Mining and Water:
A Perspective on Legal and Regulatory Risks

Nicolas Maennling, Sophie Thomashausen, Diana Nielsen, and Ajay R. Vempati

ABSTRACT

This brief outlines the importance of taking into account legal and regulatory risks in investment decisions regarding copper and gold mines and briefly discusses the research the Columbia Center on Sustainable Investment (CCSI) is conducting to qualify and quantify those risks. In relation to the quantification of such risks, the brief summarizes the key legal and regulatory risks associated with water use and discharge in mining, lists the existing water-related risk indices and tools that can be applied to assess those risks in mining operations and indicates the approach CCSI is taking to quantify the risks. The brief then provides a short overview of the water-related issues that are regulated by national legislation in the jurisdictions reviewed in terms of water usage and the allocation of water rights to mines, water discharge requirements, and other safeguards to minimize, or at least monitor, the water footprint of mining operations. Finally, the brief sets out the next steps CCSI will be undertaking to conclude its research.

INTRODUCTION

Risks related to water usage and the impact on water resources are emerging as a major risk factor for mining operations, especially in water scarce regions. The potential for water pollution due to seepages, spills, tailing dam failures, or the chronic and cumulative effects on water availability from mining in an area is well recognized as a financial liability. In addition, the competition for limited water resources can lead to disruptions in mining activities, or a sudden increase in the costs of sourcing and recycling water to the extent that water scarcity was not factored into the initial design phase of the mine. Each of these water-related risk factors also has impacts on the social and economic well-being of nearby communities who rely on the same sources of water for farming and household use. Unanticipated regulatory actions penalizing mines or halting their operations, as well as potential social conflict with the affected communities emerge as concerns.

To address these challenges, this project holistically examines financial risks posed by water to mining operations from a physical, financial, regulatory, and social perspective.

This paper provides an overview of the relationship between water-related regulatory drivers and their impact on a min's financial performance from an investor perspective. It does so by providing a brief qualitative review of the legal and regulatory frameworks governing water usage and discharge in the mining sector in nine jurisdictions and how robust the enforcement mechanics are in each jurisdiction to monitor and enforce compliance. The qualitative data are further quantified to allow easy comparisons across jurisdictions and to integrate the regulatory data into financial analyses – a key feature necessary to integrate CCSI's findings into the broader research project between Columbia University and Norges Bank Investment Management on "Mining & Water Risk: Diagnosis, benchmarking, and quantitative analysis of financial impacts".

1. IMPORTANCE OF LEGAL AND REGULATORY RISK

Legal and regulatory risk – the risk that a change in laws and regulations will materially impact a business – plays an important role for businesses when making investment decisions. Legal changes may impact the rate of return that the investment decision was based upon and may even make projects unviable from a financial perspective.

In the mining sector, the robustness, certainty, clarity, and efficiency of regulations imposed on water use and discharge by mines can have an important impact on the financial viability of mines, given that water is a vital input for each stage of the mining process. In particular, water is required for dust suppression, ore beneficiation/ concentration, the transportation of concentrates to delivery or export terminals, water cooling during the refining process, and consumption for the mine workers. In addition, mining operations can also adversely affect surrounding water courses through run off, seepages, and permitted discharges during all life cycles of mining operations as set out in table 1.

Unless compliance with more stringent water standards is built into the design and management practices of a mine, changes to the regulatory regime that affect the water-related risks listed in table 1 once a mine is operational will lead to higher capital and/or operating costs and, in extreme cases, can lead to a temporary or permanent shutdown of the mine if it is unable to comply, or its operations have resulted in environmental damage and/or social conflict arising from its impact on surrounding water sources.

