Global Mercury Project

Project EG/GLO/01/G34:
Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies

GLOBAL MERCURY PROJECT

ACTIVITIES IN ZIMBABWE 2002-2007

Final Report

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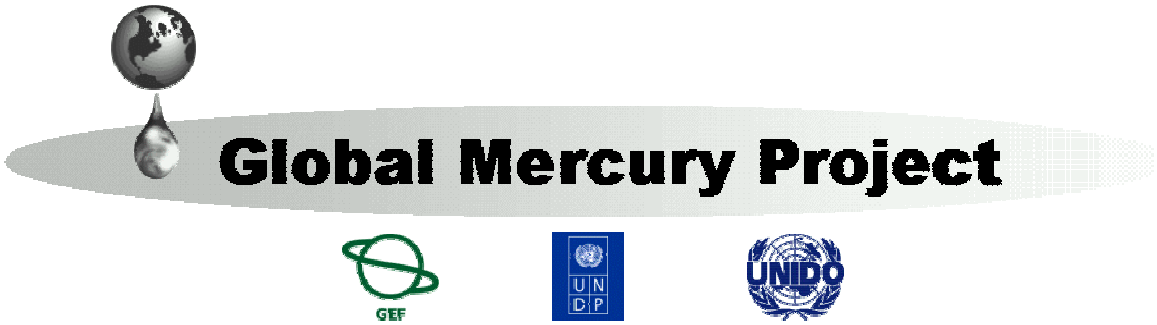

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2002-2007

Global Mercury Project, Coordination Unit, Vienna
Pablo Huidobro, Project Manager, UNIDO
Marcello M. Veiga, Chief Technical Advisor, UNIDO
Svitlana Adler, Administrative Assistant, UNIDO

Primary Authors
Stephen Metcalf, UNIDO and University of British Columbia
Samuel Spiegel, UNIDO and University of British Columbia

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Dr. Stephan Böse-O'Reilly's (Germany) assessment of the health profile of Zimbabwe's artisanal miners was a key element in the argument that the GMP take an integrated approach to mercury management: "more gold, less mercury, better health". Professor Hermann Wotruba of RWTH Aachen University (Germany) introduced vinyl loop carpeted sluices during his training of trainers program in Kadoma, and Trust Masiya of the Institute for Mining Research and Wonder Chigwida of Zimbabwe's Ministry of Mines subsequently proved that these carpets are a suitable replacements for Zimbabwe's whole ore amalgamation practices. David Love and Pilot Dube's studies provided needed guidance on legal issues and micro credit. Finally, Tich Mushayandebvu, UNIDO's representative in Zimbabwe during the implementation period of the GMP, provided invaluable logistical support from the UNDP offices in Harare.

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I. EXECUTIVE SUMMARY

Stamp mill operators: The Coetzee family

It is axiomatic that throughout the world artisanal and small-scale mining (ASM) is driven by poverty. This is especially the case in Zimbabwe, where 80% of the population is unemployed, with most people living in conditions of extreme poverty. Mining can produce environmental and health risks but also significant contributions to low income communities and the economy, and there is a growing need for development assistance in this sector in Zimbabwe.

Once considered the "Breadbasket of Africa," the combined lack of fertilizer, farming equipment and expertise, and drought has caused extensive damage to Zimbabwe's agricultural sector. Shortages of foreign exchange have led to insufficient imports of critical supplies such as fuel, medicine and many other necessities. At the time of this report, inflation is the highest in the world, having now reached well over 10,000% per annum, posing major challenges for economic, environmental and human security. Livelihood options have been critically limited. For many, ASM is the only viable option to generate earnings.

Zimbabwe saw an upsurge in ASM gold mining in the 1990s as a result of unemployment caused by the downscaling of large-scale mining activities, the collapse of the agricultural sector due to drought and the implementation of the land reform program, and the layoff of public sector workers during structural adjustment programs.

Beginning in 2002, the GMP began holding consultations with miners and other stakeholders and conducting health, environmental, legal and socio-economic background studies. These assessments guided the GMP *intervention program* that took place during 2006 and 2007.

In 2003, GMP researchers estimated that as many as 300,000 to 400,000 people were actively gold mining, while as many as 2 million of the country's 13 million people directly or indirectly relied on mining for their livelihoods. Beginning in late 2006, however, police supporting "Operation Chikorakoza Chapera" began to enforce the country's new environmental legislation, as they tried to control the illegal activities associated with ASM such as trade in gold on the black market. This suppressed virtually all ASM operations and led to the arrest of at least 32,000 miners.

The estimated numbers of people mining in Zimbabwe has ranged considerably. Just prior the beginning of Chikorakoza Chapera, estimates suggested there could be as many as 500,000 miners in the whole of the country, but the police actions have made it difficult to test the number of active artisanal miners. Even though the precipitous decline of the national economy suggests the number of people seeking a living in the

sector should be growing, some observers now believe that as few as 100,000 miners are currently active, and that most of these are working clandestinely.

The GMP Health Study showed that children who handle mercury and miners who burn amalgam have a high incidence of mercury intoxication, based on analysis of hair, urine and blood samples and on neuropsychological tests performed in 2003 and 2004. Avoidance of exposure to mercury vapor, particularly by pregnant women and children, has become one of the project's chief recommendations. The study emphasized that mercury intoxication is only one of many health challenges Zimbabwe's miners face—poverty, HIV/Aids, malaria and water borne diseases are arguably more significant contributors to the poor health of Zimbabwe's mining communities than mercury exposure (Böse-O'Reilly, 2004)

Small mining and milling operations in Zimbabwe have used both mercury and cyanide for about 100 years (Phimister, 1975), and it is no surprise that fish in the project area are bio-accumulating mercury—even small carnivorous fish have 2 to 4 times the WHO limit for consumption In some instances, drinking water mercury levels are elevated, but remain below WHO guidelines, when contaminated with Hg bearing silt or with dissolved mercury from the cyanidation of amalgamation tailings. At face-height above freshly dressed copper plates, air contains about 4 times the 8-hour TLV worker exposure limit for mercury (Billard et al, 2004).

National losses of mercury are about 25 tonnes per year, and it is estimated that up to 2/3rds of this mercury is lost to tailings that eventually undergo cyanidation. It is not known exactly how much of this waste mercury is dissolved and lost in the elution process, how much remains with the cyanide tailings, or how much is adsorbed to improperly disposed process slimes. It is likely, however, that virtually all of the mercury lost during whole ore amalgamation is eventually mobilized in the environment.

It has recently come to light that about half of the mercury loss is associated with burning the amalgam (about 4 out of 8 tonnes) and another half is lost when amalgam is dissolved in a pre-treatment of the amalgam with nitric acid before burning or retorting. This practice is the standard throughout Zimbabwe, and miners and millers simply discard the waste acid containing the dissolved Hg on the ground. Miners use nitric before burning or retorting because the sponge texture that develops in the amalgam during acid treatment is more porous than the melted button that comes from retorting, allowing the nitric to dissolve the accessory metals found with the gold, including copper from scraping and scouring the copper plates. Nitric acid is employed because buyers will not purchase doré with gold content less than 70%.

Development of financing schemes with microfinance banks is, for the vast majority of artisanal and small scale mining operations in Zimbabwe, currently all but impossible because of the country's extreme inflation rate. The GMP's financing study identified the programs that offer, or have offered, micro-credit for ASMs. In essence, the GMP recommended that the Zimbabwe government develop special loan guarantee and flexible payment schemes similar to financing programs already available to the nation's small farmers who face unpredictable outcomes analogous to the mining sector. Furthermore, the GMP recommended that Fidelity Printers, the gold buying arm of the Zimbabwe Reserve Bank and the only authorized gold buyer in the country, provide

seed capital for a revolving loan fund. Fixing loans in gold would insure that the lending institutions received the real value of their loans on repayment (Dube, 2005).

In 2004, the GPM estimated that between 1.7 and 3.4 tonnes Hg/year are lost at milling centers in the Kadoma-Chakari area (Shoko and Veiga, 2004). In a subsequent study completed in 2006, the GMP surveyed mercury imports into Zimbabwe and concluded that official imports have totaled between 20 and 25 tonnes per annum (Handelsman 2006, Appendix 5). These recent estimates square reasonably well with the GMP's 2002 figures, since it is believed that Kadoma-Chakari produces about 10% of the country's ASM gold. It is assumed that virtually all of the mercury imported into the country is lost to the environment.

