CENTER for SCIENCE in PUBLIC PARTICIPATION
224 North Church Avenue, Bozeman, MT 59715
Phone (406) 585-9854 / Fax (406) 585-2260 / web: www.csp2.org / e-mail: csp2@csp2.org
"Technical Support for Grassroots Public Interest Groups"

TECHNICAL COMMENTS
on the
ROSIA MONTANA FEASIBILITY STUDY
and the
ROSIA MONTANA PROJECT DESCRIPTION

David M. Chambers
CENTER for SCIENCE in PUBLIC PARTICIPATION
January 13, 2003

Technical Comments on the Rosia Montana Feasibility Study & Rosia Montana Project Description

Background

The Rosia Montana Project is a large, low grade, open pit gold/silver mine. The original Rosia Montana Feasibility Study (undated – Fall 2001?) presented significant technical information on the proposed project. The Rosia Montana Project Description (September 30, 2002) modified several key aspects of the proposed project. Unlike the Feasibility Study, the information presented in the Project Description is only summary in nature. These changes, briefly summarized, are:

Significant Changes from the Feasibility Study as noted in the Project Description:

- Capital requirements down from $430 million to $350 - $400 million.
- Production rate decreased from 20 million tons per year to 13 million tons per year.
- Project life lengthened from 13 years to 17 years (as a result of the lower production rate).
- Cyanide destruction using the SO_2/air process in the tailings effluent is now planned, where it was only a contingency in the Feasibility Study.
- Bench height in pits has been reduced from 15 meters to 10 meters. This is good, because the lower bench height will mean that the pit walls are less steep and more stable over the long term.
- Size of the Haul/Dump trucks lowered from 230 tons each to 150 tons each. This is probably to save on capital investment.

The comments below focus mainly on the technical aspects of the Rosia Montana proposal, with discussion of possible financial and social implications where appropriate.

1. Low Grade Ore Deposit

The Rosia Montana deposit is a low grade ore body. The economic viability of the project is related primarily to the large amount of gold projected to be in the resource.

Although the deposit contains a large reserve of gold (225.7 million tons at a grade of 1.4 gram/ton gold and 7.5 gram/ton silver containing 10.5 million ounces of gold and 54.6 million ounces of silver), the cutoff grade used to calculate these reserves is 1.2 grams/ton, which is near the practical lower limit for economically processing gold.[1]

Given the low grade of the deposit, the mine will be sensitive to market fluctuations, meaning that it could close temporarily, or prematurely, due to a drop in the price of gold.

The low grade of the deposit also makes the project more susceptible to changes in gold recovery rate, changes between estimated and actual ore grade, or other operating assumptions that have been made in the economic calculations.

[1] Feasibility Study, Table 1.1.1, page 5.

2. Sulfur Content / Acid Mine Drainage Potential

An overall mean sulfur grade of 1.9% S has been calculated for the ore coming from all the deposits. The Cetate deposit shows the highest mean sulfur grade of 2.4% S.[2] In general, material with sulfur grades greater than 1% can be expected to be potentially acid generating, and potentially produce metals as a result of acid mine drainage, although there are many variables that can affect this process.

Acid Rock Drainage (ARD), or acid mine drainage, occurs when sulfide minerals are exposed to air and water. This causes the sulfide minerals, which are unstable in a surface environment, to break down into a weak hydrosulfuric acid, while simultaneously making the metals in the sulfides available for mobilization in the water. Iron sulfides like pyrite and pyrrhotite are the most common acid-causing sulfide minerals, while lead, cadmium, copper, zinc and mercury sulfides are the most damaging in terms of releasing metals harmful to the environment. While the pH (hydrogen ion concentration) must generally remain low for these metals to remain in solution and be harmful to aquatic and, in higher concentrations, to humans, another suite of metals also contained in sulfide minerals can remain in solution even if the pH is of the effluent, or the receiving water, is later raised. This suite of metals includes arsenic, selenium, and thallium, which, like the other metals mentioned, can be harmful to aquatic life, animals that drink the contaminated water, and even to humans.

The best way to prevent or limit ARD is to restrict the amount of oxygen that is available to oxidize the sulfides, because it is almost impossible to keep water from contacting this material once it has been mined. Once acid rock drainage has begun, it is almost impossible to stop completely. Acid rock/mine drainage from both hardrock and coal mining has severely affected thousands of miles of streams in the US, and is now recognized as the greatest potential environmental problem associated with mining.

