

The renaissance of Rio Tinto's former industrial assets in France: enablers for successful post-mining transitions

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Abstract

Mineral resources are finite and therefore mining and mineral processing are temporary land uses. As a result, asset closure planning must be underpinned by the future post-mining land use. Recently, the focus of mine closure has shifted from solely environmental considerations to encompass social and economic outcomes, driving increased interest in post-mining transitions. In many jurisdictions the pathway to relinquishment and realising post-mining opportunities remains unclear and challenging to achieve. This uncertainty is resulting in suboptimal outcomes for industry, government, communities and society.

Through safe and responsible asset closure, Rio Tinto is working to deliver shared benefits for host communities, employees and investors; positive environmental, social and governance (ESG) outcomes; and innovative solutions that minimise long-term liabilities. Rio Tinto manages several legacy mining, processing and infrastructure assets in France, where the strong spirit of partnership between industry, community and government has resulted in transitions to successful post-mining land uses. Through case studies, this paper illustrates Rio Tinto's experience of asset transition in France, lessons learnt and the key enablers.

Keywords: mine closure, post-mining land use, post-mining transition, repurpose, relinquishment, legacy management, legislative policy framework, France

1 Introduction

Mining and the processing of resources is a temporary land use and therefore planning for closure and the next land use is best started early in the life of assets. The number of mines closing globally is forecasted to increase over the coming years. The International Council on Mining and Metals' survey of its members undertaken in 2018 found that over the next 25 years more than 40% of the operations that responded are expected to close, based on commodity prices and mine life estimates at that time, and almost 20% are expected to close in the next 10 years (Brock & Stevens 2021). The scarcity of examples of successfully relinquished mines and the impending mine closure 'boom' is driving increased focus on post-mining transitions. A relinquished asset is defined as a closed asset 'for which management and monitoring has been completed and tenure has been surrendered, with responsibility transferred to the relevant regulating authority or third party' (International Organization for Standardization 2020).

Closure planning has evolved over the last decade to have a greater focus on the societal aspects of mine closure rather than just the ecological. For a third consecutive year ESG remained the top business risk and opportunity according to the EY Top 10 Business Risks and Opportunities for Mining and Metals in 2024 report (EY 2023). For mining to be truly sustainable it must provide the materials the world needs and leave acceptable outcomes for both the environment and community following asset closure. The industry is now looking to maximise total value via post-mining transitions with a focus on sustainable outcomes for communities and society. Post-mining transition refers to the conversion of the asset to an alternative sustainable land use.

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Business strategies such as mine developments and acquisitions undergo rigorous study and design to inform the investment decision on whether to proceed. Conceptual-level closure cost estimates are included within the assessment to ensure that life-of-asset costs are considered. However, over the life of an asset many factors used to calculate the closure cost estimate change: additional site knowledge is acquired, operating plans change, market conditions fluctuate and societal expectations evolve, which usually leads to significant increases to the cost of closure. Industry must balance commitments to its shareholders with its closure obligations and ESG goals. Closing a mine is an investment decision, with mining executives and boards requiring certainty of process and outcome in order to invest in closure; residual risk and liability are key factors that inform the decisions (Tiemann et al. 2019). Legal liability refers to the legal responsibility that an individual or entity has for their actions or omissions that result in harm or loss to another party.

The mining lifecycle and global standards are based on the premise that once mining is completed the site will be closed to a safe, stable and non-polluting state and transitioned to its next land use, which includes the relinquishment of tenure by the mining operator. Despite this there are inadequate or uncertain policy and regulatory landscapes in many jurisdictions to support mine relinquishment and land use transition, and this uncertainty could be acting to disincentivise industry from making a substantial investment in mine closure. A review of global practices, policies and regulations on mine relinquishment for more than 40 countries or mining jurisdictions revealed that very few jurisdictions provide clear and achievable processes for the relinquishment of closed mine sites and many jurisdictions do not reference relinquishment at all within their mining or closure policies (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development 2023). Retaining an asset includes holding and site management costs, so if relinquishment cannot be achieved the business case will be revisited and could potentially drive a different closure outcome. The local context in each global jurisdiction is considered when developing asset closure strategies, and investment decisions are assessed based on financial outcome, business risk and residual liability. To avoid asset relinquishments remaining in limbo for years, it must be accepted that there is no such thing as a zero-risk closure, but risk can be managed, minimised, shared and transferred (Brock & Stevens 2021). Government and industry need to work together to facilitate responsible mine closure and relinquishment to avoid future orphaned or abandoned mines, and to release the land to provide for people and the environment both today and in the future.

1.1 Rio Tinto overview

Rio Tinto's purpose is to find better ways to provide the materials the world needs. It operates in 35 countries across six continents and has more than 57,000 employees. To produce aluminium, copper, diamonds, gold, industrial minerals and iron ore, Rio Tinto owns and operates open pit and underground mines, mills, refineries, smelters, power stations, and research and service facilities. To deliver materials to its customers, Rio Tinto uses its own railways, ports and ships. In its drive to improve company performance Rio Tinto has made several acquisitions and mergers. While these expansions strengthen Rio Tinto's portfolio, they inevitably include some sites that are either no longer economically viable in their current form or have been closed by their previous owners and require additional remediation. Some of these are mine sites but many more are industrial operations such as smelters, refineries, mills and sites of manufactured products. While these sites were never previously owned or operated by Rio Tinto, usually the company assumed responsibility for their remediation through the acquisition. Expectations from governments and communities in areas in which Rio Tinto operates are high and we are careful to ensure that social, economic and environmental sustainability is embedded throughout our investment and operational cycles. Closed assets undergoing assessment, monitoring, remediation or in-perpetuity management are called legacy sites. Rio Tinto's closure group currently manages over 90 legacy assets in nine countries, including 28 tailings storage facilities.

