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TECHNICAL ARTICLE

# Net Present Value Calculations for Mining Post-Closure Financial Assurance

**David M. Chambers**[1]

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**Abstract**
Most regulatory jurisdictions now require financial assurance for mines for post-closure activities, which typically include long-term monitoring and maintenance, and most importantly post-closure water treatment. Critical choices in calculating post-closure financial assurance include using a reputable cost estimation model to establish the amount needed for reclamation, selecting a realistic net return-on-investment for post-closure trust funds, and choosing the period of time over which the net present value calculation of the financial assurance is based. A conservative estimate of the amount of financial assurance is warranted to protect the public from assuming these costs. However, some regulatory agencies use financial assurance estimate practices that are arbitrary. The data and procedures needed to analyze and recommend conservative net present value calculations are readily available, but in too many instances are not being utilized.

**Keywords** Perpetual water treatment · Reclamation cost calculations · Mining discount rate · Mining post-closure liabilities

## Introduction

Financial assurance for a mine consists of two major components. First, there are the direct costs associated with closing the mine. This means converting an industrial mining facility into a post-mining use that, at a minimum, does not cause offsite liability or harm. However, there is usually a second cost component of mine closure financial assurance – post-closure obligations. Most mines cannot be closed without some residual care responsibilities, like monitoring and maintaining a tailings dam, assuring adequate diversion of stormwater around waste facilities, water quality monitoring, and potentially perpetual water treatment.

Post-closure monitoring and maintenance costs are typically not as large as the mine closure costs associated with earth moving and isolating waste rock, tailings, and abandoned mine workings. However, if post-closure water treatment is required, the total costs of mine closure and post-closure financial assurance, in the experience of the author, approximately doubles. For a large mine, this means that instead of tens of millions of dollars in total closure costs, the price can be hundreds of millions. Any mistakes or underestimates in the cost calculations can turn into multi-million dollar liabilities to taxpayers.

Because of the large amount of money involved, the financial assurance either needs to be revised annually, or the effects of inflation must be included in the financial assurance calculations to cover the full length of time projected in the analysis. Reclamation plans, which are typically revised every three to five years (ICMM 2019a), should reflect any increase in costs over the period until the next plan revision.

### Post-Closure Costs

Most mining regulatory jurisdictions now require financial assurance for post-closure activities, which usually include long-term monitoring, maintenance, and most importantly, post-closure water treatment (World Bank 2009). Financial assurance to cover these post-closure costs is necessary because mining activities can create large long-term financial liabilities. The companies that create these mines will not be present indefinitely to shoulder these costs, nor do corporations want indefinite operating liabilities. Since the government/public sector bears the ultimate liability for

✉ David M. Chambers
dchamber@csp2.org

[1] Center for Science in Public Participation, 224 North Church Ave, Bozeman, MT 59715, USA

managing the environmental and financial costs of post-closure obligations from mines, governments needs a way to meet these obligations.

Financial assurance for mining post-closure liabilities is typically accomplished by creating a trust fund held by a regulatory agency. Determining the appropriate amount of the financial assurance is challenging both technically and politically. From a technical perspective, not only must long-term costs be estimated both accurately and conservatively, but the long-term estimates for the rate of inflation, and the rate of return on the trust fund investments, also play a critical role in determining the net present value of the amount of financial assurance required of the mining company.

Politically, because financial assurance is a direct cost to the mining operation, there is pressure to minimize the amount of financial assurance required by the regulatory agency. This pressure filters down to those responsible for calculating the financial assurance, both to industry consultants and to government regulators.

Today there is great deal of good guidance available for mine closure planning. However, these guidance documents generally do not discuss the potential pitfalls in calculating a post-closure financial assurance, nor do they provide any guidance on how to avoid these pitfalls (e.g. APEC 2018; Hattingh 2021; ICMM 2019a, 2019b; World Bank 2021). In calculating the post-closure portion of a mine-closure financial assurance, there are essentially three critical assumptions that need to be made:

(1) Cost Calculations – the actual on-going costs of post-closure activities. If post-closure costs are underestimated, or if unexpected post-closure costs are overlooked, the trust funds will not be adequate to provide the needed services over the long-term;

(2) Real Interest Rate – the rate of return on investments, minus the rate of inflation. That is, the net return on investment for the post-closure fund. If the investment return is less than projected, or if inflation is greater than estimated, then core assets from the trust will likely be used to meet operating expenses, shortening the life of the trust; and,

(3) Net Present Value (NPV) Calculation Period – the period of time over which the NPV of the financial assurance is based. The NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. The present value is the current value of a future sum of money or stream of cash flow given a specified rate of return (both definitions from Investopedia 2023). The NPV of a trust fund will determine the amount needed to generate a steady flow of funding over a long period.

