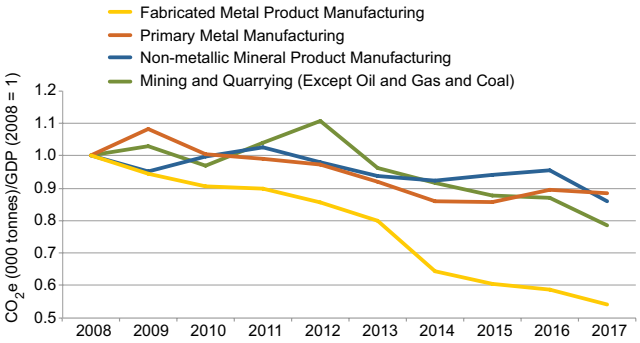
Figure 31. Minerals Sector Greenhouse Gas Emissions, 2008–2017



Sources: Canadian Energy and Emission Data Centre, Statistics Canada.

GHG emission intensity in 2017 (a ratio of GHG emissions to GDP) was below the 2008 level for all subsectors. All subsectors display a downwards trend after 2008. GHG emission intensity changes between 2008 and 2017 were primary metal manufacturing, -11.5%; non-metallic mineral product manufacturing, -14.1%; mining and quarrying (excluding coal), -21.6%; and fabricated metal product manufacturing, -45.8% (Figure 32).

Figure 32. Minerals Sector Greenhouse Gas Emission Intensity (GDP), 2008–2017



Sources: Canadian Energy and Emission Data Centre, Statistics Canada.

The Mining Association of Canada has worked with members to develop an *Energy and GHG Emissions Management Protocol* as a component of the *Towards Sustainable Mining* (TSM) initiative (Box 13).[84] Developed in 2004 and revised in 2013, the protocol establishes three performance indicators: (1) energy use and GHG emissions management systems; (2) reporting systems; and (3) performance targets. Members are assessed on systems and targets in place, with grades ranging from "C" (no systems in place) to "A" (comprehensive systems developed and implemented) to "AAA" (excellence and leadership).

The 2018 TSM Progress Report includes 2017 results for 67 mining facilities across Canada belonging to 23 member companies. In 2017, 84% of the facilities were rated A or higher for indicator 1, compared to 75% in 2014. Indicator 2 increased from 87% in 2014 to 96% in 2017 for facilities ranked A or higher, while indicator 3 (facilities that have established and met performance targets) decreased from 61% in 2014 to 54% in 2017.[85]

[84] The Mining Association of Canada, 2016, *Energy and GHG Emissions Management*, http://mining.ca/towards-sustainable-mining/protocols-frameworks/energy-and-ghg-emissions-management.

[85] The Mining Association of Canada, 2018, 2018 *Towards Sustainable Mining Progress Report*. This information should be used with discretion as the report has not yet been finalized.

Box 13: Towards Sustainable Mining – Energy Use and Greenhouse Gas Emissions Management

In 2002, the Mining Association of Canada (MAC) adopted a climate change policy statement detailing members' commitments to the environment by improving energy efficiency and reducing greenhouse gas (GHG) emissions. Additionally, with the launch of the TSM initiative in 2004, MAC introduced the *Energy Use and GHG Emissions Management Protocol* to assist member facilities in monitoring and ultimately reducing their energy consumption and GHG emissions. Subsequently, in 2009, MAC endorsed the International Council on Mining and Metals' policy on climate change, recognizing that comprehensive and sustained global action is required to reduce the scale of human-induced climate change.

The current version of the *Energy Use and GHG Emissions Management Protocol*, updated in 2013, consists of three performance measurement indicators that seek to confirm a facility's establishment of a comprehensive system for energy use and GHG emissions. For this Protocol, a facility must show that its management system includes assigned accountability from senior management and demonstrate that mechanisms are in place to ensure energy use data are reviewed regularly and well integrated with operator activities.

Facilities are also expected to provide energy awareness training and incorporate systems to track and report energy use and GHG emissions data for both internal and external reporting. Finally, the Protocol seeks to confirm that facilities establish and meet performance targets for their energy use and GHG emissions.

In 2016, MAC acknowledged the importance of supporting an efficient approach to addressing climate change by issuing principles for climate change policy design. These include support for a broad-based carbon pricing scheme, the need for revenue neutrality, and the importance of balancing meaningful emissions reductions while maintaining economic competitiveness.

