

## **Tailings Management Location Alternatives**

### **1 Background**

The need for a Tailings Management Facility (TMF) is related to the strong preference for tailings-generating metal extraction processes over heap leaching alternatives. This preference was originally established in the pre-feasibility study phase of the project and is a basic assumption of the economic model for the project.

Since 1999, several studies were conducted to identify and evaluate alternative TMF sites, considering a broad range of technical, social, economic and environmental factors. Economic, topographic, geographic, and environmental impact constraints have established a fundamental need for a valley fill structure located close to the proposed process plant.

The initial TMF options study was undertaken as part of the initial Definitive Feasibility Study (DFS) in 2001 and this identified nine sites within 4 valleys in the vicinity of the Roşia Montana project site.

During 2002, RMGC conducted a separate value engineering study, which considered the sites evaluated previously, as well as some new alternatives for the location of the proposed TMF. This study included some eight possible alternatives for a TMF location and technology, some of which represent further consideration of particular options identified during the 2001 DFS study.

This section therefore summarises the assessment of all these available options for the project in respect of the location for the proposed TMF and ranks them in order of preference, based on Environmental, Social, Technical and economical criteria.

### **2 Design Criteria**

For the purpose of the TMF site alternatives considered in this study, the following key design criteria provide a point of reference:

- Storage capacity for 240 M tonnes of tailings which includes the design capacity of 218 M tonnes plus a 22 M tonne contingency;
- No programmed discharge of TMF effluent to the environment;
- Collection and pump-back of seepage collected below the toe of the TMF embankment;
- Centre-line construction above the starter dam;
- A low permeability core and cut-off wall for the starter dam.

The above design criteria meet the design objectives for safety in the most cost-effective manner and were applied for all potential locations.

### **3 TMF Potential Sites and 2 alternatives to TMF**

### **3.1 First stage of option identification**

As indicated above, nine sites were initially identified for the location of the proposed TMF (see Exhibit 5.3.)

These potential sites were located in four valleys, as follows:

### **3.2 Tolacesti Valley (location of existing Roşia Poieni TMF) SITE A1**

Site A1 is located north of the mine site and is the more distant of the sites identified within the Tolacesti Valley downstream of the Roşia Poieni TMF. The site identified does not provide sufficient tailings storage capacity for the full planned requirements of the life of mine plan.

Development of a TMF on Site A1 will have direct impact on two villages located in the area of influence. The Tolacesti Valley although considered relatively environmentally undisturbed at this location, hosts the Roşia Poieni TMF for the storage of copper tailings from the Roşia Poieni Mine.

### **3.3 Tolacesti Valley SITE A2**

Site A2 is located immediately upstream of the Site A1 and therefore is the second most distant site to the proposed location for the Roşia Montana plant. The location is currently partially occupied by the Roşia Poieni TMF and therefore some interference might occur and a design that accommodates this effect would need to be implemented. Preliminary calculations based on a conceptual design for the proposed facility indicate that the full life of mine volume of tailings could be stored on this site.

### **3.4 Tolacesti Valley SITE A3**

Site A3 is located at the head of the Tolacesti Valley and is the nearest to the Roşia Montana site amongst those in the Tolacesti Valley. Site A3 would only allow the development of a small TMF facility that will not have sufficient capacity to store the required volumes for the Roşia Montana Project.

This section of the valley is relatively undisturbed because the existing Roşia Poieni TMF is located further downstream from this location. The development of a TMF on this site will have a direct impact on two small settlements.

### **3.5 Abruzel Valley SITE B1**

Site B1 is located to the east of the Roşia Montana project site at the foot of the Abruzel Valley. The location is currently occupied by a number of small villages and settlements and the development of a TMF on this site will directly impact on a significant number of people who will have to be relocated. The site has seen some mining activity in the past and it is possible that problem ground conditions could be found in the foundations of a

potential TMF associated with the old mine workings. The site has sustained significant environmental impact in the past as a result of this previous mining activity.

The proximity of the site to the project and the characteristics of the topography make it an efficient option with relatively low development costs although a development on this site will not have sufficient storage capacity for the planned life of mine tailings production.

### **3.6 Abruzel Valley SITE B2**

Site B2 is located upstream of the site B1 to the east of the Roşia Montana project. The characteristics of this site are similar to those of site B1 with similar distance from the project site and similar tailings disposal capacity. The location has a lower potential impact on people with only four communities directly affected although this is still considered to be high. There may also be similar foundation concerns to those for B1.

### **3.7 Corna Valley SITE C1**

Site C1 is located at the foot of the Corna Valley to the immediate south of the mine site. This valley has already been significantly impacted by previous mining activity and its proximity to the project site makes it particularly attractive due to relatively low development costs.