In September 2007, the price of mercury from commercial suppliers in Kadoma was USD 62.50 per kg, down from about USD 110.00 per kg in early 2006 (note that at the same time, Fidelity Printers sold mercury at a reduced price of USD 75.00 per kg). In 2006, the average international price of mercury was USD 18.84/kg according to Platt's Metals Week.

Stakeholders consistently identified the following legal and technical obstacles facing miners: Permitting and Environmental Impact Assessments, finding and financing of mining operations, dewatering mines, hauling ore to mill sites, high real-cost of milling, and poor understanding of modern mineral processing methods. In addition, miners are concerned about child labor and disruption of family units as family members seek mining opportunities far from home, sexually transmitted infections, alcoholism, drug use, and the widespread lack of water, sanitation, and antenatal care for expecting mothers (Appendix 1).

Responding to stakeholder concerns, the GMP trained 32 ASM trainers (1/3rd are women) to communicate simple messages about the impacts of mercury on family health, and to train miners in the use of better gold recovery methods. The Institute for Mining Research (IMR) was subcontracted to run the awareness campaign, and to assemble and operate the GMP's Transportable Demonstration Unit (TDU) containing a ball mill, a hammer mill, a centrifuge, a generator and a steel sluice equipped with vinyl loop carpets. The IMR trained 569 miners in 2006 and 100 in 2007.

The GMP worked closely with the Zimbabwe Panners Association (ZPA), a community based, grass-roots mining organization which managed most of the GMP's interventions on the ground, and which traveled to all of the major mining centers in the country where it taught better gold recovery methods and showed how to make and use low cost retorts. In addition, the ZPA trained a cohort of its regional members to sustain the mercury awareness and improved gold recovery training programs in all of the country's gold mining districts.

Awareness of mercury hazards was communicated primarily through a GMP community theater play, "Nakai" (or, "Precious Little Thing"), the story of a farmer's daughter exposed to mercury by her artisanal miner boyfriend (Appendix 4) which reached about 7,000 people as it played in 18 mining communities in the project area. A cartoon book following the story line of "Nakai" was designed (Appendix 6) but not yet produced by the IMR, owing to the above difficulties.

The GMP partnered with the Ministry of Mines, providing special funding to the Institute for Mining Research to scientifically prove that low-cost vinyl loop carpets are more efficient than copper plates, and to determine the optimum amount of cyanide necessary to recover all the gold while minimizing the dissolution of mercury in amalgamation tailings. A statutory instrument banning whole ore amalgamation will be promulgated following the introduction of the carpets to miners and millers by the Ministry of Mines' metallurgists in 2008. This regulation primarily seeks to ensure that centralized mills phase out whole ore amalgamation with less hazardous and more efficient means. The GMP also made recommendations to clarify the responsibilities of toll mill operators with respect to other health and safety concerns, based on stakeholder consultations.

II. MAIN ACTIVITIES AND ISSUES

MINERS AND THEIR COMMUNITIES

As many as 500,000 people have been earning their livelihood from mining alluvial and primary gold ores in Zimbabwe, but as indicated above, only about 100,000 of these are currently active. Few of these miners are employed in the country's large-scale gold mines. In 2003 and 2004, the Global Mercury Project established first order socio-economic, health and environmental baseline studies, held stakeholder workshops, and established an awareness and training program designed to convince miners and millers that mercury can and should be used more safely. The key message is that the worst exposure pathway—breathing mercury vapor when burning amalgam—can be avoided with relatively little effort. At the same time, simple mineral processing technologies were tested and introduced, including vinyl loop carpeted sluices which are now a proven and viable replacement for whole ore amalgamation with both copper amalgamation plates and mercury-containing Knudsen bowl centrifuges.

GMP activities included socioeconomic, environmental, health, mercury importation and micro-credit studies, stakeholder consultations and policy initiatives; an awareness campaign based on the locally developed drama, "Nakai;" establishment of a mercury analysis laboratory; training of trainers; creation of a Transportable Demonstration Unit; tests of more efficient cyanidation and gravity recovery techniques; a national retort campaign coupled with capacity building of a key community based organization; and the development of a sustainability strategy for further mercury awareness and training programs.

GMP PROJECT SITE IN KADOMA-CHAKARI

The GMP Kadoma-Chakari project area is located about 2 hours drive southwest of Harare in the Hartley and Kadoma districts of Mashonaland West Province. An active gold mining area for many centuries, first by indigenous Shona and later by European colonists, the Kadoma-Chakari area spans roughly 1,350 square kilometers (map sheets 1982-B2 and 1982-B4).

The towns of Kadoma and Rimuka (Kadoma's high-density suburb) are home to about 120,000 people. Access to Kadoma is by good paved road, and most villages in the project area are accessible by relatively good secondary gravel roads, however heavy rains in November, December and January can limit access in some places. Local transportation consists of mini buses, but fares are often beyond peoples' means owing to the inflated cost of fuel in local currency.

The average income in the region is approximately USD 15 per month. Many miners have families in rural homelands in other regions, and this disruption of basic family structure is thought to contribute to prostitution and the high prevalence of sexually transmitted diseases including HIV/AIDS. In 2006, the prevalence of HIV/AIDS in Zimbabwe was about 19%, down from previous years. In the GMP mining communities,

the prevalence is thought to be considerably higher, but concrete data in this regard is lacking.

Literacy amongst the mining communities is remarkably high with 50% of the population having attended high school—fewer than 10% are illiterate, thanks largely to the efforts of the independence government. Shona is the dominant language for day-to-day life for most people, but many Zimbabweans are multi-lingual and most people in the project can readily converse in English.

Sadza, a thick porridge made from ground maize or "mealy-meal", is the staple food in Zimbabwe and is usually served with stewed vegetables and meat, if available. Fish is imported from other regions because local stocks have been depleted. Maize production, both at the commercial and family level, has been severely limited due to droughts during the past 7 years--many children in mining communities are reported to be undernourished. The drought during the 2006-2007 rainy season was particularly severe, and the WHO and UNICEF have warned that as many as 1/3rd of the nation's people may experience food shortages by the end of 2007.

With few exceptions, rural sanitation and water quality are now substandard, having declined from the 1980s when the new independence government was a world leader in water and sanitation programs. At that time borehole wells and "ventilated improved pit latrines" (VIPs) or "Blaire toilets" named after Zimbabwe's Blaire Research Institute were installed throughout the rural countryside, but currently insufficient government funds are available for water and sanitation programs.

Healthcare is limited to the services of visiting rural nurses and a few regional clinics. Acute cases are referred to the Kadoma District Hospital which is under-equipped and understaffed, or to Harare. Private vehicles or public jitneys serve as emergency vehicles, although the district hospital has recently acquired an ambulance.

Elementary schools are within 1 to 7 kilometers from most mining villages, but increasing uniform and tuition costs are making basic education prohibitive for many mining families. Schools are generally poorly supplied and physically decaying. For example, the concrete floors of the Mayflower School which is located one kilometer from the site of the GMP environmental study at Tix Mill, are cratered with 20 cm diameter holes and blackboards are cracked and crumbled. Absenteeism is common during the active mining season due to children's (particularly boys') participation in mining activities.

ZIMBABWE'S CURRENT ECONOMIC CLIMATE

The growth of contemporary small scale mining in Zimbabwe mirrors the evolution of the nation's drastic economic situation. Inflation, now officially running at 7,600% per year has increased since the late 1990s as monitory policy reacted to the decline in GDP and foreign exchange credits. Massive unemployment, now at least 80%, is the result of structural adjustment programs and the collapse of the agricultural sector due to drought and land reforms.

Fuel shortages, regular power blackouts, and an extremely oversubscribed communications infrastructure make day-to-day business operations almost impossible.

For example, in September 2007 the Institute of Mining Research's offices and laboratories at the University of Harare had water and power service only two days a week, while the University's internet server has been often out of service since the beginning of 2007.

Gold mining contributed about 30% of the of the nation's foreign currency earnings in 2001, but deliveries to the Reserve Bank have since declined drastically--in 2006 producers declared 10.96 tonnes of gold, down from 13.45 tonnes in 2005. Despite this, gold mining remains a key economic activity in Kadoma-Chakari mining District, where most of the GMP activities have taken place. Kadoma-Chakari accounts for about 10% of Zimbabwe's ASM gold production.

