INFORMATION ON THE ISSUES DISCUSSED IN THE BILATERAL CONSULTATION HELD IN JULY 2007 ON THE ROSIA MONTANA PROJECT EIA PROCEDURE

Table of Contents

Ore processing, tailing management

1. Please provide detailed explanation (question 34, 67 [1]) why other lixiviants for gold, primarily those where environmental performance is better then cyanide's are considered economically and technically unfavourable.

There are a number of flowsheet options available for the processing of auriferous ores. Many of these options are applicable only to certain ore types and specific sets of conditions. Such conditions are dependent on ore characteristics, location, environmental, social issues, infrastructure, economic considerations and risk.

The selection of the most relevant flowsheet for processing of the Rosia Montana ore types has given consideration to numerous options. Many of these options, whilst practical in the sense that they would provide a

[1] Question raised by the Hungarian Ministry of Environment and Water (Volume 78 of RMGC answers).

recovery of gold and silver from the Rosia Montana ore, are impractical when the other considerations are applied.
The actual extraction of gold and silver from the ore to provide a metal product requires a level of chemical separation. This can be achieved by smelting, which is cost prohibitive unless the gold and silver are by-products of another process. Alternatively this separation can be achieved by leaching.
Leaching is by far the most common process with over 90% of the world's gold production over the last 20 years being provided by cyanidation.
Cyanidation is the most common leaching alternative (lixiviant) for gold and silver. There are several other chemical processes which leach gold and silver, but they are typically impractical, dangerous or prohibitively expensive. Some do not recover silver at all and most have never been practised at a commercial scale.

The use of alternative lixiviants was addressed in the EIA report Chapter 5 Assessment of Alternatives. In summary:

- Every production-scale low grade gold ore leaching operation in the world today employs sodium cyanide as a lixiviant at some stage of the process. It is a proven process with known risks and known measures for risk management, minimisation and mitigation. Some 90% of the gold produced in the world in the last 20 years has been recovered using cyanide. It is the typical technology applied to gold and silver ore processing
- Although research continues, there are no realistic alternatives to the use of cyanide for recovery of gold from low grade ores at the present time. Nor does research indicate any technologies that could be developed to a full-scale operation in the near future
- Financial assessment of flowsheet options show that for a robust project, the use of whole ore leaching with cyanide is the preferred flowsheet. Non-cyanide options are simply not practical for Rosia Montana due to the inherent characteristics of the ore including grade, existence of sulphides and gold and silver deportment
- Cyanidation is the most effective flowsheet with regard to cost effectively maximising the value of the Rosia Montana resources. Other flowsheet options or lixiviants result in reduced extractions and poor utilisation of the Rosia Montana resource
- The cyanidation process offers: minimal power and water consumption compared to most alternatives, smaller footprint compared to other processes that can provide the same level of extraction and cyanidation remains the most robust process both economically but also physically easier to operate and manage

It should be appreciated that the use of other lixiviants for the industrial recovery of gold has not been developed or found favour in the industry for the reasons stated above. Major mining houses, including Newmont Limited who owns some 16% of RMGC, have spent many millions of dollars in research to find a replacement to no avail. The issues of cyanide use are not peculiar to Rosia Montana and as such the search for a cyanide replacement continues internationally.
It should be also stressed that because of the long history of cyanide leaching, the standards of safety with cyanide technology have been greatly increased. The alternative technologies are not only economically unattractive but also many of them are not as safe as cyanidation.

Additionally, the economic viability of the project and application of cyanidation does not only affect RMGC but also the local community and government revenues.

2. The cyanide balance is still unclear. Please provide more detailed information on the expected cyanide concentrations in different technological units.
The full cyanide balance was presented in the EIA Chapter 2 Technological Processes Figure 2.6 Page 119. Salient points are presented below.
The cyanide balance shows that the major consumption of cyanide occurs in the CIL circuit itself. Here cyanide degrades (cyanide is easily broken down in many reactions with the ore itself), is consumed by metals including gold, silver, iron and copper, and is oxidised by the same oxygen and air added to the CIL to assist in leaching the gold. Around half of the cyanide that enters the CIL is degraded.
The concentration of cyanide is variable in the CIL due to the variations in ore characteristics and degradation down the tank farm with time. The sodium cyanide concentration is expected to vary between 700 ppm and decaying quickly to 300 ppm. ***It should be noted the cyanide concentration itself is around half the value reported as sodium cyanide.*** Therefore the cyanide concentration itself will vary from around 350 ppm to around 150 ppm in the CIL.
Around half of the cyanide that is in the CIL tails is recovered by the tailings thickener. This cyanide is recycled back to the grinding circuit for re-use. The tailings thickener has water addition to assist in recovering the cyanide. This water addition will dilute the incoming sodium cyanide from around 300 ppm down to around 220 ppm (or around 110 ppm as cyanide).

Cyanide is also used for elution and intensive cyanidation. Cyanide at concentrations of up to 5000 ppm (0.5%) are used in the intensive cyanidation circuit at the start of the process but this decays following reaction with the concentrates. Relatively small volumes are used. The elution circuit uses cyanide at concentrations of up to 5000 ppm (0.5%) however this is quickly diluted and is oxidised in the electrowinning process. The cyanide that remains from the intensive cyanidation process and the elution process is pumped to the CIL so as to provide residual cyanide for leaching and reduce the amount that has to be added to the CIL.

The bulk of the remaining cyanide in the CIL tails after thickening is destroyed in the cyanide detoxification reactors. The sodium cyanide is effectively destroyed in total. Only certain weak acid dissociable cyanides remain at concentration of less than 10 ppm as is required by and in accordance with the relevant EU regulations. Other cyanide compounds exist but are only dissociable in strong acids and as such are not deemed to be biologically damaging.

3. Please provide more information on the statement concerning the TMF failure that (question 23) "the risks are very, very low and acceptable".

The hazard associated with dam breach and overtopping with release of tailings and water was the subject of a very thorough event tree hazard study by the Norwegian Geotechnical Institute (NGI). The hazards associated with all aspects of the site, construction, operation and post-construction relevant for a well-functioning TMF were identified. The potential conditions and triggers of accidents and failure modes were evaluated. Combinations of events were also evaluated cumulatively.

The event tree hazard analyses considered the dam at different stages of its life and calculated the probability of non-performance. A non-satisfactory performance of the dam was defined as an uncontrolled release of tailings and water from the dam over a period of time. The release could be due to a breach of the crest of the dam or overtopping without breach of the dam. Key factors considered included:

- Dam configuration (Starter dam, dam during construction and dam at completion);
- Triggers, including earthquake shaking, extreme rainfall and/or snowmelt, natural terrain landslide in the valley and failure of the Carnic waste stockpile into the tailings reservoir;
- Failure modes, including failure of the foundation, dam slope instability downstream or upstream, unravelling of downstream toe and slope, piping, internal erosion, dam abutment failure followed by breach, liquefaction of the tailings, dam overtopping or excessive leakage under TMF, and crest settlement or collapse;
- Conditions such construction deficiencies, inadequate response of the field control team and construction schedule changes. All these events were integrated in the event tree analyses.

The event tree analyses showed the following:

- No sequence of plausible accidental events results in a probability of non-performance of the dam greater than 10^{-6} per year (once in a million years).
- The estimated probabilities of non-performance are lower than what is used as criteria for dams and other containment structures around the world and lower than probabilities of nonperformance for most other engineered structures.
- None of the probabilistic event tree analyses suggest consequences more severe than some material damage and limited contamination, both in the vicinity downstream of the dam. There would be no trans-boundary effects and breach of water standards in the immediate vicinity occurs only with the probability of one in four million years. For more details please read the annex "Hazard Assessment of Corna Dam in Tailings Management Facility", May 2008, by NGI.

4. Please clarify the issue of the TMF basin insulation. Is there an engineering liner or not?

An engineered liner is included in the design of the Tailings Management Facility (TMF) basin to be protective of groundwater. Specifically, the Roşia Montană Tailings Management Facility (TMF or "the facility") has been designed to be compliant with the EU Groundwater Directive (80/68/EEC), transposed as Romanian GD 351/2005. The TMF is also designed for compliance with the EU Mine Waste Directive (2006/21/EC) as required by the Terms of Reference established by the MEWM in May, 2005. The following paragraphs provide a discussion of how the facility is compliant with the directives.

The TMF is composed of a series of individual components including:

- the tailings impoundment;
- the tailings dam;
- the secondary seepage collection pond;
- the secondary containment dam; and
- the groundwater monitoring wells/extraction wells located downstream of the Secondary Containment dam.

All of these components are integral parts of the facility and necessary for the facility to perform as designed.

The directives indicated above require that the TMF design be protective of groundwater. For the Roşia Montană project (RMP), this requirement is addressed by consideration of the favorable geology (low permeability shales underlying the TMF impoundment, the TMF dam, and the Secondary Containment dam) and the proposed installation of a low-permeability ($1x10^{-6}$ cm/sec) recompacted soil liner beneath the TMF basin. Please see Chapter 2 of EIA Plan F, "The Tailings Facility Management Plan" for more information.

The proposed low permeability soil liner will be fully compliant with Best Available Techniques (BAT) as defined by EU Directive 96/61 (IPPC) and EU Mine Waste Directive. Additional design features that are included in the design to be protective of groundwater include:

- A low permeability ($1x10^{-6}$ cm/sec) cut off wall within the foundation of the starter dam to control seepage;
- A low permeability ($1x10^{-6}$ cm/sec) core in the starter dam to control seepage;
- A seepage collection dam and pond below the toe of the tailings dam to collect and contain any seepage that does extend beyond the dam centerline;
- A series of monitoring wells, below the toe of the secondary containment dam, to monitor seepage and ensure compliance, before the waste facility limit.

In addition to the design components noted above specific operational requirements will be implemented to be protective of human health and the environment. In the extremely unlikely case that impacted water is detected in the monitoring wells below the secondary containment dam, they will be converted to pumping wells and will be used to extract the impacted water and pump it into the reclaim pond where it will be incorporated into the RMP processing plant water supply system, until the compliance is reestablish.

5. Please provide more information on the pipelines transferring tailings (protection against low temperature, inspection methods, etc.).

The tailing delivery line will either be buried along the access road from the plant to the TMF or alternatively, it will be place on the surface with secondary containment system that will contain any leakage and direct it either to the plant site containment pond or the TMF basin.

The flow rate of tailing material through the pipeline is expected to be at a sufficient rate to prevent freeze of the liner during winter operations. In the event of a shut down the line will be drained to either the plant site pond or the TMF basin.

Experience during the previous mining operations at the Cetate pit and the associated tailing disposal in the Selestea tailing facility (Check Spelling) confirms that above ground tailing delivery lines will not freeze during operations.

