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# Mapping the Social & Environmental Impacts of Lithium Mining in the Americas

*A quantitative and qualitative analysis  
centered on Indigenous and marginalized  
lithium mining communities*

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## **INTRODUCTION**

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The increasing demand for lithium, a critical mineral for battery energy storage, represents a significant paradox for environmental policy: the pursuit of global decarbonization objectives to reduce climate change impacts on the most vulnerable risks intensifying localized socio-environmental injustices through mining impacts. This report, “Mapping the Social & Environmental Impacts of Lithium Mining in the Americas”, investigates this tension through a mixed-methods analysis.

It specifically explores how environmental justice considerations are frequently excluded in renewable energy policies, leading to disproportionate impacts on historically marginalized communities across the Americas, including disruptions to ecosystems, livelihoods, and economic stability. Given the challenges of comprehensive data availability across the expansive study area, our research employs a cluster-based analysis, mapping identified mining concentrations to understand regional impacts and highlight areas of concern.

This study will begin by reviewing existing literature on lithium mining methodologies and their known consequences, followed by the spatial analysis of mining sites. Through selected case studies, we will dive into the tangible effects on communities and environments. The primary goal of this research is to network these findings into a clear research agenda and actionable policy recommendations.

## **LITERATURE REVIEW**

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This literature review synthesizes interdisciplinary findings on the social, environmental, and economic impacts of lithium mining across key geographies. It highlights a growing body of research—predominantly from the U.S. and China—on lithium extraction’s role in the global energy transition. While lithium demand surges with electrification, the resource is highly concentrated in South America’s “South American altiplano” (Agusdinata, 2018), where brine-based extraction in arid regions raises critical concerns about groundwater depletion and ecological degradation (Kaunda, 2020; Rentier, 2024).

A limited number of interdisciplinary studies on mining globally have detailed the connection between the presence of mining in communities and mostly increased marginalization of populations within those communities resulting from varied impacts. Studies from Chile, Argentina, China, and beyond document alarming environmental consequences: toxic metal contamination from zinc mining (Shao, 2018), land degradation from copper mining (Kolala, 2019), and loss of biodiversity from lithium mining (Izquierdo, et al., in revision). Social impacts are equally profound, including erosion of Indigenous autonomy, community fragmentation, cultural loss, and public health risks from gemstone and copper-nickel mining (Mwakesi, 2020; Kojala, 2019). Although some mining regions have seen limited economic benefits—such as job creation or infrastructure improvements from lithium mining (Izquierdo)—these are often overshadowed by long-term social and ecological costs.

The following literature review expands upon previous mining impacts work to evaluate lithium mining specifically according to four major themes: (1) rising lithium demand and electrification, (2) extraction and processing methods, (3) environmental impacts, and (4) social impacts. The assembly of this literature is meant to frame the research gap that will be further explored and refined through the following mixed-methods approach (Izquierdo et al., 2015).

## ELECTRIFICATION, DECARBONIZATION, AND GROWING LITHIUM DEMAND

The global push for decarbonization is reliant on widespread electrification, particularly in the power and transportation sectors, as a primary strategy to meet climate mitigation goals. This involves a dual approach: first, achieving near-zero emissions in electricity generation, primarily through renewable energy sources, and second, expanding the use of this clean electricity to end-use sectors such as the rapidly expanding EV market and the growing need for stationary battery storage (Riofrancos, 2023). Lithium-ion batteries have emerged as a cornerstone technology for this transition, enabling the proliferation of EVs and providing essential grid-scale energy storage to support the integration of variable renewable energy sources. The International Renewable Energy Agency (IRENA) emphasizes that accelerated electrification, driven by renewables, is critical for staying on pathways to limit global warming (IEA, n.d.; International Renewable Energy Agency (IRENA), 2022).

The reliance on lithium-ion technology is fueling an unprecedented surge in lithium demand (Figure 1). This trajectory is underscored by forecasts from the U.S Energy Information Administration (EIA), which project dramatic increases in battery storage capacity to support the electrical grid (Figure 2). As the U.S accelerates its transition toward net-zero climate targets, securing a stable lithium supply has become an operational imperative.

However, this escalating demand presents significant challenges. The lithium supply chain is characterized by high geographical concentration in both mining (dominated by countries like Australia and Chile) and processing (largely centered in China), creating geopolitical vulnerabilities and supply risks. Furthermore, conventional lithium extraction methods raise substantial

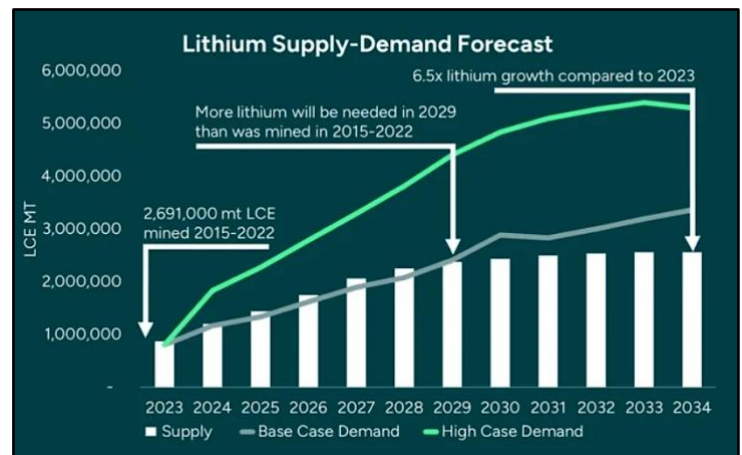


Figure 1: Source- [Lithium Harvest](#)

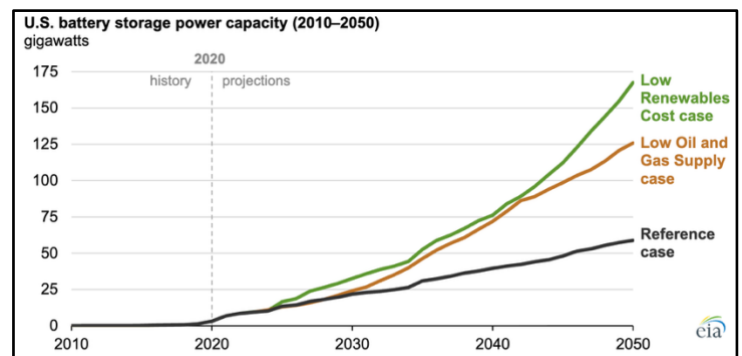


Figure 2: Source- U.S Energy Information Administration, [Annual Energy Outlook 2021](#)

environmental and social concerns, including water depletion, ecosystem disruption, and impacts on Indigenous communities, particularly in regions like South America's "South American altiplano". Consequently, there is a growing emphasis on developing more sustainable extraction technologies, such as direct lithium extraction (DLE), promoting a circular economy through battery recycling, and ensuring responsible sourcing practices to mitigate these impacts as the energy transition accelerates (Berndes et al., 2003; Sugiyama, 2012).

As demonstrated in Figure 3, the trajectory of lithium demand is on a collision course with ecological limits. The widening expanse of 'Unsustainable Supply' (highlighted in red) indicates a projected reliance on extraction techniques that carry severe socio-environmental externalities, including aquifer depletion and biodiversity loss. In contrast, the 'Sustainable Supply' (green area) remains insufficient to meet even base-case demand scenarios. Bridging this gap without resorting to the destructive practices shown in the red zone requires a paradigm shift toward circular systems. Direct lithium extraction from produced water decouples production from land-use conflicts, offering a scalable mechanism to meet demand while adhering to the strict environmental constraints represented by the green supply curve.

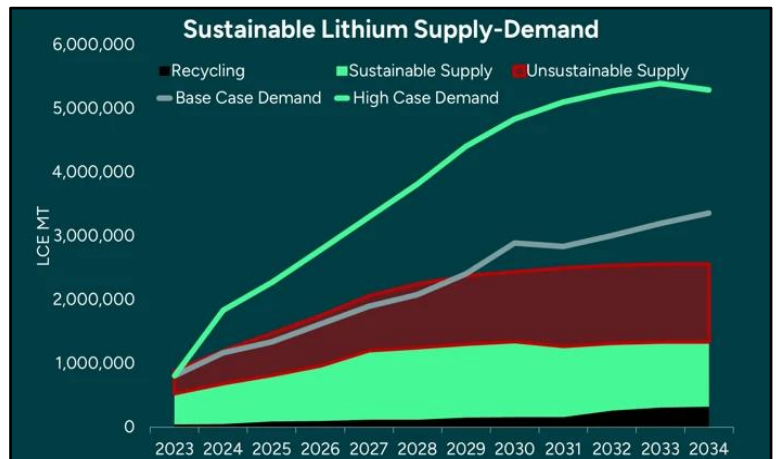


Figure 3: Source – [Lithium Harvest](#)

## LITHIUM MINING PROCESSES

The rise in global lithium demand has driven a surge in diverse extraction techniques, each with distinct environmental, technical, and economic tradeoffs. The primary lithium extraction pathways are described below, but while these processes are well-documented, their profound geographic concentration is a critical and often overlooked aspect of the clean energy transition. This concentration—with extraction dominated by a few key regions and refining controlled by a handful of nations—creates significant supply chain vulnerabilities and localized environmental justice challenges. Understanding the *where* and *how* of each step is therefore essential for evaluating the life cycle impacts and future scalability of the lithium supply chain, setting the stage for the spatial analysis that follows.

**Lithium brine evaporation:** Lithium is commonly extracted from continental salt-lake brines in the region spanning the Chile-Argentina-Bolivia borderland arid salt flats, known colloquially as *salares*. Brine containing lithium (typically 200–1500 mg/L) is pumped into large evaporation ponds and concentrated by solar evaporation over 12–18 months. As water evaporates, salts crystallize sequentially; unwanted magnesium is removed by adding reagents (lime and soda ash) that precipitate magnesium hydroxide and carbonate (Marcinov et al., 2023). After most

impurities (e.g. calcium, magnesium, boron) are removed, the enriched brine (largely lithium chloride) is treated to recover lithium. Lithium is typically precipitated as lithium carbonate by adding sodium carbonate (soda ash) at elevated temperature, yielding a >99% pure  $\text{Li}_2\text{CO}_3$  product (Marcinov et al., 2023). This lithium carbonate can be further converted to lithium hydroxide by reacting it with lime (calcium hydroxide) if needed for battery applications. Brine extraction is cost-effective but slow, and new direct lithium extraction methods are being developed to accelerate the process (Peichel & Dewanaga, 2024).

**Hard rock (pegmatite) mining:** Another major source of lithium is hard rock ore, primarily the mineral spodumene (a lithium aluminosilicate) found in pegmatite rock deposits. The ore is mined (often in open pits) and upgraded via crushing and flotation to a spodumene concentrate. To extract lithium, the concentrate is first roasted at about 1000–1100 °C to convert it from  $\alpha$ -spodumene to  $\beta$ -spodumene, a more reactive form (Marcinov et al., 2023). The roasted material is then cooled and leached with concentrated sulfuric acid at ~250 °C, converting lithium into soluble lithium sulfate ( $\text{Li}_2\text{SO}_4$ ) (Marcinov et al., 2023). Water is added to dissolve the lithium sulfate, and the solution is purified through precipitation: additives like limestone ( $\text{CaCO}_3$ ) remove iron/aluminum as insoluble sulfates, lime ( $\text{CaO}$ ) removes magnesium, and soda ash ( $\text{Na}_2\text{CO}_3$ ) removes excess calcium (Marcinov et al., 2023). The purified lithium-rich solution is then treated with soda ash to precipitate lithium carbonate, which is filtered, dried, and packaged (Marcinov et al., 2023). This technical-grade lithium carbonate may be refined to battery-grade specifications or converted to lithium hydroxide via reaction with lime (Peichel & Dewanaga, 2024), depending on the end-use in batteries.

**Other extraction methods:** Beyond conventional brines and spodumene, other lithium sources are under development. Clay-rich lithium deposits (e.g. hectorite clay in Nevada) can be processed by acid leaching—often after thermal treatment—to dissolve lithium. For example, clay or clay-like minerals (mica) are roasted with reagents or directly leached with sulfuric acid to yield lithium sulfate solutions, which can be processed into lithium carbonate like spodumene routes. Additionally, geothermal and oilfield brines are being explored using direct lithium extraction (DLE) techniques (Peichel & Dewanaga, 2024). DLE methods, using selective absorbents, ion-exchange resins, or electrochemical cells, aim to extract lithium ions from brine more quickly and with less water loss than traditional evaporation (Peichel & Dewanaga, 2024). These emerging methods are not yet widely commercial but could significantly expand lithium supply if proven at scale.

After extraction and refining, lithium compounds enter global supply chains to meet industrial demand. The lithium carbonate or hydroxide produced is shipped to battery material manufacturers (primarily in East Asia) and processed into cathode materials for lithium-ion batteries (Scott, 2022). Electric vehicle batteries have become the dominant market for lithium: in 2022 about 60% of global lithium demand was for EV battery production (IEA, 2023). Stationary energy storage systems and consumer electronics are smaller but rapidly growing lithium-ion battery markets (Vega, 2023). A portion of lithium output is still used in traditional applications (such as glass, ceramics, and lubricants), but battery-related uses now drive most of the lithium consumption. Notably, the conversion step from raw lithium to battery-grade chemicals is concentrated in a few countries; for example, China alone currently

controls roughly 60% of global lithium refining capacity (Scott, 2022). Thus, lithium extracted from brines in South America or rocks in Australia often travels through global supply networks—frequently being processed in China—before finally being incorporated into electric car batteries, grid storage systems, and other end products that underpin the clean energy transition.

## **ENVIRONMENTAL IMPACTS**

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Mining is a deeply physical process, whether occurring in brine or mineral deposits, which creates a vast potential for impacts to land, air, and water resources and those systems that rely on such resources. For example, air quality around lithium extraction sites is a major issue. Communities near California's Salton Sea (Imperial County) already endure high particulate levels (PM<sub>2.5</sub> and PM<sub>10</sub>) due to agricultural dust and the receding lakebed, resulting in asthma rates roughly double the U.S. average (Hopper, 2024; California Air Resources Board, 2023). New lithium brine facilities risk adding more dust (from construction, roads, and exposed tailings) and emissions (e.g., hydrogen chloride gas from processing) to already degraded air. In remote Andean salt flats, heavy truck traffic and dry windswept conditions also generate dust, but a lack of consistent, real-time monitoring means these impacts are often under-characterized (Borda et al., 2022). Community-driven efforts, such as balloon mapping by Alianza Coachella Valley, have thus become crucial for gathering air quality data where official monitoring is sparse.

The hydrological interconnection between lithium-rich brine deposits and freshwater aquifers remains poorly understood, complicating efforts to assess the full ecological consequences of extraction (Babidge, 2021). Water use emerges as another critical concern. Lithium brine extraction is water-intensive, straining scarce water resources in arid regions. In Chile's Salar de Atacama, pumping brine and freshwater for evaporation ponds consumes enormous volumes up to 2.2 million liters of water *per tonne* of lithium carbonate produced (Euronews Green, 2022), contributing to regional water stress. In Argentina's portion of the South America's lithium-rich Andean regions two major projects extracted 12.2 billion liters of lithium-rich brine in 2023, along with 3.7 billion liters of freshwater, an amount 31 times the annual water use of local communities (Global Press Journal, 2024). Such groundwater withdrawals far exceed recharge rates, leading to declining aquifer levels. In California's Imperial Valley, direct lithium extraction (DLE) is touted as less water-intensive than South America's evaporation ponds. However, freshwater will still be needed for cooling and processing; if the planned South America's lithium-rich Andean regions operate at full scale, it could exceed the region's entire current non-agricultural water allocation (Earthworks, 2023a). Moreover, any diversion of water from farms to lithium facilities may accelerate the Salton Sea's shrinkage, worsening dust storms and ecological collapse (Earthworks, 2023b). Across all sites, the risk of brine or chemical spills looms. A containment failure could contaminate soil or drinking water with concentrated salts, heavy metals, or process chemicals. The repercussions are expected to escalate as climate change modifies precipitation patterns and external labor

migration associated with mining operations heightens local water demand, further stressing delicate hydrological systems.

Downstream ecosystem impacts of lithium mining span habitat disruption, altered hydrology, and threats to wildlife. Brine extraction has been linked to the shrinkage of Salt Lake shorelines and wetlands, endangering species that depend on them. For example, in Chile's Atacama Desert, satellites show the salt flat's surface sinking approximately 1–2 cm per year in heavily pumped areas (Reuters, 2024), and groundwater drawdown has reduced spring and lagoon levels. Indigenous Atacameño communities report that freshwater once available for people and animals is drying up, forcing villagers to ration water or even drink arsenic-laden river water (Global Press Journal, 2024; Alarcón, 2023). Scientific studies have tied these changes to declining biodiversity; for example, flamingo populations in the Atacama have dropped significantly in the last decade, correlating with increased lithium brine pumping (Reuters, 2022). The saline intrusion of aquifers is a critical concern. Modeling in Argentina's Olaroz-Cauchari basin predicts that intensive brine extraction will pull surrounding freshwater toward the salars, irreversibly salinizing it and causing springs and wetlands to dry up (Global Press Journal, 2024). At the Salton Sea in California, the receding shoreline (a byproduct of water diversion) provides a cautionary example of ecosystem unraveling: as water levels drop, the remaining lake grows more saline and nutrient concentrated, triggering mass fish die-offs, avian cholera outbreaks, and toxic algal blooms (Mendenhall, 2023). The newly exposed playa becomes a source of contaminated dust (laden with agricultural pesticides and metals) that disperses into nearby wildlife refuges and communities (California Air Resources Board, 2023). Efforts are underway to mitigate dust by constructing wind barriers and wetland projects, but full ecological restoration remains challenging.