Acid rock/mine drainage can cause severe impacts to aquatic life in surface waters, through impacts from heavy metals; and, if left unchecked, can impact human health – primarily through mercury, lead, and cadmium contamination. Many governmental jurisdictions today require that pollution from acid mine drainage be mitigated or eliminated before impacting surface and/or ground water off of the mine site. Where acid mine drainage and/or heavy metal contamination persists after active mining has ceased, as is evidently already the case at Rosia Montana, water treatment might be required – especially if new mining will significantly increase the amount of disturbed land, and add to existing pollution problems.

The mill waste in the tailings pond will be of relatively uniform composition, and will be easier to manage in terms of preventing acid generation and potential contamination than the waste rock.

It can be assumed that the sulfide content of the waste rock will be similar to that of the ore, and that there will be a significant potential for acid mine drainage in the waste rock. Waste rock, especially in disseminated ore deposits, is really just below-grade ore, and often contains as much sulfide material as does the ore itself. The size distribution of the waste material varies greatly, from large boulders to small particles, allowing water and oxygen move easily through this material. Unless the waste dumps are capped, 30% to 60% of the incident precipitation can penetrate the waste dump. There are no liners proposed for the waste rock. If pollution is generated from this material, it will either (1) enter surface or ground waters, or (2) need to be collected and evaporated or treated.

Neither the Feasibility Study nor the revised Project Description provide acid-base accounting (ABA) data on the waste rock. The waste rock will be piled next to the pits, and left exposed where water and oxygen can easily penetrate the waste storage areas and oxidize the exposed sulfide minerals.

---

[2] Feasibility Study, page 26.

ABA data should be presented in an Appendix since the potential for ARD is such an important and potentially costly issue for the mine.

In the Project Description it is stated:

> "Based on laboratory Acid Base Accounting (ABA) tests, runoff and seepage from the new waste rock dumps are expected to be neutral and low in dissolved metals during the initial years of operation." [3]

It is not clear from this statement, or from the information presented (especially since no ABA data is included) whether the waste rock dumps may indeed go acidic at some point in time. If the waste dumps go acid, as historical waste in the vicinity of the mine already has, significant new contamination could be produced.

In the Project Description the ABA testing and other geochemical testing is described:

> "In regard to the geochemical characteristics of waste rock, a total of 46 samples of future waste rock and 24 samples of historical waste rock were characterized using ABA test procedures. The majority of the samples of future waste rock were classified as likely to possibly acid generating. However, as stated above, based on the results of recent (and prolonged) kinetic tests, it appears that the generation of ARD will not occur until well into the future. As previously noted, an ARD Treatment Plant will be provided to treat ARD, when and as required." [4]

There are two issues of concern in this statement. First, the amount of samples of the waste rock tested for ABA is far too small for the amount of waste rock being mined. Consulting the guidelines published by the British Columbia Acid Mine Drainage Task Force, which is generally recognized as the authority for determining the appropriate number of samples needed for ABA testing in order to determine the acid generating potential of a given volume of mined waste, suggests that a minimum of 350 ABA samples are required to adequately test the acid generating potential of the approximately 170 million tons of waste rock to be mined at Rosia Montana.[5]

This suggests that the ABA testing done so far for the waste rock (46 samples) is significantly under-sampled, and may not be representative of the true acid base accounting data for the waste.

Second, if water treatment is required to remediate contaminants from the waste rock dumps, reclamation/closure costs could potentially double. There is considerable uncertainty in estimating the long term costs of water treatment, so government can also assume significant risk if the long term costs of water treatment are underestimated and government is forced to pay for these increased costs if there is no mining company remaining to assume the liability, as is all too often the case.

Closure costs for Rosia Montana were estimated to be $19.53 million, and <u>do</u> <u>not</u> <u>include</u> any costs for water treatment.[6] In the United States the closure costs alone for mines of a similar size have been in the $30 - $60 million range, and long term water treatment costs, if required, could be an additional $30 - $60 million.

---

[3] <u>Project</u> <u>Description</u>, page 29.

[4] <u>Project</u> <u>Description</u>, page 34.

[5] BC ARD Task Force <u>Technical</u> <u>Guide</u>, Volume 1, Figure 4.3-1, August 1989

[6] <u>Feasibility</u> <u>Study</u>, page 88.

