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6 POTENTIAL IMPACTS AND MITIGATION MEASURES

This Chapter sets out the potential environmental and social impacts of the Project in all its phases (construction, operation and closure). It identifies the sources of impact associated with the Project's infrastructure and activities as set out in Chapter 3. It also considers impacts induced with social changes associated with the Project, including accommodation, direct employment and economic inputs and demographic changes. Impacts are assessed with regards to the regulatory framework in Section 2.1 to 2.2, the Lydian Policy Framework in Section 2.3, and Project-specific criteria presented in Section 2.4 of Chapter 2.

The assessment has been organised into the following main subject areas:

Environmental

- Greenhouse Gas Emissions and Climate Change;
- Landscape and Visual Impact;
- Air Quality;
- Noise and Vibration;
- Soils and Land Cover;
- Groundwater;
- Surface Water; and
- Biodiversity and Ecosystems.

Social

- Socio-economic
 - Demographics;
 - Economics;
 - Labour and Working Conditions
- Land Use, Agriculture and Natural Resources;
- Livelihoods
- Community Health and Safety;
- Cultural Heritage;
- Transport;
- Ecosystem Services; and
- Worker accommodation impact assessment

Note: the worker accommodation impact assessment, draws on earlier chapters in the ESIA,

in particular socio-economic, community, health and safety and transport, it has been submitted as a separate chapter, as the requirements for a bespoke study on worker accommodation has been identified in Chapter 5 and Appendix 5.1. The findings from this chapter have been referenced in earlier chapters, where appropriate.

Within the ESIA, the methodology for assessing environmental impacts is distinct from that used in the social impact assessment. This is due to the qualitative nature of the analysis required for the social studies combined with the potential for significant positive change to take place, in social terms, subject to appropriate Lydian policies and implementation of the social plans. In contrast, environmental impacts have generally been derived using quantitative assessment techniques related to aspects of the mine design and operation. In addition, the mitigation measures are generally focussed on reducing the effect of predicted impacts that, without the intervention of the appropriate mitigation, would result in a significant adverse effect. On this basis, the impact summary sections have been provided using a different format for environmental and social aspects. A summary of mitigation measures has also been provided for each of the main subject areas as well as a recapitulative table at the end of Chapter 6.

6.1 General Approach for Environmental Impact Assessment

The discussion for each subject area generally follows a format that identifies and addresses:

- **Project Activities** – Describes the Project activities and/or sources of potential impact for that particular aspect;
- **Potential Impacts** – Describes the method used within each subject area to assess potential impacts, and explains any assumptions or modification to the general impact assessment methodology described here;
- **Mitigation Measures** – Describes the engineering design that has been incorporated to reduce impacts to acceptable levels;
- **Residual Impacts** – Re-assesses significance of impacts after mitigation is applied (assuming effective implementation of mitigation measures); and
- **Monitoring and audit** - Identifying the level of monitoring that will be necessary, over a defined period, to ensure that mitigation measures remain appropriate and maintain actual impacts within acceptable limits is considered in Chapter 8.

Environmental aspects have been summarised assessing significance from a combination of direction, duration, receptor sensitivity and magnitude. Significance is given over the short and long term with mitigation during construction and operation phases, providing a summary of mitigation measures.

6.1.1 Defining Terms

The terms *impact* and *effect* are often used interchangeably but, within the context of the environmental studies considered in this chapter, these terms have specific meanings.

Impact is used with reference to changes in a particular aspect of the environment (e.g. air or water) which can be considered attributable to the Project. Where possible the degree of change is quantified.

Effect relates to the implication of changes in the baseline conditions which have been established for a particular receptor. The assessment of the significance of these changes to the baseline is based on the magnitude of the impact and the sensitivity of the receptor to that change.

Thus *impacts* are a measurement of the change upon aspects of the environment, from the baseline condition, as a consequence of the Project. The *effect* is how significant the change will be considering the sensitivity of the receptor.

The Project-affected area includes the Project footprint (see Figure 1.2) together with the surrounding areas that would potentially be affected by impacts associated with the construction, operation and closure of the mine.

6.1.2 Project Activities and Identification of Potential Impacts

The nature of the assessment and the methodology adopted to define significance is specified for each environmental aspect, within a general framework set out below.

Where quantitative techniques can be used, the approach adopted has been to model the natural environment and calculate the magnitude of the potential impact as a consequence of the Project activities.

- For example: the dispersal patterns and dilution of emissions to air. Where a numeric model has been used to define the magnitude of change, the significance of the impact has been assessed by reference to the criteria established in Chapter 2.

For a number of environmental aspects, qualitative techniques have been used to define the magnitude of the potential impact.

- For example: the use of photomontage in the landscape and visual impact assessment (Section 6.5) relies on previous experience and knowledge about the consequences of a given action; expert judgement is critical to the evaluation of significance.

Where appropriate, the details of the methodologies used for the impact assessment have been considered within individual sections.

The predictions derived in the impact assessment chapters are subject to a degree of uncertainty, and this uncertainty is explained within each topic together with any assumptions on which they are based.

6.1.3 General Methodology

Four attributes that have been applied to determine the degree of significance have been defined as:

Direction

- Positive Impact – An impact that is considered to provide a net benefit to the receptor;
- Adverse Impact – An impact that is considered to negatively affect the receptor, and may require management activities to mitigate its effects.

Duration

The duration of potential impacts associated with the Project is categorised as short-term or long-term, as defined in the context of each environmental aspect to take account of the receptor. However, for the majority of the environmental aspects, short term has been defined as the construction and/or operational life of the Project (i.e. up to 12 years) and long term effects are those that remain and continue after the post-closure phase of the Project.

Receptor sensitivity

Receptor sensitivity has been defined in Table 6.1-1.

Table 6.1-1: Receptor Sensitivity Scale		
	Sensitivity of receptor	Description of receptor
1	Minor	Low importance/receptor with low sensitivity; Abundant; Local importance or scale; Resilient to change; Potential for substitution within the local area.
2	Medium	Low to medium importance/receptor with low to medium sensitivity; Relatively abundant; Regional important or scale; Reasonably resilient to change; Potential for substitution.
3	High	Medium to high importance/receptor with medium to high sensitivity; Relatively rare; National importance or scale; Fragile and susceptible to change; Limited potential for substitution.
4	Very High	Very high importance/receptor with very high sensitivity; Extremely rare; International importance or scale; Very fragile; Highly susceptible to change; Very limited potential for substitution.
Note: the scale combines the description of the receptor together with its geographic extent. The general descriptions used in Table 6.1-1 have been developed for each environmental aspect, taking into account the relevant performance standards that are applicable.		

Magnitude

The magnitude of change has been defined in Table 6.1-2.

Table 6.1-2: Magnitude of Change Scale		
	Magnitude of change	Description of change
1	Negligible	Minimal detectable changes in baseline resource. Changes are either of short duration or infrequent periodicity, such that direct control is not required to manage potential impact.
2	Low	Detectable change to the baseline conditions or resource. During construction and operations there would be ongoing change in the underlying characteristics or quality of the baseline conditions.
3	Moderate	Degree of change is such that loss of, or adverse alteration to, the baseline conditions of a specific environmental resource would occur. Post development characteristics or quality would be partially changed during construction and operational phases.
4	High	Degree of change is such that total loss of, or adverse alteration to, the baseline conditions of a specific resource would occur. Post-development characteristics or quality would be fundamentally and irreversibly changed.

Defining significance

Using the qualitative descriptions from the Receptor Sensitivity (Table 6.1-1) and Magnitude of Change (Table 6.1-2), scales have been mapped to produce an Impact Significance Matrix (Table 6.1-3).

Table 6.1-3: Impact Significance Matrix				
Receptor Sensitivity	Magnitude of Change			
	Negligible	Low	Moderate	High
Minor	Negligible	Negligible	Minor	Moderate
Medium	Negligible	Minor	Moderate	Moderate
High	Minor	Moderate	Major	Major
Very High	Minor	Moderate	Major	Very High

More detailed definitions of the levels of significance are shown in Table 6.1-4, outlining when effects can be considered to be 'significant'.

Table 6.1-4: Impact Significance Scale			
	Significance	Description of impact (sensitivity and magnitude)	Effect
0	Positive	Provide a net benefit to the receptor	Positive
1	Negligible	Receptor not concerned or altered by a particular activity; Nearly indistinguishable from natural background variations	Not significant
2	Minor	Well within accepted limit or standard; Noticeable impact on receptor, but sufficiently small so as not to be of concern	Not significant
3	Moderate	Within accepted limit or standard, but close to reaching the threshold; High magnitude changes on relatively insensitive receptors; Low magnitude changes on highly to very highly sensitive receptors	Significant
4	Major	Accepted limit or standard is exceeded; High to moderate magnitude changes affecting highly to very highly sensitive receptors	Significant
5	Very High	Total loss or adverse alteration to extremely rare or unique receptor. No mitigation possible	Significant

6.1.4 Mitigation Measures and Residual Impacts

Adverse effects rated as Significant must be mitigated in order to reduce the level of significance of the residual impact. Monitoring measures must also be defined to assess the efficacy of the mitigation measures.

The potential impacts, with mitigation imposed, have then been reassessed to derive residual effects as a result of Project activities. This assessment is based on the same methodology and Impact Significance Matrix as used to assess unmitigated impacts. The residual effect is determined as a result of the impact and implemented through appropriate risk analysis based on the monitoring programme targeted to audit the effectiveness of the mitigation measure targeted on the potential impact.

6.2 General Approach for Social Impact Assessment

Unlike the environmental impact assessment, social impacts will not make a distinction between the use of the terms impact and effect and the methodology that has been adopted, in light of this, has been defined below. Socio-economic aspects have been summarised describing direction of the change, magnitude, extent, duration and impact prior and post-mitigation.

6.2.1 General Methodology

The four attributes applied to the determination of socio-economic impact significance are:

- **Direction:** indicates whether the impact is positive, negative or neutral. Some impacts may have mixed positive and negative dimensions, which will generate a “neutral” prediction prior to mitigation.
- **Magnitude:** indicates the degree of change in a social parameter and is generally a qualitative assessment.
- **Geographic extent:** indicates the geographic and administrative units that will be impacted. Some impacts may affect only individual households, whereas others may affect the local area of influence, regional area of influence, the entire country, or have a trans-boundary impact.
- **Duration:** indicates the length of time over which an impact may occur. Duration is usually related to the project description; short-term refers to the pre-construction and construction phase; medium-term refers to construction, operations and closure; and long-term refers to elements beyond the life of the Project.

6.2.2 Classification of social impacts

The classification of social impacts is considered in Table 6.2-1.

Table 6.2-1: Classification of social impacts	
Criteria	Definition
Direction	Positive – Impact provides a net benefit to the affected person(s). Negative – Impact results in a net loss to the affected persons(s). Mixed – Impact may be positive or negative, but requires an intervention to demonstrate net benefit. Neutral – No net benefit or loss to the affect person(s).
Magnitude	Negligible – No noticeable change anticipated. Low – Result predicted to be different from baseline conditions, but not to impair or change quality of life of the affected person(s). Moderate – Result predicted to impair or benefit quality of life of the affected persons(s). High – Result predicted to seriously impair or substantially improve quality of life.
Geographic Extent	Individual – Confined to individuals or individual households. Local – Confined to the local area of influence. Regional – Confined to the regional area of influence. National – Extends to national level. Trans-boundary – Results impact neighbouring countries in the region.
Duration	Short-term – Construction and prior to operations. Medium-term – Construction and operations. Long-term – Through decommissioning and closure.

Each social impact category and sub-category will be assessed against the four criteria. The assessment will be made prior to the consideration of mitigation or benefit enhancement measures. The assessment will consider all four criteria to assign a significance level similar to that employed for the environmental impact assessment: “Negligible” to “Very High”. The impact category and sub-category will be re-assessed after a description of mitigation or benefit enhancement with the goal of showing the anticipated change resulting from management of the impact. While all classification of the social impacts is largely qualitative, the narrative should make the rationale for the prediction transparent to stakeholders and other reviewers.

6.2.3 Monitoring and Evaluation

It is important to include a process whereby mitigation actions are monitored regularly and formally evaluated at regular intervals. Results of monitoring will be disclosed and allowance made for stakeholder feedback on a periodic basis, usually at least annually. Monitoring requirements are identified as a distinct part of each impact category. Key mitigations, and the accompanying monitoring commitments, form the basis for the socio-economic sections

of the Environmental and Social Management system.

6.3 Application of the methodology for specific environmental and social aspects

Within each section of the impact assessment, the application of the approach and methodology has been considered with specific reference to the relevant Armenia regulatory requirements, IFC Performance Standard, EBRD Performance Requirement, and other relevant criteria and/or targets that relate to the discipline such as GIIP. In addition to the general environmental and social impact methodologies outlined above, specific methodologies or modifications have been applied for landscape and visual, biodiversity, community health and safety, transport and cultural heritage impact assessment, and these are described in detail in the relevant sections.

Defining the significance of effects has been used as the basis for determining the appropriate mitigation strategies in combination with identifying the need and scope of management plans. The structure and approach to the Environmental and Social Management Plan (ESMP) has been considered in Chapter 8. The management of these effects/impacts and mitigation strategies throughout the life of the Project are embedded in the Environment and Social (E&S) Management System and Occupational Health and Safety (OHS) Management System developed by Lydian for its Amulsar Gold Project. The two systems collectively support effective health, safety, environment and community (HSEC) performance, i.e., protecting the environment, continuously improving the efficiency of natural resource use, positively impacting the quality of life of nearby communities and preventing injuries and occupational illnesses.

6.3.1 Worker accommodation impact assessment

The methodology adopted for the worker accommodation relies broadly on the principles adopted for other chapters of the ESIA, however and for consistency, because this was a bespoke study, the methodology used in the assessment has been identified in full within the chapter.

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APPENDICES

Appendix 6.4.1 GHG emissions

6.4 Greenhouse Gas Emissions and Climate Change

6.4.1 Introduction

This chapter evaluates and assesses the greenhouse gas (GHG) emissions attributable to the construction, operation, and closure of the Amulsar Project, and the potential effects climate change could have on the Project (such as temperature and precipitation changes). This chapter has been structured as follows:

- Section 6.4.2 assesses the GHG emissions, including the potential impacts, proposed mitigation measures and residual impacts;
- Section 6.4.3 presents an overview of the carbon management plan for the project; and
- Section 6.4.4 assesses the climate change projections that may affect the Project, and how these may impact the Project.

The chapter has been prepared in accordance to the International Finance Corporation (IFC) 2012 Performance Standards¹ (PSs) and EBRD 2014 Performance Requirements² (PRs), as well other relevant best practices which are referenced at the appropriate parts of this chapter (see Table 6.4.1).

¹ International Finance Corporation (IFC). 2012. IFC Performance Standards on Environmental and Social Sustainability. January 2012.

² European Bank for Reconstruction and Development (EBRD). Environmental and Social Policy, 2014

Table 6.4.1: IFC Performance Standards and EBRD Performance Requirements Key Relevant Requirements	
Greenhouse Gases	Climate Change
PS1 and PR 1 require that the risks and impacts identification process evaluates emissions of GHG.	PS 1 and PR 1 require that the risks and impacts identification process considers the relevant risks associated with a changing climate and the adaptation opportunities.
PS 3 and PR 3 require consideration of measures for improving efficiency in consumption of energy, water, as well as other resources and material inputs. Also, options should be considered to reduce project-related GHG emissions during the design and operation of the project. For projects producing >25,000 tonnes of carbon dioxide equivalent (tCO ₂ e) per year, the direct GHG emissions within the physical project boundary and indirect emissions associated with offsite production of energy (i.e. purchased electricity) should be quantified in accordance to internationally recognized methodologies (i.e. IPCC) and EBRD Methodology for Assessment of Greenhouse Gas Emissions.	PS 4 and PR 1 require that projects should take into account the fact that communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts from project activities since climate change effects may exacerbate their vulnerability; and projects must identify and mitigate risks and potential impacts on priority ecosystem services that may be exacerbated by climate change.

6.4.2 Greenhouse Gas Emissions

Scope of Assessment

Greenhouse gas (GHG) emissions have been calculated for the project based on both an annual and cumulative basis. The calculations have assessed the net gain in GHG emissions attributable to the Amulsar Project, acknowledging that it is a greenfield Project and therefore the Project will generate new GHG emissions. The emissions have been calculated using standard methodologies as defined by the Greenhouse Gas Protocol³.

The Greenhouse Gas Protocol divides emissions into three categories as follows and illustrated in Figure 6.4.1:

- Scope 1 – direct emissions: from sources owned or under the operational control of the company or project;
- Scope 2 – indirect emissions: from the consumption of purchased electricity from the grid; and
- Scope 3 – indirect emissions: an optional reporting category allowing for other

³ World Business Council for Sustainable Development (WBCSD), World Resource Institute (WRI). 2004. GHG Protocol: Corporate Accounting and Reporting Standard. 2004

indirect emissions associated with but not controlled by the company to be included, such as contractor activities.

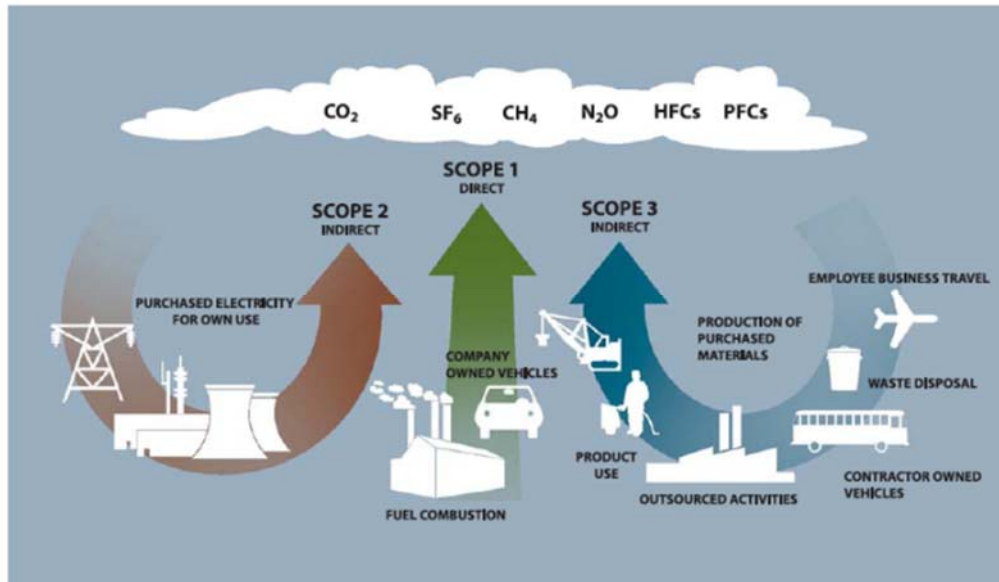


Figure 6.4.1: GHG Emissions Boundary (Source: Greenhouse Gas Protocol)

Consistent with the requirements of the IFC Performance Standards, the scope of emissions that have been assessed for the Amulsar Project are within scopes 1 and 2.

Project Activities Giving Rise to GHG Emissions

Potential GHG emissions arising from the Project will occur during exploration, construction, operations, and decommissioning phases of the project as follows:

- Exploration phase emissions are associated with project activities and air travel to date and will be reported in the Carbon and Energy Management Plan (see Table 6.4.7);
- During the construction phase of the project, Scope 1 emissions from GHGs will be emitted from the following activities:
 - Clearing of vegetation (land use change) for mine pits and construction of project facilities (land use change is applied to the life of the mine as the construction of new elements of the mine are undertaken through its operational life);
 - Construction vehicles and equipment for construction of mine facilities;
 - Fuel use from diesel generators for construction activities and a worker accommodation camp that would accommodate 500-920 employees;

- Blasting as part of the construction works;
- During construction, Scope 2 indirect emissions will arise from electricity that is sourced from the Armenian grid for temporary housing in hotels in Jermuk. The accommodation requirements for workers during the construction period has been defined in Appendix 8.25 (Workers Accommodation Management Plan) and will result in Scope 1 (direct) and Scope 2 (indirect) emissions. Grid electricity will also be used for ancillary equipment and processing facilities starting in the seventh month of construction;
- During operations, GHG will arise from both Scope 1 (direct) and Scope 2 (indirect) sources including:
 - On-road vehicles for hauling of ore and barren material;
 - Non-road vehicles for mining of ore;
 - Explosives for blasting;
 - Scope 2 indirect emissions will come from the electricity that is sourced from the Armenian grid for equipment, ancillary facilities, and the hotel accommodation; it is expected that all other employees would be commuting from their homes to the Project site and these emissions have not been taken into account;
 - Activities from the closure of the mine will also contribute to GHG emissions. These activities include the use of on-road and non-road vehicles for the removal and dismantling of ancillary mine facilities, and reclamation of the open pits and waste facilities.

Construction GHG Emissions

GHG emissions will be emitted from clearing of land, and use of both on-road and non-road vehicles for the construction of mine facilities. **The footprint of the Project covers approximately 862 hectares of land.** The footprint of land disturbed was determined by conducting a vegetative analysis using GIS shape files of the project footprint, therefore the land use types would differ from the cadastre/GIS analysis. This land can be characterized by type as shown in Table 6.4.2.

Table 6.4.2: Summary of Land Use types	
Land Type	Affected area
	ha
Scrub	14
Agriculture	138
Pasture ⁱ	616
Bare Ground	94
Wetlands	0
Settlement	0
Total	862
Notes:	
i. Includes totals for shadow, cloud, and Ice/snow	

The mine facilities will be constructed over a two year period where on-road vehicles such as diesel powered trucks and non-road vehicles such as bulldozers, loading shovels and haul trucks will be used throughout the construction phase. It is estimated that the construction period will consume 14.7 million litres of diesel fuel including power generators and the transportation of employees from the temporary construction camp site and surrounding hotels to the mine.

Additionally, emissions from ammonium nitrate/fuel oil (ANFO) blasting agent will contribute to direct operating GHG emissions. The amount of ANFO used for construction is estimated to be approximately 1.4 million kg of blasting agent.

The use of electricity from the Armenian grid (mainly nuclear power and hydroelectric dams) for the lighting, heating, and operations of the temporary construction camp, offices for employees, and other construction activities will contribute to GHG emissions, however will be minimal. During construction, approximately 22,070MWh of electricity would be used. Diesel generators would be operational as the main power source for the first seven months, and as supplementary power to the Armenian electric grid for the rest of the construction. Additionally, there will be transportation for workers from their accommodation to the site.

The estimated GHG emissions for the entire duration of the construction phase amount to 63,412 metric tonnes of carbon dioxide equivalent (tCO₂e) which are summarized in Table 6.4.3 below. This equates to 31,706 tCO₂e on average for each year of the construction period.

Table 6.4.3: Summary of GHG emission from Construction Phase				
Source	CO₂	CH₄	N₂O	CO₂e⁽ⁱⁱⁱ⁾
	tonnes	tonnes	tonnes	tonnes
Land Use ⁽ⁱ⁾	14,238	-	-	14,238
Fuel Use ⁽ⁱⁱ⁾	37992	2	2	38338
Electricity ^(iv)	10,438	0	0	10,439
Blasting	241	0	0	397
Total	62909	3	1	63412
Notes: (i) Calculated based on IPCC National Inventory Methodology, Volume 4 Chapter 2 (ii) CO ₂ , CH ₄ , N ₂ O emissions were estimated based on The Climate Registry Reporting Protocol Table 12.5, 13.3, 13.6 (iii) CO ₂ e emissions were estimated based on a global warming potential of 1, 25, and 298 for CO ₂ , CH ₄ , and N ₂ O, respectively (40 CFR Part 98, Subpart C). (iv) Calculated based on grid emission factor for the Electricity System of the Republic of Armenia for 2012 (UNDP-GEF, 2014)				

Operational GHG Emissions

The calculated annual GHG emissions for the operation of the mine are presented in Table 6.4.3 and were based upon the following:

- Direct emissions from use of on-road and non-road vehicles, and explosives which will be emitted during the operational phase of the project. On-road vehicles such as haul trucks will be used to transport ore and barren material. Over the lifetime of the project, ore will be transported from Tigranes and Artavazdes deposits initially; closer to the completion of these two pits, mining will begin in Erato. Ore mined from the open pits will be transported to the two-stage processing facility plant by diesel haul trucks. Additionally, barren rock from the open pit will be hauled to the Barren Rock Storage Facility (BRSF), and trucks will also be operating at the Heap Leach Facility (HLF). GHG emissions from use of on-road and non-road vehicles will vary each year the mine is under operation based upon the final mining sequence. For the purposes of this chapter, given this potential variation, which will only be resolved once operations commence, a conservative approach has been adopted by using the estimated highest volume of fuel required.
- The use of diesel fuel to transport employees from hotel accommodations to the site. It was estimated that five buses and 30 passenger vehicles will be utilized for transportation each day. Transportation services would be available 365 days per year.
- Additionally, emissions from ANFO blasting agent and Emulsion explosives will contribute to direct operating GHG emissions. The amount of ANFO and emulsion

explosives used will vary each year the mine is under operation. For the purpose of this chapter, given this potential variation, a conservative approach has been adopted by using the highest amount of ANFO required. Approximately 8.2 million kg of ANFO and 975,000 kg of Emulsion explosives are estimated to be used per year.

- Indirect GHG emissions will arise from electricity generation needed to power equipment, ancillary facilities, processes, and the hotel accommodations for employees. Electricity will be sourced from the national Armenian grid. It is estimated that the project facilities will use 49,636 MWh of electricity per year from the Armenian grid. The grid emission factor used in this analysis is 0.473 tCO₂/MWh, which has been adjusted for operating margin⁴ for 2013⁵. Since the conveyor will have an installed capacity of approximately 3MW, and would be generating electricity during operations due to its downhill run, electricity generated has been accounted for as regenerative energy. This has been accounted for in the total electricity consumption.

Table 6.4.4: Summary of Annual GHG Emissions from the Operational Phase

Source	CO ₂	CH ₄	N ₂ O	CO ₂ e
	Tonnes/year	Tonnes/year	Tonnes/year	Tonnes/year
Direct Emissions				
All vehicles and equipment – fuel use ⁽ⁱ⁾	65,532	4	2	66,132
Blasting – use of explosives ⁽ⁱⁱ⁾	1,565	3	3	2,576
Indirect Emissions				
Electricity ⁽ⁱⁱⁱ⁾	23,478	0	0	23,478
Total	90,575	7	5	92,186
Notes:				
(i) See Table 1 and 2 in Appendix 6.4.1 for detailed table of GHG emissions due to fuel use				
(ii) See Table 3 in Appendix 6.4.1 for detailed table of GHG emissions due to explosives				
(iii) See Table 4 in Appendix 6.4.1 for detailed table of GHG emissions due to electricity				

As shown in Table 6.4.4, fuel use in vehicles and equipment is the main source of operational GHG emissions, followed by electricity use. Figure 6.4.2 and Figure 6.4.3 show a further breakdown of GHG emissions by activity for fuel use and electricity respectively.

⁴ Operating margin is the concept where the effect of the project to the grid (e.g., drawing of electricity from the grid) is responded to by the operation of the grid.

⁵ United Nations Development Programme (UNDP). 2014. Calculation of Grid Emission Factor for the Electricity System of the Republic of Armenia for 2012. January 2014. Ministry of Nature Protection of the Republic of Armenia.

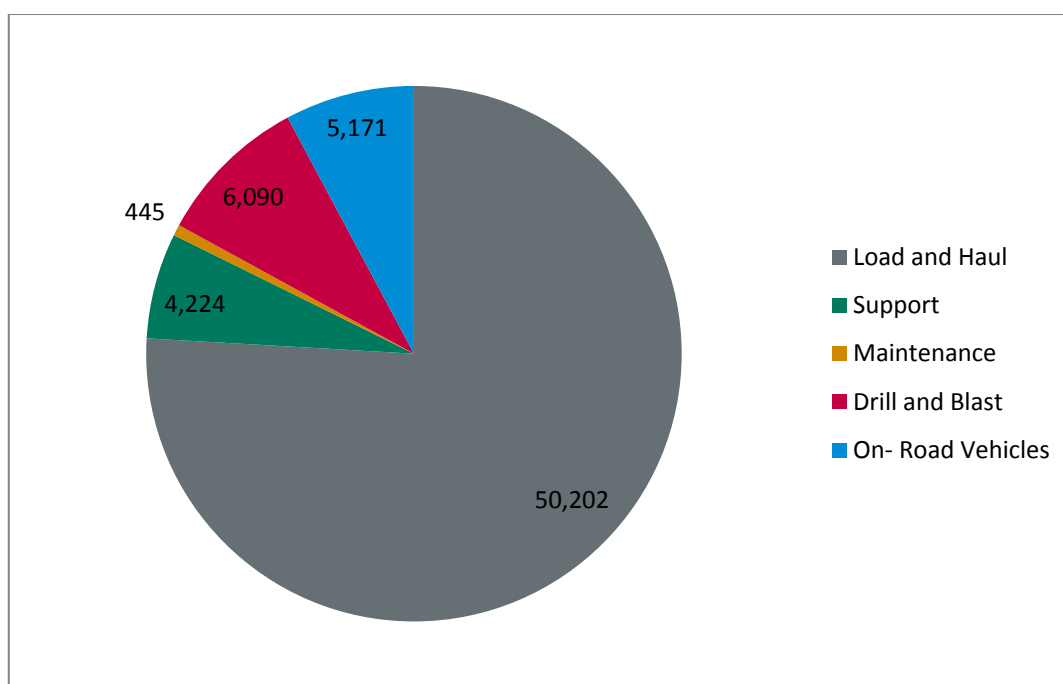


Figure 6.4.2: GHG Emissions from Fuel Use (in tCO₂e/year)

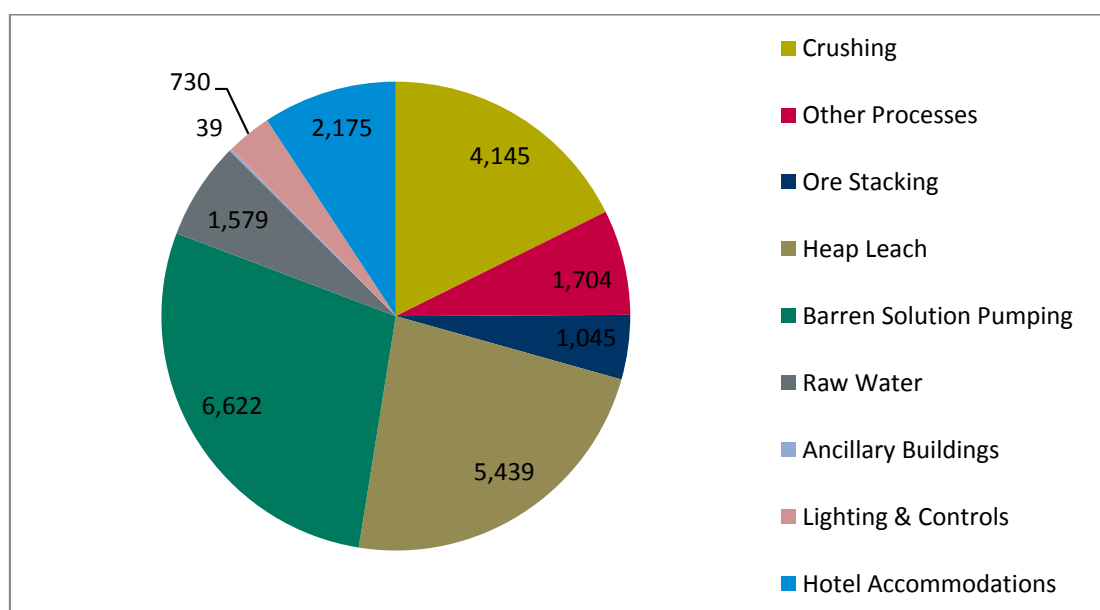


Figure 6.4.3: GHG Emissions from Electricity (in tCO₂e/year)

Mine Closure and Decommissioning

For the purposes of this assessment, it is assumed that the GHG emissions for decommissioning of the mine upon closure are the same as for construction in terms of fuel consumption. This equates to 3,025 tCO₂e on average for each year of the construction period. Land use change associated with re-vegetation as part of the mine rehabilitation plan, which would provide a carbon sink, has not been included in the calculations.

Emissions associated with mine closure are estimated to be as summarized in Table 6.4.5.

Table 6.4.5: Summary of GHG emission from Closure and Decommissioning Phase				
Source	CO₂	CH₄	N₂O	CO₂e⁽ⁱⁱ⁾
	tonnes	tonnes	tonnes	tonnes
Fuel ⁽ⁱ⁾ Use	1,541	0.09	0.04	1,555
Electricity	4,495	-	-	4,495
Total	6,036	0.1	0	6,050
Notes: (i) CO ₂ , CH ₄ , N ₂ O emissions were estimated based on The Climate Registry Reporting Protocol Table 12.5, 13.3, 13.6 (ii) CO ₂ e emissions were estimated based on a global warming potential of 1, 25, and 298 for CO ₂ , CH ₄ , and N ₂ O, respectively (40 CFR Part 98, Subpart C).				

Following rehabilitation, there will be the potential for carbon sequestration through plant growth and capture into soil biomass and organic matter. However, for the purpose of this assessment, in the early years post closure, it has been assumed that carbon sequestration will be minimal and not sufficient to calculate an offset of the carbon emissions associated with the heavy plant and equipment required for closure and rehabilitation (see Table 6.4.5).

Cumulative Emissions

The profile of emissions from the mine during its full life-cycle is presented in Figure 6.4.4. This shows the relative difference in annual emissions for the different project stages, and also the cumulative GHG emissions of 990,332 metric tonnes of CO₂e for the life-time of the mine.

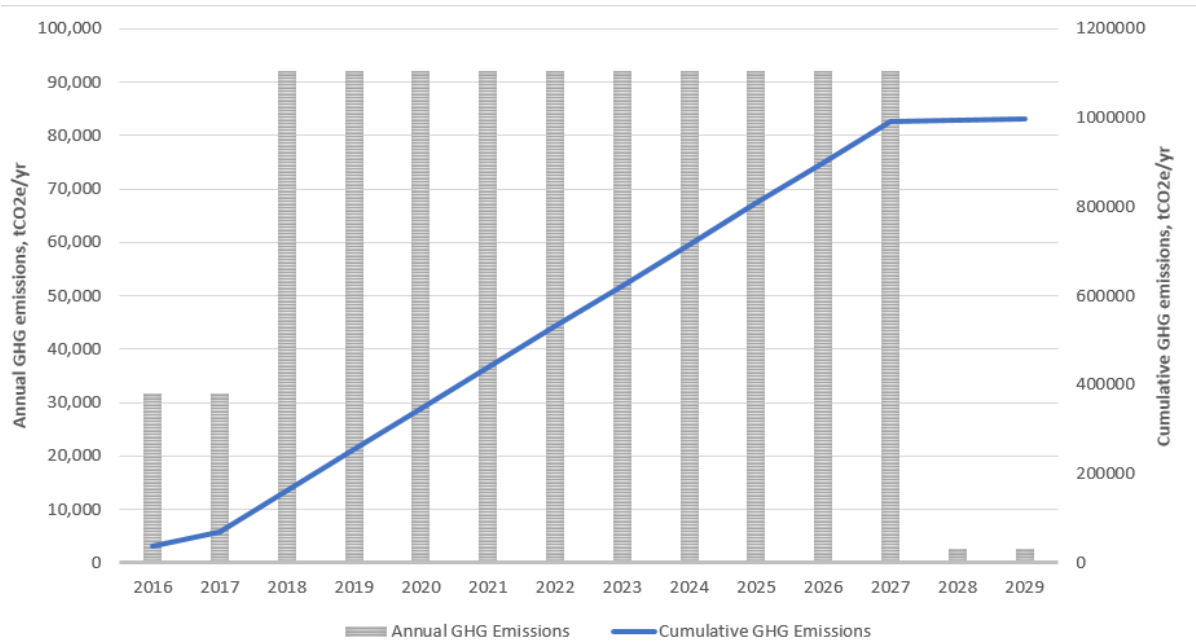


Figure 6.4.4: Cumulative GHG Emissions

GHG Mitigation Measures

Section 6.4.2 has identified the main sources of GHG emissions associated with the project, namely due to fuel combustion and electricity usage. GHG emissions have already been reduced through the design of the Project as follows:

- Minimizing the land clearance for project facilities;
- Selection of long overland conveyor transport over truck haulage of ore from the crusher to the heap leach facility (HLF);
- Regeneration capacity of electricity from the conveyor;
- Reduced the distance haul trucks travel to the BRSF by moving it closer to the open pits;
- Deployment of electric wheel motors for trucks which are more efficient while loaded and travelling downhill;
- Provide insulation for buildings to minimize heat losses;
- The use of modern, energy efficient electrical equipment and mobile plant with fuel-efficient engines;
- All new mobile plant to be fitted with remote sensed fleet management software to manage utilisation, condition, maintenance and efficiency of use within each area of mining activity;
- Process plant will be fitted with performance management software, providing continuous data on fuel consumption, efficiency of use and alert to maintenance and breakdown.

- Use of electricity for heating ancillary buildings and accommodation instead of natural gas as Armenia's electricity is primarily generated from gas fired nuclear power, hydroelectric generation and gas fired power generation.

GHG mitigation opportunities are also being explored further as the project design is advanced and operational activities are further developed. These include:

- Consideration of the use of biofuel (i.e. biodiesel) in non-road equipment. This approach requires further understanding of the opportunity to source a reliable and secure source of biodiesel, and will also require an assessment of the life-cycle emissions to ensure the source of the biodiesel is not compromising overall GHG emissions (this is particularly true when considering potential land use implication of biodiesel). At the time of writing, such sources of blended diesel fuels are not available in Armenia, however the Project will continue to monitor potential options;
- Consideration of energy efficient technology such as CFLs or LEDs for lighting if available in Armenia which are more energy efficient than incandescent light bulbs. Additionally, consideration for motion sensor lighting in ancillary building to further provide energy savings;
- Scheduling of excavation and haulage activities to optimize activities and avoid double handling, where this is operationally practical. As the mine logistics and scheduling are progressed, consideration will be given to optimizing vehicle and equipment movements so as to minimize operational distances and times. As shown in Figure 6.4.2, a particular focus on the excavation and haulage activities is merited due to their large GHG contribution;
- Consideration of alternative heat sources such as waste oil burners, ground and air source heat pumps for heating (and cooling) in buildings;
- The detailed design process will also ensure that other energy-intensive uses such as the crusher plant are analysed further for energy efficiency opportunities;
- Should incineration of non-hazardous and hazardous waste be developed for the Project, the potential for heat recovery to supplement space heating will be included in the design criteria; and
- As identified previously, the Armenian national power grid is supplied primarily by nuclear power plants and hydropower followed by gas fired thermal. The Project has investigated the potential to purchase "green" energy (specifically, hydropower from a nearby hydroelectric plant) to supply the Project. However, the plant supplies electricity to the grid and the Armenian grid cannot currently differentiate

energy sources when purchasing electricity. Green energy contributions to the national grid are expected to increase in the near-term with the commissioning of the Iran-Armenia Wind Farm and the Jermaghbyur Geothermal Power Plant. This trend is expected to result in indirectly decreasing the Project's GHG emissions. Lydian will continue to monitor and support renewable energy sources in Armenia; any change to the potential for renewable energy supply would be reported in the annual report required by the Carbon and Energy Management Plan (see Table 6.4.7).

Residual Impacts due to GHG Emissions

The Project will continue to seek to reduce its GHG emissions throughout its lifecycle. Further guidance will be provided in the Carbon and Energy Management Plan, which will be prepared prior to commencement of construction activities, when the design has been finalized and reported annually for the duration of operations. The plan will also report the annual emissions, back-dated to the commencement of exploration at the Project. Table 6.4.6 presents a summary of the anticipated GHG impacts and planned mitigation measures. It is acknowledged that whilst the main impact associated with GHG emissions is their contribution to climate change, the Amulsar Project is one of a myriad of human sources impacting the emissions of GHGs and contributing to climate change, and projected changes in local, regional, and global climate cannot be attributed in isolation to the proposed Project.

Table 6.4.6: Impact Summary – GHG Emissions

Impact	Source	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management Plan (4)
			C	O	ST	LT		
Greenhouse Gas Emissions	Offsite power generation, onsite mobile plant and heating plant emissions	A	X	X	N	M -	<ul style="list-style-type: none"> • Energy efficiency measures incorporated into engineering design. • Require use of modern, energy-efficient mobile plant. • Fleet management software for continuous management of utilisation, efficiency, condition and maintenance requirements for mobile and static plant used in mining operations. • Implement logistics management of haulage and excavation activities to avoid idling and double-handling. • Perform regular maintenance on mobile plant. • Seek additional opportunities for GHG emissions reduction throughout Project lifecycle, including consideration of renewable energy opportunities, if it is supplied as a separate generation source through the Grid. • During detailed design, energy-intensive uses such as the crusher plant will be assessed for energy efficiency opportunities. 	Carbon and Energy Management Plan (see Appendix 8.24)
<p>Notes:</p> <p>(1) Primary Receptors:</p> <p>(2) Project Phase: C = Construction, O = Operations, E = employees</p> <p>(3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, R = residents, Fl = flora, Fa = fauna, A = atmosphere, S + = significantly improved, S - = significantly adverse, M - = moderately adverse, N = neutral, M + = moderately improved</p> <p>(4) The Carbon and Energy Management Plan will be prepared during 2015, with annual emissions back calculated to the start of explanation phase at the Project.</p>								

6.4.3 Carbon and Energy Management Plan

A summary of the Carbon and Energy Management Plan is presented in Table 6.4.7.

Table 6.4.7: Carbon and Energy Management Plan		
Carbon & Energy Management Plan		
Monitoring approach	Baseline	Develop a greenhouse gas emissions monitoring programme in order to establish baseline data from key sources and within key locations of the Project area. Establishing baseline data will assist in capturing any unnecessary and potentially detrimental releases as the project progresses over time. The baseline will be based on all emission from the onset of the exploration programme. The emissions inventory will be published annually, commencing prior to commencement of construction activities of the mine, when design has been finalized. This should include GHG emissions from commencement of exploration activities. The first annual monitoring report (April, 2016) has been reported in Appendix 8.24.
Level 3 SOPs		<p>The level 3 plans will include the following:</p> <ul style="list-style-type: none"> • Develop a GHG database – energy and emissions data will be collected upon commencement of work to determine baseline factors. As the Project progresses, emissions data will be collected at regular intervals to ensure environmental outputs are continuously monitored and mitigated when possible. • Fleet management - all vehicles are to be maintained as is recommended by the manufacturer in order to decrease emissions and maximize the efficiency and longevity of the equipment. • Fleet management software – all new vehicle and static plant to be fitted with remote data capture of fuel use, efficiency of operation, plant condition and requirements for maintenance. • Vehicle Usage - guidelines will be in place for the length of time vehicles may remain idle, particularly as temperatures increase. The use of energy efficient practices such as reducing idling of equipment and maintaining construction equipment and vehicles according with manufacturer's recommendations will be conducted. This will also be supported by logistics considerations to ensure no double-handling of ore, especially of more GHG-intensive activities such as excavation and haulage. • Electricity usage management - throughout the course of the Project electricity usage is to be tracked to manage the use of electricity utilized to power project equipment. Consider the use of renewable energies to power some or all Project facilities (such as small scale wind or solar for ancillary or office buildings and ground/air source heat pumps for heating/cooling in buildings) as well as recognizing the potential to purchase green electricity from the local grid. Monitor any impacts the Project may have on the electricity availability and usage of neighbouring communities and work sites. • Continual monitoring of mitigation opportunities - as the Project progresses, potential mitigation strategies will be continually monitored. New opportunities will be identified as a component of this Plan.

6.4.4 Climate Change and Adaptation

This section considers the relevant risks associated with a changing climate and the adaptation opportunities associated with the Project.

Historical Climate Trends

Between 1895 and 2010, the annual average temperature has increased globally. Since 1935⁶, the air temperature in Armenia has increased by 0.85°C, annual precipitation has decreased by 6%, and during the summer, the average air temperature has increased by 1°C while no increases were recorded in the winter. Frequent droughts have been observed in Armenia since 1990. According to the Second National Communication on Climate Change, droughts and increased aggravated southern winds have been observed in Syunik and Vayots Dzor, the two provinces in which the Project is located, in the last ten years.

Climate Change Projections

In order to assess climate change impacts on the Project, projections for how the climate may change in the vicinity of the Project need to be determined.

Global Level

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental scientific body tasked with evaluating the science of climate change. The IPCC publishes reports relevant to the implementation of the UN Framework Convention on Climate Change (UNFCCC) to provide the international community with authoritative assessments on which to base response strategies. The latest of these is the 5th Assessment Report on Climate Change (AR5), published in 2014.

Future climate change projections are made through the construction and use of global climate models (GCMs), which distil key physical and dynamical processes of the climate systems into equations and algorithms. GCMs are getting more and more sophisticated over time and they are validated by testing their ability to recreate the observed climate record. GCMs typically have a large resolution in the range 100-300km, which restricts their use at more regional and local levels.

According to IPCC global climate models, the average annual temperature in the region of

⁶ Republic of Armenia, Ministry of Nature Protection. 2010. The Second National Communication on Climate Change. Yerevan. 2010

the Project is predicted to increase by between 0 and 2.3°C above the baseline of 1960-1990 by 2030. As a result, seasonal changes would be observed such as earlier spring season and a longer and hotter summer.

Local Level

The projections simulated by global climate models are often simulated at space scales too coarse for direct use in impact studies at regional scale or smaller. Downscaled climate change projections have been prepared for Armenia, and these have been recognized by the national government through the Ministry of Nature Protection, as presented in the Second National Communication on Climate Change, dated February 2010.

Downscaled climate change projections for Armenia with a 25-km spatial resolution are available, corresponding to the SRESA2 (A2) and SRESB2 (B2) greenhouse gas (GHG) emissions scenarios⁷ and for three time periods of 2011-2030, 2031-2070, and 2071-2100. Further discussion on long term climate trends in Armenia through 2070 is presented in Chapter 4.2.5. Taking the 2011-2030 projections, which best align with the Project timeframe, and using the more conservative A2 (high emissions) emission scenario results, the following projected changes have been used for this assessment:

- Annual temperature is expected to increase by 1°C by the year 2030;
- Summer months will experience higher temperature increases (up to 2°C) compared to winter;
- Annual precipitation is expected to decrease by 7%, although precipitation in the winter will be abundant; and
- These climate change forecasts will lead to decreased water flow by approximately 7%, reduced precipitation from snow (between 7-11%), and will accelerate the desertification process.

⁷ To account for the fact that future climate change will be impacted by emissions of GHGs which we have yet to emit, the evolution of which is highly uncertain, the IPCC published a special report on emissions scenarios (SRES) which developed a set of emission scenarios for use in GCMs. SRES scenario A1 assumes rapid economic growth, low population growth and rapid introduction of new more efficient technologies. The A1 scenario has 3 alternative future energy use storylines: fossil fuel intensive A1FI, the non-fossil fuel (nuclear and renewable) A1T, and A1B which is a balance between the two. The SRES A2 scenario assumes a very heterogeneous world, fertility patterns across regions converge very slowly, which results in high population growth. Economic development is primarily regionally oriented and per capita economic growth and technological change is more fragmented and slower. The SRES B1 scenario assumes a convergent world with low population growth. Rapid changes toward a service / information economy. Reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to sustainability. And the SRES B2 scenario has emphasis on local solutions to development and sustainability. Moderate population growth, intermediate economic development, and less rapid and more diverse technological change.

Impacts of Climate Change

The construction phase of the mine is planned to commence with early phase works in Q2 of 2016 and will continue for 2 years. Climate conditions during the 2 year construction period would not be expected to be different from current conditions even under the more conservative (A2) model scenario.

The mine is expected to be operational for 10 years after construction. During this period, the above projections show that annual temperature is expected to increase and precipitation will decrease. These projected changes are deemed to be within the proposed design and operational tolerances of the Project, and therefore no material impacts on the Project are predicted.

As the Project progresses into detailed design, these climate projections will be fully considered. In particular, issues such as the final water balance, the biodiversity (sensitivity of *Potentilla porphyrantha* and the Sub-alpine vegetation) and closure planning and restoration will be considered. Table 6.4.8 presents a summary of the anticipated climate change impacts and planned mitigation measures. This is further addressed in the cumulative impact assessment in Chapter 7.

Table 6.4.8: Impact Summary – Climate Change

Impact	Source	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
Change in Climate	Based on projections from the Armenian Government	Project (<i>note this assessment is impacts to the Project from a changing climate</i>)	X	X	N	N	<ul style="list-style-type: none"> Tolerance to changes already built into the design and operation proposals. No specific mitigation measures required, however a review detailed design stage will include a thorough integration of the climate projections. 	Annual reporting required by the Carbon and Energy Management Plan Appendix 8.24)
<p>Notes:</p> <p>(1) Primary Receptors:</p> <p>(2) Project Phase: C = Construction, O = Operations, E = employees</p> <p>(3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, VH = very high, MA = major, M = moderate, Mi = minor, N = negligible</p>								

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Note: All figures referred to in this section are presented in A3 flat format and are contained in a separate folder.

6.5 Landscape and Visual Impact Assessment (LVIA)

6.5.1 Assessment Methodology

The assessment of landscape and visual impacts takes account of the IFC PS 6 and EBRD PR 6 requirement that the design of Project components records the potential impacts upon the landscape as a natural resource, and the requirements of IFC PS 3 and EBRD PR 3 which state that the potential for visual impacts related to Project activities is assessed. Recognition is given to the potential visual impact of proposed Project components on people (visual receptors). This analysis considers the visual impacts experienced by receptors, including Project-affected communities and individual receptors and groups of receptors, from identified representative vantage points (viewpoints) and/or areas where the Project will be visible by transient visual receptors (for example roads and tracks). The methodology used for the assessment was developed in accordance with UK current good practice guidance including that contained within the *Guidelines for Landscape and Visual Impact Assessment – Third Edition*¹ (GLVIA 3). GLVIA3 provides guidance on the assessment of both landscape and visual impacts, including assessing the overall significance of impacts, taking account of the sensitivity of the receptor and the magnitude of the impact. The methodology developed for the LVIA generally conforms to the methodology used for ESIA as a whole, as defined in Section 6.1, but has been refined to take on board the details of the subject-specific guidance outlined in GLVIA3. The following methodology outlines deviations from the general methodology outlined in Sections 6.1 to 6.3.

6.5.2 Data Sources

The landscape and visual impact assessment (LVIA) was informed by data gathered from the sources of baseline information listed below:

- Base mapping (1:100,000 and 1:50,000 maps);
- Field surveys and baseline site photography;
- Aerial imagery;
- Computer generated Zones of Theoretical Visibility (ZTVs);
- Computer modelled images (wireframes and photomontages); and
- Baseline information from other associated environmental disciplines within the ESIA.

¹ *Guidelines for Landscape and Visual Impact Assessment, Third Edition* (2013) The Landscape Institute and Institute for Environmental Management and Assessment.

Sources used for the modelling of potential visibility included the following digital data:

- 3-D Topography information at 5 m contour intervals; and
- 3-D Topography information at 25 m contour intervals.

6.5.3 Key Steps in Methodology

An iterative approach was adopted during the design and development of the Project, enabling an understanding of the baseline environment and the early identification of potential impacts to be fed into the evolving design, refining and adapting it so as to help develop the final Project proposals.

The key steps in the methodology were as follows:

- Identification of designations of relevance to landscape and visual amenity;
- Identification of landscape features that may be affected by the Project;
- Identification and description of Landscape Character Types (LCTs) located across the study area, informed by field surveys (undertaken during April and June 2013), taking into account aspects such as geology, topographical structure, vegetation, features of landscape importance (e.g. cultural, archaeological, ecological), existing condition, quality and any given value (reflecting landscape designations);
- Determination of the sensitivity of each LCT to the type and scale of the Project, taking account of their value and susceptibility to change;
- The production of a draft ZTV for the Project study area, using computer modelling extending to up to a 15 km radius from the outermost components of the Project, in order to determine the study area, and to identify potential landscape and visual receptors and representative viewpoints;
- Iterative Project design development (see Chapter 5 Alternatives Analysis), and identification and evolution of appropriate measures to mitigate potential impacts;
- Identification of representative viewpoints to inform the visual assessment, and which are representative of the range of views and types of receptor likely to be affected, and determination of the nature or sensitivity of the receptors they represent to change, taking account of their value and susceptibility to change;
- The production of computer modelled wireframe and photomontage images of the Project from an appropriate selection of representative viewpoints;
- Making judgements about the nature or magnitude of impacts on the landscape (both in terms of direct changes to landscape features and resources, and indirect changes

- to the character of surrounding landscapes) of each LCT, taking cognisance of scale and extent, duration and reversibility;
- Making judgements about the nature or magnitude of impacts on views and visual amenity at each representative viewpoint, taking cognisance of scale and extent, duration and reversibility;
 - Making judgements about the significance of the potential resultant landscape and visual impacts, and setting out the required mitigation measures;
 - Evaluation of the level and significance of residual impacts following the application of mitigation measures (i.e. assuming mitigation is taken on board) upon each landscape and visual receptor; and
 - Consideration of cumulative issues so as to judge the impacts of the Project in combination with other ongoing, committed or proposed developments, or other anticipated changes nearby.

Impacts Assessed in Full

The following impacts are assessed:

- Impacts on landscape resources, including physical changes to the landscape as well as changes in landscape character resulting from a Project activity;
- Impacts on areas designated for their scenic or landscape qualities, at a national or local level;
- Impacts on visual amenity, extending to examination of changes in views arising from the introduction of the Project components in those views;
- Impacts on landscape and visual receptors resulting from changes in relation to the interaction between the development and other existing or proposed developments of a similar nature or scale (cumulative impacts) (see Chapter 7 Cumulative Impacts).

Impacts Scoped Out

On the basis of desk and field based work, initial assessment, the professional judgement of the LVIA team and experience from other relevant projects, the following potential impacts have been 'scoped out':

- Impacts on landscape and visual receptors beyond around 15 km from the outermost components of the Project, where it is judged that potential significant impacts are unlikely to occur;

- Locations where receptors are unlikely to be affected by the Project, through having minimal or no predicted visibility, as predicted by the ZTV.

6.5.4 Approach

The assessment of both landscape and visual effects requires consideration of the nature or **sensitivity** of receptors (taking account of their value and their susceptibility to change) and the nature or **magnitude** of the impact (taking account of scale and extent, duration and reversibility). Each variable is examined, and professional judgements made, based on the use of a consistent set of standard terms. The resulting judgements are then weighed up, through the application of professional knowledge and experience, in order to arrive at a reasoned statement regarding the nature, level and significance of each effect.

The assessment of landscape and visual effects is based on the weighing up and evaluation of the various contributory aspects, resulting in the presentation of a reasoned judgement as to how each has been assessed, and their contribution to the overall level and significance of the identified resultant landscape and visual effects.

A matrix, where the significance of effect is defined based on the direct correlation between the level of sensitivity and the magnitude of the impact, is therefore not used. Each effect can however be evaluated with reference to Diagram 6.5.1, which is shown below as a guide.

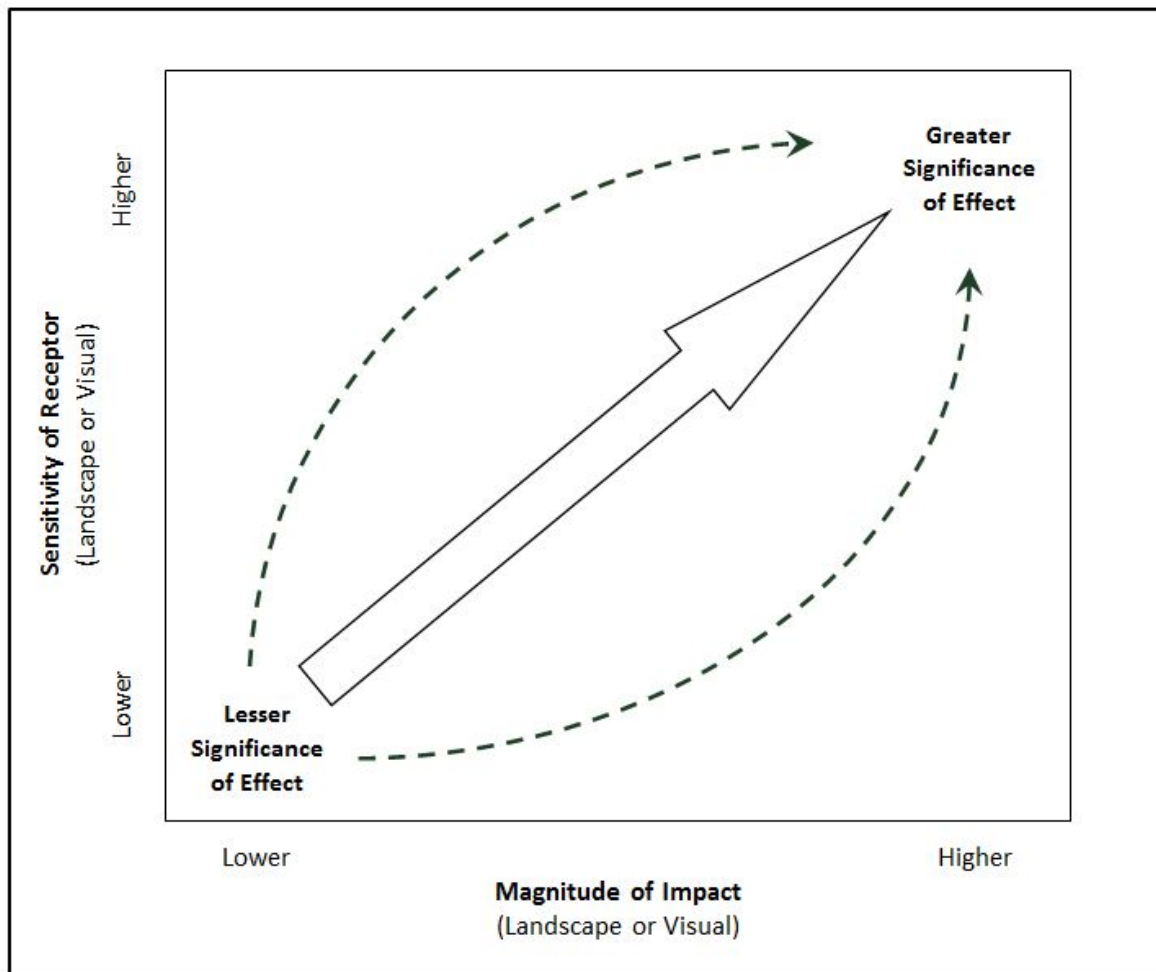


Diagram 6.5.1: Determining Significance of Effect

6.5.5 Landscape Sensitivity

The sensitivity of a landscape receptor varies depending on the condition of the existing landscape and its capacity to accommodate change. Landscape sensitivity is assessed in terms of the susceptibility of a landscape receptor to the type of change proposed and the value attached to the receptor. Landscape sensitivity varies according to the type of development proposed and the individual elements, key characteristics, inherent quality or condition, capacity to accommodate change, and the specific qualities associated with any landscape designations that may apply.

Susceptibility of Landscape Receptors

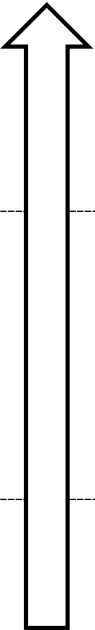
Susceptibility is defined as *“the ability of the landscape receptor (whether it be the overall character or quality/condition of a particular type or area, or an individual element and/or feature, or a particular aesthetic and perceptual aspect) to accommodate the proposed*

development without undue consequences for the maintenance of the baseline situation and/or the achievement of landscape planning policies and strategies” (GLVIA 3 Para 5.40).

Landscape Value

Landscape value is recognised as being a key contributing factor to the sensitivity of landscape receptors, and is determined with reference to the presence of relevant designations and their level of importance. In the absence of designation, reference is made to performance against criteria which are indicative of value, such as condition, scenic quality, rarity, representativeness, conservation interests, recreation value, perceptual aspects, and associations. Value encompasses both that of individual components of the landscape, as well as its resulting overall character.

Judgements regarding the sensitivity of landscape receptors are recorded as **high**, **medium** or **low**² as indicated in Table 6.5.1 below.

Table 6.5.1: Determining Sensitivity of Landscape Receptors (susceptibility and value)	
High	 <p>A landscape of particularly distinctive character, where its character, land use, pattern and scale may offer very limited opportunities for the accommodation of change, and/or development of successful mitigation, and which is therefore highly susceptible to change. May be internationally or nationally designated and valued landscapes. Landscapes or landscape features may display a strong degree of intactness and/or scenic quality, and/or particular rarity.</p>
Medium	<p>A landscape of notable character, which may offer some opportunities for the accommodation of change due to its nature, land use, pattern and scale, but which may demonstrate some susceptibility to the type of change proposed. May offer more opportunity for the development of successful mitigation. May be nationally, regionally or locally designated and valued landscapes. Landscapes or landscape features may display, to a lesser degree, relative intactness and/or scenic quality, and/or some rarity.</p>
Low	<p>A landscape which is of low scenic quality, and/or where its character, existing land use, pattern and scale are of low susceptibility to change and/or offer very good opportunities for successful mitigation, or enhancement. May be locally designated and valued landscapes. Landscapes or landscape features may display little landscape and/or scenic quality, and may be commonplace.</p>
<p>Note: there is a gradual and blurred transition between each grade and judgments about the sensitivity of landscape receptors may include individual features or areas.</p>	

² Note that a category of ‘very high’ sensitivity as defined elsewhere within the ESIA methodology is not used within this landscape and visual assessment.

6.5.6 Magnitude of Landscape Impacts

Impacts on landscape receptors are evaluated with regard to their magnitude, which encompasses size and scale, geographical extent duration and reversibility, which are outlined in more detail below.

Size and/or Scale, and Geographical Extent

This is a measure of the extent of existing landscape elements that will be lost, the proportion of the resource that this represents, the contribution of such elements to the character of the landscape, and the size of the geographical area across which the impacts will be felt. In terms of landscape character, this reflects the degree to which the character of the landscape will change by removal or addition of landscape components, and how the changes will affect key characteristics. Size/scale is described as being **large**, **medium** or **small**, and the geographical extent over which the impact will be experienced is described as **widespread** or **localised**, i.e. at a regional level, or associated with the more immediate setting of the site.

Duration

Duration is reported as **long-term** (a permanent impact remaining from construction and operation of the Project after mitigation measures have been applied, generally lasting over 15 years), **medium-term** (generally 3-15 years), or **short-term** (an impact that will occur during construction or operation activities, lasting throughout the relevant Project stage, generally lasting less than 3 years). Impacts which last for the life of the project but which will not extend beyond closure, or will be very much reduced at this stage are considered to be medium-term.

Reversibility

Reversibility is reported as **permanent**, **partially reversible** or **reversible**.

Judgements regarding the magnitude of landscape change are recorded as **high**, **moderate**, **low** or **barely perceptible**, as indicated in Table 6.5.2 below.

Table 6.5.2: Magnitude of Landscape Impact (Size and/or scale, geographical extent, duration, reversibility)	
High	A large change in landscape characteristics and/or over extensive geographical area and/or which may result in an irreversible landscape impact.
Moderate	A moderate change in landscape characteristics and/or which may be over a large geographical area, and/or which may be reversible over a long duration of time.
Low	A small change in characteristics of the landscape and/or which may be over a relatively localised geographical area, and/or which may be reversible over a short duration of time.
Barely perceptible	A virtually imperceptible change in characteristics of the landscape and/or which is focused on a small geographical area, and/or which is almost or completely reversible.

6.5.7 Assessing the Significance of Landscape Effects

The evaluations made against each consideration are set out, and then considered together to provide an overall profile of each identified landscape impact. An overview is then taken of the distribution of judgements for each aspect, in order to make an informed professional assessment of the overall significance of each resultant landscape effect. This overview balances and takes account of the relative importance of each aspect. Although without a numerical or formal weighting system, appropriate weight is therefore given to the relative importance of each of the aspects that must be considered.

Levels of Landscape Effect, and Significance

Following evaluation of sensitivity (susceptibility, value), and magnitude (size and/or scale, geographical extent, duration and reversibility), the overall significance of the landscape effect is determined, by making an informed professional judgement, on the basis of weighing up all aspects that have been considered.

The levels of landscape effect are described as being **major**, **moderate**, **minor** or **negligible**, in line with Table 6.5.3 and whereby **major** and **moderate** effects are considered significant. Note that there is a gradual, blurred transition between levels.

Table 6.5.3: Levels of Landscape Effect	
Major	Changes substantially affecting the character of the landscape or the elements therein. For example a major impact is likely when a receptor of high sensitivity is affected by a high magnitude of landscape impact.
Moderate	Change affecting, to a lesser degree, the character of the landscape or the elements therein. For example a moderate impact is likely when a receptor of medium sensitivity is affected by a moderate magnitude of landscape impact.
Minor	Slight change affecting the character of the landscape or specific elements therein. For example a minor impact is likely when a receptor of low sensitivity is affected by a low magnitude of landscape impact.
Negligible	No or minimal perceptible change, affecting the character of the landscape or specific elements therein. Note that this includes locations where there will be no landscape impacts.

Landscape effects are described as either **not significant** or **significant**, as outlined in Table 6.5.4 below.

Table 6.5.4: Significance of Landscape Effects	
<p>Not Significant</p> <p>Landscape effects may be reversible and/or of short duration, and/or over a restricted area, affecting elements and/or characteristics (including aesthetic and perceptual aspects) that contribute to but are not key to the character of landscapes.</p>	<p>Significant</p> <p>Landscape effects may be long-term and/or irreversible, and/or over an extensive area, affecting elements and/or characteristics (including aesthetic and perceptual aspects) that are key to the character of nationally valued landscapes.</p>

Direction of Landscape Effects

The direction of effect (**adverse**, **positive**, or **neutral/mixed**) is determined in relation to the degree to which the proposal fits with the existing landscape character, and the contribution the Project makes to the landscape.

6.5.8 Visual Sensitivity

The visual impact assessment assesses the impact of the proposed project on views, and the visual amenity of receptors (i.e. people who could experience views of the Project). A particular person or group of people will be affected by a change in view or visual amenity in different ways. Visual sensitivity is assessed in terms of the susceptibility of the receptor to change in views/visual amenity and the value attached to particular views.

Susceptibility of Visual Receptors

The susceptibility of visual receptors to changes in views/ visual amenity is a function of the occupation or activity of people experiencing the view and the extent to which their attention is focused on views.

Value Attached to Views

A judgement is made about the value attached to views included within the assessment of visual impacts, and takes account of the following key considerations:

- Recognition of the value attached to specific views, in relation to key landscape features, heritage assets or designation;
- Indicators of value attached to specific views by receptors (specifically visitors and tourists), through appearance in guidebooks or on maps, or through the provision of facilities to experience the view.

Judgements regarding the sensitivity of visual receptors are recorded as **high, medium or low**² according to Table 6.5.5.

Table 6.5.5: Determining Sensitivity of Visual Receptors (susceptibility and value)	
High	Communities where views contribute to the landscape setting enjoyed by residents; people engaged in outdoor recreation (i.e. users of recreational paths whose interest is likely to be focused on the landscape); visitors to heritage assets or other attractions where views of surroundings are an important contributor to experience, and travellers on scenic routes where attention is focused on the surrounding landscape. These are receptors which are deemed to be of high susceptibility to change. Recognized views, perhaps referred to in literature, recorded in guide books or on maps.
Medium	Recreational travelers on roads; people at their place of work whose attention is not on their surroundings, but where setting is important to the quality of their working life. These are receptors which are deemed to be of medium susceptibility to change. Views which are not formally recognized, but which may be valued locally.
Low	People engaged in long distance travel on roads, outdoor sport or recreation which does not involve or depend upon appreciation of views of the landscape; people at their place of work whose attention is not on their surroundings, and where setting is of less important to the quality of working life. These are receptors which are of low susceptibility to change. Views which more ordinary, and which are not specifically valued.
Note: there is a gradual and blurred transition between each grade. The presence of a large number of viewers in a location that will otherwise be of low or medium sensitivity may increase the sensitivity.	

6.5.9 Magnitude of Visual Impacts

The overall magnitude of each visual impact is evaluated with regard to the following aspects: size and/or scale, geographical extent, duration and reversibility. These aspects are outlined in more detail below.

Size and/or Scale

The size and/or scale of the visual impact takes account of:

- The scale of the change in view with respect to the loss or addition of features and /or changes in composition, including the proportion of the view occupied by the proposed development;
- The degree of integration of new features or changes in the landscape into the existing view, in terms of aspects such as form, scale and mass, line, height, colour and texture; and
- The nature of the view of the proposed development, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses.

In this assessment of size/scale is described as being **large, medium, small** or **imperceptible**.

Geographical Extent

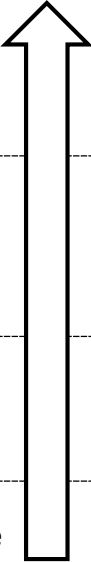
The geographical extent of the visual impact, described as **widespread, localised**, or **immediate** varies in relation to different viewpoints and reflects:

- The direction or bearing of view of the development in relation to the main activity or view experienced by the receptor;
- The distance of the viewpoint from the proposed development; and
- The extent of the area over which the changes will be visible.

Duration/Reversibility

Duration is reported as **short-term** (0-3 years – an impact that will occur throughout the exploration and construction phase), **medium-term** (3-15 years – impact that will occur during the operations, decommissioning and closure) and **long-term** (over 15 years – an impact that will remain following the life of the Project and the application of restoration measures). Reversibility is reported as **permanent, partially reversible**, or **reversible**.

Judgements regarding the magnitude of visual impacts are recorded as **high**, **moderate**, **low** or **barely perceptible**, as indicated in Table 6.5.6 below.

Table 6.5.6: Magnitude of Visual Impact (Size and/or scale, geographical extent, duration, reversibility)	
High 	Substantial changes, which may be seen for a long duration, and/or be clearly perceptible, and/or which may be in stark contrast with the existing view, and/or obstruction of a substantial part or important elements of views beyond the Project main area, and/or which may result in an irreversible change.
Moderate	Location affected by moderate changes in views, and/or visible for a shorter duration, perhaps at a slight angle from the main focus of the view, and/or where changes may be in contrast with the existing view, and/or obstruction of a noticeable part or elements of views beyond the Project main area. The change may be reversible over a long duration of time.
Low	Location affected by slight changes in views, and/or visible for a short duration, perhaps at an oblique angle, and/or which may fit to an extent with the existing view. The change may be reversible over a shorter duration of time.
Barely Perceptible	Location affected by a change which is barely visible, and/or visible for a very short duration, perhaps at an oblique angle to the main focus of the view, and/or which may blend with the existing view, usually at some distance from the Project, and/or where the change is almost or completely reversible.

6.5.10 Assessing the Significance of Visual Effects

As for landscape impacts, the evaluations against the considerations above are set out together to provide an overall profile of each resultant visual effect. An overview is then taken and an informed professional assessment made of the overall significance of each visual effect. This overview takes account of the judgements made in relation to each aspect considered. Therefore, although without a numerical or formal weighting system, appropriate attention is given to the balance and relative importance of each aspect in each case.

Levels of Visual Effect, and Significance

Levels of visual effect are described as being **major**, **moderate**, **minor** or **negligible**, outlined in Table 6.5.7 below and in line with Table 6.5.3, and where **major** and **moderate** effects are considered significant. Note that there is a gradual, blurred transition between levels.

Table 6.5.7: Levels of Visual Effect	
Major	Changes substantially affecting views and visual amenity. For example a major impact is likely when a receptor of high sensitivity is affected by a high magnitude of visual impact.
Moderate	Change affecting, to a lesser degree, views and visual amenity. For example a moderate impact is likely when a receptor of medium sensitivity is affected by a moderate magnitude of visual impact.
Minor	Slight change affecting views and visual amenity. For example a minor impact is likely when a receptor of low sensitivity is affected by a small magnitude of visual impact.
Negligible /None	No or minimal perceptible change, affecting views and visual amenity. Note that this includes locations where there will be no impacts.

Following evaluation of the various considerations (sensitivity: susceptibility, value; and magnitude: size and scale, geographical extent, duration and reversibility), the overall significance of the visual effect is determined, by making an informed professional judgement, taking account and weighing up all the aspects which have been considered.

Visual effects are described as either **not significant** or **significant**, as outlined in Table 6.5.8 below.

Table 6.5.8: Significance of Visual Effects	
<p>Not Significant</p> <p>Visual effects on people who are generally less sensitive to changes in views/ visual amenity.</p> <p>Small changes and/or changes which are well integrated into the view, often involving features already present in the view.</p> <p>These may be reversible effects/ or of short duration.</p>	<p>Significant</p> <p>Visual effects on people who may be particularly sensitive to changes in views/ visual amenity, and/or at recognised viewpoints or recognised scenic routes.</p> <p>Large scale changes which introduce new, non-characteristic or discordant or intrusive elements into the view.</p> <p>These may be long-term/ irreversible effects.</p>

Direction of Visual Effects

The direction of effect (**adverse**, **positive** or **neutral/mixed**) is determined in relation to the degree to which the proposal fits with existing views, and the contribution to the view that the Project makes.

6.5.11 Key Terminology

The key terminology used in this assessment is set out in Table 6.5.9 below.

Table 6.5.9: Key Considerations and Terms			
Consideration	Terminology		
Sensitivity	Low	Medium	High
Susceptibility	Low	Medium	High
Value	Local	Regional	National/International
Magnitude	Low / Barely perceptible	Moderate	High
Size/scale	Small	Medium	Large
Extent	Immediate / Individual	Local / Localized	Regional / Widespread
Duration	Short-term (0-3yrs)	Medium-term (3-15yrs)	Long-term (>15yrs)
Reversibility	Fully reversible	Partly reversible	Permanent
Frequency	Infrequently intermittent	Frequently intermittent	Continuous
Direction	Positive	Mixed/Neutral	Adverse
Significance	Minor / Negligible	Moderate	Major

6.5.12 Project Components Related to Landscape and Visual Resources

Sources of potential landscape and visual impact were identified based on Project activities, and the related Project components. The Project consists of a number of components of different size and scale in relation to the existing landscape. These components will occupy varying extents of the Project-affected area and result in varying levels of impact, of both a direct nature in relation to landscape resources, and an indirect nature in relation to wider landscape character and visual amenity. Those components of greatest size and extent will generally result in the greatest impacts on both landscape and visual receptors.

The key components of the development which will be the main sources of landscape and visual impacts will be:

- Open pits: Erato and Tigranes/Artavazdes;
- Barren Rock Storage Facility (BRSF);
- Haul and access roads;
- Crushing and screening facility (contains the primary and secondary crusher and building fabric that contains these units);
- Low-grade ore stockpile;
- Run of Mine (ROM) stockpile
- Overland conveyor, and truck load-out area;
- Truckshop and administration facilities;
- Passive water treatment system;

- Worker accommodation camp; and
- Heap Leach Facility (HLF) including:
 - Heap leach pad (HLP);
 - Contact water, process and storm water ponds; and
 - Adsorption-Desorption-Recovery (ADR) plant.

An existing 110kV power-line runs roughly north-south from a primary substation near the M-2 highway to the Jermuk substation; the line then continues south towards Gorayk. A new main substation will be built for the Project next to this line close to the RD-3/RD-1 road junction. Overhead 35kV power lines will run from the main substation along the conveyor to the mine facilities and crushing plant, and to the truck load out and ADR Plant. At these points area substations will further step down the voltage and distribute power to the individual components of the mine maintenance facilities, crushers and transfer conveyors, HLF, ADR plant, and Arpa River water supply pump station.

Other infrastructure and componentry are described in more detail within Chapter 3: Project Description and the overall project componentry plan is shown on Figure 3.1.

Lighting associated with some componentry and infrastructure of the proposed Project will be visible during hours of darkness and where applicable, consideration of visual impacts associated with the lighting of specific componentry is included within the assessment.

6.5.13 Project Phases and Assessment Phases

The LVIA has considered a sequence of four main Project phases³ (these are a simplification of the more detailed phases and sub-phases set out in the Project description, in order that the landscape and visual impacts associated with each key phase can be set out and illustrated), which are outlined in Table 6.5.10 below. In order to capture the potential landscape and visual changes experienced throughout the life of the Project, these Project phases required some summarisation and grouping as fully detailed in Chapter 3 Project Description:

³ The exploration phase of the project, as described with Chapter 3: Project Description has not been assessed within the LVIA. Disturbance across the project site caused by exploration or construction activities cannot in many cases be clearly distinguished, therefore any impacts from the exploratory phase have been considered within the assessment of construction phase impacts.

- Construction Phase;
- Operations Phases⁴;
- Closure Phase;
- Post-Closure Monitoring Phase.

Whilst the Project is live, it will be divided into the three main phases (construction through to closure); however, in practice there will be a fluid transition between the end of one phase and the start of the next, and some activities will occur concurrently. For example, restoration and closure of the open pit at Tigranes/Artavazdes will commence with the opening of the Erato pit whereby barren rock from the Erato pit will be used to backfill the Tigranes/Artavazdes pits. At closure, the Erato pit will be partially backfilled with barren rock from the Erato pit to an estimated depth of approximately 30m above the final pit depth.

Within each Project phase a number of project activities are identified and are scheduled to be undertaken at different stages within the life of the Project, as outlined within the project description. Landscape and visual impacts associated with the following Project phases are considered at five different assessment stages, as outlined in Table 6.5.10 below:

Table 6.5.10: Project and Assessment Phases			
Project Phase	Year	Key Project Activities	Assessment Phase
Construction⁵	Years -2 to -1	Ongoing exploratory activities, construction of Project infrastructure (including HLF) Night time lighting	Assessment at c. year 2 of construction (assumed to be before open pit extraction begins) Representing: Construction Phase: Year -1
Operations Phase	Years 1 to 3	Ongoing exploratory activities, extraction of barren rock and ore from Tigranes/Artavazdes open pit, operation of HLF and BRSF Night time lighting	Assessment at c. Year 3 of operations (assumed to be before extraction of the Erato open pit begins). Representing: Operations Phase: Year 3

⁴ Operations Phase defined as between the start and end of the mining and ore processing period.

⁵ Includes consideration of evident disturbance caused during exploration phase of the project.

Table 6.5.10: Project and Assessment Phases

Project Phase	Year	Key Project Activities	Assessment Phase
Operations Phase	Years 4 to 10	Ongoing exploratory activities, extraction of barren rock and ore from Tigranes/Artavazdes, and Erato open pit, operation of HLF and BRSF Night time lighting	Assessment and illustration at c. Year 10 of operational Project phase (assumed to be when Erato open pit, Tigranes/Artavazdes open pit, and the HLF & BRSF are all at their maximum size). Representing: Operations Phase: Year 10 - Maximum Case Scenario
Closure	Years 11 to 14	Cessation of production, closure activities and restoration measures	Assessment at c. Year 14 of Project (assumed to be when closure works cease (note some operations continue to year 11)). Representing: Closure Phase: Years 11-14
Post-Closure Monitoring	Years 15 to 19	Post-closure monitoring of closure activities and restoration measures	Assessment and some illustration at c. Year 19 of Project (assumed to be when restoration proposals have matured). Representing: Post-Closure Monitoring Phase: Year 19

A brief outline of the Project activities and Project components involved within each phase of the Project are provided below. More detailed information is provided within Chapter 3 Project Description.

Construction Phase: Years -2 to -1

During this phase of the Project the main construction works will be undertaken and will include construction of support infrastructure, haul roads, access roads, the BRSF, the crushing and screening facility, which will occupy an area of approximately 13.9 ha, overland conveyor and truck load-out area, which will occupy an area of approximately 19.3 ha (a length of approximately 5.6 km), the HLF, process ponds and ADR plant which will occupy an area of approximately 165.5 ha, substations, maintenance workshop and accommodation facilities. Two quarries will be developed to supply aggregate for construction, together with crushed, non-acid generating barren rock from developing the open pit that will be used to construct the base of the haul roads. The construction of these Project components and the final completed components will become perceptible during this phase, which will last for a period of approximately two years.

The utilisation of the workers accommodation camp will be reduced at the end of the construction phase. The area occupied by the camp will be restored, topsoil replaced and returned to grassland following the closure and removal of the camp.

Operations Phase: Years 1 to 3

During this phase, Project mining operations will begin, with the extraction of barren rock and ore from the Tigranes/Artavazdes open pit, depositing of barren rock on the BRSF and ore on the phases 1 and 2 areas of the HLF respectively. The progressive change in the profile of the open pit will become perceptible on the skyline during this period. The open pit will occupy an area of approximately 96.8 ha. During this phase the HLF will occupy an area of approximately 46 ha and at its highest vertical extent, will reach 80 m at approximately 1712 m asl. Phase 1 and 2 areas of the HLF will be approximately 40% of the total eventual extent of the HLF and will progressively increase in vertical height, as the depositing of ore takes place. The phase 1 area of the HLF will reach its maximum height of 1664 m asl in four lift stages of 8 m each, and phase 2 will add a further six lifts. Vehicle movements on site and the operation of Project components will be perceptible throughout this phase, which will last for a period of approximately three years.

Operations Phase: Years 4 to 10 – Maximum Case Scenario

During this phase, Project mining operations will extend to create the Erato open pit (starting in Year 4) resulting in a progressive change in the profile of the skyline alongside the existing open pits of Tigranes/Artavazdes. The second pit will become perceptible on the skyline. Barren rock from the Erato open pit will be deposited as backfill within the open pit of Tigranes/Artavazdes beginning in Year 4, and ore will be deposited on the phases 3 and 4 areas of the HLF. Low grade ore stockpiled at the BRSF will continue to be processed until Year 10. The extraction of ore from the Tigranes/Artavazdes open pit will cease during approximately Year 8 of the Project. During this phase of the project, the BRSF and HLF will progressively increase in size as the depositing of barren rock and ore continues. The phase 3 area of the HLF will reach its maximum vertical height of 1768 m asl at the completion of this phase, following the seven designed lift stages of 8 m. The final, phase 4 area of the HLF will reach its maximum vertical height of 1856 m asl in Year 10 at the completion of this operational phase, following the 11 designed lift stages of 8 m. The maximum height of the HLF will be 120 m above the heap leach pad liner at the completion of this phase. Vehicle movements on site and the operation of Project components will be perceptible throughout this phase, which will last for a period of approximately seven years. The potential landscape and visual impacts identified at Year 10 of the Project represent a potential 'Maximum Case

Scenario', when the Project is at its largest potential extent covering total Project Footprint area of approximately 597 ha.

Potential visual impacts arising from the lighting of Project components and lighting from plant machinery and vehicles on site within this period are considered as part of the overall judgements made regarding the impacts of night time lighting. This assessment of lighting impacts represents the maximum case scenario of lighting impacts likely to be experienced throughout the life of the Project.

Closure Phase: Years 11 to 14

The closure phase of the Project will begin before the completion of the operations phase, with progressive restoration of the BRSF from Years 3 to 7 and of the Tigranes/Artavazdes and Erato open pits from approximately Years 4 and 9 of the Project, respectively. Following the cessation of all mining and processing activities in Year 10, closure will commence with the reclamation of the HLF, ponds, south and east facing slopes of the BRSF and removal of other componentry, together with the dismantling of infrastructure and restoration of these and other disturbed areas in order to seek to establish a grassland vegetation cover which supports habitats similar to those present on the Amulsar site prior to the commencement of the Project in accordance with the Preliminary Mine Reclamation, Closure and Rehabilitation Plan (pMRCRP, see Appendix 8.18).

Post-Closure Monitoring Phase: Years 15 to 19

Once closure activities and restoration measures are implemented, post-closure monitoring is expected to continue until approximately Year 19 of Project (nine years after the completion of mining activities), to ensure that restoration and aftercare is maintained and to implement remedial actions as required. The potential landscape and visual impacts identified at Year 19 of the Project are assessed from each viewpoint and supported by visualisations from three representative viewpoints showing the proposed Project at Year 19, following implementation of the proposed closure activities and restoration measures. During this period, it is expected that low level grassland vegetation will become progressively more noticeable as it becomes established across the former disturbed areas, and that any trees which are planted at lower levels on the mountain will have grown to a reasonable size.

6.5.14 Potential Landscape and Visual Impacts

Landscape and visual impacts will result from alterations to the landscape during the construction and operational phases, and will gradually diminish post closure and restoration.

Landscape and visual impacts will vary in intensity throughout the Project development phases, as well as from location to location, depending upon the focus of activities at different times.

A detailed outline of the activities associated with each of the above Project phases is included in Chapter 3: Project Description; however, the activities which define each Project phase are outlined in Table 6.5.10 and give rise to the potential landscape and visual impacts summarised below.

Potential Impacts: Construction Phase: Years -2 to -1

Potential landscape and visual impacts resulting during the construction phase will arise from visible surface alterations and construction activities, including those arising from (see also Chapter 3: Project description and Figure 3.1):

- Use of the existing access track from access junction D at Kechut (see Figure 3.24) by construction vehicles bringing materials, components and workers involved in construction of the mine facilities at the top of the mountain;
- Use of the existing road from access junction B (see Figure 3.24) by vehicles bringing materials, components and workers involved in construction of the conveyor and nearby facilities;
- Use of the existing track from access junction A (see Figure 3.24) by vehicles bringing materials, components and workers involved in construction of the HLF facility;
- Construction of the worker accommodation camp, to the south of the HLF;
- Construction of the main haul road on the western side of Amulsar Mountain and the movement of vehicles between the worker accommodation camp area, the open pits, the BRSF and the building that will house the crushing and screening facility;
- Establishment of working, storage and fabrication areas, offices and maintenance workshops;
- The erection of site and security fencing around Project facilities;
- Installation, movement and storage of surface construction machinery, and delivery lorries;
- Clearing of vegetation, topsoil and subsoil, and construction of topsoil and subsoil stockpiles to a height of 3m to 5m (with the option to construct screening bunds using subsoil and dressed with a topsoil horizon, so that the outer facing slope can be vegetated and maintained for the duration of the operational phase), to store the materials for use in restoration and/or provide a barrier between operational and non-operational land;

- Land clearing, earthworks and installation of pad-liners for the BRSF and HLF;
- Construction of the building that contains the crushing and screening facility, overland conveyor, ADR plant and collection ponds;
- Lighting of vehicles, lay down areas and Project components with temporary lighting; and
- Landscape works and post-construction restoration activities such as removal of temporary laydown areas.

The construction phase of the Project therefore has potential to result in significant, albeit short to medium-term and, to an extent, intermittent impacts on both landscape and visual receptors.

Potential Impacts: Operations Phase: Years 1 to 3

Potential landscape and visual impacts resulting during the early operation of the Project will include continuing change to the landform, operation and activities, which are visible from outside the Project-affected area, as well as those associated with people and vehicle movements, and the operation of mobile plant. They include (see also Chapter 3: Project description):

- Restoration of quarries developed during the construction phase for supply of aggregates;
- Restoration of laydown and storage areas used during the construction phase;
- Use of the Project access and haul roads by vehicles bringing workers and materials to and from the Project-affected area (see Chapter 6.19: Transport);
- The medium-term presence of all Project components, stockpiled materials, and ancillary infrastructure in the landscape and in views;
- Operation of the Tigranes/Artavazdes open pit, including changes in the profile of the skyline;
- Movements of mine vehicles between the open pits, the BRSF and the crushing and screening facility ;
- Operation of the crushing and screening facility;
- Operation of the overland conveyor between the crushing and screening facility and truck load-out facility, and haulage of the crushed ore to the HLF;
- Operation of the BRSF and the phase 1 and 2 areas of the HLF, including mine vehicle movements and increases in the size of both these Project components during this Project phase; and
- Lighting of project components, ancillary infrastructure and vehicles.

This operations phase therefore has potential to result in significant, albeit medium-term and, to an extent, intermittent impacts on both landscape and visual receptors.

Potential Impacts: Operations Phase: Years 4 to 10 – Maximum Case Scenario

The assessment of this Project phase is supported by viewpoint visualisations from 17 representative viewpoints showing the proposed Project at Year 10, including reference to winter conditions from five viewpoints.

The potential for the visible presence of dust across snow fields during winter is also considered in the assessment. Fallout of dust from blasting and mining operations will be visible as darker particulates on the surface of the snow, particularly later in the late winter and early spring when there is less frequent fresh snowfall, and when the sun may result in earlier melting of darker areas of the snow pack. The grey/yellow colouration of snow by atmospheric dust, particularly during later winter and early spring is a natural phenomenon, but this may be emphasised slightly by the greater level of atmospheric disturbance around the site, as a result of the works. Other operations that could highlight the visibility of Project components include use of rock salt, exposing darker surfaces beneath the snow, and snow clearance that could result in exposing the underlying darker surface, and the presence of snow mounds that could be visible adjacent to working areas and the mixing of snow with darker particulate matter from the underlying surface.

Dust will be less apparent during other months (before winter snow cover or following snow melt), as it will be less visible against the brown or green of the underlying landscape.

Potential landscape and visual impacts resulting during the later operations phase of the Project will arise from operational activities and visible surface alterations to the major Project components (i.e. the open pits, BRSF and HLF), including those arising from (see also Chapter 3 Project Description):

- Use of the Project access roads by vehicles bringing workers and materials to and from the Project-affected area;
- The medium-term presence of all Project components, stockpiled materials, and ancillary infrastructure in the landscape and in views;
- Movements of mine vehicles between the open pits, the BRSF and the crushing and screening facility;
- Operation of the Tigranes/Artavazdes, and Erato open pits, including changes in the profile of the skyline;

- Operation of the crushing and screening facility;
- Operation of the overland conveyor between the crushing and screening facility and truck load-out facility, and haulage of the crushed ore to the HLF;
- Operation of the BRSF and the phase 3 and 4 areas of the HLF which will see both Project components continue to increase in size during this Project phase;
- Lighting of project components, ancillary infrastructure and vehicles; and
- Activities associated with the progressive restoration of the Tigranes/Artavazdes open pit, including the movement of mine vehicles during the backfilling of the open pit with barren rock material from the Erato open pit.

This later operations phase therefore has potential to result in significant, albeit medium-term and, to an extent, intermittent impacts on both landscape and visual receptors.

Impacts Associated with Lighting during Night Time Hours

The lighting of Project components, mobile plant machinery and vehicles across the Project-affected area may potentially give rise to visual impacts. These impacts associated with lighting may arise during the construction, operation and closure phases as a consequence of:

- Direct lighting: where light is directly experienced by the receptor, for example a vehicle moving towards a viewer (this will especially be the case for mine vehicles travelling northwards along the main haul road on the west of the mountain where headlights will shine light directly towards the settlements of Jermuk and Kechut);
- Indirect lighting: where the light source is not directed at the receptor but the pool of light from a lighted Project component, or from vehicles will be seen;
- Night glow: impacts arising from lighting which is of sufficient strength from a single or multiple source to be reflected in the atmosphere. Such impacts will be influenced by atmospheric conditions such as fog, low cloud and/or dust particles, which will reflect the light. Conversely on clear nights these impacts may be reduced.

Potential Impacts: Closure Phase: Years 11 to 14

Potential landscape and visual impacts resulting during the closure and restoration of the Project will be associated with activities which are visible from outside the Project Footprint, as well as those associated with people and vehicle movements, and the operation of machinery. They will gradually diminish as works are completed, and will include (see also Chapter 3: Project description and pMRCRP; Appendix 8.18):

- Use of access roads by vehicles bringing in workers involved in decommissioning and restoration of the Project-affected area;

- Progressive restoration of the final profile of the Tigranes/Artavazdes open pit, and partial backfill of the Erato open pit;
- Activities associated with the removal of Project components from the landscape, including the building that contains the crushing and screening facility , overland conveyor, ADR plant, ponds, substations, maintenance workshop and facilities, security fencing and ancillary structures such as visible pipework and drainage culverts; and
- Activities associated with the progressive restoration of all other disturbed areas in order to seek to blend altered land forms with those present naturally, and to promote gradual restoration of appropriate native vegetation.
- Night lighting from areas that remain illuminated during darkness and from mobile plant that is operated after night fall (see 6.5.14).

Most remnants of the Project, including concrete and other buried man-made constructions, will be removed, down to approximately 1 m below ground level, but as complete removal will result in large scale disturbance, some elements will be left in place.

The restoration phase therefore has potential to result in significant, albeit medium-term and, to an extent, intermittent impacts on both landscape and visual receptors.

Potential Impacts: Post-Closure Monitoring Phase: Years 15 to 19

The assessment of this Project phase is supported by viewpoint visualisations from three representative viewpoints showing the proposed Project at Year 19, following the implementation of all restoration measures and post-closure monitoring. Potential landscape and visual impacts resulting in the long term will be confined to the remnant permanent alteration of the land form. In the absence of restoration, disturbed surfaces could persist for a number of years; however, the implementation of appropriate mitigation measures will help ensure successful landform integration and revegetation.

This phase will last for up to five years with ongoing monitoring undertaken particularly in relation to the gradual return of the slow growing Sub-alpine vegetation which is present across a relatively large proportion of the directly Project-affected area. The recolonisation of the Sub-alpine vegetation zone will require the replication of approaches developed through ongoing studies and trials undertaken throughout the operation phase to be implemented across a much larger area in order for successful revegetation of affected areas. More information on the restoration of vegetation is provided in Chapter 6.11: Biodiversity and

Ecosystems.

Landscape and visual impacts identified during this assessment phase of the Project represent the long-term permanent residual impacts resulting from the Project.

6.5.15 Potential Landscape Receptors

Identifying Potential Landscape Receptors

Six broad Landscape Character Types (LCTs) have been defined and are described in Section 4.3, Landscape and Visual Resources. Potential impacts on landscape receptors will arise from the construction, operation and closure of the Project, as outlined in the previous section.

Direct and Indirect Landscape Impacts

Impacts can be direct (i.e. where the components of the Project are located within the LCT, and therefore will directly or physically affect the landscape resource) or indirect (i.e. where components of the Project located outside the LCT may affect the landscape character or views within an adjacent or more distant LCT).

Direct impacts on landscape character are predicted in the areas where the project components will be located, across their physical footprints.

In order to identify potential indirect impacts on landscape character, Zones of Theoretical Visibility (ZTVs) were generated to indicate the extent of theoretical visibility of the Project components across the study area (Figure 6.5.2). The extent of theoretical visibility of the Project components across the landscape types identified within the study area allows potential indirect impacts on landscape character to be identified (Figure 6.5.3 to 6.5.8). Essentially, changes to landscape character will be as a direct consequence of the visible changes experienced from the wider area.

As outlined in Chapter 4.3, there are no areas designated for landscape qualities, such as State Reserves or National Parks located within the study area. No areas outside of the study area, which are designated for special landscape qualities, will be affected by the proposed Project, either directly or indirectly.

Although there are no areas within the study area designated for their specific landscape qualities, a number of Specially Protected Nature Areas, designated for their nature conservation qualities and sensitivities are located within the study area, and are designated

as State Sanctuaries. These State Sanctuaries are listed below and shown on Figure 4.3.5, and are described and assessed in more detail within Section 6.11 Biodiversity.

- Her-her Open Woodland State Sanctuary;
- Jermuk Forest State Sanctuary.

Potential direct and indirect impacts upon the specific landscape character and landscape features, which may contribute to their nature conservation designation as Specially Protected Nature Areas, are considered within the assessment of individual LCTs within which they lie.

Table 6.5.11 outlines the LCTs identified within the study area and the associated nature of potential impacts on the landscape receptors which are considered within the assessment.

Table 6.5.11: Landscape Character Types	
Landscape Character Type	Direct / Indirect Impacts
Settled Lowland and Rocky Gorges (generally found at elevations below 2,000 m asl)	Indirect Impacts
Lower Farmed and Settled Foothills (generally found at elevations of 2,000 - 2,300 m asl)	Direct and Indirect Impacts
Forested Upper Gorge and Foothills (generally found at elevations of 2,300 - 2,500 m asl)	Direct and Indirect Impacts
High Steppe and Plateau Grassland (generally found at elevations of 2,000 - 2,300 m asl)	Direct and Indirect Impacts
Highland Hills and Grazing (generally located at elevations of 2,300 - 2,700 m asl)	Direct and Indirect Impacts
High Rocky Peaks (generally found at elevations over 2,700 m asl)	Direct and Indirect Impacts

6.5.16 Potential Visual Receptors

Identifying Visual Influence

As outlined in Section 4.3, the process of identifying the extent of visual influence of the Project was informed by generating Zones of Theoretical Visibility (ZTVs).

Zones of Theoretical Visibility

ZTVs were generated to indicate the extent of theoretical visibility of the Project across the study area (Figure 6.5.2), extending to an area of approximately 15 km radius from the outermost components of the Project, within which significant visual impacts are likely to be contained. The ZTV is based on a bare ground terrain model and therefore illustrates a 'maximum case scenario' with no account taken of screening by vegetation and buildings.

ZTVs were also generated for the following individual Project components:

- Open pit of Erato; (Figure 6.5.3)
- Open pit of Tigranes/Artavazdes; (Figure 6.5.4)
- HLF; (Figure 6.5.5)
- BRSF; (Figure 6.5.6)
- Building that contains the crushing and screening facility; (Figure 6.5.7)
- Overland conveyor. (Figure 6.5.8)

The individual component ZTVs were combined to create a Cumulative ZTV (CZTV) (Figure 6.5.9) showing the relative theoretical visibility of different combinations of the component parts of the Project.

Identifying Potential Visual Receptors

Section 4.3 provides a brief outline of the potential visual receptors (people) who may experience visibility of the Project, and a change in those views as a result. These receptors (groups of people who may experience changes in their views) are listed below:

- Residential receptors in potentially affected communities (e.g. Gndevaz, Jermuk, Kechut, Saravan, Saralanj, Ughedzor, Gorayk);
- Tourists and visitors (e.g. tourists and visitors in Jermuk);
- Recreational receptors (e.g. users of the Jermuk ski slope);
- Receptors travelling on roads through the study area – including the H-42 and M-2 highways (e.g. road users on the Armenian Silk Road, who may be travelling to or from Iran or travelling to and from Jermuk); and
- Receptors working in the landscape (e.g. seasonal herders, daily herders, agricultural workers and people foraging for food and/or plants from the land).

Receptors located outside the shaded areas of theoretical visibility shown on the ZTVs will not experience views of the main components of the Project and as a consequence, it is predicted that these receptors will not experience visual impacts in relation to these components. In some instances, receptors may experience visibility of minor components of the Project (i.e. those not modelled in the ZTVs) and from some additional viewpoints, and/or visibility of infrastructure and vehicle lighting at night. Additional viewpoint visualisations are included to illustrate these potential views. In addition, visual receptors may experience components of the Project intermittently or sequentially as they move around the area. Intermittent views, seen whilst moving along a road for example, are referred to as sequential impacts.

Table 6.5.12 below indicates where theoretical visibility of the component parts of the Project will be possible from a selection of potentially sensitive locations, which represent those visual receptors outlined above.

Table 6.5.12: ZTV Analysis						
Sensitive Locations	Project Component					
	Erato open pit	Tigranes/ Artavazdes open pit	BRSF	HLF	Buildings that contain crushing & screening facility	Overland Conveyor
Gndevaz	✓	✓		✓	✓	✓
Jermuk	✓		✓		✓	✓
Kechut			✓		✓	✓
Saravan	✓	✓				
Saralanj	✓	✓				
Ughedzor	✓	✓				
Gorayk						
Jermuk Ski Slope	✓	✓	✓		✓	✓
Spandaryan Reservoir	✓	✓	✓			
Armenian Silk Road (M-2)	✓	✓	✓			
H-42 highway (north from M-2 to Jermuk)	✓	✓	✓	✓	✓	✓
Minor road through Vorotan Valley (to its head)	✓	✓	✓			

Identifying Potential Representative Viewpoint Locations

In order to illustrate the potential views experienced by visual receptors, a number of representative viewpoint locations were identified. These viewpoint locations were identified using the ZTV and in discussion with the Project team, reflecting the potential concerns of communities and statutory authorities, and were verified in the field during field visits in April and June 2013. The locations were reviewed throughout the iterative Project design process to ensure they remained representative of potential views experienced by key visual receptors. An additional viewpoint (Viewpoint 7: H-42 highway south-west of Heap Leach Facility) was identified in October 2013 to represent the views of receptors travelling north on the H-42 highway towards Jermuk from south of the HLF. Three viewpoints (viewpoints 15-17) were identified in October 2015 to illustrate views of the revised project components following value engineering and optimisation process undertaken in 2015.

The selected viewpoints illustrate a variety of different locations which are representative of different visual receptors and were chosen in accordance with the criteria outlined in Chapter 4, Section 4.3.

A total of 17 viewpoints were identified to represent the views experienced by different receptors across the study area; these are generally ordered numerically from the Top of Jermuk Ski Lift (viewpoint 1) in the north, anti-clockwise around the Project-affected area, to Little Erato⁶ (viewpoint 14), and finally West of Kechut Reservoir (viewpoint 17). These viewpoints are shown on Figure 6.5.1 and are listed in Table 6.5.13.

Table 6.5.13: Representative Viewpoints				
VP No.	Viewpoint Name	Grid Reference		Approx. Distance from Project
		Easting (E)	Northing(N)	
1	Top of Jermuk Ski Lift	558566	4409466	6.8 km
2	Hotel Olympia, Jermuk	557105	4410044	7.4 km
3	Hotel Armenia, Jermuk	556928	4410153	7.5 km
4	Deer Sculpture, west of Jermuk	556657	4409747	7.0 km
5	Western edge of Gndevaz Village ⁷	552765	4401848	2.5 km
6	H-42 highway south of Gndevaz	551961	4398867	4.4 km
7	H-42 highway South-west of Heap Leach Facility	551805	4398323	1.0 km
8	Armenian Silk Road (M-2 highway) near Junction with the H-42 highway	548084	4393759	10.6 km
9	Armenian Silk Road (M-2 highway) in Saralanj village	557307	4395581	4.2 km
10	North end of Ughedzor village	558390	4393710	4.6 km
11	Syunik Gates on the Vorotan Pass (M-2 highway) between Saravan and Goryak	561166	4393305	3.9 km
12	Armenian Silk Road (M-2 highway) between Tsghuk and Gorayk	568877	4392779	8.2 km
13	Minor road through Vorotan valley	562986	4403300	620 m
14	Little Erato (summit of hill)	559564	4401931	50 m
15	Minor road from Gndevaz to Armenian Silk Road	555695	4400977	260 m
16	Jermuk Church	557920	4407279	4.7 km
17	West of Kechut Reservoir	555743	4405611	4.0 km

6.5.17 Viewpoint Visualisations

The visualisations which accompany the assessment aim to illustrate representative views of the proposed project. Visualisations may be produced in many forms (hand drawn sketches,

⁶ The un-named subsidiary hill, north-west of North Erato, has been referred to as Little Erato for the purpose of this assessment; the hill summit is centred on approximately E 559600, N 4402000.

⁷ The western edge of Gndevaz represents the area of the settlement from which potential visibility of the Project components will be possible.

annotated photographs, photomontages), however they will never be exactly true to life. Visualisations are tools that may inform an assessment of visual impacts, and their application therefore requires careful use. It is important therefore to note that computer generated images, including ZTVs, wireframes and photomontages are used as tools to provide an illustration of the potential visual impacts. They are not a substitute for the actual review of likely visual changes in the field, which forms a key part of the assessment methodology.

The methodology for production of the visualisations was based on good practice guidelines contained within applicable guidance^{1,8}. Further information about the approach is provided in the next section. The referenced documents also provide guidance for the correct use and viewing of visualisations and should be read prior to their use.

Viewpoint Photography

The camera used for viewpoint photography was a Nikon D7000 digital SLR with a fixed at 35 mm focal length lens (equivalent to a 52.5 mm focal length lens on a 35 mm film camera), except where otherwise stated. A tripod with vertical and horizontal spirit levels was used to provide stability and to ensure a level set of adjoining images. A panoramic head was used to ensure the camera rotated about the no-parallax point of the lens in order to eliminate parallax errors between the successive images and enable accurate stitching of the images. The camera was moved through increments of 15° and rotated through a full 360° at each viewpoint. Twenty four photographs were taken for each 360° view. This enabled a 90° angle, centred on the view towards the proposed development, to be cut from the overall 360°.

The location of each viewpoint was recorded in the field using a handheld GPS. Weather conditions and visibility were considered an important aspect of the field visits for the photography. Where possible, viewpoint photography was undertaken on clear days with good visibility during field visits in April, June and November 2013. The photography taken during the two initial site visits provided photography representative of winter (April) and summer (June) seasonal conditions. Viewpoint photography for viewpoint seven was undertaken in November 2013, in autumnal conditions, and subsequent photography was undertaken in November 2015 for viewpoint 15. Viewpoint locations were visited at appropriate times of day to ensure, as far as possible, that the sun lit the scene from behind, or to one side of the photographer. Photographs facing into the sun were avoided where

⁸ *Advice Note 01/11: Photography and photomontage in landscape and visual impact assessment* (2011) Landscape Institute

possible to prevent the Project-affected area appearing in silhouette. Adjustments to lighting of the Project-affected area were made in the rendering software, to suit the particular lighting and atmospheric conditions present at that time, and ensure that the Project components appeared realistic in the view.

Photograph Stitching, Wireframes and Photomontages

Photograph stitching software (Photoshop) was used to stitch together the adjoining images. Topos R2 (43D) software was used to view the development from selected viewpoints in model format. A default viewer height of 2 m above ground level was used for each viewpoint. Wireframe model views were overlaid onto the pre-prepared 90° stitched photography in order to accurately render the Project components into each view.

All views from viewpoints have been represented using baseline photography showing the existing views, wireframe model images showing the proposed components of the Project on a bare ground terrain model, and fully rendered photomontages, illustrating the proposed components of the Project integrated into the baseline photography, in accordance with good practice guidance.

The presentation of fully rendered photomontages involved a number of additional stages. The Topos R2 (43D) software was used to accurately reproduce the geometry of the site and also take account of the sunlight conditions and the position of the sun in the sky at the time the photograph was taken. Fixed features on the ground were used as markers to help line up the image extracted from the ground model with the baseline photography. The final stage required the rendered development to be blended into the actual view. This was carried out using Photoshop software and allowed the Project components to be located within the context of the existing elements that appeared in the baseline photography.

Each viewpoint is illustrated by the following; the original baseline photography from the viewpoint, a wireframe image and a photomontage at a 90° angle of view. Although this arrangement is less than the recommended image height and viewing distances⁹ set out by good practice guidance, the additional horizontal view information is included to provide context of the surrounding landscape. Additional images are also provided illustrating a 50° included angle. These are at image heights and viewing distances above the minimum recommended by good practice guidance.

⁹ Viewing distance is the distance at which the image should be viewed to provide a representation of the 'real life view'.

From a small number of the representative viewpoints it will be possible to experience visibility of the proposed Project components through a wider angle of view than 90°. Where visibility extends beyond the 90° angle of view, a series of 90° and accompanying 50° visualisations have been included to illustrate views of the Project from these viewpoint locations.

Operations Phase: Year 10 - Maximum Case Scenario Visualisations

The photomontages for each representative viewpoint show the likely visual changes experienced during the Operations Phase Year 10 – Maximum Case Scenario as this phase represents the greatest predicted change in views and visual amenity, and illustrates the likely most significant visual impacts to be experienced during the life of the Project.

Seasonal Visualisations

The majority of viewpoints are illustrated by summer season (June) baseline photography and photomontage visualisations, however from five representative viewpoints, baseline photography and photomontage visualisations during winter based seasonal conditions (April) are also included to illustrate the potential variations in visual impact experienced during the winter season, when the landscape is predominantly covered by snow.

Post-Closure Monitoring Phase Visualisations

Six viewpoints are illustrated by photomontage visualisations illustrating the likely visual changes experienced at the end of the Post-Closure Monitoring Phase: Year 19, when all closure activities, post-closure restoration measures and monitoring have been completed. These photomontage visualisations therefore represent the long-term permanent residual impacts of the proposed Project following completion, and a point in time at which the restoration of vegetation across disturbed areas will be reasonably well advanced.

Night Time Visualisations

In order to illustrate the potential visual impacts at night, two viewpoint locations are illustrated with night time photography taken after dusk during field work in April 2013. The baseline photography from these two locations indicates the existing lighting present across the Project-affected area and the surrounding landscape. Due to the uncertainty in the requirements for lighting and detailed design of the Project components, photomontages illustrating the potential visual impact of night time lighting do not accompany this assessment. Nevertheless, consideration of potential visual impacts arising from the expected lighting of key Project components and vehicle movements across the Project-affected area is included within the assessment of visual impacts. Essentially, all of the Project-affected area

is unlit, and so all lighting which will be introduced will be as a consequence of the Project.

Table 6.5.14 below outlines the representative visualisations which accompany each of the 14 representative viewpoints within the visual assessment:

Table 6.5.14: Representative Visualisations					
VP No.	Viewpoint Name	Baseline Photography & Maximum Case Scenario Visualisation		Post-Closure Monitoring Phase Visualisation	Night Time Baseline Photography
		Summer	Winter		
1	Top of Jermuk Ski Lift	✓	✓		
2	Hotel Olympia, Jermuk	✓		✓	
3	Hotel Armenia, Jermuk	✓		✓	
4	Deer Sculpture, west of Jermuk	✓	✓		✓
5	Western edge of Gndevaz Village ¹⁰	✓	✓		✓
6	H-42 highway south of Gndevaz	✓		✓	
7	H-42 highway South-west of Heap Leach Facility	✓		✓	
8	Armenian Silk Road (M-2 highway) near Junction with the H-42 highway	✓			
9	Armenian Silk Road (M-2 highway) in Saralanj village		✓		
10	North end of Ughedzor village	✓			
11	Syunik Gates on the Vorotan Pass (M-2 highway) between Saravan and Goryak	✓			
12	Armenian Silk Road (M-2 highway) between Tsg huk and Gorayk	✓			
13	Minor road through Vorotan valley	✓		✓	
14	Little Erato	✓		✓	
15	Minor road from Gndevaz to Armenian Silk Road ¹¹	✓			
16	Jermuk Church ¹¹	✓			
17	West of Kechut Reservoir ¹¹	✓			

6.5.18 Design and Mitigation Measures

Mitigation Measures

Mitigation measures will be incorporated into the Footprint Management Plan (FMP, Appendix 8.8) and by a requirement of the contract documents as appropriate. Measures such as 'hold points' for inspection or agreement will be utilised in order that tests and

¹⁰ The western edge of Gndevaz represents the area of the settlement from which potential visibility of the Project components will be possible.

¹¹ Baseline photography and wireline visualisation only

samples (i.e. use of specific materials, colours and finishes to componentry) can be used to demonstrate measures before being rolled out across the Project-affected area as a whole.

The successful implementation of these will be monitored and advised by an Environmental Clerk of Works.

Wider landscape and habitat enhancement, to be implemented in the early years of the project, will be developed and agreed in consultation with Lydian, landowners and statutory consultees before construction commences on site. These measures will be developed in conjunction with sensitivity maps and form a part of the commitments discussed in Chapter 8.

The pMRCRP is in a preliminary format (see Appendix 8.18), within which a detailed landscape restoration plan will be prepared. The landscape and ecological mitigation and restoration measures are described in this section and will be further developed and agreed in consultation with statutory bodies and Lydian before construction commences on site.

Mitigation by Design

The mitigation of potential landscape and visual impacts is embedded within the iterative Project design development process (see Chapter 5), whereby the location and design of Project components was devised, as far as practical given the location of the mineral reserves, in order to reduce and/or avoid direct or indirect landscape impacts and reduce and/or avoid visual impacts upon identified receptors.

The location, design and integration of the Project-affected area and components into the existing landscape and views was undertaken, where practical, to help reduce the magnitude of potential landscape and visual impacts that will result from the Project. As such the objective is to create final landforms with naturalistic and sympathetically designed landscape profiles as far as is practicable.

The phasing of the Project is designed to allow progressive reclamation and rehabilitation of Project components as extraction is undertaken and completed, so that bare unvegetated areas can be kept to a minimum, and so that stored topsoil and vegetation can be replaced on graded areas as operations are completed.

The HLF has been designed so that the ultimate finished landform will tie in with surrounding natural slopes in so far as is possible. Design iterations of the HLF were undertaken to integrate

the facility into the surrounding topography, where it occupies a natural sequence of valleys in the landscape, which will help to reduce the zone of potential visual influence, including from a number of sensitive locations; the settlements of Jermuk, Kechut and Gndevaz, and minimise visibility where possible from the H-42 highway between the Armenian Silk Road (M-2 highway) and Jermuk.

The location, layout and design of the Project components, associated buildings, infrastructure and ancillary componentry, including their aggregation, shape, and the texturing and colouring of external surfaces has been designed to help reduce the magnitude of the impacts that will result from the Project:

- Where project components are located in prominent positions which break distinguishable skylines or ridges, detailed design will seek to mitigate these impacts through their reconfiguration or alternations in their form (i.e. reduction in vertical height), to ensure best fit with surrounding landscape and in order to minimise more widespread visual effects wherever possible;
- External clutter will be reduced by enclosing Project components and containing them within simple buildings which fit and respond to the localised topography, as far as practicably possible;
- Low level clutter around the Project components, including the ADR plant, offices, and worker accommodation buildings; will be screened by vegetated topsoil bunds and topsoil storage stockpiles;
- Muted colours appropriate to the natural landscape will be considered for external building and component surfaces, which will blend into the surrounding landscape and which will not contrast or stand out when viewed from distant locations.
- Non-reflective surfaces will be used wherever feasible;
- Windows in buildings will, where possible, be shuttered to prevent light spill at night. There will be minimal security lighting in external areas (sensors will be used to ensure it does not get left on); and
- The construction of berms alongside access and haul roads to reduce light spill from vehicle headlights at night, and especially during the extended hours of darkness during the winter months.

At the detailed design stage, it is envisaged that further mitigation will be incorporated into the design of the Project components to ensure the landscape and visual impacts do not exceed the residual impacts identified in this assessment.

The following mitigation measures will be implemented to reduce the potential impacts resulting from the Project and associated workings' during the construction, operation and production, closure and post-closure monitoring phases of the Project, including the implementation of progressive restoration throughout the life of the Project.

Construction Phase Mitigation

Measures will be detailed in the Environmental and Social Management Plan (ESMP) (see Chapter 8) which identifies the policies and procedures that will be adhered to by Lydian, Geoteam and all contractors engaged for the Project. The ESMP includes an ESIA Commitments Register (CR, see Appendix 8.5) along with management plans that apply to the life cycle of the Project. The following mitigation measures will be implemented throughout the construction phase to ensure landscape and visual impacts are reduced or avoided:

- Construction vehicles will primarily access the Project-affected area from the west via the H-42. All heavy traffic will be required to use two defined Project access roads. Light vehicles may use secondary access roads (see Chapter 6.19: Transport);
- Construction vehicles will not track across undisturbed areas outside their defined working area and access corridor;
- Materials and machinery will be stored tidily during the works. Machinery will not be left in place for longer than required for construction purposes, in order to minimise its visual impact on views;
- Any contractors compounds and storage areas will be located away from sensitive receptors as far as possible;
- Reclamation of exploration works (drilling pads, access roads) will be ongoing during the construction phase to restore and revegetate previously disturbed areas, which will not be affected by the operations phase of the Project. This will include redundant access roads and drill sites, provided they are not within the planned mine facilities;
- The worker accommodation camp area, laydown and storage areas will be located away from visible areas as far as possible;
- The location of worker accommodation camp area, laydown areas and site offices will be designed at the detailed design stage to take account of natural screening provided by topography and existing landforms;
- Topsoil, and the seedbank within it, will be carefully stripped from all construction areas, including the base of the HLF and BRSF and will be stored in areas where it will not be disturbed or tracked upon, in low uncompacted mounds. Stored topsoil will be

- used for the progressive restoration of disturbed areas. Soft materials will be used to grade slopes prior to promotion of natural recolonisation of vegetation;
- Regular looking engineered profiles will be avoided where practical. Irregular concave and convex slopes mimicking existing contours, which match with the scale of the existing hill slopes, will be created as far as possible during construction and restoration of the BRSF, HLF and necessary ground works for built components of the Project;
 - Wherever possible slopes will be designed and engineered so that long-term visible man-made rock slope reinforcement measures are not required or can be entirely covered with turves and revegetated. Any reinforcement that is required will endeavour to use appropriate geotextiles, preferably of natural material;
 - Localised grading of selected sections of track cutting slopes, embankments and sides will be undertaken. Scarred track sides, slopes and tie-ins will be rounded to concave or convex profiles, and where available, topsoil/turves will be placed upon them, to encourage regeneration of vegetation;
 - Seeding will be undertaken using locally native species or culturally appropriate plants, and to tie in with adjacent vegetation types, where considered appropriate and essential to prevent erosion;
 - On completion of the construction phase, all equipment and temporary installations, buildings, etc. not required for future operational use will be dismantled and removed;
 - Removal of construction waste and its appropriate disposal;
 - Filling and compacting of pits, hollows and excavation trenches with the appropriate stockpiled materials;
 - Slope regrading activities will be undertaken to provide sustainable and erosion resistant landforms compatible with the post-closure land use and water management strategies;
 - Exposed soil and overburden slopes will be regraded so that they conform with adjacent landform, in order to achieve the mine Reclamation, Closure and Rehabilitation design criteria.

Progressive reclamation of exploratory works (drilling pads, access roads) will also be undertaken during the construction phase to restore and revegetate previously disturbed areas which will not be affected by the operations phase of the Project. This includes redundant access roads and exploratory drilling sites, provided they are not within the planned mine facilities.

Further exploratory works will be ongoing throughout the construction phase, and into the operation phases of the project, with progressive restoration undertaken as exploration activities are completed and activities move to new locations within the Project-affected area.

Operation and Production Phase Mitigation

The following mitigation measures will be implemented throughout the operation phases to ensure landscape and visual impacts are avoided or reduced:

- As each phase of operation is completed, it will be restored by shaping and grading to make these slopes match in with surrounding natural contours; treating the edges of the slopes in particular, so that scarred and eroded tie-ins are avoided, and placing soil onto slopes and ledges to promote recolonisation with appropriate natural vegetation;
- Vehicular access to the Project-affected area will be minimised. The majority of workers will arrive on site via bus and limited car parking will be available for employees within the extents of the Project main area;
- The mine and the surrounding area will be maintained in a clean and uncluttered state: the pMRCRP (Appendix 8.18), FMP (Appendix 8.8) and ESMP (Chapter 8) will include landscape and habitat management requirements;
- Spoil mounds of topsoil and soft overburden materials will be established on the periphery of the working areas of Project components and will be seeded and grassed to reduce visual impacts from receptors west and north of the Project-affected area.
- Screening, including the use of berms, will be located where feasible to the outer edge of haul roads, access roads to reduce the visual impact of mobile plant including the mitigation of the perceptibility of artificial lighting sources such as flood lighting on buildings and vehicle movements along access and haul roads, in particular mitigating the residual effect of headlights of mine vehicles on receptors in Jermuk and Kechut when travelling northwards along the on-site haul road around the western flanks of the mountain;
- Backfilling of the Tigranes/Artavazdes open pit and partial backfilling of the Erato open pit will be undertaken. The outer edges of the open pit excavation areas will be restored through the breaking down of the upper bench and 'roll over restoration', making use of the spoil storage mounds as screening, to lessen the visual contrasts and establish vegetation across the disturbed land.

In addition:

- Tree nurseries have been created in local villages to grow trees for transplantation to

the Project-affected area and adjacent areas both to provide screening of visual impacts from Project components and for landscape enhancement.

- Opportunities for further localised screening and tree planting will be included in the detailed construction plans and included as commitments in the pMRCRP (Appendix 8.18).

Mitigation of Night Time Lighting

The introduction of night time operation and production activities will potentially result in visual impacts where views of the various working components may occur, arising from the lighting of Project components and headlights of mobile plant machinery and vehicles on site. The following mitigation measures will be implemented throughout the construction and operations phases to ensure visual impacts associated with lighting are reduced or avoided:

- Contractors will be requested to use lowest emission lighting that will still provide sufficient light for safety purposes. Low visibility spectrum lights and appliances (full cut-off fixtures that emit no light above the light's horizontal line) will be preferred on mine components, with lighting mounted at the minimum necessary safe height and shrouded where appropriate;
- Lighting will be carefully enclosed within buildings so as not to contribute to light pollution/ light spillage off site/ glare to the sky. Shutters will be used during darkness. There will be minimal security lighting in external areas (sensors will be used to ensure it does not get left on);
- Lighting of work sites will be restricted to agreed working hours and that which is necessary for security. Light sources for night-time construction and operation activities will be pointed downward and away from sensitive receptors such as nearby communities (without forgoing safety purposes);
- Vehicle and mobile plant machinery operators and drivers will be instructed in the appropriate use of headlights (high and low beams) to reduce impacts on visual receptors within local communities close to the Project-affected area. Work in areas in the direct view of sensitive receptors (settlements/residential properties) will be avoided at night and/or lighting will be directed away from these locations, where practical;
- Work in areas in the direct view of sensitive receptors (settlements/residential properties) will be minimised at night where practical;
- Opportunities for further localised screening and tree planting will be included in the detailed construction plans and included as commitments in the pMRCRP (see Appendix 8.18).

Closure Phase Mitigation

Once the operation and production phases of the Project cease, the closure of all Project components will begin with the removal of all temporary Project components and will be followed by the restoration of the Project-affected area. This phase will be carried out in accordance with the detailed proposals outlined in the pMRCRP (see Appendix 8.18):

- All defunct machinery, clutter, fencing and man-made objects will be removed from the Project-affected area;
- Redundant ponds will be removed;
- Haulage, stockpiling and monitoring of growth media and subsoil layers, to serve as a visual screen during construction, a seed bank and to use for revegetation at closure;
- Provision for collection of species, storage, and reinstatement of vegetation communities from and to areas during the entire length of the Project;
- Progressive rehabilitation of affected areas, where possible, throughout the mine life;
- Removal or redistribution of temporary buildings and structures once their purpose has been fulfilled;
- Re-profiling and regrading of the BRSF, HLF, access roads, haul roads and the open pit areas, when no longer required as part of operations;
- Cutting and embankment slopes will be graded to tie in with existing natural slopes, and sharp edges will be avoided, except where minor rock or scree faces may be considered appropriate;
- The profiled faces of the HLF and BRSF, their top surface, as well as any remaining spoil heaps and horizontal breaks (vehicle access berms and more minor footways) at completion of the operational phase will be designed to tie into existing contours, so that slopes match in with surrounding natural contours - using available materials as fill to soften angles and create a rolling profile. Shaping and grading of the completed faces will be implemented prior to seeding or the placement of turves to promote natural recolonization of vegetation;
- The edges of the slopes will be treated, so that scarred and eroded tie-ins are graded out. Layers of topsoil will be placed in the correct stratigraphic order back onto the surface to promote recolonization with appropriate native vegetation;
- The outer edges of the open pit excavation areas will be restored through the breaking down of the upper bench and 'roll over restoration' making use of the spoil storage mounds for screening, to lessen the visual contrasts and establish vegetation across the disturbed land;

- Surfaces with significant compaction or degradation will be scarified or contour ripped to promote revegetation, and any overburden that was excavated will be pushed, raked or pulled back over the area. Any redundant access tracks will be ripped and windrows back-graded. Stockpiled topsoil and vegetation will be re-spread over the sites and any sumps will be backfilled;
- Storage and removal of hazardous and domestic wastes;
- Engineering and revegetation of slopes to provide erosion resistant and sustainable landforms;
- Revegetation of disturbed areas for compatibility with the selected post-mining land use, prioritising native species and vegetation types that existed before the mining operation began and species which are culturally relevant;
- Revegetation will be encouraged so as to soften the appearance of the HLF, ADR and pond faces and to integrate both the natural and manmade land forms, and the new areas of vegetation; and
- Opportunities for further localised screening and tree planting will be included in the detailed construction plans and included as commitments in the pMRCRP (see Appendix 8.18).

Post-Closure Monitoring Phase Mitigation

Following the implementation of the closure mitigation measures outlined in the pMRCRP (see Appendix 8.18), ongoing post-closure monitoring will be undertaken for a period of five years, from the start of closure activities, to ensure that restoration and rehabilitation of revegetation and enhancement landscape works and planting is successful.

- Monitor restoration and manage according to ongoing landscape and habitat management actions that will be detailed in the Biodiversity Management Plan (BMP, Appendix 8.21) and pMRCRP (Appendix 8.18), so as to promote complete and successful regeneration (it will be appropriate to retain some areas as bare mineral/rock/scree surfaces as part of the mosaic);
- Ongoing specialist supervision of vegetation recovery will be required to ensure the efficiency and effectiveness of revegetation and enhancement planting.

6.5.19 Assessment of Residual Landscape Effects

The baseline section in Section 4.3 identified six broad landscape character types (LCTs) within the study area. Each of these LCTs varies relative to its susceptibility to change and the existing value attached to the landscape. The following section outlines the residual impacts of the Project on LCTs or potential landscape features and resources contained within those

LCTs.

Impacts can be direct (i.e. where the components of the Project are located within the LCT, directly or physical affecting the landscape) or indirect (i.e. where the components of the Project located outside the LCT may affect the landscape character or views within an adjacent or more distant LCT through intervisibility).

Landscape impacts on LCTs defined within the study area are outlined in the tables which follow (Table 6.5.15 to Table 6.5.20). The assessment should be read with reference to the map of Landscape Character Types (Figure 4.3.5). Each table provides the following information:

- Project components within LCT;
- Representative viewpoints located within LCT;
- Extent of visibility across the LCT;
- Sensitivity of landscape receptor;
- Description of landscape changes;
- Magnitude of landscape impact; and
- Significance of the landscape effect.

The magnitude of landscape impact and significance of landscape effects was assessed for each phase of the Project defined within Table 6.5.10 and assumes implementation of the mitigation measures outlined earlier in this section.

Table 6.5.15: Settled Lowland and Rocky Gorges (below 2,000 m asl)

Project Components within LCT: No Project components within LCT	Representative Viewpoints located within LCT: Illustrated by viewpoints 6, 8, 9, 17	
Extent of Visibility across LCT: Visibility of the Project components from this LCT will be possible from east and north facing slopes on the edge of the Arpa and Darb River gorges where visibility of Project components will be limited to the open pits along the craggy ridge of Amulsar Mountain, and views of the HLF, building that contains the crushing and screening facility, overland conveyor, ADR plant and ancillary infrastructure, and other minor Project components located on the west and north facing foothills. To the south-west of the Project-affected area, visibility of these components of the Project. Including the open pits will be possible from the settled and farmed lowland areas which lie to the east of the steep sided Arpa River gorge.		
Sensitivity of Landscape Receptor: The settled, scenic and occasionally intimate nature of this LCT means it is judged to be sensitive to the introduction of large scale development and susceptible to changes in its underlying character as a result. The gorge landscapes which attract tourists and visitors are deemed most sensitive to landscape change, where glimpsed and framed views to the surrounding upland summits and ridges are a key characteristic. The LCT also includes areas covered by the Her-her Open Woodland State Sanctuary – Specially Protected Nature Area , judged to be of high landscape sensitivity. The sensitivity of this LCT as a whole to the landscape changes proposed is therefore judged to be medium .		
Description of Landscape Impacts: This LCT will not be directly affected by the components of the Project; however the H-42 highway which passes through the LCT will form the main public access to the Project-affected area and will experience an increase in traffic throughout the life of the project. During construction, intervisibility with Project components will be available from the valley and plateau areas, and the western slopes of the Arpa River Gorge. As operation begins the HLF, ADR plant, building that contains the crushing and screening facility and overland conveyor will become intervisible with areas of this landscape out with the main gorge, and introduce additional built development within close proximity to the LCT. The indirect impacts of dust created from Project components and vehicle movements may be perceptible along the cultivated valley along the route of the H-42 highway during the construction and operation and production phases. These impacts will be reversible and will only occur under certain weather conditions. The gorge landscape of this LCT will experience no or very limited intervisibility of the Project components, which are unlikely to affect the scenic qualities and key characteristics of the landscape. Views from the lowland plateau and valleys to the distant mountain summits and ridges, which are characteristic of this LCT, will be affected by the removal of the Tigranes, Artavazdes and Erato mountain peaks and creation of the open pits and haul road on the western flanks of the mountain ridge. Although visibility of landscape changes across areas of adjacent LCTs will be possible from this LCT, the changes will form a small part of the available views, seen at a distance and often visible from a relatively small geographical area of this LCT. These changes will be more perceptible throughout the operation and production phases of the Project and will reduce following the implementation of post-closure restoration and monitoring measures. The irreversible changes to the mountain skyline of Amulsar as a result of the Project will lead to long-term irreversible changes in the views experienced from areas of this LCT. Impacts on the landscape character of areas of relict open yew woodland and remnant pear orchards which are characteristic of this LCT and the Her-her Open Woodland State Sanctuary – Specially Protected Nature Area , are judged to be barely perceptible.		
Assessment Phase:	Magnitude of Landscape Impacts:	Significance & Direction of Landscape Effects:
Construction Phase: Year -1	Barely perceptible	Negligible adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Low	Minor adverse (not significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)

Table 6.5.16: Lower Farmed and Settled Foothills (under 2,000 m asl)

Project Components within LCT: HLF, ADR plant, overland conveyor, site offices, collection ponds, access tracks located within LCT		Representative Viewpoints located within LCT: Illustrated by viewpoints 5, 7, 10, 11, 15
Extent of Visibility across LCT: Visibility of the Project components across this LCT will be possible to the west, south-west and north-west of the Project-affected area. Views are limited to elevated slopes facing the Project-affected area, of which many to the west of the Arpa River gorge and south of the Darb River are wooded. Across the localised area of the LCT, which covers the western foothills of Amulsar Mountain, visibility will be widespread, with numerous Project components visible across the farmed and settled landscape.		
Sensitivity of Landscape Receptor: This LCT already shows evidence of man-made features and extensive landscape change through settlement, agriculture, industry and remnants of mineral extraction. Views from the often open landscape to the higher summits and ridges of Amulsar Mountain are a key characteristic experienced by receptors travelling through or concentrated within the LCT. The expansion of built development within the outer extents of this LCT could further expand the influence of man-made features to adjacent LCTs. The Her-her Open Woodland State Sanctuary – Specially Protected Nature Area is located predominantly within this LCT to the west of the Arpa River Gorge, extending into adjacent LCTs to the north and east. It is protected for its areas of relict open yew woodland and remnant pear orchards. The sensitivity of this designated area to the landscape changes proposed is therefore judged to be high . Overall the sensitivity of this LCT to the proposed landscape changes is therefore judged to be medium .		
Description of Landscape Impacts: This LCT will experience direct landscape changes from the construction of the HLF, ADR Plant, overland conveyor, water treatment plant, collection ponds and access tracks. These components will require extensive earth works, resulting in the removal of existing vegetation, manipulation of existing landform, rerouting of natural drainage and the loss of landscape features such as small river valleys and rocky outcrops, some scattered trees and semi-natural grassland vegetation. These large scale changes will be experienced over a relatively large geographical area of the LCT, between the Arpa River Gorge to the west and Amulsar Mountain to the east, however the changes will be localised when considered within the full extent of the LCT across the study area. Impacts from dust created by Project components and vehicle movements will directly affect the LCT, leading to wider scale impacts than those of the component parts and directly disturbed working areas. The changes resulting from many of the Project components will be reversible following closure and restoration of the Project main area, however long-term impacts from the change in landform and vegetation cover across the HLF site will be irreversible, leading to changes in the key characteristics of the LCT across a localised area, which is unlikely to be suitable for arable agriculture or grazing of animals in the long-term. The direct landscape changes which will occur within this LCT as a result of the Project will be visible across a much larger area of the LCT to the south-west and west of the Project main area. Views of the open pits and other Project components will also be possible from areas of this LCT west of the Arpa River Gorge, affecting the open views to the upland landscape which are characteristic of this LCT. The Her-her Open Woodland State Sanctuary – Specially Protected Nature Area will not experience direct landscape impacts upon the relict open yew woodland and remnant pear orchards as a result of the Project and indirect landscape impacts are considered unlikely to affect the attributes which are reasons for designation of this area. Therefore the impact on the landscape this area is judged to be barely perceptible.		
Assessment Phase:	Magnitude of Landscape Impacts:	Significance & Direction of Landscape Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	High	Major adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	High	Major adverse (significant)
Post-Closure Monitoring Phase: Year 19	Moderate	Moderate neutral (significant)

Table 6.5.17: Forested Upper Gorge and Foothills (elevations of 2,300 - 2,500 m asl)

Table 6.5.17: Forested Upper Gorge and Foothills (elevations of 2,300 - 2,500 m asl)		
Project Components within LCT: Existing Project access track within LCT		Representative Viewpoints located within LCT: Illustrated by viewpoints 1, 2, 3 ,4,
Extent of Visibility across LCT: Visibility of the Project from this LCT will be limited to views experienced from the elevated slopes and valley sides to the north of the Project-affected area. The central area of the LCT which includes the settlement of Kechut, Kechut reservoir and the southern extents of Jermuk will experience limited visibility of the Project-affected area due to the intervening topography of the Highland Hills to the south. Visibility from the floor of the gorge around the settlement of Kechut and Jermuk will be possible, with long distance views of the building that contains crushing and screening facility, facilities platform, mine access roads, the BRSF, the Erato open pit and smaller components of the Project visible at a distance of approximately 10 km.		
Sensitivity of Landscape Receptor: This LCT has been subject to extensive landscape change from human influence and built development, which is predominantly focused in the foot of the gorge around the settlements of Jermuk and Kechut, and the nearby Kechut reservoir. The LCT also includes areas covered by the Jermuk Forest State Sanctuary – Specially Protected Nature Area , judged to be of high landscape sensitivity. Overall this LCT is sensitive to development located on the high summits and ridges which form the focus of views out of the LCT. Therefore the sensitivity of this LCT to the landscape changes proposed is therefore judged to be high .		
Description of Landscape Impacts: The existing site access track between the H-42 highway east of Kechut and the exploration camp crosses an area of this LCT. The access track follows the route of an existing minor road through the Vorotan Valley which links Jermuk with the M-2 highway near Gorayk. Grading of this road and the creation of berms along the road edges will increase the area of direct impacts upon the LCT, and the fallout of dust from moving vehicles accessing the Project affected area will extend the visible area of disturbance wither side of the access track, especially in winter, when the access track will become more perceptible across a wider geographical area. The direct landscape impacts arising from the Project will however be relatively small scale and will be reversible following closure, restoration and post-closure rehabilitation Indirect impacts will be limited to long distance views of the Project components (Erato open pit, the building that contains the crushing and screening facility, overland conveyor and the BRSF from the elevated areas of the LCT which form the watershed of the Arpa River, north, east and west of Jermuk. The LCT displays widespread human influence from the presence of built development, linear features (tracks, roads and high voltage overhead transmission lines) and remnants of past industrial activity. The introduction of the Project components will form relatively small scale changes in views experienced from this LCT, however the Project components will be more perceptible in views towards the mountain summits and ridges in late winter and spring (i.e. when fresh snowfall is less frequent), when dust from operations could result in some local discolouration (greying/yellowing) of the snow fields, potentially accentuating the perceptibility of the Project footprint during these periods. Following closure and restoration, most impacts will be reversible; however the long-term changes to the mountain summits and ridges will remain and be perceptible from areas of the LCT. The existing Jermuk and Kechut waste dump is located within this LCT, along the route of the access track. It is proposed that a municipal landfill site will be created within an area of existing borrow pit extraction to the south-east, along the route of the access track. Impacts on the landscape of the steep forested slopes and wooded gorges which are characteristic of this LCT and the Jermuk Forest State Sanctuary – Specially Protected Nature Area , are judged to be barely perceptible.		
Assessment Phase:	Magnitude of Landscape Impacts:	Significance & Direction of Landscape Effects:
Construction Phase: Year -1	Low	Minor adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Low	Minor adverse (not significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Barely perceptible	Negligible neutral (not significant)

Table 6.5.18: High Steppe and Plateau Grassland (elevations of 2,000 - 2,300 m asl)

Table 6.5.18: High Steppe and Plateau Grassland (elevations of 2,000 - 2,300 m asl)		
Project Components within LCT: Existing access roads	Representative Viewpoints located within LCT: Illustrated by viewpoints 13, 14	
Extent of Visibility across LCT: Visibility of the Project across this LCT will be widespread throughout the Vorotan valley and plateau grassland north of Spandaryan reservoir. Specific components, including the BRSF and existing access road will be perceptible from the northern extents of the LCT within the Vorotan valley, to the east of the Project-affected area. From the southern extents of the LCT, visibility will be limited to changes in the skyline from the creation of the open pits across the linear ridge of High Rocky Peaks which form Amulsar Mountain above.		
Sensitivity of Landscape Receptor: The northern extents of this LCT are relatively undeveloped and free of extensive human influence, however an existing small scale hydro power dam is located in the upper reaches of the Vorotan Valley, and to the south remnants of industrial development, existing electricity transmission lines and settlement (Gorayk and Tsghuk) along the route of the Armenian Silk Road (M-2 highway) and adjacent to Spandaryan reservoir form key features of the LCT. Overall the openness and relative perceived naturalness of the Vorotan valley means the sensitivity of this LCT to the landscape changes proposed is therefore judged to be medium .		
Description of Landscape Impacts: This LCT will experience very little direct landscape impacts as a result of the introduction of the Project components, whereby the existing access road will form the only project component located within the LCT. However, project components located within relative close proximity in adjacent LCTs may result in impacts from dust during both the construction and operations phases of the Project components, which may increase the perceptibility of the working areas during the late winter/early spring months as the adjacent snow fields become discoloured as the frequency of the regular covering with fresh snow decreases later in the season. The BRSF will be visible from the LCT on the upper flanks of Amulsar Mountain to the west. During construction of these components, removal of vegetation, extensive earthworks, vehicle movements and the introduction of man-made elements will be visible from across the upper Vorotan Valley, which will increase the level of human influence perceptible from this LCT. As operations begin the open pits and movement of barren rock material to the BRSF will result in further impacts upon the key characteristics of the LCT, as the profile of the rocky peaks of Amulsar Mountain are changed following the irreversible removal of the mountain peaks to create the open pits. The sense of remoteness and solitude will be altered as operational activities are undertaken. These activities will become increasingly perceptible from this LCT during the operational phases as material is extracted from the open pits and the BRSF increases in size. Following closure restoration will be undertaken across the disturbed areas including the reprofiling of the open pits and immediate surrounding areas and post-closure activities to grade and revegetate the BRSF to reduce the direct landscape impacts of operations. Long-term impacts from the creation of the BRSF and removal of the rocky peaks of Amulsar Mountain will remain following restoration and post-closure monitoring; however the revegetation of the BRSF will lead to a more natural appearing landform and fit within the surrounding landscape in views from this LCT. Although large scale landscape changes will be perceptible from this LCT, the changes will be visible from a relatively small geographical area and many of the medium-term impacts will be reduced following the post-closure monitoring phase of the Project. Indirect impacts arising from visibility of the Project components across the southern extents of the LCT will be much reduced and will be visible from the context of a landscape which is already heavily influenced by man-made features.		
Assessment Phase:	Magnitude of Landscape Impacts:	Significance & Direction of Landscape Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)

Table 6.5.19: Highland Hills and Grazing (elevations of 2,300 - 2,700 m asl)

Table 6.5.19: Highland Hills and Grazing (elevations of 2,300 - 2,700 m asl)		
Project Components within LCT: BRSF, building that contains crushing and screening facility, overland conveyor, haul road, truckshop and administration facilities platform located within LCT	Representative Viewpoints located within LCT: Illustrated by viewpoints 12, 15	
Extent of Visibility across LCT: Visibility of the Project from this LCT will be widespread across the study area, with open views from elevated highland slopes and hill summits to the north-west, north and east, and to a lesser extent south of the Project-affected area. Visibility of Project components from the localised areas of the LCT which lie within and adjacent to the LCT will be widespread especially across the western and eastern slopes of Amulsar Mountain.		
Sensitivity of Landscape Receptor: This relatively remote and open landscape shows characteristics of wildness and naturalness with very little human influence. The landform of the LCT has been shaped by glacial processes and erosion and its subtle slopes and features contrast with the craggy more distinguishable summits which often lie above. Views to development within the settled valleys and foothills which surround the LCT are contrasted by views to the undeveloped mountain summits above which are a key characteristic of this LCT. The Jermuk Forest State Sanctuary – Specially Protected Nature Area is predominantly located within this LCT and is sensitive to direct landscape change, where native oak woodland is highly characteristic. The sensitivity of the landscape features of this designated area to the landscape changes proposed is therefore judged to be high . Overall the sensitivity of this LCT to the landscape changes proposed is therefore judged to be medium .		
Description of Landscape Impacts: This LCT will experience direct landscape impacts from the construction of the BRSF, the building that contains the crushing and screening facility, overland conveyor, haul road and facilities platform. These components will require extensive earth works, resulting in the removal of large areas of existing sub-alpine vegetation, manipulation of landform, rerouting of natural drainage and the loss or disturbance of landscape features such as small river valleys. The project components will remain throughout the operation and production phases of the Project, during which the BRSF will increase in size, occupying a large bowl like hanging valley between North Erato and Little Erato, west of the Vorotan Valley at the northern extent of the Project main area. During the late winter and early spring months, the presence of dust across the snowpack will potentially increase the visible area of disturbance, as the surrounding snowfields become discolored by dust, which will be more apparent as the frequency of fresh snowfall decreases, later in the season. The changes resulting from many of the Project components will be reversible following closure and restoration of the Project main area. Long-term impacts arising from the change in landform and vegetation cover across the BRSF site will be irreversible, leading to permanent landscape changes, as the broad valley occupied by the BRSF site becomes a large man-made landform across a localised area, which is likely to have reduced land use capacity in the future. The long-term direct landscape changes which will occur within this LCT as a result of the Project will be visible across a much larger area of the LCT to the east of the Project main area. Views from this LCT to the rocky peaks and ridges which are directly affected by the Project will result in impacts upon a key characteristic of this LCT, and affect the remote and wild perceptual qualities of the LCT. The Jermuk Forest State Sanctuary – Specially Protected Nature Area will not experience direct landscape impacts upon the landscape areas of ancient native oak woodland and forest as a result of the Project. Although intervisibility of the Project will be possible from this area, indirect landscape impacts are considered unlikely to affect the key landscape features or reasons for designation. Therefore the landscape impact on this area is judged to be barely perceptible.		
Assessment Phase:	Magnitude of Landscape Impacts:	Significance & Direction of Landscape Effects:
Construction Phase: Year -1	High	Major adverse (significant)
Operations Phase: Year 3	High	Major adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	High	Major adverse (significant)
Post-Closure Monitoring Phase: Year 19	Moderate	Moderate neutral (significant)

Table 6.5.20: High Rocky Peaks (elevations over 2,500 m asl)

Table 6.5.20: High Rocky Peaks (elevations over 2,500 m asl)		
Project Components within LCT: Tigranes/Artavazdes open pit, Erato open pit and haul roads located within LCT	Representative Viewpoints located within LCT: None	
Extent of Visibility across LCT: Visibility will be widespread across the LCT, with all the key components of the Project visible from the areas of the LCT located within the Project affected area. Across the wider study area, visibility from elevated slopes and mountain peaks will be possible to the north-west, north-east and south, at a distance of over 10 km.		
Sensitivity of Landscape Receptor: The distinguishable rocky peaks and summits are the key features which define the LCT and are sensitive to visually intrusive development which will directly or indirectly affect these. The LCT represents the transition to an alpine landscape, with distinctive changes in vegetation, landform and landscape features not found within LCTs at lower altitudes. Its perceptual qualities of exposure, wildness and remoteness are accentuated by the lack of man-made features or built development within it or adjacent LCTs. The LCT also includes areas covered by the Jermuk Forest State Sanctuary – Specially Protected Nature Area , judged to be of high landscape sensitivity. Overall the sensitivity of this LCT to the landscape changes proposed is therefore judged to be high .		
Description of Landscape Impacts: This LCT will experience direct impacts as a result of the construction and operation of the haul road, Tigranes/Artavazdes open pit and the Erato open pit. The construction of the haul road across the western flanks and central peaks of Amulsar Mountain will require extensive earthworks (large scale cut and fill) and lead to a large area of the LCT within the Project main area being irreversibly changed. As the operational phases begin, the creation of the open pits will lead to the removal of the Tigranes, Artavazdes and Erato mountain peaks which form the central spine of the LCT. This area of rocky peaks and summits and surrounding craggy outcrops will be disturbed by the introduction of the man-made elements of the Project and lead to long-term loss of key characteristics of the LCT across a localised area. Dust from the construction and operation of the Project components and vehicle movements on site will lead to impacts across the areas of the LCT not directly affected by the Project footprint. During the different seasons this will lead to increased visibility, as dust created by operations settles across the surrounding vegetation in summer, and snowfields in winter, extending the visibly affected areas of the Project across areas of the surrounding slopes of Amulsar Mountain. The snow covered peaks of Amulsar Mountain are a key characteristic of the LCT and the direct impacts upon a proportion of these features will result in loss of the principal landscape features of the LCT which are of local and regional significance. Indirect landscape impacts resulting from intervisibility of the Project components from other areas of the LCT to the north, east and south will result, with long distance views to the often snow covered summits craggy summits of Tigranes, Artavazdes and Erato affected by changes in the visible skyline following the creation of the open pits. These landscape changes will be irreversible and long-term, and will be visible across a relatively large geographical area of the LCT, albeit that from a regional perspective such rocky peaks are widespread in this part of Armenia. Landscape impacts on the Jermuk Forest State Sanctuary – Specially Protected Nature Area located within the northern areas of this LCT, are judged to be barely perceptible.		
Assessment Phase:	Magnitude of Landscape Impacts:	Significance & Direction of Landscape Effects:
Construction Phase: Year -1	High	Major adverse (significant)
Operations Phase: Year 3	High	Major adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	High	Major adverse (significant)
Post-Closure Monitoring Phase: Year 19	High	Major adverse (significant)

6.5.20 Assessment of Residual Visual Effects

The following section outlines the potential visual impacts of the Project on the visual receptors identified in the baseline (Section 4.3). Potential visual impacts are assessed with reference to the 17 representative viewpoints listed in Table 6.5.13. During the 21 year period of the Project within which construction, operation, closure and post-closure monitoring will be undertaken, visibility of vehicle activities, construction activities, and the visible components of the Project will provide a varying degree of intrusion into views. It may be possible to see views of the operational Project from all areas included within the ZTV (Figure 6.5.2), although the components which will be seen will vary from each location, occupy differing angles of view and to a varying extent of perceptibility.