Rio Tinto's aspiration is to create a positive legacy by meeting our commitments to stakeholders and host communities, and delivering environmental, social and financial value. As temporary stewards of the land where it operates, Rio Tinto partners with its stakeholders to develop a shared vision for the future of the lands and host communities. Balancing environmental, financial and social considerations, the business looks for opportunities associated with progressive closure, remediation and repurposing, and, where appropriate,

long-term monitoring and maintenance. In most instances asset relinquishment is key to delivering sustainable outcomes. At the end of 2023, closure provisions on Rio Tinto's balance sheet totalled USD 17.2 billion (2022: USD 15.8 billion).

Pechiney was a major aluminium conglomerate which originated in France in 1855. It grew to be the world's fourth largest producer and developer of aluminium products, employing 31,000 people and operating 320 manufacturing and sales facilities in 50 countries. In 2003 Pechiney was acquired by Alcan Incorporated: a major Canadian aluminium mining and manufacturing corporation founded in 1902, with extensive holdings and operations in 61 countries, and 65,000 employees. In 2007 Rio Tinto acquired Alcan and continues to operate several bauxite mines, refineries and smelters, and has assumed responsibility for several closed assets, throughout the world. Rio Tinto currently manages 45 legacy assets in France, including former mines, landfills, impoundments, and processing and manufacturing sites. Each site is unique and therefore closure strategies vary, however, Rio Tinto's overarching aim is to remediate the assets as required and, where possible, transfer them to local authorities or third parties for future land use.

1.2 French context

For several centuries France was a powerful mining country. However, declines since the 1960s, due to the depletion of mineral resources and international competition, have forced most mines to close (Didier 2009). The country has experienced many market cycles of expansion and recession, and therefore mine openings and mine closures are not uncommon, however the focus in recent decades has been on managing the financial, community and environmental impacts of industrial contraction. This is expected to change following the adoption of the European Critical Raw Materials Act in March 2024. It aims to ensure a secure and sustainable supply of critical raw materials and includes objectives to increase European extraction, processing and recycling (Council of the European Union and the European Council 2024).

France is divided into 18 administrative regions which are further subdivided into administrative departments, with the prefect of each region's administrative centre's department also acting as the regional prefect. A prefect in France is the state's representative in a department and their main missions are representing the state to local governments, security, safety, responsibility for official documents and ensuring respect for legality. A prefecture is the commune in which the administration of a region or a department is located. Communes are the lowest level of administrative division in France and are governed by elected officials including a mayor and a municipal council. Communes typically are based on pre-existing villages and facilitate local governance; they have extensive autonomous powers to implement national policy.

France has a national policy on regional development which identifies three main issues: boosting the companies hardest hit by the Covid crisis; greater regional resilience; and a genuine ecological and energy transition to a low-carbon economy (Organisation for Economic Co-operation and Development 2023). Each region develops a Regional Plan for Spatial Planning, Sustainable Development and Territorial Equality which summarises the regional spatial situation, produces environmental impact reports, and outlines regional strategies and objectives. The regional objectives are supported by funding from various sources such as the European Regional Development Fund, European Social Fund, Just Transition Fund and European Maritime, Fisheries and Aquaculture Fund. Regional objectives relevant to this paper include reducing the rate of land consumption by recycling land, protecting and investing in biodiversity, decarbonisation of the economy, and support for responsible tourism and sport as a lever for social and territorial cohesion.

Several major subsidence events caused by historical mining activities occurred in the Lorraine iron ore basin, located in the northeast of France, at the end of the 1990s. These resulted in damage to houses and roadways in numerous towns and cities, and required the relocation of many families. In response the French government reformed the Mining Code, including development of a mining risk management policy, and established technical support bodies, including GEODERIS, to identify, predict and secure post-mining areas likely to present risks to property and people.

1.3 French legislation

France is a civil law country. Mining exploration and extraction operations are governed by two centralised pieces of legislation: the French Mining Code, which regulates the exploitation conditions and the post-mine disposition; and the French Environmental Code, which contains provisions related to nature conservation, water management and public participation. These codes are overseen by the Ministry of the Economy, Finance and Industrial and Digital Sovereignty (Ministry of the Economy), and the Ministry for Ecological Transition and Territorial Cohesion (Ministry of the Environment), respectively. Industrial operations are also governed under the French Environmental Code.

The functions within the remit of the state are exercised by competent central authorities, being the relevant ministries, and the relevant decentralised authorities, being Regional Directorates for Environment, Land Planning and Housing (DREALs). DREALs provide technical expertise for the formulation and implementation of state policies on the environment, sustainable development and planning, including environmental impact assessment on projects and the preservation of the quality of the environments (water, air, soil) and biodiversity, the prevention of pollution, risks and nuisances, urban renewal and transport, and seeks coherence between these issues. Expert technical assessment and research functions are exercised respectively by the GEODERIS public interest group and the Scientific Interest Group on the Impact and Safety of Underground Structures. Mine policing and enforcement of environmental regulations is undertaken by local police prefects with the assistance of DREALs.