## **ECONOMIC DEVELOPMENT**

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Lithium mining has been advocated by governments and business leaders as a catalyst for regional economic rejuvenation, especially in previously underprivileged communities. California energy authorities and entrepreneurs contend that the geothermal-lithium sector near the Salton Sea may provide as many as 1,400 new jobs and rejuvenate Imperial County, one of the state's most impoverished areas (Roth, 2022). The Thacker Pass lithium project in Nevada is projected to provide 300–500 permanent employment and yield over \$1 billion in economic activity, as estimated by Lithium Americas (Lithium Americas, 2023). In Argentina's lithium-rich salars, collaborations between local municipalities and mining enterprises have facilitated investments in infrastructure, encompassing road enhancements, water access systems, and essential medical supplies in communities like those in Jujuy and Salta provinces (Baker Institute, 2022). Although technological advancements offer concrete advantages, detractors contend that these benefits are frequently ephemeral, inequitably allocated, or contingent upon market fluctuations and foreign investment interests (Babidge, 2021).

Advocates of lithium mining highlight its critical importance in facilitating the clean energy transition, which numerous communities anticipate will mitigate long-term climate-related hazards. Salton Sea proponents emphasize the possibility of "green lithium" production

through geothermal extraction, which has a reduced surface footprint compared to conventional brine or hard rock processes, potentially establishing California as a global leader in sustainable lithium sourcing (Mendenhall, 2023). In Argentina, certain Indigenous and rural groups have established royalty agreements and restricted co-management frameworks, claiming their entitlement to a portion of project earnings and the capacity to influence development priorities (Villegas & Puente, 2022). These advancements are frequently presented as paradigms for more egalitarian and sustainable resource management. Scholars warn that power imbalances in these agreements, coupled with inadequate implementation of Free, Prior, and Informed Consent (FPIC), undermine the significance of community engagement and the realization of long-term benefits (Temper et al., 2023).

## **SOCIAL IMPACTS**

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The accelerating demand for lithium across the Americas has spurred a boom in extraction projects, particularly in regions like Chile's Atacama Desert, Argentina's Jujuy Province, and California's Imperial Valley. While these projects are framed as necessary for the global energy transition, they have also led to profound social and psychological consequences for surrounding communities. These impacts include rising mental health distress, labor exploitation, gender inequities, public health challenges, and institutional failures, all of which compound environmental injustices on the ground.

Communities affected by lithium mining report increased mental health issues, including anxiety, depression, and community-wide stress related to environmental degradation and uncertainty about the future (Climigration Network, 2024; Harvard Medicine Magazine, 2023). In frontline areas like the in areas among the Andean or South America, these feelings of distress are often tied to the loss of ancestral lands, water scarcity, and fear of long-term ecological collapse (Nature, 2024). Labor conditions in these mining zones are also fraught with systemic inequality. Local Indigenous workers are frequently marginalized from significant involvement in decision-making processes concerning lithium mining initiatives. Importantly, many lithium-rich sites overlap with sacred Indigenous lands or culturally important landscapes. From the Atacama Desert where water ("puri") is revered in Indigenous cosmology, to California's Torres Martinez Desert Cahuilla lands by the Salton Sea, native communities express concern that unfettered lithium development could desecrate ancestral sites and erode traditional livelihoods. These social and spiritual dimensions underscore that the "green energy" revolution has hidden costs borne by local people. Robust engagement with Indigenous and frontline communities and inclusion of their knowledge is increasingly seen as essential to balance lithium demand with environmental justice.

This exclusion is not merely fortuitous but is entrenched in and sustained by systemic classism, racism, and colorism frameworks that marginalize persons based on socioeconomic status, racial identity, and skin tone. Scholars like Hooks (2000) and González-López (2005) demonstrate that these intersecting systems of oppression determine who is perceived as worthy of power, representation, and labor protections. The marginalization of Indigenous

laborers perpetuates their relegation to subordinate, informal, or precarious employment with no regulation, fostering an environment conducive to extensive labor exploitation. The dynamics are particularly evident in "frontline communities," a term in environmental justice research that refers to populations facing the earliest and most severe impacts of environmental degradation due to their geographic and socioeconomic status (Bullard, 2000). To comprehend labor injustices in lithium mining regions, it is crucial to examine the intersection of structural forces that perpetuate historical imbalances related to race, class, and colonial identity. The lack of local hiring or fair wages has fueled protests and social unrest in communities such as those near the Uyuni and Olaroz salars (ScienceDirect, 2022; Latin Lawyer, 2023).

The convergence of gender with other social identities such as race, class, and Indigeneity modulates the experience of affects, especially for women and gender-diverse individuals. Although gender roles may offer social organization in certain groups, they can also perpetuate inequalities in work expectations, decision-making power, and vulnerability to environmental hazards. Consequently, incorporating gender into a comprehensive intersectional study is crucial for assessing the disparate effects of extraction initiatives. Lithium extraction is a male-dominated industry, yet women disproportionately shoulder unpaid care work and participate in informal economies, such as street vending and food preparation (Extractive Industries Transparency Initiative [EITI], 2023). These roles lack protection and income stability (International Labour Organization, 2020). Moreover, the financial shifts that come with male employment in extractive industries can increase domestic violence and social instability (Data-Pop Alliance, 2021; Stockholm Environment Institute (SEI), 2024). Lithium development also contributes to public health crises. Extraction sites often lack proper infrastructure and health systems, making communities vulnerable to respiratory illnesses from dust, waterborne diseases, and other chronic illnesses resulting from mining operations (Wetlands International, 2023). In some areas, mine-related water depletion and contamination have compounded already fragile health conditions and extended the duration of local disease outbreaks (ScienceDirect, 2022).

Finally, corruption and weak governance brought about by increasing financial incentives in the rapidly growing lithium industry worsen these effects. In many regions, governments have prioritized foreign investment over local well-being, fast-tracking lithium deals without proper consultation or environmental assessments (EHN Curators, 2025). The resulting lack of governmental oversight and institutional accountability leads to community distrust and systemic exclusion (Transparency International, 2023; Earth Island Journal, 2024). Collectively, these behavioral and psychological impacts show that lithium extraction is not just an environmental or economic issue but a deeply social one. A just energy transition must recognize and mitigate these harms, centering community voices and health as key components of sustainability.

## STUDY GOALS

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With the benefits of climate-change mitigating decarbonization acknowledged, this research seeks to understand the complex, interrelated dynamics of lithium extraction impacts to the environment and society. It centers on communities impacted — with a focus on Indigenous or otherwise marginalized communities — asking the following questions:

- 1. Where are the current and emerging lithium mining operations located across the Americas, and how do these sites spatially intersect with key socio-environmental risk factors such as Indigenous territories, water stress, and biodiversity hotspots?**
- 2. What gaps exist in the data and governance frameworks surrounding lithium extraction, and how can more context-sensitive, equitable, and transparent mapping approaches inform better policy and decision-making?**

To answer these questions, this research employs a mixed-methods approach that includes a literature review (above), mine site data collection and validation, geospatial analysis, and case-study analysis from identified mining clusters or hot-spots. These analyses are then contextualized by key-informant interviews with lithium policy experts, community advocates, and government officials.

## MAPPING AND DATA PRODUCT METHODS

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### DATASET ASSEMBLY

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To identify and map lithium mine sites across the Americas, we began with a multi-pronged data assembly strategy. An AI-assisted web search was conducted to generate a preliminary list of lithium mine locations. Each of these sites was then manually validated using satellite imagery and Google Maps to confirm the presence and characteristics of mining activity.

The primary dataset used in our analysis was the U.S. Geological Survey's (USGS) Global Distribution of Selected Mines, Deposits, and Districts of Critical Minerals GIS dataset. This dataset was filtered to include only sites listing lithium as a commodity. We further refined the dataset by categorizing mine statuses as active, in development, in construction (plant), or inactive. Only sites verified as actively producing lithium were retained for core analyses. However, this filtering process revealed a key limitation: many entries labeled as "Producer" were found—through satellite imagery and online searches—to be inactive or non-operational. Over 50% of these so-called producers showed no observable mining activity, highlighting a significant shortcoming in the official USGS classifications.

To supplement the USGS data and address gaps—particularly in rapidly evolving regions—we incorporated additional sources. Literature reviews and satellite-based investigations identified further sites, while AI-generated suggestions were similarly vetted. Given the recent surge in lithium mining activity in Brazil, which has largely occurred after the most recent USGS dataset was published, we used a separate dataset from the Brazilian Geological Survey. This dataset was filtered to include sites listing either "Lítio" or "Pegmatito" as key commodities, allowing us to capture more current lithium development in the region.

Through this layered approach, we assembled a comprehensive geospatial dataset that underpins the mapping and analysis components of our project.

### IMPACT DIMENSIONS

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To begin the geospatial analysis, possible analysis questions were asked and then were categorized per their impact dimension. The data necessary to complete the analysis was identified and then searched for using internet search. Impact dimensions analyzed included the following impact dimensions (social or environmental), analysis questions, data needs, and data used:

Impact Dimension	Mapping Analysis	Mapping Data Need	Data Analyzed
Social	Identify what lithium mining sites fall within tribal territories and lands	Maps of Indigenous lands	US Reservations, Brazilian Federally Recognized Tribal

			Areas, and Native Lands Digital
<b>Environmental</b>	Identify what lithium mines fall within water scarce areas	Maps of regional water scarcity	Aqueduct Water Stress Atlas
<b>Environmental</b>	Identify what lithium mining sites are within wildlife areas or biodiversity areas	Map of wildlife areas	Bird, mammal, and amphibian biodiversity in Brazil

Additional impact dimensions proposed — that could be analyzed in the future pending data availability — include the following:

<b>Impact Dimension</b>	<b>Mapping Analysis</b>	<b>Mapping Data Need</b>	<b>Data Analyzed</b>
<b>Social</b>	Identify what lithium mining sites are within conflict areas	Conflict map	N/A
<b>Social</b>	Identify what lithium mines have high potential to impact ecotourism hotspots	Map of ecotourism hotspots	N/A
<b>Environmental</b>	Identify what lithium mines are impacting what groundwater sources	Groundwater maps	N/A
<b>Environmental</b>	Identify what lithium mines fall within proximity of surface water	Surface water maps	N/A
<b>Social</b>	Identify what lithium mines fall within proximity of urban developments	City / town maps	N/A
<b>Environmental</b>	Identify what lithium mines sites are within areas experiencing soil degradation	Agriculture maps	N/A
<b>Environmental</b>	Identify correlations between air quality degradation and mine development	AQI, PMI, satellite data	N/A
<b>Social / Environmental</b>	Count human populations in proximity to lithium mines at distances relevant to dust transport or water pollution	Population density maps, dust and pollution transport studies	N/A

## **MAPPING ANALYSIS METHODS**

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Mining sites were categorized by development stage to differentiate potential levels of impact. However, the USGS dataset had limitations: over 50% of sites labeled as “Producers” showed no active mining upon verification. To address this, a separate dataset of verified active lithium mines was created. Data gaps, especially in social and ecological dimensions, were bridged using open-access tools like Aqueduct’s Water Risk Atlas and Native Lands Digital.

Two datasets were used for the analysis of mining impacts to federally recognized Indigenous territories. The American Indian Reservations shapefile produced by the US Census Bureau and the Indigenous lands of Brazil compiled by the Global Forest Watch were mapped along with compiled mining sites. No mining sites or deposits occurred on federally recognized tribal territories.

Recognizing the small percentage of Indigenous territories that have been federally recognized, a second analysis was done using Native Lands Digital. The historical Indigenous territories compiled by this dataset were mapped with the mining sites, and the “Join Attributes by Location (Summary)” tool was used to create a new field with the number of overlapping territories on each mining site.

A more in-depth mapping analysis was done on Brazil due to its rapid and recent expansion of lithium operations, rich biodiversity, history of artisanal mining, pegmatite instead of brine mines, and extensive knowledge gaps on its lithium mining impacts. Lithium mining deposits from the Brazilian Geological Survey were visualized by status with a focus on *minas* (mines) and *garimpos* (artisanal mines). Vertebrate biodiversity rasters of Brazil were obtained from Jenkins et al. who created rasters visualizing numbers of mammal, bird, and amphibian species. “Sample Raster Values” was used to obtain the number of species of each vertebrate class for each mining location. These were then added together to create a “biodiversity index” which was then visualized to find mining sites with the highest biodiversity.

This analysis highlights both spatial patterns of impact and the limitations of existing global datasets, underscoring the need for more granular, locally validated data to inform just and sustainable lithium sourcing.

## **MAPPING RESULTS**

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### **WATER STRESS**

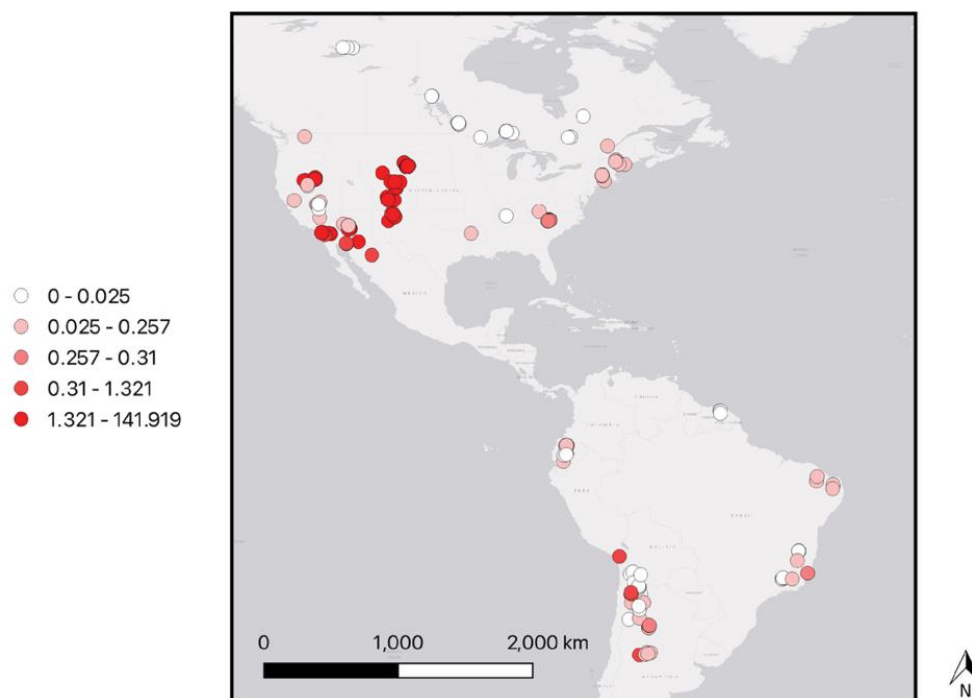
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Water stress was assessed using the World Resources Institute’s Aqueduct Water Risk Atlas, specifically the Aqueduct 3.0 Global Maps dataset. This version introduced key improvements in hydrological modeling, including integrated surface and groundwater data, higher spatial resolution, and monthly time series capabilities. Aqueduct 3.0 combines 13 indicators—spanning water quantity, quality, and reputational risks—into an intuitive composite index designed to help non-experts interpret water-related threats across regions.

For this analysis, we used Aqueduct 3.0's 2040 business-as-usual scenario projections to evaluate future water stress at lithium mining sites. These projections reflect modeled changes in water supply and demand under assumptions of continued economic and population growth with no major shifts in policy. While useful for broad-scale prioritization, the tool is not intended for site-level validation and must be supplemented with local context. In arid regions like the South American altiplano, for instance, Aqueduct's demand-based metrics may underestimate environmental risks. Low population densities can mask extreme baseline water scarcity, leading to deceptively low water stress scores in ecosystems already under hydrological strain. This highlights a broader limitation of many global datasets: they often fail to account for ecological vulnerability in low-demand areas, as well as region-specific social and environmental dynamics.

Despite these limitations, Aqueduct 3.0 served as a critical reference point in our mapping efforts—providing consistent, comparative indicators of projected water stress across geographies (Figure 1). Its insights were paired with local datasets and ground-truthed observations to more accurately assess the socio-environmental risks associated with lithium extraction. Sites were ranked by projected stress levels, revealing the Salton Sea as a clear outlier (score of 141.9)—facing nearly 8 times higher projected water stress than the next highest water stress score—likely driven by a higher regional population and agricultural demand pressures (see Case Studies: Salton Sea).

### **Aqueduct Water Stress Map**



*Figure 1: Water stress at verified lithium mining sites using WRI's Aqueduct 3.0 projections for 2040 under a business-as-usual scenario.*

## NATIVE LANDS DIGITAL

As demonstrated by data from Native Lands Digital, 304/328 mining sites overlap with at least one Indigenous territory in the dataset (Figure 2). While most of the mine locations in the USGS dataset used for this analysis do not have current mining operations, identified active and developing mining sites do show Indigenous territory overlap, with many in the South American altiplano having 4-5 overlapping territories. These results are corroborated in the case studies with each case study location having multiple local Indigenous communities expressing concerns over social and environmental impacts. This suggests that nearly all future and current mines will have local Indigenous communities who are likely to be impacted by lithium mining in some form and should be taken into consideration for each project.