An example of a change in water regulation that will, if enacted, have an adverse financial impact on mining projects is Chile's draft bill that would make it mandatory for mining projects that consume more than 150 liters per second of water to source all their water from their sea. The costs this regulation will impose, if enacted, is potentially high on mines that do not already source water from the Pacific Ocean. It will require high upfront capital investments to transport the required quantity of water from the sea to the mining operations and to construct desalination plants to treat some of the water. For example, the desalination plant that was recently constructed to service Chile's Escondida mine required a capital investment of US$3.4 billion.[1] Operating costs will also increase significantly due to the increased amounts of energy required to operate the desalination process and pump large quantities of water from the Pacific Ocean to their operations. According to a recent Morgan Stanley study on the use of desalination plants in copper mining, the cost of operating a desalination plant amounts to between US$77-$108/ton of copper produced. [2] Combined, the study estimates, these additional costs will require an uplift of US$395-515 on earnings before interest and

[1] Reuters (July 20, 2013) "UPDATE 1 – Huge desalination plant set for Chile's Escondida mine" (access: http://www.reuters.com/article/2013/07/25/chile-escondida-desalination-idUSL1N0FV1GV20130725).
[2] Morgan Stanley Research (July 22, 2015), "Metals & Mining and SRI: Copper & water – expensive solutions."

taxes per ton of copper produced, which is equivalent to an incentive price increase of copper by US$0.18-0.23/lb.

Initial observations from the qualitative reviews also indicate a strong positive correlation between the mining legacies of polluted water and the increasing awareness and concern of climate change-induced extreme weather events and the updating of water laws and imposition of more stringent regulations on the quantity of water that mines get allocated, the quality of water that mines may discharge, and the standards that tailing dams need to comply with in order to avoid spillage.[3]

Table 1: Summary of water related risks at different mining stages

Stage	Water related risks
Exploration/ Site Preparation *(Surveying, drilling, trench blasting, camp & road construction, mine construction)*	• Sediment runoff, increased sediment load to surface waters • Spills of fuels and other contaminants
Mineral Extraction *(Blasting, ore stockpiling, waste piling)*	• Chemical contamination of surface and ground waters (mine discharge) • Toxicity impacts to organisms (terrestrial & aquatic) • Altered landscapes from mine workings (open pits, changes in stream morphology) • Increased erosion and siltation • Altered patterns of drainage and runoff • Water consumption • Decreased groundwater • Reliance on power from water dependent sources (hydro and thermal)
Processing	• Discharge of chemical and other wastes to surface waters

[3] For example, sustainable water use has been cited as a motivating factor in recently passed water laws in South Africa and Australia. See Godden, L. Water law reform in Australia and South Africa: Sustainability, efficiency and social justice. J. Environ. Law 17, 181 (2005)..

(Mining, smelting, refining)	• Water consumption (mineral separation & processing) • Reliance on power from water dependent sources (hydro and thermal)
Product Transportation *(Packing & Transportation)*	• Water consumption (added to ore to facilitate transportation)
Mine Closure/ Post operation *(revegetation, fencing, monitoring seepage)*	• Persistent contaminants in surface and ground water • Expensive long term water treatment • Persistent toxicity in organisms • Permanent landscape changes

Source: Miranda, M. and Sauer, A. 2010. —Mine the Gap: Connecting Water Risks and Disclosure in the Mining Sector.‖ WRI Working Paper. World Resources Institute, Washington, DC

2. Existing water-related risk indices and tools

There are various studies and tools that have been developed to capture water-related risks. These include:

- Bloomberg, (2015), "Water Risk Valuation Tool: Integrating Natural Capital Limits Into Financial Analysis of Mining Stocks."[4]
- CDP, (2013), "Metals and Mining: A Sector under Water Pressure: Analysis for Institutional Investors of Critical Issues facing the Industry."[5]
- Chief Liquidity Series, (2012), "Water-related Materiality Briefings for Financial Institutions, Extractives Sector, Geographies of Australia, Brazil, Canada, China, and South Africa."[6]
- GEMI Local Water Tool (2015).[7]

[4] Available at: http://www.bloomberg.com/bcause/content/uploads/sites/6/2015/09/Bloomberg_WRVT_09162015_WEB.pdf
[5] Available at: https://www.cdp.net/CDPResults/Metals-Mining-sector-under-water-pressure.pdf.
[6] Available at: http://www.unepfi.org/work_streams/water/liquidity/.
[7] GEMI Local Water Tool available at: http://gemi.org/localwatertool/.

