

**INTEGRATED MINE CLOSURE PLANNING
IN THE FRAMEWORK OF
SUSTAINABLE DEVELOPMENT**

By

**Luke J. Danielson
Marketa Zubkova
Sustainable Development Strategies Group
Gunnison, Colorado**

Paper 10

Table of Contents

INTRODUCTION	1
I. MINES UNABLE TO CLOSE?	5
II. MINES AND DEVELOPMENT	6
III. CERRO DE PASCO, PERÚ	10
A. Community.....	10
1. Economic Activity.....	11
2. Daily Detonations.....	14
3. Plan L.....	14
4. Cerro de Pasco is inhabited but it is not livable.....	17
B. Mine (zinc, lead, and silver).....	18
1. Production.....	20
C. Plan for closure.....	21
D. Conclusion.....	21
IV. OK TEDI MINE, PAPUA NEW GUINEA	22
A. Community.....	22
B. Mine (copper, gold).....	23
Figure 11. Production. Targets and results. Source. Inmet Mining, Ok Tedi.....	27
C. Mine’s impact on community.....	27
1. Ecological Impact.....	30
D. Mine Closure.....	31
1. Community Foundation.....	33
V. KONKOLA, ZAMBIA	35
A. Community.....	35
1. Malaria.....	36

B. Mine (copper).....	37
1. Konkola Copper Mines (KCM)	37
2. Konkola Mine.....	38
VI. EL CHINO, NEW MEXICO	42
A. Community.....	43
1. Santa Rita	43
2. Silver City	44
3. Hurley	47
B. Mine	48
C. Mine Closure	50
New Mexico Environmental and Reclamation Programs.....	50
VII. EL SALVADOR, CHILE	52
A. Community and the Mine Closure	52
B. Mine (copper, molybdenum)	53
1. Chañaral.....	55
C. Mine closure plan and prospects	56
1. Reconversion Project.....	57
VIII. CONCLUSIONS FROM THESE STUDIES	58
VIII. INTEGRATED CLOSURE PLANNING	60

MINE CLOSURE PLANNING IN THE FRAMEWORK OF SUSTAINABLE DEVELOPMENT

Luke Danielson and Marketa Zubkova

INTRODUCTION

Modern mine closure legislation began to be adopted in the United States, Canadian provinces, Australian states, and some European countries in the 1970s. It was a response to the rapid growth of environmental consciousness and resulting public demands for environmental protection. Prior to that time, there was significant concern over the effects of closure and abandonment- and occasional attempts to mitigate the most extreme impacts -but the first comprehensive mine closure legislation did not exist until the mid 1970s.

The focus of this legislation was largely environmental in character. In general, for new projects, it required that mining companies secure a permit before mining started. To get a permit, the company had to present a plan that described an acceptable end state for the mine workings at the end of their useful life. In that end state, the mine workings – pits, adits, shafts, waste dumps, and tailings – had to be physically and chemically stabilized to prevent significant migration offsite, control erosion, prevent blowing dust or water pollution, and otherwise protect offsite areas from ongoing damage. The site also needed to be secured from a public safety viewpoint: dangerous shafts had to be sealed, chemical reagents removed, etc.

Implementation of this legislation has been critical to the ability of the industry to operate. The industry has had quite enough problems with segments of the public who are resistant to its interests, and unwelcoming local communities. If the industry were not able to point to a thoughtful, rigorous, and guaranteed plan to reclaim at the end of the mine life, which would control the most obvious future environmental and safety hazards, the 'social license to operate' would be an order of magnitude harder to obtain.

The legislation reflects these goals. State legislation in the United States, for example, states purposes such as prevention of unnecessary and undue degradation of the environment,¹ to establish plant cover and stabilize the soil,² to minimize post-closure visual effects,³ to protect public health and safety,⁴ to

¹ *Alaska Stat. §27.19.020.*

² *Mont. Code Ann. § 82-4-302.*

The views expressed in this paper are solely those of the author (or authors).

Please cite as: Danielson, Luke, and Zubkova, Marketa, "Mine Closure Planning in the Framework of Sustainable Development," *Mine Closure, Financial Assurance, and Final Reclamation*, Paper No. 2B, Page No. ____ (Rocky Mt. Min. L. Fdn. 2009).

prevent conditions detrimental to the general safety and welfare of the citizens of the state and to provide for the subsequent use of the lands affected,⁵ or to establish a self-sustaining ecosystem following closure.⁶ There are many formulations.⁷ A more recent one is:

“to assure that:

(a) Adverse environmental effects are prevented or minimized and that mined lands are reclaimed to a usable condition which is readily adaptable for alternative land uses.

(b) The production and conservation of minerals are encouraged, while giving consideration to values relating to recreation, watershed, wildlife, range and forage, and aesthetic enjoyment.

(c) Residual hazards to the public health and safety are eliminated.”⁸

Some kind of plan was required under all these statutes to propose the detailed means for achieving these objectives.

Once the plan was approved, the company then had to post a financial guarantee, intended to ensure that if the company failed, or was unable or unwilling to implement the closure plan, government would have the resources to step in to stabilize and secure the site.

This is quite important in mining for several widely understood reasons:

- First, the impact of a poorly managed mine site can be quite serious, and the impacts can last a very long time. They can continue to get worse over time. If they impact important resources (e.g. water resources), or poses imminent threats to public safety (tailings impoundment failures) it is hard to ignore.

³ Nev. Rev. Stat. § 519A.100.

⁴ S.D. Codified Laws §45-6B-20.1.

Chapter

⁵ Utah Mine Land Reclamation Act, Chapter Eight,

⁶ N.M. Stat. Ann. §69-36-7.

⁷ See generally Danielson and Nixon, *Current Regulatory Approaches to Mine Closure in the United States*, in Warhurst and Noronha, eds. *Environmental Policy in Mining. Corporate Strategy and Planning for Closure*, Lewis Publishers, Boca Raton, 2000.

⁸ Cal. Pub Res. Code § 2712, 1975.

- Second, the cost of dealing with the worst sites can be enormous. It strains government even in the richest countries. In poorer countries, if the company doesn't reclaim the mine, chances are it will not be stabilized, because in many cases government simply does not have the money to do it.⁹
- Third, the industry is subject to serious price swings that can cause operations that are profitable today to be non-viable next week. The history of the industry is that many operations close and a considerable number of them fail financially when commodity prices cycle down.¹⁰ Therefore, it is frequently the case that there will be many simultaneous closures. If there has been no advance provision for this, it will surely be more than government can manage.

Modern mine closure legislation has accomplished a great deal where it has existed. It has slowed, if not entirely eliminated, additions to the world's legacy of abandoned and unreclaimed mine sites. While there have been some mistakes and missteps as government and industry learned to manage the process (and civil society organizations learned how to be more effective watchdogs of the system), on the whole the progress has been remarkable.

But the job of ensuring that all mines are properly reclaimed and closed is far from done. There are at least three major areas in which the system is not working, and where reconsideration is appropriate.

These are:

- The mining industry has globalized, but this model of closure legislation has not. Administering such legislation well requires a degree of capacity not always present in governments, a degree of public pressure that is not always there, and money that is not always available. So while there are increasing closure requirements in many countries, they have not taken on all of the characteristics of the fully developed systems. Most strikingly, many of the closure systems in these countries do not have a system of financial guarantees, so when industry prices fall and companies fail (which happens fairly often in this risky industry), there may be no funds to

⁹ For one snapshot of the scale of this problem in one region, see Ashton, Love, Mahachi and Dirks, *"An Overview of the Impact of Mining and Mineral Processing on Water Resources and Water Quality in the Zambezi, Limpopo and Olifants Catchments in Southern Africa,"* MMSD South Africa, <http://www.iiied.org/pubs/pdfs/G00599.pdf>

¹⁰ In Colorado, we have seen the silver crisis of 1893 that closed thousands of mines, the first oil shale collapse in the 1920s, the collapse of the uranium boom in the 1960s that caused hundreds of closures, and the second oil shale collapse, among other events.

implement closure. Companies in jurisdictions that require rigorous closure planning and financial assurance¹¹ are in direct economic competition with operations in places that have few or even no requirements.¹²

- Most of this legislation was based on a view which we now find to be overly optimistic in some cases: that we could always achieve a “walk away closure.” This in turn allowed the government agency to declare victory, certify the site as reclaimed and – very important for the private sector – release the company from further legal liability. The reality is that there are more than a few projects where full implementation of the closure plan still leaves us with an ongoing need for monitoring, active management of stability, or measures such as operation of active water treatment plants for many years into the future, long after “closure” has occurred. Most of the current legislation does not deal with this adequately, nor does it answer the question of who is going to manage the site or pay the costs during the post closure period. The extent of the mining company’s legal liability for site conditions also remains undetermined.
- Finally, as the minerals industry has come under increasing pressure to show concretely that it can deliver real and sustainable social and economic benefits to the communities and countries in which it does business, it is clear that we have not adequately considered the economic and social aspects of closure. The principal purpose of this paper is to contribute to that discussion.

This last issue is critical to the industry’s social license to operate. Even where a mining project does stimulate local economic growth and increased opportunities, this development cannot be considered sustainable if, when the operation closes, progress is destroyed and the surrounding community is sucked into poverty. The fact is that in many parts of the world, from the richest countries to the poorest, former mining areas have often become impoverished and lacking in opportunity. This is true in Cornwall, Appalachia, the mining regions of the former East Germany, Romania, Potosi – in short, in a variety of places, scattered all over the world.

¹¹ As set out below, the Chino mine in New Mexico, according to information we have obtained, has a performance bond of \$375 million. An equivalent mine in another country without bonding requirements would certainly have a cost advantage over Chino. Of perhaps equal importance, if the amount of the ultimate closure obligation has never been determined, it is unclear what if any liability the company would have to carry on its balance sheet. It might have a considerably ‘cleaner’ appearance on the balance sheet, despite the company’s good faith commitment to do what is necessary for proper reclamation.

¹² There is much interest in developing some kind of certification system that would let customers choose between products produced under acceptable conditions and products that do not internalize environmental and social costs; however there is no such system in place yet.

I. MINES UNABLE TO CLOSE?

Of broad concern to the industry should be the number of instances in which neither the company nor government can find a way to close mines – even unprofitable ones – because they cannot face the social and economic crises that would be generated by closure. It seems that in these cases there is an enormous pressure to subsidize continued production, because even though production may not be profitable, the subsidy costs less than would dealing with closure.

This is not a rigorous economic study of this subject, but our work does suggest that such a study may be merited, to determine (i) the extent to which companies may internally be subsidizing less than profitable operations, and (ii) the extent to which government is subsidizing them either directly or indirectly, by lowering environmental or other legal requirements in the name of reducing operating costs. Certainly, if companies are producing at a loss, and kept in business by subsidies, this is for one thing hardly good for world mineral prices.

The concerns set out above and in the rest of this paper have led to a revolution in closure planning: a move from seeing closure as primarily an environmental issue to what is now called “integrated closure planning,”¹³ in which there are environmental, social, and economic dimensions to the closure plan. Indeed, as some of our case studies below seem to indicate, it is extremely hard, in the real world, to separate these factors. Often, trying to deal with any single one of them inevitably entangles us in the others.

In part, this is something of a North-South issue. People in the richer, more industrialized countries tend to be immediately concerned with the environmental costs of development. People in the developing world see development and poverty reduction as the immediate issue. As the perceived need for a framework for closure planning has spread to the developing world, it may only be natural that it is taking on more of a social and economic development focus.

¹³ It is hard to say who first used the term “integrated closure planning.” The idea has become more prominent partly as a result of the work of the Mining Minerals and Sustainable Development Project, where the concept is set out at some length in the 2002 study *BREAKING NEW GROUND*, at <http://www.iied.org/pubs/pdfs/G00901.pdf>. It is now an important part of the best practice concepts of the International Council on Mining and Metals. See www.icmm.com.

II. MINES AND DEVELOPMENT

In much of the world, it is now difficult to gain community acceptance of new mining projects. The phenomenon of community resistance to mining is not limited to any particular kind of community. There are poor communities that are creating tremendous obstacles to mine development, such as the community around the Marlin Project in Guatemala.¹⁴ There are rich communities that are creating tremendous obstacles to mining, such as Crested Butte, Colorado.¹⁵

In many cases, these community conflicts are proving extremely expensive to companies. In some, they are preventing projects from going forward at all: Newmont's Cerro Quilish deposit is a major gold deposit, but community resistance, at least to this point, keeps it from being developed.¹⁶

Unless we attribute all of the community resistance to random forces incapable of rational explanation, we need to seek to understand these phenomena, figure out what is happening, and try to manage our activities to fit the world we live in, rather than expecting the world to return to some more benign condition where everything is easier. We think it will continue to become more complex and challenging. Part of the answer is that mining must become a 'better deal' for the communities in which it operates. These disputes, and the communities resisting mining, will diminish if mining is meeting local needs and helping to build the kinds of communities people want. Part of what people want is more economic and social opportunity for their communities.

If one reason for the growing interest in the idea of sustainable development is simply a company desire to obtain the 'social license to operate,'¹⁷ another reason is common sense. There are more of us in the

¹⁴ See the report of the Compliance Advisor/Ombudsman of the International Finance Corporation at http://www.cao-ombudsman.org/cases/case_detail.aspx?id=95

¹⁵ Jaffe, Mark. *Mountain: Metals or Moguls*, Denver Post, Nov. 21, 2008, at http://www.denverpost.com/breakingnews/ci_11037202

¹⁶ See THE SOCIAL LICENSE TO OPERATE, Business for Social Responsibility, at <http://www.commdev.org/content/document/detail/858/>

¹⁷ This concept is explained in a number of very good writings. One excellent one is the Business for Social Responsibility report, THE SOCIAL LICENSE TO OPERATE, BSR 2003 available at www.bsr.org

world every day.¹⁸ The numbers of places where we can go mining, or even have a loud party without disturbing the neighbors, are fewer every day.

Many of us are in poverty, something like a billion of us live in extreme poverty.¹⁹ The impoverished need more resources to get out of poverty. As one example, it is hard to see how someone could be considered no longer poor until that person has access to electricity. And it is impossible to imagine people using electricity, even a modest amount of it, without copper. And even if the rich volunteer to give up part of their copper for the poor (which the rich show little sign of doing) that is probably not enough to give minimum electrification to all the people who need it. If we are going to electrify the homes of the poor, we need to produce some more copper to do so.

At the same time, as we want more resources for a growing population, our ability to produce them is constrained by a growing list of factors: community opposition, the amount of carbon it takes to produce them, rising energy costs, lower grades of ore, etc.

Ultimately, the argument for sustainable development is really an argument for efficiency. With every move we make, we need to evaluate the opportunities to alleviate more poverty, use less fresh water, educate and train more people, emit less carbon: in short, to do more, but do it with less. As we get better at this, it will accelerate the move from coercion to consent as the basis for making decisions.