1.3.1 Mining regulation

The first French Mining Code was created in 1956, based on an 1810 law issued under the rule of Napoléon Bonaparte. It has been revised several times and, in 2011, a new French Mining Code was issued. Mining exploration and extraction operations are mostly governed by this new French Mining Code, which regulates the mining and post-mine conditions and operations. The most recent important amendment of this code took place in 2022.

In France there are different regulations for mines versus quarries, and the differentiation is determined solely by the nature of the substances within the deposit. Under French law, the exploitation of materials defined as 'eligible for concession' is ruled by the regulations on mines and includes mineral substances which were considered in 1810 as strategic and of prime importance for national sovereignty (Didier 2008). The list of all the substances that fall under the mining regulation is included in one of the first articles of the Mining Code, while all the substances not listed in this article are the substances of quarries. Depending on the situation, a substance may change from one regime to another. For instance, bauxite, which used to be governed under the quarrying regime, became a mining substance in 1961 as its extraction had become more strategic due to the rising demand for it. The legal regime for mines is governed by Book I of the Mining Code, and that for quarries is mainly governed by the Environmental Code.

The French Mining Code stipulates that operating a mine is not a landowner right but a state right. The management of the mining deposit is the responsibility of the state because mining substances are considered strategic assets for the country, as mentioned previously. In this regard, a landowner has no right to grant a concession (a contract authorising extraction of a substance); this is a state monopoly.

The Ministries of the Economy and of the Environment deal with matters of national sovereignty, while more technical and administrative aspects are dealt with by local entities such as the DREAL. The operational aspects of the post-mining regulation have been entrusted to the Bureau for Research of Geology, Geophysics and Mining, which has created a special department for this purpose: the Department of Prevention and Mine Safety (DPSM). The main duties of this department are to act as the principal agent for: safety engineering works; operations following expropriation; surveillance of mining facilities under the Mining Code and Environmental Code; management of the post-mining information system, including mining archives; and the support of mining intelligence.

Given that, over time, mining operations can lead to major environmental dangers and threats, the post-mining phase is regulated. French post-mining regulation requires that the termination of a mining activity should not create any after-effects, disorders or nuisances of any type on the environment or on health. To fulfill this goal, the 'last operator' of a mine must implement post-mining measures such as safety works, remediation (if needed), and the installation of monitoring and risk-prevention equipment.

Administratively speaking, once the operator of a mine makes the decision to cease operations: (i) the holder of the mining title is required to complete a Definitive Declaration of Cessation of Mining Operations and Use of Mining Facilities (DADT); (ii) the state issues the first *donné acte* (acknowledgement order) (AP1) to ratify the operator's declaration and to prescribe, where necessary, measures modifying or supplementing those provided for in the DADT; (iii) and the operator of the mine conducts the safety works agreed with the administration. Following this step the operator submits a completion report containing all the information concerning the safety works carried out (including a presentation of the works completed, the documents attesting to the works' proper execution, etc.). As soon as possible, a completion inspection based on the aforementioned report must be carried out. Once it has been confirmed that the works have been completed to the required standard, a second *donné acte* (AP2) is issued by the prefect to record that the required post-mining safety measures have been fully and properly adopted.

This second acknowledgement order also has the effect of terminating the mining policy powers, subject to the 'residual mining policy'. The residual mining policy can be reactivated up to 30 years after the delivery of the second acknowledgement order, when significant risks to the safety of people or property have arisen after the final cessation of operations. However, the residual mining policy does not apply to security, prevention and surveillance facilities already transferred to the state (see below).

French mining law provides that, once all necessary safety measures have been implemented by the last operator of a mine (or its assignee), some of its liabilities can be transferred to the state. For example, the management of hydraulic facilities may be transferred by the last operator of the mine to the state as follows:

- For hydraulic facilities that are necessary or useful for sanitation, water distribution, and the control of rainwater, runoff and groundwater, the financial terms are freely negotiated between the operator of the mine and the buyer. If there is no buyer, these kinds of hydraulic facilities are permanently shut down by the operator of the mine.
- For hydraulic facilities that are necessary for safety, the transfer is made free of charge. The operator of the mine must pay an amount of money estimated on the basis of the expenses that will have to be borne by the state over the 10 years following the transfer of the installation (*soulte*).

The management of equipment needed to monitor and prevent major risks of ground subsidence or accumulations of hazardous gases that could jeopardise the safety of property or people, as identified at the cessation of mining activity, can also be transferred to the state.

However, even if the last operator of the mine can transfer some of its liabilities, it will remain, in any case, liable to third parties who may have suffered damages because of former mining operations. The Mining Code provides for civil mining liability specific to the operator of a mine for damage, including health and environmental damages, caused by mining activity. The liability is not limited by the perimeter of the mining title nor its period of validity. The operator may be exempted from liability by proving an unexpected circumstance (*cause étrangère*).

For abandoned mines and for mines whose operators have defaulted or disappeared, known as 'orphaned mines', the French state replaces the operators and has the liability to make the site safe or to pay for the damage caused by former mining operations.