- GRI,(2011), "Sustainability Reporting Guidelines & Mining and Metals Sector Supplement."[8]
- ICMM (2015), "A Practical Guide to Catchment Based Water Management for Mining and Metals Industry."[9]
- Lloyd's, (2010), "Global Water Scarcity- Risk and Challenges for Business."[10]
- Miranda M., Sauer A., (2010), "Mine the Gap: Connecting Water Risks and Disclosure in the Mining Sector."[11]
- PWC, (2011), "The True Value of Water: Best Practices for Managing Water Risks and Opportunities."[12]
- Reig, et al. (2013), "Aqueduct Water Risk Framework."[13]
- SASB, (2014), "Metals & Mining Research Brief."[14]
- WBSCD, (2007), "Global Water Tool."[15]
- WWF, (2011), "Assessing water Risk: A Practical Approach for Financial Institutions."[16]
- WWF,(2014), "The Water Risk Filter."[17]

Most of the measures listed above focus on aspects of water scarcity and watershed attributes. While some of these tools also try to capture regulatory risks, they tend to be subjective input variables by the user. The Columbia Center on Sustainable Investment (CCSI) is trying to build on these tools and create a more rigorous and

[8] Available at: https://www.globalreporting.org/resourcelibrary/G3-English-Mining-and-Metals-Sector-Supplement.pdf;
[9] Available at: http://www.icmm.com/publications/water-management-guide.
[10] Available at: http://awsassets.panda.org/downloads/lloyds_global_water_scarcity.pdf.
[11] Available at: http://www.wri.org/publication/mine-gap.
[12] Available at: https://www.pwc.com/gx/en/sustainability/publications/assets/pwc-the-value-of-water.pdf.
[13] Available at: http://www.wri.org/sites/default/files/aqueduct_water_risk_framework.pdf.
[14] Available at: http://www.sasb.org/wp-content/uploads/2014/06/NR0302_MetalsMining_2014_06_24_Industry_Brief.pdf.
[15] Available at: http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx;
[16] Available at: https://www.deginvest.de/DEG-Englische-Dokumente/PDFs-Download-Center/DEG-WWF_Water_Risk.pdf.
[17] Available at: http://waterriskfilter.panda.org/.

methodological approach to determine the water-related regulatory risks. Section 4 outlines this approach.

3. Mapping out Legislative and Regulatory Mechanisms Governing Mine-Water Use and Discharge

CCSI has reviewed the laws and regulations governing water usage and discharge in mining activities in 8 jurisdictions in 6 countries, including Australia, Canada (British Columbia), Chile, China, Peru, South Africa, and the United States (Arizona and New Mexico). This section provides a brief overview of some of the observations made during the review. The accompanying excel spreadsheet provides a more detailed comparison.

a. Water Allocation

While mining licenses, permits, or development agreements in some countries include a right to source the water required for a mine's operations, most of the jurisdictions reviewed for the purposes of this project require a water authority to separately determine the quantity of water a mining operation may source from underground or surface water sources (excluding from precipitation). In some jurisdictions, the mining company is required to apply for a water permit once it has obtained a mining permit. In others, the quantity of water a mine may extract from surrounding underground and surface water sources is dependent on the results of an environmental impact assessment which may or may not be required as a pre-condition to obtaining a mining permit or commencing operations. Depending on the constitutional structure of a country and how decentralized it is, the relevant water authority tends to operate at a state or provincial level, with processes for water allocation differing between states/ provinces within the same national jurisdiction, albeit subject to national legislation.

Environmental considerations in the allocation of water rights

In some jurisdictions such as Canada, water allocation permit processes analyze the potential future negative impacts of water use on the quality of surrounding watercourses. If a proposed water use is deemed likely to have a negative impact on water quality, the mining company may be required to demonstrate a plan for mitigating the identified negative impacts on water quality. In the province of British Columbia, for example, if the use or diversion of water is likely to result in an adverse impact on water quality, the authority granting the water use license may require the mining company to submit a plan with proposed mitigation measures before a water use permit is issued. Civil society may also have an opportunity to provide input in the water allocation approval process as is the case in Chile. There, once the environmental approval process is finalized, a nearby community may decide to contest the application, which can delay the development of a mine for several years or half mine development or expansion altogether.

