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5 ALTERNATIVES ANALYSIS

5.1 Approach

Analysis of alternatives from a technical, economic, environmental and social perspective has formed an integral part of the design and assessment of the Amulsar Project.

As the Project will be located on 'greenfield land' and will require intensive use of the land, it is appropriate that the locations of the main infrastructure and processing elements of the Project should be subject to a detailed review, with a view to reducing the footprint of facilities and the potential for health and safety hazards and environmental or social harm.

A series of rigorous assessments was carried out in 2013 and 2014 for alternative designs, locations and technological approaches using a robust site alternative assessment methodology developed by Golder Associates (independent consultants) working with Lydian. The outcome of these assessments was the Project design which was documented in the 2014 Feasibility Study (FS) for which Lydian obtained a Mining Right in November 2014.

In 2015 Lydian commissioned Samuel Engineering Inc. ("Samuel") to undertake further value engineering work. The objective was to reduce capital expenditure without increasing operating cost or enhancing negative environmental and social effects. The results from this optimization process, which were published in the November 2015 Technical Report (TR), have reduced capital and operational costs, thus improving the economic viability of the Amulsar Gold Project. An assessment of the environmental and social implications of the optimization design changes was undertaken in December 2015, which has been included in this chapter.

Throughout the Project design process, alternative options have been informed by a rigorous programme of stakeholder engagement. A Stakeholder Engagement Plan (SEP) has been developed in order to guide stakeholder consultations and communications during the development and execution of the Project. The SEP is updated regularly, most recently in May 2016, and is published and available at the Amulsar Information Centre (AIC) and on the Geoteam website (in English and Armenian). Between 2011 and 2015 during the period of the design of the Project and the preparation of the FS, TR and ESIA, at least 250 meetings took place with communities, broad stakeholders and Government officials. More details with the dates and topics of all the meetings is provided in Tables 7.1, 7.3 and 7.4 of the SEP (see Appendix 8.6).

Lydian has taken the following IFC Performance Standards (PS) and Guidance Notes along with EBRD Performance Requirements (PR) into account when assessing Project alternatives:

- For greenfield developments, the Guidance Note to IFC PS 1 stipulates that "*the ESIA [should include] an examination of technically and financially feasible alternatives to the source of … impacts, and documentation of the rationale for selecting the particular course of action proposed*." The alternatives analysis facilitates "*the consideration of environmental and social criteria at the early stages of development and decision-making.*" Similarly, EBRD's PR1, paragraph 10 states "*the ESIA will include an examination of technically and financially feasible alternatives to the source of such impacts, including the non-project alternative, and document the rationale for selecting the particular course of action proposed*."
- IFC PS 3 requires that environmental aspects of the Project be incorporated into the site alternatives assessment, including use and efficiency of resources, and the equipment selection process should take resource efficiency into account.
- IFC PS5 encourages companies to avoid acquisition of land that results in the physical or economic displacement of people, and requires a meaningful analysis of possible alternatives which incorporates the social and project costs associated with displacement.
- IFC PS6 requires that the client (in this case Lydian) does not significantly convert or degrade natural or critical habitats unless it can be demonstrated that no viable alternatives exist to development affecting such habitats. Paragraph 17, bullet 1 of PS6 states that "*In areas of critical habitat, the client will not implement any project activities unless (all) the following are demonstrated: No other viable alternatives within the region exist for development of the project on modified or natural habitat that are not critical*". Additionally the PS6 Guidance Notes suggest that "*alternatives may include variations in the layout of the project facilities, alternative engineering and manufacturing processes and construction practices, the selection of different sites or routing of linear facilities, and selection of alternative suppliers through screening to identify those with appropriate environmental/social risk management systems*." The EBRD's PR 6 (paragraph 16) also notes the requirement that:
  - o "*Critical habitat must not be further fragmented, converted or degraded to the extent that its ecological integrity or biodiversity importance is compromised. Consequently, in areas of critical habitat, the client will not implement any*

project activities unless the following conditions are met:

- *no other viable alternatives within the region exist for development of the project in habitats of lesser biodiversity value*
- *stakeholders are consulted in accordance with PR 10*
- *the project is permitted under applicable environmental laws, recognising the priority biodiversity features …"*

- IFC PS8 provides guidance on removal of "Non-replicable Cultural Heritage" and stipulates that it should be preserved in place unless there are no technically or financially feasible alternatives, and the overall benefits of the project conclusively outweigh the cultural heritage loss.

Other than IFC Performance Standards and EBRD Performance Requirements, considerations that have influenced the design of the Project include:

- The need to safeguard the health and safety of workers and residents in surrounding communities;
- The significance of potential social, health and environmental impacts and the ability to mitigate adverse impacts through evaluation of alternatives. This has specifically included the identification of all residents and land users to minimise physical and economic displacement where possible;
- Optimisation of the economic value from the extraction of the gold and silver resource;
- The availability of infrastructure and labour including the integration of the local skills base;
- Compliance with all applicable laws and regulations in Armenia and Good International Industry Practice;
- Adherence to Lydian's corporate environmental, occupational health and safety, social and human resources policies and commitments; and
- Cost-benefit analyses to enhance Project benefits to surrounding communities, workers, investors, and the Armenian government (through tax revenue and social investment).

5.2 Alternatives Considered

A thorough assessment of alternatives was undertaken for the Project Feasibility Study completed in 2014, including evaluation of alternative locations for the major components of mine infrastructure. The alternatives considered, and summarised in this section, included:

- No development (of the Project) – the Zero Option.
- Location: site alternatives:
    - Location of the mine and associated infrastructure, including BRSF and HLF (including processing and recovery plant);
    - Location of accommodation for construction and operation;
    - Location of access and haul roads;
    - Location of crushing facilities;
    - Location of conveyor;
    - Location of plant, fuel storage area, workshops and other surface facilities;
    - Location of infrastructure, including access and maintenance roads; leachate solution handling; power; water supply; sewerage treatment for mine offices and staff welfare; and
    - Fuel and cyanide delivery.
- Techniques including mining and processing alternatives:
    - Methods of primary processing (i.e. crushed rock vs. run of mine (ROM) stockpiles);
    - Methods of transportation (haulage compared to conveyor);
    - Methods of mining (i.e. open pit vs. underground); and
    - Methods of processing and recovery of gold and silver from the crushed ore.
- Alternatives considered to minimise landscape and visual impacts.
- Biodiversity considerations.
- Socio-economic alternatives.
- Employee accommodation options.
- Water management alternatives.
- Mine closure alternatives.

The Value Engineering and Optimization exercise undertaken in 2015 resulted in a number of relatively minor changes to the infrastructure required for the mine construction and operations. These are discussed in the following sections, where appropriate.

5.3 Zero Option

Various options for Project development were assessed including the zero option. The zero option would mean not developing the Project at all. This option would:

- Maintain the status quo of the locality and the region in terms of economic conditions and livelihoods;

- Avoid the potential risk of any disturbance to the community and current patterns of agricultural activity and the trend of out-migration from rural communities, or long term changes to the landscape;
- Not incur the potential (real or perceived) environmental and social impacts, risks or threats analysed in this ESIA;
- Avoid footprint on natural and critical habitat (as defined per PS6/PR6) and mining-related impacts on RA Red Book species; and
- Avoid long term legacy issues associated with land-use, aftercare management and maintenance of land that has been used for extraction and processing of precious metals.

The zero option would, however, also result in the loss of:

- Economic opportunity to exploit a nationally important mineral resource with potential economic benefits to the region and national economy for the duration of the Project;
- Local employment opportunities and associated economic benefits that derive from employment generation for the duration of the Project;
- Associated development and subsequent long term improvements to local infrastructure including roads, energy, waste and water management; and
- The opportunity to upgrade and develop skills, with the associated direct economic benefits on local communities as a consequence of services and contracts delivered to maintain and support the mining operations.

5.4 Site Alternatives Analysis

The locations of the main components of the mine development have been subject to a number of design iterations, supported by detailed studies of alternatives. The approach is summarised in Table 5.1.

Table 5.1: Site Selection Alternatives	
Project Components	**Approach to assessing alternatives**
Location of the mine and associated infrastructure, including BRSF and HLF	Minerals, including precious metals, can only be extracted where they occur in specific geological strata and deposits. The resource that has been assessed at high elevation on the Amulsar mountain is defined as a low grade ore, in terms of the concentration of gold and silver per tonne of ore. As such, there is no alternative site option available for assessment. To assess suitable locations for the barren rock storage facility (BRSF) and heap leach processing facility (HLF) separate studies were undertaken by adopting the following four stage process: 1 High level desk study within a maximum envelope of 25km from the open pits, identifying potential sites with suitable topographic characteristics together with high level review of potential visual impacts; 2 Scoping analysis considering: • Environmental aspects including biodiversity, access to ecosystem services, water resources, visual impacts and landscape, and residential amenity; • General location; • Social and cultural aspects associated with location including a 1km buffer zone between nearest residents and facility locations; cultural heritage; • Infrastructure requirements including transfer of ore to HLF and location of processing facilities, including the ADR plant; • Technical, legal and economic feasibility; • Development of a scoring matrix including fatal flaw analysis to determine a short list of preferred locations; and • Armenian laws and regulations, in particular the Lake Sevan Law which includes strict requirements on location of the processing facility and definition of areas where mining and processing is restricted. 3 Semi-quantitative rating assessment of short-listed sites, when each site was subjected to a detailed assessment and ranking across each of the 5 screening categories identified in stage 2; and 4 Prepare conceptual layouts of short-listed sites and integration with mine design team to select preferred option based on technical and financial feasibility.
Location of construction camp and accommodation for operation	The primary considerations when selecting the location of the temporary construction camp were: proximity to the construction activities; avoidance of privately owned land; avoidance of sites of significant cultural heritage value; and distance from nearby villages. Jermuk was selected as the primary accommodation point for non-resident employees during operations due to its greater size and availability of hotel/apartment accommodation. As an urban town rather than a rural village, the social impact of introducing new workers to the community will be reduced somewhat.

Table 5.1: Site Selection Alternatives	
Project Components	**Approach to assessing alternatives**
Location of access and haul roads	The primary location criterion was to develop the shortest and most efficient routes to connect the extraction area within the open pits with the crushing plant and BRSF. A significant proportion of the haul route will be within the open pits, extending as the pits are developed with depth. The options for routing between the open pits, crushing plant and BRSF are limited by RA legislation which places restrictions on the maximum gradient of haul roads. However, as described in Section 2.1.19, there was a change in the law in 2015 which eased the restrictions.
Crushing (ore)	The primary location characteristic was a suitable site in close proximity to the open pit to reduce haulage distance of bulk ore, within an area of the mine that does not sterilise potential ore reserves. Environmental and social factors that were taken into account in the determination of the preferred location included avoiding: • Locations above or with direct hydraulic connections to vulnerable groundwater resources and river protection zones; • Streams and tributaries with close connection to rivers; • Locations on the skyline or prominent locations with high visibility; • Areas of high biodiversity value; • Areas of high cultural heritage value; and • Locations which demonstrated high levels of usage and importance for herders. Efforts were also made to minimise potential impacts on visual or residential amenity.
Conveyor	The main criterion used to select a preferred location for the conveyor was to provide the most direct route from the crushing plant to the HLF, minimising conveying distance, number of turns in the conveyor, and amount of earthworks required along the route. A trade-off study was carried out for the overland conveyor investigating a conventional conveyor versus a pipe conveyor. The conveyor system selected is a regenerative system that will supply power to the plant when in operation.
Truckshop, fuel storage area, workshops and other surface facilities	The primary location characteristic was a suitable site or sites that can service operations within the open pits, crushing plant and BRSF, maintaining an efficient and fast response to repair breakdowns and provide maintenance of the fixed and mobile plant. In addition, design alternatives required the preferred location to enable rapid response in terms of staff supervision and management. Locations also needed to minimise potential impact on residential amenity, and avoid the following: • Above or with direct hydraulic connections to vulnerable groundwater resources and river protection zones; • Next to streams and tributaries with close connection to rivers; • On the skyline or prominent locations with high visibility; • Within areas of high biodiversity value; and • Within areas which would damage people’s livelihoods.