3. Tailings Dam Construction

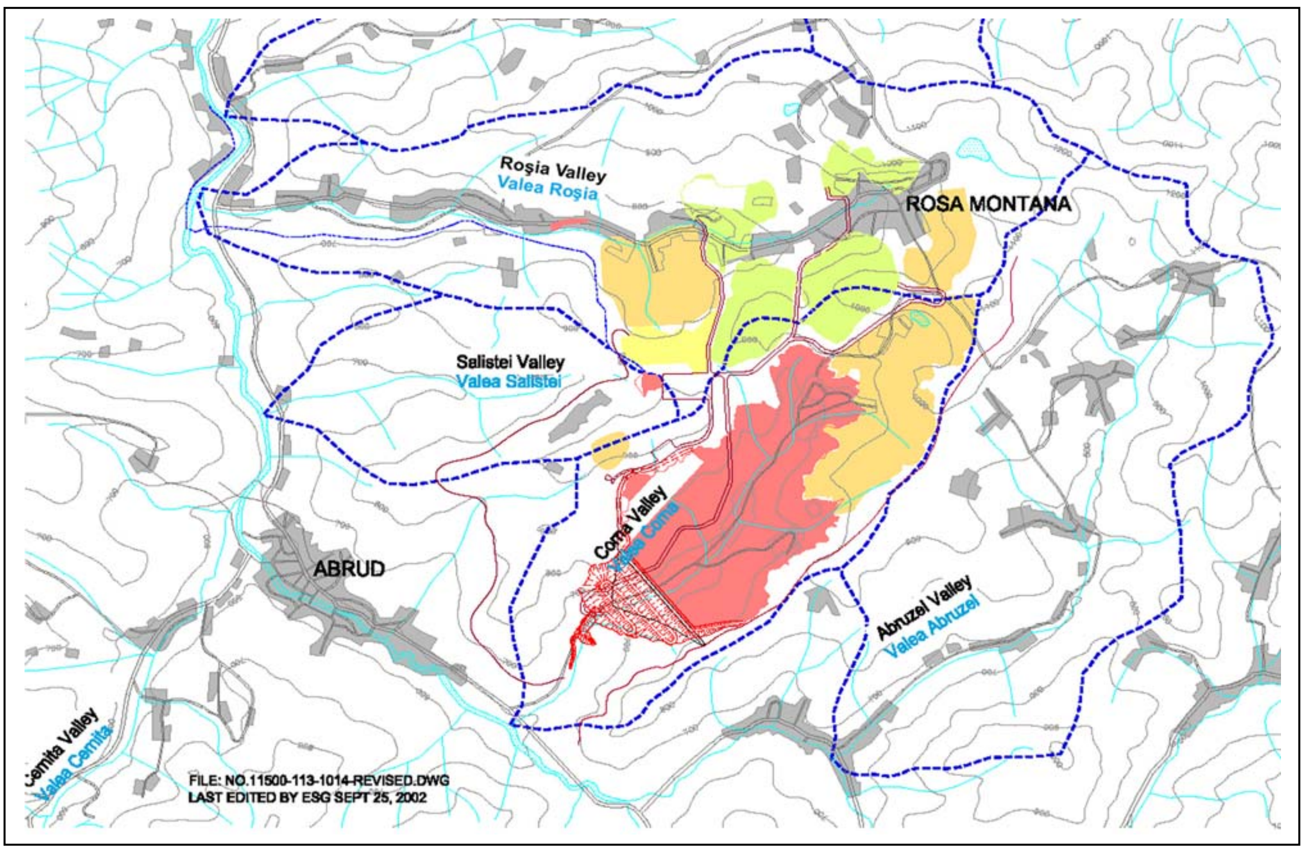
a. Dam Design

The dam design chosen for this project is commonly referred to as a "modified upstream" design.[7]

This is not the safest type of dam construction in terms of providing stability during earthquake events.[8] In any mountainous region there is usually significant potential for earthquakes, and tailings dams – unlike water reservoirs – must be designed to hold back their 'cargo' in perpituity.

The top half of the present dam, which is the portion of the dam with a modified upstream construction design, will be more vulnerable to earthquakes than the lower half, which is a centerline design. If the dam were to fail during an earthquake (the top half of the dam would be most vulnerable), sulfidic tailings could be released into the water course below the dam.

This dam is located approximately 2 km upstream from the town of Abrud (see below). A major or catastrophic failure of the dam could result in significant loss of property and possible loss of life. In most political jurisdictions, if a tailings dam is to be located above inhabited areas, then the dam



Locations of Abrud and the proposed Tailings Impoundment (approximately 2 km away)

[7] Feasibility Study, Figure 1.9.5.

