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7 Assessment of environmental impacts

This chapter documents the impact assessment for the Project. The criteria and methodology used for assessing the significance of impacts is in accordance with the regulatory requirements of the DRC and methodology accepted by the World Bank Group. The methodology has been outlined in Chapter 1 of this report.

The chapter starts with an overview of the impact assessment and a summary of the significance ratings assigned to all impacts. A detailed discussion of each impact is then provided for physical, biological and sociological impacts identified. The principles of mitigation, presented below each negative impact, are developed in further detail in Volume 3, ESMP. The cumulative effects of impacts are discussed in Chapter 9 and a further summary table showing the significance rating of impacts once mitigation and management measures have been implemented is provided at the end of this chapter. A comment is provided on residual negative impacts which remain high following mitigation, at the end of this chapter.

7.1 Overview of Impacts

Kolwezi is not a 'Greenfield' project; it is a project which will take place in a landscape that has been mined or affected by mining, directly and indirectly, for almost 100 years. Although the bulk of the concession area has not been mined, it lies adjacent to the extensive mining areas of Luilu and Kolwezi and is degraded due to its proximity to former mining activities. The greater Kolwezi area has seen a precipitous decline in mining and related industrial processing over the past two decades. This decline, coupled with the political instability of the DRC during this time, has had extensive negative socio-economic effects. These negative trends are indicated by the extent of subsistence agriculture practiced in the KMT Concession Area, a relatively recent phenomenon, as local residents have shifted from the security of mining jobs to survival strategies. Even more dramatic has been the rise over the past three years in artisanal, 'illegal' mining in the Kolwezi area, spilling over also into the KMT Concession Area, as Gécamines' production has all but ceased and the cobalt price has increased dramatically on the world market. The result of this history is that the greater Kolwezi area, although it now offers very few formal jobs, is host to some 400 000 people.

The Project is predicted to bring about significant improvements in the local human environment not only due to the economic benefits that it will bring. It will also result in improvements, such as the following:

- improved physical infrastructure and social services;
- in the long term, restoration of the Musonoi river valley after the tailings are mined out (although water quality depends, in part, on upstream activities over which KMT has no control); and
- Improved air quality, due to the removal of the Kingamyambo tailings (which is presently a major source of dust; effective management of the Project's new TSF will ensure that it does not become a new source of dust).

The consideration of impacts takes into account two phases of mining, one during which Kingamyambo is mined and Musonoi is mined using dredge barges, and the second during which the

Musonoi is drained and mined using the same hydraulic method as is used for Kingamyambo. Noise generated by the project will also generally not be an issue due to the distance between residential areas and the sources of noise, with two notable exceptions. The exceptions are the UZK mining village, which is adjacent to the Kingamyambo TSF and which will be affected by the noise of monitoring, and, the hamlet of Samukonga in the Concession Area, which lies between the plant and the new TSF. However, although the increase in noise levels at Samukonga will exceed the IFC's guideline value of a 3 dB increase in ambient noise levels, the absolute anticipated ambient noise level at the village remains within the recommended levels. An increase in 3dBA is believed to be perceptible, hence the guideline value. While noise levels have not been recalculated, the larger TSF footprint has led to the further encroachment of this on the village. This has resulted in the recommendation to relocate the village and a Resettlement Action Plan has been developed accordingly (See annex B fro the Framework Resettlement Action Plan).

Negative biophysical impacts of the project are predicted to be generally moderate (*see discussion on water impacts below in Section 7.5 and 7.6*). Parts of the Concession Area have been directly impacted by past mining, notably the Musonoi River and Kasobantu Dam filled by tailings, which constitutes the project resource. Where mining has not occurred, past commercial agriculture and currently subsistence, slash-and-burn agriculture has extensively transformed natural habitats, leaving tiny, isolated pockets of intact habitat with some conservation value.

Project infrastructure siting has largely eliminated any significant impacts on biodiversity and sensitive ecosystems. Where artificially created wetlands (created by the filling of the Musonoi valley) are threatened, the impacts can be mitigated as deemed necessary by KMT as part of the ongoing closure planning process. The mining of the Musonoi tailings is anticipated to create an opportunity to restore some of the ecological form and function of the 12 km of river valley that has been destroyed by the tailings deposit.

Air quality impacts from the plant are predicted to be minimal, due to the adoption of strict design standards for emissions. Mining of the tailings deposits by a water monitoring method will reduce dust generation from these sources in comparison with present levels. Management and ongoing rehabilitation of exposed surfaces of the new Tailings Storage Facility (TSF) will limit dust generation from that new source during the operating and post-closure phases.

Groundwater quality impacts, using the absence of significant pollution to groundwater of the past mining activities in the area as a guide, are likely to be minimal from this project (although saline seepage from the TSF is anticipated which is likely to affect certain community users. This may necessitate compensation for crops or the provision of alternative water supplies. In addition, the mining of the Musonoi tailings is expected to cause some lowering of the local water table, which has been artificially elevated due to the damming effect of the tailings.

The majority of significant biophysical impacts are related to surface water, but even here generally project infrastructure siting and design standards have circumvented many potential impacts. The TSF has been sited so as to avoid direct impact on the Muninga and Kanamwamwa streams. Excess water accumulating in the tailings pool on top of the TSF in wet weather will be pumped, as required, to the Luilu River where its impact will be relatively low, as indicated below. Seepage captured by the TSF underdrainage system will be pumped back into the tailings pool and in dry weather returned to the Plant.

Mining of the Musonoi tailings will commence concurrently with Kingamyambo and will continue through the wet season as well as the dry season. This may require the construction of a significant river diversion channel capable of managing flood flows in the mining area during the wet season. Such floods could also put workers at risk, and this must be carefully managed. Following an initial period of dredge mining, mining in the Musonoi will require draining the tailings area including Kasobantu reservoir. FQM intends to investigate and implement the means of draining the Kasobantu tailings area while dredge mining is in progress. This activity will impact on local fishing, but reportedly the fishing in Kasobantu is poor and the fish are very small. Nonetheless, loss of access to this resource could impact on food security in these villages for the duration of the project, and compensation will have to be investigated, or alternative food sources provided. In the long term, conditions in the Kasobantu will improve, because of the removal of tailings from the dam basin, and an improved resource will be available to local people.

As indicated above, the excess tailings water due to heavy rains in the wet season will be pumped to the Lulu River. The Luilu is a tributary of the Lualaba River, entering the Lualaba some 15 km below the Nzilo Dam. The Luilu has historically and presently receives effluents and waste water from pit dewatering from several mines and metallurgical plants so that its water quality and aquatic habitat are chronically severely degraded. Field observations are that the bulk of flow in the river during the dry season comes from mine and plant discharges, and that the flow increases some ten times due to runoff, during the wet season. Surveys conducted amongst villages in the Luilu river valley indicate that the river water is not utilized by local people, because they are aware that it is already polluted. Ecological studies have demonstrated that the aquatic habitat of the Luilu is effectively non-existent, due to the extent of the long-term pollution of the river.

In the Lualaba, the increment in TDS will be insignificant due to the volume of flow in the river. The effect the discharges from all sources to the Luilu will cause the TDS of the Lualaba to increase by about 40 mg/l during exceptionally low flow conditions. The contribution of the KMT tailings discharge is estimated as less than 10 mg/l TDS. At this level of impact, the effects in the Lualaba with respect to human health and aquatic ecosystem function will be negligible. None of the constituents of this effluent are a health issue (magnesium, calcium and sulfate) and neither the DRC Mining Code regulations nor the World Bank Group effluent discharge guidelines, imposes a limit of dissolved salts on effluent reporting to a TSF or water course.

7.2 Geology

Impact G-1: Sterilisation of exploitable ore body – loss of mineable resource

Impact Significance

Construction Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
1	1	2	2	4	Very low
Score	2			8	16

Operational Phases 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
1	1	2	2	4	Very low
Score	2			8	16

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
1	1	2	2	4	Very low
Score	2			8	16

Drilling at the proposed plan site has shown that there is no mineralisation of the Ks 1.2.2. orebody. Sterilisation drilling has also been undertaken within and around the new TSF area, and along the proposed rail spur route. Assays of the samples from boreholes in the vicinity of the TSF did not show any mineralization of copper, cobalt or any other resource within this area, apart from iron as hematite and other iron aluminium oxides. The Kundelungu Formation is generally regarded as sterile in the Kolwezi area. Although the TSF will be a permanent feature of the landscape there is no apparent mineralization in the area of the new TSF. The risk of sterilisation and subsequent loss of a mineable resource is thus highly improbable and no further mitigation is required for this low impact. A section of the plant access road traverses the Kakifuluwe orebody and could potentially be mineralised; however the Long Facies of this orebody is generally of low copper and cobalt grade (Francois 1973). The access road has been built but if future mining was to occur at the Kakifuluwe orebody, the road would need to be re-routed.

Principles of mitigation:

- Avoid sterilisation of any mineable resource in the KMT Concession Area.

Impact G-2: Exposure of receptors to radioactivity /Potential litigation

Impact Significance

Operational Phase 1

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	1	1	1	5	Low
Score	6			7	42

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	2	2	1	5	Medium-Low
Score	7			8	56

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	1	2	1	5	Low[2]
Score	6			8	48

The airborne spectrometric survey (Hunting 1970) indicated that the Ki 1.1. or the Grand Conglomerate does have a radioactive signal greater than background (>620 cps) due to the decay of feldspar, monazite and zircon in the conglomerate. Following recent events in the Kolwezi area, and others within the Katanga Province, The DRC Government has made it obligatory for mining enterprises to carry out radioactive screening across their concessions as part of the application for mining authorisation. It may thus be prudent for KMT to take background readings in the vicinity of the new TSF prior to tailings deposition. Since the radioactive levels measured for samples of the Musonoi and Kingamyambo tailings (See Section 5.2.1, results of radiation survey) were low the potential for any workers on the new TSF to be exposed to dosage levels which exceed the recommended daily dosage levels is unlikely hence this impact is considered to be low.

Principles of mitigation

- Monitor radioactivity levels of plant tailings and monitor background radioactivity levels at TSF prior to deposition of tailings and implement an appropriate management plan based on results.

(As indicated above, radioactive screening of the entire concession area is now required.)

Impact G-3: Failure of TSF due to subsidence, faulting or seismic activity- potential loss of life

Impact Significance

Operational Phase 2

Likelihood		Consequence			
Frequency of activity[3]	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
1	2	5	2	5	Low
Score	3			12	36

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
1	1	5	2	5	Very Low
Score	2			12	24

Failure of the proposed new TSF due to subsidence, faulting or seismic activity could lead to potential loss of life in the nearby hamlet of Samukonga and damage to the environment down gradient of the TSF. The underlying geology of the TSF area is not dolomitic and therefore karst formation and subsidence is deemed very unlikely. The geophysical surveys (both airborne and along the pathways through the TSF area) did not detect any major structural features so failure along a fault plane is highly improbable. Seismic activity within the Kolwezi area has been reported by Gécamines as 3.5 on the Richter scale but the reliability of this figure has not been verified. Potential seismic effects will be built into the design of the TSF.

Although the potential for this impact to occur extends to post-closure the potential for failure is highly unlikely. The dam will become more stable as it dries out, further reducing the likelihood of this impact post-closure. The potential loss of life that could be associated with Samukonga should the TSF fail is discussed under the Socio-economic impact descriptions. The low significance of this impact negates the necessity for further mitigation measures; however, the risk of loss of life amongst the Samukonga villagers in the event of a tailings breach is high enough to recommend the relocation of the village, particularly given the extended footprint and height of the dam. Once this has happened, which is anticipated to be during the construction phase, the risk of significant damage due to a failure in the TSF can be considered low.

Principles of mitigation:

- Conduct a seismic risk analysis and incorporate findings into design specifications.
- Ensure that the design and construction of the TSF takes adequate cognizance of these issues.

