Annex 1 – Justified and detailed presentation of the selection of Paraul Porcului and Sulei sandstone and andesite pits and assessment of cumulated impacts, considering the four pits surrounding the locality.

Under the Alternatives section, please submit a justified and detailed presentation of the alternatives for the Paraul Porcului and Sulei sandstone and andesite quarries, and include alternative uses of raw materials from the pits already under operation.

As briefly presented in the Environmental Report, page 255 and Annex 5 A, Review of Alternatives, on page 71, several alternative sources of construction rock have been considered ever since the initial design stage, including the procurement of construction material from already operational quarries.

The reasons leading to the proposed development of the two rockfill pits were based on the following rationales:

- Works Execution Schedule – the need to have sufficient construction materials at pre-established times.
- Environmental protection – proximity of the two pits to the facilities where the construction materials will be required.
- The existence of an operating license allowing the Titleholder to use all the resources within the licensed site.
- **The absence of viable construction rock resources near the Project.** The only rocks that could be used are the andesites at Rosia Poieni, however, these are located on the site of a different operating license, issued for copper-bearing ore, and held by CupruMin S.A. Abrud. The extraction and transport of these andesites would interfere with the extraction of copper-bearing ore. No data are available to date in regard to the volume and physical-mechanical parameter of these andesite rock resources and therefore they may not be taken into consideration in designing he industrial facilities; moreover, these andesites could only partly be used in building the dam but not the filters and drains required by it, for which only sandstone is suitable. No sandstone operation is currently ongoing in the area.

An assessment of available on-site aggregate material for the Project identified a possible shortfall in non-acid generating rock material at critical construction stages. To address the shortfall in such rock (sandstone, limestone, or andesite), on-site and off-site alternative material sources were considered.

The operating succession in the ore and aggregate pits took into consideration both a minimisation of environmental impacts and the implementation of a closure and cleanup plan starting as early as the operating stage.

An important aspect is the location of these aggregate quarries and the design specifications regarding the protection of residential areas and the protected historic area of Rosia Montana.

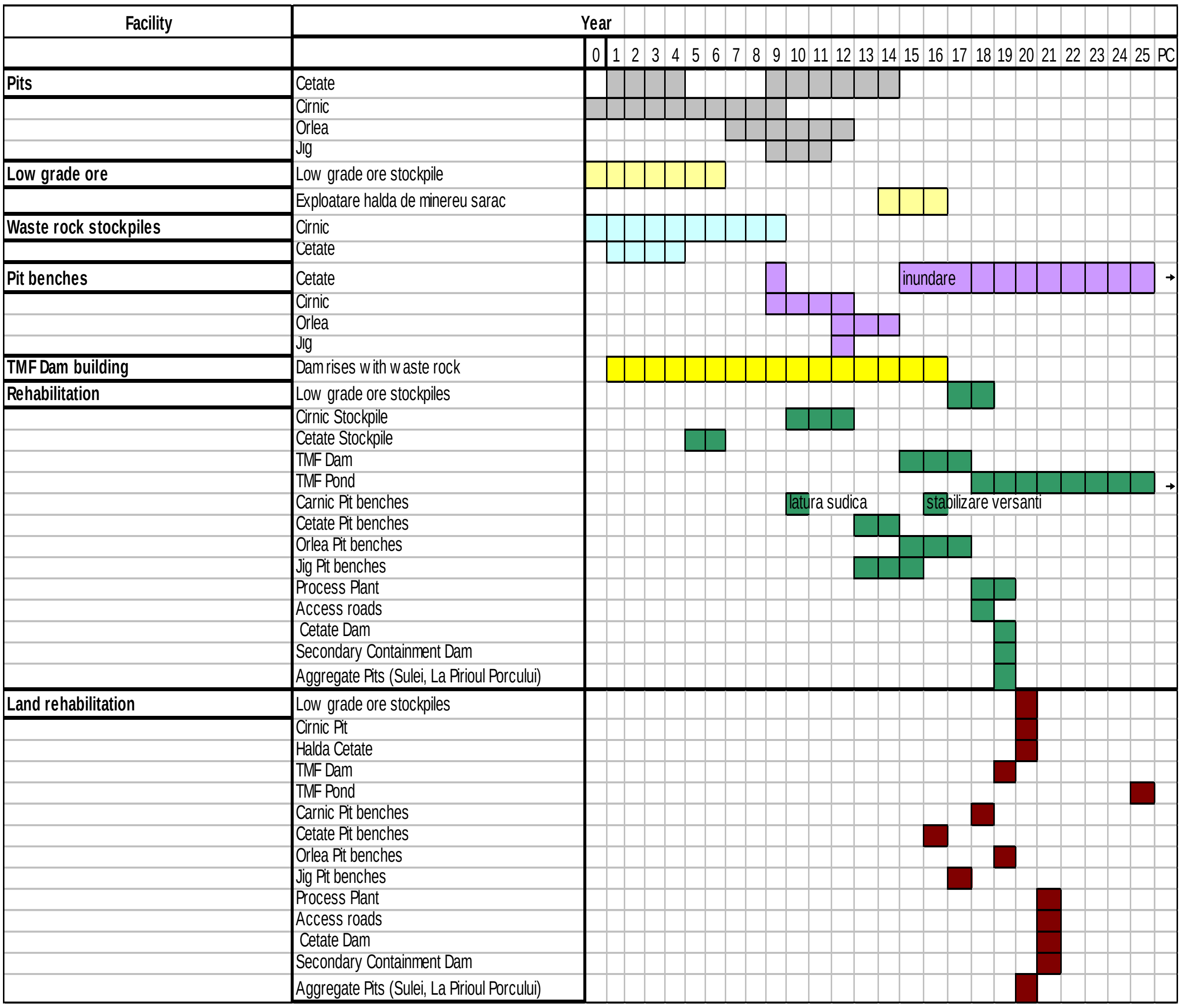
Thus, Sulei rockfill (andesite) pit is located about 700 m from the residential area, also separated by a topsoil stockpile that will act as a natural noise, dust and vibration barrier, while the rockfill quarry at La Pârâul Porcului is about 700 m of an area of **scattered, remote houses** and about 1,6 km of the residential area, and is a small-size operation.