NEW ENVIRONMENTAL LEGISLATION AND CRACKDOWNS

Until recently, as many as 78% of the region's residents were thought to be directly involved in gold production, if only casually during the dry season. In late 2006 however, artisanal and small scale miners and millers were subject to a police crackdown dubbed "Operation Chikorokosa Chapera" ("finished with illegal gold panners"), as the government attempted to manage the environmental effects of mining activities, control the diamond rush in the Eastern Highlands, and put an end to the illegal activities associated with gold mining, especially the trading in gold and foreign currency on the black market. Early this year, the Governor of the Reserve Bank estimated that about USD 50 to 60 million of gold is smuggled out of the country per month.

In early January, a new Environmental Management Act (EMA) abruptly began requiring miners and millers to have approved Environmental Impact Assessments (EIA) and Environmental Management Plans (EMP), effectively making ASM illegal because most small-scale operations had not applied for certification. In the ensuing regulatory chaos, many police were "overzealous" in enforcing the new EMA. Miners reported that the lack of an EIA and EMP was often used to confiscate gold, ore and equipment as police bulldozed what were arbitrarily deemed substandard workers' housing, destroying or confiscating their meager household possessions. Chikorakoza Chapera is ongoing, and at least 32,000 miners have been arrested, most in the first few months of 2007. On reflection, some government officials feel that many charges were not justified under the EMA.

Before Chikorkoza Chapera, there were an estimated 20,000 to 30,000 artisanal miners in the GMP area. Approximately 75% of these were thought to be alluvial panners, while the rest exploited primary ore in surface pits and underground. About 10% of miners were women, however women did not work at mill sites, or underground. Women were more commonly engaged in processing of high-grade ore in villages, and constituted the bulk of the workforce at enclosed mining and processing sites run the Reserve Bank of Zimbabwe's Carslone Corporation. Currently, between 25% and 50% of the project area's miners are back to work, but most are forced to work clandestinely because they continue to lack EIA/EMPs. Most of these miners are producing only high grade ore, leaving little low grade feed for custom milling operators whose stocks of tailings for cyanidation are running out.

The existence of the illegal gold market is a result of the low price that Fidelity Printers (the official government gold buyer) pays miners for their gold. In March 2007, for example, the "support" or official price for gold was $Z 16,000/g compared to the black market rate of $Z 3-400,000/g. In theory, this official price valued the gold at USD 64/g if one calculated based on the official currency exchange rate of $Z 250/USD. However, because the official exchange rate for USD does not reflect the real costs of goods which follow black market rates, the real price the government paid the miners was only about 2 USD/g—one thirtieth of the officially calculated rate.

CURRENT MINING AND MINERAL PROCESSING PRACTICE

ASM gold mining in Zimbabwe has a very long history, and miners still rely on many of the simple ore extraction methods that were used by pre-colonial indigenous and early colonial miners (Summers, 1969, and Phimister, 1974). Primary gold ore is extracted from narrow discontinuous quartz veins and zones of enrichment in the oxidized layer, and manually hauled up through narrow workings. Alluvial ores are also mined by non-mechanized methods. Mineral processing also still relies heavily on technologies introduced over 100 years ago: *stamp mills, amalgamation plates and cyanidation circuits.* These historical observations are not trivial—the nation's millers and miners trust the old ways and are reluctant to switch to new technologies, even if the old technologies may be inefficient and toxic. Mercury use has withstood the test of time. Mercury is an integral part of ore processing in Zimbabwe and is broadly not believed to be a serious human health or environmental hazard.

Surface and underground mining

Alluvial mining in Zimbabwe is rarely mechanized. Tools for digging gold-rich eluvial or "rubble" deposits range from shovels, picks and bars to small sticks and fragments of metal for scraping softened surface material. Primary ore is extracted from surface pits and from relatively primitive underground workings using hammers, chisels and picks; when possible, underground operations utilize rented compressors and explosives to advance workings. Ore is hauled to the surface in buckets by rope or steel cable by manual windlasses. Mine shafts are narrow, typically a meter in diameter. Workings, whether pits or shafts, are not backfilled and wasted dumps are not reclaimed. This has proven to be a considerable hazard for livestock, as well as people in many areas. Protective clothing and mechanical underground ventilation are rare.

Miners sometimes work in small syndicates mining in shifts 24 hours a day. A syndicate/team of 4 miners can produce 20 t/month, producing 200 grams of gold per month if they recover 10g/tonne. Depending on the arrangement of the miner or miner's syndicate with the claim owner, tribute is paid for the right to mine. In the Kadoma-Chakari area, tribute is typically 5%, but a Women in Mining operation reported paying tribute of 20%.

Mineral processing and gold recovery at custom milling centers

High-grade ore is often processed artisanally in villages using steel mortars and pestles and concentrated on blanket-lined earthen sluices, and then panned and amalgamated.

Low-grade ore is processed at custom stamp mills and concentrated on amalgamation plates or in mercury containing centrifuges. In September 2007, there were 243 operating milling centers in Zimbabwe delivering gold to Fidelity Printers. There are currently 117 registered custom milling centers in the Kadoma-Chakari area, but at any given time however, less than half of these are likely to be operating. A given milling center may have multiple mills. At the M+K mill, for example, there were 46 workers operating 6 mills and attendant cyanidation operations. More mills are operating in the dry season when the water table is lowest. Altogether, there are probably about 1000 milling sites in the entire country.

In early 2007, most mills were shut down by operation Chikorakoza Chapera, but by September, about 70% of these mills had obtained valid EIA/EMPs. Before Chikorakoza Chapera, there were about 1000 to 2000 workers at milling centers in the project area. Currently there is a high degree of police surveillance of gold recovery processes at custom milling centers. Miners are thus often now reluctant to ship any ore to mills and this is causing a shortage of feed at a number of mills. In addition, the current disruptions in electricity supply are restricting the output of many milling operations.

Miner's hand-crush their ore to about -10 cm, reserving the highest grade material for eventual hand milling in villages. The low-grade material is transported in hired trucks or tractor-trailers to custom milling centers where the miner pays a nominal fee for the milling, typically between USD 1 to 3 per hour. Ore delivered to the mill usually grades between 5 and 30 g/tonne. Once milled, the miner's share is immediately amalgamated.

Usually, a member of the syndicate accompanies the ore to the milling center, where they insure that the milling, concentration and amalgamation are accomplished as efficiently as possible. Unless prohibited by their tribute arrangements, miners are free to chose where they mill their ore, allowing the option to use a ball mill. However, ball mills are relatively uncommon in Kadoma-Chakari, and the extra transportation costs to a center that operates a ball mill may outweigh any benefits from more efficient liberation.

Stamp mills are electrically powered by large drive belts that turn 50 cm eccentric cams which lift and drop tall vertical steel shafts which are attached to 25 cm stamps. A mill worker shovels the ore into a narrow mortar box where the ore is mixed with water and crushed between the 250 to 800 kg stamps and anvils. Water flow is adjusted to flush the crushed ore through the discharge screen at a density of about 20% solids. A good mill will stamp at the rate of 90 to 100 times per minute. Output can be up to 1.0 tonne/hr for a 3 stamp mill, depending on the hardness of the rock. The discharged pulp flows to either a Knudsen bowl type centrifuge, or to a mercury-coated copper amalgamation plate, usually 1 meter wide, and 1 ½ meters in length.

Stamp mills are fitted with coarse screens that pass -1mm particles. When these -1mm particles contain partially or un-liberated gold, they are often not caught by the amalgamation plate and report to the tailings and become the property of the stamp mill owner. Miners receive only what is recovered in the mortar box, on the amalgamation

plate and in the centrifuge. The 50 to 70% of the gold that reports to the tailings becomes the property of the miller and is subjected to cyanidation.

By law, all milling centers are required to have two-stage concentration systems and miners must be allowed to collect gold from both stages (the law stipulates that the system may be some combination of sluices, centrifuges or copper plates). However, two-stage systems are not always offered, and often miners are allowed only to collect gold from a single concentrator, maximizing the gold passed to the miller's cyanidation circuits. The most common single concentrator is the copper plate, but more and more milling centers are offering single stage systems composed of centrifuges, which some miners believe to be more efficient than copper plates. Unfortunately, because the Knudsen-bowl type centrifuges produced in Zimbabwe are not very efficient, the usual practice is to introduce one or two spoonfuls of mercury into the centrifuge.

Ball mills are available at only 5 custom milling centers in the project area--miners tend to prefer stamp mills because gold accumulates in the ball mill liners, but in areas where stamp mills are not available, such as in Sanyati which is 90 km west of Kadoma, miners are using ball mills out of necessity and are finding that the increased recovery from more efficient grinding outweighs the losses to the liners.