The amount of money required for post-closure activities is first calculated with a mine closure model. Next, the amount of money necessary to generate the funds required on an annual basis from the trust must be determined. For example, if we need $1,000 per year for the next 100 years, it is not necessary to place $100,000 in a trust. Because the rate of return (or interest) compounds, we only need to place enough funds in the trust fund to make sure we can withdraw the needed operating funds ($1,000) every year but leave enough capital in the trust to generate the annual amount needed for the entire 100-year period of time. That amount is considerably less than $100,000 in present day funds, but determining that amount contains a number of potential pitfalls. If the NPV calculations are not conservative enough, operating funds will run out before the 100-year period is over. If this happens, either the post-closure activities must cease or the public will pay these costs.

For a large mine, post-closure operating costs involving water treatment are typically several million dollars per year and the period of time covered is often not 100 years, but perpetuity. How to determine what "perpetuity" means is the most misunderstood and misapplied component of the NPV calculation and will be addressed further in the section on the NPV calculation period below.

## Cost Calculations

A great deal of effort has been expended by regulatory agencies and engineering consulting companies over the past two decades to develop models that will calculate reclamation, closure, and post-closure costs as accurately as possible. These models often incorporate a database for personnel, equipment, consumables, etc. that is updated on a regular basis. At this time, the Standardized Reclamation Cost Estimator (SRCE), the reclamation model developed by the Nevada Division of Environmental Protection (NDEP 2023), is the de facto model used by many regulatory agencies to estimate/calculate reclamation closure costs. One of the reasons for the popularity of this model is that it is free to use. A second reason is that the source code is publicly available, so the computational mechanics can be scrutinized, unlike the proprietary source code for the models developed by engineering consulting companies.

However, although the SRCE has a place in its table of contents to determine the costs of Solution Management, nominally the place where water treatment costs would be calculated, the SRCE does not furnish a spreadsheet to calculate water treatment costs, nor does it provide guidance on calculating a post-closure financial surety.

## Real Interest Rate

Since a post-closure financial assurance is usually held as a trust fund, this money must be invested in order to generate an annual rate of return large enough to pay for the costs of monitoring, maintenance, and water treatment. The real interest rate (or net discount rate) is the difference between the rate of return and rate of inflation (Investopedia 2023). This is a rate of return that has been adjusted to remove the effects of inflation to reflect the real yield from the trust funds to the trust holder.

The issue of the proper net return on investment has received some study by regulatory jurisdictions, e.g. Alaska (2009), but has been largely ignored by others. Table 1, adapted from Stantec (2016), shows examples of several regulatory regimes and how these regulatory jurisdictions approach determining the real interest (net discount) rate. The examples cited in Table 1 demonstrate the inconsistency in determining the net discount rate that should be applied to estimate the amount of money needed to establish a post-closure trust fund.

The engineering consulting company reclamation models developed to calculate closure costs typically contain a module that will perform the calculation for post-closure NPV. However, in the experience of the author, the consulting companies almost always defer to the regulatory agencies to select a value for net return on investment, as well as the period over which to run the NPV calculation. The consulting companies do this because they realize how impactful those choices can be, and that there is essentially no existing guidance for choosing these values.

## Net Present Value Calculation Period

A critical assumption in calculating post-closure financial assurance is the period of time over which the NPV of the financial assurance is based. This is where the author has seen the most misunderstanding of a basic concept and the most misuse of a basic principle of financial management. There has been only limited discussion in the literature about this topic (GRID-Arendal 2017) and there is a great deal of misunderstanding, even false assumptions, about the importance of picking the appropriate period of time over which to run the NPV calculation.

**Table 1** Sample Discount Rates. (adapted from Stantec 2016)

| Regulatory Jurisdiction | Discount Rate Applied |
|---|---|
| British Columbia | Variable – reviewed every 5 years, but NPV calculations are limited to 100 years |
| Nevada | Not used |
| Ontario | Typically 3% |
| Nova Scotia | No specific guidance |
| Western Australia | Not used |
| Alaska | Variable |

Most of the discussion of NPV for mine closure in the literature considers the cost from the perspective of the mining company's financial planning (e.g. Brock 2019), not from the perspective of the regulatory agency responsible for protecting the public interest. Take, for example, the following statement from a consultant's report to the government of British Columbia; "*For sites that will have a liability in perpetuity, a 100-year model is used because when discount rates for NPV are applied anything beyond 100 years is no longer meaningful.*" (Stantec 2016). This statement is demonstrably false.