6. Please provide information on the possible achievement of 2 mg/L WAD cyanide concentration (question 101).

The maximum weak acid dissociable (WAD) cyanide concentration limit in mine waste set by the EU Mine Waste Directive MWD (2006) states clearly that the wastewater concentration must not exceed 10 ppm. This level was set after considerable research and debate. The IPPC/Best Available Techniques does note that two European mines did, even at the time of the analyses leading to the Directive, achieve 2 ppm or lower, but the EU still set the 10 ppm limit.

Roşia Montană pilot detoxification tests, using the best available technique on the ores from the project site did, in fact, achieve WAD cyanide levels lower than 2 ppm. (The levels achieved by the test work are as low as have been observed by the RMGC technical team in several test programs on various ores around the globe, suggesting the ore at RM is particularly amenable to the detoxification process -but there are practical limits. Each ore type is different and one cannot simply expect concentrations of detoxified tailings of one mining operation to be matched at another.) For Roşia Montana, even while designing operations to apply detoxification residence times twice that used during the test work, as well as detoxification reagent dosing systems that supply 50% more than was used during the test work, the project design and risk analysis conservatively assumes that, under scaled up operating conditions, waste will exit the processing plant and enter the waste containment facility (tailings management facility, or TMF) at maximum levels of 5 – 7 ppm. This is a prudent concentration to assume given the test work and the realities of scaled-up operation compared to laboratory bench work. Roşia Montană may well actually perform better than this and will strive to do so. However, ensuring lower concentration levels at operating volumes and conditions has practical limits determined by the characteristics of the site materials and other site-specific conditions.

The EU regulators, who determined the limit of 10 ppm WAD cyanide, would not take irresponsible chances with public safety. (In fact, an average person would have to consume over 20 liters of water containing the TMF levels of 5 – 7 ppm WAD cyanide in a short period of time – a physical impossibility – to threaten their life.) Literally hundreds of mining operations safely handle tailings with materially higher cyanide concentrations. At this time mines already permitted only have to achieve WAD cyanide levels of 50 ppm under the EU Directive. This level, five times higher than the level imposed on (and on which it improves) Rosia Montana, is still

considered to have minimal environmental effect. Employee safety in the processing plant area is a separate matter that is also very carefully addressed.
Fear of higher concentration than 5-7 ppm in the TMF, due to a failure of the detoxification unit, is unfounded as the effluent would be monitored constantly. In the event of a malfunction or design flaw in the detoxification unit, the operations would be halted. In addition, due the large volume of water stored in the TMF, there is a high dilution potential, so the unit would have to operate at higher concentrations for a long period of time to substantially increase the cyanide concentration in the TMF. The effluent entering the TMF will be monitored for indications of any such deviations. These ensure that any change in the operating parameters would be noticed before the concentrations in the TMF increased substantially. Additionally, a surface and subterranean water sample monitoring program and regular reporting is planned to detect any deviations that might show up in those locations. Authorities would be notified of any deviations from safe conditions (this will be required by the Ministry of Environment in conditions included in an Environmental Permit). Romanian Environmental legislation states that, in case of non-compliance, remedies could range from fines to a suspension and cancelling of the environmental permit. No one can afford to ignore such matters.

Stability of the TMF dam[2]

7. Where will you bore groundwater monitoring wells?
Three to five (depending on design) groundwater monitoring wells will be installed downstream of the Secondary Containment Dam (SCD). These will be used to confirm no impacts to the existing groundwater system downstream of the TMF facility. If, in the unlikely event that impacts to groundwater are observed, the wells can be converted into dewatering wells which would pump the groundwater back to the TMF reclaim pond where it would be re-circulated into the process water.
In addition, various other monitoring wells will be installed within the project area to monitor groundwater. The locations are shown on Exhibit 6.3 of the EIA Report. These groundwater monitoring well locations and details are presented in the EIA Chapter 6 and in the *Environmental and Social Monitoring Plan* (ESMS Plans, Plan P).

8. Please provide more information about the future quality assurance and quality control systems in connection with the TMF dam, including construction regulations.
The general requirements for the QA/QC during construction and operation of the TMF are presented in Section 6 of the Tailings Management Plan (ESMS Plans). This plan indicates that all construction and operational procedures will be in accordance with BAT requirements. The current BAT document makes reference to specific International Committee on Large Dams (ICOLD) and Mining Association of Canada (MAC) guidance documents that provide specific guidance on testing and observation procedures.

An example of the types and frequency of testing that will be required for construction of the TSF dam are presented in the table below.

[2] The questions, remarks and requests correspond to the "2. Technological Processes" chapter of the EIA Study Report.

TMF DAMS - EARTH WORK - TYPICAL

TABLE 2- MINIMUN FRECUENCY OF TESTING FOR CQC EVALUATION OF ZONE 1

TEST	FRECUENCY	STANDARD TEST METHOD
Material properties		
	IN BORROW AREA OR STOCKPILE	
Paste pH	1 per 5000 ccm placed (minimun 1 per source)	
Specific Gravity	1 per 5000 ccm placed (minimun 1 per source)	ASTM D 854
Sieve Analysis	1 per 5000 ccm placed (minimun 1 per source)	ASTM D6913 / ASTM D 422
Atterberg Limits	1 per 5000 ccm placed (minimun 1 per source)	ASTM D 4318
Compaction	1 per 5000 ccm placed (minimun 1 per source)	ASTM D 698 / ASTM D 1557
	IN PLACE	
Litf Thickness Before Compaction	Constant monitoring	No ASTM metohod Completed by visual observation and survey
In-Situ Moisture Content	5/hft"	ASTM D 6938 / ASTM D 3017
In-Situ Dry Unit Weight	5/hft"	ASTM D 6938 / ASTM D 2922 / ASTM D1557
Sieve Analisis	Per ENGINEER	ASTM D6913 / ASTM D 422
Atterberg Limits	Per ENGINEER	ASTM D 4318
Specific Gravity	Per ENGINEER	ASTM D 854
In-Situ Permeability	1 PER 20,000 ccm	USBR-Drainage manual / ASTM D6391
Paste pH	Per ENGINEER	
Shelby Tube	1 PER 20,000 ccm	ASTM D 1587
Permeability Lab.	1 PER 20,000 ccm	ASTM D 5084

TABLE 3- MINIMUN FRECUENCY OF TESTING FOR CQC EVALUATION OF ROCKFILL - TYPICAL

TEST	FRECUENCY	STANDARD TEST METHOD
Material properties		
Litf Thickness Before Compaction	Constant monitoring	No ASTM metohod Completed by visual observation and survey
Sieve Analisis	1 every 5th lift	ASTM C 136 / ASTM D 5519
In -Situ Dry Density	1 every 5th lift	ASTM D 5030
In-Situ Permeability (Open Pit Metod)	1 every 5th lift	EM 1110-2-2301

TABLE 4- MINIMUN FRECUENCY OF TESTING FOR CQC EVALUATION OF DRAINAGE LAYER - TYPICAL

TEST	FRECUENCY	STANDARD TEST METHOD
Material properties		
Litf Thickness Before Compaction	Constant monitoring	No ASTM metohod Completed by visual observation and survey
Sieve Analisis	1 every 5th lift	ASTM C 136
In -Situ Dry Density	1 every 5th lift	ASTM D 5030
In-Situ Permeability (Open Pit Metod)	1 every 5th lift	EM 1110-2-2301

TABLE 5- MINIMUN FRECUENCY OF TESTING FOR CQC EVALUATION OF TRANSITION LAYER - TYPICAL

TEST	FRECUENCY	STANDARD TEST METHOD
Material properties		
	IN BORROW AREA OR STOCKPILE	
Sieve Analisis	1 per 3000 ccm placed (minimun 1 per source)	ASTM C 136 / ASTM D6913
	IN PLACE	
Litf Thickness Before Compaction	Constant monitoring	No ASTM metohod Completed by visual observation and survey
Sieve Analisis	Per ENGINEER	ASTM D 6913 / ASTM C 136

TABLE 6- MINIMUN FRECUENCY OF TESTING FOR CQC EVALUATION CORE DRAIN LAYER

TEST	FRECUENCY	STANDARD TEST METHOD
Material properties		
	IN BORROW AREA OR STOCKPILE	
Sieve Analisis	1 per 3000 ccm placed (minimun 1 per source)	ASTM C 136 / ASTM D6913
	IN PLACE	
Litf Thickness Before Compaction	Constant monitoring	No ASTM metohod Completed by visual observation and survey
Sieve Analisis	Per ENGINEER	ASTM D 6913 / ASTM C 136

TABLE 7- MINIMUN FRECUENCY OF TESTING FOR CQC EVALUATION OF CORE BARRIER LAYER - TYPICAL

TEST	FRECUENCY	STANDARD TEST METHOD
Material properties		
	IN BORROW AREA OR STOCKPILE	
Paste pH	1 per 5000 ccm placed (minimun 1 per source)	
Specific Gravity	1 per 5000 ccm placed (minimun 1 per source)	ASTM D 854
Sieve Analysis	1 per 5000 ccm placed (minimun 1 per source)	ASTM D6913 / **ASTM D 422**
Atterberg Limits	1 per 5000 ccm placed (minimun 1 per source)	ASTM D 4318
Compaction	1 per 5000 ccm placed (minimun 1 per source)	ASTM D 698 / **ASTM D 1557**
	IN PLACE	
Litf Thickness Before Compaction	Constant monitoring	No ASTM metohod Completed by visual
In-Situ Moisture Content	5/hft"	ASTM D 6938 / ASTM D 3017
In-Situ Dry Unit Weight	5/hft"	ASTM D 6938 / ASTM D 2922 / **ASTM D1557**
Sieve Analisis	Per ENGINEER	ASTM D6913 / **ASTM D 422**
Atterberg Limits	Per ENGINEER	ASTM D 4318
Specific Gravity	Per ENGINEER	ASTM D 854
In-Situ Permeability	1 PER 20,000 ccm	USBR-Drainage manual / **ASTM D6391**
Paste pH	Per ENGINEER	
Shelby Tube	1 PER 20,000 ccm	ASTM D 1587
Permeability Lab.	1 PER 20,000 ccm	ASTM D 5084

9. Please provide detailed description about the monitoring system in connection with the TMF dam.

In assessing risks of accidents, it is relevant to also consider the early warning information/monitoring to detect any condition that could evidence a heightened risk, to modify relevant standard operations to correct such emergency conditions and to ensure mitigation and emergency response should an accident ever occur. It is important to add in any consideration of the environmental risks of the project that all relevant aspects of environmental hazards are monitored regularly and that results that are contrary to the specifications set out are thus to detected and addressed, e.g. the cyanide concentration of the effluent entering the TMF – as well as in the reclaim pond in the TMF - are to be checked weekly so that any malfunction in the detoxification that would alter the concentration level of the tailings would be detected well before it could become material. Such malfunction would be corrected – or the operations would be stopped – before any damage could occur.