The site selected would allow the development of a TMF which would be sufficiently large to accommodate life of mine tailings production. Due to the characteristics of the area, the site has the greater potential storage TMF capacity of the nine sites identified.

### **3.8 Corna Valley SITE C2**

Site C2 is located immediately upstream of and can be characterised similarly to Site C1. Development of a TMF on the site would provide sufficient tailings storage capacity for the life of mine plan and due to its proximity to the project site and local conditions has the lowest development cost.

As indicated earlier the valley has been impacted by previous mining activity. However there are settlements that will need to be relocated.

### **3.9 Corna Valley SITE C3**

Site C3 is located at the head of the Corna Valley closest to the Roşia Montana project site. The topographical characteristics of the area will only allow a TMF which would not provide sufficient tailings storage capacity for the life of mine plan tailings production.

The TMF will have direct impact on one village currently located in the Valley.

### **3.10 Salistei Valley SITE D1**

Site D1 is located to the west of the mine site and is in the vicinity of the existing Rosiamin mine tailings facility. The site characteristics will only allow the development of a TMF which will not have sufficient capacity to store life of mine tailings production.

Due to the presence of the Salistei TMF, the valley is significantly impacted and the proposed development would not directly impact any new villages.

### **3.11 Second stage of option identification**

Subsequent to the completion of the 2001 tailings site definition work, RMGC commissioned a further tailings alternatives evaluation study, incorporating the knowledge obtained in previous studies as well as further information on the project and conditions in the potential sites identified. Based on the initial options work described above, six potential alternatives for storage that would satisfy the tailings disposal requirements for the project were defined as follows:

### **3.12 Corna Valley**

This alternative considers the construction of a cross valley type dam in the Corna Valley. The proposed site is located south of the project area, approximately aligned with the position of Site C2 as described above.

The facility will be constructed with a prepared low-permeability tailings basin and tailings drainage system and the retaining dam will include a zoned rockfill starter dam approximately 78 metres high with a low permeability core and subsequent raises constructed using the centreline method to form a centreline zoned rockfill dam with an ultimate crest height of approximately 185 meters.

The design approach for the facility indicated that a low permeability core was required on the starter dam to minimise seepage through the embankment, however, it also indicated that subsequent centreline raises to the dam embankment will not require a low permeability core. Downstream slopes will be constructed at approximately 2H : 1V in order to provide suitable factors of safety against failure for the starter dam configuration as well as for the final dam configuration.

The design maintains a positive groundwater gradient in the tailings impoundment that prevents tailings solution migration outside the facility. Seepage through the pervious embankment will be collected and recirculated into the facility. In addition to the above, this site has the advantage that it forms a pollution control structure in relation to potentially contaminated water run-off from operational areas adjacent to the facility.

The proposed site and TMF layout allows for the storage of life of mine tailings production although, as indicated earlier, the relocation of some residents will be required.

### 3.13 Salistei Valley

This option is equivalent to that identified as Site D1 above. The Salistea Valley option entails enlarging the existing tailings facility, currently being used for tailings deposition from Rosiamin operations, to create a TMF capable of storing the life of mine tailings production for the project.

The existing TMF at Salistea consists of a small starter embankment and upstream raises constructed using the coarse fraction of the tailings materials to a height of approximately 60 m.

For the Roşia Montana project, the existing embankment would be enlarged by constructing a downstream buttress and a centreline rockfill raise to accommodate process water storage and approximately two years of tailings production. Considerable foundation preparation would be required to raise this dam where it extends over the existing tailings to ensure that it meets slope stability design criteria. Foundation preparation would include the installation of wick drains in the tailings to improve its drainage characteristics and, therefore, increasing the strength of the materials (see schematic cross section below).

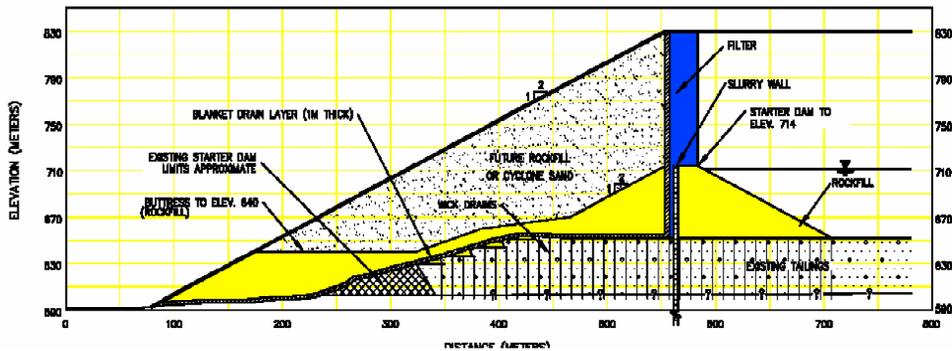
In addition, a slurry wall would be constructed to minimize process water seepage through the starter dam. Extensive instrumentation would be installed to confirm the degree of strengthening of the foundation materials prior to constructing new raises.