Where does integrated mine closure planning fit into this model?

We might express our vision in two ways. First, if we are focused on the social license to operate, communities are right to ask what kind of 'deal' mining offers. If the deal is jobs and local economic activity for as long as the mine is open, and followed by economic collapse, social problems and ghost towns, communities are right to be frightened.

Second, if we are focused on using mineral revenues for development, there are three historic problems:

- The impacts of mineral development need to be managed, at considerable cost, for some years before the project starts yielding revenue. For example, if thousands of construction workers

¹⁸ According to the International Programs Center, U.S. Census Bureau, the total population of the World, projected to 10/13/09 at 17:08 GMT (EST+5) is 6,790,252,038. See <http://www.census.gov/ipc/www/popclockworld.html>

¹⁹ See P. Collier, *THE BOTTOM BILLION: Why the Poorest Countries are failing and what can Be Done about It.* (Oxford University Press 2007).

show up in the community before there is any tax revenue to pay for the construction of schools, police, hospitals and other services, it is unclear how all these services can be financed.²⁰

- Mining revenues are cyclical. There are feast years and famine years, and it is usually not possible to predict either famine or feast. In down years, where there may be unemployment and lower business activity in the mining community, there are usually increased demands for social spending. But these increased demands coincide with lower revenues.
- Finally, and most relevant, the impacts that need to be managed tend to continue after revenue stops flowing. When a mine closes, people need to retrain, or else they move away. Government, local businesses, and individuals need to find new opportunities for livelihood, and this costs money. As we know, the environmental impacts that need to be managed may continue a considerable period after operations stop. Yet the mineral production and tax revenues have dried up, and the source of the funds to pay for all this is not always clear.

Integrated closure planning is designed to deal with this last problem: if we have made economic and social gains during the project life, can we maintain these?

As we start into our very rough case studies,²¹ we would suggest experience to date shows that an integrated closure planning model has some things in common with the more traditional environmental reclamation kind of closure planning.

- A company's responsibility for the social consequences of closure is in most cases not a matter of legal rights and agreements but of expectations on the part of communities and governments. Despite the lack in most cases of an established legal liability, powerful forces are pushing companies into accepting greater responsibilities. But they are not at all clear how much of the responsibility is theirs and how much belongs to government.
- It is very much better to plan for closure from the outset. If the closure plan is hastily developed in the last year or two of a mine's life, the chances for success are dramatically reduced.
- There is a serious need for continuous consultation of the affected community. We have heard anecdotally of closures where companies kept all of the economic forecasts and plans

²⁰ See as one example the "Tax Lead Time Study for the Colorado Oil Shale Region" available through Colorado Geological Survey, Department of Natural Resources, Denver, Colorado, 1974.

²¹ As will be seen, these are not rigorous case studies at this stage. But they are intended to be informative enough to illustrate the basic challenge on which we are focusing: how to deal with the economic and social aspects of closure where the mine is central to the economy of the region.

confidential. As a result, mine employees and the local community were not able to make plans of their own because they were kept in the dark until the pink slips were handed out. This means missed opportunities for a better outcome, and magnification of some of the negative impacts.

- o There needs to be an agreement at the outset as to who will pay for what. Trying to reach that agreement toward the end of the mine life is difficult.

With this framework, we will turn to five cases before trying to draw some lessons about the future of the economic and social elements in closure planning. The five case studies are: Cerro de Pasco (Perú); Ok Tedi (Papua New Guinea); Konkola (Zambia); El Chino (USA) and El Salvador (Chile). These mines were selected because they are large-scale mines, relatively isolated from other major centers of industrial employment, and because they have been in operation for a minimum of several decades.²² All have mine-dependent communities. Some are on the verge of closing. Others may stay open. One of our findings is that the issue of when and how to close these facilities has in most cases been subject to considerable doubt, debate, political pressure, and changes of direction. In most cases this doubt continues, and it is proving very hard indeed to reach any kind of decisions. There is in each case a considerable amount of local and regional conflict about what to do, and decisions in some cases have been made, withdrawn, reevaluated, and made again.

While part of this uncertainty may reflect uncertainty over mineral prices, much of the unsettled condition of these projects seems to come from the uncertainty of companies and governments over whether they are in a condition to manage the social and environmental consequences of closing, and how much of this responsibility belongs to the private as opposed to public sector.

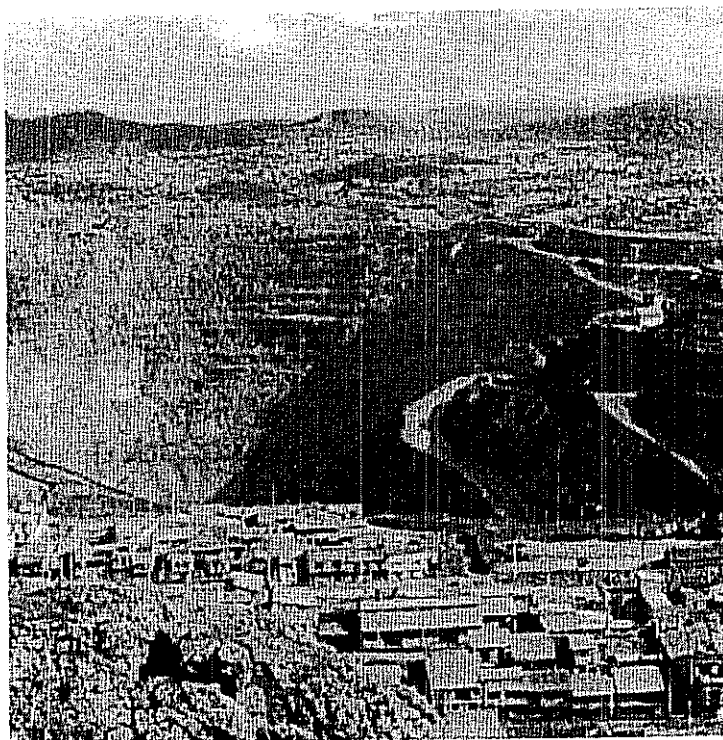
²² Indeed, El Chino was producing copper for Mexican copper coins before New Mexico became part of the United States in the wake of the Mexican War. See

<http://www.southernnewmexico.com/Articles/Southwest/Grant/SantaRita-Thetownthatvani.html>

III. CERRO DE PASCO, PERÚ

Case Study

Figure1. Cerro de Pasco open pit mine, Perú



A. Community

The community of Cerro de Pasco stretches along the open-pit mine, clinging to its edges. The population is approximately 80,000 permanent residents and more than 10,000 temporary inhabitants or non-residents who are attracted to the area mainly by the growth of mining in the region. Cerro de Pasco is the capital of Pasco Province, which is divided into 13 districts. The areas most heavily affected by historic contamination are the neighborhoods that surround the mine or outlying areas where mining companies have dumped waste for decades-- Chaupimarca, Simon Bolivar, Quiulacocha and Yanacancha.²³ Approximately 85 percent of the people living in the homes along the edge of the pit are at high to medium risk of health problems, according to a 2006 report by the government's Civil Defense Institute.²⁴

²³ Mejia Sanchez, Glodomiro. *Mineria en Pasco*. Cerro de Pasco. 2009.

²⁴ Interpress Service News. Salazar, Milagros. *Open Pit Mine Continues to Swallow City*. 2009. Available at <http://ipsnews.net/news.asp?idnews=4529>

Figure 2. Population, Region, Province and Selected Districts, 2007

Source INEI, Population Census and Housing 2007 and 1993.

Region/Province	Capital	Population	
		1993	2007
Pasco Region	Pasco	226,295	280,449
Pasco Province	Pasco	129,899	150,717
Chaupimarca	Cerro de Pasco	27,502	27,873
Simón Bolívar	San Antonio de Rancas	15,424	13,681
Yanacancha	Yanacancha	24,400	29,596

1. Economic Activity

Mining is the principal economic activity. The previous source of income was animal herding; there is a lack of assistance for people who want to continue to plant crops, the altitude is high for many types of agriculture, and the town is economically dependent on the mine. Only 2,955 workers work directly in the mining company but approximately 12,000 family members are supported by workers in the mine.²⁵ Many others in the community are supported indirectly by mining.

Mine jobs are getting scarcer; the company has considerably reduced operations due to the global crisis and the decline of mineral prices; last year Volcan temporarily suspended the operation. In January 2009, the company did not renew 2008 contracts with 450 miners.

With the plummeting prices of lead, silver and zinc, mine workers risk the loss of jobs when company makes cuts; but community members are not able to return to herding animals as an alternative livelihood.

"Few farmers now make a living from herding alone. And as many point out, while economic necessity drove people to take jobs in the mines, the different way of life - a salary, strict timetables and a short-

²⁵ El País – Lima. Cordero, Jaime. *Una Ciudad al borde de abismo*. August 23, 2009. Available at <http://www.laborpasco Peru.org.pe/index.php?c2=ampliacion&codigo=111>

term focus - weakened their bond with the environment on which they previously depended. Some feel they only realized the extent of the damage when it was too late."²⁶

The most heavily affected rural community may be Quiulacocha, whose 850 inhabitants try to make a living by raising sheep. But the village is hemmed in by waste dumps that hold a toxic mixture of refuse material from the mines. "It's terrible, especially in the summertime, when the tailings ponds heat up and the wind blows a harmful steam into our houses," says the local mayor, Silvino Guadalupe Rojas.²⁷

Alberto Rojas, a local resident who owns 200 head of cattle, says that in 2008 he lost up to 25 percent of his animals as a result of drought and polluted grasslands.

Figure 3. Pollution in Pasco region. Photo Thomas Quirynten



With farming in decline and local employment opportunities meager, most parents place great emphasis on their children's education, even when they know this will mean temporary or even permanent

²⁶ Mountain Voices is a collection of interviews with local people from Cerro de Pasco. Available at http://www.mountainvoices.org/p_th_economics.asp.html

²⁷ Salazar p.2.

migration to Lima or other cities.

"One thing's for sure, there's not much future around here," said Andrés, farmer and retired mechanic.

"You can only be a miner around here because you can't live from being a community member, working the land, the farm. The people who work the farm do it as an extra, they have to work in the mine or as a trader or in transport too. You can't live from farming any more the way our grandparents did."²⁸

There are many attempts to reverse the economic decline: communities are trying to develop new economic activities such as the extraction of sand and limestone: local cooperatives are starting bakeries, dairies, raising guinea pigs, and garment making businesses etc. (see figure 4 below), but generally there is a real lack of any manufacturing industry. Additionally, people are frustrated by the lack of investment and training which would enable them to start up alternative industries - to change the region from being just an exporter of raw materials, and to provide employment and a future for young people.²⁹

Figure 4. Pasco Region: Sectors and Gross Domestic Product in %, 2008.

Years	Agriculture and Hunting	Mining	Industry	Construction	Tourism	Renting	Government Services.	Other Services
2004	16.40	51.55	4.89	1.45	7.36	1.67	4.71	11.97
2005	16.45	51.45	4.97	1.36	7.29	1.69	4.71	12.08
2006	16.50	51.36	5.04	1.28	7.22	1.72	4.71	12.17
2007	16.55	51.26	5.12	1.19	7.15	1.75	4.71	12.27
2008	16.59	51.17	5.19	1.11	7.08	1.77	4.70	12.39

Source: BATADUR -2009

²⁸ Mountain Voices, employment. Available at http://www.mountainvoices.org/p_th_employment_and_income.asp.html

²⁹ Mountain Voices, economics.

2. Daily Detonations

There are reports that homes twist and crack from two daily detonations (11:00 am and 3:00 pm) and the residents suffer from the lead dust, toxic gases and heaps of accumulated dumped waste. "The 'shots' fill the air with a smell like burning rubber," says local resident Vilma Vicente. "When that happens, my little brother shouts and cries," says 11-year-old Angela.³⁰ Daily blasting at the pit has weakened urban areas, and many homes are unsafe. Since the mining company keeps expanding operations and the pit is growing bigger and closer to the town, homes are subsiding and are prone to collapse³¹ (see figure 5 below).

Figure 5. Houses damaged after detonations. Photos by Thomas Quiryren



3. Plan L

The imminent threat of closure comes as open pit work has been considerably restricted because the town restricts the space available for mine expansion. The Volcan Company submitted "Plan L" (see figure 6 below) that would eat up 11.4 hectares of the city, pushing the pit wall closer to the main square.

³²

The pit wall has become steeper and steeper, but there is a limit on how steep it can get: if the mine cannot encroach on the community, it has little opportunity to keep operating, even if prices permit. For environmental reasons, such as lead exposures, as will be seen below, the nearby inhabitants probably need to be relocated. But these people, many of them quite poor, understandably resist relocation until someone can tell them where they are going where they will live, and how they can support themselves,

³⁰ Salazar p. 1.

³¹ Upside Down World.org. Quiryren, Thomas, Cerro de Pasco, Perú. *Mining, Red Lakes, and Piles of Waste*. May 22, 2009. Available <http://upside-downworld.org/main/content/view/1872/68/>

³² The Economist. *If a city's the pits*. January 2009. Available at http://www.economist.com/world/americas/displaystory.cfm?story_id=13022095&fsrc=rss

and the answers to these questions are not yet clear. And ultimately, the big question is who is paying for what?

While Cerro de Pasco is a mining town, some people are concerned that the few local landmarks, such as the main church or the historical Vicente Vegas building where Pasco's independence was declared in 1820, would disappear into the hole by 2015. Last September, Volcan signed a contract with the municipal government, agreeing to invest \$10 million to relocate historic monuments and buy out homes located in "area L."³³

The old Chaupimarca district is located in the center of the open pit mine expansion project and Volcan has already started buying more and more property and many people are moving out of the district or to Lima.³⁴

Plans are being developed to relocate and rehouse the residents in 15 to 20 years.

"Twenty years? I'll be dead by then. Since I was a boy I've heard that we're leaving, but nothing ever happens. Look at the corrugated iron roofs, they're black from the mining dust," says Alberto Rojas.³⁵ Teodoro Jesús Conozco, 78, is in favor of the relocation, but not at just any price. "How can they pay us just 3,000 sols (around 1,000 dollars) for our house? I might as well just stay. And our livestock, where will it go?"

The plan is supported by the president of Perú, Alan García, and the Peruvian Congress is calling for studies to be done around the nearby villages to see if the plan is feasible.

"This situation reveals the absence of the state in the model of the mining enclave where the company has control over the social, political and economic life," says Congresswoman Gloria Ramos, whose father was a miner and who is herself from Cerro de Pasco.³⁶ "For years the right to work has been granted in exchange for a life marked by pollution and poor living conditions. We have grown up with a culture of short-term profits that has ignored sustainable development," said the legislator.