Impact G-4: TSF failure due to poor design and/or operational management leading to loss of life at Samukonga village

Impact Significance

Operational Phase 1

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
1	1	3	1	5	Very low
Score	2			9	18

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
4	4	5	1	5	Medium-High
Score	8			11	88

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
4	2	4	1	5	Medium-Low
Score	6			10	60

The proposed TSF is located 800m up-slope of Samukonga village with a height difference of 20m (1:40 slope). The tailings material which the tailing design engineers are working with (Epoch Resources) is fairly fine and the slurry density has been calculated to range from 1.1 to 1.3 t/m^3. Fine material is generally less stable than material that includes a larger fraction. Most conventional TSFs operate on a slurry density of about 1.5 which typically equates to about 50% water (by mass); at 1.1 to 1.3 the water content is much higher, and therefore the tailings is more liable to flow if there is a breach in the dam wall, or an overtopping (as may occur after a severe storm). For the first 3 or 4 years after commissioning of the TSF it will be fully contained within the starter wall (Phase 1 and then Phase 2), and can be considered a lower risk. However, the risk of loss of life amongst the Samukonga villagers in the event of a tailings breach is high enough to recommend the relocation of the village. Once this has happened the risk of significant damage due to a failure in the TSF can be considered low.

Principles of mitigation:

- Develop, implement and update regularly a site-specific TSF operating manual.
- Conduct regular inspections of the TSF and regular audits of operational records.
- Conduct regular independent risk assessments for the TSF.
- Develop Emergency Procedures to deal with high rainfall events.
- Relocate Samukonga village

7.3 Soils, Land Capability and Land Use

Impact S-1: Loss of productivity of soils due to sterilisation

Impact Significance

Construction

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	5	2	1	5	Medium-High
Score	10			8	80

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	5	2	1	5	Medium-High
Score	10			8	80

Post Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	5	2	1	5	Medium-High
Score	10			8	80

This impact pertains primarily to the soils below the new TSF (420 ha) which will be permanently sterilized. The soils beneath the plant (137 ha) will be sterilised for the life of operations and rehabilitated post-closure. Soils in both these areas will be sterilized as soon as construction of this infrastructure commences. Soils in the quarry area will also effectively be sterilised (if the material is deemed suitable), but this site is in steep, rocky areas of no agricultural potential. It should be noted that soils beneath the TSF are considered to be only marginally suitable for cropping (although the footprint areas for both the new plant and new TSF comprise primarily cassava fields) thus the significance of this impact is considered Medium-High.

Principles of mitigation:

- Ensure that the respective sites are restored to suitable land use capability after closure of the mining operations.
- Sufficient topsoil will be pre-stripped from the new TSF, quarry and plant areas and stockpiled appropriately (to avoid wind and water erosion and limit degradation) for use in rehabilitation of the TSF side walls, quarry and plant areas. An alternative revegetation approach will be developed for the upper surface of the TSF.

- When stripping topsoil, remove large trees only immediately before removal of the soil. The remaining small trees and bushes should be left in situ as this will contribute to the organic matter content of the soils when placed (and by implication the fertility of the soil).

- The topsoil will be stockpiled. Stockpile height should not exceed 5 m.

- When the soils from the stockpile are placed as cover material, fertiliser requirement determinations are necessary to redress any deficiencies that may be present in the soils.

- The appropriate rehabilitation methods adopted, following vegetation trials should mitigate visual and dust related impacts around the TSF and quarries.

Impact S-2: Degradation of soils due to increased salination

Impact Significance

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
4	4	4	2	4	Medium-High
Score	8			10	80

In particular, the soils around the tailings storage facility are likely to experience an increase in salinity due to the quality of the seepage (approximately 8,000 mg/l TDS) from the TSF during its operational phases and for several decades after decommissioning. Soils around the proposed infrastructure components may increase in salinity if storm water is allowed to run off the side slopes of the TSF or from "dirty" areas around the plant. There is the potential that sediments could be transported from the dam onto the soils, which could result in a build-up of salts in the soils onto which they were deposited. This salination could potentially result in the loss of productivity of the soils downstream of the TSF. Soils downstream of the new TSF site are currently utilised for agricultural activities, therefore, loss of this soil may impact on farmers' ability to produce food. Salination due to delivery pipe bursts could result in the contamination of the soils in the vicinity of the pipe. The spatial scope of the impact will be dependent on how quickly the burst is repaired. The severity will depend on how quickly the spilled tailings are lifted and moved to the TSF.

In relation to the plant the ESMP provides for the separation of clean and dirty water. There will be no uncontrolled discharge of dirty stormwater into surrounding areas except for accidental spillages. Contamination of nearby soils from this source will therefore be negligible.

Principles of mitigation:

- The effects of soil salination due to seepage from the TSF will decrease with distance from the TSF. However, crops grown within 1 to 2 km down-gradient of the TSF may need to be relocated due to high soil and water salinity, attracting appropriate compensation.

- Adequate runoff control measures (as described below) are needed around the TSFs including cladding or re-vegetation to stop erosion and adequate toe-paddocks around the dam to capture runoff.

- An emergency procedure will be developed by the mine to handle pipe bursts. Factors that need to be considered include:

  - Burst detection systems;

  - Pipe isolation mechanisms;

  - Construction of a number of pipe failure basins;

  - Clean-up procedures.

Land Capability/Land Use

The majority of the concession area has been subjected to slash-and-burn subsistence based agriculture. Slash-and-burn has led to a loss of organic matter from the soils, which in turn has impacted on nutrient cycling. This has probably led to a depletion of nutrients in the soils.

With the exception of 0.4% of the site, the soils in the concession area have a relatively low land capability, with the soils being marginal or unsuitable for agricultural purposes. This low classification is a result of the farming practices (slash-and-burn) that have occurred in the area. The footprint areas of the new plant and new TSF are comprised primarily of cassava fields. The loss of land capability/land use is dealt with in the discussion on Socio-Economic impacts (Chapter 8 of the ESIA)

7.4 Air Quality

The Kolwezi area is characterised by dry winters and suspended dust during the dry season is a common occurrence due to the poor management (for dust) of the existing facilities that generate dust (primarily the Kingamyambo TSF but also waste rock stockpiles and gravel roads). These existing conditions should be kept in mind when addressing potential changes in ambient dust concentrations due to the project.

Impact A-1: Increase in nuisance and health risks to residents due to increase in ambient dust concentrations (PM10 and TSP)

Impact Significance

Construction Phase

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	2	2	3	Medium-Low
Score	8			7	56

Operational Phase 1 and 2

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	3	2	4	Medium-low
Score	8			9	72

Post Closure

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	3	2	4	Medium-low
Score	8			9	72

Initially, during the construction phase, ambient dust levels in the vicinity of the KMT concession area are expected to increase due to the use of earth moving equipment, quarrying of aggregate material and construction activities. However the impacts related to these activities are expected to be low to medium, episodic in nature and limited to the construction phase.

During operations[4], the new TSF will have the potential to increase the amount of windblown dust in the north western corner of concession area and increase nuisance and health risks to people living in close proximity (i.e. Samukonga hamlet) unless appropriate rehabilitation measures, to be selected in terms of trials to be conducted (during operations), are implemented as deposition of the tailings proceeds. However, it should be noted that the probability is for reduced health and nuisance impacts relating to dust than those currently experienced in the vicinity of the Kingamyambo tailings facility due to proper design and management of the new tailings facility. See Figure 7.1 to Figure 7.8 for an illustration of changes in the PM_{10} and TSP levels in the concession area during operations once 50% of the tailings have been reprocessed and then once 100% of the tailings have been reprocessed.

Dust emissions caused by vehicle movements within the concession area will also contribute to increased ambient dust levels however these will be limited to the life of operations as opposed to dust from the TSF which will continue post-closure (in the absence of any mitigation measures), and will also be minor in comparison to current emissions from the Kingamyambo TSF. Although PM_{10} dust levels will remain below the DRC guideline levels, exceedances of the World Bank Guidelines are predicted during the operational phase, thus making it imperative that the dust suppression measures that are recommended are implemented during the operations.

Principles of mitigation:

During construction:

- Only remove vegetation cover of the footprint area where the construction activity will occur;
- Re-vegetate disturbed areas soon after the construction is complete and the lay-down area is vacated;
- Spray unpaved site roads, access roads and construction terraces with water or a bonding agent during the dry season. If water is used then this must be done as necessary;
- Implement traffic control measures such as low speed limits on unpaved roads;
- Dust generating activities such as earth works or road construction must be stopped on days when the prevailing winds exceed 20 km/hr.

During Operations and Post Closure:

- Vegetate or rock clad all side walls of the TSF, as soon as practical during operations.
- Maintain a wet beach (of between 60% and 80% during the dry season) on the surface of the TSF as far as stability conditions allow. It should be noted that this was factored into the model simulations for the operational phase with respect to dust emissions from the TSF.
- Vegetate the top surface of the TSF as soon as is practicably possible after closure i.e. after the surface has dried and it is possible to work on it.
- Enforce speed limits of less than 60 km/hr on unpaved roads and control traffic volumes in and around the concession area.
- Control dust emissions from roads with high traffic volume by applying a dust suppressant and or watering especially during the dry season
- Gradually rehabilitate and vegetate mined out footprint areas from the Kingamyambo TSF as soon as the area has been mined. However the revegetation must be practical so that it does not interfere with mining activities and at the same time future mining activities will not damage the rehabilitated areas.
- The present programme of dust monitoring will continue with regular audits and inspections of the equipment and monitoring system.

Impact A-2: Health risks to local villagers over the long term due to increases in ambient gas concentrations (SO_2, NOx and Volatile Organic Compounds)

Impact Significance

Construction Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	2	1	1	3	Low
Score	7			5	35

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	2	2	4	Medium-Low
Score	8			8	64

The limited baseline SO_2 and NO_2 monitoring that was conducted during the dry and wet seasons on site indicated that the baseline ambient concentration for these gases were negligible thus any significant emissions of these gases into the atmosphere will result in an increase in the levels of these gases within the concession area. NOx and volatile organic compounds emissions are primarily due to motor vehicle activities and biogenic processes (microbe activity in soils). Gaseous emissions from motor vehicle activities will be negligible; however, all mine vehicles should be well maintained to avoid excessive emissions. Biogenic processes are considered to be significant emitters of VOCs and NOx although these have not been quantified for the Kolwezi area.

Ambient SO_2 concentrations are expected to remain relatively unchanged for the duration of the operation. The proposed (comparatively small capacity) sulfuric acid plant will have a negligible impact on ambient sulfur levels, which will be <2% of the DRC and <5% of the World Bank Guideline values. However this prediction assumes that the emission concentration supplied to SRK (for model simulations) will not be exceeded and that all emission control devices are installed. There may, however, be short-lived episodes when ambient SO_2 levels increase due to upset conditions or accidents. However if upset conditions occur for <5% (for short periods less than 1hour) of the operating time of the sulfuric acid plant then the environmental impact during these episodes is not expected to be significant.

Whilst SO_2 emissions from the sulfuric acid plant are low during normal operating conditions, it is important to note that when upset conditions or accidents occur or there is a failure in the gas cleaning equipment, ambient SO_2 levels will increase to levels that are likely to pose a risk to human and ecological receptors in the receiving environment for short periods.

It should be recognized too that sulfur stockpiles are at risk of ignition from veld fires or careless activities. The gases released from burning sulfur are likely to pose high risks to the health and life of human and animal receptors.

Principles of mitigation:

- Specifications supplied for the simulation model should be adhered to.
- Commissioning of the sulfuric acid plant must be well planned and executed, with the emission controls systems in place having being tested prior to plant start-up.
- Ensure that a SO_2 scrubber is installed in the sulfuric acid plant since this study has found that low impact will be associated with this activity only when a SO_2 scrubber will be installed and maintained at the plant.
- When an upset condition occurs as a result of failure of the SO_2 scrubbing system the plant should be closed immediately to avoid potential health and nuisance risks to receptors.
- A vehicle maintenance programme will minimise excessive emissions.
- Refuge and Assembly points for personnel need to be defined in case of severe plant upsets or accident.
- Emergency Responses to acid plant and sulfur stockpile accidents need to be defined in detail, and emergency exercises practised periodically.