The copper amalgamation plates are freshly dressed with about 150 grams of mercury before each batch. The mercury is kept active as the pulp flows over the plate by rubbing a piece of NaCN briquette over the feed plenum; yellowish patches of mercury on the plate are cleaned directly with the cyanide briquette. Once the feed and pulp flow is exhausted, the amalgam is scraped with a rubber squeegee and collected in a small piece of cloth for squeezing off the excess mercury. The plate is then scoured with coarse sand in an attempt to recovery any gold remaining in the scratches and crevices on the plate, a practice unique to Zimbabwe and that puts large amounts of mercury to the tailings, necessitating the use of nitric acid to remove the scoured copper from the amalgam. Of the 150 grams applied to the copper plate per one tonne batch, it is estimated that approximately 120 grams are recycled by squeezing excess mercury from the amalgam scrapings, 20 grams are lost to tailings during the scouring, and about 10 grams stay with the amalgam (assuming recovery at this stage of 10 g Au/t).

Again, it must be emphasized that where copper plates aren't used, mercury is invariably used in centrifuge. Miners estimate that the loss of Hg from centrifuges is about half that of copper plates.

Amalgamation barrels are required at mills by law, but many miners prefer to amalgamate concentrate by hand in bowls. Soap is used to keep the surface of the gold clean. Hand amalgamation is suitably effective and does not tend to flour the mercury as do amalgamation barrels when they are run too long or used with steel balls to promote mixing. It is reported that many miners use a little NaCN in the amalgamation barrels to promote amalgamation. This practice has been shown to be effective, but since cyanide readily complexes both gold and mercury, this can lead to losses of both gold as well as mercury. When amalgamation barrels are used to concentrate centrifuge concentrates, between 400 to 800 grams of mercury are mixed with about 30 to 33 kg of concentrate (Shoko and Veiga, 2004).

Retorts are also required by law to be used at milling centers, but it appears that they are seldom used. Almost always, miners use nitric before burning or retorting because the sponge texture that develops in the amalgam during acid treatment is more porous than the melted button that comes from retorting, allowing the nitric to dissolve the accessory metals found with the gold, including the copper from scraping and scouring the copper plates. It is estimated that at least half of the mercury in the amalgam is dissolved and lost during pre-treating of the amalgam with nitric acid in this fashion, and miners and millers simply discard the dissolved Hg on the ground. After pre-treating with nitric acid, the amalgam is toasted on the burning end of a l0-15 cm diameter log, blowing the embers with the mouth to maximize the heat; the toasted amalgam is then mixed with a little borax and smelted with a torch. These processes expose the operators directly to inhalation of Hg vapor.

All gold recovered at custom milling centers must be sold to the miller who is required in turn to sell it to Fidelity Printers. Before Chikorakoza Chapera, much of the gold produced at mills was sold on the black market. Miners took possession of their amalgam, boiled it in nitric acid and toasted it without retorts wherever convenient. As indicated, it is believed that up to USD 60 million of gold per month was smuggled out of the country in 2006.

Cyanidation at milling centers

Small scale milling and cyanidation practice is relatively sophisticated in Zimbabwe. Because millers make their money from cyanidation, not from the nominal milling fee, they rely on the low recovery rates of the *stamp mill and amalgamation plate or centrifuge circuit* to maximize the gold content in their cyanidation processing. Custom millers must be sufficiently competitive with neighboring mills to insure a constant supply of feed to their cyanidation tanks. Millers sometimes attempt to attract the best ore in order to maximize the gold content of tailings sent to their cyanidation circuits by providing miners with legal and technical support (e.g., loans to complete environmental assessments, geological services, etc.).

The chemical consumption for passive cyanidation tanks is about 1 kg CN per tonne of ore (0.1% CN in solution). Depending both on the ore and on the operator, lime or caustic soda (about .5 kg/tonne) is used. Current cost of cyanide in Kadoma is just under USD 4/kg. The GMP has established that the main manufacturers of cyanide for small scale cyanide use in Zimbabwe are Tongsuh, Taekwang, and Dupont.

Most mills have 5 to 10 tanks for cyanide leaching. Each tank holds between 20 and 70 tonnes of tailings. Twenty tonne tanks are charged with about 18 kg NaCN and 50 kg of Ca(OH)2. Typically these tanks are dug into the ground, with the top edge of the vat at ground level. Cyanide solution is pumped into the tank and re-circulated through activated carbon cells. The tanks are not agitated, and no air is injected. Leaching takes an average 6 days, but depending on the ore can sometimes take as long as 2 weeks. The cyanide solution containing the dissolved gold passes through 3 or 4 activated carbon cells which, once loaded, are subjected to a chemical process (elution) to concentrate the gold. Gold content of the pregnant solution, free cyanide and alkalinity levels are monitored by the colorimetric methods (Singo, 2006).

It is estimated that as much as 90% of the metal mercury in the amalgamation tailings is dissolved during cyanidation. A good deal of this mercury reports to the carbon cells and is lost during elution: Mercury vaporizes in the 100 to 110 degree Celsius pressurized elution vessels (tiny beads of Hg are often observed on the lid and sides of elution vessels, and during electro winning). In addition, mercury plated with the gold on the steel wool cathode is subsequently dissolved in nitric acid and discarded on the ground. Some millers have their own elution equipment, but others send the loaded carbon to toll elution centers for stripping--operators of these toll elution plants observe that loaded carbon contains varying amount of mercury, suggesting that mercury losses to tailings vary according to practices at toll mills. Cyanidation tailings are not neutralized or washed.

IMPROVING MERCURY POLICY IN ZIMBABWE

The GMP worked with the Zimbabwe Ministry of Mines to develop appropriate policies for mercury use in ASM gold mining at milling centers and other processing sites near habitation in towns and villages. Following stakeholder consultations, GMP experts worked with government to prepare recommendations for mercury management in ASM, setting standards on practices to eliminate hazardous mercury emissions, exposures, and to address other environmental health challenges. These recommendations include proposed regulations the purchase, trade and storage of mercury.

These GMP recommendations encourage positive changes in the mining sector that will improve livelihoods, the environment and economic sustainability. It is recognized that core the Global Mercury Project goal of “removing barriers to the adoption of improved small-scale mining practices” requires an integrated approach that is responsive to local, national and regional needs. It is hoped that the GMP can continue to play a significant role in bringing together stakeholders to problem-solve and strengthen development institutions in Zimbabwe.

The GMP facilitated meetings, small workshops and large seminars with national and local officials from the Ministry of Mines, the Ministry of Environment, and the Ministry of Health, as well as with mining associations such as the ZPA and the Zimbabwe Mining Federation. These talks reinforced a shared commitment to develop policies to phase out mercury in ASM over the long term. In the short term, efforts focused on instituting clear regulations and codes of practice to minimize mercury exposure and other environmental hazards in ASM.

Promoting cleaner and equitable technology policies: Banning whole ore amalgamation

The GMP policy recommendations provide standards for amalgamation and the use of retorts and for the reduction of mercury lost to tailings. Specific provisions protect pregnant women and children from exposure. The recommendations include mechanisms for community-based enforcement and monitoring, but also suggest a statutory instrument to ban the whole ore amalgamation, whether with copper plates or in centrifuges: Banning whole ore amalgamation will significantly improve

environmental health while promoting more equitable sharing of gold recoveries between miners and millers.

The Ministry of Mines' Department of Metallurgy and the Institute of Mining Research has conducted successful trials of low cost vinyl loop carpets sourced from China. A short sluice lined with these low cost carpets has already been proven to be more efficient than current practices. Once this new technology has been demonstrated to stakeholders through out the country, it is expected that the Ministry of Mines will formally introduce a Statutory Instrument under the Mines and Minerals Act that will ban whole ore amalgamation.

Addressing environmental practice at milling centers

In Zimbabwe, miners generally bring their ore to milling centers for processing. Mercury is used intensively on these premises, and tailings management and mercury handling often present serious risks to health and the ecosystem. Because the relationship of miners and millers is not generally of a formal employer-employee nature, traditional legal definitions of employer responsibility do not necessarily apply.

GMP policy experts prepared recommendations and draft regulations on water protection, the duties of claim-holders and milling centre owners and managers that resulted from its policy reviews and stakeholder consultations. These proposals were presented and discussed on a preliminary basis with the national directors of the Ministry of Mines. These draft measures propose clear lines of responsibility for miners and claim-holders as well as milling centre owners and managers, and suggested penalties for infractions.