[8] There are three major types of tailings dams: (1) Upstream – where the dam is actually built on the tailings, and depends in part on the stability of those tailings; (2) Downstream – where the dam is essentially a wedge holding the tailings, but built on solid ground; and, (3) Centerline – which is most stable design, and is constructed much like a large rock built reservoir dam, with abutment material upstream and downstream of the "centerline" of the dam.

construction requirements are the same as those for a water-retention reservoir in order to protect public safety and property values. The current tailings dam design, as noted above, does not meet this requirement.

Just the cleanup costs for such a spill would be significant, and there would also be unmitigatable environmental damage.

It is reported in the Project Description that the tailings dam is designed for a maximum seismic event horizontal acceleration of 0.14 g, related to a magnitude 8.0 earthquake.[9] Although a magnitude 8.0 earthquake is a large earthquake, it should be noted that an earthquake of this same magnitude could be expected to produce horizontal accelerations as large as 0.86 g within 15 km of the epicenter.[10] This suggests that the distance to the projected epicenter is a great distance from the Rosia Montana Mine.

In order to judge whether a horizontal acceleration of 0.14 g is appropriate to use for modelling, the distance to the magnitude 8.0 event needs to be disclosed, and the geologic/fault model for the site location and the region needs to be discussed. In addition, testing to assure whether a smaller, but closer, earthquake might have greater potential for damage needs to be evaluated.

The safest dam design would be to make the entire dam a centerline-type construction. From an engineering standpoint construction of a full centerline dam should be simple to accomplish, but would add to the construction cost of the dam.

Stage 1 is already a centerline design, and Stages 2 – 9 are the modified upstream-type construction, which is essentially half a centerline design, plus some additional material on the upstream side of half-centerline structure.[11] (See a diagram of the proposed Tailings Dam on the next page.) In order to provide an estimate the costs of constructing a centerline dam, instead of the proposed hybrid centerline (Stage 1) / modified upstream (Stages 2 – 9) dam,[12] it is assumed the cost of building Stages 2 – 9 in a centerline configuration will be double the costs estimated in the Feasibility Study for the upstream-type construction.

Assuming a doubling of the construction cost for Stages 2 – 9 is actually overly conservative, since the costs for the dam's impermeable zone and blanket drain, the most expensive parts of the dam to construct, are already accounted for in the present costs. Also, if the dam were constructed as a centerline structure, it would be constructed all at one time, saving the mobilization costs that have been built into the present cost estimate.

The present cost estimate for construction of Stages 2 – 9 is approximately $30.6 million.[13] Doubling this cost would increase the total cost for dam construction from $46 million to $76.6 million. Again, the actual capital outlay should be less given the cost saving factors mentioned above.