Impact A-3: Reduced ambient dust concentrations

Impact Significance

Operational Phase 1+2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	3	2	5	Medium-High (positive)
Score	8			10	80

Post Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	4	4	2	5	Medium-High (positive)
Score	9			11	99

The proposed development will result in a significant decrease (up to four times) in ambient dust concentrations and the concentration of particulate matter in the atmosphere both within and around the vicinity of the concession area once the existing tailings dumps (Kingamyambo and Musonoi) have been removed. The decrease in ambient dust levels will depend on whether erodible surfaces of the new TSF will be constantly rehabilitated during the operational phase and finally rehabilitated at the end of the operation.

The Kingamyambo TSF is a major source of dust in the Kolwezi area particularly during the dry season of the year and particularly downwind of this deposit. The dredge and hydraulic mining of this tailings deposit during the life of the operation and later intermittently throughout the remaining life of mine will cause a noticeable decline in the amount of wind blown dust emanating from this deposit and an overall reduction in the wind blown dust within a 6 km radius of the KMT concession area in the vicinity of Kolwezi and the nearby villages. The project is thus anticipated to have a positive effect on dust levels within the area and the mining method is itself a form of mitigation of current ambient dust levels.

In order to maintain reduced dust levels in the vicinity of the existing tailings deposits these areas need to be rehabilitated once the tailings are removed from the footprint areas (both at the Kingamyambo and Musonoi).

7.5 Surface Water

Impact SW-1a: Pollution of downstream water courses[1]

Impact Significance

Construction Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	5	2	1	5	Medium-High
Score	10			8	80

Operational Phase 1 and 2 & Post-Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Severity of impact	Spatial/Population scope	Duration	Rating
5	3	1	4	3	Medium-Low
Score	8			8	64

All areas cleared of ground cover and topsoil for construction (during topsoil stripping and stockpiling and earthworks), including the plant site, TSF starter wall, haul roads, quarry and effluent pipeline servitude, will be vulnerable to erosion of soils caused by stormwater runoff. The transport of eroded sediments into watercourses and water bodies, notably the Musonoi River, its lesser tributaries that dissect the KMT Concession Area and a few wetlands associated with them, may lead to pollution (turbid water) and sediment depositions in such water bodies, causing ecological degradation.

Standard runoff control and water management practices, such as separation of clean and dirty water, bunding of all fuel storage depots and vehicle repair sites (to prevent surface water being contaminated by spillages from oil, grease and fuel), are built into the design parameters of the project. Other ‘natural’ mitigation of this potential impact is that slopes in the project footprint area are generally very low and soils have low erodibility. Also, the Musonoi tailings deposit and Kasobantu dam act as a settling pond. The only potentially sensitive receiving water bodies are the *dambo* to the south of the plant site, the Muninga stream and Muange dam and Kanamwamwa river below it (dealt with in SW-1b below), and the artificial wetlands where these tributaries are dammed by the Musonoi tailings.

During construction, water pollution is predicted to be low to medium, due to the limited extent of land clearance and the fact that all run-off will drain into the Musonoi, which will remain an effective pollution control sink until it is cleared up by mining operations. Standard run-off control measures will be implemented to minimise this impact.

1 This impact has been separated into two sub-sections (a & b) since the impact is rated as low for the majority of the Concession Area (SW-1a). However, in the vicinity of the Muninga stream there is the potential for a high negative

During operations, the storm water runoff from within the Kingamyambo as well as monitoring process water will need to be contained within the dam to ensure that this dirty water does not impact on the downstream environment or spill into the canal that runs south of Kingamyambo dam. Storm water run-off at the TSFs will flow towards the sump created for the capture of slurried tailings to be pumped to the plant. At the new TSF clean storm water will be diverted away from the tailings area and discharged to the environment.

The significance rating assumes that the hydraulic monitoring will occur daily and thus water management will be carried out on a daily basis as an integral part of the mining process. Post-mitigation, where sufficient storage is available within the monitoring area and sufficient bund walls are in place, will reduce the impact assessment to a very Low significance.

During the wet season, spillage from the plant storm water dam can be expected. Plant stormwater drainage will be reused within the plant where possible, but excess will discharge directly into the Kasobantu dam. Due to the dilution by high storm water volumes, such spillage is unlikely to be a significant pollution hazard. Upstream cut-off drains to divert clean water away from the plant are standard design features. Water from the tailings thickeners is returned to the plant for re-use.

It is projected that excess water in the tailings pool due to rains will be pumped to the Luilu River at variable rates peaking at about 1,300 m^3/h, with TDS concentrations between 3,000 and 6,000 mg/l.. During the dry season no dam drainage would be expected from the decant pond because the available water will be returned to the process circuit for reuse via barge pumps in the tailings pool.

There is the risk of contamination of surface water from pipe bursts and damage in the delivery pipelines from Kingamyambo and Musonoi tailings, the new tailings delivery line and the return water pipeline.

During the operational phase, when the Musonoi tailings deposit is being mined, the river diversion will in effect create a by-pass to the settling and pollution ‘sink’ role played by the Kasobantu Dam. Since the dam will be lowered and the river diverted directly into Nzilo canal, poor quality water from upstream of the Project will pass directly into Nzilo canal and into Nzilo Lake. In the lake a localized zone of impact around the discharge point from the canal can be expected. It will affect aquatic life including fish life in the bay where the canal enters the lake, but the volume of the lake as a whole is so large, that the impact beyond this immediate area will rapidly become undetectable. There will be no measurable impact on the Lualaba River downstream of the hydropower station.

Chemical reagents used in the metallurgical process will be stored according to the risks presented by accidental spillages. Where appropriate, reagents will be stored in secure areas on concrete floors within bunds of adequate volume to contain and recover spillages.

impact (SW-1b). Mitigation Measures discussed in the ESMP (Vol 3) also deal with the management of these two sub impacts separately.

Principles of mitigation:

- No earth moving equipment should be permitted to operate during the rainy season on areas not already cleared as this will increase the erosion of soils and potential pollution of surface water courses.

- The primary defence against erosion is to minimize the clearing of ground cover, and to restore ground cover as soon as is possible in the construction process;

- Construction of linear infrastructure through water courses and wetlands should be undertaken with extra care, with minimal clearing of vegetation, routine use of sandbags or rip-rap to settle sediment and divert water flow around/ away from the construction area, and rapid re-vegetation of the site. Such construction should also avoid the wet season, where possible.

- Should major erosion events occur resulting in the sedimentation of sensitive or important aquatic ecosystems, such deposits are to be removed at the contractor's cost (after due consideration of the relative benefits and impacts of such removal activity).

- The rainfall on top of the Kingamyambo dam will need to be managed during the wet season to ensure that sufficient storm water storage is available to contain the dirty water.

- The slurry collection structures for the monitoring will prevent the escape of monitored slurry to the environment.

- Cut-off drains upslope of major construction sites should be installed at the onset of construction, to direct clean stormwater runoff away from the construction site;

- Run-off from plant and tailings sites will be collected to prevent any contaminated run-off reaching the water courses.

- The present surface water monitoring system will be maintained and modified according to regular audits of the results.

- All fuels, chemicals and oils will be stored and bunded according to best practice to avoid or contain potential spillages.

- An emergency procedure will be implemented to minimise the risk of contamination from bursting or damage to pipes carrying tailings or return water.

- Erosion control measures can be used extensively to prevent the development of rills and gullies, as soon as flow paths become apparent. Sand bags, pegged logs, hay bales and rip-rap are quickly assembled and installed.

Impact SW-1b: Pollution of the Kanamwamwa River and Muninga stream

Impact Significance

Operational Phase 1

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	2	4	3	Medium-High
Score	9			9	81

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	2	4	4	Medium-High
Score	9			10	90

Post Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	3	2	2	3	Medium-Low
Score	8			7	56

Seepage of water from the TSF may potentially contain elevated salts and negligibly low metals, which could drain to the Kanamwamwa River, Muninga Stream and Muange dam (in whose catchment these facilities lie). These have a significant base flow component of near-pristine water quality. Part of the seepage water will be captured in the tailings underdrainage system and pumped back to the tailings pool. Some seepage from the TSF to the underlying soils and shallow water table may daylight in the receiving watercourses and increase the dissolved salts content. This is likely to affect fitness for use.

The impact will be medium-high during the operational phases, but post-closure the impact will reduce due to the progressive flushing of the tailings water. However potential ground water contamination (discussed under GW-1b below) could still enter the surface water supplies in this area through recharge.

Principles of mitigation:

In addition to the principles discussed in SW-1a above the following apply specifically to potential contamination of surface waters in the vicinity of the Muninga stream:

- The tailings decant pond should be discharged directly into the Kasobantu dam and not into the Muninga dam or Kanamwamwa or Muninga streams. The quality of the water that is discharged will meet World Bank guidelines and DRC regulatory requirements.

- Cut off drains upstream of the TSF and plant must be constructed to divert clean water away from this infrastructure.
- A seepage interception drain should be installed between the TSF and Kanamwamwa River to collect ground water seepage to prevent it reaching the Muninga stream. This drain should be directed towards the main tailings solution trench, which will be pumped directly back into the tailings pool.

Impact SW-1c: Diversion of the Musonoi River around the Kasobantu Dam causing erosion and seasonal flooding

Impact Significance

Operational Phase 1

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	4	3	4	Medium-High
Score	9			11	99

Post Closure (Diversion removed)

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
0	0	0	0	0	Structure Removed
Score	0			0	0

The Musonoi river will need to be diverted along the edge of the tailings. In order to take the 1:50 year event (310 m^3/s) a canal of 30m wide at base, 3 m deep (this is the minimum depth and depending on the topography, this could increase for portions of the canal) with side slopes of 1:2, resulting in a channel width of about 50 m at ground level. No detailed survey along the canal route has been undertaken so a gradient estimate of 1:300 has been used. The velocities in the canal may reach about 3 m/s. This diversion of the river will prevent the water entering the Kasobantu dam and the water level in the dam will drop significantly. The river diversion will in effect create a by-pass to the settling and pollution ‘sink’ role played by the Kasobantu Dam. Since the dam will be lowered and the river diverted directly into Nzilo canal, poor quality water from upstream of the Project will pass directly into Nzilo canal and into Nzilo Lake. The impacts of discharging directly into the Nzilo canal in terms of capacity have not been assessed but it is possible that the capacity at some places will result in spillage from the canal.

The diversion canal will need to be designed to ensure that seepage from the canal does not enter the mine workings and if the canal is made smaller then the risk of flooding the working areas will need to be carefully considered. The intention is to complete the feasibility study for a stream diversion or suitable alternative during the dredging operations in the Kasobantu Dam.

The impact will be high during the operational phase but once the diversion is removed then the impact will also be removed

Principles of mitigation:

- A detailed river diversion study will need to be conducted to assess the environmental and social impacts of this proposed diversion, using industry best practice as a guide.
- There should be areas along the diversion that people can have access to the water
- Local stormwater must be able to enter the diversion
- Areas where the diversion cuts through the farmlands will need compensation
- The impact of no attenuation on the downstream Nzilo canal will need to be addressed by relocating people that may be flooded due to the diversion (i.e. higher flows in the downstream Nzilo canal)

Impact SW-2: Reduced lake size due to lowering the Kasobantu dam water level

Impact Significance

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
2	3	2	4	4	Low
Score	5			10	50

In order to be able to mine the northern most section of the Musonoi tailings the water level in the Kasobantu dam will need to be lowered. The reduced water levels in the Kasobantu dam will impact on the lacustrine ecosystem of the dam and may impact on the fishing in the dam and canal to Nzilo Lake (these impacts are discussed under *Flora and Fauna*).

No mitigation measures are proposed at present, but will be developed during the operation if specific impacts are identified.

