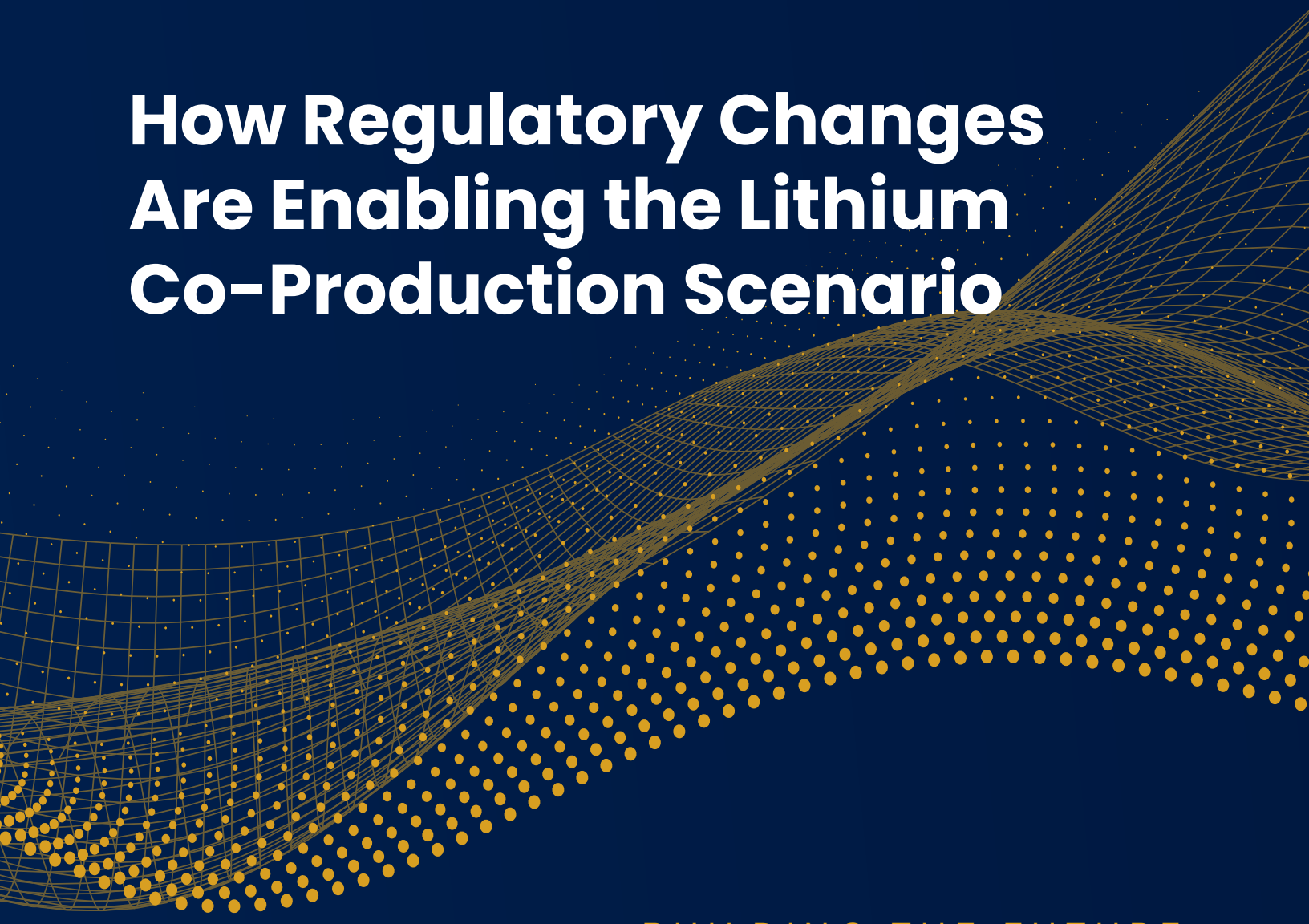
INTEGRATED SUSTAINABILITY

Alberta's Oilfield Brine Mineral Rights:

How Regulatory Changes Are Enabling the Lithium Co-Production Scenario



BUILDING THE FUTURE SUSTAINABLY

Alberta's Oilfield Brine Mineral Rights: How Regulatory Changes Are Enabling the Lithium Co-Production Scenario

With suitable regulatory support forming in Alberta for mineral extraction from oilfield brines, there is a strong value-add use case for right-sized Canadian oil and gas producers to maximize from waste production and de-intensify emissions.