The Project will have medium-term to long-term adverse impacts on the viewing experience of visual receptors identified as being within the ZTV for the Project, including people living and working close to the Project affected area. Recreational users and tourists within the Arpa River Gorge and Jermuk, residents within the settlements of Jermuk, Gndevaz, Saralanj, Saravan and Ughedzor, as the most sensitive receptors, will likely experience the most significant impacts.

Impacts on Visual Receptors

The following visual receptors will experience medium-term to long-term adverse visual impacts as a result of the proposed change in views and visual amenity from the construction, operation and closure of the Project:

- Residential receptors and tourists in the settlement of Jermuk will experience **moderate** adverse visual effects on long distance views of the building that contains the crushing and screening facility, truckshop and administration facilities during construction and operation, and the BRSF during operation, experiencing localised long-term **minor** adverse visual effects on views and visual amenity post closure and restoration, affecting a large number of residents and tourists;
- Residential receptors in the settlement of Kechut will have visibility of the most northerly components of the Project, including the building that contains the crushing and screening facility, truckshop and administration facilities during construction and operation, and the BRSF in the later stages of its operation. Residents will experience localised long-term **minor** adverse visual effects on views and visual amenity.
- Some residential receptors on the western edge of the settlement of Gndevaz will have views of the western extents of the Project during construction, operation and post closure of the Project, including visibility of the building that contains the crushing

- and screening facility, Erato and Tigranes/Artavazdes open pits, the haul road, the HLF and overland conveyor, experiencing localised **moderate** adverse visual effects on views and visual amenity, affecting a moderate number of residents;
- Residents within the settlement of Ughedzor will have views of the Erato and Tigranes/Artavazdes open pits and haul road during construction, operation and post closure of the Project, experiencing a long-term localised **minor** adverse visual effect on views and visual amenity, affecting a small number of residents who are resident for summer months only;
 - Residents within the settlement of Saralanj will have views of the Erato and Tigranes/Artavazdes open pits and haul road of the Project during construction and operation, and following closure. Receptors will experience a long-term localised **minor** adverse visual effect on views and visual amenity, affecting a limited number of residential properties with views towards Amulsar Mountain;
 - Residents within the southern extents of the settlement of Saravan will have views of the Erato and Tigranes/Artavazdes open pits and haul road during construction operation and post closure of the Project. Receptors will experience a long-term localised **minor** adverse visual effect on views and visual amenity, affecting a small number of residents;
 - Residents within the settlement of Gorayk will have no visibility of the Project components and therefore will experience no perceptible visual impacts as a result of the Project;
 - Seasonal herders, daily herders and agricultural workers will experience views of the Project from within the Vorotan valley to the east and the farmed foothills and grazed highland hills which surround the Project-affected area to the north, south and west. Visibility during construction and operation will be medium-term and result in **major** adverse visual effects which will reduce to **minor** post-closure of the Project, as the visual changes created by the open pits and BRSF will remain in the long-term, affecting a small number of people;
 - Seasonal herders, daily herders and agricultural workers will experience views of the Project from the farmed foothills and grazed highland hills which surround the Project-affected area, particularly in the vicinity of the HLF, where people on the slopes above may look down onto the HLF surface. Visibility during construction and operation will be medium-term and result in **major** adverse visual effects which will reduce to **minor** post-closure of the Project as the visual changes will remain in the long-term, affecting a small number of people moving around on the hills, away from the main arterial roads and the villages and towns;

- Agricultural workers (apricot growers etc.) and seasonal herders using the slopes west of the Arpa River gorge will experience views of the Project-affected area through construction and operation, and post closure, will experience a long-term **minor** adverse visual effect on views and visual amenity, for a small number of people, resulting from changes in the distant skyline through the creation of the open pits.;
- Receptors, including tourists, local residents and workers, travelling on the H-42 highway between the M-2 highway and Jermuk will also experience sequential views of different components of the Project-affected area when travelling from the north and south. Travellers will have views of the Erato and Tigranes/Artavazdes open pits, haul road, the HLF, ADR Plant, overland conveyor and site access roads from sections of the route resulting in **minor** to **major**, adverse medium-term visual effects during construction and operation, which will reduce to a **minor – moderate** adverse effect in the long-term, post closure of the mine. These effects will be experienced by a relatively large number of people travelling along this busy road;
- Receptors travelling east or west on the Armenian Silk Road (M-2 highway) through the study area will also experience sequential views of different components of the Project-affected area to the south of the Project-affected area. Travellers will experience glimpsed views of the Erato and Tigranes/Artavazdes open pits and haul road from different sections of the route resulting in **minor** adverse visual effects which will remain long-term post closure of the mine. These effects will be experienced by a relatively large number of people travelling along this busy road between Armenia and Iran.

Representative Viewpoint Assessment

Visual impacts from the representative viewpoints (viewpoint locations are shown on Figure 6.5.1 and are outlined in the tables which follow (Table 6.5.21 to Table 6.5.34). Each viewpoint assessment table provides the following information:

- Viewpoint location and distance from Project components;
- Potential visual receptor(s);
- Sensitivity of the visual receptor;
- Description of the existing views;
- Description of change in views;
- Magnitude of visual impact; and
- Significance of the visual effect.

The viewpoint assessment should be read in with reference to the viewpoint visualisations

(Figures 6.5.10 – 6.5.26), which include baseline photographs, bare ground wireframe images and photomontages.

The magnitude of visual impacts and significance of the subsequent visual effects was assessed for each phase of the Project defined within Table 6.5.10, and assumes full implementation of the mitigation measures outlined earlier in this chapter.

An assessment of potential visual impacts experienced during night time hours, from the lighting of the Project components and vehicle movements across the Project affected area, is also included for each viewpoint, with consideration of the magnitude of visual impact and significance of the visual effect.

Table 6.5.21: Viewpoint 1: Top of Jermuk Ski Lift

Grid Reference: E 558566, N 4409466		Elevation: 2424 m asl (+ 2 m)
Distance from nearest Project Components: 5.40 km		Figure 6.5.10 Viewpoint 1: Top of Jermuk Ski Lift
<p>Viewpoint Location and Potential Receptors: The viewpoint is located close to the top of the Jermuk Ski Slope lift occupying an elevated position overlooking the settlement of Jermuk to the west and the settled valley to the south, north of the Project-affected area. The viewpoint offers panoramic views in all directions, included long distance views south towards the Project-affected area. The potential receptors represented by this viewpoint are recreational skiers and tourists in winter, and tourists in summer (the numbers of which are relatively few). The viewpoint is located within the <i>Forested Upper Gorge and Foothills LCT</i>.</p> <p>Description of Existing Views: The foreground of the existing view towards the Project-affected area is across grassed foothills and a shallow wooded valley to the valley plateau in the middle ground beyond. From the valley plateau, which contains the settlement of Kechut and Kechut Reservoir, the topography rises up gradually across the foothills of Little Erato to the higher ground of the Project-affected area. Amulsar Mountain forms the skyline beyond, where the peaks of North Erato and Erato are distinguishable features. To the north, west and east of the viewpoint the focus of the view is to the higher summits.</p> <p>Sensitivity of Visual Receptors: Skiers, walkers in the hills and tourists are of high susceptibility to changes in the surrounding view while experiencing views of the landscape from this location. The view from this viewpoint is considered to be of regional importance and value for users who visit the ski slope from further afield, therefore the sensitivity of the representative receptors is judged to be high.</p> <p>Description of Visual Impacts: Construction of the BRSF, the building that contains the crushing and screening facility, overland conveyor, truckshop and administration facilities, the access and haul roads will be perceptible from this viewpoint and vehicle movements will continue from construction into the operation and production phases, when the BRSF will become more perceptible as it increases in size from the deposition of barren rock, although it will be partially screened by intervening topography and will undergo progressive restoration as it increases in size. The HLF will not be visible from this viewpoint. Dust arising from construction and operation of the Project components will increase visibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust. During the operations phases the open pit of Tigranes/Artavazdes will be largely imperceptible from this location, however once extraction of the Erato open pit begins, the profile of the skyline to the west of North Erato will alter as the open pit increases in size.</p> <p>Food lighting of the overland conveyor, crushing and screening facility, truckshop and administration buildings will be continuous during the operations phase, and ambient light glow will be visible from the Erato open pit. Vehicle movements on site (along the access and haul roads), will be perceptible during the hours of darkness from this viewpoint, across the skyline of Amulsar Mountain, and the foothills slopes on the north side of Little Erato, which are otherwise unaffected by lighting at present. The headlights of large vehicles travelling northwards along the haul road (towards Jermuk) will be clearly visible from this viewpoint, and will introduce a moving visual distraction across an otherwise unlit part of the view during night time hours, which will be more extensive during the winter months.</p> <p>The BRSF will form a new large feature in the views towards Amulsar Mountain, whilst the crushing and screening facility buildings will appear prominent above the skyline west of Little Erato from this viewpoint. The other component parts of the Project will form relatively small elements at this distance while affecting a small proportion of the available view and the majority of changes will be medium-term and reversible following closure of the mine. Following closure, the built components of the Project will be removed; including the overland conveyor, crushing and screening facility, the access and haul roads, and the disturbed ground will be regraded and revegetated to restore the profile and land cover to a resemblance of the baseline situation. A cover system will be applied to the final regraded surface of the BRSF (as outlined in the pMRCRP, Appendix 8.18) and revegetated, which will reduce the perceptibility of this new landform within the surrounding landscape.</p> <p>The change in landform from the creation of the BRSF and Erato open pit will be irreversible and remain long-term; however the visual change will be slight and affect a small proportion of the available panoramic views from this location. The change will be distinguishable on the skyline in the distance following restoration measures and post-closure monitoring.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

Table 6.5.22: Viewpoint 2: Hotel Olympia, Jermuk

Grid Reference: E 557105, N 4410044		Elevation: 2096 m asl (+ 2 m)
Distance from nearest Project Components: 6.5 km		Figure 6.5.11: Viewpoint 2: Hotel Olympia, Jermuk
<p>Viewpoint Location and Potential Receptors:</p> <p>This viewpoint is located outside the Hotel Olympia and Sanatorium situated in the centre of Jermuk, north of the Project-affected area. The viewpoint is situated at the car park entrance alongside the roadside public walkway to the hotel. The viewpoint represents framed views seen from the car park, grounds and surroundings of the hotel, and similar views experienced from windows on the south side of the hotel and nearby residential properties within Jermuk. The potential receptors represented by this viewpoint are tourists and residents at the hotel and local residents within Jermuk in both the winter and summer seasons. The viewpoint is located within the <i>Forested Upper Gorge and Foothills LCT</i>.</p> <p>Description of Existing Views:</p> <p>The foreground of the existing view is across the car park and surrounding grounds of the hotel, with the wooded gorge which cuts through Jermuk to the south of the hotel forming the middle ground of the view. Buildings located on the south of the gorge are partially screened by woodland. Long distance views towards the Amulsar Mountain, to the distinguishable peaks of Erato and North Erato, are framed by the eastern slopes of the valley in the middle distance. Views west, east and north from the viewpoint are enclosed by the surrounding woodland and buildings within the settlement of Jermuk.</p> <p>Sensitivity of Visual Receptors:</p> <p>Tourists and residents are judged to be of high susceptibility to changes in the view, where opportunities for views to the surrounding landscape and mountains from this location are limited and therefore the focus of the view to the distinct mountain landscape south of Jermuk is judged to be of regional value. The sensitivity of the representative receptors is judged to be high.</p> <p>Description of Visual Impacts:</p> <p>Construction of the BRSF, the buildings that contains the crushing and screening facility, overland conveyor, truckshop and administration buildings, access roads and haul road will be perceptible from this location, which along with visibility of vehicle movements (especially during night time hours) will continue through the operation and production phases of the Project. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields become discoloured, which will be perceptible from this viewpoint. The HLF will not be visible from this viewpoint. The crushing and screening facility buildings will appear above the ridgeline to the west of Little Erato introducing built development to this otherwise undeveloped skyline, appearing more perceptible at night when lit and accessed by on site vehicles. The BRSF will become increasingly more visible as the operational phases progress and the BRSF increases in size, becoming visible to the south-east of Jermuk, altering the skyline of Amulsar Mountain. When mining of the Erato open pit commences, changes to the skyline of Amulsar Mountain will become perceptible as the peak and upper slopes of Erato Mountain are removed and the open pit increases in size through its excavation. Lighting of the overland conveyor, crushing and screening facility, truckshop and administration buildings and the Erato open pit, along with vehicle movements on site along the access and haul roads will be perceptible during the hours of darkness from this viewpoint, across the foothills on the north side of Little Erato which is otherwise unaffected by artificial lighting at present. The headlights of large vehicles travelling northwards along the haul road will be clearly visible from this viewpoint, and will introduce a moving visual distraction across an otherwise unlit part of the view during night time hours, which will be more extensive during the winter months. The accompanying components of the Project (overland conveyor, truckshop and administration buildings) will form small, almost imperceptible elements in the view at this distance and will remain for the medium-term; however impacts will be reversible following their removal during closure of the mine. Following closure, these components will be removed; including the access and haul roads, and the disturbed ground will be regraded and revegetated to restore the profile and land cover to a resemblance of the baseline situation.</p> <p>The BRSF will be subject to progressive restoration during the operational phases, and will be subsequently capped and revegetated, becoming less perceptible alongside the surrounding landform. The change in landform from the creation of the Erato open pit will be irreversible and remain long-term, distinguishable on the skyline following restoration measures and post-closure monitoring.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

Table 6.5.23: Viewpoint 3: Hotel Armenia, Jermuk

Grid Reference: E 556928, N 4410153		Elevation: 2097 m asl (+ 2 m)
Distance from nearest Project Component: 6.5 km		Figure 6.5.12: Viewpoint 3: Hotel Armenia, Jermuk
<p>Viewpoint Location and Potential Receptors:</p> <p>This viewpoint is located at the entrance to the Armenia Hotel in Jermuk, north of the Project-affected area. Situated on the front terrace of the hotel, the viewpoint is frequented by visitors to the hotel and represents views experienced when leaving the hotel and views from the surrounding external grounds and south facing windows to the front of the hotel. The viewpoint also represents similar glimpsed views towards Amulsar Mountain experienced from the Jermuk hot springs to the east of the hotel. The potential receptors represented by this viewpoint are tourists and residents at the hotel in both the winter and summer seasons. The viewpoint is located within the <i>Forested Upper Gorge and Foothills LCT</i>.</p> <p>Description of Existing Views:</p> <p>The existing view from this location is focused on the surrounding foreground of the hotel and the adjacent hotel which is currently under construction. The presence of coniferous trees which surround the hotel to the south and east contain long distance views from this location, however glimpsed views between the trees in the middle distance offered framed views of the Amulsar Mountain. The peaks of Erato and North Erato are visible on the distant skyline from this viewpoint. Views west, east and north from the viewpoint are enclosed by the surrounding woodland and buildings within the immediate vicinity of the hotel.</p>		
<p>Sensitivity of Visual Receptors:</p> <p>Tourists are judged to be of high susceptibility to changes in the view, where opportunities for views to the surrounding landscape and mountains are limited and therefore where available the focus of the view to the surrounding mountain landscape is judged to be of regional value. The sensitivity of the representative receptors is judged to be high.</p>		
<p>Description of Visual Impacts:</p> <p>Construction of the BRSF, overland conveyor, truckshop and administration buildings, access roads and haul road may be perceptible from this location, in glimpsed views through the tree cover and built form which lies in the foreground of the view. Vehicle movements may be visible throughout the construction and operations phases of the project; however visibility of the Tigranes/ Artavazdes open pit, and the HLF will not be possible from this viewpoint.</p> <p>When mining of the Erato open pit commences, changes to the skyline of Amulsar Mountain will be perceptible as the peak of Erato Mountain is removed and the open pit increases in size. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields become discoloured by dust, which will extend the degree to which the Project is perceptible from this viewpoint.</p> <p>Lighting of the overland conveyor, crushing facility, truckshop and administration buildings, and the Erato open pit, along with vehicle movements on site will be perceptible in the distance during hours of darkness; however this will be from the context of the street lit settlement of Jermuk in views from this location. The headlights of large vehicles travelling northwards along the haul road will be clearly visible from this viewpoint, and will introduce a moving visual distraction across currently unlit part of the view during night time hours, which will be more extensive during the winter months.</p> <p>The accompanying components of the Project (i.e. overland conveyor, truckshop and administration buildings) will form relatively small, almost imperceptible elements in the view at this distance and will remain for the medium-term; however impacts will be reversible following their removal during closure of the mine. Following closure, the built components of the Project will be removed; including the, access and haul roads, and the disturbed ground will be regraded and revegetated to restore the profile and land cover to a resemblance of the baseline situation.</p> <p>The change in landform from the creation of the Erato open pit and BRSF will be irreversible and remain long-term, distinguishable on the skyline following restoration measures; however from this viewpoint these changes will likely be the only visible remnants of the Project following post-closure monitoring.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Low	Minor adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Low	Moderate adverse (significant)

Table 6.5.24: Viewpoint 4: Deer Sculpture west of Jermuk

Grid Reference: E 556657, N 4409747		Elevation: 2213 m asl (+ 2 m)
Distance from nearest Project Component: 6.5 km		Figure 6.5.13 Viewpoint 4: Deer Sculpture west of Jermuk
<p>Viewpoint Location and Potential Receptors: This viewpoint is located adjacent to the deer sculpture which sits atop the edge of the valley on hills to the west of Jermuk, north of the Project-affected area. Situated in an elevated position it offers panoramic views in all directions. The viewpoint is accessed via a track to the south, which climbs steeply from the settlement of Jermuk and the potential receptors represented by this viewpoint are recreational users, walkers in the hills and tourists in both the winter and summer seasons. The viewpoint is located within the <i>Forested Upper Gorge and Foothills LCT</i>.</p> <p>Description of Existing Views: The viewpoint offers elevated views across the wooded valley landscape around Jermuk and the steep gorge which runs along the foot of the valley below. The middle distance of the view is across the valley plateau with the abandoned airstrip and tower blocks of south Jermuk visible in the view. Long distance views across the foothills south of Jermuk rise up to the Amulsar Mountain which forms the skyline beyond. The peaks of North Erato and Erato are distinguishable features in long distance views and panoramic views west, east and north are possible across the surrounding foothills, to the distant mountain summits beyond.</p> <p>Sensitivity of Visual Receptors: Recreational users, walkers in the surrounding hills and tourists are judged to be of high susceptibility to change in views, whilst experiencing the landscape from this location. The view from this viewpoint is considered to be of local importance and value for users who visit the sculpture, therefore the sensitivity of the representative receptors is judged to be medium.</p> <p>Description of Visual Impacts: Construction of the BRSF, overland conveyor, building that contains the crushing and screening facility, truckshop and administration buildings, access roads, and haul road will be perceptible from this location, and the resultant changes will remain throughout the operational phases of the Project. The open pit of Tigranes/Artavazdes will not be visible from this viewpoint, however as operations and production commences, the BRSF will become more perceptible as it increases in size, appearing above the existing landform of the foothills to the north of Amulsar Mountain. Once mining of the Erato open pit commences, changes to the skyline of Amulsar Mountain will be perceptible as the peak of Erato Mountain is removed and the open pit increases in size. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust. Lighting of the overland conveyor, crushing and screening building, truckshop and administration buildings, the Erato open pit along with movements of large vehicles along the access and haul roads on the western and northern sides of the mountain, will be perceptible during the hours of darkness from this viewpoint, appearing across the distant skyline which is otherwise unaffected by artificial lighting, albeit that this lighting will be seen in the context of the settlements of Jermuk and Kechut located in the valley below the viewpoint. Due to the orientation of haul roads, the headlights of vehicles travelling northwards towards the BRSF and the building that contains the crushing and screening facility will be very perceptible during night time hours and winter months. The components visible from this location will occupy a relatively small proportion of the available view in the medium-term. The features created by the open pit of Erato and the BRSF will remain following closure of the mine however impacts associated with all other component parts will be reversed once they are removed, including the overland conveyor, crushing and screening building, truckshop and administration buildings, and access and haul roads. Disturbed ground will be regraded and revegetated to restore the profile and land cover to a resemblance of the baseline situation. The change in landform from the creation of the BRSF and Erato open pit will be irreversible and remain long-term, distinguishable on the skyline, however the BRSF will be subject to progressive restoration and will subsequently be capped with topsoil and revegetated, becoming less perceptible within the immediate landscape following the post-closure monitoring phase.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

Table 6.5.25: Viewpoint 5: Western edge of Gndevaz Village

Grid Reference: E 552765, N 4401848		Elevation: 1829 m asl (+ 2 m)
Distance from nearest Project Component: 2.08 km		Figure 6.5.14: Viewpoint 5: Western edge of Gndevaz Village
<p>Viewpoint Location and Potential Receptors: This viewpoint on the elevated western edge of Gndevaz village to the west of the Project-affected area, offering views across the settlement to the agricultural landscape and Amulsar Mountain beyond. The viewpoint represents the views experienced by residents from residential properties and their surrounding curtilages located to the western extent of Gndevaz. The viewpoint is located within the <i>Settled Lowland and Rocky Gorges LCT</i>.</p> <p>Description of Existing Views:</p> <p>The foreground of the elevated view is across Gndevaz, which is located in a natural bowl feature to the east of the viewpoint and contained by the surrounding undulating landform. In the middle ground beyond the H-42 highway to the east, the undulating steppe plateau and foothills which cover the western extent of the Project-affected area rise up to the foothills of Amulsar Mountain, where the peaks of North Erato, Erato, Tigranes and Arshak are visible features on the distant skyline to the south-east of the viewpoint. Views north, south and west from the viewpoint are contained by the presence of surrounding landform, vegetation and built elements, including a number of communication masts which sit on the elevated ridge to the south.</p> <p>Sensitivity of Visual Receptors:</p> <p>The residents which are represented by this viewpoint are judged to be of high susceptibility to changes in the view, as appreciation of the surrounding view is material to the quality of life from the residential properties it represents and are therefore the views are judged to be of local value. The sensitivity of these receptors is therefore judged to be high.</p> <p>Description of Visual Impacts:</p> <p>During construction, the preparatory earthworks for the overland conveyor and access road will be perceptible across the intervening topography of the lower farmed foothills to the south-east of the viewpoint. The crushing and screening building, will be visible to the east of the viewpoint on the western flanks of Little Erato, while the overland conveyor will be visible crossing the higher ground east of Gndevaz to reach the HLF site. The construction of these components, along with the haul road on the west side of Amulsar Mountain and vehicle movements on site will also be perceptible from the western edge of Gndevaz, however activities during this phase will occupy a relatively small proportion of the available view and appear beyond existing man-made elements, including the H-42 highway, steel tower electricity transmission line and the built development within the settlement of Gndevaz. Temporarily vegetated topsoil stockpiles will be strategically located to the west of the HLF to screen immediate views of these project components as far as is practical from the settlement of Gndevaz and the H-42 highway.</p> <p>Once operation and production commences the open pit of Tigranes/Artavazdes will be visible to the south-east and changes in the profile of the existing skyline will occur as the mountain peaks are removed. The Erato open pit will extend visible changes to the skyline northwards as the third mountain peak is removed. Visibility of the HLF will also increase as phase 2 and phase 3 of the HLF operation extend its footprint northwards across the lower foothills of Amulsar Mountain, introducing visibility from the western edge of Gndevaz, where the working surface of the HLF will contrast with the surrounding landform and vegetation in the medium-term. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust from this location. The existing steel tower overhead transmission line will remain to the west of the HLF, remaining visible from the settlement of Gndevaz and the adjacent H-42 highway.</p> <p>Flood lighting of the overland conveyor, crushing and screening facility, open pits and HLF, along with the movements of large vehicles on site will be perceptible during the hours of darkness from this viewpoint; however lighting will appear in the distance above the partially lit settlement of Gndevaz and in the context of lighting from vehicles travelling on the H-42 road.</p> <p>Following closure of the mine, the overland conveyor, crushing and screening facility and access roads will be removed and disturbed land will be regraded and revegetated, utilizing the stored topsoil stockpiles to restore the landform and land cover to a resemblance of the baseline situation. The alteration of the skyline of Amulsar Mountain to the south-east will be irreversible and although the HLF will remain, it will be capped with topsoil and revegetated, becoming less perceptible as it blends with the surrounding vegetation and landform following post-closure monitoring.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

Table 6.5.26: Viewpoint 6: H-42 highway south of Gndevaz

Grid Reference: E 551961, N 4398867	Elevation: 1665 m asl (+ 2 m)	
Distance from nearest Project Component: 150 m	Figure 6.5.15: Viewpoint 6: H-42 highway South of Gndevaz	
Viewpoint Location and Potential Receptors: This viewpoint is located alongside the H-42 highway, to the south of Gndevaz and offers open views across the surrounding plateau farmland and undulating landscape of the Project-affected area to the east. The receptors represented by the viewpoint are road users travelling north on the H-42 highway between the junction of the Armenian Silk road (M-2 highway) and the settlement of Gndevaz, and also represents the views experienced by agricultural workers within the adjacent arable and pasture fields. The viewpoint is located within the <i>Lower farmed and settled foothills LCT</i> .		
Description of Existing Views: The foreground of views from this viewpoint is across the surrounding agricultural plateau landscape which lies to the east and west of this section of the H-42 highway, where a steel tower electricity transmission line runs parallel with the road to the east and is visible in views east and north-east from the viewpoint. In the middle distance, the steppe plateau and foothill landscape which covers the western extent of the Project-affected area, rising up to the foothills of Amulsar Mountain, where the peaks of North Erato, Erato and Tigranes are visible features on the distant skyline to the south-east of the viewpoint. Views west are possible across agricultural fields to the deep gorge and wooded foothills.		
Sensitivity of Visual Receptors: Road users are judged to be of low susceptibility to changes in views from this location. However, agricultural workers and herders within the surrounding agricultural fields are judged to be of medium susceptibility to changes in the view, as appreciation of the surrounding view is of greater value to these receptors. Overall the sensitivity of the represented receptors is judged to be medium .		
Description of Visual Impacts: Construction of the HLF, HLF pond, overland conveyor, , access roads will be visible from this viewpoint, appearing across the farmed lower foothills east of the H-42 highway and the foothills beyond. The visible components will appear beyond the steel tower electricity transmission line which runs parallel to the H-42 highway in the middle distance of the view. The building that contains the crushing and screening facility and the main haul road will also be visible in views from the H-42 highway, appearing across the distant skyline formed by Little Erato and Amulsar mountain. Temporarily vegetated topsoil stockpiles will be utilized to screen immediate views of the project componentry from the H-42 highway. Once operation and production commences the open pit of Tigranes/ Artavazdes will be perceptible on the skyline to the east of the viewpoint as the mountain peaks are removed and extraction of rock takes place. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust. The changes to the skyline of Amulsar Mountain will be long-term and irreversible, and will extend northwards along the Amulsar Mountain ridge as mining of the Erato open pit begins. As the operations phase continues the HLF will become more perceptible beyond the intervening topsoil stockpiles east of the H-42 highway which will offer limited mitigation of the visual change as the HLF enters phase 2 and 3 of operation. Further screening could be provided through the provision of tree planting alongside the road to the east, however the HLF will eventually form a large feature in the available view east from this viewpoint, altering views towards the foothills of Amulsar Mountain beyond. These visual changes will remain long-term as the landform changes become permanent after regrading and revegetation during the closure phase of the Project. Flood lighting of the HLF, overland conveyor, crushing and screening facility, open pits, haul road and access roads, along with vehicle movements on site along the main access and haul roads will be perceptible during the hours of darkness from this viewpoint; and although the lighting will appear in the context of the adjacent settlement of Gndevaz to the west of the Project-affected area and lighting from vehicles travelling along the H-42 highway, it will introduce a substantial level of permanent artificial lighting across an area of relative darkness during construction and operation of the Project. During closure, potential borrow areas for obtaining clay for the capping of the HLF will be created. This short term disturbance will require the stripping and storage of vegetation and topsoil in neighboring berms and may be visible from this location. The overland conveyor, crushing and screening facility and access roads will be removed and although the visible HLF will remain, it will be regraded, capped and revegetated (as outlined in the pMRCRP, Appendix 8.18), becoming less perceptible as it blends with the surrounding vegetation and landform, so that once established the engineered landform of the HLF will be subtly altered to appear more sympathetic with the surrounding landform following post-closure monitoring. The long-term changes to the profile of the skyline of Amulsar Mountain from the creation of the open pits will be irreversible and will remain following post-closure monitoring.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	High	Major adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	Moderate	Moderate adverse (significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor adverse (not significant)
Night Time Lighting Impacts	High	Major adverse (significant)

Table 6.5.27: Viewpoint 7: H-42 highway South-west of Heap Leach Facility

Table 6.5.27: Viewpoint 7: H-42 highway South-west of Heap Leach Facility		
Grid Reference: E 551805, N 4398323	Elevation: 1589 m asl (+ 2 m)	
Distance from nearest Project Component: 410 m	Figure 6.5.16: Viewpoint 7: H-42 highway South-west of Heap Leach Facility	
Viewpoint Location and Potential Receptors: This viewpoint is located on the H-42 highway, to the south of the hairpin bends which run alongside the Arpa River Gorge, south of the HLF site. The receptors represented by the viewpoint are road users travelling north on the H-42 highway between the junction of the Armenian Silk road (M-2 highway) and the settlement of Gndevaz, and it also represents the views experienced by agricultural workers within the adjacent arable and pasture fields to the east and west of the road. The viewpoint is located within the <i>Lower farmed and settled foothills LCT</i> .		
Description of Existing Views: The foreground of views north-east from this viewpoint are along the H-42 highway towards the Project main area, with the crash barriers located along its western edge forming a key feature in the view. Views are contained by the steep topography adjacent to the east and north of the H-42 highway as it passes through the hanging valley above the Arpa River Gorge, with deciduous vegetation further screening views along the narrow valley towards the HLF site and towards the mountainous ridge on the skyline beyond. The viewpoint offers views west across agricultural land into the steep sided Arpa River Gorge and the wooded east facing slopes beyond. A steel tower electricity transmission line is located on the higher ground north of the viewpoint and appears across the skyline in the middle ground. Wood pole overhead lines also dissect the skyline in views north-east towards the HLF site and Amulsar Mountain beyond. Views east are limited by the steep road sidings directly adjacent to the H-42 highway in this location.		
Sensitivity of Visual Receptors: Road users, agricultural workers and herders within the surrounding agricultural fields are judged to be of low susceptibility to changes in the view, as appreciation of the surrounding view is not of specific value to these receptors from this location. The sensitivity of the represented receptors is judged to be medium .		
Description of Visual Impacts: Receptors travelling north along the H-42 highway will experience visibility of the ground works undertaken for the construction of the HLF, overland conveyor, and access roads. The HLF site and ADR plant are located directly north of the viewpoint but are substantially screened by the presence of steep intervening topography which lies adjacent to the H-42 highway as it winds around the edge of the Arpa River Gorge to the west. Further screening could be provided through the provision of tree planting between the corner on the road, at its lowest point, and the proposed HLF. Visibility of the overland conveyor and access roads will be possible in the distance, as they are constructed across the foothills west of Amulsar Mountain, linking the crushing and screening facility, which is visible on the distant skyline to the north-east, with the HLF site. Once operation and production commences the open pit of Tigranes/ Artavazdes will potentially be perceptible on the skyline to the north-east of the viewpoint, as the mountain peaks are removed and extraction of rock takes place. Dust arising from construction and operation of the Project components will increase visibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust, which may be perceptible from this viewpoint. The changes to the skyline will be long-term and irreversible, and will extend northwards along the Amulsar Mountain ridge as mining of the Erato open pit begins. Intervening screening from vegetation along the road sidings to the east of the viewpoint will screen some views towards the open pits in the spring and summer months. During the operational phases of the project, the HLF will increase in vertical height and extent and become more perceptible from this viewpoint, appearing above the intervening topography as the new unvegetated landform feature which will contrast with the surrounding foothills and agricultural land. The HLF will eventually form a new feature in the available view north from this viewpoint, altering views towards the foothills of Amulsar Mountain beyond. These visual changes will remain long-term as the landform changes become permanent, however during the closure phase, regrading and revegetation of the HLF will be undertaken to ensure the new landform blends subtly with the surrounding landform and vegetation, so that once established the engineered landform of the HLF will appear more sympathetic with the surrounding landscape. The overland conveyor and crushing and screening facility, will be removed during the closure phase of the project and disturbed areas of the Project site will be restored and regraded to ensure long-term impacts from these components of the Project do not occur. Lighting of the HLF, ADR plant, overland conveyor, crushing and screening facility, open pits, haul road and access roads, along with vehicle movements on site will be perceptible during the hours of darkness from this viewpoint, it will introduce a substantial level of permanent artificial lighting across an area of relative darkness during construction and operation of the Project. The long-term changes to the profile of the skyline of Amulsar Mountain will be irreversible and will remain following post-closure monitoring.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Low	Minor adverse (not significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Moderate	Moderate adverse (significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

Table 6.5.28: Viewpoint 8: Armenian Silk Road (M-2 highway) near Junction with the H-42 highway

Grid Reference: E 548084, N 4393759	Elevation: 1354 m asl (+ 2 m)	
Distance from nearest Project Component: 6.13 km	Figure 6.5.17: Viewpoint 8: Armenian Silk Road (M-2 highway) near Junction with the H-42 highway	
Viewpoint Location and Potential Receptors: This viewpoint is located alongside the Armenian Silk Road (M-2 highway) between the junction with the H-42 highway to Jermuk to the west and the settlement of Saravan to the north-east, south-west of the Project-affected area. The viewpoint illustrates framed views along the gorge of the Darb river and is representative of views experienced by road users travelling east towards Iran on the Armenian Silk Road, and also represents the views experienced by agricultural workers within the adjacent arable fields and fruit orchards. The viewpoint is located within the <i>Settled Lowland and Rocky Gorges LCT</i> .		
Description of Existing Views: The view from this viewpoint is focused along the steep sided gorge of the Darb River, with the foreground made up of the wide road along the narrow valley bottom, alongside the adjacent arable fields and fruit orchards, with the wooded river corridor below. A wood pole electricity transmission line runs parallel with the road in the centre of the view. The partially wooded slopes of the gorge make up the middle ground of the view and frame the long distance views to Amulsar Mountain which forms the skyline in the far distance. Similar views are available when travelling west along the road, while views north and south from this viewpoint are contained by the steep and partially wooded valley sides of the gorge.		
Sensitivity of Visual Receptors: Road users and agricultural workers within the surrounding agricultural fields are judged to be of low susceptibility to changes in the view, as appreciation of the surrounding view is not of specific value to these receptors from this location. The sensitivity of the represented receptors is judged to be low .		
Description of Visual Impacts: Visibility of construction activities are not likely to be perceptible from this viewpoint, as the construction of the haul road is unlikely to be perceptible at this distance, and further changes to views will not occur until operation of the Tigranes/Artavazdes open pit. Changes to the distant skyline of the Amulsar Mountain will result from the removal of the mountain peaks. This will extend northwards along the ridge as the Erato open pit commences operation. Although visible these long-term and irreversible changes to the view will form a relatively small feature within the available view, and at a considerable distance from the viewpoint, and will be experienced while travelling at speed along the M-2 highway, where the distant mountains are not the key focus of the view, and small scale changes will not be easily discernable. Dust deposited across the surrounding areas of the Project components will be largely imperceptible from this viewpoint for much of the year, however during the late winter/early spring months, the areas directly surrounding the open pits may be more perceptible as dust from the mining operations settles discolours the adjacent snow fields. Lighting of the open pits and haul road on the distant skyline, along with movements of large vehicles on site made more perceptible during the hours of darkness and during winter months from this viewpoint; however the lighting will appear in the context of the headlights of vehicles travelling along the M-2 highway and at a large distance and different elevation to receptors at this viewpoint and similar locations along the M-2 highway. The long-term permanent changes to the skyline created by the open pits will remain following post-closure monitoring of the Project.		
Assessment Phase:	Assessment Phase:	Assessment Phase:
Construction Phase: Year -1	Barely perceptible	Negligible adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Low	Minor adverse (not significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Barely perceptible	Negligible neutral (not significant)
Night Time Lighting Impacts	Low	Minor adverse (not significant)

Table 6.5.29: Viewpoint 9: Armenian Silk Road (M-2 highway) in Saralanj village

Grid Reference: E 557307, N 4395581		Elevation: 2158 m asl (+ 2 m)
Distance from nearest Project Component: 4.18 km		Figure 6.5.18: Viewpoint 9: Armenian Silk Road (M-2 highway) in Saralanj Village
<p>Viewpoint Location and Potential Receptors:</p> <p>This viewpoint is located on the eastern edge of the settlement of Saralanj, situated in an elevated position alongside the Armenian Silk Road (M-2 highway), south of the Project-affected area. The viewpoint illustrates pitched views from residential properties within the settlement of Saralanj, to the surrounding foothills and summits of Amulsar Mountain which form the skyline to the north, and is located within the <i>Lower Farmed and Settled Foothills LCT</i>.</p> <p>Description of Existing Views:</p> <p>The Armenian Silk Road (M-2 highway) crosses the foreground of the view, with residential properties and agricultural buildings located in an elevated position to the north of the road. The middle distance of the view is across the arable and pastoral land which surrounds the settlement, rising up across the foothills which are crossed by a number of electricity transmission lines from west to east. Beyond the foothills, the higher peaks of Amulsar Mountain, with their craggy summits and scree slopes form the distant skyline. Views west and east of from the viewpoint are focused along the route of the Armenian Silk Road, which climbs steeply from the deep gorge in the west, up to the head of the Vorotan pass in the east. Views south from the viewpoint are across the wooded valley of the River Darb, where the adjacent foothills rise up to high summits which mark the southern RA border with the Nakhijevan Autonomous Republic (an exclave of Azerbaijan).</p>		
<p>Sensitivity of Visual Receptors:</p> <p>The residents which are represented by this viewpoint are judged to be of high susceptibility to changes in views, as appreciation of the surrounding view is material to the quality of life from the residential properties it represents and therefore the views are judged to be of local value. The sensitivity of these receptors is therefore judged to be high.</p>		
<p>Description of Visual Impacts:</p> <p>Limited visibility of construction activities will be perceptible from this viewpoint to the south-west of the Project-affected area, limited to distant views of the haul road on the western side of the Amulsar Mountain ridge. Other key components of the Project will be screened by the steep intervening topography to the north of the viewpoint.</p> <p>During the operational phases of the Project, the open pit of Tigranes/Artavazdes will be visible across the skyline of Amulsar Mountain to the north-east. The removal of the mountain peaks to create the open pit will create a long-term and irreversible change to the skyline which forms the backdrop to views north-east from the settlement of Saralanj. As operations progress the creation of the Erato open pit will remove a third mountain peak from the Amulsar Mountain ridge. The changes to the profile of the skyline to the east, north-east will be largely imperceptible from the settlement of Saralanj and the changes will affect only a small proportion of the available views from this viewpoint.</p> <p>Dust across the surrounding areas of the visible Project components will be largely imperceptible from this viewpoint, however during the late winter/early spring months; the areas surrounding the open pits and haul road may be more visible as dust from the mining operations settles and discolours the adjacent snow fields.</p> <p>Lighting of the open pits along with vehicle movements along the on-site haul road around the western flanks of the mountain will be perceptible during the hours of darkness and exacerbated during the winter months from this viewpoint; however the lighting will appear in the context of the lights of vehicles travelling along the M-2 highway and lighting from the settlement of Saralanj and nearby settlement of Saravan, appearing at a relatively large distance and different elevation from receptors at the viewpoint and similar locations along the M-2 highway.</p> <p>The long-term changes to the profile of the skyline of Amulsar Mountain will be irreversible and will remain following post-closure monitoring.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Low	Minor adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Minor adverse (not significant)
Closure Phase: Year 14	Moderate	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Low	Minor adverse (not significant)

Table 6.5.30: Viewpoint 10: North end of Ughedzor Village

Grid Reference: E 558390, N 4393710		Elevation: 2016 m asl (+ 2 m)
Distance from nearest Project Component: 4.64 km		Figure 6.5.19: Viewpoint 10: North end of Ughedzor Village
<p>Viewpoint Location and Potential Receptors:</p> <p>This viewpoint is located within the rural settlement of Ughedzor, south of the Armenian Silk Road (M-2 highway). The settlement was uninhabited until recent years, but is now inhabited by a small number of farming families during summer months only and is accessed by a track which crosses the valley of the River Darb from the north. The viewpoint illustrates views from residential properties located within the settlement, to the surrounding foothills and summits of Amulsar Mountain which form the skyline beyond. The viewpoint is located within the <i>Lower Farmed and Settled Foothills LCT</i>.</p> <p>Description of Existing Views:</p> <p>The foreground of the view is made up of pastoral grazing land, with sporadic residential properties and agricultural buildings located either side of the access track to the north. Two wood pole electricity transmission lines cross the foreground from south to north. In the middle distance the landform rises up across the foothills of the Amulsar Mountain, where a large electricity substation and numerous steel tower transmission lines cross the landscape, breaking the skyline to the east towards the head of the Vorotan Pass. In the distance to the north, the craggy summits of the Amulsar Mountain, including the peaks of Tigranes, Artavazdes and Arshak form distinguishable features on the skyline. Views south from the viewpoint are across foothills which rise up to the high summits which mark the southern RA border with the Nakhijevan Autonomous Republic (an exclave of Azerbaijan).</p> <p>Sensitivity of Visual Receptors:</p> <p>The small numbers of residents which are represented by this viewpoint are judged to be of high susceptibility to changes in the view, as appreciation of the surrounding view is material to the quality of life from the residential properties it represents and are therefore the views are judged to be of local value. The sensitivity of these receptors is therefore judged to be high.</p> <p>Description of Visual Impacts:</p> <p>Construction activities will be largely imperceptible from this viewpoint to the south-west of the Project-affected area. Visibility of the haul road across the western side of the Amulsar Mountain ridge may be perceptible from this location, albeit at a relatively large distance and in the context of existing disturbance on this side of the mountain.</p> <p>During the operations phases of the Project the open pit of Tigranes/Artavazdes will be visible on the skyline of Amulsar Mountain to the north-east. The removal of the distinctive craggy mountain peaks to create the open pit will create a long-term and irreversible change to the skyline which forms the backdrop to views north-east across the valley from the settlement of Ughedzor. As operations progress the creation of the Erato open pit will remove a third mountain peak from the Amulsar Mountain ridge, however this will be barely perceptible on the distant horizon to the north-east.</p> <p>Dust across the surrounding areas of the Project components will be largely imperceptible from this viewpoint, however while Amulsar Mountain is snow-covered; the areas surrounding the open pits and haul road may be more visible as dust from the mining operations discolours the adjacent snow fields.</p> <p>Lighting of the open pits and haul road on the distant horizon, along with the movements of vehicle along the haul road across the western side of the mountain will be perceptible during the hours of darkness from this viewpoint; however the lighting will appear in the context of lights from vehicles potentially travelling along the M-2 highway to the north-east of the viewpoint, appearing at a relatively large distance and different elevation from the viewpoint.</p> <p>Following closure the long-term changes to the profile of the skyline of Amulsar Mountain will be irreversible and will remain following post-closure monitoring.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Low	Minor adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Low	Minor adverse (not significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Low	Minor adverse (not significant)

Table 6.5.31: Viewpoint 11: Syunik Gates on the Vorotan Pass (M-2 highway)

Grid Reference: E 561166, N 4393305	Elevation: 2345 m asl (+ 2 m)	
Distance from nearest Project Component: 3.89 km	Figure 6.5.20: Viewpoint 11: Syunik Gates on the Vorotan Pass (M-2 highway) between Saravan and Goryak	
Viewpoint Location and Potential Receptors: This viewpoint is located adjacent to the Syunik Gates which marks the summit of the Vorotan Pass on the Armenian Silk Road (M-2 highway), south of the Project-affected area. The viewpoint represents views experienced by tourists and cyclists travelling the route of the silk road and ordinary road users of this key transport link between Iran and Armenia. The viewpoint is located within the <i>Highland Hills and Grazing LCT</i> .		
Description of Existing Views: The foreground of the view towards the Project-affected area, is formed by the highland grazing pasture which covers the foothills and lower slopes of Amulsar Mountain, where a Soviet era communications tower is visible on the skyline in the mid-distance. A steel tower transmission line crosses the middle ground of the view, passing over the higher ground from east to west. In the distance to the north, Amulsar Mountain rises to where the craggy summits of Tigranes and Artavazdes, and the natural rocky escarpments and scree slopes across Arshak and its subsidiary peaks are distinguishable features on the skyline, and from a key feature in the view. The viewpoint offers open views into the valley of the River Darb to the west and to the lower Vorotan Valley and Spandaryan Reservoir to the east. Views south from the viewpoint are across foothills which rise up to the high summits which mark the southern RA border with Nakhijevan Autonomous Republic (an exclave of Azerbaijan).		
Sensitivity of Visual Receptors: Although frequented by lower sensitivity road users, the viewpoint represents tourists which are judged to be of medium susceptibility to changes in the view from this location, as appreciation of the surrounding view is of regional value. The sensitivity of the represented receptors is judged to be medium .		
Description of Visual Impacts: Construction activities will not perceptible from this viewpoint to the south-west of the Project-affected area. During the operational phases formation of the open pit of Tigranes/Artavazdes will become visible on the skyline of Amulsar Mountain, north along the ridge beyond the mountain peak of Arshak. The removal of the mountain peaks to create the open pit will create a long-term and irreversible change to the skyline which forms the backdrop to views from the gates located at the top of the Vorotan Pass. Dust across the surrounding areas of the Project components will be largely imperceptible from this viewpoint, however during the winter months; the areas surrounding the Tigranes/Artavazdes open pit will become more visible as dust from the mining operations discolours the adjacent snow fields. Although the Tigranes/Artavazdes open pit will be visible from this viewpoint, it will appear beyond the communications tower and steel tower overhead transmission line located in the middle distance of the available views, and alongside the natural rocky escarpments and scree slopes found across the mountain of Arshak and its subsidiary peaks to the south of the Tigranes/Artavazdes open pit. The Erato open pit and other more distant components will not be visible from this viewpoint throughout the life of the Project. Lighting of the Tigranes/Artavazdes open pit on the distant horizon, along with vehicle movements nearby along the haul road site will be perceptible during the hours of darkness from this viewpoint, appearing to the north of the viewpoint across the skyline of Amulsar Mountain which is otherwise unaffected by lighting at present. Following closure the long-term changes to the profile of the skyline of Amulsar Mountain will be irreversible, however they could appear similar to the existing natural rocky escarpments and scree slopes of the mountain of Arshak following post-closure monitoring.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Barely perceptible	Negligible adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Low	Minor adverse (not significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Barely perceptible	Negligible neutral (not significant)
Night Time Lighting Impacts	Low	Minor adverse (not significant)

Table 6.5.32: Viewpoint 12: Armenian Silk Road (M-2 highway) between Tsghuk and Gorayk

Grid Reference: E 568877, N 4392779		Elevation: 2127 m asl (+ 2 m)
Distance from nearest Project Component: 7.95 km		Figure 6.5.21: Viewpoint 12: Armenian Silk Road (M-2 highway) between Tsghuk and Gorayk
<p>Viewpoint Location and Potential Receptors: This viewpoint is located alongside the Armenian Silk Road (M-2 highway) between the settlements of Tsghuk and Gorayk within the lower Vorotan Valley adjacent to Spandaryan Reservoir, south-east of the Project-affected area. The viewpoint represents views experienced by road users travelling on the Armenian Silk Road, and views experienced by agricultural workers and herders within the adjacent arable fields and pasture. The viewpoint is located within the <i>High Steppe and Plateau Grassland LCT</i>.</p> <p>Description of Existing Views: The view west, north-west from this viewpoint is focused along the route of the silk road which crosses the open plateau landscape east of Spandaryan reservoir, where arable fields and pasture are dissected by steel tower electricity transmission lines which form key linear features, crossing the plateau landscape north and south of the road. To the north-west, the distant mountain peaks of Amulsar Mountain form the skyline, including the distinguishable summits of Arshak, Tigranes, Artavazdes and North Erato, rising up from the Vorotan valley to the north and from the head of the Vorotan Pass to the west of the viewpoint. Views west from the viewpoint are focused across the adjacent arable and pasture farmland to the settlement of Tsghuk and Spandaryan Reservoir, before rising up across the foothills to the high summits which mark the southern RA border with Artsakh which forms the skyline beyond.</p>		
<p>Sensitivity of Visual Receptors: Road users, agricultural workers and herders within the surrounding agricultural fields are judged to be of low susceptibility to changes in the view, as appreciation of the surrounding view is not of specific value to these receptors from this location. The sensitivity of the represented receptors is judged to be low.</p>		
<p>Description of Visual Impacts: No construction activities will be visible from this viewpoint. As the operation and production phase begins the open pit of Tigranes/Artavazdes will be visible on the skyline of Amulsar Mountain, leading to a long-term and irreversible change to a small proportion of the ridge of mountain summits which forms the skyline of the western slopes of the Vorotan Valley. Dust across the surrounding areas of the open pits will be largely imperceptible from this viewpoint, however during the winter months; the areas surrounding the open pits may be more perceptible as dust from the mining operations discolours the adjacent snow fields.</p> <p>The Erato open pit become visible from this viewpoint in the latter stages of the operations phase of the Project. Although the southern and eastern edge of the Tigranes/Artavazdes open pit and the eastern edge of the Erato open pit will be perceptible from this viewpoint, it will appear beyond the numerous steel tower transmission lines which cross the plateau north of, and in parallel to the M-2 highway. Lighting of the open pits, along with vehicle movements on site between the open pits will be perceptible during the hours of darkness from this viewpoint. Artificial lighting from fixed or mobile (vehicles) sources will appear in the distance to the north across Amulsar Mountain which is otherwise unaffected by artificial lighting at present. However, any visibility of lighting will be in the context of potential artificial lights from vehicles travelling on the M-2 highway and the settlement of Gorayk in the middle distance of views to the west.</p> <p>Following closure, to the profile of the skyline of Amulsar Mountain will be irreversible and will remain following post-closure monitoring, albeit that they will be appear relatively imperceptible following restoration and rehabilitation of the areas directly surrounding the open pits.</p>		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Barely perceptible	Negligible adverse (not significant)
Operations Phase: Year 3	Low	Minor adverse (not significant)
Operations Phase: Year 10 – Max. Case Scenario	Low	Minor adverse (not significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Barely perceptible	Negligible neutral (not significant)
Night Time Lighting Impacts	Low	Minor adverse (not significant)

Table 6.5.33: Viewpoint 13: Minor road through Vorotan Valley

Grid Reference: E 562986, N 4403300	Elevation: 2391 m asl (+ 2 m)	
Distance from nearest Project Component: 1.5 km	Figure 6.5.22: Viewpoint 13: Minor road through Vorotan Valley	
Viewpoint Location and Potential Receptors: This viewpoint is located within the Vorotan Valley, east of the Project-affected area and adjacent to the minor road which runs north to south linking the H-42 highway near Kechut to the M-2 highway east of Gorayk. The viewpoint represents views experienced by road users travelling on the minor road through the Vorotan Valley and the views experienced by shepherds, herders and people foraging from the land within the pastoral landscape of the Vorotan Valley. The viewpoint is located in the <i>High Steppe and Plateau Grassland LCT</i> .		
Description of Existing Views: The foreground of the existing view in all directions from this location is across the open steppe pasture which covers the lower slopes and valley bottom of the Vorotan Valley. The Vorotan lies to the east and south but is not visible from the viewpoint. In the middle distance to the south-west the lower foothills of Amulsar Mountain rise up from the valley, cut by narrow mountain stream valleys which feed the Vorotan River below. The peaks of North Erato, Erato, Tigranes, Artavazdes and Arshak are visible on the skyline above forming a ridge of mountains which overlook the Vorotan Valley in views south from the viewpoint. Views east to the opposing slopes of the Vorotan Valley are across open steppe pasture, backed by the foothills and eastern Zangezur Mountains beyond. To the north, rolling foothills are cut by broad and deep valleys which feed the tributaries of the Vorotan River. The small scale hydropower plant located in the valley to the south is not visible from this location; however the connecting electricity transmission line which runs south is visible, backclothed against the eastern valley slopes to the south.		
Sensitivity of Visual Receptors: Minor road users, herders and people foraging from the land within the surrounding pastoral landscape are judged to be of medium susceptibility to changes in the view, as the setting of the place of work is deemed important to the quality of working life for receptors in this location. The view from the Vorotan valley to the surrounding mountains is deemed to be of local value. The sensitivity of the represented receptors is judged to be medium .		
Description of Visual Impacts: During the construction phase, access roads, haul road and the BRSF will become visible in views towards Amulsar Mountain, as earth works are carried out to construct these components, including the stripping of vegetation, topsoil and sub soil and lining of the BRSF. Vehicle movements on site throughout this phase will continue into the operations phase as the Tigranes/Artavazdes open pit is created, removing the craggy mountain peaks which form the central ridge of Amulsar Mountain to the south-west of the viewpoint. Dust from the Project components will be visible from this viewpoint and during the winter months, the areas surrounding the open pits, BRSF and haul and access roads may be more visible as dust from the mining operations discolours the adjacent snow fields. The barren rock of the BRSF will fill the hanging bowl-like valley feature which lies out of view from the viewpoint to the west, south-west, beyond the eastern ridge of Amulsar Mountain. As barren rock is deposited in the BRSF this new landform feature will gradually become perceptible above the ridge in views from the Vorotan Valley. Excavation of the Erato open pit will remove a third mountain peak of Amulsar Mountain and although partially screened by the presence of North Erato it will extend the long-term and irreversible visual change northwards along the skyline. Lighting of the open pits, haul road, BRSF and access roads along with vehicle movements on site will be perceptible during the hours of darkness from this viewpoint. Lighting will appear in views across the skyline ridge of Amulsar Mountain from the Vorotan Valley, views of which are currently unaffected by lighting. No other sources of lighting will be visible from this location. Lighting from vehicles moving between the open pits, BRSF and the building that contains the crushing and screening facility will be perceptible within the Vorotan Valley and will introduce lighting to an area of the study area otherwise unaffected by light sources. At the closure phase of the mine, the haul road and access area will be removed and the disturbed ground regraded and revegetated. The BRSF will be progressively restored during operation of the mine, and will be subsequently capped with topsoil and revegetated, becoming less perceptible as it blends with the surrounding vegetation and landform, following the completion of mining activities. The long-term changes to the profile of the skyline of Amulsar Mountain from the creation of the open pits will be irreversible.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	Moderate	Moderate adverse (significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor adverse (not significant)
Night Time Lighting Impacts	High	Major adverse (significant)

Table 6.5.34: Viewpoint 14: Little Erato

Grid Reference: E 559564, N 4401931	Elevation: 2666 m asl (+ 2 m)	
Distance from nearest Project Component: Adjacent to BRSF	Figure 6.5.23: Viewpoint 14: Little Erato	
Viewpoint Location and Potential Receptors: The viewpoint is situated on the south-eastern flank of the summit of Little Erato, a rounded mountain located to the north of the main peaks of Amulsar Mountain. The viewpoint represents views experienced by shepherds, herders and people foraging from the land within the pastoral landscape of the steppe pasture foothills. The viewpoint is located within the <i>Highland Hills and Grazing LCT</i> .		
Description of Existing Views: This viewpoint offers open panoramic views in all directions, across the surrounding pastoral foothills, cut by broad mountain valleys in the foreground to the north, west and east. In the middle distance to the north, Amulsar Mountain rises up to form a ridge of summits trending south-eastwards from the viewpoint, with the craggy summits of North Erato and Erato visible as key features on the skyline. To the east, the rolling foothills and valleys roll down to the Vorotan Valley below, with the broad valley floor rising up to the foothills and mountains of the Zangezur, incised by the Vorotan Valley, which form the backdrop and skyline of long distance views east, north-east from the viewpoint. Views into the settled valley of the Arpa River to the north and west are possible from the summit of Little Erato, where the settlements of Kechut and Jermuk are visible in the distance below.		
Sensitivity of Visual Receptors: Herders and people foraging from the land within the surrounding pastoral landscape are judged to be of medium susceptibility to changes in the view, as the setting of the place of work is deemed important to the quality of working life for receptors in this location. The view from this prominent local hill to the nearby mountain peaks and valleys is deemed to be of local value. The sensitivity of the represented receptors is judged to be medium .		
Description of Visual Impacts: During the construction phase the main access roads, the BRSF, truckshop and administration buildings, haul road, crushing and screening facility, and overland conveyor will become visible to the east and south of the viewpoint, occupying a large proportion of the available view and introducing man-made elements to this mountain landscape. Earthworks to construct the BRSF, haul road and crushing and screening facility will lead to changes in the localised landform in the foreground and middle ground of views. As operation and production commences vehicle movements on the on-site haul road between the open pits, the building that contains the crushing and screening facility and BRSF will be continuous as barren rock and ore is extracted from the open pits, this will generate fallout of dust which will be visible across a wider area than the footprint of the components and lead to the dis-colouration of the snow fields during winter months. During this phase the BRSF will increase in size and become visible to the east of the viewpoint, as the deposited barren rock fills the bowl like hanging valley and creates a new domed landform, eventually extending to a greater elevation than the summit of Little Erato. Run of mine material and low grade stockpiles are will be located to the east of the viewpoint adjacent to the BRSF, which will become the defining feature in views to the south and east from this viewpoint, however progressive restoration will be undertaken throughout the operational period to regrade and revegetate the outer slopes of the new BRSF landform feature as it increases in size. The Tigranes/Artavazdes open pit will not be visible throughout the life of the Project, however the Erato open pit and run of mine stockpile will change the profile of the skyline from year six onwards as the extraction of barren rock and ore begins. Lighting of the Erato open pit, haul road, active areas of the BRSF, access road, crushing and screening facility, overland conveyor, truckshop and administration buildings, along with vehicle movements on site will be perceptible during the hours of darkness from this viewpoint, which will be more extensive during the winter months. Lighting will appear across a large proportion of the available view from the viewpoint, including across Amulsar Mountain and its foothills to the south and east respectively, which are otherwise unaffected by lighting. The medium-term and reversible visual changes associated with the overland conveyor, truckshop and administration buildings, haul road, crushing and screening facility and access roads will be reversed following closure of the mine as disturbed ground is regraded and revegetated. The BRSF will be capped with topsoil and revegetated, becoming less perceptible as it blends with the surrounding vegetation and landform. The long-term changes to the profile of the skyline of Amulsar Mountain, created by the removal of the Erato Mountain peak will be irreversible.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	High	Major adverse (significant)
Operations Phase: Year 3	High	Major adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	High	Major adverse (significant)
Post-Closure Monitoring Phase: Year 19	High	Moderate adverse (significant)
Night Time Lighting Impacts	High	Major adverse (significant)

Table 6.5.35: Viewpoint 15: Minor road from Gndevaz to Armenian Silk Road

Grid Reference: E 555695, N 4400977	Elevation: 2084 m asl (+ 2 m)	
Distance from nearest Project Component: 260 m	Figure 6.5.24: Viewpoint 15: Minor road from Gndevaz to Armenian Silk Road	
Viewpoint Location and Potential Receptors: The viewpoint is located on a minor road which runs between the settlements of Gndevaz on the H-42 road to the west, north-west, and Saralanj on the M-2 road (Armenian Silk Road) to the south-east. Situated in close proximity to the route of the overland conveyor and main access road to the mine, the viewpoint represents views experienced by shepherds, herders and people foraging from the land within the lower reaches of the pastoral landscape of the steppe pasture foothills, and receptors travelling along this minor road between the two settlements. The viewpoint is located within the <i>Lower farmed and settled foothills LCT</i> .		
Description of Existing Views: The viewpoint offers relatively contained views due to the immediate surrounding topography which forms a shallow bowl through which the minor road crosses from north-west to south-east. To the east, pitched views are possible towards the ridge of Amulsar Mountain which forms a linear sequence of summits on the skyline. To the west views towards the steep gorge and settlement of Gndevaz are generally screened by the intervening topography, however more open views west, south-west are possible from sections of the minor road to the north-west and south. Views north towards the settlements of Kechut and Jermuk are contained by the topography which forms the ridge directly north of the viewpoint. The landcover across the area surrounding the viewpoint is predominantly pasture used for grazing, with hay fields extending across mountain meadows. An existing high voltage overhead transmission line is located to the north-west of the viewpoint and runs broadly north to south, forming a key feature in views to the north.		
Sensitivity of Visual Receptors: Herders and people foraging from the land within the surrounding pastoral landscape are judged to be of medium susceptibility to changes in the view, as the setting of the place of work is deemed important to the quality of working life for receptors in this location. Receptors travelling along the minor road between the two settlements are judged to be lower susceptibility to changes in views from this road as they are likely to be focused on the road ahead and the direction of travel. The view from this relatively is deemed to be of local value. The sensitivity of the represented receptors is judged to be medium .		
Description of Visual Impacts: During the construction phase the main access from the H-42 near Gndevaz will be constructed broadly along the alignment of the existing minor road to the location of viewpoint. The overland conveyor will be constructed to the north of the viewpoint, broadly following the vague ridge which runs north-east to south-west and perpendicular to the minor road. Relatively large scale ground works and construction activities will be evident from this viewpoint, and when travelling along the minor road to the north, introducing additional man-made elements into the view occupied by the existing overhead transmission line. More distant views of the haul road on the western side of Amulsar Mountain will also be possible in views to the east from this viewpoint. During the operations phases the open pits will also become perceptible on the distant skyline of Amulsar Mountain to the east, while vehicles moving along the access road directly north of the viewpoint will be visible from the viewpoint and other locations on the minor road to the north. The overland conveyor will remain the most visible component of the Project from this location, as it crosses perpendicular to the minor road. During the winter months dust from the overland conveyor and access road will extend the influence of these components across the adjacent snowfields. Lighting of the Erato open pit, haul road, access road, crushing and screening facility, overland conveyor, along with vehicle movements on site will be perceptible during the hours of darkness from this viewpoint. Lighting will appear across a large proportion of the available view from the viewpoint, due to the proximity to the componentry and will introduce artificial lighting to an area of the foothills which are otherwise unaffected by lighting. The medium-term and reversible visual changes associated with the overland conveyor will be reversed following closure of the mine, removal of the componentry and as disturbed ground is regraded and revegetated. The long-term changes to the profile of the skyline of Amulsar Mountain, created by the removal of the Erato Mountain peak will be irreversible.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	High	Major adverse (significant)
Operations Phase: Year 3	High	Major adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	High	Major adverse (significant)
Closure Phase: Year 14	Moderate	Moderate adverse (significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor adverse (not significant)
Night Time Lighting Impacts	Moderate	Major adverse (significant)

Table 6.5.36: Viewpoint 16: Jermuk Church

Grid Reference: E 557920, N 4407279		Elevation: 2016 m asl (+ 2 m)
Distance from nearest Project Component: 4.7km		Figure 6.5.24: Viewpoint 16: Jermuk Church
Viewpoint Location and Potential Receptors: This viewpoint is located adjacent to the distinctive Jermuk Church which is situated east, south-east of the most southerly extent of the settlement of Jermuk and approximately 2.5km south of the centre of the settlement. The viewpoint is located approximately 4.5 km from the Project-affected area to the south and represents the views experienced by visitors to the church, including both residents of location communities (Jermuk, Kechut etc.) and tourists visiting this local landmark which is easily accessed and viewed from the H-42 to the east. The viewpoint is located within the <i>Forested Upper Gorge and Foothills LCT</i> .		
Description of Existing Views: The church sits in an elevated position west of the H-42 road and offers open views across the valley to the south, towards Kechut to the east and Jermuk to the north. To the east, the topography east of the H-42 road screens longer distance views. Open views towards Amulsar Mountain, and Little Erato are possible from the south side of the church where the viewpoint is located, with Little Erato and the ridge to the west forming the skyline in principal views. The mountain summits of Erato, Tigranes and Artavazdes are not visible from this location. The northern extents of the Project-affected area are visible to the south of the viewpoint, across the north facing slopes of Little Erato and the broad ride to the west.		
Sensitivity of Visual Receptors: Tourists and residents are judged to be of high susceptibility to changes in the view, where views across the surrounding landscape and mountains are the focus of views to the south from this location. Views from this location are judged to be of local value. The sensitivity of the representative receptors is judged to be high .		
Description of Visual Impacts: Construction of the BRSF, the building that contains the crushing and screening facility, truckshop and administration buildings, access roads, and haul road will be perceptible from this location, and the resultant changes will remain throughout the operational phases of the Project. The open pits of Tigranes/Artavazdes and Erato will not be visible from this viewpoint, however as operations and production commences, the BRSF will become more perceptible as it increases in size, appearing above the existing landform of Little Erato, while the run of mine stockpile will become perceptible on the skyline alongside the crushing and screening facility. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust. Lighting of the overland conveyor, crushing and screening facility, truckshop and administration buildings, along with vehicle movements along the access and haul roads on site will be perceptible during the hours of darkness from this viewpoint, appearing across the skyline to the south which is otherwise unaffected by artificial lighting. The components visible from this location will occupy a relatively small proportion of the available view in the medium-term. The BRSF will remain following closure of the mine however impacts associated with all other component parts will be reversed once they are removed, including the overland conveyor, crushing and screening facility, truckshop and administration buildings, and access and haul roads. Disturbed ground will be regraded and revegetated to restore the profile and land cover to a resemblance of the baseline situation. The change in landform from the creation of the BRSF will be irreversible and remain long-term, distinguishable on the skyline, however the BRSF will be subject to progressive restoration and will subsequently be capped with topsoil and revegetated, becoming less perceptible within the immediate landscape following the post-closure monitoring phase.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

Table 6.5.37: Viewpoint 17: West of Kechut Reservoir

Grid Reference: E 555743, N X4405611	Elevation: 1949 m asl (+ 2 m)	
Distance from nearest Project Component: 4.0km	Figure 6.5.24: Viewpoint 17: West of Kechut Reservoir	
Viewpoint Location and Potential Receptors: This viewpoint is located adjacent to the minor road on the western edge of Kechut reservoir and close to the former Soviet holiday camp (now derelict) to the west of the reservoir. The viewpoint is located in a slightly elevated position alongside the minor road and offers panoramic views to the north-west, east, and south-east across the reservoir, representing views experienced by receptors travelling on the minor road, recreational users of the reservoir and residential receptors at nearby residential properties to the north of the former holiday camp. The viewpoint is located within the <i>Settled lowland and rocky gorges LCT</i> .		
Description of Existing Views: Existing views from this location are focused across Kechut reservoir to the mountain landscapes of the Project-affected area to the south-east. Little Erato is the focal point on the skyline to the south-east, while the broad ridge and small knolls to the west, south-west form a distinguishable skyline which descends towards the H-42 road and Arpa River Gorge. These foothills are generally undeveloped, however the settled lowlands adjacent to the H-42 on the eastern side of Kechut reservoir which form the middle distance of views from this location demonstrate evidence of human influence through the presence of industrial remnants, an electricity substation and overhead transmission lines which cross the broad ridge from north to south east of the highway. Views are possible to the north-west towards the settlement of Kechut and the southern extents of Jermuk. The mountain summits of Erato, Tigranes and Artavazdes, and the HLF site are not visible from this location.		
Sensitivity of Visual Receptors: Tourists and residents are judged to be of high susceptibility to changes in the view, where views across Kechut reservoir to the surrounding landscape and mountains are the focus of views to the east, south-east from this location. The views to the distinct mountain landscape to the east, south-east are judged to be of local value. The sensitivity of the representative receptors is judged to be high .		
Description of Visual Impacts: Construction of the BRSF, the building that contains crushing and screening facility, overland conveyor, truckshop and administration buildings, and access roads will be perceptible from this location, and the resultant changes will remain throughout the operational phases of the Project. The open pits of Tigranes/Artavazdes and Erato will not be visible from this viewpoint, however as operations and production commences, the BRSF will become more perceptible as it increases in size, appearing above the existing landform of Little Erato, while the run of mine stockpile will become perceptible on the skyline alongside the crushing and screening facility. Dust arising from construction and operation of the Project components will increase perceptibility of the working areas during the late winter/early spring months as the snow fields are discoloured by dust. Lighting of the overland conveyor, crushing and screening facility, truckshop and administration buildings, along with vehicle movements along the access and haul roads on site will be perceptible during the hours of darkness from this viewpoint, appearing across the skyline to the east, south-east which is otherwise unaffected by artificial lighting. The components visible from this location will occupy a relatively small proportion of the available view in the medium-term. The BRSF will remain following closure of the mine however impacts associated with all other component parts will be reversed once they are removed, including the overland conveyor, crushing and screening facility, truckshop and administration buildings, and access roads. Disturbed ground will be regraded and revegetated to restore the profile and land cover to a resemblance of the baseline situation. The change in landform from the creation of the BRSF will be irreversible and remain long-term, distinguishable on the skyline, however the BRSF will be subject to progressive restoration and will subsequently be capped with topsoil and revegetated, becoming less perceptible within the immediate landscape following the post-closure monitoring phase.		
Assessment Phase:	Magnitude of Visual Impacts:	Significance & Direction of Visual Effects:
Construction Phase: Year -1	Moderate	Moderate adverse (significant)
Operations Phase: Year 3	Moderate	Moderate adverse (significant)
Operations Phase: Year 10 – Max. Case Scenario	Moderate	Moderate adverse (significant)
Closure Phase: Year 14	Low	Minor adverse (not significant)
Post-Closure Monitoring Phase: Year 19	Low	Minor neutral (not significant)
Night Time Lighting Impacts	Moderate	Moderate adverse (significant)

6.5.21 Mitigation of Residual Effects during Detailed Design

Each of the proposed Project components will be subject to future detailed engineering design iterations in consultation with the relevant specialist consultants in an attempt to reduce the identified landscape and visual effects. It is considered that through further detailed engineering design, a number of the identified effects can potentially be mitigated further.

6.5.22 Landscape Enhancement Measures

Where identified landscape and visual effects cannot be potentially mitigated, implementation of subsequent landscape and habitat enhancement measures elsewhere may be adopted to reduce the overall impact of the Project. Such measures will be developed by Lydian in conjunction with the appropriate specialist consultants and be detailed within the final ESMP (Chapter 8), pMRCRP (Appendix 8.18) and BAP (Appendix 8.20); all landscape design measures will also take account of the requirement in the BMP (Appendix 8.21).

6.5.23 Monitoring and Audit of Residual Landscape and Visual Effects

The level of significance of each reported landscape and visual effect is dependent on the complete and successful implementation and monitoring of embedded mitigation and restoration measures at each appropriate phase of the Project. These mitigation and restoration measures are outlined earlier (Section 6.5) and described in more detail in the FMP (see Appendix 8.8) and pMRCRP (see Appendix 8.18).

To ensure that the proposed mitigation and restoration measures are implemented successfully, it is envisaged that a number of supplementary Standard Operating Procedures (SOPs) will be developed and which will outline appropriate construction, restoration and rehabilitation methods and practices to be adhered to throughout the construction, operation and closure phases of the Project.

Method Statements and SOPs

Lydian will develop method statements and SOPs in conjunction with appointed contractors, which shall explicitly describe the role of the qualified landscape architect and the landscape/environmental clerk of works for all phases of the project. These will also be referenced within the final pMRCRP (see Appendix 8.18) and BMP (see Appendix 8.21). The method statements shall include, but shall not be limited to, the following activities:

- Species protected by statute¹²;
- Management and protection of existing vegetation;
- Construction of protective fencing, for vegetation and wildlife;
- Clearance of vegetation;
- Ground preparation and turf/soil stripping;
- Earthworks and landform grading;
- Preparation and cultivation of soils for planting and seeding;
- Seeding (including of trees and shrubs), and promotion of natural regeneration;
- Planting, including of trees and shrubs; and
- Monitoring, management and maintenance of restored areas.

On-site Monitoring

In order to ensure SOP compliance and the successful implementation of mitigation and restoration measures, it is suggested that all Project site area works should be overseen by a qualified environmental or landscape clerk of works, who will consult with external specialists (i.e. qualified landscape architect) as required. Regular site inspections to ensure compliance with committed mitigation, rehabilitation and restoration plans in accordance with an agreed schedule will be required throughout the construction, operation and closure phases of the Project, and also include regular inspection during the Post-Closure Monitoring Phase, to ensure any remedial treatment for unsuccessful mitigation and restoration measures is devised and implemented. Any deviations from agreed mitigation and restoration measures will be highlighted, and remedial actions implemented. Aftercare requirements for managing the landscape works to the end of the Post-Closure Monitoring Phase of the Project will be included in the final pMRCRP (see Appendix 8.18).

Lydian will ensure that a qualified landscape architect shall visit the Project Site at suitably regular intervals in accordance with an agreed schedule¹³ and the environmental clerk of works will attend the site whilst the following works are being carried out:

- Identification of vegetation to be protected or removed;
- Topsoil stripping;
- Earthworks and grading of landform;

¹² To be overseen in conjunction with an Ecological Clerk of Works.

¹³ An agreed monitoring schedule will be developed, with regular site inspections by appropriately qualified professionals being undertaken regularly (e.g. every 2 months) during the construction, operation and closure phase, and at least once annually during the post-closure monitoring phase until all areas are restored to the satisfaction of the competent authority.

- Breaking out redundant surfaces;
- Subsoil ripping;
- Spreading of soil;
- Cultivation;
- Preparation for seeding and planting; and
- Seeding and planting.

6.5.24 Summary of Residual Effects

During construction of the Project components, there will be disturbance to the landscape arising from construction activities, both within the Project-affected area and across the surrounding local area, as a result of changes being seen from areas beyond the Project-affected area. Direct effects will occur along the main access roads to the north-east and west of Amulsar Mountain, and at the sites of the BRSF, the HLF, the haul road, the buildings that contain the crushing and screening facility, the route of the overland conveyor and utilities corridor, the ADR plant and other associated infrastructure, such as the truckshop and administration facilities platform, resulting in localised significant effects on the landscape of the *Lower Farmed and Settled Foothills, High Steppe and Plateau Grassland, Highland Hills and Grazing* and *High Rocky Peaks*. These construction related effects will be short to medium-term occurring during the construction works, and for a period of time following completion of the construction phase, whilst the disturbed land outside the Project component footprint is returned to its original condition, and replacement vegetation, which is planted or encouraged to regenerate post construction, becomes established.

Once the operational phases of the Project begin, significant landscape effects will extend to a larger proportion of the *High Rocky Peaks LCT* as the open pits are created and operational activities start. During the operation and production phases of the Project (see Table 6.5.10), significant landscape effects will be limited to the directly affected areas and the immediate areas which surround the key Project components, as the presence of large man-made structures and disturbance will lead to consequential changes in the character of the adjacent and surrounding areas. These effects will diminish with distance from the Project-affected area, and although the wider landscape will be indirectly affected, no significant effects on the wider landscape are anticipated.

The assessment indicates that significant residual effects on views will occur. These will largely result when both close and longer range open views of the Project components affect visual receptors of high sensitivity, within close proximity to the Project-affected area, or in

locations where the existing view is particularly highly valued. Significant effects on views are therefore identified from the Top of Jermuk Ski Lift, Hotel Olympia in Jermuk, Hotel Armenia in Jermuk, the Deer Sculpture west of Jermuk, the western edge settlement of Gndevaz, from Little Erato, the minor road between Gndevaz and Saralanj, Jermuk Church and from west of Kechut Reservoir. There will also be significant effects on people travelling along the H-42 between the M-2 highway and Jermuk and the minor road through the Vorotan Valley. The majority of these significant effects will be experienced throughout the construction, and operation and production phases of the Project, with most diminishing over time through the closure and post-closure monitoring phases of the Project.

As vegetation becomes re-established in the longer term, landscape and visual effects may be regarded as neutral in some instances, in that the landscape and views will remain permanently altered, but the application of mine closure and rehabilitation measures will mean that these areas will gradually be seen to blend back into the surrounding landscape.

Some views from the tourist resort of Jermuk will be significantly affected by the Project during both the construction and operations phases of the Project, with visibility of the crushing and screening facility and ancillary components to the north possible, and when the BRSF will be at its largest extent, however these impacts will reduce following closure, removal of infrastructure and successful restoration and rehabilitation of the BRSF site. The settlement of Gorayk, and the majority of residential properties within the settlements of Jermuk, Kechut, Gndevaz, Saravan and Saralanj will have no or very limited visibility of the Project components.

The Project components have been designed to reduce significant landscape and visual effects, reducing visibility from sensitive receptors and where possible integrating them into the landscape. Landscape enhancement measures will be incorporated into the FMP (see Appendix 8.8) and pMRCRP (see Appendix 8.18), to offer landscape and habitat benefits in the long-term while providing mitigation of potential landscape and visual effects during the operations phases of the Project.

Overall, the Project will result in significant residual effects on landscape and visual receptors, however these effects will be largely localised, commonly occurring within approximately 5 km of the Project-affected area. Many of the significant landscape and visual effects identified will be short to medium-term and will become neutral following the cessation of operations, removal of Project components and implementation of closure restoration and

rehabilitation measures and post-closure monitoring. Significant landscape and visual effects arising from the open pits, HLF and BRSF will be permanent, albeit that many will reduce in significance over time, with some remaining following the post-closure monitoring phase of the Project. As the rock weathers, and vegetation returns, the changes will become progressively less apparent.

Through the next phase of more detailed design there may be potential to reduce further still the residual landscape and visual effects identified within the assessment. The detailed design of project components will be undertaken with reference to the mitigation measures outlined within this chapter and delivered within the engineering and operational parameters which are possible. As such, unless explicitly stated within the assessment, commitment to additional specific mitigation measures has not yet been made and has therefore not been considered when assigning levels of landscape and visual effect. The assessment therefore represents a maximum case effect scenario.

Cumulative landscape and visual effects are addressed in Chapter 7.

6.5.25 Summary Table of Residual Landscape and Visual Effects

Table 6.5.38 below summarises the potential landscape and visual effects identified in the assessment.

Table 6.5.38: Summary Table of Residual Landscape and Visual Effects

Receptor/ Representative Viewpoints	Significance and Direction of Effect					
	Construction Phase: Year -1	Operations Phase 1: Year 3	Operations Phase 2: Year 10 - Maximum Case Scenario	Closure Phase: Year 14	Post-Closure Monitoring Phase: Year 19	Night Time - Lighting Impacts
Landscape Receptors						
<i>Settled Lowland and Rocky Gorges</i>	Negligible - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Minor - neutral	n/a
<i>Lower Farmed and Settled Foothills</i>	Moderate - adverse	Major - adverse	Major - adverse	Major - adverse	Moderate - neutral	n/a
<i>Forested Upper Gorge and Foothills</i>	Minor - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Negligible - neutral	n/a
<i>High Steppe and Plateau Grassland</i>	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - neutral	n/a
<i>Highland Hills and Grazing</i>	Major - adverse	Major - adverse	Major - adverse	Major - adverse	Moderate - neutral	n/a
<i>High Rocky Peaks</i>	Major - adverse	Major - adverse	Major - adverse	Major - adverse	Major - adverse	n/a
Visual Receptors - Representative Viewpoints						
<i>VP 1: Top of Jermuk Ski Lift</i>	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - neutral	Moderate - adverse
<i>VP 2: Hotel Olympia, Jermuk</i>	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - neutral	Moderate - adverse
<i>VP 3: Hotel Armenia, Jermuk</i>	Minor - adverse	Minor - adverse	Moderate - adverse	Minor - adverse	Minor - neutral	Moderate - adverse
<i>VP 4: Deer Sculpture west of Jermuk</i>	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - neutral	Moderate - adverse
<i>VP 5: Western edge of Gndevaz Village</i>	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - adverse	Moderate - adverse
<i>VP 6: H-42 highway south of Gndevaz</i>	Moderate - adverse	Major - adverse	Major - adverse	Moderate - adverse	Minor - adverse	Major - adverse
<i>VP 7: H-42 highway South-west of Heap Leach Facility</i>	Minor - adverse	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Moderate - adverse
<i>VP 8: Armenian Silk Road (M-2 highway) near Junction with the H-42 highway</i>	Negligible - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Negligible - neutral	Negligible - adverse

Table 6.5.38: Summary Table of Residual Landscape and Visual Effects

Receptor/ Representative Viewpoints	Significance and Direction of Effect					
	Construction Phase: Year -1	Operations Phase 1: Year 3	Operations Phase 2: Year 10 - Maximum Case Scenario	Closure Phase: Year 14	Post-Closure Monitoring Phase: Year 19	Night Time - Lighting Impacts
VP 9: Armenian Silk Road (M-2 highway) in Saralanj village	Minor - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Negligible - neutral	Minor - adverse
VP 10: North end of Ughedzor Village	Minor - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Negligible - neutral	Minor - adverse
VP 11: Syunik Gates on the Vorotan Pass (M-2 highway) between Saravan and Goryak	Negligible - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Negligible - neutral	Minor - adverse
VP 12: Armenian Silk Road (M-2 highway) between Tsg huk and Gorayk	Negligible - adverse	Minor - adverse	Minor - adverse	Minor - adverse	Negligible - neutral	Minor - adverse
VP 13: Minor road through Vorotan Valley	Moderate - adverse	Moderate - adverse	Major - adverse	Moderate - adverse	Minor - adverse	Major - adverse
VP 14: Little Erato	Major - adverse	Major - adverse	Major - adverse	Major - adverse	Moderate - adverse	Major - adverse
VP 15: Minor road from Gndevaz to Armenian Silk Road	Major - adverse	Major - adverse	Major - adverse	Major - adverse	Moderate - adverse	Major - adverse
VP 16: Jermuk Church	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - adverse	Moderate - adverse
VP 17: West of Kechut Reservoir	Moderate - adverse	Moderate - adverse	Moderate - adverse	Minor - adverse	Minor - adverse	Moderate - adverse

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7.6 Air Quality

7.6.1 Introduction

The potential impact of pollution resulting from emissions to air are identified in PS 3 and PR 3 that require assessment of the Project-affected area and communities. The methodology for undertaking the assessment of potential impacts is in accordance with that set out in Section 6.1. The requirements for health and safety at work, including the worker accommodation camp, have not been specifically addressed in this Chapter, but have been considered in Chapter 6.14 and referenced through the specific policies and management requirements that are required by the Occupational Health and Safety Policy and Management Plan (see Appendices 8.3 and 8.7, in Chapter 8). Therefore, specific occupational health and safety criteria that apply to the workers within the Project affected area, including the worker accommodation camp are not considered in this assessment or the Air Quality, Noise and Vibration Management Plan (AQNVMP, Appendix 8.14).

7.6.2 Project Activities Related to Air Quality

Potential air quality emissions considered within this air quality assessment are categorised as:

- **Fugitive dust:** Particulate matter generated from mining operations, earthmoving, material transport and handling, and unpaved road traffic, crushing and screening of ore;
- **Combustion emissions:** Gas and particulate matter generated by internal combustion engines (heavy and light vehicles, equipment motors, generators) as well as emissions from the doré bullion production process in the ADR Plant; and
- **Nuisance odours:** Non-health-related (aesthetic) gas emissions affecting nearby neighbours and/or employees.

Fuel and electrical power used for the heavy equipment, light vehicles, ADR plant, and ancillary support buildings will also produce greenhouse gas emissions during construction and operations. Greenhouse gas emissions have already been addressed in Section 6.4.

Potential impacts and mitigation measures for fugitive dust, combustion emissions and nuisance odours associated with the mine are addressed in the following sections. Potential emission sources during construction, operations, and post-closure were considered and include:

- During construction, fugitive dust emissions will be generated due to earthwork activities, including stripping of vegetation, overburden and removal of rock to establish the platform for the construction of the mine infrastructure, specifically the BRSF, HLF, ADR and other support buildings, and haul and access roads. The construction related activities will include operations such as drilling, blasting, loading, hauling, unloading, crushing of rock to produce aggregate, laying of concrete and construction of buildings, including the worker accommodation camp.
- During operations, fugitive dust emissions will originate from mining operations such as, drilling, blasting, loading, hauling, unloading, crushing, transport and placement of ore; transport of barren rock along haul roads and barren rock placement, light mine vehicles; and from wind erosion in active areas such as the BRSF; ROM, and topsoil stockpiles; and potentially from the surface of the heap leach pad;
- Gas and particulate emissions from blasting, mobile equipment, and the ADR facility will occur during operations. ADR facility combustion emissions are expected to be minor in comparison to other combustion emissions sources at the Project. Mercury concentrations in assays of ore were at or below detection limits of 0.05 g/t; however mercury was detected on the loaded carbon columns in all column leach tests, therefore the potential exists for small concentrations of volatilized mercury from the ADR facility; and
- Nuisance odours during construction and operations could be generated from improperly managed domestic waste (haulage and landfilling) and domestic wastewater treatment/disposal.

7.6.3 Air Quality Significance Criteria

The significance of an environmental impact for air quality emissions is determined by the interaction of magnitude and sensitivity. The methodology for determining the magnitude of impact and sensitivity of the receptor with regard to air quality is shown in Table 7.6.1 and Table 7.6.2.

Table 7.6.1: Methodology for Determining Sensitivity	
Sensitivity	Methodology
Minor	The location is tolerant of change without detriment to its character, and is of low or local importance, for example industrial and agricultural activities, that are at a low risk from being affected by changes in air quality.
Medium	The location has moderate capacity to absorb change without significantly altering its present character, or is of high importance. For example residential dwellings and communities.
High	The location has little ability to absorb change without fundamentally altering its

Table 7.6.1: Methodology for Determining Sensitivity	
Sensitivity	Methodology
	present character, or is of national importance. For example, hospitals, and commercial / industrial premises, which have a requirement for clean air to maintain operations; and vegetation that is sensitive to changes in air quality and / or the deposition of particulates in terms of species composition and habitat quality.
Very High	The location is of the highest sensitivity to changes in air quality, or is of international importance. For example highly sensitive high-tech operations that require clean air and operate air filtration units; and specific habitats that are of international importance and sensitive to changes in air quality and / or particulate deposition.

Table 7.6.2: Methodology for Determining Magnitude of Impact	
Impact	Change compared with baseline or difference in predicted level compared to guideline level
Negligible	Minimal discernible change in the baseline environmental conditions, within margins of error of measurement (annual mean increase or decrease <1%).
Low	Impact resulting in a discernible change in baseline environmental conditions with undesirable/desirable conditions that can be tolerated (annual mean increase or decrease in range of 1 – 5%).
Moderate	Impact resulting in a discernible change in baseline environmental conditions predicted either to cause relevant objectives or guidance levels to be marginally exceeded or to result in undesirable/desirable consequences on the receiving environment (annual mean increase or decrease in range of 5 – 10%).
High	Impact resulting in a substantial change in baseline environmental conditions predicted either to cause relevant objectives or guidance levels to be exceeded or to result in undesirable consequences on the receiving environment (annual mean increase or decrease >10%).
Note: Based on published criteria for assessing the magnitude of change ¹	

For the purposes of this Air Quality assessment, the level of significance for air quality effects will be ultimately determined by using the magnitude criteria detailed in Table 7.6.2, together with the sensitivity of the receptor, as detailed in Table 7.6.1, using the significance matrix detailed in Table 6.1.3.

7.6.4 Potential Impacts to Air Quality

Table 7.6.3 below presents a summary of the various types of emissions that could affect air quality during construction and operations, by Project component.

¹ Significance in Air Quality, Institute of Air Quality Management (2009)

Table 7.6.3: Potential Sources of Emissions

Project Component	Releases and Effects	Fugitive Dust	Combustion Gases	Nuisance Odours	Other	Characteristics
Construction						
Earthworks, site clearance and construction	• Dust and dustblow from exposed surfaces.	X				Fugitive dust generated by truck movements and earth moving equipment; short duration.
	• Vehicle exhaust emissions		X			NO _x , SO _x , CO, CO ₂ ' and diesel particulates; short duration.
Drilling and blasting, (quarries and to develop facilities platforms)	• Dust from drilling	X				Fugitive dust generated during drilling activities, mitigated by dust filters; short duration, intermittent.
	• Dust from blasting	X				Fugitive dust (clouds) generated instantaneously during blasting; intermittent, periodic effects.
Crushing, loading, hauling of aggregates used in construction	• Mobile crushing plant	X				Fugitive dust from mobile crushing plant, controlled by fitting plant with water spray to reduce emissions.
	• Dust generated by loading and vehicle entrainment	X				Fugitive dust generated from haul trucks on haul roads and construction access roads. Controlled with frequent maintenance of haul road surface and water sprays to dampen the surface in potentially dusty conditions.
	• Vehicle exhaust emissions		X			NO _x , SO _x , CO, CO ₂ ' and particulate emissions
Mining						
Drilling and blasting	• Dust from drilling	X				Fugitive dust generated during drilling activities, mitigated by dust filters; short duration, intermittent.
	• Dust from blasting	X				Fugitive dust (clouds) generated instantaneously during blasting; intermittent, periodic effects.
	• Blasting gas		X			Combustion gases from blasting.
Loading, hauling and related mine traffic	• Dust generated by loading and vehicle entrainment	X				Fugitive dust from ore/waste rock may contain low concentrations of metals; only emitted during dry periods; controlled with watering of haul roads and at load out areas
	• Vehicle exhaust emissions		X			NO _x , SO _x , CO, CO ₂ ' and particulate emissions.

Table 7.6.3: Potential Sources of Emissions

Project Component	Releases and Effects	Fugitive Dust	Combustion Gases	Nuisance Odours	Other	Characteristics
BRSF	<ul style="list-style-type: none"> Dust from barren material tipping, grading, and windblow 	X				Fugitive dust particles will contain metals; emissions only during dry conditions.
Crushing and Ore Preparation						
ROM stockpile, Fine ore stockpile	<ul style="list-style-type: none"> Dust from tipping and rehandling 	X				Fugitive dust from wind blow, dependent on weather conditions; will contain low concentrations of metal contaminants; controlled with water sprays.
Primary and secondary crushing	<ul style="list-style-type: none"> Dust 	X				Fugitive dust escaping from crusher and screening buildings and transfer points; controlled with water sprays and enclosure (dust extraction).
Conveyance to truck loadout	<ul style="list-style-type: none"> Dust from transfer points 	X				Ore dust will contain low concentration of metal contaminants; controlled with water sprays during dry periods in case of visible dust; conveyor enclosed.
Loading, hauling, and fine ore deposition on HLP	<ul style="list-style-type: none"> Dust generated by loading and vehicle entrainment 	X				Fugitive dust from fine ore may contain low concentration of metals; only emitted during dry periods; controlled with watering of haul roads, at load out areas and inherent moisture in the heap
	<ul style="list-style-type: none"> Vehicle exhaust emissions 		X			NO _x , SO _x , CO, CO ₂ and particulate emissions.
ADR Plant						
Refining	<ul style="list-style-type: none"> Combustion gases from electric furnace 		X		X	Releases associated with refining the ore to Doré bullion. Small scale activity, any mercury recovered using retorts
Support Infrastructure						
Domestic wastewater treatment	<ul style="list-style-type: none"> Nuisance odours 			X		Septic tanks and wastewater treatment plant.
Mine Site Landfill	<ul style="list-style-type: none"> Nuisance odours 			X		Very small-scale activity, controls identified in the Waste Management Plan.
Storage and reagent	<ul style="list-style-type: none"> Fugitive lime dust 	X				Dust emissions from leaky seals or spillage during pebble lime transfer

Table 7.6.3: Potential Sources of Emissions

Project Component	Releases and Effects	Fugitive Dust	Combustion Gases	Nuisance Odours	Other	Characteristics
handling						from delivery vehicle to storage silo; controlled with water sprays during lime delivery times
Chemical labs and assay	<ul style="list-style-type: none"> Nuisance odours 			X		Small scale laboratory scale assays, but laboratory building is within Gorayk settlement boundary. Highly amenable to control, with appropriate abatement fitted to flues and air circulation within the design of the labs (note there are no chemical assays currently in the laboratory).
Closure						
Process plant and supporting infrastructure, open pit, HLF, BRSF, traffic movements on roads	<ul style="list-style-type: none"> Dust 	X				Dust generated from demolition activities, earthworks, reshaping heap and dump sides, and setting up safety berm around pit perimeter. Water spray where necessary.
	<ul style="list-style-type: none"> Vehicle exhaust fumes 		X			

The most significant source areas considered likely to contribute to dust emissions from the Project during construction have been identified as fugitive dust emissions from earthmoving activities taking place including:

- the removal of soils, overburden and the associated transport movements; and
- construction of haul roads using non-acid generating barren rock from the initial excavation to develop Tigranes and Artavasdes open pits.

Additional localised sources of dust emissions would be associated with:

- drilling and blasting of rock for development footprint of mine facilities,
- quarrying operations for the production of aggregates used in construction; and
- the construction of buildings, e.g. crushing plant housing, overland conveyor, truck loadout facility, and ADR plant. These facilities will also require temporary cement-mixing plants in order to prepare concrete for foundations.

Dust emission rates from construction activities have not been separately calculated, because they would be short term, temporary and the dust emissions will follow the same dispersion patterns as dust from operational activities.

The most significant sources of air emissions during operations are considered to be:

- Dust emissions from mining (including blasting), haulage, tipping, conveyor transfer points, and crushing activities; and
- Vehicle exhaust gases (mobile and static plant fuelled by diesel), with emissions including NO_x, particulates (PM₁₀) and CO₂.

An estimation of dust emission rates during the operational phase has been carried out. The potential for community health effects associated with fugitive dust emissions have been considered in Chapter 6.18. Significant receptors for potential air quality impacts have been identified in Table 7.6.4.

Table 7.6.4: Receptor Groups and Potential Impact Pathways	
Receptor Group	Potential Impact Pathways
Residents of nearby villages: <ul style="list-style-type: none"> • Gorayk (4.4km south of Tigranes/Artavazdes pit) • Saralanj (3.7km west of Tigranes/Artavazdes pit) • Gndevaz (1.0km west of HLF) • Gndevaz Livestock and Dairy Farm (700m west of truck loadout) • Kechut (<1km from the mine access junction) 	<ul style="list-style-type: none"> • Fine-particle dust in atmosphere • Fine-particle dust in atmosphere • Nuisance from soiling by deposited dust on surfaces; Fine-particle dust in atmosphere
Residents of Kechut and Jermuk– 2.4km to 6km northwest of HLF	<ul style="list-style-type: none"> • Fine-particle dust in atmosphere
Mine, plant employees including worker accommodation camp	<ul style="list-style-type: none"> • Fine-particle dust in atmosphere and direct exposure to PM₁₀ within crushing/screening buildings <p>Note: working conditions have been addressed in the Occupational Health and Safety Plan (see Appendix 8.7 and the relevant policies would extend to the workers staying in the worker accommodation camp.</p>
Soils and grazing land near the Project that has the potential to be influenced by mine activities (<1000m)	<ul style="list-style-type: none"> • Particulates containing heavy metals - with deposition on vegetation and soil surface and potential for livestock ingestion, entering food chain
Critical habitat (as defined by PS6/PR6) and other natural grassland habitats	<ul style="list-style-type: none"> • Particulate deposition on vegetation and soil surface with potential habitat quality degradation
State Reservations / Sanctuaries and Important	<ul style="list-style-type: none"> • Particulate deposition on vegetation and soil

Table 7.6.4: Receptor Groups and Potential Impact Pathways	
Receptor Group	Potential Impact Pathways
Bird Areas (IBA): <ul style="list-style-type: none"> • Jermuk Forest • Herher Open Woodland • Jermuk IBA • Gorayk IBA 	surface with potential habitat quality degradation

The receptor groups identified in Table 7.6.4 are considered of medium to minor sensitivity. The Critical habitat receptor group is considered to have high sensitivity to change, including that associated with dust deposition.

Of the receptor groups identified in Table 7.6.4, the primary receptors will be soils and vegetation and critical habitats (identified in biodiversity Section 6.11) in a zone up to 1km from construction-related activities and operational infrastructure. Residents of nearby settlements are too distant from particulate and gaseous emission sources to be significantly affected, as these are at least 1km from both construction activities and operational infrastructure.

Fugitive Dust Emissions

Fugitive dust and particulate material emissions were assessed by WAI using the USEPA methodology^{2,3} widely recognised source of emission rates used for the prediction of dust emissions from mining, materials handling, and related activities. This approach was supplemented by reference to the Australia Government's Emission Estimation Technique Manual.⁴

The next step in assessing potential impacts is to determine the dispersion of Total Suspended Particulate (TSP) dust and particulate material from the emission points, and its subsequent deposition on to land. A screening model, based on assumptions from literature sources and prevailing wind direction data, was applied for TSP dust deposition. USEPA's AERMOD Screen model was applied for PM₁₀ particulate dispersion.

Following estimation of dust dispersal and deposition, potential impacts from dust deposition as a consequence of the Project activities have been assessed, and include:

² AP-42 Fugitive Dust Emission Factors, USEPA (2006)

³ Emission factors and emission estimation methods, USEPA

⁴ NPi EET Manual for Mining, 2012, National Pollution Inventory, Emission Estimation Technique Manual for Mining Version 3.1, Australian Government

- Potential for dispersal and deposition of particulates during construction phase; and
- Potential for dispersal and deposition of particulates during operation phase.

Details of the dust emission and dust dispersion modelling follow.

Dust Emission Estimates

Fugitive dust emissions are measured as Total Suspended Particulate matter (TSP). The size fraction of concern to human health in TSP consists of particles with a diameter of less than 10µm (PM₁₀) - these particles are small enough to be inhaled and assimilated into the respiratory system.

The potential dust emission sources for the construction and operational phases are shown in Figure 7.6.1. The potential dust deposition area shown in Figure 7.6.1 demarcates a 1000m zone around the project footprint, with all areas of the project footprint considered potential dust emission sources, as small dust particles are considered to travel up to 1km⁵.

⁵ Arup Environmental; *The Environmental Effects of Dust from Surface Mineral Workings*; UK Department of the Environment, Minerals Division, December 1995

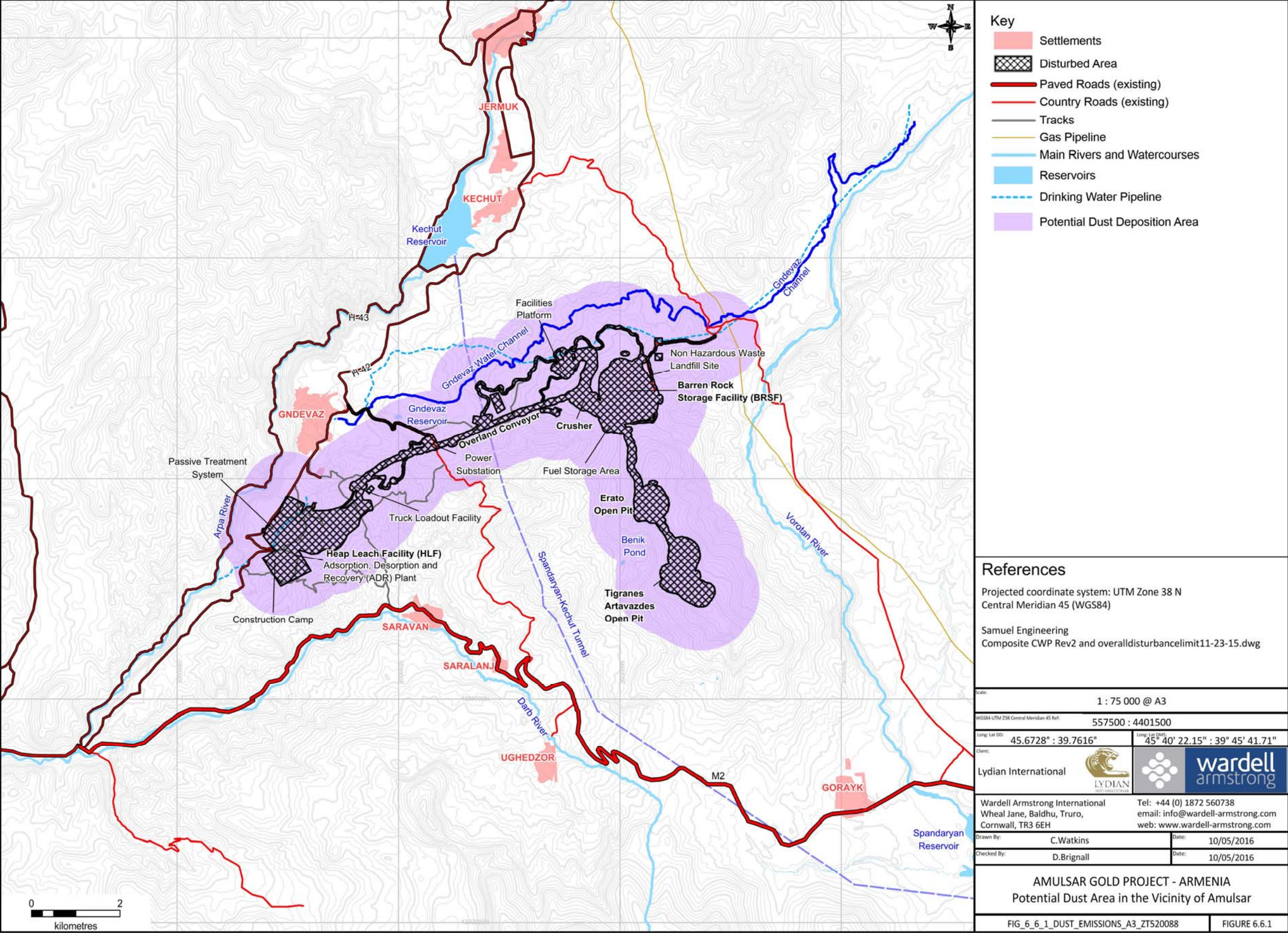


Figure 7.6.1: Potential Dust Emission Sources

Estimated dust emissions from the principal operational activities have been identified, along with reductions resulting from applying climatic conditions and planned engineering and operational controls.

The emissions estimated using AP-42 are uncontrolled emissions, i.e. with no dust suppression applied. Suppression factors are used to refine the AP-42 estimates, based on wet and snow days and dust control measures effectiveness.

Wet and snow days – days when total 24-hour rainfall exceeds $>0.2\text{mm}$ are considered sufficiently wet so that dust will not be emitted, or if it is emitted, is assumed to rapidly fall as a result of the high humidity favouring agglomeration of fine particles into heavier, larger ones that will not be transported as far. Snow days are days where there is snow covering the ground at the fugitive dust emission points, thus preventing fugitive dust from being emitted and deposited on surfaces (in particular onto vegetation surfaces).

Analysis of the meteorological data for the Vorotan Pass station (see Chapter 4.2) indicates that on an annual average, 21% of days are considered “wet days” i.e., with recorded precipitation of $>0.2\text{mm}$. Snow groundcover data indicates that snow is present on the ground at the Vorotan Pass on 46% of the days considered. As these two conditions can occur on the same day, combining “wet days” and “snow days” data yields the result that 55% of days during the year are wet and/or snow days.

Dust emission from mining operations will be deposited onto the surface of snow covered areas (a potential impact that has been assessment in Section 6.5, relating to visual impact). With respect to air quality, however because the dust will not be in contact with vegetation or other sensitive receptors, the potential impact is negligible. During snow melt conditions dust deposited on, and within the snow cover, will be transported in the melt waters that also contain elevated concentrations of suspended and dissolved solids, of which the dust associated with emission from mining operations would form a proportion.

Thus dry days occur on the average 45% of the year, recorded as $<0.2\text{mm}$ of rain and with no snow cover. Dry days are further defined as those days when dust could be generated due to favourable atmospheric conditions. Since the mine will operate throughout the year, dry conditions will conservatively occur on average for 164 days per year.

Dust control measures and their relative effectiveness were applied as per the Control Technologies section of NPi EET Manual for Mining (2012)⁴:

- Watering of haul roads with bowsters to maintain a wet surface (or using salt during winter), is considered to reduce road dust by 50% (to give a controlled emission of 50% of the uncontrolled rate);
- Enclosure of transfer station, transfer tower, crushing and screening plants; 99% reduction (to give a controlled emission of 5% of the uncontrolled rate)⁶;
- Water sprays, applied to conveyor transfer points, stockpiles, and material handling offloading locations, reduce dust emissions by 50% (to give a controlled emission of 50% of the uncontrolled rate);
- Hooding with extraction fans and fabric filters, installed at the truck load out tower and lime storage silo, reduce dust emissions by 83% (to give a controlled emission of 17% of the uncontrolled rate);
- Windbreaks, such as berms and containment barriers installed around stockpiles, reduce dust emissions by 30% (to give a controlled emission of 70% of the uncontrolled rate); and
- Activities within the open pit will be subject to an additional reduction in dust emission due to in-pit retention of dust; although the depths of the pits vary over the life of the mine, a single average factor of 50% reduction is assumed.

In some cases more than one mitigation measure is applied to a particular source (for example: water sprays on haul roads within a pit) resulting in a higher dust reduction percentage.

The far right column set in **Error! Reference source not found.** identifies the adjusted predicted particulate emission rates, taking into account local climate and mitigation measures. The annual total for dust emission in Year 3 of operation has been calculated for the number of days when emissions are considered likely.

It should be noted that this assessment methodology represents worst case, as Year 3 of operations is the maximum production year, and not all dust emission sources emit dust at all times during the operations.

⁶ NPi EET states 100% control for enclosures, but Wardell Armstrong used value was set at a more conservative 99% control after consultation with the feasibility study design engineers

Table 7.6.5: Estimated Dust Emission Rates

Source Area	Source Activity	Uncontrolled kg/day		Suppression factor		Cumulative	Controlled kg/day	
		TSP	PM ₁₀	Wet and snow days	Dust control measures		TSP	PM ₁₀
ArtavazdesPit	blasting	71.047	36.944	55%	50%	77.5%	15.986	8.312
BRSF	bulldozer	6.861	0.781	55%	50%	77.5%	1.544	0.176
HLF	bulldozer	10.590	1.662	55%	50%	77.5%	2.383	0.374
LowGradeStockpile1	bulldozer	6.861	0.781	55%	50%	77.5%	1.544	0.176
LowGradeStockpile2	bulldozer	6.861	0.781	55%	50%	77.5%	1.544	0.176
ArtavazdesPit	drilling	60.180	31.620	55%	50%	77.5%	13.541	7.115
Arts_to_BRSF	haul roads (per 100m)	435.246	111.838	55%	50%	77.5%	97.930	25.163
Arts_to_Crusher	haul roads (per 100m)	156.400	40.187	55%	50%	77.5%	35.190	9.042
Arts_to_LowGrade1	haul roads (per 100m)	36.013	9.254	55%	50%	77.5%	8.103	2.082
Arts_to_LowGrade2	haul roads (per 100m)	36.013	9.254	55%	50%	77.5%	8.103	2.082
Truck load-out to HLF	haul roads (per 100m)	206.422	44.159	55%	50%	77.5%	46.445	9.936
LimeStorage	material handling	0.306	0.123	55%	83%	92.4%	0.023	0.009
PrimaryCrusher	material handling	1730.762	865.381	55%	50%	77.5%	389.421	194.711
ScreeningPlant	material handling	1730.762	865.381	55%	99%	99.6%	7.788	3.894
TruckLoadOutTower	material handling	1730.762	865.381	55%	83%	92.4%	132.403	66.202
PrimaryCrusher	primary crusher	576.921	576.921	55%	99%	99.6%	2.596	2.596
SecondaryCrusher	secondary crusher	1730.762	346.152	55%	99%	99.6%	7.788	1.558
BRSF	stockpile wind erosion	245.558	122.779	55%	50%	77.5%	55.251	27.625
FineOreStockpile	stockpile wind erosion	5.315	2.658	55%	65%	84.3%	0.837	0.419
HLF	stockpile wind erosion	213.927	106.963	55%	50%	77.5%	48.134	24.067
LowGradeStockpile1	stockpile wind erosion	226.649	113.325	55%	50%	77.5%	50.996	25.498
LowGradeStockpile2	stockpile wind erosion	172.971	86.486	55%	50%	77.5%	38.919	19.459
ROM Stockpile	stockpile wind erosion	39.561	19.781	55%	65%	84.3%	6.231	3.115
Artavazdes Pit	truck loading	99.518	47.070	55%	50%	77.5%	22.392	10.591

Table 7.6.5: Estimated Dust Emission Rates

Source Area	Source Activity	Uncontrolled kg/day		Suppression factor		Cumulative	Controlled kg/day	
		TSP	PM ₁₀	Wet and snow days	Dust control measures		TSP	PM ₁₀
BRSF	truck loading	96.180	45.491	55%	50%	77.5%	21.640	10.235
HLF	truck loading	9.190	4.347	55%	50%	77.5%	2.068	0.978
Lime Storage	truck loading	0.073	0.035	55%	83%	92.4%	0.006	0.003
Low Grade Stockpile 1	truck loading	7.437	3.517	55%	50%	77.5%	1.673	0.791
Low Grade Stockpile 2	truck loading	7.437	3.517	55%	50%	77.5%	1.673	0.791
Primary Crusher	truck loading	66.708	31.551	55%	50%	77.5%	15.009	7.099
ROM Stockpile	truck loading	12.671	5.993	55%	50%	77.5%	2.851	1.348
Truck Load Out Tower	truck loading	66.708	31.551	55%	83%	92.4%	5.103	2.414

Notes:

Emission rates based on USEPA AP-42, Fugitive Dust Emission Factors, Midwest Research Institute Project Number 110397, November 2006 and Arup Environmental; The Environmental Effects of Dust from Surface Mineral Workings; UK Department of the Environment, Minerals Division, December 2005; Suppression factors based on Australian Government National Pollutant Inventory Emission Estimation Technique Manual for Mining, Version 3.1, January 2012

Table 7.6.6 provides a summary of the total controlled emissions from each source area.

Table 7.6.6: Summary of Total Dust Emission Estimates (Year 3 of operations)		
Fugitive source area	Controlled emissions, kg/day	
	TSP	PM₁₀
Artavazdes (excluding hauling within the pit)	51.9	26.0
BRSF (include low grade stockpiles)	175	84.9
Crushing and screening plants (including ROM stockpile)	432	214
HLF (including truck loadout and fine ore stockpile)	191	94.0
Total (excluding haul roads), kg/day	850	419
Haul Roads (maximum per 100m travelled)	149	38.4

Dust Dispersion and Deposition– TSP ‘Nuisance Dust’

The potential for dust arising from mineral sites is generally a matter of public concern. There may be the perception that the annoyance created during works could affect local amenity value and quality of life for the period during operations. The amount of dust that might cause complaint or nuisance in a particular circumstance is however very difficult to determine and there is little consensus about possible nuisance dust levels. Various national standards for nuisance dust range from 133 to 350 mg/m²/day⁷. For the purpose of the assessment of TSP dust dispersion from the Project, the extents of this range have been selected as a good indicator of the presence of nuisance dust levels.

Dispersal of gases and fugitive dust via atmospheric dispersion is dependent on atmospheric conditions. The main emission from mining activities is dust. Emission rates, based on USEPA AP-42, indicate that the percentage of PM₁₀ particles in dust emissions varies depending on the source of the dust. About 95% of dust particles emitted from materials handling activities are greater than 10µm in diameter, while blasting, drilling, and wind erosion contains roughly 50% particles smaller than 10µm. Approximately 72% of fugitive dust emitted because of vehicle entrainment on haul roads is greater than 10µm in diameter. The typical relationship between particle size and dispersion distance has been summarised in Table 7.6.7.

⁷ Quality of Urban Air Research Group *Airborne Particulate Matter in the United Kingdom: Third Report of the Quality of Urban Air Review Group* (1996) DoE, University of Birmingham

Table 7.6.7: Typical Dispersion of Particulates⁵

Particle Size, μm	Category	Effective maximum dispersion distance from source (m)
> 30	Large particles, soiling of surfaces	300
10 to 30	Intermediate	500
< 10	Inhalable, small	1000
<2.5	Respirable, very small	>1000

The distances in Table 7.6.7 indicate effective maximum dispersion distances for different particles sizes. The majority of particles in each size group will settle out long before reaching the maximum distance (depending on prevailing winds and weather conditions). Whilst dust may be observed from many mining activities, only a very small proportion will travel any distance from the source and the great majority deposits within a few hundred metres.

Dispersion of TSP dust from the emission points and its subsequent deposition on to land has been assessed through the use of a screening model based on the following assumptions:

- Emission rates based on USEPA AP-42, Fugitive Dust Emission Factors, as detailed in **Error! Reference source not found.**;
- Deposition values based on deposition rates are for a typical dry day (24hours);
- Consideration of each site specific source and operations as a single combined emission;
- Dust disperses in proportion to the frequency of dry-day winds from each direction. For the purposes of this assessment the Vorotan weather station meteorological data has been used to obtain wind direction. The percentages of dry winds from twelve wind sectors has been used (Figure 7.6.2); and
- For the dust dispersing in each direction, deposition is estimated assuming exponential decay, with the exponential decay rate based on research undertaken by US EPA and other authors⁵, and particle size distribution based on ISO12103-1⁸. The model estimates that:
 - 82.6% of the TSP dust deposits within 100m of the source;
 - 16.7% of the TSP dust deposits between 100m and 500m of the source; and
 - 0.7% of the TSP dust deposits between 500m and 1km of the source.

⁸ ISO12103-1:1997 -- Road vehicles -- Test dust for filter evaluation, A4 Coarse Test Dust

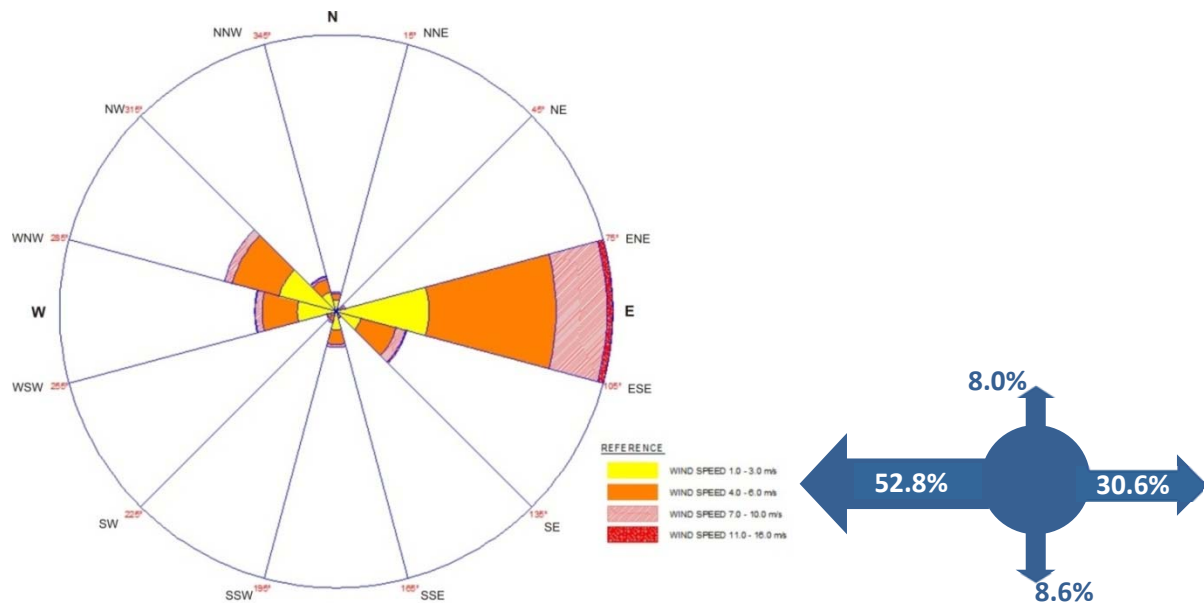


Figure 7.6.2: Frequency Distribution of Dry Winds, Long Term Met Data, Vorotan Pass - Simplified Wind Distribution for Dispersion

The dispersion assumptions used here are an approximation for the purposes of impact assessment, although they are based on sound empirical evidence from mining projects in many climates.

A screening assessment undertaken for the project identified that for operations associated with mine activities a 1km buffer zone around the primary operational dust sources would be sufficient to identify whether further more detailed modelling would be required. This analysis is shown on Figure 7.6.2. It is predicted that the majority of the dust (between 95% and 100% of airborne particulates) would settle out within this zone.

Figure 7.6.3 identifies the total estimated deposition of dust around the mine site during the operational phase, based on these assumptions and using GIS to map the extent of the area influenced.

Although dust dispersion and deposition has only been modelled during Year 3 of the operational phase, dust dispersion and deposition will follow a similar pattern during the other operational years, and during the construction phase of the Project. Unlike dust emission rates during operations, dust emission rates during construction will be considerably lower because the main contributors to dust emissions during operations (namely crushing and screening of ore together with the haulage of barren rock to the BRSF) will not be present. Thus, the model of operational emissions presents a worse-case scenario.

In considering the residential receptor groups, the potential impacts from crushing plant construction are not significant, taking account of the distance between the activity and potential receptors. The location of the ADR plant adjacent to the H-42 road (75m), and 1.3 km from Gndevaz, has greater potential for dust emissions from its construction to be considered significant. The truck loadout facility lies about 1.2km from Gndevaz, and so could be close enough to raise concern; however, its location is shielded from Gndevaz by a small ridge in the topography which will prevent visible dust from being observed at the site. Since all of these facilities will lie beyond 1 km from Gndevaz, nuisance dust fallout is predicted to have limited or no impact during construction on communities.

The dust screening assessment detailed in Figure 7.6.3 shows two regions potentially affected by nuisance dust, demarcated by a 350 mg/m²/day and a 133 mg/m²/day contour. More sensitive human receptors would tend to experience an effect at dust deposition rates of 133 mg/m²/day, while less sensitive receptors may only experience a nuisance effect at rates of 350 mg/m²/day or greater. The distance from dust emission sources where nuisance effects may be felt varies with the prevailing wind direction, but the maximum distance nuisance dust could affect human receptors is estimated to a maximum distance of up to 850m from the emission sources, with most deposition taking place to the west of the emission source. Visible dust emissions may be experienced by receptors at Gndevaz, and road users of the H-42. With the exception of the livestock and dairy farm, nearby residential and community receptors are too distant to be influenced by the potential impacts of dust dispersal during construction and therefore the significance is considered low. Sensitive receptor groups of Gndevaz, and the other neighbouring settlements, lie beyond this zone of potential nuisance, and so potential impacts of dust deposition on community receptors is considered low for both construction and operational phases.

The model output identifies that the livestock and dairy farm lies beyond the zone of potential nuisance (133mg/m²/day), being located approximately 700 m of the potential dust sources at the overland conveyor discharge and truck loadout. The livestock and dairy farm receptor is considered to have Minor sensitivity, because it is an agricultural operation, utilising intensive (housed) livestock rearing techniques fed with hay and imported cattle feed. Therefore, there is no direct pathway between fugitive dust dispersion and uptake in feed to the cattle at the farm. In addition, there are no residential quarters at the agricultural premises, therefore no residential receptors. The overall impact of dust on the livestock and dairy farm receptor is Minor, and not significant.

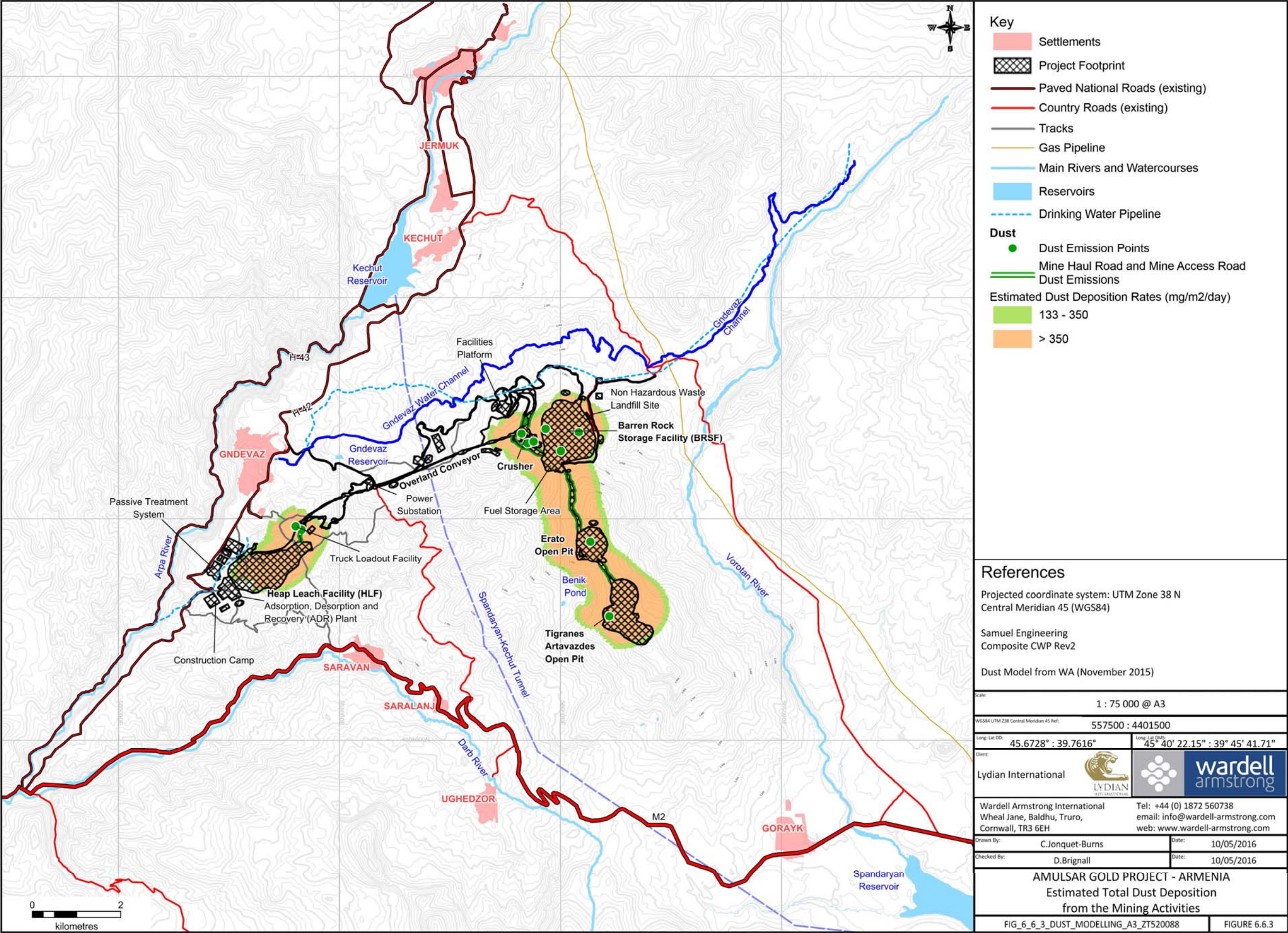


Figure 7.6.3: Estimated Total Dust Deposition from the Mining Activities

Mine employees working in close proximity of the dust emissions are considered to be primary receptors; however, they are considered of minor sensitivity to nuisance dust. Nuisance dust levels within the site will be minimised through the implementation of mitigation measures at source to reduce the impact of dust for employees and other sensitive receptors, including procedures to monitor and mitigate the exposure of workers to fine particulates, as detailed in Section 6.6.4. With mitigation, it is therefore considered that nuisance dust impacts are either minor or negligible and not significant.

There are potential impacts from dust deposition on soil and grazing land around the Project footprint, up to about 1km away, but most of the dust deposition that could alter the character of the grazing land will be deposited within 100m of the dust sources (82% of the emitted dust). The grazing land is considered to have medium sensitivity to dust deposition, due to the importance of grazing land to the neighbouring communities and herder populations. It is considered that the nuisance dust deposition on grazing land in the vicinity of the site will be of moderate magnitude closer to the footprint, dropping off to low and eventually negligible magnitude the further the grazing land receptor lies from the project footprint. Thus, within 100m of the project footprint, dustfall can be considered to have moderate impact significance and will require mitigation and management. Dust deposition beyond that distance will not have a significant effect.

Dust deposition may also have an adverse impact on the critical habitat areas intersected by and surrounding the project footprint. In the case of critical habitat supporting *Potentilla porphyrantha* at higher elevations around the peaks of Amulsar Mountain (refer to Chapter 4.10 for more detail on this Red List plant species) the receptor sensitivity is identified as very high. With respect to dust fall, Section 6.11.5 evaluates the proportion of the habitat that would be subject to the potential impact associated with dust. The proposed mitigation for this potential impact includes a monitoring programme (see Section 6.11.6 and Table 6.11.13).

Most of the receptors in the State Reservations group are too distant from the Project to be impacted by dust deposition (i.e. greater than the 815m nuisance dust deposition range), either during construction or operations. The Jermuk IBA is the exception and, during construction of the ADR plant, could experience some dust deposition on its eastern edge. The construction time period for the whole project is approximately two years, so construction of the ADR plant will take less time than this. Given the short duration of the

construction period and the area of affect (less than 0.5% of the Jermuk IBA), the magnitude of potential impact is low and the effect not significant.

During operations, the main sources of dust emission are too distant to have a discernible effect on the Jermuk IBA, and so the potential impact is negligible during operations and not significant.

There is the potential for impact associated with dust emissions from mine related traffic on roads passing through or near to communities. Traffic associated with the Project will mainly comprise workers and supply vehicles. The Traffic Assessment (Section 6.19) identifies that baseline traffic flows along the roads likely to be used by traffic associated with the Project are low, with the main road links considered operating at less than 5% of capacity in 2013 and 2015. A transport service will be provided, taking account of shift patterns, to reduce the volume of traffic from the mine workers' accommodation, including shuttle buses from local villages to the Project. Mitigation measures will be implemented to mitigate the potential for dust emissions as detailed in Table 7.6.9 below. With the proposed mitigation measures in place it is considered that the significance of effect of dust emissions from mine related traffic on roads passing through or near to communities will be minor and amenable to mitigation, through use of tarmac for the primary access junctions.

Dust Dispersion – Respirable Size Fraction PM₁₀

The USEPA dispersion screening model AERMOD Screen⁹ was used to estimate the potential maximum short-term fine particulate levels (PM₁₀) which are considered a suitable indicator of inhalable and respirable dust concentrations for sensitive receptors. The controlled emission rates for PM₁₀, given in the right hand column of **Error! Reference source not found.**, were used as input parameters, together with 'worst case' high winds combined with dry atmospheric conditions. The model thus provides conservative dispersion patterns for PM₁₀, assuming that these conditions persist continuously for a 24-hour period, to give worst case conditions and the rate of fallout has been shown in Figure 7.6.4.

⁹ <http://www.epa.gov/scram001/>

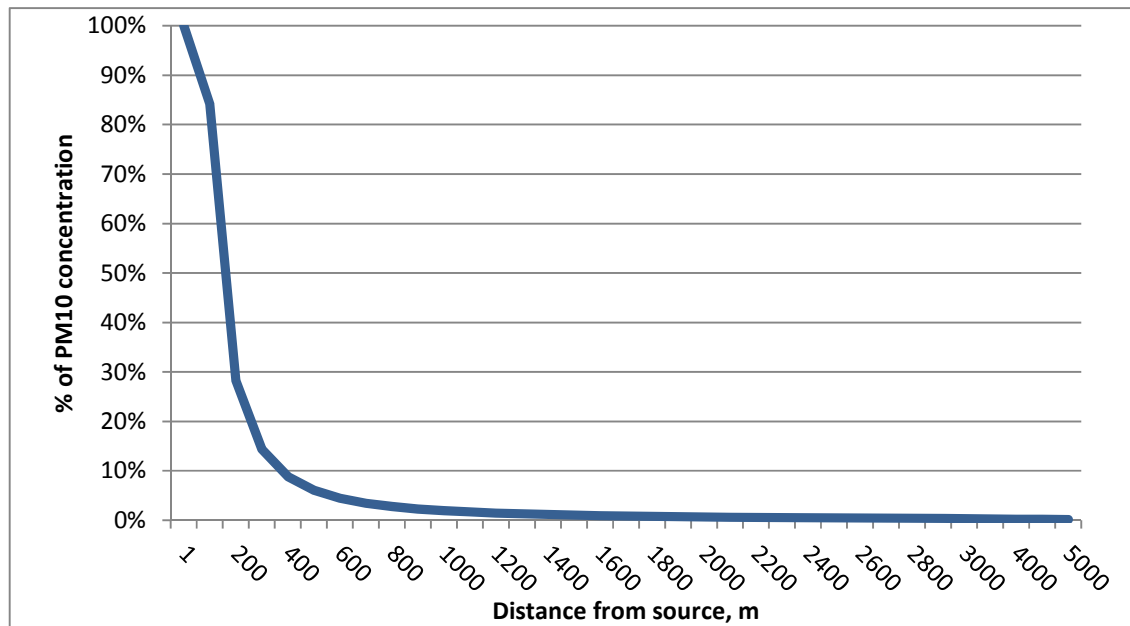


Figure 7.6.4: Relative Inhalable Dust Levels with Distance from Source

Figure 7.6.4 identifies that in worst case conditions the majority of PM₁₀ emitted from the Project (over 95%) will be deposited within 1km from the site, with over 90% deposited within 500m of the source. The nearest residential communities are located approximately 1.0km from the nearest source and therefore the fine particulate levels will have reduced to a very low proportion (less than 1% of emitted levels) as shown on Figure 7.6.4. Based on the distance from Project activities, PM₁₀ and PM_{2.5} concentrations, would not exceed the guideline values of (see also Table 2.12):

- PM₁₀ 20 µg/m³ (1yr average) 50 µg/m³ (24hr average)
- PM_{2.5} 10 µg/m³ (1yr average) 25 µg/m³ (24hr average)

The AQNVMP (Appendix 8.14) requires monitoring and reporting to audit the Project activities against these guidelines, with monitoring commencing prior to construction.

Respirable dust concentration from the Project dust sources will therefore be low at these receptors, and the magnitude of impact at these receptors is therefore considered to be negligible, with a negligible significance of effect.

Respirable dust is an issue of consideration for human receptors. The soils and grazing, critical habitat, and State Reservation receptor groups are not impacted by fine particles suspended

in the atmosphere. The impacts occur when PM₁₀ dust is deposited on surfaces. This is a subset of TSP dust deposition and was discussed in the previous section.

Mine employees working in close proximity of the fine particulate emissions are considered to be primary receptors. Without mitigation it is considered that dust impacts are likely to be moderate to high with a moderate significance of effect. Mitigation measures will be implemented through the OHSP (see Appendix 8.7) to reduce and monitor the exposure of workers to fine particulates.

Combustion Emissions

The significance of vehicle exhaust gasses from vehicles operating within the Project footprint was considered with regard to the DMRB¹⁰ screening methodology which examines potential air quality impacts of vehicle emissions. It has been used because it provides a relevant methodology for assessing the impact of Project related transportation, on air quality.

The DMRB screening methodology was developed for use by the UK's Highways Agency, but is widely used as a tool for assessing the potential impacts as a result of an increase in vehicles movements to nearby existing sensitive receptors.

The DMRB methodology begins with a screening exercise. This establishes whether there is likely to be a significant impact on air quality, as a result of an increase in vehicles associated with a project. The first part of the screening exercise is to identify if there will be a daily increase of more than 1,000 vehicles or more than 200 trucks associated with the Project. In addition, all relevant existing sensitive human and ecological receptors need to be identified. DMRB states that only receptors within 200m of a route affected by a Project should be considered.

Should any of these criteria not be met, or if there are no receptors within 200m, the potential air quality impact of the vehicles on the route is considered to be neutral and no further assessment is required.

Within the Project, the only significant source of vehicle emissions will be from the haul trucks moving material between the open pits, crushing plant and BRSF. The peak year of operations, Year 3, has 19 <190tonne capacity haul trucks using along the haul roads, between the open

¹⁰ Design Manual for Roads and Bridges (Volume 11, Section 3, Part 1, HA 207/07

pits and the BRSF and primary crusher, amounting to around 54 haul vehicle movements per hour. Haul vehicle movements at the HLF amount to around 80 per hour, using the smaller capacity <30 tonne trucks. The closest point on the HLF haul road to Gndevaz lies 1.2km south east of Gndevaz. Although the increase in number of vehicles exceeds the DMRB methodology, sensitive human receptors lie considerably beyond 200m of the haul vehicle routes. The impact of vehicle emissions is therefore considered neutral in accordance with DMRB and therefore the magnitude of the impact can be considered negligible. The communities surrounding the Project are considered of moderate sensitivity in accordance with Table 7.6.1 and, therefore, the effect of vehicle emissions is considered to be negligible and not significant.

Based on the distance from Project activities, combustion gas concentrations would not exceed the guideline values of (see Table 2.12):

- SO₂ 20 µg/m³ (24hr average from monthly readings); and
- NO₂ 40 µg/m³ (1yr average, summed from monthly readings).

The AQNVMP (Appendix 8.14) requires monitoring and reporting to audit the Project activities against these guidelines, with monitoring commencing prior to construction.

Employee health and exposure to diesel fumes is subject to routine management as detailed in the Occupational Health and Safety Management Plan (OHSP, Appendix 8.7).

Nuisance Odours

Domestic wastewater and sewage are anticipated as being handled via septic systems at relevant areas in the mine area and via a package-design wastewater treatment plant servicing the HLF/ADR area.

Sources of nuisance odours include vehicle and process emissions, but facilities with the most likelihood of causing significant nuisance odours, should appropriate operations not be maintained, include the sewage treatment systems and landfill for domestic waste disposal. Improper operation of these facilities has the potential to cause moderate short-term local impacts to aesthetic air quality, and therefore appropriate mitigation measures will be implemented as detailed in the following section.

7.6.5 Mitigation Measures for Air Quality Impacts

The following sections summarise key air quality impact mitigating actions, both incorporated into the Project's engineering design and into its construction, operation, and closure stages (see also the Air Quality, Noise and Vibration Monitoring Plan; AQNVMP, Appendix 8.14).

Fugitive Dust Mitigation Measures

To decrease potential impacts to air quality to the extent practical, substantial fugitive dust controls have been incorporated into the engineering design, which include:

- Enclosure of primary and secondary crusher and screens with dust extraction and filtration devices. Figure 3.12 illustrates the general arrangement of the plant together with dust extraction and capture systems;
- The transfer of crushed ore between the crushing plants, screening plant, transfer stations, and truck loadout facility will be via enclosed conveyor from the crushing/screening building to the loadout area for the HLF. Figure 3.13 identifies the design of transfer tower, within which the load out of ore from the conveyor to dump truck occurs. The enclosure of the loadout area has been designed so that fugitive emissions of dust from this operation are contained within the tower. The conveyor design removes the potential for dust emissions that would result from the use of dump trucks travelling on haul roads, over the same distance;
- Use of water sprays at conveyor discharge points and other identified dust emission points, updated as required by the AQNVMP (Appendix 8.14); and
- Use of dripper application system at the HLF (see Section 3.10.3).

Additional dust control measures will be systematically utilised by the Project during construction and operations, as set out in the AQNVMP (Appendix 8.14); and include:

- **Road control programmes** - Lydian will carry out appropriate dust suppression techniques including spraying roads with water and/or application of stabilising agents such as salt (winter), gravel, or environmentally inert chemicals, as appropriate. In addition, Lydian will supply adequate equipment and personnel to maintain road surfaces to control dust on the haul and access roads. The primary access junctions will be surfaced with tarmac to mitigate the spread of dust onto the public highway and reduce the potential impact of dust on the communities of Kechut and Gndevaz;
- **Speed and off-road restrictions** – Establishing and enforcing Project safety rules, including the posting and enforcement of speed limits on Project haul and access

roads and restricting off-road travel to the maximum practical extent will limit the potential for additional fugitive dust emissions, as well as public safety hazards. Those employees whose jobs include driving will be advised of the safety rules and that driving off established roadways is not allowed. Instruction on driving safety and observation of speed limits will be included in the new employee orientation and annual refresher training and in task training for specific job assignment;

- **Maintaining humid heap leach pad surface** - Lydian will operate the HLF in such a manner that the active leaching surface retains sufficient humidity to inhibit dust generation. This consideration has been incorporated into the Project's water balance;
- **Concurrent Rehabilitation and Reclaim of BRSF** – During the fourth year of operations Lydian are scheduled to begin rehabilitation and reclamation works on the parts of the BRSF that will no longer be operational. This work will proceed concurrently with operations, and the BRSF will be progressively capped and re-vegetated;
- **Vegetative barriers** – To supplement the dust suppression measures outlined above, shrubs may be planted in appropriate locations between the HLF and Gndevaz (see Section 6.5). Vegetative barriers will only be used in circumstances where the public consultation program has indicated that such additional measures are needed and acceptable to stakeholders.

Combustion Mitigation Measures

Combustion emissions have been reduced for the Project in the following ways:

- Selection of conveyor transport over truck haulage of ore from the crusher to the load out for the HLF;
- Use of modern, energy efficient electrical equipment and mobile plant with fuel-efficient engines and fleet management to ensure timely maintenance and notification of equipment malfunction that may result in an increase in emissions;
- Use of equipment exhaust controls. Exhaust controls on mobile equipment must be properly installed, maintained, and replaced as needed throughout the useful life of the equipment. Procurement of updated equipment with emissions controls and proper operation, care, and maintenance of the equipment will reduce combustion emissions to acceptable levels for vehicles and generators, as well as allowing the equipment to run more efficiently and increasing its operational lifespan; and
- In the ADR facility, leached and adsorbed mercury will be managed in the refinery using a retort furnace to volatilise, condense and capture the metal in elemental form.

The small quantity of collected mercury (estimated to be less than 60kg per year) will be kept in a closed container. The recovered mercury will be sold as a byproduct to certified consumers as it is generated.