The ultimate dam would be constructed with multiple centreline rockfill raises on the starter embankment to an elevation of 830 m. This dam design also incorporates the pervious dam concept; therefore, a low permeability core will not be installed in any of the raises. This would maintain a positive groundwater gradient towards the impoundment that will provide containment of tailings solution. Seepage through the embankment would be collected by a downstream secondary containment system and pumped back to the tailings impoundment.

Geotechnical analysis of the proposed dam layout has confirmed that the remediation measures proposed for the existing Salistei Dam together with the proposed design for the centreline raises to the dam and the provision of a slurry wall to prevent seepage would result in a dam embankment with adequate factors of safety against failure.

The site has advantages and disadvantages of which the most important are the construction on a location deeply disturbed by past and current mining activity thus minimizing the disturbance of new sites for the construction of the TMF and the difficult construction conditions to be encountered specifically in areas of the existing TMF, respectively.

In addition, the development of a TMF at this location would result in a facility that can only accommodate 225 million tonnes of tailings which is less than the design criteria of 240 million tonnes.



Salistei Schematic Design

### 3.14 Roşia Poieni TMF

This option is similar to that described during the 2001 DFS as Site A2 and consists of the utilization of the existing tailings facility for the Roşia Poieni mine operation.

The Roşia Poieni Tailings Facility is located approximately nine (9) kilometres north-east of the Roşia Montana plant site. The current tailings facility is a rockfill dam with an unlined impoundment formed by a starter rockfill dam to 630 m elevation, a further downstream raise to 680 m elevation and two consecutive upstream raises to 683 and 686 m elevation respectively.

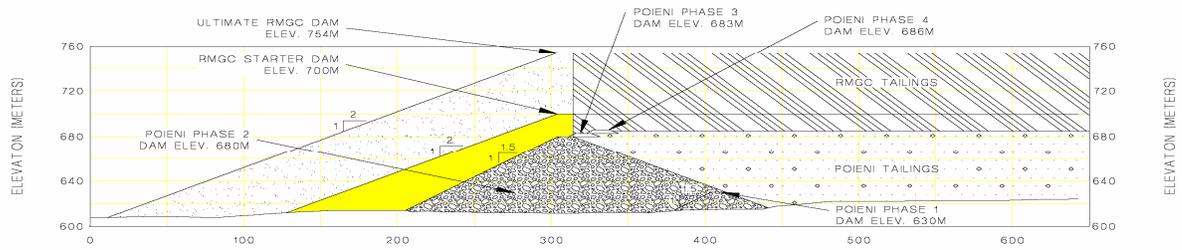
The conceptual design for the Roşia Montana TMF on this site includes the initial construction of a centreline dam raise to 700 m elevation and the subsequent construction of centreline raises to a final dam crest of approximately 754 metres.

Preliminary stability analysis conducted for the proposed layout indicates acceptable factors of safety against failure for the dam embankment at each stage of the construction and operation of the structure.

Tailings from the Roşia Montana project would be pumped over the dividing ridge to the Roşia Poieni TMF site.

Some of the advantages of the Roşia Poieni site include the fact that the site currently contains an active tailings facility; therefore, reducing the extent of new impacted areas for the project. The land around the perimeter of the existing facility has been acquired by the Roşia Poieni operations so expansion of the facility will not require land acquisition. The main disadvantage of this alternative relates to the distance of the site to the Roşia Montana project site, requiring the pumping and piping of the tailings produced over a long distance before final deposition.

The following schematic figure shows the conceptual design proposed for the raises to the existing Roşia Poieni TMF



Roşia Poieni Schematic Design

### 3.15 Combination of Săliştei and Roşia Poieni Sites

The development of this alternative was initially considered due to the expected problems envisaged for the mingling of copper and gold tailings should the Roşia Poieni TMF be used for the deposition of tailings from the Roşia Montana mine concurrently with the deposition of tailings from the Roşia Poieni operation.

The Săliştei Valley dam would be used initially for the deposition of gold tailings from Roşia Montana until operations at Roşia Poieni ceased at which time construction of the centreline raises to the Roşia Poieni dam and deposition of gold tailings at this facility would commence.

The conceptual design for the extension of these facilities is similar to that described above although the extent of the raises is adjusted to the particular requirements of the deposition plan.