In December 2008, Congress approved (95-0) a law progressively to relocate Cerro de Pasco. The law provides for Cerro de Pasco's immediate relocation 35 kilometers (22 miles) down the road and sets up an inter-institutional committee that will draw up plans for contamination control, indemnification, and

³³ Id.

³⁴ Sanchez p. 22.

³⁵ Salazar p.2.

³⁶ Federación Nacional de Trabajadores Mineros, Metalúrgicos y Siderúrgicos del Perú. *Así informa agencia Reuters sobre "cierre de operaciones" de minera Volcan en Cerro de Pasco*. FNTMMSP se mantiene expectante. FNTMMSP. 2009. Available at <http://www.fntmmsp.org/noticias/Regionales/298.html>

health care. The commission is to determine who will foot the bill for the project which is expected to cost over \$500 million dollars. "It is a forced relocation and therefore should be the state and the mining company who cover the cost," says Luz Gladys Huamán from the Labor Center, an organization that receives support from the NGO InspirAction for work with people in the region.³⁷

The local government and most of the local Cerro de Pasco residents also favor the plan. "There really is no city. What we have is a network of streets that end at a cement wall and a pit," said Félix Rivera, the governor of the Pasco region.³⁸

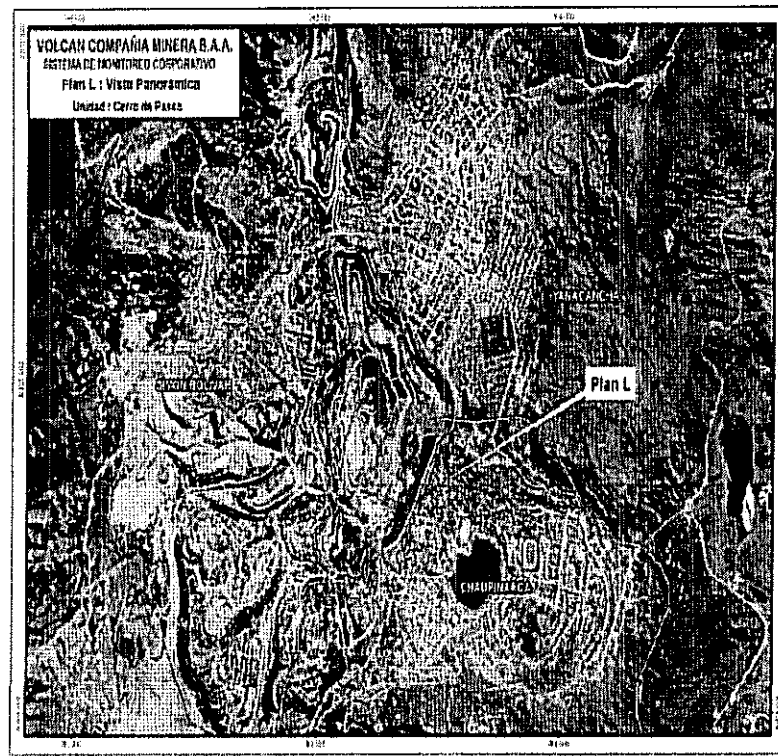
"Volcan is proposing a shorter-term resettlement plan that would involve the construction of housing and public institutions in an area not far from the mine," said Luis Pariona, the head of public relations for Volcan's Cerro de Pasco operating unit. The company has bought many homes in the area where it plans to expand the mine but has not yet started to implement its plan because to do so, it must first submit an environmental impact study.³⁹

³⁷ Peruvian Times.com. *Volcan Mining Company postpones Cerro de Pasco relocation and slows operation ahead of plummeting prices for zinc and silver.* 2009. <http://www.peruviantimes.com/volcan-mining-company-postpones-cerro-de-pasco-relocation-and-slows-operations-ahead-of-plummeting-prices-for-zinc-and-silver/>

³⁸ Quirynen p.2.

³⁹ Id.

Figure 6. Plan L



4. Cerro de Pasco is inhabited but it is not livable⁴⁰

The relocation will also solve another serious problem: the pollution the inhabitants of the city are exposed to. Studies have found that residents have high levels of lead in their bloodstream. A 2005 study by the Pasco regional health agency found that more than 85 percent of children in the communities of Quiulacocha and Champamarca had blood lead levels exceeding 10 micrograms per deciliter of blood (mcg/dl), the acceptable limit set by the World Health Organization (WHO).⁴¹ In 2006, similar results were found in Yanacancha. Chronic lead poisoning can cause irreversible neurological damage, renal disease, damages to the reproductive system, anemia, high blood pressure and cardiovascular problems. In

⁴⁰ No a la mina.org. *Cerro de Pasco el pueblo que desapareció dos veces*. 2009. Available at <http://www.noalamina.org/latinoamerica/general/cerro-pasco-pueblo-desaparecio-dos-veces>

⁴¹ Servindi.org. Vitor, Luis. *Perú: Cerro de Pasco y la expansión minera, un conflicto infinito*. 2007. Available at <http://www.servindi.org/actualidad/2249>

children, it stunts growth, causes learning difficulties and behavioral problems, and can lead to mental retardation. High concentrations of lead can cause convulsions, a state of coma, and even death.⁴²

"I know that my whole family is contaminated," says Luis Palma from Cerro de Pasco, "Four out of my seven children have a high level of lead in their blood but the most affected is my four-year-old daughter, Thais, who has seizures, constant fever, concentration problems and cannot speak." Thais has 120 micrograms of lead per deciliter of blood, three of her siblings are also highly contaminated with lead, as they have 66 mcg/dl, 96 mcg/dl and 100ug/dl. The accessible limit for lead in the blood of adults is 14 mcg/dl; Thais's mother has 29 mcg/dl and Luis has 21 mcg/dl.⁴³

"The representatives of the mining company Volcan have given us rooms where we can stay but what my family really needs is to be moved out from the contaminated city," says Luis.⁴⁴

Volcan asserts these conditions do not result from its operation, but from environmental liabilities accumulated over centuries of mining by previous operators, in addition to soil quality that is unsuitable for housing because of its high concentration of minerals. "We are not opposed to mining, but we want a new city that is livable, that has an industrial park that will allow us to develop other economic activities," said Dimas Peña, president of the Association of Local Merchants and Residents affected by the expansion of the mine.

Although most of the "cerreños" favor the relocation plan, they are also afraid that they will lose its history and identity. "Moving out of the city can help us with our environmental and health problems but our town will lose its history and identity. The mine is expanding and eating up our homes, hospitals and schools; it swallows up the local history of Cerro de Pasco and the town will disappear."

B. Mine (zinc, lead, and silver)

Cerro de Pasco one of the highest altitude cities in the world, was established by the Spanish as an important silver mining town in 1578. In spite of the extreme climate, the mining boom in the 17th and 18th century attracted many miners and the Spanish named it Cerro de Pasco, the *Royal Mine City*. In the 19th century the wealthiest and most prosperous Hispanic miners settled in Cerro de Pasco and called it the "Opulent City" for its prosperity and contribution to the national treasury based on mining.⁴⁵

⁴² Salazar p.2.

⁴³ Cordero p.1

⁴⁴ Id.

⁴⁵ Sanchez p. 4.

Cerro de Pasco's railroad – an astonishing engineering achievement that goes from near sea level at Lima to almost 15,000 feet above sea level – was built at the beginning of the 20th century, and New York based “Cerro de Pasco Investment Company” started mining in the Cerro de Pasco mine soon afterwards. In 1915, Cerro de Pasco Mining Corporation, Cerro de Pasco Railway, and Morococha Mining merged and formed Cerro de Pasco Copper Corporation. A few decades later, in 1951, various mining companies sold their shares to a new company, “Cerro de Pasco Corporation,” that started open pit work in 1956. This work expanded and demolished the old town of Cerro de Pasco.⁴⁶

Like many countries in the 1960s and 1970s, Peru nationalized parts of its mining industry. Cerro de Pasco Corporation was nationalized in 1973 and named “Empresa Minera del Centro del Perú” (CENTROMIN PERÚ).

In the 1990s, Peru privatized many of its state mining assets. In 1999, Volcan Compañía Minera S.A.A., won the international public bid convened by the Privatization Committee (COPRI) for the acquisition of one hundred percent of the shares of Empresa Minera Paragsha S.A., belonging to Centromin Peru.⁴⁷ This company became the Production Unit of Cerro de Pasco, located in the District of Yanacancha, Province and Department of Pasco. Volcan is the largest producer of lead concentrate and silver in the country, and the second largest producer of zinc concentrates. Volcan owns 44,812 hectares of mining concessions located in or near Cerro de Pasco.⁴⁸

In short, there is plenty of room for argument about who should pay any closure costs at this site: the former North American owners, if they could be found, the Peruvian government, which owned the site for years, Volcan, which has owned the mine for the last decade, or someone else. And it is not at all clear how long mining can continue at this site under any scenario, or what will happen to the local population when the biggest source of economic activity disappears.

Volcan mining operations are carried out in the Raúl Rojas Pit (the highest open pit mine in the world, it is located at 4,265 meters which is 15,173 feet above sea level) but there are now underground mines below the town neighborhoods as well.

⁴⁶ This limited one possibility: tourism to a historic mining town. Potosí in Bolivia (see <http://whc.unesco.org/en/list/420>) and Sewell in Chile (see <http://whc.unesco.org/en/list/1214>) are now official World Heritage Sites.

⁴⁷ See Volcan Compañía Minera. *About Us. Past* available at <http://www.volcan.com.pe/about/index.html>

⁴⁸ *Id.*

Figure 7. Cerro de Pasco Mine-vertical view of pit
(Source. Google Earth satellite imagery from August 2007)

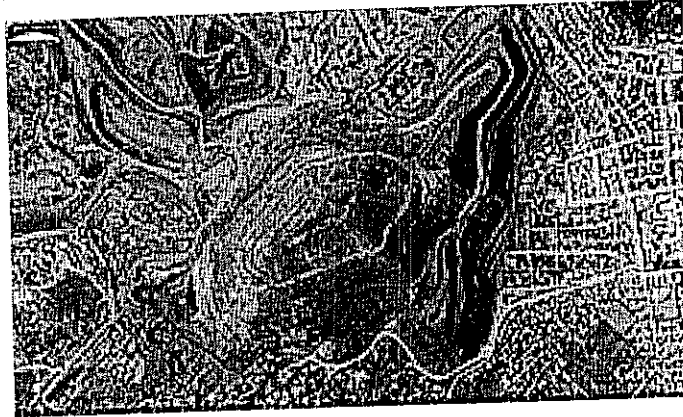


Figure 3. Panoramic view of pit.



1. Production

Volcan mining operations represent 19 % of zinc production in Perú.⁴⁹ 2006 figures for combined production from the underground and open pit mines are 3.34 million tons of ore (containing 155,300 tons of zinc, 58, 300 tons of lead).⁵⁰ In 2007, Volcan extracted more than 3.5 million tons of silver, lead and zinc ore from the open pit. The following figure shows mineral production of the Raúl Rojas open pit in the 11 years from 1995:

⁴⁹ Federación Nacional de Trabajadores Mineros, Metalúrgicos y Siderúrgicos del Perú

⁵⁰ Resource Investor.com. West, James. *Tinka Resources: 20 Million Ounces and Growing*. 2009. Available at <http://www.resourceinvestor.com/print.php?id=7849>

Figure 8. "Raúl Rojas" open pit mineral production

Year	Production	%Pb	%Zn	g/t Ag
1995	1,376,367	3.18	8.21	97.72
1996	1,568,257	2.96	7.85	95.04
1997	1,623,665	2.95	7.92	98.20
1998	1,684,864	2.93	7.56	97.00
1999	1,669,873	2.89	7.80	108.21
2000	1,632,027	2.34	5.96	81.00
2001	1,525,151	2.23	4.85	59.25
2002	1,725,155	2.21	4.92	50.86
2003	1,567,859	1.52	3.58	37.49
2004	1,602,172	1.73	3.90	37.53
2005	2,113,340	1.33	3.25	32.17

C. Plan for closure

Most of the people of Cerro de Pasco as well as the Peruvian government prefer city relocation to immediate mine closure. Although Volcan's expansion plan has been approved and the mine will not close in the immediate future, the company has prepared a mine closure plan. The closure plan will be carried out in all the fields where mining operation has occurred, for example, treatment plant, tailing deposits, waterline tailing deposits. The objectives of the closure are health and environmental protection, profitable use of land and protection of the soil. The principal mine closure activities consist of dismantling the system, demolishing, water control, replanting and removing all the valuable equipment and material that could possibly be sold or used later elsewhere.⁵¹

The impacted area will be restored and the plan is to return as much as possible of the site to pre mining conditions. But the overarching question is the future of the people of this mine dependent community.

D. Conclusion

Closure planning at Cerro de Pasco is a work in progress. There are many local groups and interests in conflict, and very little agreement how to proceed. There is on one hand urgency to doing something soon, or the mine may close, leaving all the residents in the contaminated area and without any economic engine for the future. On the other hand, there is an impasse between government and the mining company over who pays for what. And finally, it is clear under any scenario that this mine is nearing the end of its useful life, and that there will at some point be a closure. The immense social and economic impacts of closure when it occurs will stress both the private sector and public institutions,

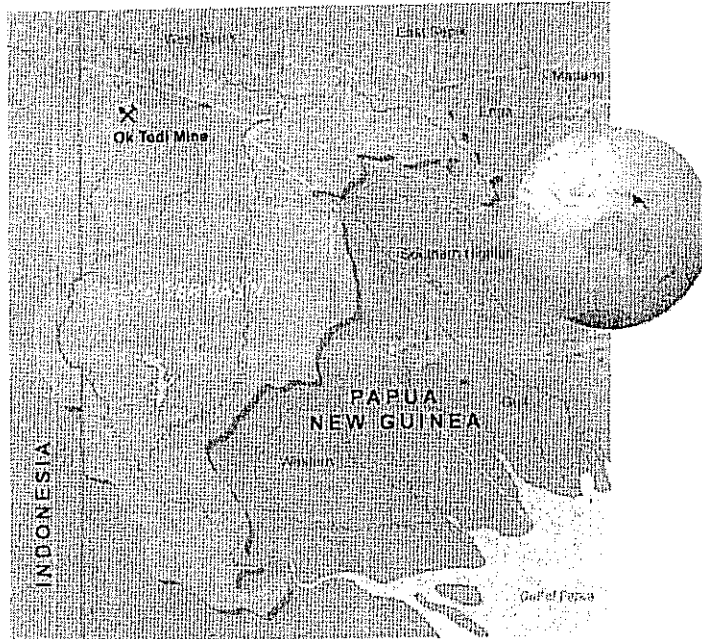
⁵¹ Sanchez p.38.

IV. OK TEDI MINE, PAPUA NEW GUINEA

Case Study⁵²

(Source is Philippe Rekacewicz, UNEP/GRID-Arendal)

Figure 9. Ok Tedi map.