Nuisance Odour Mitigation Measures

The Integrated Waste Management Plan (IWMP, Appendix 8.13) defines the procedures involved in proper waste handling and disposal for appropriate operation and nuisance odour control. Specifically, to reduce impacts from nuisance odours, the following mitigation measures will be implemented:

- Project facilities will incorporate appropriate waste handling and disposal procedures;
- Waste disposal facilities will be operated in a manner that includes the regular covering of exposed refuse with soil or gravel; and
- Sewage treatment facilities will be operated properly and monitored for operational performance, including nuisance odours.

7.6.6 Monitoring and Audit

The monitoring and audit planning required to validate the effectiveness of mitigation strategies have been identified in Table 7.6.8.

Table 7.6.8: Air Quality Monitoring and Audit		
Air quality, Monitoring and Audit programme and procedures		
Monitoring approach	Baseline	A developing programme of ambient air-sampling commenced in 2009 in order to establish baseline conditions at key locations within the Project licence area and at local settlements (see Chapter 4.4).
Level 2 Management Plan	The AQNVP (Appendix 8.14) provides the details of mitigation measures to control emissions of dust, particulates and combustion gases, associated with mobile plant	
Level 3 Standard Operating Procedures	<p>The AQNVP (Appendix 8.14) will be underpinned by five SOPs that will provide specific guidance on sampling locations and procedures during the construction, operational and closure phases. The level 3 procedures will include the following:</p> <ul style="list-style-type: none"> • Visual inspection – routine visual monitoring to identify sources of dust emission, these inspection position will be determined to demonstrate coverage of identified sources of dust, including open pits, haul roads, crushing plant, BRSF and conveyor load out points. • Meteorological station – location, download procedures, analysis of results and persons responsible for data collection and dissemination. The maintenance requirements for the met station will also be identified together with non-conformance procedures. • Location, collection, replacement and analysis of diffusion tubes (NO_x and SO_x), to include the procedures for the collection of active tubes (sample number, date, time and location reference), procedure to ensure that tubes are not contaminated between the sampling location and site offices, and procedures for shipment to accredited laboratory. Chain of custody documentation. 	

Table 7.6.8: Air Quality Monitoring and Audit

Air quality, Monitoring and Audit programme and procedures

- Location, collection and replacement of DustScan sticky pads, to follow similar procedures as those for the diffusion tubes.
- Environmental sampling and maintenance procedures for Osiris and EPAM 500 monitors.
- The location of the monitoring instruments will be determined in a revision of the Level 2 AQN&VP. Dependent on suitable positions, this SOP will therefore be informed by an audit of the site at the onset of the operational phase, when the final details of the plan will be designed. The SOP will define the monitoring requirements and periods for the use of the equipment, which will be directed towards areas of the operation where the effectiveness of mitigation measures can be determined, thus providing feedback to the aims and objectives of the AQMP.

Monitoring strategy

Visual inspection	Environmental staff	Routine observations developed against a graded system for inspecting and determining whether dust suppression techniques are sufficient or require further action.	This dynamic audit would be undertaken through a schedule to be developed in the air quality management plan and will require the training of environmental staff, shift supervisors and mine management to develop a consistent approach to auditing dust emissions. A record to be made of any exceptional events that trigger additional dust management should be kept together with approach to mitigation.
NO _x and SO _x	Diffusion tubes	Acrylic tubes designed for passive sampling of airborne gases. The tube contains an adsorbent material which can then be analysed by UV/Visible Spectrophotometry with reference to a UKAS (United Kingdom Accreditation Service) calibration curve, appropriate to this methodology.	Recommended exposure length typically in the order of 4 weeks, after which time they are removed from their sampling location and returned to the manufacturer's accredited laboratory for analysis.
Dust	DustScan DS100	Multi-directional sticky pad gauge which collect airborne dust as it passes over them. They are held in place and protected with a removable rain cap. The sampling head has a North marker which is aligned to magnetic North and the sample cylinders are fitted with North markers to ensure directional information is obtained. Dust deposition is measured as a % of the effective area covered (EAC), over the sampling period.	%EAC is monitored over a period of 1 month after which the pads are returned to an accredited laboratory for analysis. The resultant measurement will be expressed as %EAC/day. Comparison of the monitoring data, compared to the baseline condition can be used to determine whether a soiling, or significant dust impact has occurred.

Table 7.6.8: Air Quality Monitoring and Audit

Air quality, Monitoring and Audit programme and procedures

Particulates	Osiris Turnkey Monitor	The Osiris monitor measures total suspended particulates (TSP) and will be deployed as a semi-permanent installation at two locations – Gndevaz and Kechut	In its semi-permanent configuration, with a mains power supply, the meter continuously measures particulate levels and can determine trends when used long term. Results are data logged in the unit and are usually expressed as mg/m ³ /hr. The monitor is MCERTS accredited and requires regular maintenance and calibration. Two monitors are to be used for the AQNVP at the Primary Monitoring Station.
	EPAM 5000 Monitor	Portable monitor for PM ₁₀ , and PM _{2.5} concentrations. In the “workplace” mode it can indicate inhalable, thoracic and respirable concentrations.	Two monitors will be deployed to rotate around 8 locations to provide ambient, prior to construction, and environmental PM ₁₀ , and PM _{2.5} , near to communities and on the edge of the Project area (approximately 50 to 100 m from the Project footprint. Sampling period will be 24 hours and the data will be report as 1 hour, monthly and annual averages for each sampling point (see AQNVMP, Appendix 8.14).

The monitoring programme commencing during construction will be augmented with the introduction of a Primary Monitoring Station (for noise, vibration and air quality), located to the west of the livestock and dairy farm, adjacent to the apartment block that has been acquired by the Project. The monitoring affords a power supply and therefore the ability to undertake continuous monitoring of particulates (PM₁₀ and PM_{2.5}). The monitoring location (see Figure 6.6.5), can be accessed from the H-42 and therefore will be included in the community participatory monitoring programme.

7.6.7 Residual Impacts to Air Quality

Without appropriate mitigation, nuisance dust and fine particulates could have a moderate to high adverse impact upon on employees and sensitive habitats in the immediate vicinity of the site. The AQMP (Appendix 8.14) will therefore be implemented to minimise nuisance dust emissions and control fine particulates. With appropriate mitigation measures it is considered that the impact on employees and human receptors will be of negligible to minor significance in both the short term and the long term. The magnitude of impact is unknown at the sensitive habitats immediately adjacent to high activity project activities due to unknown tolerance to dust deposition but magnitude of impact will reduce with increasing distance from the project footprint.

Waste management facilities will be operated according to the plans and specifications identified in the IWMP (Appendix 8.13). With appropriate management of these facilities, nuisance odour-related impacts are considered negligible and not significant, as little putrescible waste will be produced. The waste landfill for the Project will be managed in accordance with industry best practice which will include measures to provide daily cover of waste, progressive capping and leachate containment. With appropriate mitigation measures applied, the residual impact is considered negligible in both the short term and the long term for all sensitive receptors.

Table 7.6.9 presents a summary of the anticipated air quality impacts, relevant operational phase and planned mitigation measures. The potential impact of metals in dust deposited onto critical habitats is considered in Section 6.11.

Table 7.6.9: Impact Summary - Air Quality

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	L T		
Fugitive Dust / Particulate	Blasting Drilling Conveying Loading Haulage Crushing	R, F a FI	X	X	Mi	N	<ul style="list-style-type: none"> • Speed limits for heavy equipment and general traffic on unpaved roads. • Restrict off-road travel unless absolutely necessary. • Limit number of trips with efficient loading procedures for material transport. • Apply stabilizing agents on high dust areas. • Top-wet truckloads of dusty material. • Spray water on unpaved roads and traffic areas. • Maintain gravel/laterite cover on unpaved roads and traffic areas. • Install dust suppression / control equipment at loading/unloading, storage, and material transfer points. • Crusher contained within a purpose designed building. • Provide enclosed overland conveyor between crusher and HLF. 	AQNVMP (Appendix 8.14)
	Blasting Drilling Conveying Loading Haulage Crushing	E	X	X	Mi	N	<ul style="list-style-type: none"> • All of the above mitigation measures. • Use employee personnel protective equipment where required and occupational medical monitoring. 	AQNVMP (Appendix 8.14) OHSP (Appendix 8.7)

Table 7.6.9: Impact Summary - Air Quality

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	L T		
Combustion Engine and Point Source Emissions	Construction and Haul vehicles Refining	E, R	X	X	N	N	<ul style="list-style-type: none"> • Speed limits for heavy equipment and general traffic on unpaved roads. • Train operators and drivers about maximum idling times. • Install appropriate emissions control equipment on vehicles. • Perform regular maintenance and inspection of vehicles and mobile equipment, including their emissions control systems. • Use stack control equipment on ADR Plant emissions. • Monitor ADR Plant emissions. 	AQNVMP (Appendix 8.14)
Nuisance Odours	Waste facilities	R	X	X	N	N	<ul style="list-style-type: none"> • Practice appropriate waste reduction and recycling procedures to minimize waste generation. • Incorporate appropriate waste handling and disposal procedures. • Operate waste disposal facilities such that exposed refuse is covered with soil or gravel. • Consider installing a gas relief system for solid waste disposal area. • Operate sewage treatment facilities properly and monitor operational performance (including odours). 	IWMP (Appendix 8.13)
	Waste facilities	E	X	X	N to Mi	N	<ul style="list-style-type: none"> • All of the above odour mitigation measures. • Use employee personnel protective equipment where required and occupational medical monitoring. 	IWMP (Appendix 8.13) OHSP (Appendix 8.7)
Notes: (1) Primary Receptors: E = employees R = residents, Fl = flora, Fa = fauna,, (2) Project Phase: C = Construction, O = Operations, (3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, MA = major, M - = moderate, Mi = minor, N = negligible								

7.6.8 Conclusions

An impact assessment has been undertaken to assess the effects of construction, operation and closure of the Project with regard to sensitive air quality receptors. The findings of the impact assessment are summarised in Table 7.6.9.

The potential impact magnitude of air quality impacts generated by the Project has been assessed at identified sensitive receptors and appropriate mitigation measures recommended to minimise the significance of impacts.

To reduce the potential for air quality impacts at existing community receptor locations around the site, sensitive ecological receptors in the immediate vicinity of the site and for employees working on the site, extensive mitigation measures and best practice methodology will be adopted by the Project to protect workers and off site receptors.

With appropriate mitigation measures applied, the residual impact is considered minor to negligible in the short and long term for both workers and community receptors. A significant impact may be considered at the sensitive habitats immediately adjacent to high activity project activities (within 50m), with the magnitude of any impact reducing with increasing distance from the Project footprint.

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6.7 Noise and Vibration

6.7.1 Introduction

The potential for impacts from noise to cause pollution is recognised in IFC PS 3 and EBRD PR 3, in that all Project related activities should be subject to pollution prevention and control. In addition, PS 2 and PR 2 that relate to Labour and Working Conditions require that noise is controlled in the workplace. This Chapter considers the potential impacts on environmental and social aspects of the Project affected community and surrounding area. The requirements for noise control at work have not been specifically addressed in this Chapter, but have been assessed by reference to specific policies and management requirements in Chapter 8. Therefore, specific occupational health and safety criteria that apply to the workers within the Project affected area, including the worker accommodation camp are not considered in this assessment or the Air Quality, Noise and Vibration Management Plan (AQNVMP, Appendix 8.14).

The methodology adopted in this Chapter follows that set out in Sections 6.1 to 6.3 and the sensitivity of receptors and magnitude of the potential noise impacts have been derived from the relevant guidance prepared by IFC and WHO.

6.7.2 Project Activities Related to Noise and Vibration

Ambient noise levels will increase with commencement of construction and will continue throughout the operation of the Project, and will decline and cease post-closure. Site noise will originate from construction activities to develop the mine and related infrastructure. Operational noise will result from open pit mining, mobile plant including the transport of materials to the crushing plant and waste rock to the BRSF, ore transport to the ADR facility and HLF facility operations, and noise from air overpressure resulting from blasting. Ground vibrations with the potential to damage structures may also result from blasting to extract rock within the open pit and certain other Project specific activities. Specific noise and vibration generating activities for each of these categories are considered in this Section.

Primary receptors for construction-related noise and vibration increases include Lydian employees, and residents and structures in the communities nearest to the mining operations, including: Gndevaz, Saravan, Saralanj, Jermuk (which includes the village of Kechut) and Gorayk. In addition, herders staying in temporary seasonal herder camps, for example Ughedzor and temporary summer grazing camps in closer proximity to the Project, have the potential to be disturbed as a consequence of noise and ground vibration.

The potential impacts on mammals (including livestock) and birds that contribute to the natural habitat have been assessed in terms of disturbance in Sections 6.11 and 6.20.

6.7.3 Noise and Vibration Significance Criteria

The significance of an environmental impact for noise and vibration is determined by the interaction of magnitude of change in ambient noise level and sensitivity of the receptor. The methodology for determining the magnitude of impact and sensitivity of the receptor with regard to noise and vibration is shown in Table 6.7.1 and Table 6.7.2.

Table 6.7.1: Methodology for Determining Sensitivity	
Sensitivity	Methodology
Minor	The location is tolerant of change without detriment to its character, is of low or local importance. e.g. an industrial development
Medium	The location has moderate capacity to absorb change without significantly altering its present character, or is of high importance. e.g. a residential dwelling
High	The location has little ability to absorb change without fundamentally altering its present character, or is of national importance. e.g. a hospital
Very High	The location is of the highest sensitivity to changes in noise and vibration, or is of international importance.

Table 6.7.2: Methodology for Determining Magnitude of Noise Impact	
Impact	Change compared with baseline or difference in predicted level compared to guideline level
Negligible	No discernible change in the baseline environmental conditions, within margins of error of measurement.
Low	Impact resulting in a discernible change in baseline environmental conditions with undesirable/desirable conditions that can be tolerated
Moderate	Impact resulting in a discernible change in baseline environmental conditions predicted either to cause relevant objectives or guidance levels to be marginally exceeded or to result in undesirable/desirable consequences on the receiving environment.
High	Impact resulting in a substantial change in baseline environmental conditions predicted either to cause relevant objectives or guidance levels to be exceeded or to result in undesirable/desirable consequences on the receiving environment which cannot be tolerated.

For the purposes of this noise and vibration assessment, the level of significance for noise and vibration effects will be ultimately determined by using the magnitude criteria detailed in Table 6.7.2 above, together with the sensitivity of the receptor, as detailed above, using the significance matrix detailed in Table 6.1.3.

6.7.4 Construction Activities Generating Noise and Vibrations

Construction activities at the open pits, BRSF, HLF, ADR plant, related support infrastructure and access roads can have temporary and local effects through an increase in the ambient noise climate, together with the impacts from blasting (air over pressure and ground vibration) for employees and residents of the surrounding communities. Construction operations will take place over a two year period, resulting in the potential for increased noise levels. Site preparation activities such as removal of topsoil overburden to form stockpiles, grading, excavation, and pouring of foundations are generally the noisiest construction operations, and typically result from the use of mobile plant workings in an open site. Concrete batch plants will be required at the mine and aggregate will be extracted within the project affected area and imported to the site in heavy good vehicles, from surrounding quarries, where it cannot be sourced from borrow pits. Other operations such as building construction, fit out of control equipment, laboratories are generally less noisy operations.

Drilling and blasting in the HLF area and crusher area will occur, starting Q3 2016 and continuing for 18 months. Blasting in borrow pit quarries will take place for the duration of the construction period. Blasting will occur during daylight hours only up to 3 times a week. Within the open pit, the blasting will be scheduled to maintain the mining programme and will also be restricted to daylight hours. Ground vibrations associated with rock extraction to establish the open pits at Artavasdes, Tigranes are only expected to be detected by mine operatives working within and adjacent to these working areas.

6.7.5 Operations Activities Generating Noise and Vibrations

During operations, potential impacts that are likely to affect the ambient noise level will result from operations that include: drilling and blasting, product extraction and stockpiling, crushing, conveying, hauling, stacking, and loading activities together with ground vibrations and air over pressure associated with rock extraction within the open pit. Mining and processing will occur 24 hours a day, for approximately 350 days per year, resulting in the potential for increased noise levels during the day and night time periods. Blasting activities which include drill and blast preparation works will take place continuously; however blasting will be restricted to daylight hours only and will be scheduled to maintain the mining programme. Ground vibrations associated with rock extraction within the open pits (Artavasdes, Tigranes and Erato) are only expected to be detected by mine operatives working within and adjacent to these working areas.

New haul roads will be constructed between the open pit and the crushing plant, run of mine

(ROM) stockpile, BRSF and HLF. Haul trucks with a carrying capacity of 190 tonnes will transport the ore from the open pit to the primary crushers, and transport waste rock to the BRSF. A fleet of up to 19 Cat 789D haul trucks will be needed to maintain annual production of 10Mtpa ore to the process plant. Haulage will be split between the crushing plant, BRSF and internal movements within the open pit. Transport of crushed rock to the HLF discharge structure will be via a closed conveyor, driven by electric motors and is essentially a quiet operation. 30/39t haul trucks will then be used to distribute rock onto the HLF. Haul truck reversing alarms/beepers can be a significant additional source of noise, particularly at night. The prediction methodology employed in this assessment incorporates the frequent use of reversing alarms. Lydian will investigate the optimal technology to be used for reversing alarms on haul trucks, to balance the requirement of occupational health and safety, for workers deployed on the HLF and to minimise/remove the audibility of alarms within the nearest community of Gndevaz.

Mobile equipment operations are predicted to increase the ambient noise levels in the area, including input from light vehicle operations noise, delivery trucks and heavy equipment operations noise and vibrations resulting from supply truck traffic on public roads. Supply truck traffic along public roads will be restricted to day-time hours for safety reasons. On public roads, project related traffic movements will be of low number and therefore have a negligible impact on receptors. This potential noise and vibration source has therefore not been considered further within this assessment.

6.7.6 Potential Noise Impacts

Potential impacts of noise and vibration have been modelled by using the predicted maximum levels during the construction and operational phases, to produce conservative “worst-case” assessments.

The following assumptions have been made through the noise modelling process to ensure “worst-case” assessments are maintained:

- During the construction phase each item of plant is modelled to include activity at the nearest operating location to the noise sensitive receptors;
- Two operational scenarios have been considered. The first represents the period of potentially highest impact associated with maximum ore production and highest numbers of operating plant and machinery – this will occur in year 3. The second operational scenario considered was chosen to represent the potential impact at the nearest settlement of Gndevaz associated with HLF activities when its operation is at

an advanced height – this will occur in year 8;

- A receptor location (domestic dwelling) in the south of Gndevaz (i.e. the closest to the Project area) was modelled to represent noise levels at the settlement. In reality, noise levels will be lower at properties further into the settlement; and
- During the operational phases, the crusher plant and ADR facility will be operated within enclosures; however, no noise attenuation from the buildings has been assumed within the model.

Construction Noise Sources

The primary noise sources, quantities, and sound power levels used in the assessment are shown in Table 6.7.3.

Table 6.7.3: Primary Source Sound Power Levels		
Source	Quantity of Sources	Sound Power Level L_w(dB)
Cat 6018 Excavator	2	113
Cat D10 Track dozer	3	123
Cat 824G Wheel dozer	1	111
Cat 16M Motor grader	1	111
Haul Truck	3	116
Water truck	1	116
Cat 992G Wheel loader	1	116
Cat 336 backhoe	1	106

Operational Noise and Vibration Sources

The primary noise sources, quantities, and sound power levels used in the assessment are shown in Table 6.7.4.

Table 6.7.4: Primary Source Sound Power Levels			
Source	Quantity of Sources Year 3	Quantity of Sources Year 8	Sound Power Level L_w(dB)
Cat 6240 Drill	4	4	118
Cat 5150 Drill	1	1	118
Cat 6050 Excavator	2	2	123
Cat 789D 190t Haul truck	56 trips/hr	54 trips/hr	121
Man 30t Haul truck	81 trips/hr	80 trips/hr	108
Cat D10 Track dozer	2	2	121
Cat 966 Loader	2	1	111
Cat 16M Motor Grader	2	2	114
Belaz Water truck	2	2	116
Cat 994 Highlift loader	1	1	117
Cat 824G Tyre Dozer	2	2	111
Primary Crush plant	1	1	104

Table 6.7.4: Primary Source Sound Power Levels

Source	Quantity of Sources Year 3	Quantity of Sources Year 8	Sound Power Level L _w (dB)
Secondary Crush plant	2	2	104
Overland conveyor	1	1	75
Overland conveyor drive motors	2	2	95
ADR facility area	1	1	100

The nearest noise, air overpressure, and vibration receptors to the Project are in the town of Jermuk, which is situated approximately 7 km from the nearest part of the Project's infrastructure. There are four rural communities in proximity to the Project, namely: Kechut (a rural community associated with the town of Jermuk), Saravan (including Saralanj and Ughedzor) and Gndevaz all located within Vayots Dzor Marz, and Gorayk, which is located in Syunik Marz. Gndevaz is the community closest to the footprint of the Project's infrastructure, with the HLF approximately 1 km south and east from the boundary of the village. There is also a resident currently living in accommodation near to the livestock and dairy farm located between Gndevaz and the Project area, however, the resident has agreed to sell the property to the Project sponsor and will be relocating prior to commencement of construction. This location will become a Primary Monitoring Station to allow long term compliance noise monitoring. Within the Project affected communities, the sensitive receptors are residential properties and therefore the sensitivity of all the receptors is medium (see Table 6.7.1).

The main factor affecting point-source noise transmittal is distance between noise source and receptor. For all receptors the distance identified is significant in terms of attenuating specific noise sources. For the noise prediction carried out using ISO9613-2:1996¹, accuracy is defined as ± 3 dB for distances up to 1km. Estimates of accuracy for distances greater than 1km are less certain. However, the predicted noise levels tend to equal, or be less than, those of the baseline conditions. In the majority of cases there is generally little or no change in absolute noise levels. It should be noted that all of the Project affected communities are greater than 1km from the main noise sources within the Project. Seasonal herder camps and biological receptors may be within 1km of these main Project noise source emissions, and the potential for disturbance has been considered in Sections 6.16 and 6.11 respectively.

Air and ground adsorption also influence noise transmittal, as can seasonal climatic/atmospheric changes; however for the Project noise transmission has been

¹ Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation, ISO9613-2:1996
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calculated over a rocky surface, with short vegetation, as this is representative of worse case conditions which occur during the summer. The distance between noise source and receptor remains the key pathway of interest; likewise, distance between source and receptor is the primary pathway of interest for potential air overpressure and vibration impacts. The noise models have been based on the assumption that noise, air overpressure, and vibration that emanates from the Project would remain relatively consistent throughout the year.

6.7.7 Noise Prediction Methodology

To accurately model the land surrounding the operation, an AutoCAD drawing was produced, which included the layout of the proposed mining operations and land contour data, to define natural barrier attenuation between the source of noise and receptors.

Calculations were carried out using the computer modelling software SoundPLAN Version 7.1. The computer modelling methodology conforms to the calculation procedures set out in ISO9613-1:1993 and ISO9613-2:19961 (acoustic measurement standard procedures). ISO9613-2:19961 outlines many attenuation factors that can be used in noise propagation calculations, including but not limited to geometrical divergence, atmospheric absorption, ground effect, and screening. The following assumptions were made in the prediction of site noise at each of the identified receptors:

- Geometrical divergence accounts for the hemi-spherical spreading of noise in the free-field from a point source situated near the ground surface - geometrical divergence is the most important factor in the attenuation of noise, as its main component is distance;
- Atmospheric absorption is the attenuation of noise as a result of the atmosphere. Noise propagation through the atmosphere depends on two factors: temperature and relative humidity. In all cases as stated previously no specific additional attenuation was used in the predictions;
- Attenuation due to ground effect is mainly the result of the ground surface interfering with the sound propagating directly from source to receiver. Given that the land between the Project and the noise-sensitive receptors is predominantly covered by rock and earth, the ground factor has been set at a conservative 0.25 in accordance with the guidance given in Section 7.3.1 of ISO9613-2:19961. This is considered to be worse case as during winter, snow cover would provide additional attenuation; and
- Attenuation due to screening is a result of noise being reflected or absorbed by barriers during propagation from the source to the receiver. In this calculation process, barriers will be land contours encountered along the noise propagation path,

as determined by the ground model used in the predictions.

In addition to the above, the calculation parameters of the acoustic model have been set to include the meteorological correction, C_{met} , which is used to calculate the equivalent continuous long term sound pressure level, as set out in Clause 8 of ISO9613-2:1996¹.

6.7.8 Blasting Prediction Methodology

Calculation Process

Air overpressure from blasting has been calculated using the following equation as shown in AS2187:2-2006² and outlined below:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^\alpha$$

Where: P is pressure in kPa, Q is the explosives charge mass in kg, R is the distance from the charge in m, K_a is the site constant and α is the site exponent. The calculated pressure is converted into the linear Sound Pressure Level using a reference pressure of 20mPa.

Vibration from blasting has been calculated using the following equation as outlined in AS2187:2-2006²:

$$V = 1140 \left(\frac{R}{Q^{1/2}} \right)^{-1.6}$$

Where: V is ground vibration as vector peak particle velocity in mm/s, R is the distance from the charge in m; Q is the explosives charge mass in kg, with K_g and B constants related to site and rock properties for estimation purposes.

Assumptions

Air overpressure and vibration from blasting have been calculated on the basis that the Maximum Instantaneous Charge (MIC - the amount of explosives fired at the same moment in time) is 161kg. It has also been assumed that the charges will be confined in blast holes.

6.7.9 Construction Prediction

The activities associated with the earthworks and construction phase of each of the proposed developments will have the potential to generate noise and create an impact on the surrounding area.

² Blast and Vibration Impact Assessment, Appendix J of AS2187.2-2006

Noise level limits for the Project have been defined for daytime (07:00-22:00) when the main noise emitting operations during the construction phase of the Project will be undertaken and night-time (22:00-07:00) periods^{3,4}. The construction of the mine will operate on a 24/7 shift pattern and therefore, appropriate noise conditions for night-time period have also been determined. The noise level likely to be generated in the nearby communities during the construction phase and any predicted increase in levels, i.e. the ambient noise level plus construction noise, are compared to the daytime limit value in Table 6.7.5.

Table 6.7.5: Construction Assessment Daytime Noise Impact			
Community	Predicted Site Noise Level, L_{Aeq} (dB)	Daytime Noise Criterion, L_{Aeq} (dB)	Difference
Saralanj	28	45	-17
Ughedzor	20	45	-25
Saravan	31	45	-14
Gorayk	10	45	-35
Gndevaz	39	45	-6
Kechut	25	45	-20
Jermuk	15	45	-30

It can be seen that the worst case predicted noise level from construction operations meets the Armenian Order No. 138 for daytime noise level criterion by at least 6dB (see Table 2.14).

The IFC EHS Guidelines also include a criterion stating that noise impacts should not result in an increase in background levels of more than 3dB at the nearest off-site receptor locations (see Table 2.14). Table 6.7.6 identifies the contribution of predicted site noise levels compared to pre-existing baseline (or background levels).

Table 6.7.6: Construction Assessment Daytime Noise Impact				
Community	Predicted Site Noise Level, L_{Aeq} (dB)	Measured Baseline Noise Level L_{Aeq} (dB)	Predicted Absolute Noise Level, L_{Aeq} (dB)	Increase over Baseline
Saralanj	28	49	49	0
Ughedzor	20	46	46	0
Saravan	31	48	48	0
Gorayk	10	47	47	0
Gndevaz	39	40	43	+3
Kechut	25	43	43	0
Jermuk	15	50	50	0

³ IFC EHS Guidelines (www.ifc.org/ehsguidelines)

⁴ Republic of Armenia, Noise Order No. 138, 2002

It can be seen that the worst case predicted noise level from construction operations will cause up to +3db in the monitored baseline levels, and is therefore in compliance with the IFC Guidelines. It should be noted that these predictions represent a “worst-case” scenario and that for the majority of the construction phase, the noise impact at sensitive receptors would be less.

The night-time noise levels arising from Project operations during construction have been assessed in Table 6.7.7 to Table 6.7.8.

6.7.7: Night-Time Noise Impact Assessment – Construction Phase			
Village	Predicted Site Noise Level LAeq (dB)	Night Time Noise Criterion LAeq (dB)	Difference
Saralanj	27	45	-18
Ughedzor	19	45	-26
Saravan	26	45	-19
Gorayk	11	45	-34
Gndevaz	33	45	-12
Kechut	26	45	-19
Jermuk	16	45	-29

The analysis demonstrates that the worst case predicted noise level from construction activities meets the IFC night-time noise level criterion (see Table 2.14) by at least 12dB. Table 6.7.8 identifies the contribution of predicted site noise levels compared to pre-existing baseline (or background levels).

6.7.8: Night-Time Noise Impact Assessment – Construction Phase				
Community	Predicted Site Noise Level, LAeq (dB)	Measured Baseline Noise Level LAeq (dB)	Predicted Absolute Noise Level, LAeq (dB)	Increase over Baseline
Saralanj	27	43	43	0
Ughedzor	19	47	47	0
Saravan	26	40	40	0
Gorayk	11	38	38	0
Gndevaz	33	38	39	+1
Kechut	26	36	36	0
Jermuk	16	42	42	0

It can be seen that the worst case predicted noise level from Project will increase baseline

levels by no more than 1dB in compliance with the IFC Guidelines at night (see Table 2.14).

When comparing the predicted ambient noise levels from the construction phase with the IFC Guidelines, the magnitude of the noise impact of construction phase is considered to be Minor or Negligible at all potentially affected communities and therefore not significant.

The nearest affected community is Gndevaz (which is at least 1km from major Project infrastructure), whilst workers will be in close proximity to each noise and vibration source. Standard noise mitigation and best practices will be adopted from the Occupational Health and Safety Plan (OHSP, Appendix 8.7) to protect workers. Appropriate mitigation measures will be required to ensure that residual impact on workers is safe and minimised in accordance with international best practice.

Seasonal herder camps and the grazing of animals will occur in closer proximity to the Project, including the known seasonal herder camp to the northeast and east of the proposed barren rock storage facility. If such camps occur outside of the proposed restricted area around the Project area, the magnitude of the noise impact of construction phase will be below IFC EHS Guidelines⁵ and is therefore considered to be Minor and not significant. It is not proposed to fence off the restricted area so awareness will be raised through communication with the herders.

The potential noise and vibration impact upon ecological receptors is considered in Section 6.11 Biodiversity.

The output from the noise prediction model, showing noise emission from the Project construction phase during the daytime is in Figure 6.7.1. It should be noted that the unshaded parts of the map represent areas where the predicted site noise level is less than $L_{Aeq}45dB$ ⁶.

⁵ Ibid. 3

⁶ Ibid 4

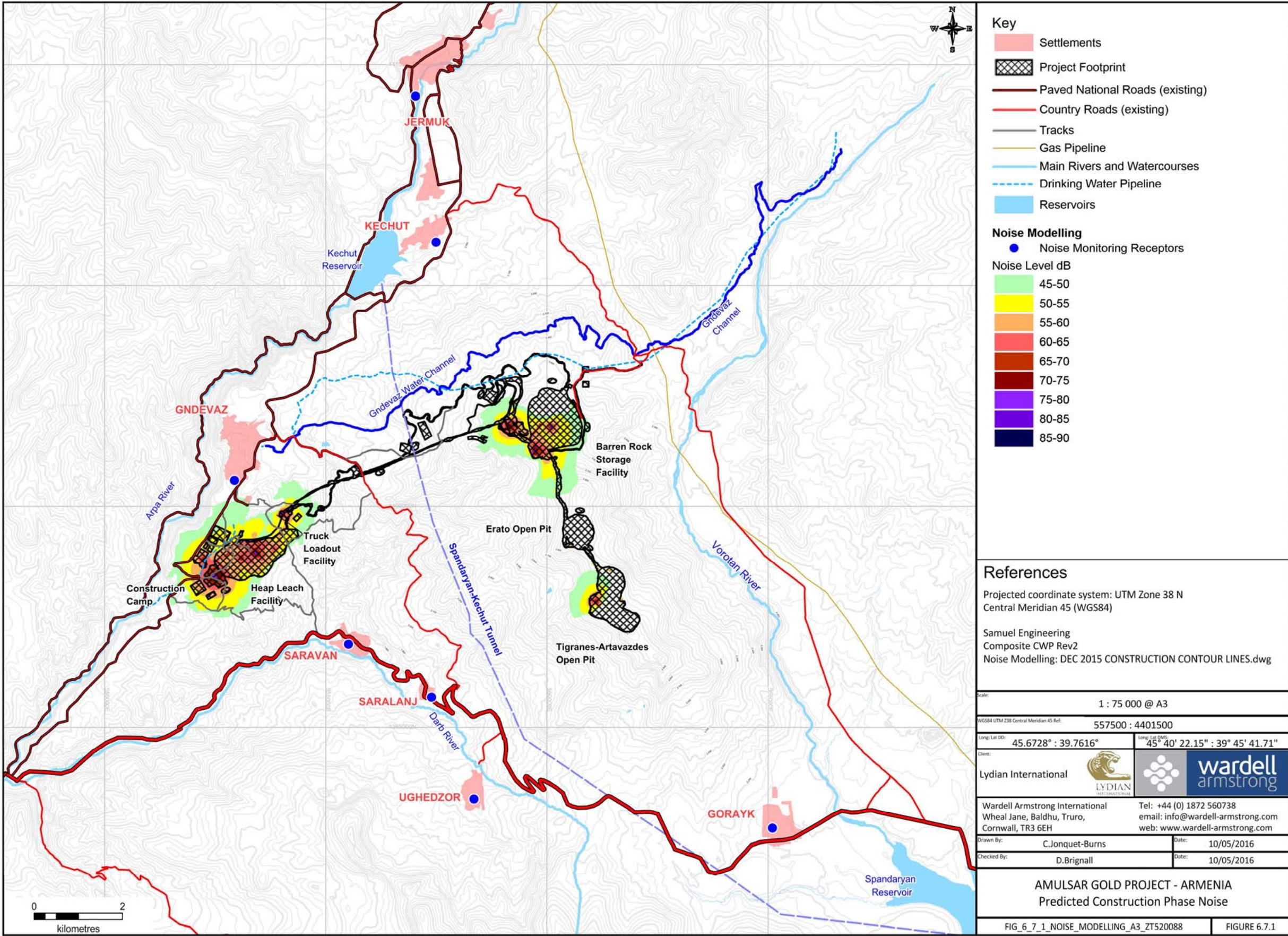


Figure 6.7.1: Predicted Construction Phase Noise

6.7.10 Operational Prediction

The changes in noise levels at each of the existing receptors considered have been assessed by comparing the noise levels predicted for the operational phase of the project with the absolute noise level limits, which should not be exceeded during daytime (07:00-22:00) and night-time (22:00-07:00) periods⁷, see also Table 2.14) The predicted day time noise values in the nearby communities for years 3 and 8 are compared to these values in Table 6.7.9 to Table 6.7.12.

Table 6.7.9: Daytime Noise Impact Assessment – Year 3			
Community	Predicted Site Noise Level, L_{Aeq} (dB)	Daytime Noise Criterion, L_{Aeq} (dB)	Difference
Saralanj	34	45	-11
Ughedzor	32	45	-13
Saravan	31	45	-14
Gorayk	24	45	-21
Gndevaz	36	45	-9
Kechut	31	45	-14
Jermuk	22	45	-23

It can be seen that the worst case predicted noise level from Project operations in year 3 meets the Armenian Noise Order criterion by at least 9dB⁸.

The IFC EHS Guidelines⁹ also include a criterion stating that noise impacts should not result in an increase in background levels of more than 3dB at the nearest off-site receptor locations (see Table 2.14). Table 6.7.10 identifies the contribution of predicted site noise levels compared to pre-existing baseline (or background levels).

Table 6.7.10: Daytime Noise Impact Assessment – Year 3				
Community	Predicted Site Noise Level, L_{Aeq} (dB)	Measured Baseline Noise Level L_{Aeq} (dB)	Predicted Absolute Noise Level, L_{Aeq} (dB)	Increase over Baseline
Saralanj	34	49	49	0
Ughedzor	32	46	46	0
Saravan	31	48	48	0
Gorayk	24	47	47	0

⁷ Ibid. 3&4

⁸ Ibid 4

⁹ Ibid. 3

Table 6.7.10: Daytime Noise Impact Assessment – Year 3

Community	Predicted Site Noise Level, L_{Aeq} (dB)	Measured Baseline Noise Level L_{Aeq} (dB)	Predicted Absolute Noise Level, L_{Aeq} (dB)	Increase over Baseline
Gndevaz	36	40	42	+2
Kechut	31	43	43	0
Jermuk	22	50	50	0

It can be seen that the worst case predicted noise level from Project operations in year 4 will not increase baseline levels by more than 2dB in compliance with the IFC Guidelines¹⁰.

When comparing the predicted ambient noise levels from the daytime mining operations with the IFC Guidelines¹¹, the magnitude of the noise impact of daytime phase is considered to be Low in Gndevaz and Negligible in all other potentially affected communities.

Table 6.7.11: Daytime Noise Impact Assessment – Year 8

Community	Predicted Site Noise Level, L_{Aeq} (dB)	Daytime Noise Criterion, L_{Aeq} (dB)	Difference
Saralanj	34	45	-11
Ughedzor	32	45	-13
Saravan	33	45	-12
Gorayk	24	45	-21
Gndevaz	34	45	-11
Kechut	28	45	-17
Jermuk	19	45	-26

It can be seen that the worst case predicted noise level from Project operations in year 8 meets the Armenian Noise Order criterion (in Table 2.14) by at least 11dB¹².

The IFC EHS Guidelines¹³ states that noise impacts should not result in an increase in background levels of more than 3dB at the nearest off-site receptor locations (see Table 2.14). Table 6.7.12 identifies the contribution of predicted site noise levels compared to pre-existing baseline (or background levels).

¹⁰ Ibid. 3

¹¹ Ibid. 3

¹² Ibid 4

¹³ Ibid. 3

Table 6.7.12: Daytime Noise Impact Assessment – Year 8

Community	Predicted Site Noise Level, L_{Aeq} (dB)	Measured Baseline Noise Level L_{Aeq} (dB)	Predicted Absolute Noise Level, L_{Aeq} (dB)	Increase over Baseline
Saralanj	34	49	49	0
Ughedzor	32	46	46	0
Saravan	33	48	48	0
Gorayk	24	47	47	0
Gndevaz	34	40	41	+1
Kechut	28	43	43	0
Jermuk	19	50	50	0

It can be seen that the worst case predicted noise level from Project operations in year 8 will not increase baseline levels by more than 1dB in compliance with the IFC Guidelines¹⁴. The nearest community is at least 1km from major Project facilities, whilst workers will be in close proximity to each noise and vibration source. Standard noise mitigation and best practices will be adopted from the OHSP (Appendix 8.7) to protect workers. With appropriate mitigation measures applied, the magnitude of the residual impact and the significance of the effect is Negligible at all Project affected communities with the exception of Gndevaz, which is Minor.

Seasonal herder camps and the grazing of animals has been noted to take place to the northeast and east of the proposed waste dump facility. If such camps occur outside of the proposed restricted area around the project site, the magnitude of the noise impact of operational phase will be below IFC EHS Guidelines¹⁵ and is therefore considered to be Negligible, with the exception of Gndevaz, which is Minor.

The potential noise and vibration impacts upon ecological receptors is considered in Section 6.11 Biodiversity.

The output from the noise prediction model, showing noise emission from Project operations during year 4 for both daytime and night time periods, is shown in Figure 6.7.2. Predicted noise emission associated with Project operations during year 8 is shown in Figure 6.7.3. It should be noted that the unshaded parts of the map represents areas where the predicted site noise level is less than L_{Aeq} 45dB (in compliance with IFC and Armenian Noise Order noise criteria¹⁶).

¹⁴ Ibid. 3

¹⁵ Ibid. 3

¹⁶ Ibid. 4

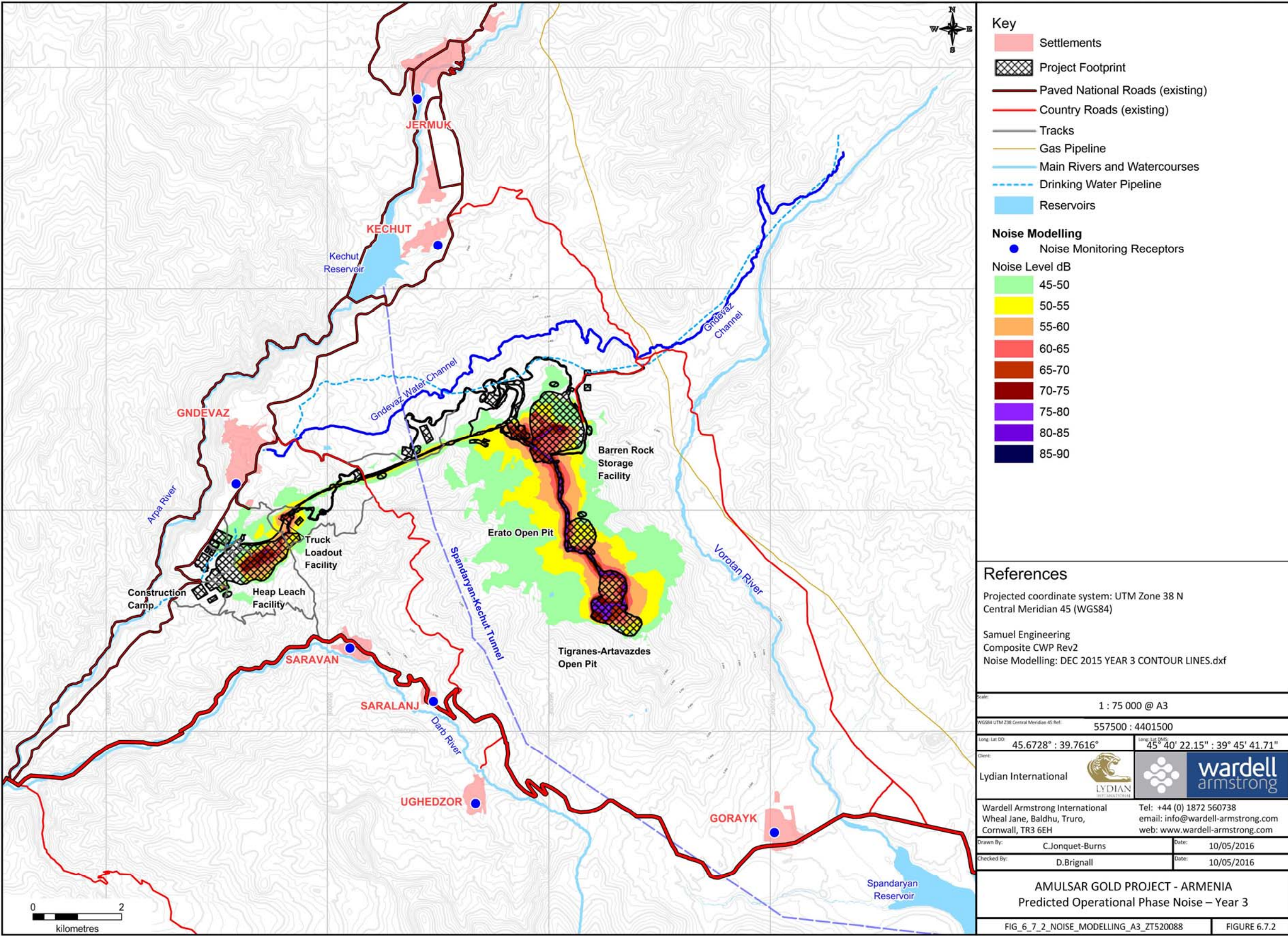


Figure 6.7.2: Predicted Operational Phase Noise Year 3

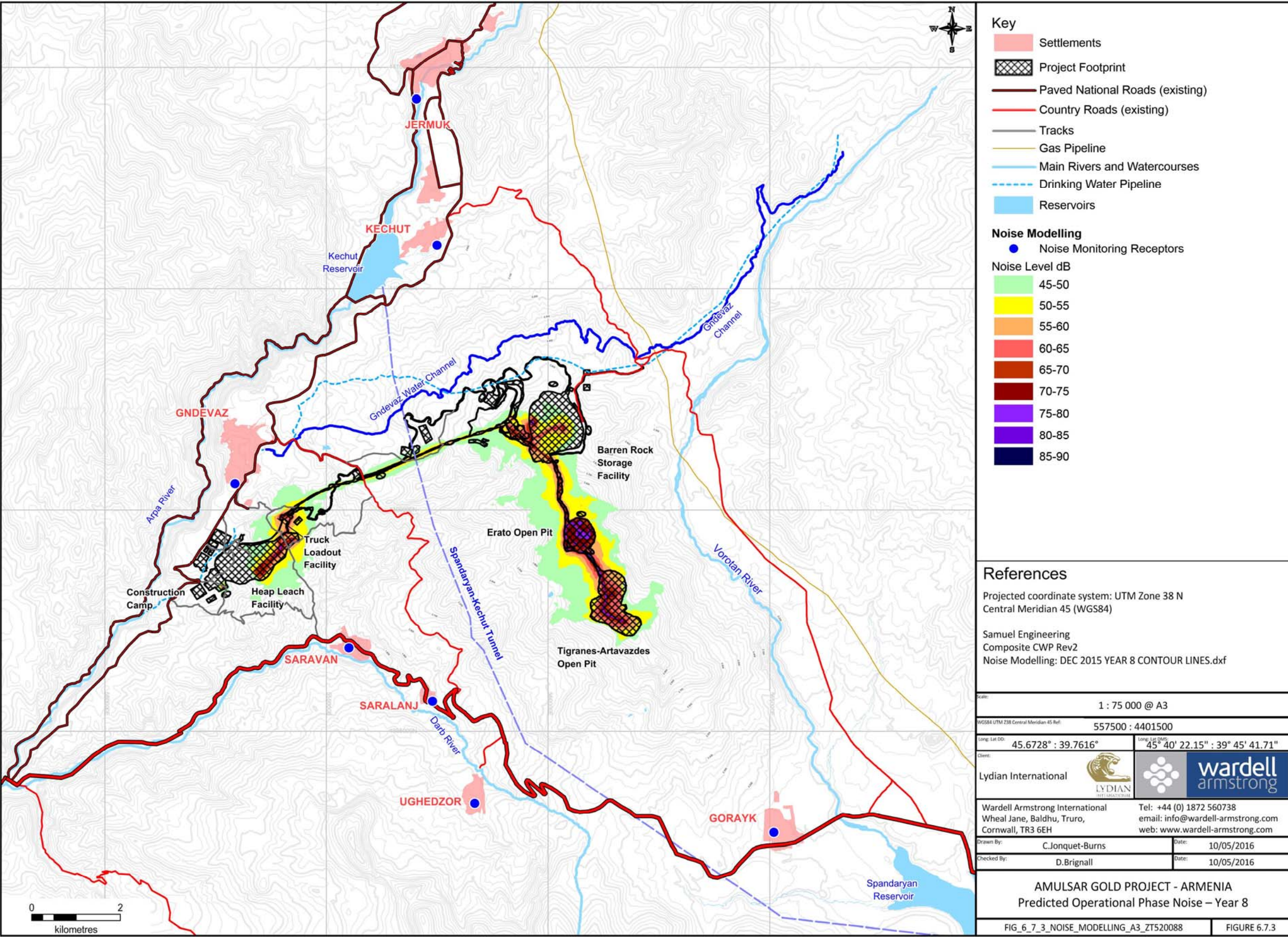


Figure 6.7.3: Predicted Operational Phase Noise – Year 8

The night-time noise levels arising from Project operations in years 4 and 8 have been assessed in Table 6.7.13 to Table 6.7.16.

Table 6.7.13: Night-Time Noise Impact Assessment – Year 3			
Village	Predicted Site Noise Level LAeq (dB)	Night Time Noise Criterion LAeq (dB)	Difference
Saralanj	34	45	-11
Ughedzor	32	45	-13
Saravan	31	45	-14
Gorayk	24	45	-21
Gndevaz	36	45	-9
Kechut	31	45	-14
Jermuk	22	45	-23

The analysis demonstrates that the worst case predicted noise level from Project operations in year 3 meets the IFC night-time noise level criterion (see Table 2.14) by at least 9dB. Table 6.7.14 identifies the contribution of predicted site noise levels compared to pre-existing baseline (or background levels).

Table 6.7.14: Night-Time Noise Impact Assessment – Year 3				
Community	Predicted Site Noise Level, LAeq (dB)	Measured Baseline Noise Level LAeq (dB)	Predicted Absolute Noise Level, LAeq (dB)	Increase over Baseline
Saralanj	34	43	44	+1
Ughedzor	32	47	47	0
Saravan	31	40	41	+1
Gorayk	24	38	38	0
Gndevaz	36	38	40	+2
Kechut	31	36	37	+1
Jermuk	22	42	42	0

It can be seen that the worst case predicted noise level from Project operations in year 3 will increase baseline levels by no more than 2dB in compliance with the IFC Guidelines at night (see Table 2.14).

Table 6.7.15: Night-Time Noise Impact Assessment – Year 8			
Village	Predicted Site Noise Level LAeq (dB)	Night Time Noise Criterion LAeq (dB)	Difference
Saralanj	34	45	-11
Ughedzor	32	45	-13
Saravan	33	45	-12
Gorayk	24	45	-21
Gndevaz	34	45	-11
Kechut	28	45	-17
Jermuk	19	45	-26

The analysis in Table 6.7.15 demonstrates that the worst case predicted noise level from Project operations in year 8 meets the IFC night-time noise level criterion by at least 11dB. Table 6.7.16 identifies the contribution of predicted site noise levels at year 8 of operations compared to pre-existing baseline (or background levels).

Table 6.7.16: Night-time Noise Impact Assessment – Year 8				
Community	Predicted Site Noise Level, LAeq (dB)	Measured Baseline Noise Level LAeq (dB)	Predicted Absolute Noise Level, LAeq (dB)	Increase over Baseline
Saralanj	34	43	44	+1
Ughedzor	32	47	47	0
Saravan	33	40	41	+1
Gorayk	24	38	38	0
Gndevaz	34	38	40	+2
Kechut	28	36	37	+1
Jermuk	19	42	42	0

It can be seen that the worst case predicted noise level from Project operations in year 8 will increase baseline levels by no more than 2dB in compliance with the IFC Guidelines¹⁷ at night (see also Table 2.14).

When comparing the predicted ambient noise levels from the night-time mining operations with the IFC Guidelines¹⁸, the magnitude of the noise impact of the night-time phase is considered to be Low at Gndevaz. At all other affected communities the magnitude of the noise impact is negligible. The significance of the effect is Minor at Gndevaz and Negligible at all other affected communities.

¹⁷ Ibid. 3

¹⁸ Ibid. 3

The nearest community is at least 1km from the major project facilities, whilst workers will be in close proximity to each noise and vibration source. Standard noise mitigation and best practices will be adopted from the OHSP (Appendix 8.7) to protect workers. With appropriate mitigation measures applied, the significance of the residual effect is Negligible at Saralanj, Ughedzor, Saravan, Gorayk, Kechut and Jermuk. The significance of the residual effect is Minor at Gndevaz.

Seasonal herder camps and the grazing of animals has been noted to take place to the northeast and east of the proposed BRSF. If such camps occur outside of the proposed restricted area around the project site, the magnitude of the noise impact of operational phase will be below IFC EHS Guidelines¹⁹ and is therefore considered to be Negligible.

Potential noise and vibration impacts upon ecological receptors is considered in Section 6.11 Biodiversity.

6.7.11 Blasting Noise and Vibration Prediction

Air Overpressure

The predicted air overpressure from blasting during the operational phase within the open pits at receptors in each community, based on the assumptions outlined in Section 6.7.8, is shown in Table 6.7.17.

Table 6.7.17: Predicted Air Overpressure Level		
Community		Operational Phase Air Overpressure Level (dBL)
Saralanj		109
Ughedzor		108
Saravan		104
Gorayk		109
Gndevaz		99
Kechut		98
Jermuk		94

The predicted air overpressure levels at the nearest villages indicate that all blasts undertaken at the Project will be audible, but only for a very short period after each blast (less than one second). The predicted levels in Table 6.7.17 are all less than the compliance targets set out in Section 2.4.4. In the construction phase, blasting may take place during HLF preparation

¹⁹ Ibid.3

and in borrow pit quarries for short periods during the daytime only. The blasting methodology will be designed to ensure the target criterion of 115dB are met.

Vibration

The predicted ground vibration from blasting during the operational phase within the open pits at receptors in each community, based on the assumptions outlined in Section 6.7.8, can be seen below in Table 6.7.18.

Table 6.7.18: Predicted Vibration Level		
Community		Operational Phase Vibration Level (mms⁻¹)
Saralanj		0.09
Ughedzor		0.08
Saravan		0.05
Gorayk		0.09
Gndevaz		0.02
Kechut		0.02
Jermuk		0.01

The predicted vibration levels at the nearest villages indicate that all blasts undertaken at the Project will not be perceptible. In the construction phase, blasting may take place during HLF preparation and in borrow pit quarries for short periods during the daytime only. The blasting methodology will be designed to ensure the target vibration criterion of 5mms⁻¹ are met.

6.7.12 Blasting Impact Assessment

Potential impacts related to blasting were assessed for air overpressure (this is a transient airborne pressure wave generated during blasting) and vibrations.

Air Overpressure

Air overpressure predictions were carried out in accordance with AS2187-2:2006²⁰. To consider the worst case prediction, the guidance states that in unfavorable meteorological conditions, it is common for air overpressure levels to be increased by up to 20dBL due to the combined effects of an increase with altitude of temperature (an inversion) and/or wind velocity (windshear). Taking account of meteorological conditions, combined with blast design for open pit mining, the air overpressure impact assessment results are presented in Table 6.7.19.

²⁰ Ibid. 2

Table 6.7.19: Air Overpressure Impact Assessment			
Community	Predicted Air Overpressure Level (dBL)	Air Overpressure Criterion (dBL)	Difference
Saralanj	109	115	-6
Ughedzor	108		-7
Saravan	104		-11
Gorayk	109		-6
Gndevaz	99		-16
Kechut	98		-17
Jermuk	94		-21

Air overpressure criteria will be met at all affected communities by at least 6dBL. Air overpressure at any of the community receptors should not exceed 115dBL for 95% of blasts in any calendar year, extending to a maximum limit of 120dBL for the remaining 5% of blasts.

When comparing the predicted air overpressure levels from the blasting operations with AS2187-2:2006²¹, the magnitude of air overpressure impact is considered to be Negligible and not significant.

Standard mitigation and best practices will be adopted from the OHSP (Appendix 8.7) to protect workers. With appropriate mitigation measures applied, the magnitude of the residual impact is considered Low, these will be identified in the OHSP (see Appendix 8.7).

Vibration

Vibration predictions were carried out in accordance with AS2187-2:2006²², which states that the use of a site constant of $K_g = 1,140$, and a site exponent of $B = 1.6$, will provide an estimate of vibration levels in 'average' conditions. In practice, due to variations in ground conditions and other factors, the resulting ground vibration levels can vary from two-fifths to four times that estimated. The vibration impact assessment results for blasting are presented in Table 6.7.20.

Table 6.7.20: Vibration Impact Assessment			
Community	Predicted vibration level (mms^{-1})	Vibration criterion (mms^{-1})	Difference
Saralanj	0.09	5	-4.91
Ughedzor	0.08		-4.92

²¹ Ibid. 2

²² Ibid. 2

Table 6.7.20: Vibration Impact Assessment			
Community	Predicted vibration level (mms ⁻¹)	Vibration criterion (mms ⁻¹)	Difference
Saravan	0.05		-4.95
Gorayk	0.09		-4.91
Gndevaz	0.02		-4.98
Kechut	0.02		-4.98
Jermuk	0.01		-4.99

Vibration criteria will be met at all nearby communities by at least 4.91mms⁻¹.

Ground vibration at any of the community receptors should not exceed a Peak Particle Velocity (PPV) of 5mms⁻¹ for 95% of blasts in any calendar year, extending to a maximum PPV of 10mms⁻¹ for the remaining 5% of blasts.

The predicted vibration levels at the nearest villages indicate that all blasts undertaken at the Project will not be perceptible. Therefore, when comparing the predicted vibration levels from the blasting operations with AS2187-2:2006², the magnitude of impact is considered to be Negligible and not significant.

There is considered to be no potential for blasting activities to impact upon Jermuk spring waters used for bottling, as a study into groundwater sources in the region (see Section 4.8 and Appendix 4.9.1) shows that the source of groundwater which feeds Jermuk Spring is not connected with Amulsar Mountain.

Standard mitigation and best practices will be adopted from the OHSP (Appendix 8.7) to protect workers. With appropriate mitigation measures applied, the magnitude of the residual impact is considered Low and therefore not significant.

6.7.13 Mitigation Measures for Noise and Vibration Impacts

Noise

General mitigation measures applicable to all noise sources which will be implemented to address identified impacts for the design life of the Project are summarized as follows (see also Air Quality, Noise and Vibration Management Plan (AQNVMP, Appendix 8.14)):

Design Mitigation

- Incorporate designed mitigation measures prior to start up, including housing for crushing plant (which should be in place before tests on crushing plant are

- commenced). Soil mounds constructed adjacent to haul roads should be located to provide additional attenuation between the haul trucks and the nearest community;
- Construct closed conveyor from crushing plant to HLF, test and prepare for operational use following commissioning of the crushers, as the use of the conveyor for transportation of crushed rock is a significant noise abatement measure, compared to use of dump trucks on haul routes; and
 - During detailed construction design, consider the use of noise barriers, baffles, or enclosures to provide abatement for noisy equipment such as generators, compressor, pumps, gearboxes; and maintain an adequate distance between the stationary noise sources from nearby communities.

Operational Plant Mitigation

- All mobile plant should undergo regular inspection and maintenance; to ensure that they have designed mufflers are perform to an adequate standard and that worn parts are replaced;
- Schedule noisy construction activities, so that when new activities commence, local communities can be made aware of the activity in advance, through existing stakeholder engagement mechanisms;
- Where practical, noisy construction related activity should be undertaken during the “normal working” daytime period; and
- Maintain the surface of haul roads in good condition and impose a speed limit.

During operations, the following noise abatement best practice measures will be implemented:

- Workers will be trained in noise abatement best practices, including avoiding unnecessary revving of engines and switching off equipment when it is not required;
- Haul routes will be well maintained and where steep gradients are required operatives will be trained to minimize engine noise through avoiding unnecessary revving, etc.;
- Drop height for materials will be minimised;
- Vehicle and plant start-ups will be sequenced to avoid simultaneous noise bursts;
- All vehicles will be fitted with reversing alarms that take account of use and area of activity within the footprint of the Project, such that the requirements for occupational health and safety and environmental noise control are achieved;
- Provide an air inlet silencer and exhaust silencers for stationary combustion engines and other units (for example generators);

- Perform regular inspection and maintenance of material handling vehicles and equipment to ensure that they have quality mufflers installed, worn parts are replaced, and lubricants are applied so that the design noise-output specifications continue to be met;
- When plant equipment has to be replaced, the selected plant will have a sound power level equal to or less than the plant that it is replacing;
- Blast design will include face profiling and explosive packing to maintain high level of environmental performance for each blast;
- Lydian employees and contractors involved in mining and blasting operations will be issued and will wear appropriate hearing protection in high-noise areas. Such areas will be designated by signage in the appropriate language, and employees and contractors will be trained in hearing protection procedures;
- Consultation will be held with herders to ensure they are aware of the presence of the restricted access zone around the BRSF to minimise their noise exposure;
- The static plant located in the crusher and ADR facility processing areas will be housed within a building, and breakout points in the facade of these buildings (i.e. doors, windows etc.) will be minimised, as well as minimising the reverberant noise inside the buildings, which will be controlled through sound absorptive material;
- Complaints related to noise or vibrations related to mining and blasting activities will be monitored through the stakeholder engagement activities and the Project's complaints and grievance process, including the use of drop boxes to encourage comments on performance;
- Noise monitoring will be undertaken in accordance with the AQNVMP (Appendix 8.14) and following any complaints from within the affected community receptors and
- All measured data will be logged and maintained as a record for the site ESMS, which should be available on request and published annually for the duration of the Project.

The following general measures will be implemented to minimize transportation-related noise impacts associated with the Project:

- Enforce speed limits in relation to road conditions and location of sensitive receptors such as local communities;
- Maintain access road surfaces in good repair to reduce tire noise; and
- Ensure continuous traffic flow to avoid prolonged idling.

Blasting

To minimise the impact of the perception of blasting on nearby residents, community engagement publicity will include providing information to the residents in affected communities identifying when blasts are likely to occur (periods during each working day); how long each blasting schedule will last; and how frequently the blasting will take place. The public engagement will commence prior to the construction phase in order to identify where blasting will take place for construction, the periods when these activities will take place over and a schedule of blast frequency and times for each of the activities.

A safe blast radius will be maintained around blasting. All blasts will have an exclusion (or evacuation) zone established prior to firing of the shot. The size of the exclusion zone shall be such that all fly rock and associated debris is contained within the zone, as well as consideration on impacts of blast environmental limits on humans and where required, animals. The size of the exclusion zone is directly related to the blasting activity and the surrounding environment. A 500m restricted area will be established around the pits.

Prior to the start of construction activities, the Project will conduct a crack and damage survey of structures within the defined potential area of influence of blasting and heavy equipment traffic vibrations, to document baseline structural conditions for sensitive receptors. This survey to be conducted by Lydian and independent surveyors commencing in spring 2015. During the early stages of operation, it is good practice to monitor both ground vibration and air overpressure at the nearest sensitive receptors to ensure compliance with the air overpressure and vibration criteria outlined in this assessment. A record of the crack and damage survey and monitoring programme results, together with blast design and mine plan geometry at the time will be maintained. This information will identify suitable monitoring locations and programmes in the event of a complaint at any stage of the operational life of the mine. Should the measured data indicate that the criteria are not being met, the blasting design will be modified to ensure compliance.

All air overpressure and vibration monitoring will be carried out in accordance with the relevant guidance and the AQMVMP (see Appendix 8.14).

6.7.14 Monitoring and Management

The approach to the management of site noise and blasting vibration has been considered in Table 6.7.21.

Table 6.7.21: Noise and Vibration Management Plan

Noise		
Monitoring approach	Baseline	A developing programme of ambient noise monitoring commenced in 2012 in order to establish baseline conditions at key locations within the Project licence area and at local settlements (see Chapter 4).
Level 3 SSPs	<p>The noise assessment detailed in the ESIA will be underpinned by a monitoring plan that will provide specific guidance on monitoring locations and procedures during the construction, operational and closure phases. The level 3 plan will include the following:</p> <ul style="list-style-type: none"> • Suitable Monitoring Equipment – Type 1 Cirrus noise meters with environmental monitoring kits will be used for noise monitoring and suitable maintenance requirements and non-conformance procedures will be identified. Chain of custody documentation. • Noise Monitoring Procedures - The SSP will define the monitoring requirements and periods for the use of the equipment, which will be directed towards areas of the operation where the effectiveness of mitigation measures can be determined. The procedure will ensure that representative data is collected and suitable records retained throughout the duration of the Project and will include details of: <ul style="list-style-type: none"> - suitable monitoring locations; - duration of monitoring to be undertaken at each location for each identified stage of works; - recording of all required noise data including noise level (L_{Aeq}), date, time, weather conditions and any other relevant information; - guideline noise levels; and - action to be undertaken in the event that guideline noise levels are exceeded at identified receptors. • Vibration monitoring procedures – The SSP will define the vibration monitoring requirements and periods for use of the equipment. • Complaints Procedure –The procedure will detail actions to be undertaken in the event that noise specific complaints are received by the operator either directly or through the dedicated liaison mechanisms implemented as part of the project 	
Monitoring strategy	Equipment	Procedure
Noise	Two type 1 Cirrus noise meters with environmental monitoring kits will be retained on site and maintained throughout the duration of the Project.	Noise monitoring will be undertaken at locations considered representative of sensitive receptors closest to the Project periodically through each stage of the proposed Project. Additional monitoring will be undertaken in response to noise complaints at suitable locations.
Vibration	Vibration meters of a suitable standard and level of maintenance will be used as required.	Vibration monitoring will be undertaken in response to vibration complaints at suitable locations.
Note: Noise and vibration have been combined into a single Air Quality, Noise and Vibration Management Plan (see Appendix 8.14)		

The monitoring programme commencing during construction will be augmented with the introduction of a Primary Monitoring Station (PMS) for noise, vibration and air quality located to the west of the livestock and dairy farm, adjacent to the apartment block that has been

acquired by the Project sponsor. Noise levels have been predicted at the PMS, compliance with which will demonstrate compliance at the nearest community of Gndevaz. The monitoring location affords a power supply and therefore the ability to undertake long term noise monitoring. The monitoring location (see Figure 6.7.4), can be accessed from the H-42 and therefore will be included in the community participatory monitoring programme.

6.7.15 Residual Noise and Vibration Impacts

Standard noise mitigation and best practices will be adopted by the Project to protect workers and community receptors. With appropriate mitigation measures applied, the noise levels at each nearby community will be below guideline values. The residual impact is therefore considered minor in the short and long term for both, workers and community receptors.

During the early stages of operation, it is good practice to monitor both ground vibration and air overpressure at the nearest sensitive receptors to ensure compliance with the air overpressure and vibration criteria outlined in this assessment and this will be done in accordance with the AQNVMP (Appendix 8.14).

Noise and vibration impact upon ecological receptors is considered in Section 6.11 Biodiversity.

Additionally, the effectiveness of mitigated noise and vibration activities will be monitored via the Project's complaints and grievances mechanism. The summary of residual impacts has been defined in Table 6.7.22.

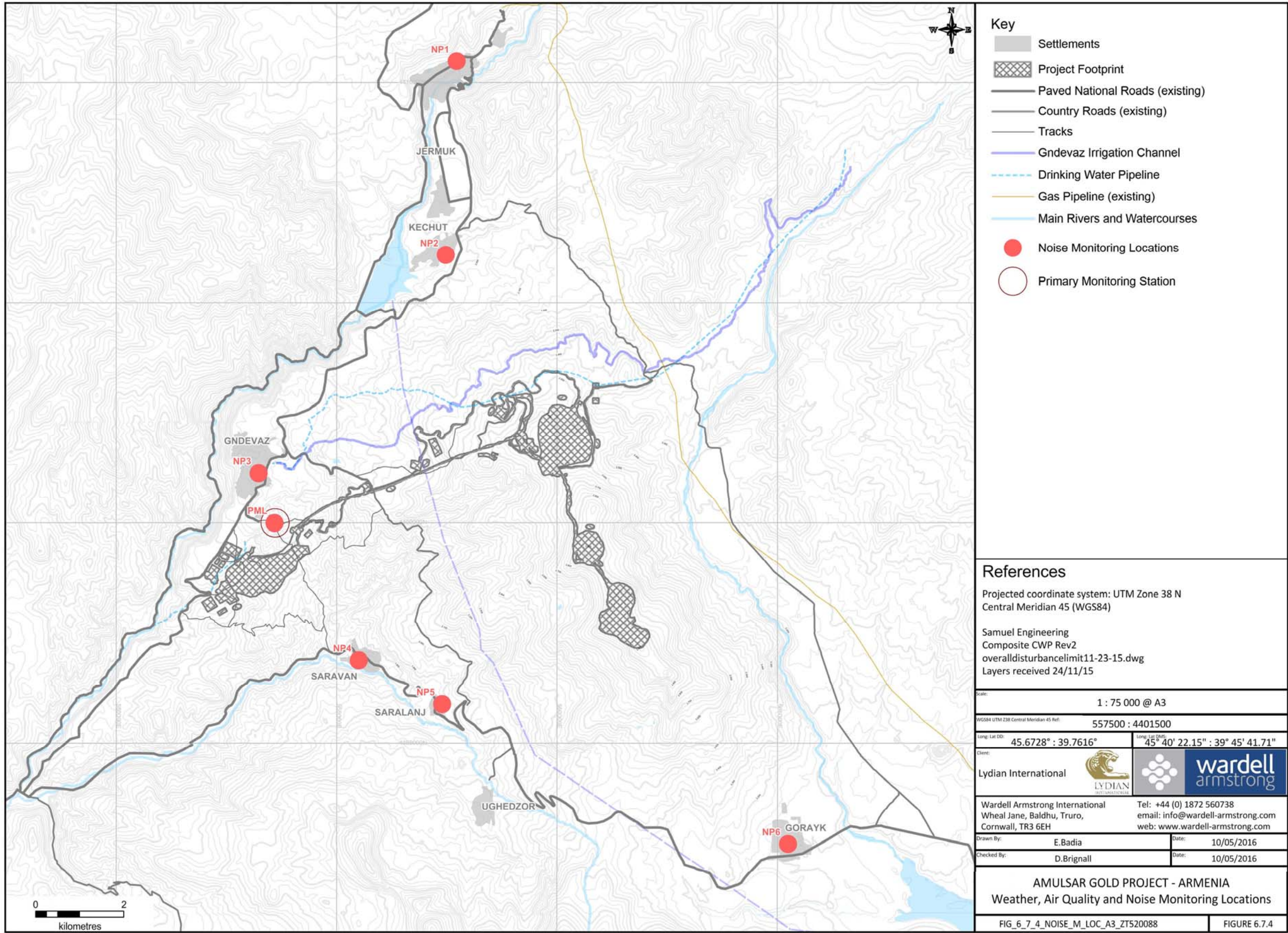


Figure 6.7.4 Noise and vibration monitoring locations

6.7.16 Conclusions

An impact assessment has been undertaken to assess the effects of construction, operation and closure of the Project with regard to noise and vibration sensitive receptors.

The potential impact magnitude of noise and vibration generated by the Project has been assessed at identified sensitive receptors and appropriate mitigation measures defined to ensure that significant noise and vibration impacts do not occur.

To reduce the potential for noise and vibration impacts both at existing receptor locations in the immediate vicinity of the site, and for employees working on the site, standard mitigation measures and best practices will be adopted by the Project to protect workers and community receptors. Additionally, the effectiveness of mitigated noise and vibration activities will be monitored via the Project's grievance mechanism.

With appropriate mitigation measures applied, the residual impact is considered minor to negligible in the short and long term for both workers and community receptors.

Table 6.7.22: Impact Summary - Noise and Vibration

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
Noise	Vehicle Traffic, Heavy Equipment, Mobile Equipment, Supply Traffic, Diesel Generators, Concrete Plant, General Construction Activities	R	X	X	MI	N to MI	<ul style="list-style-type: none"> • Perform regular maintenance and inspection of vehicles and mobile equipment, including mufflers. • Maintain speed limits for heavy equipment and general traffic on all roads, and maintain roads. • Install noise attenuation devices on construction equipment. • Position stationary noise sources away from residents. 	Transport Plan (TP, Appendix 8.10)
							<ul style="list-style-type: none"> • Schedule high noise-generating activities to daytime and/or normal work hours. • Post signage in appropriate languages denoting areas of high noise where hearing protection is mandatory. • Position containers for use as temporary noise barriers when possible. 	AQNVMP (Appendix 8.14)
							<ul style="list-style-type: none"> • Monitor noise-related complaints through the Complaints and Grievances Process. • Engage with herders to ensure they understand the importance of the restricted access zone around the BRSF to minimise their noise exposure 	Stakeholder Engagement Plan (SEP, Appendix 8.6)

Table 6.7.22: Impact Summary - Noise and Vibration

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
Noise	Vehicle Traffic, Heavy Equipment, Mobile Equipment, Supply Traffic, Diesel Generators, Concrete Plant, General Construction Activities	E	X	X	MI	N to MI	<ul style="list-style-type: none"> Use personnel protective equipment where required and occupational medical monitoring. 	Occupational Health and Safety Plan (Appendix 8.7)
	Topsoil / Soil Cover Stripping, Drilling, Blasting, Product Extraction and Stockpiling, Crushing, and Loading Activities	R	X	X	MI	N to MI	<ul style="list-style-type: none"> Perform regular maintenance and inspection of equipment, including lubrication. Perform regular maintenance and inspection of vehicles and mobile equipment, including mufflers. Limit equipment on site - have only the necessary equipment on site. Maintain speed limits for heavy equipment and general traffic on all roads, and maintain roads. Use noise barriers, baffles, or enclosures when possible. Post signage in appropriate languages denoting areas of high noise where hearing protection is mandatory. 	AQNVMP (Appendix 8.14)
							<ul style="list-style-type: none"> Monitor noise-related complaints through the Complaints and Grievances Process. 	SEP (Appendix 8.14)

Table 6.7.22: Impact Summary - Noise and Vibration

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
								8.6)
Noise	Topsoil / Soil Cover Stripping, Drilling, Blasting, Product Extraction and Stockpiling, Crushing, and Loading Activities	E	X	X	MI	N to MI	<ul style="list-style-type: none"> Use personnel protective equipment where required and occupational medical monitoring. 	OHSP (Appendix 8.7)
	Mobile Equipment	R	X	X	N	N To MI	<ul style="list-style-type: none"> Maintain speed limits for heavy equipment and general traffic on all roads, and maintain roads. Perform regular maintenance and inspection of equipment, including lubrication. Consider use of noise barriers, baffles, or enclosures if appropriate . Post signage in appropriate languages denoting areas of high noise where hearing protection is mandatory. 	AQNVMP (Appendix 8.14)
							<ul style="list-style-type: none"> Monitor noise-related complaints through the Complaints and Grievances Process. 	SEP (Appendix 8.6)
	Mobile Equipment	E	X	X	MI	MI	<ul style="list-style-type: none"> Use personnel protective equipment where required and occupational medical monitoring. 	OHSP (Appendix 8.

Table 6.7.22: Impact Summary - Noise and Vibration

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
								7)
Noise	General Project Operations	R		X	N	N	<ul style="list-style-type: none"> Enclose noise-generating equipment in a sound-insulated building. Use exhaust silencers. Perform regular maintenance and inspection of equipment. Post signage in appropriate languages denoting areas of high noise where hearing protection is mandatory. 	AQNVMP (Appendix 8.14)
							<ul style="list-style-type: none"> Monitor noise-related complaints through the Complaints and Grievances Process. 	SEP (Appendix 8.6)
	General Project Operations	E		X	MI	MI	<ul style="list-style-type: none"> Use personnel protective equipment where required and occupational medical monitoring. 	OHSP (Appendix 8.7)
Vibrations	Vehicles, Heavy Equipment	E, R, B	X	X	N	N	<ul style="list-style-type: none"> Enforce speed limits for heavy equipment and general traffic on all roads. Schedule high vibration-generating activities to daytime hours. 	AQNVMP (Appendix 8.14)
	General Project Operations	E, R, B		X	N	N	<ul style="list-style-type: none"> Schedule high vibration-generating activities to daytime hours. Perform regular maintenance and inspection of equipment. 	AQNVMP (Appendix 8.14)
							<ul style="list-style-type: none"> Monitor vibration-related complaints through the Complaints and Grievances Process. 	SEP (Appendix 8.6)

Table 6.7.22: Impact Summary - Noise and Vibration

Table 6.7.22: Impact Summary - Noise and Vibration								
Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
Notes: (1) Primary Receptors: R = residents, E = employees, B = buildings (2) Project Phase: C = Construction, O = Operations (3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, N = Negligible, MI = Minor, M = Moderate, MA = Major, NA = Not Acceptable								

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6.8 Soils and Land Cover

6.8.1 Assessment Criteria

To assess the significance of potential impacts upon soils, the general methodology, as described in Section 6.1, has been used.

Soil and Land Cover

In the absence of specific Armenian guidelines that relate to the loss of soils or the reuse of agricultural land, the following receptors have been selected as sensitive soil resources. These include potential impacts on:

- Soils that are used, or available for use, in agriculture for production of food crops other than grass; and
- Soils that support biodiverse grasslands, and provide a source of nutrition for cattle and sheep, used by seasonal herders during the summer months.

The relevant IFC Performance Standards and EBRD Performance Requirements that relate to soils are set out in Table 6.8.1.

Table 6.8.1: Relevant IFC and EBRD Requirements that Relate to Soils			
	Performance Standard / Requirement		Requirements
IFC	PS1	Assessment and Management of Environmental and Social Risks and Impacts	Assess the risks and potential impacts to environmental resources, such as soil. Potential impacts such as the loss and or deterioration of soil resources are to be considered.
	PS3	Resource Efficiency and Pollution Prevention	Natural resources, including soils, are protected from pollution risks, including contamination from chemicals and fuels, change in state as a consequence of dust deposition, and change in surface water regime or drainage.
	PS6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	Soils that support natural habitats are considered as sensitive, because they form an integral part of the natural resource and their contribution to ecosystems services.
EBRD	PR1	Environmental and Social Appraisal and Management	Consider in an integrated manner the potential environmental impacts, including that of soil, associated with the proposed project. Minimize, mitigate, or offset / compensate for adverse impacts and to identify, and where feasible adopt, opportunities to improve environmental performance.

Table 6.8.1: Relevant IFC and EBRD Requirements that Relate to Soils			
	Performance Standard / Requirement		Requirements
	PR3	Pollution Prevention and Abatement	Technical characteristics of the installation, its geographical location and local / ambient environmental conditions shall be considered to apply pollution prevention and control technologies and practices (techniques) that are best suited to all polluting activities in all economic activities, and from effluents and emissions at the facility level, to a regional and global level where appropriate.
	PR6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	The sustainable use and management of natural resources, in all types of habitats, irrespective of whether they have been disturbed or degraded previously, or whether or not they are protected or subject to management plans. This is to achieve no net loss / net gain of biodiversity in the affected habitat. Soils support these habitats and the ecosystem services they provide, and consequently are to be considered in the same way.

These Performance Standards / Requirements have been considered in determining receptor sensitivity in Table 6.8.2. The sensitivity of each soil association, defined in Chapter 4.7.1, has then been assessed in relation to the main Project components that would result in the disturbance of soil resources during the construction phase of the Project.

Table 6.8.2: Sensitivity of Soils in Terms of Productivity in Relation to Project Infrastructure Components

Table 6.8.2: Sensitivity of Soils in Terms of Productivity in Relation to Project Infrastructure Components											
Soil Association	Project Component										
	Erato	Tigranes-Artavazdes	Primary Crushing Plant	Secondary Crushing Plant	BRSF	HLF, ADR	Haul Roads and Access Roads	Overland Conveyor	Maintenance and Storage	Worker Accommodation Camp	Waterline
Brown forest steppe						HIGH					
Mountain black							MEDIUM			MEDIUM	
Mountain chestnut						HIGH					HIGH
Mountain meadow	MINOR						MINOR				
Mountain meadow steppe				MINOR			MINOR				
River Valley soils						MED-IUM					

Table 6.8.2 identifies that soils of high sensitivity (Brown Forest Steppe and Mountain Chestnut) and medium sensitivity (Mountain Black and River Valley soils) are present within the Project-affected area, and would be adversely affected as a consequence of constructing the HLF, ADR, haul and access roads, overland conveyor and worker accommodation camp. These soils represent those which support versatile agricultural land that would be either temporarily or permanently lost as a consequence of construction and operation. As a result, they are identified to have a medium to high sensitivity as these soils are currently used for agricultural production; a land use that cannot be sustained post-development, following closure of the mine, although the HLF closure would include the reclamation of the HLF and surrounding area to pasture and woodland, the agricultural uses would be limited in comparison to the baseline condition.

Other infrastructure components within the Project affected area (namely the open pits, crushing plants, BRSF, haul and access roads, overland conveyor and maintenance and storage facilities) support soils which are classified as being of minor sensitivity (Mountain Meadow and Mountain Meadow Steppe). These are classified as such due to their lack of agricultural productivity, depth of the resource, and structural integrity. Even though these soils are not agriculturally productive, their weak structure, thin depth and naturally high background concentrations of certain elements have resulted in the diverse grassland habitats considered in Chapter 4.10, and include the support of critical habitats, such as that of *Potentilla porphyrantha* (Chapter 4.10.3). Consequently, sensitivity of these soil types cannot be adequately determined using Table 4.7.3; however, they have been defined as sensitive to disturbance, handling and storage due to the presence of these critical habitats.

6.8.2 Potential Impacts

Physical Loss of Soil Resources

The baseline analysis (Chapter 4.7.7) has identified that the majority of the land that will be subject to disturbance is currently a grassland habitat (68%), and that this is currently utilised for seasonal summer grazing, as well as hay cropping and herb collection at lower elevations (see Chapters 4.7.7 and 4.10). There are five soil associations, identified in the baseline surveys (see Figure 4.7.3), within the Project affected area. These can be distinguished by altitude and underlying parent material. The soil associations identified are ubiquitous both locally, in the Amulsar region, and nationally. The soil associations are:

- Mountain chestnut;
- Brown forest steppe;

- Mountain black;
- Mountain meadow steppe;
- Mountain meadow; and
- River Valley soils

The volume of soil disturbed by soil association has been calculated for the elements of the Project footprint and is shown in Table 6.8.3.

Table 6.8.3: Potential Disturbance by Soil Association, by volume (to nearest 100m³)

Soil Type	Soil Horizon	Tigranes - Artavazdes Open Pit	Erato Open Pit	HLF	BRSF	Haul and Access Roads	Crusher platform	Overland Conveyor + Discharge Structure	Maintenance Workshop	Worker Accommodation Camp	Other	Total TS (m ³)	Total SS (m ³) Total (m ³)
Brown forest steppe soils	TS			146,800		3,600		200		30,000		180,600	
	SS			363,300		7,200		400					
Mountain black soils	TS					170,000		189,500		45,000	48,600	453,100	
	SS					170,000		189,500					
Mountain-chestnut- soils	TS			190,300		3,200		30,700			102	224,300	
	SS			269,400		6,400		30,700			205		
Mountain meadow soils	TS	246,300	93,500			75,400						415,200	
	SS												
Mountain meadow steppe soils	TS				648,200	170,200	22,000		17,600			858,000	
	SS												
River Valley soils	TS			13,600								13,600	
	SS			27,300									27,333

Where possible, natural soils and their profiles would be stockpiled for use in restoration post-closure of the mine. Within the open pits, HLF and BRSF the restoration of the land post-closure would result in a landform not suitable for the reclamation of natural soil profiles, as described in the baseline condition. Therefore, pre-mitigation, the loss of soils which are able to support agricultural production, would result in magnitude of change that is High. The sensitivity of the receptor is Minor to High, depending on soil association and location of Project Infrastructure component (see Table 6.8.4).

Table 6.8.4: Significance of Potential Impact of the Soil Types at Different Project Infrastructure Components within the Project Area as a Result of Soil Loss during Construction Phase				
Project Infrastructure	Soil Type	Sensitivity	Magnitude	Significant
Tigranes-Artavazdes open pit	Mountain Meadow	Minor	High	✓
Erato open pit	Mountain Meadow	Minor		
BRSF	Mountain Meadow Steppe	Minor		
HLF	Brown Forest Steppe	High		
	Mountain Chestnut	High		
	River Valley soils	High		
Haul and Access roads	Brown Forest Steppe	High		
	Mountain Chestnut	High		
	Mountain Black	Medium		
	Mountain Meadow	Minor		
	Mountain Meadow Steppe	Minor		
Crushers	Mountain Meadow	Minor		
	Mountain Meadow Steppe	Minor		
Conveyor	Brown Forest Steppe	High		
	Mountain Chestnut	High		
	Mountain Black	Medium		
	Mountain Meadow Steppe	Minor		
Maintenance area	Mountain Meadow Steppe	Minor		
Worker Accommodation camp	Mountain Black	Medium		
Water pipeline	Mountain Chestnut	High		

A smaller proportion of the Project affected area would be amenable to post-closure restoration to grassland; these areas include the access and haul roads that are not required on a permanent basis, and could be returned to an area suitable for agricultural use in the long term. Consequently, the disturbance of natural soils during construction in the absence of mitigation would be a significant potential impact.

Erosion of Soil Profiles during Construction and Operation

Changes in the natural soil system as a consequence of anthropogenic activities required for the Project development (see Chapter 3 Project Description) can cause destabilisation of

natural soil profiles, and soil structural deterioration. Consequently, there is the potential for increased rates of soil erosion from the outset of the construction phase. This potential adverse impact can cause short term soil loss during soil handling and longer term consequences should areas of soil erosion occur in periods of high rainfall and during snow melt. Therefore, the potential impact may be ongoing during the operational and closure phases of the development, in the absence of mitigation.

Furthermore, the sediment load and consequently the pollutant load transported into receiving waters may increase. The unlikely risk of landslides contributing additional sediment load to surface waters is a potential impact if soils become destabilised due to removal of surface cover and as a consequence of saturation of the profile following periods of high rainfall, or during snow melt (see Section 6.10.2).

Natural soils in this region vary in depth and quality with some more resilient than others. Table 6.8.5 shows the variation in the significance of the impact of erosion on the different soil types. Consequently, the shallower soils present on steep slopes (Mountain Meadow and Mountain Meadow Steppe) within the Project affected area are more at risk from erosion, as both the sensitivity and, therefore, the magnitude to change from the baseline would be greater. Erosion loss could result in a significant increase in the potential area of soils subject to damage and in the longer term increase the area adversely affected compared to the baseline conditions.

Table 6.8.5: Significance of Potential Impact of the Soil Types within the Project Area as a Result of Erosion during Construction Phase			
Soil Type	Sensitivity	Magnitude	Significant
Brown forest steppe soils	Minor	Low	×
Mountain black soils	Minor	Low	×
Mountain-chestnut-soils	Minor	Low	×
River Valley soils	Minor	Low	×
Mountain meadow soils	Medium	Moderate	✓
Mountain meadow steppe soils	Medium	Moderate	✓

Erosion of Soils Post-Closure

Vegetation establishment on bare soil surfaces provides a measure whereby soil surfaces can be stabilised during the operation and post-closure stages. For a period of time post-closure, restored soil surfaces remain bare as there would be little or no vegetation cover. However,

generally once vegetation has established, and subject to the appropriate aftercare, established vegetation would increase resilience against erosion and therefore mitigate the potential impacts of an increase in erosion. The effect of erosion has the potential to increase the visual impact of the Project and would result in soil loss. Soil run-off can reduce flow velocity of watercourses, as a consequence of the deposition of suspended particulates within those watercourses. In the absence of a restoration and aftercare plan post-closure, fragile soils would result in the ongoing loss of structure and water holding capacity and, in consequence, reduce vegetation growth resulting in an ongoing risk of erosion taking place. The Project affected area is subject to a comprehensive Preliminary Mine Reclamation, Closure and Rehabilitation Plan (pMRCRP, Appendix 8.18), and a successful restoration scheme would be a significant benefit for the long term post-closure phase compared to the operational phase.

The sensitivity of the receptor is Medium owing to the fragility of the soils in terms of structure, nutrients, water holding capacity and supporting land use. The magnitude of change, from a future baseline condition (i.e. that of the restored site), would be Moderate in the absence of effective management to reduce erosion and therefore significant in the absence of mitigation.

Erosion from Stockpiled Soils

Soils that have been in storage mounds for up to 12 years, from construction to rehabilitation of the Project, are considered to be sensitive to erosion as they would be fragile and have little or no structure. The potential for erosion increases with exposure, gradient and heavy episodic rainfall events, in the period up to complete ground cover of restored vegetation. The stockpiled soil resource, taking account of the period of storage and the climatic conditions at Amulsar Mountain (see Chapter 4.2.2), is of Medium sensitivity. The magnitude of change from the baseline as a result of the erosion of stockpiled soils is Moderate; erosion of these stockpiled soils can result in poor quality restoration post-closure, and damage / severance of any soil structural quality. Consequently, this would be significant, in the absence of mitigation.

Loss of Soil Structure

Soil Handling during Construction

Soils will be stripped where possible and stored in mounds as per Figure 3.1 for later use in restoration. Appropriate design and maintenance of storage mounds and stripping

mechanisms will be ensured (see Section 6.8.3), especially where stripping of soils particularly valuable to agriculture or biodiversity, as identified in Table 6.8.5, cannot be avoided. Activities such as trafficking over soils, soil handling and storage can lead to a loss of topsoil and the quality of this within the Project affected area if carried out inappropriately. This potential impact would affect the quality of the restoration post-development. This potential adverse impact would be for the duration of the Project's life in most cases, but can also be short-term where soil mounds are not suitably protected. Table 6.8.6 identifies the sensitivity, magnitude and resulting significance of these soils in relation to their handling during the Project.

Table 6.8.6 Significance of Potential Impact of the Soil Types within the Project Area as a Result of Soil Handling			
Soil Type	Sensitivity	Magnitude	Significant
Brown forest steppe soils	Medium	Moderate	✓
Mountain black soils	Medium	Moderate	✓
Mountain-chestnut-soils	Medium	Moderate	✓
River Valley soils	Medium	Moderate	✓
Mountain meadow soils	High	Moderate	✓
Mountain meadow steppe soils	High	Moderate	✓

When this is related to the soil sensitivity scale (Table 4.7.3) the weak, poorly structured and thin fragile Mountain Meadow and Mountain Meadow Steppe soils, which support critical habitats such as that of the *Potentilla porphyrantha* (see Chapter 4.10.3) are also considered sensitive. Therefore, this soil would be handled and stored separately. These critical habitats were found in areas of rocky outcrops, thin, weak, poorly structured soils (see Chapter 4.10.3 and Appendix 4.10.3) with a naturally high background level of As, Co, Cu, Ni, Pb, Sb and V. If stripping and storage is not carried out in an appropriate manner (Section 6.8.3), the soils and their respective seed banks will not be retained for use in restoration of the Project area during closure activities. Consequently, this could result in the permanent loss of the fragile critical habitats which have been identified within the project affected area (Chapter 4.10), and the permanent loss or degradation of the fragile soil eco-systems which support these habitats. Consequently, they are less resilient to change resulting in high sensitivity. The magnitude of the impact would be 'Moderate', due to the degree of change from the baseline and changes to the resource post-development in terms of landform. The impact is therefore considered significant in the absence of mitigation.

Soil Handling during Post-Closure Management

The potential impacts are similar to those considered for construction, and include loss of soil volume and soil structure (as a consequence of compaction) during soil restoration from storage to receptor areas within the Project. Adverse design for soil handling during post-closure would result in reduced quality for the final restoration as it is more difficult for vegetation to successfully establish. Table 6.8.7 identifies the significance of improper soil handling post-closure. Soils identified as more fragile and less resilient (Mountain Meadow and Mountain Meadow Steppe soils) are generally more sensitive resulting in significant potential impacts without mitigation.

Table 6.8.7 Significance of Potential Impact of the Soil Types within the Project Area as a Result of Soil Handling Post-Closure			
Soil Type	Sensitivity	Magnitude	Significant
Brown forest steppe soils	Medium	Moderate	✓
Mountain black soils	Medium	Moderate	✓
Mountain-chestnut-soils	Medium	Moderate	✓
River Valley soils	Medium	Moderate	✓
Mountain meadow soils	High	Moderate	✓
Mountain meadow steppe soils	High	Moderate	✓

Soil Storage

Potential impacts associated with storage of soil includes compaction and loss through erosion and inappropriate storage. The loss of the soil structural integrity also potentially impacts organism activity, water retention capacity and nutrient retention capability. Storage of soils generally takes place during the construction phase, therefore potential impacts are considered to be an adverse short-term impact. Table 6.8.8 identifies that those with shallow soil profiles and fragile structures are more prone to compaction if handled and stored in adverse conditions. The resultant potential impact is significant in the absence of mitigation for Mountain Meadow and Mountain Meadow Steppe soils, and not considered significant elsewhere.

Table 6.8.8 Significance of Potential Impact of the Soil Types within the Project Area as a Result of Storage			
Soil Type	Sensitivity	Magnitude	Significant
Brown forest steppe soils	Minor	Moderate	×
Mountain black soils	Minor	Moderate	×
Mountain-chestnut-soils	Minor	Moderate	×

Table 6.8.8 Significance of Potential Impact of the Soil Types within the Project Area as a Result of Storage

Soil Type	Sensitivity	Magnitude	Significant
River Valley soils	Minor	Moderate	×
Mountain meadow soils	Medium	Moderate	✓
Mountain meadow steppe soils	Medium	Moderate	✓

Contamination of Topsoil

Baseline soils have been identified as having naturally elevated background levels of As, Co, Cu, Pb, Ni, Sb and V (see Chapter 4.7.5). The baseline analysis in Chapter 4.7.5 identifies the Project affected areas that contain soils with naturally elevated background levels. No soil has been identified as contaminated as a consequence of anthropogenic activity.

Mountain soils that exhibit elevated metal concentration (Chapter 4.7.6) are associated with the appropriate habitat conditions for a range of mountain flora, including that of *Potentilla porphyrantha* (see Chapter 4.10.3). Project affected area topsoil will be stripped and stored separately from other soil to enable the reuse, translocation and restoration of similar habitats (see Section 6.8.3).

Soils which become contaminated as a result of construction and operational activities (e.g. oil-staining from machinery / vehicles, saturation from spills, saturation from contaminated waters at the HLF/ARD plant) will be removed and undergo clean-up procedures as required for mitigation (see Section 6.8.3). Further consideration is given to potential sources of contamination in the following sections.

Acid Rock Drainage (ARD)

ARD has the potential to contaminate natural soils adjacent to mining activity including that of the BRSF. ARD can originate from sulphur-bearing surfaces, e.g. rock containing gold ore, having direct contact with exposed surfaces (such as the open pits, BRSF and HLF) and water (see Chapter 4.6.8). ARD can precipitate or leach onto undisturbed soil surfaces, resulting in contamination of the soil profile.

Contaminated soils can potentially impact on soil ecosystems, nutrient cycling, structural stability, and their water retention capacity. This in turn impacts upon the resilience of the soils to change and rehabilitation during the closure phase.

The sensitivity of the soil resource is Medium, as a consequence of the secondary effects of associated with the potential effects from contamination from ARD, and the magnitude of change would be Medium or Major depending on the area of affected soil. In the absence of mitigation, this contamination as a result of ARD is significant. The ARD Management Plan provides the details of the mitigation resulting from this potential effect (see Appendix 8.19).

Deposition of Dust

Activities during construction and operation of the Project can result in mineral dust becoming deposited on the surface of exposed soil in the area surrounding the Project footprint (see Chapter 6.6.4). Particulate deposition can cause both long and short term adverse impacts on soil quality. Short term impacts include the temporary loss of biologic function and nutrient cycling, consequently causing a temporary loss in soil value as normal land use function is potentially reduced. Short term impacts from particulate deposition occur from sporadic events, including the periodic use of machinery, project phasing, and can be exacerbated by events such as seasonal weather patterns.

Long term impacts are those that are detrimental and persist beyond the closure phase. The long term changes in soil chemistry from particulate deposition, can have long term effects on species competition and community structure within natural habitats.

Positive benefits can also result from particulate deposition including soil enhancement; rock dust has effectively been used as a soil amendment in agriculture. Rock dust can increase the structural stability of the soil, through increased water and nutrient retention capability, allowing the soil to support more diverse plant communities and land uses. Furthermore, particulate deposition has been found to improve soil hydrology, buffer acid soils, and increase plant available potassium concentrations in the soil¹.

The sensitivity of the soils *in situ* is low, as the chemical composition derives from weathered rock that will be mined as a consequence of the Project. The magnitude of the impact is low and not significant; however adjacent to dust generating sources such as haul roads, there is the potential for a higher levels of dust fall and the magnitude of the impact would be moderate. A 50m buffer zone has been defined around the footprint of the mine (see Section 6.6) and it is within this zone that dust deposition would be greatest. The potential for

¹ Barrie Oldfield, 1996. *Rock Dust Puts Out More Than You Think*. Sixth International Permaculture Conference & Convergence.

beneficial impacts associated with dust deposition on to the soil would confer to the long term and would be evident following mine closure. The potential for deposition of dust during the life of the Project has been considered in Section 6.6.

Project Infrastructure Impacted Spills and Leaks

Spills from machinery and processing are generally associated with lubricants, engine oils and fuel. These could lead to contamination of soils in stockpiles or those *in situ* and adjacent to operational areas. This potential impact would persist over the short term but can have a long term effect, depending on the extent of the contamination. This could include oil-spills, chemicals used in extraction of the gold.

The sensitivity is considered to be Medium as the soil would be resilient to minor episodes of contamination. The magnitude of the potential impacts is considered to be Moderate depending on the contamination. There is potential for secondary impacts during restoration of the site if soils cannot be cleaned and require removal following contamination. The potential impact is therefore significant, in the absence of mitigation.

Cyanide Contamination

Soil contamination from cyanide would originate from a spill or leak from the HLF, collection ponds, and to a lesser extent the ADR plant during extraction and processing of the gold ore complex. The risk of soil contamination from cyanide is unlikely; however if failure of the cell liners, drainage ditches and geomembrane liners were to occur, or contaminated dust from the heap was released into the air and deposited on the soil surface, the impacts upon the affected area would be adverse in the short term, but in the longer term neutral, as cyanide decomposes by oxidation, via bacteria and UV, releasing nitrogen into the soil.

Consequently, the sensitivity of the resource is High, and the magnitude of change is Moderate, and therefore would be significant in the absence of mitigation measures.

6.8.3 Mitigation Measures

Loss of Soil Resource and Soil Structure

Disturbance of Natural Soils within the Project Footprint

Relevant management plans:

- Footprint Management Plan, FMP (Appendix 8.8); and
- Biodiversity Management Plan, BMP (Appendix 8.21)

Natural soils within the Project footprint include those which are important for agriculture, grassland habitats, and critical habitats, such as that of *Potentilla porphyrantha*. Agriculture and grassland land uses have a cross over due to the potential for grasslands to be used for pasture and hay depending on weather conditions. Due to the varying nature of the soils which support these different land uses, different mitigation measures are intended according to their intended post-closure land use (Table 6.8.9).

Table 6.8.9 Disturbance of Natural Soils within the Project Footprint	
Soil association	Land use
Brown Forest Steppe	Agricultural
	Grassland
Mountain Chestnut	Agricultural
	Grassland
Mountain Black	Agriculture
	Grassland
River Valley soils	Agriculture
	Grassland
Mountain Meadow Steppe	Grassland
	Critical habitats
Mountain Meadow	Grassland
	Critical habitats

Land in agricultural use comprises soils of Brown Forest Steppe, Mountain Chestnut, River Valley soils and Mountain Black (Table 6.8.9). These have been identified as potentially being significantly impacted by the Project if mitigation measures are not implemented (Section 6.8.2) as within the Project affected areas where disturbance of these soils will occur, the land use has the ability to be restored to agriculture following mine closure.

All of the soil associations host grasslands (Table 6.8.9) which are often used for hay and pasture depending on weather conditions (Section 4.7). Consequently, if mitigation measures are not implemented, the potential impact to these soils could be significant thereby impacting on the ability of the landscape to be returned to a similar baseline condition following mine closure.

Mountain Meadow Steppe and Mountain Meadow soils also support critical habitats (Table 6.8.9) such as those of *Potentilla porphyrantha*. Due to these critical habitats the impact of the development on these soils has the potential to be significant in terms of the biodiversity they support. Consequently specific mitigation measures are provided to ensure these habitats are protected either for their translocation, nursery growth or for restoration of the

habitat post-closure (see BMP, Appendix 8.21).

Implementation of the following will reduce the loss of the soil resource generally within the Project affected area (see FMP, Appendix 8.8):

- Height of soil mounds will no greater than 3 m for topsoil removed from within areas of critical habitat. Where topsoil is conserved for general reclamation and rehabilitation and not for specific commercial agricultural or ecological habitats, stockpile mounds will be up to 5 m in height. Where subsoil is present and it is required for restoration and rehabilitation, it will be removed up to a depth of approximately 1m below the base of the topsoil. Subsoil will be stored separately in heaps no greater than 5 m in height from the base.
- Where practical, the soil mounds will be designed and located to provide visual screening;
- Soil will be removed and handled only when sufficiently dry; so as to minimise the impact of compaction during handling and storage
- The separate stripping, handling and storage of topsoil from subsoil movements; and
- Minimising the number of machine movements across topsoil.

Soils supporting critical habitats, such as *Potentilla porphyrantha*, will be removed and stored separately for use in restoration of this habitat post-closure, in order to protect the substrate that supports the Armenian Red Book-listed species. These soils will be identified separately from other soil stockpiles to reduce contamination between different soils. The soils supporting these habitats are naturally elevated in certain elements (Chapter 4.7.5), which has aided the creation of their respective habitats by reducing species competition due to these generally harsher conditions. Consequently the stockpile would include rock and stones which would be removed with the soil. These stockpiles would require protection from erosion during the operational phase and could be used for translocation of *Potentilla porphyrantha* (see Section 6.11), growth of *Potentilla porphyrantha* in nurseries, or for reclamation of the *Potentilla porphyrantha* habitat following closure of the mine using the soil seed bank.

Disturbance of Natural Soils outside the Project Footprint

Mitigation has been identified in the following management plans:

- FMP (Appendix 8.8); and
- pMRCRP (Appendix 8.18).

Construction will result in the disturbance of soils outside the Project footprint. To a practical extent the footprint of temporary facilities, such as construction access roads and laydown areas, will be designed to coincide with longer term project requirements to reduce disturbance and long term impacts to soils. At the end of the construction phase, or when no longer required, the temporary facilities will be reclaimed using stored soils in accordance with the procedures outlined in the pMRCRP (Appendix 8.18). Mine traffic will be restricted to existing roads and access and haul roads to avoid the disturbance of natural soils outside of the Project footprint. This includes the progressive restoration of redundant access tracks, incorporated into the FMP (Appendix 8.8), based on the reinstatement of turf or soils, and the reseeded of areas based on the approach in Table 6.8.10. Likewise, foot traffic will be restricted to existing access roads or paths to the extent practical.

Soil Erosion

Relevant management plans:

- FMP (Appendix 8.8);
- SWMP (Appendix 8.22); and
- pMRCRP (Appendix 8.18).

Potential impacts associated with topsoil erosion will be mitigated by instituting good international industry practice (GIIP) for sediment and erosion control for all Project facilities, including soil storage stockpiles. The Project's pMRCRP (Appendix 8.18) includes the measures required for erosion control, including specific details regarding erosion prevention and sediment control measures that can be utilized at the site, as conditions require. Revegetation of disturbed areas will contribute to long-term mitigation of soil erosion during post closure phase.

Implementation of the following control measures during topsoil stripping and stockpile formation will mitigate the potential for erosion or sediment loading that may arise during soil handling and storage:

- Use of geotextile silt fencing, silt traps, and/or straw bales to reduce sediment transport within the construction site. GIIP will be implemented to avoid overland flow away from the construction area; this will reduce the transport of sediment away from its origin;
- Diversion of "clean" (non-contact) water away from works areas;
- Dust suppression by wetting or application of a dust control agent;

- Grading of the site to channel surface flows into ditches to reduce flow velocities and to decrease the potential for erosion;
- Collection and pumping of runoff to settling facilities, or the treatment of potentially affected water, including water used to decontaminate equipment, and impacted runoff;
- Regular inspection and maintenance of silt control measures;
- Provision of temporary storm water retention capacity;
- Proof-rolling of subgrade or stockpile materials;
- Covering of soil and re-establishment of vegetation on cleared areas not used for construction and establishment of a vegetative cover on topsoil stockpiles; and
- Implementation of the SWMP (Appendix 8.22), to assess impacts of site runoff on receiving surface water bodies and the effectiveness of construction erosion control measures.

Disturbed and stockpiled soils will be managed as follows:

- Where short term disturbance is required for infrastructure development, soils will be stockpiled on a temporary basis with soil returned following completion of construction and the surface revegetated; and
- Where long term disturbance is required (duration of the operational phase), soil will be stored in mounds, where appropriate separating top from subsoil. All soil mounds will be sown with a grass seed mixture appropriate to the storage location and maintained for the duration of the operational phase. The indicative location of the long term soil mounds are shown on Figure 3.1.

The pMRCRP (Appendix 8.18) contains the procedures for the restoration of soils, where practical on a progressive basis, to rehabilitate worked out parts of the site returned to grassland. The cultivation and establishment of natural and semi-natural vegetation will be challenging in the harsh mountain environments, and the extent of local practical experience is limited, as is the availability of suitable soil and plant material. Rehabilitation and restoration of soils and vegetation will therefore require early research and trials to determine the best approaches for ground replacement, creation and amelioration of soil forming materials, vegetation establishment and aftercare (see Section 6.11).

To the extent practical and based on the designs in the pMRCRP (Appendix 8.18), land disturbance will be mitigated during reclamation. Topsoil stockpiled during construction and

properly maintained in the interim will be distributed over re-graded land surfaces to facilitate revegetation. The rehabilitation plan will be implemented as a key element of mine closure, which will include progressive restoration of redundant roads, together with the reinstatement of the land surface and management of disturbed soils as a resource for the restoration of decommissioned areas. Detailed rehabilitation plans will be required for the HLF, crushers, haul roads, and other site infrastructure; these will form a part of the pMRCRP.

Management of Topsoil Stockpiles

Relevant management plans:

- FMP (Appendix 8.8); and
- pMRCRP (Appendix 8.18).

Topsoil stockpiles will be designed and maintained in a manner to retain as much of the stored materials' integrity as possible. Specifically, topsoil from areas of critical habitat will be stored in stockpiles no higher than 3 m in height, to reduce the potential for compaction and physical and biological changes to the soil during storage. The location of topsoil bunds will be located at intervals adjacent to the areas that will have soil removed, during construction (see Figure 3.1). The actual position of storage mounds will take account potential impacts during operation (over-trafficking, contamination with de-icing agents and dust from haul road surfaces), such that the integrity of the topsoil stores are maintained for the duration of the operational phase. Soils that area required principally for the restoration of the BRSF, HLF and other infrastructure that will not be returned for use in commercial agriculture (i.e. primarily used for rehabilitation and revegetation) will be stored in mounds no greater than 5 m in height.

Soil stockpiles will be graded to shed runoff, to the extent practical, and seeded with an appropriate blend of cover plants to maintain soil fertility during storage, and to further decrease the potential for erosion. An appropriate grass seed mixture will be used to stabilise the surface of the mound. The outer slopes of both top and subsoil mounds can be used receptor areas for turves of sub-alpine grasslands, as directed by the Ecological Clerk of Works.

Relevant management plans:

- Emergency Preparedness and Spill Response Plan, EPSRP (Appendix 8.9);
- Cyanide Management Plan, CMP (Appendix 8.11);
- SWMP (Appendix 8.22);
- Acid Rock Drainage Management Plan, ARDMP (Appendix 8.19);
- Air Quality, Noise and Vibration Management Plan, AQNVMP (Appendix 8.14); and
- pMRCRP (Appendix 8.18).

Contamination of Topsoil

Spills and Leaks

The location of topsoil mounds will ensure that the potential for contamination is minimised. The implementation of an EPSRP (Appendix 8.9) mitigates the potential for adverse impacts to soil and water quality in the event of an accidental spill or release during normal construction or operating conditions.

Specialised training and personal protective equipment (PPE) will be provided as necessary to employees working in proximity to cyanide-bearing solutions and in the HLF area. The CMP (Appendix 8.11) contains specific procedures for cyanide handling in accordance with the International Cyanide Code. The Plan also contains procedures for spill avoidance and for spill containment and cleanup.

The ARDMP (Appendix 8.19) mitigates the potential for adverse impacts to soils and water quality in the unlikely event that ARD is released into the environment outside of the ARD plant. The ARDMP (Appendix 8.19) details specific measures to mitigate a release of ARD from the mine, and the clean-up required for soils and water.

Appropriate bunded containment will be required around areas where spills could occur, such as storage tanks, and areas where chemicals, fuels, or lubricants are being handled or used will be underlain by a suitable liner, or paved to prevent any accidental spills from reaching the underlying soils.

Appropriate sorptive materials for the materials stored or in use in a particular area will be provided and kept stocked in an easily accessible location, so that in the event of a spill or accidental discharge, the spill can be contained and cleaned to reduce spread and contamination of adjacent soils.

Down gradient monitoring wells will be regularly sampled to verify that no fugitive solution from the BRSF underdrains or overdrains, and therefore has a potential to contaminate adjacent undisturbed soils.

A leachate detection system will be installed around the periphery/down-gradient of the sanitary landfill. Regular monitoring of the leachate detection system would provide detection of any leachate seepage from the materials disposed of in the facility through the liner system. Any leachate detected by the system will be analysed for chemical composition to determine the magnitude of the potential impact to soil quality and water resources, and to provide a context for assessing subsequent mitigation measures.

Dust Deposition

Relevant management plans:

- AQNVMP (Appendix 8.14)

To reduce dust deposition onto the soil surface, dust suppression measures will be utilised to minimise the impacts as per the measures identified in the AQNVMP (Appendix 8.14). These mitigation measures will be implemented to control dust emissions for mining operations during the construction and operational phase.

Restoration of Soils for Natural Habitat Creation

Relevant management plans:

- pMRCRP (Appendix 8.18); and
- BMP (Appendix 8.21).

Soils supporting natural habitats disturbed by the Project footprint, such as that for *Potentilla porphyrantha*, are to be stripped and stored separately so they can be used for translocation following construction, and restored post-closure. The soil supporting these natural habitats is particularly fragile and would be prone to loss through erosion following disturbance. Implementation of the following measures will ensure that there is enough soil to support the natural habitat restoration, and will compensate for the loss of these soil resources damaged during the Project lifetime:

- Loose rock from the surface of the pit would be stockpiled with soil as it is excavated and removed in advance of developing the open pit;

- Rock-soil mixture will be stockpiled separately for use in *Potentilla porphyrantha* habitat restoration; and
- Re-spreading of rock-soil mixture up to a depth of 0.2m in areas where the final landform promotes soil retention and formation (Chapter 3.15, and Appendix 8.18).

Management of Restored Soils

Relevant management plans:

- pMRCRP (Appendix 8.18).

Following restoration of soils a typical revegetation programme would include:

- Cultivation and levelling of topsoil to produce a suitable surface to establish grassland;
- Arrange collections of large boulders on the surface, where practical using weathered rocks collected prior to disturbance;
- Assessment of soil fertility and chemistry to determine the requirement for fertiliser use;
- Sow appropriate grass seed mixture, selected on the basis of soil type and elevation, at a time prior to the onset of winter snowfall to give sufficient time for grass to germinate and establish; and
- Ongoing aftercare for a minimum period of 5 years.

The details of aftercare management are required by the pMRCRP (see Appendix 8.18).

6.8.4 Monitoring and Audit

As previously identified, the mitigation measures that relate to soil management throughout the life of the Project are addressed in the following management plans:

- Footprint Management Plan (Appendix 8.8);
- Emergency Preparedness Spill Response Plan (Appendix 8.9);
- Cyanide Management Plan (Appendix 8.11);
- Surface Water Management Plan (Appendix 8.22);
- Integrated Waste Management Plan (Appendix 8.13);
- Air Quality Noise Vibration Management Plan (Appendix 8.14);
- Acid Rock Drainage Management Plan (Appendix 8.19);
- Preliminary Mine Reclamation Closure and Rehabilitation Plan (Appendix 8.18); and
- Biodiversity Management Plan (Appendix 8.21).

The effectiveness of the mitigation and management strategy will be subject to ongoing monitoring defined in Standard Operating Procedures (see Table 6.8.10).

Table 6.8.10: Soil Resources, Mitigation and Monitoring		
Soil resources, mitigation and monitoring		
Monitoring approach	Baseline	<p>Physical attributes (structure, pedology and depth) have been determined from published sources and validated through detailed soil surveys undertaken during 2013 and 2014. Five main soil associations have been identified:</p> <p>Mountain black soils: shallow to deep black earths, topsoil depth typically 25 to 300mm.</p> <p>Meadow steppe soils: weakly structured shallow topsoils, on average 150 mm, overlying a shallow subsoil. Typically chestnut brown colour with a sharp transition to underling weathered rock. generally present at elevations above 2400 m to 2600 m(AOD)</p> <p>Mountain Meadow soils: immature, weakly structure, sub-Alpine soils, generally present at elevations 2600 m (AOD). These soils generally have a shallow profile with a topsoil depth typically less than 200 mm. At altitude, there are increasing amounts of bare ground, with little or no soil cover, vegetation established in cracks and hollows in rock.</p> <p>River Valley soils: Deep topsoil approximately 0.3m, generally present at elevations up to 2200 m, comprising a loose textured silts and clay, loamy in places. The soils are fertile and suitable for a range of agricultural activities.</p> <p>Mountain chestnut soils: Topsoil is of a heavy clay-sandy texture, decreasing in clay content with depth, has weak profile development, and depths of approximately 200 mm. They have a moderate topsoil organic matter content (2-6%) and are relatively shallow. They typically lie at elevations between 1500 to 1900 m (AOD).</p> <p>Brown Forest steppe soils: They have a characteristically weak clay-sandy structure with high organic matter levels. They typically occur at elevations between 1600 to 1900 m (AOD). Within each of the soil associations the soil units should be treated separately for the requirements of soil management.</p>
Significant effects		
Loss of soil resources		<ul style="list-style-type: none"> • Mixing of top and subsoil with overburden during handling and storage; • Erosion of soil resource from stockpiles and adjacent to exposed surfaces; • Loss of the resource in areas adjacent to disturbed areas if overland surface flows extend beyond the Project affected area with suspended sediment, resulting in erosion and deposition.
Loss of soil structure		<ul style="list-style-type: none"> • Traffic over <i>insitu</i> soils, resulting in compaction of top and subsoils;

Table 6.8.10: Soil Resources, Mitigation and Monitoring	
	<ul style="list-style-type: none"> • Improper soil storage resulting in slumping and compaction of the soil resource, and the possibility of waterlogging; • Soil compaction and smearing during handling and storage, during periods when the soil profile is waterlogged.
Contamination of topsoil	<ul style="list-style-type: none"> • Dust deposition, resulting in a change in the topsoil chemical composition; • Spills from machinery and processes leading to contamination of soils in stockpiles or those <i>in situ</i> and adjacent to operational areas.
Structure, drainage and erosion during restoration & aftercare	<ul style="list-style-type: none"> • Handling of soils, including compaction, smearing during removal from soil mounds, and replacement during restoration; • Loss of soil during handling and then subsequently by erosion from exposed soil surfaces; • Poor vegetation establishment, with consequential loss of soil structure and water holding capacity and nutrients for plant growth in the early stages of revegetation.
Specific Actions	
Level 2 Management Plans	The Project Execution Plan (PEP) prepared by Lydian will direct the responsibilities of the E-PCM Contractor. The PEP will include all procedures for handling and storage of top and subsoils during the construction phase.
	The pMRCRP (Appendix 8.18) defines the management of soils from the construction phase through to the mine closure plan, so that on reclamation, the soil resource has been maintained to achieve the objectives of the Plan. Performance measures will be included against which monitoring and restoration activities will be measured against to inform when further actions can be stopped.
	The SWMP (Appendix 8.22) defines the management of surface water including the design and maintenance of ditches that control surface water flow around soil storage mounds and prevention of erosion and scour of soil resources. Performance measures will be included against which monitoring and maintenance activities will be measured against to inform when further actions can be stopped.
	The EPSRP (Appendix 8.9) defines the measures that will be taken to manage, control and monitor substances that have the potential to contaminate soil resources. Performance measures will be included against which monitoring and maintenance activities will be measured against to inform when further actions can be stopped.
	The BMP (Appendix 8.21), defines the management of ecosystems from the construction phase through to the post-closure phase, so that restoration of habitats can be effectively achieved. Performance measures will be included against which monitoring and restoration activities will be measured against to inform when further actions can be stopped.
	The AQNVMP (Appendix 8.14) defines the management of construction and operation activities throughout project life to minimise the emissions of dust and noise from vehicles and infrastructure. Performance measures will be included against which monitoring and maintenance activities will be measured against to inform when further actions can be stopped.
	The ARDMP (Appendix 8.19) defines the Project ARD sources and through Predictive modelling provides mitigation and management of these sources during

Table 6.8.10: Soil Resources, Mitigation and Monitoring

	<p>construction and operation activities throughout the project life and post-closure.</p> <p>The CMP (Appendix 8.11) defines the measures that will be taken in order to prevent Cyanide contamination of the environment. It identifies the potential sources, mitigation measures to minimise the likelihood of its transportation into the environment including the design of Project Infrastructure, and management measures for workers, Infrastructure and emergency response in the unlikely event Cyanide is leaked into the environment.</p>
Level 3 SOPs	<p>The level 2 plans will be underpinned by the following SOPs that will provide specific guidance on sampling locations and procedures during the construction, operational and closure phases. The level 3 SOPs will include the following:</p> <ul style="list-style-type: none"> • Meteorological station –Use of meteorological data from the meteorological station for determining soil handling periods, and feedback to site operations, will be covered in the ESMP. • Soil volume survey, to coincide with completion of soil stores, the mounds will be surveyed and identified on all mine plans, together with protection and route of the cut-off drainage ditching. The volume of soil together with the physical characteristics will be recorded for use in the development of the pMRCRP (Appendix 8.18). • Soil revegetation – on completion of topsoil and subsoil restoration, the surface will be sown with an approved low maintenance grass seed mixture. The establishment of vegetation will be surveyed within 1 month of sowing and then annually, to determine whether additional seeding is needed and the requirements for an annual management programme including cutting and control of pernicious weeds. • Soil erosion surveys to be undertaken twice annually, on or before the onset of winter snowfall, to determine areas where additional protection (i.e. use of geotextile) is required and after snow melt, to determine whether the areas affected by erosions and feedback into the SWMP (Appendix 8.22), with regard to surface water management. These will be augmented by continual visual observation during and following precipitation events which will consequently require some training of appropriate individuals. • Soil chemical analysis (operational phase), procedure for the annual collection of natural topsoils adjacent to: <ul style="list-style-type: none"> ○ Open pit ○ Crushing Plant ○ BRSF ○ Water treatment plant, and ○ HLF <p>Procedures for selecting sampling location and collection, together with requirements for containers, reference standards and shipment to accredited laboratory for analysis. Chain of custody documentation.</p> <ul style="list-style-type: none"> • Soil restoration (closure phase), procedures for ensuring that top and subsoils are replaced to the correct depth and altitude, taking account of the baseline conditions. Monitoring of soil physical and nutrient status for the purpose of establishing vegetation on restored areas. • Soil nutrient analysis (aftercare phase), procedures for the annual sampling of soils to determine quality for establishment and growth of vegetation. Analysis to include pH, nitrogen, phosphate and potassium and cation exchange capacity.

Table 6.8.10: Soil Resources, Mitigation and Monitoring

	Procedures for selecting the sampling strategy, duplication, together with requirements for containers, reference standards, and shipment to accredited laboratory for analysis. Chain of custody documentation.						
Soil Monitoring strategy		Strategy	Monitoring				
Removal	Top / subsoil	<p>Prior to removing soils the depth of topsoil will be identified for each working area, so that this horizon can be lifted and stored (in separate stores) with heights no greater than 3m in areas of critical habitat from the base of the stockpile.</p> <p>Where topsoil (to be used in general reclamation and rehabilitation and not for specific commercial agricultural or ecological habitats), stockpile mounds will be up to 5 m in height. Where subsoil is present and it is required for restoration and rehabilitation, it will be removed up to a depth of approximately 1m below the base of the topsoil. Subsoil will be stored separately in heaps no greater than 5 m in height from the base.</p>	<p>The location, height and volume of each storage mound will be surveyed and the details recorded on the mine plan.</p> <p>The monitoring requirements will take place during the construction phase and will be included in the ESMP.</p>				
	Soil units	<p>The primary soil units comprise:</p> <ul style="list-style-type: none">• Brown Forest Steppe• Mountain Chestnut• Mountain Black• River Valley soils• Meadow Steppe• Mountain Meadow	<p>Topsoils from each unit will be recorded by area and soil type, and will be stored, where practical within separate soil stores. Records of the use of the soil in restoration and rehabilitation to be maintained on the pMRCRP (Appendix 8.18).</p>				
Revegetation	Soil Mounds	<p>Within 1 month of completing a soil store and at least 1 month prior to the onset of winter snow fall, top and subsoil storage mounds will be sown to a suitable grass seed mix:</p> <table><tr><th>Species</th><th>%</th></tr><tr><td>Mine site</td><td></td></tr></table>	Species	%	Mine site		<p>All soil mounds to be inspected 1 month after sowing and a record of the success establishment taken.</p> <p>Actions for grass management to be prepared within the ESMP</p>
Species	%						
Mine site							

Table 6.8.10: Soil Resources, Mitigation and Monitoring

		<i>Phleum alpinum</i> 10 <i>Poa alpine</i> 20 <i>Festuca ovina</i> 40 <i>Festuca valesiaca</i> 40 HLF site <i>Festuca valesiaca</i> 40 <i>Phleum pratense</i> 30 <i>Phleum alpinum</i> 30 Sowing rate 20Kg/ha Note: The use of soils from the critical habitats in translocation and for nurseries has been considered in Section 6.11.	
	Reclamation	All restored areas to be sown to a suitable grass seed mix, within 1 month of completing a defined area. Mixtures and application rates for reclamation grass seed mix are identified in the pMRCRP (Appendix 8.18). Sowing should take place at least 1 month prior to the onset of winter snow fall. Where reclamation continues during autumn and winter months, for example within the BRSF progressive closure, the soils and revegetation will take place in the first available growing season following the completion of the reclamation works.	All restored areas sown to grass will be inspected 1 month after sowing and a visual record of the success of establishment taken. The requirements for the restoration and aftercare are to be developed in the pMRCRP (Appendix 8.18), and based on monthly inspections of restored areas during the first 12 months of the aftercare period, and biannually thereafter for a minimum period of 5 years.
Erosion control	Mounds	Following the completion of soil stores, and in the period up to the full vegetation cover of the storage mound, the surface will be at risk from erosion from surface water drainage and wind.	The monitoring requirements will be defined in the ESMP and will include regular inspection of the mound surface and cut-off ditches to determine risk and evidence of erosion.
	Adjacent to working areas	Exposed soil profiles, adjacent to working areas are at risk of incipient and ongoing erosion, in the period up to full vegetation cover.	The monitoring requirements will be defined in the ESMP and will include the regular inspection of exposed surfaces, the excavation slope and associated cut-off drains.
	Reclamation	The exposed soil surfaces on	The monitoring requirements

Table 6.8.10: Soil Resources, Mitigation and Monitoring

		restored areas are susceptible to erosion, and the risk is increased on steep gradients and where large surface areas are completed in a single season. The potential risk of erosion will be reduced through temporary soil drainage, combined with a revegetation strategy, based on establishing a suitable grass seed mix within 1 month of completing a defined area, and at least 1 month prior to the onset of winter snow fall.	will be defined in the pMRCRP (Appendix 8.18) and will include regular inspection of exposed soil surfaces in the period up to full vegetation cover, together with remedial treatment for potential sheet and/or gully erosion. Aftercare requirements for managing the vegetation, for a minimum period of 5 years, will be included in the closure plan.
Soil Chemistry	Contaminants & Dust fall	Undisturbed areas adjacent to the mine working and processing will be sampled for a range of contaminants including: pH, heavy metals, hydrocarbons and other potential contaminants. Monitoring will be ongoing during the operational phase.	Topsoil samples will be collected annually to a depth of 10cm and surface vegetation removed. Bulk samples will be submitted to an accredited laboratory for analysis.
Aftercare	Nutrients	Restored areas will be subject to a minimum of 5 years of aftercare management, in accordance with the pMRCRP (Appendix 8.18) until the vegetation is self-sustaining. Soil nutrient analysis will be undertaken annually to determine the requirements for vegetation management and fertiliser use.	Topsoil samples will be collected to a depth of 10cm using a sampling strategy determined by the size and location of the restored area. The samples will have the surface vegetation removed and bulked to be representative of the land use identified in the pMRCRP (Appendix 8.18). Bulk samples will be submitted to an accredited laboratory for analysis of: pH, and total N, P & K. The data will be used to define aftercare management over the next 12 month period (detailed aftercare as part of pMRCRP (Appendix 8.18)).
	Soil Drainage	Restored areas will be subject to soil drainage survey, dependent on the restoration topography and the intended afteruse. Drainage design will be an output from the	Performance of drainage design will be monitored during snow melt and during the spring months after periods of heavy rainfall. Ditches and surface grips will be recorded on the

Table 6.8.10: Soil Resources, Mitigation and Monitoring

		pMRCRP (Appendix 8.18) and detailed in annual aftercare management reports.	mine restoration plan. The condition and performance of ditches will be recorded and remedial actions will be identified in the aftercare programme, to be maintained for a minimum period of 5 years following restoration, until the vegetation cover is self-sustaining and the drainage integrity of the site is proven.
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6.8.5 Residual Impacts to Soils

Subject to appropriate mitigation, and because the aim of the restoration design is to return those areas suitable for reclamation to be revegetated during closure, residual impacts to soils are considered to be minor and not significant. Net soil loss will result as a consequence of the open pits, HLF and BRSF areas as they will not result in a final landform suitable to support soil profiles, or the pre-mining environment. Therefore the long term change in land use in these areas would be Major and significant because it is irreversible. Reclamation and revegetation measures are oriented towards restoration of pre-mining steppe grassland vegetation to the extent possible.

Loss of Soil Resource and Structure

Mitigation measures that have been identified are accepted industry best practice and will be implemented through the CEMP, when the bulk of soil handling will take place. Notwithstanding the mitigation measures, the significance of the residual effect will be Major for loss of the natural soils within the Project footprint; as they will not be fully recovered following disturbance. The management and monitoring requirements during soil handling and storage have been considered further in Chapter 8 and taking these mitigation measures into account the significance of the residual effect on soil structure is Minor.

Contamination of Topsoil

Mitigation measures that have been identified are accepted industry best practice and will be implemented through the PEP, including the recommendations given in Section 6.9. Procedures defined in the PEP, with respect to pollution prevention have been included in the EPSRP (Appendix 8.9), CMP (Appendix 8.11) and ARDMP (Appendix 8.19) and will continue through the operational phase in the ESMP. The residual effect is minor and not significant.

Management of Restored Soils

Management planning for reclamation and rehabilitation is also accepted as industry best practice and has been identified in the pMRCRP (Appendix 8.18). As all areas restored with soil will be subject to a minimum period of 5 years of active aftercare following closure, the significance of the residual effect is minor and therefore not significant. Comparison of the restored mine post-closure, with that of the operational phase, adherence to the requirements of the pMRCRP (Appendix 8.18), therefore the residual effect, following the appropriate aftercare management, is minor and not significant.

Table 6.8.11 presents a summary of the anticipated soil impacts, relevant operational phase, and planned mitigation measures.

Table 6.8.11: Impact Summary – Soils

Source	Activities	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management / Monitoring Plan
			C	O	ST	LT		
Loss of soil resource								
Loss of natural soils	Construction Activities	L	X		MA to M-	MA to M-	<ul style="list-style-type: none">Clearly delineate footprint of soil disturbance prior to moving top and subsoilsSoil storage defined and marked out in advanceHaul routes between strip and stockpile areas clearly defined	Footprint Management Plan (FMP, Appendix 8.8)
Soil Erosion	Construction Activities; Ongoing soil management	L, SW, GW	X		MA to M-	M	<ul style="list-style-type: none">Use erosion, sediment and drainage control measures to reduce erosion, sediment loading, and surface runoff.Salvage and stockpile as much topsoil as possible during clearing activities, and establish vegetative cover on the stockpiles to reduce erosion.Implementation of appropriate drainage measures (ditches, channels, underdrainage and attenuation ponds) in order to reduce surface water runoff over sloping land, which could lead to detachment of soil particles.Revegetate as much cleared land area as possible after construction.	Emergency Preparedness and Spill Response Plan (EPSRP, Appendix 8.9)

Table 6.8.11: Impact Summary – Soils

Table 6.8.11: Impact Summary – Soils								
Source	Activities	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management / Monitoring Plan
			C	O	ST	LT		
Loss of soil structure during operations								
Handling and storage	Ongoing soil management	L	X		M	M	<ul style="list-style-type: none">• Separate handling and storage of different soils; to include different soil types and that of topsoil and subsoil horizons• Handle during dry conditions• Avoid traffic on soil surfaces• Height of soil mounds no greater than 3 m for topsoil within areas of critical habitat. Where topsoil (to be used in general reclamation and rehabilitation and not for specific commercial agricultural or ecological habitats), stockpile mounds will be up to 5 m in height. Where subsoil is present and it is required for restoration and rehabilitation, it will be removed up to a depth of approximately 1m below the base of the topsoil. Subsoil will be stored separately in heaps no greater than 5 m in height from the base.• Sow surface of soil mound to grass seed mixture	Footprint Management Plan and Mine Reclamation, Closure and Rehabilitaion Plan (FMP, Appendix 8.8 and pMRCRP, Appendix 8.18)

Table 6.8.11: Impact Summary – Soils

Table 6.8.11: Impact Summary – Soils									
Source	Activities	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management / Monitoring Plan	
			C	O	ST	LT			
Contamination of soils									
ARD precipitati on	Construction and operational activities	L, SW, GW	X	X	M-	M	<ul style="list-style-type: none">• ARD prevention measures identified in mitigation for Acid Rock Drainage	Acid Rock Drainage Management Plan, Emergency Preparedness and Spill Response Plan, and Surface Water Management Plan (ARDMP, Appendix 8.19, EPSRP, Appendix 8.9 and SWMP, Appendix 8.22)	
Dust depositio n	Haul road traffic	L		X	M-	N	<ul style="list-style-type: none">• Dust suppression measures identified in mitigation for air quality	Air Quality, Noise and Vibration Management Plan (AQNVMP, Appendix 8.14)	
Soil Chemistry and Quality	Equipment and Vehicle Maintenance Areas; Storage, Loading/	L, SW, GW	X	X	M-	N	<ul style="list-style-type: none">• Follow the EPSRP (Appendix 8.9) and CMP (Appendix	Emergency Preparedness and Spill Response Plan, Cyanide Management Plan, and Footprint Management Plan	

Table 6.8.11: Impact Summary – Soils

Source	Activities	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management / Monitoring Plan
			C	O	ST	LT		
	Unloading, Materials Handling Areas						<p>8.11) for the site.</p> <ul style="list-style-type: none"> • Provide initial and refresher SPCC and Cyanide Management Plan training for all pertinent employees and contractor personnel. • Keep suitable containment and cleanup supplies readily available. • Install under liner or pavement in chemical, fuel, and lubricant storage areas. • Design and install adequately sized bunded areas around bulk liquid and fuel storage areas. • Use personnel protective equipment (PPE) where required and occupational medical monitoring. 	<p>(EPSRP, Appendix 8.9, CMP, Appendix 8.11 and FMP, Appendix 8.8)</p> <p>Environment Policy (Appendix 8.1)</p>
Loss of soil and soil structure during rehabilitation and restoration								

Table 6.8.11: Impact Summary – Soils

Source	Activities	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management / Monitoring Plan
			C	O	ST	LT		
Soils handling and reclamation	Mining Activities	L, SW, GW		X	MA to M-	M-	<ul style="list-style-type: none"> • Use erosion sediment control measures to reduce erosion and sediment loading. • Salvage and stockpile as much topsoil as possible during clearing activities and establish vegetative cover on the stockpiles to reduce erosion. • Revegetate as much cleared land area as possible after construction. • Install a compacted clay liner and underdrain and overdrain systems to collect and channel contact water and seepage from Amulsar Mountain to the BRSF. • Install an impermeable barrier within the sanitary landfill to contain leachate. • Perform reclamation activities according to the established closure plan to the extent practical. 	Footprint Management Plan, Emergency Preparedness and Spill Response Plan, and Mine Reclamation, Closure and Rehabilitation Plan (FMP, Appendix 8.8, EPSRP, Appendix 8.9 and pMRCRP, Appendix 8.18)
Revegetation	Post-closure mining activity	L, SW		X	M-	N	<ul style="list-style-type: none"> • Soil handling programme for restoration • Minimum 5 year aftercare management programme 	Mine Reclamation, Closure and Rehabilitation Plan (pMRCRP, Appendix 8.18)

Table 6.8.11: Impact Summary – Soils

Table 6.8.11: Impact Summary – Soils								
Source	Activities	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management / Monitoring Plan
			C	O	ST	LT		
Notes: (1) Primary Receptors: L = land, SW = surface water, GW = groundwater (2) Project Phase: C = Construction, O = Operations (3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, MA = major, M - = medium, Mi = minor, N = negligible								

6.8.6 Conclusions

Potential Impacts

An impact assessment has been undertaken to assess the effects of construction, operation and closure of the mine with regard to soils and land cover within the Project footprint (see Table 6.8.11).

Short term impacts are those arising as a result of the construction and operation of the Project. These include the loss of the soil resource, deterioration of soil structure, and contamination of topsoils. The first two potential impacts are generally related to the construction phase of the Project; whilst the third can be associated with both construction and operational phases (and to a lesser extent during rehabilitation).

Long term impacts are those which are persistent following the post-closure phase of the Project. The fourth potential impact associated with soils is the long term use of soil for rehabilitation. This is an important aspect that dictates the success of post-closure revegetation establishment and habitat creation as the quality of the restored soil, in relation to its profile and its structural integrity, can be adversely implicated if mitigation measures are not put in place. This in turn can lead to long-term soil loss.

Mitigation Measures

Soil management during the construction and operational phases is the primary mitigation measure for the protection and conservation of the soil resource. Appropriate soil management takes into account the sensitivity of each soil association identified within the Project affected area. Mitigation measures minimise the effects that construction on the soil resource creates. These include industry standard soil management techniques, such as clearly delineating areas of soil strip, handling and storage of soils in appropriate weather conditions, limiting the area and height of soil storage mounds and revegetation of soil mounds. The residual effects that relate to loss of the natural soil ecosystem are Major and cannot readily be replaced following disturbance. The residual effects in term of soil use for rehabilitation of land following mine closure is considered to be minor, subject to the requirements of the pMRCRP (see Appendix 8.18).

All soils have had their chemical composition analysed and are found to have naturally elevated metal concentrations. These will be conserved for use in translocation and

restoration of specific habitats, in particular those soils required for *Potentilla porphyrantha* restoration (see Section 6.11, BMP Appendix 8.21, and pMRCRP Appendix 8.18).

During the operational phase the management of chemicals and fuels used for mining and processing have been specified in management planning which are considered standard industry practice for mining operations. For example the CMP for the use of cyanide, the EPSRP in case of leaks and spills, the IWMP in the case of mercury, and the ARDMP in the case of ARD. The construction and use of these industry standard management plans minimise the effects on the soil resource to minor and therefore they are not considered to be significant.

Furthermore impacts to the soil resource are minimised through the specification of appropriate handling, storage and the reinstatement of these soils. These should focus on the handling of soils from stockpiles to receptor areas under rehabilitation, followed by a programme of revegetation, drainage control and long term maintenance and management. This would accord with the objective of the mine closure plan, and therefore impacts to soils arising as a result of the improper handling, storage and reinstatement of these soils are minimised and the impacts therefore reduced to minor and insignificant.

Summary

There are five soil associations present within the Project affected area. The nature of the soils that would be disturbed by the mine construction and operation depend on the height, slope, aspect and climate conditions. Sensitive soils have been considered as those that support agricultural and horticultural uses. Those that are considered sensitive in relation to biodiverse ecosystems, and rare and endangered species, are considered in Section 6.11.

Potential impacts on soil resources include the:

- Loss of the soil resource during removal and as a result of storage;
- Reduction of the soil structure that is important for plant growth and to sustain agricultural productivity;
- Contamination of soils through mixing during removal, storage and restoration, or spillage of chemicals (including oils) that would harm the potential for plant growth both in storage and later for use in restoration; and

- Strategy for long term use of the soil resource post closure to support the restoration plans for the development.

The development would result in the permanent loss of soils from the open pits together with a change of land use when soils are replaced to restore the closed BRSF and HLF. However, a detailed soil management plan would aim to achieve no net loss of the soil resource required for rehabilitation post-closure, as a consequence of the development. In addition different soil types as well as topsoil and subsoil will be removed and stored separately to allow for the design of detailed closure plans for within the Project affected areas (pMRCRP Appendix 8.18).

Management of soils would commence prior to construction so that the area disturbed during construction and operation can be minimised. In addition, rehabilitation and restoration can be completed on a progressive basis during the life of the Project.

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6.9 Groundwater Resources

6.9.1 Introduction

An assessment of the potential impacts to groundwater as a result of the Amulsar Project has been undertaken and is discussed in the following sections. The potential impacts on the various groundwater receptors are discussed and mitigation measures presented to avoid or limit adverse effects.

The impact assessment addresses the following Project facilities that may impact groundwater:

- The Tigranes-Artavazdes and Erato open pits. The Tigranes-Artavazdes pit will be backfilled during the later years of operation leaving a small southerly pit partially unbackfilled. The Erato pit will be partially backfilled at closure;
- The Barren Rock Storage Facility (BRSF);
- The Heap Leach Facility (HLF) and associated adsorption-desorption recovery (ADR) plant; and
- Additional supporting infrastructure including water storage ponds, water treatment systems, crushers, haul roads, material stockpiles, conveyor and mine buildings.

Each of these facilities has design engineering and operational measures to control the potential discharge of water during each phase of the mine life. The engineering controls incorporated into the facility designs, and which are included in this assessment, are described in Section 6.9.5.

Management of water through the mine life cycle is described in the water management plan. The objectives of the water management plan are:

- To route mine contact runoff water to ponds and collection sumps in order to minimise the release of mobilised 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 the mine facilities, use in process operations (if possible) and if necessary treat and discharge if the water cannot be used; and
- To minimise erosion of disturbed areas, and when erosion does occur, to minimise suspended sediment flow to streams.

During construction, the water management plan focusses on management of surface water runoff and sediment control; potentially impacted surface water will be routed to sediment ponds prior to discharge to surface water.

During operations, runoff from haul roads, conveyor, crushers and truck stop areas will be routed to sediment ponds, and treated if required, prior to discharge to surface water. Runoff, and any discharge from the BRSF will be routed to a pond located downstream of the facility. Some of this water will be used for dust suppression while the majority will be piped to the HLF for use in the leaching process.

Water from the pits will be routed via in-pit sediment ponds and will then be combined with the water from the BRSF pond in a contact water pond at the HLF. The water in the contact water pond will be used to supply make-up water to the HLF during operation or treated to meet environmental standards and discharged to land application or the lower Arpa catchment below the Kechut reservoir. Make-up water for the HLF will be sourced from the Arpa River when required.

A passive water treatment systems (PTS) installed downstream of the of the contact water ponds and the second PTS after HLF closure will be used to treat water for discharge during operations, and to manage the discharge of residual waters from the BRSF (after year 4 of operation and post closure) and the HLF underdrain also post-closure. The water will be treated to meet environmental standards (RA Category II MACs for the Arpa River) and then discharged land application or to the Arpa. Water entering the open pit backfill post-closure will infiltrate to ground.

There will be three major water storages available to manage water in the Project area:

- The raw water pond (volume 20,450 m³), which will receive runoff (non-contact water) from the haul and access roads, and conveyor corridor;
- The HLF contact water pond (maximum volume approximately 1,280,000 m³), which will receive discharge from the BRSF Toe Pond and water from the pit sumps and truck shop storage pond; ; and
- Three storm ponds (maximum total volume approximately 630,000m³) downstream of the HLF, which will be used for active storage of process water during operations and also contain storm storage capacity.

6.9.2 Assessment Scope

Technical Scope

The groundwater assessment relates to evaluation of impacts on groundwater resources. For the purposes of this report, groundwater is defined as all water that is below ground. On this basis, springs, perched water and regional groundwater will be considered as groundwater in this assessment.

Where groundwater is a key sustaining input to other resources (i.e. surface water, or aquatic or terrestrial habitats), the secondary impacts are addressed in the relevant chapters.

Geographical Scope

The groundwater Study Area is identified on Figure 6.9.1. This area forms the basis for the geographical area covered by the groundwater impact assessment.

Temporal Scope

The groundwater assessment considers the potential impacts to groundwater receptors during the following mine life stages:

- Construction (Pre-Operational) Phase;
- Operational Phase; and
- Closure and post closure.

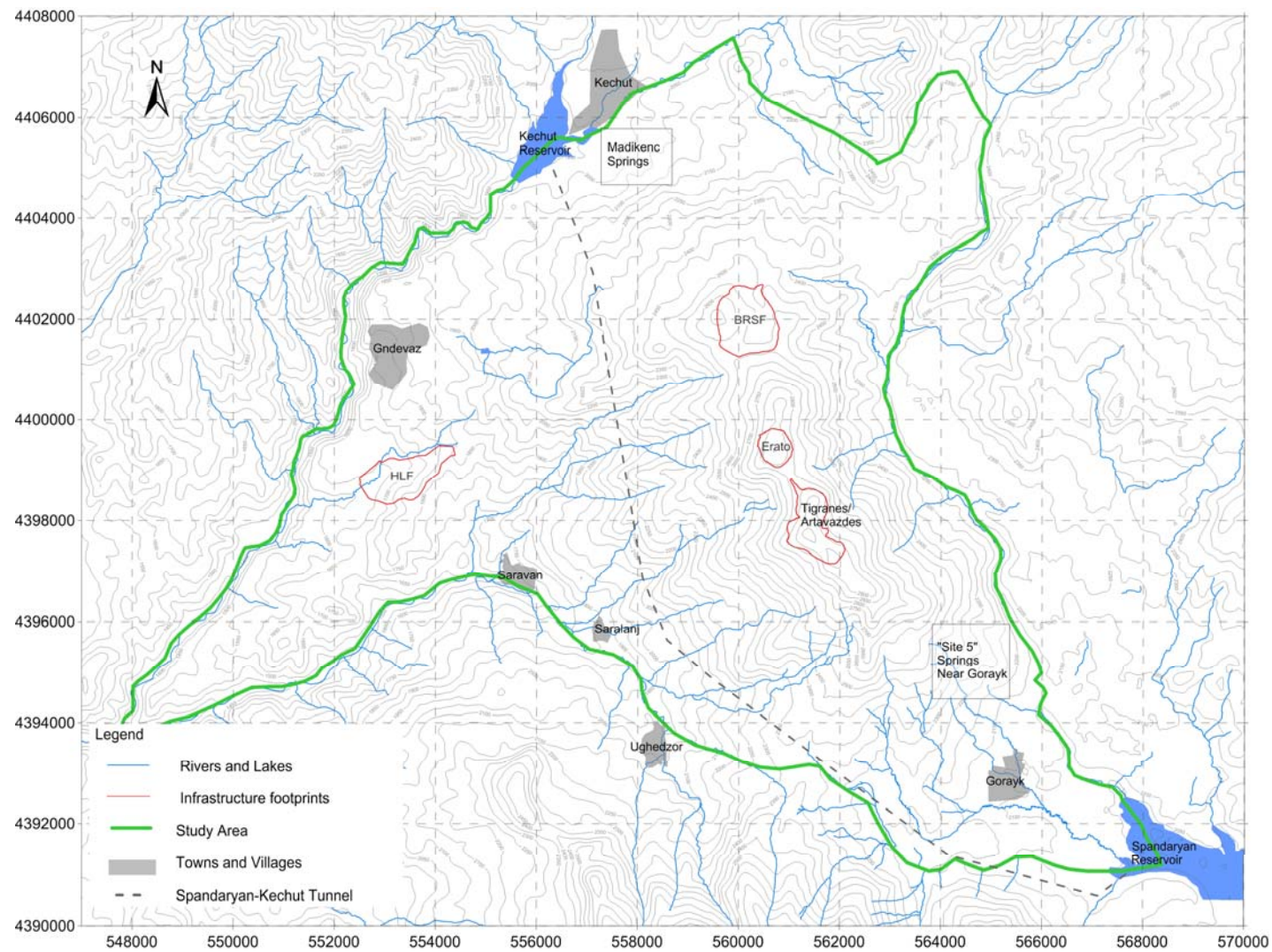


Figure 6.9.1: Groundwater Study Area

6.9.3 Impact Assessment Methodology

The general environmental impact assessment methodology is presented in Chapter 6.1. The methodology has been followed in order to complete the groundwater impact assessment.