A similar site combination concept was proposed during the initial stages of the 2001 DFS whereby the Roşia Montana Tailings could be disposed of at the Roşia Poieni facility and the remainder of tailings production from Roşia Poieni would be disposed in a separate purpose built small facility in the Ştefanca Valley.

All these site combination options are currently considered redundant due to imminent closure of the Roşia Poieni mine site and the cessation of tailings deposition at the TMF rendering the site potentially available for sole use by the Roşia Montana operation.

### 3.16 Filter Press Tailings with Disposal in Corna Valley

This option was initially considered by the post-2001 TMF options re-evaluation and discarded in the pre screening of options process for the following reasons:

High operational costs of between US\$ 2 and US\$ 3 per tonne; and

The lack of operational experience and resultant risk with this type of operation.

These reasons are still considered valid and applicable and this alternative will not be considered in any further detail.

### 3.17 Backfilling of Open Pits

Similarly to the option of Filter press tailings, this alternative was eliminated from any further consideration at the pre screening of options in the MWH study. The pits created by the extraction of ore at Roşia Montană will be backfilled using waste rock as ore extraction in each pit is completed. The presence of old workings in the pit walls would also create complications for tailings containment. There are no other available open pits for the deposition of tailings within a reasonable distance of the project site.

Similarly to the alternative of Filter press tailings, this option will not be considered any further in the analysis.

The following Table 1 presents a summary of the characteristics for the alternative sites considered and a brief description of the social and environmental impacts assessed at the preliminary stage.

**Table 1. Summary of Alternative TMF Sites**

Alternative	Technical Summary	Environmental Impacts	Social Impacts
Corna Valley	Dam Height: 190 m Impoundment Storage Volume: Adequate Foundation Conditions: Adequate Geotechnical Limitations: None	Impacts to Existing Valley: Yes Area of Disturbance: 3.5 km <sup>2</sup> Potential groundwater/surface water (GW/SW) Impacts: No	Displaced Residences: Yes Aesthetic Impacts: Yes Land Within PUG/PUZ: Yes
Roşia Poieni Tailings Facility	Dam Height: 140 m Impoundment Storage Volume: Adequate Foundation Conditions: Adequate Geotechnical Limitations: Landslide along pipe alignment	Impacts to Existing Valley: No Area of Disturbance: 4.4 km <sup>2</sup> Potential GW/SW Impacts: Existing operations – yes. Future operations will address GW/SW impacts	Displaced Residences: No Aesthetic Impacts: Yes Land Within PUG/PUZ: No
Salistei Tailings Facility	Dam Height: 230 m Impoundment Storage Volume: Adequate Foundation Conditions: Poor Geotechnical Limitations: Yes	Impacts to Existing Valley: No Area of Disturbance: 3.0 km <sup>2</sup> Potential GW/SW Impacts: Existing operations – yes. Future operations will address GW/SW impacts	Displaced Residences: Yes Aesthetic Impacts: Yes Land Within PUG/PUZ: No

Alternative	Technical Summary	Environmental Impacts	Social Impacts
Combined Alternatives	Dam Height: Varies Impoundment Storage Volume: Adequate Foundation Conditions: Adequate Geotechnical Limitations: None	Combined alternatives almost double the potential environmental impacts, since two separate facilities would need to be developed.	Combined alternatives almost double the potential environmental impacts, since there are two facilities developed.

Based on the descriptions above and an initial assessment of the potential capacity of the different alternative tailings facilities, some options were not considered for further analysis due to environmental and technical reasons that would prevent the achievement of the main purpose of the facility.

Based on the above, the sites at Ștefanca and Abruzel were not considered in any further detail because they are remote from the mine site, would significantly increase the overall Project footprint and also present a significant potential environmental impact should a TMF be constructed, requiring the displacement of people. All of the above combined with the fact that the resulting TMF would not satisfy the requirements for the life of mine tailings production plan make these alternatives unviable.

In addition, as indicated above, the alternatives of implementing a filter press system for the disposal of dry tailings on the Corna Valley and the disposal of tailings in open pits are also eliminated from the comparative analysis at this stage.

However, the following options did justify further analysis and final selection of a preferred option for the disposal of tailings arising from the Roșia Montana Gold Project:

- Valley Type TMF at Corna Valley (C2 above)
- Expansion of the Săliștei TMF
- Expansion of the Roșia Poieni TMF
- Combination of Săliștei and Roșia Poieni Sites.

Table 2 below summarises the main characteristics of the proposed tailings facilities at the sites selected for final analysis.