Restrictions on the length and scope of a water permit

In some jurisdictions, water is allocated for a specific use and timeframe; in others, water rights may be perpetual and/or tradable on an open market. In British Columbia, for example, water use rights are granted for a particular purpose for a period of time up to forty years, which does not necessarily correspond to the duration of a mining permit.[18] By contrast, under the prior appropriation doctrine in some U.S. states such as New Mexico, water use rights for beneficial uses (which mining is considered to be) may continue perpetually (in the absence of an interruption in water use and as long as the water is used for the purpose stated in the initial water use application). Similarly, in Chile, water use rights for the abstraction of water from underground or surface water sources are perpetual and

[18] Thus far, limited information has been found indicating a correlation between water allocation permitting and mine permitting. In prior appropriation jurisdictions, there is no correlation found between mining and water allocation; it is not clear if non-prior allocation water regime jurisdictions attempt to coordinate the length of water allocation permits and mine permits.

are not restricted to a particular use so that such water use rights can be purchased on an open market. Increasingly, this has resulted in mining companies purchasing additional water use rights from farmers and other water use right holders where the water allocations they have been granted are insufficient to meet the water needs of their operations.[19]

Changes to water allocations

Some jurisdictions include a prioritization of water users so that, in circumstances where there is insufficient water to meet the needs of all users, water allocations can be varied. CCSI is conducting further research into the legal regimes of each of the jurisdictions to assess under which circumstances in law, if at all, relevant local environmental, water, or mining authorities may alter the water allocation originally granted to a mining operation.

Water tariffs

In some jurisdictions mining companies must pay for fresh water used, while in others there is no tariff associated with water use. Under Peru's water law, for example, mining companies must pay a tariff for water use at a set by the relevant local authority. In the state of Arizona, the Arizona Department of Water Resources sets tariffs for water use, whereas in New Mexico, there is no cost associated with the amount of water used. In jurisdictions with an uncertain regulatory framework, there may be a potential financial risk associated with the requirement to pay for water to the extent that the imposition or amount of such tariff can be set arbitrarily.

[19] More data collection is needed on the amount of time required to obtain a permit and the process for renewing water use permits.

Encouraging efficient water use

The majority of jurisdictions reviewed have some legislation aimed at incentivizing mining operations (and other water users) to limit their fresh water intake by recycling water. This is generally done by limiting the amount of fresh water mining companies are permitted to extract from underground and/or surface water sources, and/or by requiring mining companies to implement water efficient processes at the design phase of a mine – though specific standards are really included in regulations. South Africa's National Environmental Management Act, for example, encourages the efficient use of water, including recycling, but does not state specific standards or mine design requirements. More drastically and as mentioned above, there is pending legislation in Chile that will require mining companies to utilize seawater instead of fresh water for copper and gold mining operations.

Overall, enforcement capacity related to violations of water quantity allocations is weak. This is in part due to the technical difficulties associated with monitoring water source flows. As such, reporting requirements and the processes associated with compiling an environmental impact assessment/ statement and carrying out required monitoring are of increased importance in preventing community conflicts related to water allocation. Further research is being conducted into enforcement capacity to determine how, if at all, the institutional strength of the enforcement agency and the quantity and severity of fines or other punitive measures can be quantified as a risk for the purposes of this project.

b. Water Quality

Most jurisdictions limit the types and concentrations of contaminants that can be discharged into the environment, including surrounding water sources. To regulate such discharges, pollutant discharge permits are generally required for mining operations. While some jurisdictions require only a general permit for mining discharges, others require multiple permits for the discharge of pollutants into different types of water sources. For example, in China mining companies must secure a general permit for pollutant discharge that covers all environmental discharges. In Arizona, on the other hand, mining companies must obtain separate permits for the different categories of surrounding water sources (aquifers, surface water, or groundwater) that may be impacted by the mining operations. In addition, as is the case in British Columbia, environmental impact assessments required as a condition to obtaining a mine permit require detailed descriptions of expected pollutants discharged in surrounding water sources, as well as plans to mitigate water quality disruption.

