

*Right of reply - Review of the release of naturally occurring radioactive material from the QMM Mine, Madagascar*

Findings	Right of reply
<b>Monitoring methods and approach are used in monitoring and management of radioactive materials by QMM</b>	
<p>Methods and approach used in the monitoring and management of radioactive materials by QMM is not sufficient.</p>	<p>The programme adopted by QMM has been based on a baseline assessment pre-operational study (web link) and a number of other scientific studies (web link) looking at the potential impacts on the environment and surrounding communities. The programme has been formally approved by the national regulator, and the regulator conducts periodic review missions to assess QMM's performance (web link). QMM is always seeking to improve its monitoring performance and as such is open to considering potential improvements identified in the report. The recommendations of the report will be considered in detail and any alterations in the monitoring requirements will be discussed with the national regulator. QMM acknowledges that the region has a high natural background radiation level that existed prior to the commencement of mining, and that fully understanding the impacts of mining is scientifically challenging.</p>
<p>The author was not provided with an over-arching monitoring plan with specific goals regarding radioactive releases from QMM and subsequent risk to people living in the area.</p>	<p>A pre-mining radiation study conducted in 2001 stated that the most important source of exposure, amongst the public radiation pathways, is the external gamma radiation from soils containing elevated concentrations of thorium. It also stated that measuring of offsite incremental effects from the mining activities will likely be difficult since the variability in baseline radioactivity is large.</p> <p>The radiation baseline completed in 2014 also stated that generally the exposure risk by contamination, ingestion or inhalation, is minimal for people outside the operational areas.</p> <p>The monitoring developed by QMM has therefore been essentially focused on employee exposures.</p>

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	<p>However, as mentioned above, we performed technical and scientific studies which include community exposure in 2001, 2009, 2012, 2014, and 2017 (web link).</p> <p>A new public radiation exposure study is in plan for 2019 as part of a regular assessment process. The scope of work is currently in development based on recommendations of previous studies (the findings of the report will be considered as well) as part of this review. In particular, the identified need for more monitoring data for the assessment of the ingestion pathways will be a priority for additional work. All alterations in the process will have to be approved by the regulator.</p>
<p>There was no formal Data Quality Objectives provided to the author. These DQOS would establish the minimum monitoring effort required to answer the Key Monitoring Questions within margin of error.</p>	<p>As part of regular reviews of public radiation exposure, the basis for the desired outcomes and objectives of the monitoring will be undertaken. This will include revision of the potential exposure pathways (including ingestion pathway).</p>
<p>No general conclusions can be drawn regarding total incremental radiation dose to the general public because it is unknown whether current dose estimates are, indeed, very conservative or whether in some cases they are not.</p>	<p>QMM acknowledges the findings of different reports for the gamma, dust and radon pathways and that they, even using conservative approaches, are unlikely to exceed the relevant public dose limits. QMM also acknowledges the need for more information around the ingestion pathway and this is included in the 2019 review of public radiation exposure.</p>
<p>With the exception of gamma measurements on site and airborne dust in communities, monitoring does not appear to be conducted according to a standard schedule.</p>	<p>As a result of the initial baseline studies and other scientific reports, QMM has focused its environmental monitoring efforts on the gamma and airborne dust pathways. This is based on the belief that these will be the major quantifiable exposure pathways for communities. This monitoring is undertaken with the approval of the national regulator and follows a set monitoring schedule. For the</p>

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	<p>ingestion pathway, a combination of the inherent difficulty in determining the QMM related impacts and the need for specialist radionuclide analysis which is only available in external laboratories, has meant that monitoring of this pathway requires additional work. In 2018, QMM had meetings with a number of international laboratories (South Africa, Australia) seeking to undertake these specialist analyses. Final laboratory arrangements are underway (including transport, customs and quarantine concerns, particularly where animal and plant biota requires analysis).</p>
<p>Monitoring sites are not sampled consistently – especially sites which are in the receiving environment. Supporting information necessary for interpretation of radionuclide data is not always collected.</p>	<p>We will address this issue in future studies to ensure results are directly comparable. This includes the means of sample collection and preservation, the types of physical and chemical data collected during sampling, and the chemical analysis which is performed at the site laboratory.</p>
<p><b>Are levels of naturally occurring radioactive materials resulting from the QMM Mine operation within international limits?</b></p>	
<p>The IAEA dose limit of 1 mSv/y is to be used as the incremental limit above natural levels observed near QMM. Thus, it is necessary to estimate incremental dose within an acceptable margin error.</p>	<p>The region surrounding QMM is naturally high in radiation (web link to baseline study) and the separation of the QMM incremental impacts is an essential component of verifying compliance with international dose limits. For the gamma, airborne dust and radon pathways, QMM believes that the operation can scientifically show compliance and this is acknowledged in the report. Separation of QMM incremental exposure to the ingestion pathway is scientifically more challenging. Previous scientific reports have modelled this pathway and have identified the uncertainty around this pathway. Although the expectation is that the ingestion pathway is unlikely to exceed the IAEA dose limit, further monitoring is needed to confirm this in a quantifiable form. QMM is currently conducting a 2019 public radiation exposure study.</p>