Table 6.1.1 (Chapter 6.1) presents the general description of receptor sensitivity. For the purposes of the groundwater assessment the abundance, scale, resilience to change and potential for substitution of each receptor has been considered individually in order to determine the sensitivity of that receptor. Details of this process, and the results, are presented in Section 6.9.4.

Once the receptors and their sensitivity have been identified, the baseline groundwater conditions (Chapter 4.8) and project description (Chapter 3) are considered in order to determine if there is any potential impact to the groundwater receptor. The magnitude of any change to groundwater as a result of the impact is determined using the general method presented in Table 6.1.2 (Chapter 6.1). For the purposes of the groundwater assessment, specific degrees of change have been defined for each of the categories as presented in Table 6.9.1.

There are no national groundwater or drinking water quality standards in the Republic of Armenia against which to qualify changes in groundwater quality. The Project Assessment Criteria are MAC II Standards that apply to surface water. In the absence of groundwater quality standards, these MAC II Standards have been used for information purposes only for groundwater. This is considered appropriate as a preliminary assessment tool because groundwater ultimately discharges to surface water. However, any significant effects that result from assessment using these criteria should be used with caution. Surface water and the ecology that is supported by it are more relevant receptors than the change in groundwater quality. Therefore, the end receptors of the predicted change in groundwater quality are surface water and ecology. The sensitivity of the surface water and ecology receptors, the significance of the change in groundwater quality on these, and any relevant mitigation measures are considered in Chapters 6.10 and 6.11, respectively.

Table 6.9.1: Magnitude of Change Scale (Groundwater)			
	Magnitude of change	Description of Change	
		Quality	Quantity
1	Negligible	No measurable changes from baseline conditions. Direct control is not required to manage potential impact.	No measureable changes from baseline conditions. Direct control is not required to manage potential impact.
2	Low	Measureable change to the baseline conditions. Where quality standards were not exceeded at the baseline, concentrations have measurably increased, but remain below the quality standards. If quality standards were exceeded at the baseline, the predicted concentration is less than 20 % over the baseline and change is temporary. During construction, operations or closure there would be ongoing change in the underlying characteristics or quality of the baseline conditions.	Detectable change to the baseline conditions or resource. Permanent or temporary changes are less than 10% of flow under baseline conditions.
3	Moderate	Degree of change is such that adverse alteration to baseline conditions would occur. Predictions indicate a change in groundwater quality from below the environmental standard at baseline to above the environmental standard as a result of development. The environmental standard is exceeded by up to 100 %. Changes are not permanent and improvement will occur over time in post-closure.	Degree of change is such that loss of, or adverse alteration to, the baseline conditions would occur. A permanent alteration in flow of less than 20% from baseline conditions is predicted, or a temporary change of less the 50% of baseline conditions.
4	High	Degree of change is such that adverse alteration to baseline conditions would occur. Predictions indicate a change in groundwater quality from below the environmental standard at baseline to above the environmental standard as a result of development. The environmental standard is exceeded by over 100 %. Post-development quality would be fundamentally and irreversibly changed.	Degree of change is such that total loss of, or adverse alteration to, the baseline conditions of a specific resource would occur. Development is predicted to result in a permanent change of more than 20% from baseline conditions, or a temporary change of more than 50% from baseline conditions.

As well as the magnitude of change to groundwater, the direction (positive or adverse) and duration of the impact are also presented. It should be noted that this initial potential impact

assessment takes into account mitigation measures incorporated into the design presented in Section 6.9.5.

The matrix presented in Table 6.1.3 (Chapter 6.1) is then used to determine the significance of the impact, and Table 6.1.4 (Chapter 6.1) is used to determine whether the effect of the impact is significant.

For any significant effects, additional (i.e. non-design) mitigation measures are presented and the residual impact and effect is then evaluated using the process outlined above.

6.9.4 Identification of Key Groundwater Receptors

Groundwater Receptors

This assessment considers impacts on groundwater resources only. Groundwater users in the Project area are described in the groundwater baseline (Chapter 4.8). Based on this information, and the conceptual understanding of the hydrologic environment, the key groundwater receptors are grouped as follows:

- Ephemeral springs that support surface water flow and ecology;
- Perennial springs that support surface water flow and ecology;
- Perennial springs in Jermuk that are used for therapeutic/recreational use and for water supply;
- Groundwater used for drinking water supply and irrigation; and
- Groundwater that supports surface water baseflow.

Only two community water supply springs (or group of springs) are within the Project area: the Madikenc springs that are located near to Kechut Reservoir (see Figure 6.9.2) and are used to supply domestic water to Kechut; and the springs north of Gorayk (see Figure 6.9.2) used by seasonal herders between May and October. These will be considered as the community drinking water spring receptors in this assessment.

There are no communities or individuals using wells for domestic water supply within the Project area. Therefore, groundwater wells are not considered to be a receptor in this assessment.

Receptor Sensitivity

The five groups of individual receptors are presented in Table 6.9.2. This table presents an assessment of receptor distribution, geographical importance (scale), resilience to change and potential for substitution. These elements have been combined to determine the sensitivity of each receptor.

Table 6.1.1 (Chapter 6.1) has been referred to when assigning receptor sensitivity. As groundwater resource is the receptor being considered, the greatest weighting in the determination of sensitivity has been assigned to the geographical importance of the resource (i.e. what water users over what area rely on the groundwater). The resilience to change and the potential for substitution are considered to have the next level of weighting in the determination of receptor sensitivity.

The determination of sensitivity considers groundwater resource alone as the receptor, not the sensitivity of any dependent hydrological or ecological features. The associated hydrological and ecological receptors that may be sensitive to changes in groundwater quantity or quality are addressed in Chapters 6.10 (Surface Water) and 6.11 (Biodiversity).

Table 6.9.2: Receptor Sensitivity (Groundwater)

Receptor	Area	Location	Distribution	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
Perched Water/ Ephemeral Springs	Pit areas of Amulsar Peak	Amulsar Peak - Elevation Band 2500 to 2900 m (excluding BRSF area)	Between 12 and 25 snowmelt-driven springs that flow seasonally - originate in nearly all headwater drainages on all slopes. Localised	Perched springs are localised in the elevation band surrounding Amulsar Mountain. They are of local importance as they provide flow to local surface watercourses.	Perched springs have small headwater catchments (less than a sq. km). Susceptible to relatively small changes within their catchment particularly at low flows.	Perched springs cannot be substituted.	Medium
	BRSF and Surrounding Area	Headwater tributary to Vorotan River and Arpa River. Found primarily below BRSF footprint	At least 11 snowmelt-driven springs that flow seasonally are located beneath the BRSF. There are at least six ephemeral springs located in the valley to the west of the BRSF. Localised	Local , relatively small volume, input to Vorotan and Arpa rivers.	Perched springs have small headwater catchments (less than a sq. km). Susceptible to relatively small changes within their catchment particularly at low flows.	Perched springs cannot be substituted.	Medium

Table 6.9.2: Receptor Sensitivity (Groundwater)

Receptor	Area	Location	Distribution	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
	HLF and Surrounding Area	Headwater tributary to Arpa River	One ephemeral spring located within the footprint and four in the surrounding area. Localised	Local , relatively small volume, input to Arpa River.	Perched springs have small headwater catchments (less than a sq. km). Susceptible to relatively small changes within their catchment particularly at low flows.	Perched springs cannot be substituted.	Medium
Perennial Springs	Pit areas of Amulsar Peak	Amulsar Peak - Elevation Band 2500 to 2900 m (excluding BRSF area)	At least 5, and possibly up to 17, springs could flow year-round mapped on Amulsar Mountain. Localised	Year-round springs are localized to the mid-elevation range on Amulsar Mountain. They are of local importance as they provide flow to local surface watercourses.	Springs have larger catchments than perched springs. Sustained by year-round groundwater discharge from low permeability rocks thus reasonably resilient to changes in their catchment.	Springs cannot be substituted.	Minor

Table 6.9.2: Receptor Sensitivity (Groundwater)

Receptor	Area	Location	Distribution	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
	BRSF and Surrounding Area	Headwater tributary to Vorotan River and Arpa River. Found primarily below BRSF footprint	Two flowing springs are present all year round within the BRSF footprint area. One flowing spring (SP68) located in the valley to the west of the BRSF. Localised	Local , relatively small volume, input to Vorotan and Arpa rivers.	Springs have larger catchments than perched springs. Sustained by year-round groundwater discharge from low permeability rocks thus reasonably resilient to changes in their catchment.	Springs cannot be substituted	Minor
	HLF and Surrounding Area	Headwater tributary to Arpa River	No perennial flowing springs in HLF footprint. Four areas of ground that are wet all year around identified in the immediate surrounding area (within 250 m). Localised	Local , relatively small volume, input to Arpa River.	Springs have larger catchments than perched springs. Sustained by year-round groundwater discharge from low permeability rocks thus reasonably resilient to changes in their catchment.	Springs cannot be substituted	Minor

Table 6.9.2: Receptor Sensitivity (Groundwater)

Receptor	Area	Location	Distribution	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
Hydrothermal Springs	Jermuk	Jermuk - used for recreational/medical purposes, and water supply	Selected springs used. Localised	National importance (commercial and tourism)	Springs feed by deep regional large-scale thermal groundwater system that is not connected to the Project area - thus resilient to changes in the Project area	Springs cannot be substituted	High
Groundwater Used for Water Supply Purposes	Kechut/Madikenc Springs	Madikenc springs approximately 2 km E of Kechut. Supply to Kechut	Madikenc group of springs only. Localised	Local importance for village water supply	Springs sourced from groundwater within the Cenozoic Basalt Flows. Will to be sensitive to changes in recharge within their catchment area.	Alternative supplies could be sourced, but must be a practical supply to Kechut	Medium
	Springs North of Gorayk	Springs used by seasonal herders	Small group of springs only. Most springs in the area are ephemeral. Very few are perennial. Localised	Local importance as seasonal water supply	Springs sourced from groundwater. Will to be sensitive to changes in recharge from surface within their catchment area.	Alternative supplies could be sourced or herders could locate to more preferable areas	Minor

Table 6.9.2: Receptor Sensitivity (Groundwater)

Receptor	Area	Location	Distribution	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
	Spandaryan-Kechut Tunnel	21.7 km tunnel located between the Spandaryan Reservoir and the Kechut Reservoir	Long linear feature influencing groundwater in the area to the west of the Amulsar Ridge. Local to the Project area.	National importance (drinking water distribution to Kechut Reservoir and Lake Sevan)	Supply comes from Spandaryan Reservoir. No dependence on groundwater inflow to sustain supply. Flow in the tunnel is large so it is resilient to localised changes in groundwater flow and quality that may reach the tunnel.	Tunnel could be modified to prevent groundwater inflow	High
Groundwater Component of Surface Water Baseflow	Darb River catchment	Baseflow from the southern and western Project areas feed lower elevation tributaries and baseflow in the Darb river	Groundwater baseflow discharge derived from groundwater recharge within the Project area. Discharge occurs along large reaches of river. Regionally extensive.	Baseflow contribution from the Project area is small in relation to the baseflow feeding the major rivers upstream of the Project area. Baseflow from within the Project Area is of regional importance.	The major rivers have large catchments, much of which are located upgradient of and outside the Project area, and are therefore resilient to changes in baseflow within the Project area.	Groundwater baseflow cannot be substituted	Medium

Table 6.9.2: Receptor Sensitivity (Groundwater)

Receptor	Area	Location	Distribution	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
	Arpa River Catchment	Baseflow from the northern and western Project areas feed lower elevation tributaries and baseflow in the Arpa river	Groundwater baseflow discharge derived from groundwater recharge within the Project area. Discharge occurs along large reaches of river. Regionally extensive.	Baseflow contribution from the Project area is small in relation to the baseflow feeding the major rivers upstream of the Project area. Baseflow from within the Project area is of regional importance.	The major rivers have large catchments, much of which are located upgradient and outside the Project area, and are therefore resilient to changes in baseflow within the Project area.	Groundwater baseflow cannot be substituted	Medium
	Vorotan River Catchment	Baseflow from the eastern Project areas feed lower elevation tributaries and baseflow in the Vorotan river	Groundwater baseflow discharge derived from groundwater recharge within the Project area. Discharge occurs along large reaches of river. Regionally extensive.	Baseflow contribution from the Project area is small in relation to the baseflow feeding the major rivers upstream of the Project area. Baseflow from within the Project area is of regional importance.	The major rivers have large catchments, much of which are located upgradient and outside the Project area, and are therefore resilient to changes in baseflow within the Project area.	Groundwater baseflow cannot be substituted	Medium

Based on the assessment of receptor sensitivity, the ephemeral springs have been assigned a medium sensitivity as, although they are local to the project and are of local importance, they are susceptible to changes in their catchments and cannot be substituted.

The perennial springs are similar to the ephemeral springs in their distribution and geographic importance. They cannot be substituted, but are supplied by larger groundwater catchments so are not as sensitive to changes in their catchments. On this basis, the perennial springs have been assigned minor sensitivity.

The hydrothermal springs in Jermuk are locally distributed and because they are fed from deep groundwater (as evidenced by their warm temperature) will be resilient to changes in the Project area, but are of national importance and cannot be substituted. On this basis, they have been assigned a high sensitivity.

The community water supplies to Kechut are of local importance, and the sources are currently restricted to two springs (the Madikenc springs) so are likely to be sensitive to any changes that might affect those two springs. An alternative supply may be restricted in location so that it would be practical and cost-effective for the village to source, transport and use; therefore, these springs have been assigned a medium sensitivity.

In contrast, the springs used by herders have been assigned a minor sensitivity. Although they are also of local importance and likely to be sensitive to changes in their catchment areas, the water users report (Gone Native, 2013¹) indicates that the springs used are not the herders' only options and they would be more flexible in their source of an alternative supply than the village.

The Spandaryan-Kechut Tunnel has been included in this assessment because it links the Spandaryan Reservoir and the Kechut Reservoir, which in turn supplies water to Lake Sevan. The main source of water in this tunnel is planned to be surface water from the Spandaryan Reservoir. However, while there is no current inflow to the tunnel from the Spandaryan Reservoir, there is some outflow from the tunnel that appears to be groundwater. Groundwater modelling suggests that groundwater from the Project area may enter the tunnel. Groundwater is not the main source of the water supply for the Spandaryan-Kechut Tunnel so there is no concern over the need for substitution. However, because groundwater

¹ Gone Native LLC (2013) Summary Report: Springs and Water Users Study
ZT520088
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currently enters the tunnel and the tunnel discharges to the Kechut Reservoir, and the supply is of national importance, this receptor has been assigned a high sensitivity.

Groundwater that supports surface water baseflow is assigned a medium sensitivity, largely based on its regional importance as an input to surface water. The surface water receptor sensitivity and the assessment of effects on the surface water receptors are presented separately in the surface water impact assessment chapter (Chapter 6.10).

6.9.5 Design and Management Mitigation

The design of the Project is presented in Chapter 3. The mitigation measures that are implemented in the Project design and evaluated in the impact assessment are described below.

Pits

Water in the open pits which has contacted the pit walls has the potential to be impacted both by acid rock drainage and by ammonium and nitrate from the residue of ammonium nitrate-based explosives. During operation water in the pits will be managed to minimise infiltration to ground by pumping water to the contact water management system. For the purposes of the impact assessment, it is assumed that water may accumulate in the pits in the spring, possibly remaining for two or three months. At other times of the year it is assumed that each pit will have a volume of no more than 300 m³.

Material from the pits that is awaiting processing will be stored temporarily in stockpiles. Run-off from these piles will be managed as part of the water management plan. The ground beneath these stockpiles will be compacted to limit leakage of any water on, or in, the stockpiles to ground.

As part of closure, the Tigranes-Artavazdes pit will be partially backfilled with barren rock. The barren rock will comprise permeable loose mixed Upper Volcanics and Lower Volcanics and is estimated to have a permeability of approximately 1x10⁻⁴ m/s (BRSF Seepage Model, GRE, 2014²). The backfill will be capped with an engineered evapotranspiration cover, comprising cover soils, a layer of compacted clay and a gravel drainage layer, to reduce infiltration. Infiltration through this cover and leakage through the base of the facility over

² Global Resource Engineering (GRE), Ltd, 2014. Technical Memorandum, Amulsar BRSF Seepage Model. Reference 13-1064, 14 July 2014.

the life cycle of the mine has been modelled using an unsaturated flow model (BRSF Seepage Model, GRE, 2014²).

As part of closure, the Erato pit will be partially backfilled with barren Non-Acid Generating (NAG) rock comprising permeable loose Upper Volcanics estimated to have a permeability of more than 1×10^{-4} m/s. The backfill will not have a soil cover to allow infiltration of pit runoff into the backfill. A backfill volume of 414,980 m³ is estimated (Erato Post-Closure Pit Water Balance, Golder Associates, 2014³).

BRSF

The BRSF will be constructed to prevent Potentially Acid Generating (PAG) waste from coming into contact with water as much as possible, and use NAG barren rock to serve as a contact buffer between PAG material and the natural environment.

The engineered containment will comprise the following elements:

- The existing subsoil in the footprint of the BRSF will be compacted in place to act as a low-permeability soil liner. This soil liner will restrict infiltration and will direct water that comes into contact with the barren rock to the toe of the BRSF, where the outflow will be collected in the BRSF toe pond and then piped to the contact water pond for treatment and/or piped to the HLF for use or treated through a passive treatment system (PTS) and then discharged. At closure, all flow from the BRSF toe pond will continue to be piped to the contact water ponds, with overflow to the PTS (see Appendix 3.1);
- A NAG barren rock drainage layer placed over the compacted soil liner will inhibit natural groundwater from seeps and springs located beneath the prepared soil liner of the BRSF from coming into contact with PAG waste rock. Any water emanating through the foundation of the dump (from potential seeps and springs) will travel through this layer towards the toe of the facility;
- The low grade ore stockpile is similar to NAG barren rock in terms of leachate chemistry (see Appendix 8.19) and will be treated as such (see above);
- PAG waste will be placed in engineered cells that will be surrounded by NAG waste on all sides. As a result, the PAG waste will be in contact with neither the bottom soil

³ Golder Associates, 2014. Technical Memorandum, Erato Post-Closure Pit Water Balance. Reference 14514150095.503/B.4, 4 August 2014.

liner nor the atmosphere. Amulsar PAG waste consists of argillized rock and contains a significant clay fraction. This clay fraction makes the PAG a low-permeability material. As a result, any water entering the body of the BRSF will flow preferentially through NAG waste that will be placed around the PAG cells; and

- The BRSF cover will be an engineered evapotranspiration (E/T) cover designed for the conditions found at the site. The components of the cover from top to bottom will be: topsoil to provide a vegetative growth medium; a layer of naturally-compacted clay to reduce the influx of water into the cover system; and a layer of gravel that will act as a capillary break between the cover soil and the waste rock of the dump. This cover will reduce infiltration to the BRSF in the long term.

HLF

The design of the HLF is described in Chapter 3. The design incorporates engineered containment comprising:

- A composite liner beneath the heap leach pad;
- A drainage system within the heap leach pad to control head on the basal liner to a maximum of 0.6 m;
- Underdrains beneath the leach pad footprint to drain groundwater/subsurface leakage to a collection sump located downgradient of the pad, where the underdrain discharge water quality will be monitored as required;
- A double liner system with intermediate leakage capture and recovery system underlying the solutions pond(s);
- Managed source term attenuation during the closure phase of the facility to reduce concentrations in cyanide in the leach solution to within acceptable discharge standards prior to closure; and
- Placement of an engineered evapotranspiration cover following closure to minimise infiltration to and leakage from the heap in closure. This cover will comprise cover soils overlying a compacted clay cap with underlying drainage layer of the leach pad rock to act as a capillary break.

The liner will be constructed according to international industry-accepted standards with onsite construction quality assurance/quality control. In addition, electric leak location surveys will be performed after the liner and overliner drain gravel have been placed to determine whether there are any defects in the liner requiring repair prior to leaching

operations.

In addition to the mitigation measures incorporated into the facility designs, the mitigation measures presented in the management plans (Chapter 8) will be used to avoid or limit the effects of potential impacts to the groundwater system. The management mitigation measures that are considered in this assessment include:

- Management of run-off and leakage during construction;
- Minimum 110 % tank capacity of bunds for storage of fuel/oils;
- Use of sediment/grease traps;
- Provision of spill kits and training of employees and contractors in spill prevention measures;
- No uncontrolled discharge to the water environment of effluent from facilities and wheel washes; and
- Capture of sewage effluent in sealed tanks and appropriate disposal.

In addition, a groundwater and surface water monitoring plan will be implemented during operations and closure. The purpose of the monitoring will be to evaluate the operational performance of the Project and identify any adverse trends in surface water and groundwater quality or quantity potentially exceeding those estimated by modelling that would require modifications to the mitigation measures.

6.9.6 Potential Impact Assessment

This section presents a discussion of the potential impacts to groundwater resources, how these impacts are assessed (with reference to the quantitative technical assessment where applicable), and the predicted direction, duration and magnitude of the changes.

Following the determination of the magnitude of change, the significance of the effect and the scale of significance have been defined using the matrices presented in Chapter 6.1 (Table 6.1.3 and 6.1.4). The summary of construction effect significance is presented in Table 6.9.3. The summary of operational effect significance is presented in Table 6.9.4. The summary of closure effect significance is presented in Table 6.9.5.

Groundwater quantity impacts are based on assessments of leakage from the BRSF and backfilled/restored T/A pit areas (Amulsar Pit Seepage Model, GRE, 2014⁴; and BRSF Seepage Model, GRE, 2014²) and the post-closure water balance for the Erato pit (Golder Associates, 2014³).

The impact assessment is supported by the following technical studies, which should be read in conjunction with this assessment:

- Appendix 6.9.1 - Groundwater modelling study (Golder Associates, 2014⁵);
- Appendix 6.9.2 - Assessment of nitrate and ammonium release from blasting (Golder Associates, 2014⁶);
- Appendix 6.9.3 - Assessment of risk to groundwater quality from the Tigranes-Artavazdes and Erato Pits (Golder Associates, 2014⁷);
- Appendix 6.9.4 - Assessment of risk to groundwater quality from the HLF (Golder Associates, 2014⁸); and
- Appendix 6.9.5 - Assessment of groundwater impacts from the BRSF (Golder Associates, 2014⁹).

The objective of each study and a summary of the key findings are presented in the following section.

Summary of Supporting Studies

Appendix 6.9.1 - Groundwater Modelling Study

The groundwater modelling study supports this groundwater impact assessment by evaluating the hydrogeological regime in the area of the proposed mine and associated infrastructure. The groundwater flow model represents the groundwater pathways from mine sources to the potential receptors identified in Section 6.9.4. The groundwater flow

⁴ Global Resource Engineering (GRE), Ltd, 2014a. Technical Memorandum, Amulsar Pit Seepage Model, Reference 13-1064. 7 July 2014.

⁵ Golder Associates, 2014. Groundwater Modelling Study. Report Reference 14514150095.506, August 2014.

⁶ Golder Associates, 2014. Technical Memorandum, Amulsar Gold Project: Estimate Of Nitrate And Ammonia Concentrations In Mine Water As A Product Of Blasting. Reference 14514150095.508, July 2014

⁷ Golder Associates, 2014. Assessment of risk to groundwater quality from the Tigranes-Artavazdes and Erato Pits. Reference 14514150095.512, August 2014.

⁸ Golder Associates, 2014. Hydrogeological Risk Assessment Proposed Heap Leach Facility. Report Reference 14514150095.509, August 2014.

⁹ Golder Associates, 2014. Technical Memorandum, Assessment of groundwater impacts from the BRSF. Reference 14514150095.511, August 2014.

model is used to predict changes in groundwater flow direction, groundwater level, spring discharge and baseflow in response to the changes induced by the Project.

The groundwater flow model uses a 3-D numerical approach to represent the conceptual hydrogeological understanding. The model combines information available on the climate/meteorology, topography, geology, baseline hydrology (Chapter 4.8), hydrology (Chapter 4.9), project description (Chapter 3), and predicted leakage/infiltration quantities beneath the main facilities. The model was constructed and calibrated to current conditions (i.e. groundwater levels and baseflow in the Spandaryan-Kechut Tunnel). The calibrated model uses values for hydraulic conductivity and recharge that are representative given the results of hydraulic testing and the climatic and hydrologic data for the Project Area. The model was also calibrated to the measured baseflows along river reaches. Following the completion of model calibration, three steady state model scenarios were developed: one to represent the baseline conditions (i.e. the current groundwater regime); one to represent operations at the maximum extent of mining; and one to represent post-closure when the pits have been backfilled and reclaimed.

The model was first used to determine the large-scale baseline hydrogeological conditions (i.e. before construction and operation). The key findings of the baseline model are summarised below:

- The water table largely mirrors topography, being highest beneath the Amulsar ridge and decreasing to the main river valleys;
- Groundwater flows radially away from the Amulsar ridge. Flow from the Tigranes-Artavazdes peaks is eastward to the Vorotan River and westward to the Darb River. Flow from Erato peak is predominantly to the west to the Arpa River;
- There is a shallow near-surface water table in the bottom of the BRSF valley underlain by argillized Lower Volcanics;
- There is a deep water table (in excess of 100 m below ground level) in the basalts to the northwest and west of the Amulsar ridge;
- Groundwater below the BRSF site flows northwestwards before turning west to discharge predominantly to the Arpa River downstream of the Kechut Reservoir;
- Groundwater flow is westward from the HLF site toward the Arpa River;
- The Spandaryan-Kechut Tunnel intersects the water table throughout its length, but overall the groundwater contribution area of the tunnel is localised. Simulated

groundwater flow pathlines indicate that groundwater flow originating from below the Erato, Tigranes and Artavazdes peaks and from the BRSF site flows beneath the tunnel to discharge to the Darb River; and

- The model shows groundwater discharge zones in river and stream valleys, and on the flanks of the Amulsar ridge below an elevation of approximately 2,700 m asl. The groundwater discharge on the flanks of Amulsar ridge is relatively well matched to observed areas of perennial spring discharge.

In the operational model, the groundwater flow direction from beneath each of the facilities is predicted to be similar to the baseline case. Figure 6.9.2 presents the predicted groundwater flow pathlines from each of the main mine areas.

The groundwater flow model indicates that recharge to groundwater in the BRSF area provides water to the BRSF springs, the Kechut springs, and the Arpa River. These locations are, therefore, considered to be potential receptors to changes in the quantity and quality of groundwater during operation of the BRSF.

The groundwater flow pathlines from the BRSF predicted by the model indicate that any groundwater quality changes as a result of leakage from the BRSF could potentially influence the quality of groundwater discharge to the Arpa River; thereby identifying groundwater baseflow to the Arpa River as the key groundwater receptor for the BRSF during operation.

Groundwater flow from the HLF is westward toward the Arpa River; thereby identifying baseflow to the Arpa River as the key groundwater receptor for the HLF during operation.

The operational model indicates that water infiltrating through the Tigranes-Artavazdes pit footprint will discharge both eastward to the Vorotan River and tributaries and westward to the Darb River and tributaries; thereby identifying groundwater fed springs and baseflow to these rivers as receptors. Water infiltrating through the Erato pit is predicted to discharge westward towards the Arpa River and tributaries during operation; thereby identifying groundwater fed springs and baseflow to the Arpa River and tributaries as receptors.

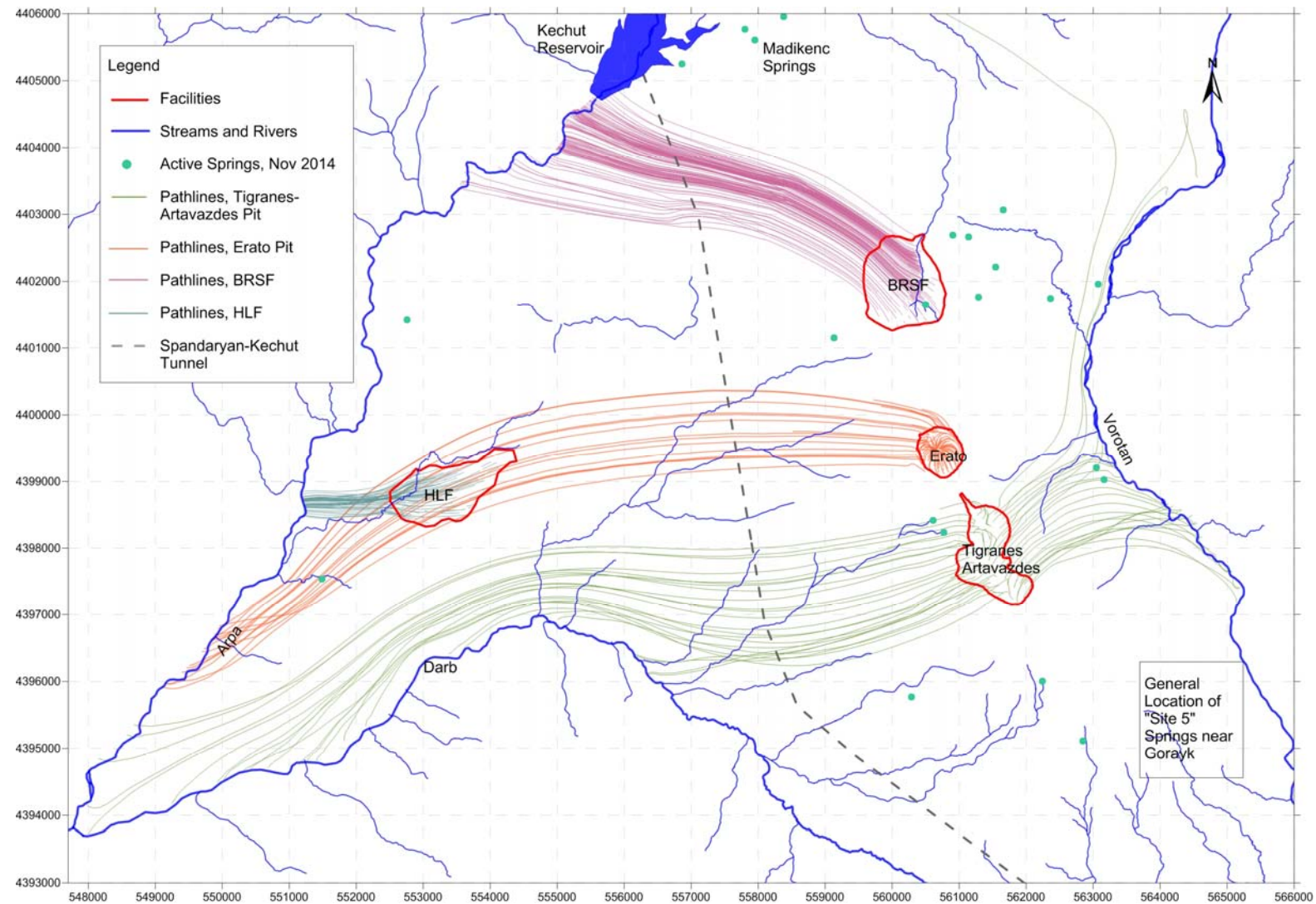


Figure 6.9.2 Groundwater Flow Pathlines during Operational Period

The Spandaryan-Kechut Tunnel intercepts groundwater, as is shown by discharge from the tunnel when the Spandaryan sluice is not open. The groundwater flow model predicts that groundwater originating from below the Erato and Tigranes-Artavazdes pits, and from the BRSF site, will flow beneath the Spandaryan-Kechut Tunnel. Under these conditions, the Kechut Reservoir and the Arpa River into which the Spandaryan-Kechut Tunnel discharges would not be secondary receptors for changes in groundwater. However, because of potential uncertainty in model results and the high sensitivity of the Spandaryan-Kechut water supply (Table 6.9.2), a worst-case analysis of groundwater inflow into the Spandaryan-Kechut Tunnel originating from the pits has been evaluated. The Spandaryan-Kechut assessment has been undertaken by combining potential impacts to groundwater quality from both the Tigranes-Artavazdes and Erato Pits and the BRSF assessment.

The operational model predicts a decrease in groundwater elevations of between 30 and 60 m in the vicinity of the BRSF because of reduced recharge. As a result, springs in the BRSF site may no longer flow. The groundwater discharge to the stream in the BRSF valley is also predicted to decline by approximately 24 %. A decrease in flow of 36 % is predicted in the spring cluster west of the BRSF.

Reduced recharge around the HLF results in a predicted decrease in groundwater elevations of between 3 m and 10 m. There are no perennial springs in this area that are predicted to be affected by this change.

None of the perennial springs present on the Amulsar flanks are located above the elevation of the pit bases and all of the springs lie within the seepage/surface discharge zone predicted by the operational model. This suggests that none of the perennial springs on the mountain flanks will be lost. However, capture and use of pit water and the consequent decrease in groundwater recharge will result in a slight reduction in spring flow of about 10 %. Ephemeral springs located above the pit floor elevation are likely to see a reduced flow because of changes in the surface water catchment area (Section 6.10).

A reduction in recharge in the BRSF area is predicted to result in a reduction in water supply to the catchment of the Kechut (Madikenc) springs. The groundwater model predicts a 10 % reduction in flow at these springs during operation.

The operational modelling indicates that by the end of mining there could be a small decrease in the amount of baseflow discharging to the major rivers and their tributaries draining from Amulsar. The decrease is estimated to be approximately 3 % of the current baseflow from the catchments within the Project Area in the Vorotan River, approximately 2 % in the Arpa River and approximately 1 % in the Darb River.

The groundwater flow model predicts that the reduction in groundwater input to the Spandaryan-Kechut Tunnel will be approximately 1 % of the current input. This reduction is predominately caused by a reduction in recharge in the area of the pits and the BRSF.

The groundwater flow model results indicate that similar receptors will potentially be impacted during both operational and closure phases. The post-closure groundwater flow pathlines are shown in Figure 6.9.3.

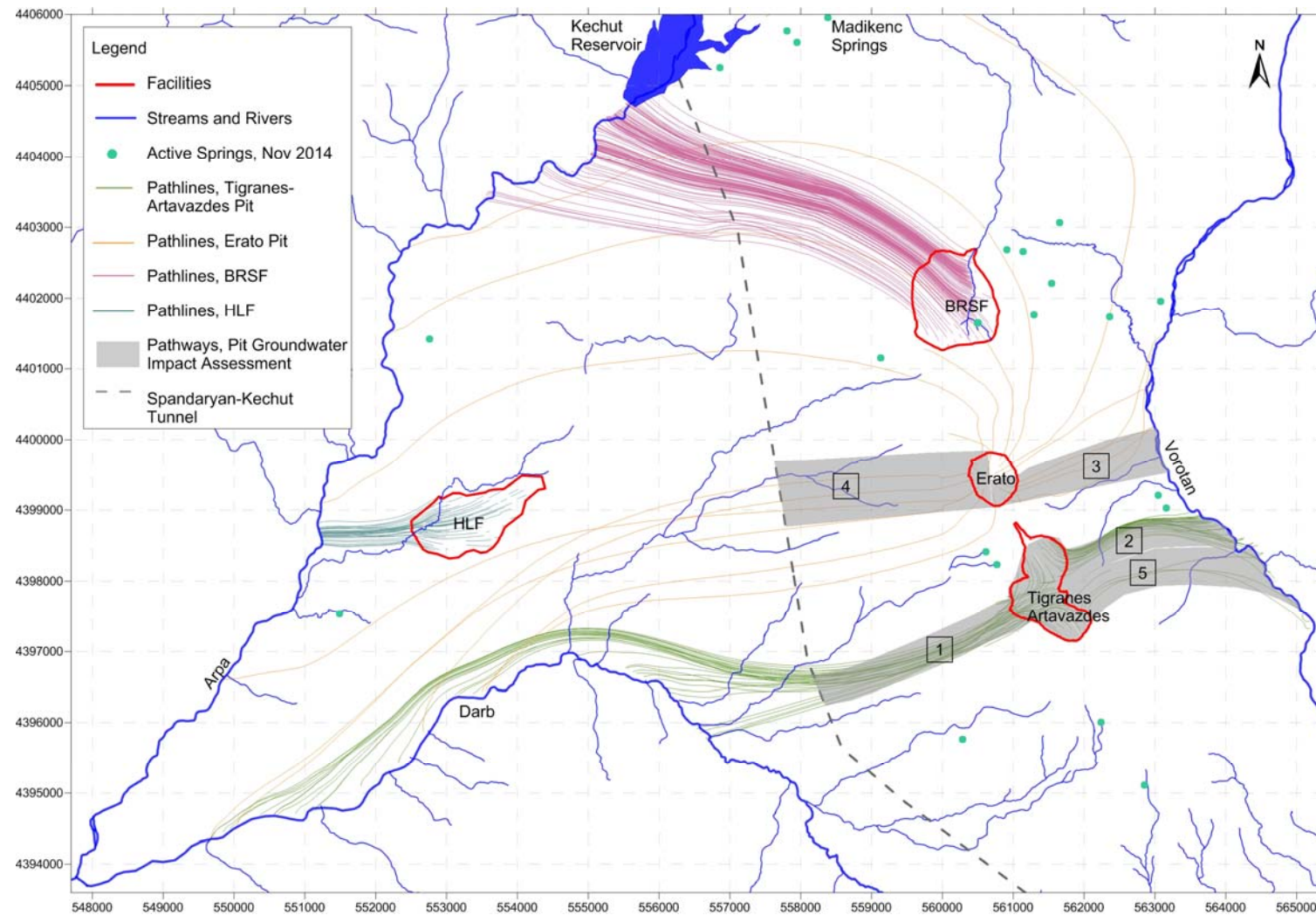


Figure 6.9.3: Groundwater Flow Pathlines during Post Closure

The key findings of the post-closure model are summarised below:

- There is predicted to be an increase in groundwater levels and perennial spring flow downgradient of the Erato pit as a result of increased infiltration in the pit footprint compared to baseline conditions. Locally (adjacent to the pit), groundwater levels are predicted to increase progressively by approximately 9 m to 16 m;
- There is predicted to be a decrease in groundwater levels and perennial spring flow, downgradient of Tigranes-Artavazdes as a result of decreased infiltration compared to baseline conditions. Locally, groundwater levels are predicted to progressively decrease by up to 40 m;
- Some perennial springs that currently flow at a very low rate during winter, particularly in the vicinity of Tigranes-Artavazdes, may become ephemeral (dry during the winter months);
- The flow in the perennial springs around the peak could progressively decrease by between 1 % and 6 % from baseline conditions;
- No perennial springs will be lost around the peak;
- Reduced recharge in the BRSF site may result in a progressive decrease in groundwater levels of up to 60 m in the southern portion of the BRSF, the decrease is anticipated to begin within a few years of construction of the facility due to the reduction in recharge within the footprint, but may occur over many years (see Appendix 6.9.1);
- Groundwater discharge to surface will likely cease in the southern part of the BRSF site;
- Discharge from springs in the valley west of the BRSF (which includes perennial spring SP68) is predicted to progressively reduce in the post-closure scenario by between 14 % and 20 % in comparison to baseline conditions;
- Groundwater discharge to the Kechut (Madikenc) springs is conservatively predicted to progressively decrease by approximately 7 % to 8 % over the long term. This change in flow is sensitive to several parameters including the interpreted hydrogeological conditions at and surrounding the BRSF, the recharge rate on the northern end of the Amulsar ridge and the rate of leakage from the BRSF (and, therefore, the change in groundwater elevation beneath the BRSF and the hydraulic gradient in the basalts feeding these springs);
- Groundwater discharge to the stream in the valley east of the BRSF is predicted to progressively decrease by between 11 % and 21 %;

- Groundwater discharge to the Spandaryan-Kechut Tunnel is predicted to progressively decrease by between 2 % and 3 %;
- Reduced recharge across the HLF footprint is predicted to result in a progressive decrease in groundwater levels of up to 13 m on the southeastern boundary. Similar to the BRSF, this decrease is anticipated to begin within a few years of construction of the facility due to the reduction in recharge within the footprint, but may occur over many years (see Appendix 6.9.1); and
- The change in groundwater recharge is predicted to have minimal impact on groundwater baseflow to the Vorotan, Darb and Arpa Rivers. Model results predict a decrease in groundwater baseflow from catchments within the Project Area of approximately 2 % in the Vorotan River, approximately 2 % in the Arpa River and approximately 1 % in the Darb River.

Appendix 6.9.2 - Assessment of Nitrate and Ammonium Release from Blasting

The planned use of ammonium nitrate based blasting agents at the Erato and Tigranes-Artavazdes pits at the Amulsar site has the potential to affect groundwater quality. The potential concentrations of nitrogen in mining-influenced water based on the proposed use of explosives is presented in Table 6.9.3.

Table 6.9.3: Calculated Concentrations of Nitrate and Ammonium (as N) in Mine Water During Operations				
	Nitrate Concentration (mg N/l)*		Ammonium Concentration (mg N/l)*	
Area	Minimum	Maximum	Minimum	Maximum
Pit Sumps	12 – 30	>1,000*	12 - 30	>1,000*
Pit Backfill Fluids	70	440	70	440
BRSF Fluids	13	420	13	420
Notes: * Significant uncertainty in this high concentration, low volume sump water. Biological and chemical reactions in the pit sumps may result in lower concentrations, but cannot be predicted with confidence ¹⁰ .				

The ranges shown in the case of the pit sumps reflect seasonal fluctuations in water quality, as well as the range attributable to uncertainty regarding the proportion of ammonium nitrate-fuel oil based explosives (ANFO) that will contribute to nitrogen in the mine water. Maximum concentrations are predicted for small quantities of water during early autumn;

¹⁰ Henrich, S. et. al., June 2011: The iron-oxidising proteobacteria. Microbiology volume 157, no. 6 pg 1551-1564.

minimum concentrations are predicted associated with the greatest quantities of water in June. For the pit backfill leakage and fluids within the BRSF engineered containment system, the range presented incorporates uncertainty regarding the degree of contact between the barren rock and infiltrating water and the proportion of ANFO which will contribute to nitrogen in mine water. These numbers represent a conservative estimate and concentrations could be reduced by applying management methods during operation and closure.

In the absence of relevant groundwater standards, and due to the fact groundwater reports to surface water in the form of springs, surface water Republic of Armenia Surface Water MACs have been used only **for information purposes** (and not as groundwater compliance targets) for the project. Calculated concentrations indicate that there is the potential for both ammonium and nitrate concentrations to exceed the MAC of 0.4 mg/l ammonium as N and 2.5 mg/l nitrate as N, in water infiltrating to groundwater from the pit sumps, and from the Tigranes-Artavazdes pit backfill. Concentrations of ammonium and nitrate in fluids within the engineered containment of the BRSF are predicted to exceed the Republic of Armenia MAC of 0.4 mg/l as N and 2.5 mg/l as N, respectively.

The results of this assessment are used to determine the source concentrations for mining-influenced water infiltrating from the Tigranes-Artavazdes and Erato Pits (Appendix 6.9.3) and the risk to groundwater quality from the BRSF (Appendix 6.9.5).

Appendix 6.9.3 - Assessment of Risk to Groundwater Quality from the Tigranes-Artavazdes and Erato Pits

Reactions between water and the exposed rock in the pits during operation have the potential to impact groundwater quality. The groundwater quality may potentially be affected by the interaction between water and the material used to backfill the pits during reclamation and onwards into the post closure phase. The purpose of this assessment was to determine the risk to drinking water supplies and the hydrologic system presented by the leakage of mine-influenced water from the pits.

The groundwater flow model indicates that leakage from the backfilled pits is most likely to flow towards Darb River and the Vorotan River. Therefore, the change in groundwater quality at the point of discharge to the Darb River and the Vorotan River has been calculated.

Predominant flow in the groundwater flow model is via Study Area-wide pathways to the

major rivers. However, the groundwater flow model represents a simplification of the complex intensely faulted geological conditions surrounding the pits. Due to the uncertainty introduced by the simplification of the geological model, the potential for infiltrating pit water to flow in shallow groundwater to springs surrounding the pits has also been considered in the pit groundwater quality impact assessment.

Given the sensitivity of the Spandaryan-Kechut water supply, its location downgradient of the pits and potential model uncertainty, the groundwater in the Spandaryan-Kechut Tunnel has also been considered as a receptor for flow from the pits.

The risk assessment predicts that because of the long groundwater travel time from the pit area to potential receptors, the peak impacts to receptor groundwater quality is not likely to be observed until the post-closure phase.

The predicted peak concentrations of the main constituents evaluated in groundwater are presented in Table 6.9.4. Figure 6.9.3 shows the flowpaths between sources and receptors. The predicted change in spring water quality has been determined for groups of springs, which are shown in Figure 6.9.4. The predicted peak concentrations of the main constituents evaluated in groundwater discharging to the springs are presented in Table 6.9.5.

In this and all subsequent tables, the colours assigned to the results relate to the magnitude of change assigned to each value using Table 6.9.1. Negligible changes have been highlighted in green; low impacts have been highlighted in yellow; moderate impacts have been highlighted in orange; and high impacts have been highlighted in red. These changes are discussed in the operational impacts and post closure impact assessment sections later in this chapter.

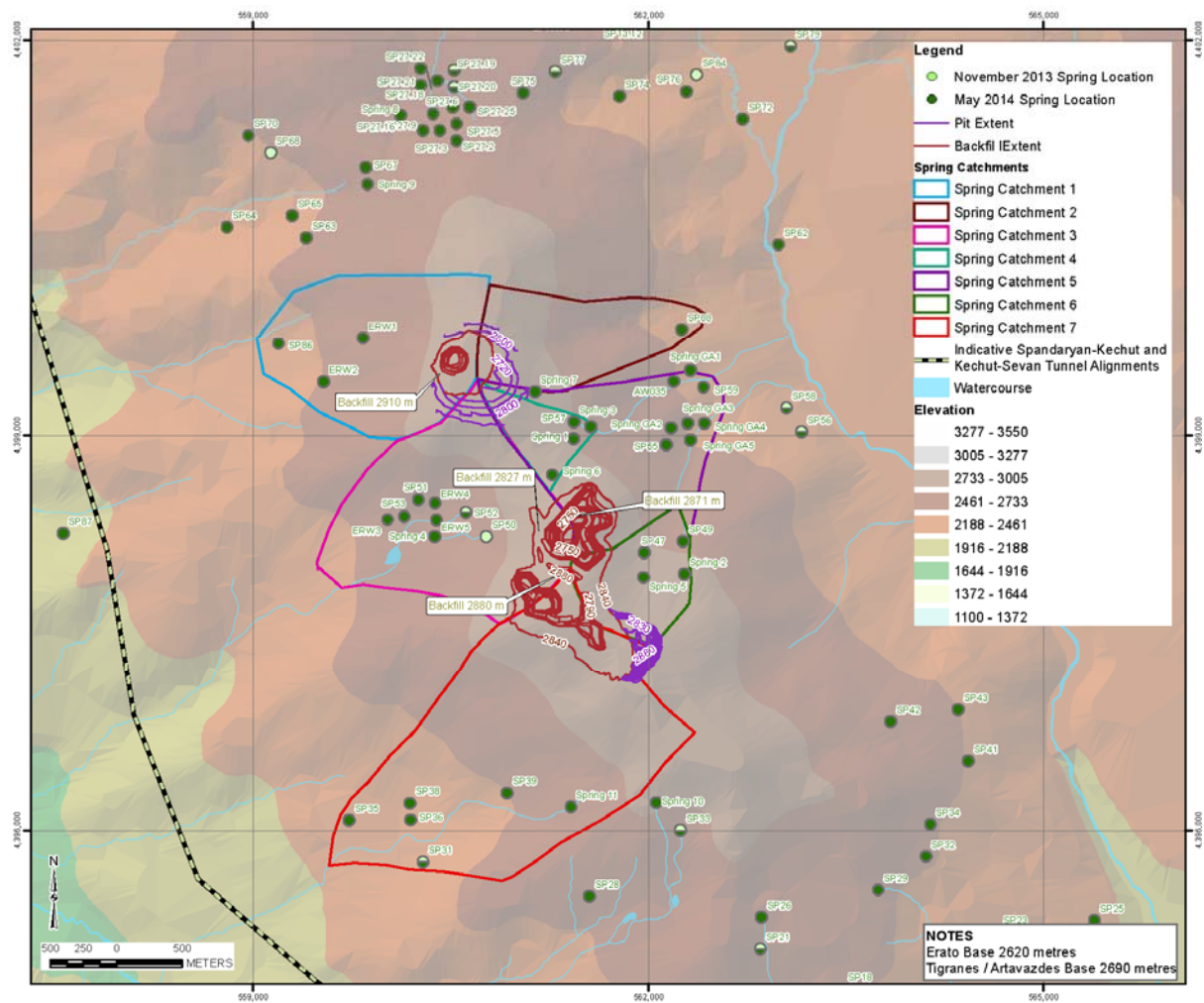


Figure 6.9.4: Spring Catchments used in Pit Risk Assessment

Table 6.9.4: Predicted Changes in Groundwater Concentrations in the Spandaryan-Kechut Tunnel and Prior to Discharge to the Rivers as a Result of Leakage from the Pits

Constituent	MAC II (mg/l) for Vorotan Catchment	Groundwater prior to discharge to Vorotan River			MAC II (mg/l) for Darb/Arpa Catchment	Groundwater in Spandaryan-Kechut Tunnel – Average Flow	Groundwater prior to discharge to Darb River	
		Predicted peak concentration from Pathway 2 Tigranes-Artavazdes Pit Source in mg/l (% change from baseline)	Predicted peak concentration from Pathway 5 Tigranes-Artavazdes Pit Source in mg/l (% change from baseline)	Predicted peak concentration from Pathway 3 Erato Pit Source in mg/l (% change from baseline)		Predicted peak concentration from combined Pathway 1 and 4 pit sources in mg/l (% change from baseline)	Predicted peak concentration from Pathway 1 Tigranes-Artavazdes Pit Source in mg/l (% change from baseline)	Predicted peak concentration from Pathway 4 Erato Pit Source in mg/l (% change from baseline)
Nitrate as N	2.5	5.79 (459%)	1.13 (9%)	n/a	2.5	0.57 (14.1%)	1.87 (274%)	n/a
Sulphate	17.02	34.02 (53%)	22.71 (2%)	25.12 (13%)	16.04	126.14 (0.1%)	127.2 (1%)	126.45 (0%)
Beryllium	5.4 x10 ⁻⁵	0.00023 (0%)	0.00023 (0%)	0.0002 (0%)	3.8 x10 ⁻⁵	0.0002 (0%)	0.0002 (0%)	0.0002 (0%)
Nickel	0.0105	0.0039 (0%)	0.0039 (0%)	0.0039 (0%)	0.0103	0.003 (0%)	0.003 (0%)	0.003 (0%)
Antimony	0.0005	n/a	n/a	0.001 (0%)	0.00028	0.001 (0%)	n/a	0.001 (0%)
Arsenic	0.02	0.001 (0%)	0.001 (0%)	0.001 (0%)	0.02	0.0068 (0%)	0.0068 (0%)	0.0068 (0%)
Cobalt	0.00028	0.0038 (0%)	0.0038 (0%)	0.0038 (0%)	0.00036	0.00051 (0%)	0.00051 (0%)	0.00051 (0%)
Cadmium	0.00101	0.0005 (0%)	0.0005 (0%)	0.0005 (0%)	0.00101	0.0005 (0%)	0.0005 (0%)	0.0005 (0%)
Chromium	0.0105	0.004 (0%)	0.004 (0%)	0.004 (0%)	0.011	0.005 (0%)	0.005 (0%)	0.005 (0%)
Molybdenum	0.002	n/a	n/a	0.0008 (0%)	0.00082	0.003 (0%)	n/a	0.003 (0%)

Table 6.9.4: Predicted Changes in Groundwater Concentrations in the Spandaryan-Kechut Tunnel and Prior to Discharge to the Rivers as a Result of Leakage from the Pits

Constituent	MAC II (mg/l) for Vorotan Catchment	Groundwater prior to discharge to Vorotan River			MAC II (mg/l) for Darb/Arpa Catchment	Groundwater in Spandaryan-Kechut Tunnel – Average Flow	Groundwater prior to discharge to Darb River	
		Predicted peak concentration from Pathway 2 Tigranes-Artavazdes Pit Source in mg/l (% change from baseline)	Predicted peak concentration from Pathway 5 Tigranes-Artavazdes Pit Source in mg/l (% change from baseline)	Predicted peak concentration from Pathway 3 Erato Pit Source in mg/l (% change from baseline)		Predicted peak concentration from combined Pathway 1 and 4 pit sources in mg/l (% change from baseline)	Predicted peak concentration from Pathway 1 Tigranes-Artavazdes Pit Source in mg/l (% change from baseline)	Predicted peak concentration from Pathway 4 Erato Pit Source in mg/l (% change from baseline)
Lithium	0.002	0.0017 (19%)	0.0016 (9%)	0.0059 (308%)	0.003	0.0044 (3.1%)	0.0044 (2%)	0.005 (17%)
Tin	0.00016	n/a	n/a	0*	8.00x10 ⁻⁵	0.00011*	n/a	3.92x10 ⁻⁶ *
Notes: n/a – not present in source term. * no baseline concentration to report percentage change. See text for shading categories. MAC II concentrations provided for information only since does not apply directly to groundwater.								

Table 6.9.5: Predicted Peak Changes in Spring Water Discharge as a Result of Leakage from the Pits

Constituent	MAC II (mg/l) for Catchments 1, 3 and 7	MAC II (mg/l) for Catchments 2, 4, 5 and 6	Predicted Concentration at Springs in mg/l (% change from baseline)						
			Spring Catchment 1	Spring Catchment 2	Spring Catchment 3	Spring Catchment 4	Spring Catchment 5	Spring Catchment 6	Spring Catchment 7
Sulphate	16.04	17.02	7.54 (1%)	36.95 (0%)	20.03 (16%)	5.08 (2%)	5.23 (5%)	9.99 (100%)	6.17 (23%)
Antimony	0.00028	0.0005	0.00022 (7%)	0.00021 (2%)	0.00021 (3%)	0.00022 (11%)	0.0002 (1%)	0.0002 (0%)	0.0002 (0%)
Arsenic	0.02	0.02	0.001 (1%)	0.0014 (0%)	0.0011 (18%)	0.00096 (2%)	0.00096 (2%)	0.00093 (43%)	0.0011 (7%)
Beryllium	3.8 x10 ⁻⁵	5.4 x10 ⁻⁵	3.95x10 ⁻⁵ (32 %)	0.00028 (1%)	0.00038 (89%)	4.37x10 ⁻⁵ (46%)	4.48 x10 ⁻⁵ (49%)	0.00033 (996%)	0.0001 (248%)
Cadmium	0.00101	0.00101	0.0005 (0%)	0.0005 (0%)	0.00053 (6%)	0.0005 (0%)	0.0005 (1%)	0.00056 (11%)	0.00051 (3%)
Cobalt	0.00036	0.00028	0.00059 (12%)	0.0086(0%)	0.0096 (1714%)	0.00056 (20%)	0.0012 (154%)	0.016 (4051%)	0.0043 (760%)
Chromium	0.011	0.0105	0.005 (1%)	0.005 (0%)	0.0044 (1%)	0.0033 (2%)	0.0032 (0%)	0.0027 (0%)	0.005 (0%)
Lithium	0.003	0.002	0.0011 (8%)	0.0022 (1%)	0.0013 (21%)	0.0011 (12%)	0.001 (2%)	0.0015 (52%)	0.0011 (8%)
Molybdenum	0.00082	0.002	0.00085 (6%)	0.00081 (2%)	0.0009 (2%)	0.00068 (11%)	0.00062 (1%)	0.00051 (0%)	0.0008 (0%)
Nickel	0.0103	0.0105	0.0031 (2%)	0.0061 (0%)	0.0098 (126%)	0.0025 (3%)	0.0029 (18%)	0.011 (526%)	0.0053 (76%)
Nitrate as N	2.5	2.5	0.53 (0%)	0.51 (0%)	3.66 (632%)	0.41 (0%)	0.66 (60%)	5.63 (1274%)	1.83 (266%)
Tin*	8.00x10 ⁻⁵	0.00016	0.00042	0.00013	0.00018	0.00061	3.78 x10 ⁻⁵	0	0
Notes:									
* No percentage change calculated as there is no baseline data for this constituent. See text for shading categories. No baseline data for tin, values shown represent predicted change only. MAC II concentrations provided for information only since this standard does not apply directly to groundwater.									

Appendix 6.9.4 - Assessment of Risk to Groundwater Quality from the HLF

The construction, operation, reclamation and closure of the HLF have the potential to affect groundwater quality. Groundwater is not used as a drinking water resource in the vicinity of the HLF, and no groundwater use occurs between the HLF and the downgradient area of groundwater discharge to surface water at the Arpa River. Groundwater as a source of supply is therefore not considered to be a receptor in the context of this assessment. However, groundwater discharging to surface water (baseflow) is considered to be a receptor. Therefore, an assessment of the potential risk to groundwater as a result of the HLF was completed using a probabilistic solute transport model.

The concentration of constituents of potential concern in the HLF leakage as predicted by the solute transport model are mixed with the groundwater underflow from upgradient of the HLF facility at baseline groundwater concentrations in order to predict the quality of groundwater downgradient of the HLF before it discharges to surface water. The model takes into account advection, dispersion, retardation and biodegradation in the groundwater pathways. The model does not represent unsaturated zone flow and transport processes. Based on the results of the groundwater flow model, two pathways are evaluated; one through deeper groundwater within the volcanic rocks towards the River Arpa; and one through shallow groundwater within colluvium and the upper volcanic rocks towards the stream in the HLF valley.

The results of the assessment of the predicted change in groundwater quality are summarised below. The 50th percentile value is considered the 'most likely' outcome, whilst the 95th percentile concentration is the conservative estimate of the possible maximum impact. Details behind the calculation of the results and any assumptions made are presented in the Appendix 6.9.4. The impact to surface water receptors as a result of the groundwater contributing to surface water flow is considered separately in Chapter 6.10.

The maximum calculated change in concentration in deep groundwater at the point of discharge to the Arpa River is presented in Table 6.9.6. The total discharge from deep groundwater to the Arpa River (i.e. including existing underflow from upgradient groundwater and the contribution of leakage from the HLF) at those predicted concentrations is between 2.1 L/s and 19.4 L/s.

Table 6.9.6: Calculated Maximum Change in Concentration in Deep Groundwater at Point of Discharge to the Arpa River

Constituent	50%ile Peak Concentration (mg/l)	Time to Peak Concentration (years)	95%ile Peak Concentration (mg/l)	Time to Peak Concentration (years)
Arsenic	$<1 \times 10^{-10}$	1000	5.6×10^{-6}	1000
Copper	N/A	>1000	N/A	>1000
Cobalt	N/A	>1000	N/A	>1000
Antimony	N/A	>1000	$<1 \times 10^{-10}$	1000
Sodium	0.015	59	0.064	81
WAD Cyanide	N/A	>1000	$<1 \times 10^{-10}$	840
NH ₃ +NH ₄ as N	$<1 \times 10^{-10}$	780	$<1 \times 10^{-10}$	384
Nitrate as N	0.018	41	0.11	33

Notes:
N/A – not applicable, parameter did not arrive at receptor inside the simulation period. >1000 – travel time to the receptor for the parameter is more than 1000 years. Positive values indicate an increase in concentration above existing conditions

The potential peak concentrations in deep groundwater discharging to the Arpa River for the constituents of potential concern were then calculated based on the predicted change shown in Table 6.9.6 and mean baseline groundwater concentration. The peak predicted impact on the quality of groundwater discharging to the Arpa River of the values presented in Table 6.9.7.

Table 6.9.7: Peak Impact on Groundwater Quality discharging to Arpa River

Constituent	Unit	Arpa MAC Category II	Average Baseline Concentration	95%ile Change in Concentration	Predicted Peak Conc'n	Percentage Change
Arsenic	mg/L	0.02	0.0042	5.6×10^{-6}	0.0042	0%
Copper	mg/L	0.021	0.0021	0	0.0021	0%
Cobalt	mg/L	3.6×10^{-4}	3.0×10^{-4}	0	3.0×10^{-4}	0%
Antimony	mg/L	0.00028	2.0×10^{-4}	0	2.0×10^{-4}	0%
Sodium	mg/L	10	27.1	0.064	27.1	0%
WAD Cyanide	mg/L	0.01*	0.005	0	0.005	0%
Ammonium as N	mg/L	n/a	0.54	$<1 \times 10^{-10}$	0.54	0%
Nitrate as N	mg/L	2.5	0.70	0.1	0.8	16%

* There is no MAC for cyanide: this is a Project-specific target (see Section 2.4)

The maximum calculated change in concentration in shallow groundwater at point of discharge to the HLF stream is presented in Table 6.9.8. These maximum changes occur during the closure and post-closure phase. The total discharge from shallow groundwater to the HLF stream at those predicted concentrations is between 0.02 L/s and 0.24 L/s in operation and 0.02 L/s and 0.08 L/s in closure.

Table 6.9.8: Calculated Maximum Change in Concentrations in Shallow Groundwater at Point of Discharge to the HLF Stream				
Constituent	50%ile Peak Concentration (mg/l)	Time to Peak Concentration (years)	95%ile Peak Concentration (mg/l)	Time to Peak Concentration (years)
Arsenic	$<1 \times 10^{-10}$	1000	0.006	960
Copper	N/A	>1000	N/A	>1000
Cobalt	$<1 \times 10^{-10}$	1000	$<1 \times 10^{-10}$	1000
Antimony	$<1 \times 10^{-10}$	1000	$<1 \times 10^{-10}$	1000
Sodium	80.5	20	168	15
WAD Cyanide	$<1 \times 10^{-10}$	1000	9.30×10^{-5}	960
NH ₃ +NH ₄ as N	2.10×10^{-4}	1000	0.57	470
Nitrate as N	152	28	319	14.9
Notes: N/A – not applicable, parameter did not arrive at receptor inside the simulation period. >1000 – travel time to the receptor for the parameter is more than 1000 years.				

The potential peak concentrations in shallow groundwater discharging to the HLF stream for the constituents of potential concern were then calculated based on the predicted change shown in Table 6.9.8 and mean baseline groundwater concentration. The peak predicted impact on the quality of groundwater discharging to the HLF stream of the values is presented in Table 6.9.9. The significant increase in sodium and nitrate concentrations will be addressed during the final design process for the HLF. At this time, modification may be implemented in the HLF design to reduce seepage quantities/qualities and/or identify additional mitigation measures to contain and collect seepage prior to discharge to surface water.

Table 6.9.9: Peak Impact on Groundwater Quality discharging to HLF Stream						
Constituent	Unit	Arpa MAC Category II	Average Baseline Concentration	95%ile Change in Concentration	Predicted Peak Conc'n	Percentage Change
Arsenic	mg/L	0.02	0.0049	0.006	0.011	124%
Copper	mg/L	0.021	0.0013	0	0.0013	0%
Cobalt	mg/L	3.6x10 ⁻⁴	3.0x10 ⁻⁴	0	3.0x10 ⁻⁴	0%
Antimony	mg/L	0.00028	2.0x10 ⁻⁴	<1x10 ⁻¹⁰	2.0x10 ⁻⁴	0%
Sodium	mg/L	10	17.0	168	185	990%
WAD Cyanide	mg/L	0.01*	0.005	9.3x10 ⁻⁵	0.0051	2%
Ammonium as N	mg/L	n/a	0.1	0.6	0.7	481%
Nitrate as N	mg/L	2.5	1.1	319.0	320.1	>1000%
Notes: MAC II concentrations provided for information only since does not apply directly to groundwater. *There is no MAC for cyanide: this is a Project-specific standard (see Section 2.4)						

The colours assigned to the results tables relate to the magnitude of change assigned to each value using Table 6.9.1. These changes are discussed in the operational impacts and post closure impact assessment sections later in this chapter.

Appendix 6.9.5 - Assessment of Groundwater Impacts from the BRSF

An assessment has been undertaken to determine the potential risk to hydrologic receptors as a consequence of leakage from the BRSF.

Groundwater is not used as a drinking water resource in the vicinity of the BRSF, and no groundwater use occurs between the BRSF and the area of discharge to surface water (the Kechut Reservoir and the Arpa River). Groundwater as a source of supply is, therefore, not considered to be a receptor in the context of this assessment.

The groundwater flow model indicates that some leakage from the BRSF flows beneath the Spandaryan-Kechut Tunnel. Given the sensitivity of the Spandaryan-Kechut water supply, its location downgradient of the BRSF and potential model uncertainty, the groundwater in the Spandaryan-Kechut Tunnel has also been considered as a receptor for flow from the BRSF.

The potential groundwater flowpath to the Spandaryan-Kechut Tunnel is the shortest flow path from groundwater originating at the BRSF. The assessment presented in Appendix 6.9.5 assumes that the leakage from the BRSF enters groundwater, mixes with natural recharge

along the flow path, enters the tunnel and mixes with the groundwater in the tunnel. The results of the assessment are reproduced in Table 6.9.10.

Table 6.9.10: Potential Change in Concentrations in the Spandaryan-Kechut Tunnel from BRSF Leakage

Constituent	Units	Arpa MAC Standards (II)	Average Quality in AWJ6 (representing current groundwater conditions in the tunnel)	Estimated Concentration in Groundwater in the Tunnel (including input from BRSF leakage)	Increase in concentration as a result of input from BRSF leakage
Aluminium	µg/l	144	72	N/A	0%
Arsenic	µg/l	20	6.76	N/A	0%
Barium	µg/l	28	20.4	N/A	0%
Beryllium	µg/l	0.038	0.2	N/A	0%
Boron	µg/l	450	0.0542	0.1	94%
Cadmium	µg/l	1.014	0.5	N/A	0%
Calcium	mg/l	100	63.9	N/A	0%
Chloride	mg/l	6.88	3.07	3.1	0%
Chromium (III)	µg/l	11	5	N/A	0%
Cobalt	µg/l	0.36	0.505	N/A	0%
Iron(III)	mg/l	0.072	0.404	N/A	0%
Lead	µg/l	10.14	1.99	N/A	0%
Lithium	µg/l	3	4.27	4.3	1%
Magnesium	mg/l	50	9.35	9.4	0%
Manganese	µg/l	12	39.1	N/A	0%
Nickel	µg/l	10.34	3	N/A	0%
Nitrate	mg N/l	2.5	0.5	0.8	67%
Potassium	mg/l	3.12	3.12	3.2	1%
Selenium	µg/l	20	5	N/A	0%
Sulphate	mg/l	16.04	126	126.4	0%
Zinc	µg/l	100	3.78	N/A	0%

Notes:

N/A – constituent will not travel to the receptor within 1000 years.

MAC II concentrations provided for information only since does not apply directly to groundwater.

The groundwater flow model indicates that the more likely groundwater flow route is a longer pathway (along which greater mixing would occur) between the BRSF and groundwater discharge to the Arpa River downstream of the Kechut Reservoir. The results of the assessment of this pathway (i.e. the concentrations of constituents in groundwater immediately before discharge to the Arpa River) are presented in Table 6.9.11. Only results for constituents that are predicted to have travel times of less than 1000 years are presented. All other constituents are predicted to arrive at the point of discharge after more than 1000 years.

Table 6.9.11: Potential Increase in Groundwater Concentration from BRSF Leakage (Post Closure)					
Constituent	Units	Arpa MAC Standards (II)	Average Quality in AWJ6 (representing current groundwater conditions)	Estimated Concentration in groundwater before discharge to Arpa River (including background)	% Increase in groundwater concentration
Boron	µg/l	450	0.0542	0.3	437%
Chloride	mg/l	6.88	3.07	3.1	0%
Lithium	µg/l	3	4.27	4.5	5%
Magnesium	mg/l	50	9.35	9.4	1%
Nitrate	mg N/l	2.5	0.5	2.1	311%
Potassium	mg/l	3.12	3.12	3.3	5%
Sulphate	mg/l	16.04	126	127.8	1%
Notes: MAC II concentrations provided for information only since does not apply directly to groundwater.					

The colours assigned to the results relate to the magnitude of change assigned to each value using Table 6.9.1. These changes are discussed in the operational impacts and post closure impact assessment sections later in this chapter.

Construction Phase Impacts

The construction phase will include the construction of the mine facilities (i.e. the ADR plant, crusher, stores, office/camp buildings, conveyors, retention and sediment ponds, and roads). There are no planned or engineered discharges to groundwater during the construction phase. This section considers the potential impacts and effects on the groundwater receptors as a result of the construction activities. The source of the potential impact and subsequent

magnitude of change, effect of significance and scale of significance are presented in Table 6.9.12. Construction and operation of the BRSF and HLF will not take place until the operational phase; therefore, potential impacts from these facilities are evaluated later.

Perched Water/Ephemeral Springs

The mine facilities that are part of construction phase development, will affect small areas of the total ephemeral spring catchments so will result in a **negligible** change in the quantity of water from the springs.

During construction, the water management plan, combined with appropriate training of contractors, will ensure that surface water runoff is managed and sediment discharge is controlled. Therefore, potential impacts to spring water quality via infiltration to groundwater are anticipated to be limited, and only associated with accidental spillages or release. Accidental spillages would result in a negative impact; the source of which would be short-lived. Such spills would be rapidly remediated so the potential change in spring water quality is considered to be **negligible**.

This assessment related only to the predicted impact on the discharge of groundwater at springs. A discussion of how spring discharge quality and quantity changes affect watercourses, and of how other aspects such as changes in surface run-off quantity and quality affect watercourses, is presented in Chapter 6.10.

Perennial Springs

The potential construction-related impacts to the perennial springs are similar to those identified for the perched water/ephemeral springs.

Hydrothermal Springs

Baseline characterisation has concluded that these springs do not receive groundwater flow from the Project area. There will not be any changes in groundwater flow or quality at the hydrothermal springs. The potential change in the quantity and quality of discharge from the hydrothermal springs is considered to be **negligible**.

Groundwater Used for Supply Purposes

Kechut Springs

Construction activities will not take place in the area of the Madikenc group of springs. Therefore, the potential change to groundwater quantity and quality at this receptor is predicted to be **negligible**.

Springs North of Gorayk

Construction activities will not take place in the area these springs. Therefore, the potential change to groundwater quantity and quality at this receptor is predicted to be **negligible**.

Spandaryan-Kechut Tunnel

Construction phase activities with the potential to influence groundwater recharge rates (such as lining of ponds and building construction) and groundwater quality (such as localised and short-lived accidental spills from vehicle fuelling) will occur in a small proportion (likely to be less than 1 %) of the groundwater catchment contributing to the tunnel within the Project area. Any spills would be rapidly remediated. Therefore, the potential change to groundwater discharge and groundwater quality in the Kechut-Spandaryan Tunnel is considered to be **negligible**.

Groundwater Component of Surface Water Baseflow

Construction phase activities with the potential to influence groundwater recharge rates (such as lining of ponds and building construction) and groundwater quality (such as localised and short-lived accidental spills from vehicle fuelling) will occur in a small proportion of the groundwater catchment within the Project Area (likely to be less than 1 %). Any spills would be rapidly remediated. Therefore, the extent of influence of construction phase activities on groundwater baseflow quantity and the magnitude of any quality impact is considered to be **negligible**.

Table 6.9.12: Potential Construction Phase Groundwater Effect Significance (Including Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
Perched Water/ Ephemeral Springs - Pit areas	Medium	Reduction in quantity as a result of spring, or spring catchment, removal.	Negligible	Negligible	Not significant
		Reduction in quality as a result of accidental spillages.	Negligible	Negligible	Not significant
Perched Water/ Ephemeral Springs - BRSF and Surrounding Area	Medium	Reduction in quantity as a result of spring, or spring catchment, removal.	Negligible	Negligible	Not significant
		Reduction in quality as a result of accidental spillages.	Negligible	Negligible	Not significant
Perched Water/ Ephemeral Springs - HLF and Surrounding Area	Medium	Reduction in quantity as a result of spring, or spring catchment, removal.	Negligible	Negligible	Not significant
		Reduction in quality as a result of accidental spillages.	Negligible	Negligible	Not significant
Perennial Springs - Pit areas	Minor	Reduction in quantity as a result of spring, or spring catchment, removal.	Negligible	Negligible	Not significant
		Reduction in quality as a result of accidental spillages.	Negligible	Negligible	Not significant
Perennial Springs - BRSF and Surrounding Area	Minor	Reduction in quantity as a result of spring, or spring catchment, removal.	Negligible	Negligible	Not significant
		Reduction in quality as a result of accidental spillages.	Negligible	Negligible	Not significant
Perennial Springs - HLF and Surrounding Area	Minor	Reduction in quantity as a result of spring, or spring catchment, removal.	Negligible	Negligible	Not significant
		Reduction in quality as a result of accidental spillages.	Low Negligible	Negligible	Not significant
Hydrothermal Springs - Jermuk	High	No activities that could impact the predicted quantity or quality of groundwater at this receptor.	Negligible	Minor	Not significant

Table 6.9.12: Potential Construction Phase Groundwater Effect Significance (Including Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
Groundwater Used for Supply Purposes – Kechut Springs	Medium	No activities that could impact the predicted quantity or quality of groundwater at this receptor.	Negligible	Negligible	Not significant
Groundwater Used for Supply Purposes - Springs North of Gorayk	Minor	No activities that could impact the predicted quantity or quality of groundwater at this receptor.	Negligible	Negligible	Not significant
Groundwater Used for Supply Purposes - Kechut-Spandaryan Tunnel	High	Construction of buildings and lined ponds will locally reduce groundwater recharge.	Negligible	Minor	Not Significant
		Reduction in quality as a result of accidental spillages	Negligible	Minor	Not Significant
Groundwater Component of Surface Water Baseflow - Darb River catchment	Medium	Construction of buildings and lined ponds will locally reduce groundwater recharge.	Negligible	Negligible	Not Significant
		Reduction in quality as a result of accidental spillages	Negligible	Negligible	Not Significant
Groundwater Component of Surface Water Baseflow - Arpa River catchment	Medium	Construction of buildings and lined ponds will locally reduce groundwater recharge.	Negligible	Negligible	Not Significant
		Reduction in quality as a result of accidental spillages	Negligible	Negligible	Not Significant
Groundwater Component of Surface Water Baseflow - Vorotan River catchment	Medium	Construction of buildings and lined ponds will locally reduce groundwater recharge.	Negligible	Negligible	Not Significant
		Reduction in quality as a result of accidental spillages	Negligible	Negligible	Not Significant

Operational Phase Impacts

The operational phase includes the mining of the pits, the operation of the crusher and conveyor, the construction and operations of the HLF and BRSF, and the construction of additional topsoil and ore stockpiles as mining continues. Additional ponds will be added and existing ponds extended during operations. Access roads and ancillary facility (workshops, offices) may be expanded during operation.

During operations, the Project has the potential to impact groundwater quantity and groundwater quality. Water management activities and lining of facilities will reduce groundwater recharge and result in lower groundwater levels in parts of the Project area, and consequent reduction in baseflow to springs, streams and rivers. Management of acid generating barren rock (in the BRSF and backfilled pits) has the potential to impact groundwater quality, as does leakage of pregnant or barren leach solution from the HLF. Infiltration from the pit sumps, and from ore stockpiles also poses a potential risk to groundwater if stockpiles are not appropriately designed and managed.

This section considers the potential impacts and effects on the identified groundwater receptors during the operational phase. The source of the potential impact and subsequent magnitude of change are summarised in Table 6.9.13. The effect significance and scale of significance are also presented in Table 6.9.13. Any potential impacts from operational activities that are not predicted to occur or peak until the post-closure phase are presented in the post_closure impact assessment section.

Perched Water/Ephemeral Springs

Pit Area of Amulsar Peak

There will be no direct loss of ephemeral springs due to mining. Where mining removes some of the catchment area supply to an ephemeral spring, there will be a reduction in catchment area leading to reduced flow. The maximum reduction would occur once the pits have been mined to their maximum extent and depth. The magnitude of potential changes in ephemeral spring discharge quantity in the pit area as a result of operation is considered to be low.

Ephemeral springs are mainly fed by small catchments and near surface flow from snow melt, consequently it is unlikely that quality of the spring water will be impacted unless an activity takes place within that catchment. During the operational phase, leakage from the pits could impact ephemeral spring water quality i.e. if the pit sump is above the elevation of the

ephemeral spring. However, during operations, the majority of the water in the pits will be captured in a sump and pumped out for use in the closed water management system and leakage will be minimal. Therefore, the source of the change in quality will be minimised. Greater leakage would occur if water was temporarily stored for an extended period within the pits (e.g. after snow melt or an extreme rainfall event). However, the quality of that water would be improved by mixing with precipitation. Overall, the magnitude of potential changes in ephemeral spring discharge quality in the pit area as a result of operation is considered to be **low**.

BRSF and Surrounding Area

There are ephemeral springs located in the BRSF area and some of these springs lie within the footprint area of the BRSF. The springs located beneath the BRSF will decrease or cease to flow after the BRSF is constructed. Any temporary discharge from these springs will be captured by the BRSF underdrain and discharged to the closed water management system. Therefore, discharge will be lost from the local and Project area hydrologic system. The magnitude of potential changes in ephemeral spring discharge quantity in the BRSF area as a result of operation is considered to be **high**.

Any spring discharges that remain and are located beneath the BRSF will be captured by the underdrain and discharged to the closed water management system. There will be no release of this captured water to the environment; therefore, the potential impact on spring quality is not considered.

Ephemeral springs that are located in the area of the BRSF, but not beneath it (i.e. springs located in the valley to the west), are predominantly supported by snow melt and near-surface flow. If there is no change to their catchment area and the amount of snow in their catchments, and the management plans are followed, the impact to the quantity and quality of these springs will be **negligible**.

HLF and Surrounding Area

There are ephemeral springs located in the HLF area and some of these springs lie within the footprint area of the HLF. For the same reasons presented in relation to springs located beneath the BRSF, the magnitude of potential changes in ephemeral spring discharge quantity in the HLF area as a result of operation is considered to be **high** and the potential impact on spring quality is not appropriate because of the loss and/or collection of flow.

As with the springs located to the west of the BRSF, the impact to quantity and quality of the ephemeral springs that are located in the area of the HLF will be **negligible**.

Perennial Springs

Pit Area of Amulsar Peak

The perennial springs in the pit area are generally located below the elevation of the final pit floor and all of the springs lie within the seepage/surface discharge zone predicted by the groundwater flow model. This suggests that all of the perennial springs on the mountain flanks will continue to flow. However, because of a reduction in recharge, the groundwater flow model predicts a decrease in groundwater levels in the pit area. This decrease in groundwater levels in turn results in a predicted reduction in spring discharge of approximately 10 %. The magnitude of this change in quantity of discharge at the perennial springs in the pit area is considered to be **low**.

During the operational phase, leakage from the pit sump could impact perennial spring water quality. During operations, the majority of the water in the pits will be captured in sumps and pumped for use in the closed water management system and leakage will be minimal. Therefore, the source of the change in quality will be minimised. Greater leakage would occur if water was temporarily stored within the pits (e.g. after snow melt or an extreme rainfall event). However, the quality of that water would be improved by mixing with precipitation. Overall, the magnitude of potential changes in perennial spring discharge quality in the pit area is considered to be **low**.

BRSF and Surrounding Area

There are perennial springs located in the BRSF area and some of these springs lie within the footprint area of the BRSF. The operational model predicts a decrease in groundwater elevations of up to 60 m in the vicinity of the BRSF because of reduced recharge and perennial springs are likely to cease to flow. The magnitude of potential changes in perennial spring discharge quantity in the BRSF area as a result of operation is considered to be **high** and potential impact on spring quality is not considered.

There is one perennial spring located in the valley to the west of the BRSF. The groundwater model predicts a decrease in flow of 36 % as a result of reduced recharge at the BRSF. The impact on quantity is, therefore, predicted to be **moderate**. The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. pits, and

BRSF) and these springs. Therefore, there is no source of impact on the quality at these springs and the change in quality is considered to be **negligible**.

HLF and Surrounding Area

There are no perennial springs located beneath the HLF footprint or the proposed adjacent PTS (two systems: one to treat contact water from the BRSF from year 5 and the second to treat seepage from the HLF post closure).

Reduced recharge around the HLF is predicted to decrease groundwater elevations of between 3 m and 10 m; therefore, the areas of wet ground near to the HLF could be affected. The potential impact on spring flow quantity is considered to be **moderate**. The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. pits, and HLF) and these springs. Therefore, there is no source of impact on the quality at these springs and the change in quality is considered to be **negligible**.

Hydrothermal Springs

Hydrogeological characterisation indicates that these springs do not receive groundwater flow the Project area. It is not, therefore, possible for changes in groundwater flow or quality within the Amulsar Project area to influence the quantity or quality of discharge from the hydrothermal springs. The potential change in the quantity and quality of discharge from the hydrothermal springs is considered to be **negligible**.

Groundwater Used for Supply Purposes

Kechut (Madikenc) Springs

The groundwater flow model predicts a reduction in recharge to the catchment of these springs, mainly due to a reduction in recharge in the area of the BRSF. The reduction in flow between the baseline and operational phases is predicted to be approximately 10 %. This operational phase change is considered to be of **low** magnitude.

The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. pits, BRSF or HLF) and these springs. Therefore, there is no source of impact on the quality at these springs and the change in quality is considered to be **negligible**.

Springs North of Gorayk

The groundwater flow model predicts that there will be no change in recharge to the catchment in the area of these springs, and no change in groundwater levels, as a result of

the mine development. Therefore, there is no source of impact to the quantity of discharge at these springs and the change is considered to be **negligible**.

The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. pits, BRSF or HLF) and these springs. Therefore, there is no source of impact to quality at these springs and the change in quality is considered to be **negligible**.

Spandaryan-Kechut Tunnel

Under baseline conditions the sluice at the Spandaryan entrance is closed and the tunnel is not in use. The water flowing out from the Kechut end of the tunnel is interpreted to be groundwater. This flow currently augments the water supply in the Kechut Reservoir. The groundwater flow model predicts that there will be a small reduction of recharge in the area that supplies groundwater inflow into the tunnel. This reduction is due to capture of precipitation in the pits for use in mine process water supply and due to reduction of infiltration associated with the construction of the BRSF. This change in recharge is predicted to reduce to groundwater inflow to the tunnel by approximately 1 %. The magnitude of change in flow quantity is considered to be **low**.

While the groundwater flow model predicts no pathways from the mine facilities to the tunnel, the water in the tunnel is considered a highly sensitive receptor and subject to considerable stakeholder concerns. Therefore, as a worst-case analysis it is assumed that infiltration flowing westwards from the pits and the BRSF has the potential to change the quality of groundwater entering the tunnel. The predicted changes in groundwater quality in the tunnel are not predicted to occur during the operational phase, so the magnitude of change in groundwater quality at the tunnel is considered to be **negligible**. The peak impact is predicted to occur during the closure phase, presented later in this chapter.

Groundwater Component of Surface Water Baseflow

Darb River Catchment

The groundwater flow model predicts that there will be a reduction in groundwater input to baseflow in the Darb River of approximately 1 %. This reduction in flow is predominantly caused by a reduction in recharge in the Darb River catchment area due to the pits capturing the precipitation that would have contributed to infiltration and groundwater recharge under

baseline conditions. Pit water will enter the closed water management system during operations. The predicted change in baseflow will be of **low** magnitude.

The groundwater flow model predicts that there are potential flowpaths from the pits to the Darb River. A change in groundwater quality could be caused by infiltration from the pit sumps. Because of the long groundwater travel time (tens of years), the predicted impacts to groundwater at the Darb River are not predicted to occur during the operational phase, so the magnitude of change is considered to be **negligible**. The peak impact is predicted to occur during the closure phase, presented later in this chapter.

Arpa River Catchment

The groundwater flow model predicts that there will be a reduction in groundwater input to baseflow in the Darb River of approximately 2 %. This reduction in flow is predominantly caused by a reduction in recharge of precipitation to groundwater beneath the BRSF and HLF compared to baseline conditions. The predicted change will occur during the operational phase and will be of **low** magnitude.

The groundwater flow model predicts that there will be flowpaths towards the Arpa River from the HLF and the BRSF. Any change in groundwater quality beneath the HLF or BRSF due to leakage from these facilities has the potential to impact groundwater quality adjacent to the Arpa River. The changes in groundwater quality as a result of leakage from the HLF are predicted to affect groundwater adjacent to the Arpa River downgradient of the HLF (a zone approximately 8 km downstream of the Kechut Reservoir). If the groundwater affected by leakage from the BRSF were to enter the Spandaryan-Kechut Tunnel rather than discharge as baseflow then there would be no quality change in groundwater adjacent to the Arpa River; the only change would be due to the potential impact of the HLF.

Therefore, impacts due to leakage from both the HLF and the BRSF are considered in this assessment. Because of the long groundwater travel time, the assessment of potential impact from the BRSF (Appendix 6.9.5) and the assessment of potential impact from the HLF (Appendix 6.9.4) predict that the maximum change in groundwater quality adjacent to the Arpa River will not occur during the operational phase. Therefore, the magnitude of change is considered to be **negligible**. The peak impact is predicted to occur during the closure phase, presented later in this chapter.

Vorotan River Catchment

The groundwater flow model predicts that there will be a reduction in groundwater input to baseflow in the Vorotan River of approximately 3 %. This reduction in flow is predominantly caused by reduced recharge to groundwater beneath the BRSF, and by the capture and use of precipitation in the pits. The predicted change will occur during the operational phase and will be of **low** magnitude.

The groundwater flow model predicts that there are potential flowpaths from the pits to the Vorotan River. A change in groundwater quality could be caused by infiltration from the pit sumps. Because of the long groundwater travel time, the predicted impacts to groundwater at the Vorotan River are not predicted to occur during the operational phase, so the magnitude of change is considered to be **negligible**. The peak impact is predicted to occur during the closure, presented later in this chapter.

Table 6.9.13: Potential Operational Phase Groundwater Effect Significance (Including Mitigation Measures)					
Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
Perched Water/ Ephemeral Springs - Pit areas	Medium	Possible reduction in flows as a result of changes within their localised catchment area.	Low	Minor	Not significant
		Leakage from water stored within the pits may decrease water quality.	Low	Minor	Not significant
Perched Water/ Ephemeral Springs - BRSF and Surrounding Area	Medium	Loss of springs under BRSF footprint.	High	Moderate	Significant
		No change in catchment area predicted for springs located in the BRSF area, but outside the BRSF footprint.	Negligible	Negligible	Not significant
		No predicted quality impact predicted for springs located in the BRSF area.	Negligible	Negligible	Not significant
Perched Water/ Ephemeral Springs - HLF and Surrounding Area	Medium	Loss of springs under HLF footprint	High	Moderate	Significant
		No change in catchment area predicted for springs located in the HLF area, but outside the HLF footprint.	Negligible	Negligible	Not significant

Table 6.9.13: Potential Operational Phase Groundwater Effect Significance (Including Mitigation Measures)					
Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
		No predicted quality impact predicted for springs located in the HLF area	Negligible	Negligible	Not significant
Perennial Springs - Pit areas	Minor	Reduction in flows of to the springs due to a reduction in recharge are and groundwater levels.	Low	Negligible	Not significant
		Leakage from water stored within the pits may decrease water quality.	Low	Negligible	Not significant
Perennial Springs - BRSF and Surrounding Area	Minor	Loss of springs under BRSF footprint	High	Moderate	Significant
		Reduction in flow to spring to the west of the BRSF.	Moderate	Minor	Not significant
		No predicted quality impact.	Negligible	Negligible	Not significant
Perennial Springs - HLF and Surrounding Area	Minor	Reduction of catchment for springs in immediate area.	Moderate	Moderate	Not significant
		No predicted quality impact.	Negligible	Negligible	Not significant
Hydrothermal Springs - Jermuk	High	No predicted change in flows.	Negligible	Minor	Not significant
		No predicted change in quality.	Negligible	Minor	Not significant
Groundwater Used for Supply Purposes – Kechut Springs	Medium	Small reduction in flows predicted as a result of reduced recharge in the BRSF area.	Low	Minor	Not significant
		No predicted change in quality.	Negligible	Negligible	Not significant
Groundwater Used for Supply Purposes - Springs North of Gorayk	Minor	No predicted change in flows.	Negligible	Negligible	Not significant
		No predicted change in quality.	Negligible	Negligible	Not significant
Groundwater Used for Supply	High	Predicted reduction in groundwater flow to tunnel of approximately	Low	Moderate	Significant [^]

Table 6.9.13: Potential Operational Phase Groundwater Effect Significance (Including Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
Purposes – Spandaryan-Kechut Tunnel		1 %.			
		Infiltration from pits and leakage from BRSF. No change in quality predicted during the operational phase. Change in quality predicted to occur in closure phase.	Negligible	Minor	Not significant
Groundwater Component of Surface Water Baseflow - Darb River catchment	Medium	Reduction in baseflow predicted to be approximately 1 %.	Low	Minor	Not significant
		Infiltration from pits. No change in quality predicted during the operational phase. Change in quality predicted to occur in closure phase.	Negligible	Negligible	Not significant
Groundwater Component of Surface Water Baseflow - Arpa River catchment	Medium	Reduction in baseflow predicted to be approximately 2 %.	Low	Minor	Not significant
		Leakage from HLF and BRSF. No change in quality predicted during the operational phase. Change in quality predicted to occur in closure phase.	Negligible	Negligible	Not significant
Groundwater Component of Surface Water Baseflow - Vorotan River catchment	Medium	Reduction in baseflow predicted to be approximately 3 %.	Low	Minor	Not significant
		Infiltration from pits and leakage from BRSF. No change in quality predicted during the operational phase. Change in quality predicted to occur in closure phase.	Negligible	Negligible	Not significant
Notes: ^ Groundwater inflow was not intended to be the main source of water in the Spandaryan-Kechut tunnel that provides supply, so this reduction in flows should not be considered as a material impact.					

Closure Phase Impacts

During closure, reduced recharge rates in developed areas (the BRSF, HLF and backfilled pits) may result in a long term decrease in groundwater levels in some areas, whilst capture of precipitation in any open pits will result in enhanced recharge and locally increased groundwater levels. Groundwater baseflow to springs, streams and rivers may therefore be increased or decreased in closure, depending on the area considered.

Areas of barren rock backfill/storage will continue to pose a potential risk to groundwater quality in closure, as will the spent ore within the HLF.

Any impacts resulting from operational activities that are not predicted to be detected at the receptors until the post-closure phase, or that are predicted to be at their peak during the post closure phase, are also considered in this part of the impact assessment. The source of the potential impact and subsequent magnitude of change are summarised in Table 6.9.15. The effect significance and scale of significance are also presented in Table 6.9.15.

Perched Water/Ephemeral Springs

Pit Area of Amulsar Peak

There will be no direct loss of any ephemeral springs in this area. There will be a possible small permanent reduction of the catchment area as the southern end of the Tigranes/Artavazdes pit and Erato pit will not be backfilled completely, leading to a reduction in flow. The magnitude of any potential long-term post closure changes in ephemeral spring discharge quantity in the pit area is considered to be **low**.

Ephemeral springs are predominantly supported by snow melt and near-surface flow, consequently it is unlikely that quality of the spring water will be impacted unless leakage from the pits enters the spring catchment, which is considered unlikely given the hydrologic setting and elevation of the ephemeral springs. Therefore, the predicted impacts on the quality of these springs will be **negligible**.

BRSF and Surrounding Area

There are ephemeral springs located in the BRSF area and some of these springs lie within the footprint area of the BRSF.

The springs located beneath the BRSF will have substantially decreased or ceased to flow

during construction of the BRSF. Any residual discharge from these springs will be captured by the BRSF underdrain, piped to the HLF drainage system, from which the overflow would be treated through a PTS¹¹ and to ground, post-closure. Therefore, although the springs beneath the BRSF will not discharge to the same location, any small residual quantities of water from the BRSF will remain in the local hydrologic system. The magnitude of potential changes in ephemeral spring discharge quantity in the BRSF area during closure and post-closure is considered to be **moderate**.

Treatment of the captured groundwater will be to MAC II standards. This will represent a measureable change in quality where the baseline quality is different to the MAC II standards. This impact would be positive where the baseline quality was poorer than the MAC II standards. The worst predicted magnitude of the impact is **low** and would occur if the treated water quality is poorer than the baseline water quality but better than the MAC II standards. The treated groundwater will be discharged to surface water; the impacts are presented in Chapter 6.10.

Ephemeral springs that are located in the area of the BRSF, but not beneath it (i.e. springs located in the valley to the west), are predominantly supported by snow melt and near-surface flow. There are no activities that will take place during closure or post-closure that will result in a change in quality of the near surface flow. If there is no change to their catchment area, or the amount of snow in their catchments, there will be no change in the amount of water available for discharge. Therefore, the predicted impact to ephemeral spring discharge quantity and quality during closure and post-closure is considered to be **negligible**.

HLF and Surrounding Area

There are ephemeral springs located in the HLF area and some of these springs lie within the footprint area of the HLF. For the same reasons presented in relation to springs located beneath the BRSF, the magnitude of potential impact to ephemeral spring discharge quantity is considered to be **moderate** and the impact to quality during closure and post-closure is considered to be **low**. The changes in quantity and quality to ephemeral springs in the surrounding area will be **negligible**.

¹¹ Sovereign Consulting Inc., 2014 Amulsar BRSF Passive Treatment System (PTS) Design Basis. Technical Memorandum to GRE, Dated 7 August 2014.

Perennial Springs

Pit Area of Amulsar Peak

The groundwater flow model predicts an increase in groundwater levels in the area of the Erato pit in the post-closure phase of up to 16 m. This will increase the perennial spring flow in this area. A decrease in groundwater levels in the area of the Tigranes-Artavazdes pit in the post-closure phase of up to 40 m is predicted. This will decrease the perennial spring flow in this area. The net flow from the perennial springs around the peak is predicted to decrease by between 1 % and 6 % from baseline conditions as a result of these changes. Some perennial springs that currently flow at a very low rate during winter, particularly in the vicinity of Tigranes-Artavazdes, may become ephemeral (dry during the winter months). The impact is therefore considered to be low.

Leakage to groundwater from the backfill in the Tigranes-Artavazdes and seepage from backfill water body in the partially backfilled Erato pit presents a potential source of a change in the quality of the springs around the pit. The water quality change is presented in Appendix 6.9.3. The results summarised in Table 6.9.5 show that there is a predicted decline in groundwater quality flowing from the pit area to nearby springs during the closure/post-closure period. The constituents that are predicted to result in the greatest impact are beryllium, cobalt, nickel and nitrate. Beryllium, cobalt and nickel are natural geochemical constituents associated with the ore body. Nitrate concentrations in groundwater could potentially increase during closure as a result of the release of ammonium nitrate from blasting. In the longer term, these peak concentrations will decline.

It is important to note that the impact magnitude indicated in Table 6.9.5 is determined in relation to the MAC II standards. These are surface water standards and have been used in the groundwater assessment in the absence of applicable Armenian groundwater standards. The World Health Organisation (WHO) provides a drinking water guideline value for nickel of 0.07 mg/l and for nitrate is 50 mg/l (11 mg N/L). The predicted concentrations for these constituents at the springs are well below these standards. There are no WHO groundwater standards for beryllium or cobalt.

It is important to note that groundwater is not used as a resource, groundwater in this area is unlikely to be used for water supply, and there are no standards against which to classify the change of quality in groundwater. The surface water MAC II standards have been used as a tool to determine the magnitude of change. Based on this, there is a predicted decline in

groundwater quality at the springs, which is classified as high. However, surface water and the ecology that is supported by groundwater discharge are the appropriate receptors with regard to change in groundwater quality. The impact of discharge of groundwater to the Votoran River on the quality of surface water is considered in Chapter 6.10.

BRSF and Surrounding Area

Reduced recharge in the area of the BRSF is predicted to decrease groundwater levels in the area by up to 60 m. Groundwater discharge to surface will likely cease in the southern part of the BRSF site. Therefore, the perennial springs that discharge in the area beneath the BRSF are predicted to be lost and the impact is considered to be **high**. As there is predicted to be no discharge from these springs, no assessment of change in quality is necessary.

In the valley to the west of the BRSF, there is predicted to be a reduction in groundwater levels that results in reduced discharge of up to 20 % from springs in the post-closure scenario (Appendix 6.9.1). This impact is considered to be **moderate**. The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. backfilled pits or BRSF) and the perennial springs. Therefore, there is no source of impact to quality at these springs and the change in quality is considered to be **negligible**.

HLF and Surrounding Area

There are no perennial springs located beneath the HLF footprint.

Reduced recharge across the HLF footprint is predicted to result in a decrease in groundwater levels of up to 13 m resulting in a post-closure reduction or loss of wet areas of ground that are present all year round. Therefore, the impact is considered to be **high**. As there is predicted to be no discharge from these springs, no assessment of change in quality is necessary.

The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. backfilled pits, BRSF or HLF) and the perennial springs. Therefore, there is no source of impact to quality at these springs and the change in quality is considered to be **negligible**.

Hydrothermal Springs

Baseline characterisation has concluded that these springs do not receive groundwater flow from the Project area. It is not, therefore, possible for changes in groundwater flow or quality within the Amulsar Project area to influence the quantity or quality of discharge from the geothermal springs. On this basis, the potential change in the quantity and quality of discharge from the geothermal springs is considered to be **negligible** for the closure phase of the Project lifecycle.

Groundwater Used for Supply Purposes

Kechut (Madikenc) Springs

The groundwater flow model predicts a reduction of recharge to the catchment of these springs, mainly due to a reduction in recharge in the area of the BRSF. The reduction in flow between the baseline and post-closure phases is predicted to be between approximately 7 % and 8 %. This post-closure phase change is considered to be of **low** magnitude.

The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. backfilled pits, BRSF or HLF site) and these springs. Therefore, there is no source of impact to quality at these springs and the change in quality is considered to be **negligible**.

Springs North of Gorayk

The groundwater flow model predicts that there will be no change in recharge to the catchment in the area of these springs, and no notable change in groundwater levels, during the post closure phase. Therefore, there is no source of impact to the quantity of discharge at these springs and the change is considered to be **negligible**.

The groundwater flow model does not predict any flowpaths between any of the potential sources of impact (i.e. backfilled pits, BRSF or HLF site) and these springs. Therefore, there is no source of impact to quality at these springs and the change in quality is considered to be **negligible**.

Spandaryan-Kechut Tunnel

The groundwater flow model predicts that there will be a reduction of recharge in the area that supplies groundwater inflow into the tunnel. This reduction is due to the remaining pits capturing precipitation and groundwater, and due to the presence of the BRSF reducing

infiltration. This change in recharge is predicted to reduce to groundwater inflow to the tunnel by approximately 2 % to 3 % during the post-closure phase. Based on this, the magnitude of change in flow quantity is considered to be low. It is important to note that groundwater inflow was not intended to be the main source of water in the tunnel that provides supply, so this reduction in flows should not be considered as a material impact.

Based on the groundwater flow model results, groundwater originating from the pits or BRSF does not enter the tunnel. However, given the sensitivity of the Spandaryan-Kechut water supply and potential model uncertainty, the groundwater in the Spandaryan-Kechut Tunnel has been considered as a potential receptor to changes in groundwater quality originating from the BRSF and pits in the operational and closure phases. Impacts to quality from both phases are predicted, with the peak being predicted in the post-closure phase. The results of both of these assessments have been combined to predict the change in groundwater quality in the tunnel presented in Table 6.9.14.

Table 6.9.14: Peak Combined Impacts on Groundwater Quality in the Spandaryan-Kechut Tunnel from the BRSF and Pits					
Constituent	Unit	Arpa MAC Category II	Average Baseline Concentration	Predicted Peak Conc'n	Percentage Change
Nitrate as N	mg/L	2.5	0.5	0.9	81%
Sulphate	mg/L	16.04	126	126.52	0.4%
Beryllium	mg/L	3.8×10^{-5}	0.00003	0.00003	0%
Nickel	mg/L	0.0103	0.003	0.003	0%
Arsenic	mg/L	0.02	0.0068	0.0068	0%
Cobalt	mg/L	0.00036	0.0051	0.00051	0%
Cadmium	mg/L	0.00101	0.0005	0.0005	0%
Chromium III	mg/L	0.011	0.005	0.005	0%
Lithium	mg/L	0.003	0.00427	0.00445	4.2%
Tin	mg/L	8.00×10^{-5}	n/a	0.00011	n/a
Notes: MAC II concentrations provided for information only since does not apply directly to groundwater.					

Based on the above predicted changes in groundwater quality in the tunnel, the magnitude of impact is considered to be **low**.

The groundwater flow in the tunnel discharges to the Kechut Reservoir. An assessment of the potential effects on that receptor is discussed in the Surface Water Impact Assessment (Chapter 6.10). However, it is more likely that the tunnel will not capture groundwater originating from the pits and BRSF, and there would be no change in water quality. In this case, the impact originating from the pits and BRSF would only have the potential to affect the concentrations in groundwater before discharge to the Darb River (see below).

Groundwater Component of Surface Water Baseflow

Darb River Catchment

The groundwater flow model predicts that there will be a reduction in groundwater input to baseflow in the Darb River of approximately 1 % during post-closure. This reduction in flow is predominantly caused by a change in recharge rates and hydraulic gradient in the area of the pits. The predicted change will occur during the operational phase and will be of **low** magnitude.

It is most likely that the Spandaryan-Kechut Tunnel will not capture groundwater affected by leakage from the pits; therefore, the pits represent a source of potential impact to groundwater quality adjacent to the Darb River. The assessment of the peak change in groundwater quality as a result of leakage from the pits is presented in Appendix 6.9.3 and summarised in Table 6.9.4. The magnitude of the peak impact is considered to be **low**. In the longer term these peak concentrations will decline and the change in quality will reduce.

Arpa River Catchment

The groundwater flow model predicts that there will be a reduction in groundwater input to baseflow in the Darb River of approximately 2 %. This reduction in flow is predominantly caused by a reduction of recharge to groundwater beneath the remaining elements of the BRSF and HLF. The predicted change will occur during the operational phase and will be of **low** magnitude.

The groundwater flow model predicts that the BRSF and HLF represent potential sources of impact to the Arpa River in the closure period. It is most likely that the Spandaryan-Kechut Tunnel will not capture groundwater affected by leakage from the BRSF; therefore, groundwater quality adjacent to the Arpa River could be impacted by leakage from the BRSF. Predicted changes in the quality of groundwater adjacent to the Arpa River as result of leakage from the BRSF are presented in Appendix 6.9.5 and summarised in Table 6.9.11.

Predicted changes in the quality of groundwater adjacent to the Arpa River as result of leakage from the HLF are presented in Appendix 6.9.4 and summarised in Table 6.9.7.

The impacts from each source will take place in groundwater in different parts of the Arpa catchment, so are localised to different areas. This is shown by the predicted pathlines from the BRSF and HLF (see Figure 6.9.3). The changes in groundwater quality as a result of leakage from the HLF are predicted to affect groundwater adjacent to the Arpa River downgradient of the HLF (a zone approximately 8 km downstream of the Kechut Reservoir). These changes are considered to be **low** in magnitude. The changes in groundwater quality as a result of leakage from the HLF are predicted to affect groundwater adjacent to the Arpa River downgradient of the HLF (a zone approximately 8 km downstream of the Kechut Reservoir). These changes are also considered to be **low** in magnitude. In the longer term these peak concentrations will decline and the change in quality will reduce.

The combined impacts of discharge of groundwater to the Arpa River on the overall quality of the Arpa River are considered in Chapter 6.10.

Vorotan River Catchment

The groundwater flow model predicts that there will be a reduction in groundwater input to baseflow in the Vorotan River of approximately 2 % in post-closure. This reduction in flow is predominantly caused by a change in recharge due to capture of precipitation in the remaining pit voids, and a change in hydraulic gradient in the pit and BRSF areas. The predicted change will occur during the operational phase and will be of **low** magnitude.

The predicted pathlines (see Figure 6.9.3) indicate that the pits represent a potential source of impact to groundwater quality adjacent to the Vorotan River. The assessment of the peak change in groundwater quality as a result of leakage from the pits is presented in Appendix 6.9.3 and summarised in Table 6.9.4. There is a high impact change in water quality predicted along pathway 3 from the Erato Pit in relation to lithium, and a moderate change predicted along pathway 2 from the Tigranes-Artavazdes Pit in relation to nitrate and sulphate. The magnitude of the peak impact is considered to be **high**. In the longer term these peak concentrations will decline and the change in quality will reduce.

It is important to note that groundwater is not used as a resource and there are no standards against which to classify the change of quality in groundwater. The surface water MAC II

standards have been used as a tool to determine the magnitude of change, but surface water, and the ecology that is supported by it, are more relevant receptors than the change in groundwater quality. The impact of discharge of groundwater to the Vorotan River on the quality of surface water is considered in Chapter 6.10.

Table 6.9.15: Predicted Closure Phase Groundwater Effect Significance (Including Design Mitigation)					
Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
Perched Water/ Ephemeral Springs - Pit areas	Medium	Potential small reduction in recharge to catchments.	Low	Minor	Not significant
		Springs fed by seasonal snow melt from a small local catchment. No predicted quality impacts in catchment.	Negligible	Negligible	Not significant
Perched Water/ Ephemeral Springs - BRSF and Surrounding Area	Medium	Reduction in spring flow due to reduced recharge.	Moderate	Moderate	Significant
		Potential impact from BRSF leakage, but captured water will be treated and discharged water will be MAC II quality or better.	Low	Minor	Not significant
		Springs fed by seasonal snow melt from a small local catchment. No change in catchments predicted.	Negligible	Negligible	Not significant
		Springs fed by seasonal snow melt from a small local catchment. No predicted quality impacts in catchment.	Negligible	Negligible	Not significant
Perched Water/ Ephemeral Springs - HLF and Surrounding Area	Medium	Reduction in spring flow due to reduced recharge.	Moderate	Moderate	Significant
		Potential impact from HLF leakage, but captured water will be treated and discharged water will be MAC II quality or better.	Low	Minor	Not significant
		Springs fed by seasonal snow melt from a small local catchment. No change in catchments predicted.	Negligible	Negligible	Not significant
		Springs fed by seasonal	Negligible	Negligible	Not

Table 6.9.15: Predicted Closure Phase Groundwater Effect Significance (Including Design Mitigation)					
Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
		snow melt from a small local catchment. No predicted quality impacts in catchment.			significant
Perennial Springs - Pit areas	Minor	Decrease in water levels leading to up to 6 % reduction in spring flow.	Low	Negligible	Not significant
		Decline in predicted water quality with respect to beryllium, cobalt, nickel and nitrate.	High	Moderate	Significant*
Perennial Springs - BRSF and Surrounding Area	Minor	Reduction of groundwater levels and a loss of springs under BRSF footprint	High	Moderate	Significant
		Predicted reduction in flow at perennial springs located to the west of the BRSF.	Moderate	Minor	Not significant
		No predicted pathway from any source to the springs located west of the BRSF.	Negligible	Negligible	Not significant
Perennial Springs - HLF and Surrounding Area	Minor	Reduction of groundwater levels and likely loss of wet areas of ground in HLF area.	High	Moderate	Significant
		No predicted pathway from any source to the springs located west of the BRSF.	Negligible	Negligible	Not significant
Hydrothermal Springs - Jermuk	High	No predicted change in flows.	Negligible	Minor	Not significant
		No predicted change in quality.	Negligible	Minor	Not significant
Groundwater Used for Supply Purposes – Kechut Springs	Medium	Small reduction in spring flow predicted.	Low	Minor	Not significant
		No predicted pathway from any source to the springs.	Negligible	Negligible	Not significant
Groundwater Used for Supply Purposes - Springs North	Minor	No change in recharge in this area predicted, so no reduction in spring flow.	Negligible	Negligible	Not significant
		No predicted pathway from any source to the	Negligible	Negligible	Not significant

Table 6.9.15: Predicted Closure Phase Groundwater Effect Significance (Including Design Mitigation)					
Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Change	Effect Significance	Scale of Significance
of Gorayk		springs.			
Groundwater Used for Supply Purposes - Spandaryan - Kechut Tunnel	High	Slight reduction in groundwater input to tunnel predicted.	Low	Moderate	Significant^
		Slight decline in the quality of groundwater inflow into the tunnel if flow from the BRSF and pits is captured.	Low	Moderate	Significant^
Groundwater Component of Surface Water Baseflow - Darb River catchment	Medium	Small reduction in flow predicted.	Low	Minor	Not significant
		Small decrease in groundwater quality as a result of leakage from the pits.	Low	Minor	Not significant
Groundwater Component of Surface Water Baseflow - Arpa River catchment	Medium	Small reduction in flow predicted.	Low	Minor	Not significant
		Small decrease in groundwater quality as a result of leakage from the BRSF and HLF.	Low	Minor	Not significant
Groundwater Component of Surface Water Baseflow - Vorotan River catchment	Medium	Small reduction in flow predicted.	Low	Minor	Not significant
		Decline in groundwater quality as a result of leakage from the pits.	High	Moderate	Significant*
Notes: * Surface water and the ecology that is supported by groundwater are the relevant receptors. See Chapter 6.10 for assessment of surface water as the end receptor, and Chapter 6.11 for ecology. ^ Groundwater inflow was not intended to be the main source of water in the tunnel that provides supply, so this reduction in flows should not be considered as a material impact.					

6.9.7 Mitigation Measures

There are no significant impacts to flow or quality predicted at the Jermuk Springs, Kechut Springs or the Springs North of Gorayk.

Throughout the Project construction, operation, and closure there are some predicted total

losses of springs due to construction of the BRSF and the HLF. These impacts are considered significant. However, the impacts cannot be avoided as the facilities are optimally located. The associated effects on surface water and ecology that result from these spring losses are considered in Chapters 6.10 and 6.11, respectively.

Elsewhere, where springs are impacted, the predicted decrease in spring flows is not significant.

Significant impact to water quality at springs located around the pits is predicted with respect to beryllium, cobalt, nickel and nitrate as a result of leakage from the pits. Nitrate originates from blasting. The blasting assessment is conservative and assumes the use of ANFO explosives and a residual nitrogen load from unexploded conditions. Monitoring is recommended to determine the actual scale of the impact from nitrates on groundwater. If monitoring identifies an increasing trend in nitrate concentrations, mitigation options (such as promotion of microbiological reactions¹⁰ or a change in explosive type), will be evaluated. The increase in beryllium, cobalt and nickel are a result of the release of these constituents from the backfill. These constituents are naturally present in this mineralised area. Design mitigation measures are proposed to limit the leakage from the pits. No further groundwater mitigation options are presented.

There is also a significant impact predicted to groundwater quality adjacent to the Vorotan River as a result of leakage from the pits. The change in groundwater quality is high, and the moderate sensitivity of this receptor results in the significant impact. As noted previously, the end receptors of the predicted change in groundwater quality are surface water and ecology. Therefore, no additional mitigation is presented here to limit or avoid this impact. The sensitivity of the surface water and ecology receptors, the significance of the change in groundwater quality on these, and any relevant mitigation measures are considered in Chapters 6.10 and 6.11, respectively.

There is a potentially significant predicted impact to groundwater input to the Spandaryan-Kechut Tunnel. However, groundwater inflow is not intended to be the main source of water in the tunnel that provides supply to the Kechut Reservoir, so this reduction in quality should not be considered as a material impact to water resources in the area. Therefore, no additional mitigation is presented to limit or avoid this impact.

Cover test plots, incorporating lysimeters, will be conducted during the operational phase to determine and confirm the long-term infiltration rates through the proposed cover systems (at sites where cover is to be placed, e.g. BRSF and HLF). These tests will be used to confirm the proposed cover or recommend modifications to limit recharge.

General good practice measures that will be followed include:

- Use of appropriate explosives handling techniques during transport and storage to minimise explosives loss, immediate containment and clean-up of any spillages, appropriate charge loading procedures to minimise explosives loss, and appropriate procedures to manage blasting to minimise misfires;
- Minimising use of water and recycling water;
- Diverting water of appropriate quality back to the environment;
- Appropriate storage of chemicals; and
- Water quality monitoring (see below).

These measures will not change the significance of the predicted impacts, but will strengthen the on-going operational assessment of mitigation measures.

6.9.8 Residual Impact Assessment

No additional mitigation measures are presented that will alter the outcome of the initial assessment. The surface water and ecology impact assessment chapters (Chapter 6.10 and 6.11) should be read in conjunction with this groundwater impact assessment in order to understand the overall significance of the predicted changes in groundwater quantity or quality.

6.9.9 Monitoring and Audit

The predicted changes in groundwater quantity or quality will be confirmed by the monitoring programme. The monitoring will enable further mitigation measures if changes are greater than predicted. Monitoring requirements identified through the assessment process are outlined below and in Table 6.9.16. Details of the proposed monitoring programme (monitoring locations, schedule, metrics and methods) are included in the Environmental Monitoring Plan (EMP) and include:

- Baseline, construction, operational and post-closure monitoring of groundwater levels and groundwater quality (wells and springs) surrounding the pits;
- Baseline, construction, operational and post-closure monitoring of groundwater levels and groundwater quality (wells and springs) hydraulically up- and down-gradient of the BSRF;
- Baseline, construction, operational and post-closure monitoring of groundwater levels and groundwater quality (wells and springs) hydraulically up- and down-gradient of the HLF;
- Monitoring of spring flow and quality in:
 - The Madikenc Springs, adjacent to Kechut Reservoir;
 - Springs above Gorayk used for seasonal water supply; and
 - Sentinel springs surrounding the pit area;
- Monitoring of water quantity and quality in the Spandaryan-Kechut Tunnel; and
- During the construction phase, participatory monitoring of ground and surface water will be encouraged through consultation with local communities, such that field sampling, on-site lab analysis and recording of environmental data is shared with representatives, to compliment participation in other aspects of environmental and social monitoring during the operational phase of the Project.

The Environmental Monitoring Plan (EMP) is a live document that will be updated during the mine development to allow for adaption as a result of monitoring location loss and replacement, and improvement in the understanding of the water environment. The most current version of the monitoring plan should be referenced for the monitoring applicable to each phase of mine development.

The mine is designed to reuse all mine contact water. Operational Management Plans for the BRSF, BRSF toe pond, contact water pond and HLF process and storm ponds will be developed to confirm that there are no discharges to the groundwater environment. Non-contact water will be discharged to the environment and will be monitored as necessary prior to discharge. Monitoring requirements for these discharges will be incorporated in Operational Management Plans. Monitoring strategies will be based on the source of non-contact water and volume of discharge.

Monitoring of operational flow and water quantity (water balance) and quality within the HLF (in the heap, leakage collection and recovery system and underdrain) and in the pit sumps is

a key part of environmental management during operations. This is not a component of the EMP, but will be incorporated in Operational Management Plans.

Table 6.9.16: Monitoring and Audit Programme		
Water Resources - Monitoring and Audit Programme		
Monitoring approach	Baseline	Pre-construction baseline monitoring has been undertaken between 2007 and 2015 to define the baseline surface water and groundwater conceptual model of the Project area, as outlined in Section 4.8. Baseline investigations and impact assessment have identified sensitive receptors and potential risks associated with aspects of the proposed mine development, which will require monitoring and mitigation during construction, operation and post-closure phases. Baseline water quality data has been used in conjunction with RA Category II MACs to derive quality targets, included in the Environmental Monitoring Plan, against which construction and operation monitoring data will be assessed.
	Construction and operation phases	Surface water and groundwater monitoring will continue to be undertaken during the construction and operation phases and compared with quality targets defined in the EMP to verify that any impacts are similar those predicted through the ESIA process and to give an advanced warning (where possible) of any potential deviation from the predicted conditions that could negatively impact surface water and groundwater receptors.
	Post-closure phase	Surface water and groundwater monitoring should continue beyond the cessation of mining activities and mine closure for aftercare purposes. Post closure monitoring requirements will be defined through development of the EMP.
Significant Effects		
Modification of groundwater flow	<ul style="list-style-type: none">• Changes in groundwater characteristics (level and distribution) due to mining activities.• Reduced flow to high elevation springs surrounding the pits.• Reduction in surface water base flows in major tributaries and in rivers.• Reduction in flow of water supply at Madikenc Springs and in the Spandaryan-Kechut Tunnel	
Modification of groundwater quality	<ul style="list-style-type: none">• Changes to groundwater quality arising from blasting residues.• Changes to groundwater quality from mining-influenced water in the open pit walls and floor.• Changes in groundwater quality arising from leakage from the BRSF and HLF to groundwater.• Changes to groundwater quality from accidental spills.	
Specific Actions		
Level 2 Management Plans	The Construction Environmental Management Plan (CEMP) will be prepared by the E-PCM Contractor. The CEMP will include best practice mitigation procedures to minimise as far as possible the risk of adverse impact to the local water environment as a result of the construction phase.	
	The Mine Closure Management Plan (MRCRP) defines the management of water resources from the construction phase through to the mine closure plan, so that on reclamation water resources will have been maintained to achieve the objectives of the Plan.	

Table 6.9.16: Monitoring and Audit Programme

Water Resources - Monitoring and Audit Programme			
	The Water Management Plan (WMP) provides an outline design for water management which complies with the relevant effluent discharge standards; and proposes a monitoring and mitigation scheme for prevention of any adverse impacts to the local and regional surface water and groundwater regime as a result of Project activities.		
	The Spill Prevention and Response Plan (SPRP) defines the measures that will be taken to manage, control and monitor substances that have the potential to adversely affect water resources.		
Level 3 SOPs	<p>The Level 2 plans will be underpinned by the following SOPs that will provide specific guidance on sampling and/or monitoring locations and procedures during the construction, operational and closure phases. The Level 3 SOPs for groundwater are incorporated in the EMP, and include the following:</p> <ul style="list-style-type: none"> • Groundwater well design and installation: procedures for the design and installation for new monitoring wells required as a result of findings of the baseline monitoring program, or well failure. • Groundwater level monitoring (construction, operation and post-closure phases): procedures for point and continuous monitoring of groundwater (levels) within existing monitoring boreholes across the open pit, WDF and HLF areas. • Groundwater quantity monitoring: procedures for the quantitative monitoring of spring flows, condition of springs and seepages will be monitored qualitatively where appropriate (i.e. springs are dry or with undetectable flow). • Groundwater quality monitoring (construction, operation and post-closure phases): procedures for sampling for <i>in situ</i> field parameter measurement and <i>ex situ</i> laboratory quality analyses, from existing monitoring locations (springs and monitoring boreholes) across the open pits, BRSF and HLF areas, Spandaryan-Kechut Tunnel discharge, and springs. 		
Groundwater Monitoring SOP		Strategy	Monitoring
Groundwater level	Open pit, BRSF and HLF areas	Construction and operational phase monitoring to identify any changes to the groundwater system.	Procedures for collection, recording, storage, quality assurance and evaluation of groundwater level data in the baseline and construction phase are incorporated in the EMP. The EMP is a live document and operational and closure phase monitoring requirements will be developed as appropriate during the life of the mine.

Table 6.9.16: Monitoring and Audit Programme

Water Resources - Monitoring and Audit Programme			
	Spring conditions	Construction, operational and post-closure monitoring to identify any changes to the groundwater system.	Procedures for collection, recording, storage, quality assurance and evaluation of spring condition data in the baseline and construction phase are incorporated in the EMP. The EMP is a live document and operational and closure phase monitoring requirements will be developed as appropriate during the life of the mine.
Groundwater quality	Main infrastructure areas	Up-gradient and down-gradient monitoring of groundwater quality within the vicinity of each of the main infrastructure areas, during baseline, construction and operational phases.	Procedures for collection, recording, storage, quality assurance and evaluation of groundwater quality data in the baseline and construction phase are incorporated in the EMP. The EMP is a live document and operational and closure phase monitoring requirements will be developed as appropriate during the life of the mine.

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APPENDICES

Appendix 6.10.1 Site Wide Water Balance (2016)

6.10 Surface Water Resources

6.10.1 Introduction

An assessment of the potential impacts to surface water resources as a result of the Project has been undertaken and is discussed in the following sections. The potential impacts on the various hydrologic receptors during the construction, operational and closure phases are discussed and mitigation measures are presented to eliminate or limit adverse effects.

The impact assessment addresses surface water impacts associated with:

- The Tigranes-Artavazdes and Erato open pits. The Tigranes-Artavazdes pit will be backfilled during the later years of operation leaving the small South Artavazdes pit partially unbackfilled. The Erato pit will be partially backfilled at closure;
- The Barren Rock Storage Facility (BRSF);
- The Heap Leach Facility (HLF) and associated adsorption-recovery (ADR) plant; and
- Additional supporting infrastructure including water storage ponds, water treatment systems, crusher, haul roads, material stockpiles, conveyor and mine buildings.

Each of these facilities has design engineering and management measures to control the potential discharge of water during each phase of the mine life. The engineering and management controls incorporated into the designs of the major facilities, and that are included in the surface water assessment, are described in Section 6.10.6.

Supporting Documents

The impact assessment is supported by the following documents and studies:

- Appendix 6.10.1 - Amulsar Project: Site Wide Water Balance (Golder, 2016¹);
- Appendix 3.1 – Amulsar Passive Treatment System (PTS) Design Basis, December 9, 2015 (Sovereign, 2015²);
- Appendix 8.22 - Surface Water Management Plan, Amulsar Project, February 2016. (Golder, 2016³); and
- Appendix 8.19 - Amulsar Project: Acid Rock Drainage Management Plan, Includes Heap

¹ Golder Associates Ltd , 2016. Amulsar Project: Site Wide Water Balance, 2 February 2016.

² Sovereign Consulting Inc, 2015. Amulsar Passive Treatment System (PTS) Design Basis. Technical Memorandum to GRE dated December 9, 2015.

³ Golder Associates (UK) Ltd , 2016. Amulsar Project: Surface Water Management Plan, February 2016.

Leach Facility (GRE, 2014⁴)

6.10.2 Assessment Scope

Technical Scope

Potential surface water impacts fall under two categories:

- 1) *Water Quality*: Adverse impacts to the baseline water quality arising from planned water management;
- 2) *Water Quantity*: Adverse impacts to the flow regime and available water quantity arising from planned water management.

There are linkages between surface water, groundwater and ecological receptors and impacts. Freshwater habitats and ecological health in particular are dependent on water quality and quantity and on the prevention of uncontrolled releases which could also adversely affect freshwater and riverine habitats. The ecological receptors are described in Chapter 6.11, whereas this section identifies changes in the surface water environment on which those receptors may depend.

Impacts to groundwater quality can also cause or result from impacts to surface water quality within the Project area. These impacts are presented in Chapter 6.9 particularly with reference to changes in the water quality and flow regime in groundwater fed springs. The uses of the different groups of springs is described in Section 4.8.10, which identifies the current use of the seasonal ephemeral springs, the perennial mountain springs, the Madikenc springs and the hydrothermal springs. Of the spring water uses, the Madikenc springs are used for drinking water supply. The baseline conditions note that a proportion of the mountain springs, in particular those surrounding the pits and BRSF, have been defined as being used for stock watering during the summer months (see Section 4.8.10).

Surface water receptors are catalogued and assigned a sensitivity grade in the following section. The magnitude of the potential impacts (if any) on each of these receptors is considered for the mine design without additional mitigation (i.e. considering mitigation measures incorporated into the current design) for the construction, operational, closure and post-closure phases of the Project. Suitable additional mitigation measures and any residual

⁴ Global Resource Engineering (GRE) Ltd, 2014. Amulsar Acid Rock Drainage Management Plan, Includes Heap Leach Facility, 21 August 2014.

impacts are detailed and a revised assessment of potential impact significance including any additional mitigation is then provided.

Project Performance Standards in relation to water quality are defined by the Maximum Allowable Concentrations (MAC) prescribed under Category II of the Republic of Armenia Decree N-75N (2011), with the exception of a standard for cyanide, which has been derived from the typical practicable limit of detection achievable by commercial laboratories (see Chapter 2). These standards and existing baseline conditions have been used to define impacts and assess impact significance.

Geographical Scope

The surface water Study Area is identified on Figure 6.10.1. This area forms the basis for the geographical area covered by the surface water impact assessment. Areas downstream of surface waters potentially directly impacted are discussed where secondary impacts may occur.

Lake Sevan has a specific law governing its protection as it is considered to be of national importance (Chapter 4.9). The 'immediate impact zone' identified by this law includes the Kechut Reservoir and its tributaries, all of which are identified on Figure 6.10.1.

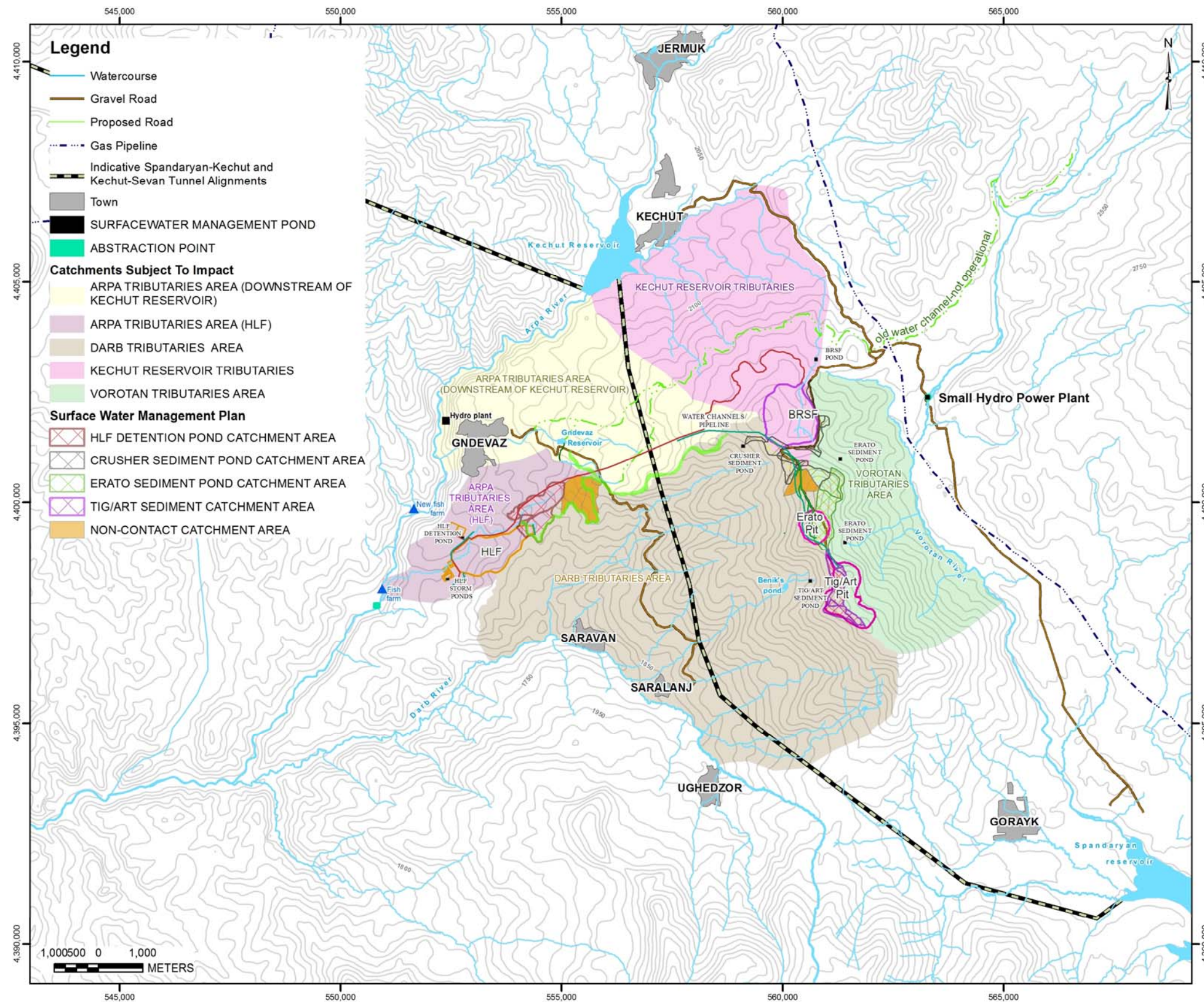


Figure 6.10.1: Surface Water Study Area and Catchments

Temporal Scope

The surface water impact assessment considers the potential impacts to surface water receptors during the following mine life stages:

- Construction (Pre-Operational) Phase;
- Operational Phase; and
- Closure and Post-closure phases.

6.10.3 Surface Water Impact Assessment Methodology

The definitions of receptor sensitivity and magnitude of impact in Chapter 6.1 are used in the assessment of the surface water receptors potentially affected by the Project. Table 6.10.1 describes the receptor sensitivity value for surface water based on Table 6.10.4 (Receptor Sensitivity Scale).

Table 6.10.1: Surface Water Receptor Sensitivity Value		
	Receptor Sensitivity Value	Receptor Description
1	Minor	Surface water features of low importance or with low sensitivity; abundance of similar receptors; watercourses of local importance or scale; resilient to changes in flow regime or quality; water feature's functions may be substituted in the local area.
2	Medium	Surface water features of low to medium importance or with low to medium sensitivity; relative abundance of similar receptors; regional importance or scale; reasonably resilient to change in influent watercourse flow rates and quality; surface water functions potential for substitution/compensation.
3	High	Surface water features of medium to high importance or with medium to high sensitivity; Relative rarity of similar receptors; national importance or scale; fragile and susceptible to change; resource vital to water supply or food production or which provides ecosystem services to a receptor of national importance or scale; limited potential for substitution of surface water functions.
4	Very High	Surface Water features of very high importance or of very high sensitivity to measureable change; receptor is of international scale or sensitivity; extremely rare or with very limited potential for substitution of surface water functions; highly susceptible to change and very fragile.

Surface water receptor sensitivity is presented in Table 6.10.4.

The magnitude of change to surface water receptors as a result of potential impacts is determined using the matrix presented in Table 6.1.2 (Chapter 6.1). For the purposes of the

surface water assessment, specific degrees of change have been defined for each of the magnitude of change categories, specified in Table 6.10.2.

Table 6.10.2: Magnitude of Change Scale (Surface Water)			
	Magnitude of change	Description of change	
		Quality	Quantity
1	Negligible	Undetectable changes from baseline conditions (<1%) of short duration or infrequent periodicity. Direct control is not required to manage potential impact.	Undetectable changes from baseline conditions (<1%) of short duration or infrequent periodicity. Direct control is not required to manage potential impact.
2	Low	Measureable change to the baseline conditions. Concentrations have measurably increased where water quality standards were not exceeded in the baseline, but remain below the quality standards. If quality standards were exceeded at the baseline, the concentration is less than 20 % over the standard and change is temporary. During construction, operations or closure there would be ongoing change in the underlying characteristics or quality of the baseline conditions.	Detectable change to the baseline conditions or resource. Permanent or temporary changes are less than 10% of flow under baseline conditions.
3	Moderate	Degree of change is such that adverse alteration to baseline conditions would occur. Predictions indicate a change in surface water quality from below the environmental standard at baseline to above the environmental standard as a result of development. The environmental standard is exceeded by between 20 % and 100 %. Changes are not permanent and improvement will occur over time in post-closure.	Degree of change is such that loss of, or adverse alteration to, the baseline conditions would occur. A permanent alteration in flow of less than 20% from baseline conditions is predicted, or a temporary change of less than 50% of baseline conditions.
4	High	Degree of change is such that adverse alteration to baseline conditions would occur. Predictions indicate a change in surface water quality from below the environmental standard at baseline to above the environmental standard as a result of development. The environmental standard is exceeded by over 100 %. Post-development quality would be fundamentally and irreversibly changed.	Degree of change is such that total loss of, or adverse alteration to, the baseline conditions of a specific resource would occur. Development is predicted to result in a permanent change of more than 20% from baseline conditions, or a temporary change of more than 50% from baseline conditions.

The matrix presented in Table 6.1.3 (Chapter 6.1) is used to determine the significance of the

impact, and Table 6.1.4 (Chapter 6.1) is used to determine whether the effect of the impact is significant.

For any significant impacts, additional (i.e. non-design) mitigation measures are presented and the residual impact and effect is then assessed using the same process outlined above.

As detailed in the surface water baseline (Chapter 4.9), elevated concentrations of trace metals are present in surface waters throughout the Study Area as a result of the natural geochemical conditions. Some of these concentrations exceed MACs for fisheries and this is taken into account in the assessment of any future impacts. Some tributaries of the Darb and Vorotan immediately downstream of the proposed open pits exhibit low pH levels (Figure 4.9.9) indicative of naturally occurring acid rock drainage (ARD). This has also been taken into account during assessment of future potential impacts.

6.10.4 Identification of Surface Water Receptors

Surface Water Receptors

Chapter 4.9.7 in the surface water baseline describes surface water users in the vicinity of the mine, adjacent to and downstream of the Project area. Based on this information, and the understanding of the hydrologic conditions, surface water receptors have been identified. Table 6.10.3 summarises the surface water receptors and water users. Wetland areas are categorised based on the ecological biodiversity assessment documented in Chapter 4.10.3.

Table 6.10.3: Surface Water Receptors and Water Users		
Receptor	Water User Category	Description
Kechut Reservoir Tributaries	Agriculture and Stock Watering	Irrigation and stock watering from streams within the catchment.
	Ecosystem Services	Natural wildlife water supply and habitat.
Arpa River Downstream of Kechut Reservoir	Stock Watering	Stock watering from Arpa River
	Ecosystem Services	Fisheries, natural wildlife water supply and habitat.
	Aquaculture	Two fish farms 6.5 km and 8 km downstream of the Kechut reservoir.
Arpa River Tributaries Downstream of Kechut Reservoir	Agriculture and Stock Watering	Stock watering from streams within the catchment.
	Ecosystem Services	Natural wildlife water supply and habitat.
Arpa River Tributaries HLF Area	Agriculture and Stock Watering	Stock watering from streams within the catchment.
	Ecosystem Services	Natural wildlife water supply.
Darb River	Agriculture and Stock Watering	Herders rely on water supply directly from the Darb River.
	Ecosystem Services	Fisheries, natural wildlife water supply and habitat.

Table 6.10.3: Surface Water Receptors and Water Users

Receptor	Water User Category	Description
Darb River Tributaries	Agriculture and Stock Watering	Irrigation and stock watering from tributaries of the Darb.
	Ecosystem Services	Natural wildlife water supply and habitat.
Vorotan River	Agriculture and Stock Watering	Herders rely on water supply directly from the Vorotan River.
	Ecosystem Services	Fisheries, natural wildlife water supply and habitat.
	Hydro-electric Power Generation	Run of river plant upstream of road crossing east of Project area.
Vorotan River Tributaries	Agriculture and Stock Watering	Herders rely on water from streams within the catchment, particularly on the valley floor in wetland meadows.
	Ecosystem Services	Natural wildlife water supply and habitat.
Kechut Reservoir	National Water Supply	Feeds the Lake Sevan water supply scheme using existing interconnector tunnels.
	Hydro-electric Power Generation	Hydro-electric Power Plant at reservoir outlet takes water from reservoir.
	Ecosystem Services	Fisheries, natural wildlife water supply and habitat.
Spandaryan Reservoir	National Water Supply	Possible future use to feed the Lake Sevan water supply scheme using existing interconnector tunnels.
	Hydro-electric Power Generation	Hydro-electric Power Plant located at reservoir outlet.
	Ecosystem Services	Fisheries, natural wildlife water supply and habitat.
Gndevaz Reservoir	Agriculture and Stock Watering	Gndevaz Reservoir perennially used for irrigation of downstream horticulture and agriculture.
Gndevaz Channel	Irrigation / Water Supply	Man-made channel (lined; currently under renovation) to divert flow from springs in the Vorotan valley to the fields near Gndevaz and the Gndevaz Reservoir.
Wetland Ponds within Darb Tributaries including Benik's Pond	Ecosystem Services	Natural wildlife water supply and habitat.
Wetlands within Vorotan Catchment	Ecosystem Services	Natural wildlife water supply and habitat.
Wetlands within Ketchut Reservoir Tributaries	Ecosystem Services	Natural wildlife water supply and habitat.

Local community potable water supplies within the wider Project area are sourced directly from springs and therefore are not classified as surface water users (Chapter 4.9.7).

The Gndevaz irrigation channel which was constructed to divert flow from the Vorotan River to the Gndevaz Reservoir is not currently fully functional (some short sections remain intact

and are used for local diversions) (Chapter 4.9.7). The channel is currently being renovated and will be lined, preventing hydraulic connection to the local groundwater system.

Surface Water Receptor Sensitivity

The sensitivity of surface water receptors are detailed in Table 6.10.4. This table describes receptor location, geographical importance (scale), resilience to change (quantity and quality) and potential for substitution used to determine receptor sensitivity.

Table 6.10.1 has been used to assign receptor sensitivity, with the greatest weighting being placed on the geographical importance of the surface water resource in determining its sensitivity (i.e. surface water user reliance over a geographical area). Resilience to change and potential for substitution are the next order of weighting in determination of receptor sensitivity.

Determination of sensitivity considers surface water alone as the receptor and not features it may be linked to. Associated groundwater and ecological receptors that may be sensitive to changes in surface water quantity or quality are addressed in Chapters 6.9 (Groundwater) and 6.11 (Biodiversity).

Table 6.10.4: Receptor Sensitivity (Surface Water)

Receptor	Area	Location	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
Kechut Reservoir Tributaries	BRSF Catchment Area	Kechut Reservoir tributaries within BRSF catchment	Local , with small volume input to Kechut Reservoir, which in turn feeds the Lake Sevan Scheme. Numerous tributary streams of this type within Project area.	Tributary streams with flow primarily following seasonal snow melt. Susceptible to relatively small changes in low flows within the catchment.	Limited potential for substitution	Medium
Arpa River Downstream of Kechut Reservoir	Project Area	Arpa River below Kechut Reservoir along the western boundary of Project area	Flow and quality from within the Project area is of regional importance.	The Arpa River has a large catchment, with the majority located outside the Project area. Tributaries provide flow primarily following seasonal snow melt. Flow out of Kechut Reservoir is controlled by Hydro-electric Scheme at it's outlet. Reasonably resilient to changes in the Project area.	Alternative water supply could be sourced from adjoining catchments	Medium
Arpa River Tributaries Downstream of Kechut Reservoir	Ore Conveyor Catchment Area draining to HLF Detention Pond	Arpa River tributaries within Conveyor catchment	Local , with small volume input to Arpa River. Numerous tributary streams of this type within Project area.	Tributary streams with flow primarily following seasonal snow melt. Susceptible to relatively small changes in low flows within the catchment.	Limited potential for substitution	Minor

Table 6.10.4: Receptor Sensitivity (Surface Water)

Receptor	Area	Location	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
Arpa River Tributaries HLF Area	HLF Catchment Area	Arpa River tributaries within HLF catchment	Local , with small volume input to Arpa River. Numerous tributary streams of this type within Project area.	Tributary streams with flow primarily following seasonal snow melt. Susceptible to relatively small changes in low flows within the catchment.	Limited potential for substitution.	Minor
Darb River	Wider Project Area	Darb River downstream from the village of Ughedzor along the southern boundary of the Project area	Flow and quality from within the Project area is of regional importance.	The Darb River has a large catchment, with the majority located outside the Project area. Tributaries provide flow primarily following seasonal snow melt. Reasonably resilient to changes in flow and quality within the Project area.	Alternative supplies could be sourced from adjoining catchments	Medium
Darb River Tributaries	Pit Areas of Amulsar Mountain, Crusher Plant and corresponding Catchment Areas	Darb River tributaries within Pit and Crusher Plant catchment areas	Flow and quality from within the Project area is of local importance. Numerous tributary streams of this type within Project area.	Tributary streams with flow primarily following seasonal snow melt. Susceptible to relatively small changes in low flows within the catchment.	Limited potential for substitution	Minor

Table 6.10.4: Receptor Sensitivity (Surface Water)

Receptor	Area	Location	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
Vorotan River	Wider Project Area	Vorotan River along eastern boundary within Project area	Flow and quality from within the Project area is of regional importance.	The Vorotan River has a large catchment, with the majority located outside the Project area. Tributaries provide flow primarily following seasonal snow melt. Reasonably resilient to changes in flow and quality within the Project area.	Alternative supplies could be sourced from adjoining catchments	Medium
Vorotan River Tributaries	Pit Areas of Amulsar Peak and Catchment Area	Vorotan River tributaries within Project area	Local , with small volume input to Vorotan River. Numerous tributary streams of this type within Project area.	Tributary streams within the headwaters flow primarily following seasonal snow melt. Susceptible to relatively small changes in low flows within the catchment.	Limited potential for substitution	Minor
Kechut Reservoir	Wider Project Area	Borders north west boundary of Project area	Water Supply from Kechut Reservoir is of national importance.	Kechut Reservoir has a large catchment, with the majority located outside of the Project area and therefore is resilient to changes in flow and quality within the Project area. Outflow from the reservoir is controlled by the dam spillway, inlet to Sevan Water Supply Scheme and intake to Hydroelectric plant.	Alternative supply to reservoir could potentially be sourced from adjoining catchments	High

Table 6.10.4: Receptor Sensitivity (Surface Water)

Receptor	Area	Location	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
Spandaryan Reservoir	Wider Project Area	South east of Project area within downstream Vorotan River Catchment	Water Supply from Spandaryan Reservoir is of national importance.	Kechut Reservoir has a large catchment, with the majority located outside of the Project area and therefore is resilient to changes in flow within the Project area.	Alternative supply to reservoir could potentially be sourced from adjoining catchments	High
Gndevaz Reservoir	Conveyor Catchment Area draining to HLF Detention Pond	East of the village of Gndevaz and north east of HLF, within Arpa River catchment	Water Supply from Gndevaz Reservoir is of local importance for irrigation and agriculture.	Gndevaz Reservoir is supplied from its' upstream drainage catchment and minor diversion from an adjacent catchment. Susceptible to changes in low flow within the Project area.	Water Supply could be replaced with troughs and piped water supply from adjoining catchments	Minor
Gndevaz Channel	BRSF Catchment Area	North and west of the Project Area, downgradient of the BRSF	Water transfer to fields near Gndevaz and the Gndevaz Reservoir from the Vorotan valley via the Gndevaz Channel is of local importance.	The Gndevaz Channel is undergoing reinstatement, anticipated to be completed during 2016. It is sourced from springs in the Vorotan valley outside of the Project area and the channel will be lined (disconnected from the local groundwater and surface water systems) and therefore the channel is generally resilient to changes in flow and quality within the Project area. Susceptible to changes in	Water transfer from the Vorotan River could be replaced with an equivalent channel or pipeline	Medium

Table 6.10.4: Receptor Sensitivity (Surface Water)

Receptor	Area	Location	Geographical Importance	Resilience to Change	Potential for Substitution	Receptor Sensitivity
				quality in the event of overtopping of the BRSF toe pond.		
Wetland Ponds within Darb Tributaries including Benik's Pond	Pit Areas of Amulsar Peak and Catchment Area	Wetland ponds generally located within tributary head waters within the Darb River Catchment	Local importance for wildlife. Small number of wetland ponds within Project area.	Supplied by springs and surface water runoff. Susceptible to changes in low flow conditions within their catchment.	Cannot be substituted.	Minor
Wetlands within Vorotan Catchment	Wider Project Area	Wetland Areas alongside the Vorotan River and its tributaries (Figure 6.10.3)	Habitat of regional importance for wildlife (amphibian) habitat. Similar wetland habitat not abundant in surrounding landscape of Project area.	Supplied by springs and surface water runoff. Susceptible to changes in low flows within their catchment.	Cannot be substituted	Medium
Wetlands within Kechut Reservoir Tributaries	BRSF Footprint Area	Spring fed wetland within the BRSF site area	Local importance as wildlife habitat. Habitat area constitutes small proportion of similar habitat within Project area.	Supplied by springs and surface water runoff. Susceptible to changes in low flows within catchment.	Cannot be substituted	Minor

The major rivers (Arpa, Darb and Vorotan) are assigned a medium sensitivity, as they are of regional importance and reasonably resilient to changes in water quality and quantity.