In 2016, MAC's Community of Interest Advisory Panel, an independent, multi-interest group that advises MAC, issued an advisory statement to MAC that identified potential opportunities to build on the industry's progress over the past two decades on climate change. In response to this advice, MAC and its members have committed to undertake more than a dozen additional actions to help fight against climate change.

The TSM *Energy Use and GHG Emissions Management Protocol* is scheduled for a comprehensive review in 2020. The advice from the Community of Interest Advisory Panel will help guide the review of the Protocol.

Data Considerations

Two datasets were used to express minerals sector GHG emissions as a percentage of Canada's overall emissions. Subsector GHG emissions and total industrial emissions are sourced from the Canadian Energy and Emissions Data Centre. The Statistics Canada *Physical Flow Account for GHG emissions* dataset (Table 38-10-0097-01) is the source for total Canada emissions.

Environmental Expenditures

Highlights

- Between 2006 and 2016, the minerals sector's environmental capital expenditures jumped almost 34% from $453.6 billion to $607.2 billion while environmental operating expenditures increased 15.5% from $1.029 billion to $1.189 billion.
- Other types of environmental expenditures increased significantly from 2006 to 2008 before declining in 2010. Between the recovery of capital and operating expenditures in 2012 and 2016, total environmental expenditures have declined 28.2%.

Definition

Environmental expenditures are defined as all capital (investment) and operating (current) expenditures incurred by businesses to comply with current and anticipated future Canadian and international environmental regulations, conventions, or voluntary agreements. Expenditures are subdivided by Statistics Canada into environmental monitoring, environmental assessments and audits, reclamation and decommissioning, wildlife and habitat protection, waste management and sewerage services, pollution abatement and control processes (end-of-pipe, including waste management), pollution prevention processes, fees, fines and licences, and others.

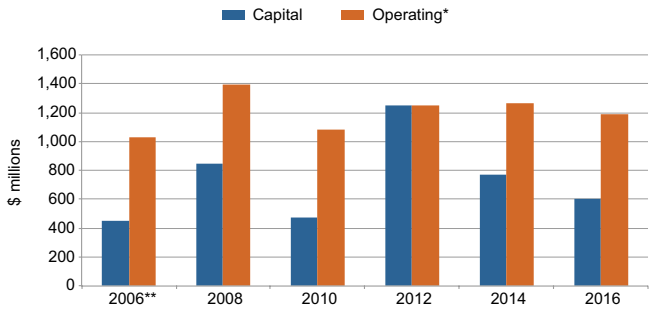
Rationale

Expenditures on environmental protection provide an indication of the amount of capital committed by the industry to comply with the above-mentioned regulations, agreements, and conventions. While there are many factors, this provides one financial measure of environmental performance.

Analysis

Between 2006 and 2016, the minerals sector's capital expenditures on environmental protection jumped from $453.6 billion to $607.2 billion (+33.9%), while operating expenditures increased from $1.029 billion to $1.189 billion or 15.5% (Figure 33). In 2006, the minerals sector accounted for 11.6% of Canada's total capital expenditures and 21.8% of operating expenditures, while in 2016, the sector's share of both capital and operating expenditures increased to 18.7% and 23.0%, respectively. As with many of the economic indicators, these expenditures fell following the global recession in 2008 and 2009. Of note, the minerals sector reduced capital expenditures by more than half in 2016 compared to 2012, receding from $1.25 billion to $607 million (-51.4%). Spending for operating expenditures was also reduced, decreasing from $1.25 billion to $1.19 billion or -4.8%.[86]

Figure 33. Environmental Protection Expenditures in the Minerals Sector, 2006–2016



Source: Statistics Canada, *Environmental Protection Expenditures in the Business Sector.*

** Data for capital expenditures in the fabricated metal product manufacturing sector in 2006 are unreliable and therefore omitted from the total—as recommended by Statistics Canada.