Finally, a recent law has also modified the Mining Code, which now provides for the liability of the parent company for its subsidiary in the event of gross negligence. This is characterised by the parent company contributing to the subsidiary's shortfall in assets. In this case the parent company must assume, at its own expense, all or part of the safety post-mining measures and damage costs.

1.3.2 Industrial regulation

In France, most of the industrial or agricultural activities likely to generate risks and cause pollution or nuisances — in particular, for the environment, safety and health — are classified under the list of regulated facilities as an Installation Classified for the Protection of the Environment (ICPE) and are governed by the Environmental Code. ICPE legislation also considers installations which may present dangers or inconveniences for the conservation of sites and monuments as well as elements of archaeological heritage. Depending on the degree of risks and nuisances raised by the facility, ICPE facilities may be subject to prior authorisation, registration or declaration. Declared ICPE facilities are those considered to have the lowest degree of risk or nuisance, and authorisation facilities are those considered to have the highest.

An ICPE facility is subject to regulatory requirements depending on its activities and/or the substances present within it, and these prescriptions are dictated by ministerial or prefectorial orders. The operator must comply with the applicable requirements and show this compliance to the authorities. Regulated facilities fall under the special policing powers of the prefect and the state. In France it is the operator of the regulated facility who is liable for pollution related to the activities for which they are the last operator; this includes pollution that is linked to these activities but resulting from operations by a former operator.

As in the post-mining regulation, the Environmental Code provides for ICPE cessation-of-activity steps that the last operator must follow. Indeed, under the applicable regulations, upon closure of an ICPE facility the last operator must carry out: (i) safety measures (i.e. remove or eliminate hazardous products and wastes, restrict access to the site, suppress any fire or explosion risk, etc.); and (ii) remediation measures (i.e. treatment of polluted areas, groundwater remediation, etc.) which are evaluated according to a determined future use. The prefect may impose measures on the operator at any time, even after the site has been remediated, up to the limitation period of 30 years from the administration's last prescription.

The proposed next land use should be comparable to the last period of operation (e.g. industrial use), although there is a pathway to define a new use with consultation following the opinion of the operator (or landowner) and the mayor, with arbitration by the prefect. In order to secure future uses and control the execution of works subject to planning permission, public utility easements may be imposed by the prefect once a site has been restored, depending on the condition of the site.

Landfill sites, including facilities storing tailings, have specific regulations such as being subject to financial guarantees set out in the authorisation order for site monitoring, response in the event of an accident or pollution, and restoration of the site after operation. Due to the potential for long-term impacts the length of the post-operational monitoring period for special industrial waste storage facilities is set at 30 years. The end of the post-operational period comes after the state has validated that the final redevelopment is in good condition and that there is no impact on the air, groundwater or surface water. Any change of landfill operator is subject to a change of operator authorisation issued by the prefect.

A hierarchy has been created in the Environmental Code for authorities to identify the party responsible for pollution. The authorities will firstly consider the party responsible for the pollution as being the last operator of a facility. If no facility was operated and the soils were polluted by waste, the producer of the waste which contributed to the pollution, or the holder of the waste whose fault contributed to the pollution, will be deemed responsible. Secondly and alternatively, the owner of the land can be held responsible 'if it is demonstrated that he has been negligent or that he is not unrelated to this pollution' (République Française 2019). It should be noted that the term 'negligent' is not defined under the regulations, meaning that it could be interpreted in a relatively broad sense. It is to be noted that the last operator's obligation does not include the measures which would be necessary for a future change of use of the site, unless the operator is responsible for such a change of use.

To facilitate the redevelopment of brownfield sites it is possible to transfer the obligation to restore a site from the last operator to the third-party applicant following a prefectorial order and the provision of financial guarantees. However, liability may return to the last operator in the event of default by the third-party applicant.

2 Case study: Le Thoronet bauxite mine

Le Thoronet bauxite mine includes the Peygros and Blanquette mining areas located in the Var department within the south-eastern region of Provence Alpes Côte d'Azur, France. Peygros was granted a concession and mining commenced in the 1960s, while Blanquette was granted an operating licence (now expired) and mining commenced in 1970. The mining areas were predominantly open cut with one small underground section. Open cut pits were mined by stripping the overburden and creating terraces, and underground mining was carried out via chutes and mining orifices using the lightning chamber and pillar method. No processing was carried out onsite and the ore was transported offsite. Mining ceased in 1989 when the economically accessible deposit was exhausted.

Le Thoronet is a commune with a population of approximately 2,600. The area is forested and the river Argens runs past the village. Le Thoronet Abbey was founded by monks of the Cistercian order and built mainly between 1160 and 1190. Completed in 1250, it was classified as a historical monument in 1840. The Peygros and Blanquette sites are mainly located within the perimeter of the listed site of Le Thoronet Abbey. The area is popular with tourists, and tourism is centred around the abbey and nature pursuits such as hiking, mountain biking, canoeing and fishing.

During mining, stability of the Blanquette-Peygros southern working face was of concern and required additional controls. The end of mining and the cessation of drainage pumping caused groundwater levels to rise and accentuated the landslide phenomenon on the Darboussière mountain, threatening Le Thoronet Abbey. A drainage gallery was created in 1990 to drain the underground water and minimise instability, and this gallery has been registered as a hydraulic safety structure with the DREAL since 2014. In addition, a monitoring network, including piezometers, inclinometers and topographic plots, has been set up to monitor movement of the mountain.