In 2023, the Government of Alberta released essential regulatory instruments enabling the extraction of critical minerals from deep geologic brine fluids. This includes consideration for Lithium contained within produced waters associated with oil and gas operations.

As stated within both the Federal and Provincial critical minerals strategies, establishing a domestic critical minerals resource supply is essential to support the development of domestic and global value chains and empowering a clean and responsible global energy transition. While various tax and grant incentives have supported emerging resource exploration and technology testing, providing further clarity on the mineral tenure of deep aquifer brines serves to mitigate an added layer of uncertainty for prospective developers.

With suitable regulatory support forming in Alberta, there is a strong value-add use case for right-sized Canadian oil and gas producers to maximize from waste production, de-intensify emissions, and contribute to the circular economy. Scrutiny from ESG investors is only increasing as regulations and frameworks develop, and co-production can both help alleviate the environmental impact of Lithium and Petroleum products and reduce North American reliance on foreign critical minerals.

Adam Leece, Manager of Decarbonization and ESG at Integrated Sustainability, outlines the coordinated effort from policymakers, regulators, and investors, to establish a regulatory roadmap and utilize the wealth of existing deep-pore infrastructure to fuel burgeoning Lithium demand.

Note: The Government of British Columbia is in the process of developing the regulatory mechanisms for critical mineral recovery from brines. To receive an analysis of BC regulations for produced water and deep aquifer brine mineral rights, please reach out to Adam Leece on LinkedIn or via email at Adam.Leece@IntegratedSustainability.com

Developing Alberta's Brine-Hosted Critical Minerals

In November 2021, the Government of Alberta (GOA) released their modern mineral strategy, Renewing Alberta's mineral future; a strategy to re-energize Alberta's minerals sector (the "AB Strategy") (Government of Alberta, 2021).

The AB Strategy emphasizes that Alberta possesses geologically favourable conditions for numerous metallic and industrial minerals, including but not limited to lithium, vanadium, nickel, and rare earth elements. While also recognizing the opportunity to

extract minerals from conventional primary sources (ores and formation waters) or unconventional secondary sources (wastes/ by-products from existing hydrocarbon developments, geothermal produced waters, oil sands waste streams).

As stated in the AB Strategy, its vision for Alberta is to become a preferred producer and supplier of minerals and mineral products and actively contribute to the global energy transformation.

The Alberta Geological Survey has conducted research uncovering elevated levels of lithium in geological formation waters, notably within the lithium-rich brines of Devonian aquifers in various areas of Alberta, including Fox Creek, Grande Prairie, Leduc, Red Deer, and the Swan Hills region. Additional investigations by Natural Resources Canada have also highlighted the possibility of lithium-enriched waters in the production waters of Duvernay and Montney regions in Northwest Alberta.

Since the release of the strategy, the GOA has now produced several accompanying guides, plans, and regulatory instruments to enable development:

- *Alberta's Critical Mineral Potential* (Government of Alberta, 2023) replacing the former: Critical minerals in Alberta.
- Brine-hosted Mineral Resource Development Rules (BMDR) (Government of Alberta, 2023a)
- *Mineral Resource Development Act* (MRDA) (Government of Alberta, 2023b)
- Amendments to the *Metallic and Industrial Minerals Tenure Regulation* (Government of Alberta, 2022)

At present, the MRDA empowers the Alberta Energy Regulator (AER) as the regulator with authority to provide for the safe, efficient, orderly, and environmentally responsible development of Alberta's mineral resources including a lithium recovery project utilizing formation brines. The AER is responsible for evaluating, permitting, and auditing wells, associated facilities and pipelines throughout the project life cycle, from initiation to decommissioning and reclamation. The regulatory framework for this oversight is outlined in the Mineral Resource Development Act.

Additionally, Alberta Energy and Minerals play a role in overseeing and issuing mineral tenure and administering metallic and industrial minerals royalties. The Tenure Regulation and royalty regime have been amended such that brine-hosted mineral tenure is required to produce lithium via a brine-hosted mineral lease or brine-hosted mineral licence.