Impact SW-3: Poorer quality of water discharging to the Nzilo canal and into downstream Musonoi River

Impact Significance

Operational Phase 2 & Post-Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating

3	3	3	4	3	Medium-low
Score	6			10	60

The water that presently discharges into the Musonoi TSF and later into the Kasobantu dam is contaminated by the activities that occur upstream, including heterogenite mining and washing, discharge from the Kolwezi plant, discharge from the KOV pit, raw sewage discharge and runoff from the mining infrastructure in the area. The tailings deposits probably act as a filter for some particulate chemical pollutants. The overall result is that the water that leaves the Kasobantu Dam via the Nzilo spillway is less polluted than that which enters at the upstream end of the tailings deposit.

Once the mining of the Musonoi tailings using hydraulic mining commences, the filtering capacity will be lost largely due to the diversion of inflow around the mining area into the Nzilo Canal. Poorer quality water will thus enter Nzilo Lake and deposition of tailings, washed down from higher in the Musonoi catchment, at the entry point of the canal into the lake can be expected, should KZC continue to operate and discharge to the Musonoi. Water quality impacts will thus be translated further afield than they were in the past, when they were contained within Kasobantu dam. Post – closure, once the majority of the tailings have been removed from the Musonoi and the Kasobantu dam has filled up with water, the filtering function will still continue due to the length of the water body, which will still enable deposition of silt along its course before discharging via the Nzilo spillway.

A weir upstream of the active mining area, to settle out solids and other pollutants, should be considered.

Impact SW-4: Pollution of surface watercourses due to discharge of excess tailings water to the Luilu River.

Impact Significance

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	3	1	2	4	Medium - Low
Score	8			7	56

Excess tailings pool water will be discharged after heavy rains by pumping to the Luilu River whose ecological status has been destroyed over a period of decades by the continued discharge of mining wastes. Under these circumstances it is considered that the KMT discharge would do no further harm in the Luilu River. The Luilu is a tributary of the Lualaba River fed consistently by the flow through the hydropower turbines at the outlet of Nzilo Lake.Consequently, the dry season dilution of the Luilu flow by the Lualaba is at least 500-fold according to long-term hydrological records, and the effect of the KMT tailings discharge would be raise the TDS of the Lualaba River at the point of mixing by less than 10 mg/l (being approximately 1 mg/l of calcium, 2 mg/l of magnesium and 6 mg/l of sulfate). Increases in soluble salt levels of this magnitude are considered to cause no harm to the aquatic ecosystem or the health of downstream users.

SW-5: Impairment of aquatic habitats

Impact Significance

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	1	3	4	Medium - Low
Score	9			8	72

The reprocessing of the tailings in this area will have an impact of low significance on the receiving habitat and macro invertebrate fauna within the Musonoi tailings deposit. The function as a retention dam for pollutants might be impaired once the tailings are removed from the river channel, and pollutants which have accumulated in the sediment, can be mobilized and influence the water body downstream of Musonoi as well as in the Nzilo Lake.

The construction of a new plant and a new TSF situated in the Kanamwamwa catchment were identified as potential causes of habitat impairment, (due to sedimentation from the new TSF and reduced water quality (e.g. dirty runoff) in the Kwanamwamwa River.

Principles of mitigation

- The seepage downstream of the TSF in the course of the Musonoi river, the Nzilo Lake and the Kwanamwamwa River, need to be monitored (Macro invertebrate Assessment, Habitat

Assessment, WET testing) on a regular basis, in order to allow for the timely identification of degradation of these systems. Especially the Nzilo Lake is a vulnerable system regarding bioaccumulation of pollutants from fish to humans due to extensive fish consumption by the community.

- Fish potentially available for consumption within local communities need to be identified and analysed for metals, in order to monitor the potential impact of tailings deposit in the Nzilo Lake on metal bioaccumulation in the food chain.

7.6 Ground Water

Impact GW-1a: Pollution of groundwater resources [2]

Impact Significance

Construction Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
4	4	3	1	2	Low
Score	8			6	48

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
4	4	4	2	4	Medium-High
Score	8			10	80

Post Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
4	3	3	2	5	Medium-Low
Score	7			10	70

The proposed project will generate a number of sources of potential groundwater pollution: the plant site, and TSF being the principal ones.

2 This impact has been separated into two sub-sections (a & b) since the impact is rated as low for the majority of the Concession Area (GW-1a). The impact in the vicinity of the Kanamwamwa river is discussed as impact GW-1b. Mitigation measures for both are listed separately and specified in the EMSP (Vol. 3).

Geochemical tests on the Kingamyambo tailings show that leaching of poor quality water from the sediments does not occur. The seepage from the TSF is expected to have a TDS concentration of about 8,000 mg/l. This will seep from the TSF at an estimated rate of 2000 to 3000 m^3/d into the underlying shallow saprolytic aquifer where it will be progressively diluted to TDS concentrations of between 2,000 and 3,000 mg/l. The shallow ground water is used by the local communities as a domestic supply from hand dug wells and indirectly as base flow to the Kanamwamwa and Muninga streams (dealt with separately under GW-1b below). Vegetable plots along the banks of these streams and the dambo adjacent to the plant site are irrigated from shallow wells and directly from the water courses. No preferential flow paths such as dykes or faults were determined from the hydro geological study; however the top 3 m of the unsaturated laterite profile has a hydraulic conductivity in the order of 0.006 to 0.019 m/day. This means that drainage driven by the hydraulic head in the tailings the profile will occur and impact on the groundwater which is generally at a depth of 10 mbgl (metres below ground level). It is likely that the ground water quality within 1 – 2 km of the TSF will be adversely affected by seepage, and should be regarded as unfit for human consumption by virtue of its salinity, typically comprising 150 mg/l of calcium, 400 mg/l of magnesium and 1600 mg/l of sulfate.

During construction, water pollution is predicted to be low as there will be no hydraulic head in the dams. However, sterilisation drilling required for the feasibility study, has created localised preferential flow paths to the aquifer, as these boreholes have not been sealed as they are being used to obtain additional hydro geological information. Boreholes presenting the most risk (i.e. within the tailings or tailings decant ponds) will be sealed off prior to operation thus these flow paths will not exist during the operation nor closure phases of the project.

Spillages or poor housekeeping at the plant site could result in contamination of the groundwater as this area is underlain by a 3 – 5 m lateritic profile (with presumably similar hydraulic conductivity) with a water table at approximately 10 mbgl. Although no hand dug wells exist within the plant site area, base flow to the Kanamwamwa stream to the north and the *dambo* to the south could result in an impact on these water bodies which are used by the local communities for irrigating vegetables grown along the banks. Contamination from the plant could potentially be worse if the spillages include solvents, oils, greases, fuel, acids etc as these contaminants have a higher toxicity to human health and the aquatic environment than the salt content of the tailings. If the seepage is acidic, there could be mobilisation of metals leached from the lateritic profile with an increase in iron, manganese and aluminium in the groundwater.

Principles of mitigation:

- The sterilisation boreholes within the TSF should be sealed prior to commissioning of the TSF.
- In terms of the monitoring requirements stipulated in the DRC Mining Code, the TSF and plant sites must each have at least 3 dedicated monitoring boreholes (their locations and the monitoring programme are shown in the ESMP) in order to sample the groundwater on a quarterly basis. These must be installed following construction of these facilities and the monitoring programme implemented prior to commissioning.

- Risk based corrective action modelling (RBCA) should be undertaken to determine risks to receptors along all flow paths due to seepage from tailings and tailings decant ponds.

- The final shape of the TSF must maximise runoff to avoid infiltration of rainfall. Capping of the TSF using alternative covers such as an evapotranspirative cap (ET cap) could be considered to minimise infiltration.

- Monitoring of groundwater should continue at least 5 years after closure, and remedial actions implemented if required.

Impact GW-1b: Pollution of groundwater resources in the vicinity of Kanamwamwa River

Impact Significance

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	5	4	2	5	High
Score	10			11	110

Post Closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	4	2	5	Medium High
Score	9			11	99

During the operational phase, the TSF will leak immediately upon commissioning and will impact on the groundwater resources due to the hydraulic loading of these areas. As indicated above, the natural groundwater recharge will dilute the seepage from the TSF to TDS concentrations of 2,000 to 3,000 mg/l. The greatest impact will be on the hand dug wells used by the community of Samukonga and base flow towards the Kanamwamwa River which is used extensively by villagers working in the cassava lands in this area (See discussions under Archaeological – C1 and C2, Fauna and Flora - F1 and F4 and Surface Water - SW1 sections respectively). The TSF is located at the top of the hill formed by the Poudingue de Base which is a topographic divide. Under normal conditions, this boundary is also a hydro geological divide, but the additional hydraulic head created by the saturated tailings could drive a component of flow across the divide towards the streams in the Luilu catchment to the north-west. Spills and leaks on the surface that seep into the water table could also pollute the ground water used by the local communities in the hand dug wells although these impacts will be small in relation to the potential seepage from the TSF.

The main impact will be an increase in the total dissolved solids (TDS) due to salt loading (sulfates, and magnesium) but it is unlikely that there will be a drop in the pH. Generally the seepage should reduce with time due to clogging of pores in the sub-surface.

Leakage from the TSF will continue following closure (and will impact on the surface water quality as outlined in SW-1b above), however, any residual effects of high salinity tailings water will reduce once deposition ceases and the residual water is flushed by rain water. The tailings themselves will not generate contaminants, thus the impact rating post-closure will be reduced.

Principles of mitigation:

In addition to the principles outlined above, the following will reduce the potential for contamination of the Kanamwamwa River.

- Control of ground water seepage towards the Kanamwamwa River will be required, to intercept potentially contaminated seepage entering the stream. The intercepted seepage must be directed via a constructed canal for discharge directly into Kasobantu Dam.

- Dewatering boreholes or a cut-off trench may be required to intercept seepage from the TSF and tailings decant pond as deep cut-off trenches to bedrock may not be possible in the highly weathered saprolite profile.

Impact GW-2: Lowering of groundwater table resulting in reduction in groundwater resources for local communities

Impact Significance

Operational Phase 2

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	2	2	4	Medium-Low
Score	9			8	72

Mining of the Musonoi tailings may result in a lowering of the local groundwater levels mainly along the banks of the Musonoi River, due to changes to the present water system in order to mine the tailings. Local communities use shallow hand dug wells at several locations and these wells may dry up during and after mining operations, due to the removal of the tailings. The main recharge to the shallow aquifer is rainfall therefore the impact is likely to be very small.

Water requirements for the project may be supplied from aquifers within the concession area. A well field could be developed along the banks of the dambo in the highly permeable limestone horizon (Ks1.3.1) which could be recharged from the *dambo*. This could result in localised drying of the dambo which would impact on the vegetable cultivations and the shallow hand dug wells. Alternatively a well field could be developed in the high yielding CMN of the Manga orebody, where there are currently no other groundwater users. Abstraction from the dolomitic Manga ore body will result in lowering of groundwater levels which can result in the development of karsts or sinkholes impacting on surface stability.

Post-closure, once the tailings deposited in the Musonoi have been removed, this area will fill up with water again preventing any further lowering of the ground water table and possibly restoring the original levels.

Principles of mitigation:

- In terms of the DRC regulations, if more than 175 000 m^3/ year of groundwater are abstracted; dedicated monitoring wells must be installed to monitor the cone of drawdown. A minimum of three monitoring bores will be installed prior to commencement of production.

- Records of daily abstraction should be used in flow equations to predict and manage drawdown.

- The monitoring programme must include the measurement of the piezometric surface on a monthly basis in a minimum of three boreholes equipped with piezometers.

- Hand dug wells may have to be deepened or boreholes equipped with hand pumps constructed in the event that depletion of water supplies is identified as a permanent impact.

- Additional work should be done to assess the risk of sinkhole development if ground water abstraction is from dolomite where the exiting groundwater level in the dolomite is less than 30m from surface.

Impact GW-3: Variable inflows to the KOV high walls

Impact Significance

Operational Phase 1

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
3	3	3	2	3	Low
Score	6			8	48

Post Closure Phase

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
1	3	+2	4	4	Low (positive)
Score	4			10	+40

Seepage from the Kingamyambo tailings appears to be evident in the northern side of KOV opencast. This has been observed by Gécamines staff and SRK. This is due to ground water mounding in the tailings and the hydraulic gradient towards the pit due to ground water lowering in the pit. Increased inflows initially may occur if there is ineffective capture of monitoring water. However, once Kingamyambo has been mined out completely, there will be a positive impact in that there should be less inflow into the high walls resulting in improved stability to the pit slopes.