Both pits will only be operated at full capacity during the construction stage, estimated to last about 2 years, and later will be operated at limited capacities, over short periods, only for the TMF dam rise work or to provide the necessary material for the maintenance of haulage roads.

During this construction stage, the Cetate Pit will not operate at all, while Carnic Pit will only operate towards the end of the construction stage, to provide non-ARD generating waste rock as construction material for the TMF starter dam …

During the first four years of the operations stage, two ore pits will operate in parallel: Cetate and Carnic, from year 5 to year 9 Carnic will be the only pit in operation, and subsequently it close down completely. Operations will start at Orlea Pit later, in year 7, while Cetate Pit will start operating again in year 9 alongside with Jig Pit, and the waste rock of all these pits will be used to backfill Carnic pit.

The Project development plan is summarised in the table below:



Four sources were identified for supply of aggregate for construction of the Corna dam and water management dams, as well as for earthworks and concrete production. These include two quarry sites (the Şulei quarry, for aqndesite, and the Paraul Porcului quarry- for sandstone), and the non-ARD generating waste rock from the two gold ore bearing pits (Cetate and Carnic Pits) Although existing regional quarries (i.e. the Roşia Poieni copper mine quarry, Rosioara quarry, or Almasu-mare quarry) could also potentially be used as back-up sources, the preferred alternative is to rely on on-site resources to obtain he necessary aggregates, considering the rather high volume required and the need for such rocks to made available on a timely and regular basis for the construction of various mining facilities. The currently existing equipment and facilities in the regional operational quarries may not ensure the necessary quantities of material for the project, according to the implementation schedule

Use of onsite quarries eliminates transportation-related and other impacts associated with the use of offsite sources. Of the sites considered within the Project boundary, the Pig Valley and Sulei sites are the preferred locations for RMGC to develop new quarries. This takes into account a preference for use of previously impacted land. Both quarries are necessary, as the Sulei Quarry andesite is not suitable for use as a source of rocks for filters and drains. However, they can supply the required volumes for construction requiring non-ARD generating material. The Paraul Porcului quarry site can provide the required volume of sandstone for concrete preparation, roadbase aggregate, and rockfill for dam construction and foundation preparations at the process plant site. The Sulei and Paraul Porcului quarries are therefore considered to be the preferred alternative.

Alternatives to the Sulei and Paraul Porcului quarries were considered, include excavating from the various limestone outcrops near the Project area, or using materials from the pre-stripping open pit areas. These alternatives are rejected because the quality of the aggregate at these sites do not meet technical requirements for their intended use.

As noted above, selection of preferred sub-options for an on-site quarry was based **on the suitability of the material to the construction requirements and on the ARD-generating potential, because all of the sites are located within a similar environmental setting with minimal risk of significant impact.**

As may be noted from the following summaries of relevant specialist studies, the cumulated impact of operating these quarries in parallel to the operation of the ore pits has been assessed in detail. The specialist studies in full are available in the Project website under the section*:* Environmental Impact Assessment*.*

http://www.rmgc.ro/sites/default/files/eia/04.2-Aerul.pdf

http://www.rmgc.ro/sites/default/files/eia/04.3-Zgomot-si-Vibratii.pdf

http://www.rmgc.ro/sites/default/files/eia/56_ro.pdf

Based on the review of cumulated impacts, a set of measures have been adopted in order to allow the simultaneous operation of these quarries within the legal limits. These measures may be reviewed in brief in the following.

Thus, since the impact on the investigated environmental media is within the legal limits, we consider that the operation of the two rock quarries in parallel to the ore pits, with a view to serve the latter, is a technical option and opportunity that totally complies with the Romanian legislation.

Annex 2 – Summary of the cumulated impacts of operating the rock quarries in parallel with the ore pits

IMPACT OF PARALLEL OPERATION OF THE QUARRIES AROUND THE NOISE AND VIBRATIONS RESTRICTION AREAS. MITIGATION MEASURES. COMPLIANCE WITH THE APPLICABLE LAWS.

In quantifying the effects of the blasting technology involving explosives placed in well pits on the structures located in the Rosia Montana restriction zone, a study of the blasting technology used in quarry extraction near the buildings and historic monuments was prepared in 2006.

That study contains three main components:

1. assessment of the technical and strength condition of the buildings;
2. "in situ" measurements of the seismic oscillation generated at building foundation level in the restriction zone of Rosia Montana for a blast as proposed for Cetate pit;
3. decision on the pit blasting technology, applicable in areas near the buildings of Rosia Montana, so that the generated seismic effect should rage within 0.2 cm/s, a speed where, according to Norms DN 4150/85 (Germany), the effects on buildings are negligible and may not cause their degradation or deterioration.

The previous study only inventoried the buildings located within the restriction zone of Rosia Montana, the restrictions on blasting technologies to be applied in the pits, in view of ensuring their protection.

Considering that other protected areas have also been designated on the Rosia Montana site (both on the surface and underground) and that there are other historic monument assets located outside Rosia Montana protection zone, **in the second half of 20010, SC Ipromin SA conducted a study detailing the blasting technologies and areas where they would be applied, so that the extraction of gold and silver ore or quarried aggregates may not cause damage or deterioration to the protected assets, whether located on the surface or underground. In practice, a customised blasting technology has been devised for each protected asset.**

The protected areas and buildings considered included:

a) Piatra Corbului Protected Area (above and under-ground),
b) The area regulated under the PUZ CP an the Catalina Monulesti Gallery,
c) The Roman Catholic Church,
d) Carpeni Protected Area (above and under-ground),
e) protected area (surface)
f) The underground galleries at Orlea,
g) the Greek Catholic Church (1781) and its vicarage,
h) Simion Balint's grave
i) 4 historic houses around the current Village Hall.