---

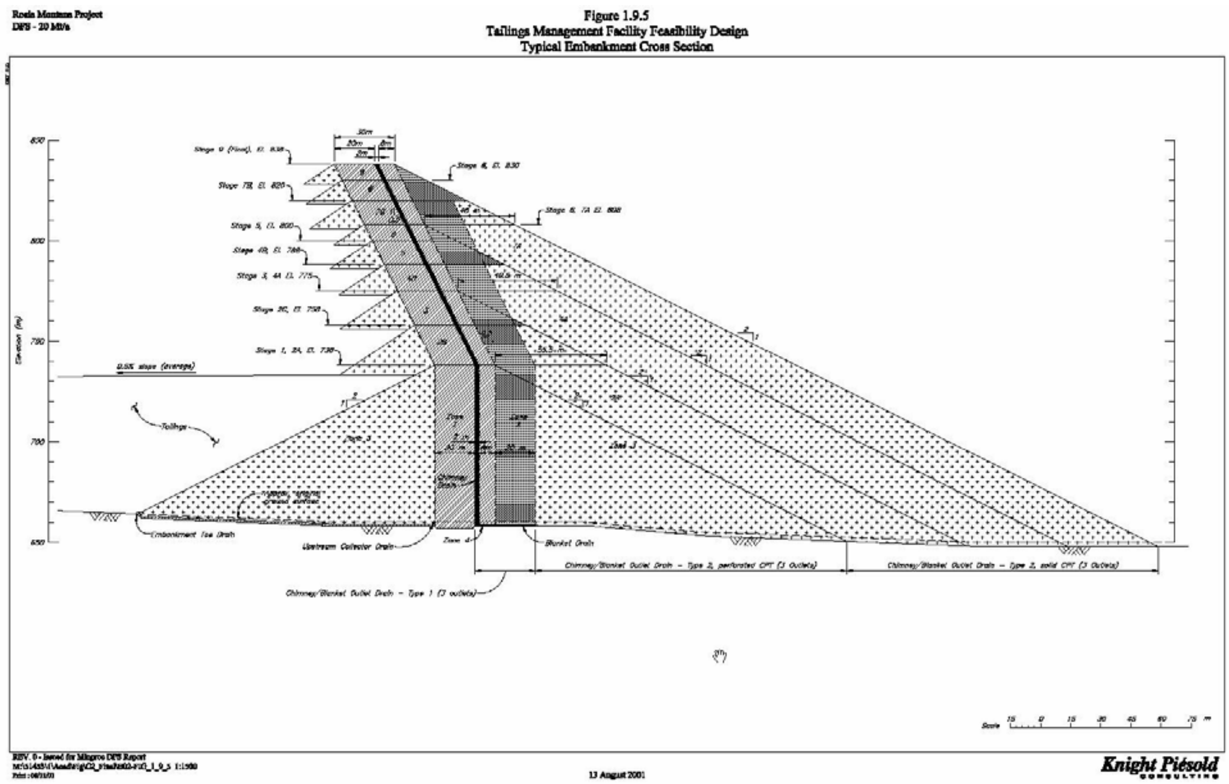
[9] Project Description, page 26.

[10] Thenhaus, P.C. et al, "Probabilistic Estimates of Maximum Seismic Horizontal Ground Acceleration on Rock in Alaska and the Adjacent Continental Shelf," Earthquake Spectra Vol. 1, No. 2, February 1985.

[11] See Figure 1.9.5, Feasibility Study, for a picture of the proposed dam structure.

[12] Feasibility Study, Figure 1.9.5

[13] Feasibility Study, Table 1.15.7, page 122, using the projected cost for years 1 - 11.



Proposed Rosia Montana Tailings Dam. Lower portion (Stage 1) is centerline-type construction, and Stages 2 – 9 with modified upstream-type construction.

b. Construction Materials

Waste rock will be utilized to construct the tailings dam.[14] As mentioned, it is possible that much of the waste rock will be potentially acid generating. The waste rock utilized for tailings dam construction must be carefully tested to insure that it has no potential to generate acid or metals. It is not evident from the information presented in the Feasibility Study or the Project Description that this will be done.

c. Waste Isolation

The tailings to be placed in the tailings facility will be potentially acid generating.

> “The tailings will contain about 4% sulfide minerals and will have a net acid producing potential. Under current European Union directives, the tailings are classified as “reactive – hazardous”. The design of the TMF must be appropriate to respond to this classification and protect the receiving environment accordingly.”[15]

In many jurisdictions where waste materials are classified as hazardous materials, a lined tailings facility is required. A double liner, usually of synthetic plastic material, is placed over a prepared bed of earth, and a conductive layer of gravel is placed between the two liners in order to facilitate detecting/collecting any leakage from the top liner.

---

[14] Feasibility Study, page 26.

[15] Feasibility Study, page 72.

It is not clear from the information provided in the Feasibility Study whether the "300 mm compacted layer" proposed for the tailings pond would be engineered, in terms of compaction to a required minimum density, and tested to insure a minimum permeability, to qualify as a "liner." At best this would constitute a single-layer liner, and would not provide any redundancy or leak detection.

It is reported in the Feasibility Study that:

> "The site investigations carried out by Knight Piésold for the TMF and the site hydrogeology indicate that both the overburden and underlying cretaceous sediments are very impermeable. This precludes the need for a formal liner system in the basin."[16]

However, in the Project Description the alluvial deposits in the Corna Valley, where the tailings impoundment will be located, are reported to consist of "… layers of silty sand, sand and gravel, and clay seams in various thicknesses."[17] If a true liner system is not installed/engineered, there are likely to be leaks from the tailings dam. The seepage control dam that will be constructed below the tailings dam is likely to be only partially effective at intercepting this seepage.