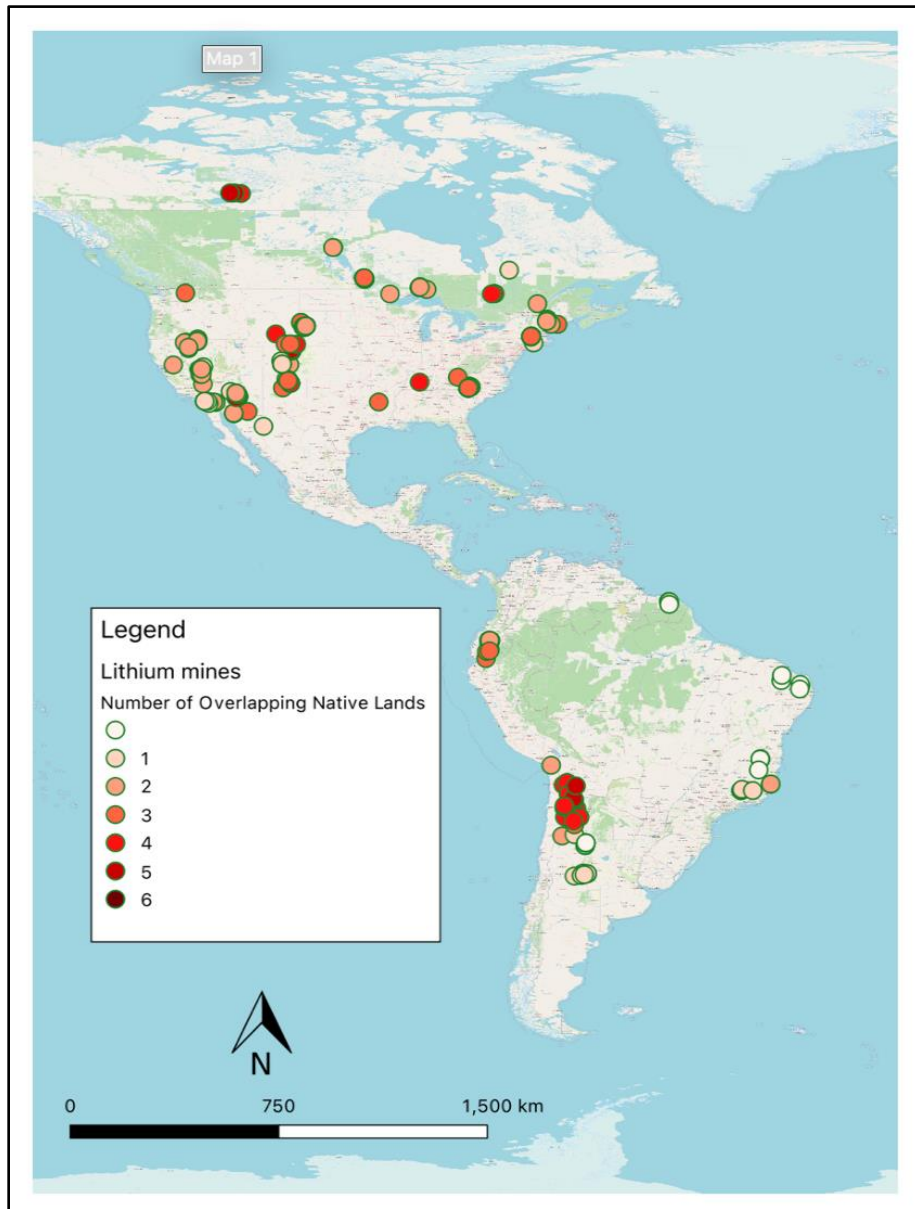


Figure 2: Map Showcasing the Number of Mines That Overlap Historic Native Lands

## BRAZILIAN GEOLOGICAL SURVEY DATA



A comparison between the 1. USGS mineral resources data and 2. the Brazilian Geological Survey (BGS) data show the disparity and rapid development and research of Brazil's lithium resources. Nearly  $\frac{1}{4}$  of BGS lithium sites are identified as artisanal mines which is unique to Brazil's mining history and invites further research due to the different impacts and unregulated nature of small-scale mining.

Species richness indices for birds, mammals, and amphibians were summed to create a total biodiversity index. Lithium sites in areas with the highest biodiversity occur in southern Minas Gerais which is expected given its proximity to the Atlantic Forest. At least one active lithium mine is known in this area, the Volta Grande mine operated by AMG. Many endangered and endemic species are found within the area, and the specific impacts of mining to these species is unclear. Pollution and silting of waterways are one known impact of pegmatite mining within Minas Gerais which has potential impacts to amphibians or aquatic mammals and birds such as the critically endangered Brazilian merganser (Lamas, I. R. and L. V. Lins, 2020). Further field research is needed to fully understand these potential impacts.



## MAPPING BARRIERS AND DATA LIMITATIONS

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This research further illuminates multiple mapping barriers related to data quality and access:

1. **Data availability:** Publicly available interactive or static maps for the indicators we identified often exist but access to underlying data source files can be difficult to obtain, hidden behind substantial paywalls, or with complex data sharing requirements, and therefore are challenging to analyze
2. **Data quality:** The USGS dataset is the most comprehensive and readily available dataset of mines we found, but there are rampant inaccuracies and outdated data points
3. **Generalizations and mischaracterizations:** Mapping datasets do not always reflect regional realities. Water stress (per Aqueduct) being relatively lower (e.g. water stress poses less of an environmental or social concern) in the Andean salt flat region is an example of this — because it is a sparsely populated area both human and ecological water demand are naturally low, however, even small pressures on the limited freshwater resources there can have drastic effects as it is an arid area with a sensitive ecosystem

Our validated dataset seeks to help fill this gap. Despite the breadth of available mapping resources, our analysis revealed major gaps in data quality, accessibility, and contextual accuracy. Many global datasets—such as those from USGS or WRI’s Aqueduct—are either outdated, overly coarse, or lack downloadable spatial files, limiting their usefulness for site-specific analysis. For instance, the USGS lithium mine dataset, while comprehensive, includes numerous inactive sites mislabeled as producers, inflating perceptions of mining activity. Similarly, Aqueduct underestimates water stress in the South American altiplano due to its reliance on demand-based metrics, which overlook baseline scarcity in hyper-arid regions. This leads to misleadingly low water risk scores in ecosystems already under severe hydrological strain.

Additionally, many datasets fail to account for region-specific socio-environmental dynamics—such as the lack of recognition of Indigenous territories or biodiversity sensitivity around artisanal mining zones. These oversights obscure key risks and can result in flawed impact assessments. By ground-truthing data and incorporating locally relevant variables, ongoing mapping efforts fill critical blind spots and underscore the need for more accurate, accessible, and context-sensitive spatial data. Identifying these gaps is itself a valuable contribution, informing both future research priorities and the development of more equitable mineral governance frameworks.

## **KEY INFORMANT INTERVIEWS (KIIS)**

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We used key informant interviews which are semi-structured and context-specific conversations designed to elicit insights from individuals with specialized knowledge or lived experience relevant to the report's focus. In this project, interviews were conducted to better understand the governance, environmental, and social dimensions of lithium extraction across multiple jurisdictions. We sought to engage experts working at the intersection of policy, regulation, and community advocacy to inform equitable and effective policy solutions.

The questions posed varied by role but generally focused on governance mechanisms, community participation, environmental oversight, Indigenous rights, permitting procedures, and strategies to align resource extraction with social equity and environmental sustainability. These questions were designed to probe both technical procedures and political dynamics, with the goal of generating grounded, context-sensitive policy recommendations for more just and accountable lithium supply chains. See Appendix A for a more detailed section on KIIs.

## **KII KEY TAKEAWAYS**

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- **Community-centered governance is essential:** Across geographies, interviewees emphasized the need for sustained, trust-based engagement with local and Indigenous communities in lithium development.
- **Environmental regulation is evolving—but uneven:** Argentina and California both face challenges in adapting legacy regulatory systems to rapidly advancing lithium technologies and ecological demands.
- Water remains a central axis of conflict and innovation, particularly in arid zones like Catamarca and Imperial Valley.
- Community Benefit Agreements (CBAs) are emerging as key tools to align public investment with equity, particularly in California.
- Institutional capacity and coordination are critical—whether between ministries in Argentina or agencies and CBOs in California.
- New technologies like Direct Lithium Extraction (DLE) offer promise but require governance systems that are both agile and precautionary.

## CASE STUDY METHODS

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The purpose of the case studies was to conduct an in-depth analysis of the tangible socio-environmental effects of lithium mining in specific "hot-spot" regions, focusing on Indigenous and marginalized communities. Across each case, the authors systematically examined key environmental impacts (like water consumption, habitat disruption, and pollution), social impacts (including effects on local employment, community health, cultural preservation, and Indigenous rights), and concluded with tailored policy recommendations. Information was gathered through a comprehensive review of diverse sources, including peer-reviewed literature, government documents and permits, news articles, reports from non-governmental organizations, and corporate publications, all of which are cited extensively throughout the case study sections.

## CASE STUDY RESULTS

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The case study findings reveal that across diverse geographies and extraction methods—from brine evaporation in the Andean salt flats and Nevada to hard-rock mining in Canada and Brazil and geothermal DLE at the Salton Sea—lithium development consistently generates profound socio-environmental conflicts. A universal link of conflict is

**Water**, with projects causing severe hydrological stress through depletion and contamination in arid and semi-arid regions. Furthermore, the case studies demonstrate that mining operations disproportionately impact Indigenous and marginalized communities, leading to the desecration of sacred lands, the disruption of traditional livelihoods, and significant community health risks. These impacts are compounded by systemic governance failures, where the promise of economic revitalization is often undermined by inequitable benefit distribution, inadequate consultation, and corporate strategies that create social fragmentation rather than shared prosperity.

The policy recommendations emerging from these findings converge on several key pillars for reform. Foremost is the mandate to institutionalize and enforce:

1. **Meaningful consultation and achieve Free, Prior, and Informed Consent (FPIC)** with Indigenous peoples, moving beyond procedural compliance to genuine partnership and respect for sovereignty. Second, there is a consistent call to strengthen environmental oversight by requiring
2. **Comprehensive, cumulative impact assessments**, particularly for water resources, and implementing transparent, long-term monitoring programs with robust financial assurances for reclamation. Finally, to ensure economic benefits are realized locally, recommendations advocate for legally binding mechanisms such as
3. **Community Benefit Agreements (CBAs)** and Indigenous-led trusts that mandate local hiring, fair wages, and direct revenue sharing to foster just and sustainable development.

## DISCUSSION

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This project revealed both the promise and complexity of using geospatial tools to assess the socio-environmental impacts of lithium mining across the Americas. While our final mining sites and indicators dataset enabled new forms of visual analysis and policy insight, the path to its creation was shaped by major data constraints. Across jurisdictions, we encountered gaps in data availability, quality, and contextual accuracy—especially concerning Indigenous land boundaries, biodiversity hotspots, and artisanal mining activity. Many global datasets, such as those from the USGS and WRI’s Aqueduct, offered broad coverage but lacked the resolution or cultural nuance necessary for place-based impact analysis. For example, Aqueduct’s reliance on demand-weighted metrics underestimated ecological vulnerability in hyper-arid regions, while the USGS dataset mislabeled inactive mining sites as active producers, requiring extensive manual verification.

Yet within these limitations, the research also highlighted critical opportunities. By ground-truthing data, layering region-specific datasets, and applying spatial analysis tools, we were able to surface patterns of environmental risk and community overlap that might otherwise go unrecognized. Our mapping of Indigenous territories using Native Lands Digital, for instance, revealed that nearly all active and developing lithium projects occur on or near lands with strong Indigenous affiliations—raising urgent questions about procedural rights, FPIC, and long-term cultural impacts. Similarly, the biodiversity index developed for Brazil showcases how geospatial tools can pinpoint areas of heightened ecological sensitivity, informing conservation priorities before impacts escalate.

This work underscored a broader lesson: the energy transition must be accompanied by a transition in how we govern and assess mineral development. The lack of transparent, granular, and locally informed data is not just a technical problem—it reflects deeper governance and equity challenges. Mapping, when done critically, can serve not only as a diagnostic tool, but as an accountability mechanism.

Moving forward, the integration of locally collected environmental data, improved classification standards, and participatory mapping processes will be essential. Our findings suggest the need for investment in open-access spatial infrastructure, Indigenous-led data stewardship, and stronger international collaboration on environmental monitoring. By bridging data gaps and centering impacted communities, we can better align mineral extraction with principles of environmental justice and sustainable development.

## **APPENDIX A: KEY INFORMANT INTERVIEW SUMMARIES**

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### *Interview #1*

#### **Theo Figurasin – California Assistant Director for Campaigns, Jobs to Move America (JMA)**

Theo Figurasin, the California Assistant Director for Campaigns at Jobs to Move America (JMA), provided insight into the organization’s community-centered approach to public investment, with a focus on lithium extraction and green manufacturing development in California. JMA’s core mission is to “get the best” out of public money, particularly as it flows into clean energy infrastructure. The organization tracks these investments and advocates for policies that maximize socioeconomic and environmental benefits for local communities.

A central mechanism in JMA’s strategy is the Community Benefit Agreement (CBA)—a legally binding contract between developers and community coalitions designed to ensure equitable outcomes. CBAs, which emerged in the late 1990s and early 2000s, are increasingly being explored in the context of lithium mining. According to Figurasin, the CBA process is rooted in long-term community engagement and trust-building, explaining that “a lot of time and investment [is needed] to get to know communities,” and the process must proceed by “moving at the speed of trust.”

Over the past two years, JMA has built relationships with organizations in Imperial County, using meetings, public comment coordination, and strategy discussions to assess alignment and eventually form a formal coalition—an essential first step in CBA development. A notable precedent for this work is the CBA JMA negotiated with BYD, a Chinese electric vehicle manufacturer in Lancaster County, which resulted in “locals [having] well-paying jobs within their communities,” while BYD benefited from public infrastructure grants.

Enforcement of CBAs relies on formalized community coalitions and agreed-upon transparency mechanisms. These include data-sharing requirements such as “numbers/ratios of local hires” and legal recourse through designated venues like courthouses. Figurasin emphasized that this infrastructure is vital for accountability.

Although the California Energy Commission (CEC) has not officially responded to JMA’s August 2024 letter, it has generally been supportive of CBAs. Several CEC-administered federal grants include CBA components in their scoring criteria, and “opt-in certification” processes can accelerate permitting for developers who adopt CBA frameworks.

In terms of tribal engagement, JMA’s outreach in the Imperial Valley is still in early stages. The organization has communicated with the Kwaaymii Laguna Band of Indians, but Figurasin acknowledged that no formal tribal partnerships have been established. He raised concerns about recent state-level legislation shifting project permitting from the CEC to local jurisdictions, noting that local governments often lack the resources to conduct meaningful tribal consultations. This is especially critical given the risk of harm to cultural resources such as mud pots and Obsidian Butte. Figurasin also pointed to broader challenges, including the

“clash of western timelines/science vs tribal timelines/science,” and emphasized that “many times all aspects of the environment are tribal cultural resources.” He underscored the need to better integrate Traditional Indigenous Knowledge (TIK), which is often overlooked in scientific and regulatory frameworks.

Beyond CBAs, JMA also advocates for structural policy reforms at multiple levels of governance. Locally, CBAs are viewed as highly effective because they “create a direct relationship between communities and developers,” circumventing the inefficiencies or political constraints of agency intermediaries. State and federal policies should provide greater oversight of how public funds are used, including mandates for job quality and community engagement. For example, the CEC’s “Power Forward” grant includes a good jobs requirement and a CBA component, which Figurasin sees as a promising model: “Developers competing for these contracts [are under] pressure... to treat communities well [and] be good to [the] environment.”

At the international level, JMA views frameworks such as the Initiative for Responsible Mining Assurance (IRMA) as a step in the right direction. Ideally, frameworks must include enforceability mechanisms for corporate accountability to impacted communities. Figurasin noted that Imperial Valley’s geothermal-powered Direct Lithium Extraction (DLE) operations have the potential to become the global benchmark for low-impact lithium mining. International demand is growing for lithium that is sourced in “environmentally or socially responsible” ways.

Looking ahead, JMA’s goal for Imperial Valley is the negotiation of a CBA that addresses “socioeconomic concerns as well as environmental concerns.” Figurasin remains cautiously optimistic but highlights the need for sustained developer-community cooperation and enforceable safeguards to ensure justice-centered outcomes.

#### *Interview #2*

#### **Noemi Gallardo, Commissioner, California Energy Commission (CEC)**

Noemí Gallardo, the first Latina appointed to the California Energy Commission (CEC), serves as the Commission’s attorney member and leads portfolios including Siting, Transmission, and Environmental Protection (STEP), Lithium Valley, and Energy Equity and Environmental Justice. Gallardo brings a strong legal background and a community-centered ethos to her role, rooted in both her experience in the solar energy industry and her early work with The Greenlining Institute, where she approached energy through a social justice lens.

Gallardo underscored California’s high regulatory standards for environmental protection, particularly in areas like air, water, and land use, enforced through the California Environmental Quality Act (CEQA) and CEC’s certification process. She acknowledged these processes are “rigorous,” and often criticized for delays, but argued that they reflect a necessary balance: “It takes a long time... but you know, it’s important to have that balance.” The CEC has discretion when weighing environmental impacts against benefits like clean

energy production and job creation. If there are “significant unmitigable impacts,” a project may be denied a permit. However, such determinations are made holistically and can include benefits and community support as a factor.

CEC staff prepare technical recommendations, but final permitting decisions rest with commissioners, who may vote differently based on broader considerations. Post-permitting, the CEC monitors and inspects development projects and reviews the use of state grants to ensure alignment with promised outcomes.

Gallardo emphasized that lithium development alone cannot create the type of ecosystem that will catalyze regional prosperity. During fieldwork in Imperial Valley, CEC staff recognized that “if we were solely focused on the developers, I don’t think the area would really thrive.” As a result, Gallardo helped spearhead the Imperial Valley Civic Ecosystem Initiative—a public-private partnership that channels philanthropic and state funds to strengthen local government capacity and support community-based organizations (CBOs). This initiative offers grant writing assistance, policy analysis, and envisions bigger impact such as supporting immigrant entrepreneurship by creating complementary small businesses near lithium facilities.

Gallardo described this approach as a “whole-of-government embrace,” aiming to strengthen “civic infrastructure, not just the metal-in-the-ground infrastructure.” The Latino Community Foundation and Institute for Local Government are leading local and CBO engagement within this initiative.

Gallardo observed residents had environmental and cultural concerns related to geothermal-lithium development in Imperial Valley. While three Berkshire Hathaway applications for geothermal plants did not initially include lithium extraction, “we’re fairly certain... they could lead to lithium development.” The suspended applications raised several critical issues, including:

- Water usage and availability, especially in a resource-scarce region.
- Tribal cultural resources, requiring consultation and protection.
- Soil degradation and air quality concerns, particularly around dust in a region already burdened by respiratory health issues.

Though she noted that the projects were “looking solid” from a technical perspective, addressing tribal and environmental concerns remains essential to moving forward.

Gallardo described Direct Lithium Extraction (DLE) as a reason for the CEC’s excitement for lithium development in the Salton Sea region due to it being a “more sustainable, less impactful type of system.” Unlike conventional mining or brine evaporation, DLE in Imperial Valley would extract lithium from geothermal brine with minimal surface disturbance. Gallardo explained, “We don’t even call it mining... they’re not using a ton of land for evaporation.” The brine is re-injected into the earth, extending the geothermal system’s usability for up to 30–40

years. Despite these benefits, challenges persist due to the heat and corrosiveness of the brine, which has slowed commercial scaling. The CEC is investing in R&D grants to improve DLE efficiency, reduce waste, and increase technological durability.