A. Community

The people of Papua New Guinea are a diverse group. Most live in rural areas where subsistence production dominates the local economy. The Western Province, where the Ok Tedi mine is located, is Papua New Guinea's largest, but it is also the most sparsely populated. In the Western Province there may be as many as 50 languages spoken in an area with a population of slightly over 100,000.⁵³

Prior to mining, the Ok Tedi Mine site itself was uninhabited. The surrounding area contained no more than 800 people and they pursued extremely basic livelihoods with low life expectancy and almost no access to government services. Two groups of people lived in the surrounding area—the Wopkamins to

⁵²We want to thank David Southworth for his insights and work on this subject, which have greatly aided our case study.

⁵³ Rannells, Jackson. PNG: A Fact on Modern Papua New Guinea. (2nd Ed., Melbourne, Oxford University Press, 1995)

the north and the Upper Awins to the south. These people had almost no exposure to the outside world; their life expectancy was 25–30 years and about three quarters of the children suffered from malaria. The physical environment was harsh with limestone mountains, steep ravines, and one of the highest levels of rainfall (8,000 millimeters per year) in the world. These are the factors that contributed to the people's isolation and low standard of living.⁵⁴

Since mining began, the population of the mine-area community has grown. As of 2005, there was an estimated population of 13,800 people in the town of Tabubil that was built to serve the mining operations. The people in the mine area villages now enjoy a far higher standard of living and have a longer life expectancy. The serious concern is whether this standard of living can be maintained after the mine closes.

Most settlers are expected to leave once mining ends, and some may leave if there is a contraction in mining activity. Until that time, the population of the settlements is likely to grow as more people are attracted to Tabubil in search of employment, or to try their hands at small-scale alluvial mining along the Ok Tedi.

People still live very close to their land. Agriculture supports 75 percent of population. Many have begun business ventures in natural resources such as rubber, rice, pineapples, ecotourism, timber and fish. Few people have invested substantially in commercial activities or the education of their children.⁵⁵

B. Mine (copper, gold)

The Ok Tedi mine is located in the Star Mountains of Papua New Guinea's Western Province, in relatively inaccessible terrain that is prone to high rainfall, frequent earthquakes, and landslides (see Figure 2).

Papua New Guinea is a relatively recently independent country⁵⁶ with a limited range of options for attracting investment for development.

The contribution of mining has been important, and from the outset Ok Tedi was important to national development plans.⁵⁷ Exploratory drilling by the Kennecott Copper Corporation began in the 1970s. The government – which became fully independent only in 1975 - wanted to use income from the mine as a

⁵⁴ Ok Tedi.com. Ok Tedi Mining. Social & Economic Report, 2006, at <http://www.oktedi.com/images/stories/reports/2006-social-economic-report-final.pdf>.

⁵⁵ Id

⁵⁶ State.gov. US Department of State" Papua New Guinea, September 2009, at <http://www.state.gov/r/pa/ei/bgn/2797.htm>

⁵⁷ Townsend, Patricia & Townsend, William. *Assesing an assessment: The Ok Tedi Mine*. 1996. Available at <http://ma.caudillweb.com/documents/bridging/papers/townsend.patricia.pdf>

source of revenue to develop infrastructure and services, in what was and is a very poor country.⁵⁸ It was encouraged in this by the World Bank and the Australian government, whose Export Finance and Insurance Corporation helped fund exploratory studies at Mount Fubilan.⁵⁹

Figure 10. Ok Tedi Mine terrain



Construction of the mine commenced in 1982 when Papua New Guinea was one of the least industrialized countries in the world. It was and is mainly reliant on agriculture for both subsistence and commercial production for export.

Like Cerro de Pasco, this project started out as the product of foreign private investment. The developer was a multinational consortium consisting of three large multinationals: Australia-based Broken Hill Proprietary (renamed BHP Billiton after merging with UK-based Billiton in 2001), Amoco Minerals, and a German consortium led by Metallgesellschaft AG.⁶⁰ In the early 80s, BHP Billiton secured a mining lease and in 1984, began exploiting the gold 'cap' on the mountain using cyanide extraction procedures. However, things changed. One of these was that the mine's environmental record, discussed below, began to attract severe criticism, both inside and outside Papua New Guinea. In 1994 *Rex Dagi v. Broken Hill Proprietary Company Ltd.*, Yonggom indigenous people brought a case against the mine operator; a

⁵⁸ The Human Development Index for Papua New Guinea is 0.541, which gives the country a rank of 148th out of 182 countries with data. See http://hdrstats.undp.org/en/countries/country_fact_sheets/cty_fs_PNG.html

⁵⁹ World Resource Institute. Ok Tedi Mine Unearthing Controversy. United Nations Development Programme, United Nations Environment Programme, World Bank, World Resources Institute. 2003. *World Resources 2002-2004: Decisions for the Earth: Balance, voice, and power*. <http://archive.wri.org/page.cfm?id=1860&z=?>

⁶⁰ Townsend p. 3.

Yonggom claim became the largest class action tort claim in Australian history.⁶¹ The court considered the case on the grounds of “negligence resulting in a loss of amenity.”⁶² The case was called a “landmark environmental case which set an international benchmark for mining operations in developing countries.”⁶³ An out of court settlement was reached in 1996.⁶⁴ It was a U.S. \$500 million settlement, to be paid to 34,000 people over the life of the mine.⁶⁵

BHP Billiton began to be deeply concerned about the scale and potential cost of the environmental liability it had created, and looked for an exit strategy to limit its further liabilities. But the government, alarmed at the potential loss of revenue from mine closure, worked to find a basis on which the mine could remain open.

Under Papua New Guinea’s Mining Act of 2000, BHP was allowed to surrender its interest in the mine in exchange for indemnification against future claims for losses due to pollution or environmental damage from the mine.⁶⁶ Thus, as in some of our other case studies, one of the changes was a much greater role for the state. BHP partnered with Papua New Guinea government and a Canadian company, Inmet Mining Corporation,⁶⁷ to mine the copper deposit.

Things changed again in 2001, again in favor of a greater state role. Ok Tedi’s huge environmental problems in the late 1990s prompted BHP Billiton to divest its shareholding to Ok Tedi Mining Limited (OTML) which is majority (52 per cent) owned by the Papua New Guinea Sustainable Development Program Limited. (PNGSDPL).⁶⁸ Inmet Mining Corporation has an 18 percent interest in the mine and the remaining 30 percent is owned by the government of Papua New Guinea. BHP no longer is an owner. The

⁶¹ Townsend p. 20.

⁶² *Id.*

⁶³ Forests.org. Harlyne Joku, *BHP Sued Again by Landowners*, The National, April 12, 2000, Available at <http://forests.org/archive/png/bhpsueag.htm>.

⁶⁴ Kirsch, Stuart. *Reverse Anthropology: Indigenous Analysis of Social and Environmental Relations in New Guinea*. (Stanford University Press, 2006) 21.

⁶⁵ *Id.*, 20.

⁶⁶ *Id.*

⁶⁷ The authors want to disclose that Mr. Danielson is a member of the Inmet Stakeholder Advisory Group.

⁶⁸ News.smh. Gridneff, Ilya. *PNG must plan for Ok Tedi mine closure*. June 2, 2009. Available at <http://news.smh.com.au/breaking-news-world/png-must-plan-for-ok-tedi-mine-closure-20090602-bu89.html>

Ok Tedi mine is currently the world's sixth-largest copper producer; its primary markets are in Asia and Europe.

In 2008, 70 percent of Ok Tedi's revenue was from copper and 30 percent was from gold. The mining company's 2008 Annual Review reports that the Ok Tedi mine produced U.S \$1.413 billion in revenue in 2008.⁶⁹ The mine's revenue amounted to 20 percent of Papua New Guinea's export earnings and 17 percent of GDP. Ok Tedi Mining Ltd. calls itself "the foremost contributor to the economy of Papua New Guinea."

In 2008, Inmet reported that 2,100 employees were working in the mine; more than 95 percent of these are Papua New Guineans and about one-third of the employees are from the Western Province and local areas.⁷⁰ In addition, businesses that work under contract to OTML employ approximately 1,500 people; the mine has also employed 600 staff as apprentices and provided training or education for over 3,000 people. Employee benefits at the mine include medical coverage, off-site housing assistance, educational assistance, personal travel and bonus schemes and training and development. The majority of the mine workforce is male (92.5 percent), and men control and use the vast majority of cash income derived from mining.

Yet the mining operation is not likely to continue indefinitely, especially in its present form: there is serious discussion that the current operations could end when the accessible ore is exhausted in 2013.

⁶⁹ See Ok Tedi Mining 2008 Annual Review, 6. Available at http://www.oktedi.com/images/stories/corporate_reports/otml%20annual%20review%2008%20e.pdf

⁷⁰ www.inmetmining.com. Inmet Mining Corporation. Ok Tedi,, Available at <http://www.inmetmining.com/default.aspx?SectionId=903bddd-37d5-4255-9032-e54bb68e0e9b&LanguageId=1>

Figure 11. Production. Targets and results. Source. Inmet Mining, Ok Tedi

	three months ended			six months ended			revised
	June 30			June 30			objective
(100 percent)	2009	2008	Change	2009	2008	change	2009
Tonnes of ore milled (000's)	5,400	5,400	-	10,500	10,400	+ 1%	23,300
Tonnes of ore milled per day	59,300	59,300	-	58,300	57,100	+ 1%	64,000
Strip ratio	1.9	1.5	+ 27%	1.7	1.7	-	1.5
Grades							
copper (percent)	0.8	0.9	- 11%	0.8	0.9	- 11%	0.8
gold							
(grams/tons)	1.1	1.0	+ 10%	1.1	1.0	+ 10%	1.1
Mill recoveries (percent)							
copper	86	87	- 1%	86	86	-	84
gold	71	74	- 4%	68	74	- 8%	68
Production							
copper (tons)	38,200	41,100	- 7%	75,100	78,400	- 4%	159,000
gold (ounces)	132,800	122,700	+ 8%	248,000	241,200	+ 3%	567,000
Cost per tons of ore milled (C\$)	\$23	\$22	+ 5%	\$24	\$22	+ 9%	\$26

C. Mine's impact on community

There are three key questions regarding the mine's impact on the community:

1. To what extent do the positive impacts -- economic benefits (employment, small business development, healthcare) balance other largely negative social impacts such as increased inequality, conflict, drinking, and prostitution,⁷¹ not to mention the ecological disaster to the Fly River? Inmet's Ok Tedi Sustainability Report for 2008 states that " the benefits of delivery of healthcare, education and employment, as well as dividends to national and local beneficiaries in Papua New Guinea offset the mine's negative environmental and social impacts and provide

⁷¹ Townsend p.8.

investment in projects to help achieve a sustainable future for local residents and PNG as whole.”⁷² The question is how we construct a calculus to test this assertion rigorously.

2. Second, to what extent are the negatives truly unavoidable? Would it be possible to obtain the positives without the negatives, or at least without so many of them?
3. Finally – and here is the focus of this paper – how can we call this a balance if most of the benefits are transitory and many of the negatives will last for centuries? If there is no ‘exit strategy’ from the current situation, and no plan that can maintain some of the benefits achieved, this project cannot be considered a success.

The impact on the Fly River will be very long term. For almost two decades, the mine has discharged about 30 million tons of metal-tainted mine tailings and 40 million tons of waste rock per year directly into the Ok Tedi River, which in turn discharges most of this load into the Fly River. The Fly River flows through dense primary tropical rain forest, wetlands, and savanna before it reaches the Gulf of Papua in the Torres Straits.

The original plan was to contain these tailings in a tailings impoundment, something difficult to achieve in an area with eight meters of annual rainfall. The original Environmental Impact Study for the mine had called for a tailings containment dam in the mountains,⁷³ which is the typical solution to tailings containment in most of the world.⁷⁴ During construction, a landslide in the area where the dam was to be built caused Ok Tedi Mining Ltd. to change its plans.⁷⁵ The problems with the dam construction threatened to delay the date that the mine would generate revenue; government was already counting on the revenue to an extent that it could not compass a delay in getting paid. When the company sought

⁷² Inmet Mining. Ok Tedi Sustainability Report, 2008.
http://www.inmetmining.com/Theme/Inmet/files/pdf/2007_Sustainability%20Report_Ok%20Tedi.pdf

⁷³ Kirsch, 2006, p. 15.

⁷⁴ Molloy, Fran, “BHP Abandoning Ok Tedi – PNG to clean up”, REPORTAGE, October 3, 2001. Available at <http://www.reportage.uts.edu.au/news-detail.cfm?ItemId=12356>.

⁷⁵ Id.

a temporary delay in building the dam,⁷⁶ the government agreed and permitted the company temporarily to dispose of tailings into the Ok Tedi River.⁷⁷

In 1988, another Papua New Guinea mine, Panguna, closed.⁷⁸ Panguna was Papua New Guinea's largest private employer and produced 45 percent of PNG's earnings for export.⁷⁹ Closure of Panguna mine put yet more pressure on the government to keep Ok Tedi mine open.⁸⁰ A further landslide in the area bolstered the mining company's argument that geological instability would prevent construction of a tailings containment facility.⁸¹ As a result the government has allowed Ok Tedi to dispose of tailings in the river⁸² to this day.⁸³ The practice of "riverine tailings disposal" has become a rallying point for environmental advocates largely as a result of Ok Tedi, and the leading industry organization, the International Council on Mining and Metals, has issued a declaration to the effect that member companies will not engage in the practice in the future.⁸⁴

⁷⁶ Id

⁷⁷ Id.

⁷⁸ Rannells p. 97.

⁷⁹ Id.

⁸⁰ Kirsch, 2006, p.15.

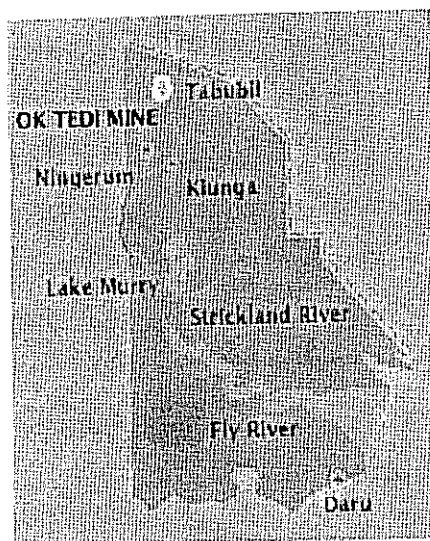
⁸¹ Colin Filer, "West Side Story: the state's and other stakes in the Ok Tedi mine", in Glenn Banks and Chris Ballard (eds) *THE OK TEDI SETTLEMENT: ISSUES, OUTCOMES AND IMPLICATIONS*, (Australian National University, National Centre for Development Studies, 1997), 60.