If prevention of groundwater contamination is desired at Rosia Montana, a synthetic liner (preferably a double liner with leak detection) should be required. The cost for a double synthetic liner, with leak detection system, at a recent US mine is approximately US$ 0.40 per square foot.[18] The area of the proposed tailings pond is estimated to be approximately 3 million square meters.[19] This would equate to a cost of approximately an additional $13 million to install a double liner. Present cost estimates include the installation of a "300 mm compacted layer," overlain by a protective layer of "300 mm of waste rock."[20] These costs would defray part of the $13 million estimate, so final increased cost of installing a double liner with leak detection would probably be between an additional $8 million and $11 million.

4. Mining in the Pits

There are significant underground workings in the areas of the proposed open pits.[21] Drilling and operating heavy trucks over these old underground workings can cause them to cave in. This could pose a significant safety risk to mine workers. In addition to the probe-hole drilling proposed in the Feasibility Study – which cannot be done at a density that can detect all possible potential openings – ground penetrating radar, or similar, should be used to screen the work area before heavy equipment is placed over the old workings.

[16] Feasibility Study, page 74.

[17] Project Description, page 24.

[18] Author's personal communication with the Manager of the Teck-Cominco Pend Oreille Mine, Metaline Falls, Washington, USA, December 12, 2002.

[19] Author's estimate based on Figure 1.9.3. of the Feasibility Study.

[20] Feasibility Study, page 74.

[21] Feasibility Study, page 39.

5. Mine Pit Closure

The mine pits will intercept the water table at some point in the mining, and pumping will be required to keep the pits dry for mining.[22] Since mining will expose sulfide minerals that have not been oxidized,[23] there will probably be a significant potential for acid water in the pits once mining has stopped. This potential for acid in pit waters can be significantly enhanced by the presence of underground workings that can feed additional pollution into the pit waters.[24] If acid-metal contaminated water develops in pit lakes that may develop after the cessation of mining, additional post closure maintenance costs could be incurred if pit waters have to be neutralized or treated.

6. Waste Dump Construction

In the Feasibility Study it is stated:

> "Scarification and compaction will provide a semi-impervious layer under the waste dumps preventing any acid water produced entering the groundwater system."[25]

This is an unrealistic conclusion. Groundwater systems in mountainous terrain are typically very shallow, and it is highly unlikely that acid produced by the waste rock will not be prevented from entering these groundwater systems by scarification and compaction.

7. Cyanide Use

Cyanide is the reagent used to recover precious metals from the ore. The project will utilize approximately 42,700 kilograms of cyanide per day, or 15.6 million kilograms per year.[26]

Great care must be taken in transporting, storing, and utilizing cyanide. Accidents in transporting cyanide have occurred at gold mines around the world with some regularity in recent years. A good Spill Response Plan should be developed, and a critical part of such a plan – a part which is often neglected – is a mechanism to notify the public when an accident occurs.

The potential for an accident transporting cyanide cannot be underestimated. For example, there was a major spill of cyanide in 1998 while transporting cyanide in an escorted convoy to the Kumtor gold mine in Kyrgyzstan. The spill resulted in significant impacts to two communities immediately downstream from the spill location. This accident highlighted not only the potential hazards in using roads and bridges that were not designed for heavy truck traffic (as may also be the case in Romania), but also the weaknesses of a Spill Response Plan that is not frequently tested to insure coordination with local officials.

The use of cyanide in processing also generates significant amounts of cyanide by-products that take time to degrade, notably cyanate, thiocyanate, and metal complexes of cyanide. The exact toxicities, residence time, and impacts on aquatic organisms are still poorly understood. It is possible, for example, that these compounds led to some of the impacts in the Baia Mare spill incident. It is also common for regulatory agencies to omit monitoring for these compounds in the discharges from mines, partially because there is

---

[22] Feasibility Study, page 40.

[23] Feasibility Study, page 39.

[24] This is a significant problem at the Berkeley Pit, Butte, Montana, and has led to a multimillion dollar requirement for water treatment in perpituity.

[25] Feasibility Study, page 40.

[26] Calculated from data given in the Feasibility Study of 0.78 CN kg/t (page 49) at a production rate of 20 Mt/a (page 2).

so little known about their long term impacts. The amounts of these compounds produced in the milling operation should be predicted, carefully monitored, and the amounts in the discharge regulated.