Seepage volume and chemistry of water coming from the TMF into the containment area behind the Secondary Containment Dam (SCD) will also be tested weekly. The water will be continuously pumped back to the reclaim pond in order to maintain the contaminated water inside the closed industrial zone system.

Ground water level and quality would be tested weekly in the wells located downstream of the SCD. If contamination were to be found, these wells would become producing wells, with the extracted water pumped back into the reclaim pond of the TMF.

The volume and chemistry of the water behind the Cetate dam, which is built to capture the currently polluting ARD run-off, is also monitored to identify its quality and to ensure the proper treatment process is applied to the impacted water.

The ARD water processing plant output is also to be monitored weekly at its discharge point so that treated water would only enter the river system at entirely acceptable purity levels – far superior to the currently prevailing conditions.

Post closing, the water in the pit partially filled with water (the Cetate pit) will also be monitored periodically to ensure its proper acidity balance. Similarly, the post closure passive treatment lagoons will also be tested weekly. These waters will not re-enter the water system unless at regulated quality levels – and the water can be treated further, if necessary prior to released. During operations there will be experiments to determine if the passive treatment lagoons are effective in treating the cyanide.

Specifically for the TMF and associated facilities, the Engineering Design will include specific construction, inspection and acceptance procedures for all completed works. The environmental impacts and quality of completed works will be monitored as early as the construction phase. Monitoring of environmental impacts, quality of works and equipment condition will continue throughout the operation and closure. The overall monitoring, inspection and reporting/recording activity will be conducted based on rigorous procedures. Specific monitoring instruments for the TMF dam are outlined below:

Vibrating wire "piezometers" (instruments placed in wells that measure water level and hydrostatic pressure) will be installed within the central core of the starter dam section, at different elevations downstream of the grout curtain and in the downstream shell of the dam in order to determine if there is an unexpected rise of saturation and water pressure.

Various hydraulic piezometers will be installed in the upstream tailings beach. The purpose of the piezometers is to determine the line of saturation in the tailings and to determine the rate of water level drop after the spigots for tailings are moved to another area.

The structural stability of the dam will be monitored to detect physical movements that could signal foundation weakness or slope instability.

Slope indicators (inclinometers) will be installed on the downstream slope of the starter dam and on a lower berm of the final dam. The purpose of the slope indicators is to check for possible downstream deformation at shallow depth in the bedrock.

A permanent nest of piezometers will be provided on each ridge of the Corna Valley, upstream of the tailings dam, for monitoring groundwater levels and quality. An existing nest on the left ridge will be used for this purpose and a new nest will be installed on the right ridge.

Two sets of vibrating wire piezometers will be located in the SCD, both upstream and downstream of the grout curtain. These piezometers will assess the hydraulic containment of the SCD. Deformation survey stations will be established on the dam to monitor any potential movements.

In summary, the project designs have committed to a rigorous system of monitoring for the project that is outlined in the EIA Management Plans. In addition, there are specific plans for monitoring the TMF for parameters that will indicate its performance in terms of stability and containment and permit a timely response before failure, should that become an issue. The design of the TMF along with the proposed operational procedures results in a very low probability of failure for the TMF. However, in the remote case that something was to occur, both early warning procedures and an Emergency Response plan have been prepared. The plan provides a detailed description of role and responsibilities for RMGC staff to respond to any unexpected event. Furthermore, it identifies the individuals/authorities that must be contacted in the downstream communities as soon as a reportable event has occurred.

The Emergency Preparedness and Spill Contingency Plan (see ESMS plans, Appendix I in EIA) is a comprehensive guidance document containing the first iterations of the measures RMGC will use to prevent, prepare for, and implement in response to emergency situations that could potentially occur during mining and mining-related activities. Prevention and preparedness is critical to RMGC's ability to minimize the extent and impact of emergency situations that may potentially occur. The Emergency Preparedness and Spill Prevention Plan is meant to operate in conjunction with existing community emergency response plans and the RMGC Occupational Health and Safety Plan. It conforms to the guidance of the UNEP APELL for Mining: Guidance of the Mining Industry in Raising Awareness and preparedness for Emergencies at Local Level, current European Union Council directives on the control of major accident hazards, as well as best management practices (BMPs) typically implemented by major international mining operations. The cornerstone of the Emergency Preparedness and Spill Contingency Plan is the RMGC "Major Accident Prevention Policy." The Emergency Preparedness and Spill Contingency Plan also addresses emergency response elements including identification of potential emergency scenarios, emergency response organization and responsibilities, co-ordination with external/governmental emergency response organizations, emergency alarms and communication, emergency response procedures (including evacuation procedures), emergency response equipment, post-emergency mitigation, spill prevention, inspections, training, and drills for the operation of all Roşia Montana Project facilities. The necessary capacities for response organizations – e.g. emergency agencies, hospitals, etc. – will be established in a collaboration of public authorities, community and health institutions and the Company.

10. Please provide detailed information about the stability analysis of the dam.

The Corna Valley TMF consists of the following main components:

- the TMF dam located across the Corna Valley. The dam will consists of a low permeability starter dam above which the final tailings dam will be raised sequentially to a final elevation by the centerline method of construction.
- secondary containment dam, located downstream of the main dam;
- tailings retention/decant pond behind the dam structure;
- secondary containment pond, behind the secondary dam structure;
- tailings delivery and distribution system;
- TMF reclaim water system;
- recirculation system for the TMF seepage collected in the Secondary Containment System (SCS) to the TMF basin

The operation of the Roşia Montană mine will generate tailings at a nominal rate of 13 million tonnes/year for a period of 16 years. From the perspective of water management, the purpose of the TMF is to contain process water in a manner that allows maximization of its recycle to the ore processing plant. The TMF will capture and contain all contaminated run-off waters from areas in the Corna Valley basin that are impacted by mine operations.

The tailings slurry from the process plant will be treated in a cyanide detoxification plant to reduce the Weak Acid Dissociable (WAD) cyanide concentration. WAD cyanide concentrations in the treated tailings slurry will be reduced to applicable EU standards of 10 p.p.m [mg/l] using the SO2/air treatment technology prior to discharge into the TMF.

Major Components of the TMF are described below:

- **Main dam (Corna dam)**

Zones of different permeability will be raised in lifts throughout the Roşia Montană Project life to accommodate the storage of tailings, process water, runoff from the PMP event and floods and provide freeboard for wave and ice protection. The TMF main dam will consist of:

- starter dam and final dam.
- tailings delivery and distribution system;
- tailings impoundment (TMF basin);
- reclaim decant water system;
- secondary containment dam and secondary containment sump.

- **Starter Dam**

The main dam will have a low permeability core, the starter dam, will be developed during the first stage of construction prior to initiation of mining operations. The starter dam will have a maximum height of 99 m and

a crest length of approximately 540m. The upstream and downstream dam faces will have an overall slope of 2H:1V and 2.25H:1V, respectively. The starter dam crest will be 10m wide.
The starter dam is designed as a low permeability dam with appropriate foundation preparation and seepage control measures for adequate structural and hydraulic stability in agreement with the best available techniques (BAT). The starter dam design involves a central low permeability core with filter/transition zones, bentonite slurry wall and upstream and downstream rockfill zones (rockfill dam shells). The dam foundation will be prepared down to the bedrock surface with appropriate foundation treatment, including injection grouting.
The Starter Dam will be initiated with the construction of a cofferdam for retention of the Corna Valley surface water, located upstream of the starter dam with potential to discharge water downstream to the starter dam.

- **TMF Final Dam**

The TMF main dam - Corna Dam - will be raised in stages using mine waste materials in accordance with the design criteria. The use of mine waste materials dictates a certain design approach for raising the tailings dam during operations. The optimum use of mine waste materials, in conjunction with stability and groundwater protection considerations, resulted in selection of the centre-line method of construction and a pervious dam design above the Starter Dam crest level. However, at a minimum, two downstream lifts will be constructed initially to allow time for adequate beach development prior to starting the centre-line lifts.
The Corna dam final crest height will be approximately 200m with a crest length of approximately 1,182 m. The downstream face will have an overall slope of 3H:1V, and the crest width will be 20m.
Prior to starter dam construction, all vegetation and topsoil will be removed within the footprint of the starter dam. Vegetation will be disposed of outside the limits of the TMF basin. Topsoil will be stockpiled for use during closure and reclamation. Within the TMF basin the surface of the colluvial layer, will be exposed after stripping the topsoil and used to seal the TMF basin. The compacted colluvial layer will achieve a relatively low permeability (10^{-8} m/sec). The extent of the basin preparation will be extended with the construction of each lift.

- **TMF Basin**

The TMF basin preparation method is in agreement with BAT and complies with the Best Environmental Practices. The compacted layer is intended to provide a barrier layer to reduce seepage from the TMF basin. In areas where the colluvial layer has been eroded or is not present, excess colluvial material within the basin and road construction areas will be used to cover these areas. The placed colluvial material will be compacted to achieve that same permeability as the native materials. This will result in a continuous barrier layer through the basin. To provide containment of the tailings and process water, a series of under-drains will be installed near the downstream toe of the dam and throughout the TMF basin. A sump is provided to collect the TMF basin drainage constructed with the cofferdam. Side-slope riser pipes will be installed to allow pumps to be installed in the base of the under-drains and allow consolidation water to be removed as quickly as possible.

- **TMF Operation**

The Project water balance and supporting hydrological studies confirm that the TMF can be managed in both water deficit and water surplus conditions under all climatic conditions throughout the life of Project. Adequate storage will be provided in the TMF to contain the runoff from a PMP event. During spring runoff and after storm events, water in excess of process requirements will be stored in the TMF for later use in the process.
The TMF will be managed to avoid discharges, however, should it become necessary, treatment to acceptable standards and the release to the environment can be initiated and monitored. The construction schedule for embankment and basin staging will be completed to ensure that 2 PMP storage requirements are available throughout the project life.
The tailings pond will collect waters from direct precipitation and runoff that is not captured in the Cârnic waste drainage holding pond or the overflow of clean water from the diversion channels.
Water will be recycled from the TMF to the process plant via a floating barge located at the northeast end of the basin. The discharge points for the treated tailings will be managed to keep the tailings supernatant pond centered around the reclaim barge and, to the extent possible, away from the tailings embankment. Minor seepage through the Corna main dam is expected which will be collected directly in the SCS sump and pumped back to the tailings basin.
The stability analyses details are presented in the Tailings Facility Management Plan (Plan F of the EIA Report). This document presents details of the stability analyses for the starter dam as well as the final dam configuration. A series of loading cases were considered for the starter dam that included:

- CASE 1: End of Construction (No water Impounded-Piezometric surface below embankment, total strength for core-Static, OBE) Downstream and Upstream Slopes

- CASE 2: End of Construction (Water Impounded to El. 700m- piezometric El. 700m at core face, total strength for core -Static, OBE) Downstream and Upstream Slopes
- CASE 3: Operational Condition – (Pool El. 735m, piezometric El. 728m at core face, full tailing, effective strength except for core, Static, OBE, MDE) Downstream Slope
- CASE 4: PMF – (Pool El. 737m, piezometric El. 737m at core face, full tailing, effective strength except for core, Static, OBE, MDE) Downstream Slope
- CASE 5: Liquefaction after Construction – Not applicable for analysis.
- CASE 6: Tailings Beach Saturated – (Pool El. 737m, piezometric El. 737 m at core face, full saturated tailing, effective strength except for core, Static, OBE, MDE) Downstream Slopes
- CASE 7: Liquefaction with all tailings – (Pool El. 737m, piezometric El. 737 m at core face, Full saturated tailing and liquefaction- 2/3MCE) Downstream Slope
- CASE 8: Rapid Drawdown: Rapid drawdown is not applicable to the TMF

A similar set of loading cases was used for the final dam configuration as well.
The general procedure that was used for the stability analyses is outlined below.