In most jurisdictions reviewed, mining companies are required to design their operations in a way that minimizes environmental risks such as leakages from tailings dams or other waste rock impoundments. For example, in British Columbia, mining companies must provide a detailed description of how they will manage tailings and why they chose this approach during the mine's baseline environmental impact assessment. Other jurisdictions, such as South Africa, provide specific requirements for the technical design of tailing ponds.

c. Post-Mine Closure Obligations

In addition to limitations on the discharge of contaminants during the life of a mine, the legislation in most of the jurisdictions reviewed requires mining companies to take measures to mitigate the environmental impact of mines – such as from acid mine drainage after a mine ceases to operate. In Arizona, for example, copper mines must incorporate acid drainage mitigation plans into their overall post-mine closure plan. In New Mexico, copper mines must construct impoundments containing leach solutions according to design requirements established by the state Water Quality Control Commission; these requirements are meant to ensure against impoundment overflow and water contamination to accommodate rainfall and surface water levels up to those expected during a one hundred year flood.

	British Columbia/Canada	S. Africa	Chile	Arizona/US	New Mexico/US
Regulation of Acid Mine Drainage	As part of required environmental assessments, mines must submit management plans for potential project accidents or malfunctions. Such accidents or malfunctions include but are not limited to acid or metal leaching downstream of reservoirs.	The Disaster Management Act of 2002 is one instrument which regulators can use to deal with acid mine drainage. The MPRDA is another piece of legislation that deals with acid mine drainage. It provides in section 38(1)(d) that a mine has to rehabilitate the environment to its original state before closing. It further places an environmental damage responsibility on mines. Directors of mines can be held personally liable for environmental degradation such as mine drainage under the MPRDA (S38(2)).	There are no specific regulations regarding acid mine drainage. However, Supreme Decree 148 sets out that if the Public Health Authority classifies the acid mine drainage as a hazardous waste, it can apply all regulations of this Supreme Decree and, in that sense, it can obligate the mining company to create a specific plan to manage this type of drainage.	Copper mines must submit post-mine closure plans (pursuant to 20.6.7.33 NMAC); these should detail plans for mitigating such environmental effects as acid drainage.	For copper mines, all waste rock stored, deposited or disposed of at a copper mine facility shall be evaluated for its potential to generate acid and to release water contaminants at levels in excess of the standards of 20.6.2.3103 NMAC. A plan for determining the potential of the material to release water contaminants, and the method for such evaluations shall be submitted to the department for approval in a material characterization plan (20.6.7.21).

In some jurisdictions, a post-mine closure plan to minimize water contamination at the end of a mine's life must be submitted and approved by the relevant environmental authority as a condition for the approval of a mine-operating permit. Environmental impact assessments are generally also required to assess post-closure environmental risks and how these should be addressed/ mitigated.

In some jurisdictions, mining companies are required to return the mine site area and associated waterways to their original condition. This is usually assessed on the basis of a baseline established during the initial environmental impact assessment. For example, in British Columbia, a post-mine closure plan must ensure watercourses are reclaimed to a condition such that drainage is restored either to original watercourses or to new watercourses that will sustain themselves without maintenance, and the level of productive capacity must not be less than existed prior to the start of mining operations. However, in other jurisdictions, requirements are more open ended. In New Mexico, for example, mines are required to prepare a mine closure plan to ensure the reclamation of the physical environment of the permit area to a condition that allows for the re-establishment of a self-sustaining ecosystem on the permit area following mine closure.

In some jurisdictions, the post-mine closure plan also requires mining companies to prepare a budget for the implementation of the plan and provide a financial security or bond for the entirety of the anticipated cost of post-mine closure actions. However, there are differences among the jurisdictions reviewed as to who certifies the anticipated cost, the extent to which such amount is negotiable, and for how long the security or bond must be maintained. In South Africa, for example, the bond may be refunded in full once the mine site is certified as having implemented all required post-closure actions. In Arizona, in turn, mining authorities may refund portions of the bond posted as segments of the post-mine closure plan are successfully implemented.

In jurisdictions with post-mine closure requirements, regulations usually stipulate that mining authorities (rather than, or in coordination with, environmental authorities) must monitor the implementation of the post-mine closure plan and ultimately either certify that post-mine closure requirements have been met or order further actions by the mining company. Under the Mines Act and Health, Safety and Reclamation Code of British Columbia, for example, inspection monitoring and maintenance requirements of the mining permit and post-mine closure plan must be met; once they have been fulfilled, mine operators will be released from further obligations under the Mines Act. Under China's Mineral Resource Law, following mine closure, mining companies must prepare a report with information on mining operations, land reclamation and utilization and environmental protection. If the report demonstrates that the mine operator has met all its statutory requirements pertaining to maintenance of the mine site and implementation of a post-mine closure plan, the relevant State authority may approve the mine site as no longer being in operation.