Impact GW-4: Return to natural hydro geological regime

Impact Significance

Post Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
1	3	2	4	4	Low
Score	4			10	40

The Musonoi River is currently a complex losing and gaining system to/from the groundwater regime. The reverse flow of the Kakifuluwe has resulted in contaminated Musonoi river water flowing back up the Kakifuluwe through a wetland before decanting into the groundwater via a karst system. Although it is not certain where this water is daylighting thereafter, the increased salt load has impacted on the groundwater quality from this point source of contamination.

Once the Musonoi tailings has been mined out at the confluence with the Kakifuluwe, the flow conditions will return to normal, and although the wetland will disappear, contaminated water from the Musonoi will no longer impact on the groundwater via the karst topography.

The Kingamyambo and Musonoi tailings have impacted locally on the quality of the underlying aquifer and removal of these sources will result in an overall improvement in groundwater quality following closure. No further mitigation measures for this impact are thus proposed.

Impact GW-5: Reduced availability of groundwater to surrounding villages due to abstraction for water supply purposes

Impact Significance

Construction Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	1	1	1	4	Low
Score	6			6	36

Operational Phase 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	1	1	1	5	Low
Score	6			7	42

The well field identified within the Manga ore body, located to the south \-east of the Concession Area will result in a localised drawdown associated with the potential abstraction. While this may result in a marginal reduction in baseflow to the Musonoi there are no local communities or ground water users in close proximity to the wellfield and for this reason the impact is rated as low. No mitigation measures are required. Other mining initiatives which may exploit the Kananga ore body and require dewatering could drain this potential wellfield should the Manga and Kananga ore bodies be hydraulically connected. Further drilling and aquifer testing at this site will be carried out as necessary

Impact GW-6: Reduced groundwater availability due to the restoration of the natural hydro geological regime in the Musonoi River.

Impact Significance

Post Closure

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	1	1	5	Medium-Low
Score	9			7	63

A number of hand-dug wells were identified by the ground water specialist in the vicinity of the Kasobantu dam. Once the Musonoi tailings have been removed the ground water table may drop along the margins of the Musonoi River and the hand dug wells may need to be deepened to access the water table.

Principles of mitigation:

- Monitoring of the situation will be conducted. Should problems emerge, alternative water supplies to affected people will have to be sought. (*see also* principles of mitigation for GW-2)

7.7 Traffic

Even though the volume of both light vehicles and heavy vehicles are expected to increase during construction of the plant, particularly along Boulevard Lumumba, Road 1 and the main access road to the FQM concession area, existing traffic flows along these roads are very low and this road network has spare capacity even though the road surfaces of many sections of road are in poor condition.

Similarly, the Kolwezi – Likasi – Lubumbashi road also has sufficient capacity to accommodate the FQM construction generated traffic.

T1 Change in traffic conditions on the surrounding road network due to FQM construction traffic

Impact Significance

Pre-construction

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Regional	3 Two years	Low
Score	6	8			48

Construction

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	3 Seldom	1 Insignificant	4 Regional	3 Two years	Medium – Low
Score	8	8			64

No mitigation measures required, however, drivers will be required to use certain routes and drive at certain speeds.

The change in traffic conditions on the surrounding road network due to accumulated construction generated traffic is illustrated below:

T2 Change in traffic conditions on the surrounding road network due to accumulated construction traffic

The project construction phase has already commenced and resulted in an increase in the number of light vehicles travelling along Road 1, the main access road as well as along the Kolwezi town road network. The First Quantum managerial / supervisory staff and sub-contractors are all using light vehicles (mainly LDVs) to travel to and from the concession and within the concession. Suppliers are also using light delivery vehicles for transporting goods to the concession during this phase.

It is estimated that at the peak of construction a maximum of 2 000 workers will be on site. The volume of light vehicles travelling along Road 1, the main access road and the internal road network of the concession area as well as along the Kolwezi town roads is therefore expected to increase substantially. Due to the many construction operations that are required during the construction phase at the numerous locations within the concession area, it is difficult to estimate the volume of light vehicle traffic that will be generated on an average day during the construction and rehabilitation phase and the distribution of this traffic. It is, however, estimated that most of the internal roads within the concession area and the major roads within the Kolwezi town will experience an increase in existing traffic flows as First Quantum construction activity increases.

Heavy vehicles

Transportation of goods and equipment during construction will be by road as heavy vehicles are quicker and offer a more reliable, flexible service and are able to respond quickly if emergency freight is required. The ability to provide the required transport at the required location within the required time frame is also critical.

Construction of the processing plant infrastructure will result in a noticeable increase in the number of heavy vehicles travelling along the internal road network of the concession area, the main access road, Road 1, the Kolwezi town road network and the Lubumbashi – Likasi – Kolwezi Road. It has been estimated that during the peak of the construction period, 750 heavy vehicles will be transporting supplies and equipment up from Lubumbashi via the Lubumbashi – Likasi – Kolwezi Road to the concession area. This is 1 500 two-way heavy vehicle trips a month or approximately 50 trips a day which is very high compared to existing heavy vehicle flow along this road.

As with the light vehicles, it is very difficult to estimate the volume of local heavy vehicle trips that will be generated on an average day during the construction phase and the distribution of this traffic on the surrounding road network. It is, however, known that most of the internal roads within the concession area and some of the major roads within the Kolwezi town will experience an increase in heavy vehicle activity throughout an average day which could be high if the construction traffic of other mine activities are taken into account.

Very few of the construction-generated heavy vehicles are expected to travel during the AM and PM peak hours on the internal road network of the concession area or the Kolwezi town roads.

When the cumulative impact of the construction traffic from other mining activities (DCP, KOL and Bazano) is taken into account, assuming that all construction will take place at the same time, Boulevard Lumumba and Road 1 are expected to experience a significant increase in light and heavy vehicle construction traffic compared to existing traffic flows. Even though the existing traffic flows along these roads are very low this road network is in poor condition and it is unlikely that the resulting slow speeds will provide sufficient capacity to accommodate the accumulated increase in construction traffic.

The Kolwezi – Likasi – Lubumbashi road is also expected to experience s significant increase in accumulated heavy vehicle traffic; however, as a two-lane carriageway this road will have sufficient capacity for the accumulated construction traffic.

The increase in light and heavy construction vehicles travelling along the local and regional road network will impact on the existing road space available for pedestrians and cyclists, particularly within the villages where there is a high concentration of pedestrian and cyclist activity along these roads. Within the town of Kolwezi there are sidewalks for the pedestrians and the roads are generally wide enough to accommodate cyclists as well. In the rural environment, the formation width of the Kolwezi – Likasi – Lubumbashi Road is wide enough to accommodate cyclists as well.

The volume of construction traffic during construction is expected to be consistent for several years and this traffic, especially the heavy vehicles will impact on the road safety conditions for all road users. Pedestrians and cyclists are the most vulnerable of road users and the biggest impact of the increase in construction traffic will be along the sections of road where there are high concentrations of pedestrians and cyclists, which are usually within the villages and towns.

Heavy construction vehicles and pedestrians / cyclists are not a good combination on any road with respect to road safety and therefore the existing road safety conditions along these roads within the villages and towns in particular will deteriorate for pedestrians, cyclists and motorists during construction.

The following sections of road have been identified as having a high potential impact between (FQM generated and accumulative) construction vehicles and pedestrians / cyclists:

1. On the Likasi – Kolwezi Road within the town of Fungurume
2. On the Barge Access Road west of the lake within the town of Lualaba

Impact significance

Pre-construction

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Regional	3 Two years	Low
Score	6	8			48

Construction

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	4 Often	3 Significant	4 Regional	3 Two years	Medium – High
Score	9	10			90

Mitigation Measures: In order to provide sufficient capacity to accommodate the accumulated increase in construction generated light and heavy vehicle traffic, it is recommended that Road 1 (Kolwezi – Luilu) and Boulevard Lumumba are rehabilitated.

The significance of the impact of the accumulated construction traffic on existing traffic conditions after mitigation for the construction phase is given below.

The preferred mitigation measure where there is a high potential conflict between heavy construction vehicles and pedestrians and cyclists is to identify an alternative route for either the pedestrians / cyclists or the heavy vehicles to avoid the conflict. In this regard, FQM are investigating an alternative route from just east of Kolwezi to Solwezi in Zambia including a new border post.

The significance of the impact of the FQM construction traffic on existing road safety conditions along the Kolwezi – Likasi – Lubumbashi road after mitigation (alternative route) for the construction phase is given below.

Construction after Alternative Route Mitigation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Regional	3 Two years	Low
Score	6	8			48

If no alternative route is available then two further mitigation measures are available as follows:

- provide a separate right-of-way for pedestrians and cyclists adjacent to the roadway
- Traffic calms the road to force slower speeds.

The following mitigation measures are therefore recommended for each of the sections of road identified above if no alternative route is constructed:

<u>On the Likasi – Kolwezi Road within the town of Fungurume</u> – increase existing traffic calming by installing additional speed humps along the road through the village.

<u>On the Barge Access Road west of the lake within the town of Lualaba</u> – investigate an alternative by-pass route to the north of the village. If this is not feasible traffic calm the road by means of speed dips. Speed dips last longer on gravel surfaced roads with minimal maintenance required, provided that they are correctly drained.

The significance of the impact of construction traffic on road safety conditions along the roads where there is a high concentration of pedestrian and cyclist activity after localised mitigation for the construction phase is given below.

Construction after Localised Mitigation

Likelihood		Consequence			
Frequency of	Freq of	Severity of Impact	Spatial / Population	Duration	Rating

Activity	Impact		Scope		
5 Daily	2 Very Seldom	1 Insignificant	4 Local	3 Two years	Low
Score	7		8		56

Operations

The increase in light and heavy vehicles generated by the proposed FQM and accumulated mine operations traffic travelling along the local and regional road network will impact on the existing road space available for pedestrians and cyclists, particularly within the villages where there is a high concentration of pedestrian and cyclist activity along these roads. Within the town of Kolwezi there are sidewalks for the pedestrians and the roads are generally wide enough to accommodate cyclists as well. In the rural environment, the formation width of the Kolwezi – Likasi – Lubumbashi Road is wide enough to accommodate cyclists as well. Once the Kolwezi – Solwezi road has been constructed, the impact of FQM generated and accumulated traffic on the existing road space available for pedestrians and cyclists along the section of the Kolwezi – Likasi – Lubumbashi road from just east of Kolwezi will be negligible as most FQM generated traffic will use this new road.

Impact significance

Operation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	2 Very Seldom	1 Insignificant	3 Local	4 Life of Operation	Medium – Low
Score	7		8		56

Closure

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	3 Local	5 Post Closure	Medium – Low
Score	6		9		54

No mitigation measures required.

T3 Impact of accumulated construction traffic on the existing condition of the road network likely to be used by the accumulated construction traffic

The construction of the proposed FQM mining operations will generate consistent volumes of heavy vehicles along some sections of the road network for a sustained period. This will be substantially exacerbated once the construction traffic from other mining activities is taken into account. Most of the roads that will be affected by this accumulated construction traffic are already in poor or very poor condition and the additional loading due to the accumulated construction traffic will cause the rapid further deterioration of these roads.

Whilst the increase in traffic flows along these roads will be significant, existing traffic flows are very low and the road network even with the poor road surface conditions is deemed to have sufficient capacity to accommodate the anticipated increase in existing traffic flows. Once the Kolwezi – Solwezi road has been constructed, the impact of FQM generated traffic along the section of the Kolwezi – Likasi – Lubumbashi road from just east of Kolwezi will be negligible as most FQM generated traffic will use this new road.