Rio Tinto filed the definitive declaration of the cessation of mining operations for the Le Thoronet mining area with the Var prefecture in February 2008. In response, the first order prefectorial decrees recorded the definitive cessation of mining operations in October 2008. Rio Tinto implemented measures in accordance with the relevant decrees with the aim of receiving the 'second act' decree; terminating the exercise of mining policing and transferring risk monitoring and prevention to the state. In 2022, after more than 20 years of administrative process, the mining licences were terminated. Rio Tinto made a payment equivalent to 10 years of risk monitoring and prevention expenses, and the DPSM assumed responsibility for ongoing monitoring. Rio Tinto continues to own the majority of the land, retain civil liability for the site and maintain several control measures, such as a fence around the pit to manage public health and safety risks.

Several new land uses have eventuated in the Le Thoronet mining area. Part of the land on the former Peygros site was sold in 1990 and is currently the base for a private company that maintains and repairs public works machinery. The significant fossil of a large marine reptile has been found in the Le Thoronet pit area, and Rio Tinto and palaeontologists attached to the French National Centre for Scientific Research and the University of Lyon have been working together for several years to investigate and unearth the find. In 2021 Rio Tinto, in partnership with the French Ministry of Ecological Transition and Territorial Cohesion, committed to restoring the Le Thoronet site to create an eco-park. Officially opened in 2024, the park features hiking trails and diverse habitat areas to support local wildlife (Figure 1). Closure activities completed include the removal of invasive species, revegetating the site by installing anti-erosion devices, preservation of habitats for local flora and fauna, and the establishment of an educational trail. Several local stakeholders from neighbouring areas have been involved in the Le Thoronet transition project, including a local shepherd who is working with Rio Tinto to utilise part of the surrounding land to provide safety and welfare for their flock. Also, the opportunity to create a solar farm at Le Thoronet is currently being explored.



Figure 1 (a) Le Thoronet hiking trail information sign; (b) Lookout information sign

3 Case study: Auzat aluminium smelter

Auzat is a commune in the Ariège department within the Occitanie region of south-western France. Aluminium production began at the Auzat smelter in 1907. By the turn of the 21st century, the smelter, powered by hydro-electricity, was producing 48,000 tonnes per year. Poor economics and outdated technologies led to the site no longer being sustainable and it was closed in 2003. Talks about closing the operation had begun as early as the 1990s, when Pechiney was experiencing financial pressure, but while closure was not entirely unexpected, the eventual closure of Auzat was sudden and fiercely contested by the workers. Following Pechiney's announcement of impending closure, protests occurred and workers exercised their right to withdraw from operations. This resulted in the site never opening again and when Auzat formally closed in November 2003, 220 employees lost their jobs.

In January 2004, Alcan (which had just taken over Pechiney) made a firm commitment to help with the economic revitalisation of the region: signing an agreement with the French local government and the community of the surrounding towns and pledging EUR 1.2 million to encourage the creation of local jobs. This commitment was in addition to the work required to decommission the site and remediate the land that had been impacted by inorganic fluorides used in the manufacturing of the aluminium.

Discussions on potential land uses for the site were long and protracted, with many different options discussed. In 2007 a compromise was found; supported by Alcan and validated by the French administration. The Rio Tinto team was mindful of the volatile atmosphere after the abrupt closure and dedicated a great deal of time and effort into ensuring that all voices were heard, and that as many needs as possible were met. The negotiations took many years but the time spent was invaluable, with the resulting redevelopment plans being widely popular throughout the local community.

The site of the former aluminium smelter in Auzat in the French Pyrénées has been transformed into a professional sports complex suitable for altitude training (Figure 2). A long-term lease of the land was drawn up between Rio Tinto (who acquired Alcan in 2007) and the town of Auzat, with a formal handover of the infrastructure to the community in June 2010 and the official opening of La Plaine des Sports in May 2011. Most of the former smelter has been demolished and the ground cleaned up, levelled and capped. The building housing the former historical electrical power station was sold to the community and restored, and is now the base for a number of small businesses. The infirmary located at the edge of the site was symbolically sold to the municipality in 2009 and transformed into a weights room.



Figure 2 (a) The Auzat aluminium smelter in 1990; (b) The site transformed in 2011

The dominance of the aluminium industry over the past century is celebrated through a 2 km aluminium walkway, Le Chemin de l’alu, that threads its way through the village. Along the path are art installations (including a 3 m-high aluminium slab), machinery from the former smelter and interpretation panels. Ex-employees participated in its making. The self-guided path starts and ends at the Le Barri – Maison des Patrimoines, or Heritage House. Le Barri houses a permanent exhibition on Auzat’s aluminium story and is the centre for information on the town’s heritage. It offers space for holding conferences, and screening films and documentaries, and is a base for site visits.

Rio Tinto took the lead on the revitalisation process, but the key stakeholders (including local government and community groups) played a crucial role in the dialogue: all working together to find a solution. Auzat’s mayor is central to the Auzat story. He participated in the wave of discontent that dominated the town after the works closed, was involved in all the negotiations about the town’s future, and La Plaine des Sports was fundamentally his idea. When the plans for the sports complex were developed and the new agreement had been signed, he was proactive in leading the community in understanding the potential of the project.