In 2006, the mining and quarrying subsector accounted for the largest share of capital expenditures (59.5%) followed by the primary metal subsector at 27.0%. By 2016, however, the primary metals subsector had surpassed the mining and quarrying subsector in capital expenditures, with 52.0% of the minerals sector's capital expenditures being on environmental protection. In 2006, 59.3% of the operating expenditures belonged to the primary metal subsector (Figure 34). However, in 2016, operating expenditures for the mining and quarrying subsector were the highest with 46.4% of total operating expenditures for the mining industry, while the primary metals subsector was the second highest in operation expenditures with 43.8%. The majority of operating expenditures for both the primary metals (45.0%) and mining and quarrying (24.2%) subsectors were spent on pollution abatement and control processes in 2016. Waste management and sewerage was second in importance among the mining subsectors (Table 14).

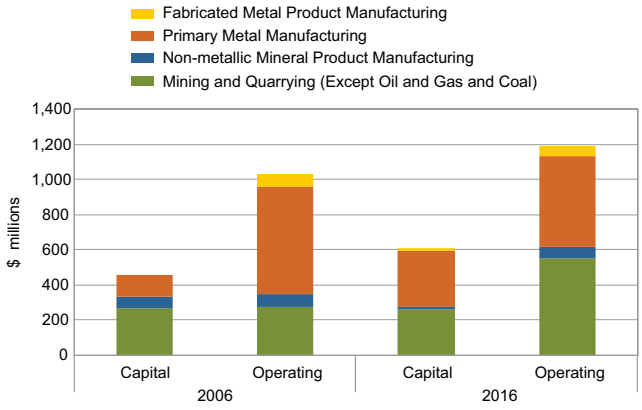
[86] Statistics Canada, *Environmental Protection Expenditures in the Business Sector*.

Table 14. Biennial Environmental Protection Operating Expenditures, 2006–2016 (in $ billions)

		2006	2008	2010	2012	2014	2016
Mining and Quarrying	Environmental monitoring	20.8	34.5	47.4	88.0	82.8	59.2
	Environmental assessments and audits	8.3	13.6	14.1	38.0	43.9	x
	Reclamation and decommissioning	49.8	61.6	56.7	56.0	31.8	x
	Wildlife and habitat protection	2.1	0.9	1.9	6.5	4.9	x
	Waste management and sewerage services**	54.5	60.1	61.8	79.2	97.4	54.1
	Pollution abatement and control processes (end-of-pipe)	71.3	127	162.2	164.7	195.7	133.4
	Pollution prevention processes	48.9	57.1	53.2	90.7	57.3	37.7
	Other types of environmental protection	10.2	31.1	18.8	33.3	15.5	x
	Total	**277.0**	**401.9**	**436.0**	**586.0**	**565.9**	**551.3**
Primary Metal Manufacturing	Environmental monitoring	34.5	27.7	30.8	27.9	38.1	34.9
	Environmental assessments and audits	8.6	7.1	8.6	8.9	7.6	10.2
	Reclamation and decommissioning	16.8	14.7	15.7	13.7	14.4	25.5
	Wildlife and habitat protection	1.4	1.5	1.0	0.8	1.3	2.4
	Waste management and sewerage services	168.6	211.8	158.7	189.7	192.9	119.7
	Pollution abatement and control processes (end-of-pipe)	290	270.5	173.7	198.0	210.3	233.8
	Pollution prevention processes	76.3	-	117.4	103.8	66.7	64.7
	Fees, fines, and licences	-	-	-	-	-	8.8
	Other types of environmental protection	10.3	19.1	12.4	13.8	11.9	20.3
	Total	**610.9**	**796.7**	**521.0**	**562.1**	**546.6**	**520.1**

- NIL.
x - supressed to meet the confidentiality requirements of the Statistics Act
Source: Statistics Canada, Environmental Protection Expenditures in the Business Sector.

Figure 34. Environmental Protection Expenditures, by Subsector, 2006 and 2016



Source: Statistics Canada, *Environmental Protection Expenditures in the Business Sector.*

Data Considerations

It is important to note that the data on environmental expenditures for the fabricated metal product manufacturing subsector are unavailable for certain years. Capital expenditures data by type of activity for each subsector are also suppressed to meet confidentiality requirements or are too unreliable to be published for select years.