The tributaries to the main rivers are susceptible to changes particularly in low flows within their catchment due to their small size. There is significant natural variation in high flows in response to snowpack melting and duration. The tributaries are of local importance and are relatively numerous. On this basis, they have been assigned a minor sensitivity. The tributaries to the Kechut Reservoir have been assigned a medium sensitivity as these provide flow to the Lake Sevan scheme (albeit only a small proportion).

The Kechut and Spandaryan Reservoirs are likely to be resilient to changes in the Project area, and are of national importance. Reservoirs of this size are not abundant in the region. On this basis they have been assigned a high sensitivity.

The Gndevaz Reservoir is of local importance for irrigation and agriculture and could potentially be substituted with a piped water supply from an adjoining catchment. Therefore, it has been assigned a minor sensitivity.

The Gndevaz Channel is currently being renovated and will be lined, preventing hydraulic connection to the local groundwater system. The channel would be at risk in the event of overtopping of the BRSF toe pond, which is located upgradient of the channel. The channel would not be at risk from the HLF and associated facilities, which are located downgradient. The channel has not been operational for some time but, following its reinstatement (due for completion during 2016), has the potential to be of local importance with regards to irrigation and water supply. Water from the Gndevaz Reservoir and associated Gndevaz channel is viewed as priority water for the Gndevaz community and as such will not be utilized by the Amulsar mine. Should the need arise to utilise some water from this source, within the Project, it would only be considered following full consultation with the local community and should full approval and authorisation has been granted to the Project. An alternative pipeline or channel could be substituted to convey water from the Vorotan valley, following a similar alignment to that of the current channel. On this basis, it is assigned a medium sensitivity.

Wetlands are found largely within the Vorotan Valley (as discussed within the Biodiversity Baseline Chapter 4.10.3) and are supported by groundwater seepage, springs and

watercourses. The wetlands are likely to be susceptible to low flow changes (because they are subject to significant natural variation during high flows) within their catchment, are of local importance for wildlife, not abundant and cannot be substituted. On this basis they have been assigned a medium sensitivity.

The small wetland area identified within the Kechut Reservoir tributaries, lying within the BRSF footprint is of local importance for wildlife habitat and constitutes a small portion of similar wetland habitat locally (Chapter 6.11). Therefore, it has been assigned a minor sensitivity.

Small natural wetland ponds on the western side of Amulsar within the Darb tributary catchment which includes Benik's Pond have been assigned a minor sensitivity. They are of local importance, likely to be susceptible to changes within their catchment and potentially used as natural wildlife water supply and habitat.

6.10.5 Water Management

The design of the Project is presented in Chapter 3. The Project's overall water management strategy is to maintain, to the maximum extent where practicable, separation of non-contact water from contact water so as to minimise the need to contain water. Contact water will be utilised within the HLF as much as practicable and the surplus water from the BRSF will be treated in a Passive Treatment System (PTS, see Appendix 3.1) prior to land application or discharge to the Arpa River downstream of the planned water intake from the Arpa.

Management of water over the life of the mine is described in detail in the Surface Water Management Plan (SWMP) (Appendix 8.22). The objectives of the SWMP are:

- To route runoff to ponds and collection sumps in order to minimise the release of sediment;
- To minimise natural ground runoff and non-contact water from entering disturbed areas and mixing with contact water;
- To capture contact water runoff from the mine facilities, for re-use in the process;
- To treat excess contact water in a PTS to MAC II standards prior to discharge; and
- To minimise erosion of disturbed areas, and when erosion does occur, to minimise suspended sediment flow to streams.

Construction Phase

During construction, the SWMP focuses on management of surface water runoff and sediment control. Potentially impacted surface water will be routed to sediment ponds, via in-channel sediment management structures (check dams) prior to discharge to surface water. Additional best management practices, such as silt fences, straw wattles and erosion control mats will also be put in place to minimise erosion, reducing the sources of erosion and sediment generation. Water will be required for the construction camp, dust suppression and concrete production, amounting to 12.3 l/s, which will be sourced as follows:

- Benik's Pond;
- New collection ponds created on site; and
- Arpa River.

Benik's Pond will supply construction water at an estimated rate of 1.3 l/s during non-freezing months. The remaining demand not met by storage in non-contact water ponds and dams (PD-14, PD-12 and D-1) will be sourced from the Arpa River. The Arpa River will provide the early construction water demands until the non-contact water ponds are constructed and operational, after which time the Arpa River will only be used to supplement construction water demands, as required (Golder, 2016¹).

Operational Phase

There will be three major water storage areas available to manage water in the Project area:

- The raw water pond (volume 20,450 m³), which will receive runoff from the haul and access roads, and conveyor corridor;
- The HLF contact water pond (maximum volume approximately 1,280,000 m³), which will receive discharge from the BRSF Toe Pond, and water from the pit sumps and truck shop storage pond; and
- Three storm ponds (maximum total volume approximately 630,000 m³) downstream of the HLF, which will be used for active storage of process water during operations and also contain storm storage capacity.

A flow chart of water management during the operational phase is provided in Figure 6.10.2.

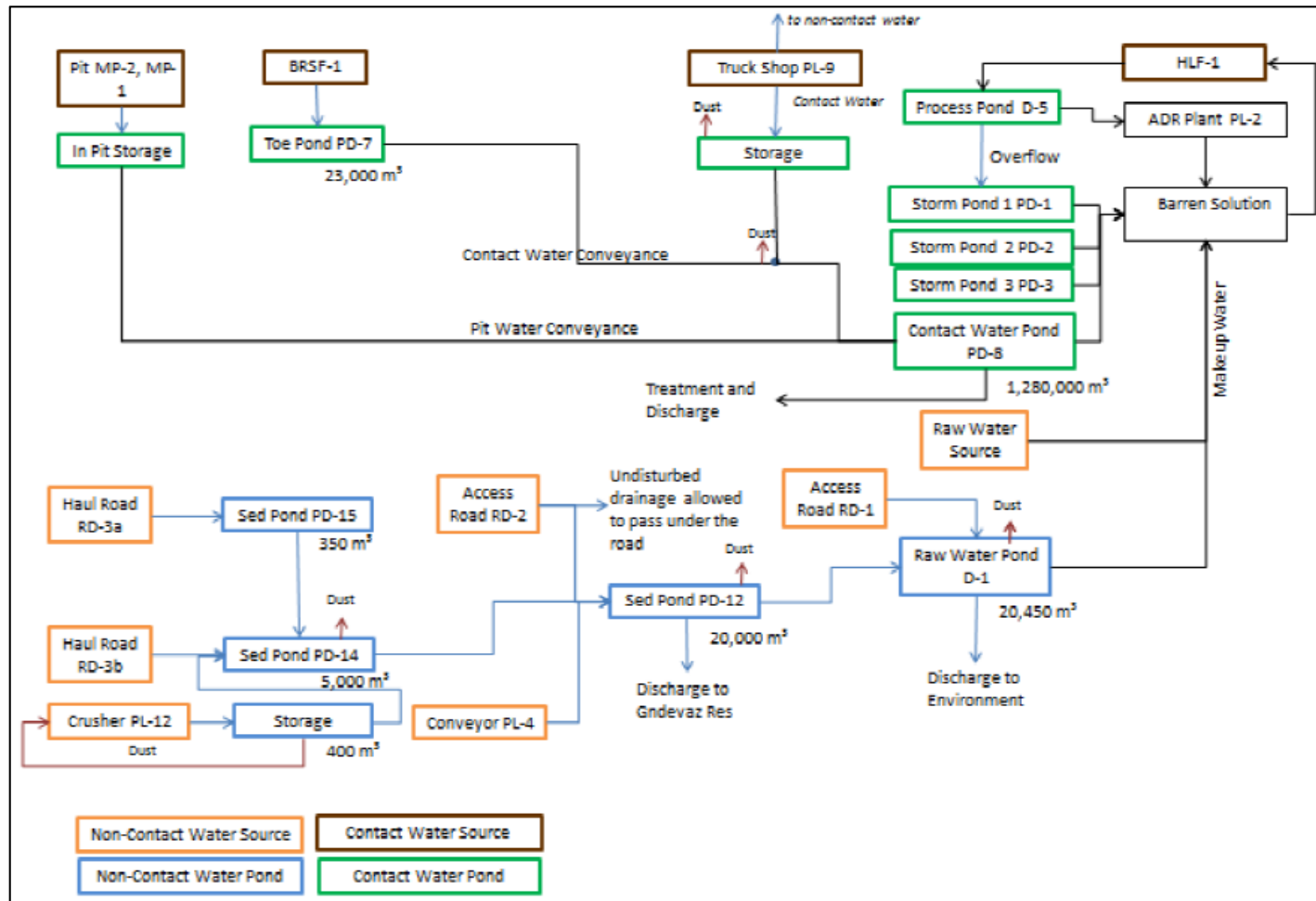


Figure 6.10.2: Flow Chart: Water Management During Operational Phase

During operations runoff from facilities areas, including haul roads, the ore conveyor and crushers, will be routed to sediment ponds, prior to discharge to surface water. The surface water design standard for non-contact water is the 100 year design standard plus a minimum 20% freeboard allowance (Golder, 2016¹). Truck shop runoff will be routed to the Contact Water Pond (PD-8) and managed as contact water.

Runoff, and discharge via the basal drainage layer (leachate and underlying spring water) from the BRSF will be routed to a Toe Pond (PD-7) and then to the Contact Water Pond in the vicinity of the HLF. Any flow through the low permeability BRSF soil liner that escapes collection will potentially infiltrate to groundwater, as discussed in Section 6.9.

Water from the pits will be routed via in-pit sediment ponds and combined with the water in the Contact Water Pond. Snow removal will minimise the volume of contact water generated and maintain storage for extreme precipitation events.

The HLF Contact Water Pond will be used to supply make-up water for the HLF during operation. Water for HLF operations will be sourced from surface water collected and diverted through the HLF Storm Water Pond catchment areas, as well as from the Contact Water Pond and from the Arpa River. Storm Ponds located at the downstream extent of the HLF will be used to manage process water. Water from the Arpa River will be used as required for make-up.

Water balance modelling shows that after year 4 of operation the average water demand will be less than the volume of water collected in the Contact Water Pond (see Figure 3.21), hence there will be a need to treat and discharge water to the Arpa River. The discharge will be treated in a passive treatment system (PTS) to MAC II standards (see Appendix 3.1) prior to discharge to the Arpa River downstream of the proposed water intake.

The components of the PTS that will be constructed to the south of the contact water ponds, are described in Appendix 3.1 and include the following:

- Nitrate Reducing Biochemical Reactor (BCR);
- Aerobic Polishing Wetland (APW) No. 1;
- Sulphate Reducing BCR;
- Sulphide Scrubbing Unit;
- APW No. 2;

- Manganese Removal Beds (MRB); and
- A discharge pipe to the Apra River tributary located downgradient from the HLF.

The design assumptions for the PTS include.

- All flows are from the BRSF toe pond through the PTS are gravity fed;
- The PTS will treat 40 m³ per hour (11.1 L/sec), includes a 30% safety factor.
- From year 5 of the operational phase, the seepage will be a blend of contact water from pit dewatering and BRSF seepage.
- Post-closure the seepage will be a blend of contact water and natural ground water flow occurring in the BRSF footprint that mixes with the contact water in the drains beneath the BRSF. Episodic seasonal flows will be moderated in the BRSF toe pond and in the contact water ponds, both of which will act as a flow equalization basin.
- Two sequential sets of biochemical reactors (BCRs) will be required. The first set will address elevated nitrate levels derived from blasting agent residue in the barren mine rock. The second set will address expected sulphate levels in the contact water. Outflow from the BCR will be constructed in parallel, so that the system can be maintained as operational during maintenance
- The sulphide scrubber unit will be filled with a sacrificial metal such as iron provided from natural mineral source such as limonite or goethite [Fe(OH)₃], hematite [Fe₂O₃], magnetite [Fe₃O₄], or Zero valent iron (ZVI) derived from a local source of scrap iron such as steel food cans that can be obtained from recycling.

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. The feasibility will commence during 2016, with the objective of the full scale treatment system constructed and tested by 2020 and at least 12 months prior to the treatment of BSF seepage, through the contact water ponds within the HLF area. These trials will 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.

Closure and Post-Closure Phases

Discharges to the environment during closure and post-closure will be as follows:

- From the HLF;
- From the BRSF; and
- From reclaimed areas, such as the pits and mine facility areas.

The discharge of post-closure residual waters from the BRSF will be treated to meet Category II MAC through the PTS (Golder, 20161) located in the vicinity of the HLF. Water will then be discharged to a series of infiltration galleries within the HLF catchment or to a tributary of the Arpa. The BRSF Toe Pond will be used to store and manage seasonal flows, controlling discharge to the PTS.

During the HLF drain down phase, water will go through active treatment before discharge to the environment. Following active treatment drain down water would pass to a second PTS, constructed adjacent to the BRSF PTS and re-using the storm water ponds to design the wetland system, to be used post-closure for the discharge from the HLF system in order to meet MAC II and/or baseline standards.

Surface water entering the closed open pits will infiltrate into the groundwater system.

A flow chart of water management during the closure phase is provided in Figure 6.10.3.

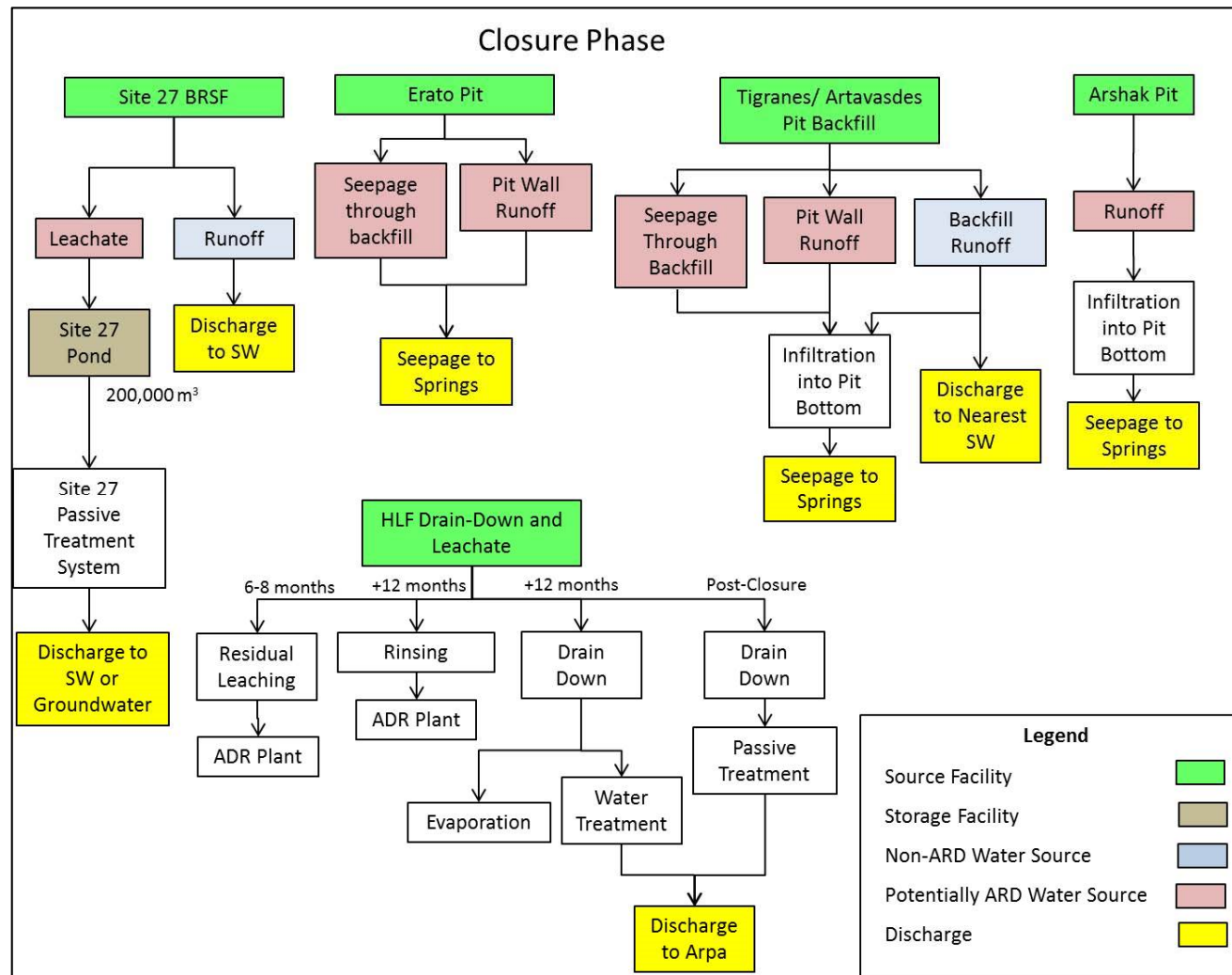


Figure 6.10.3: Flow Chart: Water Management During Closure Phase

6.10.6 Design Mitigation

Design mitigation considered in the potential impact assessment for each of the principal facilities is described below.

Pits

Contact water from the pit walls within the open pits has the potential to be impacted both by ARD and by ammonium and nitrate arising from the residue of ammonium nitrate based explosives. During operation, pit water will, if discharge standards are met, be discharged via sediment pond to the nearest watercourse (Figure 6.10.2).

However, this is not expected. In-pit mine-influenced water (contact water) will be pumped from the pits and transferred via pipeline to the Contact Water Pond near the HLF.

In closure, the Tigranes-Artavazdes pit will be backfilled with barren rock. The Tigranes-Artavazdes backfill will be covered with a store-and-release evaporative soil cover. The barren rock will comprise permeable loose mixed Upper Volcanics and Lower Volcanics and is estimated to have a permeability of approximately 1×10^{-4} m/s (BRSF Seepage Model, GRE, 2014⁵). The small South Artavazdes pit will only be partially backfilled and will allow infiltration of pit runoff.

In closure, the Erato pit will be partially backfilled with barren rock comprising permeable loose Non Acid Generating (NAG) Upper Volcanics estimated to have a permeability of more than 1×10^{-4} m/s. The backfill will not have a soil cover to allow infiltration of pit runoff into the backfill.

Material from the pits that is awaiting processing will be stored temporarily in stockpiles (Run-of-Mine/ROM piles). Run-off from these piles will be managed the same way as contact water and will be treated using sediment ponds. If water quality meets environmental standards it will be discharged to watercourses, otherwise it will be transferred to the HLF Contact Water Pond (Golder, 2016³).

⁵ Global Resource Engineering (GRE), Ltd, 2014. Technical Memorandum, Amulsar BRSF Seepage Model. Reference 13-1064, 14 July 2014.

BRSF

The design of the BRSF will restrict Potentially Acid Generating (PAG) waste from coming into contact with water as much as possible, and use NAG barren rock to serve as a contact buffer between PAG material and the natural environment.

The engineered containment will comprise the following elements:

- The existing subsoil in the footprint of the BRSF will be compacted in place to act as a low-permeability soil liner. This soil liner will restrict infiltration and will direct water that comes into contact with the barren rock to the toe of the BRSF, where the outflow will be collected in the BRSF toe pond and then piped to the contact water pond for treatment and/or piped to the HLF for use or treated through a passive treatment system (PTS) and then discharged. At closure, all flow from the BRSF toe pond will continue to be piped to the contact water ponds, with overflow to the PTS (see Appendix 3.1);
- The design will inhibit natural groundwater from seeps and springs located beneath the prepared soil liner of the BRSF from coming into contact with PAG waste rock through placement of a NAG barren rock drainage layer over the compacted soil liner. Any water emanating through the foundation of the dump (from potential seeps and springs) will travel through this layer towards the toe of the facility. Seep and spring water beneath the BRSF will mix with leachate beneath the facility, consequently all flow from the drainage system will be mild ARD, which will be collected by the BRSF Toe Pond;
- The low grade ore stockpile is similar to NAG barren rock in terms of leachate chemistry (see Appendix 8.19) and will be treated as such (see above);
- PAG waste will be placed in engineered cells that will be surrounded by NAG waste on all sides. As a result, the PAG waste will be in contact with neither the bottom soil liner nor the atmosphere. Amulsar PAG waste consists of argillized rock and contains a significant clay fraction. This clay fraction makes the PAG a low-permeability material. As a result, water entering the body of the BRSF will flow preferentially through NAG waste that will be placed around the PAG cells;
- During operations all runoff and seepage will enter the BRSF Toe Pond, where it will be pumped to the Contact Water Pond, adjacent to the HLF. The BRSF Toe Pond will be sized to accommodate potential flood events to reduce the risk of overtopping and impact to the water quality of downgradient receptors, and appropriate monitoring of defined pond level trigger levels will be undertaken. The pipeline from the BRSF Toe Pond to the Contact Water Pond (contact water pipeline) is shown on Figure 3.21;

- The BRSF cover will be an engineered evapotranspiration (E/T) cover specifically designed for the conditions found at the site. The components of the cover from top to bottom will be: topsoil to provide a vegetative growth medium; a layer of naturally-compacted clay that will reduce the influx of water into the cover system; and a layer of gravel that will act as a capillary break between the cover soil and the waste rock of the dump. This cover will inhibit infiltration to the BRSF in the long term; and
- At closure/post closure, surface water runoff from restored surfaces will discharge to the environment, downstream of the BRSF (Figure 6.10.3).

HLF

The HLF will be supplied with water from the HLF Contact Water Pond and water recycled from the three Storm Ponds (Figure 6.10.2).

The HLF design incorporates engineered containment comprising:

- A composite liner beneath the heap leach pad;
- Underdrains beneath the leach pad footprint to drain groundwater/subsurface seepage to a collection sump located downgradient of the pad, where the underdrain discharge water quality will be monitored as required;
- A double liner system with intermediate leakage capture and recovery system underlying the solution pond(s);
- A two-phase active water treatment during the closure phase (HLF draindown) of the facility. The first phase will reduce cyanide concentrations in the leach solution, and the second active phase will treat excess HLF solution (which contains elevated sulphate) until the flow decreases to the level suitable for passive treatment;
- Passive water treatment during operation and post closure with discharge downstream into the Arpa River;
- Placement of an engineered evapotranspiration cover following closure to minimise infiltration to and seepage from the heap in closure. This will comprise cover soils overlying a compacted clay cap. The underlying HLF materials will act as a capillary break; and
- Surface water runoff from reclaimed areas will discharge to the environment, downstream of the HLF.

See Figure 6.10.3 for the water management process post closure.

Infrastructure, Other Facilities and Surface Water Management

In addition to the design mitigation outlined above for the key facility areas, the management mitigation measures presented in the SWMP (Appendix 8.22) will be used to avoid or limit the effects of potential impacts to the hydrologic environment. The management mitigation measures that are considered in this assessment include:

- Management of runoff and seepage during construction;
- Minimum 110 % tank capacity of bunds for storage of fuel/oils;
- Regular maintenance of vehicles and mobile equipment including regular inspection for leaks;
- Surface water management including diversion drains and sediments ponds designed to manage the 100 year storm event plus a minimum 20% freeboard allowance;
- Training of personnel in the need to manage and control spills, and sediment runoff;
- Collection of sewage effluent in septic tanks, with residual solid waste removed to landfill, septic tank system to leach field;
- As well as the SWMP, the ESMP (Chapter 8) includes a Spill Prevention and Response Plan (incorporated in the Emergency Preparedness and Response Plan, EPRP) and a Cyanide Management Plan. These plans include management measures to control risks associated with cyanide, hydrocarbons, and other chemicals on site; and
- Reclamation will include seeding of topsoil stockpiles, and disturbed areas (as much as practical) with a cover crop to minimize wind and water erosion. After top-soiling of the final reclamation, an area will be seeded to establish a stubble crop and then reseeded with grasses the next growing season using an approved mix of live seed of native species.

In addition, a groundwater and surface water monitoring plan will be implemented during operational and closure phases. The purpose of the monitoring will be to evaluate the operational performance of the Project and identify any adverse trends in surface water and groundwater quality or quantity that would require the implementation of modifications to the mitigation measures.

6.10.7 Surface Water Impacts (Design Mitigation Only)

This section presents a discussion on the potential impacts to surface water as a result of the Project; the method of assessment; and the magnitude of the impacts, accounting for mitigation measures implicit in the Project design. Impact significance and scale of

significance have been assigned using the matrices in Chapter 6.1 (Tables 6.1.3 and 6.1.4).

The potential impacts fall into the two broad categories of change in water quantity and change in water quality.

Construction Phase

During construction of the mine facilities there is the potential for impacts to surface water receptors. Surface water diversions and sediment ponds will be constructed at commencement of the construction phase. The ponds will detain and release water to the catchments without resulting in adverse increase in streamflow that would result in channel scour and erosion. The predicted reduction in surface water catchment area within the Project area during construction are provided in Table 6.10.5. This table should be read with reference to Figure 6.10.1 which identifies the potentially affected catchment areas.

Table 6.10.5: Predicted Surface Water Receptor Catchment Reductions (Construction)	
Receptor	% Reduction in Catchment Area
Kechut Reservoir Tributaries	0%
Arpa River Downstream of Kechut Reservoir	<1%
Arpa River Tributaries Downstream of Kechut Reservoir	0%
Arpa River Tributaries HLF Area	28%
Darb River	0%
Darb River Tributaries	0%
Vorotan River	0%
Vorotan River Tributaries	0%
Kechut Reservoir	0%
Spandaryan Reservoir	0%
Gndevaz Reservoir	0%
Gndevaz Channel	0%
Wetland Ponds within Darb Tributaries including Benik's Pond	0%
Wetlands within Vorotan Catchment	0%
Wetlands within Kechut Reservoir Tributaries	Wetlands within the BRSF footprint will be progressively covered. There will be only minor direct effects during construction – the majority of impacts will be during operations. No other wetland loss in the Kechut Reservoir tributaries.

It is expected there will be negligible reduction of runoff for a majority of the receptors as diversion channels and sediment pond catchments will return water to the surface water catchments. Dewatering of the pits in advance of mining is not required. Therefore, spring

flows depending on groundwater will not be impacted and no loss of baseflow to surface water receptors from groundwater is expected (Chapter 6.9).

However there will be a minor impact to the ephemeral and perennial spring-fed wetland and downstream tributary within the BRSF area. Spring flow will be captured within this facility and used within the HLF process system.

The effect on the groundwater component of surface water baseflow in rivers and tributaries within the Project area is considered to be negligible (Chapter 6.9).

Arpa River, Kechut Reservoir, Arpa River and Kechut Reservoir Tributaries and Gndevaz Reservoir and Channel

The construction of the mine facilities will result in a negligible reduction in the surface water catchment areas (and thus reduction in runoff) in the upper reaches of most tributaries to the Arpa (including those upstream of the Gndevaz Reservoir) and Kechut Reservoir, therefore the change in water quantity is considered to be negligible. The construction of the HLF Contact Water Pond will lead to the loss of a low-flowing and seasonal Arpa tributary and a temporary reduction of catchment area (during mine construction and operation), which is considered to be a moderate impact. However downstream the impact is considered negligible as the tributary water quantity contribution to the Arpa is minimal (<1%). Construction of the BRSF will not reduce the receiving tributary catchment area nor present a risk to the Gndevaz Channel until mine operations commence (though diversions will be in place), therefore the change is considered **negligible**.

In addition, water abstraction for construction supply will reduce low flow in the Arpa River downstream of the Kechut Reservoir by less than 1% (up to 12.3 l/s) with a lower percentage flow reduction during high flows.

There will be no loss of catchment area within the tributaries of the Project area upstream of the Kechut Reservoir leading to a negligible change in water quantity contribution to the reservoir.

Due to vegetation removal, sediment load transported into receiving waters may increase. Although the existing ground cover is minimal, particularly at high-risk periods during the spring snowmelt period when highest runoff rates are observed, construction activities will adhere to the SWMP. This may include minimising the extent of vegetation removal and

constructing sediment ponds where required. Further information on measures to protect soil and vegetative cover are presented in the soil and land cover impact assessment Chapter 6.8. The magnitude of impact to water quality is considered to be **negligible**.

Plant and machinery used in the construction of the various site facilities will require storage and use of various oils, lubricants, chemicals and fuel. Given the planned protective measures and good international industry practice (GIIP) that will be implemented, any spillage will be minor and the impact on receiving waters in the upper reaches of the Arpa tributaries will be **negligible**. Any spillage will be quickly remediated. Localised small spills are unlikely to result in measurable changes to baseline conditions in larger watercourses, such as the Arpa.

Darb River, Darb River Tributaries and Wetland Ponds (including Benik's Pond)

The potential construction phase water quantity and water quality impacts to the Darb, Darb tributaries and headwater surface water ponds are the same as those identified for the Arpa i.e. **negligible** impact to water quality in the Darb, **negligible** impact to water quantity for Darb tributaries and wetland ponds (excluding Benik's Pond), and **negligible** impact to water quality for all receptors. Impact to water quantity of Benik's Pond due to seasonal water abstraction (estimated 1.3 l/s during non-freezing months) for construction supply is considered to be **minor**. The associated impacts to ecological receptors are considered in Chapter 6.11.

Vorotan River, Vorotan River Tributaries and Spandaryan Reservoir

The potential construction phase water quantity and water quality impacts are the same as those identified for the Arpa and the Kechut Reservoir.

No water abstraction for construction supply will take place from the Vorotan River.

Wetlands within Vorotan Catchment and Kechut Reservoir Tributaries

There will be a **negligible** impact on wetland areas located adjacent to the Vorotan River and its tributaries during construction. No significant reduction of groundwater flow to the wetlands is expected during the construction period and reduction of surface water catchment area is considered to be negligible. The impact to water quality is also considered to be **negligible** due to implementation of engineering measures and GIIP. The wetland within the BRSF site area (located at the headwaters of a tributary of the Kechut Reservoir) will be lost as a result of construction. There are other equivalent wetland habitats within the Project

area (see Biodiversity Impact Assessment, Chapter 6.11) and therefore the impact is considered **moderate**.

A summary of the impacts, magnitude, significance of impact and scale of significance is presented in Table 6.10.6.

Table 6.10.6: Potential Surface Water Impacts (Construction) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
Kechut Reservoir Tributaries	Medium	Reduction in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Reduction in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Arpa River Tributaries HLF Area	Minor	Reduction in flow as a result of catchment area reduction.	Moderate	Minor	Not Significant
		Reduction in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Arpa River Downstream of Kechut Reservoir	Medium	Decrease in flow as a result of water extraction	Negligible	Negligible	Not Significant
Darb River	Medium	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Darb River Tributaries	Minor	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Vorotan River	Medium	Decrease in flow as a result of catchment area reduction..	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Vorotan River Tributaries	Minor	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant

Table 6.10.6: Potential Surface Water Impacts (Construction) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Kechut Reservoir	High	Decrease in flow as a result of catchment area reduction.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Minor	Not Significant
Spandaryan Reservoir	High	Decrease in flow as a result of catchment area reduction.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Minor	Not Significant
Gndevaz Reservoir	Minor	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Gndevaz Channel	Medium	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of overtopping of the BRSF Toe Pond.	Minor	Minor	Not Significant
Wetland Ponds within Darb Tributaries including Benik's Pond	Minor	Decrease in flow as a result of catchment area reduction and decrease in spring flow.	Negligible	Negligible	Not Significant
		Decrease in water quantity within Benik's Pond as a result of seasonal water abstraction.	Minor	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant

Table 6.10.6: Potential Surface Water Impacts (Construction) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
Wetlands within Vorotan Catchment	Medium	Decrease in flow as a result of catchment area reduction and decrease in spring flow.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant
Wetlands within Ketchut Reservoir Tributaries	Minor	Decrease in flow as a result of catchment area reduction and decrease in spring flow.	Moderate	Negligible	Not Significant
		Decrease in water quality as a result of accidental spillages and sediment released from construction areas.	Negligible	Negligible	Not Significant

Operational Phase

The operational phase includes the development of the pits and stockpiles and operation of the key mining facilities. Detention ponds, sediment ponds and access roads will be constructed prior to operation, and utilised during operations. Operational surface water management is discussed in Section 6.10.5.

Water extraction and reduction of catchment areas will reduce flows in streams and rivers. In addition, the lining of specific facilities (HLF, ponds, etc.) will result in less recharge to the groundwater system below the facilities and consequently lower groundwater levels leading to a reduction in baseflow to springs, streams and rivers, as discussed further in Chapter 6.9. Accidental uncontrolled releases from the HLF, BRSF (including backfilled pits), roads and stockpiles has the potential to impact surface water quality.

The predicted reduction in surface water catchment area and baseflow contribution from perennial springs for receptors during operations are provided in Table 6.10.7. The predicted reduction in groundwater flow to the baseflow component within main rivers and reservoirs is based on the proportion of the impacted catchment within the Project area compared with the total catchment area for the receptor. Impacts to groundwater flow specifically within the Project area are discussed in Chapter 6.9.

Table 6.10.7: Predicted Surface Water Receptor Catchment Reductions (Operations)		
Receptor	% Reduction in Catchment Area	% Reduction in Groundwater Flow Contribution to Baseflow*
Kechut Reservoir Tributaries	19% for BRSF tributary or 8% of total within Project area	10% for BRSF tributary and tributaries fed by Madikenc springs or 2% of total
Arpa River Downstream of Kechut Reservoir	<1%	<1%
Arpa River Tributaries Downstream of Kechut Reservoir	0%	2%
Arpa River Tributaries HLF Area	28%	2%
Darb River	<1%	<1%
Darb River Tributaries	1% of total (due to pit)	up to 36% for individual tributaries, <10% total.

Table 6.10.7: Predicted Surface Water Receptor Catchment Reductions (Operations)		
Receptor	% Reduction in Catchment Area	% Reduction in Groundwater Flow Contribution to Baseflow*
Vorotan River	<1%	<1%
Vorotan River Tributaries	4% of total (due to pit)	3% to 24% for individual tributaries, <10% total.
Kechut Reservoir	0%	<1%
Spandaryan Reservoir	<1%	<1%
Gndevaz Reservoir	0%	<1%
Gndevaz Channel	0%	<1%
Wetland Ponds within Darb Tributaries including Benik's Pond	<1% to 20% for individual ponds. 11% for Benik's Pond.	up to 13% for individual tributaries
Wetlands within Vorotan Catchment	<1%	3%
Wetland within Kechut Reservoir Tributaries	Wetlands within the BRSF footprint will be progressively covered. There will be only minor direct effects during construction – the majority of impacts will be during operations . No other wetland loss in the Ketchut Reservoir tributaries.	All spring flow within BRSF area captured and used in HLF process.
Notes: *Groundwater Modelling Study (Golder 2014 ⁶)		

Dewatering of the pits is likely to result in a reduction in flow in some of the high-elevation perennial springs on Amulsar (surfacing in the elevation band of 2500 to 2900 m) located in proximity to the pits, which may potentially lead to some springs becoming ephemeral with dry periods during the winter.

Potential operational phase impacts on each receptor are discussed in the following sections.

⁶ Appendix 6.9.1 - Golder Associates, 2014. Groundwater Modelling Study. Report Reference 14514150095.506/B.1, 21 August 2014.

Kechut Reservoir and Tributaries

The BRSF will reduce the size of the surface water catchment within the Kechut Reservoir tributaries. The magnitude of the impact is considered **low** as the total catchment size of tributaries will be reduced by approximately 8 %.

The magnitude of impact to the Kechut Reservoir is considered **negligible** as the large size of the total catchment flowing to the Kechut Reservoir (in comparison to the very small surface water loss) provides a significant buffer against any potential flow losses including those from the perennial springs within the BRSF area and the Madikenc springs. The BRSF Toe Pond is sized to accommodate the 1:100 year event and all runoff from the BRSF will be piped to the Contact Water Pond in the vicinity of the HLF.

Accidental uncontrolled releases (for example during extreme storm events) from the BRSF could reduce pH and increase metal and nitrate concentrations in surface water, particularly during first flush events. Surface water runoff will be managed by the BRSF Toe Pond (a lined pond), which will also capture seepage from the basal drainage layer within the BRSF. Water from the BRSF Toe Pond will be piped to the HLF Contact Water Pond for use in the HLF or for treatment and discharge to the Arpa at MAC II standards. As a result the magnitude of the impact to water quality will be **negligible**.

Arpa River, Arpa Tributaries Downstream of Kechut Reservoir and Arpa Tributaries HLF Area

The HLF and upstream catchment, including HLF Detention Pond, maximise the reuse of intercepted water, consequently there will be a significant temporary loss of catchment contributing to downstream surface runoff. From year 5 of operation there will be an excess of water, which will be treated to MAC II standards prior to discharge to the Arpa River downstream of the proposed water intake. 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 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.

To minimise the volume of water managed in the HLF Contact Water Pond, non-contact water in the catchment north of the ore conveyor will be routed around the pond and into the spillway, discharging downstream of the HLF. Spring flow surfacing beneath the facility liner

will be collected in a sump and continue to be released to surface water provided it meets discharge requirements, albeit further downstream. Captured spring flow not meeting discharge requirements (i.e. MAC II standards) will be recirculated within the HLF.

The impact in the Arpa tributaries within the HLF Area is considered **moderate** and downstream in the Arpa the impact is considered **negligible**. The water quantity contribution to the Arpa is minimal (<1%) and baseflow in the Arpa is expected to reduce by no more than 1% (noting that the discharge from the PTS from year 5 onwards represents ~0.5% of the estimated low flow in the Arpa). Arpa tributaries downstream of Kechut Reservoir will have no appreciable loss in catchment size, however baseflow contribution from springs may reduce by up to 2% and on this basis the impact is considered **low**.

The HLF Contact Water Pond is designed as a zero discharge facility for events up to the 1:100 year rainfall event until year 5 of operation. After year 5, discharge at a rate of up to 40m³/hour (~11 L/s) will be treated to MAC II standards prior to discharge to the Arpa downstream of the water supply intake. To manage the flood risk the spillway will have a capacity for 1:1,000 year events. Storm Ponds will also have the capacity to manage the 1:100 year events. Excess water will be pumped back to the HLF for leaching.

The water supply for the mine will be pumped from the Arpa River, downstream of the fish farms. Make-up water is required in the dry months (January to March and July to December) of most years and increases during the last two years of mining operations because pit dewatering is no longer a source of water. The average pumping rate is estimated to be less than 2% of the baseflow during low flow periods and less than 4% of the low flow baseflow during peak pumping periods. The magnitude of impact as a result of pumping water from the Arpa is **low**.

To mitigate the risk of mining-influenced water entering the environment, the HLF, Storm Ponds and HLF Contact Water Pond will be lined. Water in the HLF Contact Water Pond, which includes water piped from the BRSF and pits, and surface water runoff from the catchment upstream of the HLF, will be recycled through the process. Excess water not used in the HLF will be treated in the PTS and discharged as described above.

During extreme hydrologic events, contact water would be significantly diluted with precipitation/snowmelt and background runoff water. Storm Ponds and the Contact Water

Pond will be used for extreme event storage and will be used to cycle water onto the HLF to increase available water storage if required. While an unmitigated release of cyanide containing water during operations would be potentially harmful to the downstream surface water environment, the design mitigation measures, procedures and management measures in place to address this risk are very robust. Consequently the likelihood of such an occurrence is considered extremely low. Details of the procedures that will be in place to address cyanide control are presented in the Cyanide Management Plan (Appendix 8.11). The magnitude of the impact to water quality during operations is therefore considered **low**.

Little or no surface water flow was observed in the HLF catchment during the baseline monitoring period, consequently any leakage from the HLF may not appear in the watercourse downstream. Should it occur and given the hydrogeological conditions, surface water will be similar to groundwater quality, potentially containing elevated nitrate, sodium and ammonium concentrations (Golder, 2014⁷). Should these conditions occur, modifications to the leach system operations, repairs to the liner or other engineering mitigation measures such as a sump and/or pump-back system will be constructed to collect and reuse the water thus mitigating this impact (SGS, 2014⁸). The magnitude of impact is considered **negligible**.

Any leakage from the HLF entering the Arpa River via groundwater pathways will not lead to a significant change in water quality in the Arpa River. No measurable change is predicted for the majority of parameters, including cyanide. A small measurable change in nitrate, sodium and ammonium may occur, however all changes will be below MAC II standards. The magnitude of impact is **low**.

Gndevaz Reservoir

Sediment ponds will manage surface water runoff from the ore conveyor corridor footprint and access roads running through the Gndevaz Reservoir catchment before discharging to the environment, with negligible reduction of catchment to the downstream environment. The drainage system has been designed for 1:100 year design events. The water quality and quantity magnitude of impact is considered **negligible**.

⁷ Appendix 6.9.4 - Golder Associates, 2014. Hydrogeological Risk Assessment Proposed Heap Leach Facility. Report Reference 14514150095.509, August 2014.

⁸ SGS Metcon/KD Engineering, 2014. Amulsar 43-101 Feasibility Study, Reference Q439-07-028-01 August 2014

Gndevaz Channel

Impact upon water quantity within the Gndevaz Channel (once reinstated and functional) is considered **negligible** during the operational phase, as the channel will be lined and raised so as to be essentially isolated from the local surface water and groundwater systems which may be affected by the Project. Additionally, the area of the Vorotan valley from which the channel receives water is upstream of the Project area. The greatest perceived risk to the Gndevaz Channel (once reinstated and functional) during the operational phase is considered to be from an accidental uncontrolled release from the BRSF Toe Pond during an extreme event, causing a potential impact to the water quality within the channel. Appropriate design mitigation will include appropriate sizing of the Toe Pond to accommodate potential flood events; and monitoring of pond level trigger levels. The magnitude of impact to water quality during operations is considered **moderate**.

Darb River Tributaries, Darb River and Wetland Ponds including Benik's Pond

The upper section of the ore conveyor corridor, access roads, pits and the crusher are located in the upper reaches of Darb River tributaries. There will be a progressive decrease in the Darb River catchment area as the pits are mined. Overall, the reduction in catchment area is minimal. The magnitude of impact to the Darb is considered **negligible** as the relatively large size of the Darb outside of the Project area provides a significant buffer against any potential flow losses. Impact to the Darb River tributaries is considered **moderate** as the total reduction in catchment area is <1%, and perennial spring flow contributing to tributary baseflow may decrease by 10 to 36% (significant during low flow periods).

The decrease in the catchment area providing runoff to Benik's Pond and other wetland ponds is significant and reduction of perennial spring flow is anticipated due to dewatering of the pits (Chapter 6.9). There will be a reduction in catchment area of up to 20% to three small wetland ponds in the tributaries upstream of Benik's Pond. Therefore, in terms of water quantity, the magnitude of the impact is considered **moderate**.

Sediment ponds located west of the crusher and Tigranes-Artevasdes Pit will mitigate potential increases in sediment loads from these areas before discharging to the environment. The sediment ponds and drainage system are designed for the 1:100 year design events and will be monitored prior to discharge.

Surface water runoff and groundwater pumped from the pit sumps will be treated by a double

sediment pond system. In-pit sediment ponds will provide initial treatment and will discharge to the drainage system surrounding the pits if discharge standards are met (i.e. MAC II standards and/or baseline). Mining-influenced water in the pit and water that fails to meet MAC II standards will be piped to the BRSF Pond. Pumping of water accumulating in the pits will minimise the potential for mining-influenced water to reach springs and nearby surface water on Amulsar. Therefore impacts are expected to be **low**.

Vorotan River Tributaries, Vorotan River and Spandaryan Reservoir

Impacts to the Vorotan River are expected to be similar to those presented for the Darb River i.e. a **negligible** impact to water quantity and a **low** impact to water quality. The Vorotan River tributaries are expected to have a moderate impact due to the loss of catchment from expansion of the pits during operation and reduction in groundwater flow to baseflow. The Spandaryan Reservoir is located a significant distance downstream of Amulsar, consequently catchment area losses are insignificant, and any water quality changes will be minor and not measurable in the Spandaryan Reservoir. Impacts to the Spandaryan Reservoir are **negligible**.

Wetlands within Vorotan Catchment and Kechut Reservoir Tributaries

Wetland areas located adjacent to the Vorotan River and tributaries are considered to have a **low** impact during operations. Reduction of groundwater baseflow to the wetland areas within the Vorotan catchment is expected to be approximately 3% in total and reduction of surface water catchment area is minimal. Impact to water quality is considered to be **negligible** because mining-influenced water will not be released to the catchments unless extreme hydrological events occur.

The wetland within the BRSF site area (within Kechut tributaries) will be lost as a result of construction of the BRSF, however there are other equivalent wetland habitats within the Project area and therefore the impact is considered **moderate**. Impact to water quality is expected to be **low** because any spring water will be collected for use in the leaching process.

A summary of the impacts, magnitude, significance of impact and scale of significance can be found in Table 6.10.8. Scale of significance to all surface water receptors during mine operations is considered **not significant**.

Table 6.10.8: Potential Surface Water Impacts (Operations) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
Kechut Reservoir Tributaries	Medium	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from BRSF.	Negligible	Negligible	Not Significant
Arpa River Downstream of Kechut Reservoir	Medium	Decrease in flow as a result of catchment area reduction and water extraction.	Low	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from HLF and HLF Detention Pond	Low	Minor	Not Significant
Arpa River Tributaries Downstream of Kechut Reservoir	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from HLF and HLF Detention Pond.	Low	Negligible	Not Significant
Arpa River Tributaries HLF Area	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Moderate	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from HLF and HLF Detention Pond.	Low	Negligible	Not Significant
Darb River	Medium	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release during an extreme event from Haul Road, Pit and Crusher Sediment Ponds.	Low	Minor	Not Significant
Darb River Tributaries	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Moderate	Minor	Not Significant

Table 6.10.8: Potential Surface Water Impacts (Operations) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
		Decrease in water quality as a result of accidental uncontrolled release during an extreme event from Haul Road, Pit and Crusher Sediment Ponds.	Low	Negligible	Not Significant
Vorotan River	Medium	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release during an extreme event from Haul Road, sediment ponds and mining-influenced water from the pits.	Low	Minor	Not Significant
Vorotan River Tributaries	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release during an extreme event from Haul Road, sediment ponds and mining-influenced water from pits.	Low	Negligible	Not Significant
Kechut Reservoir	High	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from BRSF.	Negligible	Minor	Not Significant
Spandaryan Reservoir	High	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of release from Haul Road, sediment ponds and mining-influenced water from the pits.	Negligible	Minor	Not Significant
Gndevaz Reservoir	Minor	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant

Table 6.10.8: Potential Surface Water Impacts (Operations) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
		Decrease in water quality as a result of accidental uncontrolled release from Haul Road sediment ponds.	Low	Negligible	Not Significant
Gndevaz Channel	Medium	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from the BRSF Toe Pond during an extreme event.	Moderate	Moderate	Not Significant
Wetland Ponds within Darb Tributaries including Benik's Pond	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Moderate	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from Haul Road, sediment ponds and mining-influenced water from pits.	Low	Negligible	Not Significant
Wetlands within Vorotan Catchment	Medium	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from Haul Road, sediment ponds and mining-influenced water from the pits.	Negligible	Minor	Not Significant
Wetlands within Kechut Reservoir Tributaries	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Moderate	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release during an extreme event from the BRSF.	Low	Negligible	Not Significant

Closure and Post-Closure Phase

Mine closure will impact water quality and quantity at surface water receptors. Reduction of catchment area may continue to reduce flows in streams and rivers; and covering of the BRSF and HLF with a store-and-release evaporative soil cover will result in decreased runoff in these catchments. Reduced recharge over parts of the Project area will lead to a reduction in baseflow to springs, streams and rivers. Accidental uncontrolled and/or untreated releases from the HLF and BRSF (including backfilled pits), have the potential to impact surface water quality.

The closure phase will include partial backfill of the Tigranes-Artavazdes and Erato pits (Section 6.10.6 and Golder 2014⁹). No permanent open water is predicted within the closed pits. The BRSF will be capped with an engineered cover to inhibit infiltration. Runoff from the facility (non-contact) will be to the downstream Kechut Reservoir tributary. Section 6.10.5 describes the closure treatment cycles of the HLF. Upon closure a second HLF PTS will be constructed by reusing the HLF Storm Ponds, which will be re-purposed and become part of the wetland system. Negligible impact to receptor catchments is expected post-closure as surface water will discharge to the environment from the pits, HLF and BRSF. Two passive treatment systems will operate on site until any discharge from the BRSF and HLF, separately, to meet MAC II standards unaided.

Other mine facilities and infrastructure will be demolished, where appropriate, and project-impacted areas will be stabilised and reclaimed. Surface water runoff from reclaimed areas will discharge to the environment following sediment management in ponds during the closure phase and directly during post-closure when reclamation of these areas is complete.

Surface water control features will be maintained for closure and post-closure activities to minimise erosion in reclaimed areas and to minimise the transport of sediment in surface water runoff.

⁹ Golder Associates, 2014. Preliminary Mine Reclamation, Closure and Rehabilitation Plan 1138159714 009 R2, 19 August 2014

The predicted reduction in surface water catchment area and baseflow contribution from groundwater (perennial springs) for receptors during closure and post-closure are provided in Table 6.10.9

Table 6.10.9: Predicted Surface Water Receptor Catchment Reductions (Closure and Post-Closure)		
Receptor	% Reduction in Catchment Area	% Reduction in Groundwater Flow Contribution to Baseflow*
Kechut Reservoir Tributaries	0%	1 to 6% for BRSF tributary and 7-8% for Madicenk Springs, or 2% of total.
Arpa River Downstream of Kechut Reservoir	0%	<1%
Arpa River Tributaries Downstream of Kechut Reservoir	<1% Closure 0% Post-Closure	2%
Arpa River Tributaries HLF Area	28% Closure 0% Post-Closure	2%
Darb River	<1% (due to pits)	<1%
Darb River Tributaries	<1% of total (due to pits)	1% for all tributaries or up to 20% for individual perennial springs at the head of catchments
Vorotan River	<1%	<1%
Vorotan River Tributaries	1% of total (due to pits)	11% to 21% for tributary east of the BRSF, 1 to 6% for other tributaries
Kechut Reservoir	0%	<1%
Spandaryan Reservoir	<1%	<1%
Gndevaz Reservoir	0%	<1%
Gndevaz Channel	0%	<1%
Wetland Ponds within Darb Tributaries including Benik's Pond	<10% for individual ponds.	1% to 6%
Wetlands within Vorotan Catchment	1%	2 %
Wetland within Ketchut Tributaries	Wetland lost beneath the BRSF footprint. No other wetland losses in the Ketchut Tributaries.	Any spring flow will be released to catchment following passive treatment.
Notes:		
*Groundwater Modelling Study (Golder 20146)		

Potential closure and post-closure phase impacts for each receptor are discussed below.

Kechut Reservoir and Kechut Reservoir Tributaries

Discharge from the BRSF will enter the downstream catchment at closure following passive treatment, and there will be a negligible change to the size of the overall surface water catchment within the Kechut Reservoir tributaries. The magnitude of the impact is considered **low** as the change to catchment runoff characteristics (with a slight decrease due to the E/T cover on the BRSF) within this tributary will be minor. The total reduction in groundwater contribution to baseflow within the tributaries is predicted to be approximately 2%. The magnitude of impact to the Kechut Reservoir is considered negligible as the size of the total catchment flowing to the reservoir provides a significant buffer against any potential reduction in baseflow from a decrease in spring flow.

Should the PTS become less effective during post-closure, there could be a reduction in pH and increase in metal concentrations during the snowmelt period. The magnitude of impact is considered to be **negligible** within the Arpa/Kechut Reservoir and **low** within the Arpa tributaries. Any change will be temporary as ongoing monitoring will identify the need for any treatment improvements.

Two potential pathways have been evaluated with respect to the migration of groundwater from the BRSF and Pit area:

- Groundwater originating at the pits or BRSF will flow north-westwards, passing below the Spandaryan-Kechut Tunnel, in a diffuse manner to reach the Arpa River downstream of the Kechut Reservoir. No groundwater from the BRSF and pit areas reaches the Kechut Reservoir so no change in water quality will occur;
- Groundwater originating at the BRSF or pit areas may discharge to the Kechut-Spandaryan Tunnel (although not indicated by the groundwater flow model), and thus reach the Kechut Reservoir. The impact of this scenario is no change for the majority of constituents; Boron and nitrate concentrations in the reservoir are predicted to increase slightly but will remain well below MAC II standards with no change measurable against baseline levels. The magnitude of this impact is therefore considered to be **negligible**.

Arpa River, Arpa Tributaries Downstream of Kechut Reservoir and Arpa Tributaries HLF Area

The HLF facility and upstream catchment, including HLF Detention Pond and Storm Ponds, will

continue to discharge through the PTS during the closure period. HLF drain down water will be treated prior to discharge to the downstream catchment. Post-closure water will discharge to the downstream catchment following passive treatment. Spring flow beneath the facility liners will continue to be released to surface water (Chapter 6.9). The quantity impact in the Arpa tributaries within the HLF area is considered **moderate** and downstream in the Arpa the impact is considered **negligible** as the reduction in baseflow to the Arpa is minimal (<1 %). Arpa tributaries downstream of Kechut Reservoir will have a negligible loss in catchment size and a predicted minor 2 % reduction in baseflow from groundwater and on this basis the impact is considered **low**. In the absence of long term data for flow in the Arpa and information on the regulation and operation of the Kechut Reservoir the potential impact has been determined using a scaled estimate of flow in the adjacent Vorotan catchment provided a proxy low flow estimate given similar hydrologic conditions. This includes low flow measurements from spot flows; and continuous monitoring data and anecdotal information on the operation of the reservoir were used as further points of reference. The approach to low flow estimation in the Arpa River outlined in Chapter 4.9.4 (Long Term Data) and Chapter 4.9.5 (Low Flow and Environmental Flow Conditions) has been used in the absence of long term data for flow in the Arpa and information on the regulation and operation of the Kechut Reservoir. During extreme events, water from the HLF Contact Water Pond in the initial phase of closure could pass downstream via the spillway; however, any water would be significantly diluted because of the large volume of background water. During the initial phase of closure, Storm Ponds will also be used to manage runoff during extreme events. Given the design standard of the Storm Ponds and Contact Water Pond, the magnitude of impact is considered **low**. The ponds will be removed at the end of the closure phase.

Impacts arising from leakage from the HLF and BRSF and groundwater flow are described in Chapter 6.9. Any leakage reaching groundwater from the BRSF will flow north westwards, below the Spandaryan-Kechut Tunnel, in a diffuse manner to reach the Arpa River downstream of Kechut Reservoir. Any leakage from the HLF that is not collected and that escapes the water management system will flow westwards towards the Arpa River. Combined leakage impacts from the Project are assessed at station AW009, on the Arpa River downstream of the BRSF and HLF. The only change in concentration will be nitrate, which will remain below MAC II standards with no change measurable against baseline levels. Given the predicted impact, the magnitude will be **negligible**.

All known users of this reach of the Arpa River have been considered to determine the

potential impacts associated with the abstraction from the River Arpa, for makeup during the operational phase of the mine (see Chapter 6.10.7). The EMP (see Appendix 8.12) requires continuous monitoring of flow in the Arpa River together with monitoring the effects on water flow from the operation of the Kechut Reservoir.

Gndevaz Reservoir

The conveyor infrastructure will be demolished at closure and access roads running through the Gndevaz Reservoir catchment will be reclaimed. Sediment ponds will remain until infrastructure is removed and vegetation re-established. The water quality and quantity magnitude of impact to Gndevaz Reservoir is considered **negligible** at closure and post-closure.

Gndevaz Channel

The renovated Gndevaz Channel would be flow to the village of Gndevaz irrigation systems and to the Gndevaz Reservoir. The contact water from the Project including the BRSF will drain from the toe pond, via a gravity fed pipeline to the contact water ponds within the HLF. The drainage system will be effective during the operational phase and continue through the closure phase so that seepage from the BRSF flows through the contact water ponds and is either used for HLF water treatment, or overflows through to the BRSF PTS (after year 4 of operations). After closure of the HLF, the BRSF seepage will be treated through the PTS. In the event of an accidental uncontrolled release from the BRSF toe pond there is a risk that the water quality of the Gndevaz Channel may be impacted.

Ongoing monitoring of discharge water quality will be performed as part of the SWMP and EMP. On this basis, the water quality magnitude of impact to the Gndevaz Channel is considered **minor**.

Darb River Tributaries, Darb River and Wetland Ponds including Benik's Pond

The upper section of the ore conveyor corridor, access roads, pits and the crusher are located in the upper reaches of Darb River tributaries. The conveyor and pit crusher infrastructure will be demolished and removed at closure. Runoff from the backfilled T/A pit area (Figure 6.10.3) is anticipated to be directed towards the pre-existing catchments via catch drains. Runoff from exposed and reclaimed pit slopes (Erato and South Artavazdes) will infiltrate to groundwater via the pit floor.

Darb tributary catchment area reductions at closure are expected to be minimal (< 1% of total). Perennial spring flows at the head of tributaries (above 2,300 m asl) may decrease by up to 20% for individual springs providing a significant reduction during low flows, however the total decrease in baseflow from perennial springs is expected to be approximately 1% for all the tributaries within the Project area. The pit closure analysis (Golder, 2014⁹) shows that a post-closure pit water body will not develop.

The magnitude of impact to the Darb is considered negligible as the size of the downstream catchment to the Darb provides a significant buffer against any potential flow reductions. Impact to the Darb River tributaries is considered **low** as the total reduction in spring flow affecting tributary baseflows is approximately 1 % during low flows. The up to 10% reduction of the surface water catchment contributing to the three wetland ponds located upstream of Benik's Pond will be permanent as a result of the Erato and South Artavazdes pit. Therefore, in terms of water quantity, the magnitude of impact is considered **low**.

Groundwater modelling (Golder, 2014⁶) indicates seepage from the pits will flow towards the Vorotan and Darb. Modelling suggests measurable increases in nitrate and lithium concentrations (not exceeding MAC II standards) in the Darb River, around Darb 1 monitoring station. The impact will peak approximately 20 years after closure and will be permanent (Golder, 2014¹⁰). The potential impact to the Darb River is **low**.

Seepage to springs is presented in the groundwater Chapter 6.9 (see Figure 6.9.4: Spring Catchments used in Pit Risk Assessment), and highlights concentrations of some parameters above MAC II standards during seasonal low flows in Catchment 1 (upstream of MP4), Catchment 3 (upstream of AW064, Benik's Pond (AW019)) and Catchment 7 (upstream of AW004). Parameters with peak concentrations above MAC II standards are as follows:

- Catchment 1 – beryllium, cobalt and molybdenum;
- Catchment 3 – sulphate, beryllium, cobalt, molybdenum and nitrate; and
- Catchment 7 – beryllium and cobalt.

Catchments are identified on Figure 6.9.3 within the groundwater Chapter 6.9. The impact to

¹⁰ Appendix 6.9.3 - Golder Associates, 2014e. Assessment of Groundwater Quality Impacts arising from Pit Development. August 2014 Reference 14514150095.512

each tributary has been assessed by mixing spring flow with baseline flows downstream. The results above MAC II standards and baseline are presented in Table 6.10.10. Baseline cobalt concentration at AW064 and AW004 is above MAC II standards and predicted to increase following closure. The long term impact at AW064 is considered **moderate**, and **low** at AW004. Downstream, due to mixing in the Darb, impacts would be **negligible**. Average baseline concentrations have been used in the assessment.

Table 6.10.10: Predicted Darb Tributary Water Quality		
	Catchment 3 Tributary to Darb River (AW064)	Catchment 7 Tributary to Darb River (AW004)
Constituent	Cobalt	Cobalt
MAC (mg/l)	3.60E-04	3.60E-04
Baseline (mg/l)	9.00E-04	2.24E-03
Impact – Tributary Water Quality (mg/l)	1.72E-03	2.60E-03
Long Term Impact (mg/l)	1.15E-03	2.28E-03

Leakage from the pits will impact the springs within the head of the Darb tributaries (Catchment 3) which include springs which feed four wetland ponds, including Benik's Pond (baseline monitoring location AW019). Water quality parameters which exceed MAC II standards are provided in Table 6.10.11.

Table 6.10.11: Predicted Benik's Pond Water Quality at Post-closure					
	Beryllium	Cobalt	Nitrate	Sulphate	Tin
MAC (mg/l)	0.000038	0.00036	2.5	16.04	0.00008
Catchment 3 Tributary to Darb (AW019)					
Catchment 3 Benik's Pond Baseline* (AW019) (mg/l)	0.0002	0.00078	1.66	10.9	Not tested
Catchment 3 Benik's Pond Impact (mg/l)	0.00038	0.0096	3.66	20.03	0.00018
Catchment 3 Benik's Pond Long Term Impact (mg/l)	0.00033	0.0071	2.78	19.27	0.00018
Notes:					
*Average Baseline Value					

Concentrations of beryllium and cobalt are predicted to rise above average baseline readings but are already above the MAC II standards. Nitrate and sulphate baseline concentrations are predicted to rise above MAC II standards. Tin will exceed MAC II standards, however no baseline data exist to provide comparison. Given the predicted impact, the magnitude will be **high**.

Vorotan River Tributaries, Vorotan River and Spandaryan Reservoir

Closure activities discussed above for the Darb also apply to the Vorotan River catchment. Water quantity discussed above for the Darb at closure also apply to the Vorotan River i.e. **negligible** impact to water quantity. Tributaries will have a low impact due to a permanent reduction in perennial spring flow to the tributaries and a 1% loss of catchment area due to the pits. The Spandaryan Reservoir is located a significant distance downstream of Amulsar, consequently catchment losses are insignificant. Impacts to Spandaryan Reservoir are **negligible**.

Groundwater seepage from the pits will flow towards the Vorotan and Darb River. The only predicted measurable changes impacting the Vorotan River are minor increases in concentration of lithium, nitrate and sulphate (Golder, 2014¹⁰), all of which will not exceed MAC II standards. In addition, the impact to the Vorotan only considers baseflow and does not consider seasonal flow variations. The impact to the Vorotan will be **low**.

Seepage to nearby springs is presented in Groundwater Chapter 6.9, and highlights no parameters in Catchment 2 or 5 will increase above MAC II standards. Dilution in the catchments draining the eastern flank of Amulsar will lead to no measureable change in water quality downstream, remaining below MAC II standards, therefore the impact will be **negligible**.

Impacts to the Vorotan River will be diluted downstream such that in the Spandaryan Reservoir no measurable change is predicted in water quality. The impact will be **negligible**.

Wetlands within Vorotan Catchment and within Kechut Tributaries

Wetland areas located adjacent to the Vorotan River and its tributaries are considered to have a **low** impact at closure. A minor reduction (2%) of groundwater flow to the wetlands is expected and reduction of surface water catchment area due to the pits will be 1% of the total tributary area. Impact to water quality is considered to be **low** due to impacts from pit seepage which contributes flow to the wetland areas.

The wetland within the BRSF site area will be permanently lost however in Chapter 4.10, the biodiversity baseline identifies equivalent wetland habitat areas within the Project area and therefore the impact is considered **moderate**.

A summary of the impacts, magnitude, significance of impact and scale of significance can be found in Table 6.10.12.

The impacts to Benik's Pond and the three upstream wetland ponds (Wetland Ponds within the Darb tributaries including Benik's Pond) are classified as **significant**; mitigation strategies to address this impact are presented in Section 6.10.8. The impacts of the remaining surface water receptors are classified as **not significant**.

Table 6.10.12: Potential Surface Water Impacts (Closure and Post-Closure) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
Kechut Reservoir Tributaries	Medium	Change in flow as a result of changes in catchment runoff and spring flow decrease.	Low	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release of sediment during reclamation or decreased performance of the BRSF passive treatment system.	Low	Minor	Not Significant
Arpa River Downstream of Kechut Reservoir	Medium	Change in flow as a result of changes in catchment runoff.	Low	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release of sediment during reclamation, release of water from the HLF and HLF Contact Water Pond during closure or decreased performance of the HLF passive treatment system.	Low	Minor	Not Significant
Arpa River Tributaries Downstream of Kechut Reservoir	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from sediment during reclamation.	Negligible	Negligible	Not Significant
Arpa River Tributaries HLF Area	Minor	Change in flow as a result of changes in catchment runoff and spring flow decrease.	Moderate	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release of sediment during reclamation, release of water from the HLF and HLF Contact Water Pond during closure or decreased performance of the HLF passive treatment system.	Low	Negligible	Not Significant
Darb River	Medium	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	Low	Minor	Not Significant
Darb River Tributaries	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Negligible	Not Significant

Table 6.10.12: Potential Surface Water Impacts (Closure and Post-Closure) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	Moderate	Minor	Not Significant
Vorotan River	Medium	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	Negligible	Negligible	Not Significant
Vorotan River Tributaries	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Negligible	Not Significant
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	Low	Negligible	Not Significant
Kechut Reservoir	High	Change in flow as a result of changes in catchment runoff and spring flow decrease.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release of sediment during reclamation or decreased performance of the BRSF passive treatment system.	Negligible	Minor	Not Significant
Spandaryan Reservoir	High	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Minor	Not Significant
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	Negligible	Minor	Not Significant
Gndevaz Reservoir	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from sediment during reclamation.	Negligible	Negligible	Not Significant
Gndevaz Channel	Medium	Decrease in flow as a result of catchment area reduction.	Negligible	Negligible	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from BRSF, toe pond.	Minor	Minor	Not Significant

Table 6.10.12: Potential Surface Water Impacts (Closure and Post-Closure) and Significance of Impact (considering Design Mitigation Measures)

Receptor	Receptor Sensitivity	Potential Impact	Magnitude of Impact	Impact Significance	Scale of Significance
Wetland Ponds within Darb Tributaries including Benik's Pond	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Low	Negligible	Not Significant
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	High	Moderate	Significant
Wetlands within Vorotan Catchment	Medium	Decrease in flow as a result of catchment area reduction and spring flow decline.	Low	Minor	Not Significant
		Decrease in water quality as a result of infiltration of mining-influenced water from Pit to springs.	Low	Minor	Not Significant
Wetlands within Kechut Reservoir Tributaries	Minor	Decrease in flow as a result of catchment area reduction and spring flow decrease.	Moderate	Minor	Not Significant
		Decrease in water quality as a result of accidental uncontrolled release from sediment during reclamation or decreased performance of the BRSF passive treatment.	Negligible	Minor	Not Significant

6.10.8 Surface Water Mitigation Measures and Residual Impacts

Impacts and Mitigation Measures

With the appropriate mitigation measures included in the facility designs and operational procedures, most of the identified impact risks will be eliminated or reduced to acceptable levels. The only significant impact predicted (considering design mitigation only) from the impact assessment is to water quality within wetland ponds to the west of the pits (which include Benik's Pond), following closure. No significant impact is predicted during construction or operations. The magnitude of change for water quality parameters is high, relating to beryllium, cobalt and that for nitrate and sulphate considered moderate. Cobalt and beryllium are naturally occurring within the local geology (and concentrations in Benik's Pond already exceed MAC II standards) and the increase in concentrations is due to the mobilisation of metals from the barren rock backfill within the pits. These impacts have been minimised with the design of the backfill cover for the Tigranes-Artavazdes pit but cannot be avoided as the constituents occur naturally within the geology of the pit area and seep/flow into the wetland areas via perennial springs.

To provide additional mitigation, runoff from the backfilled Tigranes-Artavazdes pit area will, to the greatest extent possible, be diverted to the wetland ponds. However this mitigation may not fully reduce the impacts during low flow conditions. Monitoring during the post-closure period will be used to determine the effectiveness of this additional mitigation measure. No further mitigation measures are proposed since the water quality parameters with a high impact already exceed MAC II standards. Further mitigation in regards to the effect on aquatic habitat or appropriate compensation are discussed within Chapter 6.11 (Biodiversity).

Minor impacts to other receptors which include the HLF tributary and wetland within the Kechut tributaries (BRSF Area) are identified but are determined 'not significant'. Therefore, no further mitigation is proposed at these locations.

Mitigation measures with regard to surface water receptors to be included in the SWMP are summarised in Table 6.10.13.

Table 6.10.13: Summary of Surface Water Mitigation Measures

Potential Impact	Stage of Impact	Location	Mitigation	Responsibility
Sediment, Oils and Constituents released into surface water	Construction	All Areas	<ul style="list-style-type: none"> Implement environmental control measures for storage and handling of materials. Implement appropriate Erosion and Sedimentation Control Plans. 	Geoteam, EPC Contractor
Contact Water Discharging to Environment	Operation and Post-Closure	HLF and BRSF	<ul style="list-style-type: none"> Contact water management system sized to manage extreme precipitation events/years. Passive treatment of BRSF contact water if necessary after year 4 of operations and following closure of the HLF. Active treatment during HLF drain down. For closure the HLF passive treatment system will be constructed by reusing the the storm water detention pond system as the wetland phase. Cyanide Management Plan. 	Geoteam
Reduced water quality in Vorotan and Arpa River from non-contact water	All stages	All Areas	<ul style="list-style-type: none"> Adequate treatment and settlement of runoff prior to discharge through provision of adequate environmental controls, ponds, etc. Surface water management system (non-contact water) sized to manage extreme precipitation events/years. Ensure regular monitoring of water quality downstream of the mine. 	Geoteam, EPC Contractor
Unsuitable environmental water flow in Arpa River	Operational	All Areas	<ul style="list-style-type: none"> Ensure abstractions do not adversely impact river by imposition of abstraction schedules. 	Geoteam

Residual Impact Assessment

Residual impacts stem from pit seepage impacts. The mitigation measures presented in Table 6.10.13 will not change the significance of impacts described in Section 6.10.7. In addition, mitigation failure remains a residual risk that will be managed by monitoring at all stages of the development. Surface water monitoring is discussed in Section 6.10.9.

The impacts to surface water quality and quantity are considered further in the Biodiversity assessment (Chapter 6.11) including the impact on aquatic habitat.

6.10.9 Monitoring

Monitoring requirements identified by the assessment process are outlined below. Details of proposed monitoring programmes will be included in the SWMP and include construction, operational and post-closure monitoring of flow rates and water quality at the following locations:

- Springs and tributaries surrounding the open pits;
- Tributaries prior to discharge to the Arpa, Darb and Vorotan Rivers;
- Benik's Pond to the west of the pits;
- Gndevaz Reservoir;
- Vorotan and Arpa River upstream and downstream of Amulsar;
- All points of discharge during operations i.e. sediment ponds; and
- Groundwater and surface water downstream of all major facilities including HLF and BRSF facilities and the passive water treatment discharge locations at closure.

The monitoring required to confirm the effectiveness of the mitigation strategies has been identified in Table 6.10.14.

Table 6.10.14: Surface Water Mitigation, Monitoring and Audit		
Surface Water Mitigation, Monitoring and Audit Programme and Procedures		
Monitoring Approach	Baseline	Pre-construction baseline monitoring has been undertaken between 2007 and 2015 to define the baseline surface water and groundwater conceptual model of the Project area, as outlined in Chapter 4.9. Baseline investigations and impact assessment have identified sensitive receptors and potential risks associated with aspects of the proposed mine development, which will require monitoring and mitigation during construction, operation and post-closure phases. Baseline water quality data in conjunction with National water quality standards (MACs; where relevant) provide targets against which construction and operation monitoring data will be assessed.
	Construction and Operation Phases	Surface water and groundwater monitoring will be undertaken during the construction and operation phases and compared with the baseline data and MACs to ensure compliance with appropriate regulations; to confirm that any impacts are consistent with those predicted through the ESIA process; and to give an advanced warning (where possible) of any potential deviation from the predicted conditions that could negatively impact surface water and groundwater receptors.

Table 6.10.14: Surface Water Mitigation, Monitoring and Audit		
	Post-closure phase	Surface water and groundwater monitoring should continue beyond the cessation of mining activities and mine closure for aftercare purposes.
Significant Effects		
Modification of surface water flow regime		<ul style="list-style-type: none"> • Changes to Arpa River flow regime from abstraction during construction and operational phases (where required). • Changes to Benik's Pond surface water levels from abstraction during construction phase.
Modification of surface water quality		<ul style="list-style-type: none"> • Non-contact water discharge. • Contact water discharge.
Specific Actions		
Management Plans		The SWMP will be adopted by site contractors (or they will generate their own). It will include best practice mitigation procedures to minimise as far as possible the risk of adverse impact to the local water environment as a result of the construction activities.
		The Mine Reclamation Closure and Rehabilitation Plan (MRCRP) defines the management of water resources from the construction phase through to the mine closure plan, so that on reclamation water resources will have been maintained to achieve the objectives of the Plan.
		The SWMP provides an outline design for water management which complies with the relevant effluent discharge standards; and proposes a monitoring and mitigation scheme for prevention of any adverse impacts to the local and regional surface water and groundwater regime as a result of Project activities.
		The Spill Prevention and Response Plan (incorporated in the EPRP) define the measures that will be taken to manage, control and monitor substances that have the potential to adversely impact water resources.

Table 6.10.14: Surface Water Mitigation, Monitoring and Audit

Environmental Monitoring Plan	<p>The plans will be underpinned by the following SOPs that will provide specific guidance on sampling and/or monitoring locations and procedures during the construction, operational and closure phases. The SOPs will include the following:</p> <ul style="list-style-type: none"> • Surface water level monitoring (construction, operation and post-closure phases): procedures for point and continuous stage monitoring at defined locations on the Vorotan, Arpa and Darb rivers and their tributaries and at Benik's Pond (part of the baseline monitoring network). • Surface water flow monitoring (construction, operation and post-closure phases): procedures for point flow monitoring at defined locations on the Vorotan, Arpa and Darb rivers and their tributaries (part of the baseline monitoring network). • Surface water quality monitoring (construction, operation and post-closure phases): procedures for surface water sampling from defined locations on the Vorotan, Arpa and Darb rivers and their tributaries (part of the baseline monitoring network) for <i>in situ</i> analysis and <i>ex situ</i> laboratory analysis. • Discharge water quality monitoring (construction, operation and closure phase): procedures for <i>in situ</i> analysis and <i>ex situ</i> laboratory analysis of water quality from the HLF, BRSF and sediment ponds, to determine whether water quality meets planned targets or if (additional) treatment prior to discharge is required. • Collection of meteorological data (construction and operation phases): procedures for the collection of local meteorological data. Data will be used to develop the baseline hydrologic and hydrogeological conceptual model and calibrate relevant surface water datasets collected during construction and operation phases.
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Surface Water Standard Operating Procedures		Strategy	Monitoring
Surface water flow	Project area catchment watercourses	Monitoring to assess the extent (if any) of impacts on flow regime attributable to mine development. Weirs should be installed where feasible at selected locations to define the stage-flow relationship for each of these points so that the level data can be converted into flow rate (to allow flow rates to be monitored in real time, and the total constituent flux to be calculated). Data will also be used to control the maximum discharge rate for any treated water.	Continuous flow monitoring at the locations specified in the WMP using weirs and installed pressure transducers. Monthly point flow measurements using a hand-held impellor during baseline phase should be intensified during construction and operation phases. Data to be collated in the long-term database, maintained by the Site Environmental Manager.
Discharge water quality	Sediment Ponds	Monitoring of water quality parameters during initial stages of operation phase to determine trigger levels with respect to compliance targets. Monitoring will be completed immediately upstream and downstream of discharge locations.	Automated continuous <i>in situ</i> monitoring of pH, temperature, turbidity and electrical conductivity using automatic analysers (supplemented by manual measurements as the need arises from any discharges to natural watercourses). To be performed weekly during the first three months of operation; and monthly thereafter. Turbidity to be monitored as a proxy for total suspended solids; relationship between the two parameters should be determined within initial months of monitoring. Data to be collated in the long-term database, maintained by the Site Environmental Manager.

	Treated discharge from active and passive water treatment systems for HLF and BRSF during closure.	Water quality monitoring during closure phase to ensure compliance with MAC/baseline. Monitoring will be completed immediately upstream and downstream of discharge locations.	<p>Automated continuous <i>in situ</i> monitoring of pH, temperature, turbidity and electrical conductivity using automatic analysers.</p> <p>Samples to be submitted for laboratory analysis for the same suite of parameters for groundwater samples plus dissolved oxygen (DO), Total Petroleum Hydrocarbons (TPH), oils and grease and Total Suspended Solids (TSS).</p> <p>Monitoring to be performed weekly for the first three months of closure and then reviewed.</p> <p>Data to be collated in the long-term database and screened against compliance targets/appropriate MAC standards.</p>
Surface water quality	Project area surface watercourses	Water quality monitoring during operation phase downstream of mine facilities i.e. HLF, BRSF and pits facilities to ensure compliance with MAC or baseline water quality standards. Monitoring will be completed immediately upstream and downstream of discharge locations.	<p>Sampling for <i>in situ</i> analysis and laboratory analysis to be performed. <i>In situ</i> analysis to comprise pH, temperature, electrical conductivity and turbidity using a hand-held multi-parameter device.</p> <p>Samples to be submitted for laboratory analysis for the standard suite of parameters as specified in the WMP, plus DO, TPH, oils and grease and TSS.</p> <p>Samples to be collected and analysed weekly during initial construction and operation phases then reducing to monthly after initial data review.</p> <p>Data to be collated in the long-term database and screened against compliance targets/appropriate MAC standards.</p>

6.10.10 Conclusions

An impact assessment has been undertaken to assess the effects of construction, operation and closure of the Project with regard to sensitive surface water receptors. The findings of the impact assessment are summarised below:

- Surface water impacts fall under two main categories: water quality and quantity, which result primarily in environmental impacts;
- Where point discharges to the water environment are proposed these will be compliant with Armenian regulations and/or comparable to baseline;
- With appropriate mitigation and management measures, the impact of the proposed mine activity on surface water resources will mostly be eliminated or reduced to acceptable levels. Serious impact risks from ARD, mine influenced water, operational pond overflow and flow regime modification are dealt with in the design and construction of appropriate storage and treatment works. Water quality and hazardous material control will be conducted through specification of appropriate equipment and environmental controls and careful management; and
- Residual surface water impacts are expected to be minor and relate to the alteration of the flow paths of some mountain streams in the vicinity of the HLF and the BRSF; and localised impacts to water quality within wetland ponds to the west of the pits which includes Benik's Pond. Proposed mitigation measures will reduce but may not eliminate the water quality impact to these ponds. Compensatory measures are also proposed to offset the reduction in water quality. The post-closure status of other surface waters will generally be unchanged from existing and/or below MAC II standards based on proposed surface water mitigation; the ecological mitigation measures are expected to improve further environmental conditions.

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6.11 Biodiversity and Ecosystems

6.11.1 Introduction

In line with Lydian's Biodiversity Policy, the Project aims to achieve "no net loss" (NNL) of biodiversity and to ensure that biodiversity and ecosystem functions are not systematically degraded or lost from the landscape as a result of the Project. This means that species occurring in the Project-affected area should have the same chances of long-term survival with the Project in place as without it, and have access to similar amounts of suitable habitat as in the baseline situation. Lydian has also committed to implement the Project according to good international industry practice, as exemplified by its commitment to lender policies, standards and requirements. To comply with the requirements of the International Finance Corporation's Performance Standard 6 (IFC PS6) and the European Bank for Reconstruction and Development's Performance Requirement 6 (EBRD PR6), a NNL outcome should be achieved if possible for natural habitats and a "net gain" outcome must be achieved for critical habitat. Compliance with EBRD's PR6 further requires the Project to follow the intent of EU law with respect to conservation of habitats and species, notably according to the requirements of the EU Habitats Directive.

Section 6.11.2 is an overview of the approach taken to assessment of impacts on biodiversity and ecosystems as a result of the Project. Section 6.11.3 identifies the "priority" biodiversity components that have been selected for detailed consideration, though impacts on biodiversity in general have also been considered. Section 6.11.4 identifies the main Project activities or components expected to give rise to ecological impacts and the biodiversity receptors likely to be exposed to them. In Section 6.11.5, the likely significance of impacts is considered, based on the sensitivity and vulnerability of affected biodiversity. This provides the basis for development of an effective mitigation strategy for biodiversity and ecosystems as discussed in Section 6.11.6.

Table 6.11.14 presents a final summary of the conclusions of this Chapter, showing the predicted significance of impacts on biodiversity pre- and post-mitigation. Proposed offsets are identified, as well as any further work needed (through the implementation of a Biodiversity Action Plan (BAP)) either to confirm that further offsets are necessary or to provide the evidence needed to ensure that they will be appropriate and effective.

6.11.2 Overview of Approach, Assessment Criteria and Overall Mitigation Strategy

As explained in Chapter 4, biodiversity data relevant to the Project area have been collected since 2008, with input from local and national experts and international specialists. Government and non-governmental organisations were consulted and involved, notably the National Academy of Sciences of the Republic of Armenia (NAS RA) Institute of Botany and Institute of Zoology; the Armenian Society for the Protection of Birds (ASPB); the Caucasus Nature Fund; and WWF.

Since the ESIA process commenced formally in 2010, results of ecological surveys have been used systematically to inform Project design, with continuous dialogue taking place between the engineering and biodiversity teams and others involved in environmental and social studies for the ESIA. Information on priority issues and constraints has been provided to the Project design team throughout, allowing them to modify elements of the design as needed to avoid or minimise significant impacts in line with the mitigation hierarchy. In other words, the current Project design already benefits considerably from "in-built" or "embedded" avoidance and mitigation measures to safeguard biodiversity and ecosystems.

Section 5.7 describes instances of Project design elements being adjusted to address biodiversity concerns (amongst others). These include the following:

- The identification of *Potentilla porphyrantha* on Amulsar Mountain was recognised at an early stage as a significant constraint, this species later confirmed as having Tier 1 critical habitat affected by the Project per IFC PS6. A formal set-aside (referred to as the "Arshak Set-aside") was identified to avoid/ safeguard a viable proportion of the population south of Arshak Peak. Elsewhere, individual occurrences of the plant have been marked, and access routes required during exploration activities have been designed to avoid them.
- The Arshak Set-aside also preserves important breeding habitat for *Ursus arctos*, high quality examples of sub-alpine meadow vegetation, habitat for other species of conservation importance (Eurasian Lynx, Wolf, Bezoar Goat) and habitat for bird species included on the RA Red List.
- Conveyor rather than truck transport was selected to transport crushed ore to the HLF, reducing footprint on natural habitat. In 2015, the line of the conveyor was adjusted slightly (during Value Engineering and Optimization) to avoid crossing the end of a rocky gorge important for breeding birds (for the location of this gorge see Figure 6.3.1.

- Topsoil storage locations were reviewed and higher quality vegetation avoided.
- The site selection process for the HLF took the precautionary approach of treating the nearby Gorayk Important Bird Area (IBA) as critical habitat, thus weighting the process heavily against footprint impacts on a Key Biodiversity Area (KBA).

The impact assessment described in this Section 6.11 applies to the current Project design as described in Chapter 3 with "in-built mitigation" incorporated.

The overall aim of the assessment described in this chapter was to determine whether NNL (or net gain as appropriate) could be shown for the various biodiversity receptors in the residual situation, taking account of efforts to avoid or mitigate impacts during Project design and implementation, and to offset any significant residual impacts according to the mitigation hierarchy.

Impact sources were identified based on Project infrastructure and activities. Receptors are ecosystems or any biodiversity component identified during baseline surveys and assessments for which specific consideration of impacts was considered necessary.

As part of the development of the Project's biodiversity mitigation strategy, "priority" biodiversity components or receptors were identified for which it was considered necessary to demonstrate an explicit NNL or net gain outcome through the mitigation hierarchy. These components were chosen for various reasons, for example because there are legal or policy requirements to demonstrate that they will be safeguarded, or because local people value them. They included:

- Species protected in the RA (listed in the Armenian Red Book);
- Species considered by specialists to be threatened or declining either in the RA or in the region or globally;
- Areas of natural habitat according to the definition in PS6 or PR6;
- Habitats or ecosystems which are considered "critical" according to PS6 and PR6; and
- Legally protected areas for nature conservation and their designated features.

The ability to achieve a NNL outcome was considered in detail for these receptors. The ESIA was supported by a detailed “Natural and Critical Habitat Assessment” (NCHA; Appendix 4.10.3) that examined the implications of the Project in detail for natural and critical habitat per PS6/PR6 and identified actions needed to achieve NNL of natural habitat and a net gain of critical habitat.

In line with Lydian’s corporate policy on biodiversity to achieve NNL of biodiversity overall, implications of the Project were also considered for wider biodiversity that might be exposed to impacts (i.e. including receptors which were not identified as priority biodiversity according to the criteria above). These are generally habitats and species considered to be relatively widespread and resilient, having extensive and stable distributions in the RA or the Caucasus region.

How receptors might respond to Project activities depends on the following key considerations:

1. Whether the receptor will be exposed to a Project activity or its effects.
2. The sensitivity of the receptor to the activity or its effects (will it respond?).
3. The vulnerability of the receptor to impacts (will it decline or be damaged?).
4. The ability of the receptor to recover independently, without intervention in the form of mitigation.
5. The effectiveness of mitigation in reducing impacts to a point where it can be concluded that there is NNL.
6. If significant effects remain after mitigation, the ability to compensate or offset so that NNL or a “net gain” can be demonstrated.

These have been defined or interpreted as summarised in the following subsections:

Receptor Exposure

Whether a receptor is likely to be exposed to an impact source depends on the temporal and spatial relationship between a Project activity (e.g. a noise emission) and the receptor. It is assumed that the receptor may be exposed if baseline surveys or other information searches suggest it could be present at the time or location concerned. Without exposure, there is no impact, and these cases were screened out from further consideration.

Receptor Sensitivity

Whether a receptor will show a measurable response to the changes associated with a Project activity depends on its sensitivity. For example, individuals of a species might be exposed to increased levels of noise during construction, but if they are not sensitive to noise, they will not be exposed to a significant impact as a result of elevated noise levels. Sensitivity has been considered in relation to the particular Project activity under consideration and the characteristics of the receptor in every case where a receptor may be exposed to an impact.

Receptor Vulnerability

As used in this approach, receptor “vulnerability” refers to the consequences of a change caused by a Project activity for a receptor that is both exposed and sensitive to an impact. Specialists have considered the extent to which the impacts identified might threaten the status or viability of receptors throughout their range or distribution. The proportion of populations of a species or habitat extent affected by the Project has therefore been considered, as well as the extent to which habitats or populations of species are stable, increasing or declining.

Receptor Resilience and the Need for Mitigation

In order to achieve a NNL outcome for biodiversity, any receptor exposed to a measurable adverse effect must either recover spontaneously without the need for any intervention, or must be restored to pre-impact levels or condition through mitigation. The resilience of a receptor and its ability to recover has a bearing on the need for mitigation to achieve NNL and depends on the impact source being considered (its type, magnitude, frequency and duration), as well as the characteristics of the receptor and its ability to recover from any perturbation.

For example, species that are mobile, adaptable and breed readily are more resilient than species with slow population growth that are highly specific in their habitat requirements and relatively immobile. It is also generally easier for populations to recover if a relatively small proportion of the original population is lost as a result of an impact. In this ESIA, a “resilient population” has been defined as one able to recover at a speed and to a level within the bounds of normal variation without mitigation. Similarly, resilient habitats are able to re-establish through natural regeneration, without restoration. If receptors are not judged to be resilient in this way, mitigation is needed and if there is any uncertainty, further assessment may be needed in the pre-construction phase of the Project to confirm the need for

mitigation.

Mitigation Measures

Mitigation is needed if the impact will result in a measurable change to the receptor that is outside the bounds of normal variation. In such cases, it will not be possible to achieve NNL unless mitigation is implemented.

Offsets

If NNL cannot be achieved even with mitigation, a significant residual impact will occur. In cases where residual impacts have been identified for “priority biodiversity”, the need for offsets has been considered. Note that the option to offset was only considered as a last resort if significant residual impacts on natural or critical habitat were predicted despite mitigation, though gains may also be achieved for some “wider biodiversity” through requirements of PS6 to achieve NNL for natural habitat if possible.

Impact significance

The ecological implications of the Project as a whole or of a specific Project activity may be:

- **Neutral:** no detectable change occurs, or the affected biodiversity/ ecosystems are able to accommodate the change without any long-term consequences. The changes are within bounds of normal variation, or spontaneous recovery is likely. No specific mitigation measures are necessary beyond general good practice measures that form part of Project design.
- **Moderate/ not significant with effective mitigation:** the Project causes detectable changes relative to baseline conditions and these changes are outside the bounds of normal variation (if known). Mitigation is needed to reduce or minimise impacts, or to aid recovery but proven mitigation measures are available and with these measures in place, receptors will recover to a viable residual state or condition.
- **Significant:** significant impacts occur if the Project will cause populations of species or the extent of ecosystems/ biotopes to decline below baseline trends in the longer term, despite mitigation. If there might be residual loss of “natural habitat” or a long term decline in the range, distribution or population size of any species, scope for biodiversity offsets to achieve a NNL or net gain outcome (as necessary) has been considered. Use of offsets that have sufficient assurance regarding likely success may reduce a significant residual impact to a moderate level.
- **Significant/ not offsetable:** there may be significant adverse impacts that cannot be

offset because an effective outcome cannot be assured, given available conservation or restoration techniques, or because suitable offset locations cannot be identified or secured or because it is not possible to restore habitats or species populations in reasonable timeframes.

In some cases, outcomes may remain uncertain because the information needed to predict impacts is not yet available. Where this is the case, plans to obtain the required information are detailed in the Project BAP.

The geographic scale used to assess impacts has a bearing on their significance, as ecological outcomes depend critically on the viability and functionality of what remains as much as the specific characteristics of the proportion lost or damaged. A suitable geographic unit to consider impacts on biodiversity components therefore needs to be identified. This generally equates to the scale at which affected biodiversity is considered important and varies between receptors: e.g. if there is a loss of a vegetation type which supports species endemic to the Caucasus Region, ability to achieve NNL should be demonstrated for that vegetation type within the Caucasus Region. Similarly, if a species is protected at national level, ability to achieve NNL or a net gain has been considered at a national level.

Table 6.11.1 summarises the approach that has been taken to apply the mitigation hierarchy based on these significance criteria.

Table 6.11.1: Summary of Significance Criteria and Supporting Mitigation Strategy for Biodiversity and Ecosystems

Category of impact significance	Impact characteristics	Receptor characteristics and response	Required action in mitigation strategy
Neutral	<p>Changes attributable to Project actions are temporary and/ or of low duration, intensity and extent</p> <p><i>and</i></p> <p>There is no lasting change in the status or condition of the receptor outside the bounds of baseline or background fluctuation</p> <p><i>and</i></p> <p>Spontaneous recovery from the impact can occur.</p>	<ul style="list-style-type: none"> • Receptors are sufficiently adaptable and resilient to recover from the impact spontaneously, without intervention and without any detectable change in viability, e.g. species might be characterised by high mobility, high tolerance of disturbance, rapid regeneration times. • Receptor is able to avoid impacts by relocating to alternative suitable habitat (e.g. highly mobile species). • If exposed, receptors are either insensitive to the impact or they are able to tolerate it, e.g. species are able to recover from the impact without intervention within one breeding season. • Any losses of individuals from a species population are within bounds of normal variation. • The receptor is likely to be ubiquitous or represented on many sites (i.e. to have low irreplaceability), e.g. habitats might be widespread so that losses are insignificant when compared with overall extent and do not affect the viability or functioning of the habitat. 	<p>No mitigation is needed beyond standard “good practice” or generic measures, because there are no lasting effects beyond natural or background rates of change.</p>
Moderate	<p>Impacts are measurable. They may vary in duration, extent, intensity, frequency but cause changes of a magnitude/amplitude greater than background</p>	<ul style="list-style-type: none"> • The receptor is sensitive to the impact. • The receptor is not able to recover from the impact without intervention, so mitigation is needed, e.g. decline in species population is outside bounds of normal variation but recovery is possible with proven mitigation measures. • Receptors are more likely to have properties that make 	<p>Mitigation is needed to ensure that impacts are within acceptable limits in terms of global, national or local priorities for nature conservation as appropriate.</p> <p>An effective mitigation strategy is needed to deal with impacts and to show that</p>

Table 6.11.1: Summary of Significance Criteria and Supporting Mitigation Strategy for Biodiversity and Ecosystems

Category of impact significance	Impact characteristics	Receptor characteristics and response	Required action in mitigation strategy
	<p>variation, e.g. impacts result in measurable decline in population of an affected species or the extent of a habitat.</p> <p>Impacts can be shown to be reversible with suitable mitigation.</p>	spontaneous recovery unlikely, for example restricted distributions, lower mobility, less rapid breeding cycles.	<p>NNL of biodiversity can be achieved.</p> <p>Proven mitigation measures must be available and these must be “tried and tested”.</p> <p>Precautionary measures may be recommended if there is any uncertainty about the status or resilience of the receptor.</p> <p>If there are likely to be residual impacts, a “like for like” outcome may be needed to offset for moderate impacts on some receptors but not necessarily all.</p>

Table 6.11.1: Summary of Significance Criteria and Supporting Mitigation Strategy for Biodiversity and Ecosystems

Category of impact significance	Impact characteristics	Receptor characteristics and response	Required action in mitigation strategy
Significant	<p>Impacts are measurable and may vary in duration, extent, intensity or frequency.</p> <p>If impacts are frequent, regular, high intensity and long term or permanent, it must be possible to offset them.</p>	<ul style="list-style-type: none"> • The species has a declining population and/ or high irreplaceability. • The proportion of the receptor's distribution or population affected results in longer term or permanent decline in the viability of what remains. • A very large proportion of the total known distribution or extent of the receptor is affected given the relevant geographic scale of consideration. • The integrity of a protected area or its ability to continue supporting its designated species is affected. • There will be residual effects even with mitigation in place, which mean a NNL outcome can only be achieved through an offset. 	<p>Highly precautionary approach needed with strong burden of proof to show that impacts could not be avoided.</p> <p>Techniques for mitigation must be proven. If there are residual impacts with mitigation in place, an offset is needed. Suitable offsets must be identified and there will be a strong requirement to achieve "like for like or better" outcomes.</p>
Significant /not offsetable	<p>Impacts are not reversible and there is no reliable evidence that they can be offset.</p>	<ul style="list-style-type: none"> • Impacts affect a large proportion of a population of an endemic species, e.g. impacts are on a population of a single site endemic species. • Affected sites or ecosystems are essential to maintain the national or global population of any critically endangered species. • Entire global population potentially exposed. • Affected population unlikely to recover from Project impacts, with possible risk of extinction at national or global levels. 	<p>If there is no proven method for mitigation and it is not possible to confirm that impacts can be offset, the impact may be considered unacceptable or a decision may be made to pursue alternative forms of compensation.</p>

6.11.3 Important Receptors, Other Biodiversity and Protected Areas Potentially Affected

Based on the results of baseline surveys and assessments (Chapter 4.10), Table 6.11.2 identifies priority receptors for which a NNL or a net gain outcome needs to be explicitly demonstrated. Table 6.11.3 identifies other biodiversity, which is considered to be relatively widespread and resilient and able to accommodate impacts, but which nevertheless needs to be given consideration in the light of Lydian's corporate policy of achieving NNL overall.

Implications for the integrity of Protected Areas and other areas of acknowledged importance for biodiversity have also been considered, including the possibility that the Project might affect ecological supporting functions for these sites. These include:

- Caucasus Biodiversity Hotspot (Conservation International).
- Caucasus Mixed Forest Ecoregion.
- State Sanctuaries (Jermuk Forest, Herher Open Woodland and Jermuk Hydrological).
- Sevan National Park.
- Proposed Jermuk National Park.
- Jermuk IBA: a Key Biodiversity Area, identified using recognized selection criteria.
- Gorayk IBA: a Key Biodiversity Area, identified using recognized selection criteria.

Table 6.11.2: Priority Biodiversity Identified for the Project-affected Area Based on Results in Chapter 4.

Priority receptors identified through baseline surveys	Rationale for importance
Plant species and vegetation	
Natural Habitat, including:	Natural habitat with a high proportion of species endemic to the Caucasus or Trans-Caucasus region. This vegetation is widespread in the region but under-represented in Armenia's protected area system. Rocks with <i>Potentilla porphyrantha</i> occur within a Sub-alpine Meadow matrix and form part of the critical habitat for the species (see below).
<ul style="list-style-type: none"> Species-rich Sub-alpine Meadows and Sub-alpine Meadows with Alpine Elements 	
<ul style="list-style-type: none"> Vegetation with Shrubs, particularly Juniper scrub and associated populations of Caucasian endemic species of plant such as <i>Juniperus polycarpus</i> 	Juniper scrub vegetation has declined dramatically in the region and small fragments persist in the Project-affected area. It is of national and regional conservation importance as an indicator of Juniper woodland, which used to be extensive in the region and is one of the characteristic, constituent types of the Caucasus Mixed Forest Global 200 Ecoregion.
<ul style="list-style-type: none"> Other natural and semi-natural vegetation types: Montane Meadows, Montane Meadow Steppes, Wetlands, Riparian, Gorge 	IFC PS6 and EBRD PR6 require identification of natural vegetation and the use of the mitigation hierarchy to ensure NNL of natural vegetation if feasible.
<ul style="list-style-type: none"> At least 22 endemic plant species 	Identified by specialists as regional endemics, either within the Trans-Caucasus (TC) or the Caucasus (C) region. Constituents of natural vegetation types. Apart from <i>Potentilla porphyrantha</i> and one other species <i>Fritillaria armena</i> (endemic to Asia Minor, Iran within the biogeographic zone referred to as the Hyerano-Eusine Element, and found only in one location on Amulsar) these are relatively widespread or dispersed throughout the "natural" vegetation affected by the Project and can be assessed and managed as part of that matrix.
Amulsar sub-population of <i>Potentilla porphyrantha</i> (Tier 1 critical habitat - IFC PS6)	Critically Endangered in the Armenian Red Book (criteria D 1 ab(iii) + 2 ab(iii)). Area occupied in Armenia is less than 10 km ² . Preliminary assessment against IUCN criteria suggests it would be listed as Endangered by IUCN. Amulsar Mountain supports one of five known sub-populations globally and has critical habitat for this species.

Table 6.11.2: Priority Biodiversity Identified for the Project-affected Area Based on Results in Chapter 4.

Priority receptors identified through baseline surveys	Rationale for importance
Bird species	
Resident breeding bird populations, including Endangered species <i>Neophron percnopterus</i> (Egyptian Vulture) and <i>Falco cherrug</i> (Saker Falcon)	<p>Amulsar Mountain and its foothills provide habitat for a rich assemblage of 23 resident raptor species; 14 are listed in the RA Red Book, and seven of these breed in the Project-affected area. This includes Egyptian Vulture, which is listed as Endangered in the IUCN Red List and the RA Red Book, and is a trigger species for Gorayk and Jermuk IBAs, with breeding pairs referred to in each site. The Project-affected area is not critical habitat for the species but provides occasional feeding habitat for one pair nesting in the Arpa Gorge. Saker Falcon is also listed as Endangered in the IUCN Red List and RA Red Book and may be resident in the wider area, though it was observed infrequently in surveys. No evidence of breeding could be found and the Project-affected area is not confirmed as critical habitat for the species.</p> <p>Lesser Kestrel (<i>Falco naumanni</i>), hunts in the Project-affected area, particularly in the south near Gorayk and on the grassy Amulsar slopes. The breeding colony in Gorayk IBA, together with “offshoot” colonies at Sisian are RA’s only breeding population.</p> <p>Seven other (non-raptor) species listed in the RA Red Book also nest in the Project-affected area. On an individual basis these species do not meet criteria and thresholds for critical habitat. However, explicit efforts to ensure no net loss of breeding habitat for these species are appropriate because of their national status and their dependence on natural habitat.</p>

Table 6.11.2: Priority Biodiversity Identified for the Project-affected Area Based on Results in Chapter 4.

Priority receptors identified through baseline surveys	Rationale for importance
Migratory birds	The Project-affected area is important for migratory birds, providing habitat for them to feed and rest while on migration in spring and autumn, but does not constitute critical habitat according to PS6 or PR6. The numbers recorded in surveys do not meet BirdLife International's Criterion A4 for congregations and numbers of migratory birds do not meet thresholds for global significance. However, the species assemblage is diverse and of national importance, including four species listed as Endangered in the RA Red Book: Egyptian Vulture, Saker Falcon, Black Vulture and Pallid Harrier.
Mammal species	
<i>Ursus arctos</i> (Brown Bear) (critical habitat - EBRD PR6)	<p><i>Ursus arctos</i> is listed as Vulnerable in the RA Red Book and is targeted for conservation action in the Caucasus Biodiversity Action Plan. Amulsar Mountain (in particular the Arshak Set-aside and the woodlands on the western flank of the Mountain north of Saravan) is regularly used by 10 bears, including two females who are able to successfully rear young, at least three males, and associated cubs and youngsters, currently estimated at five.</p> <p>The Project's adherence to the EBRD PR implies compliance with the EU Habitats Directive, in which Brown Bear is listed in Annex IV, meaning that degradation of its habitat is prohibited. It is therefore interpreted that critical habitat for Brown Bear exists in the Project-affected area, the Arshak Set-aside preserving a part of it. Brown Bear is also an apex predator and therefore a keystone species associated with the natural habitat affected by the Project.</p>
<i>Capra aegagrus</i> (Bezoar Goat)	Bezoar Goat occurs in the Arpa Gorge and the Jermuk IBA and has been observed in the Arshak Set-aside. It is targeted for conservation action in the Caucasus Biodiversity Action Plan. Therefore it is identified as a priority species.

Table 6.11.2: Priority Biodiversity Identified for the Project-affected Area Based on Results in Chapter 4.

Priority receptors identified through baseline surveys	Rationale for importance
<i>Lynx lynx</i> (Eurasian Lynx)	Eurasian lynx has been observed in the Arshak Set-Aside. It is listed by IUCN as Least Concern, but is prioritized for conservation action in Europe as a recent assessment of its status in Europe shows that some isolated subpopulations remain Critically Endangered or Endangered. The Caucasus subpopulation is considered a distinct subspecies (<i>Lynx lynx dinniki</i>) and the numbers in the southern Caucasus are estimated at only 40 individuals, which is why it is a priority species in the region and in terms of compliance with EBRD's PR6.
Invertebrates	
Dorcadion Beetles (<i>Dorcadion sevangense</i> , <i>D. sisianum</i> Lazar and <i>D. bistratum</i>)	<i>D. bistratum</i> is included in the RA Red Book. <i>D. sisianum</i> Lazar and <i>D. sevangense</i> are considered the most vulnerable endemic beetles of Armenia and are a conservation priority. Dorcadion beetles have been observed in surveys undertaken for the Project, but not in the Project-affected area. The possibility of under-recording needs to be recognized, but all records to date have been outside the proposed Project footprint.
Amphibians and reptiles	
Radde's/ Armenian Rock Viper <i>Montivipera (Vipera) raddei</i> , Armenian Mountain-Steppe Viper <i>Vipera eriwanensis</i> and Cat Snake <i>Telescopus fallax</i>	10 reptile species have been found in surveys of Amulsar in 2015. The three species listed here are included as Vulnerable in the RA Red Book, and <i>Vipera eriwanensis</i> is also listed on the IUCN Red List as Vulnerable, while <i>Montivipera raddei</i> is listed as Near Threatened. The HLF location supports these and other reptile species but there is considered to be abundant suitable habitat in the wider landscape..

Table 6.11.3: Biodiversity that is Widespread, with Resilient Populations

Receptor	Rationale for inclusion
Vegetation and plant species	In addition to vegetation types that are considered as a priority because they are species-rich or relatively unmodified, the Project will affect some grassland areas that are not considered to be a priority for conservation of biodiversity and that are widely distributed throughout the country and region. These include areas of grassland modified by relatively intensive grazing or presence of herder camps, reducing their species-richness and characteristic species; and also vegetation alongside roads and tracks and other disturbed areas including cultivated areas.
Birds	The Project-affected area provides habitat for a large number of other bird species, which are considered to be relatively common or widespread, with resilient populations. They include species such as <i>Alauda arvensis</i> (Eurasian Skylark), <i>Anthus spinoletta</i> (Water pipit), <i>Carduelis flavirostris</i> (Twite) and <i>Saxicola rubetra</i> (Whinchat).
Mammals (including bats)	<p>Baseline surveys identified several mammal species within the Project-affected area which are not considered to be threatened within the region or country and which are considered to be relatively mobile and adaptable. This includes larger mammal species such as:</p> <p><i>Vulpes vulpes</i> (Fox) <i>Canis lupus</i> (Wolf) <i>Sus scrofa</i> (Wild Boar) <i>Felis chaus</i> (Jungle Cat)</p> <p>Smaller mammal species include:</p> <p><i>Martes foina nehringi</i> (Stone Marten) <i>Mustela nivalis</i> (Weasel) <i>Meles meles</i> (Badger) <i>Erinaceus concolor</i> (Southern White-breasted Hedgehog) <i>Sorex volnuchini</i> (Caucasian pygmy shrew) <i>Lepus europaeus</i> (European Hare) <i>Cricetulus migratorius</i> (Grey Hamster) <i>Apodemus (sylvaeus) sylvaticus</i> (Long-tailed Field Mouse) <i>Apodemus sylvaticus</i> (Wood Mouse) <i>Microtus arvalis</i> (Common Vole) <i>Chionomys nivalis</i> (Snow Vole)</p> <p>Bat species <i>Myotis blythii tomes</i> (Lesser Mouse-Eared Bat) and <i>Vespertilio pipistrellus</i> (Common Pipistrelle) have been observed in the</p>

Table 6.11.3: Biodiversity that is Widespread, with Resilient Populations

Receptor	Rationale for inclusion
	wider Project area. Species listed in the RA Red Book are reported to occur in the vicinity, but were not recorded in baseline surveys.
Invertebrates (terrestrial and aquatic)	A wide variety of terrestrial and aquatic invertebrate species will be affected by the Project. Most are not in the RA Red Book, though much of the Project-affected area is probably under-recorded. Surveys in 2012 found a species-rich butterfly assemblage with Apollo Butterfly, but the area where this was recorded is no longer in the Project footprint and there is abundant butterfly habitat available.
Reptiles and amphibians	<p>Reptile species recorded on Amulsar Mountain or in the wider Project-affected area are listed below (these are not included in the RA Red Book):</p> <p><i>Coronella austriaca</i> (Smooth Snake) <i>Darevskia raddei</i> (Radde's Lizard) <i>Darevskia valentini</i> (Darevskia Valentine) <i>Dolichophis schmidt</i> (Schmidt's Whip Snake) <i>Eirenis modestus</i> (Ring-headed Dwarf Snake) <i>Eirenis punctatolineatus</i> (Dotted Dwarf Snake) <i>Hammerhois vergieri</i> (Ravergier's Whip Snake) <i>Hemorrhhois ravergeri</i> (Spotted Whip Snake) <i>Laudakia caucasia</i> (Caucasian Rock Agama) <i>Lacerta media</i> (Eastern Three-lined Lizard) <i>Macrovipera lebetina</i> (Levantine Viper) <i>Natrix tessellata</i> (Dice Snake) <i>Platiceps najadum</i> (Dahl's Whip Snake)</p> <p>Amphibians in the Project-affected area are generally relatively widespread, e.g. Marsh Frog (<i>Pelophilax ridibundus</i>), Long-legged Wood Frog (<i>Rana macrocnemis</i>) and Green Toad (<i>Bufo viridis</i>).</p>
Fish	<p>No endemic or RA Red Book species of fish were identified in baseline surveys of the Project-affected area. Fish species affected include:</p> <p><i>Salmo trutta</i> (Brown Trout) <i>Alburnoides bipunctatus</i> (Spirilin) <i>Aspius aspius</i> (Asp) <i>Barbus capito</i> (Barbel) <i>Barbus mursa</i> (Barbel)</p>

Table 6.11.3: Biodiversity that is Widespread, with Resilient Populations	
Receptor	Rationale for inclusion
	<p><i>Acanthalburnus microlepis</i> (Blackbrow Bleak) <i>Capoeta capoeta</i> (Sevan khramulya or Caucasian Scraper)</p> <p>Although suffering reductions in biomass and population size due to a range of threats and pressures (not associated with the Project), these species are not threatened from a biodiversity conservation perspective.</p>

6.11.4 Project Activities and Sources of Impact on Biodiversity and Ecosystems

The main sources of biophysical change that would be expected to give rise to impacts on biodiversity and ecosystems in the Project's area of influence without mitigation are listed in Table 6.11.4. This table is based on a rigorous examination of the different activities that will take place during the construction and operational phases of the Project and has been used as the basis for identifying which biodiversity features are likely to be exposed to impacts. The Preliminary Mine Reclamation, Closure and Rehabilitation Plan (pMRCRP, Appendix 8.18) includes initial arrangements for decommissioning and the ecological implications of this are reviewed to the extent possible, given the level of detail available in the Plan. The table includes a brief description of the potential ecological implications of these activities. These potential implications are considered in the absence of the application of any biodiversity-specific mitigation measures.

Based on Table 6.11.4, the main activities with potential to alter biodiversity and ecosystems during the construction and operational phases of the Project can be summarised as:

- Removal and clearance of vegetation and topsoil.
- Construction activities requiring soil excavation and movement, which may lead to spread of invasive weeds already occurring in the area, as well as generating dust, some of which may be contaminated with heavy metals.
- Exposure of soils and resulting soil erosion, causing increased sediment levels in downstream water bodies and courses.
- Construction and operation activities requiring use of large machinery which will generate noise and disturbance 24-hours a day.
- Lighting for security and extending work hours, which may disrupt animal behaviour patterns, particularly for species active at night, early dawn or dusk.
- Introduction of barriers including roads, the conveyor, fences, power cables and other infrastructure components which may disrupt movements of animals in the landscape or cause collisions/ mortality.
- Activities leading to pollution of air, water or soil associated with unintended leaks or emissions.
- Activities leading to long-term pollution of water and soil with heavy metals due to acid rock drainage.
- The presence of people during construction and operation of the Project as a whole.

- The land use changes associated with the presence of the Project, including changes in grazing patterns and possible implications for other grazing lands due to displacement of herding and/or crop-growing activity onto them.
- Land use changes associated with induced access (vehicles and people) to the Vorotan Valley and other areas surrounding the Project due to road upgrades and creation of “through roads”.
- The movement of water under- and above ground will be affected by the mine pits and elements of the associated infrastructure, including the BRSF and HLF. The alterations to hydrology and hydrogeology will affect vegetation and the animals that depend on springs and waterholes.

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project

Project component	Main source or driver of biophysical change	Potential ecological implications
Construction Phase		
Earthworks, site clearance and construction	Land clearance, removal of vegetation for construction of mine pits, haul roads, crushing plant, access roads, conveyor, BRSF and HLF. Total estimated physical or infrastructure footprint of 599 ha.	<p>There will be permanent ecosystem change within the mine pits and haul roads (this affects critical habitat for <i>Potentilla porphyrantha</i>) and potentially where the crushing plant, HLF and BRSF are located (predominantly natural habitat). Vegetation clearance and earthmoving will spread invasive weed species already present in the area.</p> <p>There will be reduced habitat availability and quality for some animal populations. Biomass of widespread small mammals and amphibians will be reduced, with implications for raptor food supply. There will be loss of reptile habitat and loss of breeding area, foraging area, resting areas and hibernation dens for Brown Bear.</p>
	Dust generated by truck movements and earth moving. As indicated in Chapter 6.6 approximately 80% of dust will be deposited within 100m of sources. 323 ha are in the Project Disturbed Area (identified in addition to the Project Physical Footprint) within which significant dust deposition is considered likely. Lower levels of deposition may occur in a further Ecologically Disturbed Area of 368ha that extends beyond the Project Disturbed Area.	Smothering of terrestrial and aquatic vegetation and reduced plant productivity within the deposition zone. Suitability of habitat for amphibians and small mammals will also be reduced within the deposition zone. There will be dust deposition on critical and natural habitat outside cleared areas.
	Vehicle exhaust emissions including NO _x , SO _x , CO, CO ₂ and diesel particulates and dust from roads. Significant deposition and associated changes in natural vegetation are predicted to occur within a 50 m buffer along haul roads and a 30 m buffer along smaller un-surfaced roads with less traffic (i.e. the Project	Nutrient enrichment and changes in soil chemistry cause permanent changes in plant species composition. Transformation of natural vegetation to more modified types will occur with attenuation away from the source, within the Project Disturbed Area and Ecologically Disturbed Areas.

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project

Project component	Main source or driver of biophysical change	Potential ecological implications
	Disturbed Area, extending to 323ha in addition to the Project footprint). Some wider changes are possible at lower levels of deposition, within an additional zone (referred to as the Ecologically Disturbed Area) estimated at 368ha.	
	Soil exposure.	Erosion and scour from rain or melting snow could have localised impacts on natural habitat.
	Changes in surface and groundwater hydrology.	Loss of aquatic habitat, disruption of flow, reduced recharge of wetlands, could reduce biomass of amphibians and availability of habitat for wetland birds.
	Topsoil storage (could have footprint of up to 40ha and storage may be long-term).	Permanent changes in vegetation on receptor sites as well as loss of the soil seed bank from stored topsoil. Localised losses of natural habitat may occur.
Construction of roads	Mine haul roads and access roads (footprint of 79 ha).	Loss of natural habitat under physical footprint. Barrier effects to movements of larger mammals due to controlled access arrangements and traffic.
	Introduction of alien materials.	Altered soil chemistry and structure due to deposition of introduced aggregate and graded material along boundaries of roads and tracks. pH of soils may alter some distance away, where there is surface run-off from roads, particularly in winter when salt may be spread on the road surface. Plant community composition may be altered locally, with a transition from natural to more modified types, including by the spread of invasive weeds.
Import of materials and machinery	Traffic on access roads and public highways.	Disturbance to animal populations and barrier effects; increase in roadkills among reptiles
	Emissions of dust, exhaust, etc.	Smothering of crops and vegetation adjacent to key transport routes, contamination by pollutants, reduced productivity.

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project

Project component	Main source or driver of biophysical change	Potential ecological implications
Worker Accommodation Camp	Land take, lighting, noise, disturbance, traffic between camp and site. Physical footprint is 6.3 ha.	Displacement of raptor feeding activity. Habitat loss for reptiles. Possible disruption of nocturnal activity for bats and some birds and reduced resting area for birds on migration. Displacement and disturbance is expected over an area larger than the physical footprint.
Operation Phase		
Mining		
Excavation, drilling and blasting	Dust from excavation and blasting.	Reduced productivity of vegetation and suitability of habitat for small mammals in the deposition zone (Project Disturbed Area and Ecologically Disturbed Area), reducing food supply for raptors.
	Noise and disturbance.	Some animal species will cease to feed or breed on current sites in proposed mine pit or potentially be displaced from remaining habitat outside the pits. Some animals will be displaced completely. Brown Bear, Lynx and Bezoar Goat could all be exposed and sensitive.
	Altered topography.	Removes potential habitat for alpine plants in Sub-Alpine Meadows and on rock outcrops during operational phase. Removes breeding locations for some raptors during operational phase.
	Altered substrate.	Soils are sensitive and poorly structured. Permanent changes may occur. Soil removal may result in new areas of exposed rock. Rocky outcrops may also be damaged or removed. These provide habitat for some plants and reptiles that are globally and nationally rare including Tier 1 critical habitat for <i>Potentilla porphyrantha</i> .
Loading and hauling	Dust emissions.	Smothering of crops and vegetation, contamination by pollutants, reduced productivity. Reduced suitability of habitat for small mammals in the deposition zone, reduced food supply for raptors.
	Vehicle exhaust emissions.	Deposition of NO _x , SO _x , CO, CO ₂ and particulates may cause localised changes in soils and plant communities (eutrophication), modifying natural habitat.

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project

Project component	Main source or driver of biophysical change	Potential ecological implications
	Noise, light and disturbance.	Some birds and mammals may be displaced as noise and disturbance is 24-hour. Brown Bear is likely to be exposed and sensitive.
Access, transport	Haul roads: permanent haul roads within the mine operation have an assumed 50m width. The combined footprint of access and haul roads is 79 ha with another 120 ha within the Project Disturbed zone and 368ha in the Ecologically Disturbed Area.	Permanent footprint and change in substrate, loss of habitat for Sub-alpine species. Loss of natural habitat. Cumulative noise, disturbance, salt run-off and dust impacts.
Barren Rock Storage Facility and associated water treatment facilities	Dust emissions.	Fugitive dust particles deposited on vegetation alter its productivity and may cause long term changes in plant species composition due to changes in soil chemistry. Loss of natural habitat.
	Physical footprint (footprint of Barren Rock Storage Facility estimated at 139 ha).	Reduced natural habitat area and quality, possible Acid Rock Drainage causing future changes in vegetation and aquatic habitat. Loss of biomass/ food supply for other species (e.g. frogs caught by raptors).
	Land use change.	Loss of natural habitat (Montane Meadow) and pasture used for grazing. Loss of raptor feeding habitat.
	Downstream pollution from drainage and leachate.	Pollution of aquatic habitat with implications for invertebrates, amphibians, fish, plants. Risk of long term acid drainage and heavy metal contamination.
Crushing and ore preparation		
Stockpiles	Dust from tipping.	Fugitive dust from wind blow. Localised pollution of soil. Water used for suppressing dust may infiltrate other water/ wetlands, reducing quality of wetland habitat.
	Stockpiles.	Forms part of physical footprint and removes biotope/habitat.
Crushing	Crusher and transfer points.	Fugitive dust escaping at crusher building and transfer points will be controlled with water sprays and enclosure (dust extraction) but this may not be 100% effective. Deposited dust will alter plant communities and possibly cause long-term soil quality changes.
	Noise during crushing.	Displacement of animals and birds.
Conveyor to Heap	Dust from transfer points.	Although the conveyor is covered, ore dust may cause localised pollution and

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project

Project component	Main source or driver of biophysical change	Potential ecological implications
Leach Facility		alteration of plant communities at transfer points. Associated lighting could disrupt behaviour of bats and birds. There will be loss of reptile habitat. The conveyor is close to a gorge in which Armenian red-listed bird species nest. <i>Fritillaria armena</i> (species endemic to Asia Minor, Iran, Hyerano-Eusine Element) is found close to the conveyor and could be exposed to dust deposition. This species only occurs in this location on Amulsar Mountain but is present in other areas outside the Project footprint.
	Physical barriers including the conveyor, service road and fencing and also the trench for piped water from the BRSF toe to the conveyor.	The conveyor is close the ground and likely to constitute a complete barrier to animal movement, even for small mammals. This will cause habitat fragmentation and reduce foraging or feeding areas for Brown Bear. Could also affect Lynx and Wolf as well as smaller mammals such as martens
Processing		
Process plant and supporting infrastructure	Dust. Vehicle exhaust fumes.	Dust generated from demolition activities, earthworks, reshaping heap and dump sides, and setting up safety berm around pit perimeter could affect small remnants of Juniper scrub vegetation and reduce its viability.
Storage and reagent handling	Lime: outdoor stockpile.	Possible changes in soil pH due to fugitive lime-laden dust, changes in plant communities. Large volumes of lime are needed, though the intention is to cover stockpiles.
	Reagents (caustic soda, NaCN).	Although reagents will be stored and handled only under contained, controlled conditions, there is a risk of leaks and spills which could have effects on biodiversity receptors.
Heap Leach Facility	Physical footprint of approximately 165ha.	Proposed location is above Gndevaz Village in an area traditionally used for grazing, hay-making, growing crops and producing apricots. These uses could be displaced onto other areas with implications for biodiversity. There are fragments of juniper and hawthorn scrub vegetation in the affected area that are of conservation importance. The area is a hotspot for reptiles; 11 species have been recorded here, including three that are listed in the RA Red Book.

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project

Project component	Main source or driver of biophysical change	Potential ecological implications
	Dust with heavy metals.	Small mammals, birds feeding on small mammals (including Lesser Kestrel), aquatic species.
	Disturbance associated with operation.	Migratory and breeding birds.
ADR plant and supporting infrastructure	Physical footprint.	Loss of relatively modified biotope/ habitat.
Support infrastructure		
Domestic wastewater treatment	Physical footprint of works, possible enriched wastewater released to streams/ the river.	Loss of biotope/ habitat and possible eutrophication of watercourses.
Electrical power supply	Power lines.	Risk of collision with power lines by raptors, especially in combination with lighting, particularly on elevated areas, including Amulsar Mountain.
Storage and reagent transport and handling	Lime: outdoor stockpile.	Changes in soil pH due to fugitive lime-laden dust, changes in plant communities.
	Reagents (caustic soda, NaCN).	Leaks and spills, including during transport of reagents to the mine, could have multiple effects on various biodiversity receptors
	Delivery of flaked sodium cyanide.	Details of the transportation route to the site have not been finalised. Ecological risk assessment is needed to evaluate the consequences of accidental spills during transport or storage, which could cause mortality of animals.
Employment	Presence of people and associated traffic.	Disturbance of animal populations including sensitive species.
Worker Accommodation	Worker accommodation currently proposed is hotel accommodation at Jermuk and a workers accommodation camp during construction, and then a combination of Project hotel in Jermuk and local employees residing in hotels in surrounding villages.	Impacts limited to transport to and from site on mine access road (traffic, barrier effect, noise, emissions).
Security measures	Lighting.	Disturbs nocturnal species including bats and night-flying moths. Could also disrupt animals hunting at night such as Wolf. Brown Bear shows avoidance of lit areas; could also affect behaviour of night-flying birds.

Table 6.11.4: Potential Sources of Ecological Impact (Pre-Mitigation) Associated with the Project		
Project component	Main source or driver of biophysical change	Potential ecological implications
Fencing	Restricted access.	Land use will be affected within a restricted zone throughout construction and operation. Some areas will be fenced for security reasons. Current land use and grazing patterns may alter. Some grazing activity will have to be relocated with possible consequences for biodiversity on other areas where additional grazing is concentrated.

Having identified the main Project activities that may lead to ecological change, a detailed assessment of impacts and their significance for specific receptors is provided in Section 6.11.5. To support this assessment, the following assumptions have been made about the extent of areas occupied by mine infrastructure, affected by pollution or experiencing restrictions on land use (see Section 4.1.6 for details):

- There will be a direct physical footprint of infrastructure extending to 599 ha, including the mine pits, haul roads, BRSF, conveyor, HLF, crusher, and other buildings and infrastructure.
- There is a Project Disturbed Area of 922 ha, comprising the Project Footprint plus an additional 323ha based on an assumed 50m buffer around areas where earth-moving occurs and the haul roads; a 30m buffer where there is less traffic on unsurfaced roads; a 20m buffer around infrastructure where some earth moving may take place; and a 15m buffer around administration buildings (to take into account disturbance during construction and incidental disturbance once occupied). For purposes of assessing ecological impacts, this area is considered to represent a zone within which direct impacts such as dust deposition, atmospheric pollution, polluted surface run-off or changes in soil structure are likely.
- An additional “Ecologically Disturbed Area” of 368 ha has been identified beyond the Project Disturbed Area within which levels of dust or pollution deposition will be lower, but where a degree of vegetation change is still likely, based on the scientific literature. Levels of noise may also be sufficiently high within this zone to affect wildlife behaviour.
- An additional area of 180 ha has also been included in the overall Project Footprint for purposes of assessing ecological impacts on natural vegetation on land disturbed by previous upgrades of the Kechut to Gorayk Road that may also be affected to some degree in future by emissions from local traffic and light mining traffic for transporting staff.
- The Project has identified an Additional Restricted Area of 477 ha, within which access and land use will be controlled, though not necessarily fenced. This area is classified in three separate sections as “the ecological restricted area” (95 ha), the “operational restricted area” (323 ha), and the restricted area by fencing (60 ha). Land use may change within this area (to different extents depending on level of restriction needed for security and safety reasons) with some ecological consequences.

This gives a total assumed area of 1766 ha, future area of potential impact and 180 ha previously affected, as a consequence of developing the Kechut to Gorayk road. This combined area is considered to represent a realistic spatial scope for direct impacts.

Indirect ecological impacts may occur over a much wider area that isn't possible to quantify, due to induced socio-economic change and associated land use change. Levels of traffic may increase and land use patterns in the surrounding landscape may alter due to changing economic circumstances and activities. The possibility of these impacts has been considered when development the Project's mitigation strategy for biodiversity.

6.11.5 Exposure, Sensitivity and Vulnerability of Biodiversity to Project Impacts

In this section, the nature of predicted Project impacts on the biodiversity receptors identified in Table 6.11.2 and Table 6.11.3 is discussed. Impacts are summarised in three tables: Table 6.11.6 summarises the Project's impacts on priority biodiversity receptors identified for the Project; Table 6.11.7 summarises the Project's impacts on other biodiversity that is considered to be generally widespread and resilient; and Table 6.11.8 summarises the Project's impacts on Protected Areas or other "Key Biodiversity Areas". Potentially significant impacts on priority biodiversity are discussed in more detail below. Unless stated otherwise, the potential impacts apply during the construction, operational and decommissioning phases of the Project.

Impacts on natural habitat

Impacts of the Project on natural habitat were assessed as part of the NCHA (Appendix 4.10.3) as this is a PS6 requirement. The results are discussed here for natural habitat overall and for individual ecosystem types.

The Project's physical footprint on ecosystem types is shown in Figure 6.11.1. For the Disturbed and Additional Restricted Areas, refer to Figure 4.1.6.

A permanent loss of natural habitat within the Project's physical footprint is predicted, as considerable modification of soil/ substrate will occur during mine construction, operation and decommissioning. Vegetation will be destroyed or fundamentally modified for the lifetime of the mine, and thereafter is expected to remain in a significantly modified condition. As explained in Chapter 4 and in Appendix 4.10.3, areas where natural and semi-natural vegetation has become significantly "modified" around herder camps, for example, are at a

scale that is too localised or small to indicate on maps and the Project has elected to include them in its estimates of natural habitat extent. Estimates of the Project's physical footprint on natural habitat can therefore be regarded as conservative.

Table 6.11.5 shows that approximately 1807 ha of the 1946 ha that may be exposed to impacts on biodiversity as a result of the Project activities are classified as natural habitat. The table provides a breakdown of the Project's footprint for component vegetation types.

In addition to the physical footprint of the Project, there are areas of natural habitat within which plant communities are expected to change as a result of dust deposition, deposition of pollutants (including salt spread on roads in winter) or eutrophication, for example due to deposition of nitrogen and sulphur oxides (NO_x and SO_x). In other words, their condition may change. This area is estimated at 279 ha for the mine, haul and access roads and an additional 180 ha for the Kechut to Gorayk Road. Additional (lower magnitude) changes are likely on 355ha natural habitat within the Ecologically Disturbed Area. Changes in species composition of vegetation such as these often persist for long periods and are difficult to reverse.

There are additional areas where land use will change due to restrictions and controls on access and plant communities will change to some degree as a result. Project infrastructure is relatively dispersed, so the security arrangements for the Project and restrictions on access and land use (including some fenced areas) will extend over an area of 476 ha of Natural Habitat. There may be some benefits from excluding people (reduced disturbance of animals) but changes in grazing management are expected to be generally negative, as characteristic species and overall species richness are both linked to traditional grazing management. A total of 1807 ha could be affected by altered land use and management overall and this is considered to represent the Project's overall footprint on natural habitat.

About 900 ha of Sub-Alpine Meadow are affected, and 130ha of Sub-Alpine Meadow with Alpine Elements. These are the most species-rich and distinctive of the natural habitats affected by the Project. While juniper shrub vegetation is also considered to be of conservation importance, this vegetation type is more widely represented in the surrounding landscape. As well as being important for endemic plants, areas of rocks are important from a wildlife perspective, as they include suitable habitat for RA Red Book Reptiles. Similarly, the gorge within the footprint and disturbed areas is important as breeding habitat for RA Red Book birds. Natural habitat in general is important for all the species identified in Chapter 4

as well as being critical habitat for *Potentilla porphyrantha* and Brown Bear. Impacts on wildlife are considered in more detail in subsequent sections, but the role of natural habitat in supporting threatened species at national and international levels needs to be recognised.

As Figure 6.11.1 shows, the Project is located within extensive natural habitat, making options for relocating infrastructure to avoid footprint on it very limited. The mine pits themselves cannot be moved, and there are practical limitations as to how far away from them the other key infrastructure such as the BRSF and HLF can be sited. Although efforts have been made to avoid priority biodiversity areas where possible (as described in Chapter 5), application of the mitigation hierarchy in terms of avoiding impacts on natural habitat is challenging in this case.

Table 6.11.5: Project Physical Footprint on Natural Vegetation Types

Natural Habitat Type	Area in Project physical footprint (ha.)	Project Disturbed Area (ha.)	Project Restricted Area (ha.)	Restricted Area through fencing (ha.)	Operational Restricted Area (ha.)	Ecological Disturbance Area (ha.)	Disturbed zone for Kechut-Gorayk Road (ha.)	Total area (ha.)
Gorge	7.0	1.1	0.0	0.0	0.0	0.0	0	8.1
Montane Meadow	38.7	32.8	11.4	0.6	11.6	28.5	16.5	140.1
Montane Meadow Steppe	37.9	54.2	65.4	0.5	0.0	111.9	147	417.8
Rocks	24.5	7.7	0.1	0.0	9.4	4.7	0	46.4
Sub-alpine Meadow	254.2	126.3	3.3	58.0	277.0	171.5	9.5	899.8
Sub-alpine Meadow With Alpine Elements	85.5	17.3	0.0	0.0	25.2	2.1	0	130.1
Vegetation With Shrubs	65.5	38.7	10.7	0.1	0.0	34.8	0	149.8
Wetland	5.2	1.2	0.3	0.1	0.0	1.3	7.1	15.2
Total	519.5	279.3	91.2	59.3	323.2	354.7	180.1	1807.3

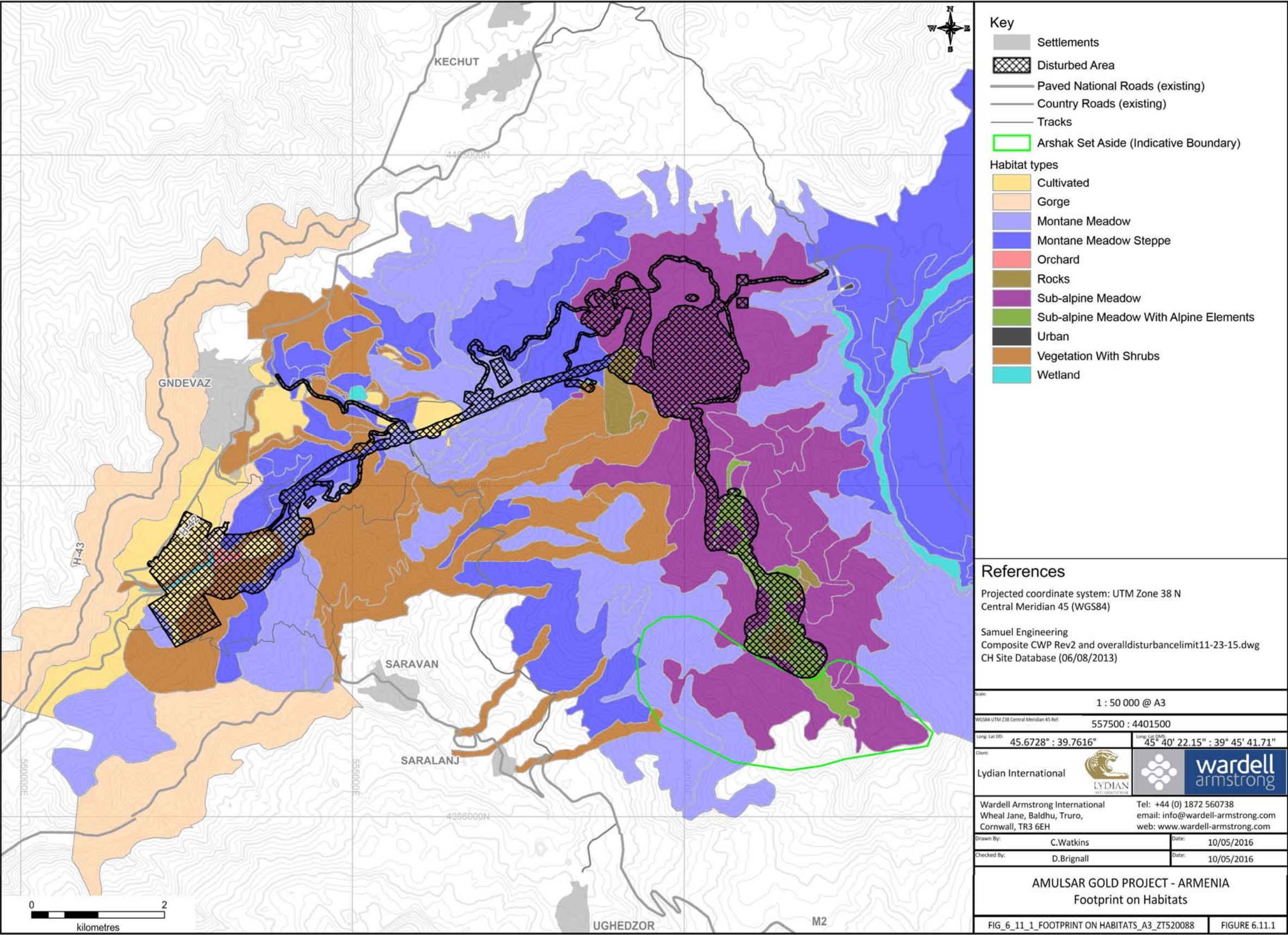


Figure 6.11.1: Footprint on Habitat Types

Impacts on critical habitat for *Potentilla porphyrantha*

Impacts of the Project on critical habitat are described in detail in the NCHA (see Appendix 4.10.3). There will be a physical footprint on Tier 1 critical habitat for *Potentilla porphyrantha*, notably from the mine pits (see Figure 6.11.2). These are located in the Sub-alpine Meadow with Alpine Elements and Sub-alpine Meadows habitats, within which *Potentilla porphyrantha* occurs on suitable rock substrate. The physical footprint is on 150.5 ha, representing 12.5% of the total area of critical habitat, which is 1,200 ha. The Project has translocated the proportion of the population located within the mine pits (see below), but further impacts may occur on remaining plants, due to reduced habitat quality caused by fugitive dust and changes in microclimate around the rock outcrops supporting them. There were 1560 plants recorded in 2012-2014 within the direct footprint of the mine pits on Tigranes, Artavazdes and Erato, representing 33% of the recorded plants and 21 % of the estimated sub-population at Amulsar. A further 377 plants were found in 2015 within the mine pits area. There were an additional 607 plants within the Project Disturbed Area around the working areas, and 1621 plants in the Operational Restricted Area, but the fact that they grow on rocky substrate makes them less sensitive to effects of land use change than the Sub-alpine Meadow vegetation that they are associated with.

Research has been undertaken on plants that grow in and around the proposed open pits. In the autumn of 2015, plants were translocated from the open pit areas to the Sevan Botanic Garden of the Institute of Botany of the National Academy of Sciences under a permit granted by the Ministry of Nature Protection. This work was undertaken as a mitigation measure for the Project as determined by the v9f ESIA produced for the 2014 Feasibility Study Project design, and the permit was granted based on the figures in the v9f ESIA. The number of plants translocated was 1686 and these were from exactly the same area surveyed in 2012-2014. The difference between the number surveyed (1560) and the number collected was due to some plants being missed during the survey and also because plants often grow in clumps which can only be prised apart when removed from the rocks. Some plants (251) were left *in situ*, because they were growing in locations where collection was too dangerous to be attempted and others were left to produce seed in 2016.

The relocation of the main haul road to the west side of Amulsar brings it close to an area on the south-west side of the proposed Erato pit that has a significant concentration of *Potentilla* plants. The haul road route is designed to avoid all of these plants with the exception of one loose rock boulder. The assessment in this chapter is based upon the assumption that the

plants on Erato, with the exception of those on the aforementioned boulder, will not be damaged or destroyed during the construction, operation or closure of the mine. Indeed, it is a requirement of the permit received from MNP for the translocation of the plants from the mine footprint that no additional plants will be damaged. Monitoring plots on Erato were put in place in 2014 to determine if there are any effects from dust deposition on *Potentilla* plants.

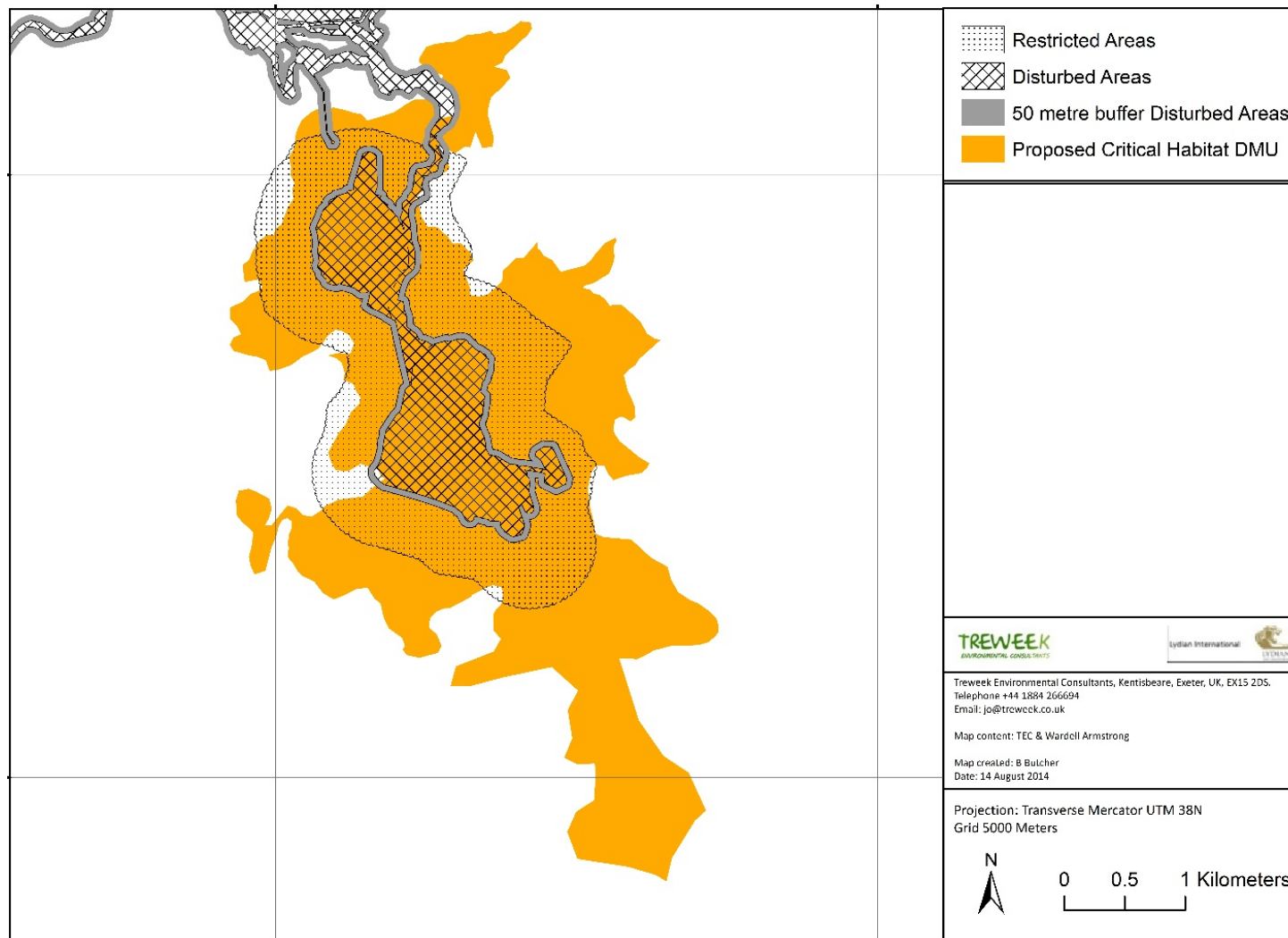


Figure 6.11.2: *Potentilla porphyrantha* Critical Habitat Affected by the Project

Resident and breeding bird populations

The Project-affected area includes varied and important habitat for many bird species, including several that are included in the RA Red Book and/or the IUCN Red List. Implications for priority species and breeding populations in general are summarised here.