While Auzat’s relatively remote location provided a challenge, it also proved to be a critical factor in the success of the project. The elevation of Auzat (737 m) lends itself to excellent conditions for mid-altitude training for professional athletes. This, combined with an unspoilt mountainous landscape, created an ideal setting for outdoor enthusiasts, and the numbers of visitors to the region are predicted to increase.

One of the leading alternative options for the land that the community asked for was a large hotel complex (3,000 beds). The Rio Tinto team was able to demonstrate how, as a single solution for the revitalisation of the Auzat economy, a hotel was not economically viable and therefore not a sustainable option. It was also not a desirable use of the previously contaminated land in the context of French environmental law. Instead it was agreed that moving the existing sports facilities across from the other side of the river to the old smelter site, and improving them, would provide an ideal solution for the capped land. It also freed up a large area of uncontaminated land that could be developed into a hotel complex, should visitor numbers to the area increase.

4 Case study: Lannemezan aluminium smelter

The Lannemezan aluminium smelter located in the Hautes-Pyrénées department of the Occitanie region in south-western France was constructed in 1938. Production commenced at the smelter after World War II and ramped up to its peak in the 1960s, with production declining from 1978 and permanently ceasing in 2008. The announcement of the intention to close the smelter was made in October 2005 and discussions surrounding the futures of the 238 staff started immediately. Prior to closure, Rio Tinto Alcan was the main employer in Lannemezan, with aluminium production being a significant economic activity in the region.

At the time of the closure announcement the area was experiencing a decline in industrial activities generally. Opportunities for redeployment into other industries were therefore potentially very bleak.

The site at Lannemezan comprises two zones: a brownfield site that needed decommissioning and remediation; and a greenfield site that had no industrial heritage, some fluoride contamination in the soil and ample open space, allowing for the development of new businesses. When the smelter closed the mayor of Lannemezan saw an opportunity to reverse the fortunes of the town by marketing it as an attractive place to locate an industrial company. He recognised that the nearby city of Toulouse was fast becoming saturated with industry and that businesses were beginning to look for space further afield. Greenfield space in the industrial zone and a skilled workforce were readily available at Lannemezan, and a new highway from Toulouse meant that it was easily accessible. Brownfield space on the same site would be available in the future, once it had been remediated. The town's proximity to the Pyrenean mountain ranges and the sea meant that it was also an attractive place for people to relocate to.

After environmental and archaeological investigations on the greenfield site a very small amount of remediation was undertaken, and the land was subsequently sold to several private companies for large-scale industrial projects. Several of the new companies on the site benefitted from the pre-existing skilled and experienced workforce in the area.

The brownfield zone has since been decommissioned, the unwanted buildings demolished, the soil remediated, the secure industrial waste landfill capped, and the leachate recovered and treated by a licenced water treatment facility (Figure 3). Closure activities have been completed to meet the requirements of the Environmental Code. In 2021 the land parcels, totalling 50 hectares, were transferred to the commune of Lannemezan, which is partnering with the state, the region, the Hautes-Pyrénées department, Banque des Territoires, Initiative Pyrénées, the Chamber of Commerce and Industry, and Business France to make the area a ready-to-use industrial zone.



(a)



(b)

Figure 3 (a) The Lannemezan aluminium smelter in 1990; (b) The site transformed in 2024

Rio Tinto and the commune of Lannemezan came to an agreement whereby Rio Tinto provided a lump sum payment to fund the ongoing water treatment and site monitoring, and the commune will use the profits from the redevelopment of the area to supplement this funding. Through this transfer agreement the commune is the registered last operator and is negotiating with several groups on reindustrialisation opportunities including renewable energy projects such as the production of electro-fuels for aviation.

The former aluminium smelter is now a thriving industrial hub known as the Peyrehitte Business Park and home to 40 companies. There continues to be strong cooperation between the key players, underpinning the spirit of partnership that has been evident throughout the revitalisation process. Monthly stakeholder meetings led by a state representative, the sub-prefect, enabled the business community to take ownership of the redevelopment process.

5 Key findings and discussions

Throughout Rio Tinto's journey of asset acquisition and closure in France there have been several recurring lessons learnt, and key enablers that have shaped our approach and facilitated the delivery of positive outcomes — many of which are transferrable across asset contexts and jurisdictions. Table 1 lists the key enablers, which are described in more detail in the following text.

Table 1 Key enablers for asset transition

Item	Key enablers
1	Thorough understanding of the local context as early as possible and throughout the asset's life
2	Early, comprehensive, and ongoing communication with the local community, government, industry and the private sector regarding the possibilities of closure
3	Local ownership of the post-mining opportunities
4	Strategic regional planning strategies that provide direction to guide future land use planning and decision-making
5	A collaborative relationship with external stakeholders based on transparency and trust
6	Maximisation of opportunities for local businesses throughout the asset lifecycle
7	Thorough characterisation of the asset to inform health, safety, environment and community risks, and development of the closure strategy
8	Early planning and agreement with external stakeholders on the sustainable post-mining land use
9	Targeted investment to support asset transition
10	Robust governance
11	Closure activities completed to meet agreed closure outcomes
12	Legislative framework to facilitate asset transitions
13	Transparent and complete consideration of residual risk and liability
14	A robust business case that supports the asset transition

To achieve a positive legacy it is vital to understand the local context as early as possible. To ensure as complete a picture as possible, a reliable fact base in the following areas should be developed: community needs and expectations; socio-economic conditions; health, safety and environmental benchmarking; technical and financial considerations, and regulatory frameworks governing the site. With this knowledge, and having identified key local stakeholders to work with, planning for post-mining land use possibilities can commence.