Orphaned and Abandoned Mines

Highlights

- Over the past three years, since the publication of the previous edition of this report, The Northern Contaminated Sites Program (NCSP) has committed over $408 billion to rehabilitate and monitor orphaned and abandoned mines in Yukon, Nunavut and the Northwest Territories.
- In Quebec, the Ministère de l'Énergie et des Ressources naturelles invested $1.2 billion in March 2017 as a contingency fund for environmental liability in relation to mining activities. Of this $1.2 billion, $744.9 million was allocated for assessing, remediating and monitoring abandoned mining sites, and $455.2 million was allocated for existing mines that may require financial assistance with mine reclamation.

Definition

Orphaned or abandoned mines are mines for which the owner cannot be found or for which the owner is financially unable or unwilling to remediate the site. Canada's long mining history has left many orphaned or abandoned exploration and mine sites requiring varying degrees of rehabilitation.[87]

Rationale

Orphaned and abandoned mines may pose environmental, health, safety, and economic risks to local communities, the mining industry, and governments. They also represent a significant liability to the Crown. Mining legislation in all Canadian jurisdictions requires mine developers to submit mine closure plans that describe how the site will be rehabilitated throughout its life cycle and, how it will be decommissioned when mining activities end and to post a financial surety to ensure these activities are carried out.[88]

Analysis

To address the problem of orphaned and abandoned mines, Canada's federal, provincial, and territorial Mines Ministers requested that a multi-stakeholder advisory committee be established to study issues towards remediation of these sites. In 2002, the National Orphaned/Abandoned Mines Initiative (NOAMI) was created with representatives from governments, industry, Indigenous communities, and civil society.

Since it began, the various jurisdictions have taken significant steps to address existing and prevent future orphaned and abandoned mines through either regulations or voluntary initiatives. While the potential for new orphaned and abandoned mines is very low, NOAMI continues to work towards eliminating any future abandonments, and Canadian jurisdictions are constantly striving to improve the management and rehabilitation of existing properties through new and innovative approaches.

Over the past 16 years, NOAMI has built up a strong national and international reputation. Several countries are using NOAMI as a model to develop their programs for their legacy mine sites (Australia, United States). The initiative has successfully produced a number of important guidance documents and reports to assist Canadian stakeholders in both the cleanup of abandoned mines and their prevention. In 2017, the program delivered on one of its key objectives, as laid out in 2002, with the launch of the web-based NOAMI Inventory of Orphaned and Abandoned Mines (www.noami.org). The interactive map-based inventory allows users to view information about sites as provided by the various Canadian jurisdictions and to connect directly to their databases where possible.

At the core of NOAMI lie two major strengths. One is that the initiative is multi-stakeholder in nature and the other is that it is truly national in scope. Direct and in-kind funding and other valuable resources are provided by the mining industry, several provinces and territories, and the federal government. It is a pan-Canadian effort that has made measurable progress in addressing issues related to orphaned and abandoned mines in Canada.

Much reclamation and closure work remains for abandoned mines across Canada—and NOAMI is well placed to address these issues. In 2018, a session was held to review and update the scope and mandate of the initiative in the current context. A value proposition for a renewed NOAMI was built with the concept of creating public confidence in the minerals sector by addressing and preventing future abandonments. Recommendations for a renewed NOAMI were put forward to the Intergovernmental Working Group (IGWG) on the mineral industry for further consideration.

[87] National Orphaned/Abandoned Mines Initiative *(NOAMI), 2015, NOAMI Performance Update 2009–2015*, http://www.abandoned-mines.org/wp/wp-content/uploads/2015/08/NOAMI-2015-UPDATE-ENG-WEB.pdf.

[88] Standards and requirements vary. These are not a guarantee of the obligations that a company may incur (e.g., may not be a financial surety for 100%) but, rather, an assurance of compliance with the defined closure plan.

Federal and Provincial Initiatives

Federal Government – Crown Indigenous Relations and Northern Affairs

The Northern Contaminated Sites Program (NCSP), within *Crown Indigenous Relations and Northern Affairs* (CIRNAC), was created in 1991 to manage remediation of contaminated sites across the North. In 2005, the Federal Contaminated Sites Action Plan was established by the federal government. This program committed $3.5 billion over a 15-year period for the assessment and remediation of contaminated sites under the federal government's responsibility, which includes abandoned mines in the Yukon, the Northwest Territories (N.W.T.), and Nunavut.