Table 5.1: Site Selection Alternatives		
Project Components	**Approach to assessing alternatives**	
Infrastructure	Access and maintenance roads	Review of options was undertaken for access to the mine, including maintenance and upgrade of exiting access roads, modification to main haul routes, improving roads to pits, new access roads to the HLF and plant, and construction of a security gate at mine entrance. For footprint management, locations of roads were reviewed in order to try to minimise: • Impacts on water courses; • Impacts on friable soils; • Impacts on sensitive vegetation; and • Creation of barriers e.g. to wild animals or to local grazers.
	Leachate solution handling	Avoid pipelines crossing the rivers.
	Power	Electrical power will be supplied to the project area via an existing overhead electricity transmission line connected to a new substation mid-way along the conveyor. From the substation, overhead connections will run to the main Project components at the HLF, including the ADR plant, and to the crusher. When considering new routing of power cables, the approach was to try to: • avoid overhead lines, where these are exposed and cross land outside the project footprint; • follow the route of the overland conveyor and utility corridor; and • where practical connect circuits using underground cabling.
	Water supply	Protect water resources (surface and aquifer) and ensure that the mine and processing needs do not adversely affect village, herding and agriculture water supply.
	Sewage treatment for mine offices and staff welfare	Details will be defined at the detailed design stage for these facilities and will take account of: • Avoiding areas above or with direct hydraulic connections to vulnerable groundwater resources and river protection zones; and • Avoiding streams and tributaries with close connection to rivers. Septic tanks and leach fields will be located at the ADR plant, primary crusher, secondary crusher and the truck shop.

Table 5.1: Site Selection Alternatives	
Project Components	**Approach to assessing alternatives**
Fuel & Cyanide Delivery	The delivery route is to be confirmed, but should use major roads, avoiding where possible minor roads. Minimisation of community safety risks associated with cyanide delivery through avoidance of heavily populated areas will be critical.

Two Site Alternative Analysis (SAA) reports were prepared for this project in 2013: one covering the Heap Leach Facility (HLF) and a second covering the location of the Barren Rock Storage Facility (BRSF). The SAA reports completed in June 2013 by Golder with input from other independent experts (TEC, ERM, Gone Native and Shared Resources) have been shared with the Government of Armenia (MNP, MENR and ME). The findings of the reports are summarised in the following sections.

5.4.1 Preferred Location of BRSF and HLF

BRSF Site Alternative Assessment (SAA)

The initial screening analysis described in the Waste Dump Facility (WDF, renamed BRSF) SAA (Golder 2013) resulted in elimination of 12 of the 27 sites considered due to fatal flaws and 11 sites eliminated due to significant adverse impacts. Figure 5.1 presents an overview of all sites considered, and the 3,000m buffer zone on either side of the Spandaryan-Kechut tunnel. The remaining four sites, consisting of Sites 11, 13, 19 and 27 were evaluated as part of a semi-quantitative rating assessment in the 2013 WDF SAA (Golder 2013).

Those sites were ranked in order of preference by the scoring as follows:

- Most preferred ranking sites were Sites 13 and 27 that had an equal score of 77 points;
- 3rd ranked site with 83 points was Site 11; and
- 4th ranked site with 97 points was Site 19.

The 2013 WDF SAA concluded that Sites 13 and 27 were the most optimal sites for development of the BRSF for the Amulsar project. The report indicated that additional studies would be completed for these selected sites. Site 13 had been evaluated in 2013 in support of the studies performed for the Amulsar Project initial FS and ESIA. Site 27 was also investigated further in the autumn of 2013 which included additional site geotechnical investigations.

Based on the results of the additional site information obtained in December 2013 and in

2014, some of the scores developed in the 2013 semi-qualitative SAA ranking for Sites 13 and 27 required revision and update. The four remaining sites, Sites 13, 27, 11, and 19 were re-ranked as viable BRSF sites for consideration by Lydian and the various stakeholders. The results of the SAA weighted re-ranking resulted in the following order of preferred site location:

- 1st ranked site was Site 27 with 59 points;
- 2nd ranked site with 77 points was Site 13; and
- 3rd ranked site with 83 points was Site 11.

The detailed assessment of sites which remained eligible past the screening assessment included consideration of: visibility of the site by residents (day and night considerations); presence of community water supplies; presence of known cultural heritage; avoidance of physical displacement; avoidance of economic displacement; proximity to Gorayk Important Bird Area (IBA) and its supporting habitat; and proximity to natural habitat and areas of potential critical habitat.

Approximately 50% of the barren rock from the open pit has potentially acid-generating properties. Therefore, in setting the location requirements of the BRSF, consideration was given to the requirements for the capture and management of contact water.

The preferred site location for the BRSF is identified on Figure 3.1, in relation to the open pits and interconnecting haul routes.

HLF Site Alternative Assessment (SAA)

The SAA for the HLF was completed in 2013. This SAA evaluated 26 potential sites for the location of the HLF. The fatal flaw analysis described in the HLF SAA (May 2013) resulted in the elimination of 16 of the 26 sites considered. On July 18, 2013 the Government of the Republic of Armenia (RA) adopted an amendment to Resolution N 143-N that changed the definition of the immediate impact zone defined as the “Catchment Basin” of Lake Sevan and applied a restricted zone of 3,000m on each side of the Spandaryan-Kechut tunnel. This amendment to the Resolution referenced above prohibits the operation of ore processing facilities within this buffer zone which resulted in the elimination of the 10 remaining sites. Figure 5.2 identifies the sites analysed together with the buffer zone identified in Resolution N 143-N. In August 2013, Lydian commenced a further search for a technically feasible site for the HLF outside the restricted area, to be compliant with the Lake Sevan law and also taking account of all IFC and stakeholder requirements. A potentially viable site, designated as Site 28, was located approximately 1.25 km south of Gndevaz (see Figure 5.2). To verify conformance with the same initial screening criteria and to ensure that Site 28 did not have any fatal flaws, it was subjected to a similar review per the five main criteria used in the SAA. The five criteria consisted of the following:

- Biodiversity and Environmental Factors;
- General Location;
- Infrastructure;
- Social and Cultural Factors; and
- Technical Factors.

5.4.2 Location alternatives for other facilities

The locations of the other mine facilities are dictated mainly by the positioning of the open pits, BRSF and HLF, with the aim of efficient mine operation. However, alternatives have been considered for some elements, as summarised below:

Haul road

The route of the main haul road connecting the three pits to the BRSF has undergone several design iterations. It was originally proposed to contour around the western slopes of Erato and North Erato, but was moved during the design iteration process in 2013-2014 to the eastern slopes, mainly to reduce visibility of the road (and trucks travelling on it) from the west (particularly Gndevaz). However, in 2015 the law governing maximum road gradients was revised (see Section 2.1.19) and this opened up the potential for a more direct haul route on the western side of the mountain. This is now the preferred option.

The present haul road is shorter than the eastern option, which allows significant savings in fuel costs over the life of the mine. It also requires less excavation in both rock and colluvium, has a lower likelihood of encountering PAG in the material excavated, will have less interference with seeps and springs that would be a problem on the east side of the mountain, has lower risks related to slope stability (less chance of slope failure or avalanche in high cut areas), and has improved visibility for haul truck drivers and therefore improved safety. The relocation of the haul road and the truck shop (see below) from the east to the west side of Amulsar Mountain also means that related drainage infrastructure is removed from the Vorotan valley (all mine drainage infrastructure is now located in the Arpa drainage). However, these locations do mean that visual impacts are increased from Gndevaz and parts of Jermuk (see Section 6.5).

Conveyor

The Value Engineering and Optimization exercise undertaken in 2015 resulted in changes to the route and design of the conveyor, which has resulted in the elimination of the transfer tower connecting two separate conveyor lengths. The conveyor will now be a single-length, curved structure. It runs east of the previous corridor, with less footprint on privately own lands.

Crusher

The original planned location for the crusher was on a relatively flat saddle between the Erato pit and BRSF. However, geotechnical investigations suggested that subsoil conditions are not favourable for foundations in this area, and the crusher site was therefore moved approximately 1km to the north-west to its current location. This has increased visual impacts (the facility will now be visible on the skyline from locations to the west and north, in particular from Jermuk; see Section 6.5) and the location coincides with an area in which *Fritillaria armena*, a regional endemic plant, has been discovered. However, if the Project footprint cannot avoid individual plants, the impact may be mitigated by transplanting them to a nearby location, as discussed in Section 6.11.

Truck shop

The truck shop was originally planned to be on the east side of the BRSF. However, this location near the top of the mountain would be exposed during the winter, making operation more challenging. The move of the haul road from the east to the west side of Amulsar (see above) presented an opportunity to move the truck shop to the west side also. Consideration was given to siting the facility lower down on the west side of the mountain, since this would be a much less exposed location. However, it was recognised that this area is important for the local community of Gndevaz, whose residents use it intensively for animal herding and hay cropping. Therefore, an alternative location was sought. The present site, to the north-west of the crusher, is less used by local communities but still affords better protection from weather than the original location. The facility and/or glow from lighting will be more visible from Jermuk (see Section 6.5).

Worker accommodation camp

The original planned location for the temporary construction camp was in the Vorotan valley, east of the BRSF. This location originated from the time when serious consideration was being given to locating the HLF at the nearby Site 13.

In 2015, several alternative locations were considered for the potential construction camp in addition to the Vorotan site. These included two locations at the HLF, Site 14 (see Figure 5.1), and the present location of the truck shop. The Site 14 location was rejected because of the importance of the area for local communities (see also above relating to the truck shop). The HLF area was deemed to be preferable because of the lower elevation and easier access to utilities. Of the two possible locations, the site east of the ADR plant further away from the H-42 road is the preferred option. The worker accommodation camp has also been considered with respect to the option of using available hotel and apartments within Jermuk (see Chapter 6.21).