⁸² For further discussion on Ok Tedi river disposal see *Breaking New Ground: Mining Minerals and the Environment* at <http://www.iied.org/pubs/pdfs/G00902.pdf>

⁸³ Kirsch, 2006, p. 15.

⁸⁴ See International Council on Mining and Metals website (www.icmm.com) for "ICMM Toronto Declaration: Goals and Implementation Process."

Figure 12. Map of Fly River and Ok Tedi River.



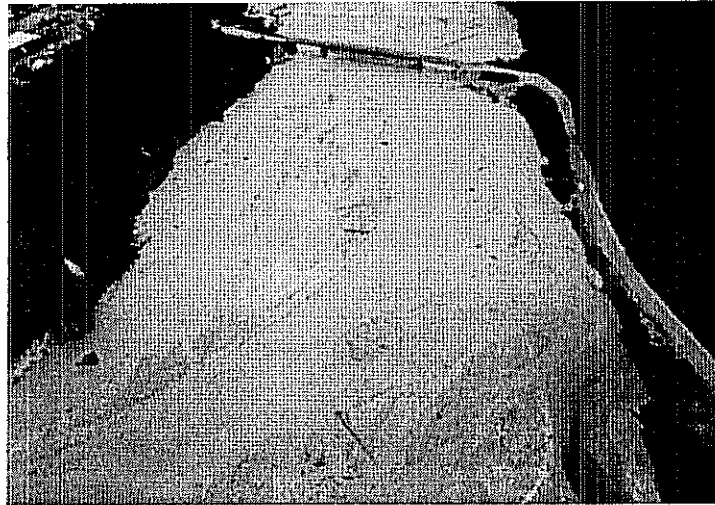
1. Ecological Impact

For the Yonggom people and their neighbors living along the lower Ok Tedi and Fly rivers, the mine's ecological impact shattered a centuries-old way of life. An anthropologist working with the Wopkaimin people described the mine waste's impact on local wildlife and people as "ecocide."⁸⁵ By the early 1990s, fish were dying, turtles disappearing, and canoes running aground midstream as sedimentation raised river beds. The overflow destroyed food gardens in downstream indigenous communities and killed thousands of trees; the damage to their sago trees caused a decline in productivity. When the mine closes an acid pit lake will be formed.⁸⁶

⁸⁵ World Resources Institute p 2.

⁸⁶ Cultural Survival.org. Kirsch, Stuart. *Litigating Ok Tedi (Again)*. Melanesia: The Future of Tradition. 2002, Available at <http://www.culturalsurvival.org/ourpublications/csq/article/litigating-ok-tedi-again>

Figure 13. Polluted Ok Tedi River



The effects on the Ok Tedi River will last at least another 60 years and the effects on the Middle Fly River may last hundreds of years.

Figure 14. Dying Sago Tree and Ok Tedi River



However, some indigenous communities assume that cessation of mining will relatively quickly produce a return to pre-mining conditions.⁸⁷

D. Mine Closure

Ok Tedi mine is expected to close around mid to late 2013 when accessible ore is exhausted. There is a possibility of the mine life extending for a number of years beyond 2013, either through continued open pit mining, or underground mining, though underground mining seems to raise some very difficult questions in an area with this much rainfall and instability. The government of Papua New Guinea will

⁸⁷ Townsend p. 7.

undoubtedly want to keep the mine open as long as possible because, as in the preceding Cerro de Pasco case study, there are no adequate resources to deal with the economic and social issues that closure will create. How long the mine can be kept in operation, and at what cost in environmental impact and worker safety, will depend on a range of factors including the reserves, mineral prices, geologic conditions, and operating costs.

Mine closure will have a major impact on the Papua New Guinea economy as a whole. Closure will significantly reduce the value of mineral production and the value of goods and services provided to the mining sector. Closure will result in a substantial reduction in Gross Domestic Product, exports, foreign exchange earnings and government revenue.⁸⁸

OTML developed the Mine Closure Plan and sustainability development program. OTML has, or is in the process of, initiating a number of programs aiming to prepare their staff for mine closure. Almost 50 percent of the staff is expected to be approaching retirement age by 2012/13, which means many employees will retire to towns or villages in their home provinces. Others will seek employment with other mines or in other industries. OTML aims to offer a high level of assistance to its staff during the mine closure process, to help ensure the successful repatriation of staff and successful transition to life after Ok Tedi.

The range of programs to assist employees in preparation for mine closure includes:⁸⁹

- A grant of agricultural equipment, planting materials, and livelihood training;
- Retirement counseling;
- Personal Viability Training;
- A Home Ownership Scheme, which is essentially a one-off tax free grant for purchasing, building, renovating or equipping a house that is to be the employee's main residence; and
- A wide range of training programs for staff, the spouse (husband or wife) and children, including for example, basic carpentry and bricklaying, motor mechanics, bookkeeping, the installation and maintenance of solar powered systems, and computing.

PNG government is involved in planning for mine closure. Training of local workers is required by Papua New Guinea law. After the mine closes, OTML plans to have Star Mountains Training Institute take over its training facilities to continue to provide training to local citizens.⁹⁰ As OTML's largest shareholder, PNGSDPL will play an important role in minimizing the dislocation caused by mine closure in the Western

⁸⁸ Ok Tedi Annual Review, p.8.

⁸⁹ Id. p.42.

⁹⁰ Id. p.37.

Province and in promoting sustainable development.⁹¹ But the possibility of a 'soft landing' for the local economy seems remote.

1. Community Foundation

The Ok Tedi Development Foundation assists in community and regional development in the areas of "Economic Programs," and "Rubber, Rural, Ecotourism, and Community Development Programs." OTDF was registered as a company in April 2002 and was established to "ensure that in the lead up to mine closure, impact area communities, the government and the company remain focused on managing the social and economic opportunities and risks associated with the remaining community and government benefit streams."⁹² It provides agricultural starter stock, schools, sewing machines, outboard motors, job training, small business assistance, special projects for women, and assistance to farmers and a variety of other needed and desired services after the mine closure.⁹³

E. Mine Closure and the Community

While many local people have benefited in terms of improved health, as measured by increased life expectancy, it is unlikely that their current lifestyles will be sustainable following mine closure. With the cessation of mining, most household incomes will be significantly reduced, and there will be increased reliance on subsistence production to supplement livelihoods. This is likely to affect women disproportionately, as they are the principal providers of subsistence food. A transition back to a subsistence lifestyle will be particularly difficult, as the Tabubil area is not well suited to agriculture, and the younger population will have few subsistence skills. The mine area communities have not invested in the education of their children,⁹⁴ and future employment opportunities will be limited. There is a high potential for the younger population to migrate to other provinces, leaving behind an elderly population.

⁹¹See PNG Sustainable Development Program at <http://www.pngsdp.com/>

⁹² Ok Tedi Social and Economic Report, p. 45.

⁹³ Eye of the storm leadership.com. Adler, Brewer and McGee. The Ok Tedi Negotiations. The Keystone Center. August 2007. Available at <http://www.eyeofthestormleadership.com/docs/The%20Ok%20Tedi%20Negotiations-TKC-08-24-07.pdf>

⁹⁴ Ok Tedi Social and Economic Report p. 14.

It also appears that the mine area communities have allocated a relatively small proportion of their income to financial investments. It is therefore unlikely that their financial investments alone will sustain their existing cash-based lifestyle beyond mine closure.

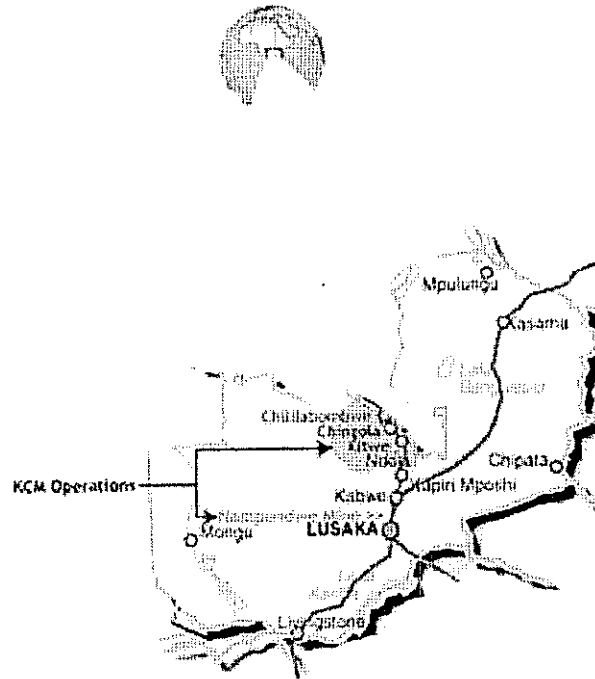
Mining has transformed the lives of the people in the mine area from a traditional way of life to a more modern lifestyle. Modernization has come quickly and in many unexpected ways and it has been a huge challenge to cope with the changes. Most people seem to have accepted the changes and are moving forward with their lives, but they are now confronted with the impending mine closure, which will be a transition that may be almost as much of a shock as was the mine opening.

Residents of the mine-area community have become almost entirely dependent on the mine for their livelihoods, which makes them vulnerable to the impacts of mine closure. It is generally assumed that they will not be able to maintain their current lifestyle or continue to reap economic gains as they have during the life of the mine.

V. KONKOLA, ZAMBIA

Case Study

Figure 15. KCM operations



A. Community

The Konkola mine is

located in the town of

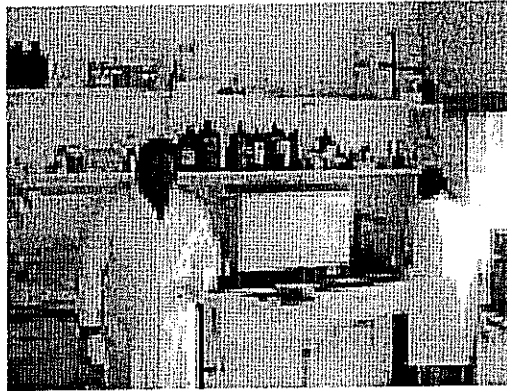
Chililabombwe in the Copperbelt province of Zambia, lying very close to the border with the Democratic Republic of Congo (DRC) and approximately 500km north of Lusaka. Its main copper mine, the Bancroft Mine, was opened in 1957.⁹⁵The town has a population of over 90,000 with most of the socio-economic activity related to the mines in one way or the other. Mine closure would have a huge impact on the city as a whole. Other economic activities are agriculture, transportation and healthcare. Although the eventual development of vast copper reserves in the Konkola Deep Mining Project (KDMP) is expected to create 5000 construction-related jobs, this will also create negative impacts. It will lead to the influx of a large number of job seekers and contractors into the town, which will put a significant strain on already overstretched service. Once construction is completed the labor force required to operate the Konkola mine will drop from 4,300 to about 3,900. It is anticipated that there will be an increase in crime,

⁹⁵Chililabombwe, Zambia. Encyclopædia Britannica Online. September 2009. Available at <http://www.britannica.com/EBchecked/topic/111476/Chililabombwe>

increased health risks (especially AIDS and malaria), an increase in rentals in existing townships and the spread of informal settlement.⁹⁶

1. Malaria

Figure 16. KCM hospital in Chililabombwe



In Zambia, malaria is found in all areas of the country. Malaria is endemic to Zambia and is the leading cause of morbidity and mortality.⁹⁷ In 2000, KCM launched a malaria spraying program to reduce the burden of disease on KCM employees and on community members.⁹⁸ The program achieved a 52 percent reduction in malaria hospital cases in the 2001 calendar year and continued to show sustained reductions in cases in 2002.⁹⁹ There have been no reported deaths in Chingola and Chililabombwe due to malaria since 2002.¹⁰⁰

KCM owns and operates two hospitals and seven clinics. Their malaria control program reduced malaria cases by more than 50 percent. The mine health facilities provide free healthcare to all employees of KCM and their dependents. Others who can afford \$100/day rate also use this hospital.¹⁰¹

In towns like Nchanga and Konkola there are no government hospitals and non-mine employees and their dependents rely on mine hospitals for access to medical services.

⁹⁶ Mines and Communities.org. Feeney, Patricia, *The Limitations of Corporate Social Responsibility on Zambia's Copperbelt*, Oxfam 2001. Available at <http://www.minesandcommunities.org/article.php?a=244>

⁹⁷ Konkola Copper Mines plc *Malaria Vector Control Programme in Chillilabombwe and Chingola technical Report*, 2001. Available at www.weforum.org/globalhealth/cases.

⁹⁸ World Economic Forum. *Malaria Konkola Case Study*, 2002 Available at www.weforum.org/globalhealth/cases.

⁹⁹ *Id.*

¹⁰⁰ Konkola Copper Mines Plc. *Community Support*. 2006. Available at http://www.kcm.co.zm/community_support.php

¹⁰¹ Hutto, Texas-Chillilabombwe, Zambia. 2008. Available at <http://www.huttozambia.com/>

The two hospitals, the Nchanga South Hospital in Chingola and the Konkola Mine Hospital in Chililabombwe, rank among the best in Southern Africa and offer health care services of the highest quality to its employees and the general public.¹⁰²

B. Mine (copper)

1. Konkola Copper Mines (KCM)

Konkola Copper Mines Plc (KCM) is the largest mining and metals company in Zambia with capacity of 200,000 metric tons of copper per year. Zambia is Africa's largest copper producer and the copper mines are its major employer and economic mainstay.¹⁰³ Copper is Zambia's most important industry and represents 56 percent of national export earnings. But Zambia remains one of the world's poorest countries.¹⁰⁴

KCM's main business is copper mining, but it also has a pyrite mine and contract manages a smelting and refinery operation. KCM is a fully integrated copper producer operating underground and open pit mines as well as metallurgical plants with operations being located at Nchanga in Chingola, Konkola in Chililabombwe, Nkana in Kitwe and Nampundwe near Lusaka. KCM is the largest private sector employer in Zambia, with over 11,000 fulltime employees and an additional 7,000 working for its contractors.

Before the nationalization of the mines in the 1970's and 1980s, private foreign investors, Anglo American Corporation and Roan Selection Trust owned the mines. The properties were nationalized in 1981 and operated by Zambia Consolidated Copper Mines, a Zambian state company.¹⁰⁵

Thus, as in the previous case studies of Cerro de Pasco and Ok Tedi, what started as a mine privately owned by foreign investors became state owned. As in the case of Cerro de Pasco, there was an attempt to reprivatize the project, though in this case it was not very successful. In 1998, Anglo American Corporation took over the Nchanga, Nkana and Konkola mines together with 51 percent shares in KCM.

¹⁰² Id.