Gallardo also noted that other critical minerals beyond lithium could be recoverable from geothermal brines, and highlighted additional emerging uses—for instance, lithium’s potential role in nuclear fusion technologies.

As a state-certified interpreter and advocate for multilingual access, Gallardo has prioritized inclusive engagement. Beyond legal obligations, the CEC now proactively translates materials in Spanish and Purépecha, a local Indigenous language, where interpreters are available. However, she noted that “just because we translate the information doesn’t mean they’re going to actually understand it.” To address this, the CEC uses plain language, shorter documents, and visual materials, and conducts smaller community meetings co-organized with local CBOs.

Regarding Community Benefit Agreements (CBAs), Gallardo noted that these are not mandated across all permitting pathways but are required within the AB 205 “Opt-In” program. AB 205 is currently limited to requiring the existence and legal enforceability of a CBA—it does not provide guidance on its quality. However, as in its traditional permitting processes, the CEC has discretion when weighing community impacts and benefits. Gallardo also acknowledged that the presence—or absence—of a CBA is a strong signal of community support: “If no one in the community is agreeing to [a] benefits agreement, you may think something’s off here.”

She expressed a desire to improve the CBA process, emphasizing that the CEC can currently only “encourage” or “suggest” rather than mandate particular community partnerships.

Gallardo closed the interview with a hopeful but realistic perspective: “Silicon Valley helped us change the world, and I think Lithium Valley is going to help us change the world again—but this time with a focus on equity and justice.” She envisions a regional transformation that goes beyond extraction, emphasizing local prosperity, environmental sustainability, and meaningful community participation.

### *Interview #3*

#### **Diego Vallejo, General Supervisor of Water Resources, Secretariat of Water Resources of the Province of Catamarca**

As lithium extraction expands across the South American altiplano region, Argentina’s Catamarca Province has emerged as a critical case for understanding the challenges of environmental governance in arid, lithium-resource-rich regions that must balance tradeoffs between resource extraction and water resource sustainability. This interview explored the experiences of a key official from Catamarca’s provincial government—Diego Vallejo, General

Supervisor in the Water Resources Secretariat—shared insights into their roles, regulatory practices, and lessons learned in overseeing lithium mining projects.

Vallejo operates within a complex institutional landscape. While the Ministry of Mining retains primary authority over brine extraction, the Ministry of Water, Energy, and Environment, through its Environmental Management Directorate and Water Resources Secretariat, is charged with evaluating and monitoring freshwater use and broader environmental impacts. Water scarcity remains a central concern. Vallejo noted that most freshwater sources in Catamarca do not meet potable standards and that mining operations, although geographically distant from major population centers, still exert cumulative pressure on limited water resources. Projects in the Salar del Hombre Muerto, for example, have seen rapid expansion, with more than ten major lithium projects operating in a region inhabited by fewer than twenty people per 100 square kilometers. In response, the Water Secretariat has intensified oversight of freshwater use, requiring companies to submit detailed water footprint calculations and adhere to increasingly rigorous monitoring protocols. Conductivity measurements and other hydrological indicators are employed to trigger early warnings and mitigate risks to aquifers and surrounding ecosystems.

The official also discussed the evolving role of community participation in mining governance. Public hearings and environmental assemblies are now characterized by active citizen involvement and scrutiny. He described this shift as part of a broader societal transformation, wherein communities are “empowered and environmentally aware,” demanding greater transparency and accountability from both industry and government. These dynamics are embedded within Argentina’s broader environmental governance framework, including the Ley General del Ambiente (Law 25.675), which holds constitutional authority and enshrines principles of precaution, prevention, and intergenerational equity. The official acknowledged the importance of adhering to both national and international standards, including provisions related to Indigenous rights and Free, Prior, and Informed Consent (FPIC).

In reflecting on institutional challenges, Vallejo emphasized the steep learning curve experienced by provincial agencies. Catamarca shifted from managing a single major mining project (Minera Alumbrera) to overseeing over 300 lithium-related initiatives in various stages of exploration and development. This rapid escalation, coupled with the unique hydrogeological conditions of the Puna region—where freshwater, brackish, and saline aquifers can coexist within a single stratigraphic profile—required the development of new conceptual models and technical capacity. Vallejo described this process as a “trial-and-error” phase, during which field-based expertise and adaptive governance mechanisms became essential to effective oversight.

Vallejo also underscored the importance of iterative regulation. Environmental assessments evolve alongside a project’s life cycle, with increasing demands placed on companies as they move from preliminary exploration to advanced development and eventual production. Early-stage projects may be required to conduct baseline inventories of water quality and availability, while more advanced operations must produce detailed hydrological and

hydrogeological models. The officials stressed that water use permits are not granted indefinitely; rather, they are subject to annual renewal and conditional upon sustained compliance with environmental indicators.

In addition to technical oversight, the officials emphasized the role of innovation and evolving technology. New methods such as brine reinjection and improved lithium precipitation processes have the potential to significantly reduce water consumption.

Finally, the interview highlighted the need for continued institutional development. Vallejo acknowledged that while Argentina's legal frameworks provide a strong foundation, they often rely on outdated environmental thresholds that may not reflect contemporary scientific understanding or the specific ecological characteristics of the Puna region. Capacity building, cross-sectoral collaboration, and field-based training were identified as ongoing priorities.

In sum, the interview offers a nuanced account of how Catamarca is navigating the environmental, social, and regulatory complexities of the lithium boom. It underscores the need for a multi-scalar governance approach that combines legal rigor, scientific precision, and meaningful community engagement to ensure that lithium extraction proceeds in a manner consistent with long-term ecological sustainability and social equity.

## **APPENDIX B: CASE STUDIES**

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### **NORTH AMERICA**

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#### **NEVADA**

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#### **SILVER PEAK**

The Silver Peak Lithium Mine in Esmeralda County, Nevada, has been producing lithium since 1966<sup>1</sup> and is the only one in the United States. Albemarle Corporation owns this mine, which harvests lithium by injecting lithium-rich brine from subterranean aquifers into enormous solar evaporation ponds located around the Clayton Valley playa. Over 18-24 months, the water in the brine evaporates, concentrating lithium salts for conversion into lithium carbonate or hydroxide. As lithium has become increasingly important for electric car batteries and renewable energy storage, Silver Peak's strategic relevance has expanded. The Biden administration's effort for domestic lithium manufacturing to safeguard supply chains and encourage green technologies has highlighted Silver Peak.<sup>2,3</sup>

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<sup>1</sup> [https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm\\_campaign=widget&utm\\_medium=section\\_row&utm\\_source=sports&utm\\_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25%20expansion#:~:text=increase%20its%20size%20by%20about.25%20percent](https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm_campaign=widget&utm_medium=section_row&utm_source=sports&utm_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25%20expansion#:~:text=increase%20its%20size%20by%20about.25%20percent)

<sup>2</sup> <https://www.albemarle.com/us/en/silver-peak#:~:text=Tapping%20into%20targeted%20aquifers%20that,evaporation%20ponds%20at%20the%20surface>

<sup>3</sup> <https://www.pbs.org/newshour/show/water-domestic-lithium-mining#:~:text=The%20Biden%20administration%20is%20pushing.national%20security%20and%20green%20energy>

## **Environmental Impacts**

**Groundwater Depletion:** Silver Peak's extraction technique requires massive amounts of groundwater. In 2020, the facility pumped over 4 billion gallons of lithium-rich brine and added fresh water for processing.<sup>4</sup> The Central Nevada Regional Water Authority's research reveals that this intense pumping is lowering the water table in Clayton Valley. Groundwater levels have plummeted dramatically, leading to dry wells and the formation of cracks and sinkholes.<sup>4</sup> For example, a monitoring well in the valley ran dry, with the Authority's 2022 annual report stating that the drying was "due exclusively to de-watering throughout Clayton Valley for lithium mining purposes".<sup>4</sup> Local officials have seen disturbing changes: According to an Esmeralda County Commissioner, the mine's hunger for water has caused fissures and sinkholes in the valley, potentially changing the environment.

These hydrological impacts raise concerns about aquifer sustainability and potential effects on any connected springs or fresh water sources. Albemarle claims to precisely control water withdrawals from deep, non-potable saline aquifers that are "four times saltier than seawater"<sup>4</sup> and not suitable for drinking or cultivation.<sup>5</sup> Critics point out that even if the brine is not drinkable, large-scale extraction can have an impact on the groundwater system. Since 2020, Silver Peak has been draining roughly 4 billion gallons per year, resulting in "drastic drops in groundwater levels and visible fissures scarring the land".<sup>6</sup> To minimize long-term aquifer degradation, environmental organizations recommend establishing defined limitations and monitoring standards for mining water consumption.<sup>10</sup>

**Habitat Disruption and Wildlife:** The mine's footprint comprises thousands of acres of evaporation ponds and well pads in a remote desert valley, causing habitat disruption and wildlife damage. Surface operations have a minimal direct impact on desert plants and fauna. There are just a few special-status species on-site, but the activity has created an enticing nuisance for migratory birds. Each spring and autumn,<sup>7</sup> dozens of waterbird species migrate through western Nevada and flock to the huge ponds. Many ponds have high levels of salt and lithium, posing a risk to birds who settle there. Albemarle acknowledges this impact and has committed over \$4 million in an avian control effort at Silver Peak since 2013. This program involves monitoring the ponds, deterring birds with hazing techniques, and rescuing and rehabilitating birds that encounter the brine.<sup>8</sup> A specialized avian team (up to 8 people during migration season) now cares for about 600 birds annually at the location.<sup>9</sup> This corporate mitigation effort, although commendable in terms of assisting individual birds, highlights the ecological disturbance created by the mine's manmade ponds. Aside from avifauna, there is minimal indication of significant habitat degradation associated with Silver Peak's operations in contemporary research. Notably, a separate proposed lithium mine<sup>12</sup> in the neighboring Silver Peak Range threatens an indigenous wildflower, Tiehm's buckwheat, although this is

<sup>4</sup> <https://www.pbs.org/newshour/show/water-domestic-lithium-mining#:~:text=Albemarle%20is%20permitted%20by%20the,of%20freshwater%20to%20extract%20lithium>

<sup>5</sup> <https://www.albemarle.com/us/en/silver-peak#:~:text=Water%20Management>

<sup>6</sup> <https://nevadacurrent.com/2024/08/13/protect-our-water-or-well-face-the-consequences/#:~:text=In%20the%20midst%20of%20a,no%20accountability%20for%20the%20damage>

<sup>7</sup> <https://www.albemarle.com/us/en/silver-peak#:~:text=Wildlife%20Conservation>

<sup>8</sup> <https://www.albemarle.com/us/en/silver-peak#:~:text=stronger%20brine%20concentrations%20can%20pose,a%20risk%20to%20birds>

<sup>9</sup> <https://www.albemarle.com/us/en/silver-peak#:~:text=Since%202013%2C%20we%20have%20invested,about%20600%20birds%20every%20year>

close to the Rhyolite Ridge project, not the Silver Peak brine operation.<sup>10</sup> The BLM's ongoing environmental review for Silver Peak's expansion indicates it will assess impacts on "*migratory birds and raptors; special status species...soils and vegetation*" among other resources, suggesting habitat effects will be scrutinized before any further disturbance is permitted.<sup>11</sup>

**Chemical and Pollution Risks:** Lithium brine extraction is sometimes advertised as being more ecologically friendly than hard-rock mining, however it is not without pollution risks. Silver Peak is experiencing air quality difficulties.<sup>12</sup> In 2025, Nevada state inspectors noticed that the facility was emitting more particulate matter than authorized.<sup>13</sup> An inquiry discovered that one of the mine's rotary dryers (used to dry lithium-bearing material) was spewing particulate at 484% of the allowed limit, suggesting a major breakdown in pollution management.<sup>13</sup> Particulate pollution is a health danger, associated with respiratory and heart difficulties.<sup>13</sup>

As a result, this infraction endangered the safety of workers and neighboring neighbors. In March 2025, the Nevada Division of Environmental Protection convened an enforcement meeting, which demanded corrective steps.<sup>13</sup>

Albemarle updated their equipment and claimed compliance by mid-2024 but were penalized again in January 2025 for delayed reporting.<sup>13</sup> Aside from air emissions, land and water pollution from the Silver Peak business has not been frequently documented in recent years. This episode emphasizes the importance of rigorous monitoring of industrial pollutants and dust in lithium operations.<sup>13</sup> Aside from air emissions, land and water pollution from the Silver Peak business has not been frequently documented in recent years.<sup>13</sup> Early in its existence, the site experienced leaking evaporation ponds due to the very permeable desert soils, which had to be designed to avoid brine seepage.<sup>13</sup> The continuing government examination will also look into hazardous materials management. Overall, while Silver Peak's sun evaporation approach avoids some of the harsh chemicals used in other mining, it still poses environmental hazards such as water depletion, animal damage, and pollution, which are increasingly documented and subject to regulatory supervision.<sup>13</sup>

### **Social Impacts**

**Employment and Economic Dependency:** Albemarle's facility employs over 60 full-time employees, making it the largest employer in the area.<sup>14</sup> These positions are relatively high-paying and highly skilled; according to Albemarle, Silver Peak employees earn in the top percentile of Nevada earnings. The mine also works with local suppliers and service providers, which benefits the rural economy. For the little town of Silver Peak and neighboring Esmeralda County, the mine's existence over decades has provided infrastructural investment and consistent employment in a region with few other businesses. Local leaders typically favor the mine's ongoing operation because of the economic stability it brings. As lithium demand rises, Albemarle has announced intentions to expand the business by around 25% to increase

<sup>10</sup> <https://insideclimatenews.org/news/07062024/nevada-lithium-mine-threatens-endangered-wildflower#:~:text=in%20the%20Silver%20Peak>

<sup>11</sup> <https://www.federalregister.gov/documents/2025/02/28/2025-03299/notice-of-intent-to-prepare-an-environmental-impact-statement-for-the-silver-peak-lithium-mine#:~:text=Summary%20of%20Expected%20Impacts>

<sup>12</sup> <https://www.reviewjournal.com/local/local-nevada/lithium-mine-was-polluting-air-until-nevada-stepped-in-3351566/#:~:text=The%20country%E2%80%99s%20only%20fully%20operational,pollution%20problem%2C%20Nevada%20regulators%20found>

<sup>13</sup> <https://www.reviewjournal.com/local/local-nevada/lithium-mine-was-polluting-air-until-nevada-stepped-in-3351566/#:~:text=Protection%20Agency>

<sup>14</sup> <https://www.albemarle.com/us/en/silver-peak#:~:text=Community%20Benefits>

output. This might result in increased jobs and building activity. However, economic reliance on a single enterprise can be a double-edged sword: inhabitants understand any downturn or stoppage at the mine might jeopardize the community's survival.<sup>15</sup>

**Community Concerns - Water and Environment:** Paradoxically, the same mine that creates work raises quality of life issues among communities. Water security and environmental health are among the most pressing concerns.<sup>16</sup> Silver Peak people rely on the same groundwater basin that the lithium business draws from. The town's municipal well (Silver Peak's fresh water source) is located down-gradient from the brine fields, and monitoring has revealed a consistent fall in water levels over the last decade, coinciding with increasing pumping by the mine.<sup>16</sup> Farmers and ranchers in the surrounding areas have reported wells going dry, which they ascribe to the mine's groundwater use.<sup>16</sup> This creates a conflict between the mine's commercial benefits and the fundamental necessity for water in the desert. There is also concern about pollution and health risks. The revelation of increased air emissions in 2025 was concerning since it indicated that residents and workers had been exposed to hazardous dust levels.<sup>17</sup> Nonprofit watchdog organizations believe that such instances demonstrate why "common-sense measures like air pollution limits are needed to keep communities safe" and that stringent enforcement is required.<sup>17</sup> The mine's operator responded by improving pollution control measures, which may have comforted some neighbors. Nonetheless, the experience is likely to have heightened local aspirations for environmental openness. BLM hosted public hearings throughout the expansion's scoping process, which garnered input from neighboring neighbors worried about how expanding the mine might harm their water, air, and everyday lives.<sup>17</sup>

**Indigenous Community Concerns and Practices:** Unlike several of the new lithium mining projects proposed elsewhere in Nevada, the Silver Peak business has not been a high-profile flashpoint for Indigenous rights, possibly because to its origins in the 1960s and position on an already established salt flat.<sup>18</sup> However, Indigenous populations have a vested stake in any serious disruption to their ancestral grounds. The area surrounding Silver Peak is the ancestral homeland of the Western Shoshone and Paiute peoples.<sup>18</sup> As the mine plans to expand on public lands, federal law mandates consultation with any tribes who may be traditionally associated with the region. The Bureau of Land Management has said that Native American tribal nations will be consulted during the Silver Peak expansion's EIS process.<sup>19</sup> The environmental study clearly includes "Native American religious concerns" as a subject to be examined. This suggests that the BLM has identified tribes with potential cultural links to Clayton Valley who should be given a say in the decision.<sup>19</sup> The agency will contact tribal governments, most likely the Timbisha Shoshone (whose ancestral territories extend into

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<sup>15</sup> [https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm\\_campaign=widget&utm\\_medium=section\\_row&utm\\_source=sports&utm\\_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25](https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm_campaign=widget&utm_medium=section_row&utm_source=sports&utm_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25)

<sup>16</sup> <https://water.nv.gov/>

<sup>17</sup> [https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm\\_campaign=widget&utm\\_medium=section\\_row&utm\\_source=sports&utm\\_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25%20expansion#:~:text=BLM%E2%80%99s%20National%20Register,m](https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm_campaign=widget&utm_medium=section_row&utm_source=sports&utm_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25%20expansion#:~:text=BLM%E2%80%99s%20National%20Register,m)

<sup>18</sup> [https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm\\_campaign=widget&utm\\_medium=section\\_row&utm\\_source=sports&utm\\_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25](https://www.reviewjournal.com/local/local-nevada/countrys-only-operational-lithium-mine-seeks-25-expansion-3312155/?utm_campaign=widget&utm_medium=section_row&utm_source=sports&utm_term=Country%E2%80%99s%20only%20operational%20lithium%20mine%20seeks%2025%25)

<sup>19</sup> <https://www.federalregister.gov/documents/2025/02/28/2025-03299/notice-of-intent-to-prepare-an-environmental-impact-statement-for-the-silver-peak-lithium-mine#:~:text=The%20EIS%20analysis%20will%20focus.resources%3B%20paleontology%3B%20soils%3B%20and%20ve>

western Nevada) or Paiute/Shoshone tribes in the vicinity, to get feedback on any holy sites, burial grounds, or other cultural treasures that may be damaged.<sup>19</sup>

The broader backdrop of Nevada's recent lithium boom demonstrates why tribal consultation processes are under investigation. A notable example is the Thacker Pass lithium mine in northern Nevada, where numerous tribes complained that they were not properly engaged before the BLM approved the project on culturally significant ground.<sup>20</sup> Under US law, agencies must engage with tribes on decisions that impact them, although opponents claim this is frequently a "check-box exercise".<sup>20</sup> In Thacker Pass's instance, the BLM simply contacted a few surrounding tribes and, after receiving no response during the 2020 holidays, approved the mine in January 2021.<sup>20</sup> Other tribes with historical ties to the region were not consulted, and they thought their holy location was given to mining interests without their consent. In response, tribes and advocates are demanding for stricter consultation standards and respect for Indigenous sovereignty in mining decisions.<sup>21</sup> A 2022 government assessment recommended "new rules...to protect sacred, cultural or historical sites, so that some areas are considered off limits" to mining and "Tribes should have more control over sacred lands".<sup>21</sup> They recommend authorities to move beyond formal letters and participate in face-to-face discussions, provide more time for tribal involvement (particularly during emergencies such as COVID-19), and seek permission rather than merely consultation.<sup>21</sup> In late 2022, President Biden issued a memorandum instructing federal agencies to adopt a more standard, comprehensive consultation process, noting that agencies should "strive for consensus with Tribes" on tribal-related issues.<sup>21</sup>

### **Policy Recommendations**

The story of Silver Peak exemplifies the changing environment of US policy towards key resource extraction. On the one side, there is a national urgency to boost lithium production for renewable energy. To lessen dependency on foreign supplies, the federal government has invested billions of dollars in domestic mining operations for lithium, cobalt, and other important minerals.<sup>22</sup> The Silver Peak mine benefited from this drive, attracting interest from the Department of Energy and others as a test case for rapidly increasing output. In fact, Albemarle said that it will increase Silver Peak's lithium output by 2025, in line with US targets for EV battery supply.