**Table 2. Summary of Short-listed TMF Options**

Alternative	Starter Dam Downstream Slope (H:V)	Final Dam Downstream Slope (H:V)	Starter Dam capacity rockfill ratio	Final Dam capacity to rockfill ratio	Ultimate Dam Height (m)	Ultimate Storage Capacity (Mt)
Corna	2 : 1	2 : 1	6.01	11.83	185	240
Salistei	2 : 1	2 : 1	3.10	5.63	230	225

Roşia Poieni	2 : 1	2 : 1	34.99	38.23	148	241
Salistei / Roşia Poieni	2 : 1	2 : 1	6.40	7.91	180/124	242

## 4 Comparison Criteria for short-listed TMF options

### Basis of analysis

In order to conduct a comparative analysis and rank the site options, six basic categories were considered in order that the ranking process was not biased to any particular item. In addition, the ranking process assumed that each of the six categories is of equal weighting or importance. The six categories are as follows:

- Environmental Risk
- Impact on Community
- Constructability
- Capital costs
- Operating costs
- Complexity / ease of operation.

It was assumed that the closure and rehabilitation costs, and the long term monitoring costs for each option (on a cost per tonne of ore processed basis) will be similar for each site under consideration. It should be noted that closure, rehabilitation and post closure monitoring costs are largely dependent on the type of TMF (i.e., valley, paddock, side of hill, central thickened discharge etc) for a given size of facility, and therefore these costs have been considered similar at this stage as all the options considered are of the same type (valley dam) and relatively similar in size. The exception to this is the alternative option that comprises a combination of the Roşia Poieni and the Săliştei Valleys for which a penalty factor will be included in the operating cost category to account for the increased rehabilitation and post closure costs resulting from dealing with two separate sites.

### Analysis

#### 4.1 Environmental Risk:

The main environmental risks / impacts for each of the options have been assessed as follows:

- i. Seepage from the TMF impacting on the downstream groundwater / surface waters, and ultimately any groundwater source downstream of the facility.
- ii. Rupture of the tailings delivery pipeline.
- iii. Failure of the TMF embankment (due to an extreme seismic event) leading to the flow of tailings downstream.

- iv. Failure of the TMF embankment (breach following extreme precipitation and accumulation of water on the facility) leading to the flow of tailings downstream.
- v. Impact on areas not previously impacted by mining and mineral processing operations.

Item (i) has been assessed as having a low to very low probability of occurrence, provided appropriate seepage control measures are incorporated into the final design of the tailings facility. These measures are simple to construct and relatively inexpensive and are considered essential to any modern tailings management facility.

Item (ii) has been assessed as having a moderate to high probability of occurrence, however as this event is envisaged to have less consequence than a failure embankment, the risk is assessed as similar to the other hazards. It should be noted that the risk from a failed pipeline increases with the length of line and the hazard posed increases where the pipeline crosses a river or a new valley on its way to the tailings facility. Based on this, the Corna alternative is considered to have the lowest risk as the proposed TMF site is located near the proposed plant site for the project and the pipeline will be fully contained by the same valley to which the TMF will form a containment dam thus minimising the potential impact beyond the project site. The Săliștei alternative is also considered of low risk as the pipeline route would follow the route of the existing tailings pipes thus minimising any additional impact. The Roșia Poieni alternative is considered to have the greater risk given the distance to the plant site.

Item (iii) has been assessed as having a very low probability of occurrence provided the embankments are designed and constructed using good construction practices and the operation of the facility follows best practice. The potential environmental impact for each option was assessed as being similar, although the options including the use of the Săliștei Dam are considered to be more at risk due to the condition of the underlying materials in the site of the proposed embankment and the extensive foundation preparation works required to remediate the site prior to construction of the dam raise. The Roșia Poieni alternative is considered to have a lower risk due to the lower height of the ultimate dam wall.

Item (iv) has been assessed as having a low to very low probability of occurrence provided drainage diversion works are constructed to minimise the potential for the accumulation of water on the facility. Although similar, the Roșia Poieni alternative is considered to have a lower risk as the shape of the impoundment, resulting in a greater capacity to rockfill ratio, also reflects the potentially smaller catchment for this alternative. In addition, some diversion works would already be in place for the Roșia Poieni dam resulting in lesser additional impact.

Item (v) has been assessed to have similar risk for the Roșia Poieni and the Săliștei alternatives because they are all located in areas currently hosting tailings storage facilities and therefore already impacted. The Roșia Poieni alternative is considered slightly more favourable as land ownership and use issues have already been resolved by the acquisition of the land surrounding the existing TMF by the Roșia Poieni mine. The alternative at Corna is considered less favourable because it involves the occupation of a new valley with a tailings facility. In this case, although the Corna Valley has some significant impact from previous mining activities, the impact of a new tailings facility on the site will be incremental and less favourable when compared with the other options. The alternative of the combinations of sites is also considered less favourable as it will involve the further complicating impact on two valleys rather than one.