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<p>Based upon available information, conservatively estimated doses due to gamma radiation and exposure via dust inhalation due to QMM operations are less than 1mSv/y.</p> <p>Incremental contribution to dose via radon exposure is expected to be negligible.</p>	<p>This is the information that QMM has been using to inform its monitoring program, based on conclusions from 2001, 2014 and 2017 reports.</p> <p>For the gamma, airborne dust and radon pathways, QMM believes that the operation can scientifically show compliance and this is acknowledged in the report.</p>
<p>Exposure of specific individuals with a combined exposure to gamma radiation on-site (e.g. for wood collection) plus dust inhalation exposure, plus exposure via ingestion may approach or exceed 1 mSv/y</p>	<p>For the gamma, airborne dust and radon pathways, QMM believes that the operation can scientifically show compliance and this is acknowledged in the report. Separation of the QMM incremental exposure to the ingestion pathway is scientifically more challenging. Previous scientific reports have modelled this pathway and have identified the uncertainty around this pathway. Although the expectation is that the ingestion pathway is unlikely to exceed the dose limit, further monitoring is needed to confirm this in a quantifiable form. QMM is currently conducting a 2019 public radiation exposure study.</p>
<p>No conclusions are possible with respect to incremental doses from ingestion of water, food and soil.</p>	<p>Separation of the QMM incremental exposure to the ingestion pathway is scientifically more challenging. Previous scientific reports have modelled this pathway and have identified the uncertainty around this pathway. Although the expectation is that the ingestion pathway is unlikely to exceed the dose limit, further monitoring is needed to confirm this in a quantifiable form. QMM is currently planning a 2019 public radiation exposure study.</p>
<p>Given the reliance of local people on surface water for drinking water and the use of locally produced foods, the complete lack of monitoring data in water and food is unacceptable.</p>	<p>Current environmental monitoring has focused on the exposure pathways where the incremental contribution from QMM can</p>

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	<p>quantitatively be measured. QMM acknowledges that there is historically missing information for the ingestion pathway.</p> <p>Given that this approach is approved by the national regulator and the expectation is that the ingestion pathway is unlikely to exceed the dose limit, QMM does not agree with the term “unacceptable”.</p> <p>Rather QMM believes that a more constructive and appropriate finding would be: <i>Given the reliance of local people on surface water for drinking water and the use of locally produced foods, it is recommended that QMM assess the need to gather more data with regards to community exposure.</i></p>
<p>In summary while the expectation is that incremental doses to the public due to QMM operations will meet international limits, there are insufficient data to come to any confident conclusions in this regards.</p>	<p>QMM, based on the baseline study and subsequent scientific reports and monitoring, agrees with this finding. The aim of the 2019 study will be to close these gaps and improve understanding. The end result will be to quantifiably verify QMM’s compliance with international limits for all potential exposure pathways.</p>
<p><b>Are pathways of radionuclide exposure managed to internationally recognized standards for the protection of local citizens?</b></p>	
<p>It is expected that QMM use “good practices” which have been demonstrated to be effective in reducing radiation exposure at other, relevant mining operations.</p>	<p>QMM currently operates the mine in a similar manner to other mineral sands operations globally. Continual review of the operational methods is undertaken to ensure it remains abreast of good practices in use internationally. This is part of QMM’s commitment to continuous improvement for environmental performance.</p>
<p>The author did not receive information which would indicate that QMM consistently is using good practices with respect to control of gamma, dust, or ingestion pathways. Additional monitoring data are</p>	<p>QMM has conducted regular off-site radiation monitoring since the start of mining. The frequency and scope of these studies were determined by the limited exposure (according to the studies).</p>

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essential in order to inform QMM about where additional measures are required.	Potential improvements have been identified and QMM will address this in future monitoring to ensure that any additional risk is identified and controlled. Aspects that relate to the naturally occurring radiation will be addressed in partnership with the regulator.
It is impossible to draw any conclusions with respect to the degree to which QMM applies good practice because of the absence of comprehensive monitoring data, particularly with respect to the ingestion exposure pathway.	
It is imperative that QMM demonstrates that it is managing risk using good practice and in accordance with the 1 mSv/y limit.	
<p>Risks from exposure to the chemical hazard of uranium in drinking water must also be managed.</p> <p>The uranium concentration in the MMM river are much higher than WHO drinking water guidelines. These elevated concentrations may be due to a combination of natural sources and QMM operations.</p> <p>However, no matter what the source of the uranium is this issue must be addressed in order that the risk associated with uranium toxicity is confirmed and managed.</p>	<p>As was determined before the commencement of mining (web link baseline study) the area surrounding QMM has naturally elevated levels of radiation. This is a result of the surrounding geological conditions and this leads to naturally enhanced levels of uranium in drinking water. This is not a QMM related impact and is an aspect of the water used by local communities before the commencement of construction or operations at QMM.</p> <p>Due to the vital need for access to water for local communities, care must be taken when comparing to conservative guidelines such as the WHO Drinking Water Guidelines. In fact, in the WHO Drinking Water Guidelines, it specifically states :</p> <p><i>Where supplies exceed 30 µg/l, it is important that precipitate action be avoided. Consideration should first be given to exposure from all sources and the availability of alternative safe sources.</i></p>