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<sup>20</sup><https://cronkitenews.azpbs.org/howardcenter/lithium/stories/indigenous.html#:~:text=OROVADA%2C%20Nev,Fort%20McDermitt%20Paiute%20and%20Shoshone>

<sup>21</sup>[https://cronkitenews.azpbs.org/howardcenter/lithium/stories/indigenous.html#:~:text=The%20report%20found%20that%20the\\_historical%2C%20cultural%20and%20spiritual%20ties](https://cronkitenews.azpbs.org/howardcenter/lithium/stories/indigenous.html#:~:text=The%20report%20found%20that%20the_historical%2C%20cultural%20and%20spiritual%20ties)

<sup>22</sup><https://cronkitenews.azpbs.org/howardcenter/lithium/#:~:text=Federal%20officials%20are%20investing%20billions,decrease%20reliance%20on%20foreign%20countries>

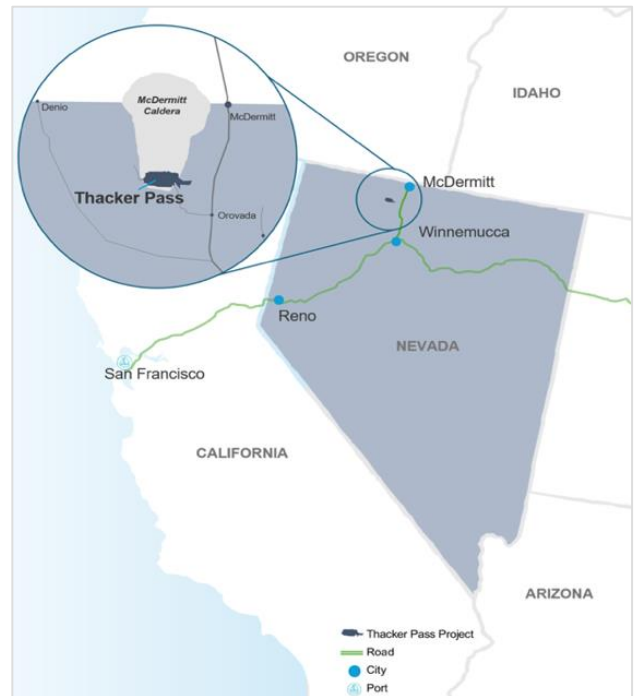
## THACKER PASS

The 'Thacker Pass' proposed lithium mine, will be in Humboldt County, northern Nevada. This area is one of North America's greatest lithium resources.<sup>23</sup> The project, run by Lithium Americas Corp., intends to produce lithium for electric car batteries and grid storage, in line with the United States government's goal for domestic essential mineral production to assist sustainable energy efforts.<sup>23</sup> At the same time, Thacker Pass has become a focal point of controversy, as its development pits national demand for lithium against local environmental impacts and Indigenous rights concerns. This case study evaluates the project's environmental and social implications and discusses policy solutions to reconcile resource development with community and ecological well-being.<sup>24</sup>

### Environmental Impacts

**Water Usage:** The mine's operations are projected to consume significant water resources, with Phase 1 using approximately 2,600 acre-feet per year and Phase 2 increasing to 5,200 acre-feet annually.<sup>25</sup> This has raised concerns about water availability for local agriculture and ecosystems. This water would be obtained through groundwater rights transfers from local agricultural operations. These massive withdrawals raise worries about aquifer depletion in the Quinn River Valley. A nearby rancher opposed the transfer of water rights to the mine, claiming it would harm his cattle property (Bartell property) and the public interest.<sup>25</sup> In February 2023, Nevada's State Engineer overturned the appeal and approved the water transfer after assessing the mine's impact on groundwater.<sup>25</sup> However, hydrologists and environmental organizations worry that continued pumping might deplete the water table and dry up neighboring springs.<sup>25</sup>

Environmentalists fear that groundwater pumping might jeopardize the species livelihood. Such a scenario would be disastrous for the Kings River pyrg, a rare springsnail found only in a few springs east of Thacker Pass.<sup>26</sup> Scientists highlight that this little snail is particularly sensitive to groundwater depletion, and even a minor decrease in spring flow might push the species to extinction. Similarly, any pollution or loss in groundwater might affect the region's streams that feed the Lahontan cutthroat trout (a federally classified endangered species).



Map: Location of the Thacker Pass proposed lithium project in Humboldt County, northern Nevada, near the Nevada–Oregon border.

<sup>23</sup> <https://apnews.com/article/lithium-mine-endangered-snail-nevada-15c0008372a93a984c64ddbd741232c4>

<sup>24</sup> <https://journals.library.columbia.edu/index.php/consilience/blog/view/517#:~:text=The%20Thacker%20Pass%20lithium%20mine,indigenous%20communities%20and%20mining%20interests>

<sup>25</sup> <https://sierranevadaally.org/2020/08/28/thacker-pass-lithium-mine-draft-environmental-impact-statement-reaction/>

<sup>26</sup> <https://www.eenews.net/articles/feds-weigh-protections-for-tiny-snail-near-massive-lithium-mine/#:~:text=The%20petition%20argues%20that%20large,groundwater%20in%20two%20major%20ways>

Protecting water supplies, both in quantity and quality, is a major environmental problem for the project.<sup>27</sup>

**Wildlife and Habitat:** Thacker Pass is part of the sagebrush-steppe environment, which supports a broad range of species. The mine's footprint (about 5,700 acres of proposed disturbance) covers 2,866 acres of large sagebrush habitat, which is home to vulnerable species such as greater sage-grouse.<sup>28</sup> Thacker Pass, which connects the Double H and Montana Mountains, is a crucial wildlife corridor and wintering ground for species that descend to lower altitudes during cold months, according to conservationists.<sup>28</sup> The project is likely to destroy or fragment thousands of acres of sage-grouse habitat and interrupt two pronghorn antelope migratory routes in the pass.<sup>28</sup> Golden eagles may be seen in the region, with nesting grounds nearby.<sup>28</sup> They feed their young on open meadows in the pass.

To protect raptors from danger, Lithium Americas obtained a federal "eagle take" authorization and an Eagle Conservation Plan after destroying breeding and hunting habitats.<sup>29</sup> Desert bighorn sheep and pygmy rabbits, found in the adjacent high desert environment, are also under risk.<sup>29</sup> Biologists remark that the Montana Mountains region (next to Thacker Pass) is one of the remaining largely untouched blocks of the sagebrush ecosystem in Nevada, a landscape already threatened by wildfires and alien species.<sup>29</sup> They are concerned that an open-pit mine, with its roads, noise, and dust, will "obliterate" remaining sagebrush habitat, causing losses in these sensitive animal species.<sup>29</sup>

**Air and Soil Pollution:** The extraction process requires sulfuric acid leaching, which increases the danger of air pollution and soil contamination. Additionally, the mine's operations may result in the emission of harmful compounds, affecting local air quality and soil health.<sup>30</sup> The proposed sulfuric acid plant will create energy by burning elemental sulfur, in addition to producing acid for leaching purposes.<sup>31</sup> While the business claims this is a carbon-efficient option, the process will nonetheless produce pollutants. According to the Final Environmental Impact Statement (FEIS), phase 2 of the mine will emit about 132,000 tons of CO<sub>2</sub>-equivalent per year.<sup>1</sup> Potential sulfur dioxide (SO<sub>2</sub>) emissions from the acid factory and dust from mining operations pose urgent concerns for local air quality.<sup>32</sup> The claystone rock near Thacker Pass includes naturally occurring arsenic and other heavy metals that may be discharged in dust or leached into water. Windblown dust from blasting, crushing, and transportation, if not well regulated, can pollute nearby soils and endanger wildlife and humans. The mine's waste rock and tailings also constitute a contamination risk: when exposed to air and water, they may produce acid drainage or release harmful components.<sup>32</sup> The Nevada environmental authorities have confined the project to mining above the water table for the time being (as a provision of the state water pollution control permit). This should lessen the possibility of acid

<sup>27</sup> ["Conservation and Public Accountability Groups File Legal Challenge to the Thacker Pass Lithium Mine"](https://westernwatersheds.org/2023/01/conservation-and-public-accountability-groups-file-legal-challenge-to-the-thacker-pass-lithium-mine/)

<sup>28</sup> <https://westernwatersheds.org/2023/01/conservation-and-public-accountability-groups-to-argue-the-illegality-of-the-proposed-thacker-pass-lithium-mine/#:~:text=Thacker%20Pass%20is%20critically%20important,springsnail%2C%20are%20known%20to%20live>

<sup>29</sup> <https://westernwatersheds.org/2023/01/conservation-and-public-accountability-groups-to-argue-the-illegality-of-the-proposed-thacker-pass-lithium-mine/#:~:text=Other%20wildlife%20at%20risk%20from,bighorn%20sheep%2C%20and%20pygmy%20rabbits>

<sup>30</sup> [Table 4.10. Facility-Wide On-site Operational Emissions Thacker Pass Lithium Mine - FEIS](#)

<sup>31</sup> <https://westernwatersheds.org/2023/01/conservation-and-public-accountability-groups-to-argue-the-illegality-of-the-proposed-thacker-pass-lithium-mine/#:~:text=Plaintiffs%20will%20further%20argue%20that,tem%20financial%20assurances>

mine drainage contaminating groundwater.<sup>33</sup> However, detractors of the proposal point out that the open pit is likely to become a source of groundwater contamination for millennia after mine closure, if pit lakes develop and concentrate contaminants.<sup>33</sup>

For the time being, Nevada environmental officials have limited the project to mining above the water table (as required by the state water pollution control permit).<sup>33</sup> This should reduce the risk of acid mine drainage polluting groundwater. However, opponents of the idea argue that if pit lakes form and concentrate toxins, the open pit would continue to pollute groundwater for millennia after the mine is closed.<sup>33</sup> They argue that further long-term measures and bonding will be necessary to prevent Thacker Pass from leaving a harmful legacy.<sup>33</sup>

### **Social Impacts**

**Impacted communities:** Although the Thacker Pass project is in a remote area of Nevada, it has a significant social impact on multiple towns. The nearest minor towns are Orovada (to the east) and McDermitt (to the north, on the Nevada-Oregon border), both farming and tribal settlements with minimal populations.<sup>33</sup> The closest regional hub is Winnemucca, located about 60 miles to the south. Local ranchers and farmers are concerned about the mine's impact on their livelihoods, particularly the availability of water.<sup>34</sup> In this high desert terrain, agriculture is dependent on precious groundwater for irrigation and animals. Ranchers, such as the Bartell family, are concerned that the mine's extensive use of water may deplete aquifers and restrict water availability for crops and livestock.<sup>34</sup>

There are also fears that dust from mining activities would settle on grazing meadows or alfalfa fields, affecting soil quality and cattle health.<sup>34</sup> Furthermore, increasing traffic (from haul trucks and staff vehicles on rural roadways) increases the danger of accidents and wears down local roads that are not intended for heavy industrial usage.<sup>34</sup> Local governments in Humboldt County have had to examine how an influx of workers will affect public services, housing, and law enforcement in these tiny towns.<sup>34</sup> While some inhabitants embrace the mine's economic benefits (jobs, investment, and increased infrastructure), others are concerned that the rural calm and environmental integrity of their valley would be forever damaged.<sup>34</sup>

**Native American Tribes and Cultural Ties:** Perhaps the most visible societal controversy over Thacker Pass is its significance to Indigenous peoples. The project site is in the traditional territory of numerous Paiute Shoshone tribes.<sup>34</sup> Thacker Pass is known in Paiute as "Peehee Mu'huh," which translates to "Rotten Moon."<sup>35</sup> According to oral tales, this name commemorates horrible occurrences in the 19th century. The pass was supposedly the location of massacres that slaughtered Paiute men, women, and children, including an 1865 raid by the US Cavalry.<sup>35</sup> In that occurrence, troops are reported to have left the victims' bodies to deteriorate on the ground, earning the nickname "Rotten Moon."<sup>35</sup> The descendants of individuals who survived the atrocities currently live in area tribes, particularly the Fort McDermitt Paiute and Shoshone Tribe to the north.<sup>35</sup> The Fort McDermitt Tribe owes its

<sup>33</sup> [Water Permit Ruling #6522 - Office of the State Engineer, Nevada State](#)

<sup>34</sup> <https://nevadacurrent.com/2021/06/11/opposition-to-lithium-mine-grows-among-tribes-conservationists/#:~:text=Thacker%20Pass%20is%20the%20traditional,the%20Reno-Sparks%20Indian%20Colony>

existence to the shelter given by Thacker Pass, since some of their ancestors sheltered there to avoid forced removal. Several tribal nations have historical links to the area, including the Shoshone-Paiute of Duck Valley, Burns Paiute Tribe of Oregon, Pyramid Lake and Lovelock Paiute Tribes, Fallon Paiute-Shoshone, and Reno-Sparks Indian Colony, among others.<sup>35</sup> Indigenous people have been visiting Thacker Pass for millennia to hunt, harvest traditional foods and medicinal plants, and hold ceremonies.<sup>35</sup> This profound cultural and spiritual link explains why many Native Americans see the lithium mine as a serious danger to not only the land and water, but also their legacy and ancestors.

**Cultural Preservation and Conflict:** The Thacker Pass mining permitting process revealed divisions between federal authorities and Indigenous populations.<sup>35</sup> In 2020, the BLM conducted a fast-track evaluation with only a few tribes (including Fort McDermitt and Summit Lake Paiute), originally reporting "no historic properties of concern" in the region.<sup>36</sup> However, other tribes who attach religious value to Peehee Mu'huh, including the Reno-Sparks Indian Colony and the Burns Paiute, claim they were not consulted prior to the mine's clearance.<sup>36</sup>

These tribes, together with a group of traditional Fort McDermitt residents calling themselves "People of Red Mountain," filed lawsuits against the BLM and the mining firm in 2021, trying to block the project on cultural and historic preservation grounds.<sup>36</sup> They claimed that the mine would disrupt Paiute massacre sites, burial grounds, and artifacts protected by legislation such as the National Historic Preservation Act and the Archaeological Resources Protection Act. Tensions rose when tribal activists established protest camps near Thacker Pass in 2021, claiming a sacred obligation to safeguard the site from degradation.<sup>36</sup> In court, the tribes had an uphill struggle. Judge Miranda Du acknowledged the tribe elders' spiritual grief but found no empirical proof that the planned mining would irreversibly impair cultural treasures. She pointed out that archaeological surveys (conducted as part of the approval procedure) had not found a massacre site within the local project area.<sup>36</sup> Consequently, pleas for injunctions based on cultural grounds were dismissed.

Excavation for archaeological mitigation (e.g., trenching to retrieve any artifacts) was allowed to continue. Many Indigenous opponents were frustrated by this conclusion because they believed the legal criteria required documentation of their history on the land, which is frequently hard to provide.<sup>36</sup> The controversy underlined the importance of more inclusive and strong tribal consultation. It also prompted interaction between the corporation and local tribes: the Fort McDermitt Paiute-Shoshone Tribe, who had earlier signed an engagement agreement with Lithium Americas, withdrew support at one time due to community criticism.<sup>36</sup>

Later, the tribe signed a new Community Benefits Agreement to secure jobs, training, and revenue-sharing.<sup>36</sup> This suggests that even among Indigenous stakeholders, there is a range of views on the mining, from outright hostility to conditional participation.