The following Table 3 summarises the ranking of the sites with respect to items (i) to (v).

**Table 3. Site Ranking - Environmental Risk (1 lowest – 5 highest)**

Alternative Risk-/ Impact	Corna	Salistei	Roşia Poieni	Roşia Poieni / Salistei
Seepage risk	1	3	2	4
Tailings line rupture	1	2	3	4
Stability risk	2	3	1	4
Runoff diversion	2	3	1	4
Impacted area	3	2	1	4
Rank Score	9	13	8	20

The table 5-8 indicates that the Roşia Poieni and Corna alternatives have a similar ranking with respect to “Environmental Risk”. The Săliştei alternative is third ranked and the combination of sites at Roşia Poieni and Săliştei is a distant last-ranked option. This is mainly due to the fact that this alternative has to include the potential impact of two tailings disposal sites and the associated infrastructure.

## 4.2 Impact on Community:

An assessment of the “Impact on the Community” of each of the TMF alternatives being considered was made based on the distance of the proposed facility or its associated infrastructure to the nearest village and the requirement for the relocation of population should a particular alternative be selected.

The Roşia Poieni and Săliştei alternatives will be developed entirely within the confines of an existing TMF and therefore will have no significant direct impact on any surrounding community. Furthermore, the proposed tailings pipeline route will utilise the existing routes to Săliştei and partly to Roşia Poieni with a new section required from the Roşia Montana plant to the Roşia Poieni.

The Corna alternative will have direct impact on existing communities in the Corna Valley. As indicated earlier, this valley has been significantly impacted by previous mining activity. However, there are still a significant number of settlements in the valley and the relocation of people currently living in the footprint on the proposed TMF will be necessary.

## 4.3 Constructability:

An assessment of the constructability of embankments for each of the TMF alternatives was made based on an assessment of availability of borrow materials at each site (i.e.

within the TMF basin) and the potential difficulties envisaged for foundation preparation activities for some of the sites.

The constructability of the proposed TMF embankment for the Corna and Roşia Poieni alternatives is considered to be similar, although the efficiency of the embankment at Roşia Poieni will result in a higher ranking. This will be compensated at the Corna site by the abundance of rockfill available for the construction of the embankment. This material will be sourced from the waste rock from the mine given its proximity to the proposed Corna dam embankment.

The alternatives involving the Săliştei TMF have been given a lower ranking as the stabilisation of the existing dam and the foundation preparation works could present a serious risk to the development. The alternative considering the combination of the Roşia Poieni and Săliştei Dams will require lesser works at Săliştei due to the lower final embankment height of the Săliştei Dam for this alternative.

#### **4.4 Capital Costs:**

Various capital cost analyses, to different degrees of accuracy, have been undertaken for the comparison of alternative TMF options for the Roşia Montana Project. Conceptual level cost estimates are included in Table 4 and the level of costs has been considered in the determination of the ranking for each individual alternative.

**Table 4. Alternatives Conceptual Level Cost Estimates**

Alternative	Cost (US\$)
Corna Valley	148 433 153
Total Initial Direct Cost	56 467 576
Total Initial indirect Cost	8 420 993
Total Sustaining and capital Cost	83 544 584
Salistei Valley	269 976 875
Total Initial Direct Cost	89 745 926
Total Initial indirect Cost	8 420 993
Total Sustaining and capital Cost	171 809 956
Roşia Poieni Valley	75 507 522
Total Initial Direct Cost	37 958 729
Total Initial indirect Cost	8 420 993
Total Sustaining and capital Cost	29 127 800
Combination of Roşia Poieni and Salistei Valleys	237 739 856
Total Initial Direct Cost	37 958 729
Total Initial indirect Cost	8 420 993
Total Sustaining and capital Cost	191 360 134

#### 4.5 Operating costs:

An assessment of the operating cost for the operation of a TMF for each of the alternatives was made based on the length of pipe from the plant site to the dam site location and consideration of the likely pump static head (i.e., the greater length and static head, the greater the 'pipe losses' and hence greater the power requirements).

It has been assessed that power costs represent the main operating cost for the TMF. Other costs would include general maintenance, labour (to switch on pumps, changes spigots etc). It should be noted that general maintenance and labour costs will also increase the further the TMF is away from the plant.

In addition to the above, maintenance costs of non-pipeline items, such as tunnels and bridges for the pipeline installations, as well as booster pump stations also need to be considered.