As of April 1, 2016, over 1,000 contaminated sites in the North have been assessed by the NCSP. In 2018, 50 sites are currently classified as high priority for action (N.W.T. = 38, Nunavut = 5 and Yukon = 7). Of these 50 sites, 20 are under remediation across the three territories with 15 of those sites in the final stages of remediation. Over the past three years, remediation activities for four abandoned mine sites have been completed, and over $408 billion has been spent on assessment, remediation, care and maintenance, and long-term monitoring of current and former mineral exploration sites. The program budget has been approved for $168 billion for 2019–2020 with 90% targeted towards the rehabilitation of abandoned mines. Giant Mine and Faro Mine are the two largest active remediation projects and are in the process of developing a remediation strategy and implementing a care and maintenance strategy.

British Columbia

British Columbia (B.C.) established the Crown Contaminated Sites Program (CCSP) in 2003, based on a report by the Office of the Auditor General seeking improvements on the management of contaminated sites. The mandate of CCSP is to identify and remediate high-risk contaminated sites that are located on Crown land and for which no responsible person can be identified and consequently, the responsibility for remediation falls to the province. Remediation undertaken complies with the *Environmental Management Act*, the Contaminated Sites Regulation, and the Hazardous Waste Regulation.

In 2014, the province introduced PS 3260 that establishes standards on how to account for and report a liability associated with the remediation of contaminated sites. These standards are overseen by the provincial contaminated sites secretariat, which is made up of representatives from several ministries.

Between April 2016 and March 2018, 87 sites have been investigated, of which 48 have been determined to be low risk where no immediate action is required, 19 have been fully remediated, and 15 are under investigation or already undergoing remediation. Orphaned and abandoned mine sites make up approximately 95% of the contaminated sites within the CCSP portfolio.

In 2019, the B.C. Ministry of Energy, Mines and Petroleum Resources (EMPR) initiated an abandoned mines program with a mandate to address abandoned mines located on Crown Land and that pose a risk to public safety. EMPR is working on compiling records and prioritizing abandoned mines with hazardous openings.

Manitoba

In 2000, Manitoba established the Orphaned/ Abandoned Mine Site Rehabilitation Program to address the environmental, health, and public safety concerns of orphaned and abandoned mines in the province. Since the last report, rehabilitation for theGods Lake, Lynn Lake, and Baker Patton sites has been completed and other mine sites (Ruttan, Sherridon, Fox, Central West Manitoba) have been targeted as high priority for rehabilitation. The Manitoba Department of Growth, Enterprise and Trade has spent $40 billion over the past three years on reclamation of abandoned mines. Currently, a budget of $30 billion has been estimated for 2019–2020 for the continued remediation of the Ruttan and Sherridon mines and, sites in the Snow Lake area and for ongoing monitoring of other rehabilitated sites. As of March 31, 2018, the province had spent $244.8 billion on orphaned and abandoned mine site rehabilitation with an estimated $41 billion available for future projects until 2041.

Newfoundland and Labrador

Orphaned and abandoned mines (OAM) in Newfoundland and Labrador are mostly historic and predate the province joining Confederation in 1949. All of the sites predate the *Mining Act* of 2000. These properties, ranging from exploration sites to large-scale former producing mines, can pose safety risks to the public, and some have environmental issues.

Newfoundland and Labrador has spent over $1.7 million on OAMs in the past three years. The province currently has two projects underway. The Minworth and CRM tailings dams are remediation

projects that follow under the Newfoundland and Labrador program of dam safety reviews and repairs with the goal of bringing the dams to Canadian Dam Association standards. Another tailings dam, Whaleback, has been identified as a high priority site and is awaiting remediation. The Newfoundland and Labrador government has allocated $100,000 per year for mine rehabilitation.

Nova Scotia

There are approximately 7,500 abandoned mine openings (AMO) in Nova Scotia, about 2,200 of which are located on Crown land. In 2001, the Department of Natural Resources (DNR) instituted an Abandoned Mine Openings (AMO) Remediation Program to address AMOs on Crown land. The program is managed jointly by the Mineral Resources and Regional Services branches of DNR. It is overseen by the executive directors of the Mineral Resources, Regional Services and Land Services branches. Rehabilitation for mines found on Crown land falls under the purview of two departments: the Department of Lands and Forestry, together with the Nova Scotia Environment, handle site reclamation regarding environmental impacts, while the Nova Scotia Department of Energy Mines (NSEM) responds to potential physical hazards to public safety on Crown land sites exclusively. NSEM has identified 10 to 12 priority sites, and in the past year, they have conducted work on two sites to eliminate physical hazards. Work has been performed over the past three years on 14 sites to remove physical hazards, but no remediation or rehabilitation has been noted for any mine sites.