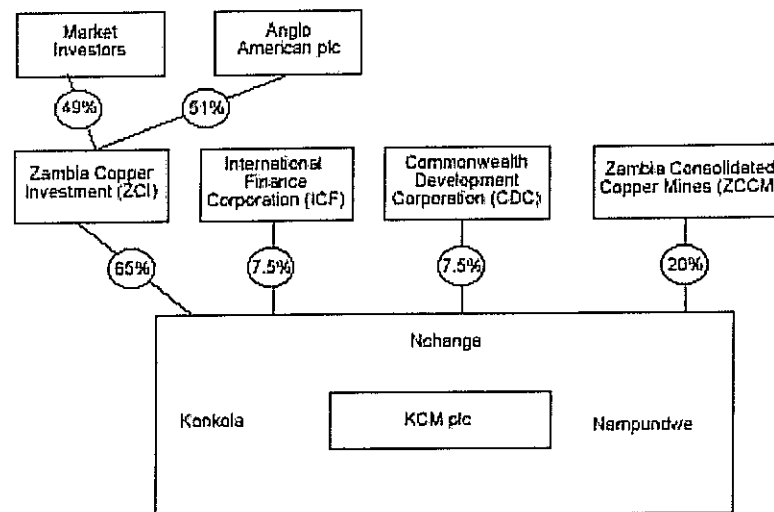
¹⁰³ *Zambian Chronicle. Konkola Mine Plans to purchase Congo Copper.* 2009. Available at <http://zambianchronicle.com/?p=3069>

¹⁰⁴ *Mining Weekly.com. Zambia Remains One of the Poorest Countries despite Mineral Wealth.* September 11, 2009. Available at <http://www.miningweekly.com/article/projects-overview-in-zambia-2009-09-11>

¹⁰⁵ *Konkola Copper Mines Plc. Our History.* 2006. Available at <http://www.kcm.co.zm/history.php>

¹⁰⁶ But in 2002 weak copper prices and unprofitable operations drove Anglo to decide against further investment in the Konkola Deep Mining Project. In 2004, Vedanta Resources took over Anglo's share and the new shareholding structure of KCM as follows: Vedanta (51 percent), Zambia Consolidation Copper Mines (ZCCM) Investment Holdings (20.6 percent) and Zambia Copper Investments (28.4 percent).¹⁰⁷ This development has opened the way for KCM to gain access to new capital and technical assistance.

Figure 17. KCM ownership



2. Konkola Mine

The mining operations currently exploit the Kirilabombwe ore body by underground methods and are focused on two existing shaft systems called the No. 1 shaft and No. 3 shaft. Konkola No.3 shaft is the most northerly shaft of the operations owned by Konkola Copper Mines Plc in the rich Copperbelt Province of Zambia; mining operations in No. 3 shaft started in the late 1930's.¹⁰⁸

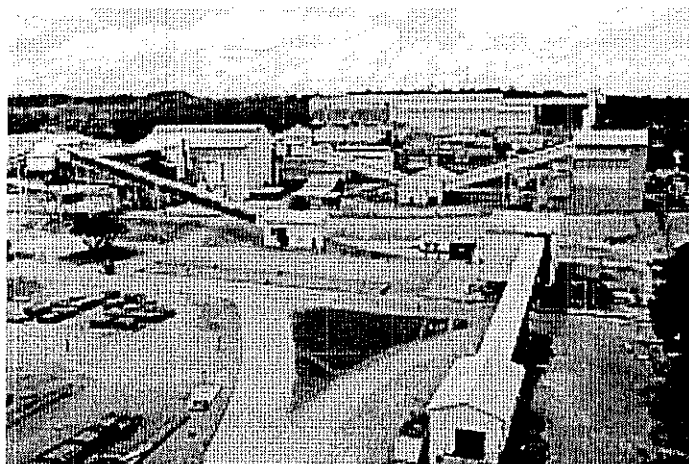
¹⁰⁶ McNeil, Donald. *Zambia announces deal to sell copper mines*. New York Times. December 21, 1996. <http://www.nytimes.com/1998/12/21/world/zambia-announces-deal-to-sell-copper-mines.html>

¹⁰⁷ Mutunweno, Nawa. *Brighter Days for Konkola Copper Mines*. Mining Review Africa. Issue 3, 2006.

¹⁰⁸ Basemetals.org. Lipalile, Naismith, Tunono. *Geotechnical Considerations in the Resign of MOCB Mining Method at Konkola No. 3 Shaft*. Available at http://www.basemetals.org/Kitwe2005/235-252_Lipalile.pdf

Konkola is famous as the wettest mine in the world¹⁰⁹ and the mining operations are constrained by the necessity to de-water from both hanging wall and footwall aquifers at an overall pumping rate of 300,000m³ per day.¹¹⁰

Figure 18. Konkola mine



Konkola mine has deep ore bodies that in some estimates could last 100 years but it will cost more than \$600 million to get to them.¹¹¹ KCM decided to invest in a mine expansion project in order to prevent, or at least delay, mine closure, which seemed imminent. While earlier attempts to access investment capital failed, and it seemed closure might actually occur, a crisis has been staved off at least for the immediate future.¹¹²

The key project underway is the US\$400 million Konkola Deep Mining Project (KDMP) which is aimed at deepening the Konkola mine in Chililabombwe to access the deep, rich ore. This supposedly contains 250 million tons of copper ore at 4 percent contained copper. Its cost of \$400 million makes KDMP the largest single investment in the history of Zambian mining, and could increase the life of the mine for an

¹⁰⁹ Infomine.com. Konkola goes deep. International Mining. February 2007. Available at <http://www.infomine.com/publications/docs/InternationalMining/Chadwick2007f.pdf>

¹¹⁰ KCM at Glance. Available at <http://www.kcm.co.zm/>

¹¹¹ McNeil p 1.

¹¹² Zambian Chronicle.com Shacinda, Shapi. *Konkola Mine plans to purchase Congo copper*. Jan 07, 2009. Available at <http://zambianchronicle.com/?p=3069>

additional 22 years.¹¹³ With the KDMP project KCM has a vision of increasing production to up to 500,000 tons annually.

As in our previous case studies, there are significant health problems from environmental damage. KCM has been involved in serious incidents in environmental mismanagement that have compromised the health of local people. The discharge of heavy metal effluents seriously pollutes the river water and excess sulphur dioxide emissions from smelter create acid rain that damages the river.¹¹⁴ The Kafue River, part of the Zambezi basin, is a source of potable water for over forty percent of Zambia's population. It is also host to wildlife and birds.¹¹⁵ In 2007, KCM overlooked pollution control measures and caused widespread water pollution when its acidic effluent entered the Kafue River. Hundreds of people felt sick after eating fish poisoned by the polluted water; farmer's crops withered and died after being irrigated with water from the river.¹¹⁶ As a local environmentalist noted, "The only crops that survived are mangos, avocados and cactus. With low salaries, people can't buy food. But they can't grow their own vegetables either."¹¹⁷ Moreover, aquatic life is diminishing because of high level of pollution and cattle losses have been reported due to consuming copper-rich sediments from the river.¹¹⁸

High incidences of environmentally related diseases, such as gastro-enteritis, intestinal worms, and diarrhea diseases or skin irritations and swelling of eyes mostly in children have been reported from communities around the river and have been linked to drinking water from certain parts of the river. Toxicity through inhalation may result in 'manganism" which is a disease of the central nervous system involving psychic and neurological disorders. The symptoms of manganism resemble Parkinson's disease symptoms.¹¹⁹ The raw sewer pollution of Kafue River could inadvertently lead to outbreaks of epidemics like cholera.¹²⁰

¹¹³ KCM at Glance p 2.

¹¹⁴ Konkola Copper Mines. Zambia. Issues. Available at http://www.banktrack.org/show/dodgydeals/konkola_copper_mines

¹¹⁵ See Advocacy and Restoration of the Environment at <http://www.blacksmithinstitute.org/projects/display/17>

¹¹⁶ Africa.com. *Mining Companies Accused of Environmental Negligence*. January 8, 2008. Available at <http://allafrica.com/stories/200801080713.html>

¹¹⁷ banktrack.org

¹¹⁸ ¹¹⁸ See Pollution of the Kafue River by Konkola Copper Mines. Available at <http://pencoedkabundilink.wordpress.com/2006/11/28/pollution-of-the-kafue-river-by-konkola-copper-mines-2>

¹¹⁹ See Manganism at <http://www.healthdangers.com/toxic-substances/welding-fumes/index.htm>

¹²⁰ Blacksmith institute

Under Zambian law, environmental management is a vital component of mining and all mining firms are obliged to prepare detailed environmental impact assessments, indicating how they will mitigate environmental problems such as air and water pollution.¹²¹ Companies face prosecution, fines or the withdrawal of their operating licenses if they do not fulfill the environmental obligation.

KCM had its operating license suspended for 10 days after the water pollution episode in 2007, and was instructed to install new environmental safety measures. The company reportedly lost \$26 million during the suspension period.¹²²

C. Potential for Closure and Closure Planning

A few years ago, closure of this operation appeared imminent. The government company's inability to access capital or interest outside investors, together with significant environmental issues, made it look as if the project would have to close. The withdrawal of Anglo American seemed it might be the end of the line.

While restructuring, support from the World Bank, and access to capital may have averted an immediate crisis, the potential for closure still exists, and the question remains what planning exists for a transition to post-mining or even reduced mining economy. As in the previous case studies, it is hard to imagine in what form or at what social price the local community or the national government could survive the consequences of a closure.

The Zambian government, aware of the damage that mine closure will cause the country's economy, has embarked on an ambitious program to shift the focus from copper to agriculture.¹²³ One of the projects identified in the pilot project for diversifying the economy is fish farming and miners are being taught how to get into fish farming. "We have realized that copper is a perishable asset and hence the need to develop agriculture as an alternative to mining," said Jean Phiri, a district administrator of Chingola.¹²⁴

¹²¹ All Africa.com

¹²² *Id.*

¹²³ ¹²³ Uncertain Future for Konkola. Mail & Guardian online. Jan 1, 2002. Available at <http://www.mg.co.za/article/2002-01-01-uncertain-future-for-konkola>

¹²⁴ *Id.*

VI. EL CHINO, NEW MEXICO

Case Study

Figure 19. El Chino mine, New Mexico



A. Community

1. Santa Rita (a site of today's mine and yesterday's town)¹²⁵

Figure 20. Santa Rita in 1919 with mine in background¹²⁶



When Santa Rita mine was converted to an open pit in 1901, the pit quickly overtook the town. The town was forced to move several times as the pit grew bigger. Shortly after the town relocated in 1957, heavy rains washed boulders and mud into the new townsite. It was abandoned in 1967, and the school system for the area was discontinued in 1972. The population of Santa Rita was about 500 in 1884; by 1915 it was 2,500 and by 1920 had reached 6,000.¹²⁷ It remained at 6,000 until significant layoffs at the mine started in the 1950s. Now Santa Rita is a ghost mining town.

¹²⁵ Sinclair, John. *Santa Rita- the town that vanished into thin air*. March 17, 2003. Available at <http://www.southernnewmexico.com/Articles/Southwest/Grant/SantaRita-TheTownThatVani.html>.

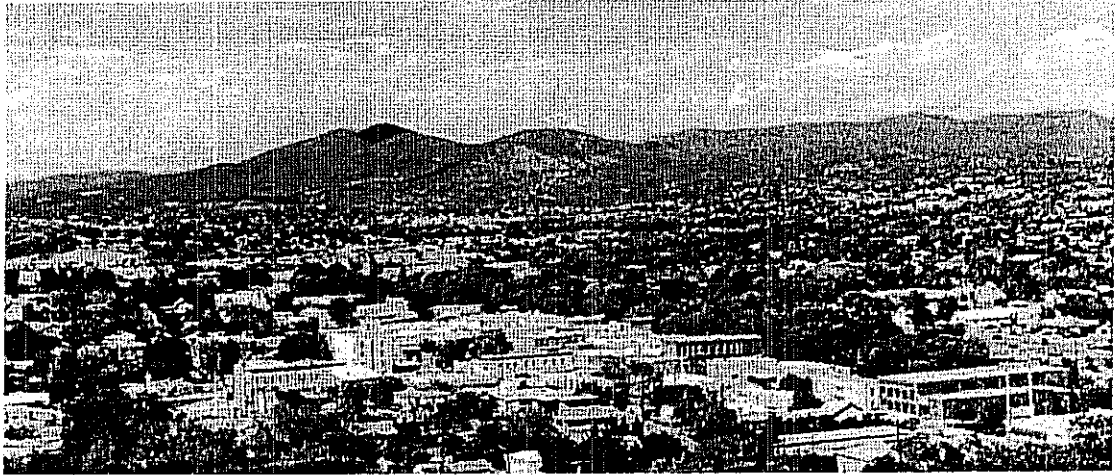
Mr .Danielson's father was born in Santa Rita when his grandfather was the mine doctor at Chino.

¹²⁶ Source http://en.wikipedia.org/wiki/Santa_Rita,_New_Mexico

¹²⁷ Id.

2. Silver City

Figure 21. Silver City, New Mexico



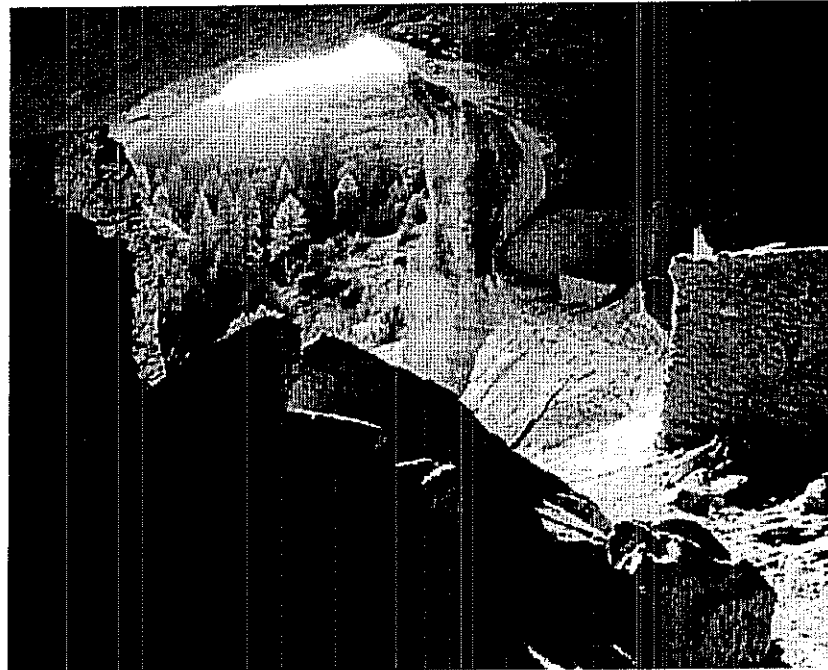
This case study differs from the preceding case studies in several ways. The mine is not set in a poor developing country, but in one of the wealthiest countries in the world, the United States. While loss of tax revenues resulting from closure of Chino is not going to have an overwhelming impact on national government revenues, closure is still a serious economic and social issue at the local and regional levels. Silver City was founded as a mining town in the summer of 1870, shortly after the discovery of silver ore deposits.¹²⁸ The silver industry crashed in 1893 but at the same time the town was becoming a haven for tuberculosis patients - Billy the Kid's mother among them - because of the desert air and healing hot springs. (Billy himself passed some of his youth in Silver City.) By the 1900s, TB patients flocked to Silver City en masse. After 1910, large-scale copper mining began, and that continues to be the basis of the economy, making Silver City a place where miners, artists, ranchers and extreme sports types mix easily.¹²⁹ Nowadays, Silver City has a population of 10,329¹³⁰ and it is a popular tourist and retirement town because of its climate and nearby Gila Wilderness, which offers many outdoor and recreational opportunities.