The assessment indicates that the alternatives for Corna and Săliştei are the most favourable given their relative proximity to the plant site and the simplicity of the proposed pipeline route which lacks any complicated structures, has no tunnels or bridges to maintain and does not require the maintenance of pollution control dams or

infrastructure along the pipeline route. The Săliștei alternative is marginally more favourable than the Corna alternative given the potential use of an existing pipeline corridor from the plant site to Săliștei.

The Roșia Poieni alternative presents the most unfavourable conditions, with greater distances to the plant site resulting in increased power costs for the pumping of the tailings and the return water and increased maintenance costs for the pipeline and associated infrastructure, including tunnels, bridges and pollution control measures.

#### **4.6 Complexity of Operation:**

It is envisaged that a TMF developed at each of the sites under consideration would comprise a similar operational design concept, as follows:

- i. Surface water management: Surface water would be recovered from the facility by a floating pontoon pump or similar and pumped back to the plant.
- ii. Tailings deposition: Spigotting will be undertaken from the main embankment and from several spigot locations off a slurry ring main surrounding the facility.

It has been assessed that complexity of the operation is directly related to the length of the embankment required and to a lesser extent the length of the delivery pipeline. A long embankment requires additional control over the spigotting to ensure appropriate management of the surface pond and the return water system. A lengthy pipeline will require the operation of booster pump stations and/or break pressure systems which could create some operational problems, in particular during start up.

Similarly, seepage control is of primary importance for environmental protection and a long embankment will require additional drainage collection features and a proportionately greater risk of failure of such features.

An important part of the complexity of operations analysis is the consideration of the effect on the overall project water balance of having two operating tailings facilities at any time during the project. This could have a significant impact on water treatment costs and therefore the exposure to risk of this alternative is considered high.

Based on the above, it has been assessed that the Corna Alternative is the most favourable location, as it requires a relatively short length of dam embankment but will require a significantly simpler tailings delivery system. The Roșia Poieni alternative is marginally less favourable than Corna with the Săliștei alternative being considered the least favourable of the single site alternatives given the expected additional complexity of deposition control due to the seepage and other risk associated with the foundation preparation works and the management of the risk from the existing embankment.

The operation of the Combination alternative is considered the least favourable given the requirements to operate two tailings facilities at some stage of the project.

## 4.7 Results

The results of the comparative analysis are based on the assessment of the different alternatives in relation to the criteria as described above. The ranking system used is similar to that presented above for environmental risk.

The summary ranking system incorporates the results of the environmental risk assessment as one element in order to avoid excessive bias of the options in favour of environmental considerations. Table 5 presents the results of the comparative ranking.

**Table 5. Site Ranking – Assessment of Site Options**

Category \ Site	Corna	Salistei	Roşia Poieni	Roşia Poieni / Salistei
Environmental Risk	3	4	2	6
Impact on Community	5	1	4	5
Constructability	2	6	2	5
Capital Cost	3	5	2	5
Operating Cost	2	3	6	4
Complexity of Operation	2	5	3	5
Rank Score	17	24	19	30

Notes:

Rating based on a scale of 1 “best” to 6 “worst”

Minimum possible score for an individual site is 6.

Total score for an individual category, 15

Total of all scores, 90

Where sites were considered as having a similar ranking with respect to a category, the respective sites were given the ‘same’ score (the total score of the individual category should always be 15)

The above assessment and ranking provides a scoring for environmental impact that focuses on the most significant issues relating to siting of the TMF (e.g., land take and impact on local communities). The following Table 6 provides a more comprehensive summary of the environmental impact for each of the valid options identified above.