All the results of previous research of the effects of using explosive blasting for mining were used in the preparation of the study, i.e. the "Study of the Open Cast Mining Technology in the Areas of Napoleon and Corhuri and the Influence of Blasting Explosives on the Surrounding Area and Buildings" and the results of site investigations carried out in the first three months of 2010.

The mining technology using explosives placed in well pits has a number of side-effects such as soil oscillations, air wave, material blowing – all of different magnitudes, depending on the distance between the explosion site and the measurement points.

In order to protect structures that were assigned to the national heritage, the parameters in question exceed the acceptable values for distances less than 300 m.

This criterion led to the zoning of operations areas as follows:

- Zone I: a zone where the basic design technology may be applied as such;
- Zone II: a zone where the blasting technology will be modified in order to comply with the acceptable dynamic parameters, and which was sub-divided in its turn as follows:
  - Zone II C,
  - Zone II B,
  - Zone II A,

For the current level of knowledge and measurement of blasting side-effects on protection areas, this zoning is still provisional, and will continue to be adapted based on the practical results obtained in the operations process.

Based on this zoning, it is estimated that the volume of mined mass blasted using the basic technology will be about 85% of the total volume, while for the other 15%, the technology would be blasting with explosives placed in well pits of 125 mm diameter or in mine holes.

The side effects of pit blasting, such as the oscillation speed and the shock wave over-pressure may be controlled and mitigated by a number of technical and management measures.

The conclusions of this study are presented in the following:

For the protection of buildings of the outstanding importance, it was stipulated as a condition that the maximum acceptable oscillation velocity near the protected object should be 0.2 cm/s.

For natural monuments and ancient mining works, the maximum acceptable oscillation velocity should be 0.4 cms.

The analysis revealed that the classic mine blasting technology using explosives placed n well pits may be applied up to distances of maximum 300 m from the nearest structure.

At shorter distances, for the oscillation velocity measured neat the building to be a maximum 0.2 cm/s, i.e. for the seismic effect to be negligible, in the case of buildings of outmost importance, special technological alternatives for blasting will be required, consisting of a reduced hole diameter and length, reduced amount of explosive in each blasting step or round, etc.

Mining in Cetate Pit may cause an increase in seismicity in the protected areas of Taul Gauri and Carpeni, Orlea underground and especially in the area of the buildings surrounding the current Village Hall.

For the southern part of Cetate Pit, between the current area and the 770 m step, in order to protect the protected area of Taul Gauri (Mausoleum), blasting recipes will involve smaller amounts of explosive, i.e. the solutions proposed for Zones IIB and IIC.

For the north-western sector of Cetate Pit, between the current surface and the designed hearth of the pit, all three proposed blasting technology alternatives will be used. In this way, the potential oscillation velocity at foundation level in the area of the buildings around the current Village Hall (the buildings with the highest seismic risk that might be affected in this area) will be a maximum 0.2 cm/s, thus not causing damage or deterioration to the buildings.

The same oscillation velocity will also be registered on the surface, in the protected area of Carpeni.

In the area of the Roman galleries at Orlea and Carpeni, the oscillation velocity will be far below the acceptable 0.4 cm/s value, this additional protective measures resulting from the need to ensure the protection of much more sensitive assets (the houses around the Village Hall)

The mining operations at Carnic may generate influences on the protected area of Piatra Corbului, the protected zone of Rosia Montana, including the Roman-Catholic Church and on Catalina Monulesti Gallery.

For the protection of the above assets, the blasting technology to be applied in the south-eastern and north-eastern sectors of the pit will involve lesser amounts of explosive per blasting round.

Thus, it is expected that the surface oscillation velocity in the protected area of Piatra Corbului may be a maximum 0.4 cm/s, while in the area of Catalina Monulesti, also corroborated with the very long distance, of about 600m, the velocity would be a maximum 0.2 cm/s.

In order to limit the seismic effects of the blasting explosive, three alternatives of the blasting technology were proposed, and will be applied in succession, as the operations approach the assets that require the adoption of protective measures.

The technological alternative to be applied in sub-zone IIA – maximum 100 m distant from the protected asset – will involve well pits of 125 mm diameter in 5 m sub-steps, of long duration blast with micro-delay or in 10 m steps. The explosive load will be 78 - 352 kg.

In sub-zone IIB – distance of 100-200 m from the protected asset - two technologies , both well pits of 125 mm and of 210mm may be applied. The load per round will be 630 - 2,820 kg.

In sub-zone IIC – distance of 200-300 m - the recommended well pit diameter is 125 mm (Q = 2,130 kg) or 251 mm (Q = 6,860 kg).

In all the cases of explosive mining, the work fronts will be so orientated as to provide the least resistance line 90^0 - 180^0 from the protected asset. This will ensure a reduction of the oscillation velocity and of the hazard of material projection (throwing), and the air wave and gases generated in the blast will not affect the residential area.

The mining operations at Jig may generate seismic effects on the assets in the protected zone of Rosia Montana and on Catalina Monulesti Gallery.

In the eastern sector of the Pit, between the current surface and the designed hearth of the pit, alternatives IIB and IIC of the blasting technology will be used, with a maximum generated oscillation velocity of 0.2 cm/s.

Mining in Orlea Pit may generate influences on the Greek-Catholic Church and its vicarage the monument buildings surrounding the current Village Hall, Simion Balint's grave and the protected area of Carpeni.