In July 2017, the Department of Natural Resources released Version 7 of the Nova Scotia AMO database. This is an update to Version 6, released in May 2016, which contains about 150 newly discovered AMOs and updates to 2,400 records in the database. This database is available on-line at http://novascotia.ca/natr/meb/geoscience-online/about-database-amo.asp.

Ontario

Ontario established its Abandoned Mine Rehabilitation Program (AMRP) in 1999. AMRP has an annual budget of $5 billion that supports rehabilitation of physical mine hazards. Ontario has rehabilitated more than 80 of the highest priority abandoned mine sites in the province through this program since 2016–2017. In 2015–2016, AMRP provided $5.87 billion to conduct reclamation work on 11 sites and $5 billion in 2016–2017 for remediation on 13 sites.

The Ministry of Energy, Northern Development and Mines (ENDM) is responsible for the environmental remediation of 47 contaminated sites under Ontario's Contaminated Sites program and 1,948 sites for physical mine hazard remediation under Crown responsibility. Ten Ontario sites are undergoing various stages of remediation in 2018-2019, including the monitoring of 16 sites that have been rehabilitated in the past three years. In the three years ending March 31, 2019, Ontario will have allocated over $29 billion for environmental remediation of contaminated mine sites and spent $15 billion through the Abandoned Mines Rehabilitation Program for other types of abandoned mine hazards.

Quebec

Abandoned mines in Quebec are the responsibility of the Ministère de l'Énergie et des Ressources naturelles (MERN). Since 2006, MERN has invested $157 billion for reclamation, security, maintenance, and monitoring of abandoned mining sites. MERN invested $1.2 billion in March 2017 as a contingency fund for environmental liability in relation to mining activities; $744.9 million of the $1.2 billion was allocated for abandoned mining sites and $455.2 million for existing mines that may require financial assistance with mine reclamation. As of March 31, 2017, there were 459 listed abandoned sites in Quebec. Of these 459 sites, 225 were mining sites of which 139 have been reclaimed or secured. Currently, reclamation is being performed on 20 major sites with work scheduled for another 35 mine sites. The remaining 31 sites are designated to be secured in the near future. By 2022, MERN hopes to reduce environmental liabilities by 80% for mining activities.

Saskatchewan

The Government of Saskatchewan enacted legislation in 2007 to implement an Institutional Control (IC) Program for the post-closure management of decommissioned mine and mill sites on provincial Crown land. The IC Program has garnered international attention, and NOAMI has identified the program as the most advanced Canadian regulatory regime that addresses all aspects of site relinquishment and an important component in preventing future abandoned sites.

Project CLEANS (Cleanup of Abandoned Northern Sites) is a multi-year, multi-million dollar project aimed at assessing and reclaiming the Gunnar mine, Lorado mill, and 36 satellite sites in northern Saskatchewan. In 2006, the governments of Saskatchewan and Canada signed a Memorandum of Agreement to share equally in the costs to clean up the Gunnar and satellite legacy

uranium sites in northern Saskatchewan. Encana Corp. contributed to a liability fund held by the Government of Saskatchewan that will be used to clean up the Lorado portion of the project. The Saskatchewan Research Council (SRC) is managing Project CLEANS.

There are currently 37 high-priority sites located in Saskatchewan including the Gunnar uranium mine and mill site. Since 2015, remediation has been completed at 10 satellite sites and the Lorado Mill site. Remediation is underway for the Gunnar site and eight additional satellite sites. Eighteen more sites are being assessed including six non-uranium sites. A liability of $222 billion was established in 2014 to fund the remediation of the Gunnar and satellite sites and an additional liability of $30.4 billion for the other six non-uranium sites in the Uranium City area. In the past three years, $72.5 billion was spent on remediation of the Gunnar and satellite sites.