**Community Health and Safety:** Large-scale mining projects can pose a number of social issues in rural communities. One issue is the temporary staff needed for building and early

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<sup>35</sup> <https://www.rgj.com/story/news/2021/09/06/thacker-pass-lithium-mine-tribes-lose-bid-block-digging-nevada-mine/5746578001/>

operations. Thacker Pass is projected to attract hundreds of laborers to a distant "man camp" or adjacent towns.<sup>36</sup> Research indicates that a male-dominated temporary workforce can raise local drug usage and violent crime rates.<sup>37</sup> Indigenous groups in the region have expressed concerns about violence against Native women and girls, citing a relationship between extractive sector boomtowns and increased incidence of missing and killed Indigenous women.<sup>37</sup> Humboldt County officials and the mining business have examined how to lessen these dangers. Public health experts are also monitoring possible consequences on community health: locals are concerned about dust and pollution, as well as the mental health effects of fast social change.<sup>37</sup> Another concern is traffic safety; as more large trucks go down rural roads, the probability of accidents or road deterioration increases.<sup>37</sup> On the plus side, if well managed, the project may result in socioeconomic advantages such as enhanced medical services or emergency response in the region (financed by higher tax revenue or direct investment). The mine has pledged to prioritize local hiring and contracting, which may minimize the influx of foreigners while increasing benefits for adjacent communities.<sup>37</sup> Still, the balance of social impacts will be determined by continued community participation and the implementation of business obligations. Many people just want their opinions heard in decision-making so that Thacker Pass's lithium, which is intended to provide a clean energy future, is not mined at the expense of their community's health and safety.

### **Policy Recommendations**

While sustainable energy depends on developing vital minerals like lithium, the Thacker Pass case demonstrates that it must be done so in a way that honors social justice and environmental boundaries. This case study suggests various policy suggestions that might help to solve the issues.

**Enhance Tribal Collaboration:** Government agencies should change their procedures of consultation to guarantee that Indigenous people are actual partners in any project influencing their ancestral territory. This involves paying weight to their concerns and considering all tribes with possible cultural ties to a location early in the process - before judgments are taken. Regarding Thacker Pass, the BLM might have aggressively contacted the Reno-Sparks Indian Colony, Burns Paiute, and others before mine permission, instead of only interviewing a small number of tribes and presuming no resistance. Policies requiring consent or agreement (not only notification) and demanding thorough tribal outreach might help to build confidence and maybe help to avoid prolonged legal fights. Encouragement of tribal co-management of cultural resources can help to ensure that any historical sites are found and preserved with Indigenous knowledge.

**Stronger Environmental Safeguards:** State and federal authorities should insist on tougher environmental protections for mining operations. For Thacker Pass, this may include keeping water extraction to scientifically calculated acceptable limits and ongoing groundwater level monitoring surrounding the mine. Plans for protecting wildlife must be strong; for instance, developing wildlife corridors around the mine, timing building to minimize sage-grouse habitat loss, and designating set-aside habitat elsewhere to counterbalance loss of this habitat.

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<sup>36</sup> <https://thisisreno.com/2021/07/judge-to-decide-on-injunction-request-to-halt-work-on-thacker-pass-lithium-mine/>

Agency requirements for lined tailings storage, thorough dust control programs, and redundant containment for process chemicals will help to prevent contamination. Plans for long-term effects should include a significant reclamation bond to guarantee that, should the firm fail or close, money exists to address any contamination and reclaim the land.<sup>37</sup> Authorities can minimize the environmental impact of lithium mining by strengthening licensing criteria and enforcement.

## SALTON SEA



FIGURE 1

Source: Governor's Office of Land Use & Climate Innovation. [CEQAnet - 'Lithium Valley Specific Plan'](#)

### **Brief Description**

The Salton Sea region is in Imperial County, California and is a case study that highlights a connection between environmental degradation, economic depression, and increased opportunity for critical mineral extraction. Accidentally formed in 1905 by a Colorado River flood, the Salton Sea, California's largest inland lake, has suffered decades of ecological decline due to increasing salinity, receding shorelines, and severe dust pollution impacting local communities.<sup>38</sup> At the same time, the area sits atop a Known Geothermal Resource Area (KGRA), where geothermal power plants have operated since the 1980s. This region, one of

<sup>37</sup> <http://westernwatersheds.org/>

<sup>38</sup> DOI: [10.1016/j.scitotenv.2019.01.365](https://doi.org/10.1016/j.scitotenv.2019.01.365)

California's poorest with high unemployment rates, is now a point of interest nationally due to the discovery of lithium resources dissolved within the deep geothermal brines.<sup>39</sup>

Reported estimates suggest the Salton Sea KGRA holds one of the world's largest lithium brine deposits, potentially containing between 4.1 and 18 million metric tons of Lithium Carbonate Equivalent (LCE).<sup>40</sup> Lithium Concentrations, reported up to 400 parts per million (ppm), surpass those found in some traditional South American sources.<sup>25</sup> This resource is projected to be sufficient to supply batteries for hundreds of millions of electric vehicles (EVs), potentially enabling U.S. self-sufficiency in this critical mineral.<sup>41</sup> The region has been branded "Lithium Valley", signifying its strategic importance for establishing secure domestic battery supply chains, a priority for both state and federal governments.

The proposed extraction method uses Direct Lithium Extraction (DLE) technology<sup>42</sup>, with existing or newly developed geothermal power facilities. In this process, hot geothermal brine is pumped to the surface; its heat is used to generate electricity, after which the cooled brine is processed to selectively remove lithium ions, often using adsorbent materials like EnergySource Minerals' ILiAD.<sup>43</sup> The lithium-depleted brine is then reinjected underground. Supporters highlight DLE's potential environmental advantages over conventional methods like hard rock mining (common in Australia) or large-scale evaporation ponds (used in South America), citing a significantly smaller land footprint, drastically reduced water consumption, higher recovery rates, and faster processing times. Key companies pursuing projects include EnergySource Minerals (ESM), Controlled Thermal Resources (CTR), and BHE Renewables (BHER), a subsidiary of Berkshire Hathaway Energy.<sup>44</sup> The Lawrence Berkeley National Laboratory published an excellent report detailing the specifics and characterization of geothermal lithium resource extraction at the Salton Sea.

The co-production model, combining geothermal energy and lithium extraction, forms an interesting and compelling narrative – generating renewable power and extracting critical mineral simultaneously through a single process. However, despite the popularization of new and "greener" extraction methods like DLE, lithium development in the Salton Sea region faces significant challenges, particularly given the area's existing vulnerabilities.

### **Environmental Impacts**

**Water Consumption:** DLE, while potentially more efficient per ton of lithium than evaporation, still requires substantial freshwater inputs for cooling, reagent rinsing, and other operational needs. This demand occurs in an extremely arid region heavily reliant on the already over-allocated Colorado River. Specific project estimates indicate considerable water use; for instance, ES Minerals projected needing 3,400 acre-feet per year, while CTR estimated 6,700 acre-feet per year. While industry sources claim DLE uses over 90% less water than Chilean evaporation ponds<sup>45</sup>, concerns persist that the cumulative water demand from

<sup>39</sup> [https://autl.assembly.ca.gov/sites/autl.assembly.ca.gov/files/Lithium\\_Info\\_Hearing\\_-\\_Background.pdf](https://autl.assembly.ca.gov/sites/autl.assembly.ca.gov/files/Lithium_Info_Hearing_-_Background.pdf)

<sup>40</sup> <https://emp.lbl.gov/publications/characterizing-geothermal-lithium>

<sup>41</sup> <https://www.gov.ca.gov/2023/11/28/new-report-highlights-the-promise-of-lithium-valley/>

<sup>42</sup> [https://www.researchgate.net/publication/388921752\\_The\\_Lithium\\_Valley\\_Project](https://www.researchgate.net/publication/388921752_The_Lithium_Valley_Project)

<sup>43</sup> <https://www.esminerals.com/iliad>

<sup>44</sup> <https://today.usc.edu/powering-up-lithium-valley/>

<sup>45</sup> <https://transform.ucsc.edu/wp-content/uploads/2022/12/Lithium-and-Geothermal-Resources.pdf>

multiple large-scale facilities could strain regional supplies, potentially exceeding non-agricultural allocations managed by the Imperial Irrigation District (IID), especially under worsening drought conditions influenced by climate change. State regulations cap water uses at 50,000 gallons per metric ton of lithium carbonate equivalent, and initial federal assessments suggest a "modest impact" on water availability (around 3% of historical supply for *currently proposed* operations)<sup>46</sup> but explicitly caution about future restrictions due to long-term drought affecting the Colorado River.

**Air Quality:** Imperial County already suffers from severely degraded air quality, failing to meet federal standards for particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and ozone. A major contributing factor is windblown dust from the exposed playa of the shrinking Salton Sea, which contains pesticides, heavy metals, and other contaminants.<sup>47</sup> This pollution is linked to devastating public health consequences, most notably childhood asthma rates.<sup>48</sup> While direct emissions from geothermal and lithium operations (including hydrogen sulfide, ammonia, benzene, hydrochloric acid aerosols from reagents, and greenhouse gases) are projected by some analyses to have a relatively small impact individually, the addition of *any* pollution burden is a major concern. Furthermore, impacts from construction dust and increased vehicle traffic (estimated at 179 trips per day for one project) must be considered.<sup>49</sup> Critically, the potential for lithium projects' water consumption to exacerbate the Salton Sea's decline, thereby exposing more playa and increasing dust pollution, highlights the need for rigorous *cumulative* impact assessments.<sup>50</sup>

**Induced Seismicity:** The Salton Sea region is seismically active due to its proximity to the San Andreas Fault. Geothermal energy production involves injecting and extracting large volumes of fluid, which can alter subsurface pressures and potentially trigger earthquakes.

**Chemical Use and Waste Management:** The DLE process involves industrial chemicals, including hydrochloric acid for stripping lithium from adsorbents. Federal analysis suggests chemical use is consistent with other industrial settings and has not identified persistent organic pollutants or acutely toxic chemicals in *current* use. Waste streams include the lithium-depleted brine, which is reinjected underground, and solid wastes generated from removing impurities like silica, zinc, and manganese from the brine. Some developers propose commercializing these co-products, though concerns have been raised in legal challenges about the feasibility and environmental implications of managing all byproducts and potentially hazardous waste. The highly corrosive nature of the geothermal brine also presents material handling and maintenance challenges.<sup>51</sup>

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<sup>46</sup> <https://emp.lbl.gov/publications/characterizing-geothermal-lithium>

<sup>47</sup> <https://earthworks.org/wp-content/uploads/2023/10/California-Lithium-Valley-Report.pdf>

<sup>48</sup> <https://cronkitenews.azpbs.org/2024/05/02/salton-sea-immigrant-community-experiences-high-rates-asthma/>

<sup>49</sup> Earth Works and Comite Civico del Valle, INC. Environmental Justice in California's Lithium Valley. November 2023. Accessible at: <https://earthworks.org/wp-content/uploads/2023/10/California-Lithium-Valley-Report.pdf>

<sup>50</sup> [https://saltonseaca.gov/wp-content/uploads/2024/09/SSMP-and-Community-Needs\\_final.pdf](https://saltonseaca.gov/wp-content/uploads/2024/09/SSMP-and-Community-Needs_final.pdf)

<sup>51</sup> <https://www.energy.ca.gov/filebrowser/download/7411?fid=7411>

## **Social and Economic Impacts**

The proposed development of Lithium Valley carries social and economic implications for the region, presenting both potential opportunities and significant risks, particularly for vulnerable populations.<sup>52</sup>

**Local Affected Communities:** The communities most directly adjacent to the Salton Sea KGRA and the area designated in the Lithium Valley Specific Plan include small, unincorporated towns like Niland, Bombay Beach, Desert Shores, and Salton City, as well as nearby cities such as Calipatria, Westmorland, and Brawley. These communities are predominantly Latinx, including significant populations of Indigenous Mexican immigrants (e.g., Purépecha), and are characterized by high rates of poverty, low median incomes, historically high unemployment, and significant deficits in essential infrastructure such as broadband access, reliable transportation, adequate housing, and healthcare services.<sup>53</sup> CalEnviroScreen data confirms that these communities bear a disproportionate burden of environmental pollution and possess population characteristics that make them more vulnerable to its effects.

This pre-existing vulnerability is starkly reflected in public health outcomes. As previously noted, childhood asthma rates in communities near the Salton Sea are estimated at 20-22.4%,<sup>36</sup> dramatically higher than state or national averages, leading to frequent emergency room visits and hospitalizations. Limited access to healthcare, particularly for low-income and immigrant families, exacerbates these health challenges.

The primary promise of Lithium Valley is economic revitalization. Developers project the creation of thousands of construction jobs and hundreds of permanent operational positions, alongside significant local investment and tax revenue generation. Local institutions like Imperial Valley College have launched workforce development initiatives, such as the Lithium Training Plant Operator Program, aiming to ensure local residents can access these anticipated jobs.

However, significant community skepticism exists in Imperial County, established in historical experiences where resource extraction industries profited without substantially benefiting local populations. This skepticism fuels controversy surrounding the implementation of California's Lithium Extraction Excise Tax (codified in SB 125).<sup>54</sup> The law mandates that 80% of the net tax revenue generated goes to the county of extraction (Imperial County), with at least 30% of that county share specifically allocated to communities "directly and indirectly impacted" by lithium activities. Imperial County's allocation plan, however, has drawn criticism. The plan directs 60% of the funds Imperial County receives to general county services (including public safety and planning), and 10% of these funds to a county-managed "Lithium Community Benefits Program". The remaining 30% of these funds is distributed to cities, unincorporated areas, and recognized tribes largely based on population size.<sup>55</sup> This allocation

<sup>52</sup> <https://cronkitenews.azpbs.org/2024/05/02/salton-sea-immigrant-community-experiences-high-rates-asthma/>

<sup>53</sup> <https://www.icpds.com/planning/land-use-documents/general-plan/environmental-justice-element>

<sup>54</sup> [https://lithiumvalley.imperialcounty.org/wp-content/uploads/2024/08/Lithium-Excise-Tax-Funding-Plan\\_Draft-20240829.pdf](https://lithiumvalley.imperialcounty.org/wp-content/uploads/2024/08/Lithium-Excise-Tax-Funding-Plan_Draft-20240829.pdf)

<sup>55</sup> [https://lithiumvalley.imperialcounty.org/wp-content/uploads/2024/08/Lithium-Excise-Tax-Funding-Plan\\_Draft-20240829.pdf](https://lithiumvalley.imperialcounty.org/wp-content/uploads/2024/08/Lithium-Excise-Tax-Funding-Plan_Draft-20240829.pdf)

method has drawn criticism, as opponents argue that the reliance on population means that even with a "Location Priority Bonus" intended to provide additional funding to certain smaller, fence line communities designated as "directly affected" (such as Calipatria, Niland, Westmorland, and Bombay Beach), their total share of the community funds remains comparatively small. Conversely, larger population centers like Brawley—also designated "directly affected" but not eligible for this specific bonus—receive a much larger allocation from the community funds due to their population.<sup>56</sup>

**Local Indigenous Tribes:** The Salton Sea region is the ancestral homeland of several Indigenous Peoples, including the Torres Martinez Desert Cahuilla Indians (TMDCI), the Quechan Indian Tribe, and others with deep cultural and historical connections to the area, particularly the ancient Lake Cahuilla.<sup>57</sup>

Tribal leaders have voiced significant concerns regarding the adequacy and meaningfulness of government-to-government consultation processes related to lithium projects. The principle of Free, Prior, and Informed Consent (FPIC), enshrined in the UN Declaration on the Rights of Indigenous Peoples, emphasizes the right to meaningful dialogue and potentially to refuse projects impacting tribal lands, resources, and heritage. Chairman Tomas Tortez, Jr. of the TMDCI specifically criticized the consultation process, noting that initial outreach from companies sometimes waned even as partnerships were publicly referenced, leading to a feeling that decisions proceed "without us" despite extensive participation. While official planning documents indicate efforts to consult tribes, and courts have sometimes found procedural requirements met, the tribal perspective often highlights a gap between procedural compliance and genuine, respectful engagement that honors sovereignty and incorporates tribal knowledge and concerns into decision-making.<sup>41,58</sup>

Specific concerns include potential impacts on cultural resources and sacred sites, such as Obsidian Butte, a volcanic formation on the Salton Sea shore considered sacred by multiple tribes. Expansion of geothermal development has previously been identified as potentially diminishing the integrity of such sites. Additionally, water rights and access are critical issues, particularly given the region's aridity and the lithium industry's water demands. The TMDCI, for example, face existing challenges with inadequate water infrastructure, making the allocation of scarce water resources a point of potential conflict. Discussions regarding provision of water to the tribe have occurred but underscore the complexity of resource allocation.

**Social and Psychological Issues:** The prospect of large-scale lithium development brings a complex mix of emotions and social dynamics within local communities. There is real hope for economic improvement and transformation in a region long plagued by poverty and lack of opportunity. However, this hope is tempered by inherent skepticism based on past experiences with corporate mining industries and anxiety about potential negative environmental and health consequences. Residents express frustration and fatigue over the slow pace of

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<sup>56</sup> <https://www.kpbs.org/news/environment/2024/10/07/hope-and-worry-in-imperial-county-after-supervisors-adopt-controversial-lithium-spending-plan>

<sup>57</sup> [https://autl.assembly.ca.gov/sites/autl.assembly.ca.gov/files/Lithium\\_Info\\_Hearing\\_-\\_Background.pdf](https://autl.assembly.ca.gov/sites/autl.assembly.ca.gov/files/Lithium_Info_Hearing_-_Background.pdf)

<sup>58</sup> <https://earthworks.org/wp-content/uploads/2023/10/California-Lithium-Valley-Report.pdf>

addressing the existing Salton Sea environmental crisis and worry about being sacrificed for state or national energy goals without adequate local protection or benefit.

The development process itself can impact social cohesion. While the shared goal of economic improvement could foster collaboration, disagreements over the best path forward – particularly regarding the balance between economic development and environmental protection, and the equitable distribution of benefits – can create or deepen social divisions. Community-based organizations like Comité Civico del Valle, Alianza Coachella Valley, and the Lithium Valley Community Coalition play a crucial role in amplifying resident concerns, advocating for environmental justice, and attempting to bridge the gap between community needs and developer/government actions. The persistent gap between official engagement efforts and the community's perception of meaningful influence points to a significant trust deficit, hindering the collaborative partnerships needed for truly equitable and sustainable development.