In order to protect the Greek-Catholic Church and its vicarage the monument buildings surrounding the current Village Hall, between the current surface and the 660 and the 660 m step of Orlea Pit, alternative IIA of the blasting technology will be used, i.e. a reduced amount of explosive per blasting round and reduced hole diameter.

At distances farther from these assets, technological alternatives IIB and IIC will be applied, and thus the oscillation velocity at foundation level in the area of the Greek Catholic Church and Village Hall will be a maximum 0.2 cm/s.

In regard to the other assets, Simion Balint's grave and the protected area at Carpeni, the oscillation velocity will be below the maximum acceptable level, i.e. 0.4 cm/s, which would exclude any potential deterioration or damage to the respective assets.

Mining in Orlea Pit may also influence the Roman galleries at Carpeni and Orlea.

In the sections developed in the direction of underground mining works, it may be noted hat the distances between those galleries and the fronts of the future open cast mine are more than 200 m, and thus the adoption of blasting technologies to protect surface assets will also provide protection to the underground galleries.

In order to quantify the effects of mine blasting on the *protected area of Piatra Corbului, Catalina Monulesti Gallery, the Roman-Catholic Church, the protected area at Carpeni, protected area at Taul Gauri, the underground galleries of Orlea, the Greek Catholic Church and its Vicarage, Simion Balint's grave, the monument houses around the current Village Hall,* the following measures have also been proposed for adoption.

- ✓ *implement a monitoring system consisting of a stationary digital seismograph network with three components located by the main assets to be protected and a mobile network consisting of three portable seismographs located along a longitudinal profile between the protected asset and the explosion focus;*
- ✓ *start mining operations in the pits in areas located about 300 m distant from the nearest asset to be protected, and check with instruments the blasting solutions involving explosives placed in well pits.*

Summary of Potential Noise and Vibration Impacts at each Step of the Project, and Applicable Mitigation Measures

Potential impacts	Mitigation Measures
Construction, operation, and decommissioning/closure phases	

Transient nuisance impacts on adjoining communities as well as residences inside protected zone boundaries from non-blasting Project-related noise and vibration, including:
 	
• motorised sources (e.g. worker transport; onsite vehicle transport; transport/delivery of materials and equipment, transport of waste; haulage of topsoil, ore, and waste rock; operation of emergency generators; operation of mobile and stationary heavy machinery);
• backing up alarms or warning sirens; and
• other non-blasting related noise from construction/demolition activities
	• Ongoing consultation with the local residents on the noise / vibrations impacts
	• Optimum location of haul/access roads, of the process plant, stockpiles, TMF system and other Project-related facilities within the limits provided under various requirements of the Urbanism Certificate
	• Install berms and earth embankments as permanent acoustic barriers in the sensitive areas of the Project
	• Avoid steep inclines on the haul and access roads during operations, as limited by various provisions of the Urbanism Certificate
	• Monitor ambient noise and vibrations and initiate corrective/preventative action where necessary
	  •Minimise the landfilled and handled quantities, and the height of the tipping piles
	  •Minimise drop height on conveyor systems
	  •Provide noise absorption liners for the material silos
	  •Industrial fall-arrest systems in the collection hoppers
	  •Screen off or noise-insulate the crusher systems
	  •Screen off or noise-insulate the conveyor systems
	  •Screen off or noise-insulate the pumps or compressor sets
	  •Install the main revolving or vibrating equipment inside screened or noise-insulated buildings
	  •Mount vibration-control systems on stationary equipment and main pipeline systems
	  •Install noise measuring devices in the vehicle/machinery maintenance areas
	• Procure trucks, bulldozers and other key equipment in line with the EU standards, equipped with noise control engines and other technical characteristics to help reduce the noise footprint; provide noise control systems post-procurement to meet the impact mitigation requirements, based on necessity

Potential impacts	Mitigation Measures
	• Locate mobile noise barriers to control the noise from mobile or portable motorised equipment (e.g. graders, bulldozers, drills) • Establish and enforce standard operating procedures in maintaining and operating the vehicles/equipment, including maintenance and replacement of engine noise buffers • Plan/ delay important deliveries to arrive during the day time • Enforce speed limits on the mine access/haul roads • Use buses for personnel transport and accurately schedule to minimise Project-related road traffic • Manage the vehicle fleet to minimise the numbers in use
Hearing impacts to workforce from noise and vibration from the operation of mobile and stationary heavy machinery, construction/demolition activities, and other non-blasting sources	• Implementation of standard operating procedures under a hearing protection programme, use of personal hearing protective equipment, and associated training programmes • Procurement of motorised equipment of EU compatible current technical specifications for noise/vibration protection • Establish and enforce standard operating procedures in maintaining and operating the vehicles/equipment, including maintenance and replacement of engine silencers
Construction phase (only)	
Hearing impacts on construction workers from drilling/blasting operations (quarrying), handling and crushing of aggregate, and operation of the concrete batch plant	• Implementation of standard operating procedures under a hearing protection programme, use of personal hearing protective equipment, and associated training programmes
Transient impacts on the residents of neighbouring communities and housing in the protected areas from noise and vibrations generated in drilling/blasting operations (quarrying), handling and crushing of aggregate, and operation of the concrete batch plant	• Consultation with local residents with regard to the scheduling of blasting activities • Implementation of controlled blasting procedures incorporating millisecond delay techniques between successive blasting and minimisation of strong explosives in combination with ANFO blasting agents or explosive emulsions • Scheduling of quarry blasting to limit blasting operations to daylight hours and avoidance of blasting in very bad weather • Routine monitoring/measurement of noise and vibration impacts for all blasting activities and initiation of blasting plan adjustments and other corrective/ preventive action where required • Manage the vehicle fleet to minimise the numbers in use
Potential vibration damage to sensitive structures from drilling/blasting operations (quarrying) aggregate handling and crushing and the	• Consultation with local residents with regard to the scheduling of blasting activities • Implementation of controlled blasting procedures incorporating millisecond delay techniques