- The idealized section used in analysis of the starter dam is shown in the attached stability analysis results. The section has been idealized to include the lowest points at the upstream, core, and downstream.
- Engineering parameters for the Zones 1 through 5, overburden and foundation materials were taken from the "Rosia Montana Project Geotechnical Design Parameters – MWH 2003".
- Andesite rockfill is used as Zone 4 fill material for all stability cases.
- The Spencer slope stability method was used in the calculations. The Spencer method satisfies both moment and force equilibrium.
- The Slope/W V.5.1 slope stability software was used to run the computations for all load cases.
- Pseudostatic coefficients for Operation Basis Earthquake (OBE), Maximum Design Earthquake (MDE) Maximum Credible Earthquake (MCE) provided by SNC Lavalin (OBE = 0.082g, MDE = MCE = 0.14g) were used for pseudostatic stability analysis.
- Loading cases, and assumptions are in conjunction with MWH, 2003, "Seepage and Stability Analysis Basis and Considerations. Loading conditions are described for each case.
- Total strength parameters are used for the clay core for all cases.

The specific stability analysis results are presented in the tables below for the starter dam and the final dam.

Table 4-3. Stability analysis, the starter dam

Loading Condition		Lowest Calculated Safety Factor	Minimum Required Safety Factor
Downstream			
Static	End of Construction (no water impounded in the tailings pond). Case 1a	1.5	1.3
	End of Construction (water impounded in the tailings pond). Case 2a	1.4	1.3
	Operation and Closure. Case 3a	1.8	1.5
	Flood. Case 4a	1.7	1.3
	Saturated Tailings Beach	1.7	1.3
OBE	End of Construction. Case 1b	1.2	1.1
	End of Construction. Case 2b	1.1	1.1
	Operation and Closure. Case 3b	1.4	1.1
	TMF. Case 4b	1.3	1.1
	Saturated Tailings Beach. Case 6b	1.3	1.1
MDE	Operating Conditions. Case 3c	1.2	1.1
	Probable Maximum Flood. Case 4c	1.1	1.1
	Saturated Tailings Beach. Case 6c	1.1	1.1
Liquefaction	Operation. Case 7c	1.3	1.1
Upstream			
Static	End of Construction (no water impounded in the tailings pond). Case 1a	1.9	1.3
	End of Construction (water impounded in the tailings pond). Case 2a	1.7	1.3
OBE	End of Construction. Case 1b	1.6	1.1
	End of Construction. Case 2b	1.4	1.1

Table 4-4. Stability analysis, final dam

Loading Condition		Lowest Calculated Safety Factor	Minimum Required Safety Factor
Static	Operation and Closure. Case 3a	2.0	1.5
	Probable Maximum Flood. Case 4a	1.9	1.3
	Saturated Tailings Beach. Case 6a	1.9	1.3
OBE	Operation and Closure. Case 3b	1.6	1.1
	Probable Maximum Flood. Case 4b	1.4	1.1
	Saturated Tailings Beach. Case 6b	1.4	1.1
MDE	Operation and Closure. Case 3c	1.3	1.1
	Probable Maximum Flood. Case 4c	1.2	1.1
	Saturated Tailings Beach. Case 6c	1.2	1.1
Liquefaction	Operation. Case 7c	1.4	1.1

11. Please provide more information about the materials used for the watertight core, and about the places from where the materials will be got.

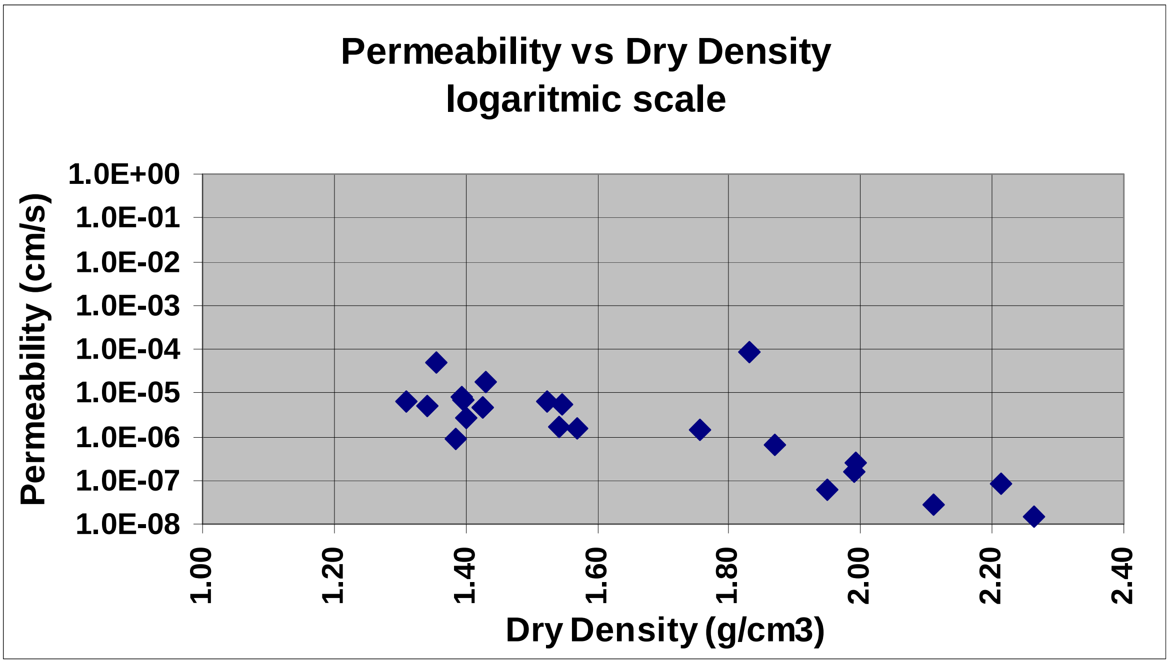
The initial dam will be made of clay core rockfill materials with low permeability which will be built during the Project construction stage, prior to the mining operations start up. According to the design criteria , the initial dam final level will be at +739 m, staring from +640 m level and it will ensure the required capacity for the tailings and technological water storage during the first 15 months of operation.

The initial dam is designed like a water accumulation dam because during the first 15 operational months it will operate as an accumulation am for the water required for the processing flowsheet. The initial dam is designed with clay core with low permeability provided with filtration and transition zones and concrete walls as well as rockfilling material both upstream and downstream. The dam foundation will be prepared up to the rocky ground using suitable treatments including watertight diaphragm (details in the section *Tailings Managemen Facility TMF* and drawings 2.50; 2.51)

During the construction stage of the initial dam it is provided to build a water containment cofferdam on Corna stream, upstream the initial dam and providing the possibility of a bypass and flow – rate discharge downstream the initial dam.

The material for the core of both the TMF dam and the SCD will be obtained from the colluvial deposits within the footprint of the dam or just upstream of the dam. These materials have been sampled and tested as part of the site investigation studies for both strength and recompacted permeability. These tests indicate that the material will be suitable for a low permeability core for the dams.

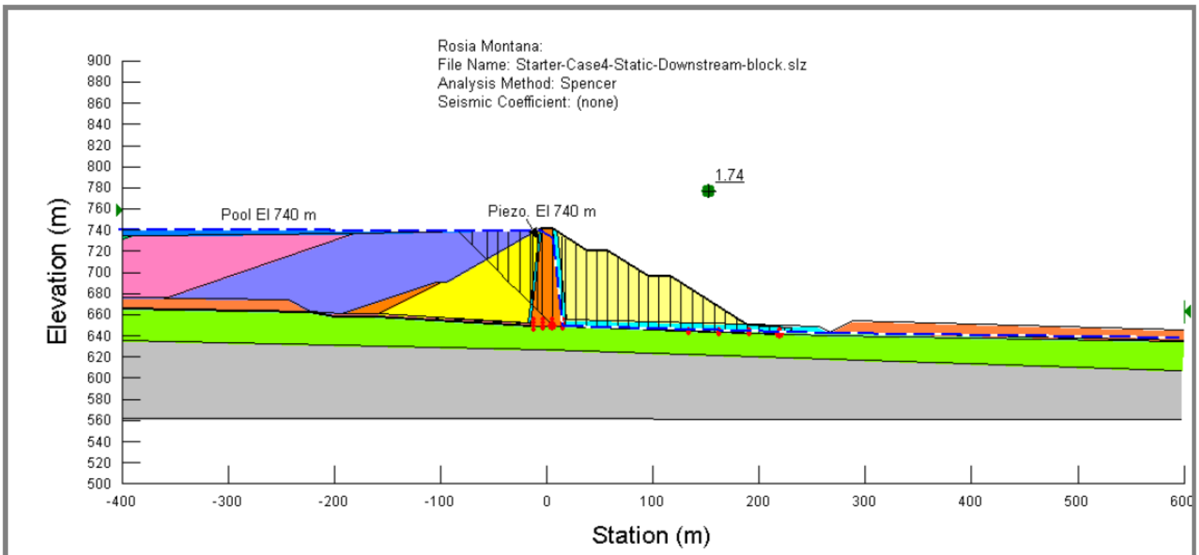
Specific details regarding the sampling and testing of the low permeability core of the dam are presented below. This indicates the low permeability nature of the material that will be used for the core zone of the starter dam.