The condition of the following sections of road is expected to be impacted the most by the accumulated construction traffic:

1. Kolwezi – Likasi – Lubumbashi Road
2. Boulevard Lumumba

The impact of accumulated construction traffic on the condition of the road network likely to be used by this construction traffic is illustrated below:

Impact Significance

Pre-construction

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Impossible	1 Insignificant	4 Regional	3 Two years	Low
Score	6	8			48

Construction

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	5 Highly Likely	5 Extremely Harmful	4 Regional	3 Two years	High
Score	10	12			120

Operational phase

When the cumulative impact of the traffic generated by other mining activities (DCP, KOL and Bazano) is taken into account, Boulevard Lumumba and Road 1 are expected to experience a significant increase in light and heavy vehicle traffic compared to existing traffic flows. Even though the existing traffic flows along these roads are very low this road network is in poor condition and it is unlikely that the resulting slow speeds will provide sufficient capacity to accommodate the accumulated increase in accumulated operational traffic.

The Kolwezi – Likasi – Lubumbashi Road is also expected to experience a significant increase in accumulated heavy vehicle traffic, however, as a two-lane carriageway this road will have sufficient capacity for the accumulated mine operations generated traffic. Once the Kolwezi – Solwezi road has been constructed, however, the impact of the accumulated traffic along the section of the Kolwezi – Likasi – Lubumbashi road from just east of Kolwezi will be minimised as a significant volume of this accumulated traffic is expected to use this new road.

Mitigation Measure: Unfortunately the local authority and provincial government do not have any funds to maintain these roads and therefore if they are not maintained eventually no vehicles will be able to travel along these roads (as currently for some sections of Road 1) and construction of the mine and re-treatment operations will essentially slow down and stop. In order therefore to ensure that the construction of the mine and re-treatment operations continues through the rainy season, the current main road users need to maintain the roads. It is therefore recommended that the group of biggest road users (TFM, FQM, DCP, KOL and Bazano) form an association, identify the roads that need to be maintained and agree on a maintenance programme and responsibility thereof. Should FQM construct their proposed alternative route to the Kolwezi – Likasi – Lubumbashi Road then FQM will only need to contribute towards the cost of maintaining the section of this road that their construction traffic uses.

The significance of the impact of accumulated construction traffic on the existing condition of the road network likely to be used by this construction traffic after mitigation for the construction phase is given below.

Construction after Mitigation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Regional	3 Two years	Low
Score	6	8			48

Impact significance

Operation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	4 Often	3 Significant	4 Regional	4 Life of Operation	Medium – High
Score	9	11			99

Closure

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5	1	1	4	5	Medium – Low

Daily	Almost Never	Insignificant	Regional	Post Closure	
Score	6	10			60

Mitigation Measure: In order to provide sufficient capacity to accommodate the accumulated increase in mine operations generated light and heavy vehicle traffic, it is recommended that Road 1 (Kolwezi – Luilu) and Boulevard Lumumba are rehabilitated.

The significance of the impact of the accumulated mine generated traffic on existing traffic conditions after mitigation for the operational phase is given below.

Operation after Mitigation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	2 Very Seldom	1 Insignificant	4 Regional	4 Life of Operation	Medium – Low
Score	7	9			63

T4 Impact of additional mine operations generated traffic on existing road safety conditions for pedestrians and cyclists on identified roads

Impact significance

Operation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	4 Likely	3 Significant	3 Local	4 Life of Operation	Medium – High
Score	9	10			90

Closure

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	3 Local	5 Post Closure	Medium – Low
Score	6	9			54

Mitigation Measures: The preferred mitigation measure where there is a high potential conflict between heavy mine vehicles and pedestrians / cyclists is to identify an alternative route for either the pedestrians or the heavy vehicles to avoid the conflict. In this regard, FQM are currently constructing an alternative route from just east of Kolwezi to Solwezi in Zambia including a new border post.

The significance of the impact of the FQM traffic on existing road safety conditions along the Kolwezi – Likasi – Lubumbashi road after the Kolwezi – Solwezi road has been constructed for the operational phase is given below.

Operation after Alternative Route Mitigation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Regional	4 Life of Operation	Medium – Low
Score	6	9			54

If mine generated traffic uses the Likasi – Kolwezi road before the Kolwezi – Solwezi road is complete, then the following two mitigation measures are recommended as follows:

- provide a separate right-of-way for pedestrians and cyclists adjacent to the roadway
- Traffic calms the road to force slower speeds.

The following mitigation measures are therefore recommended for each of the sections of road identified above:

<u>On the Likasi – Kolwezi Road within the town of Fungurume</u> – increase existing traffic calming by installing additional speed humps along the road through the village.

<u>On the Barge Access Road west of the lake within the town of Lualaba</u> – investigate an alternative by-pass route to the north of the village. If this is not feasible traffic calm the road by means of speed dips. Speed dips last longer on gravel surfaced roads with minimal maintenance required, provided that they are correctly drained.

The significance of the impact of the FQM and accumulated mine generated traffic on road safety conditions along the roads where there is a high concentration of pedestrian and cyclist activity after localised mitigation for the operational phase is given below.

Operation after Localised Mitigation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Local	4 Life of Operation	Medium – Low
Score	6	9			54

T5 Impact of additional mine operations generated traffic on existing traffic conditions (road capacity and congestion) on the surrounding external road network

Impact significance

Operation

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	3 Infrequent	1 Insignificant	4 Regional	4 Life of Operation	Medium – Low
Score	8	9			72

Closure

Likelihood		Consequence			
Frequency of Activity	Freq of Impact	Severity of Impact	Spatial / Population Scope	Duration	Rating
5 Daily	1 Almost Never	1 Insignificant	4 Regional	5 Post Closure	Medium – Low
Score	6	10			60

No mitigation measures required.

Notwithstanding this, it is recommended that the traffic conditions on the road network that the FQM generated traffic is likely to have the most impact on, are monitored on a yearly basis and should congestion start occurring appropriate mitigation measures are implemented by the association of mine operators.

Post Closure

The impact of the closure of the FQM and other mine operations will be a significant reduction or a complete reversal of the impacts of the operational phase of the proposed mine operations. The alternative Kolwezi – Solwezi road will be a positive post closure impact as this road will be an additional road in the public road network.

7.8 Noise

Impact N-1: Noise disturbance to local communities

Impact Significance

Construction Phase

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	1	2	3	Low
Score	8			6	48

Operational Phase 1 and 2

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Severity of impact	Spatial scope	Duration	Rating
5	3	1	2	4	Medium-Low
Score	8			7	56

The changes in noise levels that residents of Luilu, UZK and Tshala villages may experience due to activities relating to the proposed project should be put into context. Kolwezi was established as a mining town, and many people who moved into these villages would have done so aware of noisy activities in their immediate environment. Current and potential noise levels due to the project will still be far lower than would have been experienced in this area when mining operations were in full swing.

During the construction phase noisy activities will be mainly in the vicinity of the new plant due to clearing of ground, earthworks and construction of floors and platforms. During construction (which will take place during daytime only) the ambient noise levels for most of the villages are well within the 55 dBA required by the IFC guidelines and the DRC regulations. While Luilu will have an ambient daytime noise level between 50 and 55 dBA, UZK, Tshala and Kamimbi will have daytime ambient noise levels below 50 dBA (Figure 7.9). During the night-time construction activities the ambient noise levels are below the 45 dBA (as required by DRC Regulations and IFC guidelines) at Kamimbi, Samukonga, UZK and Tshala villages while Luilu experiences noise levels between 45 and 50 dBA (Figure 7.10). None of the villages in close proximity to the construction activities will experience a significant noise increase (>3 dBA[7] according to World Bank guidelines) although a noise increase may be perceived by some of the households on the southern edge of Samukonga village (Figure 7.11).

During Operational Phase 1 the modelled day and night ambient noise levels conform to the criteria of the DRC regulations and IFC guidelines. It is clear that the quarry operations have no effect on any of the settlements (See Figure 7.12 and Figure 7.13) due to the fact that they only take place during the day. However, during the noisiest hour of the night the 3dBA noise impact contour will cover the southern part of UZK and Samukonga (See Figure 7.14). Thus there is a portion of the residential areas where noise requirements of the IFC are not met. The increase is due to plant and noise emissions from the slurry pumping station at the Kingamyambo tailings facility.

During Operational Phase 2 the ambient noise levels are within the DRC regulatory requirements and IFC guidelines: Kamimbi, Samukonga and UZK all experience noise levels between 45 and 50 dBA (See Figure 7.15) during the day while Luilu experiences noise levels between 50 and 55 dBA. During the night most of the villages experience noise levels between 40 and 45 dBA aside from Luilu where the whole town experiences noise levels between 45 and 50 dBA and parts of UZK experience similar noise levels throughout operational phase 2 due to monitoring of the Kingamyambo tailings (See Figure 7.16). Most of the villages do not experience an increase of 3dBA, however, the southern part of UZK does have a noise increase of 3dBA during the night as does the southern part of Samukonga village. The worst case scenarios for Samukonga village (See Figure 7.17) and Kipepa (See Figure 7.18) in terms of noise increases have been depicted in this report. This noise impact is primarily caused by the noise emissions from the water pumps for the monitors and the slurry pumps. Although certain villages in the concession area will experience an increase in ambient noise levels of 3 or more dBA during operations; experience in rural communities suggests that rural communities are not as sensitive to this 3dBA threshold as would be expected. The severity of the noise impact thus remains the same for construction and operation activities and the frequency with which these communities are expected to experience a noise disturbance remains unlikely during construction and operation activities.

Principles of mitigation:

- The enclosure of key noise sources in well designed industrial buildings or within bunds.
- Limit noisy activities i.e. fitting of silencers onto the cooling towers.
- Maintain all earth moving equipment and vehicles in good operating condition and ensure regular maintenance of equipment.

7.9 Flora and Fauna

Impact F-1: Destruction, degradation[3] or fragmentation of natural (terrestrial) habitats[4]

Impact Significance

Construction and Operational Phases 1 and 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	3	4	3	Medium-High
Score	9			10	90

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	1	2	4	5	Medium-Low
Score	6			11	66

Some 97% of the area of the non-built-up area in the KMT Concession is in a significantly degraded state, due to extensive slash and burn subsistence agricultural activities, charcoal-making and past large scale farming activities in some areas. The tree component of what would have been Miombo woodland has been largely lost, and the under storey has been severely disturbed by shifting cultivation. As illustrated on the vegetation map (See Figure 5.44) vegetation types 1 (mosaic of agro-ecosystems) and 6 (steppes and swards on heavy metal polluted soils) comprise the majority of

3 Degradation is modification of a critical or other natural habitat that substantially reduces the habitat’s ability to maintain viable populations of its native species.

4 Natural habitats are land and water areas where (i) the ecosystems' bio-logical communities are formed largely by native plant and animal species, and (ii) human activity has not essentially modified the area's primary ecological functions. All natural habitats have important biological, social, economic, and existence value. Important natural habitats may occur in tropical humid, dry, and cloud forests; temperate and boreal forests; Mediterranean-type shrub lands; natural arid and semi-arid lands; mangrove swamps, coastal marshes, and other wetlands; estuaries; sea grass beds; coral reefs; freshwater lakes and rivers; alpine and sub alpine environments, including herb fields, grasslands, and paramos; and tropical and temperate grasslands. (World Bank OP 4.04 – Natural Habitats). The IFC’s Performance Standard 6, Conservation of Biodiversity and Sustainable Natural Resource Management combines OP4.04 and OP4.36 (Forestry) to extend the focus to identify and avoid harmful impacts on all levels of biodiversity in all types of habitat, including degraded habitat, and ensure sustainable management of natural resources.

the concession area. Such areas are of little conservation value. A few pockets of natural habitats do however exist within the concession area; these include the riverine gallery forest, called the Muninga forest, along the mid-section of the Kanamwamwa stream in the Tshilenge valley, and the cemetery forest (See Figure 5.44). These two areas are the last surviving remnants in the concession area of original vegetation types. As such they have local conservation importance. The Muninga forest is an important site in terms of its ecological processes and biodiversity value. The forest also has cultural/spiritual value (See Chapter 6 in the section on archaeological impacts) and entry into this little forest is forbidden to all except "*les delegations en provenance du Chef de Terre Kamimbi*" and cutting of wood is formally forbidden in this forest.