One pair of the IUCN Red-listed (Endangered) Egyptian Vulture (*Neophron percnopterus*) nests in Arpa Gorge. The breeding site itself is not likely to be exposed to any impacts as a result of the Project (the proposed water abstraction point and pipeline will not be near to the nest), but the birds could be affected by loss of feeding area within the Project-affected area. However, as discussed in Section 4.10.6, results of monitoring in spring 2013 and 2014 suggested that the pair use the Project-affected area for a very small proportion of their overall feeding time and therefore no significant impact is predicted.

Saker Falcon (*Falco cherrug*) is similarly Endangered according to IUCN, although evidence of the species breeding in the Project-affected area has so far not been encountered, and significant exposure to Project impacts is not expected.

The implications of the Project for Lesser Kestrels (*Falco naumanni*) associated with the Gorayk IBA breeding colony have also been considered in order to check that there will not be any significant adverse impacts on the integrity of the site or its ability to support its designated features. Lesser Kestrels have preferential hunting areas in spring and autumn, including the southwards facing grassy slopes of Amulsar that may be affected by traffic moving to and from the mine. They could be deterred by activity and noise and their feeding habitat could deteriorate due to dust deposition, suppressing vegetation and numbers of the grasshopper larvae present in this area and on which they feed. Much of the Vorotan Valley is considered to be potentially important as supporting habitat for the IBA. Construction of the conveyor and its associated service road, as well as the mine access road and HLF, will affect high quality bird breeding habitat associated with the Arpa Gorge and the gulley running south and eastwards from Gndevaz (this habitat is particularly favoured by Ruddy Shelduck and White-throated Robin). Remaining habitat may be affected by noise, disturbance and lighting during operation. Raptors may collide with overhead power lines, particularly in areas with lighting at higher altitude. Impacts on breeding success could also occur due to pollution of water and introduction of heavy metals into the foodchain if mitigation were not in place.

Due to the Project's footprint on natural vegetation and disturbance associated with construction and operation, there could be impacts on the breeding success of several resident bird species that are listed in the RA Red Book as Vulnerable, including Ruddy Shelduck, Corncrake, Lesser Spotted Eagle, Booted Eagle, Northern Goshawk, Golden Eagle and Short-toed Snake Eagle. Impacts on breeding success of some species could also occur if heavy metals or other pollution entered the foodchain or surface water bodies. Ruddy Shelduck bred in the Project-affected area in 2013 and 2015 but not in 2014 and is potentially affected by loss or pollution of aquatic habitat.

Construction of the conveyor and its associated service road, the mine access road and HLF, and the water abstraction pipeline from the Arpa River, will affect high quality bird breeding habitat associated with the Arpa Gorge and the gulley running south and eastwards from Gndevaz. This habitat is important for White-throated Robin (listed as Data Deficient in the RA Red Book), which nests here and was not found breeding anywhere else in the Project-affected area, and is particularly favoured by Ruddy Shelduck due to the proximity of the gorge to a suitable water body.

Remaining feeding habitat may be affected by noise, disturbance and lighting during operation and there is a possibility that raptors could collide with overhead power lines, particularly in areas with lighting at higher altitude.

Migratory birds

Detailed surveys of migratory birds in spring and autumn of 2013 (see Appendix 4.10.5) confirmed regular use by several globally and nationally threatened species, notably raptors such as Egyptian Vulture, Black Vulture, Pallid Harrier, Eastern Imperial Eagle and Red-footed Falcon. Numbers using the Project-affected area did not meet PS6 thresholds for critical habitat but the Project-affected area is considered to be of national importance as a stop-over for raptors on migration, providing extensive and relatively undisturbed feeding and resting conditions. Significant impacts are not predicted as a result of the Project alone, but could occur over time due to cumulative disturbance impacts and land use changes that could cause reductions in prey populations. The introduction of lighting, combined with overhead power lines at altitude could cause collisions and mortality of migratory birds, some of which fly at night, early dawn or dusk.

Brown Bear

The Project-affected area is considered critical habitat for Brown Bear according to PR6, because the species is listed in Annex IV of the EU Habitats Directive. This means that the Project must ensure (i) that the ecological functionality of breeding sites and resting places for Brown Bear are not damaged or destroyed; and (ii) that the Project will not result in disturbances that affect the species' survival or breeding success, or reduce its area of occupancy.

Surveys in 2015 suggest that up to 10 bears could be affected directly, though final results are needed to confirm the number of individuals photographed. There is regularly used breeding habitat on Amulsar Mountain, with consistent presence of two females and young of different ages. Three adult males are regular visitors. The Arshak Set-aside preserves confirmed breeding dens, but the construction of the mine will introduce a major source of disturbance. The woodland north of Saravan, on the western slopes of Amulsar, offers important breeding habitat too, and may be affected by construction of the HLF and conveyor belt nearby. In addition to possible loss of hibernating or temporary "resting" dens, there would be some loss of foraging area. Bears eat apricots regularly and will lose some supply due to the HLF (although the proportion of supply lost is likely to be relatively small), as well as other foraging areas on the top of Amulsar Mountain and its western flank. Haulage roads, access roads and the conveyor will act as barriers, limiting accessible feeding area. Bears may not be able to range widely enough to find food; this applies particularly to small cubs. Levels of night-time lighting and noise may be sufficient to cause bears to attempt to relocate. However, this could expose them to risk of mortality from hunting or territorial disputes with other bears. The Project has taken steps to retain breeding habitat, in the form of the Arshak Set-aside, but residual impacts are highly likely. The significance of these impacts at a population level cannot be evaluated until final results are available, so that numbers of bears in the wider landscape can be estimated and compared with the affected population. The proposed approach to ongoing monitoring and development of offsets is discussed in a Species Action Plan for *Ursus arctos* that forms part of the Project BAP.

Bezoar Goat

The Bezoar Goat population is centred in Herher State Reserve, Arpa Gorge and the area proposed for Jermuk National Park but Bezoar have also been observed in the Arshak Set-Aside and could therefore be exposed to disturbance and some loss of feeding habitat for the lifetime of the Mine.

Eurasian Lynx

Lynx have been observed on the Arshak Set-aside and will be exposed to disturbance and barrier effects that will disrupt access to undisturbed hunting area. They will be affected in a similar way to Brown Bear but are even more sensitive to presence of people and may therefore be displaced when construction and operation start.

Dorcadian beetles

These were not recorded in any areas where significant changes will occur as a result of the Project, and exposure to impacts is not predicted. However, a precautionary approach is considered appropriate given their national importance.

Radde's/ Armenian Rock Viper, Armenian Mountain-Steppe Viper and Cat Snake

These three species all occur in the proposed HLF location as well as having other suitable habitat on the western flank of Amulsar Mountain. They are listed as Vulnerable in the RA Red Book, with Armenian Mountain-Steppe Viper also being listed as Vulnerable on the IUCN Red List and Radde's Viper as Near Threatened. Both are sensitive to habitat loss and disturbance. They are considered likely to be distributed throughout the wider landscape.

Table 6.11.6: Summary of Potential Pre-Mitigation Ecological Impacts (for Priority Biodiversity Receptors Exposed to Impacts)

Priority receptors	Potential exposure to impacts	Sensitivity	Vulnerability	Significance
Plant Species and Vegetation				
Natural Habitat, including:				
<ul style="list-style-type: none"> Species-rich Sub-alpine Meadows and Sub-alpine Meadows with Alpine Elements 	A large part of the mine footprint is on species-rich Sub-alpine Meadows with an estimated footprint of 254 ha associated with infrastructure (haul roads, mine pits and the crushing plant) and a further 126 ha in the buffer zone. A large proportion of the Mountain's Sub-alpine Meadow with Alpine Elements is also affected (a total of 103 ha).	High (vegetation removed)	Moderate as these vegetation types are extensive in the region. However condition is also declining throughout the region and these types are under-protected in Armenia	Significant
<ul style="list-style-type: none"> Vegetation with Shrubs (particularly Juniper scrub) 	Fragments of juniper scrub occur in the proposed HLF location and conveyor corridor. The Project has a total footprint of 66 ha on this vegetation type.	High (vegetation removed)	High (rare habitat on Amulsar Mountain but more common in Jermuk IBA where grazing is at low intensity)	Significant
<ul style="list-style-type: none"> Other natural and semi-natural vegetation types: Montane Meadows, Montane Meadow Steppes, Wetlands 	Permanent footprint due to the BRSF, haul and access roads on Montane Meadows (39 ha), Montane Meadow Steppes (37 ha) and Wetlands (5 ha). Further areas affected by induced changes in land use. Invasion of disturbed vegetation by weed species such as <i>Astragalus aureus</i> and <i>Verbascum laxum</i> may result in long-term changes in vegetation composition.	High	Moderate	Significant
<ul style="list-style-type: none"> 22 endemic plant species 	All are widespread throughout the wider Project-affected area apart from <i>P. porphyrantha</i> (addressed as an individual species below)	High	Low (species are widespread in the region)	Neutral – Moderate

Table 6.11.6: Summary of Potential Pre-Mitigation Ecological Impacts (for Priority Biodiversity Receptors Exposed to Impacts)

Priority receptors	Potential exposure to impacts	Sensitivity	Vulnerability	Significance
Amulsar sub-population of <i>Potentilla porphyrantha</i> (Tier 1 critical habitat – IFC PS6)	Proposed mine pits and other infrastructure are within Tier 1 critical habitat for <i>Potentilla porphyrantha</i> . An estimated 33% of the population has been translocated from Amulsar to avoid being lost as a result of mining. Other plants could be exposed to damage due to construction of associated infrastructure (roads or tracks), from deposition of fugitive dust that may include heavy metals or other pollutants; or from localized changes in microclimate that might affect availability of water.	High	High as there are only five confirmed populations in the world and the size of these populations is unknown	Significant
Birds				
Resident Breeding Bird Populations:				
<ul style="list-style-type: none"> Egyptian Vulture (<i>Neophron percnopterus</i>) 	Only one breeding pair located in Jermuk Gorge. The breeding site will not be exposed to any impacts as a result of the Project. It is not within the Project footprint and levels of disturbance are not expected to alter at this location. Egyptian Vultures feeding in the Project-affected area could potentially be exposed to Project impacts due to loss of feeding area or poisoning if birds eat food contaminated by heavy metals entering the food chain if mitigation were not implemented. However results of monitoring in spring 2013 and 2014 suggest that the pair use the Project-affected area for a very small proportion of their feeding time.	High for the affected pair (loss of feeding habitat), low for national or regional population	Low (extensive alternative feeding habitat)	Neutral

Table 6.11.6: Summary of Potential Pre-Mitigation Ecological Impacts (for Priority Biodiversity Receptors Exposed to Impacts)

Priority receptors	Potential exposure to impacts	Sensitivity	Vulnerability	Significance
<ul style="list-style-type: none"> Saker Falcon (<i>Falco cherrug</i>) 	Observed three times on migration (four birds). A small number of individuals considered potentially resident in the wider area. No significant exposure to impacts as a result of the Project due to low frequency of occurrence and lack of confirmed breeding activity in Project-affected area.	High (loss of feeding habitat)	Low (extensive alternative feeding habitat)	Neutral
<ul style="list-style-type: none"> Lesser Kestrel 	Preferential hunting area adjacent to the old construction camp and on southern flank of Amulsar could deteriorate due to dust deposition, suppressing vegetation and numbers of the grasshopper larvae on which they feed. See also considerations for breeding birds in general below.	High (loss of feeding habitat and disturbance)	Moderate	Neutral to moderate
<ul style="list-style-type: none"> Other Species of Bird listed in the RA Red Book which breed in the Project-affected area 	Construction of the conveyor, service road, mine access road, HLF and Arpa water abstraction pipeline will affect high quality bird breeding habitat, particularly for Ruddy Shelduck and White-throated Robin which nest in the rocky gorge north of the HLF. Remaining habitat may be affected by noise, disturbance and lighting during operation. Raptors may collide with overhead power lines, particularly in areas with lighting. Impacts on breeding success could also occur due to pollution of water and introduction of heavy metals into the foodchain if mitigation were not implemented. Alpine birds currently breeding on Amulsar Mountain in Sub-Alpine areas could potentially be adversely affected by noise and	High (loss of feeding and breeding habitat and reduced quality of remaining habitat)	High (these species are all threatened)	Significant

Table 6.11.6: Summary of Potential Pre-Mitigation Ecological Impacts (for Priority Biodiversity Receptors Exposed to Impacts)

Priority receptors	Potential exposure to impacts	Sensitivity	Vulnerability	Significance
	disturbance.			
Migratory birds, especially raptors	Some feeding habitat for migratory raptors may be affected, both due to loss of habitat within the footprint, disturbance and land use changes which might reduce small mammal populations and food availability in the longer term. Availability of undisturbed resting habitat will also decline.	High	Moderate (extensive alternative feeding habitat is available in theory, so only a small proportion of available feeding habitat will be exposed to impacts from the Project).	Moderate
Mammals				
Brown Bear (<i>Ursus arctos</i>)(critical habitat – EBRD PR6)	Up to five individuals regularly use areas around the proposed mine pits on Amulsar Mountain and will lose feeding area due to the mine pits and other restricted use requirements. They may also lose breeding habitat due to noise, disturbance, habitat fragmentation and loss of food supply. Bears will be exposed to noise from blasting, haulage and conveyor operation, which will take place day and night. Disturbance from presence of people, light pollution, possible increases in exposure to hunting due to induced access, toxic effects from drinking polluted water or heavy metals that have entered the food chain, if mitigation were not implemented could all potentially cause displacement, placing bears at threat of poaching or hunting or competition with other bears.	High (sensitive to loss of habitat, disturbance by noise during day and night, loss of high quality breeding, feeding and winter hibernating habitat, barriers to movement)	High (Vulnerable in RA Red Book; threatened throughout region; EU Habitats Directive Annex IV species)	Significant

Table 6.11.6: Summary of Potential Pre-Mitigation Ecological Impacts (for Priority Biodiversity Receptors Exposed to Impacts)

Priority receptors	Potential exposure to impacts	Sensitivity	Vulnerability	Significance
Bezoar Goat	Population centred in Herher State Reserve, Jermuk Gorge and area proposed for Jermuk National Park. Not exposed to direct effects from the Project.	High (sensitive to disturbance)	High (declining throughout region)	Neutral (not exposed)
Eurasian Lynx	Observed in the Arshak set-aside and will be exposed to disturbance during construction and operation, with similar sensitivities to those of Brown Bear, though Amulsar is not considered to provide breeding habitat.	High (very sensitive to disturbance)	High (declining throughout region). Targeted for conservation action in EU due to more endangered sub-populations. However observations also made in the proposed Jermuk National Park, so Amulsar is not the only suitable habitat available.	Moderate
Invertebrate Species				
Dorcadion Beetles (<i>Dorcadion sevangense</i> , <i>D. sisianum</i> Lazar and <i>D. bistratum</i>)	Locations where these have been recorded in baseline surveys are not within the Project footprint and are not considered likely to be exposed to impacts as a result of the Project.	High (not mobile species, highly sensitive to land use change)	High (threatened species where recorded)	Neutral (key areas where species recorded are not exposed)
Reptiles				
Radde's/ Armenian Rock Viper <i>Montivipera (Vipera) radeii</i> , Armenian Mountain-Steppe Viper <i>Vipera eriwanensis</i> and Cat Snake <i>Telescopus</i>	These reptile species are listed in the RA Red Book as Vulnerable, and <i>Vipera eriwanensis</i> is also IUCN Red-Listed as Vulnerable. They occur in rocky habitat largely on the western flank of	High (significant land use change)	Moderate as large areas of suitable habitat remain	Moderate

Table 6.11.6: Summary of Potential Pre-Mitigation Ecological Impacts (for Priority Biodiversity Receptors Exposed to Impacts)

Priority receptors	Potential exposure to impacts	Sensitivity	Vulnerability	Significance
<i>fallax</i>	Amulsar Mountain. Some suitable habitat will be within mine pits, but this is slightly too high altitude to be preferred.			

Table 6.11.7: Implications of the Project for Biodiversity which is Widespread, with Resilient Populations

Receptor	Summary	Implications of the Project
Vegetation and plant species	Areas of grassland that are modified by relatively intensive grazing or presence of herder camps, reducing their species-richness and characteristic species.	Induced impacts might include an increased level of harvesting of species used for herbs, vegetables and medicines, possibly causing declines in populations of targeted species. However species in this category are generally able to regenerate well and are sufficiently widespread for populations to recover.
Birds	The Project-affected area provides habitat for a large number of species that are considered to be relatively common or widespread, with resilient populations.	The land use changes and disturbance associated with the Project will affect a variety of bird species but most will be able to relocate to alternative areas as they are relatively mobile and adaptable.
Mammals (including bats)	Baseline surveys identified several mammal species within the Project-affected area which are not considered to be threatened within the region or country and which are considered to be relatively mobile and adaptable. This includes some bat species that have been observed in the wider area. No Red Book bat species were confirmed to be present in baseline surveys.	Mammals in general will be affected by loss of habitat, land use change, barrier effects, habitat fragmentation and disturbance. Some local population declines may occur, but populations are considered sufficiently resilient to recover spontaneously. Bat species are thought to have resilient populations, with abundant feeding habitat available regardless of the presence of the Project.
Invertebrates (terrestrial and aquatic)	A wide variety of terrestrial and aquatic invertebrates will be affected by the Project, most of which are not included in the RA Red Book, though much of the Project-affected area is probably under-recorded due to the time-intensive nature of invertebrate survey.	The areas considered to be most important for invertebrates have generally been found outside the Project-affected area. The Project could exacerbate existing baseline impacts on water quality by removing vegetation from large areas, mobilizing sediment and fugitive dust, which could be

Table 6.11.7: Implications of the Project for Biodiversity which is Widespread, with Resilient Populations

Receptor	Summary	Implications of the Project
	Aquatic invertebrates have been sampled as a basis for water quality monitoring, and no threatened species have been recorded.	deposited on surface water bodies.
Reptiles and amphibians	Several reptile species have been recorded in the Project-affected area. Amphibians potentially affected by the Project are generally relatively widespread.	The main threat to reptiles in the baseline situation is considered to be decline in biomass of prey animals due to deterioration in the quality of grassland. The Project will cause a decline in overall availability of reptile habitat during operation. It will also remove some wetland habitat that supports abundant amphibian populations. Pollution of wetlands and watercourses could also depress populations of amphibians.
Fish	No endemic or RA Red Book species of fish were identified in baseline surveys of the Project-affected area. Although suffering reductions in biomass and population size due to a range of threats and pressures, the fish species present are not threatened from a biodiversity conservation perspective.	The Project could affect fish populations in the Vorotan and Arpa Rivers. Water will be abstracted from the Vorotan during construction and the Arpa during operation. Fish populations in the baseline situation are lower than they should be due to presence of artificial barriers in watercourses, including development of hydro-electric schemes. There are no fish passes, for example allowing access upriver for fish from Spandaryan Reservoir and this is constraining populations. The Project's Water Balance Model suggests that impacts on flow will be negligible even during low flow periods and stringent measures are proposed to avoid pollution.

Table 6.11.8: Implications of the Project for Protected Areas and Other Key Biodiversity Areas

Site or Area	Summary of implications of the Project
Caucasus Biodiversity Hotspot (Conservation International)	Covers the whole of Armenia. Project does not affect a significant proportion of the hotspot or the species targeted for conservation within it.
Caucasus Mixed Forest Ecoregion	Extensive WWF Global 200 Ecoregion. Presence of target habitats and species has been reviewed, for example presence of Caucasian mixed broadleaved woodland. Very small, degraded fragments of shrubby vegetation occur in the HLF location between cultivated areas supporting Caucasian endemic species of plant (e.g. <i>Phelypaea tournefortii</i>) and slow growing mature shrubs (e.g. <i>Juniperus polycarpu</i>). These are not high quality examples in the context of the Ecoregion as a whole; however, the Project has been designed to avoid remaining individual shrubs.
State Sanctuaries (Jermuk Forest, Herher Open Woodland and Jermuk Hydrological)	Not exposed to impacts
Sevan National Park	Not exposed to impacts
Proposed Jermuk National Park	The HLF and some parts of the mine would be visible from parts of the Park.
Jermuk IBA Key Biodiversity Area identified using recognized selection criteria	The Project affects feeding habitat for breeding birds associated with Jermuk IBA including <i>Neophron percnopterus</i> (Egyptian vulture), <i>Alectoris chukar</i> (Chukar), <i>Pernis apivorus</i> (European Honey-Buzzard), <i>Accipiter brevipes</i> (Levant Sparrowhawk), <i>Aquila chrysaetos</i> (Golden Eagle), <i>Crex crex</i> (Corncrake). The Project-affected area is used for foraging by breeding Egyptian Vulture protected in Jermuk IBA for a maximum of 20% of its time. Other birds of prey also use the Project-affected area, but have abundant alternative feeding areas available to them (see Table 6.11.6).
Gorayk IBA Key Biodiversity Area identified using recognized selection criteria	Part of the Project-affected area is considered to be supporting habitat for <i>Falco naumanni</i> (Lesser Kestrel) breeding colony and also for other target species <i>Aquila chrysaetos</i> (Golden Eagle) and <i>Buteo rufinus</i> (Long-legged Buzzard). Birds hunt regularly in the Vorotan Valley and may be affected by land use change and disturbance. Only one Egyptian Vulture was seen in the vicinity of the IBA in the period 2013-2014.

6.11.6 Mitigation for Impacts on Biodiversity and Ecosystems

The evaluation in Section 6.11.5 considered the potential impacts that might result from the Project without mitigation. These are summarised in Table 6.11.6 for priority biodiversity, Table 6.11.7 for more resilient and widespread biodiversity, and Table 6.11.8 for protected areas and other "key biodiversity areas".

The Project mitigation strategy for biodiversity addresses these impacts through application of the mitigation hierarchy. It is based on the objective of achieving NNL as reflected in Lydian's Biodiversity Policy, and on NNL or net gain as required by PS6 and PR6.

The Project's mitigation strategy includes:

- General design and control measures:
 - "built-in" biodiversity-related avoidance measures identified and implemented during early Project design;
 - control measures to be implemented by the Project in accordance with good mining industry practice, which will contribute to reduced risks or impacts on biodiversity;
 - mitigation measures aimed at other, non-biodiversity impacts (e.g. to prevent pollution of surface water) which also reduce risks of impacts on biodiversity and ecosystems; and
- Mitigation measures specifically designed to address impacts on biodiversity and ecosystems.

Table 6.11.9 summarises the general design and control measures that will be undertaken. The specific biodiversity-related mitigation measures are identified in Table 6.11.11 for priority biodiversity, Table 6.11.12 for widespread and resilient biodiversity, and Table 6.11.13 for protected areas or other "key biodiversity areas".

Table 6.11.9: General Biodiversity Mitigation Measures

Step in mitigation hierarchy	Project approach	Mitigation measures
Avoid	<p>Impacts on biodiversity are avoided where possible and particularly when the following situations occur:</p> <ul style="list-style-type: none"> • Priority biodiversity features are affected, e.g. natural or critical habitat according to PS6/PR6, designated areas for conservation, species protected at national level, species threatened at a global level, amongst others. • The features concerned have restricted or localized distributions. • There is a risk of losing biodiversity with very high irreplaceability, and/or it is threatened and declining throughout its remaining area of occupancy. • Impacts will result in remaining portion of the resource becoming non-viable because critical viability thresholds have been exceeded (remaining habitat too small or fragmented, population unable to recover). • Recovery from impact is uncertain and no proven mitigation measures are known. 	<ul style="list-style-type: none"> • Design modified to avoid impacts on protected areas or key biodiversity areas, for example HLF relocated to avoid direct footprint on Gorayk IBA and now has a reduced footprint on natural habitat. • Set-aside established to safeguard a viable proportion of the <i>Potentilla porphyrantha</i> population and preserve species-rich Sub-alpine Meadow with Alpine Elements, as well as to protect Brown Bear dens and suitable habitat for alpine birds. Awareness training for relevant personnel will reinforce awareness of protected features. Access will be prohibited. • As far as possible, construction activities will be scheduled to avoid disturbance of Brown Bear breeding habitat in early spring, between March and June. • Haulage routes designed to avoid remaining <i>Potentilla porphyrantha</i> plants, which are clearly marked. • An ecological risk assessment to evaluate the consequences of accidental spills during transport or storage of hazardous chemicals will be undertaken once transport routes are confirmed. This will focus particularly where routes run adjacent to sensitive water courses or water bodies. • Design process for HLF, topsoil storage piles and BRSF reviewed alternatives and avoided the most damaging alternatives on biodiversity. • Pre-construction checks (surveys) will be carried out immediately prior to ground disturbance to confirm that the biodiversity baseline as reported in this ESIA has not changed significantly and that there are no additional features that should be avoided (see Table 6.11.11 for survey requirements for specific species). • Small mammals, reptiles and amphibians will be excluded from working areas. Any individuals that become trapped will be removed by a suitably qualified ecologist. • Fauna, including birds, will be prevented from accessing settling ponds. Monitoring will determine whether measures additional to standard practices (fencing, use of bird scarers, etc.) are required.

Table 6.11.9: General Biodiversity Mitigation Measures

Step in mitigation hierarchy	Project approach	Mitigation measures
Minimise	If avoidance is not possible, measures will be taken to minimize ecological impacts, e.g. to reduce the proportion of a receptor affected, or the magnitude or intensity of an impact.	<p><i>Footprint and barrier effects</i></p> <ul style="list-style-type: none"> • As a fundamental design principle, the footprint of Project infrastructure and the areas of land to be cleared will be minimised. • Any new access roads required will be designed to minimise habitat fragmentation, barrier effects and induced access to previously undisturbed areas. • Vehicular access to the Project-affected area will be minimised. The majority of workers will arrive on site via bus and limited car parking will be available for employees (see Section 6.5, landscape and visual impacts). <p><i>Site management</i></p> <ul style="list-style-type: none"> • All site workers will have awareness training on biodiversity issues and particularly the provisions that have been made to minimise impacts on biodiversity, both prior to initial access to site and on an as-needed basis throughout the project (via tool-box talks etc.). • Hunting and gathering by Project staff will be prohibited. • The Project site will be maintained in a clean and uncluttered state: the pMRCRP (Appendix 8.18), FMP (Appendix 8.8) and ESMP (Chapter 8) will include landscape and habitat management requirements (see Section 6.5, landscape and visual impacts). • Litter will be removed from water bodies and areas within the restricted access zone. • A waste management plan will be implemented. Waste disposal facilities will be operated in a manner that includes the regular covering of exposed refuse with soil or gravel (see also Section 6.6, air quality impacts). This will reduce risk of exposure of birds such as Egyptian Vulture that regularly forage in waste dumps to potentially damaging waste products. • Areas to be disturbed during construction and operation will be clearly delineated and marked out in advance, and encroachment outside these areas will not be permitted. In particular, off-road/track driving will be prohibited.

Table 6.11.9: General Biodiversity Mitigation Measures

Step in mitigation hierarchy	Project approach	Mitigation measures
		<ul style="list-style-type: none"> Vehicle speed limits will be set in relation to road conditions and presence of sensitive receptors (e.g. populated areas). On access and haul roads, speed limits will be posted and maintained to minimise dust emissions and the risk of mortality of animals. Instruction on driving safety and observation of speed limits will be included in the new employee orientation and annual refresher training and in task training for specific job assignment (see also Section 6.6, air quality impacts). Vehicles considered to have the potential to introduce invasive plant species or spread existing invasive plants to areas where they do not currently occur will be washed before entering site or current weed-free locations (wash water to be contained). <p>Dust</p> <ul style="list-style-type: none"> Topsoil storage piles will be stabilized as necessary to reduce wind-blown dust emissions. All mounds will be sown with a grass seed mixture appropriate to the location and will be maintained for the duration of the operational phase (see Section 6.7, soil and land cover impacts; FMP (Appendix 8.8); pMRCRP (Appendix 8.18)). Crushing and screening facilities will be enclosed in a purpose-constructed building with dust extraction and filtration systems (see Section 6.6, air quality impacts). Transfer of crushed ore between the crushing and screening plant and truck loadout facility will be via covered conveyor, thereby significantly reducing the potential for both dust emissions and noise compared with use of dump trucks and haul roads (see Section 6.6, air quality impacts; and Section 6.6, noise & vibration impacts). Water sprays will be used at conveyor discharge points and other identified dust emission points (see Section 6.6, air quality impacts). The HLF will be operated such that the active leaching surface retains sufficient humidity to inhibit dust generation (see also Section 6.6, air quality impacts). Water spraying will be employed on roads to suppress dust (see Section 6.6, air quality impacts). To the extent practical, haul and dump truck loads prone to dust will be sprayed with

Table 6.11.9: General Biodiversity Mitigation Measures

Step in mitigation hierarchy	Project approach	Mitigation measures
		<p>water as appropriate to decrease the potential for fugitive dust emissions during transport (see Section 6.6, air quality impacts).</p> <p>Water management</p> <ul style="list-style-type: none"> • Control measures, including for material storage and handling and for erosion and sedimentation prevention, will be in place to prevent release of contaminants into the environment via leakage, spills and run-off. (see Section 6.9, groundwater impacts; Section 6.10, surface water impacts; and Emergency Preparedness and Response Plan (Appendix 8.9)). • Sites will be graded to channel surface flows into ditches to decrease the potential for erosion (see Section 6.7, soil and land cover impacts). • Roadside berms will be installed and surface water run-off managed to reduce footprint of gravel wash-out, particularly where natural vegetation could be affected. • Culverts will be installed at all road/track stream-crossings to minimise sedimentation downstream. • Geotextile silt fencing, silt traps, and/or straw bales will be used to reduce sediment transport within the construction site (see Section 6.7, soil and land cover impacts). <p>Noise</p> <ul style="list-style-type: none"> • All Project vehicles and equipment will be maintained in good condition. During detailed construction design, use of noise barriers, baffles, or enclosures to provide abatement for noisy equipment such as generators, compressor, pumps, gearboxes will be considered (see Section 6.6, noise & vibration impacts). • Where practical, noisy construction-related activity will be avoided at dawn and dusk and during the night (see also Section 6.6, noise & vibration impacts). • Workers will be trained in noise abatement best practices, including avoiding unnecessary revving of engines and switching off equipment when it is not required. Haul routes will be well maintained and where steep gradients are required operatives will be trained to minimize engine noise through avoiding unnecessary revving etc. (see

Table 6.11.9: General Biodiversity Mitigation Measures

Step in mitigation hierarchy	Project approach	Mitigation measures
		<p>also Section 6.6, noise & vibration impacts).</p> <ul style="list-style-type: none"> Lydian will investigate the optimal technology to be used for reversing alarms on haul trucks, to balance the requirement of occupational health and safety for workers deployed on the HLF and to minimise/remove the audibility of alarms within the nearest community of Gndevaz (see Section 6.6, noise & vibration impacts). <p>Light</p> <ul style="list-style-type: none"> Only the minimum artificial lighting necessary to ensure safety will be employed. Downward-directed lighting will be employed to minimise light pollution for nocturnal species. Low visibility spectrum lights and appliances (full cut-off fixtures that emit no light above the light's horizontal line) will be preferred, with lighting mounted at the minimum necessary safe height and shrouded where appropriate (see Section 6.5, landscape and visual impacts). Lighting will be carefully enclosed within buildings so as not to contribute to light pollution/ light spillage off site/ glare to the sky. Shutters will be used during darkness (see Section 6.5, landscape and visual impacts). There will be minimal security lighting in external areas (sensors will be used to ensure it does not get left on) (see Section 6.5, landscape and visual impacts). Lighting of work sites will be restricted to agreed working hours and that which is necessary for security. Light sources for night-time construction and operation activities will be pointed downward and away from sensitive receptors (see Section 6.5, landscape and visual impacts). Vehicle and mobile plant machinery operators and drivers will be instructed in the appropriate use of headlights (high and low beams) to reduce impacts (see Section 6.5, landscape and visual impacts).
Restore or repair	The Project will aim to restore the condition of biodiversity to its present	A comprehensive soil and vegetation restoration programme will be employed to reinstate appropriate vegetation types post-impact. Ecologists have worked closely with

Table 6.11.9: General Biodiversity Mitigation Measures

Step in mitigation hierarchy	Project approach	Mitigation measures
	condition after work in each area. This will be a progressive activity during and after the construction phase, throughout operations, and after mine closure. It will be employed for all areas where vegetation has been cleared, including haul roads and temporary material or equipment storage areas.	<p>landscape specialists to identify suitable native species, and field trials will be undertaken in conjunction with the national herbarium and the NAS RA Institute of Botany to investigate restoration techniques. Restored areas will be monitored for a period of five years post-mine closure. See also Section 6.5, landscape and visual impacts; and Section 6.6, soil and land cover impacts.</p> <p>All re-vegetation carried out for the Project will be carefully reviewed and monitored to avoid accidental introduction of invasive alien species.</p>
Offset	Offsets will be developed for significant residual impacts on natural and critical habitat and will deliver NNL and net gain outcomes, respectively.	Specific measures required; see Table 6.11.11.

The mitigation required for priority biodiversity is discussed in further detail below.

Mitigating impacts on natural vegetation

As noted in Table 6.11.9, a set-aside of land that has remained relatively undisturbed during the exploration phase for the Project has been designated by Lydian to ensure the preservation of high quality Sub-alpine Meadow with Alpine Elements vegetation and to safeguard a viable population of *Potentilla porphyrantha*, as well as Brown Bear dens and breeding habitat for alpine birds. The proposed boundary of the set-aside is shown in Figure 6.11.1. Preliminary consultations have been held with local communities, but further discussion will be needed to finalise land use agreements, though significant changes to current use are not likely to be necessary. A wider area than this is appropriate to maintain Brown Bear habitat, due to the importance of the woodlands north of Saravan on the western flank of Amulsar Mountain. Discussions are needed to confirm whether this can be incorporated and included in a zone of controlled access. The Ministry of Nature Protection has approved the set-aside in principle as a measure to meet the requirements of the Flora Decree.

Outside the set-aside, efforts will be made to minimise the Project's footprint on natural vegetation types, by for example preventing access of vehicles outside haul roads or working areas; by suppressing pollution and dust that could alter vegetation in adjacent zones; and by covering stockpiles to avoid fugitive dust and polluted run-off.

A programme of vegetation rehabilitation will be implemented throughout mine development and in the mine closure and rehabilitation period. To ensure that the best available techniques for restoring the vegetation types affected by the Project are used, a trial restoration programme involving the national herbarium and the NAS RA Institute of Botany is in place. Several temporary access routes used during the exploration phase have already been rehabilitated and restored using a variety of techniques and the outcomes will be monitored. This experience will be built on to improve techniques.

Vegetative cover will be restored on temporary haul and access roads using native species that are known to be constituents of affected vegetation. As a general practice and where it is technically feasible, the top 10cm of topsoil will be stripped and stored separately from other soil that is removed. However, there are areas where the abundance of rocks will make soil-stripping impossible. A detailed map will be created in association with engineers to

illustrate the areas that can be stripped of soil and those that cannot. Because many alpine plants rarely produce seed and spread vegetatively, turves of species-rich vegetation will be removed and stored prior to excavation and stored for use as 'plugs' in amongst seeded areas during restoration. A seed collection programme has been initiated for native plant species and three plant nurseries have been established in local villages to provide stocks for re-vegetation. These have been used initially to produce trees for visual screening purposes, but will be expanded to cater for restoration requirements, in partnership with the local communities in which they are located.

All re-vegetation carried out for the Project will be carefully reviewed and monitored to avoid accidental introduction of invasive alien species. Trees used for landscape or visual screening purposes will be native species and they will not be planted in areas where the typical vegetation is grassland.

Despite the efforts described above, reinstatement of suitable soil conditions for restoration of vegetation is expected to be challenging in some locations, particularly in the harsh mountain environment (see Section 6.7, soil and land cover impacts). There are also places within the mine footprint where irreversible changes will occur that make it impossible to reinstate the original vegetation types. Significant residual impacts on natural habitat will therefore occur. As discussed in Section 6.11.5, the Project has chosen to take a conservative approach and assume that loss of natural habitat will be effectively permanent within the Project's entire physical footprint (518 ha). In other parts of the Project-affected area, natural habitat may not be destroyed, but is likely to decline in condition, either because of dust and other pollution impacts or because restrictions on access mean that traditional management may be discontinued.

A method has been devised to quantify the residual biodiversity losses associated with the footprint and other Project-affected areas as the basis for a natural habitat offset. This is described in full in the NCHA (Appendix 4.10.3) and summarised here. Each affected vegetation type is assigned a score, based upon its distinctiveness and condition. For each vegetation type, the affected area (in hectares) is multiplied by the appropriate score to give a normalised area expressed in "habitat impact units" (HIU). For the 518 ha of natural habitat within the physical footprint that will be lost, the overall HIU is calculated by summing the HIUs for each vegetation type within the Project footprint. For the 1288 ha of natural habitat in the Project Disturbed Area, Operational Restricted Area, Restricted Area, Restricted Area

(by fencing), Ecologically Disturbed Area, and along the Kechut-Gorayk road, the calculation method is slightly different because the vegetation in these areas is not expected to be lost entirely, but rather will remain in a degraded state post-mining. The score used to derive the HIU for each affected vegetation type is based on the difference between the distinctiveness and condition of the vegetation now, and its predicted distinctiveness and condition post-mining. The summed HIU for all vegetation types in the buffer and restricted zones is then added to the figure generated for the Project footprint, to give the total impact value, which constitutes the natural habitat offset requirement of the Project. The calculation for some of the restricted zones was complicated in that some of the impacts will be positive e.g. the exclusion of people will be good for species that are normally disturbed by people and their grazing animals whereas others will be negative e.g. plant species that require grazing to persist may be over-topped by the development of shrubby vegetation. However, because the land has been overgrazed in the past and nutrient levels are higher than natural, it is assumed that the vegetation that will develop if grazing ceases will not be of high natural quality and therefore the overall change will be slightly negative.

The calculation as described in the NCHA (Appendix 4.10.3) derived a figure of 836.5 HIUs required as an offset in order to achieve NNL.

The Project proposes to achieve NNL of natural habitat through implementation of a management plan which will involve improving the condition of target vegetation types (and habitat conditions for other priority biodiversity) in a proposed new National Park near Jermuk (Figure 6.11.3), possibly through management agreements with herders. The proposed Jermuk National Park is potentially suitable to offset residual impacts of the Project on natural habitat because it is adjacent to the Project-affected area and has a similar range of altitudes. Initial botanical surveys indicate that there are extensive areas of suitable habitat available that would benefit from improved management. A preliminary survey of land use within the proposed National Park was carried out by WWF Armenia which suggested that there were 9386 ha of pasture land, currently in poor condition due to over-grazing that would offer ample scope for delivering enhancements needed to achieve NNL of natural habitat. Further details are given in the NCHA (Appendix 4.10.3).

More detailed surveys of the habitat types represented in the proposed National Park, and assessments of their current condition and suitability for other priority biodiversity including Brown Bear and some bird species (including White-throated Robin and Ruddy Shelduck),

were undertaken in June and July 2015. These confirmed the availability of suitable habitat types for offsetting the impacts of Amulsar on natural habitat. The results, summarised in Table 6.11.10, are described in a survey report and used in the Project's Biodiversity Offset Strategy (BOS) to identify suitable management interventions. They also confirmed the presence of opportunities to offset impacts on the full range of species associated with natural habitat on Amulsar Mountain, with the exception of Eastern Rock Nuthatch. Preliminary stakeholder mapping was also carried out in the proposed National Park area and interviews were held to discuss attitudes to the concept of the National Park and also conservation of large carnivores such as Brown Bear, Eurasian Lynx and Wolf. Further consultations will take place with herders who use the area to seek their involvement in grazing management and to ensure that implementation of a biodiversity offset would be compatible with existing or potential alternative livelihoods.

The Project BOS provides further consideration of potential costs and funding mechanisms and outlines Lydian's proposed approach to provision of support during National Park establishment and ongoing management.

Table 6.11.10: Scope to offset potential residual impacts on RA Red Book species in the proposed Jermuk National Park

RA Red Book species	Current habitat in Jermuk National Park (JNP)	Need and potential for offset in Jermuk National Park (JNP)
<i>Potentilla porphyrantha</i>	This plant species has been looked for in apparently suitable locations but has not been found, so suitable habitat conditions do not seem to be present.	Research is ongoing on its ecology and growing conditions as outlined in the Species Action Plan, together with research on restoration techniques and searches for other populations in Armenia.
Egyptian Vulture	The only nesting site in the region is south of JNP. Little or no breeding habitat is available but there is plentiful feeding habitat.	No residual impacts identified but monitoring of breeding pair in Arpa Gorge recommended. Little suitable breeding habitat is available in the region and extension of the indicative boundary to include the Arpa Gorge would incorporate it the one confirmed location into JNP. The species would benefit from this and from increased availability of food (e.g. by means of a vulture restaurant) within JNP
Saker Falcon	No direct evidence of breeding in the Park, but suitable feeding habitat is available, especially in the high-altitude, stony north-eastern part.	No residual impacts identified, but this species will benefit from protection in JNP.
Lesser Kestrel	JNP is a too great a distance from the current breeding location (the Gorayk area), but potentially suitable habitat is available for hunting (southwards facing slopes with short grass and abundance of voles) although these are covered in snow for a long time in spring.	Residual impacts from the Project are possible, but would be confirmed through monitoring. No specific conservation measures are currently proposed, but in theory it may be possible to extend breeding range into JNP, e.g. by setting up containers with nest boxes. This would be an ACA.
Ruddy Shelduck	This species breeds on lakes just north of the Park (Pokr Al Lake) but suitable breeding habitat seems absent within the Park itself. There is some feeding habitat in spring (before herders arrive).	Residual impacts on current breeding habitat on Amulsar identified. Actions needed through Natural Habitat offset. The small lake located along the northern border of JNP could be expanded to create suitable breeding habitat. Herder camps should be relocated away from this lake, as Ruddy Shelduck is sensitive to disturbance.
Lammergeier	No good breeding habitat available (the species breeds south of the NP); plenty of feeding habitat present.	No residual impact identified but monitoring recommended. If long-term monitoring shows an impact of mining activities on the current breeding pair in Arpa gorge (south of NP), the species could benefit from development of a vulture restaurant.

Table 6.11.10: Scope to offset potential residual impacts on RA Red Book species in the proposed Jermuk National Park

RA Red Book species	Current habitat in Jermuk National Park (JNP)	Need and potential for offset in Jermuk National Park (JNP)
Griffon Vulture	Limited breeding habitat available in parts of Arpa gorge (within NP), although the species does not currently breed there. Plenty of feeding habitat present.	No residual impacts identified.
Cinereous Vulture	The species does not currently breed in the region, but formerly did. Suitable breeding habitat is available in Herher Open Woodland State Sanctuary. The species breeds on mountain grasslands alternated with arid Juniper sparse forests on slopes at 1200 - 2000 masl. Plenty of feeding habitat present.	No residual impacts identified, but species would benefit from measures to increase the number of ungulates in the area (e.g. a hunting ban), including Bezoar Goat. Also, any potential nesting sites should be strictly protected. A vulture restaurant could also have a positive impact on the species as an ACA.
Short-toed Eagle	Suitable breeding habitat is present in Herher Open Woodland State Sanctuary, though it is not clear if the species currently breeds there. The same area also offers good feeding opportunities for snakes. The rest of the NP is probably at too high an altitude to offer enough food.	Intended to benefit from natural habitat offset due to some residual loss of feeding area. More information (through monitoring) is needed on the current breeding situation in Herher. Conservation action could possibly entail expanding the habitat for reptiles in certain places through prescribed fire, mowing and forest thinning.
Pallid Harrier	A migratory species (does not breed in Armenia) for which plenty of feeding habitat is available in the central and northern parts of the NP	No residual impacts identified.
Montagu's Harrier	Suitable breeding (mountain grasslands) and feeding habitat is available in the central and northern parts of JNP.	No residual impacts identified, but species would benefit from restrictions on grazing in JNP.
Northern Goshawk	Breeding and feeding habitat is available in the wooded valley west of Kechut Lake and the wooded valley along the Arpa river north of Jermuk; possibly also in Herher Open Woodland State Sanctuary and in woodland in the southeastern corner of JNP.	No residual impacts identified, but the species would benefit from restriction of human activities (such as road construction or hunting) in wooded valleys, as well as expansion of the current woodland areas.

Table 6.11.10: Scope to offset potential residual impacts on RA Red Book species in the proposed Jermuk National Park

RA Red Book species	Current habitat in Jermuk National Park (JNP)	Need and potential for offset in Jermuk National Park (JNP)
Lesser Spotted Eagle	Breeding habitat is available in the wooded valley west of Kechut Lake and the wooded valley along the Arpa river north of Jermuk; possibly also in Herher Open Woodland State Sanctuary and in woodland in the south-eastern corner of JNP..	Residual impacts on this species are likely due to loss of natural habitat and disturbance. Offset could target restriction of human activities (such as road construction or hunting) in wooded valleys, as well as expansion of the current woodland areas (tree planting).
Steppe Eagle	A migratory species (does not breed in Armenia) for which plenty of feeding habitat is available in the central and northern parts of the NP (mountain grasslands)	Possibility of residual impact due to loss of feeding habitat on migration. Species will benefit from restrictions on grazing in JNP.
Golden Eagle	Suitable breeding habitat is present in Arpa gorge (e.g from Gndevaz to Kechut Lake) and likely also in the north-western corner of the NP and the wooded valley north of Jermuk. Possibly also in Herher State Reserve. Feeding habitat is available throughout JNP.	Possibility of residual impact due to loss of natural habitat. Species would benefit from restriction of human activities (such as road construction or hunting) in wooded valleys as well as restrictions on grazing and the number of herder camps in the rest of JNP.
Booted Eagle	Breeding habitat is available in the wooded valley west of Kechut Lake and the wooded valley along the Arpa river north of Jermuk; possibly also in Herher State Reserve and in woodland in the south-eastern corner of the NP. Feeding habitat is available throughout the whole Park.	Possibility of residual impact due to loss of natural habitat. Species would benefit from restriction of human activities (such as road construction or hunting) in wooded valleys, as well as expansion of the current woodland areas (tree planting).
Peregrine Falcon	Limited breeding habitat available in parts of Arpa gorge (within NP). Abundant feeding habitat present.	Breeding opportunities could be increased by placing nest boxes high up on electricity pylons or radio masts.
Caspian Snowcock	Suitable breeding habitat is available on the highest peaks in JNP (2500 - 3500 masl).	May be displaced from Arshak set-aside due to disturbance. The species would benefit from restrictions on grazing and reduction of the number of herder camps in the NP. This would limit disturbance by people and shepherd dogs and would increase the quality of habitat now suffering from overgrazing.

Table 6.11.10: Scope to offset potential residual impacts on RA Red Book species in the proposed Jermuk National Park

RA Red Book species	Current habitat in Jermuk National Park (JNP)	Need and potential for offset in Jermuk National Park (JNP)
Corncrake	Suitable breeding habitat (hay meadows) is available in the eastern, central and northern parts of JNP.	Possibility of residual impact due to impacts on wetlands. This species would certainly benefit from a restriction on grazing and relocation of herder camps. A restriction on herb-picking is also likely to have a positive effect as well as controls on hunting.
Great Snipe	A migratory species (does not breed in Armenia); suitable feeding habitat is available in wetter areas in the northern parts of JNP.	Possibility of residual impact due to impacts on wetlands. Expansion of the small lake near the northern border of JNP (as suggested for Ruddy Shelduck) would increase feeding habitat for this species, provided the lake shores are flat, with an extensive zone of moderately short vegetation (especially rushes and Carex). The species would also benefit from restrictions on grazing and reduction of the number of herder camps in JNP.
Eagle Owl	Suitable breeding habitat is available in Arpa gorge and in the wooded valley west of Kechut Lake. Possibly also in Herher Open Woodland State Sanctuary, the wooded valley north of Jermuk and craggy areas near the highest peaks. Breeds predominantly in caves.	Potentially affected by collisions with power lines. The species would benefit from restriction of human activities (such as road construction or hunting) in wooded valleys, as well as expansion of the current woodland areas (tree planting).
Roller	This species does not appear to breed in the region but it is a regular migrant. Within JNP, the species prefers the open plateau along the western edge of Jermuk, where mountain meadow is interspersed with scattered bushes, trees and telephone poles that are used as perches.	No residual impact identified, so not targeted for any conservation action within JNP.
White-throated Robin	This species has not been recorded within JNP, but suitable habitat seems present on the semi-arid slopes of Arpa gorge and along the southernmost edge of the Park (close to Herher Lake and village).	Residual impact due to displacement of breeding pairs by disturbance associated with the Conveyor and access roads. The species prefers semi-arid, stony slopes with scattered scrub and hot microclimate. Most of JNP is at too high an altitude for this species. However, there may be potential to create additional habitat in the southern part of Herher State Reserve through prescribed fire, mowing and forest thinning.

Table 6.11.10: Scope to offset potential residual impacts on RA Red Book species in the proposed Jermuk National Park

RA Red Book species	Current habitat in Jermuk National Park (JNP)	Need and potential for offset in Jermuk National Park (JNP)
Eastern Rock Nuthatch	Suitable breeding habitat is present in Arpa gorge.	Residual impact: displacement of breeding pairs by disturbance associated with the Conveyor and access roads. The species breeds in rocky gorges with tall cliffs and hot microclimate, a habitat that is challenging to recreate.
Brown Bear	Suitable habitat is available in Herher State Reserve, the wooded valley west of Kechut Lake and in the steep valley north of Jermuk. Herher and the valley west of Kechut Lake are already important areas for bears; the valley north of Jermuk is also a breeding site but the woodland here shows relatively little bear activity which is surprising since the habitat looks good.	Offset needed. Potential offset measures are: restriction of human activities in JNP (road construction, hunting, herder camps etc); expansion of current woodland (planting of trees, especially fruit trees).
Bezoar Goat	Suitable habitat is available in Herher State Reserve and Arpa gorge.	Residual impact due to disturbance. The species would benefit from restriction of human activities and overgrazing. Also, habitat could be expanded by planting scrub on certain steep, arid slopes in JNP. Inclusion of Arpa Gorge in JNP would confer protection.
Radde's Rock Viper	Suitable habitat is present on the slopes of Arpa gorge and in Herher State Reserve.	Residual impact: habitat loss due to HLF. Additional habitat could perhaps be created in Herher State Open Woodland Sanctuary through prescribed fire, mowing and forest thinning.
Armenian Mountain-steppe Viper	Suitable habitat is present throughout the NP, especially in the southernmost part.	Residual impact: loss of habitat due to HLF. Potential for creating additional through prescribed fire, mowing and forest thinning.
Cat Snake	Suitable habitat is present on the slopes of Arpa gorge and in Herher State Reserve.	Residual impact: loss of habitat due to HLF. Potential for creating additional habitat in some parts of Herher Open Woodland State Sanctuary through prescribed fire, mowing and forest thinning.

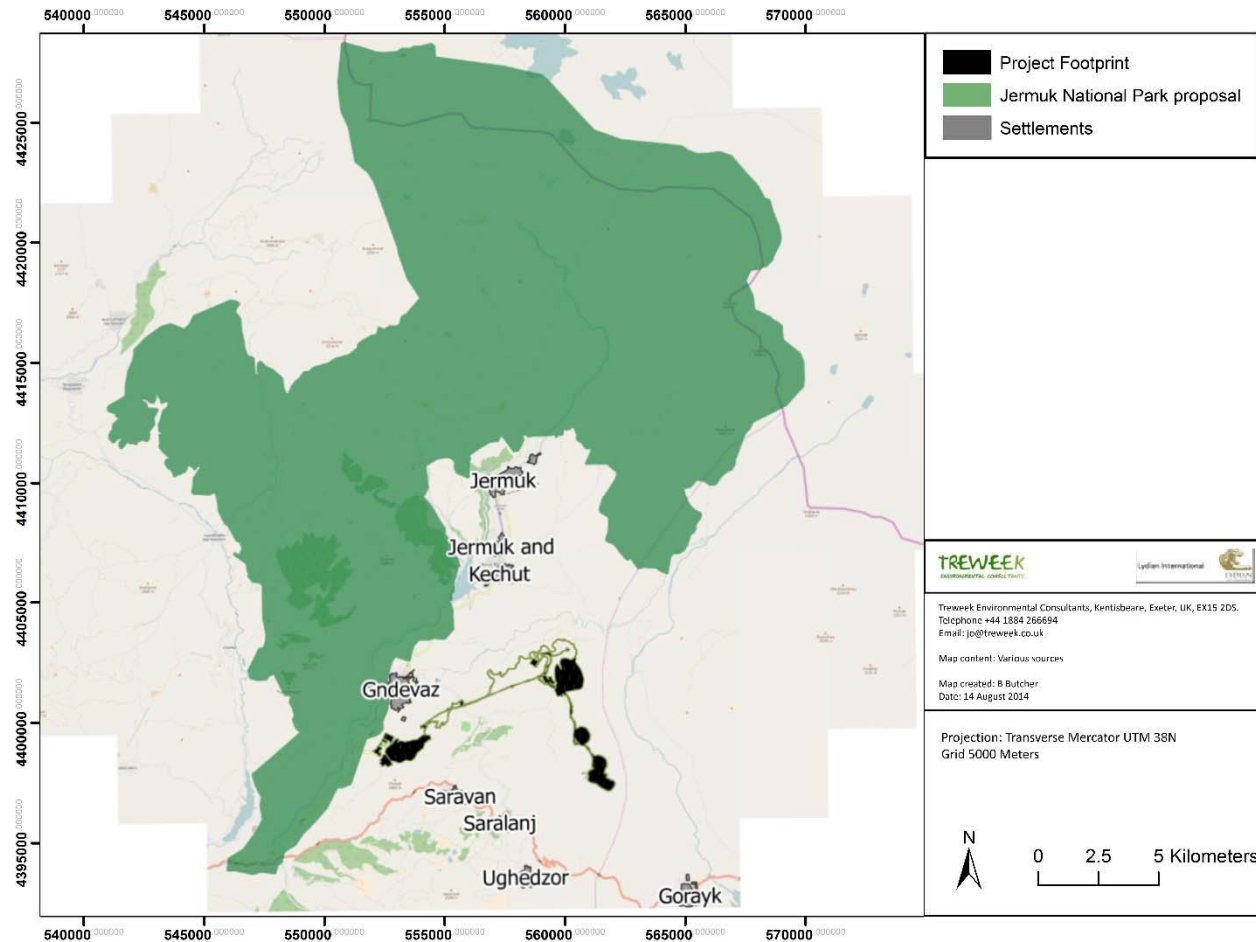


Figure 6.11.3: Proposed Jermuk National Park in relation to Project

Mitigation for impacts on critical habitat for *Potentilla porphyrantha*

Amulsar Mountain has Tier 1 critical habitat for *Potentilla porphyrantha* and there will be a residual loss of population due to the Project, at least in the shorter term.

IFC PS6 requires Projects potentially affecting critical habitat to demonstrate that it is not possible to avoid areas of critical habitat through viable alternative options for development on habitats that are not critical. Complete avoidance of critical habitat is not possible at Amulsar, as the gold-bearing strata are at the top of the mountain, coincident with the distribution of the plant. There are no viable alternatives to the location of the mine but a large proportion of the sub-population will be avoided as it is outside the infrastructure footprint. Protection to a proportion of remaining plants has been afforded through a set-aside, within which no Project activities will take place.

To the extent possible, the design of the mine footprint has been adapted based on survey results to avoid habitat with a high density of plants. For example, the design for the pit on Erato and the roads leading into it were altered partly to minimise removal of rocks with *P. porphyrantha* growing on them (see NCHA in Appendix 4.10.3 for further detail).

Potentilla porphyrantha plants that could not be avoided because they were within the physical footprint of the mine have already been translocated from Amulsar Mountain to the Sevan Botanic Garden, in accordance with permit requirements and in discussion with the Ministry of Nature Protection and its specialist advisors (the Institute of Botany of the NAS RA). These plants will be maintained in controlled conditions and used to research the ecological requirements of the species and to produce plants for re-introduction to restored mine pits in future, if suitable conditions can be created. Rockeries have been constructed at the Sevan Botanic Garden and on North Erato to act as experimental nurseries.

Preventing destruction of or damage to plants that remain on Amulsar Mountain in areas not directly affected by mining activity is essential, and measures have already been taken in the pre-development phase to minimise incidental damage by protecting plants with fencing and signs. Rocks supporting plants that were to be translocated and those at risk of collateral damage were marked in August 2013 with large green dots that are visible from over 200m away. These rocks were repainted in 2015. Regular inspection and monitoring by an on-site environmental officer is being undertaken to ensure that these remain visible, that personnel are aware of the need to safeguard marked rocks and that detailed design changes are

compatible with the need to avoid impacts. Monitoring will also be undertaken to observe the potential effects of dust deposition on the species. These measures will be consolidated and maintained throughout construction and operation.

Options for creating suitable conditions for *Potentilla porphyrantha* post-Project are the subject of a programme of research being carried out in partnership with the Institute of Botany of the NAS RA and the University of Cambridge Botanic Garden. This is currently planned to last for four years, with a view to studying the ecological requirements of the plant in detail, identifying propagation techniques, improving knowledge of the genetics of the species, modelling the time needed to achieve population growth and supporting development of an effective restoration programme. Some seed has already been harvested from plants on Amulsar Mountain and has germinated successfully in trials carried out by the Institute of Botany. Further seed will be collected from Amulsar plants for experimental growing of plants *ex-situ*, that can be used for potential re-introduction to the mine sites on closure (plants from seed and/or transplanted stock will be re-introduced.) Further detail on the ongoing work is included in the Project Biodiversity Action Plan (BAP), which includes a Species Action Plan (SAP) for *Potentilla porphyrantha*.

There will be a residual impact on the population in the shorter term with at least 21% and up to 33% of plants lost from the sub-population on Amulsar Mountain. The sub-population should remain viable despite this reduced population size, but a precautionary approach is being taken. If research, monitoring and modelling suggest that pre-mining population size and the extent of the population cannot be restored, a comprehensive review of offsetting options will be undertaken.

Mine development is phased over time and allows for a period of monitoring and research to refine population models that are being developed to support estimates of the time needed for the population to recover post- mining, with or without re-introduction of plants.

Mitigation for impacts on resident breeding bird populations

The IUCN Red-listed (Endangered) Egyptian Vulture (*Neophron percnopterus*) and Saker Falcon (*Falco cherrug*) are present within the Project-affected area, but are not expected to be significantly affected by the Project due to the fact that it forms a small part of their overall range and feeding areas. Nevertheless, given their Endangered status at a global level, the presence and behaviour of these species will be monitored routinely during Project execution.

If monitoring suggests that either species is being adversely affected by the Project, then appropriate mitigation will be considered, e.g. use of a vulture restaurant to ensure that food supplies are maintained for Egyptian Vulture.

The new Lesser Kestrel colony associated with Gorayk IBA, which has established in the military tower between Ughedzor and Gorayk will also be monitored in partnership with ASPB, as these birds hunt on the southern slopes of Amulsar. Contingency measures will be identified and implemented if any decline in breeding success is noted and if this is considered to be linked to food supply or disturbance due to the Project during construction and operation. These measures would be implemented through partnership arrangements with the ASPB, and might include enhancements to the breeding colony and possibly also to prey populations for hunting in its vicinity. Some radio-tagging of birds is proposed to improve knowledge of their preferred hunting areas.

For breeding birds in general, significant impacts are likely due to the importance and sensitivity of confirmed breeding habitats on the western flank of Amulsar Mountain and the fact that key infrastructure is located in close proximity. The rock gulley adjacent to the conveyor and HLF is one such location. The Conveyor route was redesigned so that it would no longer cross the gulley but it is only 150m from its northern edge and is also likely to be affected by noise and dust from traffic. Affected species are included in the RA Red Book, notably White-throated Robin, Ruddy Shelduck and Eastern Rock Nuthatch. Construction of an earth bank where the conveyor belt and road(s) are closest to the gulley might reduce visual and noise disturbance and could be feasible, e.g. with earth from local road construction. Monitoring is needed and if breeding success is adversely affected, targeted conservation measures will be identified for these species to be implemented in the adjacent proposed Jermuk National Park in addition to planned measures to offset impacts on natural habitat, which are expected to have some benefit for birds in the long term due to protection conferred by the new National Park.

There are a number of actions that could be taken with respect to Project operations that might further reduce the risk of impacts to breeding birds in general. These include temporal constraints on import of materials and on construction activity during the early spring breeding season; and the planting of woodland - as is being considered in relation to landscape and visual impacts (see Section 6.5) - with native species and in suitable locations. At the moment these are presented as benefits for consideration, rather than required

mitigation measures, but they may become more important depending on the results of the monitoring that will be ongoing during Project execution.

Mitigation for impacts on migratory birds

Loud noise, lighting and disturbance may affect migratory raptors particularly in spring and autumn. As far as possible, Project activities will be planned to minimise disturbance during these periods. If possible, materials, components and machinery will be imported to the site for construction during the summer when the majority of migrating birds have passed through the area. Measures listed in Table 6.11.9 include use of minimum lighting and downward-directed lights to minimise light disturbance effects on birds (and bats).

Migrating raptors and other birds are at risk from collision with above-ground electricity cables, particularly those flying at night, early dawn or dusk. This includes several species of conservation concern and also species listed in the RA Red Book. New above-ground power lines will therefore be insulated and fitted with bird flight diverters to reduce collision risk.

The project will aim to support and promote, where possible, traditional grazing management practices (e.g. by minimising access restrictions for herders), because of their role in maintaining small mammals and other prey on which raptors feed.

Given the uncertainty of the effectiveness of the above measures, impacts on numbers and behaviour of migratory raptors will be monitored throughout Project execution. Based on the monitoring results, further measures may be deemed necessary, for example restoring small mammal populations for birds of prey. Residual impacts may only be detected in the longer term and it may be that positive conservation measures are needed to compensate for reduced habitat extent and quality in the longer term, for example by boosting food supplies or improving protection from hunting in Gorayk or Jermuk IBAs.

Mitigation for impacts on Brown Bear

The set-aside shown in Figure 6.11.1 will protect some confirmed breeding and hibernating habitat of Brown Bear, but was largely designed to preserve a viable part of the *Potentilla porphyrantha* population. Surveys in 2015 confirmed the importance of the woodland north of Saravan, situated 1.5 km east of the HLF. This was used by at least 6 bears. Extending the Set-aside westwards to include this forest would make it more ecologically viable and suitable for bears. This possibility will be discussed when the boundary of the Set-aside and its

proposed management are formalised with stakeholders in 2016. Many of the general mitigation measures listed in Table 6.11.9 should be effective in minimising impacts on the species. However, as described in Section 6.11.5, Brown Bear is a critical habitat trigger species for PR6, and the Project needs to demonstrate that (i) the ecological functionality of breeding sites and resting places for Brown Bear are not damaged or destroyed; and (ii) that the Project will not result in disturbances that affect the species' survival or breeding success, or reduce its area of occupancy. Based on the extensive survey carried out in 2015 it is known that mining activities could displace an established breeding group of up to 10 individuals, including those using the woodland described above.

Particular concerns are barrier effects from mine infrastructure, footprint of infrastructure on feeding habitat and reduced availability of undisturbed breeding habitat. The possibility of designing crossings for the conveyor, fencing and other linear infrastructure is being reviewed as a means of maintaining mobility for Brown Bear (and other mammals such as Wolf). Measures to enhance food supply for Brown Bear might be needed due to loss of feeding habitat, and will be developed if monitoring suggests a decline in population. Residual impacts are considered to be likely due to scale of the Project and the level of associated noise, disturbance and habitat fragmentation. Therefore, some form of offset is likely to be necessary. Brown bear is associated with natural habitat and therefore the proposed natural habitat offset will also include measures to offset impacts on brown bear.

Bezoar Goat

Bezoar Goat also uses the area identified as a set-aside and will be exposed to disturbance during operation. Given the importance of the species, routine monitoring will be undertaken during Project execution within the set-aside.

Eurasian Lynx

Eurasian Lynx uses the area identified as a set-aside and will be exposed to barrier effects and loss of undisturbed hunting habitat. Due to its conservation importance at an EU level it will be monitored within the set-aside. Specific conservation measures may be developed in the proposed Jermuk National Park as part of the Natural Habitat Offset if it is displaced from the set-aside, but it will benefit from protection within the proposed Park if effective controls on hunting can be developed.

Dorcadion beetles

These are not considered likely to be affected and no specific mitigation measures are needed.

Radde's/ Armenian Rock Viper, Armenian Mountain-Steppe Viper and Cat Snake

Mitigation for impacts on these reptile species should focus on minimising the extent of habitat destruction (including gravel roads etc), particularly where infrastructure is proposed in meadow steppe habitat. Reptile diversity is greatest on the stony slopes and rocky outcrops to the north and west edge of the proposed HLF area (see Figure 4 of Appendix 4.10.10). The best way to limit impacts on reptiles would be to safeguard as much of this habitat as possible by keeping the size of the heap leach infrastructure to a minimum and controlling incidental habitat damage outside the proposed footprint. Residual impacts are likely and can be offset through protection of reptiles and their habitats within the proposed Jermuk National Park, together with local awareness-raising about conservation importance to reduce levels of deliberate killing of snakes. Monitoring will be needed due to Red List status.

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors

Priority receptors	Avoid	Reduce or minimise	Restore	Residual impact/ requirement to offset
Plant species and vegetation				
Natural habitat, including:				
<ul style="list-style-type: none"> Species-rich Sub-alpine Meadows and Sub-alpine Meadows with Alpine Elements 	Footprint on these vegetation types is not possible to avoid as they are within the mine footprint.	Measures to control use of vehicles on undamaged vegetation are already in place. Measures to control soil erosion and impacts of wash-out on remaining vegetation.	A programme is being developed to restore vegetation using a variety of methods including harvesting of seed and turves and reinstatement of suitable substrates for seeding/ turf replacement. Field trials are underway to clarify the ecological basis for restoration and monitoring of restoration success. A seed storage facility will be established so that seed can be harvested and retained for future use. Re-seeding will always be with a species mix suitable to the location of the area to be restored. All re-vegetation carried out will be monitored to avoid introduction or spread of invasive alien species.	An offset of 837 Habitat Impact Units (HIU) is required to achieve NNL of natural vegetation due to long term degradation and loss associated with Project development. The Project has chosen to take a conservative approach to estimation of impacts due to the importance of natural vegetation and the fact that restoration success cannot be guaranteed. It is planned that the offset will be established in the proposed Jermuk National Park and Lydian will engage with national and local government and NGOs on its set-up, and will establish an endowment or similar mechanism to ensure financial support for the offset.
<ul style="list-style-type: none"> Vegetation with Shrubs, particularly Juniper scrub vegetation 	Footprint on this vegetation type is not possible to avoid as fragments occur within the HLF footprint. Translocation of some bushes will be attempted but success is uncertain.			
<ul style="list-style-type: none"> Other natural and semi-natural vegetation types: Montane Meadows, Montane Meadow Steppes, Wetlands, Gorge 	Set-aside preserves some undamaged natural vegetation. HLF avoids natural vegetation. Topsoil storage locations will be chosen to avoid “good” examples of natural vegetation types as well as rocks supporting <i>Potentilla porphyrantha</i> (see below).			
<ul style="list-style-type: none"> 22 endemic plant species 	Important examples or habitat have been and will continue to be avoided when possible. Locally rare species (e.g. <i>Fritillaria armena</i>) that would otherwise be destroyed will be translocated out of the disturbed area.	No specific measures needed.	No specific measures needed.	These species will benefit from the planned offset referred to above.

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors

Priority receptors	Avoid	Reduce or minimise	Restore	Residual impact/ requirement to offset
Amulsar sub-population of <i>Potentilla porphyrantha</i> (Tier 1 critical habitat - IFC PS6)	<p>A proportion of the Amulsar population is avoided through a set-aside south of Arshak Peak.</p> <p>Roads have been located to avoid high-density concentrations of plants.</p> <p>Plants within the mine pits have been translocated to suitable research and propagation facilities.</p>	<p>Locations of plants are recorded and fencing and signs used to safeguard them for as long as possible. Measures are being taken to avoid incidental damage.</p>	<p>A research programme has been established to test techniques for propagating plants and to improve knowledge of requirements. This will provide the basis for restoring plants to suitable habitat on mine closure if suitable conditions can be created.</p>	<p>There will be a residual impact on the population in the shorter term with 33% of plants lost from the sub-population on Amulsar Mountain. The sub-population should remain viable despite this reduced population size, but a precautionary approach is being taken. If research, monitoring and modeling suggest that pre-mining population size and the extent of the population cannot be restored, a comprehensive review of offsetting options will be undertaken.</p>
Birds				
Egyptian Vulture	<p>Essential habitat is avoided. Footprint on Gorayk IBA for which this is a designated species is avoided. There is no footprint in Arpa Gorge near where one pair nests.</p>	<p>No specific measures needed</p>	<p>No specific measures needed.</p>	<p>Residual impact is unlikely but monitoring will be carried out due to the Endangered status of the bird and the proximity of the Project. If monitoring suggests that the species is being affected then appropriate mitigation will be considered, e.g. use of a vulture restaurant to ensure that food supplies are maintained.</p>
Saker Falcon	<p>No specific measures needed.</p>	<p>No specific measures needed.</p>	<p>No specific measures needed.</p>	<p>Residual impact is unlikely, but monitoring will be carried out due to its Endangered status.</p>

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors

Priority receptors	Avoid	Reduce or minimise	Restore	Residual impact/ requirement to offset
Lesser Kestrel	No specific measures needed.	No specific measures needed.	No specific measures needed.	Monitoring of the breeding colonies will be continued, with a focus on the extended colony at Sisian which is not currently monitored by ASPB. Mitigation will be implemented if any decline in breeding success is noted and considered to be linked to food supply or disturbance due to the Project.
Other species included in RA Red Book and which breed in the Project-affected area	Conveyor routing was altered to avoid crossing the rocky gorge near the HLF (favoured by Ruddy Shelduck, White-throated Robin and other birds) but is still in close proximity. A temporal constraint on import of materials and on construction to avoid the breeding season would avoid/minimise impacts in the first year.	Detailed Project design to investigate options for reducing impacts on breeding birds in the gorge east of Gndevaz where the conveyor and access roads are nearby, possibly by constructing an earth bund to screen them from noise and visual disturbance.	Some woodland planting with native species in suitable locations would benefit certain species of this group (though not Ruddy Shelduck or White-throated Robin). Distribution of breeding birds and signs of breeding activity will be monitored.	There could be a residual impact on Ruddy Shelduck, White-throated Robin and other birds breeding in the Project-affected area. Measures to offset impacts on natural and critical habitat will benefit breeding bird populations and offset proposals will include any interventions needed to ensure net gain of their populations. In particular, breeding birds would benefit from a community-based conservation project focused on Gorayk IBA and/or the proposed new Jermuk National Park.

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors

Priority receptors	Avoid	Reduce or minimise	Restore	Residual impact/ requirement to offset
Migratory birds including raptors	Impacts cannot be entirely avoided. If possible, significant activity in spring and autumn will be avoided, including import of construction equipment and materials through the Vorotan Valley.	New, above-ground electricity cables will be insulated and fitted with bird flight diverters. General measures to minimise project footprint will also minimise loss of feeding area. The project will aim to support and promote, where possible, traditional grazing management practices (e.g. by minimising access restrictions for herders), because of their role in maintaining small mammals and other prey on which raptors feed.	Based on monitoring results, future measures may be needed to restore small mammal populations for birds of prey.	Residual impacts may be detected in the longer term and monitoring is necessary. Positive conservation measures may be needed to compensate for reduced habitat extent and quality in the longer term, for example by boosting food supplies or improving protection from hunting in Gorayk or Jermuk IBAs
Mammals				
<i>Ursus arctos</i> Brown Bear (critical habitat - EBRD PR6)	Set-Aside south of Arshak protects one known breeding location and if extended further west, it would protect two.	Measures to limit noise will benefit bears at dawn and dusk. Conveyor, other linear infrastructure and fencing will be designed	Measures to enhance food supply might be needed due to loss of feeding habitat or of access to suitable areas because of barriers. These measures will be developed if monitoring suggests decline in population.	Residual impacts likely due to scale of the Project and the level of associated noise and disturbance, and habitat fragmentation caused by barriers. At present, compliance with PR6 in terms of the Project not affecting the ecological

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors				
Priority receptors	Avoid	Reduce or minimise	Restore	Residual impact/ requirement to offset
		to maintain mobility for Brown Bear, including installation of crossings.		functionality of breeding sites and resting places, or the species' survival, breeding success or area of occupancy is proposed to be achieved through a set-aside, combined with offsets associated with natural habitat restoration in the proposed Jermuk National Park. Final analysis of data from 2015 is needed to quantify the gains needed, based on estimates of population size.
Eurasian Lynx	Observed and avoided within set-aside.	No specific measures needed.	No specific measures needed.	Monitoring will be undertaken and this species should benefit from the Natural Habitat Offset in the new Jermuk National Park.
Bezoar Goat	Observed and avoided within set-aside.	No specific measures needed.	No specific measures needed.	Monitoring will be undertaken and this species should benefit from the Natural Habitat Offset in the new Jermuk National Park.
Invertebrates				
Dorcadion Beetles (<i>Dorcadion sevangense</i> , <i>D. sisianum</i> Lazar and <i>D. bistriatum</i>)	No specific measures are considered necessary at present, because these species were not observed within the Project footprint.			No residual impact is expected on the basis of current information.
Reptiles				
Radde's/ Armenian Rock Viper <i>Montivipera (Vipera) radeii</i> , Armenian Mountain-	All three species are present in the HLF area. The small gorge between this area and Gndevaz village is important for them as	Minimise footprint and incidental damage in HLF location, particularly stony slopes and rocky	Based on monitoring results, future measures may be needed to restore suitable habitat for reptiles. Possible restoration measures could include	The residual impact on regional numbers of these three species is expected to be small since ample habitat is present outside of the Project-affected area. In

Table 6.11.11: Mitigation Measures for Impacts on Priority Biodiversity Receptors

Priority receptors	Avoid	Reduce or minimise	Restore	Residual impact/ requirement to offset
Steppe Viper <i>Pelias</i> (<i>Vipera</i>) <i>eriwanensis</i> and Cat Snake <i>Telescopus fallax</i>	well as breeding birds and is no longer crossed by the Conveyor, but will be exposed to disturbance. Speed of vehicles should be severely limited to avoid roadkills.	areas. Conduct awareness-raising about conservation importance through education to reduce levels of deliberate killing of snakes and reduce this threat to local numbers.	prescribed fire, mowing, grazing and forest thinning in certain areas post mining.	the longer term, residual impacts may be detected through monitoring. Positive conservation measures may be needed to compensate for reduced habitat extent and quality in the longer term and to this purpose restoration measures could be undertaken within the proposed Jermuk National Park.

Table 6.11.12: Mitigation Measures for Impacts on Biodiversity which is Widespread, With Resilient Populations

Receptor	Implications of the Project	Mitigation
Vegetation and plant species	Induced impacts might include an increased level of harvesting of species used for herbs, vegetables and medicines, possibly causing declines in populations of targeted species. However species in this category are generally able to regenerate well and are sufficiently widespread for populations to recover.	No specific mitigation is required.
Birds	The land use changes and disturbance associated with the Project will affect a variety of bird species but most will be able to relocate to alternative areas as they are relatively mobile and adaptable.	As noted in Table 6.11.10, certain priority bird species will be monitored. The monitoring programme will be extended to include other representative species in order to determine whether there are any unforeseen impacts on birds, particularly in the long term.
Mammals (including bats)	Mammals in general will be affected by loss of habitat, land use change, barrier effects, habitat fragmentation and disturbance. Some local population declines may occur, but populations are considered sufficiently resilient for populations to recover spontaneously. Bat species are thought to have resilient populations, with abundant feeding habitat available regardless of the presence of the Project.	No specific mitigation is required. Barrier effects should be reduced by the measures proposed for Brown Bear.
Invertebrates (terrestrial and aquatic)	The areas considered to be most important for invertebrates have generally been found outside the Project-affected area. The Project could exacerbate existing baseline impacts on water quality by removing vegetation from large areas, mobilizing sediment and fugitive dust, which could be deposited on surface water bodies.	No specific mitigation required. However, annual monitoring of surface water quality using aquatic invertebrate indicators will be continued.
Reptiles and amphibians	The main threat to reptiles in the baseline situation is considered to be decline in biomass of prey animals due to deterioration in the quality of grassland. The Project will cause a decline in overall availability of reptile habitat during operation. It will also remove some wetland habitat that supports abundant amphibian populations. Pollution of wetlands and watercourses could also depress populations of amphibians. However, amphibians potentially affected by the Project are generally relatively widespread.	No specific mitigation required, unless surface water quality monitoring programme indicates deterioration, in which case amphibian survey will be undertaken.

Table 6.11.12: Mitigation Measures for Impacts on Biodiversity which is Widespread, With Resilient Populations

Receptor	Implications of the Project	Mitigation
Fish	The Project could affect fish populations in the Vorotan and Arpa Rivers. Fish populations in the baseline situation are lower than they should be due to presence of artificial barriers in watercourses, including development of hydro-electric schemes. There are no fish passes, for example allowing access upriver for fish from Spandaryan Reservoir and this is constraining populations. The Project's Water Balance Model suggests that impacts on flow will be negligible even during low flow periods and stringent measures are proposed to avoid pollution.	No specific mitigation required unless the Project results in significantly lower flows in the river than has been predicted, or in case of a release of pollutants to surface water, in which case fish surveys may be required.

Table 6.11.13: Mitigation Measures for Impacts on Protected Areas and Other Areas Important for Biodiversity

Site or Area	Summary of implications of the Project and mitigation measures
Caucasus Biodiversity Hotspot (Conservation International)	Project does not affect a significant proportion of the hotspot or the species targeted for conservation within it; no mitigation necessary.
Caucasus Mixed Forest Ecoregion	Very small, degraded fragments of shrubby vegetation occur in the HLF location between cultivated areas supporting Caucasian endemic species of plant (e.g. <i>Phelypaea tournefortii</i>) and slow growing mature shrubs (e.g. <i>Juniperus polycarpu</i>). These are not high quality examples in the context of the Ecoregion as a whole, but the Project has been designed to avoid remaining individual shrubs and the very small number affected will be translocated.
State Sanctuaries (Jermuk Forest, Herher Open Woodland and Jermuk Hydrological)	Not exposed to impacts; no mitigation required.
Sevan National Park	Not exposed to impacts; no mitigation required.
Proposed Jermuk National Park	The Project has identified opportunities to offset some of its impacts on biodiversity in general and on natural habitat in particular as part of a National Park Proposal and management plan. This would improve regional conservation and nature protection significantly.
Jermuk IBA Key Biodiversity Area identified using recognized selection criteria	The Project will not have a direct impact on the IBA. Measures to mitigate impacts on species originating from the IBA that use the Project-affected area are included in Table 6.11.11. Establishment of Jermuk National Park would benefit these species. No further mitigation measures are necessary.
Go-rayk IBA Key Biodiversity Area identified using recognized selection criteria	The Project will not have a direct impact on the IBA. Measures to mitigate impacts on species originating from the IBA that use the Project-affected area - particularly Lesser Kestrel - are included in Table 6.11.11. No further mitigation measures are necessary.

6.11.7 Summary and Conclusions

The impact assessment process has identified a number of priority biodiversity receptors that will be affected by the Project. The mitigation hierarchy has been employed to avoid, reduce, and restore those impacts to the extent possible, prior to considering offsetting for significant residual impacts. Lydian aims for no net loss (NNL) of biodiversity for the Project, and is also committed to NNL of natural habitat as defined by PS6 and PR6, and a net gain for critical habitat trigger species.

The following summarises the main outcomes of the assessment process. A summary of impacts, mitigation measures and residual impacts is shown in Table 6.11.14. All commitments to mitigation measures are reflected in the Project Commitments Register and in the Biodiversity Action Plan (see Chapter 8).

- The Project is located in a region characterised by extensive natural habitat (as per the definition of PS6/PR6) and will result in both losses of, and degradation to, such habitat. Avoidance and mitigation measures will be employed to the extent possible, and a research programme will be implemented to prepare for restoration post-mining. In addition, a set-aside has been established. Nevertheless, the project will also take the precautionary approach of establishing an offset to compensate for its direct impacts on natural habitat. This will be undertaken in conjunction with planning for the proposed Jermuk National Park, which is already underway.
- The mine pits will affect Tier 1 critical habitat for the endemic plant *Potentilla porphyrantha*. Residual impacts will occur at least in the short term. However, efforts will be made to ensure that a viable population remains, or will be restorable in the longer term. An extensive programme of research (using plants translocated from the mine area) is underway to explore propagation techniques. If the results of this work cast doubts on the ability to achieve net gain for the species post-mining, then an offset will be designed and implemented.
- The Project affects critical habitat for Brown Bear. Surveys in 2015 confirmed the presence on Amulsar of regularly used breeding habitat, and potential impacts of the Project could affect up to 10 bears (mother, young of different ages and visiting males). The planned set-aside will avoid impacts on the area where one breeding den is located. The set-aside could be extended, following discussion and formalisation with stakeholders, to incorporate a second den in woodland north of Saravan. Measures such as wildlife crossings will be built into the design of the conveyor and access routes to minimise barrier effects. Construction works will also be phased, to

the extent possible, to avoid the early spring when mother and cubs would emerge from the hibernating/breeding den. Nevertheless residual impacts are considered highly likely due to high levels of disturbance when operation starts and the bears may be displaced. Surveys in the wider area confirmed the likely suitability of the proposed Jermuk National Park for conserving and restoring breeding and feeding habitat for Brown Bear. Offset activities for impacts on Brown Bear will be built into the National Park Management Plan, but the precise requirement cannot be quantified until final analysis of survey data has taken place.

- The Project area provides foraging and hunting habitat for breeding and migratory birds (especially raptors), some of which are listed as Endangered at the national and/or international level. Although the Project is not expected to impact significantly on these species, options to reduce impact will be sought during detailed Project design and monitoring will be undertaken throughout the Project lifetime in order to detect any unexpected impacts and to allow appropriate actions to be taken.
- The Project area, especially the HLF, offers important habitat for reptiles, including three species that are listed as Vulnerable at the national and/or international level. Although the Project is not expected to impact significantly on these species since plenty of suitable habitat is also present outside of the Project area, options to reduce impact will be sought during detailed Project design and monitoring will be undertaken throughout the Project lifetime in order to detect any unexpected impacts and to allow appropriate actions to be taken.

The necessary actions arising from this ESIA are developed in the Project Biodiversity Action Plan (BAP) and Biodiversity Management Plan (BMP). The BAP is focused on actions required to address Project lender requirements and includes:

- Species Action Plans (SAPs) - these have been produced for the two critical habitat species affected by the Project, *Potentilla porphyrantha* and *Ursus arctos* (Brown Bear), for which final analysis of survey data is needed before the Project mitigation strategy can be finalised.
- Biodiversity Offset Strategy (BOS) - this describes the Project's approach to offsetting and details the additional survey work to be undertaken to enable design of the offset to achieve NNL of natural habitat. The document will be developed and enhanced as the additional research work proceeds, and eventually it will evolve into a Biodiversity Offset Management Plan (BOMP).

The BMP describes the biodiversity-related actions to be undertaken as part of the design, construction, operation and decommissioning of Project infrastructure. It is a site-orientated document that details the practical actions to be undertaken during the implementation of the Project, along with responsibilities, timeframes and monitoring requirements. The BMP is implemented as part of the Project ESMP, which is discussed in Chapter 8.

In addition to the above, a Biodiversity Monitoring and Evaluation Programme (BMEP) will be developed for implementation in parallel with Project execution, with the aim of demonstrating that the Project's commitments as outlined in this ESIA and associated documents are met. This includes the commitments to>NNL in natural habitat and net gain in critical habitat, for which monitoring of the priority biodiversity identified in this ESIA will be required, including natural and critical habitat (and critical habitat trigger species) both on the Project site and in offset location(s). The BMEP will also aim to confirm the ESIA's predictions that certain species will not be significantly affected by the Project, which will involve monitoring a representative selection of breeding bird species, mammals, invertebrates, and reptiles (as identified in the ESIA). This will enable the detection of any unanticipated exposure to impacts as the Project progresses.

The BMEP will be developed during the pre-construction phase as the further research referred to above progresses.

Lydian is considering the establishment of an independent biodiversity advisory group and will work with Project lenders to develop possible terms of reference.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Protected Areas and other Key Biodiversity Areas					
Caucasus Biodiversity Hotspot (Conservation International)	Impact due to presence of Project as a whole.	Loss / degradation of natural habitat.	Project does not affect a significant proportion of the hotspot or the species targeted for conservation within it.	No specific mitigation necessary.	Overall strategy of NNL should mean hotspot is not compromised.
Caucasus Mixed Forest Ecoregion	No direct impacts on any features of importance. Possible indirect effects due to concentration of grazing and other activities outside Project area.	Very small, degraded fragments of shrubby vegetation supporting Caucasian endemics occur in the HLF location, but these are not high quality examples in the context of the Ecoregion as a whole.	Very limited exposure to impacts.	The Project has been designed to avoid remaining individual shrubs and the very small number affected will be translocated.	Offset for natural habitat in proposed Jermuk National Park will benefit Juniper scrub.
State Sanctuaries (Jermuk Forest, Herher Open Woodland and Jermuk Hydrological)	No direct impacts on any features of importance.	Not exposed to impacts.	Not significant.	No mitigation required.	Not significant.
Sevan National Park	No direct impacts on any features of importance.	Not exposed to impacts	Not significant.	No mitigation required.	Not significant.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Proposed Jermuk National Park	No direct impacts on any features of importance.	Not exposed to impacts	Not significant.	The Project is planning to establish a natural habitat offset in the National Park, which should improve regional conservation and nature protection.	Positive impact.
Jermuk IBA	Potential indirect effect due to loss of feeding area for resident species.	Project-affected area provides foraging habitat for some birds which breed in the IBA.	Affected birds range over wide areas to search for food. Surveys suggest key species use Project area for <20% of foraging time.	No further mitigation measures are necessary.	Not significant.
Gorayk IBA Key Biodiversity Area identified using recognized selection criteria	Project footprint (HLF) was relocated out of IBA. Potential indirect effect due to loss of supporting habitat for birds.	Potential loss of preferred hunting areas for Lesser Kestrel and undisturbed feeding areas.	See below for individual consideration of Lesser Kestrel.	No further mitigation measures are necessary.	Not significant.
Plant species and vegetation					
Species-rich Sub-alpine Meadows and Sub-alpine Meadows with Alpine Elements	A large part of the Project footprint, including the open pits, is on these vegetation types and cannot be avoided.	Loss and degradation of natural vegetation.	These vegetation types are extensive in the region, but their condition is declining and these types are under-protected in Armenia	Arshak set-aside will preserve some undamaged natural vegetation including an area of species-rich Sub-alpine Meadow with Alpine Elements. Where possible infrastructure will be located to avoid “good” examples of	NNL of natural habitat, assuming offset successful.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Vegetation with Shrubs, particularly Juniper scrub vegetation	Fragments of juniper scrub occur in the HLF location and conveyor corridor.	Loss and degradation of natural vegetation.	This type is rare on Amulsar Mountain but more common in Jermuk IBA where grazing is at low intensity.	natural vegetation types and particularly rocks supporting <i>Potentilla porphyrantha</i> . Translocation of Juniper bushes is to be attempted.	
Other natural and semi-natural vegetation types: Montane Meadows, Montane Meadow Steppes, Wetlands	BRSF and haul & access roads.	Loss and degradation of natural vegetation.	Project exacerbates regional decline in extent and quality of natural habitat, as well as potentially affecting the viability of land use traditions.	It is planned to restore all impacted areas post-mining. A supporting programme of research is underway. A natural habitat offset will be established in the proposed Jermuk National Park to compensate for loss and degradation of natural vegetation due to the Project footprint and adjacent buffer and restricted zones.	
22 endemic plant species	Some avoidance or translocation is possible (e.g. <i>Fritillaria armena</i>) but not in all cases.	Loss and disturbance.	All are widespread throughout the wider Project-affected area apart from <i>Potentilla porphyrantha</i> (addressed separately below)		

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Amulsar sub-population of <i>Potentilla porphyrantha</i> (Tier 1 critical habitat - IFC PS6)	A large part of the Project footprint, including the open pits, is on critical habitat for <i>Potentilla porphyrantha</i> .	Between 21% and 33% of the population at Amulsar will be lost. Other plants could be damaged due to infrastructure (roads or tracks), deposition of fugitive dust, or localized changes in microclimate that might affect availability of water.	The Amulsar sub-population is one of only three in Armenia and five known in the world.	Arshak set-aside preserves a proportion of the population. Efforts have been made to locate infrastructure to avoid the species. Plants within the mine pits have been translocated to suitable research and propagation facilities. A significant research programme has been established to determine optimum restoration conditions and allow plants to be restored and numbers increased post-mining. The residual population is predicted to remain viable albeit with reduced numbers. Net gain will be achieved through an offset if restoration is not successful.	Net gain in numbers to be achieved within a reasonable timeframe, currently estimated at 20 years, if restoration techniques successful. Offset options will be reviewed if necessary.
Other vegetation and plant species considered resilient and widespread	Loss and disturbance.	Induced impacts might include increased harvesting of herbs, vegetables and medicinal plants.	Species in this category are generally able to regenerate well and are sufficiently widespread for populations to recover.	No further mitigation measures are necessary.	Not significant.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Birds					
Egyptian Vulture	The breeding site in Jermuk Gorge will not be exposed to any impacts as a result of the Project, but HLF is an occasional feeding area.	Feeding of the breeding pair could be affected, and exposure to poisoning is possible.	Results of monitoring suggest the breeding pair use the Project-affected area for a very small proportion of their feeding time.	No specific mitigation necessary. Precautionary monitoring will be carried out due to its Endangered status.	Not significant.
Saker Falcon	Loss off feeding habitat over the Project area in general.	Feeding of the small number of individuals considered potentially resident may be affected.	Low frequency of occurrence and lack of confirmed breeding activity in Project-affected area.	No specific mitigation necessary. Precautionary monitoring will be carried out due to its Endangered status.	Not significant.
Lesser Kestrel	Loss of feeding habitat over Project area in general.	Preferential hunting area could deteriorate due to dust deposition, suppressing vegetation.	Neutral to moderate	No specific mitigation necessary. However, monitoring of the breeding colony will be continued and mitigation will be implemented if adverse impacts are observed.	Moderate risk assumed until monitoring confirms otherwise

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Other species included in RA Red Book and which breed in the Project-affected area	Presence of Project in general, but particularly conveyor, service road, mine access road and HLF.	High quality bird habitat occurs in a rocky gorge north of the HLF; presence of the conveyor and mine road may affect breeding birds.	Significant due to presence of RA Red Book species breeding in the rocky gorge east of the HLF	Options for reducing impact to be investigated during detailed Project design. Distribution and signs of breeding will be monitored. Establishment of offset for natural habitat will benefit these species.	Moderate risk assumed unless design is modified or until monitoring confirms otherwise
Migratory birds, especially raptors	Loss off feeding habitat over the Project area in general, and HLF and BRSF in particular. Risk of collision with power lines.	Loss of habitat might reduce small mammal populations and food availability. Lighting and overhead power lines could be a cause of mortality through collisions.	Extensive alternative feeding habitat is available in theory, so only a small proportion of available feeding habitat will be exposed to impacts from the Project.	New power lines will be insulated and have bird flight diverters fitted. The project will aim to support and promote, where possible, traditional grazing management practices because of their role in maintaining small mammals and other prey. Precautionary monitoring will be undertaken.	Not significant.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Other birds considered resilient and widespread	General land use changes and disturbance.	Loss of breeding and feeding habitat.	Most will be able to relocate to alternative areas as they are relatively mobile and adaptable.	The monitoring programme for priority bird species will be extended to include other representative species in order to detect any unforeseen impacts on birds, particularly in the long term.	Not significant.
Mammals					
<i>Ursus arctos</i> Brown Bear (critical habitat - EBRD PR6)	The open pit footprint is currently used by up to five individuals; the woodland 1.5 km east of HLF is used by at least six.	Loss of feeding area, breeding habitat and food supply. Displacement may place bears at threat of hunting or competition with other bears. Noise, light and presence of people are likely to affect the bears.	Brown Bear is Vulnerable in RA Red Book, threatened throughout region, and a EU Habitats Directive Annex IV species	Arshak set-aside will protect known breeding location. Conveyor and linear infrastructure will be designed to maintain mobility for Brown Bear, including installation of crossings. Detailed analysis of survey data from 2015 will make it possible to quantify impacts and design offsets accordingly.	Moderate risk and residual impacts predicted in the longer term, requiring an offset.




Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Eurasian Lynx	Infrastructure and operations in open-pit area.	Some disturbance and possible displacement from some habitat.	Important at EU level.	Avoidance of some habitat through Arshak Peak set-aside.	Not significant with National Park in place as level of protection from hunting should improve.
Bezoar Goat	Population centred in Jermuk Gorge not exposed to direct effects. Also observed using the Arshak set-aside.	Some disturbance and possible displacement from some habitat.	Uncertain at population level (no detailed census)	Avoidance of some habitat through Arshak Peak set-aside.	Not significant with National Park in place as level of protection from hunting should improve.
Other mammal species considered widespread and resilient	General presence of Project.	Potential loss of habitat, barrier effects, habitat fragmentation and disturbance.	Some local population declines may occur, but populations are considered sufficiently resilient for populations to recover spontaneously.	None required.	Not significant.
Invertebrates					
Dorcadion Beetles (<i>Dorcadion sevangense</i> , <i>D. sisianum</i> Lazar and <i>D. bistriatum</i>)	Project footprint.	Possible loss and degradation of suitable habitat in some areas.	Not recorded in the Project footprint and not considered likely to be exposed to impacts as a result of the Project.	None required	Not significant.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Other invertebrates (terrestrial and aquatic)	General presence of Project.	The Project could exacerbate existing baseline impacts on water quality by removing vegetation from large areas, mobilizing sediment and fugitive dust, which could be deposited on surface water bodies.	The areas considered to be most important for invertebrates have generally been found outside the Project-affected area.	No specific mitigation required, unless surface water quality monitoring programme indicates deterioration, in which case aquatic invertebrate survey will be undertaken.	Not significant.
Reptiles and amphibians					
Radde's/ Armenian Rock Viper <i>Montivipera (Vipera) radeii</i> , Armenian Mountain-Steppe Viper <i>Pelias (Vipera) eriwanensis</i> and cat snake <i>Telescopus fallax</i>	Project footprint, in particular the HLF location. Also mortality due to being run over by vehicles.	Potential loss of habitat and reduced local population size	HLF is best habitat for reptiles on Amulsar Mountain and has high reptile diversity. Local reductions in population will occur, but these species also occur in the wider landscape.	Minimise footprint at HLF and minimize incidental damage, Monitoring and pre-construction checks needed. Regulate traffic speeds. Otherwise awareness raising to reduce levels of deliberate killing of reptiles.	Not significant.

Table 6.11.14: Summary of Impacts on Biodiversity, Planned Mitigation and Residual Impact Significance

Receptor	Impacts to which receptor is exposed	Ecological implications	Significance pre-mitigation*	Specific mitigation	Residual significance*
Other reptiles and amphibians	Project footprint and adjacent affected areas.	Potential decline in prey animals and decline in availability of habitat. Pollution of wetlands and water courses.	Reptiles and amphibians potentially affected by the Project are generally relatively widespread.	No specific mitigation required, unless surface water quality monitoring programme indicates deterioration, in which case amphibian survey will be undertaken.	Not significant.
Fish					
	Withdrawal of water from, and potential pollution of, rivers.	Possible reduction of fish populations in Arpa and Vorotan rivers.	Fish populations in the baseline situation are lower than they should be due to presence of artificial barriers in watercourses. The Project's Water Balance Model suggests that impacts on flow will be negligible even during low flow periods; and stringent measures are in place to avoid pollution.	No specific mitigation required unless the Project results in significantly lower flows in the river than has been predicted, or in case of a release of pollutants to surface water, in which case fish surveys may be required.	Not significant.
* Key to significance rating:					
 Significant					
 Moderate or uncertain					
 Not significant					

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6.12 Demographics

The socio-economic affected area is defined at three levels. The national affected area is the entire country. The regional affected area includes the two Marzes (provinces) straddled by the mine layout and footprint: Vayots Dzor and Syunik. The local affected area is defined as the settlements most likely to experience changes from environmental and social impacts. The local affected area is linked to the definition of Project Affected Person (PAP), which refers to residents in the three closest rural settlements (Gorayk, Gndevaz and Saravan (including Saralanj and Ughedzor)) and the town of Jermuk (including Kechut) (Figure 4.1.5).

Development of the Amulsar project has implications for various aspects of the demographic profile of the local population. Key issues include increases in population through bringing new workers to the area and potentially encouraging an influx of opportunistic migrants and changes to existing social structures.

This section does not attempt to analyse if the expected increase in population is positive or negative. Rather, the section looks at the likely interactions between residents in nearby communities and how the introduction of new in-migrants, returning family members and other types of in-migrants, may impact their quality of life.

Key impacts addressed in this section include:

- Influx and population movement; and
- Social issues.

6.12.1 Influx

Project Activities Affecting Influx and Population Movement

At a national level, the trend of out-migration for work is commonplace, with workers leaving rural areas and heading either to urban centres (e.g. Yerevan) or to different countries (e.g. Russia) to seek and gain work. The perceived level of economic opportunity in the community influences the level of out-migration within a rural area. This was evident in the local affected area in 2013 and 2014 when development of the Amulsar project was delayed and levels of out-migration rose within the local communities. The development of the Project is expected to reverse this trend or at least minimise it, with fewer rural residents in the local affected area leaving to seek work and potentially some who have left returning to seek opportunities locally.

Construction Phase

The construction phase will require a peak workforce of approximately 1300 workers. Due to the skills needed for construction, it is anticipated that approximately 70% of the construction workers will be sourced from other parts of Armenia and potentially other countries.

A worker accommodation camp, with capacity for between 500 to 920 workers, will be built by the Company to accommodate the majority of non-local construction workers together with the use of hotel and apartments within Jermuk (See Section 6.21 for more details).

The worker accommodation camp will be located at the HLF, to the west of the ADR facility (approximately 2.5km south of Gndevaz). The fenced worker accommodation camp will be managed to minimise disruption in local communities associated with a large construction workforce.

Approximately 380 workers required for the construction period will be sourced from the local area. It is expected that these workers will continue to reside in their own homes during the two-year construction period, making use of the bus services which will be provided by Lydian to collect workers on a daily basis.

Therefore, there is the potential for the local employment opportunities and the accommodation of workers (potentially between zero and 370) in Jermuk hotels to encourage some level of in-migration.

The use of a closed camp for between 500-920 workers during construction is likely to reduce (although not exclude) the incentive for people to migrate into the region seeking to provide services to that segment of the workforce. Recruitment from local communities and the potential presence of workers living outside the camp (hotel accommodation for camp overflow depending on the size of camp selected) will, however, act as an enticement for people to in-migrate to the area. If the smaller camp is selected (500 beds) at peak, approximately 750 workers will be residing outside of the camp during the construction period, leading to a significant increase in the cash income levels within the communities and the potential purchasing power of local residents (temporary and permanent). This is likely to be viewed as an opportunity by opportunistic migrants.

The requirements for worker accommodation during the construction phase have been considered in a separate Chapter of the ESIA (see Chapter 6.21 and the management plan

relating to worker accommodation (see Appendix 8.24). Only those aspects relevant to in-migration are considered in this chapter.

Operations Phase

The operations phase will require a workforce of approximately 657 people. The Project will endeavour to minimise influx through prioritising local employment where possible (see Section 6.14 for more information). Lydian anticipates that 30% of the operational workforce will come from the local area and nearby municipal centres (e.g. Vayk and Sisian). Workers who originate from the local area will continue to live in their existing homes while working for the Project. A total of approximately 5% of the workforce is anticipated to be expatriates at the beginning of operations with plans to reduce this percentage over time. Workers will be sourced from regions outside of the local and regional areas when the skills required for the roles are not held within the local area. This commitment is documented in the Lydian Local Recruitment Procedure, which applies equally to the company and its contractors. Training programmes will be established by Lydian during the construction period to help enhance the employability of local residents in readiness for the operations phase.

During the operational period, hotel accommodation in Jermuk will be used by Lydian to accommodate approximately 250 workers. These workers are assumed to be professionals who are not from the local area, who will work on a rotational basis, returning to their families and point of origin on a regular basis. This leaves a workforce of approximately 405 people who will also need to be accommodated in the local area. Assuming 30% of the workforce are recruited locally, this leaves a remaining 210 workers who will need to be accommodated. It is assumed that these workers will move with their families to the Project area for the duration of the mining operation. The local recruitment initiatives will be seeking to fill these roles with local residents where possible; however, this is also likely to act as a source of attraction for potential in-migrants looking for work.

In addition to bringing new workers to the local area, economic opportunities associated with the Project are likely to have an impact on population movement and influx in the local area during the operations phase. Employment generated by the Project will increase the level of cash income within local communities leading to a significant increase in the buying power of local residents (temporary and permanent) during this phase. This is likely to be viewed as an opportunity by opportunistic migrants. There will also likely be opportunities generated by the Project's local procurement policies which may encourage some level of in-migration.

A second transition will occur when the project moves from operations into mine closure. During the closure period, employment levels will reduce in a step-wise manner, likely leading to a reduction of indirect employment opportunities as well. The effect of this transition on influx levels will depend on the number of in-migrants who have moved into the area during operations. It will be specifically addressed as part of the planning for mine closure.

Potential Influx Impacts

In-migrants could choose to move into the Project area for a number of different reasons including employment and indirect economic opportunities (summarised in Table 6.12.1, see also Chapter 6.21).

Table 6.12.1: Potential Typologies of In-migrants			
Characterisation		Likelihood	Amulsar scenario
1	Returning family, extended family members, & former residents of the area	Construction: Likely	Former residents of Gorayk, Saravan, Gndevaz, Kechut and Jermuk, seeking to return to their settlements, expecting improved living conditions and employment, or opportunities to provide goods & services to the project or the local population.
		Operations: Likely	
2	Project employees from outside the project area and their immediate and extended families	Construction: Somewhat likely	Temporary or permanent workers employed by the project or its contractors who move to the area with or without family to be close to their place of employment.
		Operations: Likely	
3	Potential providers of goods and services to the local population	Construction: Likely	Traders, entrepreneurs, small and medium enterprise owners, commercial sex workers, etc., aiming to capture substantial increases in disposable income through provision of goods and services. Jermuk would be the most likely destination for such in-migrants given that the area has excess housing capacity due to a decreased population since the peak population in the 1980s. Jermuk is the nearest town offering accommodation, medical and recreational facilities, which may also attract this type of in-migrant.
		Operations: Likely	
4	Service providers to the project	Construction: Somewhat likely	Entrepreneurs and SMEs from the formal sector; aiming to secure contracts to provide goods and services to the project and its contractors, seeking to establish offices in Gndevaz and Jermuk.
		Operations: Likely	

Table 6.12.1: Potential Typologies of In-migrants			
Characterisation		Likelihood	Amulsar scenario
5	Service providers to the expanding population	Construction: Likely	Entrepreneurs and small and medium enterprises (SMEs) aiming to take advantage of new business opportunities catalysed by the development and operation of the project would seek to establish their presence in Jermuk, but depending on the type of service they offer, could be attracted to any of the villages in the area.
		Operations: Likely	
6	Opportunistic migrants	Construction: Likely	Unskilled, semi-skilled or skilled people, seeking direct or indirect employment or entrepreneurial opportunities would be attracted to Gndevaz and Jermuk, as above.
		Operations: Likely	

It is almost impossible to predict the scale of influx which may occur due to a Project; as such, all estimations need to be considered with significant caution. The scale of influx is influenced by a variety of factors, including, but not limited to: the mobility of the host population; availability of economic opportunities and employment in other areas of the country; traditions of migration for work etc. Armenia does have a reasonably mobile population, with a long established trend of young males migrating (predominantly to Russia) for work opportunities, and there are relatively few rural job opportunities available within the country. Given this synopsis, it seems likely that the development of the Amulsar Project will act as an attractant for some level of in-migration. Using the influx categories outlined in Table 6.12.1, and considering both the construction and operations periods, the following assumptions can be made:

- Returning family, extended family members & former residents of the area – If it were assumed that 50% of those people reported to have migrated away seasonally from Gorayk, Gndevaz, Saravan and Jermuk in 2015 were to return to their communities, this would equate to approximately 137 people¹ (see Table 4.12.6 for migration data). As the vast majority of people migrating away for work are married males aged between 21 and 50 years, it is reasonable to assume they would move back as individual males also.
- Project employees from outside the project area and their immediate and extended families – The scale of this type of in-migration is highly dependent upon on the success of the training and local recruitment efforts in the local area. Taking construction and operation in turn, it is intended that approximately 30% of the workforce be sourced

¹ The seasonal migration figures recorded in the Village Passports for 2015 were substantially reduced from those recorded in 2014 (50% reduction). The basis for this change is not known.

locally during the construction period. This equates to approximately 380 to 390 local jobs during the peak of construction. The training programme to improve the skills and capacity of local workers will only commence during the construction period, hence there may be an incentive for people to in-migrate in the early stages of construction to be eligible for these “local” jobs. During operations, if 30% of the workforce is sourced locally, there is the potential for up to 210 workers to move with their families into the local area for work purposes (assuming 250 workers reside in Jermuk hotel accommodation also during the operations period). Section 4.12.6 indicated the average family size in Armenia is four people, so it could be assumed that up to 840 people (210 households) might in-migrate into the community under this scenario.

- Potential providers of goods and services to the local population; services providers to the project; service providers to the expanding population; and opportunistic migrants – these four categories are considered collectively as there is no data to support a more detailed assessment. For the purposes of this discussion, these four categories of influx combined might contribute another 300 - 400 people migrating into these communities, with a relatively similar level seen during construction and operations. It is assumed many of these people would migrate as individuals, waiting to see if they found success before bringing family members to the area. These opportunistic migrants would be likely to be men.

Combining these figures would suggest there is potential for over 1000 people to migrate into the communities during the operations period, of which a significant proportion might be single males. This assessment should not be used for planning purposes, but rather as an indication of the potential scale of influx the project might generate.

The effects of this potential influx will not be felt evenly within the villages, with Jermuk likely to experience the greatest impact from influx due to the location of the project activities and accommodation locations and the attractions and opportunities that a city of this size can offer. Gndevaz is also likely to experience a higher level of influx when compared to the other villages due to its proximity to the Project operations. The impacts described below (with the exception of inflation which is addressed in Section 6.13) are not expected to affect any groups differentially from the rest and the impacts are expected to be gender neutral.

Unmanaged influx (project induced in-migration) into the Project area can have the potential negative impact of decreasing the standard of living due to increased pressure on local

resources and existing infrastructure. Such pressure can impact community resources like schools and health facilities or exceed the capacity of community infrastructure. Potential impacts are discussed below:

- Education – The education facilities in the local affected area are all operating significantly under capacity at present (see Section 4.14.1). In 2014, the secondary and high schools in the local area were operating at an average of 27% capacity (a notable exception is Jermuk Number 1 school which reported near full capacity in 2015), with an additional 1,845 places available for students. Additional student numbers from in- migration or worker families would benefit these schools.
- Sewerage – During construction, the temporary worker accommodation camp of between 500 and 920 persons will be operated with its own package sewage treatment plant, with no impact on community systems. Treated water will be used for construction earthworks or discharged into an infiltration gallery on the Amulsar project site. The additional workforce residing in Jermuk during peak construction (up to 370 workers, based on a worker accommodation camp of 550 persons) will use the existing Jermuk sewerage system. The Jermuk waste water treatment plant is being upgraded in two phases. Phase 1, which comprised the installation of a mechanical separation plant, was completed in December 2014 through support from KfW. The capacity of this plant is understood to be capable to supporting a population of 22,000, far exceeding the current demand and any increased demand associated with project induced in-migration. The timing for Phase 2 of the water treatment plant upgrade, which will focus on the chemical treatment of the discharge, is unclear. While the impact of up to an additional 1000 in-migrants contributing to the existing sewerage system is relatively small, these impacts will be further reduced when the Phase 2 programme of works is implemented. Commercially available septic systems will be sufficient to manage and treat domestic wastewater from the offices and plant facilities. Septic systems will be provided for the mine truck shop, primary crusher, secondary crusher, ADR plant/administration offices and the worker accommodation camp. Gndevaz, Gorayk and Saravan do not have any form of wastewater treatment in place. Lydian will work with the village administrators to ensure that town planning includes planning for septic systems as the communities expand. No impact on host community sewerage systems is anticipated.
- Water – Water extraction for the project will not impact the water supplies for the host communities (see Chapter 6.10) and no impacts to water supplies associated with the growth of population through influx are anticipated.

- **Waste** – A mine landfill facility will be constructed on the Project site to the east side of the BRSF, to handle domestic and non-hazardous industrial waste generated from mining operations. It will have a depth of approximately 3m with perimeter berms and exterior surface water diversions or berms to keep surface water runoff away from the landfill. The landfill will be constructed in accordance with appropriate standards including the IFC EHS Guidelines and EU waste directives for disposal of non-hazardous wastes. All domestic waste generated by the Project from the mine and its accommodation sites that is not recycled or reused will be disposed of in this landfill. At present, waste from Jermuk is disposed of in an existing landfill site approximately 2km east of the town.. The Company will work with Jermuk authorities to identify options for improved municipal waste disposal, taking in consideration potential increased demand associated with project induced in-migration. Unless a suitable, improved landfill facility is constructed by the Municipality of Jermuk, all domestic waste generated by the mine, worker accommodation camp, and by the workforce resident in Jermuk, will be disposed in the landfill built at the mine site.
- **Inflation** – An increased population is likely to increase demand for a number of key items: accommodation and staple foods. This has the potential to generate local inflation, as discussed in detail in Section 6.13.

Potential impacts to health infrastructure and services from influx are addressed in Section 6.18.

Mitigation measures are aimed at reducing the scale of influx and managing potential negative impacts.

Mitigation Measures for Influx Impacts

Actions which the Project will take to minimise influx and mitigate potential negative impacts fall into two categories:

- Measures that help minimise influx; and
- Measures that help manage influx impacts.

Minimisation measures will include:

- Developing and implementing a training programme for local residents to assist them to be successful in gaining work with the Project. The training programme design is being informed by the results of the skills survey conducted in 2014 (initial results reported in

Section 4.17), combined with development of job descriptions for roles required in construction and operations. Training is not expected to exceed 6 months for any specific skill and will be accessible to all residents within the local affected area on a merit basis. Training is being designed to target operations roles, as these provide a longer-term opportunity than the short-term construction roles. This is described in more detail in Section 6.14.

- The Project will have two administrative site offices where management will be based: one located at the truckshop facilities, and the other located at the ADR plant. The community relations staff will be based at the ADR office. Locating both offices away from the rural villages and city of Jermuk will minimise the likelihood of people associating a specific village with recruitment opportunities with the Project. While it may not reduce the level of opportunistic in-migration, it is likely to minimise the risk of one village or town being more affected than others, on the basis of recruitment alone. To add a further disincentive to migration near project offices, no recruitment will be undertaken at the “mine gate”, with all positions being awarded in alignment with the recruitment procedure. Given the low level of car ownership within the local communities, locating a recruitment centre at a distance from the project would actively discourage local recruitment, counter to the aims of the Project.
- Implementation of the Local Recruitment Procedure which states:
 - Lydian will maintain an up to date skills register for the residents of the local affected area. This register will be used as the basis for all recruitment processes.
 - Notification – all jobs will be advertised at the Amulsar Information Centres (AIC) in Gndevaz and in Jermuk for at least two weeks prior to closing dates. Only local residents will be eligible to apply for jobs at the AICs. A recruitment location will also be established in Yerevan to facilitate Armenian’s from outside the local area to apply for jobs.
 - Award – decisions will be based upon merit, commitment to safety and their personal behaviour. Within this context, local² recruitment will be prioritised.

² *Local* - For the context of this procedure, “local” is defined to include people normally resident in Gndevaz, Saravan, Gorayk and Jermuk/Kechut. It also includes those people who originate from these villages but have moved away to seek employment in other places (e.g. internal migrants etc.).

Regional – For the context of this procedure, “regional” includes people who are normally resident in Syunik Marz or Vayots Dzor Marz. It also includes those people who originate from these Marzer but have moved away to seek employment in other places within Armenia.

National – Refers to all people who normally reside in Armenia.

If the skills are not held locally, regional candidates will be prioritised. If the skills are not held regionally, Armenian nationals will be given priority over foreign applicants.

- Contractor requirements – when bidding for work on the Amulsar Project, contractors must demonstrate how they will meet the Local Recruitment Procedure and indicate the proportion of local, regional and national recruitment they will achieve. If these levels are low, the contractor must demonstrate how they will build skills and increase these levels over the duration of their contract.
- Employment communication / consultation programme that consistently and clearly informs the national and local populace of the company's Local Recruitment Procedure and Human Resources Policy, employment opportunities and requirements. Monitoring of population changes to be conducted in coordination with Village and Town Mayors through the "Village Passport" system.

Management measures to mitigate the potential negative impacts will include:

- Consultation with local administrators to ensure there is joint recognition of the potential adverse impacts of un-managed influx. Lydian to provide assistance to village administrators to plan for population growth in their communities, including considerations of potential impacts to services;
- Widely disclosed and effectively managed grievance mechanism for communities to register complaints or contribute information important in the event of any strain on resources; and
- Continued monthly consultation with the nominated CLC groups, which will be used as a formal procedure for soliciting information on unanticipated indirect impacts from any influx.

Residual Influx Impacts

Indirect impacts of influx are complex interactions. Mitigation is targeted towards minimising the number of people who move into the area and improving opportunities for local employment. If negative impacts are to occur, the main mitigation is related to maintaining good communication with nominated leaders and responding to potential strains on resources and infrastructure in a timely fashion. If properly implemented, such impacts will still be possible, but should be identified and solved quickly to avoid impairing current residents' quality of life or ability to enjoy their resources and infrastructure (Table 6.12.2).

Table 6.12.2: Impact Assessment, Influx Impacts						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Influx	Negative	High	Local	Medium term	Major (negative)	Moderate (negative)

6.12.2 Social Issues

Project Activities Affecting Social Issues

Social issues are related to the indirect impacts of the influx of workers, service providers and other opportunistic in-migrants. The topic is also difficult to predict, but similar Projects in other parts of Armenia and the world provide a solid indication of some issues that commonly emerge when large numbers of workers, mostly men living without their families, are placed in a community with which they are not familiar.

The Project will bring a new and diverse group of people into the local affected area communities and will increase the disposable income at the same time. Specific social issues associated with workforce accommodation are further described in Chapter 6.21.

Potential Social Issues Impacts

Social issues often result in tension between different customs and norms. They are also linked to behavioural changes that can result from changes in the socio-economic dynamic. In this case, the largest change will be from the influx of new people, many with little connection to the local affected area, as well as shifts in the labour market that will see a substantial increase in salaried employment in an area that has largely been linked to agriculture in the rural settlements and tourism and other service-related livelihoods in Jermuk. Similar projects have experienced increased alcohol consumption, new or widening commercial sex networks and prostitution, closely associated to problems with sexually transmitted diseases and an increase in crime and violence in communities proximal to their operations. These impacts will disproportionately affect women and girls within the local communities either directly or indirectly.

Social issues are influenced by economic inequalities. In a situation where high numbers of local residents report difficulty buying enough food, the emergence of a sizeable group of people with relatively high wealth associated with mining employment can cause jealousy, especially if there is any real or perceived corruption in employment practices and procurement. Those most vulnerable to this impact will be people and / or households with

limited finances.

All communities are susceptible to the impacts related to social issues, though Jermuk will be most likely to experience changes because it will accommodate up to a maximum of 370 workers during construction and approximately 250 workers during operations. Gndevaz is also likely to be impacted through its relative proximity to the temporary construction worker's camp. The location of the camp would be either within the construction area of the HLF (see Figure 3.1). While the worker accommodation camp will be solely for persons working at the mine, given the reliance on the use of hotel and worker accommodation in Jermuk, it is also inevitable that there will be mixing between the workers resident in the camp and those residing in Jermuk, and given the proximity of the worker accommodation camp location to Gndevaz, mixing may also occur in this village, as well.

The temporary construction camp will also be managed as a "dry camp" (meaning that no consumption of alcohol will be permitted) to ensure a safe working environment for the Project and to maintain employee standards as defined in the Code of Conduct and the Employee Certificate. It will not be possible to restrict access to alcohol to workers residing in Jermuk hotel accommodation as the level of company control will be considerably lower, however compliance with the Code of Conduct will be expected of all employees and contractors.

Jermuk, and to a lesser extent Gndevaz, are the settlements most likely to absorb other immigrant workers. The excess housing capacity and services already catering to tourists and outsiders within Jermuk will potentially make this process of expansion simpler, although it also has the potential to displace tourism income, in the short to medium term.

The use of Jermuk hotel accommodation during construction and operations will increase Jermuk's exposure to social change resulting from the mining project. Although workers will be accommodated in a limited number of hotels, they are likely to be inter-mixed with other guests (tourists predominantly). The characteristics of a mining workforce will vary significantly from those of tourists and the dispersion of workers across more than one hotel and more than one location within Jermuk will extend this impact.

Mitigation Measures for Social Issues

Economic inequality is likely to occur to some extent regardless of mitigation measures. It can be minimised, however, through the successful implementation of assistance programmes targeted at non-industrial sectors (e.g. agriculture, tourism, or small and

medium scale enterprise development). Such assistance, if transparently implemented with equal opportunities for all local residents, will reduce tension between influx workers and local residents by providing opportunities for non-mining related workers to benefit as well.

Other social issues relating to alcohol and drug consumption within the broader community are difficult for a mining company to influence. However, Lydian will require certain standards of behaviour from its workers (and its contractors) through a Code of Conduct and Employee Certificate. Training on the Code of Conduct will be required as part of the Induction process for all employees (including contractors) and visitors. The Code of Conduct includes commitments from all workers and contractors that they will uphold the following standards:

- Personnel must not be under the influence of, sell, distribute or possess alcohol, narcotics, depressants, stimulants, hallucinogens, marijuana or any other mind altering drugs, when reporting for work, while working on company property, and while operating any company motorized vehicle.
- Employment will be based on the principle of fair treatment, free from discrimination. Discrimination on the basis of race, religion, gender, nationality, age, disability, any other category protected by the United Nations Declarations on Human Rights, and all applicable laws and regulations in the jurisdiction where Company Personnel operate is prohibited.
- The Company will not tolerate harassment.
- The Company will not tolerate violence in the workplace.

These commitments will be assessed on a regular basis through compliance testing, including, but not limited to, random drug and alcohol tests for employees and contractors. Employees will also have the opportunity to speak out about non-compliance they have observed through the confidential whistle-blowing system in place across Lydian. Through influencing the behaviour of its own workforce, the workers may provide a positive role model for community members, effectively discouraging social issues.

Lydian will also continue to support sporting and cultural events within the local area of influence as part of its community investment portfolio. Through this support, Lydian will be incentivising those who participate in community activities and who partake in a healthy lifestyle.

The Code of Conduct requires all employees and non-employee workers to conduct themselves in accordance with Armenian law. Lydian has developed a clear policy on HIV/AIDS that requires non-discrimination for anyone who may have the disease, as well as providing clear and accurate information on the spread of the disease, and other sexually transmitted infections. Further analysis of this impact is addressed in Section 6.18. Mitigation measures will include:

- Supporting local information education and communication campaigns on HIV and STI awareness that promote behaviour change;
- Distribution of condoms and information materials in local restaurants and entertainment areas
- Supporting women's empowerment and education programmes to avoid the temptation to be involved in forms of transactional sex work.

Healthy lifestyles will be promoted through information, education and communication campaigns run by the Project within the local community. These campaigns will address the following topics as a minimum: alcohol consumption, healthy eating, conflict awareness and cultural awareness.

Reducing the level of interaction between workers and tourists and other residents in Jermuk will reduce the potential for social conflict. The Project will seek to minimise the number of hotels (and apartments, if utilised during operations) used to accommodate workers in order to minimise the level of interaction. Worker accommodation within Jermuk has been assessed and defined in the Worker Accommodation Management Plan (Appendix 8.24).

Similar to the mitigation measures related to influx, a key mitigation tool will be the community grievance mechanism. Residents of Jermuk and all settlements will be encouraged to use the mechanism if they observe any behaviour that they consider to be unwelcome or harmful to the local social fabric of their communities.

Residual Social Issues Impacts

Prior to mitigation, social issues are considered to be a potential negative impact. The magnitude of the impact is high as the characteristics of the town of Jermuk change (from a family tourist area to an area that also will accommodate a significant proportion of the mine workforce). These workers will live in Jermuk for several years and will therefore alter the balance of tourists to semi-permanent workers for the duration of the mine's life. The spread

of STIs including HIV and other diseases and public nuisances such as increased alcoholism can seriously impair the quality of life and generate significant tension and social dysfunction within a community. These consequences of these impacts can disproportionately affect women and girls.

The mitigation measures are meant to set high standards of conduct for all employees and non-employees and to incentivise behaviours which minimise social issues. This will not stop all instances of negative behaviour, but additional engagement efforts will allow Lydian to become aware of abuses quickly so that measures can be put in place to manage them (Table 6.12.3).

Table 6.12.3: Impact Assessment, Social Issues						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Social Issues	Negative	Medium	Local	Medium term	Moderate (negative)	Moderate (negative)

Table 6.12.4 summarises Project impacts on demographics.

Table 6.12.4: Impact Summary - Demographics						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Influx and population movement	Negative	High	Local	Medium term	Major (negative)	Moderate (negative)
Social Issues	Negative	Medium	Local	Medium term	Moderate (negative)	Moderate (negative)

6.12.3 Monitoring and Audit

As described above, mitigation measures that relate to managing demographic impacts from the Project will be addressed in a number of management plans. Table 6.12.5 outlines monitoring indicators which will be used and developed further to assess the effectiveness of mitigation measures, see also Appendix 8.24.

Table 6.12.5: Mitigation Summary Table

Section	Mitigation	Monitoring Indicator	Management Plan
6.12.1 Influx	<p>Minimisation measures will include:</p> <p>Provision of training to local area of influence communities to increase their skills and maintenance of a skills register to be used as basis for all recruitment. Training will target operations roles;</p> <p>Preferentially hiring from the local area of influence where skills are held (or can be developed) within those communities to undertake the role;</p> <p>No recruitment will be undertaken at the “mine gate”, with all positions being awarded in alignment with the recruitment procedure;</p> <p>Two offices for the Project: one located at the truck shop and one to be located at the ADR. Two recruitment points will be defined, one at the local AICs for local residents only; and a second recruitment point in Yerevan for Armenians originating from other areas;</p> <p>Implementation of the Local Recruitment Procedure; and</p> <p>Consultation with local administrators to ensure there is joint recognition of the potential adverse impacts of un-managed influx.</p> <p>Monitoring of population changes to be conducted in coordination with Village Mayors</p>	<p>Local Recruitment Procedure up to date and disclosed as part of worker induction;</p> <p>Audit of contractors to determine compliance with Local Recruitment Procedure and regular reporting required</p> <p>Employment statistics up to date, including:</p> <ul style="list-style-type: none"> • Gender statistics • Home of record (region and city) • Age <p>Minutes of engagement with local administrators complete.</p> <p>Monitoring of population changes through Village Passports</p>	<p>Stakeholder Engagement Plan (Appendix 8.6)</p>

Table 6.12.5: Mitigation Summary Table

Section	Mitigation	Monitoring Indicator	Management Plan
6.12.1 Influx	Management measures to mitigate the potential negative impacts will include: Widely disclosed and effectively managed grievance mechanism for communities to register complaints or contribute information important in the event of any strain on resources; and Continued monthly consultation with the nominated CLC groups, which will be used as a formal procedure for soliciting information on unanticipated indirect impacts from the influx.	Number of internal and external grievances received; Number of internal and external grievances resolved; Number of internal and external grievances transferred to court of third party resolution; and Minutes of engagement with CLC complete.	Stakeholder Engagement Plan (Appendix 8.6)
6.12.2 Social issues	Lydian will seek to provide clear inductions for all workers on its employee Code of Conduct and will require compliance with this Code (failure to comply will have disciplinary consequences). These commitments will be assessed on a regular basis through compliance testing, including, but not limited to, random drug and alcohol tests for employees and contractors.	Code of Conduct included in worker induction. Human resources records for disciplinary concerns regarding Code of Conduct compliance Random drug and alcohol testing for employees and contractors. Whistle-blowing system reports (confidential and anonymised)	Environmental and Social Management Plan (Chapter 8)
6.12.2. Social Issues	The Project will seek to minimise the number of hotels (and apartments, if utilised during operations) used to accommodate workers in order to minimise the level of interaction (see Appendix 8.24).	Number of hotels used to accommodate workers Community grievance system reports and analysis of trends	Stakeholder Engagement Plan (Appendix 8.6)

Table 6.12.5: Mitigation Summary Table

Section	Mitigation	Monitoring Indicator	Management Plan
6.12.2 Social issues	Lydian has a clear policy on HIV/AIDS that establishes non-discrimination for anyone who may have the disease, as well as providing clear and accurate information on the spread of the disease, as well as other sexually transmitted infections. Supporting local information education and communication (ICE) campaigns on HIV and STI awareness that promote behaviour change; Distribution of condoms and information materials in local restaurants and entertainment areas Supporting women's empowerment and education programmes to avoid the temptation to be involved in forms of transactional sex work.	HIV/AIDS policy included in worker induction. Audit of ICE campaigns conducted per year Audit of condoms distributed in local communities	Environmental and Social Management Plan, and Community Health and Safety Plan (Chapter 8 and Appendix 8.15)
6.12.2	Healthy lifestyles will be promoted through information, education and communication campaigns run by the Project within the local community. These campaigns will be address the following topics as a minimum: alcohol consumption, health eating, conflict awareness and cultural awareness.	Audit of ICE campaigns conducted	Community Health, Safety and Security Management Plan
6.12.2 Social issues	Similar to the mitigation measures related to influx, a key mitigation tool will be the community grievance mechanisms. Residents of Jermuk and all settlements will be encouraged to use the mechanism if they observe any behaviour that they consider to be unwelcome or harmful to the local social fabric.	Community grievance system reports and analysis of trends	Stakeholder Engagement Plan (Appendix 8.6)

6.12.4 Conclusions

The Impact assessment has been carried out to assess the effects of construction, operation and closure of the mine on demographics. Findings are summarised below:

- Impacts fall into two main categories: influx and social issues, which are both considered to create medium term impacts during the construction and operational phases of the Project.
- Influx has a major negative impact before mitigation and a moderate negative impact after mitigation. Social issues will have a moderate negative impact prior to mitigation and a moderate negative impact after mitigation.
- Mitigation measures for influx include: preferentially training and recruiting local people, the continued operation of the grievance mechanism, on-going monthly CLC group meetings to gain regular feedback about people's concerns and any issues relating to influx.
- Mitigation measures for social issues include minimising the level of interaction between workers and community members (including tourists), the development of inductions for employees and an employee Code of Conduct, and compliance testing against the Code of Conduct commitments. Geoteam has a policy on HIV/AIDS which creates a culture of non-discrimination of affected employees and implements measures to reduce the spread of sexually transmitted diseases, including HIV. The grievance mechanism outlined in the SEP encourages stakeholders to raise concerns relating to unwelcome or anti-social behaviour.

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6.13 Economics

The Amulsar Project will have a tangible positive macroeconomic effect, but will also generate local economic impacts. Four different economic impacts are assessed in this section:

- Macroeconomic effects, including contribution to the country's GDP and exports; and contribution to public revenues;
- Contribution to the local economy (Jermuk and surrounding area);
- Local level inflation; and
- Payment of land taxes at a local level.

6.13.1 Macroeconomic Effects

Project Activities Affecting Macroeconomics Effects

The Project as described in the ESIA includes the mining of Tigranes, Artavazdes and Erato deposits. General equilibrium economic modelling was undertaken by Armenian consultant economists, Avag Solutions, in 2014 to obtain direct and induced effects of the project on the country's economy¹. Avag Solutions assessed the Project as described in the v9f ESIA. While the Project description for this ESIA (v10) is different in some respects from that described in v9f (e.g. the assumed gold price has changed from USD \$1,250 per ounce to USD \$1,150 per ounce), the 2014 analysis has been included in this ESIA as it provides an indication of the Project's macro-economic contribution.

Direct economic effects refer to immediate project outcomes, whereas induced effects are concerned with increase in output in other sectors of the Armenian economy due to implementation of the Project. In particular inter-sector relationships described with the help of a detailed social accounting matrix were complemented with updated projections from Armenian Development Strategy. Macroeconomic impacts due to Project implementation were estimated for two component stages – construction (investment) stage and mining (operations) stage.

These models assumed an expected gold price of \$1,250 per ounce and the conservative estimate of approximately 2.2 million ounces in the internationally approved *reserve* over an 11 year mine life. The estimates of royalties and taxes would increase greatly if it were

¹ Indirect or induced effects are additional results of project's activities that arise due to the multiplicative nature of increased spending.

possible to extract some or all of the current *resource*, estimated at 3.03 million ounces².

Potential Macroeconomic Impacts

Absolute Contributions

In the 2014 model, Lydian International anticipated committing more than USD 426 million³ in capital investment during the first two years in the form of construction and equipment to develop the Project (n.b. the capital investment is anticipated to be USD 370 million in the v10 ESIA). Over the life of the Project, it was expected to contribute USD 485 million to the state budget through taxes (including income tax on salaries and tax on dividends paid, as well as taxes paid during the construction stage) and royalties. Wages for employees were expected to be around USD 230 million over the life of the Project, including wages paid during the construction period. The Project was expected to increase Armenia's export earnings on average by around USD 285 million annually for the operational years. Table 6.13.1 summarises the total cumulative direct and induced contributions of the Project, as described in 2014, in nominal terms.

Table 6.13.1: Total (Direct and Induced) Cumulative Nominal Contributions from the Project (2014 base case, not adjusted for 2016 design changes)				
	Description	Total (in USD mln)	Direct - Project(in USD mln)	Induced(in USD mln)
1	Capital Investment	426.1	426.1	--
2	Taxes	584.4	485.4	99.1
3	Value added (GDP)	1,563.8	1,192.2	371.6
4	Export	2,688.0	2,575.4	112.5

Contribution to GDP and Export

Construction Phase

According to estimations undertaken by Avag Solutions in 2014, the construction stage of the Project was likely to increase the output of Armenia's construction sector by approximately USD 92 million per annum between 2015-16. This equated to a respective annual contribution to overall GDP of 0.62% during the construction years. The multiplier effect of increased output in construction on GDP was estimated at 1.29.

² Gold *reserves* are approved and technically and economically feasible to extract. *Resource* is not proven as certain given the current technical studies, but are possible.

³ This figure may change as detailed engineering design progresses.

Operations Phase

The primary macroeconomic effects of the project stem from the operations period. It should be noted that the intensity of the modelled operations were not evenly distributed along the project lifetime. The operational plan, as defined in 2014, indicated higher net cash flow between 2017-2020, with higher profits in the second half of the operational period. This was reflected in the absolute and relative figures of contribution to GDP in Table 6.13.2, as well as in the contribution to exports. Direct contributions alone to GDP between 2017-2020 would have been almost 1% annually, constituting approximately 8% of export from Armenia. The multiplier for mining is higher than that for construction (1.32 compared to 1.29). This means that for each unit of contribution to GDP there will be an additional 0.32 units of positive impact.

Table 6.13.2: Contribution to GDP and Exports at Operation Stage of the Project (2014 base case, not adjusted for 2016 design changes)					
		2017-2020 (yearly average)		2021 and on (yearly average)	
		% of Total	USD mln	% of Total	USD mln
1	Total Contribution to GDP	1.2%	156.5	1.1%	160.2
1a	Direct	0.9%	118.8	0.8%	121.7
1b	Induced	0.3%	37.6	0.3%	38.5
2	Total Contribution to Export	7.8%	337.2	5.2%	269.1
2a	Direct	7.5%	324.3	4.9%	255.6
2b	Induced	0.3%	12.9	0.3%	13.5

Contribution to Taxes

Construction Phase

Total tax revenues during the two years of the construction stage (including the induced taxes due to expanded output across the sectors of the economy) were estimated in 2014 to be USD 16 million, which was approximately 0.6% of total tax revenue.

Operations Phase

On average, each year taxes (including employee income tax and dividend tax) and royalties paid to the Government would have been in the order of USD 50 million according to the 2014 calculation. The Project was expected to be among the top five tax payers in Armenia. Royalties made up the largest proportion of taxes paid by the Project. Figure 6.13.1 provides a breakdown of taxes by element to be paid by the Project during operations.

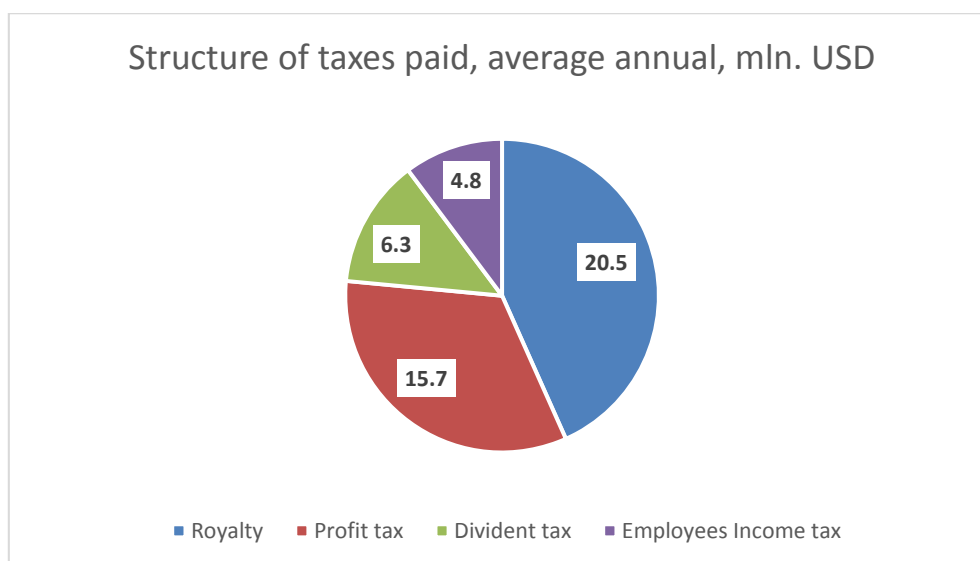


Figure 6.13.1: Structure of Tax Payments by the Project

It is important to mention that taxes paid are highly sensitive to changes in the price of gold. For example, a USD 500 increase in the gold price would almost double tax revenues, however a USD 500 decrease in the gold price would drop the tax revenue by 80%.

Absolute contributions, GDP contributions, and royalties and taxes are considered positive impacts, though the overall significance is lessened by the potential risk of non-transparent payments and corruption that is possible when large payments are not properly monitored and reported. These benefits will also cease when the mine closes, making these positive impacts temporary.

Mitigation/Enhancement Measures for Macroeconomic Impacts

The management of economic benefits from the project is primarily the responsibility of the RA. While Armenia is not currently a candidate country for the Extractive Industries Transparency Initiative (EITI), Lydian will comply with IFC requirements to report on all taxes and government payments. This disclosure is part of the EITI process and is required by the IFC for new extractive industry projects.

Full disclosure of royalties and taxes will build on the trend already established by the Project where it has been reporting on the amount of land tax paid to each rural community each year (see Section 6.13.3). Full details of Lydian's corporate governance commitments are available on the company's website.

The Project will also seek to promote economic growth within Armenia through its local procurement and recruitment policies.

Residual Macroeconomic Impacts

Table 6.13.3: Impact Analysis, Macro Economics						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Macroeconomics effects	Positive	High	National	Medium term	Moderate (positive)	Major (positive)

6.13.2 Contribution to Local Economy

Project Activities Contributing to the Local Economy

The Project will contribute to Jermuk's economy both directly and indirectly. The primary direct contributions will be the occupancy of up to 370 hotel rooms in Jermuk during the construction period, and rental accommodation for approximately 210 families and hotel accommodation for 250 individuals during the operations period. These direct benefits will be experienced predominantly by the hotel owners and operators and families renting out apartments during the operations period. The indirect contributions will include: increased spending within Jermuk due to the increased level of cash income within the Project area; increased demand for goods and services which may prompt and support the development of new businesses during the period of mining operation; and an expansion in the number of local jobs within Jermuk to operate and maintain hotel accommodations.

The project will also contribute to the economy of the local communities, sourcing approximately 380 to 390 locally recruited workers together with associated skills training for the life of the Project. It is also anticipated that there will be an increase in procurement of locally based goods and services, for example supplies of fresh fruit and vegetables to the worker accommodation camp and for increased hotel occupancy in Jermuk. Similar to the potential impacts in Jermuk, indirect spending may result in increased spending on goods for example from market stalls in Saralanj and Saravan and this may also prompt the potential for new business ventures to support the mining operations, based in the surrounding villages.

Potential Impacts on the Local Economy

A specific assessment on the impacts of worker accommodation on Jermuk has been completed by InterSocial and included as Chapter 6.21 of this ESIA.

Jermuk is primarily a spa tourism town. Tourism in Jermuk is highly seasonal, with hotels reporting full or near-full capacity in summer, and for a week over New Years Eve, and periods of occupancy rates around 20% for the remainder of the year. An absence of heating in one large hotel (Gladzor) requires it to shut for the winter period. The Jermuk economy is under-performing, with hotel operators reporting changes to the tourism industry following the Russian crisis (negative impact) and the introduction of Social Packages (positive impact).

The Project's construction accommodation requirements vary with the manpower schedule (see Figure 6.13.2, for construction phase). The worker accommodation assessment (summarised in Chapter 6.21) assumes a range of between zero and 370 beds might need to be rented in Jermuk during the construction period, peaking in May 2017. Assuming an average room rental rate of USD 85/night, this will make a significant contribution to the Jermuk economy in room rental alone. On top of this, the Jermuk economy will also benefit from payments for "board", ie meals and ancillary services.

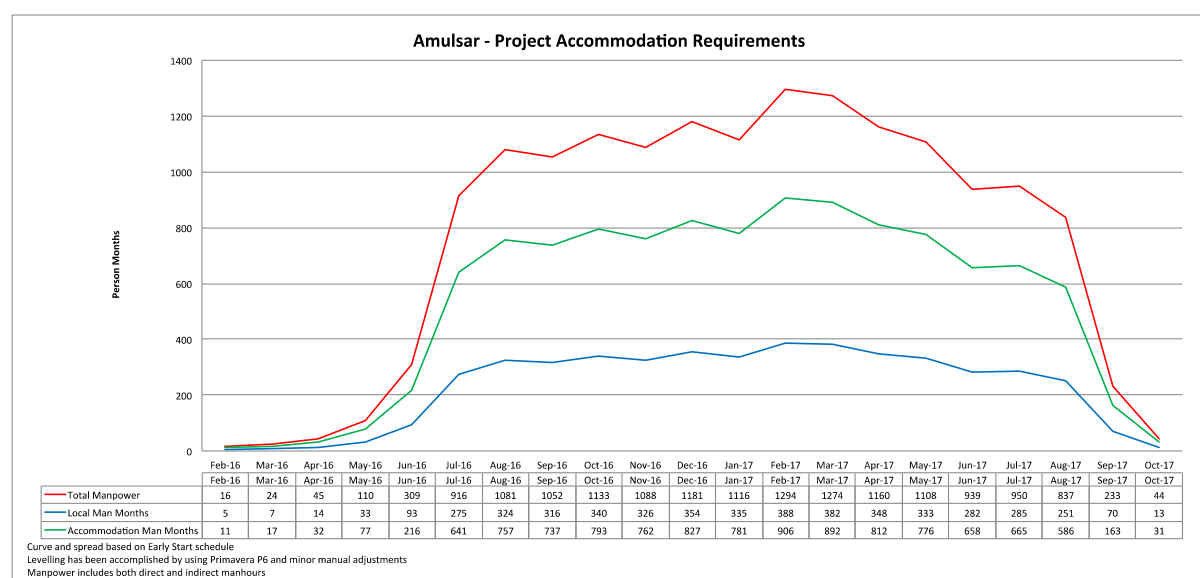


Figure 6.13.2 Manpower Schedule (December 11th, 2015)

During the off-season periods (October – December and mid-January – April/May), the Project's rental of rooms is unlikely to displace significant tourism activity. However, during peak tourist seasons, the rental of up to 370 beds is expected to displace some tourist activity,

effectively replacing tourist dollars with Project dollars. As such, the Project's economic contribution to Jermuk from the rental of hotel rooms can be considered new investment only in those times when it does not displace tourist revenues.