### **Policy Recommendations & Conclusion**

The Salton Sea lithium project represents a moment for environmental policy, balancing the urgent need for domestic critical minerals for the clean energy transition against the imperative to protect vulnerable ecosystems and communities. The resource potential offers a chance for economic revitalization in Imperial County. However, this potential is shadowed by significant environmental risks (water scarcity, air quality, seismicity), profound environmental justice concerns for historically marginalized communities already facing severe health burdens, unresolved tribal consultation and rights issues, and uncertainties stemming from technological scale-up challenges, project delays, and legal contests. **Policy**

#### **Recommendations:**

- I. **Mandate Comprehensive Cumulative Impact Assessments:** Move beyond project-by-project Environmental Impact Reports (EIRs). Require a robust programmatic and cumulative impact assessment for the entire Lithium Valley development, explicitly modeling the interconnected effects on water resources (including Colorado River allocations and Salton Sea levels), air quality (especially dust generation from playa exposure), public health (asthma rates), and seismicity. This assessment should inform all permitting decisions. Implement transparent, publicly accessible real-time monitoring systems for air, water quality, water consumption, and seismic activity.<sup>59</sup>
- II. **Uphold Tribal Sovereignty through Meaningful Consultation (FPIC):** State and local agencies must adopt and implement policies ensuring early, consistent, and meaningful government-to-government consultation with culturally affiliated tribes (TMDCI, Quechan, etc.) that respects tribal sovereignty and aims to achieve Free, Prior, and Informed Consent (FPIC). This includes dedicated resources for tribal participation, protection of cultural resources and sacred sites like Obsidian Butte and addressing concerns regarding water rights and access.<sup>60</sup>

<sup>59</sup> [https://www.scienceforconservation.org/assets/downloads/Lithium\\_Report\\_FINAL.pdf](https://www.scienceforconservation.org/assets/downloads/Lithium_Report_FINAL.pdf)

<sup>60</sup> <https://legal-planet.org/2024/03/19/critical-insights-on-the-mineral-boom-part-ii/>

- III. **Prioritize Local Hire and Just Transition:** Couple investments in local workforce training programs (e.g., Imperial Valley College's lithium program) with legally binding Community Benefits Agreements (CBAs) that mandate local hire targets, fair wages, benefits, safety standards, and pathways to union representation for construction and operations jobs.
- IV. **Improve Regional Coordination and Address Infrastructure Gaps:** Support initiatives like the proposed Southeast California Economic Zone (SB 534)<sup>61</sup> to create a more appropriate regional planning framework that addresses the unique needs of the Imperial and Eastern Coachella Valleys and ensures local voices are central in decision-making. Address the critical infrastructure bottlenecks, particularly electrical transmission capacity and state energy procurement processes, that have hampered geothermal project development and investor confidence. This policy fragmentation, where state energy goals, permitting processes, regional planning structures, and local realities are misaligned, needs urgent attention.<sup>62</sup>

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## CANADA

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### TANCO MINE

The Tantalum Mining Corporation of Canada (Tanco) mine, located on the northwest shore of Bernic Lake in Manitoba, approximately 180 km (112 mi) east-northwest of Winnipeg, represents a significant case study in resource extraction. Operating for over five decades, the mine reserves an LCT (Lithium, Cesium, Tantalum) pegmatite deposit, a geological formation noted for its enrichment in these rare elements.<sup>63</sup> The Tanco pegmatite holds the largest known global deposit of pollucite, the primary ore of cesium, making the mine a dominant producer. In recent years, the mine has become Canada's only current producer of lithium concrete (spodumene) for the battery market.<sup>64</sup>

The mine has a history of fluctuating operational priorities. Exploration began in the 1920s, with initial small-scale mining for tin and beryl. Commercial operations began in 1969, initially focused on tantalum. Over its lifespan, Tanco has commercially produced in, tantalum, cesium, lithium, and rubidium, adapting its output to shifting markets demands and commodity prices. Since June 2019, Sinomine Resource Group, a publicly traded, non-governmental Chinese entity, via its subsidiary Sinomine (Hong Kong) Rare Metals Resource Co., Ltd are the owners of Tanco.

The Tanco Mine's long operational history has resulted in measurable environmental impacts, primarily concerned within Bernic Lake and managed through *tailing facilities* (specifically designed and managed areas used to store the waste materials, or tailings, produced during mineral and metal extraction processes), under the oversight of provincial and federal regulations.

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<sup>61</sup> [https://calmatters.digitaldemocracy.org/bills/ca\\_202520260sb534](https://calmatters.digitaldemocracy.org/bills/ca_202520260sb534)

<sup>62</sup> <https://legiscan.com/CA/text/SB534/id/3134930>

<sup>63</sup> <https://tancomine.com/about/>

<sup>64</sup> <https://gov.mb.ca/iem/info/libmin/OF2024-3.pdf>

## **Environmental Impacts**

**Water Quality and Aquatic Ecosystem:** The primary pathway for environmental interaction is the West Discharge, the sole effluent release point, channeling water from the active West Tailings Management Area (WTMA) into Bernic Lake.<sup>65</sup> Effluent quality and discharge volumes are regulated under Manitoba Environment Act License No. 973 R<sup>66</sup> and the federal Metal and Diamond Mining Effluent Regulations (MDMER).<sup>67</sup> Decades of discharge since 1969 have altered Bernic ecosystem. Moreover, increased phosphorus loading has shifted the lake from its natural oligotrophic (low-nutrient) state to a mesotrophic (moderate-nutrient) condition. This eutrophication has stimulated primary productivity, leading to increased algal biomass and a greater abundance of benthic invertebrates.

Concentrations of several dissolved elements (e.g., Cs, Li, Rb, Sr, Be, Sb) are also elevated in Bernic Lake compared to reference conditions, though currently below levels considered acutely toxic or directly linked to observed ecological effects under existing guidelines. However, environmental assessments often frame these changes as “measurable” but not “adverse” based on regulatory definitions that focus on preventing severe degradation or loss of key species. But this can seem may not align with broader ecological health goals or the communities who rely on the lake.

**Land Disturbance:** The mine’s long-term operation has established a considerable physical footprint. While past assessments indicated no expansion plans, recent proposals for tailings reprocessing and potential future open-pit mining signal a shift towards expansion.<sup>68</sup> Construction activities entail vegetation clearing and potential impacts on wildlife habitat (including identified caribou overlap), managed through standard mitigation practices.<sup>69</sup>

## **Social Impacts**

The Tanco Mine exists within a complex social landscape, generating economic benefits for nearby communities while operating within the traditional territories of Indigenous Nations, leading to distinct social issues and responsibilities.

**Local Communities:** The towns of Lac du Bonnet and Pinawa serve as the primary residential centers for the Tanco workforce. The mine is a principal part of the regional economy, historically employing up to 150 people directly, plus contractors. Current job postings confirm ongoing employment opportunities.<sup>70</sup> The economic reliance, however, makes these communities vulnerable to the mine’s operational fluctuations driven by global markets, a vulnerability potentially heightened by the mine’s history of intermittent operations. Increased mine traffic can also strain local infrastructure like roads, necessitating agreements for maintenance.

<sup>65</sup> [https://www.gov.mb.ca/sd/eal/registries/1906.2tanco/noa\\_19\\_chapter\\_5.pdf](https://www.gov.mb.ca/sd/eal/registries/1906.2tanco/noa_19_chapter_5.pdf)

<sup>66</sup> <https://gov.mb.ca/sd/eal/registries/1906.5/index.html>

<sup>67</sup> <https://www.gov.mb.ca/sd/eal/registries/1906.5/973r.pdf>

<sup>68</sup> <https://www.manitoba.ca/sd/eal/registries/1906.2tanco/executive.summary.pdf>

<sup>69</sup> [https://www.gov.mb.ca/sd/eal/registries/1906.3tanco/noa\\_20\\_chapter1.pdf](https://www.gov.mb.ca/sd/eal/registries/1906.3tanco/noa_20_chapter1.pdf)

<sup>70</sup> [https://www.gov.mb.ca/sd/eal/registries/1906.3tanco/noa\\_20\\_chapter1.pdf](https://www.gov.mb.ca/sd/eal/registries/1906.3tanco/noa_20_chapter1.pdf)

**Local Indigenous Nations:** The mine's location carries profound significance for Indigenous Nations. It lies within territory where the *Sagkeeng First Nation* asserts unextinguished Aboriginal Title, and the Bernic Lake is part of their traditional lands. Sagkeeng has established its own Consultation and Accommodation Protocol and has been involved in negotiating resource agreements in the region. They have explicitly voiced concerns regarding potential mine expansions, demanding comprehensive impact assessments and adherence to the principle of Free, Prior, and Informed Consent (FPIC).<sup>71,72,73</sup>

The *Manitoba Métis Federation (MMF)* identifies the area as part of the Red River Métis National Homeland. An MMF-led study documented extensive historical and ongoing Red River Métis land use, including harvesting, trapping, fishing, and cultural practices, in the vicinity of the mine.<sup>74</sup> The MMF has raised concerns about potential impacts on MMF Section 35 rights<sup>75</sup>, environmental contamination risks (particularly to water), and inadequate past consultation, while engaging with Tanco/Sinomine.<sup>76</sup> Other First Nations, including *Brokenhead Ojibway Nation*, *Hollow Water First Nation*, and *Black River First Nation*, have also been identified as having interests in the area.

**Social Issues Related to Mining in the Region:** Tension exists between the localized economic benefits, largely accruing to non-Indigenous communities like Lac du Bonnet and Pinawa, and the potential adverse impacts on the rights, environment, and cultural practices of Indigenous Nations whose traditional territories host the mine. This social dynamic requires careful consideration by policymakers. The assertion of Indigenous rights and title, tied with constitutionally protected harvesting rights (Section 35) and the Crown's duty to consult and accommodate, forms a critical legal and social context.

Past consultation efforts have been criticized, leading to demands for more robust, meaningful engagement process that respect Indigenous protocols and potentially lead to FPIC. Mining activities pose direct threats to traditional land use, potentially contaminating water sources used for drinking and fishing, destroying habitat vital for hunted and trapped species (including caribou), restricting access to harvesting areas, and disrupting the intergenerational transfer of ecological knowledge. These impacts raise environmental justice concerns, as Indigenous communities may disproportionately bear the long-term environmental and cultural costs of resource extraction.

The mine's foreign ownership by Sinomine Resource Group introduces further complexities regarding local benefit sharing, reinvestment strategies, adherence to Canadian ESG standards, and federal government scrutiny under critical minerals and national security frameworks. The consultation landscape itself is evolving, moving from historical neglect

<sup>71</sup> [https://www.gov.mb.ca/sd/eal/registries/1906.3tanco/noa\\_20\\_chapter1.pdf](https://www.gov.mb.ca/sd/eal/registries/1906.3tanco/noa_20_chapter1.pdf)

<sup>72</sup> <https://www.youtube.com/watch?v=-5MTsDa-CSk>

<sup>73</sup> <https://sagkeeng.ca/wp-content/uploads/2023/07/Signed-Consultation-Protocol.pdf-1.pdf>

<sup>74</sup> <https://www.mmf.mb.ca/wcm->

[docs/docs/eirm\\_mining/red\\_river\\_me\\_769\\_tis\\_knowledge\\_land\\_use\\_and\\_occupancy\\_study\\_report\\_tanco\\_mine\\_project\\_feb\\_2025.pdf](https://www.mmf.mb.ca/wcm-docs/docs/eirm_mining/red_river_me_769_tis_knowledge_land_use_and_occupancy_study_report_tanco_mine_project_feb_2025.pdf)

<sup>75</sup> The Manitoba Métis Federation (MMF) is a rights-bearing Aboriginal people whose rights are recognized under [Section 35 of the Constitution Act, 1982](#). Section 35 recognizes and affirms the Aboriginal and treaty rights of Canada's Indigenous peoples, including the Métis. The MMF represents the Manitoba Métis and its relationship with the government is a direct result of these constitutional rights.

<sup>76</sup> <https://www.mmf.mb.ca/news/mmf-calls-for-consultation-and-sound-environmental-stewardship-principles-in-proposed-expansion-of-tanco-mine-activity>

towards more formalized engagement processes, but the adequacy and outcomes, particularly regarding consent for major projects, remain under scrutiny and negotiation.

### **Policy Recommendations & Conclusion**

The Tanco Mine case study highlights the need for adaptive policy frameworks to govern critical mineral extraction, particularly for long-operating facilities undergoing expansion under new ownership within sensitive environmental and social contexts. Based on the analysis, the following policy recommendations are proposed:

- I. **Strengthen Environmental Assessment and Oversight:** Future major alterations or expansions (e.g., potential open-pit development, further capacity increases beyond the recently approved reprocessing project) should trigger comprehensive environmental assessments that explicitly evaluate cumulative effects, integrating impacts on the already altered Bernic Lake ecosystem with legacy risks (e.g., TMA stability, long-term water quality) and new pressures. Provincial licensing (Environment Act License 973 R) must be rigorously enforced, incorporating the precautionary principle and potentially stricter water quality objectives that reflect ecosystem health beyond minimum compliance. Closure planning requires robust financial assurance and clear, ecologically sound rehabilitation goals. Monitoring programs (EEM) should be periodically reviewed for adequacy in detecting subtle or long-term impacts.<sup>77,78</sup>
- II. **Enhance Indigenous Consultation, Consent, and Partnership:** Provincial consultation processes should formally recognize and prioritize adherence to community-specific protocols developed by Indigenous Nations (e.g., Sagkeeng, MMF) where available. For projects with significant potential impacts on asserted Aboriginal Title lands or Section 35 rights, consultation frameworks should evolve towards seeking FPIC, supported by adequate capacity funding for Indigenous participation and the meaningful integration of Indigenous Knowledge into decision-making. Clear, equitable, and enforceable benefit-sharing and accommodation agreements are crucial to ensure affected Indigenous Nations share in the project's prosperity and have their concerns addressed.<sup>79</sup>
  - a. A possible template for collaboration: [https://cedf.mb.ca/wp-content/uploads/manitoba first nations mineral development protocol template.pdf](https://cedf.mb.ca/wp-content/uploads/manitoba_first_nations_mineral_development_protocol_template.pdf)
- III. **Address Regional Socio-Economic Vulnerability:** Recognizing the economic dependence of Lac du Bonnet and Pinawa on the mine, provincial and regional development policies should actively support economic diversification initiatives to build resilience against mining sector volatility and eventual mine closure.<sup>80</sup>

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<sup>77</sup> [https://www.manitoba.ca/iem/mines/procedures/pdfs/procedures\\_minedevelopment.pdf](https://www.manitoba.ca/iem/mines/procedures/pdfs/procedures_minedevelopment.pdf)

<sup>78</sup> [https://www.gov.mb.ca/sd/eal/regisries/1906.2tanco/noa\\_19\\_chapter\\_6.pdf](https://www.gov.mb.ca/sd/eal/regisries/1906.2tanco/noa_19_chapter_6.pdf)

<sup>79</sup> <https://www.gov.mb.ca/iem/mines/fnmdp.html>

<sup>80</sup> [https://mbeconetwork.org/wp-content/uploads/2024/01/Manitoba-Eco-Network\\_TANCO-EAP-Comments\\_Jan-2024.pdf](https://mbeconetwork.org/wp-content/uploads/2024/01/Manitoba-Eco-Network_TANCO-EAP-Comments_Jan-2024.pdf)

## WHABOUCHI MINE

The Whabouchi Mine, located in the Eeyou Istchee James Bay territory of northern Quebec, is a Canadian hard-rock lithium deposit. Owned by Nemaska Lithium (a joint venture between Arcadium Lithium [formerly Livent] and Investissement Québec), the Whabouchi project involves the development of an open-pit and underground mine to extract spodumene concentrate.<sup>81</sup> Spodumene concentrate is a high-purity lithium ore derived from the mineral spodumene, typically containing 5-7% lithium oxide (Li<sub>2</sub>O). It's a key starting material for producing lithium chemicals like lithium hydroxide and lithium carbonate, which are needed for lithium-ion batteries.<sup>82</sup>

### Environmental Assessment Processes

The Whabouchi project underwent environmental assessment (EA) under both federal and provincial jurisdictions. The project triggered an EA under the Canadian Environmental Assessment Act, 2012 (CEAA 2012) as a designated activity (mine construction). The Canadian Environmental Assessment Agency (now the Impact Assessment Agency of Canada) conducted the assessment, registry reference number 80021.<sup>83</sup> The project was also subject to the environmental and social impact assessment (ESIA) procedure established under Section 22 of the James Bay and Northern Quebec Agreement (JBNQA).<sup>84</sup> For projects south of the 55<sup>th</sup> parallel like Whabouchi, the Evaluating Committee (COMEV), comprising Cree, Quebec, and federal representatives, assesses preliminary information and recommends whether a review is needed. However, for this project there was no formal federal-provincial cooperation agreement that was established for coordinating these two assessment processes for the Whabouchi project. Notably, there was some efforts on the developer's side to try and implement mitigation efforts but without the coordination mechanism that was required, it is not known the success of said mitigation efforts.<sup>85</sup>

### Environmental Impacts

Based on EA summaries, the assessments identified several potential adverse environmental effects. **Water Resources:** Potential degradation of surface water quality in water bodies like Whabouchi Lake and downstream systems (potentially affecting Nemiscau Lake) due to contaminants in mine effluent (from the water treatment plant) and dust deposition. Changes in surface runoff patterns from site infrastructure (mine pit, waste storage, roads) could alter hydrological systems and affect fish habitat. Groundwater quality and flow was also an area of concern.<sup>86</sup>

**Waste Rock and Tailings Management:** The project involves storing large volumes of waste rock and filtered tailings. A key consideration was the potential for Acid Rock Drainage (ARD) and metal leaching (ML) from these materials. Though, testing indicated that the ore and

<sup>81</sup> <https://www.canadianminingjournal.com/featured-article/canadas-lithium-is-in-quebec/>

<sup>82</sup> <https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/lithium-facts>

<sup>83</sup> [https://comexqc.ca/wp-content/uploads/Whabouchi\\_Final\\_Report\\_ENG.pdf](https://comexqc.ca/wp-content/uploads/Whabouchi_Final_Report_ENG.pdf)

<sup>84</sup> [https://www.cngov.ca/wp-content/uploads/2021/03/ibnqa-esia-procedure\\_2021.pdf](https://www.cngov.ca/wp-content/uploads/2021/03/ibnqa-esia-procedure_2021.pdf)

<sup>85</sup> [https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/rmd-rrm/Nemaska\\_Lithium\\_Whabouchi\\_EN.PDF](https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/rmd-rrm/Nemaska_Lithium_Whabouchi_EN.PDF)

<sup>86</sup> [https://publications.gc.ca/collections/collection\\_2015/acee-ceaa/En106-144-2015-eng.pdf](https://publications.gc.ca/collections/collection_2015/acee-ceaa/En106-144-2015-eng.pdf)

waste rock are non-acid generating and that problematic elements are not readily leachable. This finding may help with the long-term environmental risk often associated with mining, and aiding waste management compared to sites with significant ARD/ML potential. However, long-term geochemical stability remains a factor requiring monitoring. The plan involves a co-disposal storage facility (CSF) where waste rock forms the outer berms containing the filtered tailings, designed to minimize footprint and manage water.<sup>87</sup>

***Land Disturbance & Biodiversity:*** Significant alteration, disturbance, and loss of terrestrial and wetland habitats due to site clearing pit excavation, road construction, and the footprint of the CSF and other infrastructure. The habitat loss poses risks to biodiversity, including migratory birds and species at risk. While specific mitigation details for woodland caribou were not detailed in the provided environmental assessments, habitat fragmentation and disturbance are known stressors for these species.