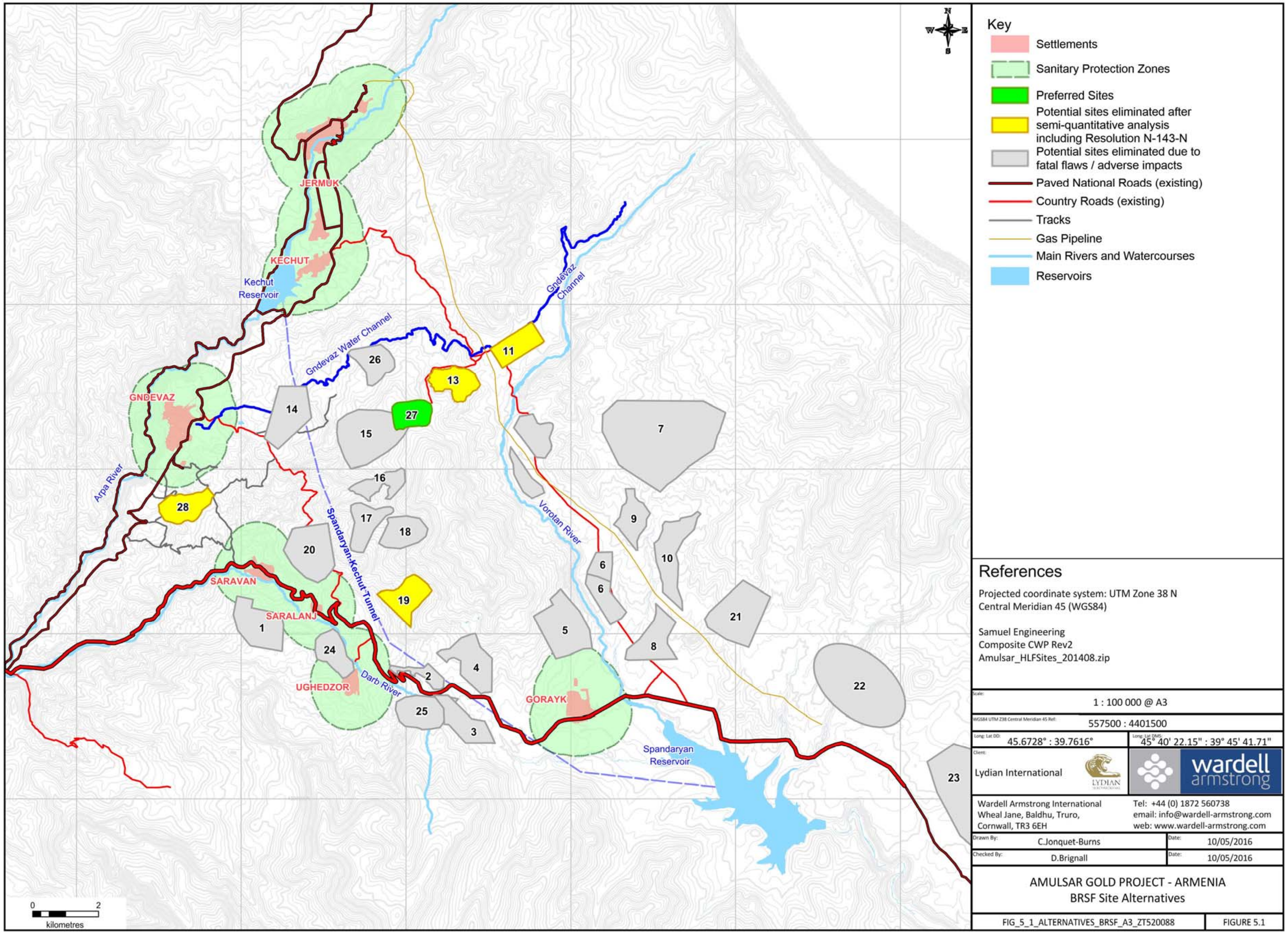

Figure 5.1: BRSF Site Alternatives

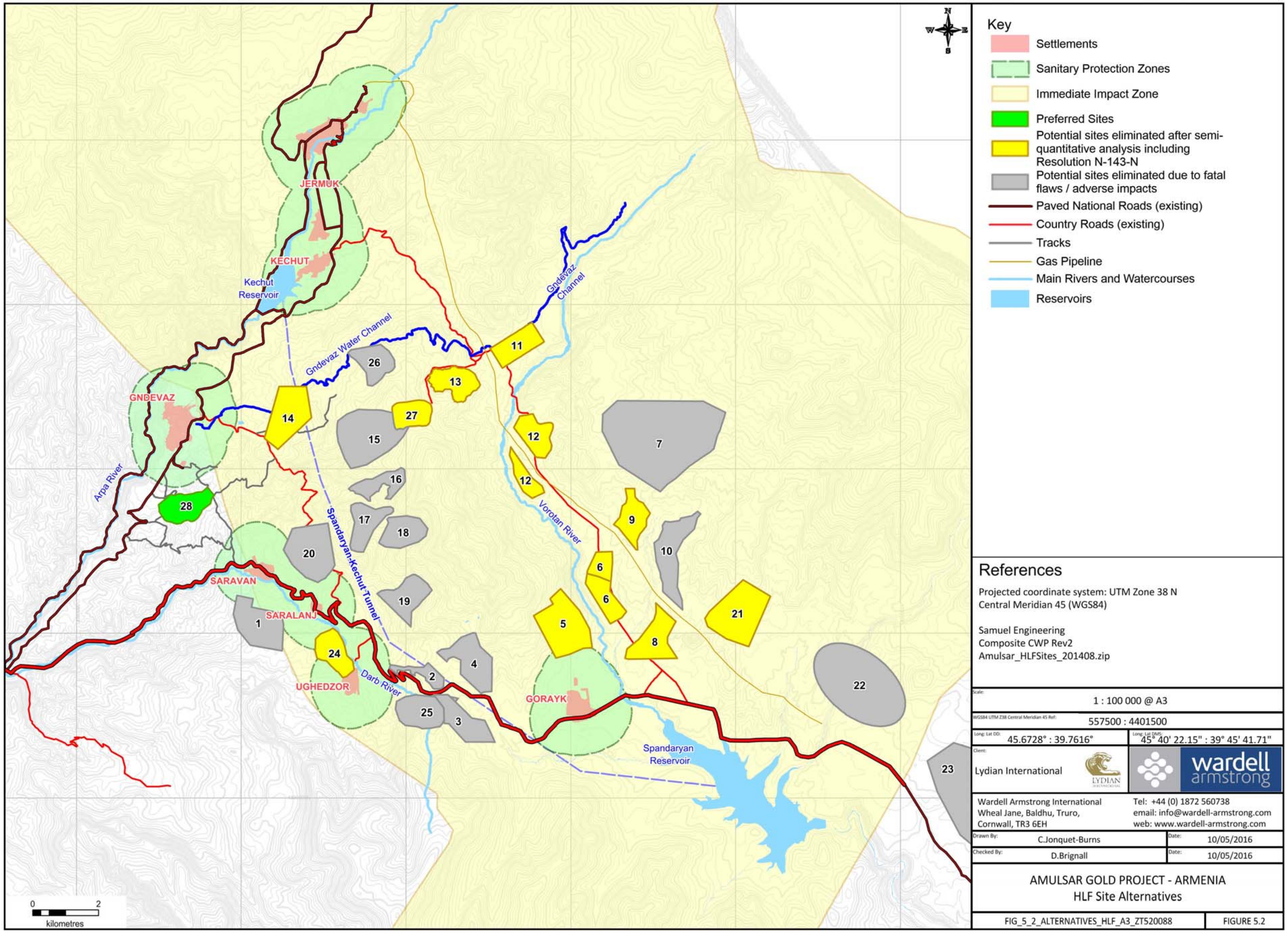

Figure 5.2: HLF Site Alternatives

5.5 Technical Alternatives

The technical, mining and mineral processing options available to the Project are summarised in a schematic flowchart that illustrates the design decision processes that were considered (Figure 5.3).

The detail of the decision-making that relates to Figure 5.3 is described in the following sub-sections.

5.5.1 Mine Design

Three options for mining a deposit are possible: in-situ leaching, open-pit mining, and underground mining. In-situ leaching was discounted without further analysis because the technique is not suitable for the recovery of precious metals such as gold and silver.

A comparison between open-pit and underground mining methods, with specific reference to the resource at Amulsar, is made in Table 5.2.

Table 5.2: Comparison of Open-Pit and Underground Mining Options for Amulsar

Mining operations	Open-Pit Mining	Underground Mining
Operational		
Pre-mining development cost	Lower initial capital cost. The development of the pit would not require full capital expenditure prior to extraction of ore. Therefore, certain capital costs can be deferred during the development period for the Project.	High capital cost. Pre-operational infrastructure costs to develop mine shafts are high. There is also a higher technical, and health and safety requirement that would have to be in place prior to extraction of ore. The pre-mining period can be prolonged depending on the nature of the development.
Operating costs	Lower operational costs. These can be maintained through efficient mine design, as identified in Table 5.1. Open pit extraction techniques would be a primary requirement for the economic extraction of low grade ores, such as that at Amulsar, and determine the use of heap leach for mineral extraction	Higher ongoing operational and infrastructure costs. High OPEX is suited to extraction of high grade ores, located at depth (i.e. not accessible using open pit techniques).

Table 5.2: Comparison of Open-Pit and Underground Mining Options for Amulsar		
Mining operations	**Open-Pit Mining**	**Underground Mining**
	from the ore (Table 5.5).	
Electrical consumption per tonne ore mined	Electrical consumption is associated with conveyors (main conveyor will have electrical regeneration, as it is downhill) and processing at the ADR plant.	Comparable estimates for underground mine depend on the nature of the deposit.
Barren rock generation	The volume of barren rock extracted would be higher due to removal of overburden and removal of non-ore-containing rock increasing with the depth of the deposit/pit.	The volume of barren rock would be generally lower as mine design would follow the ore body, thus producing less barren rock (rock without valuable mineral content).
Closure	The mine design would result in a certain land take for the open pit and BRSF landforms. The extent of open pits would be reduced through back-filling Tigranes /Artavazdes pit, and to some extent Erato, with barren rock from Erato.	Footprint of the mine workings would be much less than for an open pit, as it is based on a shaft and mine head for access to the deposit.
Workforce and conditions		
Health & Safety	All mining operations require attention to health and safety requirements of the work force.	
Environmental and Social		
Surface footprint	The surface footprints of the open pits extend to 170ha for the extraction of the combined ore bodies at Tigranes, Artavazdes and Erato. The surface footprint is located within the Discrete Management Unit identified for *Potentilla porphyrantha*, a critical habitat trigger species according to IFC PS6.	As identified previously, access to underground mined ore bodies would have a significantly lower footprint, limited to the shaft, mine head and associated infrastructure. It would also considerably reduce (or avoid completely) footprint on Tier 1 critical habitat for *Potentilla porphyrantha* and species-rich sub-alpine meadows.

Table 5.2: Comparison of Open-Pit and Underground Mining Options for Amulsar		
Mining operations	**Open-Pit Mining**	**Underground Mining**
Extent of landscape and visual impact	Mining of the open pits would result in the permanent alteration of the skyline from some viewpoints resulting from the loss of the three mountain peaks (Erato, Tigranes and Artavazdes). The construction of the BRSF and HLF would result in two new large landforms, which would require restoration following closure of the mine and coupled with the open pits would have a permanent effect upon the landscape character.	Mining workings are contained underground, however tall structures associated with the mine head (such as shaft headgear) can potentially be visually prominent. Underground mining would have limited impact upon the character of the landscape in the long term because of the reduced land take but would still result in a permanent barren rock storage facility of excavated materials that would create a new landform and require restoration following closure of the mine.
Noise, air quality and vibration	Emissions associated with the extraction of rock can be mitigated through adoption of good design and strict adherence to environmental management.	Emissions tend to be fixed and relate to underground blasting and noise and dust associated with surface activities (mobile plant, ventilation fans, etc.), which can be mitigated through adoption of good design and strict adherence to environmental management.
Water resources	Water resource management, including acid generation from barren rock would be significant management factor for the deposit at Amulsar, but this is amenable to good site design and environmental management.	Water resource management is a significant factor for underground mine projects and requires a similar level of detail in terms of mine design and environmental management to that applied at Amulsar for open pit extraction.
Seismic activity	Generally able to withstand earth tremors and quakes; production would not be affected in the majority of circumstances.	Underground mines are susceptible to disruption of production and risk to health and safety, where there is the potential for seismic activity during the operational life of the mine.
Remediation	Requires detailed closure and aftercare planning, with ongoing maintenance until the remediation is stabilised and a sustainable after use has been achieved.	
Employment	Capacity to employ larger number of workers due to above ground operations	Smaller labour force required.
Economic displacement through land take	Open-pit mining requires a larger area of land to be acquired by the Project. Depending on the use of the land taken, this can generate economic displacement for households, directly impacting	The land required for underground mining is less, reducing the potential for economic displacement impacts.