The draft measures acknowledge the need for shared responsibilities among the different people involved in ASM mining and processing. Responsibilities that were addressed in the draft regulations relate to mine management, fair labor practice, safety, health and the preservation of the environment. Millers would be responsible for sound mercury management on their premises and for ensuring compliance with regulations. The draft provisions stipulate that milling centers must not exist within 100 meters of water bodies, and prohibit the combined use of cyanide together with mercury.

Regulating mercury trade

The GMP believes that the regulation of mercury sales to miners is a crucial step to decrease the negative health, social and environmental impacts caused by mercury in Zimbabwe. In December 2005, GMP policy experts prepared draft regulations under the Mining Laws to address trade and distribution of mercury within the ASM sector. These were discussed with senior directors of the Ministry of Mines as potential measures that could become part of a larger national effort to regulate the trade of mercury. The draft measures propose licensing the use and trade of mercury and require penalties for contraventions. Provisions for mercury trade stipulate that "…no person may purchase mercury for amalgamation purposes unless they hold an amalgamation license."

"1) The use of mercury for amalgamation purpose shall require an amalgamation license, which shall be applied for by the manager of the mining location at which the amalgamation is being contemplated.

2) An amalgamation license shall be issued by the Mining Commissioner and shall specify the mining location at which amalgamation is being licensed, to whom the license is granted, and the site within the mining location at which amalgamation shall take place, designated by a plan.

3) An amalgamation license shall be valid for 1 (one) year and may be renewed.

4) In the event of breach of these regulations, the Mining Commissioner may cancel the amalgamation license for the mining location for which the breach has taken place."

Improving gold pricing policy and fairness of gold trade

Due to the current economic crisis in Zimbabwe, gold mining has grown in importance as a source of survival. As many as 2 million people depend, directly and indirectly, on artisanal and small-scale gold mining. As the mining sector has grown, so too has smuggling, illegal mining, and mercury use as well as other environmentally destructive practices. The GMP found that these problems were mainly fuelled by the underlying failure to implement economic policies that pay miners fair and appropriate gold prices.

Between February and April, 2007, the GMP conducted stakeholder meetings in Zimbabwe to bring together miners, government decision-makers from different agencies, and other organizations, to identify and advance strategies for bringing solutions to the challenges facing the mining sector. The aim of the meetings was to allow participants to express a diversity of concerns and to influence policy changes. In addition to conducting stakeholder meetings, the GMP participated in Special Committee Hearings in Parliament to review gold mining policies. A variety of GMP recommendations were generated, including increasing the gold price to the level of the international bullion market.

Following these advocacies advanced by the GMP and other stakeholders, The Reserve Bank of Zimbabwe established a review committee to ensure that gold prices are regularly evaluated and adjusted to inflation. On October 1, 2007, for example, the official purchase rate was increased from Z$3,000,000/gm to Z$5,000,000/gm which is equivalent to USD 520 an ounce at the official exchange rate of $Z30,000/USD. This significantly reduces the illegal trade of gold, and provides a viable economic basis for gold mining. It is expected that the government will continue to adjust the price of gold upwards.

The GMP advocates that, in addition to maintaining fair gold prices, it is crucial that official gold buying centers and agents be located near mining areas so that miners have access to equitable markets.

TRAINING OF TRAINERS

A four day *training of trainers* workshop was conducted in Kadoma on May 25 to May 28, 2006. Thirty two stakeholders received instruction in the objectives of the GMP, an overview of Zimbabwe Health and Environmental studies and strategies to effectively communicate the effects of mercury on health, how to minimize exposure, how to use and reuse mercury safely, how use of retorts, and how to achieve high efficiency gravity concentration. In addition, trainers presented an exhaustive review of mining practices

and equipment used by artisanal and small scale miners around the world. Mining engineer Patience Singo, a UNIDO small scale mining expert based in Bulawayo, Zimbabwe, presented an overview of underground mine safety. Participants included the Ministries of Health, Environment and Mines, local medical staff, the Institute for Mining Research (Harare), the Zimbabwe School of Mines (Bulawayo), Amakhosi Theater (Bulawayo), the Zimbabwe Panners Association and independent miners (Appendix 2)

During the training, an interactive workshop identified ASM legal, health, social, micro-credit, and technical needs from the perspectives of the miners themselves and government stakeholders. Stakeholders consistently identified the following legal and technical obstacles facing miners: Permitting and Environmental Impact Assessments, finding and financing of mining operations, dewatering mines, hauling ore to mill sites, high real-cost of milling, and poor understanding of modern mineral processing methods. In addition, miners are concerned about child labor and disruption of family units as family members seek mining opportunities far from home, sexually transmitted infections, alcoholism, drug use, and the widespread lack of water, sanitation, and antenatal care for expecting mothers.

A 1 x 2 meter sluice lined with 3M Nomad carpet (medium traffic with backing, Type 6050) was installed and demonstrated at Tix Milling Center. Participants of the workshop received copies of the Global Mercury Project's "Manual for Trainers of Artisanal Miners" and a copy of Patience Singo's manual, "Good Practices in Gold Processing for Small Scale Mining".

TRANSPORTABLE DEMONSTRATION UNIT (TDU)

TDU operations were subcontracted to the Harare based Institute of Mining Research in July 2006. Training began in September and continued until mid-December 2006, by which time 569 miners (188 women and 381 men) had been trained at seven milling centers. In its December report, the subcontractor reported that it had purchased a generator, ball mill, camping equipment, tents and chairs, tools, first aid kit, scales and fuel cans. During these first 4 months, the IMR had developed a comprehensive curriculum and met reasonable expectations of the number of individuals trained.

Operation Chikorakoza Chapera shut down virtually all mining and milling operations in the project area until April 2007 when a few operations managed to complete the requisite environmental assessments. In early June, the IMR reported that its foreign currency assets had been frozen by the Zimbabwe government in an investigation of illegal currency trading by the NMB Bank. About half of the IMR's assets were released in early July, enabling some field work (mostly testing of the Chinese vinyl loop carpets) in late July and August. The IMR has not yet reported its current accomplishments, but it is estimated that only about 100 miners were trained between January and September 2007. Thus far, the brochures, posters and billboards slated to be produced based on the play "Nakai" have not yet been produced.

AWARENESS CAMPAIGN

Mercury has been used in ASM for over 100 years, and as indicated above, most miners do not believe its use leads to negative health or environmental consequences. Awareness building and offering acceptable solutions are therefore are the first steps toward safer practices. The grass roots awareness program in Zimbabwe was built around the community theater production "Nakai" which illustrates the hazards of mercury use while demonstrating alternatives. The IMR is responsible for production of all GMP awareness materials including cartoons, posters and billboards and is required to report on this at the end of the TDU training contract. To date, the IMR has not provided a report of their contributions to the awareness campaign, but it appears that they have not yet produced or distributed any of the required materials.

National Retort Campaign

In June and July of 2007, the ZPA trainers carried out a national outreach program to raise awareness about the dangers of mercury, demonstrating retorts to make mercury use safer and vinyl loop carpets to increase gold recovery. The ZPA trained over 1000 people at 27 mill sites and one school. The ZPA found that the signs and symptoms of mercury poisoning were common amongst miners in many communities throughout Zimbabwe. At one site, the ZPA observed that "children were engaged in gold mining activities. The situation was bad, most of these children are aged between 8 to 12 years. However they seemed very bright as it was easy for them to catch up on the use of retorts." By and large, miners were unaware that mercury is a poisonous substance and they were surprised to see so much mercury recovered in retorts. Invariably, miners were very appreciative that the United Nations was making the effort to bring these kinds of messages to them.

The Play "NAKAI"

"Participatory" or "community theater" is often used in Africa to create awareness about health and other issues. Community theater is an approach to awareness building that can enable people to assume agency over their lives. Research has shown that community members gain power to solve the problems they face when they are involved in the development of such a play, when they participate informally during the play (e.g., singing and dancing with the performers, or voicing comments and suggestions) or when they participate in post-performance audience discussions.

In order to increase awareness of the hazards of unsafe mercury use, the GMP contracted the Amakhosi Theater group to produce a play to communicate directly to mining communities the message that mercury makes people sick. Amakhosi has produced community theater in Zimbabwe for over 20 years, notably focusing on HIV/Aids and on the need for post abortion care. Importantly, Amakhosi has credibility amongst ASM communities because it produces the popular, award-winning weekly television drama, "Amakorakosa" which contrasts the lives of poor gold panners with the lives wealthy small-scale mine owners.