¹²⁸ Silver City.org. *Silver City, New Mexico*. Available at <http://www.silvercity.org/>

¹²⁹ Finn, Maria. *36 hrs in Silver City*. January 13, 2006. Available at <http://travel2.nytimes.com/2006/01/13/travel/escapes/13hour.html>

¹³⁰ See US Population Projects at <http://www.census.gov/population/www/>

Figure 22. Gila Cliff Dwellings National Monument.¹³¹



Besides mining there are other economic activities in Silver City such as tourism or education; Western New Mexico University is situated at the heart of Silver City and offers a range of associate, bachelor and graduate degree programs and non-degree study options.¹³²

Figure 23. The most common Silver City occupations for males and females¹³³

#	INDUSTRY (males)	%	INDUSTRY (females)	%
1.	Mining	14	Educational Services	23
2.	Construction	11	Health Care	17
3.	Educational Services	10	Social Assistance	9
4.	Accommodation and	7	Accommodation and food services	8

¹³¹ <http://www.destination360.com/north-america/us/new-mexico/images/s/gila-cliff-dwellings.jpg>

¹³² Silver City.org. A Guide to Educational Resources. Available at http://www.silvercity.org/resource_education.shtml

¹³³ City-data.com. *Silver City, New Mexico*. Available at <http://www.city-data.com/city/Silver-City-New-Mexico.html>

	food services			
5.	Public Administration	6	Department and other general merchandise stores	4
6.	Repair and Maintenance	4	Public Administration	4
7.	Health Care	4	Administrative and support and waste management services	3

The nearby mining operations are still the most important single pillar of the local economy. The Chino mine is located approximately ten miles east of Silver City; Tyrone mine is located ten miles south of Silver City. Although the Chino mining operations have been suspended, the Tyrone mine is still operating.

On city-data.com¹³⁴ forum users discussed the pros and cons of living in Silver City. While many agreed that Silver City is a friendly town, some expressed concern about the pollution-- particularly air pollution -- allegedly caused by mining operations:

"Air pollution would be one of my biggest concerns. At 6,000 ft. elevation, the air feels clean and dry. But according to the government scorecard, a mine at Tyrone is in the country's top 30 for toxic emissions. More than two and a half million pounds of copper compounds and nearly half a million pounds of lead compounds were pumped into Grant County's atmosphere to be breathed in by residents of the Silver City area. I'm sure those that live there do not see or feel anything wrong with the air, but it's something to be aware of."¹³⁵

¹³⁴ Stats, data and profiles of US cities.

¹³⁵ See the discussion on Silver City at <http://www.city-data.com/forum/new-mexico/7948-silver-city.html>

3. Hurley

Figure 24. Hurley, New Mexico¹³⁶



Hurley, located about 14 miles southeast of Silver City, was established as a company mining town and now is transforming into a quaint retirement community with an estimated population of 1,400 residents. Hurley's economic base is diversifying with its close proximity to Silver City.

Figure 25. The most common Hurley occupations for males and females¹³⁷

#	INDUSTRY (males)	%	INDUSTRY (females)	%
1.	Mining	28	Healthcare	17
2.	Construction	14	Educational Services	15
3.	Educational Services	7	Accommodation and Food Services	15
4.	Public	5	Social Assistance	6

¹³⁶ http://farm1.static.flickr.com/210/465494087_7af913545b.jpg?v=0

¹³⁷ City-Data.com. Hurley, New Mexico. Available at <http://www.city-data.com/city/Hurley-New-Mexico.html>

	Administration			
5.	Motor Vehicle and parts dealers	4	Department and other general merchandise stores	6
6.	Administrative and Support and waste management services	4	Food and Beverage Stores	5
7.	Healthcare	4	Finance and Insurance	5

Those families who have depended on mining to provide a good living over the years must find other jobs or leave the area.

B. Mine

El Chino is an open-pit copper mine located near Silver City, New Mexico. Its early origins date back to the 1500s when Apaches, Spaniards, Mexicans, and Americans obtained native copper and copper ore from this site, but it was not commercially mined until the 19th century. At that point, it was a tunnel mine known as Santa Rita and was operated by the Spaniards. Mexico abandoned the mine in 1837.¹³⁸ The modern mine is the third oldest open pit copper mine in the world after the Bingham Canyon Mine and Chuquicamata.¹³⁹ It is almost 1,500 feet deep and 1.5 miles across. El Chino was not always an open-pit operation. A few New York investors acquired the mine in 1900 and established Santa Rita Mining Company. Meanwhile an engineer, John M. Sully, surveyed the area and discovered the land actually held millions of tons of ore with low-grade copper. His conclusion was that the mine was a "bonanza" for anyone willing to finance a long-term commitment. It took him five years to find financial support. In 1909, Chino Copper Company was established and digging began in 1910. It was at this point

¹³⁸ Ritchiewiki.com. *El Chino mine*. Available at http://www.ritchiewiki.com/wiki/index.php/El_Chino_Mine

¹³⁹ Absolute Astronomy.com. *El Chino Mine*. Available at http://www.absoluteastronomy.com/topics/El_Chino_Mine

that Santa Rita mine became an open-pit operation, and was renamed El Chino after one of the many mines within Santa Rita.¹⁴⁰

Digging began in 1910 and a processing facility (mill) was opened a year later in the nearby town of Hurley. In 1937 Chino Copper Company sold El Chino to Kennecott Corporation which operated the mine until 1980. During this time, a smelter was built, making El Chino a fully integrated copper mine and processing center. The smelter in Hurley was modernized in 1985 to increase capacity and achieve compliance with the Clean Air Act. In 2005, the smelter was permanently closed.

Kennecott sold one-third of the company to Mitsubishi Corporation in 1980, and the remaining two-thirds to Phelps Dodge in 1987. El Chino is now owned and operated by Freeport-McMoRan Copper & Gold who acquired the mine's previous owner Phelps Dodge in March 2007. Freeport is the second largest producer of copper in the world and the world's largest producer of molybdenum and molybdenum based chemicals; it produces about 8 percent of the copper and 20 percent of the molybdenum used globally each year.¹⁴¹

In 2001, a period of low copper prices, milling operations at the main concentrator were put on hiatus for three years. During this hiatus, Phelps Dodge reached a tentative deal with environmental officials for the closure and reclamation plan for El Chino. The plan required Phelps Dodge to construct and maintain a comprehensive remediation system to remove toxic chemicals from the groundwater for the next 100 years. It must cover and revegetate certain tailings piles associated with the mine.¹⁴² Phelps Dodge was also required to post a \$375 million bond with the state, to guarantee performance. This plan was originally approved in December 2003; however, some environmental groups protested against some of the specifics of the plan. Gila Resources Information Project (GRIP) opposed the cleanup plan because it required 9,000 acre-feet (1,110 ha m) of groundwater per year to dilute the contaminated wastewater. GRIP demanded that Phelps Dodge use a more effective treatment technology. On June 27, 2008, GRIP won its fight against Phelps Dodge's water treatment plan. Freeport-McMoRan, the successor to Phelps

¹⁴⁰ Ritchiewiki

¹⁴¹FCX.com. Freeport-McMoRan Copper & Gold, Inc. *Form K*. Available at http://www.fcx.com/ir/downloads/FCX2008_10K.pdf

¹⁴² Infomine.com. Chino Mine Site. December 21, 2005. Available at <http://www.infomine.com/minesite/minesite.asp?site=chino>

Dodge, is now "required to use an advanced form of reverse osmosis to remove metals and sulfates from the wastewater it will produce for hundreds of years after mining stops at the site."¹⁴³

C. Mine Closure

With the decision to construct a concentrate-leach, direct-electro-winning facility at the Morenci copper mine in 2005, the company reassessed its operating capacity, flexibilities, efficiencies and costs, which resulted in the permanent closure of the Chino smelter.¹⁴⁴ The closure of the Chino smelter resulted in an asset impairment charge of \$89.6 million (\$68.6 million after-tax) in the 2005 second quarter.¹⁴⁵ On December 4, 2008 Freeport announced a planned suspension of mining and milling activities at the Chino mine due to poor market conditions and the revised operating plans. The concentrator is being held on a care and maintenance status. The mine will continue reclamation activities and copper production from its SX-EW plant. On December 31, 2008, Freeport had accrued reclamation and closure costs of \$372 million for its New Mexico operations.¹⁴⁶

Figure 26. El Chino. Mined Copper (millions of recoverable pounds of copper at the end of December 31)

Source. Freeport-McMoRan and Gold Inc.

2004	2005	2006	2007	2008
183	201	186	190	155

About 600 from the current work force of 830 were laid off at the beginning of 2009.¹⁴⁷

New Mexico Environmental and Reclamation Programs

Freeport's New Mexico operations are subject to regulation under the New Mexico Water Quality Act and the Water Quality Control Commission (WQCC) regulations adopted under that Act. The New Mexico Environment Department (NMED) has required each of these operations to submit closure plans for NMED's approval. The closure plans must include measures to assure meeting groundwater quality

¹⁴³ Freeport McMoRan Copper and Gold. "Mining Reclamation in New Mexico." Available at <http://www.fcx.com/envir>

¹⁴⁴ Infomine.com Chino Mine Mining Property in the USA. Available at http://www.infomine.com/index/properties/CHINO_MINE.html

¹⁴⁵ Id.

¹⁴⁶ Freeport-McMoRan Copper & Gold, Inc. Form K. 2008.

¹⁴⁷ Infomine, Chino Mine Site, 2005.

standards following the closure of discharging facilities and to abate any groundwater or surface water contamination.¹⁴⁸

Freeport's New Mexico operations also are subject to regulation under the New Mexico Mining Act which was enacted in 1993, and the Mining Act rules, which are administered by the Mining Minerals Division (MMD).¹⁴⁹ Under the Mining Act, mines are required to submit and obtain approval of closeout plans describing the reclamation to be performed following cessation of mining operations at all or a portion of the mines. New Mexico Mining Act requires mining companies that upon closure they restore mine sites to "self sustaining ecosystem compatible with the surrounding environment."

The pertinent question here is how the closure of these facilities will impact the economic and social conditions in surrounding communities. There seems no doubt that there will be major losses in payroll, and in local tax collection. Reportedly, there are a variety of efforts in local communities to plan for a post-mining future, but there is considerable conflict among competing organizations with differing agendas, that has preventing a clear plan from emerging. There is some diversity in the local economy, and there is some ability of displaced workers to relocate and seek work elsewhere.

¹⁴⁸ Freeport's New Mexico Mining Reclamation

¹⁴⁹ Id.

VII. EL SALVADOR, CHILE

Case study

Figure 26. El Salvador mine. Source Codelco, Chile.



A. Community and the Mine Closure

Anaconda Copper Mining Company built El Salvador as a self-contained and self-sustaining town before the mine was opened in 1959. It was completed with housing, schools, stores, water and electrical plants, and a railway. There are approximately 7,000 inhabitants in the town of El Salvador (10,000 in El Salvador district in 2008).

Today 1,584 staff members work in El Salvador, 2,500 employees are contractors and service providers, and about two thousand more work in public transportation and other businesses related to the mine, such as construction or trade. El Salvador economy is entirely based on mining. When the mine closes in 2011, other businesses and services will have to close too. There will be a high rate of unemployment and almost half of the community will have to move out. Mine closure will produce a domino effect because it will impact not only the El Salvador district but also other districts and communities surrounding El Salvador; for example 50 percent of the economy in Diego de Almagro directly depends on El Salvador mining activity.¹⁵⁰

“El Salvador has its days counted which means a huge social and economic impact on the Atacama Region but mainly on the Chañaral Province. El Salvador closure appears as a death of one city and its

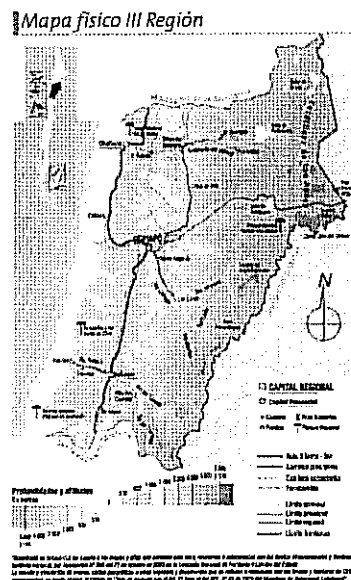
¹⁵⁰ Chañarillo.cl. Consejero Palma: “Tenemos que asumir el grave impacto en Atacama por el cierre de El Salvador.” Available at http://www.chanarillo.cl/notas_ver.php?idnota=3996

people, and we have to accept the responsibility for El Salvador mine closure,” says the regional director Julio Palma Vergara.¹⁵¹

B. Mine (copper, molybdenum)

El Salvador mine is a combined open pit and underground copper mine in Chile. The mine is located in the company town El Salvador at an elevation of more than 2,300 meters at the foothills of the Andes and in the middle of the Atacama Desert. The Salvador Division is one of five divisions owned by the Corporación Nacional del Cobre, CODELCO (National Copper Corporation). It is located in the Chañaral province, 1100 kilometers from Santiago de Chile, 122 kilometers from the port city Chañaral and Barquito (loading point for produced copper) and at 198 kilometers from Copiapó which is the region's Capital (See figure 27 below).

Figure 27. Map of the region. Source. Codelco, Chile



The Atacameños extracted copper from this area for more than a thousand years. Nevertheless, it was exploration in the 1950s that revealed the presence of ore that could be exploited on an industrial scale. Anaconda Copper Mining Company was concerned about declining reserves in its Potrerillos mine and it sent prospectors in search of a new Chilean ore body in 1951. Under the auspices of Anaconda's Andes

¹⁵¹ Id.

Mining subsidiary, the mineralization was discovered in 1954 and mapped in 1955. The mine opened in 1959.

An article from 1956 describes the importance of discovery of the mine at that time¹⁵²:

"In the shade of a chilly, barren mountain called Indio Muerto (Dead Indian), 9,000 feet up in the northern Chilean Andes, lies the world's newest major find of copper ore. The new mine will go into production in four or five years, just in time to replace the company's dying Potrerillos mine. It thus promises not only to increase Chile's total output of about 450,000 tons of copper a year, but will head off an actual decrease. Out of satisfaction and relief, the company last week renamed the mine El Salvador—The Savior."