Table 5.2: Comparison of Open-Pit and Underground Mining Options for Amulsar		
Mining operations	**Open-Pit Mining**	**Underground Mining**
	their livelihoods or their use of ecosystem services.	

Open pit mining is most suited to near-surface ore bodies that have a generally low stripping ratio of surface overburden to the ore deposit. Amulsar is a deposit that has a low stripping ratio of 2.37. Mining a mineral deposit located near to surface via underground methods incurs greater capital and operational costs as compared to open pit extraction of the same deposit. To economically mine the Amulsar deposit, the cut-off grade is estimated to be approximately 2.5g/t, when mined using underground mining techniques.

This means that only the ore with a concentration of 2.5 g/t or higher would be mined in an underground system, leaving behind the lower grade gold ore. At this cut-off grade, the gold resource would be approximately 780,000 oz (in-situ) and the revenue generated would be insufficient to pay back the capital necessary for the development of the Project. The sparse spatial distribution of the ore above the 2.5g/t cut-off grade is also unsuitable for underground operations as excessive access development would be required. In summary, underground mining of the Amulsar deposit is not economically feasible.

Mining the deposits with open pit mining techniques allows for the extraction of ore to a significantly lower cut-off grade of 0.2 g/t. Thus a much greater quantity of metal can be economically extracted, which the updated 2015 TR has identified as a mineral reserve of approximately 2.4 million ounces of gold and 11.2 million ounces of silver.

In summary, the options analysis identified the development of open pit extraction of ore as the preferred mining technique. The Project design involves the development of three open pits to extract separate ore deposits at Tigranes, Artavazdes, and Erato. After a few years, the two open pits at Tigranes and Artavazdes will combine to form a single open pit as extraction proceeds to a maximum depth of 300m below ground level. The open pit at Erato will be developed at a later stage of the mine life (from year 4 onwards). During extraction of Erato, some of the voids left behind from the Tigranes / Artavazdes open pits will be backfilled with barren rock from the Erato open pit.

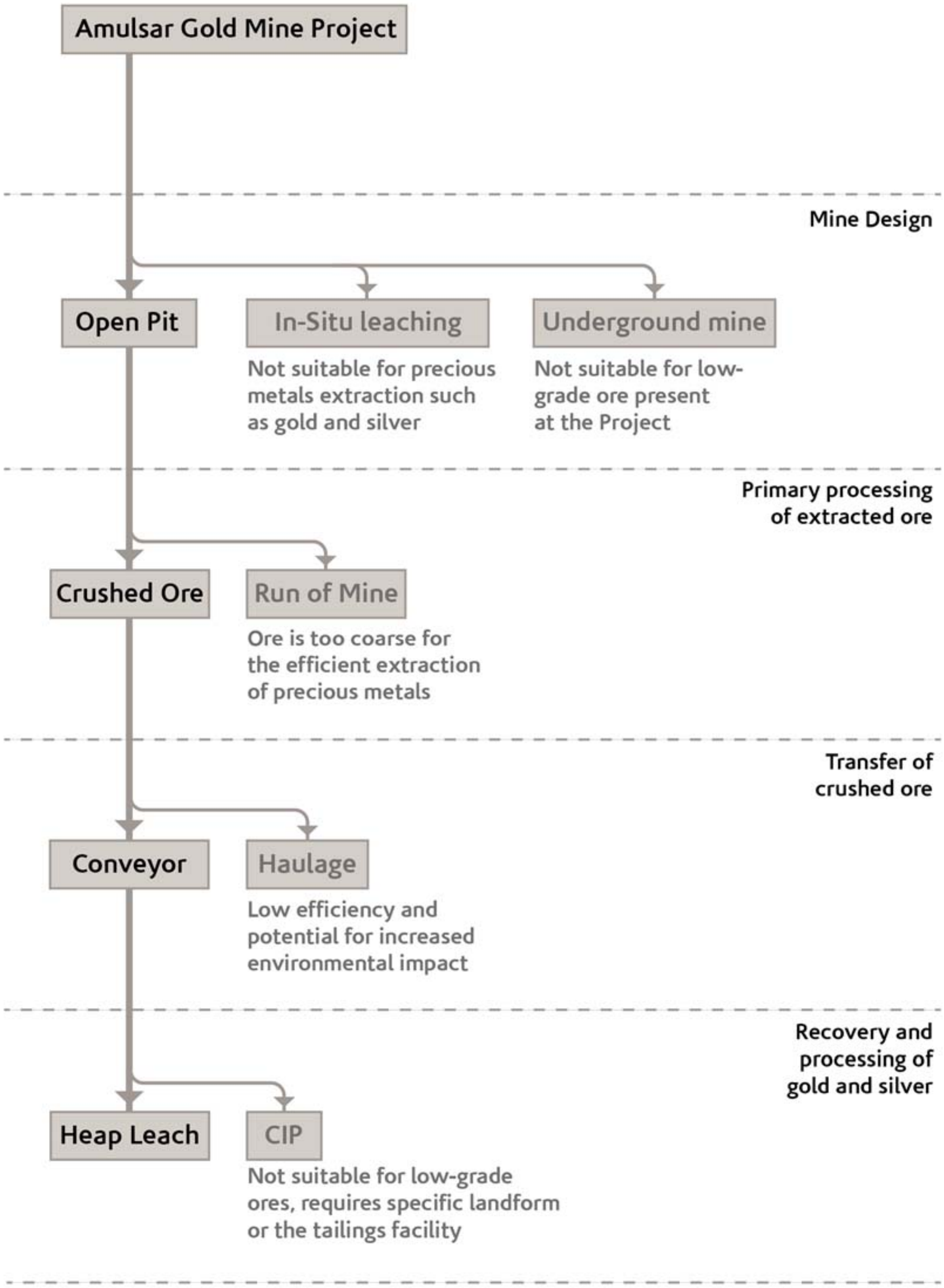

Figure 5.3: Alternatives Assessment Decision Flowchart

5.5.2 Primary Processing of Extracted Ore

Generally, ore bodies are extracted by a combination of blasting and breakage to a size suitable for loading into dump trucks followed by haulage to the processing facility. Further processing, such as crushing and agglomeration, allows the ore to be treated more efficiently. In certain deposits sufficient fragmentation of the rock occurs during blasting to select material for run of mine (ROM) treatment processes, such as dump or ROM ore leaching. Generally, ores tend to require further size reduction prior to processing and recovery of precious metals, using such process routes as heap leaching and carbon in pulp (CIP).

The main alternative for the majority of hard rock ore bodies is to crush material to a fine crush size (100% passing - 19mm in the Amulsar case), to increase the efficiency of processing and therefore the metal leach recovery. Some ores with significant quantities of clay require agglomeration prior to heap leaching, although this incurs additional costs and environmental risk. Agglomeration is not deemed to be required for the Amulsar mine, since suitable percolation rates are achieved without using cement for agglomeration. The remaining alternatives have been compared in Table 5.3.

Table 5.3: Comparison of crushed ore against run of mine

Primary processing options	Crushed ore	Run of Mine
Operational		
Pre-mining development cost	Run of mine material would be crushed to a crush size of 100% -19mm. The crushing plant requires construction prior to mining operations.	Requires no size reduction, although this limits further processing and recovery techniques.
Operating costs	Operating costs relate to the strength of the rock combined with the maintenance of the plant.	Low operating costs associated with haulage of ore from mine.
Electrical consumption	Connected electrical load for crushing plant, primary and secondary crushing is 2MW, with an annual load of 13632MW.	No additional energy requirements other than that required for blasting and extraction.
Workforce and conditions		
Health & Safety	The crushing plant building would be a controlled area for H&S and specific training would be required for operatives.	No specific health and safety requirements.
Environmental and Social		
Surface footprint	Ore is processed through two stages of crushing. The crusher unit operations include a primary gyratory crusher and a closed circuit secondary cone crushing and screening system. The disturbed area for the crushing plant is 14.7 ha.	The ROM stockpile would be similar to that of a barren rock storage facility, with the size dependent on the volume of material stored.

Table 5.3: Comparison of crushed ore against run of mine		
Primary processing options	**Crushed ore**	**Run of Mine**
Extent of landscape and visual impact	Potential visual impacts would be defined by the footprint and design of the componentry. At Amulsar, the location of the crushing plant could appear in the skyline from Jermuk. Detailed design will consider further screening to mitigate the impact of the componentry.	Generally the ROM stocks would not be a significant size, comprising only stocks prior to processing.
Noise and air quality	Noise and air emissions would be contained.	No additional emissions.
Remediation	The building housing the crushing plant would be removed on closure together with all machinery. The area would be prepared for soil and seeded as part of the restoration scheme.	ROM stocks would be located adjacent to open pits or at the transfer point to conveyor or haulage. The area would be prepared for soil and seeded as part of the restoration scheme.
Employment	Generally comparable in terms of the number of persons required and skills of the operatives.	

A crushing plant optimisation study was carried out by SNC Lavalin at the end of 2012. The objective of the study was to look at the overall crushing plant layout, and the crushing equipment configuration for the design throughput rate of 10Mtpa at the target crush size of 100% -12.5mm. Another optimization completed in 2015 concluded that ore would be processed through two stages of crushing to a target crush size of 80 percent passing 18 mm (P100 = 19 mm). The crusher unit operations include a primary jaw crusher, and secondary cone crushing in closed circuit with triple deck multi slope screens. The crushed ore storage bin, secondary crushing feed bin, and crushed ore stockpile provide crushing surge capacity for the facility.

Although ROM ore is the preferred environmental option and requires less capital, the metallurgy of the ore at Amulsar makes ROM ore processing inefficient and not economically feasible. At the large lump size of the ROM ore there is insufficient liberation of the gold and silver to ensure high leach recoveries and fast leach kinetics are obtained.

Although, the crushing operation is more energy intensive, the crushed ore can be conveyed for processing, where the crushed material allows high gold recoveries to be obtained during subsequent processing, using heap leach technology.

5.5.3 Transfer of Crushed Ore for Extraction of Gold and Silver

When the transportation of a mineral is over a fixed route longer than 2km, with relatively static loading and deposition points, conveyors are more effective and have less environmental impact than haulage by truck; they can also take more direct routes across difficult terrain. Table 5.4 provides a comparison of the two alternatives.