During 2005 and 2006, Amakhosi held a series of workshops with the Zimbabwe Panners Association and the Kadoma-based Tamuka Theater Group to generate an

entertaining script that carries the core GMP messages. The plot follows the blossoming love of two young people, Nakai and her miner boyfriend Aringo. Much like Shakespeare's Romeo and Juliet, the two lovers come from families with a history of animosity—one's father is a farmer whose land has been invaded by gold panners, and the other's is a successful gold miner. In the course of the story, Aringo develops symptoms of mercury intoxication (irrational behavior and impotence) and Nakai has complications with her pregnancy. In the end, the feuding families find common ground in the love of their children, and resolve to support safer mercury use and better waste management. The play's Shona title, "Nakai," means "precious little thing" and refers equally to the gold amalgam that artisanal miners recover and burn, and to the wife and unborn child of the artisanal miner who are all exposed to mercury vapor.

Performances of "Nakai" are proceeded by 45 minutes of the Tamuka Theater's energetic traditional singing and dancing, which projects a feeling of vitality and contextualizes the story of "Nakai" in a milieu of positive health and power. Again, research shows that people gain power as they learn to take their place with confidence in a physical space and have their voice heard by others. The vitality of Tamuka's dance and dramatic performance inevitably sparks joy in the audience–joy itself is an agent of transformation.

Performance of "Nakai" in Kadoma, 2007

Pending awareness activities

A cartoon book, commissioned from the Bulawayo-based illustrator Levi Phiri followed the plot line of the community theater play and embedded core GMP messages. The graphics were delivered to the IMR for publication in Shona in April, 2007. Selected cartoons are to be used by the IMR in hand bills, posters and billboards placed along the main mining roads leading to Kadoma.

III. CONCLUSIONS AND RECOMMENDATIONS

Even though the GMP faced many challenges in Zimbabwe, many barriers to the adoption of cleaner technologies were substantially lowered. For example, high efficiency, low cost vinyl loop carpets have been introduced and accepted as a viable substitute for whole ore amalgamation, and a cadre of committed grass roots trainers has been established. Awareness of mercury hazards and more productive gold concentrating methods has dramatically increased in the project area. Local stakeholder participation in the policy discussion processes yielded critical insights and some developments in the short term, with longer term aims identified too. Also, the entertaining awareness-raising play "Nakai" was presented to about 7000 ASMs and community members.

Perhaps the greatest legacy of the GMP is the strengthened Zimbabwe Panners Association. The ZPA now has a network of 30 ASM trainers placed in all of the country's gold mining districts. These individuals are committed to improving the health and livelihood of small scale miners.

It almost goes without saying that good interactive relationships with stakeholders are the key to success, because acceptance of new health and safety practices occurs only when the messenger is credible. Solid relationships with community-based organizations have been developed by the GMP in Zimbabwe, but new *long-term* commitment is essential if Zimbabwe is to sustain miners' health and safety programs.

The challenge remains to develop programming that can insure that the benefits of the funds reach the people at the bottom of the socioeconomic spectrum. The experience of the GMP in Zimbabwe suggests that new mechanisms for accountability need to be put in place. Such mechanisms might include the creation of community based trusts directed by local individuals committed to improving the lives of miners, and who because of their professional standing (e.g., priest, hospital administrator, etc.) are unlikely to find themselves in a conflict of interest situation.

Action programs such as trainings could be administered by NGOs that have established relationships with grass roots community based organizations. Government partners should include the Ministries of Environment and Health, as well as the Ministry of Mines. The Assistant Country Focal Point position should be eliminated, and activities should be coordinated by an empowered UNIDO staff member residing in the project area. Quarterly evaluation visits should be made by senior UNIDO managers.

It has been observed during this project that relatively small programs such as the ZPA's National Retort Campaign have been more successful than large subcontracts such as the TDU. Payment schedules for large contracts (e.g., the TDU) should be in small regular increments during the lifetime of the contract, rather than a large balloon payment midway through. Contracts should include provisions that clarify the nature of any extensions to the agreed upon timeframe. Mechanisms should be developed to let more small subcontracts, rather than fund small interventions through Aide Memoires. In addition the GMP should develop a way to pay casual wages to locals. Future initiatives should consider eliminating or revising the DSA system because it has often come to be

seen a salary entitlement that can break down trust between various stakeholders. Indeed, trust-building takes a great deal of sensitivity and innovation in numerous ways and is an integral component of empowerment in development processes.

In spite of the challenges that virtually all development programs face in Zimbabwe, the GMP has shown that progress, especially through grass-roots interventions, is possible. GMP should develop funding partnerships with organizations that share common objectives, such as UNICEF, WHO, UNEP, EU Development Fund, DFID, etc., directing this funding to community based organizations.

It is incumbent on the international community to increase commitment to achieving the Millennium Development Goals in Zimbabwe, where families and especially children face impossible lives: We should not forget that 25% of the country's children (1.6 million) are orphaned, or that 13% of children die before the age of 5 years old, up from 8% in 1990. The FAO and the WFP predict that drought and lack of agricultural inputs will lead to food shortages for 1/3rd of the population by the end of 2007. Zimbabwe's impoverished mining families find themselves in a crisis environment, and they need the help of the international community.

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V. APPENDICES

Appendix I: Voices of miners on major priorities: Interactive workshop 2006

LEGAL ISSUES		
PROBLEM	**SOLUTIONS**	**ROLE OF THE GMP**
Poor law enforcement on the hazardous substance act	The act should be lawfully enforced and individuals should be educated on the use and control of the hazardous substances	Once the Environmental Protection Act is operational, the GMP should support the Zimbabwe Panners Association (ZPA) to teach miners how to comply
Abuse of gold panning legislation	Government should implement legislation in a friendly but effective way. Enforcement of gold panning laws is necessary	The GMP should recommend legislation concerning mercury use in mining, maybe following models implemented in other countries such as those in Latin America.
Easy availability and accessibility of mercury	There should be law to control the buying and selling of mercury from the manufacturer to the end user.	The GMP should promote awareness about the hazards of mercury --e.g., prepare labels with skull and cross bone/diamond warning label)
Unlicensed panners, buyers and miners	Government should monitor the industry seriously so that only licensed individuals are allowed to operate. Government should educate people about how to acquire licenses and should relax the license requirements	
The issue of protective clothing is not being emphasized	The Government mining inspectors should make regular inspection of mining and milling sites.	The GMP Transportable Demonstration Unit should educate miners about protective clothing, produce posters and calendars for awareness; TDU trainers should model safe practice
Mine inspectors are immobile due to the lack of fuel		The GMP should draft voluntary codes that are simple enough for miners to follow with minimum regulator surveillance
Environmental impact assessments and management plans not done	The Government should consider alternatives such as self-assessment environmental management plans as the “environmental impact declarations” miners complete in Bolivia and Peru	The TDU should introduce “SSM Env 1 Form” to miners Once the environmental protection act develops its new policy, this can be taught to miners by ZPA

GEOLOGY		
PROBLEMS	**SOLUTIONS**	**ROLE OF THE GMP**
Lack of expertise in geological survey procedures	Government should expand the Ministry of Mines (MoM) geological survey dept to include extension services	Consider supporting pegging with differential GPS
Ore reserve estimation	Government could periodically provide district geologist from KweKwe to participate in TDU and other trainings	TDU can create awareness that miners would benefit from geological professionals
Prospecting	MoM could provide peggers to control costs Government could provide microfinance to assist prospective miners pay pegging fees	
Suitable Exploration Tools	MoM to resuscitate Mining Investment Loan Fund (MILF)	

MINING		
PROBLEMS	**SOLUTIONS**	**GMP**
Tools and equipment		TDU should demonstrate low cost heavy duty Bosch electrical drills (Bosch GBH 11) with 2kW generator
Finance	Recapitalization of MILF (this is not enough)	TDU should provide training in: --how to get investors -- how to make a good contract --business planning The GMP should suggest benefits of partnerships between millers and miners
Lack of experienced mining personnel	Training The Zimbabwe Panners Association can sponsor ZSM classes in Kadoma --e.g., mine safety	
Access roads are bad or non-existent.	Miners need to take responsibility (miners need to solve their own problems themselves)	
Occupational hazards --roof collapse/support --Personal Protective Equipment --Ventilation and lighting --blasting hazards	Government (MoM) should provide training and extension services	The TDU should focus on safety awareness The TDU should demonstrate ventilation equipment The GMP should prepare a miners handbook
Environmental degradation	Training, awareness, supervision	TDU should raise awareness of miners about the responsibilities to future generations of extracting mineral wealth today
Dewatering pits		TDU should include a demonstration dewatering pump
Lack of business planning		Teach business planning