The new Metallic and Industrial Minerals Tenure Regulation has been in force as of January 1, 2023. Currently, the rock-hosted mineral permits in the province also include brine-hosted mineral rights. Alberta Energy is in the middle of a transition to separate rock-hosted and brine-hosted mineral rights, giving the option for the rock-hosted mineral rights owners to also acquire their existing brine-hosted rights. Under the new regulation, there will be new agreements for the allocation of brine-hosted mineral rights, namely the brine-hosted minerals lease. The Brine-hosted minerals licences are in place to aid the transition of brine-hosted mineral rights into a separate tenure regime.

It is important to highlight that after the first of implementation of the new regulation, requests for public offerings can be submitted for any area where brine-hosted mineral rights remain undisposed and are not subject to other restrictions. It is our opinion that smaller-scale operations associated with existing oil and gas production in certain areas and geologic formations could consider participating in this space once the availability of brine-hosted mineral tenure is fully resolved.

Further insight into the transition can be found in the Metallic and Industrial Minerals Information Bulletin released in December 2022 (Alberta Energy, 2022).

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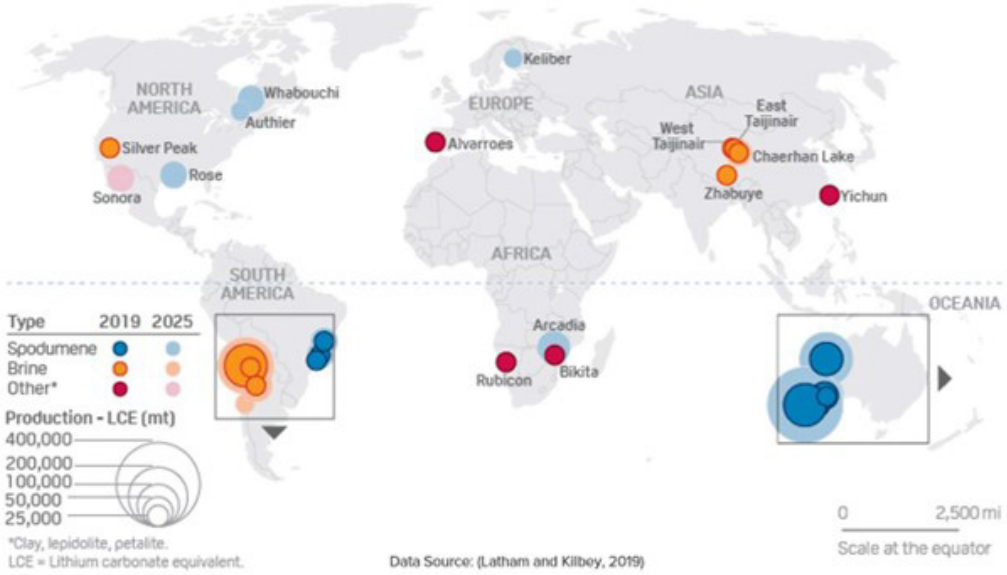


Global Lithium Production Forecast 2019 - 2025

Canadian Brine Competitiveness

Lithium spot prices had risen dramatically and peaked in late 2022. Within the last 12 months, they have softened due to short-term uncertainty in demand and high interest rates, leading to oversupply, most notably in the Asian market. We expect that in the mid to long term, prices will stabilize, driven by a demand increase for electric vehicles and battery storage in the next decade. More recently, with the arrival of various grant and tax incentive schemes for clean energy projects in both Canada and the United States of America, the economic case for waste-recovery development from flowback brine water from Oil and Gas operations has shifted to a more positive outlook.

Global lithium production is currently focused within three main regions: the Australian mineral ores, the Chilean continental brines (Salars), and, more recently, the Chinese continental brines. Of this existing production, approximately 45% is sourced from mineral ore, almost exclusively from Australia, with South American and Chinese continental brines producing nearly 35% and 15% respectively. To a lesser extent, recycling operations are starting to see first-generation lithium batteries from recycled minerals, lithium, cobalt, and nickel, and recycled volumes will increase as more material is front-loaded into the market.

For context, Canadian brines consist of lower concentration, often in the range of 40-75 parts per million, while the Chilean Salars yield upwards of 1500 ppm. In lieu of lower concentration, Canadian lithium brines draw upon several benefits:

• The location of Canadian deep aquifer brine deposits east of the Rocky Mountains provides ready access to the continental United States, the Eastern automotive industries, and sea-lane proximity to the European market.