Cyanide levels in the tailings pond should be reduced to at least 50 milligrams per liter (mg/l) Weak-Acid Dissociable (WAD) or less to avoid wildlife mortalities. Cyanide levels in the discharge from the mill to the tailings pond are projected to be 100-130 milligrams/liter.[27] If left untreated, this level of cyanide is high enough to cause bird and other wildlife mortalities. The project planners analyzed the methods and costs of treating the cyanide to a level where wildlife mortalities can be eliminated, but did not program these estimations into the costs presented in the Feasibility Study.[28]

8. Cyanide Treatment

The revised Project Description (9 Sep 02) does anticipate the use of the INCO sulfur dioxide / air (SO_2/Air) process to destroy enough cyanide in the tailings effluent to meet World Bank/Romanian guidelines (50 mg/l WAD cyanide). This will not remove all of the WAD cyanide, or cyanide by-products in the tailings effluent, but it will reduce the level of cyanide so that birds and mammals that come in contact with water in the tailings pond will not be killed.

The SO_2/Air treatment process could be used to reduce the level of cyanide to approximately 1 mg/l, but with a commensurate rise in the operating costs. However, even at this level the cyanide would be fatal to fish and other aquatic organisms, and there significant quantities of cyanide by-products like thiocyanate that would also likely be present in quantities sufficient to cause mortality to aquatic organisms, so the tailings effluent must be contained within the tailings impoundment.

The cost to the project of implementing the SO_2/Air treatment to the 1 mg/l level will require an additional $9.1 million in capital for the project, and will increase the operating costs $2.95 million per year.[29] This would mean an increase in overall capital costs for the project of 2%, and an increase in operating cost of 3%.

If treatment is required only to the 50 mg/l level, the cost to the project of implementing the SO_2/Air treatment will increase the operating costs $1.22 million per year.[30] Mixing would take place in the tailings pipeline, so no additional capital costs are proposed.[31] Mixing in the tailings pipe is not a technique that is widely used for the treatment of tailings containing cyanide, and might be difficult to control with the high volume of waste produced at Rosia Montana. If difficulties are encountered maintaining consistent cyanide levels in the discharge, it is possible that additional treatment facilities might have to be constructed, similar to the capital costs estimated for the 1 mg/l treatment described above.

---

[27] Feasibility Study, page 72.

[28] Feasibility Study, page 59.

[29] Ibid.

[30] Ibid.

[31] Ibid.

9. Low Power Costs

Power costs for the Rosia Montana project are calculated at $0.0225/Kwh.[32] Electrical power is a major cost to large mining projects because of the grinding and other large-volume processes involved in milling of the ore material.

The costs for electrical power projected for the Rosia Montana are very low by western standards, which would typically be 2 to 3 times higher. It is possible that electrical power will be available at the rates quoted. But even if this is the case, cost escalation like that which has taken place in the US in 2001 could significantly increase the operating cost of the project, and might force a temporary or premature closure, as has happened to a low-grade metals producer in the US.[33]

10. Jobs

The Project is predicted to provide some 500 jobs during operation.[34] It is interesting to note that the proposed mine is 50 times larger than the present mine,[35] but the increase in employment is only from 336 to 558 jobs.[36]

The amount of land disturbed due to the open pits, the waste rock dumps, and the tailings impoundment, will add an additional 722 hectares to the present disturbance of 625 hectares – more than doubling it, to some 17% of the total Comuna land, [37] and requiring that 877 households be relocated.[38]

In the Project Description it is predicted that the job multiplier, that is the number of local jobs created for every mining job, will be 5 to 7 jobs created for every job at the mine.[39] If this is true, then there will be a significant increase in the demand on public infrastructure like schools, health care, police, etc.

Communities affected by similar large mining projects in North America have found it necessary to require early payment of taxes from the mine in order to fund development of this infrastructure (for example payments required by the Hard Rock Mining Impact Act in Montana, USA).

If this project is typical of other mining projects managed by foreign owned companies, many of the high paying jobs will go to expatriates. In addition, 500 jobs are somewhat larger than would be expected for a mine of this type and size. When cost cutting becomes an issue, trimming the number of employees often becomes a primary consideration, so a reduction in the number of jobs in long-term might be expected, and the jobs cut will almost certainly be those of local workers.

#####

[32] Feasibility Study, page 5.

[33] Montana Resources Continental Mine, Butte, Montana, was forced to close in 2001 due the increased cost of electrical power. The mine has not reopened.

[34] Feasibility Study, page 8.

[35] Feasibility Study, page 90.

[36] Feasibility Study, page 94.

[37] Feasibility Study, page 96.

[38] Feasibility Study, page 101.

[39] Project Description, page 11.