Table 5.4: Comparison of Conveyor against Road Haulage for Crushed Ore		
	Conveyor	**Haulage**
Operational		
Pre-mining development cost	Conveyor system requires complete construction prior to commencement of operations and is inflexible once constructed.	Haul routes are generally flexible and cost effective to design and can be flexible in terms of routing within the mine.
Operating costs	Operational costs are associated with power consumption that depends on the length of the conveyor, combined with ongoing maintenance to belts and drives. For large distance and / or difficult terrain such as at Amulsar, conveyors represent a cost effective solution.	Operation costs would relate to the haulage distance and diesel consumption and maintenance for trucks.
Energy consumption	The overland conveyor from the crushing plant to the HLF is loaded downhill and will therefore generate electricity, with a potential generation capacity of up 4.85 MW, equivalent to 6134.4MWh per year and equivalent to a saving of 40,000 tCO_2e^2 over the life of the mine for this operation. The electricity generated can be used elsewhere within the mine.	Fuel usage for dump trucks to haul ore to HLF, based on use of 130 t capacity dump trucks, equivalent to 125,732 tCO_2e^2 over the life of the mine for this operation.
Closure	At closure the conveyor infrastructure would need to be removed. There would be limited impact on the surface, save for an access track that can be maintained or removed.	Haul roads can be reclaimed and covered with soil, prior to re-seeding; there may also be opportunity to retain as access tracks in the final design.
Workforce and Conditions		
Health & Safety	Low level of human involvement, therefore minimised risk to workers from a safety perspective.	Risk of accidents is greater due to greater human involvement in transportation.

Table 5.4: Comparison of Conveyor against Road Haulage for Crushed Ore		
	Conveyor	**Haulage**
Environmental and Social		
Surface footprint	The conveyor would be fixed, and although it would generally be narrower than the width of a haul road it will have its own parallel service road. The conveyor belts would be fully enclosed, such that emission of dust are completely mitigated. The alignment of the conveyor has a single interchange point (see Figure 3.1) and a load out area, where ore will be transferred to haul truck for transport to the HLF. The conveyor will be constructed along the ground surface and will be fenced to restrict the movement of people and animals adjacent to the conveyor. The fence and conveyor structure will restrict the passage of people (including herders and grazing animals), larger mammals and vehicular access to passing points that will be designed into the conveyor. These passing places, four in total are shown on Figure 3.24. The design of the conveyor has been considered in Section 3.7.	The land take required for haul roads has the potential for disruption to the land and natural drainage pattern in the vicinity of the road. A larger area would be required for fleet parking and maintenance.
Extent of landscape and visual impact	The overland conveyor will have a relatively low profile. During detailed design the visual impact of the conveyor can be reduced by taking account of landform features, topographical variances and the appearance of the componentry alongside the surrounding landscape. The visual effect would be reversible once the componentry is removed at closure and restoration is undertaken.	Haul routes can be visually intrusive when crossing steep and complex topography where extensive engineering works may be needed (i.e. cut and fill of upward and downward slopes, construction of retention structures etc.) and as a consequence of moving vehicles, particularly on exposed sections of routes crossing high ground. The impact can be increased during hours of darkness as headlights and additional lighting would be required. The visual effect would be reversible following closure and restoration of disturbed areas.

Table 5.4: Comparison of Conveyor against Road Haulage for Crushed Ore		
	Conveyor	**Haulage**
Noise, air quality and vibration	Generally low emissions from noise and fugitive dust from conveyors, following installation.	Dust and noise emission by vehicle traffic on the haul road (which can be controlled by proper management). Vehicle exhaust emissions from use of diesel fuel.
Water resources	No emissions predicted	Transportation and storage of diesel fuels and potential release of hazardous substances (hydrocarbons).
Seismic activity	The conveyor is a fixed item that can be designed to withstand earth tremors; significant vibration and associated rock fall are likely to affect capacity while repair and maintenance is undertaken. However, stoppage would be factored into the design of the conveyor through storage capacity at the heap leach.	Flexible option, as surface to haul routes can be relatively easily maintained.
Remediation	Once the conveyor is dismantled the line of the route would be soiled and seeded. The access tracks to the conveyor are relatively small and would be retained for access or soiled and seeded.	Haul routes are relatively simple to restore, as the soil would be stored adjacent to the route. On closure the routes would be re-soiled and seeded.
Employment	Use of a conveyor is likely to require fewer employees as it is a largely automated process.	Haulage will have a greater workforce requirement, as each vehicle will require an operator.

The transportation of the crushed ore from the crushing plant to the HLF by fixed conveyor is a better long-term option. Conveying is more cost-effective over a longer period and has significant environmental benefits over the life of the mine.

5.5.4 Recovery and Processing of Gold and Silver

Cyanidation of disseminated gold ores is achieved by either heap leaching, agitated tank leaching, or flotation, to produce a gold bearing concentrate for further downstream processing. Agitated tank leaching also requires carbon adsorption, and this is carried out after the leaching step using the carbon-in-pulp (CIP) method, or during the leaching step with the carbon-in-leach (CIL) method. Heap leaching is generally suited to processing lower-grade gold ores. The main alternative process option for processing low grade ores by agitated tank leaching is CIP.

Heap leaching requires ore to be crushed to crush sizes in the range -50mm down to -6mm. Test work has shown that the optimum crush size for the Amulsar deposits to maximize leach recovery is that of 100% passing 19mm. Alternatively CIP/CIL requires ore to be prepared with both crushing and wet grinding stages producing particles typically 80% passing 75 microns (0.075mm) in size, thus requiring additional energy usage. The grinding stage would be undertaken in an enclosed, wet environment and therefore does not generate additional dust. It also produces a pulp, which requires disposal in a Tailings Management Facility (TMF).

With CIP/CIL, leaching takes place in agitated tanks, while leaching on a heap takes place in-situ as the cyanide solution percolates down through the ore (see Chapter 3.10 for a description of the heap leach process).

Table 5.5 compares the technology options from a technical, and social and environmental standpoint.

Table 5.5: Comparison of Gold Recovery Methods		
	Heap leach processing and recovery (HLF)	**Carbon-in-pulp processing and recovery (CIP)**
Operational		
Capital cost	Generally simple to design and construct, however there would be costs associated with engineering a suitable design. Heap leach pad would be constructed in phases and the gold recovery plant would be constructed once the heap leach has commenced.	A milling circuit is required in order to grind the ore to the required size fraction for tank leaching, thus incurring additional capital cost. The processing plant requires construction to intended capacity at the outset, resulting in increased capital costs prior to commencement of processing.
Operating costs	Generally low power consumption associated with heap leach, therefore operating costs are lower.	Grinding down to -75µm requires significant energy and therefore results in high installed power costs. A combination of processing plant and set up, plus the long term maintenance of the TMF, are generally associated with higher costs.

Table 5.5: Comparison of Gold Recovery Methods		
	Heap leach processing and recovery (HLF)	**Carbon-in-pulp processing and recovery (CIP)**
Energy consumption	Crushing the ore to 75 – 50mm requires 4-19kWh/t. The Erato ore is slightly harder than that of the Tigranes / Artavazdes deposits.	The energy consumption required to grind the ore down to -75µm is much higher than that required to crush the material to 100% - 12.5mm. Grinding to this fine product size requires 15-16kWh/t.
Waste	The spent ore is maintained in situ on the heap leach pad, developing a final permanent landform that is dependent on size of the facility. At Amulsar, the design is for a maximum size of 105Mt.	Spent ore is settled from solution in a TMF, contained by a clay or membrane lined dam.
Closure	The HLF closure cover will consist of an evapotranspirative (ET) cover which is designed to promote revegetation, limit infiltration of meteoric water and snowmelt into the spent ore, manage stormwater, and limit long-term erosion of the cover. During the post-closure period, the HLF seepage will be treated with a passive treatment system until it meets Arpa Category II surface water discharge standards. Long term drainage and monitoring requirements would remain in place. The processing plant (ADR) would be removed.	The TMF is designed to have enough capacity for the mine life, after which the surface can be capped and revegetated. Long term drainage and monitoring requirements would remain in place. The processing plant (ADR) would be removed.
Workforce and conditions		
Health & Safety	Comparable processing operations require strict adherence to the cyanide management code.	
Environmental and Social		
Surface footprint	The heap leach facility includes both the heap itself and the processing plant. The land area required for this can be larger than that required for the CIP option, however this would depend on factors such as the design and depth of the TMF.	While the CIP would require the development of a TMF, this would still be smaller than the land required for the heap leach facility.

Table 5.5: Comparison of Gold Recovery Methods		
	Heap leach processing and recovery (HLF)	**Carbon-in-pulp processing and recovery (CIP)**
Extent of landscape and visual impact	The HLF has the potential to be visible due to the extent and vertical height of the structure. However, through detailed site selection, it is possible to locate the HLF within an area that provides visual enclosure as far as possible. To an extent this has been achieved through the design of the Amulsar Project HLF site.	TMF can also be designed to have a limited visual impact, and potential visual effects typically relate to the height of the dam wall and the footprint of the dam.
Noise, air quality and vibration	Heap leach requires the drip addition of cyanide solution onto the ore; there is the potential of atmospheric exposure due to the processing methodology. However, this can be avoided using appropriate techniques (drip addition of solution) and adherence to the cyanide management code.	Treatment processes are enclosed and noise emissions more easily managed. However, certain operations such as the agitation tanks, and the feed to a TMF require specific noise mitigation and control as these are in the open.
Water resources – ARD potential and other potential pollution (CN and heavy metals)	The Amulsar orebody has the potential to be acid generating, It also has the potential to produce leachate with sulphate concentrations in excess of surface water standards. After detoxification, cyanide concentrations will meet discharge standards. The seepage will be treated by a passive treatment system prior to discharge.	The Amulsar orebody has the potential to be acid generating. This potential can be controlled through appropriate treatment of tailings prior to discharge to a TMF. A higher concentration of cyanide is used in the CIP process. This system would be marginally more damaging because of the combination of CIP with a need for tailings, which represents a long term legacy of potential pollution problems.
Seismic activity	HLF requires engineering design according to the risk of seismic activity in the area.	TMF would require design according to the risk of seismic activity at that location.
Closure and Remediation	After rinsing, decommissioning of the piping system, and capping the HLF, contouring and landscaping would be required to harmonize the shape to a more natural landscape feature with outer slopes at a gradient on which vegetation can be managed. Monitoring points would require access for sampling to validate the stability and emissions during aftercare management.	At closure, the TMF would be a large flat area of land that would be designed for the management of vegetation during the aftercare period. A wide range of revegetation options are available depending on the design of capping and soil layers. Monitoring points would require continued access to validate stability and emission, particularly downstream of the TMF dam.

Table 5.5: Comparison of Gold Recovery Methods		
	Heap leach processing and recovery (HLF)	**Carbon-in-pulp processing and recovery (CIP)**
Employment	Generally comparable in terms of the number of persons required and skills of the operatives.	

The column test work conducted on representative samples from each of the deposits at Amulsar established high recoveries, low reagent consumptions, and fast leach kinetics. The additional recovery achievable by design of CIP technology would not be economic when compared to the recovery obtained by heap leach technology, for the same input breakage energy. The additional capital cost required for constructing a CIP plant and the higher operational costs associated with milling to 80% -75µm, required for the CIP process, would both have a negative effect on the Project finances; particularly given the low grade. In environmental and social terms both processes can be managed to minimise potential impacts, subject to appropriate management plans.

Heap leach processing has therefore been selected for the Amulsar Project based primarily on the metallurgical response and high gold leach recovery. Heap leach technology is also the more economically viable choice, with lower capital and operating costs, and has a shorter construction period to be in production from the date of Project initiation.