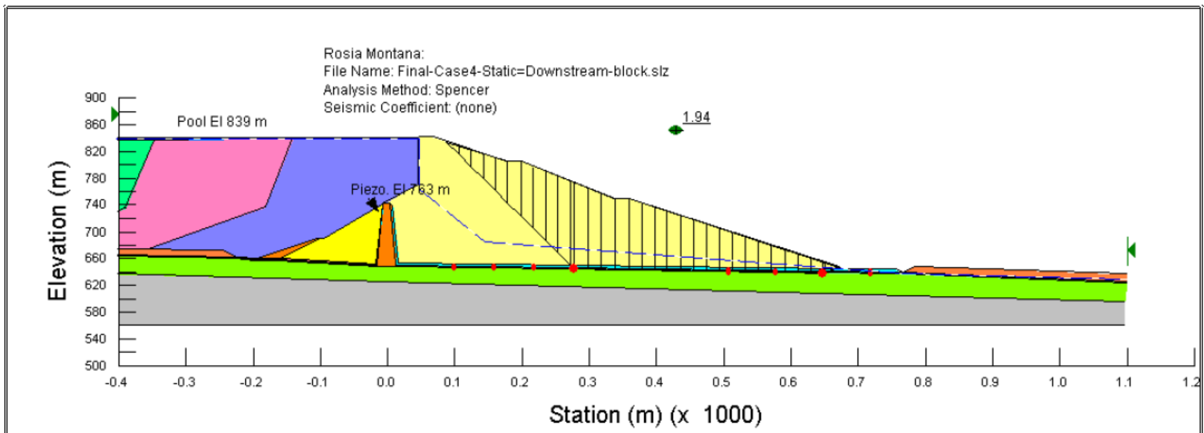
12. What is the function of the spillway on Exhibit 2.45A (profile along centerline)?
The design of the starter dam and all subsequent dam raises will have capacity for storage of 2 PMF events with out any discharge. However, the project has also included the design of a spillway in the crest of the starter dam and all subsequent dam raises. The spillway has been designed to pass and 10-year, 24-hour rainfall event that would occur immediately after two PMF events.

13. Is the downstream slope stable in each of its sections, or only in respect of the general slope?
The stability analyses for the starter dam and the final dam are presented in the Tailing Facility Management Plan (Plan F of the EIA Report). The stability analyses for the starter dam and final dam considered both circular and sliding block failure modes. The analyses utilized a search routine to look for small, shallow failure in-between benches on the downstream face of the dam and large scale failures that encompassed the entire dam section. The factors of safety that are reported are the lowest for the search routine.

A typical section showing the critical failure plane is shown below for the starter dam and final dam.



Case 6a Downstream Static
Starter Dam Section



Case 6a - TMF Main Dam - Static
Final Dam Section

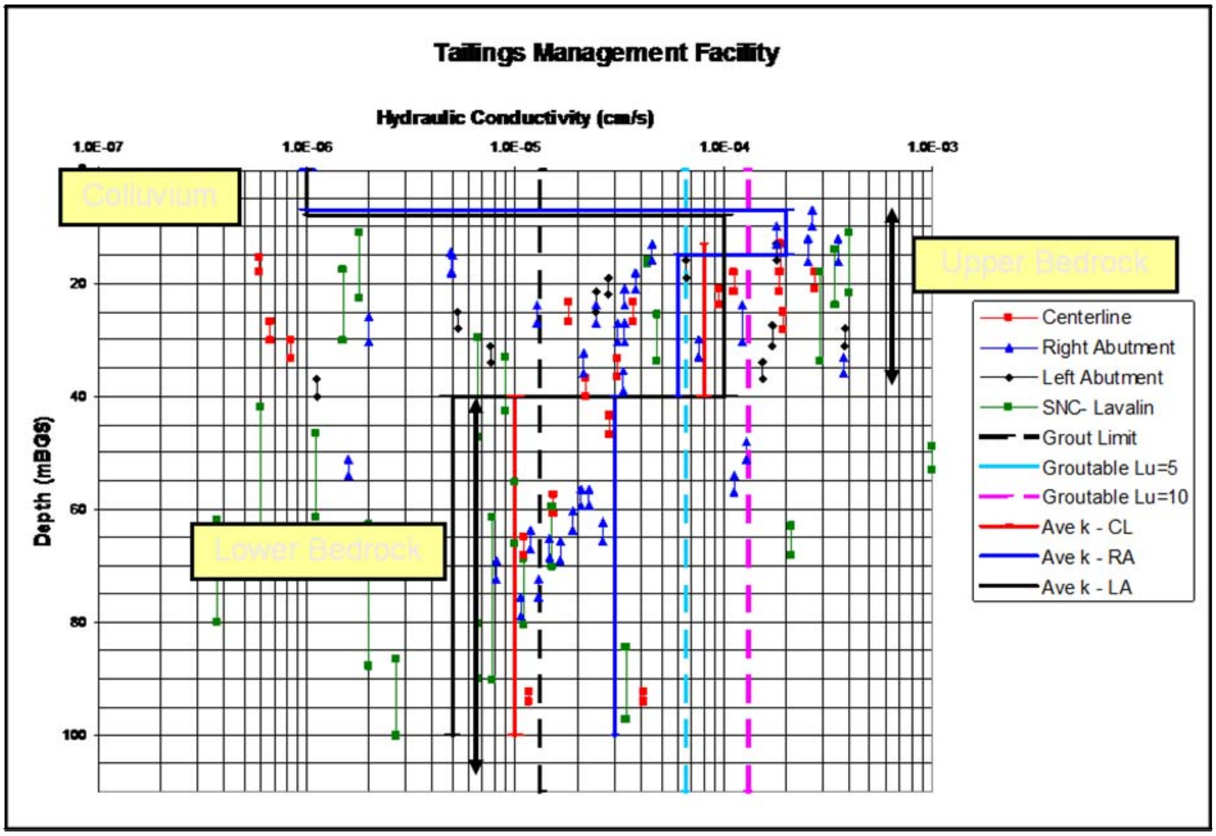
14. What is the solution for collecting water leaking through the bedrock?
The main TMF dam will include a bedrock cut off trench and a grout curtain to minimize bedrock groundwater seepage. However, the secondary containment dam (SCD) and associated sump is located downstream of the main TMF dam. This is designed to collect and contain any seepage migrating through the main dam section and allow it to be pumped back to the TMF reclaim pond. In addition, the sump behind the SCD will be operated at a very low level that will result in collection of bedrock groundwater seepage. This will also be pumped back to the reclaim pond.

As an additional redundant measure, the project has planned to install a series of groundwater monitoring wells below the SCD. These wells will be used to detect any impacted groundwater. If impacted groundwater is observed, the wells can be converted into groundwater extraction wells that will pump the groundwater back to the reclaim pond where it will be recycled in the process water system.

15. How did you calculate the embedding of the core in the bedrock? Would it be possible to embed the watertight core in the axis of the dam into the lower bedrock?

The core of the main dam is embedded into the upper bedrock approximately 3 to 4 meter over a width of approximately 20 meters. At that level a slush grouting and contact grouting program will be implemented to ensure a positive contact between the bedrock and core and a positive cutoff of groundwater flow below the dam core. If specific features in the foundation are observed during construction, grouting can be extended to any depth required to ensure a positive cutoff in the bedrock.

The figure presented below indicates the field permeability measurements that were made during the investigations and provided the basis for the cut-off depth and grouting program.



16. What pressures did you apply at the Lugeon tests?

The specific testing procedures and data reduction methodology that was used is presented in the Engineering Review Report prepared by MWH in 2005. An excerpt from that report is presented below that discusses the pressure that were applied during the insitu packer tests at the dam sites.

Maximum Allowable Pressure

Geologic structure (bedding and rock type) was used to set the initial maximum water test pressures. As testing progressed, the maximum allowable pressure for each test was determined using the rule of thumb of not exceeding 1 psi per foot of overburden, from USBR 7310. In some instances, lower pressures were used when softer material was suspected or when bypassing through the annulus was occurring.

Prior to conducting a water test in a drillhole, the core was visually inspected and the pressures were reviewed to ensure that the pressures selected were suitable. In most instances, the pressures utilized were slightly to considerably less than the 1 psi per foot depth assumption. In no case was the maximum allowable pressure exceeded.

Test Intervals
An attempt was made to achieve continuous permeability testing in all of the drillholes. In all instances the core was available to review and confirm packer depths. Generally, this was accomplished using 1.8m and 3.3m test intervals with the AGE Development® packers. Test intervals of 3.0m were used when utilizing the Geopro® packers. Some packer tests using the Geopro packers had a test interval of 2.92m after some of the equipment was damaged. Other intervals were used when there was difficulty seating the packers or specific intervals were of interest.

17. Do you have any plans for increasing the number and the depth of the boreholes? After elevating the dam with 100 meters, this is going to be a more difficult task.
Specific plans for additional investigation have not been prepared at this time. However, if any anomalous conditions that vary from the current characterization are encountered during the construction of the starter dam, then additional exploration work would be required prior to design and or construction of the subsequent dam raises.

18. Do you have any information about the direction of flow of the confined water? Is it possible, that the pollution penetrated into the cracked rock appears in another valley?
This condition has been considered in the design of the TMF dam and impoundment. Specific piezometers have been installed within the dam abutments and impoundment to measure water levels in the Corna basin. The resulting piezometric surface that has been generated from peizometer reading is presented in the Hydrogeology Baseline Report in the EIA (Figure 4.1). This indicates that the groundwater levels in the valley walls are above the maximum tailings elevation (840 meters) and therefore, we do not expect leakage from the Corna valley to adjacent valleys.

19. The water levels in the piezometers indicate overpressure almost everywhere. Do this and the RQD values indicate a relatively good conductivity of the rock?
A significant feature of the groundwater flow system is the presence of a downward vertical
hydraulic gradient in the vicinity of the TMF Dam alignment. These gradients were measured by comparing water levels in 22 pairs of nested piezometers located in this area. The downward vertical hydraulic gradient is somewhat higher below the right abutment (0.6, downward), compared to the left abutment (0.4, downward), possibly due to the different bedrock formations at these locations. The vertical gradients along the axis of the Corna Valley were as follows:

a. 0.17 (downward) upstream of the proposed TMF Dam
b. -0.01 (upward) to 0.04 (downward) at the centerline of the TMF Dam
c. -0.01 (upward) to 0.3 (downward) near the centerline of the SCD

The bedrock across the Corna Valley at the location of the TMF is a sequence of competent and incompetent foliated, faulted and sheared shale with interbeds of sandstone, breccia and fault gouge. The frequency of interbedded sandstone layers generally increases below a depth of 50 meters.
The core recoveries and RQD have a moderate scatter ranging from less than 10 to 100% and zero to 100%, respectively for drillholes advanced within the valley axis (03DH-C2-01, 03DHC2-07 and 03DH-C2-07A). The right abutment drillholes (03DH-C2-02 and 03DH-C2-02A) recorded good to excellent recoveries (60 to 100%) with some to few recoveries less than 40. However, the quality of the rock as measured using RQD, is consistently zero with few intervals recording RQD at 10 to 40%. The left abutment drillholes (03DH-C2-03 and 03DH-C2-03A) clearly show a significant increase in rock quality, as reflected in much higher percent recoveries and RQD. The rock quality on the left abutment were recorded above 50% from a depth of 11 meters to above 70% at a depth of 25 meters. Percent core recovery were consistently in the 80% range, with 100% recoveries from a depth of 25 meters to total depth at 50 meters.
The best representation of the hydraulic conductivity of the bedrock is based on the in-situ hydraulic conductivity tests. Due to the nature of the bedrock, interbedded shale and sandstone, the core recovered from the field investigations does not always provide a good characterization of the in-situ hydraulic conductivity. The figure presented as part of the response to question 9 indicates a summary of all permeability testing results.