In 1971, with the nationalization of the copper industry in Chile, control of the El Salvador mine was turned over to the newly formed, state owned copper company Codelco. Codelco is the world's largest copper producer, with annual output of about 1.7 million tons, and the most important company in Chile.¹⁵³ The El Salvador mine is Codelco's smallest operation and has the highest cash costs per pound of copper.

In 2008 El Salvador exploited oxide and sulphide minerals, producing 42,682 metric tons of copper cathodes a year. It also produced 872 metric tons of molybdenum, anodic sludge and sulphuric acid.¹⁵⁴ (See figure 28 below for the mine production)

¹⁵² CHILE: The Savior. Time, Monday, Mar. 19, 1956. Available at <http://www.time.com/time/magazine/article/0,9171,824038,00.html>

¹⁵³ See Codelco Report 2008 at http://www.codelco.cl/english/la_corporacion/memorias/2008/web_memoria/index2.htm

¹⁵⁴ See El Salvador Division at http://www.codelco.com/english/la_corporacion/fr_division_salvador.html

Figure 28. El Salvador Division. Production. Source. Codelco. Chile

	Year 2007	Year 2008
Production	63,885 metric tons of fine copper.	42.682 metric tons of fine copper
Cash cost	77,6 c/lb.	150,7 c/lb
Own personnel	1,717 (December 31 st 2007)	1,584 (December 31 st 2008)

Copper and molybdenum production (mt)					
Copper				Molybdenum	
2006	2007	2008	2006	2007	2008
80,615	63,885	42.682	1,366	1,214	872

1. Chañaral

The coastline near Chañaral is one of the most highly contaminated zones in the world due to discharges from mining activities for more than sixty years.¹⁵⁵ Flotation tailings from El Salvador mine were discharged into the El Salado valley and transported in suspension to the sea.¹⁵⁶ For over sixty years almost five hundred million tons of untreated tailings of the mine were discharged into the coast, forming large tailings deposits and destroying all traces of marine life in the area.¹⁵⁷ A 1983 survey conducted by the United Nations Environment Programme listed Chañaral as one of the Pacific Ocean's most serious cases of marine pollution from industrial waste.¹⁵⁸

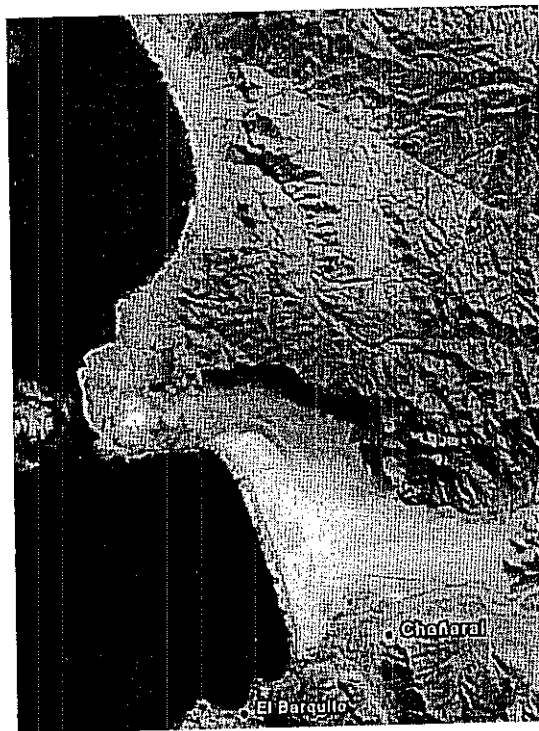
¹⁵⁵ See Andrade, Moffett and Correa's study "Distribution of Dissolved Species and Suspended particulate Copper in an Intertidal Ecosystem Affected by Copper Mine Tailings in Northern Chile" at <http://www.bio.puc.cl/caseb/pdf/prog7/proofs%20Andrade%20et%20al.pdf>

¹⁵⁶ See abstract of Element flows associated with marine shore mine tailings deposits at <http://cat.inist.fr/?aModele=afficheN&cpsidt=17730973>

¹⁵⁷ See Compendium of Summaries of Judicial Decisions in Environmental Related Cases at <http://www.unescap.org/drpad/vc/document/compendium/ch1.htm>

¹⁵⁸ Compendium of Summaries

Figure 28. Tailing deposits in Chañaral Bay¹⁵⁹



Since all the fish population was depleted the town of Chañaral sued the company to stop the waste dump. In 1988 the Supreme Court of Chile enjoined Codelco from further activities damaging the marine environment of Chañaral.¹⁶⁰ The company had a one-year period, from the date of the decision, to put a definitive end to its dumping of mineral tailings into the Pacific Ocean. Moreover, Codelco had to build a dam to dispose of its wastes.

C. Mine closure plan and prospects

Since 2001, and in spite of sustained increases in the international price of copper, the mine has experienced losses of more than \$3.4 million. In July 29, 2005 Codelco announced the planned closure of the mine beginning in 2008.¹⁶¹ Copper reserves will come to an end as of December 2010 for oxides and

¹⁶⁰ Pedro Floresy otros v. Corporacion del Cobre, Codelco, Division Salvador. Recurso de Proteccion. Copiaco. Corte de Apelaciones 23.06.1988. Rol. 2.052

¹⁶¹ El Salvador Division

December 2011 for sulphides. As of these dates mining operations at El Salvador will cease while only the Smelter-Refinery will continue operating. It is expected that the town site will be closed in 2011.

1. Reconversion Project

The closure of the mining operations at the El Salvador Division is an important landmark in the history of mining industry in Chile. It is the first time when a copper mine of this importance closes and it is also the first Codelco plant that will go through the process. Codelco is developing a Productive Reconversion Project which will focus on the technical closure of the mining operations, the socioeconomic impacts, environment and assets management.¹⁶² All these areas are still being discussed and Codelco will submit the final closure plan in 2010.

However, El Salvador inhabitants feel very uncertain about the future of their community. Termination of El Salvador mining operations generates a big impact on a poor province and region that is principally dedicated to the mining. Codelco employees will retire and other will be transferred to other Codelco divisions. Also, Codelco offers trainings and educational programs for their employees but so far has not come up with a plan for the rest of the community. Presidential candidate,¹⁶³ Sebastian Piñera, promised to re-evaluate the El Salvador closure in 2011 because "the next government believes that El Salvador Division has more reserves that can be exploited."¹⁶⁴ There is a possibility that Codelco will develop new projects in El Salvador Division that will increase the life of the mine.¹⁶⁵ But nothing is certain and the community hopes that Codelco and the government will work together on the mine closure plan that will diversify the economy and sustain their community.

¹⁶² Challenges for Codelco, *Salvador Division, in the development of a closure plan and production reconversion project*. Codelco, 2007.

¹⁶³ Chilean presidential elections are scheduled for December 13, 2009.

¹⁶⁴ Diario Atacama.cl. *Dirigentes del cobre alzan la voz por el futuro del Salvador*. Available at http://www.diarioatacama.cl/prontus4_notas/antialone.html?page=http://www.diarioatacama.cl/cgi-bin/prontus_search.cgi?search_prontus=prontus_searchengine&search_idx=all&search_texto=mina+de+el+Salvador

¹⁶⁵ Chanarcillo.cl. *Codelco busca alargar la vida de El Salvador con nuevos proyectos*. October 2009. Available at http://www.chanarcillo.cl/articulos_ver.php?id=17011

VIII. CONCLUSIONS FROM THESE STUDIES

These studies were selected specifically because we believed that relatively large mines, which had operated for decades in areas without a diversified industrial base, would show some of the phenomena of interest in their starkest form. This does not mean that these same phenomena do not exist where there are more diversified economies, the mine is a smaller part of the total economy, or the mine has not been in operation as long. But they may be more muted and less obvious.

The points we take from these case studies include these:

- The problems in these cases really cannot be dealt with purely as environmental issues. The environmental issues are there, but they cannot be solved without dealing with the social, economic and community dimensions as well.
- Governments and companies are both under considerable pressure to keep these projects in operation, because in most cases neither companies nor governments are really in a position to manage the social and economic (and environmental) impacts that would result from closure.
- The fact that keeping the economic benefits flowing from projects like these is such a high priority for the public makes it a high priority for government. The result is a considerable degree of government involvement in all of these projects, and deep government entanglement in their future.
- The high stakes and lack of any clear structure for making decisions, and lack of clarity as to the boundaries of company and government roles mean that in each case there is a fragmentation of the community, with multiple factions promoting multiple objectives, often resulting in something that looks a good deal like a political gridlock.
- Decisions on closure of these facilities seem to be very hard to reach. There are announcements of closure, adverse public reactions, further study, and changes of plan. No decision ever seems to be final.
- In none of these cases can we detect much evidence that there has been from the outset a plan for closure dealing with the anticipated economic and social dislocation of closure. To this extent that there are such plans, they seem to be relatively recent and created only as the specter of closure becomes imminent.
- In each case there seems to be a real prospect that some of the communities or subgroups that have been able to use mining to improve their social and economic position

during the mine life may well lose some of those gains when the mine closes; i.e. the benefits do not all look sustainable.¹⁶⁶

This leads to the obvious question of whether we could in the future avoid this kind of difficult or problematic outcome by consciously planning for the social and economic – as well as the environmental – dimensions of closure from the outset. In short, will integrated closure planning work?

We have not been at it long enough to have a set of outcomes to study. The supposition is that if advance planning, or “planning for closure from the outset” works as well as it does in the environmental dimension, it will have equally good results when applied to the social and economic challenges. Or put another way: since it seems that these issues are deeply intertwined, closure planning in general will improve when it is done in an integrated framework.

¹⁶⁶ Malaria control is one example. Clearing mine sites may actually create better habitat conditions for *anopheles*. During the mine life, active spraying may keep malaria levels low. But if at the end of the mine life spraying stops, there could be more *anopheles* than existed prior to mining.

VIII. INTEGRATED CLOSURE PLANNING

All models for managing complex problems tend to evolve over time. We believe that the traditional model for mine closure planning will evolve from a model that focuses principally on managing the environmental issues of closure to a model of integrated mine closure planning that incorporates all of the three “pillars” of sustainable development: environmental protection, and economic and social development.

Part of this tendency is an increased focus on creating greater value in the post-mining use of mined land. This is a natural trend, as the population grows and land resources become scarcer. The recent book from the Eden Project, G. Pearman, *101 Things to do With a Hole in the Ground*,¹⁶⁷ contains some imaginative examples. We can foresee a future when selection of post-mining land use includes ideas like these:

¹⁶⁷ See Pearman’s project at <http://www.edenproject.com/shop/101-Things-To-Do-With-A-Hole-In-The-Ground-8229.aspx>

A. Local Economic Stimulus.

Mining companies can develop some kinds of post-mining economic uses of mined lands, but almost by definition any post-mining economic use of the site is likely to be led by other actors in the community. Engaging early with others in the community about what use may be made of the site after mining is very likely to obtain better results than waiting to the end of the mine life.

B. Tourism, Recreation and Art.

Mining moves more solid material than any other industry. This should create the opportunity for imaginative post-mining land forms that either fit specific recreational or economic activities or that catch the eye and attract tourist visits.

C. Biological Diversity Assessment.

We already know that mined land is on occasion the last best chance for habitat for some species that are in trouble in their traditional habitat: for example, some species of bats might not exist today if not for habitat in abandoned mines.¹⁶⁸ Former mined lands may also create unique conditions on which rare plant species thrive, raptor habitat, or other ecological niches where threatened species can survive.

Most of this has resulted either from accident, or from sudden realization of an opportunity. If this idea is pursued systematically, we can anticipate much more dramatic results.

Of course, the mined site itself is only a part of the picture. The bigger picture is the local community and regional economy. It is obvious that there will be major changes in both when mines close. After all, if the principal activity will no longer be mining, that necessarily requires a variety of major adaptations. But if this transition can be seen and planned for from the beginning, and if industry can engage with other actors in the community and region, there is every reason to think that we can do much better than in the past in creating a positive post-mining future. This has enormous potential reputational benefits for the industry as a whole: depressed, decaying post-mining communities are hardly an advertisement for the benefits of mining.

It also has specific benefits for individual companies. As the preceding case studies show, companies can be put in exceedingly uncomfortable positions where there is no assurance of a stable post-mining

¹⁶⁸ See Bureau of Land Management, *Bats and Mines in the California Desert*, http://www.blm.gov/ca/st/en/fo/cdd/abandonedmineland/aml_bats.html and Altenbach, *Abandoned Mines as Bat Habitat*, Available at <http://www.cerrilloshills.org/mines/bats.html>

regional economy. On one hand, normal commercial calculations of cost might dictate closure. On the other hand, the risks of unknown liabilities, and public and government pressure to maintain employment levels and avoid implosion of local communities may make companies hesitant to act based on the normal commercial calculations. This leaves companies without much guidance, and in a position with which most of them are profoundly uncomfortable. The high social stakes in some of these situations seem inevitably to lead to deeper and deeper government involvement, which may create even more discomfort for industry. Few companies want decisions about whether to pursue deeper ore reserves, or move into large underground operations, to be dependent upon political calls by government.

Governments have their own set of concerns and anxieties about the social and economic impacts of closure. There is a long history of political destabilization with its roots in masses of unemployed miners, from Margaret Thatcher and the British coal industry to marches on La Paz by unemployed tin miners. The state of the art or "best practice" in dealing with these issues is the International Council on Mining and Metals' *PLANNING FOR INTEGRATED MINE CLOSURE: TOOLKIT*,¹⁶⁹ a framework for engaging both internal and external stakeholders in a process of planning that looks to the long run environmental, social and economic future of the mining project once operations cease.

The TOOLKIT states four goals:

- Minimize the negative consequences of closure;
- Maximize the positive benefits of closure;
- Minimize the likelihood that closure goals are not met; and
- Maximize the likelihood that opportunities for lasting benefits are captured.¹⁷⁰

These ideas are starting to seep into the legal system in some countries via the processes of social and environmental impact assessment.

We forecast that this trend will continue, driven by:

- The increased difficulty companies have in making a 'clean break' from projects at the end of their useful life, especially where the project has created an island of relative prosperity in a sea of continuing poverty;

¹⁶⁹ Available on the ICMM website at www.icmm.com/document/310; also available in Spanish at <http://www.icmm.com/page/15468/icmm-launches-spanish-version-of-mine-closure-toolkit>

¹⁷⁰ Id at 25.

- The continuing difficulties countries have in trying to keep projects operating where closure would have social and economic consequences that government is not prepared to manage;
- The desire of companies to make decisions about the future of projects based on commercial calculations rather than political factors; and
- The continued progress toward a model of sustainable development, in which there is ever greater emphasis on trying to sustain the benefits achieved during the project life.

[This page was left blank intentionally]