Potential impacts	Mitigation Measures
operation of the concrete batch plant	between successive blasting and minimisation of strong explosives in combination with ANFO blasting agents • Scheduling of quarry blasting to limit blasting operations to daylight hours and avoidance of blasting in very bad weather • Routine monitoring of noise and vibration impacts on sensitive structures and blasting plan adjustments and other corrective/ preventive action where necessary
Operations phase(only)	
Transient nuisance impacts on the residents of adjoining communities and residences within the protected zone limits, from drilling/quarrying noise and vibration	• Consultation with local residents with regard to the scheduling of blasting activities • Implementation of controlled blasting procedures incorporating millisecond delay techniques between successive blasting and minimisation of strong explosives in combination with ANFO blasting agents • Scheduling of quarry blasting to limit blasting operations to daylight hours and avoidance of blasting in very bad weather • Routine monitoring of noise and vibration impacts on sensitive structures and initiation of blasting plan adjustments and other corrective/ preventive action
Potential vibration damage to sensitive structures from drilling/blasting operations in open pits	• Consultation with local residents with regard to the scheduling of blasting activities • Implementation of controlled blasting procedures incorporating millisecond delay techniques between successive blasting and minimisation of strong explosives in combination with ANFO blasting agents • Scheduling of quarry blasting to limit blasting operations to daylight hours and avoidance of blasting in very bad weather • Routine monitoring of noise and vibration impacts on sensitive buildings and initiation of blasting plan adjustments and other corrective/ preventive action

Potential Alternatives in the Best Available Techniques Category for Noise and Vibration Impact Mitigation/Minimisation

Best Available Techniques	Minimisation potential
1. Scheduling heavy truck material delivery frequency to prevent the concentrated impacts on neighbouring communities	• variable
2. Phasing the construction work schedule so as to minimise noise-generating equipment use during night time (bulldozers, excavators, etc.)	• variable
3. Create noise control barriers in the form of earth/slag berms ("bunds"), which can be as long as required and 10 to 20 m high depending on the topography and geometry of the source(s) and receiver(s)	• 5 to 20 dB(A)
4. Acoustic insulation of residential buildings in special situations, as necessary to improve residential spaces	• 10 to 20 dB(A)

Best Available Techniques	Minimisation potential
5. Equip heavy trucks with additional noise control systems, as necessary in order to meet certain noise levels; depending on the options installed by the supplier for the EU certified equipment, alternatives may include: • engine combustion management systems • engine chassis design • aerodynamic cooling fan design • radiator screens with noise buffer slots and baffles • noise buffering slots and baffles on the hydraulic system cooling fans • high-performance silencers • rearing vehicle warning systems, adapted to the ambient conditions • noise buffering devices • profiled tires to help reduce noise	• 2 to 5 dB(A) • 5 to 10 dB(A) • 2 to 3 dB(A) • 2 to 3 dB(A) • 2 to 3 dB(A) • 2 to 3 dB(A) • 5 to 10 dB(A) • <3 dB(A) • 1 to 3 dB(A)
6. Equip excavators with noise control systems, as necessary in order to meet certain noise levels; depending on the options installed by the supplier for the EU certified equipment, alternatives may include: • engine combustion management systems • sound-absorbing panels on the engine body, under the deck area, and inside the counterweight • sound absorbing panels around the powerpacks and hydraulic cooler house • use multiple electrostatically-controlled units for engine cooling (vs. single belt-driven fans) • rearing vehicle warning systems, adapted to the ambient conditions • primary/secondary silencers, tuned to engine exhaust characteristics	• 2 to 5 dB(A) • 3 to 5 dB(A) • 5 to 10 dB(A) • 2 to 4 dB(A) • 1 to 3 dB(A) • 5 to 10 dB(A)
7. Equip bulldozers with noise control systems, as necessary in order to meet certain noise levels; depending on the options installed by the supplier for the EU certified equipment, alternatives may include: • **engine combustion management systems** • high-performance silencers • engine design • rearing vehicle warning systems, adapted to the ambient conditions • **optional tread control systems to reduce "track slap" characteristics**	

IMPACT OF PARALLEL OPERATION OF THE QUARRIES AROUND THE RESTRICTION AREAS – AIR QUALITY MITIGATION MEASURES. COMPLIANCE WITH THE APPLICABLE LAWS

Calculation Methodology and Modelling

Activities and operations generating short-term fugitive emissions associated with stacks or ducted sources were inventoried. Atmospheric dispersion modelling was performed to estimate offsite concentrations of NO2, NOx, CO, SO2, TSPs, particulate matter less than 10 microns in diameter (PM10), Pb, As, hexavalent chromium [Cr (VI)], Ni, and Cd, PAHs and benzo(a)pyrene. A separate atmospheric dispersion modelling study was performed to evaluate the potential impacts of cyanide volatilisation to HCN in the CIL and clarifier tank areas of the process plant as well as the decant pond of the TMF.

The environmental air quality impact of the air pollutants associated with Project-related activities was assessed by means of concentrations field modelling for various averaging times. The averaging times were based on limit, threshold and target values that define the criteria for air quality assessment. The impacts on sensitive receptors within the Project vicinity were assessed in accordance with the Romanian law (Law 655/2001, M.O. 592/25.06.2002,MO 756/1997, MO 448/2007) and the modelling results were related to the limit values provided in Order of the Minister of Waters and Environmental Protection No. 592/2002 on approving the Norms in setting limit values, threshold values and assessment criteria and methodologies for sulphur dioxide, nitrogen dioxide and nitrogen oxides, suspended particles (PM_{10} and $PM_{2,5}$), lead, benzenes, carbon monoxide and ozone in the ambient air supplemented by Order of the Minister of Environment and Water Management No. 27/2007, and threshold values as per Order of the Minister of Water, Forests and Environmental Protection No. 756/1997, approving the Environmental Pollution Norms and the target values provided in Order of the Minister of Environment and Water Management No. 448/2007 approving the Assessment Norms for arsenic, cadmium, mercury, nickel, ad polycyclic aromatic hydrocarbons in the ambient air.