20. Do the faults in the rock function as spread zones of pollution? Do the boreholes intersect the faults?
The bedrock foundation of the Corna Valley is the flysch sequence of the Maastrichtian on the left abutment reposing over the flysch deposits of the Albian on the right abutment in a stratigraphic unconformity. A schematic cross section of the flysch sequence near the TMF is presented in the Tailings Facility Management Plan and in the Hydrogeology Baseline Report. The age difference between the two formations is significant in

that the materials encountered on the right abutment are 30 million years older than those encountered on the left abutment.
The flysch facies is a sequence of competent and incompetent tectonically altered, faulted and sheared shales with interbedded sandstone and conglomerates. At the TMF location, the bedrock gently dips south into the left abutment at 30 to 55 degrees.

Resource Service Group conducted an airborne magnetic survey over the Rosia Montana – Bucium concession in 2001. An interpretation of the survey results revealed numerous linear features that were interpreted to be faults. The survey results revealed two dominant conjugate sets of faults trending north-northwest and east-northeast. An older, north-south trending set of lineaments can also be traced and appear to be associated with the emplacement of the mineralization.
An inclined drillhole was advanced across one of the north-northwest interpreted faults in the lower part of Corna Valley to a depth of 90 meters (along the incline) with the objective of defining the presence and condition of this interpreted fault. A shear zone consisting of coarsegrain fault breccia was encountered and was identified as likely being a minor fault or shear. Given the tectonically altered nature of the bedrock flysch facies and mineralisation emplacement shear zones of various thickness would be expected. No movement of the shear/fault zones is likely following the intrusion of the main dacite body and associated mineralization (Nash 2002).

One borehole was advanced specifically to intercept one of the inferred faults, located along or near the axis of the Corna Valley. The borehole was packer tested along three intervals. The results of the packer testing indicated that the brecciated fault zone has a hydraulic conductivity on the order of 10-6 cm/s. This suggests that the fault is a low permeability feature with a hydraulic conductivity similar to the surrounding bedrock. The fault zone is narrow without significant dilation and does not create a significant discontinuity.

21. What justifies the different dam structure envisaged at the later heightening of the dam?
The starter dam is being designed as a water retention dam with a full low permeability core in the centerline of the dam. This design concept was selected as the starter dam will contain the start-up water for the process facilities and a tailing beach is not expected to form until the end of the starter dam filling. Therefore, subsequent dam raises after the starter dam are being designed as a pervious dam using either a downstream construction methodology or centerline construction. This dam section will not include a low permeability core and will allow the upper section of the tailing material near the dam to be drained. This will result in low hydraulic heads near the dam face and reduce the potential for tailing water seepage to the adjacent valleys.

22. What kind of measures will you apply for preventing cracks in the core due to unequal compression of the core and the shell?
The low permeability core of the starter dam will be constructed in a vertical section. It is expected that this zone will primarily be subjected to vertical compression loading as the dam is raised. However, the low permeability core of the starter dam will be constructed with filter and transition zones between the core and the rock shell material. These will assist with mitigation of cracks in the core material if they were to occur.

23. What kind of methods will you apply for preventing infiltration on the hillside of the reservoir? Will you install geomembrane in the reservoir and on the headwater side of the dam?
It is proposed to recompact the existing colluvial layer within the impoundment basin to achieve a recompacted permeability of 1E-06 cm/sec or less. In areas of the basin where the colluvial layer is not present, low permeability soil will be borrow from within the basin and will be placed and compacted to achieve a permeability of 1E-06 cm/sec or less. Alternatively, in steep areas a geosynthetic clay liner could be substituted. Additional details regarding the justification of the engineering compacted clay liner are presented in the response to question 4.

Additional Remarks

24. In our opinion the safety factor n=1.1 given in tables 2.6-2.8 is too small.
All of the Factors of Safety indicated in Tables 2.6 to 2.8 meet or exceed the design criteria that was established for the project. These factors of safety meet or exceed internationally excepted levels for the specific loading conditions.
A summary of the Factors of Safety for the starter dam and the final dam are presented below.

Table 4-3. Stability analysis, the starter dam

Loading Condition		Lowest Calculated Safety Factor	Minimum Required Safety Factor
Downstream			
Static	End of Construction (no water impounded in the tailings pond). Case 1a	1.5	1.3
	End of Construction (water impounded in the tailings pond). Case 2a	1.4	1.3
	Operation and Closure. Case 3a	1.8	1.5
	Flood. Case 4a	1.7	1.3
	Saturated Tailings Beach	1.7	1.3
OBE	End of Construction. Case 1b	1.2	1.1
	End of Construction. Case 2b	1.1	1.1
	Operation and Closure. Case 3b	1.4	1.1
	TMF. Case 4b	1.3	1.1
	Saturated Tailings Beach. Case 6b	1.3	1.1
MDE	Operating Conditions. Case 3c	1.2	1.1
	Probable Maximum Flood. Case 4c	1.1	1.1
	Saturated Tailings Beach. Case 6c	1.1	1.1
Liquefaction	Operation. Case 7c	1.3	1.1
Upstream			
Static	End of Construction (no water impounded in the tailings pond). Case 1a	1.9	1.3
	End of Construction (water impounded in the tailings pond). Case 2a	1.7	1.3
OBE	End of Construction. Case 1b	1.6	1.1
	End of Construction. Case 2b	1.4	1.1

Table 4-4. Stability analysis, final dam

Loading Condition		Lowest Calculated Safety Factor	Minimum Required Safety Factor
Static	Operation and Closure. Case 3a	2.0	1.5
	Probable Maximum Flood. Case 4a	1.9	1.3
	Saturated Tailings Beach. Case 6a	1.9	1.3
OBE	Operation and Closure. Case 3b	1.6	1.1
	Probable Maximum Flood. Case 4b	1.4	1.1
	Saturated Tailings Beach. Case 6b	1.4	1.1
MDE	Operation and Closure. Case 3c	1.3	1.1
	Probable Maximum Flood. Case 4c	1.2	1.1
	Saturated Tailings Beach. Case 6c	1.2	1.1
Liquefaction	Operation. Case 7c	1.4	1.1

25. The soil (rock) shear strength parameters (Table 2.5) in many cases significantly diverge from the standard values. For example the $\Phi = 30°$ and $c = 0$ kN/m^2 of the watertight core and the $\Phi = 20°$, $c = 0$ kN/m^2 of the fine tailings silty clay do not seem to be the desired values.
As indicated in Table 2.5, the strength parameters for the low permeability core material were based on actual laboratory testing data. The values for the tailing materials are based on values reported in the literature.

26. The 1:1.6 ratio of slope (Exhibit 2.45A) looks too steep compared to the parameters given in Table 2.5.
The inter-bench slopes on the downstream face of the dam are 1.6H to 1V. However, the overall slope of the starter dam is approximately 3H:1V. The stability analyses evaluated both slope conditions

27. The RQD values indicate significant cleavage in several boreholes, even in the lower bedrock.
The interbedded shale and sandstone materials did exhibit low RQD values in the recovered core. However, this is dependent on the thinly layer nature of these materials. The insitu tests provide the best indication of actual hydraulic conductivity of these materials.

28. It is necessary to improve the accuracy of the stratigraphical section along the longitudinal section of the dam. The distance between boreholes reaches 200-300 meters at certain locations.
The longitudinal section is based on the specific borings along the profile combined with an interpretation of the geologic conditions based on the regional geology. The actual profile will be updated based on materials exposed during foundation excavation and based on additional exploration that will be performed prior to final design and construction.

29. The elevation scale of Exhibit 2.40 is not correct.
We request additional information on the discrepancy of elevation scale on Exhibit 2.40.

30. The bedrock stratification of the valley bottom (Exhibit 2.40, A-A Section) is very fluctuating.
We concur that the stratification of the valley is fluctuating. However, it provides the best representation of the actual field information.

Accidents/risk assessment

31. Considering the 6.2.2 para. on page 108. it would be necessary to identify those major accident scenarios, which can lead to transboundary damage and effect, namely HCN contamination. The effect must be calculated considering the "worst case" scenario. It would be necessary to produce the failure events combination (causes), which lead to the top event scenario (major accident events). Practically it should be presented by fault trees and/or event trees. In the fault trees passive failures and the failures of the safeguards have to be considered.
To reply to these concerns (expressed in questions no 1 and 2 above), RMGC decided to do more complete hazard analyses of the TMF (i.e. estimation of the annual probability of unsatisfactory performance of the TMF). RMGC contracted an independent organization to execute this. The hazard analyses used the event tree analysis approach. The detailed quantitative event tree analyses replace the earlier extreme scenarios of dam breach presented in the EIA Report (Report on Environmental Impact Assessment Study, Chapter 7 "Risks", May 2006). The probability of occurrence for the extreme dam break scenarios presented earlier was found to be too small to be considered realistic. Other scenarios with higher probability of occurrence were considered in the event tree analyses.
The event tree analyses were carried out by the Norwegian Geotechnical Institute (NGI), an internationally recognized organization for its work on dam safety and risk assessment. NGI, with the help of its own and external experts, assessed the hazard and evaluated the possible consequences associated with a non-performance of the TMF. The report with all scenarios analyzed for the TMF is available. It is RMGC's plan to hold a meeting with concerned parties to go through the results of the hazard analyses. Please see the entire report in the annex 2 "Hazard Assessment of Corna Dam in Tailings Management Facility", April 2009, by NGI.

32. It would be necessary to determine and quantify the frequencies related to these major accident scenarios.
To establish whether the dam provides acceptable safety against "uncontrolled" release of tailings and water during its life, an event tree approach was used to do the hazard analyses. This technique identifies potential failure mechanisms and follows how a series of events leading to non-performance of a dam might unfold. The probability of each scenario, given a triggering event, is quantified.
The event tree hazard analyses considered the dam at different stages of its life and calculated the probability of non-performance. A non-satisfactory performance of the dam was defined as an uncontrolled release of tailings and water from the dam over a period of time. The release could be due to a breach of the crest of the dam or overtopping without breach of the dam.
The analyses looked at critical scenarios, including all potential modes of nonperformance for the Corna dam under extreme triggers such as a rare, unusually strong earthquake and extreme rainfall in a 24-hour period.
The detailed event tree analyses replace the earlier extreme scenarios of dam breach, which were established in a more arbitrarily manner than the scenarios in the present report. These earlier extreme scenarios were presented in the EIA Report (Report on Environmental Impact Assessment Study, Chapter 7 "Risks", May 2006). The probability of occurrence for the extreme dam break scenarios presented earlier by RMGC was found to be too small to be considered realistic for the present analyses, given the design and characteristics of the TMF. Therefore, other scenarios with higher probability of occurrence were considered in the event tree analyses. Please see the entire report in the annex 2 "Hazard Assessment of Corna Dam in Tailings Management Facility", April 2009, by NGI.