During the operations period, the Project will again contribute to Jermuk through the rental of hotel rooms and the anticipated arrival of a number of families who move into the area for the period of mining operations. The sustained benefit of 12-13 years of hotel room occupancy will no doubt have a strong economic impact upon the owner/s of affected hotels, while also spilling over to the rest of the economy through direct (eg catering and laundry services) and indirect support services.

The surrounding communities are expected to benefit from indirect economic impacts associated with the provision of food and services to support the accommodation industry in Jermuk and the construction phase accommodation camp. These communities will also benefit from the introduction of close to 400 new jobs in the area. The social implications of these impacts as addressed in Chapter 6.14.

Mitigation Measures / Opportunities for Contribution to the Local Economy

Based on the potential impacts (both beneficial and negative) associated with worker accommodation a separate study was undertaken during Q1 of 2016, in order to inform the impact assessment, mitigation measure and the requirement for the worker accommodation management plan. The results of this study are reported in Chapter 6.21 and Appendix 6.24 (the management plan), including a series of mitigation measures.

Residual Contribution to Local Economy Impacts

Residual effects are analysed and defined in Chapter 6.21.

6.13.3 Local Inflation

Project Activities Affecting Local Inflation

The Project will provide job opportunities for a peak of approximately 1300 workers during construction and 657 in operations. These workers will be earning salaries which are considerably higher than wages currently earned in the nearby communities, as can be seen in Table 6.13.4.

Table 6.13.4: Comparison of Monthly Salaries in Rural Communities	
Armenian Labour category	Monthly Rate (AMD)
Teacher (range)	AMD 35,000-100,000
Librarian	AMD 30,000-40,000
Mineral Water plant employees	AMD 55,000-110,000
Amulsar Mine Operator (range)	AMD 120,000-420,000
Amulsar Mill operator (range)	AMD 80,000-200,000
Amulsar Junior Professional (range)	AMD 80,000-180,000
Amulsar Senior Professional (range)	AMD 115,000-520,000

Local procurement will also occur which has the potential to affect inflation of local prices if not managed.

Potential Impacts on Local Inflation

Localised inflationary effects can primarily impact two economic sectors: the cost of goods and services within local communities and the cost of accommodation. The extent of these impacts is dependent upon the procurement policies of the Project, the number of employees who are likely to purchase and consume locally, and the accommodation approach adopted by the Project.

The Project anticipates purchasing locally where possible; however, the availability of local produce and the range of products available will provide a limit to the extent of local procurement. Local procurement is anticipated to focus upon produce which can be used for catering purposes in the construction workers camp and the hotel accommodations in Jermuk, and other supplies primarily linked to workforce services in the office area.

As described in Chapter 3, the Project expects to have a peak construction workforce of 1300, and an operations workforce of 657. During the construction period, it is anticipated that 30% of the workforce will be recruited locally, allowing them to remain living in their own homes while working for the Project. For the remaining 920 construction workers (at peak), a temporary camp will be constructed to accommodate a proportion of the workers. The size of the camp is yet to be determined, but will be accommodate between 500 and 920 workers (see Chapter 6.21 for further details). If a camp smaller than 920 beds is selected, the overflow of workers will be accommodated in hotel accommodation in Jermuk. It is anticipated that the camp will operate as a closed camp, and thus would limit the interaction between construction workers and local communities. Limited interaction will also limit the level of purchasing made by these workers in the local communities. However, because workers would also be resident in Jermuk and surrounding areas, including Gndevaz, it is very

likely that these workers, based in an onsite camp, would also make use of local services and facilities. From an inflation impact perspective, this results in between 400-770 workers with good access to local communities (this considers both workers resident in the communities and the maximum potential use of hotel rooms in Jermuk for 370 workers). With a study area population of 6,678, this could represent a significant increase in the volume of local purchasing, with consequences for inflation of local prices, during the construction period.

This trend is likely to continue and expand during operations, with approximately 195 local workers (30%) expected to be working for the Project. Of the remaining 462 workers, approximately 250 are expected to be accommodated in hotels in Jermuk, with the remainder comprising non-local workers who are expected to move with their families in to the area for the duration of the operation. This equates to approximately 250 single workers living in hotel accommodation and purchasing items in Jermuk, with another 210 families expected to take up residence within the Project area (likely to focus on Jermuk due to its greater size and availability of rental accommodation). Jermuk contains over 2500 apartment units, of which approximately 30% are typically made available for rental during holiday periods. These apartments have generally not been refurbished since their construction in the 1960s.

Project employees will have higher levels of disposable income than is typical in the rural and urban communities at present, where subsistence activities dominate. It is likely that this will result in mine workers being able to pay higher prices for accommodation, food, transport and other staple items. Depending on the availability of these items and the reaction of local traders, it is anticipated that this additional spending power will generate localised inflation. This is inter-related to the resource curse considerations discussed in Section 6.11. Households who own their own homes and remain predominantly reliant upon subsistence are likely to be shielded from inflationary impacts to a large extent. More significant inflationary impacts would be expected in the urban city of Jermuk, where cash income and transactions predominate, making households more vulnerable to price fluctuations for purchased goods.

Inflationary effects are likely to particularly impact households where no members are directly or indirectly employed by the Project but who are reliant upon a cash based economy either through renting or purchasing property or purchasing food items. Within this group, households headed by women, elderly people or households with no males of working age would be more vulnerable to this impact.

Mitigation Measures for Local Inflation Impacts

The negative impacts of inflation are difficult to predict. Lydian will monitor prices for a staple basket of goods on a monthly basis. The basket of goods will be defined with reference to the “basket of goods” used in the ILCS poverty surveys applied in Armenia⁴. This will be done in the local area of influence, as well as in other areas of the regional area of influence to determine if inflation is a localised impact related to the Project or may have other causes. This assessment will focus on the cost of goods in Jermuk as it is likely to experience the greatest potential impact.

Lydian will also work with tourism operators and hotel owners in Jermuk to ascertain an appropriate room rental fee which will be supportive of their businesses, without overly influencing the average room prices for tourists in the town.

The level of salaries paid to mine workers is often fundamental to localised inflationary pressures. Lydian has conducted extensive benchmarking studies within Armenia to determine salary ranges for equivalent positions across all of the majority categories of employees. The salaries proposed for Amulsar mine workers have been developed to be consistent with Armenian norms, thereby minimising the risk of wage related inflation, while still ensuring workers are compensated through an appropriate salary for their skills. Benchmarking will be repeated on an annual basis to ensure this consistency is maintained.

Even with salaries within the Armenian norms, the introduction of the Project will generate significant change to the salary profile of the local area (from a largely agriculture based economy with limited formal employment to an economy with an additional approximately 657 permanent jobs during the operations period). To assist in managing this change, Lydian will continue to support agricultural technical assistance projects in the local area of influence. These programs will serve two goals: to increase production ensuring sufficient supply is available to meet growing demand for agricultural items; and to improve the economic returns for farmers and cultivators to minimise the gap between the mining and non-mining sectors.

The scale of potential impacts to apartment prices during the operations period will depend

⁴ <http://www.armstat.am/en/?nid=82&id=1716> accessed December 23rd, 2015.

in part upon the success of the local recruitment undertaken by the Project. The training programmes discussed in Section 6.14 will be designed to increase the employability of local community residents and as such, enhance the level of local recruitment (target of 30%). Lydian will monitor apartment prices, both for purchase and for rental, within Jermuk. If significant changes in rental prices are observed, Lydian will work with Jermuk administrators and community representatives to understand the impacts of these price increases upon the residents of and businesses in Jermuk, and to assist with accommodation planning for the communities. Potential impacts to services are addressed in Section 6.12.

If prices are seen to be rising in the local area of influence, or inflation is raised as a significant concern through the community grievance mechanism, Lydian will consider additional support which may take the form of targeted social and financial assistance in the affected area or support to local producers through the local procurement strategy. This might include supporting small producers to gain better access to markets through identifying potential buyers and designing training programmes for small producers to improve business skills to enhance productivity and product quality. While a programme like this is primarily focussed on income generation opportunities, it would also contribute to the management of inflation within the host communities.

Residual Local Inflation Impacts

Armenia has a history of significant fluctuations in inflation nationally. The project will not influence these national trends, but a local impact is found in projects within a similar context, where a large increase in salaried employment causes an increase in the price of important staple goods and accommodation. This impact prior to mitigation is considered moderate (negative). Lydian will aim to mitigate this impact through promoting local recruitment, through use of a temporary construction camp (with capacity for between 500-920 beds), and technical assistance targeting productivity improvements in agriculture to maintain the supply of staple goods, thereby reducing the chance that there will be a spike in prices. This impact will have a particular effect upon households who are reliant upon purchased food and rental accommodation. Through this programme, the residual local inflation impacts are expected to remain Moderate (negative), potentially impairing the quality of life for residents in the local area of influence.

Table 6.13.5: Impact Analysis, Local Inflation						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Local Inflation	Negative	Moderate	Local	Medium term	Moderate (negative)	Moderate (negative)

6.13.4 Contribution to Land Rental Payments

Project Activities Affecting Land Rental Payments

Until 2014, the company rented two types of land from the rural communities of Gorayk, Saravan and Gndevaz: exploration licence area land with agricultural land use classification and rock allocation area land where land has been converted to industrial use classification. Land tax is calculated by government decree on the basis of a cadastral evaluation of the net income potential of each soil type and agreed with the receiving authority, which in this case is the Community Administration.

In 2012, Lydian received approval for the formal change of land use from land that had previously been rented with agricultural status to Industrial, subsurface use and production lands. In 2013, most of the rented land within the rock allocation area was registered to industrial use classification, causing substantial increases in the rents paid for land.

The process of municipal consolidation which is unfolding in Armenia will have a significant impact on the local political and administrative configuration, which will in turn affect who receives the payment of land rental from the Amulsar Project. The details of how the consolidation will be applied had not been confirmed at the time of the completion of this ESIA, however, it is anticipated that Gndevaz will effectively become “junior” partners in the larger municipality of Jermuk.

Potential Impacts to Land Rental Payments

As described in Chapter 2, under the Land Code, land rental is payable directly to rural communities and often forms one of the most important sources of revenue for community administration. The Council of Community Elders and the Community Head (often referred to as Mayor) are elected positions with a four-year term of office, hence the community is able to exert influence over the investment decisions made by the community administrators through an electoral process.

The land rents payable by the Project to each of the three rural communities in 2015 are summarised in Table 6.13.6. All of the land rented in 2015 was classified as “industrial” land

with the exception of 621.3ha in Gndevaz (classified as agricultural land).

Table 6.13.6: Annual Land Taxes Paid to Rural Communities, 2015			
	Rural Community		
	Gorayk	Gndevaz	Saravan
Number of hectares rented	245.2	946.6	1,102.7
Annual Amount (AMD)	177,156,668	57,986,155	188,433,163
Amount (USD)	\$369,076	\$120,804	\$392,569

This rental payment is retained by the rural communities, and is used for community projects as defined by the community administration. These rental payments represent major increases in community administration budgets derived from land. This is highlighted in the following figures, which represent the land tax payments made by Lydian to the rural communities.

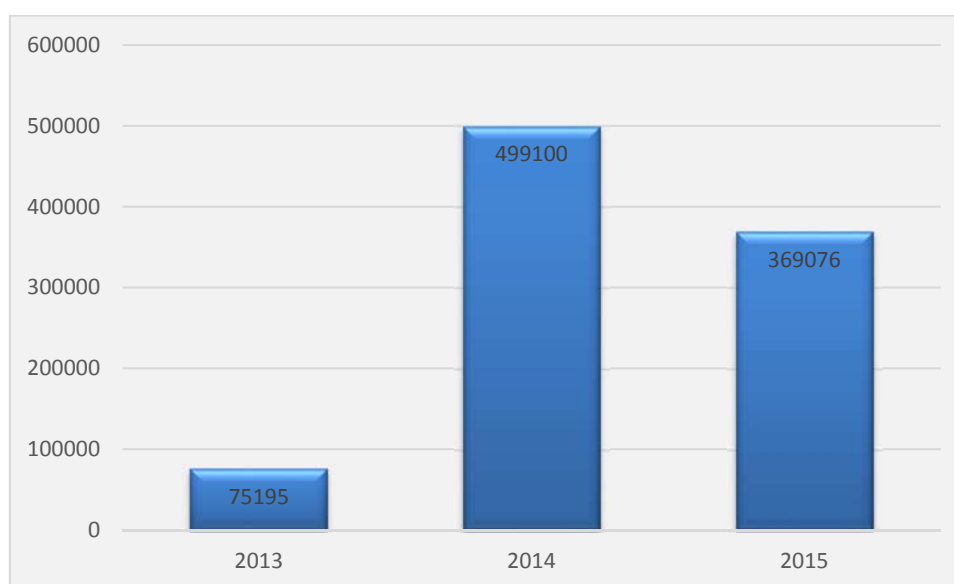


Figure 6.13.3: Gorayk Land Tax Payments by Lydian (USD)⁵

⁵ USD values for land rental have reduced from 2014 to 2015 primarily due to exchange rate changes between the USD and Armenian Dram.

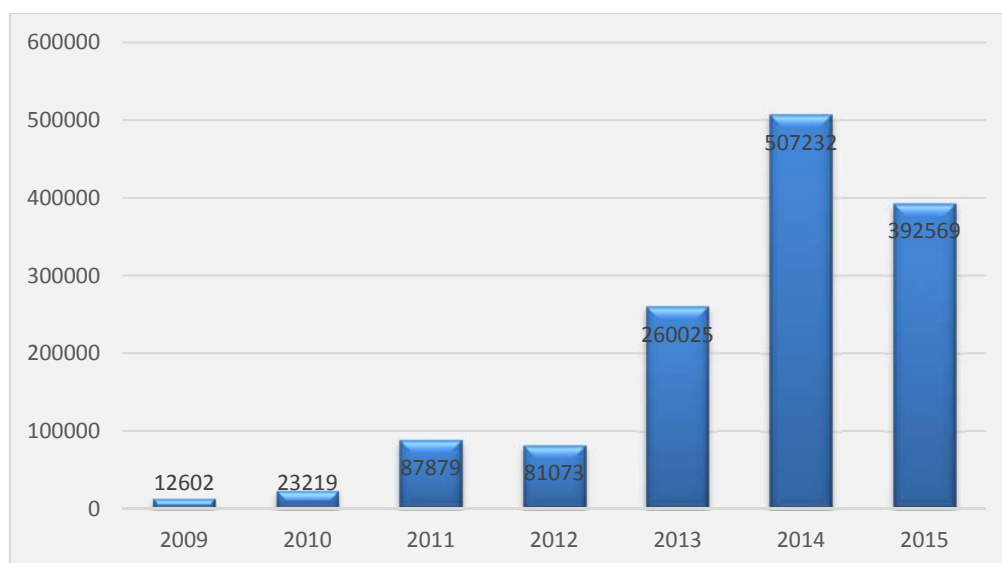


Figure 6.13.4: Saravan Land Tax Payments by Lydian (USD)

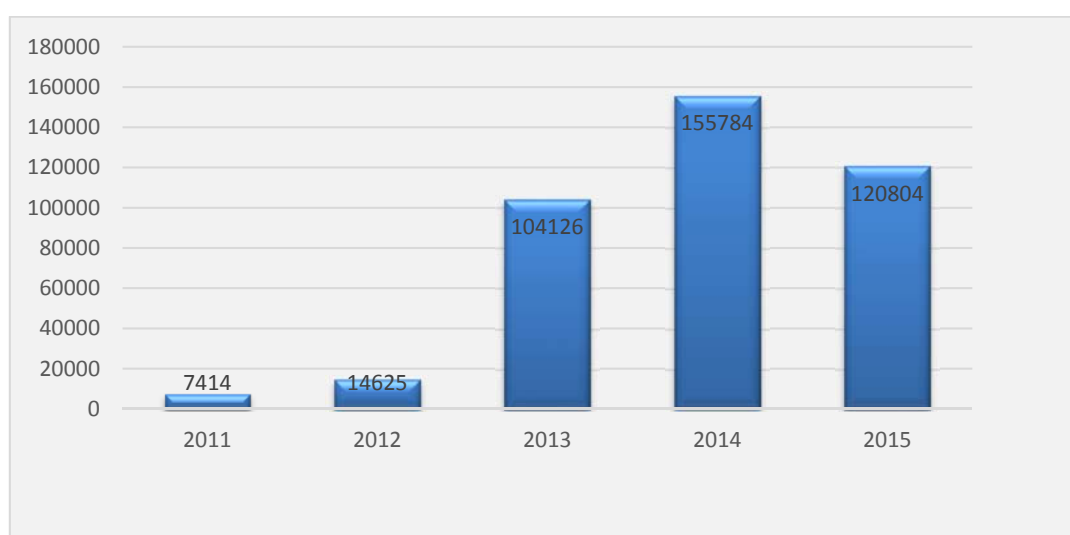


Figure 6.13.5: Gndevaz Land Tax Payments by Lydian (USD)

Under Armenian law, there is no provision or regulation that mandates local governments receive (either directly or indirectly via transfers) any other revenues from mining. While the land rental figures represent large increments in the income of the rural communities (ranging from 4 to 40 times what they receive from state sources), they are, in absolute terms, still relatively moderate payments for a community to manage. Similarly, the cessation of land rental payments associated with mine closure will also be moderated through the relatively modest amounts being paid.

Community administrators will need increased support in managing larger budgets, and

without support there is a risk that the income could be misspent or poorly managed and/or that this could generate conflict with other administrations that are not getting an increase in land taxations.

Mitigation Measures for Land Rental Payment Impacts

Increase in land rent is a positive outcome for communities renting the land. The transition to different land classifications has substantially increased the revenues for rural communities. However, the disparity between the increases in rental payments means that two of the rural communities (Gorayk and Saravan) will have substantial inflows of cash relative to the third (Gndevaz). This disparity will be reduced however by the land acquisition process which will occur within Gndevaz, affecting their economy in a different manner (predominantly through private land sales). The effect of the municipal consolidation process on the Gndevaz beneficiaries of the land rental payments is as yet unknown, but is expected to dilute the control over funds by the rural communities.

In situations where small communities and local administrators are expected to receive (or have already started receiving) large revenues from mining projects, it is good practice to implement a revenue management scheme with the affected administrators to train them in transparency and accountability and budget planning. An IFC Revenue Management expert has visited the Amulsar Project to assess the situation and provide guidance to the Project on how best to manage this impact. Given the relatively moderate scale of the land rental payments and the likelihood of change within the community administration structure, the expert advised against an ambitious revenue management program⁶.

In 2013, Lydian facilitated a financial capacity building training course for the Mayors of the four communities. To further target this assistance, Lydian will focus on providing access to community administrators to ensure they have a “voice” and are in a position to operate effectively in consolidated local government structure. Activities will include: building capacity of community administrators so they are well informed and trained on relevant issues (e.g. budget issues, relevant laws and regulations), and provision of information on the

⁶ This recommendation was made on the three counts: 1) the amounts received, although important for the local governments, are relatively small and they are not expected to increase significantly over their current levels, 2) the responsibilities of local governments are narrower than those in other countries, and 3) a process of “consolidation” grouping local governments in the near future. The first 2 points mean that no significant investments are likely to be undertaken by local governments to warrant a significant capacity building program. The third that any effort should take into account the upcoming changes.

municipal consolidation process to the communities. This will need to be undertaken through close partnership with the Government bodies and donor groups implementing the consolidation process. Opportunities to partner with donor groups to support this transition will be sought.

In addition to the land rental payments, these communities also receive contributions from Lydian through the community development programmes. The recent increase in the level of revenue received by these communities from land rental payments will provide additional opportunities for communities to implement medium-longer term projects, and to co-invest with Lydian to achieve community needs. Lydian's community development team will work closely with community administrators to build capacity around this medium to long-term budgeting and prioritisation of projects.

Residual Impacts of Land Rental Payments

With the measures described above, and steps that will provide all stakeholders with clear information on the changes in local rural budgets, the land payments will be a moderate improvement on the existing situation. Through applying medium term financial management approaches, this revenue could potentially be used by community administrators to remedy challenges faced by their communities at present. The residual impact of these land rental payments will be significantly altered by the changes (yet to be defined) associated with municipal consolidation.

Table 6.13.7: Impact Analysis, Land Rental Payments						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Local Taxes and Land Payment	Positive	Moderate	Local	Medium term	Moderate (positive)	Moderate (positive)

Table 6.13.8 summarises Project impacts on economics.

Table 6.13.8: Impact Summary - Economics						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Macroeconomic effects	Positive	High	National	Medium term	Moderate (Positive)	Major (Positive)
Local Inflation	Negative	Moderate	Local	Medium term	Moderate (negative)	Moderate (negative)
Land Rental Payments	Positive	Moderate	Local	Medium term	Moderate (Positive)	Moderate (Positive)

6.13.5 Monitoring and Audit

As described above, mitigation measures that relate to managing economic impacts from the Project will be addressed in a number of management plans. Table 6.13.9 outlines monitoring indicators which will be used and developed further to assess the effectiveness of mitigation measures.

Table 6.13.9: Mitigation Summary Table

Section	Mitigation	Monitoring Indicator	Management Plan
6.13.1 Macroeconomic effects	<p>Lydian will comply with IFC requirements to report on all taxes, royalties and government payments. This disclosure is part of the EITI process and is required by the IFC for new extractive industry projects.</p> <p>The Project will also prioritise local procurement to enhance the macroeconomic contribution of the Project.</p>	<ul style="list-style-type: none"> Royalty, tax and profit sharing payments reported annually. Proportion of procurement which is undertaken with Armenia 	Environmental and Social Management Plan
6.13.2 Contribution to the Local Economy	See Table 6.21.2 Summary of pre-mitigation and post- mitigation		
6.13.3 Inflation	<p>Lydian will monitor prices for staple basket of goods on a monthly basis. This will be focused on Jermuk, as well as in other areas of the regional area of influence to determine if inflation is a localised impact related to the Project or may have other causes.</p> <p>Lydian will work with tourism operators and hotel owners in Jermuk to ascertain an appropriate room rental fee which will be supportive of their businesses, without overly influencing the average room prices for tourists in the town</p> <p>Geoetam will monitor salary levels paid to its staff on an annual basis to ensure it is not causing inflation within the labour market.</p> <p>Lydian will monitor house prices (rental and sale price) in Jermuk and Gndevaz to assess potential impacts to housing market. Lydian will assist village administrators to plan for expansions as required.</p> <p>Lydian will support agricultural technical assistance projects to increase supply and to boost economic returns for local producers.</p>	<ul style="list-style-type: none"> Basket of goods identified and prices monitored on quarterly basis. Hotel room rates and apartment rental and sale price monitored in Jermuk Salary levels for standard positions in mining company Bi-annual analysis of agricultural productivity and economic returns (small-scale survey) in affected communities Follow-up on outcomes from targeted technical support to small producers 	<p>Environmental and Social Management Plan</p> <p>Human Resources Management Plan</p>

Table 6.13.9: Mitigation Summary Table

Section	Mitigation	Monitoring Indicator	Management Plan
	If prices are still seen to be rising in the local area of influence, Lydian will consider additional technical support which may include providing producers with better access to markets and business skill training for small producers		
6.13.4 Land Rental Payment Impacts	Lydian will continue to facilitate capacity building for community administrators to assist them with medium term budgeting and to manage the consolidation process.	<ul style="list-style-type: none"> • Training sessions attended by community administrators • Level of co-investment from Lydian and communities on community priority projects 	Environmental and Social Management Plan , Stakeholder Engagement Plan

6.13.6 Conclusions

The Impact assessment has been carried out to assess the effects of construction, operation and closure of the mine on economics. Key findings are summarised below:

- Impacts fall into four main categories: macro-economics (including royalties, taxes and profit sharing), contribution to the local economy, local inflation, and land rental payments. All of these impacts are expected to be medium term during construction and operational phases of the Project.
- Macro-economic impacts are likely to have a moderate positive impact before mitigation measures are considered and a major positive impact following the implementation of mitigation measures. Mitigation for macro-economic impacts focus on transparency and disclosure of financial transactions. At a national level, this will include disclosure and accountability in accordance with EITI standards.
- The Project's contribution to the local economy is expected to be seen as a positive economic contribution (n.b. the social impacts of this contribution are considered in other parts of this ESIA) so long as it is maintained at a level which does not "crowd out" existing tourism activity.
- Local inflation will have a moderate negative impact prior to mitigation, and this will remain a moderate negative impact after mitigation. Mitigation measures are embedded in the project design (through consideration of salary levels and accommodation planning) and in the agricultural technical assistance programmes directed at increasing productivity and economic returns for small producers.
- Land rental payment impacts will vary depending on the outcome of the municipal consolidation process. Under the current administrative structure, they are likely to have a moderate positive impact before mitigation and a moderate positive impact after mitigation.

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6.14 Labour and Working Conditions

The following topics are considered in this chapter:

- Direct employment;
- Indirect employment and procurement;
- Working Conditions.

6.14.1 Direct Employment

Project Activities Affecting Direct Employment

The Project will employ (either directly or through contractors) a peak workforce of approximately 1300 during the construction period. The construction period will last for two years. Direct employment generated by the Project will reduce to an estimated 657 workers for the operational period, which will continue for an estimated 10 years.

Anticipated manpower schedules have been developed for the construction period (see Figure 3.25). Table 6.14.1 provides a breakdown of the operational personnel requirements, illustrating the dominance of mining related roles. As described in Chapter 3, much of the bulk earthworks associated with the HLF and BRSF will be undertaken by personnel operating Company owned equipment, however local Armenian contractors will be used to supplement the Company equipment where additional or specialised equipment is required.

Table 6.14.1: Summary of Operations Personnel Requirements	
Department	Number of Personnel
Mining	315
Processing	199
General and Administration	133
Laboratory	10
Total	657

Potential Direct Employment Impacts

Opportunities for salaried employment in the host communities are currently limited due to the economic environment, raising the value attributed to new salaried jobs in the area. Rural communities reported that approximately 35% of their income was derived from salaried employment in 2010 (this would have included the approximately 50 people working for the Project at the exploration stage due to the time of the survey¹).

¹ This figure has increased since the time of the survey, with 94 contractors recruited from the local area in addition to the Lydian workforce of 31 as at July 2014.

Construction Phase

The construction period will last for two years and will require a peak workforce of approximately 1300 workers (see Figure 3.25). The nature of construction work typically requires a high proportion of skilled or semi-skilled labour. Given the limited experience of mining project construction work within the host communities, 30% local employment is anticipated during this time. The training programme led by Lydian will be targeting operational roles which provide longer term opportunities rather than short-term construction opportunities. Construction is anticipated to be a mixed contracting approach with a Project Construction Management (PCM) contractor overseeing a number of local contractors. It is likely that the PCM will be a foreign company.

Operations Phase

Of the proposed 657 operational roles, it is anticipated that 30% (just under 200 roles) could be filled by residents from the local area and the broader region, including both the rural and urban communities. Access to these opportunities will be improved through the implementation of the Lydian training programme. This would be expected to significantly increase the proportion of income derived from direct salaried labour in these communities.

Closure Phase

Mine closure will result in the retrenchment of the vast majority of employees. Employee retrenchments will be staggered, reducing to a closure workforce of approximately 20 people within 18 months of the cessation of mining operations.

The salaries paid by the Project will be in line with national norms for mining projects, making them considerably higher than the average salaries in the host communities at present, as discussed in Chapter 6.13. The benefit of direct employment is likely to disproportionately affect men within the local communities.

Direct employment and new jobs are generally considered a positive social impact. However, there are inherent risks common with the development of large industrial projects. Environmental, health and safety standards need to be maintained and labour managed in an appropriate manner. Without well-administered human resource policies, job creation can exacerbate existing social divisions and in some cases generate local conflict if job seekers do not trust that recruitment and human resource decisions are transparent.

Without mitigation measures, poor management of recruitment and employment can create accusations of corruption, jealousy and conflict. This dynamic may be heightened in the local area where residents have limited experience with industrial employment and may not fully understand the technical requirements needed for construction and operation of a mine. The mixed direction of direct employment impact is the primary factor in only assessing a minor (positive) impact prior to mitigation.

Mitigation/Enhancement of Direct Employment Impacts

To ensure that the benefits are maximized and positive, Lydian will adhere to the international guidelines set out by the International Labour Organisation (ILO), IFC Performance Standard 2 and EBRD's Performance Requirement 2. Such mitigation steps include:

- Implementation of the existing Human Resources Policy (Chapter 8), which represents the main internal policy for managing and developing staff. The policy includes information on the following key elements:
 - Personal Conduct
 - Non-discrimination
 - Recruitment
 - Induction
 - Training
 - Probation
 - Medical and life insurance schemes
 - Travel and expenses
 - Occupational health and safety
 - Equal employment opportunity
 - Leave policy
 - Performance management
 - Performance improvement
 - Grievances
- Ensuring all employees (including contractors) have clear documentation of their working relationship; and

- Developing clear policy statements that forbid any form of child or forced labour².

The main instrument used to provide documentation of the working relationship is the existing Employment Contract, a document given to every employee at the time of hire. The Employment Contract is written in parallel in Armenian and English languages and includes the following key information:

- Employment conditions;
- Remuneration;
- Employer and employee rights and responsibilities;
- Leave;
- Liabilities, contract period and termination; and
- Dispute resolution.

Armenia has ratified the core Conventions of the ILO related workers' right to organise. Both CO87 – Freedom of Association and Protection of the Right to Organise and CO99 - Right to Organise and Collective Bargaining Convention are in force. These rights are further stated in Lydian's Human Resources Policy: "Lydian recognises the rights of the employees to form and to join any workers' organizations of their choosing, without interference, and have the right to bargain collectively. Lydian does not restrict employees from developing mechanisms to express their grievances and protect their rights regarding working conditions and terms of employment, without interference from the Company. Any such workers' organizations are expected to fairly represent the workers in the workforce".

Lydian will document efforts to explain to contractors and suppliers that they must conform to the international guidelines related to child and forced labour. If there is a specific risk of child, bonded or forced labour within a primary supply chain, steps will be taken to assess the risk and develop measures to minimise it.

Similarly, Lydian will document efforts to explain to contractors and non-employee workers that the key elements³ of ILO, IFC Performance Standard 2 and EBRD Performance

² Article 35 of the Constitution of the Republic of Armenia states that persons under the age of 16 are not allowed to work in a full-time capacity. Lydian will impose a more restrictive standard, not allowing anyone to work on the Project who is under 18 years of age (unless for summer / vocational training).

³ All elements of PS2 are applicable to contractors with the exception of sections related to retrenchment and supply chain.

Requirement 2 are relevant for non-employee workers. This will include using commercially reasonable efforts to incorporate these requirements into contractual agreements.

In cases where a Lydian contractor does not have a formal grievance procedure, Lydian will inform the contractor's workers of their internal policy and invite contractors to use its own Grievance Mechanism to raise worker complaints. Where contractors have their own grievance mechanism, they will be required to report grievances they receive and actions taken to resolve them to Lydian within a timely manner.

Lydian has a Human Resources Policy and subsidiary Local Recruitment Procedure (Appendix 8.4 & 8.25). The Human Resources Policy confirms the company's commitment to non-discrimination and to select workers based on performance, professional behaviour and their approach to safety. The policy and recruitment procedure give priority, other factors being equal, to selecting workers from the local area. The Local Recruitment Procedure defines a clear hierarchy of hiring preference:

- Recruitment decisions will be made upon merit, commitment to safety and personal behaviour. Within this context, local recruitment will be prioritised. If the skills are not held locally, regional candidates will be prioritised. If the skills are not held regionally, Armenian nationals will be given priority over foreign applicants. The following definition apply within this procedure:
 - *Local* - For the context of this procedure, "local" is defined to include people normally resident in the villages of Gndevaz, Saravan, Gorayk and Kechut/Jermuk. It also includes those people who originate⁴ from these villages but have moved away to seek employment in other places (e.g. internal migrants etc.).
 - *Regional* – For the context of this procedure, "regional" includes people who are normally resident in Syunik Marz or Vayots Dzor Marz.
 - *National* – Refers to all people who normally reside in Armenia.

Lydian faces a common challenge of similar mining projects to meet the high expectations for employment with nearby residents who may have little technical training in the skills needed for the operation of an industrial mine. A register of skills held within the local communities

⁴ To be considered to "originate" from a village, an individual must have been born and raised within the village.

will be developed during construction and maintained at all times and used as the basis for recruitment decisions. To enhance the likelihood of local (and regional) residents gaining direct employment with the Project, a training programme will be rolled out which offers access to technical training over a fixed time period. The development of this training programme is being informed by the results gained from the skills survey conducted in June 2014 (see Section 4.17 for discussion of results). The training programme will focus on building skills within the local community to enhance local employability during the operation period. At the professional level, since 2010, Lydian has supported the university tuition fees for students from the three nearby settlements to study geology and mine engineering. This opportunity will be expanded and opened to others in the region⁵.

A key means for addressing the high expectations will be through a proactive stakeholder engagement programme, which will continue to be managed by the Social Development Programs Manager and the Community Liaison Officer (CLO). These key managers will work with the human resources department, local leaders in Vayots Dzor and Syunik and residents of nearby communities to create a realistic strategy for attracting and retaining local workers. This iterative communication process includes explaining to local residents the types of jobs available and why more skilled positions require higher levels of education and technical training. This process will also form the basis for the consultation which will need to occur in preparation for mine closure.

Mine closing planning involves detailed human resource planning, including retrenchment considerations, and the opportunity for re-training for employees to enhance their employment and livelihood prospects post mine closure. The transition from construction to operations will also generate a significant reduction in workforce size, and will again require retrenchment planning to be put in place. The full local effect of the retrenchments associated with the cessation of construction and commencement of operations may be reduced through the comparatively limited number of local employees anticipated during the construction period. Contractor employee retrenchment considerations will also be addressed in the Contractor Management Plan (in development). Retrenchment plans will be developed to be consistent with EBRD's PR 2.17 and IFC requirements.

⁵ Eleven students had received support through this programme between 2010 and 2013. The programme is ongoing.

Residual Impacts of Direct Employment

The impacts of direct employment vary considerably across the construction, operations and closure phases. While the construction phase will generate the largest employment requirement, it is expected that 70% of this employment will be filled by workers recruited from outside the Project area due to the skills required for the work programme. As such, this is considered a moderate positive impact. Direct employment during operations is also likely to generate a moderate positive impact for a period of 10 years. With mine closure, there will be a significant negative impact on direct employment which is likely to be felt over a 12-18 month period as positions are retrenched, which with mitigations in place will be a moderate impact. Training received and professional development will benefit individuals and the economy beyond the estimated life of the mine.

Table 6.14.2: Impact Assessment, Direct Employment						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Direct Employment - construction	Mixed	Moderate	Regional	Short Term	Moderate (positive)	Moderate (positive)
Direct Employment - operations	Mixed	Moderate	Regional	Medium term	Moderate (positive)	Major (positive)
Direct Employment - closure	Mixed	Moderate	Regional	Long-term	Major (negative)	Moderate (negative)

6.14.2 Indirect Employment and Procurement

Project Activities Affecting Indirect Employment and Procurement

Indirect employment refers to the additional employment generated by an institution's economic activities. Indirect employment is likely to be more significant during the operations phase than during the construction phase.

The introduction of around 657 operational wage earners to the host communities, with a target of recruiting 30% from the local and regional areas, will prompt the development of service activities and industries which will in turn generate expanded employment opportunities as a multiplier effect. There is no formally defined multiplier effect for a project of this nature in rural Armenia; however, general equilibrium modelling conducted by Avag Solutions Consultants suggests induced employment could be as high as 3,900 people across Armenia during the operations phase. Note, these estimates of induced employment do not account for productivity improvement, so likely over-estimate the induced employment

levels. Regardless, this modelling suggests that an assumption of one new job being generated at a national level for every Project job is a conservative estimate.

Locally, indirect employment will be enhanced through the accommodation of up to 370 workers in hotel accommodation during construction and between 500-920 in a construction camp, and approximately 250 employees in hotel accommodation in Jermuk during the operations period. A detailed assessment on worker accommodation impacts was undertaken during Q1/2 2016 and is reported in Chapter 6.21.

An additional 210 workers (potentially with their families) are expected to migrate into the area during operations. These employees and any families moving in to Jermuk or Gndevaz in order to work on the Project are likely to stimulate the local economy, potentially providing ballast for Jermuk through the highs and lows of the tourism seasons.

Indirect employment opportunities can also expand through the development of local markets or the improvement of access to larger markets allowing local traders to benefit from the economic expansion. This may be proactively sought after through support from Lydian to assist farmers and cultivators with access to markets and productivity improvements.

Potential Indirect Employment and Procurement Impacts

The multiplier effects related to the Project and in-country investment through the process of procurement for goods and services is considered to be a positive impact. The introduction of a significant wage-earning base into the local economy is anticipated to generate considerable indirect employment (at least equitable to the size of the operational workforce). These opportunities will include: base-load of hotel occupancy in Jermuk during operation periods (and potentially during construction depending on the size of the construction camp which is selected), expansion of restaurants and entertainment facilities in Jermuk, opportunities for rental of accommodation in Jermuk in particular, and increased sales of local consumption items. It will also increase the size of the economic activity at a more general level across the nearby communities. The two year construction period and 10 year operational life will allow sufficient time for enterprises to develop and to transition towards a diversified and independent income stream during the life of the mine. Initially, these suppliers may be potentially heavily reliant upon sales to Amulsar workers or as suppliers for the Project. Unmanaged, the closure of the mine is likely to have a significant negative impact on indirect employment opportunities, however this can be moderated

through transition processes put in place during the operational life of the mine.

Currently, producers of agricultural goods in the host communities have difficulty marketing their goods due to their relative geographical isolation. The expansion of the local economy through the addition of significant new wage earners, and regular transport between Yerevan and the host communities, is anticipated to make it easier for these communities to link into larger markets and to be in a better position to negotiate over prices (at present sale prices are reported to be diminished in the area as national buyers apply a transport cost to the transactions). The daily need for meals for the workforce is also a great opportunity.

As noted above, approximately 250 workers will reside year-round (although each individual will be on rotation, the rooms will be occupied year-round) during the operations period in Jermuk. This hotel occupancy will help make Jermuk feel occupied and alive across the tourism low-season as well as high-season. This is expected to convert a small proportion of the 450 seasonal tourist jobs into year-round employment opportunities.

The Project has recruited a procurement manager to develop detailed procurement requirements, and is expected to continue the company policy of prioritising local procurement where possible. In the exploration period this has prompted the award of a catering contract for the exploration camp to a resident of Gorayk village; a garbage collection contract (for the exploration camp and the rural communities) to a local supplier in Sisian and Vayk towns; establishment of a sewing contractor to prepare sample bags for the exploration activities in Gndevaz; the creation of three major tree nurseries in Gndevaz (1) and Saravan (2); and use of local labour to plant trees in the area to minimise the visual impact of the project.

The impacts from indirect employment and procurement are expected to reflect a moderate improvement on the current situation during operations and even into mine closure. The multiplier effect associated with creating more salaried employment is likely to develop additional economic activity, even if it is difficult to predict exact figures.

Mitigation/Enhancement of Indirect Employment and Procurement Impacts

The key limitation for indirect employment and local procurement is the lack of capacity (either human or financial) to deliver the required service or product.

Lydian has developed a Supply Chain & Logistics - Local Business Initiative (SCL-LBI) programme. The objectives of SCL-LBI programme are to:

- Provide opportunity for local business participation by maximizing the use of the sourcing process for goods and services that are within the capacity and capability of local businesses;
- Ensure that major, non-local contractors and suppliers follow the same principles and procedures to maximize local opportunity and participation when sourcing and managing their sub-contractors and sub-suppliers;
- Emphasise the LBI programme requirements needing consideration and inclusion of requirements into the various activities associated with sourcing and management of goods and services, and disposal of certain goods;
- Focus on planning and packaging goods and services requirements in a manner that is LBI programme suitable, which includes classifying suppliers and contractors based on geographical origin, capability and goods and services suitability;
- Over time, to build capacity and capability of local businesses to increase participation in Lydian's operations, but also to support sustainability post operations closure; and
- Provide a sense of transparency and inclusivity to the local procurement process.

The LSC-LBI defines local, regional and national business, which it will use in targeting businesses closest to the operation as part of the criteria in selecting suppliers. Key steps will include forming a dedicated team that will further develop the LBI governance, goals, communication plan, reporting criteria and key performance indicators. The team will assess local business capability and capacity and target opportunities that would be suitable for these businesses.

Working with other managers, a guideline on "How to do Business with Lydian" will be developed. This will be done in cooperation with local authorities, financial institutions, NGOs and media.

Lydian will establish and maintain a prospective supplier register and prepare a qualified bidder list. The list will enable the identification of local businesses that may not be able to

show full compliance with Lydian's requirements, but can demonstrate initiative to do so if given support.

At the completion of the bidding process, proposals will be evaluated using a number of criteria that will include, but not be limited to:

- Proximity to the Project and impact on the community and local businesses;
- Demonstrated understanding of the scope of work;
- Health and safety standards;
- Previous history of performance or provision of similar goods or services;
- Capability and capacity to fulfil the requirement;
- Price; and
- Quality.

To ensure that all contractors and sub-contractors maximise the contribution to the local economy, local procurement requirements will request information on contractor's methods and processes to recruit locally with reporting on local employment on an annual basis. The skills survey results and register developed by Lydian will be shared with contractors to support this process. For any procurement to occur from somewhere outside of the host communities, a justification for why the procurement could not occur locally will be required.

Residual Impacts of Indirect Employment and Procurement

Detailed plans in the SCL-LBI will aim to identify and solve many of the barriers that would keep local, regional and businesses from participating in the Lydian procurement process. These efforts, as well as the commitment to monitor and track procurement, will increase the overall significant of impact to be moderate (positive). If training initiatives are implemented, the increased professionalism of businesses at every level will likely aid those businesses for longer than the duration of the mine life itself.

Table 6.14.3: Impact Assessment, Indirect Employment and Procurement						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Indirect Employment and Procurement - construction	Mixed	Moderate	National	Short term	Minor (positive)	Minor (positive)
Indirect Employment and Procurement - operation	Mixed	High	National	Medium term	Moderate (positive)	Major (positive)
Indirect Employment and Procurement - closure	Mixed	Low	National	Long term	Minor (positive)	Minor (positive)

6.14.3 Working Conditions

Project Activities Affecting Working Conditions

Amulsar Project will employ a peak of around 1300 people during construction and is expected to have an operational workforce of 657. All labour will be hired in a manner consistent with Armenian law and a safe and healthy work place will be provided for employees and contractors. It is outside the scope of this ESIA to detail the employee health and safety considerations put in place for the project. Notwithstanding this, an initial Occupational Health and Safety Plan has been prepared (Appendix 8.7) with additional details to be covered in the Health and Safety Management Systems which will be developed for construction and operations⁶. The focus of this section rests on the construction and operation accommodation plans for the Project, and further detail on this topic can be found in Appendix 8.25.

Potential Working Condition Impacts

Construction Phase

During construction, between 500 and 920 non-local workers (employees and contractors) will reside in a temporary worker accommodation camp, with any overflow being accommodated in hotel accommodation in Jermuk. The size of the camp is yet to be

⁶ An Health and Safety Management System (HSMS) will be developed to be in compliance with IFC's PS, the EHS Guidelines (General and Mining) and EBRD's Performance Requirement 4 "Health and Safety".

confirmed, however, the maximum use of Jermuk hotel accommodation during the construction period will not exceed 370 beds (see Chapter 6.21). The worker accommodation camp would be managed as a closed facility and all employees staying in the camp will work on a roster returning to their point of origin with sufficient frequency to maintain family connections. The remaining 380/390 construction phase employees are assumed to be sourced from local communities and it is anticipated that they will continue to reside in their existing accommodation.

Operations Phase

During operations approximately 250 workers will be accommodated in hotels in Jermuk. These workers will be working on a rotational roster, returning to their families on a regular basis. The remainder of the operational workforce are expected to reside within commuting distance of the Project site in their own accommodation with their families.

Ideally, all workers would be accommodated with their families in their town of origin. Given the personnel requirements for the Project during construction and operations, this will not be possible. A number of options exist to address the accommodation requirements for the Project: construction of new houses; construction of a long-term 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 not pursued as they would likely fall into dis-use post mine closure. Instead, the Project has been designed using a hybrid approach, with a camp being used to accommodate the bulk of the temporary workforce during construction, coupled with hotel accommodation. During operations, hotel accommodation will also be used, coupled with the anticipated in-migration of workers and their families into the Project area. The camp and hotel accommodation options are temporary accommodation solutions for workers, and all workers accommodated in this manner will be working on a rotation basis to ensure they have contact with families and their point of origin. Those families who are expected to migrate into the Project area during the operations period are expected to reside in the area for the period of their employment contracts.

The provision of accommodation and basic services to workers, if unmanaged, has a number of potential impacts, including:

- Discriminatory practices – The allocation of accommodation can be open to

discrimination if standards vary across the workforce. This does not imply that all rooms must be identical, however the basis on which the decision for room allocation is made needs to be transparent.

- Restriction of workers' rights – Company control over accommodation has the potential to curtail or restrict workers' rights and freedoms.
- Housing standards⁷:
 - Space – Accommodation must be planned and managed to ensure that all workers have a specified minimum space per person that includes the provision of their own bed and separate gender based accommodation. Accommodation designs also need to ensure that space is allocated for common dining rooms, canteens, rest and recreation rooms and health facilities.
 - Access to water – the camp and accommodation options must be designed to ensure that workers have sufficient access to safe water in quantities required for their personal needs.
 - Sewerage and garbage disposal – Worker accommodation will generate sewerage and garbage disposal requirements which need to be managed in a manner which does not overload existing systems (if connected to a municipal system) or can be managed independently (if in an isolated area). The construction camp will need independent systems, and the needs of Jermuk hotel accommodations have been taken into consideration.
 - Health and safety – The same level of care applied to the construction of the mining infrastructure needs to be applied to the accommodation options to ensure a safe and healthy living environment for employees. This includes consideration of fire, seismic, flooding and other hazards.

Working condition impacts are considered potentially negative impacts prior to mitigation.

Mitigation/Enhancement of Working Conditions Impacts

The effective management of working conditions is a core element of Lydian's operational philosophy. The accommodation options which have been chosen by the Project were selected for a number of reasons, including: the local setting and its ability to absorb new

⁷ IFC, EBRD (2009) Workers' Accommodation: Processes and Standards, www.ifc.org, accessed June 2013

accommodation structures; inflationary pressures upon house prices in the local area; management of influx and social issues; health and safety considerations for workers and cost considerations. For the options selected, the following mitigation measures will be applied (see also Chapter 6.21):

- Accommodation at both the temporary construction camp and hotels will be designed to ensure all workers have a minimum of 5.5m² of floor space each, in a room with a minimal roof height of 2.1m. Hotel rooms which do not meet this requirement will not be rented by the Project.
- Room occupancy levels will be minimised, with no more than four people sharing any single room and all residents will have their own bed (hot-bunking will not occur). If double-bunks are used, a minimum space of 1m between bunks will apply and all beds will be at least 1m apart.
- The accommodation will be designed so that males and females have separate rooms and sanitary facilities, of equitable standards.
- The accommodation will be designed so that a minimum temperature of 20° Celsius can be maintained during the cold winter months in Armenia. Hotel rooms which do not meet this requirement will not be rented by the Project.
- Catering will be established at the camp and the hotels to ensure food meets the tastes of the majority of residents. Camp residents will have an opportunity to influence catering choices through suggestions boxes and other feedback processes. The Company will engage with catering services at hotels to ensure food supplied meets the requirements of the workforce and is largely equitable with the catering at the camp and across other hotels. Further detail on nutrition is covered in Chapter 6.18.
- Worker accommodation management considerations have been further refined/detailed by Lydian in a Worker Accommodation Management Plan (see Appendix 8.25)
- The camp will be a closed dry camp, meaning that workers will not be able to leave the camp at their discretion during their work rotation, with the exception of going to work on the Project. A closed camp has the advantages of minimising the impact of a large construction workforce on host communities, however, the rights of the workers' also need to be considered. To manage this restriction on workers' liberties during their work rotation, leisure and recreational facilities, including and gym and entertainment facilities, will be provided within the camp.
- Hotel accommodation will be an open form of accommodation, i.e., workers will be

free to leave their hotels at their discretion and will likely make use of the leisure and recreation facilities in Jermuk. In the absence of recreation and leisure facilities within Jermuk (e.g. a gym) workers residing in hotels may be granted access to camp facilities.

- The construction camp will be constructed with a packaged wastewater treatment plant suitable to camp capacity. Jermuk's sewerage system will be used for the management of wastewater from workers resident in hotel accommodations.
- Domestic garbage from the camp and hotels will be disposed of in the Project landfill to avoid adding to the existing municipal waste challenges experienced in Jermuk and the rural villages. An incinerator could be also procured.
- As noted in the Human Resources Policy, Lydian respects and supports workers' right to organise and will ensure that the accommodation controls put in place do not restrict workers' freedoms.
- Equitable conditions will be applied across all accommodation options to the extent possible. Where variations in conditions exist, the Project will endeavour to ensure that workers of similar positions are accommodated in an equivalent manner. The worker grievance mechanism will be a key mitigation to understand if worker conditions are considered inequitable or unacceptable by workers.

Residual Working Conditions Impacts

Through the implementation of appropriate conditions in workers accommodation and the development of additional detail in the Worker Accommodation Management Plan (Appendix 8.25), the residual working condition impacts are considered to be Moderate, as shown in Table 6.14.4.

Table 6.14.4: Impact Assessment, Working Conditions						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Working Conditions	Negative	Moderate	Local	Medium term	Moderate	Moderate

Table 6.14.5 and Table 6.14.6 summarise Project impacts on labour and working conditions.

Table 6.14.5: Summary of Impacts on Labour and Working Conditions						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Direct Employment-construction	Mixed	Low	Regional	Short Term	Minor (positive)	Moderate (positive)
Direct Employment-operations	Mixed	High	Regional	Medium term	Moderate (positive)	Major (positive)
Direct Employment - Closure	Mixed	High	Regional	Long-term	Major (negative)	Moderate (negative)
Indirect Employment and Procurement - construction	Mixed	Moderate	National	Short term	Minor (positive)	Minor (positive)
Indirect Employment and Procurement - operation	Mixed	High	National	Medium term	Moderate (positive)	Major (positive)
Indirect Employment and Procurement - closure	Mixed	Low	National	Long term	Minor (positive)	Minor (positive)
Working Conditions	Negative	Moderate	Local	Medium term	Moderate	Moderate

6.14.4 Monitoring and Audit

Mitigation measures that relate to managing labour and working conditions related to the Project will be addressed in greater detail in the Worker Accommodation Management Plan. Table 6.14.6 outlines monitoring indicators that will be used and developed further to assess the effectiveness of mitigation measures.

Table 6.14.6: Impact Summary – Labour and Working Conditions

Section	Mitigation	Monitoring Indicator	Management Plan
6.14.1 Direct employment	Such mitigation steps include: <ul style="list-style-type: none"> • Implementation of the existing Human Resources Policy and Procedure Manual; • Ensuring all employees have clear documentation of their working relationship; and • Develop clear policy statements that forbid any form of child or forced labour. 	<ul style="list-style-type: none"> • HR Policy up to date and disclosed as part of worker induction; • Employee contracts up to date; • Policy statements on child and forced labour included in HR Policy; • Number of worker grievances received; • Number of worker grievances resolved; and • Number of worker grievances transferred to court of third party resolution. 	Environmental and Social Management Plan (Chapter 8)
6.14.1 Direct employment	Lydian will document efforts to explain to suppliers that they must conform to the international guidelines related to child and forced labour.	<ul style="list-style-type: none"> • Contracts with suppliers include language on child and forced labour. 	Environmental and Social Management Plan (Chapter 8)
6.14.1 Direct employment	In cases where a Lydian contractor does not have a formal grievance procedure, Lydian will inform the contractor's workers of their internal policy and invite contractors to use its own Grievance Mechanism to raise worker complaints. Where contractors have their own grievance mechanism, they will be required to report grievances they receive and actions taken to resolve them to Lydian within a timely manner.	<ul style="list-style-type: none"> • Contractor grievance procedures available or grievance procedures provided to non-employee workers; • Number of contractor grievances received; • Number of contractor grievances resolved; and • Number of contractor grievances transferred to court of third party resolution. 	Environmental and Social Management Plan, Stakeholder Engagement Plan (Chapter 8 and Appendix 8.6)

Table 6.14.6: Impact Summary – Labour and Working Conditions

Section	Mitigation	Monitoring Indicator	Management Plan
6.14.1 Direct employment	Lydian has drafted and will finalise a Recruitment Policy that confirms the company's commitment to non-discrimination and to select workers based on performance, professional behaviour and ethics and their approach to safety. The recruitment policy gives priority, other factors being equal, to selecting workers from the regional area of influence, defined at the regions of Vayots Dzor and Syunik. If positions cannot be adequately filled from this area, workers will be sought in other areas of Armenia before any recruitment efforts are made for workers from outside the country.	<ul style="list-style-type: none"> Recruitment Policy up to date and disclosed as part of worker induction; and Employment statistics up to date, including: <ul style="list-style-type: none"> Gender statistics Home of record (region and city) Age 	Environmental and Social Management Plan (Chapter 8)
6.14.1 Direct employment	Where local recruits are identified that possess the skills and qualifications that could be integrated with Lydian, staff will refer the potential candidate to the Human Resources department for either direct employment or as a potential candidate into the company's training programmes.	<ul style="list-style-type: none"> Training programme statistics updated and reported, including: <ul style="list-style-type: none"> Gender Home of record (region and city) Age 	Environmental and Social Management Plan (Chapter 8)
6.14.1 Direct employment	A key means for addressing the high expectations will be through a proactive stakeholder engagement programme, which will continue to be managed by the Social Development/Programmes Manager and Community Liaison Officer (CLO). These key managers will work with the human resources department, local leaders in Vayots Dzor and Syunik and residents of nearby communities to create a realistic strategy for attracting and retaining "local" workers. This iterative communication process includes explaining to local residents the types of jobs available and why more skilled positions require higher levels of education and technical training.	<ul style="list-style-type: none"> Number of job advertisements; and Percentage of jobs advertised regionally. Proportion of jobs awarded to "local" residents 	Environmental and Social Management Plan, Stakeholder Engagement Plan (Chapter 8 and Appendix 8.6)

Table 6.14.6: Impact Summary – Labour and Working Conditions

Section	Mitigation	Monitoring Indicator	Management Plan
6.14.1 Direct employment	Since 2010, Lydian has supported the university tuition fees for students from the three nearby settlements to study geology and mine engineering. This opportunity will be expanded and open to other interested in the regional area of influence.	<ul style="list-style-type: none"> University tuition programme statistics updated and reported, including: <ul style="list-style-type: none"> Gender Home of record (region and city) Age 	Environmental and Social Management Plan (Chapter 8)
6.14.1 Direct employment	Transition planning from construction to operations phase, and from operations through mine closure will take account of retrenchment considerations. Contractor required will be built into the Contractor Management Plan	<ul style="list-style-type: none"> Retrenchment plans prepared in advance which include reasonable notification periods for worker's representatives and effective consultation plans 	Contractor's Management Framework (forthcoming) Retrenchment Plan (tbd)
6.14.2 Indirect employment and procurement	Lydian has developed a Supply Chain & Logistics -- Local Business Initiative (SCL-LBI) programme. The LSC-LBI defines local, regional and national business, which it will use in targeting businesses closest to the operation as part of the criteria in selecting suppliers. Key steps will include forming a dedicated team that will further develop the LBI governance, goals, communication plan, reporting criteria and key performance indicators. The team will assess local business capability and capacity and target opportunities that would be suitable for these businesses.	<ul style="list-style-type: none"> Governance, goals, communication plan and reporting criteria developed. 	Environmental and Social Management Plan (Chapter 8)
6.14.2 Indirect employment and procurement	Working with other managers, a guideline on "How to do Business with Lydian" will be developed. This will be done in cooperation with local authorities, financial institutions, NGOs and media.	<ul style="list-style-type: none"> "How to do Business" developed and disclosed. 	Environmental and Social Management Plan (Chapter 8)

Table 6.14.6: Impact Summary – Labour and Working Conditions

Section	Mitigation	Monitoring Indicator	Management Plan
6.14.2 Indirect employment and procurement	Lydian will establish and maintain a prospective supplier register and prepare a qualified bidder list. The list will enable the identification of local businesses that may not be able to show full compliance with Lydian's requirements, but can demonstrate initiative to do so if given support.	<ul style="list-style-type: none"> • Supplier register up to date. • Number of local businesses referred for additional support. 	Environmental and Social Management Plan (Chapter 8)
6.14.2 Indirect employment and procurement	To ensure that all contractors and sub-contractors maximise the contribution to the local economy, local procurement requirements will request information on contractor's methods and processes to recruit locally with reporting on local employment on an annual basis. The skills survey results and register developed by Lydian will be shared with contractors to support this process. For any procurement to occur from somewhere outside of the host communities, a justification for why the procurement could not occur locally will be required.	<ul style="list-style-type: none"> • Contractor records to include information on methods to process and recruit locally. 	Environmental and Social Management Plan (Chapter 8)

Table 6.14.6: Impact Summary – Labour and Working Conditions

Section	Mitigation	Monitoring Indicator	Management Plan
6.14.3 Working Conditions	<p>Accommodation size standards have been defined and will be maintained across the project.</p> <p>No more than 4 people will share any single room and hot-bunking will not occur.</p> <p>Males and females will have separate rooms and sanitary facilities</p> <p>Catering will be provided for camp and hotel residents. The Company will engage with catering services at hotels to ensure food supplied meets the requirements of the workforce and is largely equitable with the catering at the camp and across other hotels</p> <p>In the absence of recreation and leisure facilities within Jermuk (e.g. a gym) workers residing in hotels may be granted access to camp facilities.</p> <p>Equitable conditions will be applied across all accommodation options to the extent possible. Where variations in conditions exist, the Project will endeavour to ensure that workers of similar positions are accommodated in an equivalent manner.</p> <p>The worker grievance mechanism will be a key mitigation to understand if worker conditions are considered inequitable or unacceptable by worker</p>	<ul style="list-style-type: none"> • Camp and hotel audits • Kitchen audits • Worker grievance reports 	<p>Environmental and Social Management Plan (Chapter 8) and Worker Accommodation Management Plan (Appendix 8.25)</p>
6.14.3 Working Conditions	<p>Camp will be a “dry camp” and will be closed.</p>	<ul style="list-style-type: none"> • Compliance audits • Random sampling 	<p>Occupational Health and Safety Plan (Appendix 8.7)</p>

6.14.5 Conclusions

The Impact assessment has been carried out to assess the effects of construction, operation and closure of the mine on labour and working conditions. Findings are summarised below:

- Impacts fall into three main categories: direct employment, indirect employment and working conditions;
- Impacts on direct employment and indirect employment vary across the three phases of the project: construction, operation and closure. Direct employment will be a moderate positive impact during construction, a major positive in operations and a moderate negative with the retrenchments associated with closure. Indirect employment will provide a minor positive impact in construction, a major positive impact during operation and a minor positive during closure. Impacts on working conditions will be medium term and moderate negative.
- Implementation of mitigation measures to increase local employment and develop local capacity through training programmes, will ensure direct employment and indirect employment and procurement have a moderate positive impact rather than a minor positive.

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6.15 Land use, Agriculture and Natural Resources

The development of the Amulsar Project will require 1,399 ha to have restricted access during the life of the Project, and will be largely unavailable for access by nearby communities and seasonal herders. Land impacts are classified into five categories (see Figure 4.12.3):

- Footprint – the physical footprint of the Project's facilities as defined in Figure 3.1;
- Disturbed area – The area of land that comprises the project footprint plus the immediately adjacent land that is expected to be affected as a consequence of both construction (disturbance of topsoil) and operations (as a consequence of deposition of dust on vegetation, thereby reducing the value of agricultural land);
- Restricted area (through operations) – A buffer zone that has been defined around the limits of each of the open pits (Tigranes, Artavazdes and Erato) within which land use will be restricted as a consequence of mining operations, mainly for safety reasons during blasting;
- Restricted Area (through fencing) – Additional areas of land, within which use will be restricted due to fencing that defines the perimeter of mining operational land;
- Restricted Area (ecological) – Areas of land, within which it is predicted that the presence of mine infrastructure (including access roads and the conveyor) may inhibit use by fauna, including livestock.

The footprint of the project will cover 599 ha, with a disturbed area of 922 ha and further restricted areas totalling 477ha¹.

The project requires land acquisition that has been based on negotiated settlement, with a number of plots through expropriation, as detailed in the LALRP publicly disclosed in February 2015 and the Addendum to the LALRP disclosed in March 2016 (see Appendix 8.23).

The following number of privately owned land plots are affected by the Project:

- Phases 1-3 of land acquisition affect 252 private land plots, affecting 150 households, covering an area of 138.9ha.
- Phase 4 of land acquisition will affect an additional 22 private land plots, impacting 20 households (17 of these households are affected as part of Phase 1 -3 land acquisition as well), covering an area of 13 ha.

¹ Please note this figure is different from that reported in Section 6.11 Biodiversity where an additional area is included in the disturbance calculation. Please see Chapter 6.11 for further details.

- One household will be physically displaced, through a negotiated agreement. The property will be used by the project as a primary monitoring station for noise, dust, ground vibration and air overpressure, together with office facilities and scope for participatory monitoring.

This Section provides an assessment of the impacts to the land and agricultural resources. It provides the context upon which Section 6.16 then undertakes the analysis of how these impacts affect livelihoods. Similarly, this section provides the context for the assessment of ecosystem services impacts (Section 6.20) linked to land loss or reduced access. By providing this context in a separate section, it allows for all the land impacts to be presented once in a comprehensive manner.

The Project will affect the land holdings of three rural communities: Gorayk, Saravan and Gndevaz. Jermuk will not be affected by the Project's need for land. The proportion of land taken varies considerably between the communities, as indicated in Table 6.15.1 and shown in Figure 4.12.3 (reproduced below).

Table 6.15.1: Land Take Impacts by Rural Community²				
Rural Community	Disturbed (ha) (includes footprint and deposition zone)	Restricted Areas (ha)	Disturbed plus restricted areas (ha)	% of community lands disturbed plus restricted access
Gndevaz	743	184	927	15%
Saravan	70	128	199	3%
Gorayk	109	165	274	1%
Total	922	477	1399	

6.15.1 Assessment Criteria

To assess the significance of potential impacts upon agricultural land, the methodology described in Section 6.2.2 has been used. This approach has been used due to the relevance of sensitivity of the receptor for this analysis, and it is consistent with the analysis used in many of the environmental sections. This assessment considers the direct and indirect loss of land to agricultural use, as a consequence of the Project. The consequences of this loss of land upon livelihoods are addressed in Section 6.16. The consequences of this loss of land or access to agricultural land upon ecosystem services are addressed in Section 6.20. The potential impacts considered in this section include:

² Data sourced from Armenian Cadastre in August 2014.

- Loss of agricultural land (including pasture and grazing land), as a consequence of soil disturbance; and
- Loss of agricultural land (including pasture and grazing land), as a consequence of restricted access.

Loss of agricultural land can result from the removal of soils during the development phase of the Project. During the operational phase the soil quality may be subject to change as a consequence of dust deposition and vehicle exhaust emissions.

Loss of agricultural land can also result from restricted access zones (as described earlier). This includes areas which are physically fenced, as well as areas which will not be fenced but to which access will be deterred through other measures, including extensive consultation with affected communities (e.g. operational safety buffers around the open pits during blasting). The sensitivity of these receptors has been considered in Section 6.8, and the sensitivity scale in Table 6.15.2 aligns with this assessment.

Table 6.15.2: Receptor Sensitivity Scale		
	Sensitivity of receptor	Loss of agricultural land and restricted access to farmland
1	Minor	Non agricultural land or land that infrequently supports low intensity grazing or other non commercial crops
2	Medium	Agricultural land suitable for a range of annual crops, with a regional importance in terms of production.
3	High	Agricultural land suitable for a wide range of agricultural and horticultural crops, nationally important for food production.
4	Very High	Agricultural land suitable for high value agriculture and horticulture supporting export products.

6.15.2 Potential Impacts

Project Activities Affecting Loss of Agricultural Land

The Project will disturb approximately 922 ha of agricultural land available to nearby communities during the operational period. An additional 477 ha will have restricted access, although the land will not be disturbed.

Table 6.15.3 Table 6.15.3 indicates the land take per component of the project.

Table 6.15.3: Project Land Take by Component³			
Project Component	Footprint (ha)	Disturbed Area (ha)	Restricted area (ha)
Tigranes - Artavazdes Open Pit	96.8	26.4	323.2
Erato Open Pit	40.5	6.2	
Barren Rock Storage Facility including Landfill, Contact Water Pond and Explosives Magazines	139.2	22.8	59.5
Construction Camp	6.3	41.7	-
Overland Conveyor and Discharge Structure	19.3	57.4	94.5
Heap Leach Facility and Ancillary Infrastructure	165.5	37.3	
Primary, Secondary and Tertiary Crusher	13.9	-	-
Haul and Access Roads	78.8	121.0	-
Facilities platform	6.1	5.6	
Quarries	9.1	4.3	
Misc. Stockpiles, Landfill Laydown Areas & Ponds	23.8	-	
Total Areas	599	322.7	477.2

As described in Chapter 3, the Project design includes a 5.6km long overland conveyor to transport ore from the crusher to the truck load-out facility near the HLF. In order to minimise restrictions to access caused by this conveyor, a series of crossings will be constructed to allow herders, their livestock and equipment (including a combine harvester) to access lands on both sides of the conveyor.

The baseline presented information on permitted land use as reported by the Armenian cadastre. The cadastre evaluation represents the greatest economic use which is anticipated for different areas. For example, land categorised as “pasture” is considered by the cadastre to be of a lower quality than “arable land”. During the development period of the Project, significant areas within the Project footprint have been reclassified as “mining lands” as is required for the permitting process. For the purposes of this assessment, however, all land

³ Data derived from GIS mapping completed by Lydian linked to engineering design plans

is considered to be agricultural in nature, as this land re-classification would not have occurred in the absence of the Project. Minor areas of non-agricultural and non-mining land did exist within the Project footprint prior to the Amulsar Project, however they are negligible compared to the scale of land changes described here.

A verification assessment was undertaken in 2013 to determine the correlation between cadastral classifications and actual use of the land. The survey confirmed that the large majority of land categorisation was accurate.

Potential Loss of Agricultural Land Impacts

Table 6.15.4 summarises the loss of agricultural land per rural community. The assessment captures the major land categorisations only, and is based upon land classifications as reported by the Cadastre in 2014. As a result, the land categorisations already include some land which has been converted from its original categorisation to “mining land”. To ensure a conservative approach has been taken in this analysis, it has been assumed that all land currently categorised as “mining land” was formerly considered to be “pasture land”. As such, a subsequent table has been added which highlights the loss of pasture land, including lands now classified as mining land.

Table 6.15.4: Loss of Agricultural Land per Cadastre Categorisation⁴				
Community		Gndevaz	Gorayk	Saravan
Arable land (ha)	Disturbed	75.3	-	-
	Restricted	2.8	-	-
	Available	461.2	1727.76	381.81
	% loss disturbed	16.3	-	-
	% loss restricted	0.6	-	-
Hayfields (ha)	Disturbed	14.9	-	-
	Restricted	10.3	-	-
	Available	115.6	860	400
	% loss disturbed	12.9	-	-
	% loss restricted	8.9	-	-
Garden (ha)	Disturbed	8.65	-	-
	Restricted	-	-	-
	Available	24.3	-	-
	% loss disturbed	35.6	-	-
	% loss restricted	-	-	-

⁴ Calculations completed by Lydian based upon Cadastre data

Table 6.15.4: Loss of Agricultural Land per Cadastre Categorisation⁴				
Community		Gndevaz	Gorayk	Saravan
Irrigated arable land (ha)	Disturbed	12.7	-	-
	Restricted	-	-	-
	Available	124.3	-	10.0
	% loss disturbed	10.2	-	-
	% loss restricted	-	-	-
Mining land (ha)	Disturbed	160.5	109.4	67.2
	Restricted	40.6	164.8	128.4
	Available	324.4	1646.2	1010.6
Other agricultural land (ha)	Disturbed	83.4	-	-
	Restricted	21.9	-	-
	Available	421.9	3324.8	1249.3
	% loss disturbed	19.8	-	-
	% loss restricted	5.2	-	-
Pasture (ha)	Disturbed	386.9	-	-
	Restricted	108.5	-	-
	Available	4501.1	13477.8	4323.2
	% loss disturbed	8.6	-	-
	% loss restricted	2.4	-	-

Table 6.15.5 Loss of Pasture Land (including lands classified as mining land)⁵				
Community		Gndevaz	Gorayk	Saravan
Pasture Plus Mining (ha)	Disturbed	547.4	109.4	67.2
	Restricted	149.1	164.8	128.4
	Available	4825.5	15124.0	5333.7
	% loss disturbed	11.3	0.7	1.3
	% loss restricted	3.1	1.1	2.4

Based on this assessment, Gndevaz will lose more agricultural land than the other rural communities. The greatest proportional losses in Gndevaz will be in the garden land category (36% loss of access to garden lands). Gndevaz will also lose access (combining disturbed areas and access restricted areas) to 25% of lands classified as “other agricultural”. The loss of access (including disturbed and restricted access areas) to arable land, hayfields, pasture (including land classified as mining in 2014) and irrigated arable land is less than 20% in Gndevaz.

⁵ Calculations completed by Lydian based upon Cadastre data

Proportionally (in comparison to land available per category per community), Gorayk and Saravan will lose (through disturbance and access restrictions) relatively small areas. If the mining land is considered to be pasture land, then the greatest impact will occur in a loss of pasture lands (approximately 1% in Gorayk and 2% in Saravan).

The post-rehabilitation availability of land will need to be confirmed during the Project operational period, through the assessment of bio-accumulation in different species. The BRSF and HLF areas will be re-profiled and covered with a cap and vegetative cover. Taking a conservative approach, it is possible that these lands will not be available for the same agricultural purposes post mine closure as they were pre-mining.

Drawing on this assessment, the un-mitigated impact to agricultural land from soil disturbance is considered to be a long-term adverse impact on a receptor of medium sensitivity. This would result in a moderate adverse impact which would be considered to be significant.

The un-mitigated impact to agricultural land from the restriction of access is considered to be a short-medium term positive impact on a receptor of medium sensitivity. This is because the restriction of access of livestock to the land may allow it to improve over a number of years. Long-term, the restriction of access will have a negligible change to the agricultural land, and would result in a negligible impact which would not be considered to be significant. This assessment considers the impacts to the land and does not address the impacts to land users affected by these restrictions (see Section 6.16)

Mitigation Measures for Loss of Agricultural Land

The Project has been designed to minimise its footprint wherever possible, and opportunities for further footprint reduction will be sought during the detailed design and engineering processes. The design process has also sought to maintain access to agricultural land where it is safe for project staff and community members to do so. Land will only be fenced off when it is necessary to do so and access crossings will be put in place to maintain access over linear features.

Footprint minimisation is evident in the design of the conveyor structure. A number of crossing points have been designed into the facility. It is intended that herders, their livestock and equipment (including vehicles and a combine harvester) and potentially some wildlife will

be able to use these crossing points to ensure that access on both sides of the conveyor is maintained. During the detailed design phase, consultation with communities, herders, engineers and biodiversity specialists will be undertaken to ensure the crossing points are placed as close as possible to current livestock routes used by the daily herders from Gndevaz and seasonal herders more broadly.

Land will be rehabilitated as part of the mine closure plan. Assessments of the final land quality targeted as part of the closure programmes will be developed once seed trials have been advanced and once community consultation has occurred. The pMRCRP outlines the planned rehabilitation and re-vegetation activities which will be undertaken by the Project. Despite best efforts, some areas of land will not be rehabilitated to their original state for the purposes of agricultural use. These are likely to include:

- The Erato, Tigranes and Artavazdes open pits will not support agricultural use post closure;
- The HLF will be leached with barren solution to extract residual gold and silver, and will then be rinsed so that residual cyanide is destroyed. It will subsequently be capped following the conclusion of mining. It will also be re-contoured to better fit the natural environment in a post-closure setting. Chemical bio-availability studies will be conducted prior to the final design for rehabilitation options (at least 5 years before closure) in the future to determine appropriate and safe future use of the land;
- The BRSF will also be revegetated and re-contoured to better fit the natural environment in a post closure setting. The final state of the land will again depend on the results of bio-accumulation studies which will be undertaken during the operational period; and
- Land impacted by dust deposition is expected to return to pre-existing agricultural condition within a few years of the cessation of road traffic and dust generated by the Project.

Residual Loss of Agricultural Land Impacts

Through implementation of the mitigation measures outlined above, the short and long term residual impacts are considered to be moderate (negative) for land which is disturbed, some of which will not be returned to its previous condition. Table 6.15.6 summarises Project impacts on agricultural land.

Table 6.15.6: Impact Assessment, Loss of Agricultural Land Impacts						
Sub-category	Direction	Magnitude	Sensitivity	Duration	Impact (prior)	Impact (post)
Soil Disturbance	Negative	Moderate	High	Long-Term	Major (negative)	Moderate (negative)
Restriction of access	Positive	Low	Medium	Short-term	Minor (positive)	Minor (positive)
Restriction of access	Negative	Low	Medium	Long-term	Minor (negative)	Minor (negative)

6.15.3 Monitoring and Audit

As described, mitigation measures that relate to managing agricultural land impacts will be addressed through both social and environmental management plans. Monitoring and audit requirements have been addressed in Section 6.8.

Table 6.15.7: Mitigation Summary Table

Section	Mitigation	Monitoring Indicator	Management Plan
6.12.2 Soil disturbance and physical barriers	<ul style="list-style-type: none"> • Project footprint will be minimised where possible • Access to land adjacent to Project affect area will be maintained where it is safe to do so • Rehabilitation trials to determine how best to enhance soil quality as part of mine closure process and return land for grazing use in the long term 	Footprint disturbed Footprint rehabilitated	Footprint Management Plan Livelihood Restoration Plan
6.12.2 Restriction of Access	<p>Minimisation of restricted access where safe to do so</p> <p>Consultation with communities, herders, engineers and biodiversity specialists will be undertaken to ensure the crossing points are placed as close as possible to current livestock routes used by the daily herders from Gndevaz and seasonal herders more broadly.</p> <p>Monitoring of land users (see Section 6.16) to assess impacts caused by restricted access to pasture and grazing land, with identification of additional mitigations as necessary.</p>	Quantification of restricted area Community grievances	Footprint Management Plan Preliminary Mine Reclamation, Closure and Rehabilitation Plan (pMRCRP) Livelihood Restoration Plan

6.15.4 Conclusions

The impact assessment has been carried out to assess the impacts on agricultural land due to the Project's activities. Findings are summarised below:

- Impacts fall into two main categories: loss of agricultural land due to soil disturbance; and loss of agricultural land through medium term access restrictions.
- This section provides the basis upon which impacts to livelihoods and ecosystem services can then be derived (Sections 6.16 and 6.20 respectively).
- The Footprint Management Plan has been developed to minimise the footprint of the Project and ensure agricultural land is returned to as close to its original condition where possible. This will likely be impossible at the HLF site where land quality will be permanently reduced.

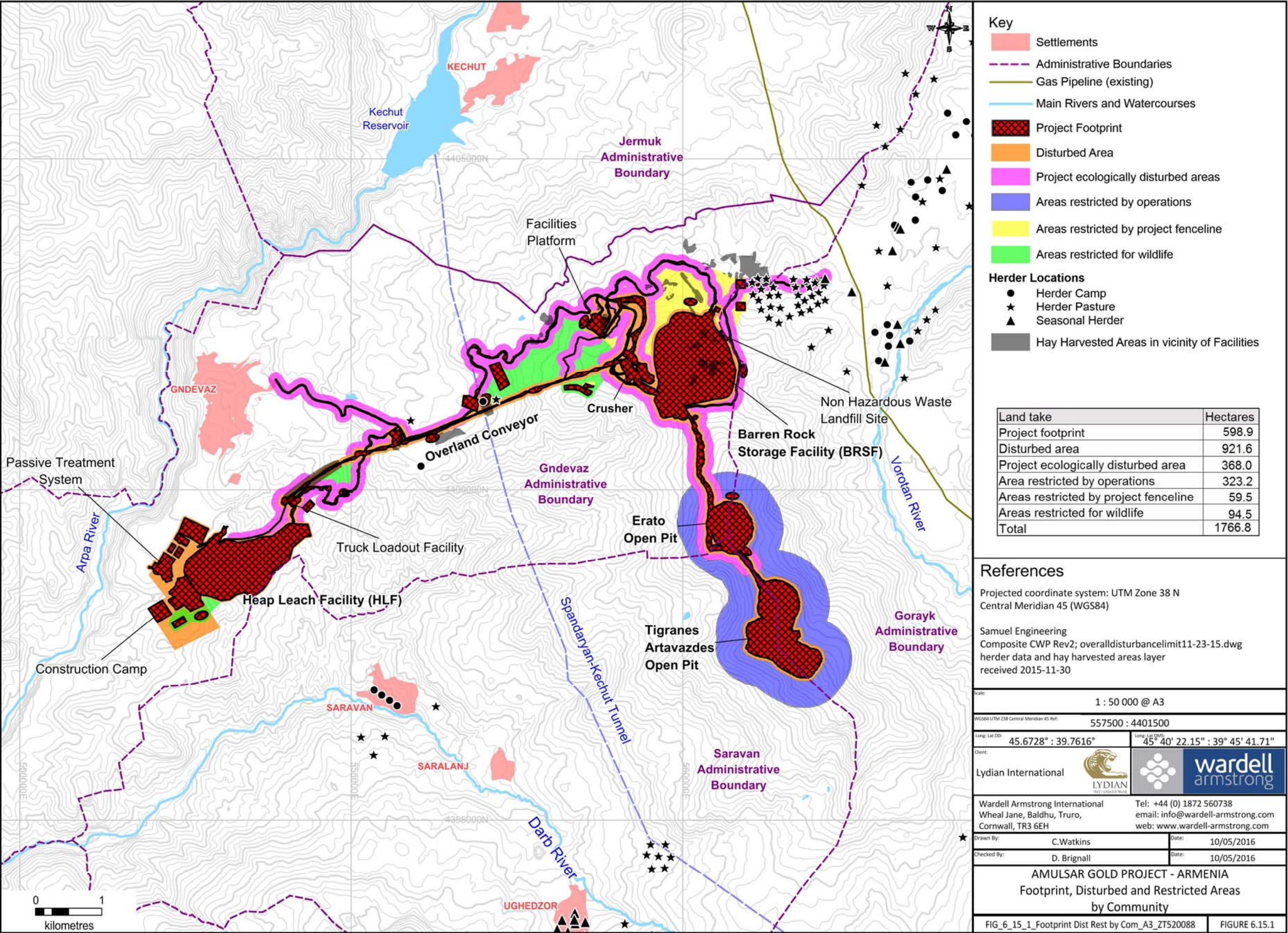


Figure 6.15.1: Footprint, Disturbed and Restricted by Areas of Community

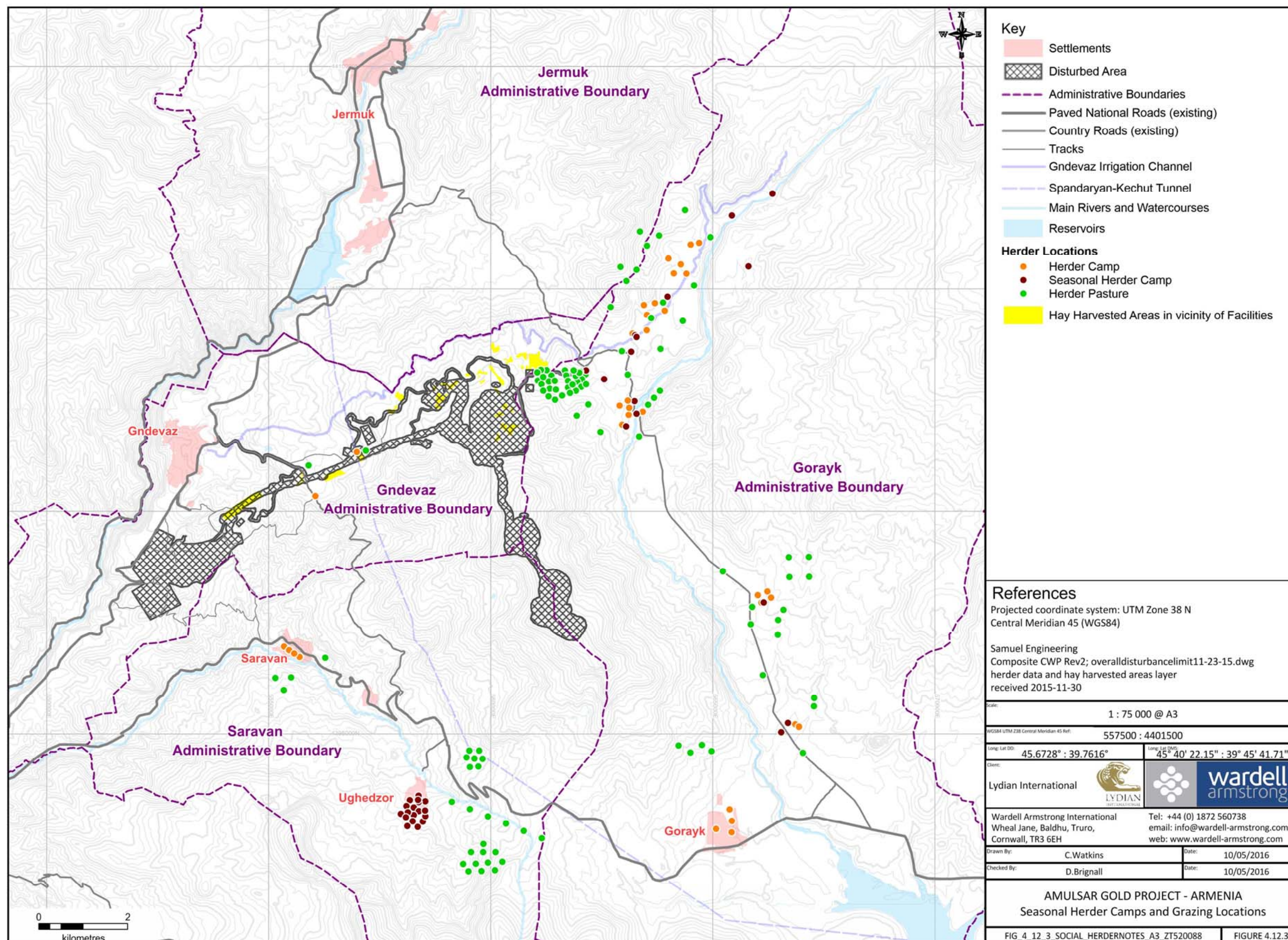


Figure 4.12.3: Seasonal Herder Camps and Grazing Locations

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APPENDICES

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6.16 Livelihoods

This section draws on the analysis described in Section 6.15 regarding impacts to land. This section addresses the Project's impacts upon various aspects of the livelihoods of nearby communities, as follows:

- Economic displacement of land owners and users; and
- Economic displacement of herders.

In line with the requirements of IFC PS 5 and EBRD PR 5, a Land Access and Livelihood Restoration Plan (LALRP) was developed to address economic displacement impacts caused by the Project, specifically focussing on the impacts to land owners and land users including seasonal herders. Following project changes, an Addendum to the LALRP has also been developed (see Appendix 8.23). This chapter provides a summary of the land acquisition and livelihood restoration measures; full details are available in the LALRP and its Addendum which are also disclosed publicly. The activities required by the LALRP will be implemented over a number of years to ensure their sustainability.

6.16.1 Physical and Economic Displacement of Land Users and Land Owners

Project Activities Affecting Physical and Economic Displacement of Land Users and Land Owners

Land required for the construction and operation of the Amulsar Project is located in the communities of Gndevaz, Saravan and Gorayk, as illustrated in Figure 1.2. Only state land will be affected in Gorayk, whereas in both Gndevaz and Saravan, private landowners will be impacted.

In terms of their impacts on land use and livelihoods, Project facilities can in summary be classified as follows:

- High elevation areas, above 2,000 masl. Location of mine pits and facilities, including the existing exploration camp, crushing facilities, BRSF, truck shop and administration facilities, explosives magazine, and part of the conveyor. There is no private land in these high altitude areas and changes to current land use will be limited to impacts on hay cutting activities around the BRSF and herding patterns by a number of seasonal herders who graze their livestock in the area during the summer months (May – September/October).

- Lower part of conveyor, electricity substation, mine access road and quarries. The affected land area is used mainly for hay and wheat production.
- Lower elevation areas under 1,700 masl. Location of the HLF, including the ADR Plant and temporary construction camp. These areas are used for agricultural production, including orchards (mainly apricot), wheat and hay.

Potential Physical and Economic Displacement Impacts to Land Users and Land Owners

The extent of physical and economic displacement generated by the land impacts described above depends upon the current use of the land by households, the number of households impacted, the duration of the impact, land tenure and potential vulnerabilities within affected households. Each of these topics is addressed in turn in this section.

Types of Land Use

Several types of agriculture are observed in different parts of the affected area:

- Mainly found in the north-west of the HLF footprint, a number of small plots are used for garden crops; part of the produce is sold but a significant portion is retained for consumption at home and preserves. These plots host a mixture of garden crops (typically potatoes, fruit trees, and tomatoes, maize, pepper, cabbage etc.)
- The valley that forms the bulk of the HLF footprint is used for apricot plantations, see Figure 6.16.1 (approximately 25 ha of orchards in total). These are a relatively recent extension of the main apricot areas of Gndevaz, which are located immediately to the south of the residential area where irrigation water is available. These orchards are run as businesses, with farmers using a combination of family and paid workers, and all the produce sold. Interspersed within the apricot orchards a few plots are used for annual crops, particularly spring wheat, maize meant for silage, and barley. Some of the apricot farmers have used a small part of their orchard for a garden. In some cases, the farmer collects the hay that grows in between the apricot tree rows.
- Higher in the mountain (eastern end of the HLF, conveyor) colder climate combined with steeper and rockier terrain are such that land is dedicated to natural grass. Where tractor access is possible, hay is gathered and taken back to Gndevaz, otherwise land is simply used as pasture.



Figure 6.16.1: Apricot orchards in the lower part of the heap leach facility site

Scale of Impact

The heap leach facility will affect a total of 252 private land plots, and a total surface area of private land of 138.9 ha. Land acquisition has been divided into a series of phases, with Phases 1 and 2 being undertaken in 2015, comprising 238 land plots. All 144 households who would be impacted by the loss of private land plots in Phase 1 and 2 were interviewed in a livelihood survey conducted in June-July 2014. While all of the households surveyed owned an agricultural plot that would be affected by the Project, the percentage of households stating that farming was their primary occupation was relatively low, at 9%. Most households base their livelihoods on a combination of activities, including farming and others, including salaried work (for those working in Gndevaz, mainly in public organisations such as education, health, municipal services, and for those working in Jermuk mainly private enterprises based there).

An additional 22 land plots (13 ha, with 17 known owners and three yet to be confirmed) will be affected by the conveyor (known as Phase 4 and requiring a 15m strip of land to be taken for life of the mine and subsequently restored and handed back to landowners). Phase 3 will affect 15 land plots, over 15.7 ha, affecting 7 landowners. Land acquisition for these phases will be undertaken during 2016.

The Project has been designed to minimise displacement where possible. While no houses are directly impacted by the footprint of the Project, an apartment building containing three apartments (one of which is inhabited) is located between the HLF and Gndevaz. This location has been identified as suitable for a primary monitoring station during the construction and operational phases of the Project. Discussions with the owners of the apartment building and

its resident have indicated a willingness to relocate to a different location. This is the only case of physical displacement anticipated from the Project. Adjacent to this apartment building is a recently established livestock and dairy farm. While in relative proximity to the HLF, this farm unit has no residential apartments or houses.

Duration of Impact

Some of the land required for the Project will be needed for the period of construction and mining only (approximately 12 years). This is particularly the case for the conveyor between the crusher and the HLF and the BRSF in the communities of Gndevaz and Saravan. Upon mine closure, any facilities on this land will be removed and the land will be re-contoured, restored and transferred to community ownership for communal use as pasture or forest land. Due to slope and safety issues, the mine pits will not be usable for grazing and will likely not be returned to community ownership.

Land Tenure Considerations

Most plots were inherited from the original owners to whom they were allocated at the time of land privatisation in Armenia (in the early 1990s). As a result they are currently held under co-ownership arrangements by successors to these original owners. All registered co-owners have been identified through the identification stages of the land acquisition process that are described in detail in the LALRP.

Vulnerable People

Vulnerable people are people who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage, or social status, may be more adversely affected by the land acquisition process than others and who may be limited in their ability to claim or take advantage of compensation. In the context of the Amulsar Project, potentially vulnerable people include: disabled persons (mental or physical); seriously ill persons; the elderly (particularly when they live alone); households who heads are female and who live with limited resources; households who have no or very limited resources; and widows and orphans. Based on the livelihood survey of Gndevaz landowners and land users, affected people have been pre-screened for potential vulnerability as follows:

- There are 15 female headed households (11.7%). Most of these are one-person households (typically an elderly widow). These households are pre-identified as potentially vulnerable;
- 22 household heads are 65 years of age or over, and are also pre-screened as

potentially vulnerable;

- 1 household is categorised as “very poor and unable to cope with their basic needs”
- There are 32 invalids (either people registered as invalids 1st to 3rd categories per Armenian law, or people declared as chronically and seriously ill in the survey) amongst the affected households;
- All together, and taking account of overlaps between the categories, 27 households are pre-identified as potentially vulnerable.

Taking all these factors into consideration, the land acquisition process has the potential to affect the livelihoods of land owners and land users (typically one of the co-owners in most cases or one distinct land user). This is considered to be a localised negative impact, occurring in the medium-long term, with a high impact level. A second impact relates to the physical displacement of a resident in an apartment building in proximity to the HLF. This is considered a localised negative impact, occurring in the long-term, with a high impact level.

Mitigation of Economic Displacement Impacts on Land Users and Land Owners

The Project is implementing all land acquisition activities in conformance with IFC PS 5 and EBRD PR 5, in addition to Armenian law. The Project strategy for land access is defined within the Land Access and Livelihood Restoration Plan (LALRP) and its Addendum, see Appendix 8.23 and is based upon the following principles:

- Physical displacement is minimised (Project facilities avoid all residential areas and only one resident will have to move as a result of the Project);
- Land access is based upon negotiated settlements in the sense of PS5 and PR5; expropriation is used only as a last resort if all avenues to reach a reasonable amicable settlement have been exhausted;
- Any compensation is at replacement value;
- A land for land option is available to those willing to choose replacement land rather than cash compensation;
- Identification of affected plots and affected people is based on cadastral information, complemented and ground-truthed if claims arise;
- Impacts to livelihoods are assessed and mitigated where needed;
- Wherever legally, technically and economically possible, land used for the Project is returned to its previous physical condition and ownership after use for mine construction and operations;
- A grievance mechanism is in place;

- Affected people are informed and consulted with; and
- Vulnerable individuals are identified and assisted where needed.

The process of land acquisition includes the following five steps:

1. Identification of affected land plots, landowners and land users, including informal land users, based on cadastral information and title search and gathering of all legal documentation (land titles, leases, mortgages, liens, certificates of death and wills to determine inheritance, powers of attorney);
2. Socio-economic survey of affected landowners and land users;
3. Inventory of assets on the affected plots, including structures, trees and crops;
4. Compensation offer to the affected landowner (including land for land option), and land user if applicable, consultation process and signature of a Preliminary Agreement (option agreement); and
5. Finalisation of the transaction (sale-purchase agreement) and transfer of the land plot to Lydian's property.

Cadastral information for affected land plots was obtained in 2014 and 2015 from the relevant institution based on the Project footprint, per step 1 above. This information includes the identity of the owner (or co-owners) and data pertaining to the categorisation of the land (arable or not, irrigated or not) in view of the determination of the cadastral value for taxation purposes.

The socio-economic survey referenced in step 2 above was undertaken between June and July 2014, covering 128 affected households, and extended in November 2015 to capture households affected by later phases of land acquisition. The purpose of the survey was to establish the socio-economic circumstances of every affected household, in line with international requirements. An inventory of crops, trees, and structures was carried out at the same time, creating a cut-off date for each phase of land acquisition.

A three visit process is being used to undertake the negotiation and reach an agreement with each household based on standard legal agreements. In cases where the landowner does not use the land and there is a distinct land user, land compensation will be offered to the landowner, while crop and tree compensation will be offered to the land user. This also applies to land users farming on municipal land. It is understood from preliminary interaction with the communities that there is a preference towards cash compensation rather than in-

kind (land for land. The Project will accommodate such requests by providing irrigated replacement land of similar agronomic potential, with details presented in the LALRP.

All land to be acquired for the Project is agricultural land (there is no industrial or residential land).

Compensation rates were calculated by Armenian professional valuers in compliance with Armenian law and reviewed by an international resettlement specialist to meet international requirements. The details of the valuation methodology (land, crops and trees, buildings etc.) are included in the LALRP and its Addendum and will be disclosed to affected parties as part of the proposed compensation agreements. Valuation of each land plot is done by the “comparative method”, whereby relevant transactions are identified in the area based on official information, with a top-up to meet rates observed in Armenia on other international projects.

Annual crops (wheat, barley, potato, maize, garden crops, etc.) are valued based on observations of the crop density and condition in each plot when the inventories were conducted. Market prices were gathered based on official Armenian statistics complemented by observations at local markets. Apricot and other fruit trees were valued to compensate for the loss of income incurred by the land user or land owner. Trees were categorised by variety and age, with a value for each category of age, based on the average productivity of the tree and the average market price of the produce.

Lydian will seek to ensure that no vulnerable people are disproportionately affected by the land acquisition process. The following activities will be implemented in cooperation with local authorities in respect of vulnerable people affected by the Amulsar Project:

- Assistance during the land acquisition and negotiation process, including, at the stage of plot and landowner identification, specific individual meetings to explain eligibility criteria and entitlements, clauses in compensation agreements, grievance avenues etc.;
- Assistance in the payment process (provision of transport to the bank effecting compensation payment, support in the payment procedure, money management awareness etc.); and
- Prioritization for training courses to enhance employability and prioritization for employment by contractors where possible and subject to contractors’ operational

needs.

The implementation schedule of the land acquisition process itself, as well as the monitoring and evaluation requirements are defined in the LALRP and its Addendum.

All people affected by the land acquisition process will have access to the Lydian grievance mechanism, whereby:

- All grievances are registered, reviewed and responded to. Grievance coordinators will acknowledge receipt of a grievance within 7 days of receipt and will respond within 30 days of receipt;
- The grievance management mechanism includes amicable grievance review and resolution;
- In cases where the aggrieved individual or group is not satisfied with the outcome proposed by the amicable mechanism, they are able to resort to Justice at any stage in the resolution process.

The household requiring physical relocation will be compensated for the value of their lost assets, and assistance will be provided to relocate to a new location of their choosing.

Residual Economic Displacement Impacts to Land Owners and Land Users

The mitigation measures outlined above, including the availability of a land for land option, are expected to minimise the impact of economic displacement experienced by land users and land owners in Gndevaz and Saravan communities. Where land needs to be acquired permanently it will be purchased through a negotiated settlement and compensation for loss of land, crops, trees and buildings will be paid at replacement value. Monitoring and evaluation will be conducted to assess residual impacts and implement additional livelihood restoration measures if monitoring indicates that such are necessary.

Based upon the successful implementation of the mitigation measures outlined above, the residual negative economic displacement impact is expected to be medium-long term, moderate and with localised focus (Table 6.16.1), and the residual physical displacement impact is expected to be a long-term moderate and localised.

Table 6.16.1: Impact Assessment, Economic Displacement to Land Owners and Land Users						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Economic displacement of land users and land owners	Negative	High	Local	Medium – Long term	Major	Moderate
Physical displacement of household	Negative	High	Local	Long-term	Major	Moderate

6.16.2 Economic Displacement of Herders

Project Activities Affecting Economic Displacement of Herders

In the Project area, most herders use rented community land held by the respective municipalities, in practice mostly the municipality of Gorayk.

The Project footprint will cover 599 hectares, with a total of 922 hectares of land being disturbed (this total includes the Project footprint). A further 477 hectares will have restricted access (including areas restricted by fencelines, operational safety requirements (e.g. blasting zones) and areas where wildlife will be unable to pass through), resulting in a total land disturbance and a restricted access zone of 1399 hectares. Some of this area is used by seasonal and local resident herders to graze animals and grow hay during the summer months. The restricted access areas are shown in Figure 4.1.6 and the fencing that restricts access is shown on Figure 3.24. Regardless of Project impacts, access to these areas is limited at present due to the limited presence of roads to the west of Amulsar Mountain.

Potential Economic Displacement Impacts to Herders

There are two main categories of economic displacement impacts for seasonal and resident herders, which could be generated by the Project:

- Loss of access to land which is used by herders at present for grazing and hay, with resultant economic displacement; and
- Loss of access to temporary structures that herders use as temporary camps during the summer months while they are in summer pastures.

A census of the seasonal herders was undertaken in August and September 2012 by WAI and Geoteam staff and results from this census are briefly described here. This was complemented by focus group discussions held in the summer of 2014 and a further survey

of herders conducted by Geoteam in September 2015. As herders are mobile, a composite of the herder locations identified across each of these surveys and focus group discussions is illustrated in Figure 4.12.3.

Fifty-eight seasonal herders migrated to the broader area in 2012 (believed to be a typical year). Thirty seasonal herders were identified in September 2015 as using land in areas which are likely to be affected by the Project. These herders primarily use land to the east of the BRSF. Daily herders will also be impacted by the Project. Daily herding activities undertaken by the residents of Gndevaz using lands near the HLF and conveyor are likely to be impacted by Project land take and restriction of access. Nine daily herders were interviewed; however, this is only a representative sample of affected daily herders from Gndevaz. Table 6.16.2 summarises the Project footprint areas which will affect seasonal herders.

Table 6.16.2: Herders Affected by Project		
Herder Locations	Herder Use	Affected or Not-Affected
HLF and conveyor area used by daily herders from Gndevaz	Nine herders interviewed, representing all herders living in Gndevaz who use the HLF and conveyor area for daily herding activities. 1100 sheep, 430 goats, 650 cattle, donkeys, and horses. Gndevaz herders take their cattle to pastures daily, and when land dries out during summer they use lands at higher altitudes. Herders operate on a rotational basis, with alternative sources of income, using income from herding to supplement other income. Two professional herders are known to operate in Gndevaz.	Potentially Affected
BRSF	Thirty seasonal herders surveyed who have camps in and near the BRSF footprint and who use the area to graze cattle (all originate from the village of Xndzoresk). They bring approximately 1420 animals to this area each year (920 cattle, 470 sheep and goats, 30 horses and donkeys). They stay in tented camps for the duration of the herding season (April – September or later depending on the weather). Animals use wider area for grazing, milk collection	Potentially Affected

Table 6.16.2: Herders Affected by Project		
Herder Locations	Herder Use	Affected or Not-Affected
	occurs twice daily through milk collection trucks. This area provides high altitude alpine fields which herders have been using for many years. These herders travel between 80-100km from their home to use this land each summer. See Figure 6.16.2.	
Ughedzor	All residents interviewed, none use the restricted area for grazing	Not affected



Figure 6.16.2: Seasonal Herders from Xndzoresk (based to the east of the BRSF), July 2014

The scale of the displacement impact caused by the Project depends on the availability of alternative pasture and hay of equivalent quality and the inconvenience caused to the herders by restricting their access to pasture and hay land. Land of equivalent quality must be of a similar agronomic potential, have similar access to infrastructure and services used by the herders, including roads and tracks (used for the sale of dairy products), water sources and structures available for use for camps. Focus group discussions with herders conducted in July 2014 highlighted the range of livelihood activities undertaken by seasonal herders while they are in the area. For example, the herders originating from Xndzoresk reported the following productivity and income:

- Up to 30-40 kilos of cheese are produced in the camp during the summer season;
- Up to 6 trucks collect milk from the herders daily (morning and evening), yielding 140 AMD per litre of milk sold.

Availability of Land

Herders rent land from the community administrators, with most of the potentially affected seasonal herding activities taking place on land administered by Gorayk. Lease agreements are typically formalised between the local authority and the herder, and a minimal rental fee is paid into the community budget. Local Mayors of Gorayk, Saravan and Gndevaz report having sufficient additional similar pasture and hay land available for rent which could be used by herders when the Project restricts access to the land they are currently using. The census work identified that access to land and water and proximity to any existing milk collection services and herders permanent houses were the key considerations for herders.

A visual land capability assessment conducted by WAI indicated that some of the land being used for grazing purposes at present is over-grazed. This is supported by feedback from herders during the census. The quality of the land which will be lost is discussed in greater detail in Section 6.15.

Inconvenience

During the 2012 census, herders indicated a preference to stay in the same area if the option was available, but in the absence of that option, only minimal inconvenience was anticipated if a move was required as similar land is available. In September 2015, 75% of the impacted seasonal herders indicated their willingness to relocate to new lands so long as water sources and access to the land were equivalent to the land they were vacating. Importantly, during the focus group discussions held in July 2014, the herders who originate from Xndzoresk (and

are based to the east of the BRSF during summer months) indicated it takes three days for them to move their cattle from their village to this area at the beginning of summer (May each year). If the mine were to require this land, the herders indicated that they would like to move to land closer to home, using pasture areas in mountains that they consider to be “idling” in proximity to their village. They have been using the Vorotan valley for generations because the Vorotan stays green longer than other areas in south-eastern Armenia.

For those herders who have formal agreements with the community administrators (mainly Gorayk) entitling them to rent the land, the formalisation of a new agreement for use of a different area is not anticipated to cause significant inconvenience. Also, a small proportion of herders use the land in the Project area without a rental agreement or payment of fees to the community administrators. In this context, they are more vulnerable to a change in circumstances. These herders reported that the primary reason for non-payment of access fees for land by this group is that they cannot afford it, hence they may be more vulnerable to this change in circumstances. The Company will monitor herders to check that all herders visited in 2012, including those without a lease, have been able to identify and exploit new pasture areas with minimal inconvenience, whether under a formal or informal arrangement.

Infrastructure and Services

There are no permanent residential structures constructed or used by herders as camps, however, the 2012 census identified nine herders within the broader area who use ruins, semi-completed buildings and abandoned structures to support their camps. None of these structures are expected to be impacted by the Project. A proportion of the herder camps are mobile and use portable tents, so can be moved to a new location with comparable ease.

No services are provided to the herder camps (i.e. no electricity, sewerage, waste collection, water distribution etc.)

Mitigation of Economic Displacement Impacts on Herders

Potential livelihood impacts to herders will be mitigated through a variety of measures, based upon the nature of the impact experienced. The most important mitigation measure is Project design, whereby areas important to herders (for access, water supplies, pasture, accommodation or holding other values) have been avoided. This is evident in the Project footprint when overlain with the location of herding activities (as seen in Figure 4.12.3). It is expected that 30 seasonal herders will be impacted by the Project, requiring relocation to

alternate lands. Seasonal herders will be relocated to lands owned by Gorayk to the east of the Vorotan River.

Impacts are also expected for daily herders living in Gndevaz. Daily herders will be affected at a lower level than seasonal herders, with impacts to their activities primarily connected to a restriction of access due to the linear conveyor feature. To manage this impact, the Project will install a number of conveyor crossings, allowing herders, their animals and equipment to cross the conveyor. The location of crossings will be determined through discussion between biodiversity specialists, design engineers and community administrators.

In addition, the following mitigation measures will be put in place:

- The Project will notify herders well in advance of its land needs (three months as a general rule), such that they are given sufficient notice to be able to take steps to move to alternative pasture;
- The Project will support herders to engage with community administrators to identify new equivalent lands available for rental, and monitor that access to similar land is actually achieved as of the summer of 2015 when construction starts;
- If immovable structures are lost (e.g. buildings used as part of the pasture camps) and the herders can ascertain ownership or usufruct (even informal), the Project will provide compensation for the shelters, as monetary compensation following consultation with the affected herders. Herders will also be eligible for a one-off compensation for disruption to their activities if they are required to relocate. In the event that the new herding lands do not have access to sufficient spring catchments, the Project will support the establishment of new water sources for herders;
- Herders who currently lack formal rights to the land which they have been using will be supported by Lydian in gaining access to the new land parcels;
- Lydian will monitor the livelihood impacts of these changes upon the herder communities by conducting for three years an annual survey with clearly established indicators to evaluate material changes in livelihoods against the 2012 baseline; and
- Opportunities to support animal husbandry improvements in the region through technical assistance enhancing milk and meat production and marketing will be reviewed in collaboration with herders. This could include improved refrigeration and collection of milk, artificial insemination and associated introduction of new genetic stock. A test animal husbandry programme has already been implemented that will be expanded based on lessons learned in the pilot phase. Details are available in the

LALRP.

In addition to the impact mitigation activities outlined above, the broader group of seasonal herders will be a target group for the technical assistance programme described in Chapter 6.13. Technical assistance will focus on increasing agricultural output and diversification of economic activities will be prioritised.

The rehabilitation plans described as part of the mine closure plan will minimise these impacts in the long-term, however some land will be affected permanently (pMRCRP, see Appendix 8.18). The HLF and open pits (Erato, Tigranes and Artavazdes), even once rehabilitated, will have a modified land capacity which will not support herding activities.

Residual Economic Displacement Impacts to Herders

Economic displacement has been avoided wherever possible in the Project design, as can be seen in the Project footprint. Some displacement of herders may still occur as a result of the Project footprint, and changes to herding locations may present some challenges. The mitigations described above, as well as the commitment to monitor any unforeseen changes through annual surveys, would make the residual impact Minor (negative).

Table 6.16.3: Impact Assessment, Economic Displacement Impacts to Herders						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Economic Displacement of Herders	Negative	High	Local	Medium term	Major (negative)	Moderate (negative)

Table 6.16.4 summarises Project impacts on livelihoods.

Table 6.16.4: Impact Summary - Livelihoods						
Sub-category	Direction	Magnitude	Extent	Duration	Impact (prior)	Impact (post)
Economic displacement of land users and land owners	Negative	High	Local	Medium – Long term	Major	Moderate
Physical displacement of household	Negative	High	Local	Long-term	Major	Moderate
Economic Displacement of Herders	Negative	High	Local	Medium term	Major	Moderate

6.15.1 Monitoring and Audit

As described above, mitigation measures that relate to managing impacts of the Project on livelihoods will be addressed in a number of management plans. Table 6.16.5 outlines monitoring indicators which will be used and developed further to assess the effectiveness of mitigation measures.

Table 6.16.5: Monitoring Indicators and Impact Mitigations

Section	Mitigation	Monitoring Indicator	Management Plan
6.16.1 Economic displacement of land users and land owners	<p>Land access principles clearly defined:</p> <ul style="list-style-type: none"> Physical displacement is avoided (Project facilities avoid all residential areas and nobody will have to move as a result of the Project) Land access is based upon negotiated settlements in the sense of PS5 and PR5; expropriation is used only as a last resort if all avenues to reach a reasonable amicable settlement have been exhausted; Any compensation is at replacement value A land for land option is available to those willing to choose replacement land rather than cash compensation Identification of affected plots and affected people is based on cadastral information, complemented and ground-truthed if claims arise; Impacts to livelihoods are assessed and mitigated where needed; Wherever legally, technically and economically possible, land used for the Project is returned to its previous physical condition and ownership after use for mine construction and operations; A grievance mechanism is in place; Affected people are informed and consulted with; and Vulnerable individuals are identified and assisted where needed. 	<ul style="list-style-type: none"> Compensation payments tracked and reported on to management at regular intervals Number of sale agreements tracked Total amount of compensation paid (cumulative) is tracked Grievance mechanism reports Livelihood assessments conducted regularly on sample of affected people 	Land access and livelihood restoration plan (Appendix 8.23)
6.16.1 Economic displacement of land users and land owners	<p>The following activities will be implemented in cooperation with local authorities in respect of vulnerable people affected by the Amulsar project:</p> <ul style="list-style-type: none"> Assistance during the land acquisition and negotiation process, including, at the stage of plot and landowner identification, specific individual meetings to explain eligibility criteria and entitlements, clauses in compensation agreements, grievance avenues etc.; Insistence on the land replacement option where it is obvious that 	<ul style="list-style-type: none"> Livelihoods assessments conducted regularly with vulnerable households Grievance mechanism reports 	Land Access and Livelihood Restoration Plan (Appendix 8.23)

Table 6.16.5: Monitoring Indicators and Impact Mitigations

Section	Mitigation	Monitoring Indicator	Management Plan
	<p>the affected land is critical to the household's livelihood;</p> <ul style="list-style-type: none"> Assistance in the payment process (provision of transport to the bank effecting compensation payment, support in the payment procedure, money management awareness etc.); Prioritization for training courses to enhance employability and prioritization for employment by contractors where possible and subject to contractors' operational needs. 		
6.16.1 Physical displacement of household	The household requiring physical relocation will be compensated for the value of their lost assets, and assistance will be provided to relocate to a new location of their choosing.	<ul style="list-style-type: none"> Follow-up assessments of individual being resettled 	Land Access and Livelihood Restoration Plan and Addendum (Appendix 8.23)
6.16.2 Economic displacement of herders	<p>Impacted seasonal herders will be relocated to lands owned by Gorayk to the east of the Vorotan River.</p> <p>To manage the impact to daily herders from Gndevaz, the Project will install a number of conveyor crossings, allowing herders, their animals and equipment to cross the conveyor.</p> <p>For herders who lose access to pasture lands:</p> <ul style="list-style-type: none"> Lydian will support herders to engage with community administrators to identify new equivalent lands available for rental; If structures are lost (e.g. buildings used as part of the pasture camps), and herders can ascertain ownership, Lydian will provide replacement structures or means to construct replacement shelters following consultation with the affected herders and herders will be eligible for a one-off compensation payment for disruption caused to their 	<ul style="list-style-type: none"> New herder census to update all people using land; Minutes of engagement with community administrators complete; Report on structures replaced complete; Number of herders with no formal rights to land use; Census of new lands made available for herders who previously had no legal rights; Annual socio-economic survey with herders; and Assessment of technical assistance for animal husbandry complete. 	Land Access and Livelihood Restoration Plan, Environmental and Social Management Plan (Appendix 8.23 and Chapter 8)

Table 6.16.5: Monitoring Indicators and Impact Mitigations

Section	Mitigation	Monitoring Indicator	Management Plan
	<p>activities;</p> <ul style="list-style-type: none"> • In the event that the new herding lands do not have access to sufficient spring catchments, the Project will support the establishment of new water sources for herders; • Herders who lack formal or informal rights to the land which they have been using will be supported in gaining access to new land; • Lydian will work with community administrators to monitor the livelihood impacts of these changes upon the herder communities by conducting an annual survey about material changes; • Opportunities to enhance milk and meat production of animals through improving animal husbandry practices will be reviewed in collaboration with herders; and • Monitoring systems will be established to assess the livelihoods of displaced herders and to ensure efforts are launched to address issues before they negatively impact on the herders. 		
6.16.2 Economic displacement of herders	<p>In addition to the impact mitigation activities outlined above, the broader group of seasonal herders will be a target group for the technical assistance programme described above in relation to the mitigation of impacts on non-industrial livelihoods and economics. Technical assistance will focus on increasing agricultural output and diversification of economic activities will be prioritised.</p>	<ul style="list-style-type: none"> • Community development expenditure • Input – outcome evaluation for technical assistance programmes 	<p>Land Access and Livelihood Restoration Plan, Stakeholder Engagement Plan, Community Development Plan (Appendix 8.23, Appendix 8.6 and Appendix 8.16)</p>

6.16.3 Conclusions

The impact assessment has been carried out to assess the effects of construction, operation and closure of the mine on livelihoods both within and surrounding the direct Project footprint. Findings are summarised below:

- Impacts fall into two main categories: economic and physical displacement of land users and land owners, and economic displacement of herders;
- The LALRP has been developed to mitigate and compensate impacts associated with the economic and physical displacement of land users, owners and herders. Effective implementation of mitigation measures including: avoidance of displacement; compensation at replacement value of all affected assets; a process based on negotiated settlements; providing a viable land for land compensation option to those willing to select such rather than monetary compensation; ensuring vulnerable households are not disproportionately affected by the land access process; assisting herders in securing access to alternative pasture; and providing technical assistance for animal husbandry and crop cultivation will reduce economic displacement impacts to moderate for land owners and users and moderate negative for herders.

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6.17 Cultural Heritage

Potential impacts to cultural heritage from the Amulsar Project consist of direct physical disturbance of archaeological sites as a result of construction and mining activities. The Project is set in an archaeologically rich region, with evidence of past occupation beginning more than fifteen thousand years ago, at the latest, and extending through the Late Medieval period to the present. The region surrounding the Project area has not yet been the subject of comprehensive academic research, and may hold substantial potential to illuminate Armenian prehistory, particularly that of the Palaeolithic and Neolithic periods which are not well understood in this region or in Armenia as a whole. In addition to the sites and potential sites identified by the baseline investigations, there is also a high potential for undiscovered archaeological sites within the Project area. Baseline investigations have identified no built heritage, or tourist sites in or near the Project area.

6.17.1 Project Activities Affecting Cultural Heritage

The assessment focuses on potential direct physical impacts to archaeological cultural heritage that would affect a site's scientific or perceived cultural value through physical disturbance. Examples of direct physical impacts include soil disturbance and displacement of an archaeological site caused by grading, excavation, or other site preparatory activity. Wherever ground-disturbing construction or operation activities directly encroach on cultural heritage resources, these direct physical impacts will occur. Thus, the area of direct physical impact will include the footprints of the following Project components as well as their associated construction disturbance footprint:

- Erato open mine pit;
- Tigranes and Artavazdes open mine pit;
- Barren Rock Storage Facility (BRSF) and associated sediment pond;
- Run of Mine (ROM), crushed ore and low-grade ore stockpiles;
- Topsoil stockpiles;
- Crushing plant;
- Fueling area;
- Truck shop and administration offices;
- Explosives magazine;
- Haul roads (approximately 30 m wide corridor)
- Access roads (approximately 10 m wide corridor);
- Overland conveyor line (approximately 30 m wide corridor);
- Conveyor truck load-out structure;

- Electrical substation;
- Heap Leach Facility (HLF) including:
 - Heap leach pad (HLP);
 - Process Pond and Storm Ponds;
 - Contact Water Pond;
 - Water passive treatment system (PTS);
 - Adsorption-Desorption-Recovery (ADR) plant; and
 - Offices and laboratories;
- Domestic waste water treatment facilities;
- Landfill for domestic and non-hazardous industrial waste;
- Temporary construction workers' camp;
- Arpa River Pump Station;
- Quarries for construction materials; and
- Temporary construction laydown areas.

In addition to these larger mine components, the construction of smaller mine infrastructure such as water pipelines and electrical lines could result in impacts to cultural heritage sites. Areas that will be subject to ground disturbance as part of construction staging and preparation, such as laydown areas and construction access roads, could also result in direct physical impacts to cultural heritage sites. As the locations of all of these construction components may not yet have been determined, their associated impacts will be evaluated as part of the post-ESIA commitments outlined in the Project's Cultural Heritage Management Plan (CHMP).

Direct physical impacts are anticipated during the construction phase of the Project in the majority of the Project areas identified above. The Project will disturb approximately 922 ha of land. Operational phase archaeological impacts would only occur as new mining areas are excavated, as archaeological resources in mountainous terrain are typically located near the ground surface. The majority of impacts to potential cultural heritage sites identified during baseline survey and located within the Project footprint can be avoided or mitigated prior to construction and operation. There is the potential for archaeological remains not identified prior to construction to be inadvertently damaged during the construction or operation phase. In order to mitigate damage to previously undiscovered cultural heritage sites, the Project will implement a Chance Finds Procedure during the construction and operations phases.

The Project affected area is largely an undisturbed or developed area that contains objects, structures, and natural landscape features used by the community for a range of traditional agricultural and leisure activities with cultural heritage value. The cultural services associated with the Project affected area are considered in Chapter 6.20. Appendix 8.6 (Stakeholder Engagement Plan) identifies the discussions that relate to the intangible cultural assets of the Project affected area and Appendix 8.16 (Community Development Plan) includes a commitment to supporting a maintaining traditional uses of the land, including summer herding.

6.17.2 Impact Prediction Methodology

The magnitude of direct physical impacts to cultural heritage sites is determined by the physical extent of the damage. Such impacts are immediate and permanent, as once an archaeological site has been damaged or modified its lost value cannot be recovered or restored. The method used for gauging the magnitude of direct physical impacts to cultural heritage sites is based on the impact assessment methodology detailed in Section 6.2.2. The application of this methodology to assessing the magnitude of impacts to cultural heritage is summarized in Table 6.17.1.

Table 6.17.1: Magnitude of Change Scale		
	Magnitude of change	Description of change
1	Negligible	No discernible change in the physical condition.
2	Low	Small part of the site is lost or damaged, resulting in a loss of scientific or cultural value.
3	Moderate	A significant portion of the site is lost or damaged, resulting in a substantial loss of scientific or cultural value.
4	High	The entire site is damaged or lost, resulting in complete, or nearly complete loss of scientific or cultural value.

The potential consequence of impacts to archaeological heritage is the loss of scientific information about the history or prehistory of Armenia and the legal consequence from the destruction of cultural property, as defined by the Republic of Armenia *Law on Immovable Monuments of History and Culture Considered Property of the State and Not Subject to Alienation* of 2003 (Section 2.1.12) and the Armenian Mining Code (Section 2.1.2).

The sites identified in the Project area have been divided into six sensitivity categories as identified in Table 6.17.2.

Table 6.17.2: Cultural Heritage Resource Sensitivity Scale		
	Sensitivity of resource	Description of resource
1	Un-assessed	Site provisionally identified by the archaeological teams or satellite imagery analysis but not subsequently re-visited, evaluated, or assessed using cultural heritage sensitivity scale.
2	Negligible ¹	Site judged to have very little scientific or cultural value and/or is very common, being easily substituted by information from other sites.
3	Minor	Site judged to have low importance based on scientific or cultural value. Has potential for substitution. Value not formally recognized.
4	Medium	Site judged to have medium importance based on scientific or cultural value. Limited potential for substitution. Value is often recognized regionally and resources may already be protected by either local or national legislation, but recognized as a resource of local significance.
5	High	Site judged to have high importance based on scientific or cultural value. Very limited potential for substitution. Value is often recognized nationally and resources may already be protected by national legislation. High sensitivity sites qualify as non-replicable cultural heritage as defined in IFC Performance Standard 8.
6	Very High	Site judged to have very high importance based on scientific or cultural value. No potential for substitution. Value is often recognized internationally and resources may already be protected by national legislation and international conventions. Very high sensitivity sites qualify as critical cultural heritage as defined in IFC Performance Standard 8.

All of the potential cultural heritage sites identified during the ESIA baseline surveys were identified by professional archaeologists during archaeological reconnaissance surveys. However, the non-intrusive, rapid reconnaissance methods employed during the baseline study did not allow for the determination of site sensitivity at every potential cultural heritage site.

The sensitivity of 138 potential cultural heritage sites identified during the reconnaissance surveys were assessed using the criteria outlined in Table 6.17.2. Sensitivity determinations were made by the Armenian Archaeological Team through additional investigations at sites initially identified during pedestrian survey, including evaluation excavations. ERM archaeologists re-visited a number of sites, originally documented by the Armenian archaeological team (Cultural Heritage NGO), and assessed site sensitivity through the

¹ The methodology for assessing impact significance in Section 6.2 does not include a receptor sensitivity level of negligible. For the purposes of this analysis, the significance of impacts to cultural heritage resources of negligible sensitivity will be assessed as one degree lower than a similar magnitude impact to a minor sensitivity resource. As a result, the most significant impact to a site of negligible sensitivity is minor: a high magnitude impact to a site of negligible sensitivity is an impact of minor significance.

application of the scale outlined in Table 6.17.2. These sensitivity assessments were conducted to characterize the importance of different site types and to inform the Project's post-ESIA commitments to mitigate potential impacts. The cultural heritage sensitivity of unassessed sites which could potentially be impacted by the Project will be determined as part of archaeological surveys and evaluations outlined in the Project CHMP.

6.17.3 Predicted Magnitude of Potential Impacts

Sites located within the Project footprint of proposed mine components will be subject to high magnitude impacts as the entire site will likely be damaged or lost, resulting in complete, or nearly complete loss of scientific or cultural value. The extent of each potential site could not be determined during the non-intrusive pedestrian surveys conducted to date. As a result, it is assumed that portions of potential sites with centre points within 50 m of proposed Project components could be subject to direct physical impacts as these sites may extend into the Project's Project footprint. Sites within 50 m of proposed Project components will be subject to moderate magnitude impacts. Until the boundaries of these sites can be determined through intrusive excavations, it is assumed that a significant portion of these sites will be lost or damaged, resulting in a substantial loss of scientific or cultural value.

6.17.4 Sensitivity of Cultural Heritage sites

The magnitude of potential impacts to known sites in the Project area was established by mapping the sites on the design layout of the Project, particularly the Project's proposed disturbance footprint. The map review identified 81 potential or known archaeological sites within the Project's disturbance footprint or within 50 m of the disturbance footprint. The sites include:

- 1 site of minor importance;
- 9 sites of negligible importance; and
- 71 sites of un-assessed importance.

Apparent centre points of 70 known or potential sites lie within the Project disturbance footprint, indicating that all or nearly all of each of these sites could be subject to high magnitude impacts during Project construction. The apparent centre points of an additional 11 known or potential sites are located within 50 m of the proposed Project disturbance footprint. The sensitivity and scientific importance of sites within the Project's Project footprint and sites within 50 m of the Project footprint will be assessed as part of the post-ESIA commitments described in the Project's Cultural Heritage Management Plan (CHMP).

6.17.5 Potential Significance of Impacts to Cultural Heritage Sites

The significance of potential impacts to cultural heritage sites is based on a cross-tabulation of the magnitude of Project impacts and the sensitivity of cultural heritage resources. A total of 81 known or potential archaeological sites could be impacted by the development of the Project. Using the assessment methodology described in Section 6.2.2, the sensitivity of these sites was combined with the impact magnitude to determine impact significance. The construction of the proposed Project components would result in the following impacts²:

- **HLF and adjacent facilities:** High magnitude impacts to 45 potential sites of unassessed sensitivity within the Project footprint and moderate magnitude impacts to five potential sites of unassessed sensitivity within 50 m of the Project footprint;
- **Erato and Tigranes-Artavazdes pits:** high magnitude impacts to eight resources of negligible sensitivity and one resources of minor sensitivity ;
- **BRSF and adjacent facilities:** High magnitude impact to one site of negligible sensitivity, and thirteen sites of unassessed sensitivity. Moderate magnitude impacts to two sites of unassessed sensitivity within 50 m of the disturbance footprint; and
- **Conveyor corridor and Access Roads:** High magnitude impacts to three potential sites of unassessed sensitivity and moderate magnitude impact to three potential sites of unassessed sensitivity.

The significance of potential impacts to 10 cultural heritage sites of assessed sensitivity is summarized in Table 6.17.3 and shown in Figure 4.19.1.

² The significance of impacts to potential cultural heritage sites of unassessed sensitivity could not be determined because no assessment of site sensitivity has been conducted.

Table 6.17.3: Significance of Potential Impacts to Assessed Cultural Heritage Sites				
Site Number	Project Component Footprint	Sensitivity	Impact Magnitude	Impact Significance
79	BRSF	Negligible	Medium	Minor
85	Erato Mine Pit	Negligible	High	Minor
86	Erato Mine Pit	Negligible	High	Minor
87	Erato Mine Pit	Minor	High	Moderate
88	Erato Mine Pit	Negligible	High	Minor
89	Erato Mine Pit	Negligible	High	Minor
90	Tigranes Artavazdes Mine Pit	Negligible	High	Minor
91	Tigranes Artavazdes Mine Pit	Negligible	High	Minor
92	Tigranes Artavazdes Mine Pit	Negligible	High	Minor
93	Tigranes Artavazdes Mine Pit	Negligible	High	Minor

The majority of the potential cultural heritage site impacts would result from the construction of the proposed HLF and adjacent facilities, with 50 potential sites of unassessed sensitivity subject to impacts. A total of 45 potential cultural heritage sites are located within the Project footprint of the proposed HLF while an additional five sites are located within 50 m of the HLF, ADR Plant, topsoil stockpile, water pipeline, and their associated Project footprints. The 43 potential sites within the footprint of the HLF would be subject to high magnitude impacts, while six potential sites located within 50 m of the HLF could be subject to medium magnitude impacts.

Construction of the proposed BRSF could result in moderate to high magnitude impacts to 16 sites of un-assessed sensitivity and one site of negligible sensitivity. Thirteen potential sites are located within the Project footprint of the BRSF and would be subject to high magnitude impacts, while two potential sites located within 50 m of the BRSF could be subject to medium magnitude impacts. The scientific importance of these sites was not evaluated after their initial identification during the rapid reconnaissance survey. One site of negligible sensitivity would be impacted by construction of the BRSF resulting in an impact of minor significance

Potential site types identified by the Armenian Archaeological Team within the Conveyor Corridor, Main Access Road, HLF, and BRSF areas include tombs, crypts, grave mounds, fish petroglyph and associated temple, Bronze Age tomb mounds, Eneolithic artefact scatters, Bronze Age fortifications, wall fragments and observation tower foundations. Based on potential site types provided by the Armenian archaeological team, the sensitivity of the remaining sites is likely to range from negligible to high, resulting in potential impacts of minor to not acceptable significance.

The scientific importance of these sites was not evaluated after their initial identification during the rapid reconnaissance survey and, as a result, their scientific importance is unknown. However, a number of the potentially impacted sites were identified as possible tombs or tomb mounds. If these sites are tombs they would be considered high to very high sensitivity sites and the high magnitude impacts associated with the creation of the Project components would result in impact significances of very high to not acceptable.

6.17.6 Mitigation of Impacts

Further research is being carried out to gain a better understanding of values and cultural associations of known cultural heritage sites. A Project CHMP (Appendix 8.17) has been drafted to establish specific management measures to be implemented in order to minimise impacts to known and undiscovered cultural heritage sites. This plan will include the following general mitigation measures which will be implemented by the Project. Different mitigation strategies will be applied to different sites based on their sensitivity and the magnitude of potential impacts.

Preconstruction Mitigation

(a) Avoidance

The preferred means of mitigating direct archaeological impacts is avoidance through Project design. Based upon the findings of the cultural heritage surveys, a number of Project components have already been relocated to avoid impacts to archaeological sites. For a discussion of alternatives considered, refer to Chapter 5.

(b) Additional Surface Reconnaissance Survey

The substantial number of archaeological sites already identified in the vicinity of the Project suggests that un-surveyed footprint areas may contain additional, as yet undiscovered, archaeological sites. Additional surface reconnaissance surveys will be conducted in these areas. If additional sites are found the mitigation measures of avoidance or excavation would be implemented at these sites to mitigate and manage the potential impacts.

(c) Excavation

When potential archaeological sites cannot be avoided (i.e. all or part of the site will be lost or damaged) excavation will be carried out to assess the scientific integrity and significance of the site through the recovery of artefacts and cultural information. The Project will take a staged approach to evaluating which sites will require full excavation and the extent of those excavations. Potential sites within the footprint of proposed Project components will be subject to an archaeological field evaluation³ to determine the presence or absence of archaeological features, structures, deposits, artefacts, or other resources through a programme of limited and targeted excavation. If these types of resources are present the field evaluation will define their character, extent, and archaeological integrity.

Potential sites located within 50 m of proposed Project components will be examined in a similar fashion with a focus on confirming the existence of a site and identifying its boundaries. In addition, a sample of the sites of minor and negligible importance within the mine pits will be archaeologically evaluated in order to confirm the sensitivity value currently assigned to these sites. An excavation strategy will be developed to determine if this group of similar sites represent archaeological sites, modern stone or earthen piles, or natural landscape features.

Archaeological excavations will be used to establish or confirm a site's sensitivity level. If sites prove to be of medium or greater sensitivity, a data recovery excavation will be executed to mitigate the loss with scientific recordation and study. Site specific excavation strategies will be developed and executed in consultation with the Ministry of Culture (MoC) of RA, specifically with the Historical and Cultural Heritage Protection Agency (HCHPA), an agency within the MoC and the Marzpet of Vayots Dzor and Syunik.

Excavation techniques will be aligned with internationally recognised practice and executed by qualified archaeologists. Sites will be systematically excavated prior to impact by Project activities. Excavation will be accomplished in stratigraphic layers using hand tools. Soils will be carefully culled for artefacts, which will be retained for further study and curation. Excavation activities will be recorded in drawings, digital photographs and detailed field notes. When appropriate, special analyses such as human osteology or C¹⁴ dating will be

³ "Standards and Guidance: Field Evaluation", Institute for Archaeologists November 22, 2013.

undertaken. Data and artefacts will be analysed and described in archaeological reports that reflect current international practice. Artefacts and scientific samples from excavated sites will be retained by appropriate local museums or universities.

Construction Phase Mitigation: Chance Finds Procedure

Due to the potential of encountering undiscovered archaeological sites in the Project area during construction, a Chance Finds Procedure (CFP) has been developed. The procedure will address any finds made during ground disturbing activities through the following measures:

- Training of relevant staff and contractors in the recognition, handling, and response to archaeological chance finds;
- Conducting pre-construction site inspections when the ground is cleared in advance of construction activity;
- Deploying archaeologists to monitor construction sites to guide the recognition of and response to archaeological finds made during ground disturbance;
- Establishing protocols for responding to chance finds, including temporary cessation of work in the area of finds and evaluation by the archaeological monitor;
- Notification of government authorities when appropriate;
- Use of expedited procedures for evaluation and excavation of significant chance finds in order to limit impacts while minimising construction delays; and,
- Keeping an auditable record of monitoring activities and chance find responses.

The Chance Finds Procedure will also be implemented during operation of the mine, but only in cases where ground disturbing activities might affect previously unknown archaeological sites. If low or negligible cultural heritage sites cannot be avoided through Project redesign, the Chance Finds Procedure will serve as the primary means for mitigating impacts to these cultural heritage sites.

6.17.7 Monitoring and Audit

The monitoring and audit planning necessary to assess the effectiveness of the mitigation strategies have been identified in Table 6.17.4.

Table 6.17.4: Cultural Heritage Monitoring and Audit

Cultural heritage resources			
Monitoring approach	Baseline	Cultural heritage field reconnaissance in the Project area was undertaken in stages beginning in 2010. A total of 6 pedestrian field reconnaissance surveys have been conducted within the Project area. These surveys identified a total of 487 known or potential cultural heritage sites. Construction of the proposed Project layout could result in impacts to 81 potential or known sites and an unknown number of undiscovered sites.	
Significant effects			
Direct physical impacts to known and undiscovered archaeological sites.		Construction and operation phase activities could result in significant damage and/or the complete removal of 81 known or potential archaeological sites located within the Project’s Project footprint or within 50 m of the Project footprint. Construction and operation phase activities could result in damage to undiscovered archaeological sites within the Project area.	
Specific Actions			
Level 2 Management Plans	The Cultural Heritage Management Plan (CHMP) defines steps to minimise potential Project impacts to cultural heritage sites. The CHMP contains the following commitments for the protection of cultural heritage sites based on the mitigation measures outlined in the Project ESIA: <ul style="list-style-type: none">• Avoidance and marking of known cultural heritage sites;• Additional surface reconnaissance and archaeological evaluations, and potential archaeological data recovery excavations;• Implementing protocols and procedures in the Chance Finds Procedure (level 3 SSPS);• Providing cultural heritage awareness training to Project staff; and• Consultation with stakeholders, including the Armenian MoC as well as the Marzpet of Vayots Dzor and Syunik, and local community leaders in Jermuk and Gndevaz.		
Level 3 SOPs	The commitments in the level 2 CHMP will be implemented through the Chance Finds Procedure (CFP) and additional level 3 SSPs to be developed to meet commitments outlined in the CHMP. The CFP provides a process for conducting archaeological monitoring of Project ground disturbing activities and responding to any potential tangible cultural heritage (Chance Find) encountered unexpectedly during Project construction or operation. Additional level 3 SSPs will be developed to execute the CHMP commitments concerning site marking and additional survey and excavations.		
Cultural Heritage Monitoring strategy		Strategy	Monitoring
Impacts to known cultural heritage sites	Avoidance by re-design and marking of known cultural heritage sites	Avoidance is the preferred means of mitigating impacts to cultural heritage sites.	A number of project elements originally sited in the Vorotan River Valley have been relocated to avoid impacts to cultural heritage sites. If additional sites are identified within 50 m of un-surveyed Project components they will

Table 6.17.4: Cultural Heritage Monitoring and Audit

			be marked for avoidance.
Impacts to undiscovered archaeological sites	Surface reconnaissance and excavation	A number of Project components have not been subject to archaeological reconnaissance. In order to minimize impacts to potential undiscovered archaeological sites in these areas, reconnaissance will be conducted.	Professional archaeologists will conduct non-intrusive, pedestrian survey of Project components. These surveys will focus on identifying above ground indicators of archaeological sites. If potential medium or high importance sites are identified, additional excavations may be necessary.
	Chance Finds Procedure/ Archaeological Monitoring	The Project CFP includes the commitment to have an archaeological monitor(s) on-site during all ground disturbing construction activities. The CHMP includes a commitment to provide training in the identification of archaeological resources to Project staff in order to increase the ability of staff to identify potential cultural resources.	A professional archaeologist(s) will monitor multiple construction activities in the Project area and provide on-call support if potential Chance Finds are identified by Project staff. Training in the identification of potential cultural heritage resources and the protocols outlined in the CFP will be provided to Project staff.

6.17.8 Residual Impacts

Residual adverse impacts to cultural heritage sites will range from negligible to minor, assuming that the mitigation measures outlined above are implemented as part of the Project's cultural heritage management plan. This also assumes that no undiscovered or un-assessed sites of high or very high importance are present in the Project area. The significance of the potential unmitigated impacts to the known or potential cultural heritage sites in the Project's Project footprint are assessed as one moderate, nine minor, and 71 of unknown significance.

The one moderate impact will result from the construction of the Erato Mine Pit. The nine minor impacts will result from the construction of the Erato and Tigranes Artavazdes Mine Pits and BRSF. The application of mitigation measures will reduce the significance of these impacts by at least one degree, from moderate to minor or minor to negligible, depending on the mitigation measures to be used. Excavating a site would reduce an impact by one degree by mitigating the impact through the recovery of scientific information. Avoiding sites through Project redesign would prevent direct physical impacts to cultural heritage sites, reducing the

impact magnitude two degrees to negligible or neutral.

An additional 71 impacts of undetermined significance resulting from impacts on unassessed potential cultural heritage sites will also occur. These will be the result of impacts to sites of unassessed cultural heritage sensitivity within the Project footprints of the HLF, ADR Plant, BRSF, Main Access Road, Conveyor Corridor, and other associated Project infrastructure. A number of sites identified during surveys of the conveyor corridor and some of the infrastructure adjacent to the BRSF have not been evaluated by an archaeologist to assess their cultural and/or scientific significance. These sites were initially identified during surveys of previous Project infrastructure locations or alignments prior to the conveyor alignment shown in Figure 3.1. Therefore, depending on the outcome of the planned site assessments to be undertaken, prior to commencement of construction, unmitigated Project impacts to cultural heritage could be as high as not acceptable. The implementation of the mitigation measures will reduce the significance of these impacts by at least one degree or more depending on the measure used.

Table 6.17.5: Impact Summary – Cultural Heritage

Impact	Source	Primary Receptor (1)	Phase (2)		Significance(3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
Direct physical impacts to cultural heritage	Excavation, grading and other ground disturbing activities; Passage of heavy vehicles on top of archaeological sites, especially in wet weather.	N	X	X	M -	M -	<ul style="list-style-type: none"> • Additional surface reconnaissance surveys to evaluate sites of unknown importance that cannot be avoided through Project re-design • Chance finds procedure implemented, including training of staff and contractors • Project footprint re-alignment where possible to avoid cultural heritage sites • Excavation of cultural heritage sites by national authorities, to meet standards required by Armenian law and IFC PS 8; • Marking of known sites or high potential areas with high visibility, allowing sensitive areas to be avoided. 	Cultural Heritage Management Plan, including Chance Finds Procedure (Appendix 8.17, Annex 1)
Indirect physical impacts to cultural heritage	Blasting, vibration; transit of heavy vehicles in close proximity to archaeological sites	N	X	X	N	N	<ul style="list-style-type: none"> • Establish appropriate buffer zones and no go areas around known archaeological sites and high potential areas. 	Cultural Heritage Management Plan including Chance Finds Procedure (Appendix 8.17, Annex 1)

Notes:

(1) Primary Receptors: E = employees, R = residents, Fl = flora, Fa = fauna, N = National

(2) Project Phase: C = Construction, O = Operations

(3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, S - = significantly adverse, M - = moderately adverse, N = neutral, M + = moderately improved, S + = significantly improved

6.17.9 Conclusions

Overall, residual impacts to known cultural heritage will be limited to negligible to minor with the implementation of these mitigation measures, which are aligned with applicable national and international standards. The impacts to potential cultural heritage sites of unassessed sensitivity will be determined as part of the Project's post-ESIA commitments. The development of the Amulsar Mine Project will also result in positive impacts to Armenian cultural heritage. Project-related archaeological discoveries and investigations in the Amulsar concession area will contribute substantially to scientific and cultural understanding of Armenia's past. Substantial capacity building will also occur as a consequence of activities and international collaboration sponsored by the Project in the execution of its cultural heritage management program.

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APPENDICES

Appendix 6.18.1 Radiological report (Radman, 2012)

6.18 Community Health, Safety and Security

This analysis combines the results of the health impact assessment (HIA) with an assessment of community safety and security impacts (refer to Section 6.3 for impact assessment methodology).

6.18.1 Methodology

A HIA is intended to identify and estimate the lasting or significant changes of Project activities on the health status of a defined population by adopting a systematic approach to identifying the different health and wellbeing impacts, both positive and negative, of plans and Projects on this population. The HIA followed the methodology outlined in the Good Practice Note on HIA, as supported by the IFC. The methodology addresses health impacts across twelve Environmental Health Areas (EHAs), each of which is addressed in this section, but limited to their respective relevance to the Project. The EHA framework defines the types of health impacts and provides a structure for organizing and analysing potential Project impacts in the community.¹

6.18.2 Potentially Affected Communities

In order to undertake a HIA it is necessary to define the potentially affected communities (PACs) which are not necessarily the same as the affected communities defined for social or environmental impacts. A PAC is a defined community within a clear geographical boundary where Project-related health impacts may reasonably be expected to occur. PACs are inherently prospective and represent best professional judgements of health impact assessors. To define the PACs, the following considerations were made:

- Is there a hazard?
- Who or what may be exposed to this hazard (pathway and rate of exposure to estimate the concentration/extent to which human receptors of concern may be exposed)?
- The mode: air, water, food, vector, and social determinant etc. and route: inhalation, ingestion etc. of exposure?
- What is the risk of exposure based on a likelihood and consequence analysis (magnitude, duration and length)?
- How sensitive or vulnerable the receptor is to the potential hazard or impact? The

¹ IFC (2009), Introduction to Health Impact Assessment (HIA) – Good Practice Guidance

prevailing health needs in the area underscore these vulnerabilities; and coupled with the institutional capacity to manage potential health impacts, highlights potential sensitivities in the PACs.

Based on these questions, five potential PACs were considered for the Project as described below and illustrated in

Figure **6.18.1**. This includes a brief description of the potential exposure hazards of the respective PACs:

PAC 1: Gorayk and Saravan Communities

Gorayk village is east of Saravan on the M2 highway, approximately 12km south-east of the HLF and 4.7 km to the Tigranes/Artavazdes open pits (see Table 3.1, in Chapter 3 for the distances of each element of the Project to Gorayk and Saravan. This community used to reside 2km further to the east but were resettled in the 1960's to allow for the creation of the Spandaryan Reservoir. This has created numerous challenges, as the new area is prone to flooding and the high water table creates significant challenges with dampness or damp conditions, coupled with the heating in houses the high levels of indoor humidity leads to the growth of mould². Indoor air quality is a known existing challenge with high measured radon levels in the local houses (see Section 6.17.9). While this may pose a future health risk to the community, this is entirely unrelated to the Project and will not be directly influenced by future Project activities.

Saravan is located on the M2 highway, southwest of the Project. Saravan includes the villages of Saralanj and Ughedzor (which is only occupied during summer months). The heap leach facility will be located approximately 2km to the north of Saravan. Livelihood strategies include agriculture and small-scale commerce. The village, as with other rural communities, does not have access to an adequate sanitation system. Until recently, Saravan did not have access to natural gas, but in 2013/2014 an external and internal system was developed by the local government, with support from Lydian.

The impacts from the Project on these two communities are expected to be relatively homogenous. The development of the HLF (Gndevaz) and mining of Erato and

² Wardell-Armstrong, Amulsar Open Pit Gold Project Scoping Report. 2011
ZT520088
May 2016

Tigranes/Artavazdes pits are the most likely direct impacts to these communities, but they are expected to be minimal (3.9 km away at closest point to Saralanj). There may be some limited noise from blasting from the HLF platform construction, open pits and some limited visual impacts, with these more relevant in Gndevaz (full analysis of visual impacts is contained within Section 6.5 and for blasting, in the context of noise and vibration, in Section 6.7).

Reduced air quality due to dust or emissions from the HLF should not influence Gorayk and Saravan but may influence Gndevaz (full analysis of air quality impacts is contained in Section 6.6).

Traffic impacts are discussed in Section 6.18, but are unlikely to impact significantly in these communities as the main road to Iran is not likely to experience increased traffic from direct association with the Project. Most of the traffic generated as a result to the Project will use the H-42 road.