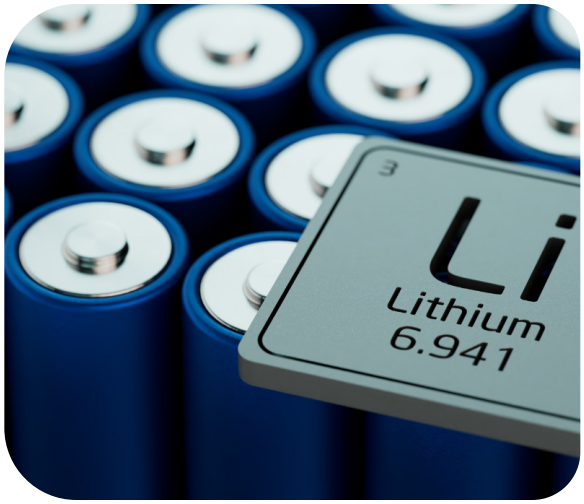
• The South American Salars are largely dependent on stable environmental conditions – i.e., lots of sun and low humidity. Due to climate change, this region is forecasted to experience increased humidity and monsoon activity - and a single monsoon event can set production back two or three years, adversely impacting an investment payback period.

• A rise in resource nationalism, where exporting nations and their governments designate their particular commodities as strategic resources, resulting in state intervention and control. Consequently, this can give rise to regulatory uncertainty, a reduction in the speed and magnitude of investments, concerns about supply security, and fluctuations in prices and regional investments.

• In contrast, Canadian solution miners are set to use pre-existing extraction infrastructure and a co-existing regulatory framework, providing investors with a dependable political and market environment.

• The pre-existing infrastructure also minimizes environmental disturbances and supports efforts to protect biodiversity in undeveloped habitats. Lithium extraction from ores is also very energy and chemical-intensive, even prior to further energy consumption via refinement in China.

Capital investing within a coproduction scenario (e.g., from a waste stream) can be geared toward understanding and developing the potential lithium-bearing asset, as opposed to capital-intensive infrastructure, including production and disposal wells, conveyance pipelines, or other associated infrastructure. In short, coproduction opportunities can focus on investing in technology or system efficiencies to advance efficient small-scale production, as opposed to gaining large-scale access to the mineral itself.



Direct-Lithium Exchange (DLE) technology is positioned to change the way that lithium is extracted from brine fluids. While there are several different technologies, each with its own approach, they generally involve selective sorbents, ion-exchange resins, or membrane technologies to selectively capture lithium ions from brine. Currently, DLE extraction remains unproven on ultra-low concentration lithium. Coupled with challenges in overall scale and potentially inconsistent flow rates, this may inhibit market entry for some smaller producers; however, partnering or combining produced water volumes to further increase the quantity of flow through, or licensing flow back from larger producers, would increase or maximize the facility utilization and total production potential.

As DLE technologies develop, smaller-scale co-production opportunities could work in parallel with larger-scale developments, emphasizing the importance of thoroughly assessing the prevalence of lithium-enriched co-produced brines across Alberta. As a result, the Alberta Geological Survey (AGS), Alberta Energy Regulator (AER), and the Government of Alberta have partnered to produce one of the largest mineral mapping programs in Alberta's history to help us better understand Alberta's mineral potential.

In combination, the GOA has made significant strides to overcome market barriers and develop supporting services for lithium production from produced oilfield brines. Many producers already benefit from extensive access to brine production throughout the continent and can now leverage Canada's expertise in produced water treatment and recycling to contribute to a more circular use of resources and capitalize on the growing lithium market.

About the Author

Adam Leece is a Professional Engineer with over 20 years of project management, civil engineering, environmental, and regulatory experience within upstream oil and gas operations. He has co-authored several research papers on lithium production from Canadian Oil and Gas Operations including a co-authored assessment with Natural Resources Canada to study lithium extraction from flowback and produced water from unconventional shale and tight hydrocarbon operations in Western Canada. He now leads the Decarbonization and ESG consulting teams for Integrated Sustainability.

Integrated Sustainability is a leading sustainable development company providing multi-disciplinary services supporting industrial project feasibility, regulatory engagement planning, water treatment engineering, fabrication, and operations. For additional information regarding extracting lithium from oilfield brines, and the mineral tenure of deep aquifer brines, please reach out to Adam Leece, M.Sc., P.Eng., or Yves Matson, Director of Strategic Development.

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