33. The in-site domino effects should be taken into consideration because some originally not major accident event can lead to major accident as a secondary effect. The frequencies of these domino events must be involved into the final event scenario frequency. It would be necessary to involve the frequency of the possible earthquake event into the major event frequencies and the contribution of this frequency to the final frequency.
The key factors considered in the analyses included: dam configuration (Starter dam, dam during construction (times 3 years, 9-12 years) and dam at completion (16 years); triggers, including earthquake shaking, extreme

rainfall and/or snowmelt, natural terrain landslide in the valley and failure of the Carnic waste stockpile into the tailings reservoir; "failure" modes included failure of the foundation, dam slope instability downstream or upstream, unraveling of downstream toe and slope, piping, internal erosion, dam abutment failure followed by breach, and liquefaction of the tailings; and conditions such construction deficiencies, inadequate response of the field control team and construction schedule changes. These factors were integrated in the event tree analyses. Please see the entire report in the annex 2 "Hazard Assessment of Corna Dam in Tailings Management Facility", April 2009, by NGI.

The analyses showed the following:

- No sequence of plausible accidental events results in a probability of nonperformance of the dam greater than once in a million years (or 10-6/yr).
- The estimated probabilities of non-performance are lower than what is considered acceptable as design criteria for dams and other containment structures around the world and lower than probabilities of non-performance for most other engineered structures. The event tree analyses suggest that the probability of non-performance of the Roşia Montană TMF is about 100 times lower than the probability of non-performance of comparable containment dams around the world.
- None of the probabilistic event tree analyses suggest consequences more severe than some material damage and limited contamination, both occurring only in the vicinity downstream of the dam. In the case of a breach of the Starter Dam, essentially all material released will be contained by the Secondary Containment Dam. In the case of a maximum plausible breach of the completed Corna Dam, the release would be less than approximately 250,000 m3 of tailings and 26,000 m3 of water.
- The low computed probabilities of occurrence suggest that no mitigation action is required. Instrumentation and monitoring during construction and operation of the dam is probably the most cost-effective measure to reduce even further hazard and risk.

The scenarios modeled, with a probability of occurrence of once in 1 million years, resulted in considerably smaller released volumes than estimated in the extreme breach scenarios presented earlier in the EIA. The scenarios studied with the event tree analyses, with a probability of occurrence of once in a million years, indicate no damage or contamination, except in the vicinity of the dam downstream. There would be no trans-boundary effects.

The factors that contribute to the low probability of non-performance include the use of good quality rockfill for the downstream surface of the dam, gentle downstream slopes for both the Starter and the main dam, dam capacity to store extreme precipitation and/or snowmelt events, spillway to release excess water in a controlled manner, the planned safety monitoring to warn of any early signs of unexpected performance and the proposed preparedness to remediate to any indication of unexpected behavior. These factors, combined with the low concentration of cyanide in the tailings, contribute to reducing the risks.

34. As final result it would be necessary to perform a ranking of the scenarios, which can lead to transboundary damage and effect.

The impact of the development of a gold mine at Roşia Montană, Romania, as proposed by Gabriel Resources, has been closely re-examined in order to:

- quantify the beneficial effect of the proposed clean-up of the currently continuing pollution from the site caused by the abandoned historic mining operations; and,
- assess the risks of an accident and its consequences for the river system from the site of the mine through to the Hungarian border 595 km downstream.

To do these evaluations, RMGC requested Professor Paul Whitehead of University of Reading in UK and Professor Steven Chapra of Tufts University, Boston, USA to undertake river flow and water quality modeling studies, and the Norwegian Geotechnical Institute (NGI) to undertake an event tree hazard analysis of the TMF. Mr. Patrick Corser, P.E. and Mining Sector Leader, MWH, contributed his expertise to both aspects of this work, along with advice from cyanide experts. The joint conclusions of this work are:

- the proposed clean-up would achieve an almost complete removal of the current and constant pollution coming from the site, a definite environmental benefit of the project;
- the probability of an accident resulting in a toxic discharge is very small (1 chance in 1 million years). The scale of a discharge from an accident would not cause the water, even in the immediate vicinity, to exceed the regulated standard set for safe surface or drinking water - except in the circumstance of a low water flow condition in the river system. Such combined set of conditions was evaluated to have a much lower probability (1 chance in 4 million years). In that event, the water would have, temporarily and to a limited extent, cyanide concentration levels in excess of the regulated water standard over a distance of some 80 km downstream.

The cyanide concentration in these circumstances is not dangerous to human, animal, bird and most aquatic life. Only the most vulnerable of fish species (the river trout) – and only the most vulnerable individual specimens,

rather than this entire species in the river or in the area – would potentially be affected. This is because of the limited level of toxic materials that would be discharged by an accident and the limited duration of exposure as the wave of contaminated water passes. As cyanides are not bio-accumulated, once the contaminated water passes, any adsorbed toxins will quickly be excreted or oxidized by partially affected organisms such that they will make a rapid and full recovery in a short time.
In most water flow conditions, the dilution and dispersion in the river would reduce the toxic concentration immediately at the point of discharge into the river to a level that complies with the regulated standards;

- these remote and limited impacts from an accident are based on the worst case assumption that the discharge is not contained within the industrial area nor diluted by emergency procedures, both of which are possible mitigating measures; and,
- given the very robust design, large capacity and the conservative operating criteria of the containment facilities, any worse discharge is unrealistic. The event tree analyses show that the probability of non-performance of the TMF is about 100 times lower than the probability of failure for containment dams, based on the performance observed for dams around the world.

The following table summarizes the key conclusions:

Event	**High Flow river conditions**	**Low Flow river conditions**
Overtopping of the dam due to extreme rain or snow melt - two 1 in 10,000 yr rainfall in 24 hours followed by 1 in 10 yr flood (probability of occurrence less than 1 in 100 million years)	No breach of water standards	Not considered. Extreme rainfall and low flow condition in river would not occur at same time.
Dam breach caused by large earthquake or other triggers (probability of occurrence 1 in 1 million years)	No breach of water standards	Standards exceeded for 80 km downstream, only for extreme concurrence of events (probability of occurrence of 1 in 4 million years). Temporary and limited consequences potentially mitigated
Environmental Impact Assessment (EIA) hypothetical dam breach cases – unrealistic. (probability of occurrence 1 in 100 million years or less)	Not realistic Theoretically exceeds standards	Not realistic Theoretically exceeds standards

Please see the entire report in the annex 3 "**Clean-up Strategy, Risk Assessment and Analysis of Accidental Pollution at Roşia Montană"**

35. It would be necessary to give the interventions and recovery actions related to the ranked specific major accidents identified above.
A Safety Report has been prepared and submitted to the Romanian authorities in accordance with the legal requirements in 2006. In 2010, in order to reflect changes in legislation, an updated version developed under the requirements of Governmental Decision no. 804 of 25th of July 2007 on the control of major accident hazards involving hazardous substances, amended by Governmental Decision no. 79/2009, stipulated under art. 2 and art. 10 was also submitted to the Romanian authorities.
Following the Safety Report, an Internal Emergency Plan will be developed before starting of construction and this plan need to be approved by Emergency Situation Inspectorate, which will develop (based on the data from the Internal Emergency Plan) an External Emergency Plan where will be detailed specific actions to be taken in case of an emergency.

Other remarks

36. Table 7-23. 110. p. The reference thresholds are slightly different from the values accepted in the Hungarian practice. In case of toxic effects the use of Probit-functions are highly recommended instead of using of LC50, IDLH, etc. The Hungarian regulation, which is based on the EU Document CPR18E

(Guidelines for quantitative risk assessment, "Purple Book") orders the establishments to consider and to involve possible major accident scenarios if a)Frequency of occurrence is equal to or greater than 1E-8/year and b) Lethal damage (1% probability) occurs outside the establishment's boundary. The "Legal framework" of the EIA study identifies as relevant document the EU Seveso II. Directive. In this context referring to European regulations and practices would be more appropriate than using principles and values recommended by HSE for screening. The Figure 7.24 is confusing. The societal and individual risks cannot be represented on the same diagram. Generally the individual risk curves are represented on a map as isorisk curves and their values depend on the distances and consequence effects. In our view many of the questions are coming from, that the softwares applied in the EIA study are suitable for spread and consequence calculations, but their application to risk calculation is very limited, or not possible at all. It can be the case, that the Hungarian legislation is more restrictive than the Romanian one, however, the Hungarian requirements reflect the European practice followed by the majority of the nations.

We agree that Figure 7.24 (in the Report on Environmental Impact Assessment Study – Chapter 7 Risks) may not represent the most appropriate illustration of risk levels, and that individual and social risk should not be presented in the same frame of reference.
During 2009 – 2010, the results presented in Figure 7.24 have been replaced with a series of hazard and risk analyses. The complete results are presented in NGI's report: "Hazard Assessment of Corna dam in Tailings Management Facility", dated April 2009. In this report, the results of the hazard analyses for the Corna Dam were compared to the probability of non-performance for dams and other containment structures around the world, and for other engineering structures. The hazard level for the Corna dam was found to be significantly lower than that for similar structures.
"The graph in Figure 1 relates the annual probability of failure with costs and number of fatalities for a number of structures and accidents (Whitman (1984); Baecher and Christian (2003)). Dams are in the probability range of 10-4 to 10-5 per year (once in 10,000 to 100,000 years). Most engineered structures have probabilities of failure greater than 10-4 per year (once in 10,000 years). For the Corna Dam the annual probability of non-performance was found to be 10-6 per year, or once in one million years. This graph along with others existing similar f-N curves in the scientific literature, suggest that the annual risk associated with the Corna dam not performing as planned is well inside the acceptable range.