The expansion of the TSF toward the Kanamwamwa stream and the Muninga forest, and the routing of the plant-TSF road through the middle of this remnant forest habitat area, will fragment the gallery forest along the river and come so close to it as to isolate it and impact it physically (damage caused by plant clearing and excavating for the TSF) to a significant degree. Has this now been changed? If not, it needs to be re-routed. The Muninga forest area may also be impacted by uncontrolled access particularly during construction of the TSF, as more people will be working in the vicinity that may not be aware of the local significance of the forest.

The access road outside the Concession and the 6.9 km long effluent pipeline route to the Luilu River will pass through similarly degraded habitat. The Luilu's riparian zone as far as its confluence with the Lualaba River is also severely degraded, due to the impacts of uncontrolled releases and poor water quality of mine effluents into that river in the past, and continuing today. The river channel is scoured by regular high flows and in many places the roots of riparian trees are exposed. Bank collapse and an absence of ground cover along the channel banks are prevalent. There is no habitat or biodiversity here that will be negatively impacted by the effluent to be disposed in the river.

Loss of degraded habitat will occur largely during the construction phase, when sites are cleared for the plant, TSF starter wall, railway line and other linear infrastructure (pipeline, haul road). Some 400 ha of land is implicated so, although the habitat to be lost is in a degraded state, as the extent of the impact is quite significant the impact rates Medium-High. Some loss of habitat will be permanent, such as the area occupied by the TSF and railway line, but much of the surface infrastructure will be removed in the decommissioning/closure phase and, with or without active rehabilitation, natural habitat in those areas will be restored. This is particularly the case along the Musonoi River, where the removal of the tailings deposits is expected to create an opportunity for ecological recovery. The impact is thus anticipated to have a Medium-Low significance rating post-closure.

Principles of mitigation:

- Minimize loss of natural habitats and critical natural habitats (e.g. strategic habitat retention and post-development restoration), where it is impossible to avoid destruction of such habitats establish and maintain a similarly protected area.

- Re-route the plant-TSF road to depart from the quarry road further to the north-west, such that it comes approaches the TSF from north of the farm dam on the Muninga stream and does not cut through the gallery forest area below the dam wall.

- Re-align the foot of the TSF wall and its cut-off drain to move it away from the Muninga forest.

- Conservation of natural habitats and maintenance of ecological functions – possibly fence the Muninga forest and signpost to avoid destruction/degradation during construction or operations. This could also be converted into a reserve to provide some sort of protected status. Corridors of natural habitat connecting it to the upstream and downstream areas must be maintained to allow for animals to move from refuge to refuge.

- Rehabilitation of degraded natural habitats.

- For rehabilitation, utilize as many indigenous species as possible including cultivation of trees and medicinally useful plants.

- Monitor the Lualaba River below its confluence with the Luilu River for cumulative impacts on riparian habitat resulting from increasing effluent disposal via this channel.

Impact F-2: Loss of plant and animal biodiversity

Impact Significance

Operational Phase 1 and 2 & Post-Closure

Likelihood		**Consequence**			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
3	2	1	3	3	Low
Score	5			7	35

Overall, due to the degraded nature of the Concession Area and surroundings, the proposed project is not expected to cause a significant loss of plant and animal biodiversity. KMT will make every effort to avoid disturbance to areas of habitat with diverse species assemblages. Some of the orchid species (described Section 5.15.2) found in the natural wetland areas may be lost once the tailings in the Musonoi River are mined and the portion of wetland between the existing road and the Musonoi River dries up. None of these species are classified as protected according to the DRC Regulations however, they are considered to have conservation value for the Katangan province by the specialist despite not being listed. Although this may be a permanent impact the section of wetland that may be lost is relatively small and the impact is thus rated as having a low significance. The only way to prevent this impact occurring would be to follow the mitigation principles outlined in F-4 below.

On closure the Kasobantu Dam will flood and the wetland can develop once more.

Impact F-3: Degradation of terrestrial and wetland/ riverine ecosystems (due to runoff and stream pollution as a result of tailings water discharge into the Luilu River)

(Please Note: Impacts that may result from the Musonoi River diversion were not assessed since information regarding its delineation is not available)

Impact Significance

Construction Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
4	3	1	3	3	Low
Score	7			7	49

Operational Phase 1

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
3	2	1	3	3	Low
Score	5			7	35

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
2	2	1	3	4	Low
Score	4			8	32

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
2	1	1	1	5	Very low
Score	3			7	21

Construction activities may lead to contamination of soils by hydrocarbon and cement pollutants in the vicinity of the plant and linear infrastructure. The removal of vegetation and topsoil from the construction areas will leave these areas exposed. Run-off in these areas may become polluted and lead to degradation of nearby ecosystems (both terrestrial and aquatic). This impact is most likely during construction activities and is expected to decrease during the course of the project's operations. All facilities and infrastructure will have water management systems to minimise the risk of contamination.

While there is currently little definitive information on the various discharges that might report to the Luilu River, the disposal of excess tailings water during wet periods into the Luilu River may raise TDS levels in the Lualaba River by less than 10 mg/l on average.

This discharge into the Luilu River is not considered to hold significant risks for habitat integrity, nor for riverine flora and fauna, given the poor ecological status of this river. The local communities are even reported not to use the river due to its long-term poor water quality. This severe degradation is mainly ascribed to decades of mining effluent disposal in the upper catchment of the Luilu. It is therefore unlikely that further disposal of KMT excess tailings water during wet periods into this river will add any significant impacts to this already degraded system. Given the low assimilative capacity of the Luilu River, however, essentially the impacts of the project will be transferred further down the receiving water body system, notably into the Lualaba River, although the impacts will be largely nullified by the high levels of dilution from the upstream Nzilo hydropower station.

Although the dilution in the Lualaba is of such a magnitude that these concentrations might only have a small effect on the river's aquatic integrity it is important to recognize that the high biotic integrity in the Lualaba river is one of the most important regional ecological attributes that could be affected by the proposed development. Future cumulative impacts from other developments may significantly affect the Lualaba and specific focus in the Lualaba's biotic integrity during monitoring is recommended.

Principles of mitigation:

- Implementation of standard soil erosion measures (as discussed in the ESMP).
- Contaminated water around all new infrastructure needs to be captured and recycled (as discussed under surface water, Section 7.5).
- Only remove vegetation on infrastructure footprint (as discussed in the ESMP).
- Timeous rehabilitation and revegetation of exposed areas.
- Monitor water quality and habitat integrity in key affected areas, notably the Lualaba River, to track conditions for species survival (as described in the ESMP).

Impact F-4: Loss of sensitive areas - wetlands

Impact Significance

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	4	3	1	4	Medium-Low
Score	9			8	72

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating

1	1	1	4	5	Very low
Score	2			10	20

Wetlands are defined as sensitive areas in Annexe XII Article 3 of the Mining Regulations. As such, where impacted, mitigation measures apply. Two naturally formed seasonal wetlands (dambo's) exist in the concession area, one in the vicinity of the plant and the other west of the Musonoi (labelled as area dambo 1 and dambo 2 respectively on Figure 5.29) whereas others such as where the Kakifuluwe and Kanamwamwa rivers are crossed by the old haul road, have been created due to damming by the road embankment and the Musonoi tailings. All the wetlands provide various ecosystem services, fishing sites and refuges for plant and animal biodiversity in a "sea" of transformed land. The *dambo's* are important resources to communities for cropping, and the dambo near the plant site is intensively cultivated for maize and vegetables. The occurrence of various orchid species in some of the *natural and artificial* wetlands is an indication of their biodiversity value. The artificial wetlands may be lost once the tailings are removed from the Musonoi and the water table drops, while the dambo's may shrink unless mitigation measures are put in place. Local communities will lose access to fish and other resources from these areas. These impacts will be permanent, unless mitigated, thus a residual impact will remain post-closure. There will however be an off-set as a result of the formation of new local wetlands, which are likely to establish around the edges of the newly created Kasobantu Dam. This will be monitored and if wetlands do not develop, a habitat creation scheme will be put into place which encourages the development of wetland areas similar to those which have been created by the damming of the watercourses flowing into the Musonoi valley. The newly created impoundment will also likely support a substantial fisheries resource.

Principles of mitigation:

- The dam on the lower Kanamwamwa River should be retained and strengthened, to ensure the preservation of this valuable wetland. [Due to its strange flow characteristics, which would make damming futile, and low biodiversity value, the Kakifuluwe wetland is not recommended for mitigation.]

- The eastern dambo should be monitored when mining of the Musonoi is underway to establish if it is impacted. Should shrinkage and the loss of wetland species in its lower reaches occur, remedial measures will have to be undertaken.

- Loss of crops and resources should be compensated for (See SE-10).

- Wetland development will be monitored and should this not occur, a habitat creation scheme will be put into place.

Impact F-5: Loss of lacustrine habitat

Impact Significance

Operational Phase 2

Likelihood		Consequence			
Frequency of	Freq of	Benefit/Severity of	Spatial/Population	Duration	Rating

activity	impact	impact	scope		
1	3	2	4	4	Low
Score	4			10	40

The reduced surface area and depth, or potential elimination of, the Kasobantu dam during mining of the Musonoi will lead to a temporary reduction in the area of lacustrine (deep, still water body) habitat for aquatic species including fish and birds. However, the nature of the dam at present, with a substrate of tailings and poor quality water discharging into it from the Kolwezi area, is such that it provides poor aquatic habitat. Bio monitoring and field observations show that the biodiversity is poor and fish small. The dam will fill up again post-closure.

Impact F-6: Loss of fish resource to local communities

Impact Significance

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
4	5	2	2	4	Medium-Low
Score	9			8	72

The reduced surface area and depth, or potential elimination of, the Kasobantu dam during mining of the Musonoi will lead to a reduction in fish stocks and fishing activities carried out by inhabitants (mainly children) of the nearby villages (Kipepa, Kashala, Ndanzama, Kisangama and Kanyembo). Fish currently present in the Kasobantu are, however, small and, by all accounts, catch per unit effort is low. They may also be chemically contaminated. Once all the tailings are removed from the Musonoi, the natural flow regime will be restored in the Musonoi River and it is anticipated that fish will recolonise thereby eliminating this impact post-closure. Water quality in the Musonoi will largely not be affected post mining unless upstream activities change; there will most likely still be raw sewage, plant discharge etc flowing through the new course of the river and this will not be conducive to fish recolonisation.

Principles of mitigation:

- Loss of fish resources will be compensated for.

Impact F-7: Destruction of vegetation swards in Musonoi tailings useful for rehabilitation (due to monitoring)

Impact Significance

Operational Phase 2

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
5	5	1	1	4	Medium-Low
Score	10			6	60

Post-closure

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
1	1	1	1	5	Very low
Score	2			7	14

Mining of the Musonoi will lead to the loss of swards of metal tolerant and cuprophytic species that have established themselves on the moist tailings deposit. Some of these species may be useful for later rehabilitation of the upper surface of the new TSF. However, until their natural distributions and habitat requirements are established, it must be assumed that removal of the Musonoi tailings will eliminate their habitat, hence they would have to be sourced from elsewhere. Depending on the outcome of proposed trials regarding revegetation the following may be implemented.

Principles of mitigation:

- Possible retention of peripheral zones with dense stands of cuprophytes, particularly the sedge *Bulbostylis cupricola.*
- Possible cultivation of metal tolerant species in another area that could be used for later rehabilitation of the new TSF
- Establish a nursery to cultivate species that could be used for rehabilitation post-closure.

Impact F-8: Re-establishment of natural habitats

Impact Significance

Post-Closure Phase

Likelihood		Consequence			
Frequency of activity	Freq of impact	Benefit/Severity of impact	Spatial/Population scope	Duration	Rating
1	4	+4	3	5	Medium-Low (positive)
Score	5			12	+60

Once the tailings in the Musonoi have been removed, the natural river regime will be restored and in time it is expected that some of the natural vegetation will re-establish along its banks. Owing to the importance of the Kasobantu dam as a resource to local communities, this study proposes that the dam be left in place. Should that be the case, water levels in the dam will be restored post-mining and conditions will improve markedly. Fish are likely to re-colonize the dam and river from upstream and via the Nzilo canal.