The applied methodology is summarised in the following paragraphs.

Model Selection and Input Parameters

Atmospheric dispersion modelling was performed using international best available techniques to simulate the offsite transport of pollutants generated by mining activities. In recent years, the ambient air modelling methods have undergone major modifications based on the criteria contained in the regulatory requirements, including: 1) air dispersion fundamentally based on planetary boundary layer turbulence structure, scaling and concepts; 2) the inclusion and refinement of both surface and elevated sources; and, 3) the incorporation of simple and complex terrain algorithms.

AERMOD is a steady-state plume model. In the stable boundary layer, the concentration distribution is assumed to be Gaussian in both the vertical and horizontal. In the convective boundary layer, the horizontal distribution is assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function. This behaviour of the concentration distributions in the convective boundary layer was demonstrated by (Willis, and Deardorff, 1981) and (Briggs, 1993). Additionally, in the convective boundary layer, AERMOD treats “plume lofting,” whereby a portion of plume mass, released from a buoyant source, rises to and remains near the top of the boundary layer before becoming mixed into the convective boundary layer. AERMOD also tracks any plume mass that penetrates into elevated stable layer, and then allows it to re-enter the boundary layer when and if appropriate.

AERMOD incorporates, with a new simple approach, current concepts about flow and dispersion in complex terrain. Where appropriate the plume is modelled as either impacting and/or following the terrain. This approach has been designed to be physically realistic and simple to implement while avoiding the need to distinguish among simple, intermediate and complex terrain, as is required by present regulatory provisions. As a result, AERMOD removes the need for defining complex terrain regimes; all terrain is handled in a consistent, and continuous manner that is simple while still considering the dividing streamline concept (Snyder, et al., 1985) in stably-stratified conditions.

The American Meteorological Society (AMS) and the United States Environmental Protection Agency (EPA) have developed the AMS/EPA Regulatory Model (AERMOD) to incorporate these modifications. This model was selected to asses the impacts from mining operations because it has the capability to: 1) efficiently use onsite hourly meteorological data; 2) calculate both short-term and long-term concentrations from multiple sources and source types; 3) incorporate localised terrain data to estimate impacts in complex terrain; and 4) is a publicly available system that has been validated under numerous experimental validation programs The AERMOD modelling system contains three components: AERMET, version 99211 (AERMOD meteorological pre-processor), and AERMAP, Version 99211 (AERMOD terrain pre-processor), and AERMOD, Version 99351 (the dispersion model).

Hourly meteorological measurement data were obtained for a representative calendar year, from the National Administration of Meteorology. The data is from the Rosia Montana Meteorological Station (located approximately 1 kilometre north-northwest of Roşia Montană). These data were used as inputs into the AERMET program to generate the appropriate hourly meteorological data inputs (both upper air and surface parameters) for the dispersion modelling. The processed meteorological data set was reviewed for data adequacy.

A receptor grid system was selected estimating impacts from the Project, consisting of 2,115 discrete receptor locations in a 250-metre by 250-metre gridded array, beginning at approximately 4,400 metres southwest of Abrud and continuing to a location approximately 3,000 metres north of Birdesti. AERMAP was used to estimate critical hill heights for each receptor location using gridded terrain elevation data for the project site that obtained from SNC Lavalin. Critical hill heights, in combination with each hour's meteorological parameters, are used in the AERMOD model to determine how plume concentrations will be addressed upon the elevated terrain.

AERMOD can predict pollutant concentrations from multiple sources for a wide variety of locations, meteorological conditions, pollutants, and averaging times. For this project, short-term concentrations were calculated using maximum hourly emissions rates for simultaneous operations for 1-hour, 8-hour, and 24-hour averages. Annual concentrations were modelled using all sources in operation for each given year.

Maximum offsite impacts were assessed against the established limit values for each pollutant and averaging time. The impact was also assessed for each of the 15 sensitive receptor communities located around the Project Site: Roşia Montană (zona protejată), Abrud, Bisericani, Bucium Sat, Coasta Henţii, Dogăreşti, Floreşti, Gârda Bărbuleşti, Gura Roşiei, Heleşti, Iacobeşti, Ignăteşti, Petreni, Ţarina and Vârtop. Based on the distribution of residential areas at the time of Project inception, the nearest receptors to the Project site (individual households) were selected in each locality for impact assessment as expected to get maximum impacts from Project activities.

Scenario Selection

In order to assess the maximum impacts from the overall mining operations, impacts were assessed during construction, full operation, and closure periods. Given the nature of the mining operation, the majority of the sources are transitory and it is difficult to select a single time-period that represents worst-case conditions. Therefore, six years within the life of the mining activities were selected to represent potential worst-case scenarios.

Construction Stage Scenario

Pre-Operation (Year 0) was selected as the worst-case year for construction operations. During this year, it is expected that all of the roads, processing plant, and the TMF dam will be constructed, along with the development of the pads for topsoil, waste rock stockpiles, and ore stockpiling. During the latter part of the year, limited operation of the Cârnic pit will be conducted. Although many of these activities will occur only a limited time period within the year, all sources were included in assessing the long-term impacts.