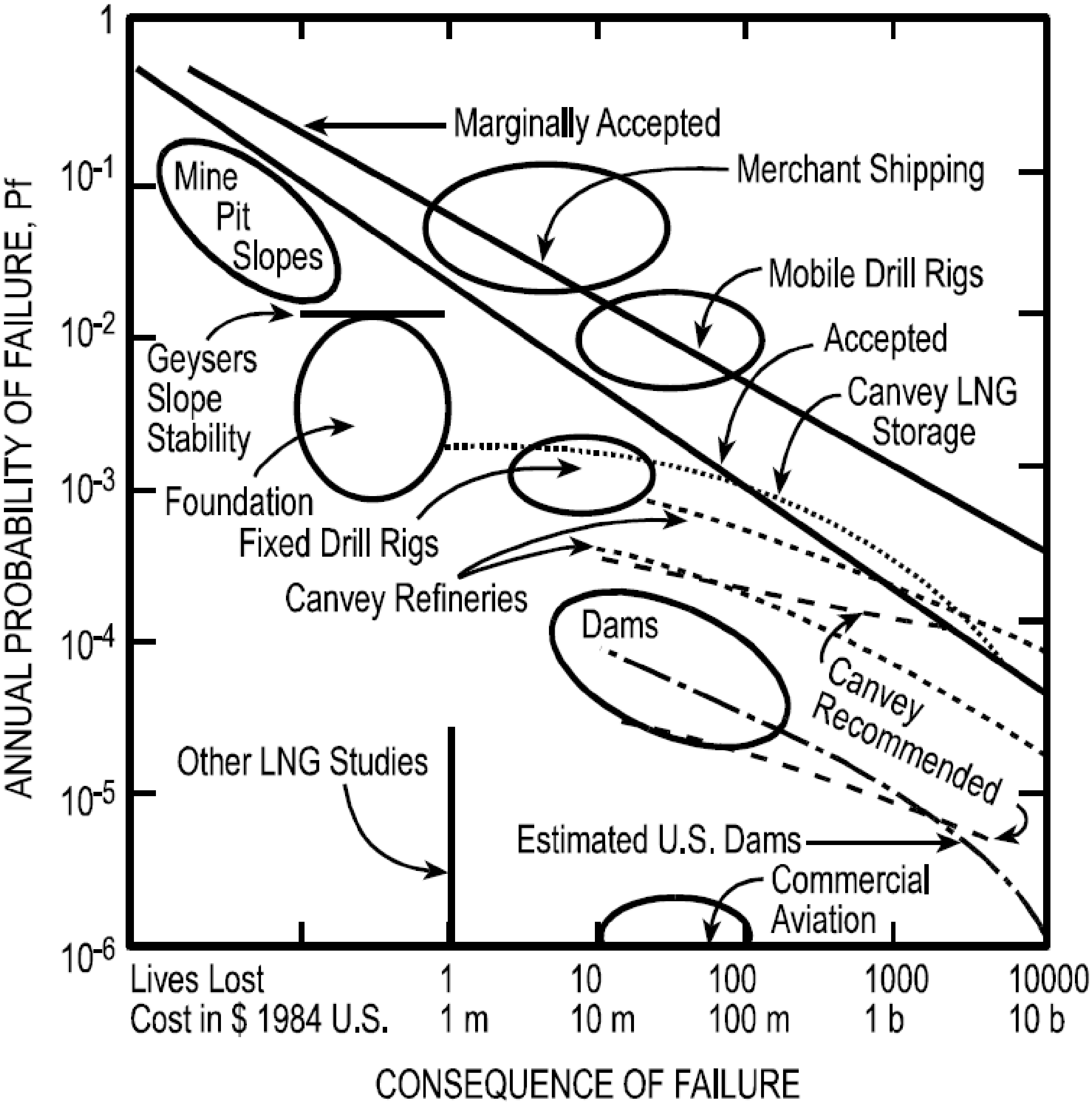


Figure 1. Acceptable levels of risk on f-N chart (Whitman, 1984).

Please see the entire report in the annex 2 "Hazard Assessment of Corna Dam in Tailings Management Facility", April 2009, by NGI.

37. Accident spill (pollutant spread) modelling by hydrological, hydraulic and water quality models
Following the meeting with the Hungarian delegation in Bucharest in July, 2007, it was agreed to address the key areas of concern. These consisted of a set of questions posed by the Hungarian team at the time of the meeting and these are answered below. The second area of concern was the very high values obtained by the Hungarian Dispersion modeling and this is addressed below. Finally, in a new set of requests after the meeting, the Hungarian team requested a modeling exercise using a dispersion equation model. A new version of the dispersion equation model has now been developed by Professor Steve Chapra, which incorporates dispersion behavior, the dilution effects of incoming streams and also the chemical decay processes. This dispersion equation model is solved numerically and a set of scenarios undertaken to address the pollution issues.

38. Both the hydrological-hydraulic and water quality models are inadequate, because they are neither calibrated nor verified against measured data. Hungarian expert wishes to present a model simulation with the same data, assumptions and models as of the study by Prof. Whitehead with resulting much higher cyanide concentration at the Romanian/Hungarian border in River Mures/Maros.
The INCA model has been calibrated against the flow and water quality data for the upper catchments and the main river. The observed water quality data were obtained from the long term sampling program conducted by RMGC and from the local water authorities. Tables of model results compared to observed data are given in the report, as well as plots of detailed hydrological time series.

With regard to cyanide there is, of course, no data to compare for the Mures River as there are no cyanide releases along the river. However, the model has been set up for the Baia Mare event and it is shown that the model can reproduce the cyanide concentrations that occurred during this pollution incident. This shows that the model does reproduce the mixing, dilution and decay processes in the river.
There is a large literature on Acid Rock Drainage (see list of papers in the modeling report) and there is worldwide consensus about the rapid loss of metals from streams downstream of mines as aeration processes rapidly oxidize the metals. The rate coefficients used in the model are consistent with this understanding.
It is very important to incorporate all the factors affecting water quality in rivers. These include mixing or dispersion processes, dilution effects from inflowing downstream water and also the chemical decay effects. It is the combination of all of these that determine downstream concentrations.

39. The water quality model actually used cannot be fully identified from the study and the method of determining its critical dispersion (mixing) parameter (on the basis of empirical formula) is not acceptable.
The INCA model is fully described in the modeling report (see pages 10-21 and pages 37-53). The INCA papers referred to the main report by Whitehead et al (1998) and Wade et al (2002) give further descriptions of the model and the application to similar large catchment systems. The Dispersion Model used for the Monte Carlo analysis is fully described by in the report and is drawn from the standard water quality modeling textbook by Professor Steve Chapra (Chapra, 1997). The estimation of dispersion coefficients is difficult but it would be impossible to conduct an experiment along the Aries and Mures River system in order to directly measure these. The size of the rivers and the residence times would mean that only a radioactive tracer would produce accurate results and this would be environmentally unacceptable. Further discussion of this issue is considered in section 5 of this Annex. Without direct measurements dispersion coefficients are always estimated using empirical formula. The empirical formula developed and tested by Professor Roger Falconer and his team at Cardiff University is probably the best relationship to use and is published in a refereed international journal. However, in section 4 of this annex an alternative method based on the classical method of Fisher is used. The inevitable uncertainty in estimating dispersion coefficients is taken into account by using the Monte Carlo approach and specifying a range of dispersion coefficients. The subsequent 5000 simulations enabled the complete range of likely dispersion coefficients to be explored. This is well beyond what most dispersion modeling studies undertake to reflect the difficulty of estimating dispersion coefficients.

40. We need the details of all models (with special regard to the pollution spill, that is dispersion-advection model utilised)
All these details are given in the report (Annex 1) and attached papers. Further details of the dispersion modeling work are included in the annex of the report elaborated in June 2009, after the completion of risk analysis for the Corna dam, in order to reflect the updated version of the worst case scenario.

41. We need the details of obtaining the values for the most critical cyanide input (source) parameters for each scenario (it might be the "plane source" m_p for CN input for equations 1 and 2 in Chapter 7, page 76). Evidently this assumption on the magnitude of the pollutant source determines the calculated response that is the peak concentrations of CN in the river system.).
The report gives a list of the released flow under each scenario and this together with the dam concentrations defines the inputs to the models. Typically the m_p value in the dispersion equation Monte Carlo analysis is of the order of 800 g m^{-2} reflecting the high loads from the Dam failure. Whilst the loads may be high, the CN concentrations in the Dam are fairly low (see Tables in the main report). These low concentrations of cyanide from the dam are crucial to understanding the lower concentrations down the river, as the Dam concentrations are subject to a combination of dispersion processes down the river, then dilution from all the inflowing tributaries and, in addition, chemical decay. This issue is revisited in section 5 where further information on dispersion modeling is presented.

42. Peak cyanide concentrations shown (Figure 5.4, page 66) correspond to the lowest (1a) input scenario. We would like to see the detailed data and simulation results of all scenarios (with special regard to 2b). All the six dam-failure scenarios of Table 5.10 assume average and high-flow river conditions, while the critical values will evidently correspond to low flow conditions. We would like to see a scenario related to that case as well.
In order to answer the concerns above (questions no. 5 and 6), the impact of the development of a gold mine at Roşia Montană, Romania, as proposed by Gabriel Resources, has been closely re-examined in order to:

- quantify the beneficial effect of the proposed clean-up of the currently continuing pollution from the site caused by the abandoned historic mining operations; and,

- assess the risks of an accident and its consequences for the river system from the site of the mine through to the Hungarian border 595 km downstream.

To do these evaluations, RMGC requested Professor Paul Whitehead of University of Reading in UK and Professor Steven Chapra of Tufts University, Boston, USA to undertake river flow and water quality modeling studies, and the Norwegian Geotechnical Institute (NGI) to undertake an event tree hazard analysis of the TMF. Mr. Patrick Corser, P.E. and Mining Sector Leader, MWH, contributed his expertise to both aspects of this work, along with advice from cyanide experts. The joint conclusions of this work are:

- the proposed clean-up would achieve an almost complete removal of the current and constant pollution coming from the site, a definite environmental benefit of the project;
- the probability of an accident resulting in a toxic discharge is very small (1 chance in 1 million years). The scale of a discharge from an accident would not cause the water, even in the immediate vicinity, to exceed the regulated standard set for safe surface or drinking water - except in the circumstance of a low water flow condition in the river system. Such combined set of conditions was evaluated to have a much lower probability (1 chance in 4 million years). In that event, the water would have, temporarily and to a limited extent, cyanide concentration levels in excess of the regulated water standard over a distance of some 80 km downstream.

The cyanide concentration in these circumstances is not dangerous to human, animal, bird and most aquatic life. Only the most vulnerable of fish species (the river trout) – and only the most vulnerable individual specimens, rather than this entire species in the river or in the area – would potentially be affected. This is because of the limited level of toxic materials that would be discharged by an accident and the limited duration of exposure as the wave of contaminated water passes. As cyanides are not bio-accumulated, once the contaminated water passes, any adsorbed toxins will quickly be excreted or oxidized by partially affected organisms such that they will make a rapid and full recovery in a short time.

In most water flow conditions, the dilution and dispersion in the river would reduce the toxic concentration immediately at the point of discharge into the river to a level that complies with the regulated standards;

these remote and limited impacts from an accident are based on the worst case assumption that the discharge is not contained within the industrial area nor diluted by emergency procedures, both of which are possible mitigating measures;

Please see the entire report in the annex 3 “Clean-up Strategy, Risk Assessment and Analysis of Accidental Pollution at Roşia Montană”