In all of Rio Tinto's French asset closure experience a key lesson learnt is the importance of early and comprehensive communication with the local community, government, industry and the private sector regarding the possibilities of closure. Industries are temporary stewards of the land where they operate, and it is essential to understand the aspirations of the local stakeholders early to ensure the asset closure strategy developed during the operations phase is maximising the desired post-mining opportunities. Early communication allows sufficient time for community and government stakeholders to build capability and the capacity to contribute to the mine closure challenge. Ongoing and regular communication that

continues long after mine closure is necessary to adjust for change and ensure alignment between parties, particularly as individuals change and stakeholder expectations evolve over the extended time frames associated with the asset lifecycle phases, including development, operation and closure. For the assets described above the length of the operational phase ranged from 29 to 96 years, and the closure phase (time from cessation of operations to asset handover) ranged from eight to 33 years (and remains ongoing); this demonstrates the multi-generational time frames to be considered.

Mining and industry often have a profound impact on local communities as they bring people, well-paying jobs and social investment to a region over multi-generational time frames. The cessation of mining and processing operations usually means job losses, reduced community investment and uncertainty for local communities. Rio Tinto has found that key organisations and individuals communicating the positive opportunities can turn the negative atmosphere into constructive energy and play the most pivotal role in driving a repurposing agenda. This was the experience in both the Auzat and Lannemezan case studies, where the local mayors were central to driving the asset transitions for the benefit of their local communities. The role of industry is to empower the local community to identify the sustainable post-mining opportunities they would like to pursue, and to remove barriers and provide support, where appropriate, to help them achieve their aspirations. Industry must challenge the public bodies to play a role, and collaboration across government departments and tiers should be encouraged. Boggs et al. (2022) found that major economic transformations require the support and active participation of stakeholders including government at different levels, trade unions, industry and business, civil society and academia. Multi-stakeholder buy-in ensures that the transition plan addresses the interests of all those affected by the asset closure.

Regional plans that set a long-term framework, vision and direction for strategic planning and land use are valuable for guiding land use decisions, encouraging investment by government and industry, prioritising key infrastructure, helping to manage conflicts and priorities between land uses, and maintaining and protecting the natural environment. Therefore they play a key role in guiding the selection of sustainable post-mining land use options and decision-making, and lead to an alternative source of funding for the next land user. The Regional Plans for Spatial Planning, Sustainable Development and Territorial Equality, and public utility easements, play an important role in France.

Over the life of an asset there may have been operational decisions that resulted in negative impacts on the local community, environment or cultural heritage that caused significant hurt and loss of trust. A fractured stakeholder relationship is likely to lead to suspicion of the company's intentions, rejection of technical work completed by the company, proposal objections and delays to the asset transition. Communication, transparency, stakeholders feeling heard and self-determination are key to rebuilding relationships and enabling collaboration. The importance of long-term key relationship holders cannot be understated when navigating the asset closure phase. A key driver of success in the French case studies was trusting relationships, which led to a strong spirit of partnership between industry, community and government.

Opportunities for local businesses were maximised throughout the asset transition case studies described, which ensured that the local community profited from the redevelopment and increased the transparency of the work being completed. Local procurement had the added benefits of building community trust, creating jobs, developing local infrastructure and simplifying logistics for industry. Industry must use this investment wisely to reduce the community's dependence on the company's activities and build livelihoods, capacity and resilience.

As Rio Tinto had not operated the assets described in this paper it was very important that comprehensive site assessments were completed to fully understand their health, safety, environmental and community characteristics and to inform the asset's closure risk assessment and strategy. Information and data secured during the asset acquisition, including legal and constructive obligations, were reviewed, onsite monitoring was undertaken and studies such as contaminated site assessments were conducted. An infrastructure inventory and asset integrity assessment are critical information to inform repurposing opportunities. This information was used to determine land capability, inform the post-mining land use options' selection and drive the asset closure strategy.

Early planning and agreement with stakeholders on the sustainable post-mining land use will help define a shared vision and act to reduce disruption to the local community caused by ongoing uncertainty around the next land use and the impacts of closure. When planning the post-mining land use for an asset it is important to keep front of mind that industry's goal is often to relinquish the site; therefore the decision must be driven by external stakeholders, particularly the next land user. Local context, site characteristics, residual risks, existing infrastructure and land capability are key inputs to the decision and a thorough economic assessment must be undertaken to confirm the sustainability of the proposed land use. This was demonstrated in the Auzat case study (see Section 3), where the local community initially believed a large hotel complex was the best option. Through an economic assessment, however, it was determined that a hotel would not be financially viable. As in the Le Thoronet example, sites are typically reused for more than one purpose and therefore there may be multiple post-mining land uses to plan for. The third party intending to operate the next land use must be informed of any factors relevant to their proposed use and due diligence undertaken to ensure their technical and financial capability. Timely confirmation of the post-mining land use will enable operational and closure plans to optimise the post-mining landform and infrastructure for the identified future use. It is important to retain optionality as it is likely the post-mining land use will change as more information is collected, technology develops and economic conditions fluctuate.

