Environmental Risk Reduction for Contaminated Sites at the Khaidarkan Mercury Mine

Remediation Synthesis Report

Prepared for UNEP Chemicals

by

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The report was produced as an outcome of an expert mission to Kyrgyzstan in September 2009 bringing valuable experience from Almaden and Idrija mercury mines, and advice from US EPA and Zoi Environment. It should be recognized that this is a synthesis report that is intended to provide an overview of the current situation. More detailed information on data gaps, monitoring needs and specific activities are to be provided in an extended version.

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1 Context

The world's governments agreed at the United Nations Environment Programme Governing Council in 2009 to prepare a legally binding instrument on mercury to protect human health and the environment from mercury. In doing so, the Intergovernmental Negotiating Committee that will negotiate the instrument is to develop a comprehensive and suitable approach to mercury, including provisions to reduce the supply of mercury taking into account the circumstances of countries. Negotiations are to conclude in 2013.

After the closure of major mercury mines in Almaden (Spain) and Idrija (Slovenia), the Khaidarkan mine in Kyrgyzstan is the last remaining major supplier of primary mined mercury to the international marketplace.

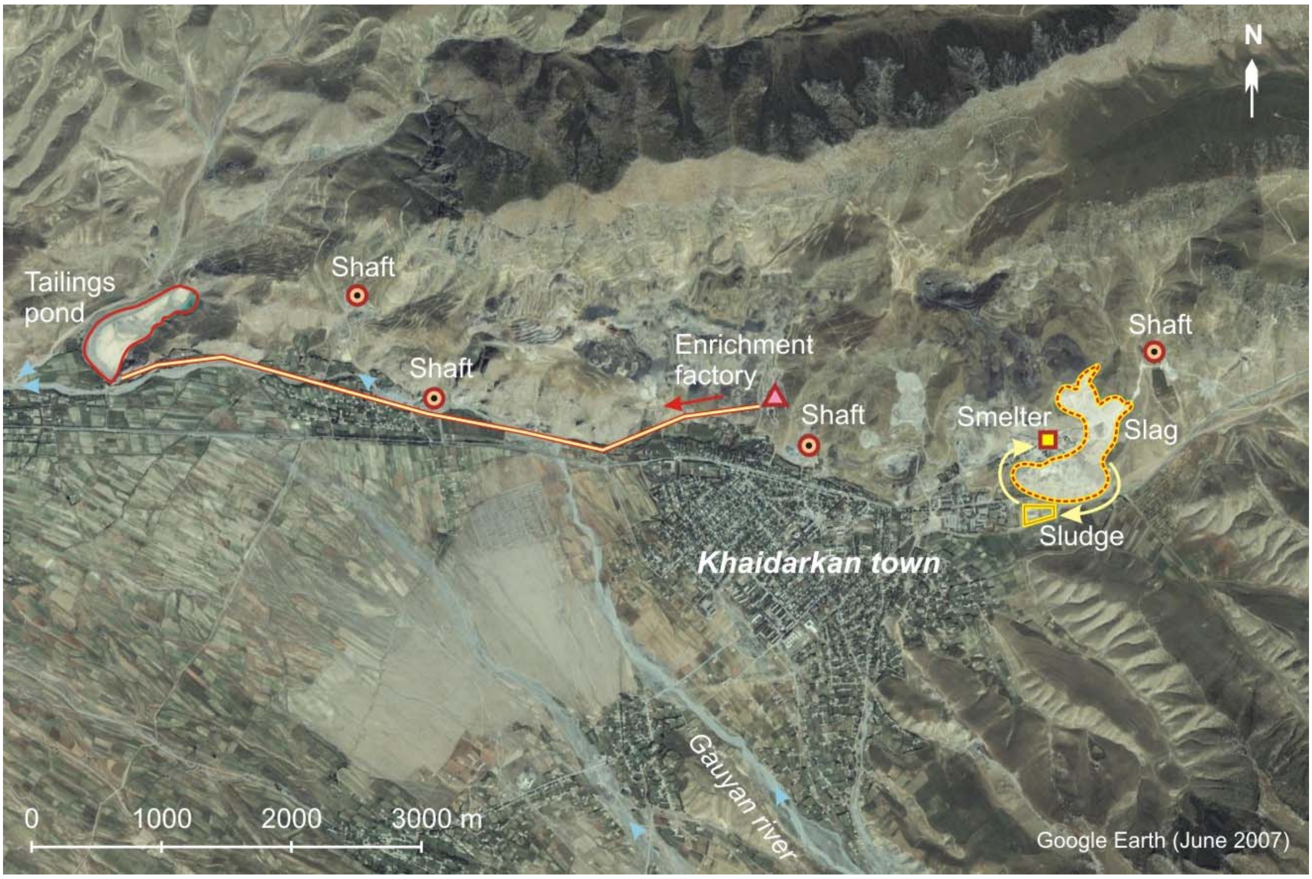
This report outlines options for remediation of selected potentially contaminated areas around the Khaidarkan mine site and town, including sludge pond, slag heaps, and tailings pond. Remediation approaches that are sketched out in this document are based on the initial assessment by international and local experts. Remediation measures will have several important benefits. The implementation of risk reduction measures will provide near term jobs and economic opportunities to local workers and enterprises with longer term regional / local environment and health benefits.