Principles of mitigation:

- The project should establish a habitat and biodiversity management programme which will, during the life of the mine, conduct rehabilitation trials and grow plants in a nursery for eventual use in rehabilitation and restoration programmes.

- At closure, the landscape restoration process could be encouraged by planting indigenous tree species along the banks of the Musonoi. Collection of seeds from grasses and shrubs in the concession area and spreading them in previously tailings-smothered areas will also assist recovery.

- Stocking the lake with tilapia would assist in the re-establishment of the fish resource.

7.10 Summary of Environmental Impacts

Table 7.1 below makes it clear that, in common with many mining/ industrial projects in developing countries, the key trade-offs to be made are between a suite of positive socio-economic consequences and a series of negative impacts on the biophysical environment in which the project is to be established. It is also clear that a number of the significantly positive socio-economic effects are removed after the mine closes, but this is 23 years away.

7.11 Mitigation of impacts and the Environmental and Social Management Plan

In this section, *principles* of mitigation for biophysical impacts are spelled out for the cumulative impact of the entire project on each component impact, where the impacts are rated significant (Medium-Low rating or higher, generally). These principles are then elaborated for the impacts as they apply to specific sites in Table 4.2 of the Environmental and Social Management Plan (ESMP in Volume 3). In that Table, the impacts are referenced by the same reference numbers as used in this section, for ease of cross-referencing. The ESMP then formulates a set of management programmes and plans through which the mitigation measures will be implemented in a coordinated manner. The management programmes applicable to each impact are listed against the appropriate impact and its mitigation measures in Table 4.1. The management programmes in the ESMP directly applicable to this chapter are:

- Soil stripping and management programme;

- Air quality management programme;

- Water management programme;

- Noise management programme;
- Conservation of natural habitats programme;
- Cultural resources management programme.

A series of plans, contained as Annexures to the ESMP, will support and in cases supplement the above programmes. These are:

ESMP Annexure A:	Labour and Human Resources Plan; Workplace Health and Safety Plan; Community Health and Safety Plan
ESMP Annexure B:	Framework Resettlement Action Plan
ESMP Annexure C:	Emergency Preparedness Plan
ESMP Annexure D:	Community Development Plan
ESMP Annexure E:	Rehabilitation and Closure Plan
ESMP Annexure F:	Stakeholder Engagement Plan
ESMP Annexure G:	Waste Management Plan
ESMP Annexure H:	Influx Management
ESMP Annexure I:	Artisanal Mining Strategy

e 7.1: Summary of significance rating for physical, biological and socioeconomic impacts prior to mitigation meas implemented

act o.	Environmental Components and Impacts	Pre-construction	Construction	Operation 1 (mining Kingamyambo and Musonoi using dredging only)	Operation 2 (+ yr 7, Musonoi being drained and mined)	Po
	PHYSICAL ENVIRONMENT					
	GEOLOGY					
	Sterilisation of exploitable ore body – loss of mineable resource		VERY LOW	VERY LOW	VERY LOW	VI
	Exposure of receptors to radioactivity /Potential litigation			LOW	MEDIUM-LOW	
	Failure of TSF due to subsidence, faulting or seismic activity				LOW	VI
	GEOPHYSICS					
	TSF failure due to poor design and/or operational failure			VERY LOW	MEDIUM-HIGH	MEI
	SOILS & LAND USE					
	Loss of productivity of soils due to sterilisation		MEDIUM-HIGH	MEDIUM-HIGH	MEDIUM-HIGH	MEI
	Degradation of soils due to salination			MEDIUM-HIGH	MEDIUM-HIGH	
	CLIMATE & AIR QUALITY					
	Increases in nuisance and health risks to residents due to increase in ambient dust concentrations (PM10 and TSP)		MEDIUM-LOW	MEDIUM-LOW	MEDIUM-LOW	MEI
	Health risk to local villages over the long term		LOW	MEDIUM-LOW	MEDIUM-LOW	

ITIVE IMPACTS		NEGATIVE IMPACTS	
High	126-150	Very High	126-150
	101-125	High	101-125
um-High	76-100	Medium-High	76-100
um-Low	51-75	Medium-Low	51-75
	26-50	Low	26-50
low	1-25	Very Low	1-25

act o.	Environmental Components and Impacts	Pre-construction	Construction	Operation 1 (mining Kingamyambo and Musonoi using dredging only)	Operation 2 (+ yr 7, Musonoi being drained and mined)	Po
	due to increases in ambient gas concentrations. (SO2, NOx and Volatile Organic Compounds)					
	Reduced ambient dust concentrations			MEDIUM-HIGH	MEDIUM-HIGH	MEI
	SURFACE WATER					
a	Pollution of downstream water courses		MEDIUM-HIGH	MEDIUM-LOW	MEDIUM-LOW	MEI
b	Pollution of the Kanamwamwa River			MEDIUM-HIGH	MEDIUM-HIGH	MEI
	Diversion of the Musonoi River around the Kasobantu Dam causing erosion and seasonal flooding				MEDIUM HIGH	
	Reduced lake size due to lowering the Kasobantu dam water level				LOW	
	Poorer quality of water discharging to Nzilo and downstream Musonoi R				MEDIUM-LOW	MEI
	Pollution of surface watercourses due to discharge of excess tailings water to the Luilu River			MEDIUM-LOW	MEDIUM-LOW	
	Impairment of aquatic habitat			MEDIUM-LOW	MEDIUM-LOW	
a	Pollution of ground water resources		LOW	MEDIUM-HIGH	MEDIUM-HIGH	MEI
b	Pollution of ground water resources in the vicinity of Kanamwamwa River			HIGH	HIGH	MEI
	Lowering of groundwater table resulting in reduction of groundwater resources for local communities				MEDIUM-LOW	
	Variable inflows to the KOV high walls			LOW		
	Return to natural hydro geological regime					

ITIVE IMPACTS		NEGATIVE IMPACTS	
High	126-150	Very High	126-150
	101-125	High	101-125
um-High	76-100	Medium-High	76-100
um-Low	51-75	Medium-Low	51-75
	26-50	Low	26-50
low	1-25	Very Low	1-25

act o.	Environmental Components and Impacts	Pre-construction	Construction	Operation 1 (mining Kingamyambo and Musonoi using dredging only)	Operation 2 (+ yr 7, Musonoi being drained and mined)	Po
	Reduced availability of ground water to surrounding villages due to abstraction for water supply purposes		LOW	LOW	LOW	
	Reduced groundwater availability due to the restoration of the natural hydro geological regime in the Musonoi River					MEI
	TRAFFIC					
	Change in traffic conditions on the surrounding road network due to FQM construction traffic	**LOW**	**MEDIUM LOW**			
	Change in traffic conditions on the surrounding road network due to accumulated construction traffic	**LOW**	**MEDIUM HIGH**			
	Impact of accumulated construction traffic on the existing condition of the road network likely to be used by the accumulated construction traffic	**LOW**	**LOW**	**MEDIUM-HIGH**	**MEDIUM-HIGH**	**MEI**
	Impact of additional mine operations generated traffic on existing road safety conditions for pedestrians and cyclists on identified roads			**MEDIUM-HIGH**	**MEDIUM-HIGH**	**MEI**
	Impact on additional mine operations generated traffic on existing traffic conditions (road capacity and congestion) on the surrounding external road network			**MEDIUM-LOW**	**MEDIUM-LOW**	**MEI**

ITIVE IMPACTS		NEGATIVE IMPACTS	
High	126-150	Very High	126-150
h	101-125	High	101-125
um-High	76-100	Medium-High	76-100
um-Low	51-75	Medium-Low	51-75
	26-50	Low	26-50
low	1-25	Very Low	1-25

act o.	Environmental Components and Impacts	Pre-construction	Construction	Operation 1 (mining Kingamyambo and Musonoi using dredging only)	Operation 2 (+ yr 7, Musonoi being drained and mined)	Po
	NOISE					
	Noise disturbances to local communities		LOW	MEDIUM-LOW	MEDIUM-LOW	
	BIOLOGICAL ENVIRONMENT					
	FLORA AND FAUNA; ECOSYTEMS					
	Destruction, degradation or fragmentation of natural (terrestrial) habitats		MEDIUM-HIGH	MEDIUM-HIGH	MEDIUM-HIGH	MEI
	Loss of plant and animal biodiversity			LOW	LOW	
	Degradation of terrestrial and wetland/ riverine ecosystems (due to runoff and stream pollution)		LOW	LOW	LOW	VI
	Loss of sensitive areas - wetlands				MEDIUM-LOW	VI
	Loss of lacustrine habitat (for fish)				LOW	
	Loss of fish resource to local communities				MEDIUM-LOW	
	Destruction of vegetation swards in Musonoi tailings useful for rehabilitation (due to monitoring)				MEDIUM-LOW	VI
	Re-establishment of natural habitat					MEI

/here a rating is shown in the Post-closure column after ratings in other project phases, this usually refers to a residual impact, i.e., an i
anent that will endure beyond closure

ITIVE IMPACTS		NEGATIVE IMPACTS	
High	126-150	Very High	126-150
	101-125	High	101-125
um-High	76-100	Medium-High	76-100
um-Low	51-75	Medium-Low	51-75
	26-50	Low	26-50
low	1-25	Very Low	1-25

Figure 7.1: Average maximum 24 hr TSP concentrations during operations (50% tailings reprocessed)

Figure 7.2: Average annual TSP concentrations during operations (50% tailings reprocessed)

Figure 7.3: Average maximum 24 hr PM_{10} concentrations during operations (505 of tailings reprocessed)

Figure 7.4: Average annual PM_{10} concentrations during operations (50% tailings reprocessed)

Figure 7.5: Average maximum 24 hr TSP concentrations during operations (100% tailings reprocessed)

Figure 7.6: Average annual TSP concentrations during operations (100% tailings reprocessed)

Figure 7.7: Average maximum 24 hr PM_{10} concentrations during operations (100% tailings reprocessed)

Figure 7.8: Average annual PM_{10} concentrations during operations (100% tailings reprocessed)

Figure 7.9: Contours of the resulting absolute ambient noise levels for the construction period during the day (07:00 to 19:00)

Figure 7.10 Contours of the resulting absolute ambient noise levels for the construction period during the night (19:00 to 07:00)

Figure 7.11: Contours of the increase in L_{Aeq} (1 hr) for the noisiest hour during the night for the construction period. The red dotted line indicates the location of the Δ = 3dBA contour.

Figure 7.12: Contours of the resulting absolute ambient noise levels during the dry season for the operational phase 1 during the day (07:00 to 19:00).

Figure 7.13: Contours of the resulting absolute ambient noise levels during the dry season for the operational phase 1 during the night (19:00 to 07:00).

Figure 7.14: Contours of the increase in L_{Aeq} (1 hr) for the noisiest hour during the night for Operational Phase 1. The red dotted line indicates the location of the Δ = 3dBA contour.

Figure 7.15: Contours of the resulting absolute ambient noise levels during the dry season for the Operational Phase 2 during the day (07:00 to 19:00).

Figure 7.16: Contours of the resulting absolute ambient noise levels during the dry season for the Operational Phase 2 during the night (19:00 to 07:00).

Figure 7.17: Contours of the increase in L_{Aeq} (1 hr) for the noisiest hour during the night for Operational Phase 1 illustrating the worst-case scenario for Samukonga village. The red dotted line indicates the location of the Δ = 3dBA contour.

Figure 7.18: Contours of the increase in L_{Aeq} (1 hr) for the noisiest hour during the night for Operational Phase 1 illustrating the worst-case scenario for Kipepa village. The red dotted line indicates the location of the Δ = 3dBA contour

Figure 7.19: Traffic Volumes at the Kisanfu Mine intersection