5.6 Alternatives Selected to Minimise Landscape and Visual Impacts

5.6.1 HLF

Section 5.4.1 considers the alternative and site selection process that was adopted to screen the preferred location for the HLF. Landscape and visual impact was a component of the five criteria that were considered to assess the alternatives and this was weighted with other technical, environmental and social aspects.

5.6.2 Location of other Project Componentry

The location of other Project componentry (i.e. crushing plant, ADR plant, mine infrastructure and buildings, and overland conveyor) was originally considered to minimise potential landscape and visual impacts as far as is feasibly possible within the operational constraints of the Project. Project componentry was designed to avoid prominent skylines, ridges or locations with high visibility.

As a result of the Value Engineering and Optimisation there are changes in the degree of visual impact of the mine infrastructure, including:

- The building that houses the crushing and screening equipment and processes is now visible on the skyline when viewed from Jermuk ski lift and from various locations within Jermuk;
- The truckshop has moved from the east side of the mountain to a lower elevation on the north-west side. It will no longer be visible from the Vorotan valley, but skyline view and light-glow from the facility will be visible from Jermuk at night; and
- The ADR plant will now be located further from the H-42 road and will be less visible.

5.6.3 Design of the Open Pits

Utilisation of barren material from the Erato open pit to backfill and regrade some of the construction voids of the Tigranes and Artavazdes open pit will reduce the required capacity, and thus associated impacts of the BRSF.

5.7 Assessment of Alternatives to Minimise Impacts on Biodiversity and Ecosystems

IFC PS6 and EBRD PR6 require application of the mitigation hierarchy to avoid impacts on important biodiversity identified during the ESIA process. An iterative approach was taken throughout the process of Project development to identify biodiversity and ecosystems affected by the Project and to assess their likely exposure and sensitivity to Project impacts. Implications of the Project for biodiversity and ecosystems identified as important and for which No Net Loss (NNL) or net gain was required were considered in detail as described in Chapter 6. The need for avoidance was determined for any case where adverse impacts were identified on:

- Protected areas;
- Natural habitat;
- Critical habitat according to IFC PS6 criteria;
- RA Red Book species, particularly those listed as Vulnerable or above;
- Threatened ecosystems which are difficult to restore; and
- Local biodiversity hotspots or concentrations of biodiversity.

Avoidance was particularly prioritised in cases where the ability of the receptor concerned to recover (either independently or with mitigation) could be called into question such that a long term decline in population or viability might occur. The need for avoidance was strengthened in cases where there was a lack of evidence concerning effectiveness of mitigation or the ability to implement mitigation even if it is considered to be theoretically feasible.

As discussed in Chapter 6, the need for avoidance was identified for:

- Footprint within Gorayk IBA;
- Extensive areas of natural habitat;
- Tier 1 critical habitat for *Potentilla porphyrantha;* and
- Locations of known RA Red Book or endemic species with limited distributions within the Project-affected area.

In 2012, the original proposed location of the HLF was partially located within Gorayk IBA. The IBA protects Armenia's only breeding colony of Lesser Kestrel and has a high public profile, making it important in a national context. It was designated using established criteria for selection and identification of "Key Biodiversity Areas". For these reasons it was considered important to avoid footprint on the IBA if possible. In undertaking the assessment of potential alternative sites for mine infrastructure, Gorayk IBA was treated as "critical habitat" on a precautionary basis, even though it does not strictly meet IFC PS6 criteria for such habitat on the basis of the status of its qualifying species or the numbers of migratory birds which use it regularly. However, because it was possible to identify technically feasible alternatives to the location within the IBA, the HLF was relocated to avoid direct impacts on the site.

Avoidance of impacts on natural habitat was also factored into the site selection process for the HLF. Unlike the original location within Gorayk IBA, the current location (Site 28) is largely on modified habitat and avoids areas identified as important for biodiversity and ecosystems during baseline surveys and assessments. The proposed location minimises footprint on natural habitat to the extent possible, given the range of options available. There is, however, an unavoidable residual impact on natural habitat as a result of the Project. Measures proposed to minimise and offset this impact are described in Chapter 6.

As documented in the Natural and Critical Habitat Assessment (Appendix 4.10.3) and in Chapters 4.10 and 6.11, part of the Project footprint (and particularly the mine pits) is within an area of Tier 1 critical habitat for *Potentilla porphyrantha,* according to the criteria in IFC PS6. The discrete management unit (DMU) identified for the affected population cannot be avoided entirely due to its coincidence with the location of the ore body. However, a set-aside area has been designated on Arshak Peak to ensure that a viable existing and known proportion of the population can be safeguarded. Furthermore, a detailed plant census has been carried out and the results used to ensure that haul roads and other access routes required within this area avoid *Potentilla porphyrantha,* as well as sensitive sub-alpine meadows, to the extent possible. In particular, the route of the main haul road on the west side of Amulsar has been designed to avoid a concentration of habitat on the south-western side of Erato.

The route and design of the conveyor that transfers the ore from the crushing and screening plant to the load out area of the HLF has been through several design iterations, in order to:

- Avoid the end of a rocky gorge which is favoured breeding habitat for several bird species including the Red-Listed White-Throated Robin. Avoidance of this area was identified as a preferred design-phase mitigation during the assessment (considered in v9f ESIA) and is therefore a significant benefit from the biodiversity perspective, although further mitigation in terms of screening measures is deemed appropriate (see Section 6.11).
- Take account of the vertical change in level between the crushing and screening plant (~3600m AOD) and load out area (~1600m AOD).
- To reduce the number of transfer points on the conveyor, the final design has a no transfer points and it can therefore be designed as fully covered and closed system.
- Provide long term access for maintenance during the operational phase, thus limiting the potential risk associated with closing the conveyor for maintenance and/or break down and the need for back up haul road transport in order to maintain production.

As a consequence of achieving these design requirements, the conveyor would be constructed at ground level (see Table 5.4), thus reducing the engineering complexity together with a potential reduction in capital and operational cost associated with operating the elevated conveyor that was considered in v9f of the ESIA. The design of an elevated conveyor had the advantage of not restricting movement of people, cattle and mammals, as they would be able to pass underneath, with few restrictions. However, the engineering requirements for a high level conveyor would result in land disturbance during construction and potentially ongoing and increased zone of disturbance during operation, because a second haul route option would also be required in order to maintain production during maintenance and/or breakdown of the high level conveyor.

The design option identified in v10.1 of the ESIA (see Figures 3.1 and 3.36) includes the provision of four crossing points on the length of the conveyor route. The design of the crossing points will take into account the requirements for light vehicles, agricultural plant, access for seasonal herders with animals and passage of mammals across the route of the conveyor. The indicative location of crossing points are shown on Figure 3.24 and the design of each of the crossing points will take account of the local topography to maintain ease of passage for each of the likely identified groups. Specific crossing points for mammals will also be designed.

The location of the accommodation camp has also been re-evaluated. The original location, as identified in the v9f ESIA, was within the Vorotan Valley and had the potential to adversely affect a known feeding area of Lesser Kestrel, a Red-List species. The location of the accommodation camp, will be adjacent to the ADR (see Section 5.10). This location is at a lower elevation and within modified habitat, and is considered to be more desirable from a biodiversity perspective.

5.8 Socio-Economic Alternatives

IFC PS5 and EBRD PR5 require that the Project avoids and, when avoidance is not possible, minimises displacement by exploring alternative project designs. This applies to both physical and economic displacement. The Project has been designed to avoid physical displacement to the maximum extent possible. Avoidance and minimisation of economic displacement were specifically factored into the site selection process for the HLF and the BRSF, with maps of private land holdings used to inform the decision process. This process was also applied to the route chosen for the conveyor and maintenance roads, with alignment to follow existing tracks where possible. Despite these considerations, due to technical constraints, including legal requirements, the final HLF site selected has resulted in the need for physical relocation of one resident, and economic displacement of several landowners. The land acquisition process started in February 2015 with completion expected in June 2016. Details are provided in the land acquisition plan (LALRP) completed in February 2015 with an addendum produced in January 2016 (see Appendix 8.23). A comprehensive Livelihood Restoration Plan (LRP) was completed in December 2015, currently being implemented. Avoidance of these impacts was not possible due to the absence of alternatives for the HLF location.

IFC PS8 and EBRD PR8 require that the Project protect cultural heritage from adverse impacts of project activities and supports its preservation. Identified sites of known or potential cultural heritage were used to inform site selection choices for all major facilities. While it was not possible to avoid all known or potential sites, all sites of cultural heritage significance were avoided through facility design or siting considerations.

5.9 Employee Accommodation

Ideally, all workers would be accommodated with their families in their town of origin. However, given the number of workers required for the Project, influx of skilled and unskilled labour will be required. A number of options exist to address the accommodation requirements for the Project, including:

- construction of new houses;
- construction of a long-term camp (used both for construction and operation);
- Construction of a temporary construction camp; and
- renovation of existing accommodation options in nearby centres.

Given the location of the Project, and the trend of rural migration within Armenia, the option of constructing new houses was rejected as it is considered likely that they would fall into disuse post-mine closure. The Project has, therefore, been designed using a hybrid approach, with the use, if required, of a temporary camp to support periods of the peak work force and the use of available hotel accommodation and locally available private rented apartments during the construction phase. Neither of these options are permanent accommodation solutions for workers, and all workers accommodated in this manner will be working on rotation to ensure they have contact with families and their point of origin. From a Lydian standpoint, it is better to accommodate all construction workers in available hotels in Jermuk. During the operational phase a smaller number (approximately 250) of non-local workers will be accommodated in Jermuk, with additional workers looking at renting flats or houses for a longer period (single status or with family) .

The effective management of working conditions is a core element of Lydian's operational philosophy. The accommodation options which have been chosen by the ESIA team for the Project have selected for a number of reasons, including: the local setting and its ability to absorb new accommodation structures; management of influx and social issues (note the option selected will still generate some level of influx); health and safety considerations for workers; maintaining a degree of flexibility such that existing hotel space can be used, where it would otherwise remain empty for large period of the year, and cost considerations.

The preferred options selected minimises potential impacts associated with working conditions as they afford the Company significant control over decisions taken with regard to workers accommodation during the construction phase. These options are based on a peak, estimated construction workforce comprising 1,300 persons, with up to 920 of these being non-local and therefore requiring accommodation. As there is the provision in the impact assessment for a temporary camp to be constructed as required during the construction phase, it is believed that the capacity of this camp would be between 500 to 920 persons to provide additional accommodation during peak work force requirements. A maximum of 370 workers will be using existing hotels locally to take account of the periods of peak tourism visitors to Jermuk.

The Technical Report considered the option of housing all construction workers in existing, commercially available accommodation (i.e. hotel rooms and apartments) within the local communities, principally Jermuk.

The requirement and design of the camp has been subject to a separate study to assess alternative options for construction workforce accommodation by a team of independent specialists to be appointed by Lydian. The study includes:

- An analysis of number of bed spaces in local available hotels together with the private rented sector, principally in Jermuk;
- Socio-economic analysis of the options developed in the first part of the study; and
- Structural, seismic and technical evaluation of worker accommodation requirements.

The recommendations of this study have been in report is a separate chapter 6.21, which also informs the Worker Accommodation Management Plan (Appendix 8.25).