While there are circumstances where this statement is true, the "no longer meaningful" assumption requires a high net return on investment. While such returns are typically realized by mining operations, assuming a high net return on investment is generally inappropriate as guidance for use by a regulatory agency because investments for public funds require more conservative securities, which do not generate a high rate of return. Yet, in the experience of the author, the assumption of a 100-year point for ending NPV calculations has been utilized by regulators from several U.S. and Canadian regulatory agencies. If a regulatory agency makes the assumption of a 100-year cutoff for the NPV calculation, without explicit documentation that a high rate of return can be guaranteed over the life of the post-closure requirements, then the funds will not last in perpetuity, and the public is placed at risk.

Calculating NPV is economic modeling. Like most models, the fundamental mathematics behind calculating NPV is sound, but the results of the model are highly dependent on the assumptions and data that are fed into the model. Poor data and poor assumptions lead to poor predictions.

## Determining the Simulation Period for the NPV Calculation

The World Bank (2021) has offered this description of the time period required for an NPV calculation: "*Although there several models used by various government to estimate the quantum of a trust, most of them rely on a net present value estimate of all included costs over a sufficiently long period of time that any additional years become immaterial.*"

The simulation period for the NPV calculation needed to perform a conservative estimate for a mine post-closure trust fund initial amount should be determined on a case-by-case basis. In addition to considering the net rate of return, the total amount can also affect the period of time needed to reach the point that additional years of calculation become immaterial. However, in general, for the NPV calculations

to be terminated at 100 years, the net rate of return needs to be 6% or larger. This is difficult level of return to achieve for most public investments.

What would be reasonable way to determine the period of time over which the increment added to each increment of the NPV calculation becomes insignificant? Calculating an NPV is a relatively simple exercise on an Excel spreadsheet. The NPV calculation is usually done on an annual basis, so each year becomes one line on the spreadsheet calculation. After the first 100 years is set up on the spreadsheet, adding another 100 years of calculation simply involves copying the previous 100 lines, and pasting them into the spreadsheet.

The calculation can display the amount of present value added for each additional year. As the calculation adds each additional increment of time, nominally a year, the NPV asymptotes toward $0/year, but never reaches that value. A reasonable termination point for the present value added for each additional year would be less than $1 added per additional calculation year.

The logical way to determine the period of time to be considered in an NPV calculation for a mining trust fund would be to establish a minimum cutoff amount (e.g. $1) to be added by each incremental iteration (e.g. one year) of the calculation, not to pick an arbitrary cutoff period (e.g. 100 years) before the calculation is even run.

Some might argue there is enough variation in the assumptions that carrying the NPV calculation down to this level is not meaningful. This observation has some merit, but it is not an assumption that is most protective of the public interest and is also imposing an arbitrary cutoff point to a theoretically simple calculation that is trivial to extend to any number of years desired. All of the power available in the calculation should be utilized, rather than arbitrarily terminating it based on a predetermined number of years.

## Conclusions

Calculating the post-closure financial assurance for a mine should be a rational exercise of regulatory judgement. Broad use of the SRCE model to calculate the post-closure costs associated with long-term monitoring and maintenance has provided a stable approach to making these calculations, but the SRCE does not provide a template for calculating the costs of long-term water treatment. The proprietary models developed by engineering consulting companies typically do provide a means to make long-term water treatment calculations and are in general agreement with the SRCE model in estimating long-term monitoring, maintenance, and other reclamation costs. However, none of the models reviewed provide guidance as to what net discount rate should be applied to these long-term cost estimates, or what period of time the model should be run to determine the point at which an additional year of calculation adds only an immaterial amount to the NPV calculation.

The data and procedures needed to analyze and recommend a conservative net discount rate and NPV calculation period are readily available but are not being utilized. In fact, review of existing assumptions for financial assurance calculations for these values shows that the choices made by regulatory agencies is often arbitrary. This does not serve the public well, and at best introduces additional uncertainty into the post-closure NPV calculation. This is a situation that can, and should, be remedied.



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