Yukon

In 2003, the Government of Canada and the Government of Yukon signed the Devolution Transfer Agreement. Under this agreement, responsibility for managing resources in Yukon was transferred from the federal government to the territorial government. In the Devolution Transfer Agreement, there are seven mine sites, called Type II, identified as having, or potentially having, unfunded environmental liabilities. Some are abandoned, and others are still operating. Funding for remediation of Type II sites is provided by the Government of Canada.

Out of the Type II sites, five are considered abandoned, including Faro, Clinton Creek, Ketza River, Mount Nansen and Keno Hill. These sites are in various stages of remedial planning. Mount Nansen and Keno Hill are slated to be remediated by private industry through a sale arrangement led by the Government of Canada. The Government of Canada currently oversees care and maintenance and remedial planning at the Faro Mine site. The Government of Yukon is responsible for overseeing care and maintenance and remediation planning at the Clinton Creek and Ketza River sites.

Over the last three years, approximately $64 billion was spent on care and maintenance activities, remediation planning, and implementation of urgent works to address high risk hazards on Type II abandoned mine sites.

Data Considerations

One of the initial goals of NOAMI was the development of a national inventory of orphaned and abandoned mines. This inventory provides a Canada-wide perspective on the number, status, and features of orphaned and abandoned mines and allows a better understanding of the situation and the development of appropriate policies to address them.

Conclusion

The objective of this report was to articulate the performance of Canada's mineral sector over the last 10 years, including its successes, information and data gaps, and areas where there remains further room for improvement. The continual improvement of the economic, social, and environmental performance of the minerals sector is an important part of its image, reputation, and potential for long-term success in Canada. The information contained in the preceding sections is intended to support the efforts of industry, governments, civil society, and academia in ensuring that Canada benefits from a sustainable and responsible mineral resource sector.

Canada's minerals sector makes a significant contribution to Canada's economy as well as those of the provinces and territories. Companies operating in the minerals sector are also often major contributors to the local economy in many Canadian communities that play host or are adjacent to their operations. Socially, the sector has made strides in community engagement efforts, highlighted by the increased number of agreements signed between mineral companies and Indigenous communities or groups. Governments and industry in Canada are making commitments to these groups as equal partners in the mineral development cycle. Environmentally, the minerals sector continues to minimize greenhouse gas emissions and energy consumption and shows ever greater efficiency in its energy intensity. The sector as a whole has demonstrated success in maintaining compliance with increasingly regulatory requirements governing mining effluent. However, past incidents such as the Mount Polley mine dam breach serve as reminders that environmental incidents can erode public confidence and trust in the sector and can overshadow ongoing efforts made to improve the environmental performance of the industry.

Products extracted and manufactured by the minerals sector are used in critical infrastructure such as highways, communication networks, and housing. Mined products are used in everyday products like electronic devices, toothpaste, and the fertilizers that increase crop yield and plant resistance to disease. These and innumerable other items are essential to modern life. The fundamental inputs of clean energy technology and green products including hybrid-electric vehicle batteries, solar panels, and wind turbines all rely on minerals and metals generated by the sector.

In short, the sector continues to make far-reaching contributions to Canada's socio-economic vitality. These contributions include providing income to individuals through gainful employment, creating and sustaining economic opportunities, and generating prosperity that extends from rural and remote communities to cities and onwards to every corner of the country.

It is important to note that, while this report identifies the progress that has been made in relation to the outcomes described in earlier sections, data and knowledge gaps remain. Environmental, social, and economic sustainability is an ever-increasing area of concern both domestically and internationally. The rapidly changing landscape of international politics and trade will inevitably have an effect on Canada's minerals sector, as will climate change. Continued competitiveness of the sector and the appeal of Canada as a location of choice for exploration and mining investment require meaningful investment and advances in productivity and innovation. Identifying, understanding, and quantifying these issues will be critical to understanding and predicting the future performance of the sector.

Other issues—including enhancing economic opportunities for Indigenous communities throughout the mineral development cycle, attracting and retaining highly skilled personnel, employing innovative practices and emerging technologies, and attaining the investment necessary to capture the full potential of Canada's minerals and metals resource advantage—will continue to be vital to the sector's success and warrant careful and ongoing attention. Future editions of the MSPR will define and analyze new economic, social, and environmental indicators so that the minerals sector's performance can be better monitored and evaluated.