***Air Quality & Noise:*** Potential degradation of air quality due to dust generated from mining activities (blasting, crushing, hauling, storage piles) and vehicle emissions. Increased noise levels from equipment operation and blasting could affect wildlife and human populations in the area.

Both the federal and provincial EA processes concluded that the project, with the implementation of the proposed mitigation measures, it was not likely to cause significant adverse environmental effects. The federal Minister of Environment issued a Decision Statement in July 2015, establishing legally binding conditions, including mitigation measures and follow-up program requirements, that the developer must adhere to throughout the project's lifecycle.<sup>88,89</sup>

### **Social Impacts**

The most directly affected community is the Cree Nation of Nemaska, located approximately 30 km west of the mine site. Nemaska serves as an administrative hub, hosting offices for the Grand Council of the Crees (Eeyou Istchee) and the Cree Nation Government. Family camps belonging to Nemaska members are located near the mine site. The formal ESIA processes and community consultation brought numerous concerns to light, revealing a link between potential environmental effects and the social, cultural, and health well-being of the Cree Nation of Nemaska.<sup>90</sup>

There was a report created by the women of the Cree Nation of Nemaska on the impacts of the Whabouchi Project. A major highlight was a gap between initial consultation and the project design team which led to the insufficient incorporation of concerns expressed by local communities and other individuals. The report states that the developer fulfilled their

<sup>87</sup> [https://www.sec.gov/Archives/edgar/data/1742924/000114036123045135/ny20009544x3\\_ex96-1.htm](https://www.sec.gov/Archives/edgar/data/1742924/000114036123045135/ny20009544x3_ex96-1.htm)

<sup>88</sup> <https://www.canada.ca/en/news/archive/2015/07/whabouchi-mining-project-environmental-assessment-decision.html>

<sup>89</sup> <https://www.globenewswire.com/news-release/2015/07/30/1470176/0/en/Nemaska-Lithium-Receives-Positive-Federal-Environmental-Assessment-Decision-for-Whabouchi-Project.html>

<sup>90</sup> [https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/rmd-rrm/Nemaska\\_Lithium\\_Whabouchi\\_EN.PDF](https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/rmd-rrm/Nemaska_Lithium_Whabouchi_EN.PDF)

mandated procedural steps but inadequately translate community feedback into tangible project modifications.<sup>91</sup>

The impacts on traditional lands use and harvesting remains a central area of concern.<sup>92</sup> The ESIA processes formally identified adverse effects on the current use of lands and resources by the Nemaska Cree for traditional purposes. Community consultations revealed deep anxieties about how habitat loss, noise, dust, potential water contamination, and general mine activity could disrupt hunting, fishing, trapping, and gathering practices, potentially affecting food security and cultural transmission.<sup>93</sup> The connection to the land makes its physical alteration or perceived contamination a source of significant distress.

While the project attempted at a redesign aimed to reduce the physical footprint and relocate infrastructure away from sensitive areas, impacts remain, including the formal suspension of James Bay and Northern Quebec Agreement (JBNQA) [guarantees harvesting rights for the Indigenous peoples of the region, including the right to harvest any species anywhere in their territory at any time] harvesting rights within the immediate mine site and safety Zones. Cumulative impacts from Whabouchi added to existing pressures from hydro development and forestry on traditional territories are a significant factor increasing these concerns.<sup>94</sup>

**Community Cohesion:** Evidence points to the Whabouchi project being a source of internal division within the Cree Nation of Nemaska. While official leadership (Chief and Council) approved the Chinuchi Agreement [agreement between the developer and Cree Nation addressing impacts and establishing framework for partnership], framing it as a vital economic opportunity, significant concerns and opposition were voiced by other community members, including elders, women, and a former chief.<sup>95</sup> Focus group participants described feelings of being “split” and experiencing conflict within families and the community over development projects.

### **Policy Recommendations & Conclusion**

The Whabouchi lithium project case study highlights governance for critical mineral development with different provisional governments and Indigenous Nations. Based on the Whabouchi experience, the following recommendations are proposed for enhancing environmental governance policy for future critical mineral projects:

- I. **Streamline Dual Environmental Assessment Processes:** Where projects trigger multiple jurisdictional EAs (federal, provincial/territorial, and treaty-based regimes like JBNQA Section 22 [establishes the environmental and social protection regime for the Eeyou Istchee (Cree territory). It aims to minimize negative impacts on Native people and wildlife resources caused by development projects in the region. This regime includes a two-tiered environmental and social impact assessment and review procedure]), formal cooperation agreements or equivalent mechanisms should be

<sup>91</sup> [https://comexqc.ca/wp-content/uploads/Women.Group\\_.pdf](https://comexqc.ca/wp-content/uploads/Women.Group_.pdf)

<sup>92</sup> <https://comexqc.ca/wp-content/uploads/CCSSBJ.pdf>

<sup>93</sup> [https://repertoireoug.com/wp-content/uploads/2022/05/8262002M\\_20210818\\_Rapport\\_Reg\\_Ress\\_Dvl\\_Plan\\_FINAL\\_LowRes.pdf](https://repertoireoug.com/wp-content/uploads/2022/05/8262002M_20210818_Rapport_Reg_Ress_Dvl_Plan_FINAL_LowRes.pdf)

<sup>94</sup> <https://www.ree.environnement.gouv.qc.ca/dossiers/3214-14-055/3214-14-055-50.pdf>

<sup>95</sup> <https://www.theenergymix.com/lithium-mine-divides-nemaska-cree-over-impacts-benefits/>

prioritized. This would streamline requirements, timelines, and consultation efforts, reduce duplication and improve efficiency for developers, Indigenous Nations, and regulators.

- II. **Mandate and Fund Independent Long-Term Monitoring:** Policy should require developers to establish and fund independent, long-term environmental monitoring programs extending well beyond operational closure. Co-management or oversight roles for Indigenous partners, building on models like the Chinichi Agreement's Environmental Committee, should be standard practice, ensuring transparency and accountability in verifying mitigation effectiveness and detecting later impacts.

## **SOUTH AMERICA**

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### **ANDEAN SALT FLATS REGION: CHILE, ARGENTINA, & BOLIVIA**

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The arid salt-flat arc that spans northern Chile, north-western Argentina, and south-western Bolivia—commonly referred to as the *South American altiplano*—holds more than 50% of the world's lithium reserves, primarily in brine beneath high-altitude salars like Atacama, Uyuni, and Hombre Muerto (USGS, 2020). As global demand for lithium surges to support battery production and the low-carbon transition, this region has become a focal point for socio-environmental conflict. This case-study reveals acute hydrological impacts, disproportionate burdens on Indigenous communities, and pressing governance challenges related to lithium mining and production in the South American altiplano region.

#### **Environmental impacts**

**Water depletion and hydrological impacts:** Brine evaporation and freshwater extraction are profoundly altering regional hydrology. In the Salar de Atacama, operations by SQM and Albemarle have been linked to declining water tables and the desiccation of adjacent wetlands and lagoons critical for biodiversity and local subsistence (Liu & Agusdinata, 2020). Peer-reviewed assessments of lithium carbonate production from brine in the South American altiplano report extremely high full water footprints (including blue, green, and grey water), on the order of tens to several hundred cubic meters per tonne  $\text{Li}_2\text{CO}_3$  on average, with maximum values approaching  $\sim 800 \text{ m}^3/\text{tonne}$  in some operations – among the highest water intensities recorded for any mineral production globally (Díaz Paz et al., 2025; Vera et al., 2023). In comparison, hard-rock lithium mining (e.g., in Australia or China) generally consumes far less water (typically on the order of a few hundred  $\text{m}^3$  per tonne or lower), and while direct lithium extraction (DLE) technologies aim to eliminate evaporation losses, some studies indicate their water-scarcity footprints remain similar or even higher than conventional brine evaporation methods (Mas-Fons et al., 2024; Schenker & Pfister, 2025).

**Ecological degradation:** Brine drawdown affects nesting sites of endemic flamingos and contributes to desertification (Gutiérrez et al., 2022). Satellite imagery has captured shoreline retraction of critical wetlands, while  $\text{PM}_{10}$  levels in Atacama communities regularly exceed

WHO guidelines due to mining dust, which can be transported up to 50km from mine sites (Zanetta-Colombo, 2022).

**Technological transitions and risks:** DLE is being piloted as a “greener” alternative. However, early studies suggest unresolved brine waste risks (Flexer et al., 2018), and uncertainty remains around DLE’s freshwater use intensity and energy demands (Vera et al., 2023). Bolivia’s state lithium company launched pilot plants in 2024, but transparency on baseline hydrology impacts remains limited, raising concerns among surrounding communities (Ruas, 2025).

### **Social impacts**

**Indigenous rights and resistance:** The Atacameño people, also known as the Likan Antay people in N. Chile; Kolla and Atacameño in Argentina, and Quechua and Aymara communities in Bolivia have long histories of territorial governance and cross-border cooperation, having lived in this region since before national borders were drawn. Lithium extraction, often permitted without their Free, Prior, and Informed Consent (FPIC) — a violation of the UN Declaration on the Rights of Indigenous Peoples and the Argentinean constitution — undermines traditional livelihoods, such as llama herding and subsistence farming (Izquierdo et al., 2022).

In Argentina, more than 30 Indigenous communities around Salinas Grandes have rejected lithium development, citing water mismanagement and procedural violations. Their coordinated resistance includes formal complaints to international bodies (Flores, 2024).

**Socio-economic fragmentation:** While national and provincial revenues from lithium extraction have surged—Chile’s government received over \$5 billion from lithium royalties in 2022 alone (AP News, 2023)—benefits for local communities remain highly uneven. Even in the South American altiplano’s mining zones, state-of-the-art operations sit alongside Indigenous villages lacking basic services like clean water, prompting residents to ask, “where are the benefits?” (Villegas, 2023). Employment opportunities are limited and highly technical: in Chile’s Salar de Atacama, for example, under 20% of the lithium mining workforce is hired locally (Liu & Agusdinata, 2020) with most skilled jobs going to outsiders. Moreover, corporate social responsibility programs have been widely criticized for fragmenting community cohesion and undermining traditional leadership. Companies have been accused of “divide-and-rule” tactics that split once-unified Indigenous communities (Barber, 2024), with some villages striking separate agreements that bypass communal councils (Villegas, 2023).

### **Policy recommendations**

- I. **Mandate FPIC through enforceable national legislation:** Chile’s 2023 National Lithium Strategy commits to Indigenous participation, but legal clarity is lacking. Argentina must harmonize provincial mining codes with national human rights obligations, and Bolivia should institutionalize meaningful consultation in their state–enterprise partnership.
- II. **Require hydrological baseline assessments:** Governments should obligate mining firms to complete participatory water accounting and scenario modeling before

permitting. This must include aquifer interconnectivity analysis, traditional water uses, ecological monitoring of sensitive wetland ecosystems, and seasonal hydrological patterns.

- III. **Establish Indigenous-led benefit trusts like US-based CBAs:** Autonomous funds governed by affected communities should manage a share of royalties to support local infrastructure, water systems, cultural programming, and general development modeled in consultation with community-based organizations.
- IV. **Create a tri-national Atacama mining impacts research organization:** A regional body should collect harmonized environmental data, share development metrics, and mediate cross-border issues.
- V. **Tie extraction to circular economy obligations:** Acquiring mining development rights should require investment in battery recycling infrastructure to reduce future primary demand and foster local value addition.

The South American altiplano sits at the nexus of global climate action and local justice struggles. Without robust, community-centered governance frameworks, the transition risks reproducing extractive harms under a green banner. Recognizing hydrological impacts, monitoring ecological impacts, securing FPIC, and centering Indigenous sovereignty are essential to ensuring that decarbonization is not achieved at the expense of South American altiplano peoples and ecosystems.

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## BRAZIL

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Minas Gerais is a state in Brazil that possesses significant pegmatite lithium deposits which have been coined “Lithium Valley.” Large scale lithium production and research in Minas Gerais and other parts of Brazil have gained significant interest relatively recently in the past decade. This is showcased by the large flood of companies and investors in the region as well as significant funding for lithium research by the National Mining agency, up to 64% of the budget for all mineral research in the country.<sup>96</sup>

Today, Lithium Valley continues to attract investors and mining companies with numerous mining projects in development such as the Neves Project by Atlas Lithium, the Bandeira project by Lithium Ionic, the Salinas project by Latin Resources, and other lithium explorations by companies such as Spark Energy, North by Northwest Lithium inc., and Hawk Resources.<sup>97,98</sup> There are currently 3 active, lithium-producing mines in Minas Gerais: the Cachoeira mine owned by Companhia Brasileira de Lítio (CBL), the Grota do Cirilo Project by Sigma Lithium, and the Mibra mine (Volta Grande) by AMG Lithium. Both the Mibra mine and Grota do Cirilo project are open pit mines while the Cachoeira mine mine is an underground operation.<sup>99</sup>

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<sup>96</sup> <https://www.sciencedirect.com/science/article/pii/S0301420724008079#bib66>

<sup>97</sup> <https://wreg.com/business/press-releases/ein-presswire/687285757/north-by-northwest-lithium-inc-acquires-claims-in-brazils-lithium-valley-minas-gerais-state-brazil/>

<sup>98</sup> <https://wreg.com/business/press-releases/ein-presswire/687285757/north-by-northwest-lithium-inc-acquires-claims-in-brazils-lithium-valley-minas-gerais-state-brazil/>

<sup>99</sup> <https://alderanresources.com.au/projects/brazil/#:~:text=The%20Projects%20are%20all%20located,the%20Minas%20Gerais%20State%20capital.>

Besides large-scale industrial mining, Brazil has a history of small scale and artisanal mining, many of which still operate today. Small scale mining for pegmatites is less well known and is generally less precise, technical, and organized and is more dangerous.<sup>96</sup>

### **Environmental impacts**

Large scale lithium mining in Brazil is still relatively new, and the environmental impacts are not fully known. Although most operations are underground, local communities have anecdotally observed a few environmental impacts. A major one is decreased air quality due to dust and other pollutants from mining explosives and waste with residents near the Grota de Cirilo mine complaining of asthma and other diseases like silicosis.<sup>100</sup> Likewise, nearby waterways like Piauí Creek have also been significantly polluted and are no longer safe for drinking or bathing. Depletion of water resources is also a threat with mining operations using 3.6 million liters a day from the Jequitinhonha River in an area that is already semiarid.<sup>101</sup> Artisanal mining has also been noted as a significant cause for deforestation.<sup>102</sup>

### **Social impacts**

The main communities impacted by Lithium mining in the region are the Quilombolos, settlements established by escaped Afro-Brazilian slaves, and Indigenous communities like the Arana, Pataxo, and Pankararu Indigenous Peoples. These communities face a wide range of challenges and harmful impacts due to mining such as housing damage due to explosions, health impacts due to dust and other pollutants, buying of desired farming land for mining, negotiations without consulting the entire community, providing low paying jobs, and violations of National mining regulations.

### **Policy recommendations**

- I. **Mandate consultation and agreements with local communities:** The government of Minas Gerais should create and enforce a policy that requires mining companies to consult with and form agreements with local communities. This includes negotiating incomes and benefits from mining profits as well as FPIC. Companies can no longer just negotiate with landowners and ignore communities who will be impacted.
- II. **Require public health monitoring:** Monitoring methods and personnel should be determined in prior agreements between local communities and mining companies.
- III. **Recognition of Indigenous Territories:** Local Indigenous tribes such as the Arana, Pataxo, and Pankararu should have their communities and lands be recognized at the federal level.

<sup>100</sup> <https://news.mongabay.com/2024/11/lithium-mining-brings-sickness-to-jequitinhonha-valley-communities/>

<sup>101</sup> <https://news.mongabay.com/2025/04/in-brazils-lithium-valley-communities-share-how-to-reduce-mining-impacts/>

<sup>102</sup> <https://www.sciencedirect.com/science/article/pii/S1462901123002125>

## GENERAL SOURCES

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Chaudary, 2025

Lithium dreams, local struggles: Navigating the geopolitics and socio-ecological costs of a low-carbon future:

*The global demand for lithium, driven by the transition to renewable energy, has intensified environmental degradation, Indigenous land commodification, and biodiversity loss, revealing deep tensions between sustainability goals and extractive practices. Scholars highlight how "green extractivism" and sociotechnical imaginaries shape narratives legitimizing lithium extraction, linking it to national identity, sovereignty, and visions of sustainable progress while masking socio-environmental harms. The literature also emphasizes the geopolitical struggle over lithium supply chains, particularly between China and Western powers, and calls for more equitable, sustainable governance frameworks that align climate goals with social and environmental justice.*

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