It is recognized that a more detailed planning document complemented with risk analysis, environmental impact assessment (EIA), environmental monitoring and activities raising public awareness should be established as part of the overall future remediation process.

In order to support the planning, implementation and assessment for remediation works, the Spanish National Technology Center for Mercury Decontamination is planning to conduct a risk analysis at Khaidarkan and develop a monitoring program, including training for local counterparts, in 2010 which will provide the basis for concrete interventions and their adjustment as required

2 Sources of contamination

After more than 60 years of primary mercury mining at Khaidarkan and lack of technical and environmental measures a large number of contaminated sites occurred which are now the sources of mercury emissions. These sources are joined by non-point source emissions arising from atmospherically deposited mercury in the area. In order to address the issue efficiently, it is necessary to prioritize sites according to relevant criteria such as level of hazard, expected risk, feasibility and benefit of potential interventions, and cost.



2.1 Sludge pond

2.1.1 Site description

The sludge pond is considered one of the most problematic areas in Khaidarkan by the expert group and town authorities. Further analysis of contaminants, in particular methylmercury, is required to determine actual risk more precisely.

The sludge pond is a flat, low-lying area where residues from the mercury purification during the smelting process are collected. The sludge contains grained material that has been transported to the area via canals as a suspension and subsequently drained onto the site. The area is about 4 ha and reportedly partly lined with concrete. Samples taken from waste stream leading to sludge pond indicate highly elevated mercury concentration (solids 1-2 kg Hg/tonne, liquids ~14mg Hg/l). The total amount of mercury-rich waste stored is estimated to be around 90000 tonnes. Surface water naturally accumulates on the sludge material which constitutes a risk for methyl mercury formation. The site is located next to the main road leading to Khaidarkan town in the eastern part and is frequented by herders whose livestock drink and feed around the site. Vegetables are cultivated nearby. There are no fences or covers that prevent access, erosion and drainage.

The sludge pond is potentially a source of atmospheric mercury emissions and mercury discharges to surface and groundwater. It is feared that contamination of cattle and related products such as meat and milk occurs via this site.

2.1.2 Possible remediation approaches

Should it prove true that the deposited material displays highly elevated concentrations of mercury or other contaminants, as preliminary sampling indicates, it may be necessary to remove the sludge and store it in a safer location. The sludge could be excavated and mixed with cement slurry which would be backfilled into secure empty spaces in the underground mine, if possible in areas with no underground water. Addition of stabilizing agents (e.g. sulpide, polysulphide) should be considered before treatment with cement (if there is elemental mercury or other soluble mercury compounds present). Otherwise elemental mercury remains mobile and could pose a risk when groundwater enters the deposited waste. Considerable experience with this technique exists at the mercury mine in Idrija.

Alternatively, the material could be treated in the metallurgical plant to remove mercury from the sludge and to facilitate environmentally sound disposal. This option could prove to be cost-efficient given that it will not involve additional equipment and will use simple excavation and transport to the smelter. It should be noted that reprocessing this waste could result in several tons of marketable mercury and atmospheric emissions if the smelter is not operated properly.

After excavating the sludge, the area could be filled with low-mercury waste material, e.g. waste rock from areas that require physical stabilization. To enable re-cultivation, the area should be covered with an impermeable layer and topsoil followed by re-cultivation to avoid water ingress. A cover layer of clay, geotextiles, or synthetics maybe applied. Given that there are various clay deposits in the vicinity of Khaidarkan, this may be the most cost efficient solution.

If the mercury content in the sludge is below levels of concern, excavation could be avoided and a cover as described above would be applied directly. The capping will prevent exposure to livestock, limit water ingress, reduce dust generation and allow safe agricultural production in the area.

2.1.3 Estimated cost and employment generated

Environmentally sound and through project planning for this task will comprise in-depth analysis of mercury contamination levels throughout the waste site and characterization of pollution pathways for efficient risk reduction measures. This works will comprise drilling, sampling and laboratory analysis of the waste material and surrounding areas. It is estimated that this work can be concluded within a period of 2-4 months during warm weather. The results will determine appropriate measures relevant for determining the resources required to address this site.

Potential tasks comprise:

- Project planning and engineering
- Excavation and transport of waste material and contaminated soil over an area of 4ha to a depth of 1.5m
- Installation of a cement slurry mixing unit and pumping facility
- Transport of solidified waste into underground cavities
- Clay extraction, transport and application
- Topsoil application and re-cultivation (phytoamelioration)

Equipment such as excavator, bulldozer and trucks can be supplied by the mine, while plants for re-cultivation can be provided by the local authorities.