Short-term impacts (one-hour through 24-hour impacts) were assessed based upon a selection of sources occurring simultaneously. Since the construction of the roads will occur first, followed by the construction of the other operational areas, short-term from these two major sets of activities will not occur concurrently. However, it is difficult to determine whether the road construction or the construction of the remainder of the site, will produce higher impacts from their respective emissions. Thus, two different short-term modelling scenarios were selected for this analysis. The first scenario assumes the construction of the roads and that during this time no other plant operations will be under construction, since the roads are needed for transport to the other sites. The second scenario assumes the construction of the remainder of the site: the processing plant, the TMF dam, the topsoil, waste rock, and stockpile pads, and the operation of Cârnic pit.

On any given day or hour, not all operations would be occurring simultaneously. Based upon the mining operations schedule, it was determined that the following concurrent operations would present the worst-case emissions scenario:

- Overburden removal on Major Roads 1 and 2 and Minor Roads 1, 4, 8, and 14;
- Topsoil removal on Minor Roads 3 and 9;
- Base layer construction on Minor Roads 8A, 9 and 13.

All other road construction activities were assumed to occur at other timeframes within the year. In each of the above operations, maximum hourly emissions were utilised.

Similarly, the worst case short-term scenario for the construction of all other activities and mining operations having the potential for concurrent emissions includes the following:

- Overburden removal from the Processing Plant and TMF embankment areas;
- Mining operations at the Cârnic pit (i.e. drilling, truck loading, and stockpiling);
- Ore-unloading operations at the Low Grade Ore Stockpile;
- Waste rock-unloading operations at the Cârnic waste rock stockpile.

The combination of these operations is expected to produce the worst-case emissions. Other activities are not expected to be in concurrent operation.

Operations Stage Scenario

Four operational years (Years 9, 10, 12, and 14) were selected to represent possible worst case operations from the four pit operations (Cetate, Cârnic, Orlea, and Jig). In each of the four scenarios, maximum overall mining production is expected. However, production will differ in each pit, in both quantitative and site configuration terms, depending on what year is considered. Consequently, the most realistic situation will be to consider that irrespective of the analysed year no more than 2 pits will be operating simultaneously. This is based on the limited number of equipment and the requirement to avoid overloading the process plant.

Year 9 represents the operation of all four pits, with high production rate within the Jig and high level of the activity in the northern part of Cârnic pit (close to the protected area). Year 10 represents a more typical year with three pits operating. Year 12 represents the maximum mining production rate for the Cetate pit with Orlea pit operating concurrently. This year also has reclamation activities occurring at the Cârnic pit area. Finally, Year 14 is the scenario representing high production rate from the Cetate pit, with no activity carried out in any of the other pits.

Although operations during the four modelling scenario years were assumed to occur 24 hours per day and 365 days per year, short-term and annual average impacts were modelled using maximum hourly and annual averaged emissions, respectively, since annual averaged emissions take into account load factors for equipment and would not be appropriate for short-term impact modelling.

Closure Stage Scenario

Year 19 of the Mining Development Plan was selected to represent worst case emissions from closure operations. During this period, the following works will be required: demolition and reclamation of the processing plant, area, the reclamation of the TMF embankment and impoundment areas, and the use and reclamation of the TMF stockpile. At the same time, the Topsoil Stockpile will be used to cover the TMF and reclaim its footprint.

Similar to the approach used for the construction stage, annual impacts were assessed using all the emissions from processes and equipment active in that year, although their will not operate simultaneously. However, the short-term analyses were conducted based upon maximum hourly emission rates from activities that were likely to occur concurrently.

For particulates, both TSP and PM10, the worst-case scenario occurs during the reclamation of the simple cover construction of the downstream TMF dam, the reclamation activities at the processing plant area, and the transfer of topsoil from the TMF stockpile. For all other pollutant analyses, worst-case emissions were associated with the simple cover construction of the TMF impoundment region, the demolition of processing plant buildings and structures, and the transfer of topsoil from the TMF stockpile.

Emission Sources

Given the nature of the mining operation, most emissions will be short term. The influences of moving equipment associated with these releases tend to rapidly mix the pollutants near the surface, allowing for increased dispersion of the emissions. Surface-based volume sources allow for the initial dispersion due to this mechanical mixing near the release. Thus, areas where emissions are being influenced by moving equipment were modelled as volume sources. The horizontal and vertical dimensions are based on the size of each source and the height they extend vertically. In all cases, the vertical mixing was assumed to be 10 metres. In addition, road sources were modelled using a series of smaller volume sources (representing the width of the roads) to represent the pathway of the roads. Due to the size of the roads and their distance from the property boundary, 250 m spacing separated the volume sources. The ducted sources were modelled as point sources.

Model input parameters for the point sources included: the release height, stack gas exit temperature and speed (velocity), internal stack diameters source position and base elevation. Volume source model inputs include source locations, source base elevations, release heights, horizontal initial dimensions and the vertical initial dimensions.

The number of individual sources varied in each modelling scenario analysis, due to the variation in the types of operations occurring for a given period. The number of sources used to represent the emissions characteristics for each scenario ranged from 60 sources for closure operations to 415 for construction activities (long-term averaging).

Assessment and Interpretation of Results

The overall results of the air quality modelling for the construction, operations, and closure phases of the project generally show that concentrations were generally low and fell below the limit values in the populated areas. Generally, the construction impacts are generally higher than the operational or closure phases of the project. Maximum predicted pollutant concentrations beyond the property boundary are also below their respective limit values except for 30-minute TSP which will exceed the alert threshold during the construction and operation phases, but will range below the limit value. Maximum average concentrations of significant pollutants (NO2, NOx, SO2, TSP, PM10, CO, Pb, (in the operating stage) As (in the operating stage) Cd, Ni, PAH and benzo(a)pyrene are compared to the alert and limit values (in the case of NO2, SO2, TSP, PM10, CO and Pb) and target values (in the case of As, Cd, Ni and benzo(a)pyrene as provided in the governing regulations, for short-term and long-term averaging times. The results are summarised in the following sections.