Once the post-mining land use has been agreed to, targeted investment to seed new industries, undertake research and trials, build capability and capacity, upgrade existing infrastructure or construct new infrastructure may be required to facilitate the transition. As seen in France, financial support from private investors and regional, national and supranational levels can be secured to support post-mining transitions. For example, a review of the German Just Transition, a set of policies and initiatives aimed at supporting workers and communities impacted by the decline in coal production in Germany, recommended giving municipal governments more financial and administrative autonomy so they can implement projects relevant to their local circumstances and reduce the coordination of efforts between the political levels (Furnaro et al. 2021).

To support a positive transition a governance framework overseen by a governance body with representatives from the local community, government, the private sector and industry is recommended to ensure that: different perspectives are heard; competing priorities are worked through collaboratively; there is transparency; and the right decisions are made. Governance arrangements should continue into the post-closure phase to ensure independent oversight, to monitor the success of the post-mining land use and to trigger intervention when necessary.

Prior to asset transition, closure activities such as redundant infrastructure removal, remediation and rehabilitation are undertaken to ensure all legal conditions and constructive obligations have been met and the site condition is compatible with the agreed post-mining land use. In most jurisdictions, government regulation requires assets to meet agreed closure outcomes, with a focus on safety, stability and non-pollution, before they can be relinquished. Rio Tinto considers compliance with regulatory expectations the minimum standard and has developed internal standards that incorporate international industry guidance (e.g. the Global Industry Standard on Tailings Management) and which are implemented across our global portfolio. Due to the long time frames to be considered in the post-closure phase it is recommended that closure outcomes are future-proofed in that they consider climate change and increasing societal expectations to ensure the asset is handed over in good condition.

The case studies presented in this paper demonstrate how the French legislative framework is enabling the transition of closed mining and processing assets to alternate land uses that are benefitting society. Industry brings many benefits to regions, such as international investment, essential infrastructure, employment, community investment, royalties and taxes, and therefore governments should play a lead role in facilitating relinquishment once operations end. This may require them to assume responsibility for post-closure monitoring and land management activities, e.g. fire management. In many other jurisdictions, legislation is driving the return of the environmental state that was present prior to mining. In contrast, the French system recognises that land which has already been disturbed should be prioritised for repurposing to reduce the need for clearing of undisturbed native vegetation for development. Mine closure legislation should provide

a clear pathway to asset relinquishment, facilitate land use transitions, and consider the transfer of residual risk and liability.

To maximise post-closure opportunities, industry must become comfortable with their risk and liability exposure to release land they have operated. Typically risk-averse governments must accept some exposure. Any transfer of asset operation or ownership must address residual risk and liability. The transferring party must be transparent and the receiving party must understand the significance of becoming the last operator. Residual risks are those that are still present at the point of asset relinquishment, following the implementation of agreed closure management activities. Some types of closed facilities, such as tailings storage facilities, will require post-closure monitoring and maintenance to ensure ongoing protection of life, property and the environment. Where ongoing management activities have been identified, a fund can be established to undertake them for the foreseeable future and should include consideration of net present value. Once closure activities based on the best of the company's knowledge have been completed, and care has been exercised to a level to protect others and the environment from actions or conditions that may cause harm, it is reasonable to expect that entities can legally transfer liability. Transfer of monitoring and maintenance costs and liability are managed in France via a lump sum payment and the establishment of a *fiducie*. Inspired by a trust under English law, a *fiducie* is a well-established regulated financial and legal framework in France.

A robust business case that considers the full cost of closure activities, community investment, residual risk (environmental, reputational and financial) and liability must be developed to inform mine closure investment decisions. The total cost of closure has increased over recent years due to several factors, including increasing stakeholder expectations and the rising prices of goods and services, which could be placing companies at risk of default and mine abandonment. Return on investment in the form of a transfer of residual risk and liability, and therefore an end to expenditure associated with the asset, is a key benefit of the decision to proceed. A known pathway to asset relinquishment and transition that reduces business risk will further incentivise companies to invest in responsible mine closure.

6 Conclusion

By its very nature, mining and processing disturbs the environment and impacts surrounding communities. Yet it delivers significant economic and social benefits, yielding materials needed for the energy transition and the demands of increasing urbanisation. It also creates local employment, small business development, tax and royalty streams, and training, skills and community development. Focusing on the next land use once mining and processing has been completed is delivering ongoing economic and lifestyle benefits to local communities.

Rio Tinto's experience in France is demonstrating how flexibility on post-mining land uses is enabling the renaissance of former industrial assets and contributing to thriving economies and communities. Key enablers for asset transition include collaborative stakeholder relationships, government at all levels leaning in to help develop solutions, a clear legislative framework that supports asset transition, and industry aspiring to leave a positive legacy for future generations.

Rio Tinto continues to develop its approach to asset transition, refining the methods and tools used, learning from its experiences and building on its successes. Rio Tinto has significant challenges ahead of it but is committed to finding ways to overcome them to generate value for the company, and for the communities and regions in which it operates.

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