MINERAL PROCESSING		
PROBLEMS	**SOLUTIONS**	**GMP**
Miners don't understand mineralogy: --e.g., is the ore oxide ore or sulfide ore? -e.g., what is gold particle size range? -e.g., how does one achieve maximum recovery?	Training and Site demonstrations --analyze rock samples --teach basic mineralogy	TDU should provide training in geology and mineralogy: --distinguish between ores and know how fine to grind --train how to collect a representative sample --train to use simple methods to test grade (e.g., the Plattner Blowpipe method for assaying gold which was a 19th Century method where the weight of a tiny bead of gold was determined by measuring it between two sub-parallel lines.
Lack of knowledge: --milling --liberation --gravity concentration	Training of alternatives such as ball mills, hammer mills, shaking tables, sluices, strakes	TDU should demonstrate testing the efficiency of grinding to different sizes
Low Recovery --Copper plates --Screen sizes of stamp mills are too coarse leading to poor liberation --Use of stamp mills is not efficient --Clay James tables	Use better methods --centrifugal concentrators --use smaller screen sizes --use of other mill types --use proper sluices and mats	TDU should educate about proper grinding vs. over grinding --demonstrate liberation analysis to determine proper screen size
Very high milling costs	Government should establish own mills at low rates --Government will buy the gold!	
Transport --high charges --must pay in gold but the government price is too low	Micro-credit finance --groups could buy tractors, transport	
Existing legislation, SI 329, Custom milling regulations --Metallurgical requirements necessitate copper plates	Government must amend regulations	Educate how copper plates release Hg to environment Educate miners on advantages and disadvantages of copper plates Support ban of copper plates and mercury in centrifuges as in Latin America

SOCIAL ISSUES		
PROBLEMS	**SOLUTIONS**	**GMP**
Improper Accommodation --overcrowding Prostitution leading to spread of STI and HIV/AIDS	Distribution of condoms	GMP should increase awareness of STIs through Drama and Brochure
School dropouts Petty and violent crime Poor water and sanitation Child labor and sexual abuse	Law enforcement, statutory instruments (SI), awareness of children's rights Enforce UN convention on child labor and right to education Enforcement of SI 275	GMP should promote awareness that child labor in mining is bad
Disruption of family units and normal social fabric Corruption		
General --enforcing SI of alluvial mining --improve conditions of service of regulatory agents --awareness and training --introduction of technologies --mobile clinics/awareness	ZPA could: --Establish a national association/council of mining/panners associations to lobby government (trustees could monitor this national association to prevent in-fighting and greed to insure stability. --ZPA could function as an intermediate between MoM and panners --Panners should define the needs for training	

HEALTH ISSUES		
PROBLEMS	**SOLUTIONS**	**GMP**
Pneumoconiosis Injuries Respiratory diseases and suffocation		
High manifestation of communicable diseases High incidence of malaria and water borne diseases	--Enforcement of SI 271 --Awareness and education of communicable diseases --Awareness and prophylactic treatment --Rehabilitate mined areas; spraying insecticides --low cost water treatment units --boreholes --larvicide funding needed --Blair Research Institute of (MoH) has a plant whose leaves have toxic effects on mosquitoes—it's up to miners to implement	TDU should educate miners on -- how to refill pits and replant --how to prevent mosquito habitat --BioSand filters
No antenatal care for expecting mothers No immunization for children		
Carbon monoxide poisoning Methane—explosive Mercury intoxication		
Alcoholism		The GMP should consider if it could address this complex problem through drama TDU should support awareness that drinking and marijuana leads to accidents
Panners Association needs support --vehicle		GMP should consider loan of project vehicle to ZPA at end of project

MICRO FINANCE ISSUES		
PROBLEMS	**SOLUTIONS**	**GMP**
Inability to access finance	Set up micro finance scheme for ASMs Introduce flexible lending conditions that can be achieved by ASMs --Low interest rate is 60% per year --No collateral except for mine claim --Grace period of 4 months or more	Lobby Minister for free services
No finance for geological services	Facilitate free geological services	
Transport	See above	
Labor	See above	
Mining Equipment	Establish sustainable plant and equipment hire schemes --hire to buy or direct hiring	Zimbabwe Panners Association acquire equipment for hire Partnership with Government/RBZ and share 50/50
Safety considerations	See above	
Milling charges	See above	
Lack of skills	Training facilities for ASMs Finance management	
Security		
Water sanitation and electricity	Introduce heavily subsidized electricity and water scheme for the period of 5 years	

Appendix 2: List of Trainers

TRAINING OF TRAINERS, KADOMA (March 2006)	
NAME	**AFFILIATION**
Evans Ruzvidzo	Zimbabwe Panners Association
Stanley Tavengwa	Zimbabwe Panners Association
Walton Mazhude	Zimbabwe Panners Association
Tendai Shamu	Zimbabwe Panners Association
Mable Nyamkure	Zimbabwe Panners Association
Ellen Ncube	Women in Mining
Coras Digindawo	Zimbabwe Panners Association
Oliver Phiri	Zimbabwe Panners Association
Irvine Masanga	Zimbabwe Panners Association
Tendai Teteni	Zimbabwe Panners Association
Simbarashe Mabonga	Environmental Health Officer, Ministry of Health
Sister Nyarai Tembo	Rural Health Nurse, Kadoma, Ministry of Health
Spiwe Mungu	
Evlyne Moyana	Zimbabwe Panners Association
Maria G. Chidimu	Zimbabwe Panners Association
C.Z. Gambara	Institute for Mining Research
Lesley Kupahurasa	Institute for Mining Research
Edgar Kagumba	
Livi Phiri	Graphic Designer
Styx Mhlanga	Amakhosi Theater Company
Givemore Sakuhuni	Zimbabwe School of Mines
Simbarashe Gumbanjera	
Patience Singo	GMP UNIDO, Good Life Enterprises
Ndatenda Mondoh	Hazardous Substances Director, Ministry of Health
Martin Nkhata	
Paradzai Sibochiwe	
Shadrack Mutimbanyoka	Ministry of Environment
Spencer Kahwai	Institute of Mining Research
Dr. Isidore Yama	Kadoma District Medical Officer, Ministry of Health
E.E.D. Dzingai	District Metallurgist, Ministry of Mines
Nomvuyo Mdluli	Amakhosi Theater Company

Appendix 3: Schedule of Theatre Performances

PERFORMANCES OF "NAKAI" BY TAMUKA THEATER COMPANY		
Date (2007)	**Location**	**Size of Audience**
March 21	Kadoma Playhouse Grand Opening	200
March 31	Kadoma Sports Club, Women in Mining	200
April 1	Patchway Field	400
August 15	Botha Mine 1	500
August 16	Botha Mine 2	400
September 11	Cotton Research Beer Hall	600
September 12	Hoffmarie Farm	350
September 18	Riyon Mine	300
September 19	Patchway Mine	400
September 20	Alabama Farm	450
October 10	Venice Mine	400
October 11	Rio Tinto Mine	400
October 12	Golden Valley Mine	400
October 13	Martin Spur	400
October 14	Empress Mine	400
October 15	Etina Mine	400
October 16	Brompton Mine	400
October 17	Chakari Mine School Final Show and Evaluation	400
TOTAL AUDIENCE		7,000

Appendix 4 - Theatre Education Program

"NAKAI" - Play Synopsis

The story is about two feuding families, the Tabengwas and the Jimu family. The central conflict of the play hinges on the use of the farmland which Mdala Tabengwa, a promising commercial farmer owns. Meanwhile, Mdala Jimu, a vicious gold dealer and his team of panners own some gold claims inside Tabengwa's farm. Tabengwa complains about the health hazard and environmental degradation occurring in his farm. He wants Jimu and his team of Makorokozas / gold panners out, but Jimu is adamant he won't leave.

Underneath all this animosity, Jimu's nephew, Aringo (nicknamed Bhinya) falls in love with Nakai, Tabengwa's daughter (the apple of his father's eye). When Nakai becomes pregnant, women from both sides (Batete and Bhinya's mother) want to patch-up the relationship and bring peace between the two families to facilitate a marriage between Nakai and Aringo. Tabengwa won't hear of it. Jimu says, " Nakai is not the only woman under the sun." Tabengwa final disowns the pregnant Nakai and kicks her out of the family house. She moves in with boyfriend, Aringo.