5.10 Water Management Alternatives

During the design phase of the Project and the development of the baseline studies, a number of alternatives have been assessed in order to properly manage surface water, groundwater, water supply and community water usage.

Throughout mine life, the water management strategy has been designed to separate non-contact water from contact water. Non-contact water is defined as water that runs off from undisturbed ground within the mine footprint and water that runs off disturbed ground that does not have the potential to produce water quality impacts apart from total suspended solids (TSS). Therefore, non-contact water includes runoff from haul roads, service roads, the overland conveyor and utility corridor and crusher areas. Non-contact water will be allowed to flow to the existing natural drainages with sediment ponds or traps installed upstream of the outlets where necessary. All sediment ponds are designed to contain the 100-year 24-hour storm and to have sufficient retention time to settle out solids and meet TSS discharge standards. Sediment ponds have been designed in the Arpa catchment area.

There are potential changes predicted in the catchment area of the Gndevaz reservoir, or the degree of snow melt or runoff available to supply it as a result of the Project. The Project will aim to restore the connection between the irrigation channel and the Gndevaz reservoir in order to maintain a constant flow into the impoundment without decreasing water availability because of mine operations. One alternative is proposed for this source of supply, using "non contact" water flowing from mine infrastructure in the upper slopes. It requires Lydian to commit to a continuous monitor whilst discharging into the impoundment. The reservoir mainly used for downstream irrigation will remain for its original purpose during the construction and operation of the mine, and beyond. The majority of the existing surface water inflows will be maintained by the diversion of surface water around and/or below all infrastructure required for construction and operation and the creation of settling ponds. The Project will provide alternative water troughs for supply to herders as appropriate and following discussion with the appropriate communities.

Mine contact water is water that has the potential for contamination. Contamination risks include Acid Rock Drainage (ARD), increased salt concentrations (such as sulphate) and oil and grease (from the truck shop). All mine contact water will be collected and used by the Project under a minimum-discharge operational plan. The ultimate destination for contact water is the Site 28 detention ponds near the HLF. The use of contact water as the preferred source of makeup water not only consumes the water entirely, but it also reduces potential environmental impacts on the lower Arpa River by significantly reducing the water consumption requirements of the Project. The excess contact water expected in Year 5 will drain to the passive treatment (wetland) system prior to discharge to the Arpa River (see Appendix 3.1).

The contact water storage and containment system uses a series of lined ponds to capture and convey mine contact water. The storage system has been designed to accommodate extreme weather events including the 100-year, 24 hour storm event. This will prevent accidental discharge of mine contact water to the environment.

All contact water generated during operation as well as at the closure and post closure phases will be treated to ensure compliance with Armenian MAC's and World Bank Group/IFC EHS guidelines prior to discharge to the environment. Chapter 3 provides a description of the water treatment facilities and Chapter 6.10 includes an analysis of potential impacts of surface water resources including proposed mitigation measures that have been designed for the Project.

During a dry year, the mine may require additional water.

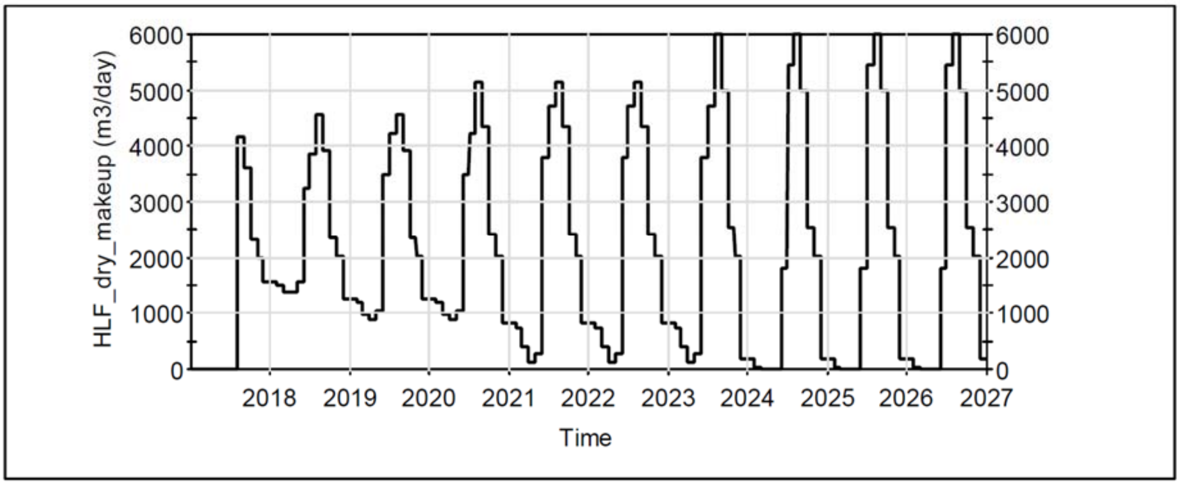

Figure 5.4: Process Make Up Water demand during a Typical Dry Year

Process make-up water demands that must be supplemented from an external source are determined by evaluating the dry year simulation in any given year. These process make-up water demands are shown in Table 5.6. The maximum process makeup water demand is 546,000 m3/year assuming dry year conditions and modelling the deterministic climate inputs.

Table 5.6: Annual Process make up Water Demand from External Water Sources (results x 1,000m^3

Climate Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Average	206	272	133	99	24	0	0	0	0	0	0
Typical Wet	60	104	104	8	0	0	0	0	0	0	0
Typical Dry	370	546	483	448	349	290	366	270	232	251	0

The Project will also consume water from the open pits and the BRSF preferentially to reduce the demand for freshwater makeup. Due to restrictions imposed by Armenian regulators on the use of water within the Sevan catchment basin, no other alternatives have been considered.

The main drivers in designing the water supply for the mine are as follows:

- Minimize the abstraction of makeup water from the Arpa River;
- Avoid any abstraction from the Vorotan River;
- Reduce the requirements for sedimentation and release of mine non-contact water on the Amulsar Mountain; and

- Fully consume mine contact water to ensure compliance with environmental regulations and to delay the need for a passive treatment system until year 5.

The current design of the water management system is intended to achieve the following primary objectives:

- To route runoff to ponds and collection sumps in order to minimize release of mobilized sediment;
- To prevent natural ground runoff and non-contact water from entering disturbed areas and mixing with contact water;
- To capture contact water runoff from mine facilities for consumption; and
- To minimize erosion of disturbed areas; and, when erosion does occur, to minimize suspended sediment in stream flows.

5.11 Closure Alternatives

There are a range of alternatives available for closure of the mine and the preferred options have been integrated in the design (see Chapter 3).

5.11.1 Pit Management

The preferred option for mine design would develop three open pits, with those of Tigranes and Artavazdes coalescing at surface to form a single pit. Erato would be worked last, with extraction commencing at year 4 of the Project.

The western portions of the Tigranes/Artavazdes pits will be backfilled with Erato barren rock to a level over the pit rim. Upon closure, the backfill in these pits will be graded with slopes to provide 2.3H:1V interbench slopes, with nominal 7.0-m wide rehabilitation benches (including the v-ditch and safety berm) sloping at a nominal 2%, to provide post-closure surface water management. The backfill will be covered with 0.5m of clayey soil to promote revegetation, to prevent erosion, and to act as an ET cover over the barren rock contained in the backfill. Surface water management methods will be employed to permit most of the surface area of the pit backfill to discharge to natural drainages.

In the south eastern portion of the pit, a small temporary pit lake will form in the spring. Most of the water in this pit will be lost to evaporation in the summer, but some will infiltrate into groundwater.

The Erato pit will be partially backfilled with stockpiled barren rock. This level will be significantly below the pit rim. Most of the water in the Erato pit will infiltrate into groundwater. Chapter 6.10 of the EISA considers the potential impact of pit seepage.

5.11.2 BRSF

The BRSF will be constructed through the life of the mine and the preferred option is to maintain the BRSF in-situ as a permanent restored landform. The BRSF has been designed to accommodate mine barren rock from the Tigranes / Artavazdes and Erato open pits, with the majority of the barren rock from the Erato open pit scheduled as backfill for the Tigranes / Artavazdes open pit void. The current BRSF design includes the segregation and encapsulation of potentially acid generating (PAG) materials with non-acid generating (NAG) materials, as well as the segregation of low-grade ore that will be re-mined for processing and metals recovery prior to closure. The BRSF feasibility-level closure design provides for regrading of the operational side slopes to provide 2.3H:1V interbench slopes, with nominal 7m wide rehabilitation benches (including the v-ditch and safety berm) sloping at a nominal 2%, to provide post-closure surface water management. The closure cover for the BRSF is designed to minimize flux into the BRSF by use of an ET cover. These layers will overlie ROM upper-volcanics NAG barren rock, and therefore the cover will have a natural capillary break of non-acid generating erosion-resistant rock.

It is anticipated that once the cover system is constructed, there will be no impacts to surface water runoff and that surface water runoff will be discharged to natural watercourses.

The ET cover system was included in the closure design of the BRSF to minimize any post-closure flux of meteoric water (including snowmelt) into the barren rock. The proposed PTSF design at the HLF is the preferred option to mitigate the potential formation of ARD from the BRSF for the long-term and at a low cost. It is anticipated that the PTS will treat seepage flows from the base of the BRSF during closure, and post-closure.

During year five, the BRSF seepage of mining influenced water (MIW) will drain to the 200,000 m^3 capacity contact water ponds, located within the HLF area. Contact would drain by gravity through the BRSF gravity pipe. The contact water ponds will function as an equalization pond, leveling the peak BRSF seepage flows to an average of approximately 30.1 m^3/h or 8.4L/s. The BRSF MIW will be treated in a passive water treatment system PWT (also called a constructed wetland, see Appendix 3.1). The MIW is predicted to be mildly acidic and the primary constituents of concern (COC) will be nitrate and sulfate. With the exception of aluminum, dissolved metals concentrations in the MIW are predicted to be dilute. The PWT will be constructed on available gently-sloping ground to west of the HLF (see Figure 3.1 and 3.15 for the location of the PWT, in relation to the HLF).

5.11.3 HLF

Following placement of the last ore, the HLF will continue to be leached and rinsed for a period of approximately 8 months to remove residual gold.

Following the final leaching and rinsing cycle, there will be a cyanide destruction and rinsing circuit that is expected to last for approximately 10 months. Once the cyanide destruction and rinsing circuit has achieved the appropriate environmental standards for cyanide in the effluent of the HLF, then the remaining MIW within the HLF will drain to a temporary active treatment system for the treatment of residual sulfide and nitrate. Once the drain down decreases to ~2 L/s (predicted to be approximately one year after closure) the seepage will be treated in a second PTS, constructed adjacent to the BRSF PTS wetlands. The HLF PTS would be specifically designed to bring the effluent into environmental compliance for nitrate, and sulphates (see Appendix 3.1). The effluent from the PTS will be collected and monitored to assure that the appropriate discharge standards are reached prior to discharge to the environment. The treated water will be transported via pipeline to discharge into the Arpa River. As the MIW remaining in the HLF begins to drain down and pass through the PTS, then the final regrading and recontouring of the pad will be commenced. Following final regrading, construction of the HLF closure cover will take place. The HLF closure cover will consist of an ET cover, designed to promote revegetation, limit infiltration of meteoric water and snowmelt into the spent ore, manage stormwater, and limit long-term erosion of the cover.