Estimated employment:	20 people over 6 months
Estimated cost[1]:	150 000 - 900 0000 USD

[1] Depending on the implemented approach, lower estimate refers to waste reprocessing and the upper estimate refers to backfilling. Cost estimates provided are based on rough calculations and experience elsewhere transferred into the Kyrgyz context. They strongly depend on local availabilities which could vary considerably at a remote location like Khaidarkan. The indicated figures will be subject to further improvement considering the international good practices and should be seen as approximations.

2.2 Slag heaps

2.2.1 Site description

Slags are smelting residues left over after the ore roasting process. Commonly these dry and rather coarse materials are backfilled into the mine shafts after exploitation to increase shaft stability, reduce land take and limit environmental impact. In Khaidarkan, no backfilling was conducted which resulted in 13 million tonnes of slag stored on 40 ha surface next to the town.

Significant risks related to the slag heaps area include:

- high slope angle, which can result in sliding (note that the area is prone to earthquakes);
- close proximity to the town, resulting in dust contamination of the residential area;
- possibility mercury leaching into surface and ground waters via precipitation
- possibility to generate gaseous mercury emissions entering the global cycle

The sheer quantity of slag stored in addition to the environmental risks listed is causing a general problem to landscape and limits options for land use in the area.

The mining company reports that slag contains low levels of mercury, however analysis conducted earlier in this project shows mercury concentrations around 0.2 kg Hg/tonne. If not mitigated, mercury evaporation from the slag constitutes a permanent emission source. Proposed risk analysis and monitoring planning by the Spanish National Technology Center for Mercury Decontamination is expected to characterize the waste in more detail to specify required action.

2.2.2 Possible remediation approaches

One option is to backfill the slag into the existing shafts. While at other mining operations, backfilling of this material is the most common and cost-efficient approach for reducing associated risks, the Khaidarkan management has raised concerns about using this method because of the mine water pumped from the shafts and used for irrigation in the valley. If the water level rises after mine closure and voids filled with slag become flooded, it is feared that irrigation waters become contaminated. Compared to sludge, the amount of slag that requires relocation is much higher (13 million tonnes of slag and 90 000 tonnes of sludge) so it is expected that not enough dry and safe voids for backfilling the material, as proposed for sludge, exist in Khaidarkan.

The area should undergo a detailed hydro-geological analysis. Such a study would determine whether a proper drainage system that deals with all water sources (meteoric water, springs) will need to be installed, and also if the water is polluted with mercury or other contaminants, in which case a water treatment facility may be necessary.

If concerns are confirmed, safe storage of this waste should be conducted in place. This would require reshaping of the slag to increase stability and to eventually allow for safe alternative land use options. By filling large depressions on the waste surface, water seepage through the waste material becomes limited and water impoundment on the surface is avoided.

Reshaping would be followed by capping with an impermeable layer (e.g. clay), topsoil, and re-cultivation to further limit water seepage, erosion and accessibility. This could eventually make this area environmentally safe and available for agricultural land use.

2.2.3 Estimated cost and employment generated

Cost and effort for remediation will depend on the approach chosen for this site. Potential tasks comprise of the following:

- Study and prioritization of slag waste areas for implementing risk reduction measures
- Project planning and engineering

The above studies are required. Cost for implementing risk reduction measures at the slag heaps will depend on the amount of slag requiring reshaping and capping. This will need to be decided based a physical and chemical analysis of the various slag heaps.

- Reshaping
- Capping, top soil application and re-cultivation
- Water drainage and treatment
- Establish sanitary-buffer zones

Estimated employment: 50 people over 5 years

Estimated cost: 3-5 million USD

2.3 Tailings pond

2.3.1 Site description

The tailings pond is located about 5 km west of the town and processing plant, with a surface of 22 ha. It is filled with fine-grained residues from milling and floatation processes (tailings) to extract fluorite, antimony and mercury from complex ore. The amount of tailings is about 400 000 tonnes with mercury content of around 0.1 kg Hg/tonne or below. Other contaminants such as arsenic and antimony are present in the tailings.

The tailings pond is neither covered on the top, nor isolated from the bottom which can lead to the release of dust or gaseous mercury to the atmosphere and/or the release of mercury containing effluents to surface and ground waters. There are no fences or other protection measures around the pond. There have been complaints by residents about dust formation during dry and windy periods.

The tailings are currently being considered by the plant administration for reprocessing to produce fluorite concentrate. Cover and re-cultivation of the tailings will only be possible if tailings are not reprocessed.

2.3.2 Possible remediation approach

In order to reduce atmospheric mercury emissions, contaminated dust generation, and water seepage from the tailings pond, it is recommended to apply a clay cover similar to the approaches described earlier for the sludge pond. In addition it will be necessary to ensure the dam stability