Mdala Jimu's change of heart comes when he sees his nephew Aringo's health and that of Nakai becoming adversely affected by mercury. Aringo becomes impotent and has memory loss. Nakai on the other hand gives a pre-mature birth. Mdala Jimu becomes eager to learn more about mercury and the legal aspect of his trade. He solicits for micro finance to enable him to improve his mining activities in the farm. As Mdala Jimu changes the way he runs his operations in the farm, bridges are built and relationships improve between the two then correlated families.

Scene Outline

1. The play opens with an energetic Jerusalem dance. During the course of this dance our young cross-star lovers Nakai and Aringo are introduced. The girl Nakai is a Tabengwa while Aringo comes from Ndebvudzewaya family. Their two families are always at loggerheads over the use of a farm that Mdara Tabengwa, a promising commercial farmer occupies. When the dance stops, our young lovers remain on stage. They talk about their love and how it has been difficult to see each other / date with all the hostilities going on between t heir families. Their party is spoiled by the coming in of Nakai's young brother. He wants Aringo to leave his sister alone and get away from the farm house or else there will be trouble.

2. Tabengwa's farm - Mdara Ndebvudzewaya, a vicious gold dealer and his team of Makorokoza / gold panners are at work. While Mdara Ndebvu is talking about his lucrative deals on the cell phone, a sound of a car approaching is heard. It spells trouble. The black-boots!! Gold panners scatter, despite

Mdara Ndebvudzewaya's assurance that he will take care of the police. Instead of the police, in comes Mdara Tabengwa. He complains about the health hazard and environmental degradation caused by Ndebvu and his men in his farm. He says they import / bring in prostitutes and leave the place scattered with condoms. Tabengwa wants Ndebvu and his men out of his farm, but Ndebvu is adamant he won't leave. He says he has a permit to mine. He flashes it out. The mineral policy gives him the right to dig for gold in the farm. Ndebvu says it's about time small scale miners are given a chance. Aringo approaches and tries to calm down the scuffle between the two men, but Tabengwa threatens to bring in the riot squad.

3. Nakai is with Aringo. She is afraid that she is pregnant. Aringo assures her that he will take care of things. Nakai says his father will kill her; what are they going to do with all the animosity going on between their families. Aringo has hope. He says their relationship will help patch up the differences between his uncle Ndebvudzewaya and Nakai's father.

4. Tabengwa's farm house – Aringo and his go-between have come to talk to Nakai's family. They have come with the hope of settling damages and paying lobola. Mdara Tabengwa breathes fire. He does not want anything to do with a makorokoza family that is destroying his land. Batete (Nakai's aunt) tries to calm him down. She calls for peace between the two families in order to facilitate a marriage between Nakai and Aringo. Tabengwa won't hear of it. He wants the pregnant Nakai and her in-laws out of his house.

5. Aringo's hut- Aringo is working behind closed doors with a mercury amalgam. He is burning it. Nakai sits besides him knitting a jersey for their unborn baby. Mdara Ndebvudzewaya comes in and tells Nakai that she is welcomed in his family. He is happy that his nephew Aringo will soon be a father. Ndebvudzewaya points out that if Nakai's father continues misbehaving,- thus, giving his family uncalled for problems then his nephew has to look elsewhere, " Nakai is not the only woman under the sun". Nakai breaks down crying.

The group starts a song that talks about " the pain of loving someone and the unfair treatment the lovers are getting from their parents.

6. A short scene – Aringo and his friend are chatting. The friend gives Aringo a bottle of Vuka Vuka concoction. He comments on the strength and magic the herb can bring in his marriage. They laugh heartily.

7. Aringo's hut- Nakai and Aringo are quarrelling. She drags him into the room by his pair of trouser. Aringo has not been performing in bed. Nakai says that she is sick and tired of his endless excuses. She wants to make love just like they used to do before. He feels she is mocking his macho. Aringo loses his temper and almost beat her up. They are interrupted by Mdara Ndebvu who was called in to stop the brawling. Mdara Ndebvu wants to know what's happening. Aringo pulls him aside, he tells him about his health problem. He is scared that mercury has affected him. Ndebvu says,"

Nonsense!! My grandfather was a miner, my father was a miner, they were using mercury to catch gold but they both died at an old age of above 85 years." He says Aringo should try everything – chibvanu or visit a mental specialist doctor. Money is not a problem- he himself will foot the bill.

8. A short scene – Aringo is talking to Batete (Nakai's aunt) He discloses that Nakai is in hospital. She has given birth to a still –born baby. Batete wants to know whether Nakai was attending an antenatal care. Aringo says NO. Batete says Why not? He says the clinic is far away from the mine. Batete freaks out. She finally cools down and says she will talk to his brother Tabengwa before coming to the hospital.

9. Hospital ward – Aringo, Batete and Ndebvudzewaya are talking to the doctor. Ndebvu wants to know what caused Nakai to give birth to a still –born baby. The doctor says he suspects it was mercury. He found a high concentration level of mercury in Nakai's blood, urine and hair. Aringo wants to know whether they are any cure for mercury affected victims. The doctor says not any that he knows off. Mdara Tabengwa comes in. He talks to Nakai who is lying on the makeshift hospital bed. Tabengwa is sorry that he sent her away. He accuses Ndebvudzewaya for causing all this, - thus, lack of precaution in the use of mercury and all his mining activities. Batete tries to stop him, but Ndebvudzewaya says, " let him speak. I have been wrong about some things.". Ndebvu says he wants to make improvements to protect life in his mine. He says he has just secured a business loan that will help him improve the environment, safety and operations in the farm.

10. Tabengwa's farm – The group sing a working song. Mdara Ndebvu and his men are busy covering old mine pits and trenches in their claim. Some are planting trees. They are now wearing proper protective clothes, gumboots, helmets etc. Tabengwa the farmer joins them. He is happy to see what they are doing. Ndebvu jokingly says that the Tabengwas and the Ndebvudzewayas are now relatives. They need to live side by side amicable.

11. The play ends with the group singing a marriage / wedding song. The Ndebvudzewayas are paying lobola to their in laws. Nakai is now officially Aringo's wife.

Appendix 5: Zimbabwe Mercury Imports, 2001-2005

Year	Country	Imports, kg	Imports, $Z	Imports, $Z/kg*	Unit Value US$/kg (computed[1])
2001	South Africa	47	14,200.51	302.14	$0.55 - $5.71
2001	Germany	2774	942,307.59	339.69	$0.62 - $6.42
2001	UK	3751	1,058,554.87	282.21	$0.51 - $5.34
2001	Netherlands	17500	3,699,660.30	211.41	$0.38 - $4.00
2001	Switzerland	2	11,978.32	5,989.16	$10.87 - $113.23
Total		**24,074.00**	**5,726,701.59**	**237.88**	**$0.43 – $4.50**
2002	South Africa	306	161,165.72	526.69	$9.17 – $9.97
2002	Netherlands	25250	5,779,537.97	228.89	$3.98 – $4.33
Total		**25,556.00**	**5,940,703.69**	**232.46**	**$4.05 – $4.40**
2003	South Africa	8292	4,443,591.92	535.89	$0.65 –$10.06
2003	Germany	2682	2,462,592.71	918.19	$1.11 – $17.24
2003	Netherlands	15688	540,5183.5	344.54	$0.42 – $6.47
Total		**26,662.00**	**12,311,368.13**	**461.76**	**$0.56 – $8.67**
2004	South Africa	2334	207,238,481.40	88,791.12	$14.68 – $111.29
2004	UK	25	3,247,215.62	129,888.62	$21.47 – $162.81
2004	Netherlands	8768	56,001,379.13	6,387.02	$1.06 – $8.01
2004	India	3805	28,301,928.00	7,438.09	$1.23 – $9.32
2004	Russia	4340	190,953,568.70	43,998.52	$7.27 – $55.15
Total		**19,272.00**	**485,742,572.90**	**25,204.58**	**$4.17 – $31.59**
2005	South Africa	13795	6,224,729,606.00	451,230.85	$5.47 – $82.04
2005	Germany	690	187,475,242.40	271,703.25	$3.29 –$49.40
2005	Netherlands	2691	2,044,700,989.00	759,829.43	$9.21 – $138.15
2005	Switzerland	4650	2,526,945,967.00	543,429.24	$6.59 – $98.80
Total		**21,826.00**	**10,983,851,804.87**	**503,246.21**	**$6.10 – $91.50**

Appendix 6: Educational Cartoon by Levi Phiri – Scene From The Play "NAKAI"