The HLF closure design includes the regrading of outer slopes to an overall 3H:1V slope, with 2.3H:1V interbench slopes separated by drainage benches to control the slope lengths and manage stormwater. The closure cover for the HLF is designed to minimize flux into the HLF by use of an ET cover. The ET cover will consist of an active infiltration and storage zone underlain by a capillary break layer.

This cover will overly the silicified upper volcanics rock that comprises the spent ore, and therefore has an unreactive and erosion-resistant capillary break.

5.12 Outcomes of the Value Engineering and Optimization work

The Value Engineering and Optimization exercise undertaken in 2015 aimed to reduce the overall Project development cost. It did not result in significant changes to the locations or detail of the major Project components (open pits, BRSF and HLP), but the locations and details of some of the supporting infrastructure were modified, as has been described in the preceding sections.

A summary of the environmental and social impacts of the current Project design, in comparison to the design before Value Engineering and Optimization, is shown in Table 5.7

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
1	Footprint of facilities a	Footprint of the Project is 687 ha	Footprint of the Project is 599ha	
2	Wider footprint including disturbed buffer zone, fenced, restricted access and affected areas	The projected disturbed area is 1203 ha (including the Project footprint) and areas which are largely undisturbed but which will have access restricted, often for safety reasons, are an additional 483 ha. Total area of land affected is 1,685ha.	The projected disturbed area is 922ha (including the footprint) and areas which will be largely undisturbed but which will have access restricted for safety reasons are an additional 323 ha. Additional areas restricted and potentially subject to ecological disturbance are 521.9ha. Total area of land affected is 1,767ha.	
3	Land use analysis in terms of land acquisition and livelihoods	265 plots of private land totalling 135.6 ha, mostly belonging to Gndevaz residents, to be acquired by the Project. In addition, 83 land plots affected by the conveyor totalling 45.3ha to be acquired.	252 plots of private land totalling 146.2 ha, mostly belonging to Gndevaz residents, are being acquired by the Project. In addition, 22 land plots affected by the conveyor and infrastructure, totalling 25 ha, are to be acquired in 2016. Purchase of the property to the north of the HLF area to be used as the primary monitoring station for noise, air quality, blasting vibration and air quality.	
4	Employment including local hiring	Approximately 1,300 people will be employed during mine construction, and 770 during operation – 30% target for local hiring in impacted area during the operational period.	A peak workforce of approximately 1,300 people will be employed during mine construction, and 657 during operation – 30% target for local hiring during both construction and operation periods.	

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
5	Footprint/impact on critical and natural habitat	The footprint on Natural Habitat was 608 ha with a further 1100 ha of Natural Habitat in disturbed Areas and restricted zones. The footprint would affect 155 ha of the 1200 ha of Critical Habitat for Potentilla porphyrantha.	The footprint will affect 520 ha of Natural Habitat with a further 1288 ha in the Disturbed Area and Restricted Areas. The footprint would affect 151 ha of the 1200 ha of Critical Habitat for Potentilla porphyrantha.	

Table 5.7: Environmental and Social Impact Summary

#	Criteria selected	Oct 2014 FS 43-101 + ESIA v9	Nov 2015 TR 43-101 + ESIA v10	Outcome
6	**Landscape and visual impact assessment**	Views of the Project from the tourist resort of Jermuk will be possible during the later stages of the operational phase, when the Artavazdes-Tigranes pit is in operation and the BRSF has reached its maximum extent. The settlement of Kechut will have limited visibility of the BRSF from the later stages of the operational phase. The residents of Gorayk and the majority of those within the settlements of Gndevaz, Saravan and Saralanj will not be able to see either the mine or its infrastructure.	Relocation of the crushing and screening facility, truck shop, warehouse and administration facilities to the west and north-west of Little Erato increases the perceptibility of the project overall from the north. These components will be visible to varying degrees from a number of locations north and north-west of the Project, with the housing building that contains the crusher and screening processes appearing on the skyline. Views of the Project from the tourist resort of Jermuk and the settlement of Kechut will be possible during the construction and operational phases, when these components are being constructed and become operational, with the Artavazdes-Tigranes and Erato open pits, and the BRSF visible as before. The residents of Gorayk and the majority of those within the settlements of Saravan and Saralanj will not be able to see either the mine or its infrastructure. The relocation of the main mine haul road to the west side of Amulsar results in some visibility of this component from the Arpa Valley, including Gndevaz.	

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
7	**Implications of layout for lighting**	Impacts from lighting will mainly be indirect, in the form of a night-time glow above the pits and other facilities on the mountain. Lights of trucks on the main haul road will be visible from certain viewpoints in and around Jermuk.	The location of the crusher, truckshop administration offices and associated roads to the north and west of the BRSF, together with the orientation of the main haul road to the west side of the mountain, will result in direct-light sources being visible, during night time operations when viewed from the residential areas in Jermuk and Gndevaz.	
8	**Archaeological artefacts – cultural heritage**	Total of 479 potential cultural heritage sites identified in the area, of which 138 have been assessed for their sensitivity and 75 will be impacted by the Project, including. The majority of the 75 had not been formally assessed for sensitivity, but there was potential for 63 to be subject to high-magnitude impacts (because they are within the Project footprint).	Total of 487 potential cultural heritage sites identified in the area, of which 138 have been assessed for their sensitivity and 81 will be impacted by the Project. Of these, 70 have the potential to be subject to high-magnitude impacts (because they are within the Project footprint). All need physical investigation.	
9	**Energy consumption and Greenhouse Gas (GHG) emissions**	The Project could generate a maximum annual output of approximately 140,344 tonnes of CO_2e during operation. The estimate during construction was 17,199 tonnes of CO_2e (but this may have been in error). The annual demand for power is 94,667MWh/year.	The Project could generate a maximum annual output of approximately 92,186 tonnes of CO_2e during operation. During construction the estimate is 58,164 tonnes of CO_2e. The annual demand for power is 50,303 MWh/year.	

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
10	**Implications of layout for air quality, noise**	Assessment using computer modelling confirmed that noise levels will be within compliance limits at all surrounding communities, although the predicted night-time noise level in Gndevaz is close to the limit. Quantitative assessment of dust emissions confirmed that deposition will occur within 1km of the major mining operations (open pits, haul roads and BRSF). The likely effect within local communities is not significant. Similarly, effects from SOx and NOx will be insignificant. A detailed management plan and ongoing monitoring during the construction and operational phase is required to ensure and confirm these conclusions.	Detailed modelling of both noise and air quality impacts confirms no significant change to that identified for v9f. The requirement for a detailed management plan and ongoing monitoring during the construction and operational phase is reconfirmed. One resident living in the property to the north of the HLF area (near the Gndevaz livestock and dairy farm) has agreed to sell the property to the Project sponsor. The property will be established as primary monitoring station for noise, air quality, blasting vibration and air overpressure.	

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
11	**Accommodation of workers**	In the construction phase, 1,000 of the anticipated 1,300 workers will live in a temporary construction camp located a few km from the nearest village. This camp will be closed and dry (i.e. alcohol will not be permitted within the camp). The workforce will have little interaction with the local communities, minimising the economic demand associated with a large workforce and reducing the attraction of the area to opportunist in-migrants. The plan was to have the camp in the Vorotan valley.	During the early phases of the construction phase, workers will be accommodated in hotel accommodation in Jermuk. This workforce will also commence work on the construction of a 500 to 920 accommodation camp. Therefore, as the number of construction workers increases to peak requirement, accommodation options include: - Living at home, as the number of locally recruited workers increases during the construction phase - Accommodation in local hotels, or other privately rented apartments, principally in Jermuk - Accommodation camp within the Site to the south of the HLF. Chapter 6.21 together with Appendix 8.25 provide the details of this assessment and accompanying management plan.	
13	**Accommodation of operational phase workers**	During operations, the employee accommodation will be predominantly home based. Most employees will reside in their own homes in the surrounding villages, with about 250 workers (on a rotational schedule) based in a single renovated hotel building in Jermuk.	Non-local operations workers will be accommodated in the camp and in hotels / apartments in Jermuk.	

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
14	**Water balance and surface water management**	Water will be taken from the Vorotan River for use during Project construction. During the operational phase, water will be taken from the Arpa River. Water used for HLF/ADR processes will be in a closed system. No contact water will be discharged directly to the environment. All water pumped from the open pits, seepage and run-off from the BRSF, and drainage from the truck maintenance facility will be captured as contact water and used in operations.	Water for construction will come from runoff and snowmelt captured in ponds. Make-up water will be abstracted from the Arpa River during construction and for the first five years of the operational phases. Excess contact water (from Year 5 of operations) will be treated in a passive treatment system (PTS) to RA MAC standards and then discharged to the Arpa River.	
15	**Impacts on fish farming**	Not considered in any details in ESIA v9f. It is mentioned that the Arpa water intake will be located downstream of the fish farms.	The water intake and discharge points will be downstream of the existing fish farms, which will therefore will not be affected. Farmers downstream are predicted to be similarly unaffected.	

Table 5.7: Environmental and Social Impact Summary				
#	**Criteria selected**	**Oct 2014 FS 43-101 + ESIA v9**	**Nov 2015 TR 43-101 + ESIA v10**	**Outcome**
16	**Efficiency and final discharge characteristics from the BRSF and HLF PTS**	Not applicable during operations because the process is planned to be closed-circuit. During the closure phase the heap is rinsed with water which then passes through a process plant and passive treatment wetland before discharge. The PTS was only anticipated post-closure for treatment of low volumes of leachate from the BRSF.	BRSF contact water will be treated to meet the Category II MAC though a PTS constructed in the HLF area taking the outflow from the contact water ponds. Prior to construction of the PTS a series of treatment trials will be undertaken, initially at laboratory-scale and then at bench- and field- scale. These trials will focus the design on the use local materials and will be under local climatic conditions to optimise the design and demonstrate that the treatment standards can be met. In the event that the treatment trials demonstrate that there is a risk the PTS may not meet the required MAC II standards a conventional packaged active water treatment plant will be used. The HLF PTS will be designed and constructed to the design standards identified in ESIA v9. The wetland system will be constructed adjacent to the BRSF PTS.	

Table 5.7: Environmental and Social Impact Summary

#	Criteria selected	Oct 2014 FS 43-101 + ESIA v9	Nov 2015 TR 43-101 + ESIA v10	Outcome
17	**Closure Management**	A PTS will be installed down-gradient of the BRSF to mitigate the risk of acid rock drainage generation post-closure. At the HLF, rinsing will continue until residual cyanide is destroyed. The spent ore heap will potentially continue to produce poor quality seepage post-closure, but this impact will be limited to elevated sulphate (a natural salt) or nitrate. Due to these residual water quality issues during the rinsing period of the HLF, water will be treated through the ADR facility water processing plant. After the pad has drained down to approximately 2 litres per second of discharge, water leaving the HLF will be switched to a passive treatment (wetland) system, which will remain in place until discharge water quality meets Armenian discharge standards.	Post-closure, all contact water will be treated at as described in 16 (above). The treated water from the outflow from both the HLF and BRSF PTS wetlands be discharged to a series of infiltration galleries within the HLF catchment or to a tributary of the Arpa. Discharge will meet MAC II standards. Closure and post-closure monitoring will be performed to confirm the effectiveness of strategies employed to mitigate identified potential risks to water quantity and quality within the Project area.	(Neutral)

Key

- Positive - Neutral - Negative