In order to obtain an estimation of this cumulated effect, the maximum background concentrations for the existing situation before Project implementation (total values, expressing the contributions from all local emission sources and the regional background levels) were overlain by the maximum levels of concentrations corresponding to the exclusive Project impacts, separately for each stage of its implementation (construction, operations - year 9, closure), or every pollutant and every averaging time. It needs to be specified that this approach to cumulated impact assessment is very conservative, as it relies on the assumption that, for any receptor, the maximum concentrations caused by the exclusive Project impacts are obtained at the same time as the levels caused by the other emission sources. Thus, the analysis focused on the worst case air quality situation, while in reality the concentration levels of the cumulated impacts might be lower.

Construction Phase

The results of the cumulated impact assessment for the construction phase calculated at the sensitive receptor level closest to the Project site, located in the 15 communities around the Project site and comparison with the limit values.

Based on air pollutant dispersion modelling, it may be noted that the Project specific activities in the construction phase will not be capable of generating exceedances of the limit values, target values or threshold values in sensitive receptor points, due to effects cumulated with the existing background, or any of the pollutants, except potential short-term exceedance of TSP limit values, in the Abrud Town area. Such exceedances, however, cannot be blamed on the Project activities, as their contribution to the concentration levels in this area was appreciated at a maximum 7 %. Taking into consideration that the calculation assumptions used in estimating the cumulated impacts were very conservative, it may be stated that this contribution might be much lower.

For short averaging times (1 hr, 24 hr), maximum average levels in the receptor points closest to the Project site in the construction phase may reach up to 82 % of the levels corresponding to the cumulated impacts for a maximum hourly concentration of NO_2 (19^{th} highest) – at Vârtop, 80 % of the maximum 30 minute TSP concentration – at Coasta Henții or 51 % of the maximum 24 hr TSP concentration – the protection zone of Roşia Montană.

For longer averaging times (1 year), for the same pollutants, the percentage of the total concentration levels corresponding to the exclusive impact of the Project will reach a maximum 13 % for the average annual NO_2 concentration in the protected area of Rosia Montana, showing low Project contribution to nitrogen oxide and suspended particle pollution in sensitive receptor points during the construction phase.

As for the other pollutants, the percentage of Project activity contributions in the construction phase for the maximum concentration levels at sensitive receptor points may only reach significant values for the annual average concentration of polycyclic aromatic hydrocarbons (maximum 45 % at Gura Rosiei)

Operations Phase – Year 9

The results of the cumulated impact assessment for year 9 of the operational phase calculated at the sensitive receptor level closest to the Project site, located in the 15 communities around the Project site and comparison with the limit values.

Based on the modelled concentrations after dispersion, it may be noted that the Project specific activities in year 9 of the operations phase may not be capable of generating exceedances of the limit values, target values or threshold values in sensitive receptor points, due to effects cumulated with the existing background, or any of the pollutants, except potential short-term exceedance of TSP limit values, in the Abrud Town area. Such exceedances, however, cannot be blamed on the Project activities, as their contribution to the concentration levels in this area was appreciated at a maximum 7 %. Taking into consideration that the calculation assumptions used in estimating the cumulated impacts were very conservative, it may be stated that this contribution might be much lower.

For short averaging times (1 hr, 24 hr), maximum average levels in the receptor points closest to the Project site in year 9 of the operations phase may reach up to 74 % of the levels corresponding to the cumulated impacts for a maximum hourly concentration of NO_2 (19^{th} highest) – at Floresti, 69 % of the maximum 30 minute TSP concentration – at Coasta Henții or 27 % of the maximum 24 hr TSP concentration – at Floresti.

For longer averaging times (1 year), for the same pollutants, the percentage of the total concentration levels corresponding to the exclusive impact of the Project will reach a maximum 10 % for the average annual NO_2 concentration in the protected area of Rosia Montana, showing low Project contribution to nitrogen oxide and suspended particle pollution in sensitive receptor points during the operations phase.

As for the other pollutants, the percentage of Project activity contributions in year 9 of the operations phase for the maximum concentration levels at sensitive receptor points may only reach significant values for the annual average concentration of Nickel (maximum 91 % in Rosia Montana protected area) and 22% of the respective target value for Cadmium.

Closure Phase

The results of the cumulated impact assessment for the closure phase calculated at the sensitive receptor level closest to the Project site, located in the 15 communities around the Project site and comparison with the limit values.

Based on a review of the estimated concentrations obtained from air pollutant dispersion modelling, it may be noted that the Project specific activities in the closure phase will not be capable of generating exceedances of the limit values, target values or threshold values in sensitive receptor points, due to effects cumulated with the existing background, or any of the pollutants, except potential short-term exceedance of TSP limit values, in the Abrud Town area. Such exceedances, however, cannot be blamed on the Project activities, as their contribution to the concentration levels in this area was appreciated at a maximum 1.36 %. Taking into consideration that the calculation assumptions used in estimating the cumulated impacts were very conservative, it may be stated that this contribution might be much lower.

For short averaging times (1 hr, 24 hr), maximum average levels in the receptor points closest to the Project site in the closure phase may reach up to 87 % of the levels corresponding to the cumulated impacts for a maximum hourly concentration of NO_2 (19^{th} highest) – at Gura Rosiei, 23 % of the maximum 30 minute TSP concentration – at Dogaresti.

For longer averaging times (1 year), for the same pollutants, the percentage of the total concentration levels corresponding to the exclusive impact of the Project will reach a maximum 17 % for the average annual NO_2 concentration in the protected area of Rosia Montana at Gura Rosiei, showing low Project contribution to nitrogen oxide and suspended particle pollution in sensitive receptor points during the closure phase.

As for the other pollutants, the percentage of Project activity contributions in the closure phase for the maximum concentration levels at sensitive receptor points is insignificant.