Mining companies remain liable for water quality impacts for some period of time following mine closure. In British Columbia, mining companies remain liable for water quality impacts within the project site for three years following mine closure. In New Mexico, mining companies remain liable for violations of their discharge permits for the duration of that permit.

d. Enforcement Mechanisms

A range of mechanisms aimed at ensuring compliance with water use permits and water quality standards exist across jurisdictions. In Peru, the National Court of Resolution of Hydrological Controversies takes regulatory enforcement actions against mines for infringements on water use or conditions of discharge permits. The Chinese Environmental Protection Authority may order a mine to either limit its production or cease operations if discharge requirements are violated. Environmental legislation in South Africa provides standing to downstream communities and companies affected by polluted water to institute civil action claims against mines responsible for the pollution.

e. Reporting Obligations

Reporting requirements are generally tied to both water quality permitting and water allocation in the mining, environmental, or water regulations governing mine water use or discharge. Follow up monitoring may be required as part of the environmental impact assessment process, though the enforcement of such monitoring requirements may be weak, particularly where no periodic updates to a mine's environmental impact assessment is required or no baseline environmental or water data has been established. In New Mexico, the Surface Water Quality Board responsible for water discharge permitting also requires mining companies to report on water quality. In Western Australia, the Department of Environmental Protection requires mines to monitor both water quality and the amount of water used in the mining operation. In Chile, mines must submit a site decontamination plan during the environmental impact assessment phase. The Superintendent of Environmental Affairs monitors mines' implementation of the decontamination plan.

4. Quantification of Legislative and Regulatory Mechanisms Governing Mine-Water Use and Discharge

In order to quantify the qualitative assessment of the regulatory frameworks, CCSI has developed a matrix that will allow for the rating of the regulatory framework. The matrix is based on:

a) The clarity of the legislation in regard to obtaining water permits and environmental licenses.
b) The existence of timelines for obtaining permits, clearances and approvals.
c) The requirement for community consultations in order to receive water licenses and the environmental impact assessment.
d) The requirement for disaster management plans.
e) The existence of periodic review mechanisms for the allocation of water quantities.
f) Standards and restrictions regarding the water consumption and discharge.
g) The composition of review and monitoring agencies.
h) The frequency of reporting and monitoring requirements.

More developed and detailed regulatory frameworks will be rated as lower risk for potential changes. So although a more detailed legislation may, for example, require standards and restrictions on water consumption and discharge, which in turn may increase up-front capital expenditure and operating costs, this legislation is less likely to change.

5. Next Steps

To further refine, qualify, and quantify the research undertaken to date, CCSI proposes to undertake the following next steps:

a) Preparation of an in-depth comparative analysis of jurisdictions reviewed: A more in-depth comparative analysis of the legal and regulatory regimes in the eight jurisdictions reviewed will be prepared, for which the templates assessing the legal and regulatory frameworks in each jurisdiction will be refined, updated and finalized.

b) Research of changes in regulation in one jurisdiction: One legal framework will be selected to be reviewed over time in order to get a better understanding of the reasons leading to regulatory change and the costs for mines resulting from these changes over time.
c) Quantification of legal and regulatory risks: CCSI will use the matrix explained in section 4 above to quantify and rate the country/jurisdiction profiles. Based on this exercise, CCSI will further refine the matrix by adding more questions or taking out questions that do not seem relevant. Apart from serving the financial team as an input to assess whether these factors do in fact have a significant impact on the cost variables of mines, or the perceived riskiness of investing in them, this exercise will also aide the legal comparative assessment.
d) Further data collection: Apart from quantifying the quality of the regulatory frameworks, CCSI will focus on collecting data and indicators that measure the implementation of the rules. This is important, because while the regulatory framework might be advanced and very clear regarding the rights and obligations of mining companies, this may not be implemented and monitored in practice. As part of this exercise, CCSI is considering reviewing the number of fines and legal instances for various jurisdictions.