**Table 6. Impacts of Alternative TMF Site Options compared to Selected Option**

Environmental Issues	TMF Siting Options			
	Corna (selected)	Salistei	Roşia Poieni	Roşia Poieni / Salistei
Water flows and quality	Direct impacts on Corna stream and valley drainage; positive impact on water quality due to management of existing ARD problem	Site is centred on a valley that is already impacted by a TMF; opportunity to improve the safety and security of existing TMF, but construction and operating risks are higher due to existing structures	Land take less significant than for Corna because of existing TMF; opportunity to improve the environmental performance, safety and security of existing TMF; increased potential for spills due to extended tailings pipelines	Land take favourable, however two sets of infrastructure increases complexity and risk of operational problems; extended pipeline hazard created
Air quality	Introduces additional potential dust nuisance source to Corna valley	Site already impacted, but potential for impact would be increased due to greater area	Site already impacted, but potential for impact would be increased due to greater area	Increased potential for impacts in two valleys
Noise and vibration	Introduces new noise emission sources to Corna valley	As above	As above	As above
Soil	Land take creates direct impact on soils over tailings basin	Land take less significant than for Corna because of existing TMF	Favourable option regards minimising land take and impacting soils	Favourable option regards land take and impacting soils; less favourable than single site, due to increased infrastructure
Biodiversity	Land take creates direct impact on habitats over tailings basin	Land take and habitat loss is less significant than for Corna because of existing TMF	As above, regards habitats	As above, regards habitats
Landscape	Creates new landform in floor of valley	Impact on landscape is less than Corna due to existing TMF	As for Salistei	As for Salistei and Roşia Poieni
Socio-economic issues	Results in relocation of people living within the TMF footprint	Favourable location to minimise impacts on local community	Less favourable than Salistei option due to pipeline and supply corridor construction	Less favourable than Salistei/Roşia Poieni single site options due to additional infrastructure and impact on two valleys
Cultural heritage	Potential for impacts on cultural heritage over TMF basin	As above	As above	As above
Transportation issues	Requires relocation of Roşia Poieni access road	No significant transportation issues	Possible pressure on existing village transport corridor above existing TMF due to pipeline construction	As above
Transboundary impacts	High safety factors due to ease of construction, minimises risk of dam failure or overtopping	Complexity of construction due to existing structures; less favourable than Corna sites regards risks of failure or overtopping	Requirements for extended pipelines increases potential for rupture and spillage	Less favourable than Salistei/Roşia Poieni single site options due to additional infrastructure, complexity and resulting risks

## 4.8 Conclusions

The results of the assessment of potential alternatives for the location of the proposed TMF at Roşia Montana indicate that although numerous sites are available for the construction of the facility, only a few are suitable given their size or location.

Based on the comparative analysis carried out for the alternatives identified, the preferred site for the development as a TMF site for the project is the Corna Valley. This alternative ranks second in terms of environmental impact alone, however, due to its relatively moderate capital costs, low operating costs and a relatively low complexity of operation, the overall ranking results in a more favourable score than that of the Roşia Poieni option.

The Roşia Poieni option ranks second most favourable site. Despite being the preferred option both in regard to environmental impact and impact on community criteria, expected high operating cost and the additional complexity of the operation of the tailings delivery pipeline have a detrimental effect on its overall ranking.

The Corna Valley site provides the required design storage capacity for the life of the mine plus a substantial contingency. It has the advantage of being close to the process plant and open-pit sites, thus minimising the project footprint. It will be designed to accept tailings that have been detoxified in the process plant's SO<sub>2</sub>/air treatment circuit.

## 4.9 Inert Waste Landfill Location Alternative

As noted in Chapter 3, non-hazardous inert wastes generated during construction or mining operations will be deposited in a specially constructed Inert Waste Landfill adjacent to the waste rock stockpile at the upper end of the Corna Valley. Location of this landfill (see Exhibit 5.2 for initial location) is based on a desire to use only previously impacted land, upgradient from a facility able to contain any runoff, and to eliminate the impacts that would be associated with the rejected alternative, (i.e., offsite transportation and disposal at an appropriately permitted municipal landfill).

It is anticipated that during the mine life the facility will eventually be covered by the extension of the Cârnic waste rock stockpile. Therefore, new landfill cells may be created periodically, based on need, in either the Cârnic or Cetate waste rock stockpiles. During the later years of the mine life, after active mining is completed and the low-grade ore stockpile is being processed, a final inert waste disposal cell will be established in the Cetate waste rock pile near the plant site. This will be sized to accommodate the inert waste generated as part of the last years of mining and closure.

The following Table 7 sets out a comparative assessment of environmental impacts associated with the selected option and disposal off-site.

**Table 7. Impacts of Alternative Inert Waste Landfill Location Options compared to Selected Option**

Environmental Issues	Options		Comments
	Disposal off-site	Disposal on-site (selected)	
Water flows and quality	No differentiation between the options		This conclusion assumes that the off-site facility is appropriately regulated and managed
Air quality			
Noise and vibration	Additional noise and vibration generated as a result of transport off-site	Deposition within the site boundary and a buffer protecting adjacent communities	
Soil	No differentiation between the options		This conclusion assumes that the off-site facility is appropriately regulated and managed
Biodiversity			
Landscape			
Socio-economic issues	Results in consumption of landfill space that could be used for other wastes	Efficient use of on-site facilities for disposal	
Cultural heritage	No differentiation between the options		This conclusion assumes that the off-site facility is appropriately regulated and managed
Transportation issues	Transportation off-site adds to highway traffic with noise, safety and traffic congestion issues	No off-site transportation	
Transboundary impacts	Issue of no significance in transboundary context		