PAC 2: Gndevaz

Gndevaz is located on the national H-42 road, to the south of Jermuk. This community is likely to be most directly impacted by the presence of the Project due to the location of the HLF, ADR plant, overland conveyer, contact process and storm water collection ponds and the temporary construction camp. The two primary access routes to the Project will be from immediately east and 1.3km to the south of Gndevaz. It is expected that traffic will significantly increase along the H-42 passing alongside the village, as a direct result from Project or service vehicles.

Environmental health effects are likely to be most evident in Gndevaz with noise, air quality and water quality all potential impacts. These specialist reports address potential human health impacts related to specific regulatory compliance targets in more detail in Sections 6.7, 6.6, 6.10 respectively.

PAC 3: Jermuk Area

The Jermuk area includes Jermuk town, including the so-called 'east bank' and Kechut. Jermuk is located on the national H-42 road at an altitude of about 2000m on the Arpa River. Jermuk's

main economy is driven from its attraction as a local tourist destination with thermal waters and numerous spas, as well as mineral water bottling plants.

This area is located approximately 7km to the north-west of the open pits, 4km from the BRSF and is 6.5km from the HLF. The BRSF is closest to Kechut at 4.1km but the topography of the land makes impacts from ground or surface water quality unlikely. Depending on the size of the camp selected for construction (options range from 550 to 920 beds), a peak of 370 workers may be accommodated in Jermuk hotel accommodation during the construction period. During operations approximately 250 workers will reside in Jermuk, primarily in hotel accommodation.

The Project is located downstream from the Kechut reservoir so any potential water impacts are not likely to affect this area. Noise and vibration from the mine or related activities are not anticipated. Air quality from the mine is not likely to impact on Jermuk, with any air quality and noise concerns related to increased motor vehicle traffic in the town, with an associated increase in emissions (sulphur dioxide and diesel particulate matter). Again, these will be described in separate specialist studies and related stakeholder communication where interested and affected parties have expressed concern on environmental impacts from the Project.

The indirect effects of the Project are likely to be most significant in Jermuk.. The accommodation plans for the Project may alter the social and economic structure of the town and be likely to influence some social determinants of health. However, Lydian is working with and supporting this community as part of its social strategy to enhance the benefits of the Project, as well as to mitigate any indirect impacts. Different health impacts will also be managed as part of this social strategy.

PAC 4: Seasonal Herders

Seasonal herders who graze their livestock in the valleys around the BRSF area may be impacted. Direct impacts may include noise and concerns related to water quality and water accessibility. Changes in the socio-economic structures may also influence these seasonal migrants especially in terms of potential inflation of food and housing. In addition, if herders need to access pastures more removed from roads there may be a reduced ability to transfer their produce (especially milk) to markets with an associated reduced income.

PAC 5: Transport Corridor

The various transport corridors to support the supply chain of the Project is considered a separate PAC, as partially presented on the map in

Figure **6.18.1**.

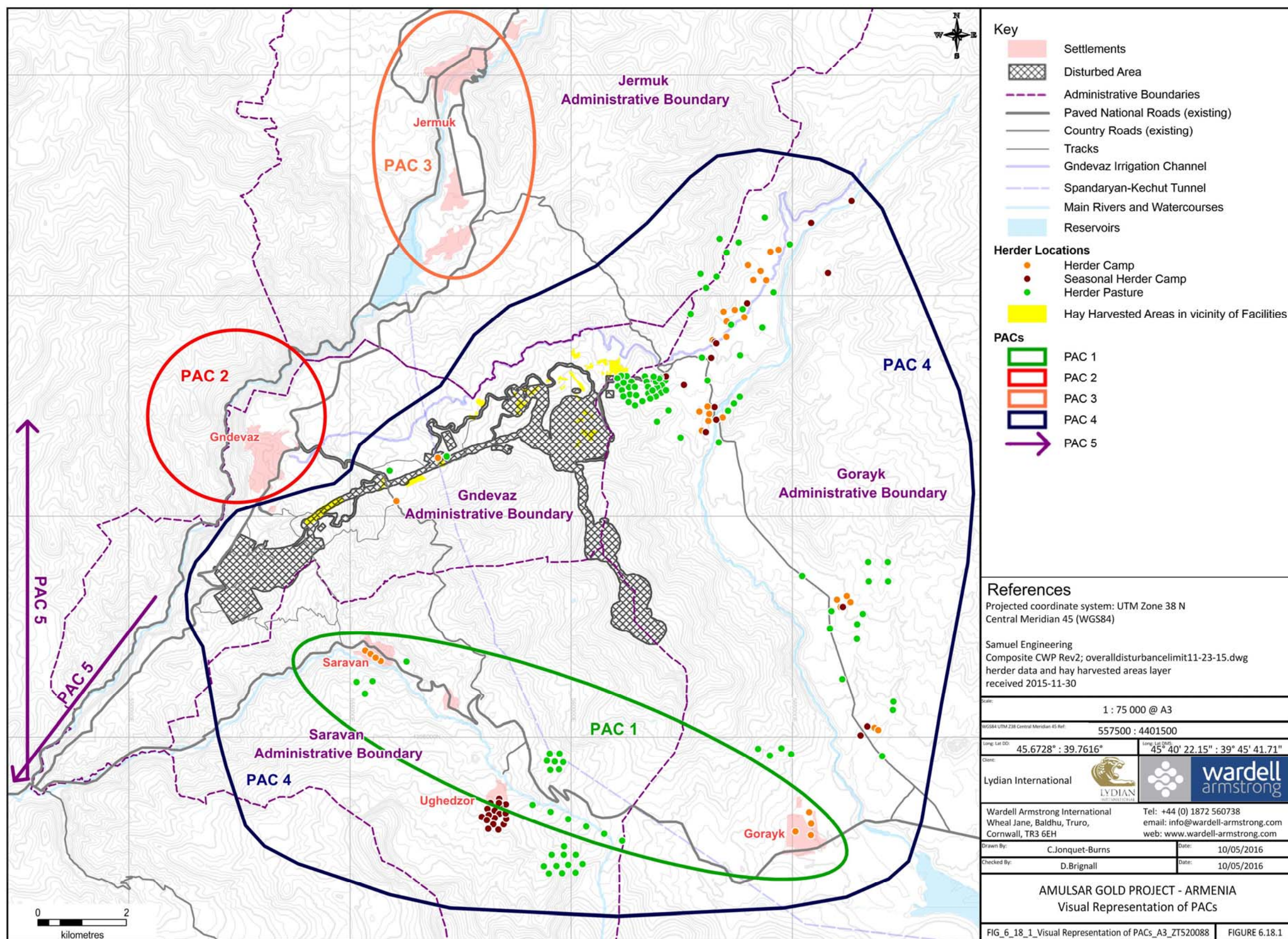


Figure 6.18.1: Visual Representation of PACs

Gender and Vulnerable Groups in Potentially Affected Communities

The social impact assessment discusses specific gender impacts and vulnerable groups in the study area. However, there is merit in mentioning these from a health impact perspective. They include:

- **Women:**
 - Due to the nature of mining, local women are less likely to benefit from employment on the Project. This includes the unskilled portion of the workforce, as this work is likely to involve manual labour to which men will be more suited. Thus, the direct socio-economic benefits of the Project may not be experienced by local women. Improved socio-economic attainment by women has been associated with better outcomes in maternal and child health and any improvement or deterioration in socio economic conditions can play an important role in these development indicators.
 - Women and young girls may be susceptible to advances from men that are employed on the Project. The poor socio-economic circumstances in the community and lack of opportunity for young girls may lead to the development of transactional sexual relationships that can influence social cohesion, increase risk of sexually transmitted infections and unwanted pregnancies in this group. Local social services are poorly resourced to support young girls.
- **Herders and agriculture dependent households:**
 - Reduced access to land and proximity of pastures to access roads may limit the ability to generate produce or reduce access to markets to sell produce. This may lead to a loss of income or increase the effort required to generate the same income with potential health impacts on nutrition and quality of life.
- **Poor people:**
 - The development of the Project has the potential to influence socio-economic conditions in the study area and in the PACs. Inflation on goods and services (housing and food) may occur with an associated significant negative impact on already poor people. Improved access into the area may limit the ability for poor people to sell goods locally but may also increase exposure to markets that were not accessible before the Project started.

- Elderly:
 - The elderly may be more susceptible to social-economic and environmental health changes related to the Project including:
 - Inflation of goods and services and ability to afford them given the inability to work or increase incomes.
 - Influence on sense of place and altered quality of life linked to increased activity associated with mining - even if indirect in the broader study area.
 - Increased susceptibility to health conditions related to potential environmental exposures associated with mining - for example respiratory conditions related to dust exposure (although a minor to negligible significance).
- Children may be more susceptible to health conditions related to potential environmental exposures associated with mining - for example respiratory conditions related to dust exposure (although a minor to negligible significance).

6.18.3 Key Potential Community Health, Safety and Security Impacts

The key potential impacts summarised by relevant EHA include:

- Communicable disease linked to the living environment;
- Vector related disease;
- Water sanitation and waste related disease;
- High risk sexual practices, STIs including HIV/AIDS;
- Food and Nutrition;
- Non-communicable diseases;
- Environmental health determinants;
- Social determinants of health;
- Cultural health practices;
- Health services and systems;
- Injuries and accidents, including road accidents; and
- Security conflicts.

Environmental health issues have been raised by stakeholders as a topic of concern during the ESIA engagement process. To fully address these concerns, additional studies have been

conducted on the following topics: radiation, water quality, air quality and noise/vibration, each of which is summarised in this chapter.

6.18.4 Communicable Diseases Linked to the Living Environment

Project Activities Affecting Communicable Disease Transmission Linked to the Living Environment

There are a number of communicable diseases whose local transmission patterns may be directly and indirectly influenced due to changing social and environmental health conditions related to the Project development. Accommodation of workers is a key factor in managing risk related to transmission of communicable diseases. The construction camp will be designed as a closed, dry facility to limit interaction with local communities. However, the regular shuttle bus services from the mine to Jermuk and surrounding settlements will limit the level of separation between workers and the community. The hotel accommodation will be open in nature; however, services will be provided within the hotels to provide self-sufficiency for workers. The hotels will provide accommodation for a peak number of 370 construction workers on a short term basis, and 250 operational workers, who are non-resident in the local area and commute regularly back to their point of origin and families. It is assumed the majority of these workers will be men.

Depending on the success of the local recruitment initiatives, additional non-local employees may also move into the area (predominantly to Jermuk/Kechut or Gndevaz it is assumed). These additional non-local employees (expected to be in the order of 210 workers) are likely to either rent or buy housing in the local area and may well move with their families (see Section 6.12 for greater discussion on this topic).

The most important of these diseases is tuberculosis (TB), which is noted as a significant national public health issue, although trends in both incidence and prevalence rates appear to be improving. The baseline section describes TB in more detail but of relevance in the impact assessment is that most cases that are notified locally are cases that are imported from outside of the immediate study area. This underscores the importance of migration of people related to TB transmission and spread and the relevance of managing accommodation and where people work in close association on the Project. The weak health system and the poor health seeking behaviour of the community are both risk factors that may increase the risk for disease transmission.

Measles is also an important disease risk, with recent outbreaks reported across Europe, especially in people above 20 years of age, reflecting ineffective vaccination campaigns when they were children.

Potential Communicable Disease Impacts Linked to the Living Environment

Prior to mitigation, it is anticipated that impacts related to communicable diseases linked to the environment could be felt in the medium term, be restricted to the study area, and have a moderate negative health effect. It is possible that these health consequences will occur representing an overall **moderate negative health impact significance**. The impacts are anticipated to occur in construction and will persist to a lesser degree in the operational phase due to the reduced size of the workforce.

These potential impacts could affect Gndevaz, Gorayk/Saravan and Jermuk PACs. The elderly, children, and those with impaired immune systems (elderly, malnourished etc.), are likely to be specific vulnerable groups due to their increased susceptibility in acquiring these conditions. There are not likely to be specific gender related impacts.

The Project development has the potential to impact community health linked to communicable diseases in the living environment, in the following direct and indirect manners:

Direct:

- The incoming workforce has the potential to introduce communicable diseases into the study area if they originate from areas where there is a higher incidence of circulating communicable disease. This is especially important for TB with an associated high proportion of MDR-TB cases. Reports that recently diagnosed TB cases in the study area were imported from migrants underscore this risk. This may be exacerbated through the return of family members who have been working in other countries (predominantly Russia).
- Overcrowding in workplace accommodation may promote the spread of communicable diseases, with TB and influenza specific concerns.
- Influenza may be introduced from different areas of the world and this may pose a significant health risk, especially to vulnerable groups in the community. This will be important in construction with the movements of large groups/numbers of people in and out of the area. This is especially relevant for expatriate staff and travellers as they

may introduce novel communicable diseases into the area, potentially even seasonal viruses circulating in other hemispheres. The recent and current risk of pandemic outbreaks of influenza, especially H1N1 and H7N9, are such examples.

Indirect:

- In-migration into the area may occur with migrants (both returning and speculative) seeking direct or indirect employment opportunities from the Project (see Section 6.12 for a more detailed analysis of this impact). The increased population may place pressure on housing in the area. This has the potential to cause overcrowding as the ability to afford the construction of new houses in the PACs is low. Increased opportunities in the area is also likely to reduce the trend of people leaving the rural communities to seek work in other parts of Armenia or Russia, (this practice reduced in the period 2011-12, but re-commenced in 2013-14 when Project development was delayed).
- Influx and use of hotel facilities by workers and migrant businessmen may influence local pricing due to supply and demand. This potential impact is discussed in more detail in Chapter 6.21, with due consideration for associated health impacts related to potential influences on the local economy and the entire tourism supply chain.
- The Project has the potential to improve the local housing in the study area through indirect economic development. The workforce that is hired locally will reside in their host community, and by earning a good wage, will be in a position to improve their living environment. There is also the possibility that the housing in the general community will improve because of economic development.

Mitigation of Communicable Disease Linked to the Living Environment Impacts

These potential impacts will be mitigated through the following activities:

Project Impact Mitigation:

- Adequate accommodation arrangements will be made available to the workforce so that overcrowding does not occur in the temporary construction camp or in Jermuk hotel accommodation to the extent that it is utilised by the Project. The IFC and EBRD guidance note should serve as a reference to support this. Monitoring will also take place to determine the level of in-migration which is occurring;
- Monitor housing inflation in Jermuk and the other PACs, and costs of hotel rooms in Jermuk and bed occupancy in peak tourist seasons;

- Support the development of a community health information system (CHIS) to monitor specific key health indicators on communicable diseases from longitudinal health data sources; and
- Monitor pandemic influenza alerts through the World Health Organisation (WHO) notifications.

Occupational Health, Safety and Environmental Management:

- Workplace pandemic preparedness policies and programmes will be developed and maintained to reduce the impact of any suspected or confirmed outbreak of communicable disease at the local level. These will include effective surveillance mechanisms;
- A workplace TB management policy and programme for the workforce (including contractors and short term labourers) will be developed. This will be integrated into the Project's HIV policy. Programmes will be based on and integrated into national programmes;
- Screening of employees at recruitment for TB and provision of adequate referral and support for on-going treatment programmes from the workplace medical service to the national treatment programmes. This will need to occur prior to final appointment and mobilisation of workers to ensure that diseases are not brought into the area. These screenings must be part of the contractor management framework and a KPI for the Company and contractors to address;
- Develop programmes for vaccine preventable diseases and ensure that all staff receive a booster of diphtheria and pertussis as well as measles, mumps and rubella vaccines;
- Monitor airborne pollutants to ensure that occupational exposure limits are not exceeded for elements such as respirable crystalline silica as development of silicosis has the potential to synergistically increase risk for development of TB. These risks are classified as low based on current knowledge and need to be addressed in the occupational health and safety plan; and
- Consideration will be given to developing seasonal influenza vaccinations to all staff that rotate between the Project and their country of origin.

Residual Communicable Disease Impacts Linked to the Living Environment

Effective and sustained implementation of the mitigation measures described above is anticipated to support a residual a minor negative health impact, in the short term and at a localised level. These impacts are unlikely, providing for an overall **negligible health impact with mitigation**.

6.18.5 Vector Borne Diseases

Project Activities Affecting Vector Borne Diseases

The only Project activity that would be likely to have any effect on vector borne diseases is through the development and use of a transportation corridor. Regardless of the expansion of transport corridors, the risk for transmission of vector related disease is low in the Project area.

Potential Vector Borne Disease Impacts

It is anticipated that impacts related to vector related disease will be felt in the short-term, be localised and have a negligible health effect. It is improbable that these health consequences will occur, representing an overall **negligible health impact significance**. The impacts are unpredictable, may occur at any time of the Project life cycle, and could affect Gndevaz, Gorayk/Saravan and Jermuk PACs.

The Project will transport some construction and operations employees and contractors between Yerevan and the Project site on a regular basis, increasing the opportunity for disease transmission from one region to the other. In addition, the Project may import goods through Georgia, increasing transport between these areas and the Project region.

Mitigation Measures for Vector Borne Disease Impacts

This impact is considered **negligible** and does not require mitigation. Health records could be monitored to ensure no changes are occurring to the health profile of the region as a precaution. Gender specific impacts are not anticipated.

Residual Vector Borne Disease Impacts

The short and long term residual vector borne disease impacts are **negligible**.

6.18.6 Soil, Water and Waste Related Diseases

Project Activities Affecting Soil, Water and Waste Related Diseases

The major contributors that could affect soil, water and waste related diseases include direct Project activities involving earthworks and inadequate wastewater management, and indirect factors such as the in-migration of people placing pressure on the already limited basic services.

Gndevaz, Saravan, and especially Gorayk, currently have limited access to potable water sources, independent of the Project. Jermuk/Kechut has better access to potable water. Sewerage systems in the rural communities are limited, with Jermuk having access to a wastewater management system (this system was recently upgraded and now has a design capacity for 18,500 people, although it only includes a mechanical separation plant at the time of writing of the ESIA).

Domestic garbage management is poor, with Lydian supporting collection and disposal in the study area as part of a social contribution. A landfill for non-hazardous waste will be developed by the Project to the eastern side of the BRSF. Unless a suitable municipal landfill is developed by Jermuk, all domestic waste generated by the mine, temporary camp (built for duration of the construction phase) and by workers residing in Jermuk will be disposed of in the landfill built at the mine site. Hazardous waste generated by the Project will be minimised and that which requires disposal will be contained in a designated hazardous waste storage facility located adjacent to the ADR Plant. If feasible, a waste incinerator will be procured.

Sewerage generated from the plant, office buildings, crushing plant, and truck shop will be managed by septic tank systems, with effluent disposed of in accordance with local regulations and IFC EHS guidelines. The design of the temporary camp will include a packaged wastewater treatment plant. Plans have been developed for septic sanitation facilities in different Project work areas, with adequate numbers of male and female facilities.

Potential Soil, Water and Waste Related Disease Impacts

It is anticipated that impacts related to soil, water and waste related disease will be felt in the medium term, be restricted to the study area, and have a minor negative health effect. It is possible that these health consequences will occur, representing an overall **moderate negative health impact significance**. The impacts are anticipated to occur in the construction phase, but will persist to a lesser degree into operations. Jermuk, Saravan, Gndevaz and the

seasonal herders are anticipated to be most impacted. Gender related impacts are not anticipated.

The Project development has the potential to impact community health related water quality and waste/sanitation in the following direct and indirect manners:

Direct:

- Contamination and / or redirection of the surface water (rivers, streams), springs and superficial groundwater from construction activities and mining operations. Contamination may also occur from the naturally occurring chemical composition and associated mineralisation of parent soil or superficial rock material. This potential direct impact is linked to environmental management, and is discussed further under environmental health determinants in Section 6.18.11.
- Contamination of surface as well as superficial groundwater sources and soil from the generation of sewerage, spills and solid waste from the Project's activities.
- Cessation of water springs used by herders.
- The capacity of local services in Jermuk to accommodate additional demand has been assessed and, an allowance has been considered for a 500-920 person camp being built and used for the peak periods during the construction period to allow the project to reduce the additional load on public utilities. Service capacity in Jermuk is further addressed in Section 6.12 and 6.14.
- It is not anticipated that the Project will induce any health impacts through the abstraction of water for Project related needs.

Indirect:

- In-migration of migrants or returning citizens to the area may place pressure on the already limited supplies of potable water and waste management facilities in the broad study area. This can result in the potential for increased disease risk, especially diarrhoeal diseases, as well as for social discord due to increased demand for what is a scarce resource. This is however, unlikely, as large-scale and sudden in-migration that could place stress on existing systems is not anticipated. The potential for these impacts to occur is further considered in Section 6.12.
- Unplanned development that may occur with rapid increases in population has the potential to contaminate surface and superficial groundwater sources in a similar manner, but as mentioned, this is unlikely.

- Increased demand for services within Jermuk linked to accommodation of up to 370 workers during construction and 250 workers during operations will place additional pressure on these systems. Effective resolution, working in coordination with Jermuk Municipality, of waste management and wastewater treatment challenges facing Jermuk will be required.

Mitigation/ Enhancement Measures for Soil, Water and Waste Related Diseases

These potential impacts will be managed through the following measures:

Project impact mitigation:

- Water quality management as part of the Project's environmental management plan, surface water management plan (contact and non-contact water) and water use licence. This will include surveillance of community water sources and supply (including water sources used by herders).
- Effective communication strategies with the local communities on water and soil quality will be developed. This needs to include transparent reporting of water quality results from the Project's water monitoring program and effective communication thereof (see the Surface Water Management Plan in Appendix 8.23). Participatory monitoring of water quality has been established and will be continued by the Project.
- Infrastructure and systems will be developed, and locations selected, to ensure that domestic water use, sewerage and domestic waste management by the mine will not adversely affect available water supplies in the PACs.

Occupational health, safety and environmental management:

- Conduct information, education and communication (IEC) campaigns in the workforce and with the community on proper water use, hygiene and sanitation to prevent pollution of community water sources.
- Ensure work areas have adequate potable water supply and waste management facilities. This needs to include security guards or other staff stationed in remote areas of the mine. Portable chemical toilets should be provided as required to prevent the need to use the environment for ablution activities.
- As part of the use of hotel accommodations in Jermuk, ensure that there is adequate potable water availability as well capacity to manage wastewater and domestic garbage.

Residual Soil, Water and Waste Related Diseases Impacts

Effective and sustained implementation of the mitigation measures described above is anticipated to support a minor negative health impact, in the short term at a study area level. These impacts are possible, with a potential **minor negative health impact significance with mitigation**.

6.18.7 Sexually Transmitted Infections (including HIV/AIDS) and High Risk Sexual Practices

Project Activities Affecting Sexually Transmitted Infections (including HIV/AIDS) and High Risk Sexual Practices

The Project will influence the increased transmission of sexually transmitted infections (STIs) through the “four m’s” of “men, money, mobility and mixing”. This is an acronym that is often used to describe the influence of extractive industry development and determinants that may influence an increased risk for the transmission of STIs.

The study area is reported to have a low current prevalence and incidence of HIV/AIDS, and other STIs. All HIV/AIDS cases currently under care in Jermuk were reportedly infected while working as migrant labourers in Russia.

Key Project activities that may influence this health outcome include:

- i) the location of workers in accommodation in hotel accommodation and a temporary construction camp;
- ii) the origin of workers (including contractors, expatriates and visitors) especially those from outside the immediate study area;
- iii) the transportation corridors used by the Project;
- iv) gender balance of employees/contractors; and
- v) migrants who move into the Project area.

Potential Sexually Transmitted Infections (including HIV/AIDS) and High Risk Sexual Practice Impacts

It is anticipated that impacts related to STIs may be felt in the long term, have regional effects with a predicted major negative health effect. It is possible that these health consequences will occur, representing an overall **very high negative health impact significance**. The impacts are anticipated to occur in the construction phase, and will persist into operations. Jermuk, Gndevaz and communities along the transport network are the PACs who are likely to

experience the most significant impacts, but Gorayk, Saravan and seasonal herders may also experience impacts. Women and young girls are likely to be more vulnerable to these impacts than men.

Direct:

- **Transport Corridors:** There is the potential for increased high-risk sexual encounters along the transport corridors to the Project. Transport workers are a well-described high-risk group, known to have multiple sexual partners and to develop sexual networks along transport corridors. These can include long distance truck drivers as well as drivers of light duty vehicles. There is thus the risk of transmission of STIs along the transport route as well as in the local communities, especially if truck stops develop in the communities around the Project.

This potential risk can allow for the mixing of the virus with new strains introduced from other areas. This can have public health implications as resistant strains may be introduced from other areas with implications on national anti-retroviral therapy (ART) strategies.

- **Increased disposable income:** People (generally men) who benefit directly and indirectly from the Project may have more money available to partake in forms of transactional sex. The poor and vulnerable sectors in the community may be more susceptible to advances for opportunistic transactional sexual encounters with the risk of a "sugar daddy" phenomenon developing, where men that have disposable income entice young girls, who are vulnerable through poverty and lack of opportunity, into transactional sexual relationships.

In addition, increased incomes in the local community, especially in those employed by the Project may increase the incidence of transactional sex in their host communities. This will then pose a risk to their normal family unit with potential increased transmission of STIs, and with local women again a specifically vulnerable group.

The temporary construction workforce is a high-risk group as they will have disposable income with limited entertainment opportunities. Those workers residing in the temporary camp (between 500-920 workers) will have limited exposure to

communities, minimising this risk. However, up to 370 workers may reside in hotel accommodation in Jermuk during the peak of construction making commercial and transactional sexual relations likely in the communities in the study area.

- **Workforce mixing with the local population:** Approximately 70% of the temporary construction workforce are expected to be sourced from outside of the study area, as the local community is not expected to have the requisite skills to support all the required activities. In general, construction workforces are mobile and move from site to site, often in different regions. Due to potential high-risk practices and behaviours, these groups often have higher rates of STIs and HIV, and are thus a high-risk group that have the potential to transmit STIs in the local community, even if for a short period.

In addition, these workers are often in remote settings away from their normal partners for extended periods, and thus casual sexual relationships (with multiple sexual partners) are commonplace. Rotational work, with limited entertainment opportunities, means that they often have little means to spend cash they earn locally, and thus disposable income may be used in return for sexual favours.

The hotel accommodation and the onsite camp are thus potentially high-risk, with the temporary construction workers likely to seek entertainment opportunities in the towns and villages in the study area, with Jermuk and Gndevaz particularly at risk. This risk is being mitigated in part through project design choices, with the construction camp operating as a closed facility, thereby reducing interaction between rotational construction workers and local communities. However, restrictions of intermixing between workers accommodated in hotels in Jermuk and residents of Jermuk and other villages is unlikely to be fully feasible, due to the open nature of accommodation arrangements. Taverns and similar establishments may develop and with substance abuse, may become areas where high-risk sexual encounters are initiated.

In addition, the planned accommodation of workers in Jermuk town will place this community at specific risk. Hotel and catering staff, especially cleaners, reception staff and restaurant staff may be specific risk categories. Knowledge of the hotels and the financial status of the workers may attract "formal/professional" commercial sex

workers (CSW) to the area. This group may have a higher STI disease burden than the local community, which may lead to increased transmission of STIs in the study area. This is described further below.

Indirect:

- **In-migration to the area in returning and new migrants** can result in mixing of people with higher disease prevalence with local residents that may have a lower prevalence of disease, as well the introduction of different viral strains locally. This may include returning citizens or migrants from countries that have higher circulating rates of HIV and STI, including Russia, Kazakhstan and other eastern European and Central Asian countries. Figure 6.18.2 below underscores this risk by depicting that the Central Asia region has experienced a more than 25% increase in HIV prevalence from 2001 to 2009 (in red), with UNAIDS reporting the region as a concern due to the increasing rates³.

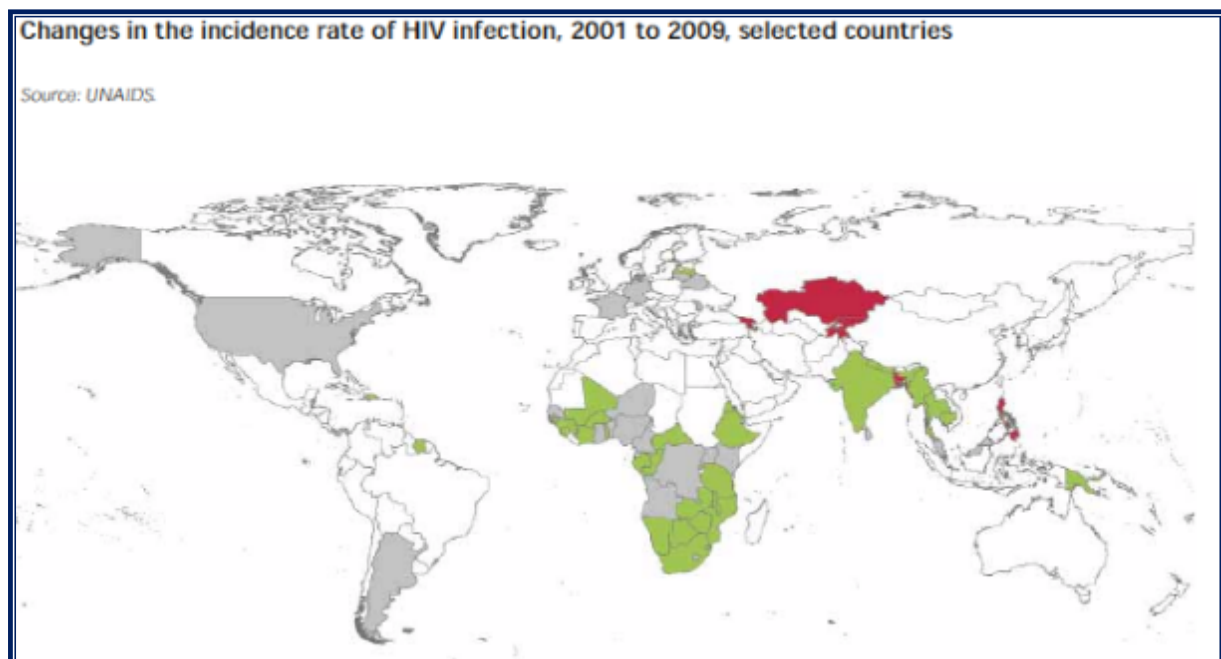


Figure 6.18.2: Increasing Trends of HIV Infection in Central Asia

³ Knowledge, Attitudes and Behaviour Related to HIV/AIDS among Transport Sector Workers - A Case Study of Georgia. June 2008. Published with World Bank Europe and Central Asia Region. Retrieved on 25 October 2011 from url: <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTHEALTHNUTRITIONANDPOPULATION/EXTHIVAIDS/0,,contentMDK:21735886~menuPK:376477~pagePK:148956~piPK:216618~theSitePK:376471,00.html>

- **Development of a local commercial sex industry:** The commercial sex industry in Armenia is well described. This is supported by the challenging economic situation, migration of men out of the country with a lack of men for women to marry, poor upbringing due to poverty and a decline in moral values⁴. There is potential that the Project will be an attraction to outsiders, including CSWs who may look to benefit from the improved economy. While they may target the mine workforce, the social implications may be experienced in the broader community.

Jermuk, with its existing tourist attraction will be at higher risk for this potential and the accommodation of a portion of mine workforce in this town may enhance this (as described above). This has the potential to impact the tourist attraction of the town, especially for families. CSW may bring about other social ills such as alcoholism and drug abuse including injecting drug use.

Mitigation/Enhancement Measures for Sexually Transmitted Infections (including HIV/AIDS) and High Risk Sexual Practice Impacts

These potential impacts will be managed through the following measures:

Project Impact Mitigation:

- A clear HIV policy and programme in the workplace and community has been developed (see Appendix 8.4b).
- Support for in-migration management planning with the local town and village authorities and Marz level administrators as appropriate.
- Thorough implementation of Lydian's Code of Conduct and corporate policies as they actively discourage the external fraternisation of the workforce with the local community. This is especially important in Jermuk as well as the other surrounding communities.
- Develop if needed a specific code of conduct for contractors that discourages sexual relations and prohibits sexual harassment within the workforce, especially towards female employees that originate from the local community. This should extend where possible to cleaning and catering staff in Jermuk hotels.
- A closed and dry camp policy be implemented during the construction period. Adequate entertainment facilities will be developed to reduce the need to travel out

⁴ Report on Some Aspects of Commercial Sex Work in Armenia. 2001. Retrieved on 14th March 2012 from url: hopehelp.am/.../Report%20of%20CSWs%20eng%20_book_.pdf

of the camp. Entertainment facilities will also need to be made available for workers residing in Jermuk hotel accommodation.

- Contractor management with clear and enforceable sanctions for breach of conduct will be established.
- Limit the development of truck stops in the local communities. Either accommodate transport workers in identified parking areas, or in the temporary construction camp, or develop procedures to limit overnight stops in local communities, including Jermuk.
- Develop support programmes for women working in hotels and other recreational establishments in Jermuk to reduce risk of transactional sex. This will need to include support from owners of the establishments.
- Monitor any increase in CSWs - especially in Jermuk - and work with local authorities to uphold local legislation and by-laws. The development of a baseline of CSW activities should be a condition subsequent to the ESIA so monitoring can be performed effectively.
- HIV and STI prevention programmes for long distance truck drivers and drivers of light duty vehicles. This will require contractor support and management. Education and awareness programmes will be important to develop.
- In the operations phase promote family friendly accommodation at the Project. This will be achieved through promoting training opportunities and local recruitment in the operation phase allowing employees to reside with their families. Rosters for non-residential workers will be designed to ensure they spend a sufficient amount of time with their families.
- Develop a CHIS on key HIV and STI indicators from longitudinal data sources.

Occupational Health, Safety and Environmental Management:

- Develop a HIV and STI management programme in the workforce. It is essential that this be developed prior to construction so the incoming construction workforce can be effectively targeted with appropriate prevention programmes. Where possible and relevant the HIV programme should be integrated into the activities of the local health services and in close cooperation with the Ministry of Health.
- Widespread availability and social marketing of condoms in the workplace and accommodation areas. Consider condom distribution programmes in local restaurants and entertainment areas where sexual transactions are likely to take place.

Social Development Mitigation and Management:

- Support local IEC campaigns on HIV and STI awareness that promote behaviour change;
- HSS to support the functionality of the local health care services so that the community attend the facilities for the effective management of STIs; and
- Support women's empowerment and education programmes to avoid the temptation to be involved in forms of transactional sex work.

Residual Sexually Transmitted Infections (including HIV/AIDS) and High Risk Sexual Practice Impacts

Effective and sustained implementation of the mitigation measures described above is anticipated to reduce the consequence of impacts to a moderate negative health impact, in the medium term, but still at a regional level. It is possible that the impacts will still occur, with a residual **moderately negative health impact significance**.

6.18.8 Food and Nutrition Related Illnesses

Project Activities Affecting Food and Nutrition Related Illnesses

Food security and malnutrition is not a major concern in the study area.

Access to land to support agriculture or animal husbandry is a key element in local livelihoods, as it supports local subsistence nutritional requirements and generation of cash from sales. Increasing food prices, particularly in staple foods have placed pressure on affordability of food nationally with vulnerable groups more susceptible.

Reduced access to land, inflation and an improved local economy will all play a role in Project impacts associated with food and nutrition.

Potential Food and Nutrition Related Illness Impacts

It is anticipated that impacts related to food and nutrition may be felt in the short-medium term, be restricted to the study area, and only have a minor negative health effect. It is possible that these health consequences will occur, representing an overall **minor negative health impact significance**. The impacts are anticipated to occur in the construction phase but will persist into operations. Gndevaz, Jermuk, Saravan and Gorayk, as well as seasonal herders are anticipated to be most impacted. Gender specific impacts are not anticipated, but poor people and those with restricted access to land may be more vulnerable.

The following potential impacts have been identified:

Direct:

- Land take by the Project with reduced land available for agriculture and to graze livestock. A detailed description of land required for the Project is included in Section 6.15. While much of this land is used for grazing, restricted access to this land is not expected to have a significant impact on food availability.
- Land take is also affecting commercial and subsistence crops, e.g. apricots and wheat, therefore affecting livelihoods. This impact is addressed from a livelihoods perspective in Section 6.14. It is not expected to generate a significant impact on food availability.
- Increased food consumption (workforce) from onsite catering facilities and hotel kitchens may potentially lead to an increase in obesity and non-communicable diseases. The type of foodstuff will also be an important predictor in this potential impact.

Indirect:

- The development of the Project will alter the economics of the study area with potential positive and negative impacts:
 - A potential benefit may be the provision of meals at work for employees and contractors. This initiative may produce a well-worker effect through a balanced diet and may free up some disposable income to improve nutrition in the community. However, a potential negative may be the transition from traditional home grown foods to processed and commercially packaged foods, leading to a potential increase in non-communicable diseases.
 - Negative impacts may be associated with food inflation in the study area, because of supply and demand and from the improved local economy and ability to afford different products.

Jermuk will especially be at risk for food and other inflation because of the accommodation of the externally hired workforce in this town. This section of the workforce will have disposable income and thus be more able to afford goods and products for sale in town. There is the potential that the other communities in the smaller towns may also be impacted through inflation of basic food products. This may increase the costs for general and even basic commodities with the vulnerable section of the population potentially not able to afford price increases resulting in potential food insecurity.

Mitigation/ Enhancement of Food and Nutrition Related Illness Impacts

The following mitigation actions have been identified:

Project Impact Mitigation:

- Monitor food inflation in the study area, with a specific focus on Jermuk and the other small towns. Basic and staple commodities should be used as key indicators;
- Ensure adequate access to agricultural land for the production of local produce and grazing of animals. Minimize disturbance to animals by limiting restrictions of access to mining and immediate surrounding area while maintaining a safe boundary between community access and industrial activities. This is also considered in Sections 6.8 and 6.11;
- Undertake specific nutritional surveillance in children and adults using data from the local health centres. This data should be fed into the proposed CHIS;
- In-migration management and support with local economic development initiatives.

Occupational Health, Safety and Environmental Management:

- Ensure meals provided by the Project are subject to a clear menu that promotes a balanced diet, healthy eating options and restriction of portions. Ideally a dietician should provide input into the menu.
- IEC programmes and nutritional programmes at the workplace to promote proper feeding practices to prevent obesity and NCD.

Social Development Mitigation and Management:

- Continue to support programmes that promote local farming practices to increase yields through improved farming techniques as described in the livelihood restoration plan; and
- Promote access to markets for locally produced produce to support the local livelihoods. This will stimulate local economic development and support food security.

Residual Food and Nutrition Related Illness Impacts

Through sustained and effective implementation of the mitigation measures outlined above, the residual food and nutrition related illness impacts are considered to be **negligible** both in the short and long term as the impacts will be minor, occur for a short term, be localised and not likely to occur.

6.18.9 Non-Communicable Diseases (NCDs) Linked to Lifestyle Changes

Project Activities Affecting NCDs Linked to Lifestyle Changes

NCDs are the biggest health challenge in Armenia and a major contributor to the burden of disease. Cardiovascular disease, diabetes and cancers are major contributors with obesity, smoking and alcohol abuse all modifiable risk factors. The prevalence of hypertension is over 50% in the general population.

The development of the Project is unlikely to have a significant direct role per se in increasing the burden of disease but factors affecting lifestyle and demographics may cause indirect impacts.

Potential NCD Impacts Linked to Lifestyle and Demographic Changes

It is anticipated that impacts related to NCDs will be felt in the long term, be restricted to the study area, and have a minor negative health effect. It is possible that these health consequences will occur, representing an overall **moderate negative health impact significance**. The impacts are anticipated to occur in construction but will persist into operations and even into the closure period. Jermuk, Gndevaz, Saravan and Gorayk, as well as seasonal herders are anticipated to be most impacted. Gender specific impacts are not anticipated.

The following indirect impacts are considered:

- **Increased disposable income with current lifestyle practices:** As mentioned the development of the Project is likely to generate some economic spin-offs and may increase the amount of disposable income at the household level. Unfortunately, this may serve to support the existing poor lifestyle practices in the community with increased smoking, limited balanced diet, and a lack of exercise. These can in turn cause an increase in NCDs.
- **Increase of NCDs in the workforce:** The workforce that is hired for construction and operations will be especially susceptible to the effects of NCDs. They will have an increased disposable income and the benefits of working at the mine will include meals and other benefits. The workforce who will also be hired from the community may thus be susceptible to the risks of NCD with the following potential impacts:
 - High costs associated with absenteeism due to ill health;
 - Loss of trained or skilled people from the workforce because of disease. This will result in higher operational costs due to the need to retrain or recruit replacement staff, and

- Impact on the family unit with potential social and behavioural impacts.

Mitigation/Enhancement Measures for NCD Impacts Related to Lifestyle Changes

Even though the Project is not anticipated to impact NCDs linked to lifestyle changes, opportunities exist to enhance the management of NCDs in the Project area, especially linked to workplace wellness programmes.

The following mitigation actions have been identified:

Project Impact Mitigation:

- Support IEC programmes as part of community based outreach programmes with a focus on modifiable lifestyle factors such as diet, exercise, smoking, oral health and alcohol consumption. These should be done in partnership with the local public health authorities, in association with local agencies or NGOs.

Occupational Health, Safety and Environmental Management:

- As part of the medical surveillance activities in the workforce, screen for NCDs. This is an important fitness for work requirement and should be incorporated into the occupational health programme as an essential health promotion intervention. Surveillance of weight or body mass index (BMI) as a predictor can be used and screening for hypertension, cholesterol and diabetes should be routine in high-risk groups, especially those operating heavy or mobile machinery.
- Initiate wellness programmes in the workplace for the prevention of chronic diseases through management of modifiable risk factors.

Social Development Mitigation and Management:

- Promote well-being and healthy lifestyle programmes in the communities through different planned interventions.
- Support with HSS that promotes health seeking behaviours to the formal health sector so that medications are routinely collected and follow-ups are adequately performed as per national guidelines. There is an opportunity to support the existing Oxfam and UMCOR programmes.

Residual NCD Impacts Linked to Lifestyle Changes

Through sustained and effective implementation of the mitigation measures outlined above, the residual NCD impacts will bring about a probable moderate health benefit in the long

term, but at a localised level. It is possible that these impacts will still occur, with a residual **moderately beneficial health impact significance**.

6.18.10 Veterinary Medicine and Zoonotic Diseases

Project Activities Affecting Veterinary and Zoonotic Diseases

While zoonotic diseases are unpredictable and have a significant outbreak potential in the study area, the Project is unlikely to influence the risk of transmission of these diseases in any significant manner. In fact, it is likely that the Project may actually reduce the seasonal movements of animals/livestock in the immediate study area. This in itself is not likely to play a meaningful role in reducing disease risk from the prevailing baseline. Gender specific impacts are not anticipated.

6.18.11 Environmental Health Determinants

Typically, in this section, impacts associated with environmental health determinants such as noise, water, air pollution and visual impacts are assessed. The assessment also considers exposure to heavy metals, hazardous chemicals substances, exposures to mal-odours, as well as radiation impacts. Many of these topics have been assessed in detail in the environmental impact assessments and associated specialist studies and are not repeated here with the exception of:

- i) exposure to hazardous chemical substances;
- ii) soil contamination and potential exposure to heavy metals, and
- iii) radiation risks.

For clarity, the locations of the specialist studies are summarised here:

- Water Quality and Quantity – Section 6.9 and 6.10;
- Noise and Vibration – Section 6.7;
- Landscape and Visual Amenity – Section 6.5;
- Hazardous Chemical Substances – this section;
- Air Quality and Mal-odours – Section 6.6;
- Radiological risk assessment – this section;
- Food chain risks from dust and groundwater – this section; and
- Safety risks associated with earthquakes and blasting – this section.

Not all of the topics captured in this EHA will be affected by the Project; however, they have been raised as concerns by stakeholders during the consultation process. This includes radiation impacts and food chain risks through soils and groundwater. The Project has

responded to these concerns through public consultation processes and through the provision of reports specifically targeting stakeholder concerns. Technical assessments of the human health risks associated with these concerns are described where relevant in this section. For clarity, these concerns are addressed from a technical standpoint and do not follow the same structure as is applied to Project generated impacts.

Hazardous Chemical Substances Risks

Potential Impacts Associated with Hazardous Chemical Substance Risks

A number of potentially hazardous chemical substances (HCS) will be used or generated because of Project activities. Sodium cyanide is the most important of these, with its use in the recovery of gold in the HLF. Cyanide is toxic to humans and other living organisms even at low concentrations. It will thus be important to manage cyanide across the supply, storage and use chain as per the requirements of the International Cyanide Management Code (ICMC). This will include transport to site, storage on site, handling in the HLF, and spill response as well as waste management. Lydian is committed to become a signatory company of the ICMC.

In addition, the mercury that is present in the ore and that will be produced in the process phase needs to be considered in relation to its potential impact on human health. Based on designs this will be effectively managed within the framework of the Project's Waste Management Plan with minimal risk for environmental exposure that may affect the community health. However, as there may be workplace exposures these will need to be controlled as part of the Project's occupational health and hygiene management plans, to include the potential for community exposure (usually close family) as a result of contaminated personal protective clothing.

Other HCS that require evaluation based on their use and risk to human health include:

- The geological, assay and environmental laboratories;
- The site based infirmary with cleaning agents and other chemicals as well as medications;
- Pesticides and cleaning agents as part of general management of onsite facilities;
- Hydrocarbons, mineral oils and other lubricants and products; and
- Glues or solvents used for hot splicing (vulcanization) of the conveyer belts or other applications.

These HCSs are likely to present a greater workplace risk exposure than a community health exposure and it is anticipated that the occupational health and safety plan will address these potential hazards and recommended procedures or systems to manage the associated risks. However, community health risks need to be considered including:

- Contamination of clothing at the workplace, which is not changed before returning home resulting in a potential exposure to the community and especially direct family members. This can include lead from the fire assay lab, mercury as described above, acids and other chemicals from the laboratory or plant, pesticides, oil etc.
- Spills in the community either during transport or from poor storage or handling onsite.

It is likely that additional HCS will be used on the Project as it develops and a risk assessment process should be followed that includes occupational and community health risks prior to the products being purchased. This generally needs to include environmental approval and should be managed by the supply chain manager as the gatekeeper with sign-off from each department (health, safety and environment) prior to purchase.

Potential Impacts Associated with Hazardous Chemical Substances

It is anticipated that impacts related to HCS will be felt in the medium term, may have regional effects with a predicted major negative health effect. It is possible that these health consequences will occur, representing an overall **major negative health impact significance**. The impacts are anticipated to occur in the construction phase, and extend into the operational and decommissioning period. There is the possibility that all PACs may be impacted. Gender specific impacts are not anticipated.

Mitigation Measures for Hazardous Chemical Substance Use

Effective management of hazardous chemical substances requires a comprehensive materials handling process, including procurement, transportation, storage and use. The following mitigation measures have been identified:

Project Impact Mitigation:

- Develop appropriate HCS management programmes in alignment with IFC PS3 guidance and EBRD and EU requirements;
- Implement training for staff to handle HCS, with a specific focus on cyanide handling and storage;

- Implement the cyanide management plan prepared and ensure that it is compliant with the International Cyanide Management Code (ICMC); and
- Support effective communication programmes with the community on the use, handling and risks of cyanide and mercury. This needs to be performed carefully so as not to cause alarm but to allay fears and misconceptions.

Occupational Health, Safety and Environmental Management:

- Develop a system to ensure that a detailed risk assessment is undertaken for all HCS prior to it being allowed on site and determine the specific human health risks that may potentially result from exposure to a product or by product.
- Provide personal protective equipment and clothing (PPE/PPC) to minimise exposure risks as appropriate. However, PPE and PPC need to be appropriate for the nature of the exposure and employees trained in appropriate use and handling.
- Staff that are exposed to HCS that may represent a risk if transferred off site and must shower and change their clothes prior to leaving site. Soiled PPC must be washed on site and not by family members off site.
- Ensure effective workplace cyanide monitoring and management programmes. A detailed hazard identification plan will need to be developed to manage cyanide management from supplier to site once a supplier is selected. Emergency preparedness and response planning will need to be included in the overall cyanide management.
- Medical surveillance (including biological monitoring) of employees handling HCS must be incorporated into the Projects occupational health and safety management system. This should include surveillance for lead and mercury as there may be limited exposures to these metals in assay labs and gold room. Occupational hygiene and exposure assessment of control systems will be an important element to have in place.

Residual Impacts Associated with Hazardous Chemical Substances

Effective and sustained implementation of the mitigation measures described above and the development of a comprehensive HCS management plan as part of the health and safety management system, should reduce the residual impact, in the short and long term, to a negligible level.

Soil, Water and Heavy Metal Exposure

Potential Impacts Associated with Potential Heavy Metals Exposure Risks

The baseline soils and land cover studies reported the following data from the soil chemistry in the study area:

- There is an absence of soil contamination from human activities (pesticides, fertilizers, coal fired power stations, other industrial activity etc.). It was not evident if lead was present in gasoline or in paints in the area (or other human sources).
- There was a presence of heavy metals in the soils of the study area, which reflected the naturally occurring chemical composition and associated mineralisation of parent soil or superficial rock material. The concentrations of six heavy metals were exceeded when considering the Armenian Maximum Allowable Concentration (MAC), United States Environmental Protection Agency (USEPA) and United Kingdom General Assessment Criteria (UK GAC) values, including the following findings:
 - Arsenic:
 - All samples (n=93) are above the USEPA and MAC values, with 27.5% of samples exceeding the UKGAC.
 - The likely source is from naturally occurring material from arsenic bearing rock.
 - It is likely that the arsenic is in an inorganic form but it was not clear if the metal is bioavailable to cause potential human health impacts.
 - It is noted that arsenic is associated with significant human health risks and regarded as one of the most toxic elements, especially in an inorganic form.
 - Lead:
 - 47.5% of samples exceeded MAC, but with nil exceeding USEPA or UK GAC values.
 - There was minor lead mineralisation from naturally occurring soils and mineralised zones.
 - Lead is considered one of the top four heavy metals that are most damaging to human health, especially to children.
 - Cobalt:
 - All samples exceeded MAC, with only 23 samples exceeding USEPA levels.
 - Minor cobalt mineralisation from underlying rock.

- While an important trace element, high concentrations of cobalt do cause human health effects and it is regarded as a possible human carcinogen.
- Uptake in plants can be very high, as soils contain high amounts of cobalt. These can be taken up by animals but cobalt does not biomagnify up the food chain.
- Cobalt is metabolised through the kidneys and as it has a short half-life, detection is only accurate for a few days after exposure.
- Copper:
 - All samples exceeded MAC, with no samples above USEPA or UK GAC thresholds.
 - Minor levels reflecting underlying mineralisation in local soils.
 - Copper is not readily available for uptake by plants, with only a few plant species surviving in copper rich soil.
 - Copper is an important trace element for human health and while humans can handle large concentrations of copper very high levels can cause human health concerns.
 - Sheep suffer a lot from copper exposure, even at low concentrations but this does not biomagnify in the food chain.
- Nickel:
 - All samples exceeding MAC, with no samples exceeding USEPA or UK GAC levels.
 - Often associated with cobalt and copper.
 - Plants are known to accumulate nickel, but as with other metals described above, it does not biomagnify.
 - Significant potential health consequences including a potential carcinogen, cause of birth defects, and lung/heart disease.
- Antimony:
 - One third of samples exceeded MAC, with 8% of samples exceeding USEPA levels.
 - Probably originates from minor naturally occurring mineralisation from parent rock.
 - Inhalational route with antimony bound to hydrogen in gaseous form is what mainly causes health effects. Thus, exposure from Project activities is highly unlikely.

- In addition to the naturally occurring heavy metal exposure, it is important to understand the potential for acid rock drainage (ARD) that may be associated with Project activities as this may be associated with an increased risk to leach heavy metals from barren rock and ore. Studies for potential impacts associated with ARD found:
 - The main sources of ARD during operations will be:
 - Pit dewatering water;
 - Runoff from the BRSF;
 - Seepage from the BRSF; and
 - Seepage from backfilled barren rock in the Artavazdes and Tigranes pits.
 - There is minimal potential to leach metals from the barren rock storage facility.
 - There is a high acid generating potential and metal leaching potential from the ore body, but preliminary tests on heap leach residues indicate that there is a limited likelihood that ore material will be acid generating.
 - Certain materials that may be used from borrow pits may be acid generating.
 - Leach testing showed:
 - Short-term leach tests results showed that effluent is not likely to contain the six heavy metals discussed above as naturally occurring in soil or surface rocks.
 - Long-term leach test results indicate that lower volcanic samples have potential for ARD and long-term metals release, including arsenic cadmium, copper and cobalt.
 - Borrow material may result in leaching of iron, copper, manganese and barium but this depends on the type of material and potential for sulphide oxidation. This and future testing will direct the type of borrow material used to reduce the potential for leaching of these heavy metals.
- Surface Water
 - Surface water quality has been monitored since 2007 with a number of different metals and other parameters detected from different sampling areas including the following exceedances in heavy metals of concern:
 - Vorotan and Arpa Rivers: arsenic, cobalt, copper, chromium, nickel, lead and low pH. These samples are considered to reflect the influence of naturally occurring acid drainage and heavy metals from Amulsar Mountain.

- Vorotan River and tributaries from the Amulsar Mountain: average pH is not significantly low in the immediate sampling area of the river, but mountain streams and tributaries are consistently moderately to highly acidic. Water quality in the river is better than the tributaries with cobalt, manganese, and barium exceeding MACs consistently in both the river and tributaries.
- Darb River and tributaries: the Darb River showed near neutral pH with slightly acidic pH in the main tributary, with a separate tributary on the south-west flank of the mountain indicating strongly acidic surface water. Heavy metal analysis was similar to the Vorotan River, but with lead and nickel also detected.
- Arpa Rivers and Tributaries: the water had near neutral pH, with heavy metal exceedances similar to other sites, including aluminium, barium, iron and manganese.
- Groundwater
 - Groundwater flow paths are away from Jermuk and the Kechut reservoir, but towards the settlements of Gndevaz, Saravan and Gorayk.
 - Some groundwater samples from Amulsar Mountain and Vorotan plateau have shown elevated levels of lead. In addition, nickel, copper and iron was detected above MAC from Amulsar Mountain.

This baseline provides insight into the potential for human health impacts to occur from heavy metal exposures from the naturally occurring material. However, exposure pathways to humans are vitally important, and a standard toxicological conceptual framework needs to be considered to determine if a significant health effect may be caused from a potential exposure.

On the current available data, it is not possible to determine if the naturally occurring heavy metals present in the soil or parent rock have contributed to any human health effects in the study area. Thus, it is not possible to describe an accurate point of departure of potential human exposure to heavy metals in communities at different exposure points. A plan is in place to carry out detailed village biomedical surveys in 2016 before the operations phase to gain additional baseline data.

The toxicological framework considers the following elements in determining the significance of potential human health impacts:

- The hazard's potency;
- The exposure level;
- Number of people exposed;
- Probability for exposure to occur; and
- Any modifying factors.

Due to the current lack of data, these five factors need to be considered in modelling potential future health impacts from the Project, and importantly, what the baseline exposure of heavy metals was in the general community in the study area prior to the commencement of the Project. The data presented above indicates the potential for exposure from a number of metals, with lead and arsenic the most significant from a human health perspective. Both metals occur naturally, but mining activities may increase exposures from barren rock, ore bearing rock and other material, and the potential for ARD may increase mobilisation of the metals in the presence of acidic water. Thus, to ensure that future environmental controls are effective (and can be monitored) it is important that the Project establish a robust baseline of human exposure before commencement of construction and operations. This will also support an understanding of the potential for exposures to occur in the future.

Potential Impacts Associated with Potential Heavy Metals Exposure

It is anticipated that impacts related to potential heavy metals exposure will be felt in the long term, with impacts in the study area, with a predicted a major negative health effect. It is possible that these health consequences will occur, representing an overall **major negative health impact significance**. The impacts are anticipated to occur in the construction phase, and extend into the operational and decommissioning period. There is the possibility that all PACs may be impacted. Gender specific impacts are not anticipated.

Mitigation Measures Associated with Potential Heavy Metals Exposure

Project Impact Mitigation:

- Environmental management as per the recommendations of the specialist studies on surface and ground water, soil and land use and ARD.
- Undertake in 2016 a baseline biomedical study in the PACs to determine the current exposures to heavy metals (study limited to arsenic and lead) that occur naturally in soil and water. This study will need to be performed with a local partner and preferably in association with the local health/environmental authorities. In addition, a statistical sample size will be essential to enable future comparisons and analysis of

- samples must be completed at a laboratory with international accreditation.
- Develop an effective monitoring system that tracks potential environmental exposures from heavy metals. This can be supported by serial sampling of humans based on the same methodology applied in the baseline studies. However, the basis for surveillance using human sampling is to determine the effectiveness of environmental concerns, and is not a control in its own right due to ethical considerations.
 - Develop effective communication programmes in the PACs to report on water and soil quality as well any results linked to human sampling.
 - Work with the Marz and national health authorities in remedying any health concerns or conditions identified as part of the baseline examination or serial surveillance.

Occupational Health, Safety and Environmental Management:

- Effective environmental management.
- Effective occupational health and safety programmes.

Residual Impacts Associated with Soil and Heavy Metals Exposure

Effective and sustained implementation of the mitigation measures described above is anticipated to reduce the consequence of impacts to a moderate negative health impact, in the short term, and at a localised level. It is unlikely that the impacts will occur, with residual **minor negative health impact significance**.

Radiological Risk Assessment

Introduction

During operations, the Project will not utilize, store, or process radiologically active materials. Additionally, there are no industrial or anthropogenic sources of radiation in the Project area. In response to stakeholder concern, a radiological study was conducted to assess the potential for Project activities to affect the health and safety of workers and residents of surrounding communities.

During the 1970s the Amulsar area hosted Soviet geologists exploring for uranium; additionally, elevated concentrations of radon gas have been detected in some buildings in surrounding communities. Residents and local NGOs are specifically concerned that Project activities could potentially mobilize and concentrate naturally occurring radiologically active material present in local soils and rocks, in the form of both dust and radon gas.

Background

Lydian contracted with Radman Associates, a UK-based radiological safety consulting firm, to investigate radiological risk associated with the potential mobilisation of dust containing naturally occurring radioactive components ("radionuclides") present in the study area. The study focused on potential risks associated with radon, uranium, and thorium.

Radon gas is known to be present in the region and is of specific concern to local residents. As part of the baseline program, radon measurement was carried out in the surrounding communities (see Appendix 6.18.1). Certain buildings in the communities of Gorayk, Gndevaz, and Saravan registered elevated radon levels; radon-generating rocks are known to be present in the Project area. Radon is a naturally occurring inert gas that is colourless, odourless, and tasteless. Because it is heavy, radon gas tends to accumulate in basements and low parts of buildings. Radon gas is typically composed of two isotopes of radon: radon-222 and radon-220. These isotopes are formed as decay products of other naturally occurring radiologically active elements. Radon-222 is a decay product of uranium-238; radon-220 is a decay product of thorium-232. Radon gas is generated in rocks and soils containing these decay chain parent elements, and can escape through dissolution in groundwater and via cracks and faults in the overlying rock and soil layers.

Uranium is a naturally radioactive mineral that is commonly present in very small concentrations (a few parts per million) in virtually all soil, rock, and water resources worldwide (Argonne National Laboratory, Human Health Fact Sheet - Uranium, August 2005). Nearly all (> 99%) of naturally occurring uranium is present as the isotope uranium-238, which has a half-life of 4.5 billion years. Because of its extremely long half-life, uranium-238 is considered to have a low radioactivity. Uranium can be mobilized by water percolating through soils, and will preferentially adhere to fine-grained soils.

Thorium is another naturally radioactive mineral that is also commonly present in low concentrations in the Earth's crust, typically at around 10 parts per million (ppm or mg/kg - Argonne National Laboratory, Human Health Fact Sheet – Thorium, August 2005). In general, thorium is about three times as abundant in environmental media (soil, rocks, surface water and groundwater, plants, and animals) as uranium, or at about the same average concentration of lead or molybdenum. Virtually all (> 99%) naturally occurring thorium is present as the isotope thorium-232. At 14 billion years, the half-life of thorium-232 is even longer than that of uranium-238, and thus it is considered to have a very low radioactivity.

Thorium preferentially adheres to sandy soils, but unlike uranium it has a low solubility in water.

Data provided by Lydian from its exploration database of 81,939 rock samples indicate average uranium concentrations of 14.54ppm (mg/kg) and thorium concentrations of 5.13ppm in Project area rocks.

Risk Assessment

The Radman study focussed on potential risks associated with dusts bearing uranium-238 and thorium-232 and radon gas accumulation. Separate assessments were conducted to determine potential risks associated with exposure to dust and water-borne concentrations of uranium-238 and thorium-232 and for radon gas accumulation, for both workers and the general public.

It is anticipated that impacts related to radiation will be felt in the short term, be restricted to the study area and not contribute to any negative health effect above baseline. It is unlikely that these health consequences will occur, representing an overall **negligible health impact significance**.

Radman was supplied with uranium and thorium concentrations from soil and rock samples collected during Lydian's exploration program, including samples of both ore and waste rock lithologies. Soil and rock will be the main sources of dust during Project construction and operations. Radman analysed the data from 2399 soil and 46,964 rock samples to calculate maximum activity concentrations for the Project site soils and rocks. Radiologic materials are described by their activity, which is the number of nuclear decays per unit of time. The unit of activity is the Becquerel (Bq); one Becquerel is one decay per second. The calculated maximum activity concentrations are shown in Table 6.18.1.

Table 6.18.1: Maximum Activity Concentrations – Amulsar		
Project-Area Material Type	Maximum Activity Concentrations, Bq/kg	
	Uranium-238	Thorium-232
Soil	79	100
Rock	855	692

Data exists at the national level for activity concentrations of uranium-238 and thorium-232 in Armenian soils. Radman performed statistical analyses of the Project-area soils geochemical data to calculate mean, minimum, and maximum activity values; these statistics are shown in Table 6.18.2. For comparison, activity concentrations of natural Uranium-238 and Thorium-232 reported in soil in Armenia by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR⁵) are also shown in Table 6.18.2.

Table 6.18.2: Reported Levels of Uranium-238 and Thorium-232 in Soil				
Activity Concentration, Bq/kg	Uranium-238		Thorium-232	
	Armenia (UNSCEAR)	Amulsar (Lydian)	Armenia (UNSCEAR)	Amulsar (Lydian)
Mean	46	13	30	12
Minimum	20	1	29	1
Maximum	78	79	60	100

As can be seen from the table above, the maximum activity concentration for soils measured from the Project site are slightly in excess of the maximum values reported for Armenian soil. However, the mean values are lower, indicating that only a few of the 2399 soil samples analysed had elevated uranium and/or thorium concentrations, with the majority of samples being well within the reported Armenian natural values.

Uranium concentrations in the soil samples were evaluated against United States Environmental Protection Authority (US EPA) residential (red) and industrial (green) thresholds, as shown in Figure 6.18.3 below.

⁵ United Nations Scientific Committee (UNSCEAR) 2000 Report on the Effects of Atomic Radiation to the National Assembly, Volume II Sources and Effects of Ionizing Radiation.

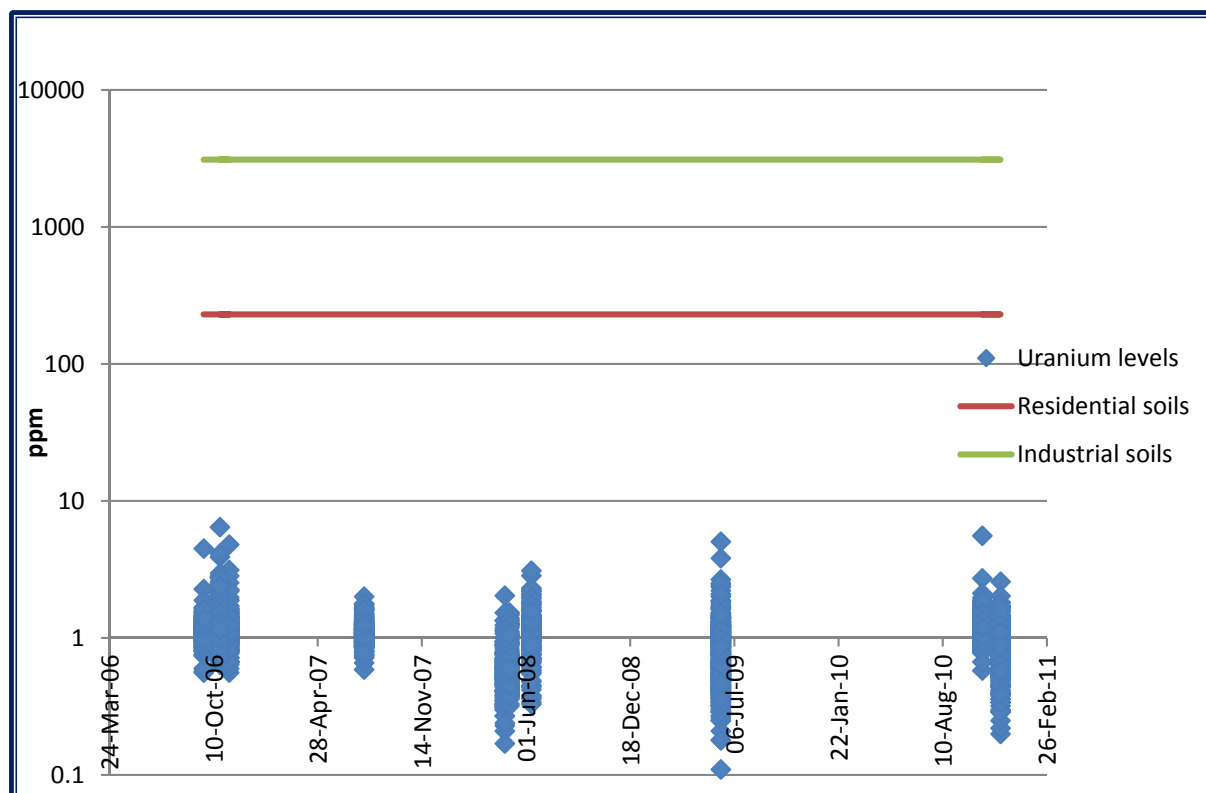


Figure 6.18.3: Uranium Concentrations in 2,400 Soil Samples at the Project Verses Soil Quality Thresholds from the US EPA

Pathways

The risk assessment considered the feasible potential pathways that uranium, thorium, and radon gas could become parameters of concern to Project workers and residents of surrounding communities. These pathways are summarized in Table 6.18.3.

Table 6.18.3: Qualitative Pathway Analysis for Naturally Occurring Radiological Exposure at the Project Site		
Item	Potential Primary Pathway - Human Receptors	Comment
1	Soil ingestion (direct)	Not anticipated in quantity. Accidental only.
2	Inhalation – dust indoors: occupational exposure to rock crushing	Dust has the potential to be generated indoors from rock crushing.
3	Inhalation - dust outdoors: direct exposure to workers and members of the public from fugitive dust during soil and rock excavation, movement and processing.	Dust has the potential to be generated outdoors by mechanised liberation & passive window of soil & rock during excavation, transportation & deposition. Dust dispersion will be limited to 1 km from the source & therefore is not expected to reach community receptors. Refer to Air Quality Impact Assessment (Section 6.1).

Table 6.18.3: Qualitative Pathway Analysis for Naturally Occurring Radiological Exposure at the Project Site

Item	Potential Primary Pathway - Human Receptors	Comment
4	Inhalation – radon indoors/confined spaces: gas rising from underlying geology or radon gas indoors)	Radon has the potential to be generated locally & migrate from substrate through fractures, poorly constructed floors & ventilation/service access points to accumulate in overlying structures.

According to the qualitative pathway analysis, direct inhalation of dust or radon gas is the primary applicable pathway to human receptors. The risk of direct ingestion of soil is considered to be very low and thus is not further evaluated here.

Uranium and Thorium Dose Assessment

To estimate the potential exposure to human health from naturally occurring radiological activity from soil and rock at the Project site, Radman conducted a dose assessment based on relevant Armenian and international standards. Armenian regulations are oriented toward industries that handle and process radioactive materials, rather than the lower concentrations found in situ at the Project site. In addition, Armenia only has a standard for worker exposure, and not one for general public exposure. Therefore, to estimate the potential exposure of Project workers involved in high-dust situations, a generic dose assessment was performed in accordance with United Kingdom Health Protection Agency (UK HPA) assessment tool for radioactively contaminated land (NRPB-W36)⁶.

The dose assessment used the maximum uranium-238 and thorium-232 values measured in rock and soil samples collected from the Project site. Thus, this dose assessment provides conservative exposure estimates; actual exposures are expected to be lower. These doses were then compared to the current Armenian and United Kingdom dose constraints for both workers and the general public. The calculated exposure doses are shown in microSieverts per year ($\mu\text{Sv/yr}$).

The basic quantity used to express the exposure of biological material to radiological activity is the absorbed dose, for which the unit is the gray (Gy). However, the biological effects per

⁶ UK Environment Agency Radioactive Contaminated Land - Briefing Note 2 and 8, An Overview of Land Contaminated with Radioactive Substances and Land Contaminated with Radioactivity and the Principles of Radiation Protection (2007)

unit of absorbed dose vary with the type of radiation and the part of the body exposed. To take account of those variations, a weighted quantity called the effective dose is used, for which the unit is the Sievert (Sv). The effective dose is usually used to report levels of human exposure. The absorbed dose and the effective dose are typically termed the "dose", for which the units provide the necessary differentiation. Exposures can also vary as a result of human activities and practices⁷ (Table 6.18.4).

Table 6.18.4: Regulatory Dose Limits		
	Regulatory Dose Limits, in $\mu\text{Sv}/\text{year}$	
	Armenia	United Kingdom/IFC
Workers	1,000	20,000
General Public	--	1,000

The UK dose limit for workers is 20,000 $\mu\text{Sv}/\text{yr}$, which corresponds with the effective dose limit for the workplace (5 consecutive year average) according to the IFC EHS Guidelines (2007). The UK dose limit for members of the public in the workplace is 1000 $\mu\text{Sv}/\text{yr}$. The Armenian "Rules on Protection Against Ionising Radiation and Safety of Ionising Source"⁶ indicate that the worker dose limit for exposure from natural sources is equivalent to the UK public dose limit (1000 $\mu\text{Sv}/\text{yr}$), which is in addition to the dose received from natural background, in the region of 2000 $\mu\text{Sv}/\text{yr}$.

Assessment of potential construction worker exposure has been performed based on the maximum reported uranium-238 and thorium-232 activities in soil and rock and assuming an initial undisturbed, buried, uniform spatial distribution. It was further assumed that workers would remain exposed to the material for a full working year. The results are shown in Table 6.18.5. An effective dose of 63.4 $\mu\text{Sv}/\text{yr}$ was estimated (7.3 and 56.1 $\mu\text{Sv y}^{-1}$ from soil and rock respectively), which is well below the UK/IFC annual effective worker dose limit of 20,000 μSv^4 . The estimated exposure is also considerably within the threshold of 1,000 $\mu\text{Sv}/\text{yr}$ above which the UK Ionising Radiations Regulations 1995 (IRR99) would apply in full to the development, and the currently accepted dose constraint for a single site of 300 $\mu\text{Sv}/\text{yr}$ (Table 6.18.5).

⁷ Rules on protection against ionizing radiation and safety of ionizing source. Supplied by Wardell Armstrong

Table 6.18.5: Effective Dose			
Project-Area Material Type	Calculated Effective Dose, $\mu\text{Sv/yr}$	United Kingdom / IFC, $\mu\text{Sv/yr}$	UK IRR $\mu\text{Sv/yr}$
Soil	7.3	--	--
Rock	56.1	--	--
<i>Total</i>	63.4	20,000	1,000

Using ICRP7 inhalation and ingestion dose coefficients and UK National Radiological Protection Board (NRPB) habit data, estimated doses from inhalation and ingestion of dust from soil are 23.8 $\mu\text{Sv/yr}$ and from rock are 202 $\mu\text{Sv/yr}$ giving a combined internal dose of 225.9 $\mu\text{Sv/yr}$, based on a 2000 hour working year. These estimated doses are again below the international dose thresholds as described above⁴.

The estimated doses to workers are all significantly below the dose constraints for both workers (20,000 $\mu\text{Sv/yr}$) and for members of the public (1,000 $\mu\text{Sv/yr}$). Since potential dose estimations for members of the public be lower than for construction workers, no further dose assessments were deemed necessary and dose estimates for the general public are assumed to be well within guideline values⁴.

The impact of dust generated by mining activities is assessed in Section 6.1. The dose assessments performed indicate that no doses in excess of the current UK/IFC dose constraints are expected as a result of the mining operation, from the uranium and thorium present in the rocks and soil at Amulsar. Thus, regardless of pathway, no impact on human or environmental receptors from radiological activity in dust is expected.

Radon Assessment

Household surveys for radon were conducted in households in the villages of Gorayk, Saravan, Saralanj, and Gndevaz. The measurements were taken in 149 locations in December 2010 until March 2011, during the lowest atmospheric pressure conditions when radon concentrations are likely to be at their most elevated. The results varied from 40 to 620 Bq/m³ and were notably higher in Gorayk. The monitoring location and range of results are shown in Figure 6.18.4.

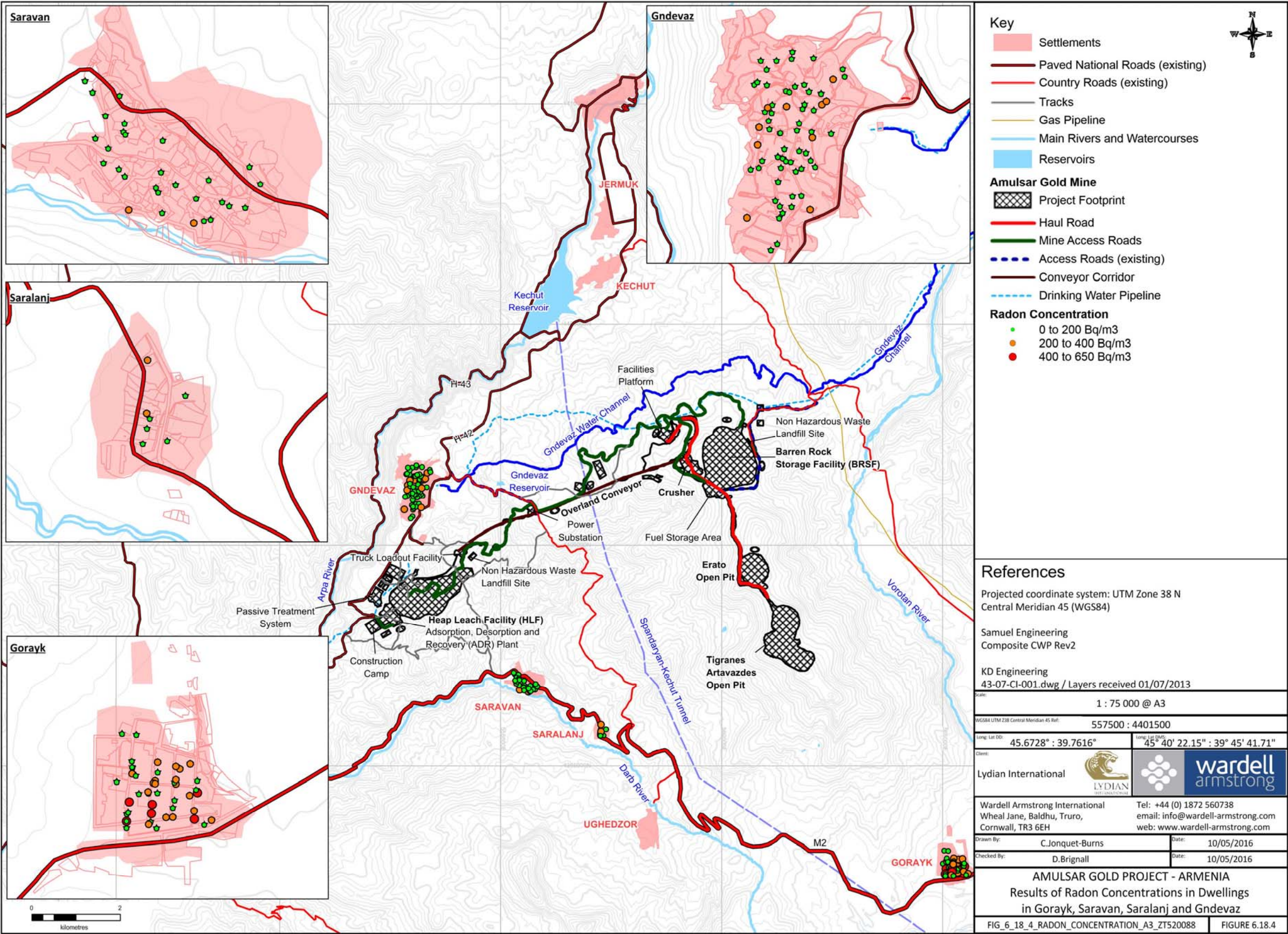


Figure 6.18.4: Results of Radon Concentrations in Dwellings in Gorayk, Saravan, Saralanj and Gndevaz

Armenia has no regulations regarding radon gas. Therefore, internationally accepted radon guidelines were considered for the radon assessment. The UK HPA recommends that radon levels should be reduced in homes where the annual average radon gas concentration is more than 200 Becquerels per cubic metre (Bq/m³). The International Atomic Energy Agency (IAEA) and WHO consider 200-600 Bq/m³ applicable to basic safety standards for radiation. For radon gas, 200 Bq/m³ is considered an appropriate conservative guidance threshold for a dwelling or for dormitories. In the UK, the Ionising Radiations Regulations (UK IRR, 1999) require action to protect employees in the workplace if the average radon gas concentration exceeds 400 Bq/m³. Relevant radon guideline values are summarized in Table 6.18.6.

Table 6.18.6: Radon Guidance			
	Radon Guidance, in Bq/m³		
	UK HPA	IAEA/WHO	UK IRR
Home	200	200-600	--
Workplace	---	---	400

There are no existing buildings at the site, thus no radon concentrations were measurable at the Project site. However, there are measured radon concentrations in a minority of dwellings in Gorayk in excess of 400 Bq/m³ and measured radon concentrations in dwellings in Gorayk, Gndevaz and Saravan in excess of the 200 Bq m⁻³ action level. Poor construction, use of radioactive construction materials and situation above radon-generating substrate can result in localised concentrations of radon gas exceeding the above referenced guidance.

Although not directly comparable to seismic activity related to earthquakes, concern has been raised by stakeholders regarding blasting at the Project that could produce an increased release of radon gas. This would occur without prior build-up, resulting in lower radon concentrations than those released during seismic activity and without any significant short-term increase in radon or additional exposure⁴.

The impact of radon gas to worker health as a result of the Project is considered to be minor and can be easily avoided by incorporating protective and monitoring measures into Project design and operations. Herders tending animals in lands surrounding the Project site typically reside in loosely constructed and well-ventilated temporary dwellings that would not be conducive to the accumulation of radon gas, therefore potential impact to herders is considered very unlikely. The probability of blasting at the Project being able to trigger a seismic event is remote. Even so, the nearest community is situated beyond the distance of

impact from blast vibration both during construction and operations, therefore the likelihood of blasting being able to influence radon migration is improbable. Taken together, the potential impact of radon gas as a result of the Project on these receptors is considered to be negligible.

Water Assessment

Radiologically active elements can emit alpha and beta particles as they decay. The activity of these particles in disintegrations per second can be measured in Becquerels and is commonly used as a measure of radiological activity in natural waters. The WHO screening levels for drinking water are 0.5 Bq/l for gross alpha activity and 1 Bq/l for gross beta activity. If neither of these is exceeded, the Individual Dose Criterion (IDC) of 0.1 mSv/yr (100 µSv/yr) will also not be exceeded. The IDC is a measure of the effective dose of radiation the human body may receive from drinking water. The values are based on the International Commission on Radiological Protection (ICRP), a partner of UNSCEAR, as Armenia does not have drinking water IDC standards.

Routine groundwater and/or surface water samples were obtained from sample points around the Amulsar vicinity in 2008, from July 2011 to April 2012, and in 2015. The levels recorded in the majority of samples did not exceed the WHO guideline values for gross alpha (0.5 Bq/l) and gross beta (1.0 Bq/l) levels. However, in March 2012 in surface water, exceedences of the gross alpha and beta levels were recorded at 0.64 Bq/l (sample DWJ-9) and 2.58 Bq/l (sample DWJ-8) (see Section 4.9).

Mitigation Measures

Dust

The results of the radiological risk assessment indicate that no potential impacts to the surrounding communities are expected as a result of Project operations, in terms of radiological risk. Potential impacts to Project workers are considered to be related to standard risks associated with dust generation (see Section 6.1) and limited to within a 1-km radius of the major dust generating sources. Potential fugitive dust impacts will be mitigated as described in Section 6.6.

Radon

Mine buildings will be adequately ventilated and will incorporate measures to reduce potential radon gas accumulations. Radon reduction measures normally consist of gas-

impermeable membranes to prevent radon from seeping into buildings or pumps to remove radon from occupied areas, again preventing any build-up of radon gas. It is unlikely that pumps would be required, especially where active dust extraction systems are present, so simple radon protective barriers will be installed in all buildings. Suitable barriers include 300 µm (1200 gauge) polyethylene (polythene) sheets, prefabricated welded barriers, or self-adhesive bituminous-coated sheet products. Installation of radon barrier products will be supervised by a suitably qualified and experienced engineer to verify that welds and joints are adequately sealed.

Radon monitoring of basements or ground floor indoor areas, will be carried out to validate the protection measures. If these measures are employed, it is considered that the radon risk to Project workers will be reduced to neutral.

The cause and extent of elevated radon concentrations in village dwellings has not been fully ascertained, however it is a pre-existing condition for the villages and is not linked to the Project's activities. Building materials, design, and ventilation systems strongly influence indoor levels of radon.

Given that radon concentrations in village dwellings are known to be high, Lydian could consider working with the villages and local administration to alleviate this issue as part of their community development programme.

Drinking Water Monitoring

The sources of water used for irrigation and potable purposes by members of the public are outlined in Section 4.9. The cause and extent of elevated gross alpha and beta concentrations in surface water needs to be ascertained by additional monitoring of water sources used by the public in the Project area, and will be monitored prior to construction and thereafter.

The summary of impacts is shown in Table 6.18.7.

Table 6.18.7: Qualitative Impact Assessment of Radionuclides (dust and radon) to Human Receptors at Amulsar Mine

Type of Radiation	Receptor Group	Sensitivity of Receptor	Type of Exposure (internal/external)	Frequency/Duration of exposure	Likelihood of Exposure	Dose/Severity of Consequence
Radionuclides in fugitive dust	Workers	High	Internal (inhalation)	Regular/Limited Duration	Low to Medium (occasional/very infrequent to periodic)	Negligible (within accepted dose limits)
	Public (herders and/or villagers)	High	Internal (inhalation)	Rare /Limited	Very Low	Negligible (within accepted dose limits)
Radionuclides in radon gas	Workers (at infrastructure & dormitories)	High	Internal (inhalation)	Occasional/Short Duration	Low (occasional/very infrequent)	Minor/Localised
	Public (herders and/or villagers)	High	Internal (inhalation)	Exceptional circumstances/Limited Duration	Very Low (unlikely)	Negligible to Minor/Localised
Radionuclides in water (via dust)	Drinking water users	High	N/A	Occasional/Limited Duration	Low (occasional/very infrequent)	Minor/Localised

Food Chain Risks

Introduction

This assessment has been undertaken in response to stakeholder concerns regarding the potential impacts of dust generation from the proposed Amulsar Project on herders who graze cattle in the vicinity of the proposed mine site. The results of a quantitative assessment of the risks to herders and their cattle from the uptake of metal contaminated dust are summarised here. The assessment of potential uptake through apricot orchards will be undertaken during the construction period.

The purpose of the Human Health Risk Assessment (HHRA) is to predict whether metals present in dusts represent an unacceptable risk to human health via direct and indirect exposure pathways. The potential risk to the health of cattle from metals in dusts has also been assessed.

Composition and Distribution of Mine Dust

The composition of dust from the primary elements of the mine infrastructure has been estimated based on chemical analysis of more than 20,000 samples of ore rock and more than 50,000 samples of barren rock from the proposed Project. Estimated mean dust composition for barren rock and ore is shown in Table 6.18.8.

The distribution of dust in the area surrounding the mine has been predicted through modelling of dust deposition as a function of emission rates and distance from point sources at the operational facilities (Chapter 6.6). The findings showed that the maximum dust deposition rate 815m from a source was approximately 133mg/m²/day, with fallout concentrations dropping off to negligible levels 1km of the most significant point source in the direction of the prevailing wind. The rate of dust deposition surrounding the operational pit, crusher plant, haul roads, HLF and BRSF calculated in Chapter 6.6 is shown in Figure 6.6.3. The majority of dust deposition occurs surrounding the haul roads, the open pit, crusher plant, and truck loadout facility.

Table 6.18.8: Summary of Dust Composition			
Dust emissions from:		Barren Material	Ore Material
Estimated metal concentration in dust emission	Au ppm	0.05	1.02
	Ag ppm	1.63	4.29
	As ppm	115.02	320.06
	Cd ppm	0.27	0.26
	Cr ppm	25.41	25.08
	Ni ppm	6.41	5.88
	Pb ppm	125.73	240.72
	S %	1.57	0.78
	Sb ppm	36.65	145.37
	Th ppm	16.43	12.34
	U ppm	5.31	5.47
	Zn ppm	16.62	12.63

Calculation of Metal Concentrations in Soil from Dust

It is reasonable to assume that as a result of wind action and rainfall, dust falling surrounding the mine will become mixed into the upper few centimetres of the soil column. For the purposes of this assessment, it has been assumed that this mixing occurs to a depth of 2 cm. Dust deposits at a rate greater than 1mg/m²/day into an area transcribed roughly within a 1km buffer from the active facilities during the life of mine. This information has been provided by WAI (2012). Maximum concentrations in the upper soil layer within 1 km of the mine have been determined through calculation of soil concentrations within each distinct area for which a dust deposition rate was calculated (Figure 6.6.3) as follows:

$$C_f = \frac{D_M L}{D_T L + \rho t A}$$

Where C_f (mg/kg) is the final soil concentration at the end of mine operation, D_M is the deposition rate of metals during operation calculated for the specified area (g/day), D_T is the deposition rate of metals during operation for the specified area (kg/day), L is the mine life (days), A is the area under consideration (m²), t is the depth of soil in which dust mixing occurs (m) and ρ is the dry density of the soil in which mixing occurs (kg/m³). The spatially averaged soil concentrations within the 1 km zone are shown in Table 6.18.9.

Table 6.18.9: Weighted Average Soil Concentrations (mg/kg)											
Gold	Silver	Arsenic	Cadmium	Chromium	Nickel	Lead	Sulphur	Antimony	Thorium	Uranium	Zinc
0.01	0.066	4.75	0.01	0.63	0.16	3.92	311.17	1.96	0.36	0.13	0.39

Risk to Cattle from Metals in Dusts

Method

The assessment of risk to cattle was undertaken by comparing metal concentrations in surface soils with ecological screening values sourced from:

- United States Environmental Protection Agency (US EPA) Ecological Soil Screening Levels (<http://www.epa.gov/ecotox/ecoss/>) which were accessed on 24 July 2012; and
- Environment Agency of England and Wales (EA) Ecological Soil Screening Values.

Results

None of the concentrations of metals in soils exceed published US EPA or EA ecological screening values. Based on this Tier 1 assessment, concentrations of metals in soil do not present an unacceptable risk to cattle.

Risk to Human Health via direct Exposure Pathways

Method

The assessment of risk to human health from direct exposure pathways, such as soil and dust ingestion, dermal contact with soil and dust inhalation, was undertaken by comparing metal concentrations in surface soils with conservative health based screening values, considering a residential land-use scenario, sourced from:

- USEPA Regional Screening Levels database (<http://www.epa.gov/region9/superfund/prg/>), last updated in May 2012 and accessed on 24 July 2012; EA Soil Guideline Values; and Generic Assessment Criteria developed using the approach and software published by the EA.

Results

With the exception of arsenic, none of the soil metal concentrations exceed published US EPA or EA screening values for a residential land-use scenario. The concentration of arsenic of 4.81 mg/kg exceeds the USEPA screening value of 0.39 mg/kg but is below the EA screening value of 32 mg/kg. Using screening values for residential soils represents a conservative approach;

for example, the residential scenario assumes exposure occurs 365 days/year and exposure is for a 6 year old child. The soil concentration of 4.81 mg/kg is unlikely to present an unacceptable risk to human health in the context of land-use in the study area; however, arsenic was selected for further assessment using a multi-pathway approach which is discussed below.

Risk to Human Health via Multiple-pathways

Method

Four metals (arsenic, antimony, lead and trivalent chromium) were selected for further assessment using a multi-pathway approach. These metals were selected on the basis of their toxicity and soil concentration. The multi-pathway assessment considered the following indirect exposure pathways:

- Uptake of metals from soil into above ground produce which is eaten by cattle;
- Uptake of metals by an adult and child farmer by eating beef from cattle which have fed on contaminated above ground produce;
- Uptake of metals by an adult and child farmer by drinking milk from cattle which have fed on contaminated above ground produce; and
- The uptake of metals by an adult and child farmer through accidental ingestion of soil was also included in the multi-pathway assessment to provide a conservative assessment of exposure.

The multi-pathway HHRA predicts chronic exposure to contaminants in soil. The methodology used to perform the modelling is the internationally recognised HHRA Protocol (HHRAP) for Hazardous Waste Combustion Facilities, published by the United States Environmental Protection Agency in 2005 (US EPA HHRAP, 2005). The HHRAP has been reviewed by 58 Environmental Protection Agency experts, 18 external State Reviewers and 9 external Scientific Peer Reviewers.

The multi-pathway assessment predicts the total daily intake of each metal from each exposure route. Toxicological or health effect values are used to benchmark the predicted exposure levels. Toxicological values for use in the HHRAP were sourced from the US EPA Regional Screening Levels database i.e. Reference Doses (RfD_{oral}) and Cancer Slope Factors (CSF_{oral}).

Results

The risk from non-carcinogens (antimony, lead and trivalent chromium) was assessed by

deriving a hazard quotient (HQ). A HQ is derived for each metal and is the comparison of metal-specific total daily exposure to the metal-specific toxicological value. The likelihood of unacceptable risk to human health increases if the HQ is greater than 1 and the risk is acceptable if the HQ is less than 1. The highest HQ derived for the multi-pathway assessment scenarios was an adult farmer exposed to antimony, with a HQ of 0.161.

For carcinogens (arsenic) risk estimates represent the incremental probability that an individual will develop cancer over a lifetime as a result of a specific exposure to a carcinogenic chemical. Excess cancer risks that range between 1×10^{-6} and 1×10^{-4} are generally considered to be acceptable by the US EPA. Predicted excess cancer risks for the multi-pathway assessment scenarios for arsenic of 5.53×10^{-5} and 9.65×10^{-5} are within this range.

Based on the modelled exposure scenarios, concentrations of metals in soils do not result in an unacceptable risk to identified receptors (adult or child farmers) within the study area.

Conclusions

Based on the results of the human health and ecological (cattle) risk assessment **negligible** risks have been identified either to cattle grazing or to herders working in the vicinity of the Project site. Further studies will be completed to assess the impacts associated with apricot orchards, but they are not expected to be significant.

Safety Risks Associated with Earthquakes and Blasting

Earthquake Impact Assessment

The Project is located within a seismically active region and there are detailed records of historical seismicity available. A number of potentially active fault systems have been identified around the site that could generate these earthquakes and a Probabilistic Seismic Hazard Assessment (PSHA) has therefore been undertaken for the Project (see Section 4.6).

The principal impact of earthquakes on the Project facilities arises from the propagation of seismic waves through the rock mass and soil cover. These waves can cause deformation of unconsolidated materials, such as waste rock and heap leaching facilities, and decrease the stability of slope profiles by inducing dynamic loading to the normal static conditions. Such deformation and loading could cause instability to occur and consequent failure of the facilities.

The historical seismicity and geological setting have been used in the PSHA in order to determine the potential activity along the fault systems that could generate earthquakes. This has enabled the Peak Ground Accelerations that could occur at the open pit, crusher site, waste dump and heap leach facility to be calculated.

The Barren Rock Storage Facility (BRSF) and Heap Leach Facility (HLF) have been analysed to determine the degree of stability under normal static conditions and with the induced loading caused by Peak Ground Accelerations (PGA) calculated in the PSHA. The operational phase of these facilities has been assessed using an Operating Basis Earthquake (OBE) with a 10% probability of exceedance in 50 years (equivalent to a return period of 475 years). The closure phase of the facilities has been assessed using a Maximum Design Earthquake (MDE) with a 2% probability of exceedance in 50 years (equivalent a return period of 2,475 years).

The slopes have been designed to be stable under the PGA loading induced by these earthquakes using criteria that provide an acceptable engineering standard of care for the industry.

Most buildings in Jermuk were constructed prior to the application of the Armenian Seismic Code. Structural compliance with this code is being assessed as part of the accommodation selection process for construction and operations.

Blasting Safety in a Seismically Active Zone

Blasting technologies and technics rarely produce energy outputs that exceed the energy of natural earthquakes on a global scale, however in some cases, the regional contribution to seismic energy release by blasting operations is by a few orders of magnitude higher than the energy released by natural earthquakes.

Thus to prevent the seismic effect of the blast, a Blast Management Protocol will be developed to evaluate the method of sequential blasting to be undertaken. In order to manage the energy released from blasting activities the spatial distribution of explosive activities will be considered, the consumption of explosives is calculated, the technology of short-delay mass explosions evaluated. The use of short-delay blasting increases the intensity of fragmentation of the rock by the blast, reduces disruption of the rock mass outside the crushing zone, provides localised disintegration of the rock mass, and decreases the seismic effect of the blast. Zoning the regional seismic zones in terms of the release rate of seismic

energy and the peak local magnitudes observed when blasting activities blasting operations are undertaken. This would be undertaken to demonstrate that the hazard level associated with blasting activities does not exceed the corresponding parameters of seismic zoning.

6.18.12 Social Determinants of Health

Project Activities Affecting Social Determinants of Health

The main social determinants of health relevant to the Project include employment and local economic development, wellbeing linked to quality of lives and inequalities, general social cohesion as well as Project expectations. These topics are covered in the social impact assessment in Sections 6.13, 6.14, and 6.15, but some health specific areas are discussed below.

Potential Impacts from Social Determinants of Health

It is anticipated that impacts related to local employment and economic development will be felt in the medium term, be restricted to the study area, and have a minor beneficial health effect. It is possible that these health consequences will occur, representing an overall **moderate beneficial health impact significance**. The impacts are anticipated to initiate in the construction phase, and extend into the operational period. The communities of Jermuk, Gndevaz, Saravan and Gorayk are likely to benefit most from this. Without specific mitigation measures, men are more likely to benefit than women.

To maximise these potential benefits, the PACs will need to support initiatives through effective community cohesion, with assistance from the Marz and local government authorities. The potential extended benefits may improve livelihoods and perceptions of well-being, as well as allow for the ability to afford local services (such as health care) which may promote better life styles and health seeking behaviour. The potential benefits may include:

- Although it will not be a major employer, there is the opportunity for some of the local community to be employed by the Project. The Project promotes local employment and will implement a training programme to enhance the likelihood of local residents being eligible for jobs on the Project. To promote gender equality and to reduce potential impacts on local women they should be eligible and enrolled in these training programmes and be considered for employment.
- The presence of the Project may stimulate the local economy and create multiplier effects through linkages of potential supply and service companies in the study area. Economic upliftment may further stimulate local investment and development opportunities and even generate interest from donor funding and even improved

government commitments. Gender equality is considered in the economic development programmes.

- The improved services and access that may occur in the study area has the potential to improve local tourism and even create the establishment of secondary businesses.

However, a number of potential negative social health impacts may be indirectly associated with the Project, including:

- Potential impacts on social cohesion and emergence of social issues such as breakdown of family structures, crime, domestic violence and substance abuse as a result of in-migration (of workforce and opportunistic migrants) and altered economics/demographics;
- Unmet expectations of anticipated benefits from the Project, including employment, economic benefit and a better quality of life.

Mitigation/Enhancement Measures for Social Determinants of Health

Project Impact Mitigation:

- Mitigation actions are discussed in the ESIA, with the key opportunity in supporting local economic development that should result in an improved quality of life and perceived well-being of the PACs; and
- Effective communication strategies to manage expectations and perceived impacts from the Project will be important to address at the local level.

Social Development Mitigation and Management:

- Promote improved community cohesion in the PACs so that self-regulation of potential social ills is promoted. These can include promotion of healthy lifestyle activities or sporting events etc.

Residual Impacts on Social Determinants of Health

Through enhancing the management of social determinants, the residual benefits will be **moderately beneficial health impact significance**, but in the longer term and with greater probability.

6.18.13 Cultural Health Issues and Health Seeking Behaviour

Project Activities Affecting Cultural Health Issues

Health seeking behaviour in the community is affected by the affordability and acceptability of the local health services. The Project is unlikely to negatively impact on the local health infrastructure or programmes but may in fact support mechanisms to improve delivery of health care in the study area. Due to the influence of cultural health practices and importance of traditional medicine (TM) the activities of the Project are unlikely to impact meaningfully on the prevailing local health seeking behaviour. However, the following potential impacts are considered:

- The development of the Project may reduce access to areas that the community utilises to collect medicinal plants. This is assessed as part of the ecosystem services impact assessment in Chapter 6.19.
- A potential positive impact of the Project may be the indirect improvements in health care delivery, which may promote better health seeking behaviour and better disease prevention and control. This is challenging to predict or quantify.

Potential Cultural Health Issue Impacts

It is anticipated that impacts related to cultural health will be felt in the long-term, be restricted to the study area, and have no meaningful health impact past the current baseline. It is unlikely that these health consequences will occur, representing an overall **minor negative health impact significance**. The impacts are unpredictable, may occur at any time of the Project life cycle, and could affect Gndevaz, Gorayk/Saravan and Jermuk PACs. Gender specific impacts are not anticipated.

Mitigation Measures for Cultural Health Issue Impacts

This impact is considered minor and does not require extensive mitigation other than evaluating the access to local herbs and plants that may be used for medicinal purposes on the Project site. Supporting health systems strengthening to improve health seeking behaviour through improved access to affordable and acceptable local health services will be a useful social development initiative that may serve as an overall health benefit.

Residual Cultural Health Issue Impacts

The short and long term residual cultural health issue impacts are negligible, but if social development initiatives are developed these may result in a moderate beneficial health impact significance.

6.18.14 Health Systems Issues

Project Activities Affecting Health System Issues

The Project will build and maintain an infirmary at the mine, which will be staffed with a paramedic at a minimum. Occupational health and emergency care/first aid requirements will be managed through this service delivery option. This will be addressed in more detail as part of the occupational health and safety management plan.

Potential Health System Impacts

It is anticipated that impacts related to health service infrastructure and health programme delivery will be felt in the medium-term, be experienced at the study area, and cause a moderate negative health impact. It is possible that these health consequences will occur, representing an overall moderate negative health impact significance. The impacts could affect Gndevaz, Gorayk/Saravan and Jermuk PACs. Gender specific impacts are not anticipated unless access to health care is altered for maternal and child health care services.

The Project has the potential to impact the national/ local health service infrastructure and delivery mechanisms in the following ways:

- **In-migration:** In-migration and an increased population have the potential to exceed the capacity of the available health care services, especially in Jermuk. This is however likely to be limited in terms of infrastructure as the health services in the area are under-utilised at present. However, in terms of institutional and human resource capacity this may induce a significant impact as there is minimal capacity to support this potential growth, from a planning, budget or a delivery perspective. As rapid in-migration is not anticipated to occur this impact may be limited, but careful monitoring and anticipation of impacts will be important.
- **Workforce health requirements:** The Project is developing primary, occupational and emergency care facilities to serve the needs of the workforce. The health facilities in the area have minimal capability to address occupational and emergency care, so these will need to be developed and maintained on site. However, there is an opportunity for the Project to utilise the available public health services for basic

primary health care recognising that this should not reduce accessibility for the local community. This could represent a win-win situation, as the Project will receive access to suitable medical care for its staff and the payments levied for this service could support refurbishments and improvement of services to the benefit of the broader community. However, this will need to be carefully planned and the model developed in consultation with the government. It is essential that the Project is not viewed as the de-facto Ministry of Health in this area but merely a customer seeking services of the correct quality in the correct place to the benefit of the broader community.

- **Health service inequalities and Project expectations:** There is the potential for inequality, or perceptions of inequality to develop, between different communities because of Project supported health initiatives. It is thus essential to plan equitable support in this sector to avoid potential criticisms. There may be an expectation on the Project to support or supplement the delivery of health care services in the study area, but as mentioned above any corporate social investment activities or activities aimed at reducing impacts through health systems strengthening must be done in partnership with the local and national authorities and the delivery should be tasked to entities other than Lydian.
- **Health management information systems (HMIS):** While this is not a direct health impact from the Project, the limited HMIS restricts the ability to effectively monitor health impacts based on secondary data collected from the health facilities. This can pose a risk to the Project, as the available data sources to monitor health impacts will be limited.

Mitigation/Enhancement of Health System Impacts

The following mitigation and enhancement activities have been identified:

Project Impact Mitigation:

- Monitor the demographic changes in the immediate Project area and work with local health authorities to determine if the available health facilities are adequate for the needs of the community. This will require constant surveillance so that any impacts on health services can be anticipated at an early stage. In addition, this will require support from the planning section of the Ministry of Health.
- Support the development of a CHIS using longitudinal data from the local health services. A basic health database should be developed to track indicators from both primary and secondary forms of data and be used to monitor for both impacts as well

as the success of interventions and assist in the planning of interventions with the local authorities.

- Develop effective communication strategies on the role and responsibility of the Project in supporting health care service delivery in the study area.

Occupational Health, Safety and Environmental Management:

- Ensure that the Project health services can adequately cater for the needs of the workforce in terms of occupational health and emergency care.
- Evaluate the potential to utilise the available primary health care services to serve the needs of the Project. This needs to be done carefully to limit the risk of inducing a health impact through reduced capacity to cater for local health care needs, or inequalities to patients unrelated to the Project.

Social Development Mitigation and Management:

- Seek opportunities to collaborate with donor agencies or NGOs to improve health care services in the broader area. These should be managed and run separately from the Project, but the Project can consider elements of support. This will build on existing programmes being undertaken with Oxfam, other NGOs and their partners.

Residual Health System Impacts

Effective and sustained implementation of the mitigation measures described above is anticipated to generate a neutral/negligible health benefit in the study area. It is possible that these changes will occur, with the likelihood that they are experienced in the medium term and in the study area. This represents an overall negligible/minor beneficial health impact significance to the health system.

6.18.15 Accidents and Injuries

Project Activities Affecting Roads Traffic Accidents and other Accidental and non-Accidental Incidents

The Project will increase the amount of traffic on the H-42 to Jermuk and along the M-2 towards Vayk, and to a lesser extent Saravan/Gorayk and a number of other routes along the supply chain route from Yerevan. Jermuk and Gndevaz are likely to be most impacted by an increase in road traffic, either directly or indirectly related to the Projects activities. Traffic related impacts are discussed in a separate chapter.

The Project could also generate increased levels of violence associated with crime through changing the social fabric of the communities as discussed in Section 6.12.

Potential Traffic Accidents and other Accidental and non-Accidental Incidents Impacts

It is anticipated that impacts related to accidents and injuries will be felt in the long-term, be experienced at a regional level, and cause a moderate negative health impact. It is probable that these health consequences will occur, representing an overall major negative health impact significance. These potential impacts could occur in all five of the identified PACs.

The Project has the potential to influence accidents and injuries in the following direct and indirect manners:

Direct:

- **Transport Corridors:** The development and operation of the Project will increase road traffic in the immediate study area as well as the transport corridors to Yerevan and potentially to Georgia. This will include the transport of goods and personnel to service the needs of the Project. This can include long distance truck hauling and use of light duty vehicles, which may increase the risk of road traffic accidents (RTAs) along the route. General transport issues are addressed on the Transport Management Plan (Appendix 8.10) and the transportation of cyanide is addressed in the Cyanide Management Plan (Appendix 8.11) developed as part of the ESIA and are not specifically addressed in this chapter.
- **Heavy mobile mining equipment:** There should not be any community exposure to heavy mining vehicles as the proposed mining area is located outside of any human settlements. In addition, there should be no interaction with heavy mining vehicles, as the mining area will be secured and the haul roads will not be open for public use.

Indirect:

These can relate to RTAs as well as non-accidental injuries due to social pathologies and include:

- Improved economy in the area may allow more people to be in a position to afford motorised transport. This will result in increased numbers of motorised forms of transport on the road with the potential for accidents and injuries.
- Change in the social structures in the area due to potential migration, change in local practices and potential for social decay. Crime and associated violence may increase as part of these potential social pathologies.

Mitigation/Enhancement Measures for Traffic Accidents and other Accidental and non-Accidental Incidents

Project Impact Mitigation:

- Develop community security and safety management plans for the Project based on a risk assessment of planned activities. This should include emergency preparedness and response plans for both community and workplace related accidents. This must include a fire, rescue and chemical spill response capability, as well as medical emergency preparedness and response.
- Develop a clear policy for the management of emergencies or accidents in the community as a direct result of the Project's activities as part of the community security and safety management plans.
- Mitigation measures as described in the traffic and transport impact assessment specialist report.
- Support the surveillance of RTA and non-accidental injuries (assault) in the proposed CHIS.
- In-migration management and protection of social structures and cohesion where possible.

Occupational Health, Safety and Environmental Management:

- Management of mobile equipment and machinery within the framework of the Projects occupational health and safety management plan.
- Maintain appropriate emergency preparedness and response capabilities at the Project.
- Strictly enforce the drug and alcohol policy for all work related vehicles- including contractor transport vehicles.

Social Development Mitigation and Management:

- Work with local authorities and law enforcement authorities in the area to promote adherence to road traffic laws and to inform community members of the legal speed limits.

Residual Traffic Accidents and other Accidental and non-Accidental Incidents Impacts

Through implementing the measures outlined above the short term residual impact is considered to be **moderately negative**, and the long-term impact, neutral.

6.18.16 Security Conflicts

Project Activities Affecting Security Conflicts

The Project will employ a number of security guards during construction and operations to protect its assets and ensure un-authorised access to facilities does not occur.

Full details of the security arrangements for the Project will be prepared as part of the Project Execution Plan as well as in a specific Security Plan being developed. High-risk facilities, such as the ADR plant and explosives magazine, will have an enhanced security presence to prevent any loss of the doré product and access to explosives used in mining. Security guards working at the ADR and transporting the doré product are expected to be armed.

The Project currently employs a local security contractor to protect the exploration activities. In addition, a contract has been signed with the Armenian police who have established control points on the access roads to the Project area, restricting unauthorised access.

Potential Security Conflict Impacts

It is anticipated that impacts related to security conflicts will be felt in the short and medium-term, be experienced at the local level, and cause a moderate negative safety impact. It is probable that these safety consequences will occur, representing an overall major community safety impact significance. These potential impacts could occur in Gndevaz, Gorayk and Saravan PACs.

The use of private and public security guards by the Project has the potential to create the following impact:

- Inappropriate use of force – Where tension exists between a Project and host communities, the presence of security guards can escalate that tension. If the security guards have not received appropriate training, they may resort to inappropriate use

of force to manage conflict. This issue is even more important where security guards are armed. In the worst case scenario, this can lead to human rights abuses.

Mitigation Measure for Security Conflict Impacts

The Project will apply the following mitigation measures:

- Lydian is becoming a signatory of the Voluntary Principles on Security and Human Rights. As part of this commitment, a risk assessment is being undertaken to minimise the security and human rights risks created by the Project. A full review of the security arrangements put in place will be conducted.
- Security contracts will be awarded to local companies where possible to minimise the risk of creating unnecessary tension between host communities and security guards.
- Access to grazing and pasture land will be maintained wherever possible, while maintaining security of the Project facilities and safety of employees and community residents.
- A Memorandum of Understanding will be developed with the Armenian Police to establish the use of force, which is appropriate for the protection of the site assets and personnel.
- Armed guards will be used to protect the *doré* product and to secure the explosives magazine. Effective training will be provided and their performance monitored closely.

Residual Security Conflict Impacts

Through applying the Voluntary Principles on Security and Human Rights and the other measures outlined above, it is considered that security conflict impacts would be **minor negative** in the short term and negligible in the long-term (see Table 6.18.10).

Table 6.18.10 summarises Project impacts on Community Health and Safety.

Table 6.18.10: Impact Summary – Community Health and Safety

Sub-category	Direction	Extent	Duration	Impact (prior)	Impact (post)
Communicable disease linked to the living environment	Negative	Local	Medium term	Moderate (negative)	Negligible
Vector related disease	Negative	Local	Short term	Negligible	Negligible
Soil, water and waste related diseases	Negative	Local	Medium term	Moderate (negative)	Minor (negative)
High risk sexual practices, STIs including HIV/AIDS	Negative	Regional	Long term	Very High (negative)	Moderate (negative)
Food and Nutrition	Negative	Local	Short term	Minor (negative)	Negligible
Non-communicable diseases	Negative	Local	Long term	Moderate (negative)	Moderate (Positive)
Environmental health determinants	Negative	Regional	Medium term	Major (negative)	Negligible
Social determinants of health	Positive	Local	Medium term	Moderate (Positive)	Moderate (Positive)
Cultural health practices	Negative	Local	Long term	Minor (negative)	Negligible (Moderate positive if social development initiative are implemented and successful)
Health services and systems	Negative	Local	Medium term	Moderate (negative)	Minor/Negligible (positive)
Injuries and accidents, including road accidents	Negative	Regional	Long term	Major (negative)	Moderate (negative)
Security conflicts	Negative	Local	Short - Medium term	Major (negative)	Minor (negative)

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6.19 Transport

Impacts relating to traffic associated with the Amulsar Project include direct increase in traffic on the local road network, potentially affecting journeys, junction capacity and safety. The Project is, however, served by Magisterial and Republic roads, the M-2 and H-42 respectively, that provide direct access from existing access junctions to the proposed mine and associated infrastructure areas. The Project has, therefore, direct access to the strategic road network. Other potential impacts include increased wear and tear of road surfaces as a consequence of increased HGV traffic to and from the Project and a potential increase in environmental impacts such as an increase in noise levels and a decrease in air quality resulting from increased traffic on the highway network.

The main access junctions to the Project include (see Figure 4.18.3):

- Approximately 1.3km south of the turn-off to Gndevaz on the H-42 highway is an existing junction with an unmade agricultural track leading to the east. The track and junction will be upgraded as the main site access to the HLF, ADR plant and ancillary operations. This junction (Access A) will be required during the construction, operation and closure phase of the Project. Employees who work within the HLF will use this junction as their main work access.
- North of Gndevaz turn-off on the H-42 highway is an existing junction with an old tarred road leading to Saravan that will connect with the lower section of the conveyor, other infrastructure in the area, and the main mine access road (when constructed). This access road and junction (Access B) will be upgraded and used by staff and for deliveries accessing the main mine operational area.
- To the north of Access A, a secondary junction (Access C) will provide access from the H-42 to the east of the HLF for light vehicles only.
- North of Kechut on the H-42 highway is an existing junction onto a gravel track to the east of the H-42, which is currently used to gain access to the site exploration camp. This is also the access to Kechut landfill, which is approximately 0.5km off the H-42. This junction (Access D) will be the initial route to the mine facilities at the top of the mountain during the construction phase only, until the main road from Access B has been constructed.

6.19.1 Impact Prediction Methodology

Introduction

TIA methodology conforms to current good practice and in the absence of appropriate standards for Armenia, traffic impacts are assessed in line with the following published UK guidance, (which to a large extent harmonises with that of the EU):

- Institute of Environmental Management and Assessment (IEMA) Guidelines for the Environmental Assessment of Road Traffic (1991);
- Institution of Highway and Transportation (IHT) Guidelines for Traffic Impact Assessment (1994); and
- Department for Transport (DfT) Guidance on Transport Assessments (2007).

In taking account of this guidance, the methodology has been specifically tailored to address the requirements of the Amulsar Project and ESIA methodology (Section 6.1-6.3).

Summary of the Impact Assessment Process

The technical approach for the assessment of traffic impact associated with the Amulsar Project has the following stages:

- Establishment of baseline conditions;
- Characterisation of the transportation aspects of the Project;
- Assessment of the effects of the construction phase;
- Identification of mitigation measures for construction impacts;
- Assessment of the effects of the operational phase;
- Identification of mitigation measures for the operational phase;
- Identification of the effects of the closure phase (quantitative, as these are significantly less than the construction and operational phase); and
- Identification of residual impacts for the Project and their significance in relation to pre-determined criteria.

More detailed aspects of the methodology are discussed in the following sections.

6.19.2 Methodology for Evaluating Traffic Impact

Baseline conditions have been established using a combination of sources including secondary and primary sources of data (see Chapter 4.17). The methodology used for this assessment has been outlined in the following paragraphs and in Table 6.19.1 and has been based on that set out in Sections 6.1 to 6.3.

Direction

The direction of potential impacts takes account of existing road infrastructure and baseline conditions. In terms of the highway network, a project that delivers improvements to the current road infrastructure can be positive in terms of improving connectivity between affected communities and access to the strategic road networks. Negative impacts relate to whether the existing infrastructure can accommodate an increase in traffic associated with project phase(s).

Magnitude

The use of the highway link capacity assessments conforms to advice within the IEMA Guidelines for the environmental assessment of road traffic and is a standard tool for assessing traffic impacts for ESIA required for development projects. Link capacity assessment has been used in this instance, because the marginal changes in traffic on the perceptible environment are less sensitive than changes in traffic flows at junctions in the surrounding network. This allows for a more direct assessment of changes in traffic levels which might be deemed significant in environmental terms.

For key highway links, a baseline case in terms of link capacity has first been established which accords with the standards set out within the UK's Design Manual for Roads and Bridges Volume 5, Section 1, Part 3, TA 46/97 (DMRB). The highway links assessment has been based on the key site access points. (See Figure 4.18.3)

The magnitude of direct physical impacts, with respect to traffic, is determined by the analysis of the base flows on the road network and assessing these against the predicted Project traffic at peak hours.

Geographic Extent

The traffic impact assessment is primarily focussed on local and regional areas of influence. The access roads to the Project are in the proximity of Gndevaz (Access B immediately east of the town and Accesses A and C to the south) and Kechut (Access D). Figure 4.18.3 shows that the site access junctions are directly off the H-42 and that Project traffic (including HGVs) will not pass directly through the local communities (unless the traffic originates in the communities, e.g. staff or supplies) because the H-42 by-passes the communities of Gndevaz and Kechut. Employment-related traffic is predicted to increase from each of the communities and has therefore been considered for each Phase of the Project.

Duration

The IEMA guidance suggests undertaking separate assessments when significant phases of a development will have differing natures and effects, or where there are likely to be notable levels of construction traffic. Consequently, changes to the highway link capacity of surrounding roads and for relevant road junctions have been assessed for both the 'construction' and 'operational' phases of the Project. These have then been compared to baseline conditions to assess potential impacts and derive the significance of the effects. The closure phase has been considered qualitatively, as the predicted traffic flows are significantly less than the earlier phases of the Project.

The IEMA guidelines indicate that assessment of the traffic impact for construction phases should be based on the period where construction traffic activities are at the greatest intensity. The guidance also indicates that assessment of the completed development should be undertaken relative to the first full year of completion rather than for any period extending into the future. This is because the year of opening represents the period where environmental change resulting from the development traffic will be at its greatest relative to the general growth in background traffic.

The construction and operational phases are therefore considered separately because of their different nature and effects. Traffic impacts associated with each phase have been set out quantitatively where information is available. However, in many instances, gaps in the Project information have required assumptions to be made, based on experiences with TIAs of similar projects. Individual Project activities with associated traffic implications have been categorised and, where possible, quantified for the purpose of assessment.

Significance Criteria

A critical feature of an assessment of traffic impacts is determining whether a given impact is significant. Having identified the magnitude of the impact there are various ways of interpreting whether or not this is considered significant.

Two broad principles outlined within the IEMA guidelines advise on the screening process to limit the scale and extent of the assessment. These are to:

- "Include highways links where traffic flows will increase by more than 30% (or the number of heavy goods vehicles will increase by more than 30%); and
- "Include any other specific sensitive areas where traffic flows will increase by 10% or more."

In considering thresholds for significance, it is important to recognise the difference between variations in traffic activity that constitute a highway impact, for example congestion or delay at junctions, and those that would constitute an environmental impact.

A key characteristic for this assessment is that for many effects there are no simple rules or formulae which define thresholds of significance within an environmental impact assessment. Whether an impact is considered significant will depend on the level of development traffic activity, the level of traffic already on the surrounding network, the level of traffic congestion in the area and the environmental setting within which the Project and its associated traffic is located. There is therefore, a need for interpretation and judgement, qualified by appropriate data, secondary information and expert opinion.

The methodology to make judgements has been developed with due cognisance to the thresholds set out in the IEMA guidance. Table 6.19.1 provides a summary of the attributes that have been considered in order to assess significance.

Table 6.19.1: Classification of Transport Impacts			
Criteria	Scale	General definition	Application to transport assessment for the Project
Direction	Positive	Impact provides a net benefit to the affected person(s).	Improvements in road infrastructure, public transport and reduction in traffic generation in communities
	Negative	Impact results in a net loss to the affected persons(s).	Reduction in public transport, increase in traffic and congestion at road junctions, increase in risk of accident and reduction in road safety.
	Mixed	Impact may be positive or negative, but requires an intervention to demonstrate net benefit.	Combinations of the examples given above
	Neutral	No net benefit or loss to the affect person(s).	No net change in traffic, or the change would not be significant given the nature of the M-2 & H-42 roads
Magnitude	Negligible	No noticeable change anticipated.	No net change in traffic; or the change would not be significant given the nature of the M-2 & H-42 roads.
	Low	Result predicted to be different from baseline conditions, but not to impair or change quality of life of the affected person(s).	Small change in capacity of junctions. Transport flow limited to major roads, with minimal or no change in roads serving communities and residential properties.
	Moderate	Result predicted to impair or benefit quality of life of the affected persons(s).	Noticeable change to capacity of junction to accept additional traffic. Wear to road surface sufficient to affect other road

Table 6.19.1: Classification of Transport Impacts

Criteria	Scale	General definition	Application to transport assessment for the Project
			users. Increase in volume of traffic through communities or near residential properties.
	High	Result predicted to seriously impair or substantially improve quality of life.	Inability of junctions to cope with level of traffic generated, resulting in driver delay and reduced safety. Major wear of road surfaces to cause a reduction in safety of the road for other users. Congestion and heavy goods traffic through communities or near residential properties.
Geographic Extent	Individual	Confined to individuals or individual households	Traffic generation is restricted to main or strategic highways, no properties impacted.
	Local	Confined to the local area of influence.	Traffic generation is restricted to main or strategic highways, no communities impacted.
	Regional	Confined to the regional area of influence.	Traffic generation extends to communities on the highway network
	National	Extends to national level.	Traffic generation such that impacted communities extend to a national level.
	Trans-boundary	Results impact neighbouring countries in the region.	Traffic generation affects impacts trans-boundary routes.
Duration	Short-term	Construction and prior to operations.	Includes: employees, deliveries of construction material, plant and equipment and other services
	Medium-term	Operations	Includes: employees, deliveries of material and export of products, services and repairs
	Long-term	Through decommissioning and closure.	Includes: employees, deliveries of material, export of redundant plant and equipment.

6.19.3 Description of Predicted Traffic Generation

Highway Links

Construction Phase

Traffic volumes on the M-2 and H-42 main roads will increase during construction due to the following (see Figure 4.18.3 for the location of the access junctions):

- Transport of construction materials, mine equipment and fleet vehicles, potentially sourced internationally from the ports of Poti or Batumi in Georgia, and then transported through Armenia, which will be transported by road from Yerevan on the M-2 and be delivered to the Project on the H-42 to Junctions A and B. Light goods vehicles (LGVs) may also use Junctions C and D.

Traffic volumes on the local road network will also increase due to the increase in employment and provision of goods and services, including:

- Transport of construction workers to Junctions A and B, southbound on the H-42 from the worker accommodation camp and/or Jermuk, at shift changes;
- Transport of locally based construction workers from other surrounding communities, travelling to and from Junction A at shift changes;
- Local supplies that are sourced from Jermuk, Kechut and Gndevaz, via the H-42 to the site access, or from Saralanj, Saravan and Gorayk via the M-2 and H-42 to Access A, B and D; and
- Supplies that are sourced from greater distances, but within Armenia that will access the Project via the M-2 and H-42.

Operational Phase

Heavy goods traffic volumes on the M-2 to H-42 main roads will increase during operations, in comparison to the baseline conditions, due to:

- Transport of bulk material within Armenia, including spares, plant and equipment required to support and maintain mining operations;
- Transport of materials sourced internationally and delivered via the ports of Poti and Batumi in Georgia, or through Yerevan International Airport and then transported through Armenia, travelling on the M-2 and H-42 to Project Junctions A and B; and
- Export of doré product, by armoured transport from Junction A approximately every 2 weeks.

Traffic volumes on the local road network will also increase due to the local employment and provision of goods and services required for the operation of the mine, including:

- Transport of employees from the Project employee accommodation in Jermuk to the mine (Access A & B);
- Local employees, who reside in surrounding communities, travelling to and from work at shift change (Access A & B);
- Local supplies that are sourced from Jermuk, Kechut and Gndevaz, via the H-42, or from Saralanj, Saravan and Gorayk via the M-2 and H-42 (Access A and B);
- Supplies that are sourced from greater distances, but within Armenia and will access the site via the M-2 and H-42 (Access A & B); and
- Transport of goods and services in LGVs required to maintain mining operations (Access A & B).

Mine Closure

Similar to operations, the junctions used by the Project will be A and B, onto the H-42. Light vehicle traffic will also make use of the access junction C (see Figure 4.18.3 for the location of junctions).

Traffic volumes on the M-2 to H-42 main roads will result from the following:

- Transport of unused materials and dismantled equipment that will remain within Armenia, expected to be transported on the H-42 to M-2 and then in the general direction of Yerevan;
- Transport of fuels and other supplies required for rehabilitation and closure activities and to be delivered to the Project on the M-2 to H-42; and
- Export of redundant plant and equipment for sale outside Armenia, travelling on the H-42 and M-2 from the Project to the ports of Poti and Batumi in Georgia.

Access roads will also be rehabilitated following mine closure.

Traffic volumes on the local road network will continue to be generated from continued (albeit much reduced) employment and to a lesser extent the provision of goods and services required for the mine post closure activities, including:

- Local employees, who reside in surrounding communities, travelling to and from work at shift changes; and
- Local supplies that are sourced from Jermuk, Kechut and Gndevaz, via the H-42 to access junctions A and B, or from Saralanj, Saravan and Gorayk via the M-2 and H-42 to the mine and HLF.

6.19.4 Impact Assessment

Traffic Generation during Construction

The estimated traffic generation of the construction period has been determined for two categories of traffic: construction workforce trips, and construction materials and equipment trips. To generate the workforce traffic estimates, the following assumptions were made:

- The majority of senior staff will reside in Jermuk and will travel by car to the Project site. These senior staff are assumed to be travelling by car to site and are likely to travel on the public highway on a daily basis;
- Construction workers will be transported directly to site each day by chartered shuttle bus using the H-42 (through Access A & B). Operations will be over two 12 hour shifts.

Table 6.19.2 summarises the estimated construction workforce trip generation at peak (see also Figure 3.25 that show the profile of work force numbers for the duration of the construction phase.

Table 6.19.2: Estimated Construction Workforce Trip Generation				
Scenario	Mode	No. of workers	No. of vehicles	Total peak hour vehicle movements
At shift changeover assuming senior and construction staff arriving at the same hour	Chartered bus (Locally based construction staff)	690 ²	19 ²	38 ²
	Private vehicles (senior staff)	<30	30 ¹	30 ⁴
Notes: 1 Assumes approximately 1 senior employee per car and maximum for each shift change over. 2 Assumes that the majority of staff that travel to the site are picked from local villages by bus with an average capacity of 35 persons. This also assumes that at peak periods there is the potential for the shuttle buses to travel on the H-42 from worker accommodation (either the camp and/or Jermuk) and access junction A or D. 3 Assumes that all chartered buses will enter and leave the site during the 1 hour peak period. 4 Assumes Senior staff will travel to the site and do not leave until the end of the shift.				

HGV requirements for the construction have been determined based on assumptions taken from the Project Description (Chapter 3, section 3.15.4) (see Table 6.19.3):

- Concrete supplies (cement and sand) during construction: 2 trips per day.
- Structural steel: 1 trip per day.
- Fuel delivery: 1 fuel delivery, using an 8 tonne delivery truck, every 2 days.

- Miscellaneous modular buildings required for offices and contractor facilities: up to 10 deliveries at the onset of construction, with repeats during the construction period.
- Additional materials, including items such as piping, wiring, cables, rebar, cable tray and pipe supports: 4 trips per week or 1 trip per day.
- Transport of equipment including components for crushers, screens, mills, conveyor, ADR plant and various tanks and liner material: during peak time 15 trips per day.
- Abnormal or oversized loads: in excess of 1000 trips will be required in the construction period, with most travelling through the Port of Poti (Georgia) and overland by road through Armenia. These loads will therefore likely have to travel along the M-1 and M-2 highways passing through Yerevan. Assume 3 per day on average and up to 15 per day during peak periods.
- There is the potential for road transport of aggregates and construction fill for various requirements during construction that cannot be met by onsite quarries. A peak traffic generation of 36 trips per day has been assumed.
- Food and consumables would generate up to 2 deliveries per day, based on use of LGVs.
- There will also be a requirement for delivery of potable water during the early stages of the construction phase. Assume LGV service vehicles 2 per day.

It should be noted that the breakdown of construction materials across project components and activities has not been determined at this stage of Project planning and will be further developed during the detailed design phase. For the purpose of the transport assessment, the traffic generation assumes a worst case of all deliveries arriving within a peak hour, to assess the significance of the potential impact in the context of the road and existing users (see Table 6.19.3).

Table 6.19.3: Summary of Construction Materials and Equipment Trip Generation			
Source	Light Vehicle (VPD)¹	Heavy Vehicle (VPD)¹	Daily Traffic Generation (VMPD)²
Construction Materials	0	37 ³	74
Waste Materials	0	1	2
Mine Equipment, and Fleet Vehicle and oversized vehicles	0	30	60
Service Vehicles	5	0	10
Total	5	68	146
Notes: 1 Vehicles per day 2 Vehicle movements per day 3 Total daily vehicle trips consists of an equal number of trips 'into' and 'out' of the site Assumptions above would generate traffic 50:50 to Junctions A (or B) and D			

Traffic Generation during Operations

To generate the operational workforce traffic estimates, the following estimates were derived (see Table 6.19.4):

- Operational workers will either be based in a hotel in Jermuk or based locally in the villages. All staff will therefore be arriving by car or chartered bus to the Project.
- Traffic generation at shift change will be through the Junctions A and B.
- 40 senior staff [30 on one dayshift and 10 nightshift], the majority of whom will reside in hotel accommodation at Jermuk, are assumed to travel by car to site.
- There will be two shifts and it is assumed that, at the worst case, approximately 65% of workers will arrive at the start of the day shift, with the remainder working the night shift.

Table 6.19.4: Estimated Operational Workforce Trip Generation				
Scenario	Mode	No. of workers	No. of vehicles	Total peak hour vehicle movements
At shift changeover assuming senior and operational staff arriving at the same hour	Chartered bus from Jermuk (operational staff)	Up to 427 operational staff travel to site	12 ²	24 ³
	Chartered bus from other villages	Up to 200 operational staff to the site	5 ²	10 ³
	Private vehicles (senior staff)	30	20 ¹	30 ⁴
Notes: 1 Assumes 1 senior employee per car 2 Assumes that bus occupancy will be an average of 35 staff per bus 3 Assumes that all chartered buses with an average 35 workers per bus will enter and leave the site during the 1 hour peak period 4 Assumes Senior staff work daytime shift only, will travel to the site and do not leave until end of the shift. However, 10 senior staff will leave the site from the night shift The total work force is anticipated to be 657, working over two shifts.				

Heavy vehicle deliveries are anticipated throughout the operational phase of the Project. Deliveries will be required for equipment spare parts, miscellaneous materials, building supplies and fuel. In addition, a variety of process materials, chemicals and reagents will be needed for input into process operations. Maintenance and service vehicles can also be expected to access the Amulsar site at regular intervals during the operational phase.

All traffic generation calculations for process materials are based on operational throughputs for processing 10 million tonnes of crushed ore per year. This ensures that a worst-case assessment has been made for potential traffic generation for process materials, chemicals

and reagents during the operational phase. The trip generation estimates are as follows (see also Table 6.19.5):

- Lime – 3 trips per day. The deliveries will be through Junction B to the conveyor truck loadout area.
- Activated carbon – 1 trip per month through Junction A to the ADR plant.
- Sodium Hydroxide – 2 trips per month through Junction A to the ADR plant.
- Cyanide (Sodium Cyanide) – Deliveries once per month in a convoy of 3 delivery vehicles. The deliveries will be through Junction A to the ADR plant.
- Antiscalant – 3 trips a month through Junction A to the ADR plant.
- Fuel - 4 trips per day. The deliveries will be through Junction A and B.
- General fleet maintenance, goods and other services will be delivered to the mine on a daily basis; assume up to 11 trips per day through either Junction A or B.
- Four additional LGV trips for food / sustenance will deliver through Junctions A and B.

Operation transport requirements are detailed in Chapter 3 (Section 3.13.2).

Table 6.19.5: Summary of Operational Materials and Equipment Generation			
Source	Light Vehicle (VPD)	Heavy Vehicle (VPD)¹	Daily Traffic Generation (VMPD)²
Operational Materials	0	8	16
Cyanide delivery (estimated 20 trips per month in two deliveries)	0	5	10
Fuel	0	6	12 ³
Maintenance	0	10	20
Mine Equipment, and Fleet Vehicle and oversized vehicles	0	1	2
Service Vehicles	4	0	8
Total vehicles per day on cyanide delivery day	4	30⁴	68
Notes: 1 Vehicles per day 2 Vehicle movements per day 3 Total daily vehicle trips consists of an equal number of trips 'into' and 'out' of the site 4 See assumptions above			

Traffic Generation during the Closure Phase

The closure workforce would reduce compared to that predicted during operations and although it is difficult to predict at this stage, the majority of this work force are likely to live locally and the requirements for mine employee accommodation at the Jermuk hotel would reduce significantly. Therefore traffic estimates have been based on local traffic generation from surrounding communities (see Table 6.19.6):

- 25 senior staff on dayshift all of whom live locally and work either at the mine or within the site offices at the ADR plant. These senior staff are assumed to be travelling by car to site;
- 25 operational staff all of which will work day shift and will travel predominately by charter bus on a pick up and drop off basis from Jermuk, Kechut, Gndevaz, Saravan, Saralanj and Gorayk.

Table 6.19.6: Estimated Closure Workforce Trip Generation				
Scenario	Mode	No. of workers	No. of vehicles	Total peak hour vehicle movements
At shift changeover assuming senior and operational staff arriving at the same hour	Chartered bus from Jermuk. (operational staff)	Reducing to 10 operational staff within 18 months of cessation of operations	1 ²	2 ³
	Chartered bus from other villages (operational staff)	Reducing to 10 operational staff within 18 months of cessation of operations	1 ²	2 ³
	Private vehicles (senior staff)	25 (assumed)	25 ¹	30 ⁴
Notes: 1 Assumes approximately 1 senior employee per car 2 Assumes that bus occupancy will be up to 35 staff per bus, operating two buses 3 Assumes that all chartered buses will enter and leave the site during the 1 hour peak period 4 Assumes Senior staff work daytime shift and cars will park at the mine and approximately 5 senior staff will leave from the night shift				

Heavy vehicle deliveries are anticipated throughout the closure phase of the Project. Deliveries will be required for equipment spare parts, miscellaneous materials for closure works, general supplies and fuel. Maintenance and service vehicles can also be expected to access the Amulsar site during the closure phase. In addition, a variety of HGVs will remove plant and equipment from the mine, for resale or reuse on another project and waste materials for recycling or disposal. The predicted vehicle movements during the closure phase have been summarised in Table 6.19.7.

Table 6.19.7 Summary of Closure Phase Materials and Equipment Generation			
Source	Light Vehicle (VPD)	Heavy Vehicle (VPD)	Daily Traffic Generation (VMPD)
Equipment and spare parts	0	3	10

Table 6.19.7 Summary of Closure Phase Materials and Equipment Generation			
Source	Light Vehicle (VPD)	Heavy Vehicle (VPD)	Daily Traffic Generation (VMPD)
Building rubble and scrap	0	2	10
Fuel	0	2	12
Maintenance	0	5	10
Mine Equipment, and Fleet Vehicle and oversized vehicles	0	1	2
Service Vehicles	4	0	8
Total vehicles per day	4	13	52

6.19.5 Impact Assessment

Highway Links

Potential impacts to the five highways links identified in the baseline were assessed and summarised in Table 6.19.6. The assessment identifies the significance of the impact of traffic volumes based on the majority of all vehicular movements [construction materials / deliveries + staff + management] will enter and egress the Project via the access off the H-42 at Junctions A and B.

This assessment assumes a worst-case scenario where traffic is modelled for shift changeovers. This assumption has been applied for both the construction and operational phases.

Construction Phase

Table 6.19.8 provides the link capacity during the construction phase.

Table 6.19.8: Construction Phase - Highway Links Capacity							
Link Description	Link Capacity	Direction	Baseline 2016 (PCU/hr)¹	Traffic at 2016, including construction (pcus)	% Increase (PCUs) or magnitude of impact	% HGVs	RFC (%)
Link 1: on H-42 from M-2/H-42 junction to Access A	1380	NB	16	71	229.9	61.0	15.4
	1330	SB	46	96	393.1	46.0	14.1
Link 2: on H-42 from Junction A to Access D	1380	NB	16	83	476.6	69.6	24.8
	1330	SB	46	142	229.9	56.6	26.0
Link 3: on H-42 from	1307	NB	64	90	47.3	13.1	7.6

Table 6.19.8: Construction Phase - Highway Links Capacity

Link Description	Link Capacity	Direction	Baseline 2016 (PCU/hr) ¹	Traffic at 2016, including construction (pcus)	% Increase (PCUs) or magnitude of impact	% HGVs	RFC (%)
Access D to Jermuk	1380	SB	70	86	26.6	10.5	7.1
Link 4: on M-2 from M-2/H-42 junction to the east	1025	EB	147	263	31.5	29.8	25.3
	855	WB	141	172	25.7	26.8	17.5

Note: PCU = Passenger Car Unit

Links 1 and 2 both north bound and south bound will experience significant increases in traffic volume (increases of more than 100% to 400% on baseline levels). These links are from the H-42/M-2 junction to the turn-off at access junction D. The ratio of flow to capacity (RFC) remains low (< 26%) for the link between access junction A and D during the peak hour, on the H-42.

The Link to the north of Junction D, to Jermuk will have a modest increase of ~7.6 %RFC. This is due the small proportion of construction related travelling south from Jermuk to the mine.

On the M-2 the %RFC will rise to 25% for both east bound carriageways. Nevertheless, this still indicates that the H-42 and M-2 highways have considerable spare capacity. Based on this assessment, the predicted impacts during the construction phase have been summarised in Table 6.19.9).

Table 6.19.9: Significance of Impacts – Construction Phase

Link		Direction	Magnitude	Geographic	Duration
Link 1: on H-42 from M-2/H-42 junction to Access A	NB	Neutral	Moderate	Local	Short
	SB		Moderate		
Link 2: on H-42 from Access A to Access D	NB		Moderate		
	SB		Moderate		
Link 3: on H-42 from Access D to Jermuk	NB		Low		
	SB		Low		
Link 4: on M-2 from M-2/H-42 junction to the east	EB		Low		
	WB		Low		

The traffic impacts will be significant on the H-42 from the junction with the M-2 to Junction D (Links 1 & 2) both north and south bound. Links 3 to 4 the predicted impact will not be significant.

Operational Phase

To assess impacts on highway links from operational traffic, the predicted traffic under operational conditions was added to the extrapolated 2017 background traffic volumes (the opening year for production at the mine) which includes a high compound growth of 8.3% per annum.

Table 6.19.10 provides the link capacity assessment during the operational phase.

Table 6.19.10: Operations Phase - Highway Links Capacity Assessment							
Link Description	Link Capacity	Direction	Baseline 2017 (PCU/hr)	Traffic at 2017, including construction (PCUs)	% Increase (PCUs) or magnitude of impact	% HGVs)	RFC (%)
Link 1: on H-42 from M-2/H-42 junction to Junction A	1380	NB	18	97	562.0	23.7.0	9.5
	1330	NB	50	111	154.0	31.8	12.3
Link 2 & 3: on H-42 from Junction A to Jermuk	1307	NB	70	99	52.8	20.0	9.1
	1380	SB	76	125	81.6	15.7	10.9
Link 4: on M-2 from M-2/H-42 junction to the east	1157	EB	202	249	29.6	23.7	24.3
	1120	WB	153	200	39.0	35.0	23.4

Links 1 both north and south bound will experience significant increases in traffic volume, identified by the magnitude of impact. However, the RFC remains low for each of the links and indicates that both the H-42 and M-2 highways have considerable spare capacity to absorb this additional traffic at the peak hour. Based on this assessment, the predicted impacts for the operational phase have been summarised in Table 6.19.11.

Table 6.19.11: Significance of Impacts – Operational Phase					
Link		Direction	Magnitude	Geographic	Duration
Link 1: on H-42 from M-2/H-42 junction to Access A	NB	Neutral	Moderate	Local	Long
	SB		Moderate		
Link 2 & 3: on H-42 from Access A to Jermuk	NB		Low		
	SB		Low		
Link 4: on M-2 from M-2/H-42 junction to the east	EB		Low		
	WB		Low		

The traffic impacts will be significant on the H-42 from the junction with the M-2 to Access A to D (Links 1), both north and south bound. For links 2 to 4 the potential impact during the operational phase will be not significant.

Mine Closure Phase

During the mine closure phase, it is anticipated that:

- The work force will decline to approximately 20 within 18 months of cessation of operations and then for the duration of the closure phase;
- Materials would still be required mainly fuel, materials and services at approximately 20% of the operational load
- All equipment would be removed off site with equipment for resale, reuse or scrap, therefore a proportion of oversize vehicles would be required.
- The main period of mine closure works would take 2 years and continue for a further 3 years, with reduced traffic volumes.

Based on the above, Link 2 would experience a significantly lower vehicular movement than that during the operational phase. Links 3 and 4 would continue to have an impact of low magnitude, therefore not significant. Since the Operational Phase scenarios concluded that the RFC remained low for each of the links, which indicates that the H-42 and M-2 highways have considerable spare capacity, no further capacity assessment is necessary since the impacts of the Closure Phase would be far lower than those of the Operational Phase, and potential impacts would be not significant.

6.19.6 Impact Assessment for Traffic Generation within Affected Communities

Jermuk and Gndevaz will attract traffic generated by the Amulsar Project in the construction and Operations phases. Jermuk is the largest of the affected communities. However, baseline traffic levels within the settlements of Jermuk, Kechut and Gndevaz have been identified as very low, from observations. Site observations also suggest that there are no issues for the safe and efficient operation of local roads within either Jermuk, Kechut or Gndevaz. Due to the location of the mine access roads, both off the H-42, there will be no construction or operational HGV traffic that passes through Jermuk. The majority of construction HGV traffic travelling from the Project will be routed along H-42 around Gndevaz and south towards the M-2 highway. Only light vehicles and mini buses or coaches would travel to and from Jermuk and these trips will relate to staff movements and locals commuting to the mine under shift working arrangements. Outside of the peak commuting hour, traffic to and from Jermuk will be resemble that of the baseline conditions. The magnitude of the traffic impact to Jermuk is therefore Minor and not significant.

Gndevaz is accessed from the H-42 highway, just west of the access to the HLF. No development related HGV traffic would access Gndevaz. Residents of Gndevaz may be

employed during the construction, operational and closure phases of the Project. However, traffic generation is likely to be minimal. Baseline traffic flows show that the H-42 highway carries very low levels of traffic, less than 5% of the potential capacity for this link. Even with allowance for summer traffic variations and high compound growth in background traffic year on year, the additional development traffic has a negligible impact on capacity of the H-42. The ratio of traffic flow to capacity on the H-42 remains below 26% under the construction assessment. The magnitude of the traffic impact within the settlement of Gndevaz in the construction and operational phase is therefore considered to be Negligible and not significant.

Saravan and Saralanj are located directly adjacent to the M-2 highway. This section of the M-2 highway carries a high percentage of heavy vehicle movements, approximately 25% in the baseline flows. The assessment has considered increase travel by both car and HGVs, an estimated total of 30 light vehicles (senior management cars) some of which could travel eastbound along this section of the M-2 highway, although it is likely that the majority would travel west from the H-42/M-2 junction in the direction of Yerevan. It is also important to note that this scenario represents the worst-case assessment for this link and the daily estimated traffic generation will not ordinarily travel within a 1 hour period used in the impact assessment. The assessment predicts that on this section of the M-2 highway during the construction and operations phase the potential impact is Negligible and not significant.

Sections of the highway adjacent to Saravan, Saralanj and Ughedzor are also used by informal fruit and cheese sellers, who are known to set up roadside stalls for passing trade and car traffic. Roadside trading is common practice along the M-2 highway and will not be affected, in terms of HGVs generated by the Project on the road network, during the construction, operational and closure phases. The Project may also result in an increase in business for these traders from passing traffic.

Gorayk will have light vehicles and employee cars only passing through on a daily basis from the geological lab. Traffic impacts to Gorayk are considered to be Negligible and not significant.

The section of highway to the east of Gorayk in particular, and much of the M-2 highway near the Project, is a commonly used route for seasonal herders to bring livestock to pastures within the mine license area. This can amount to hundreds of head of livestock on the highway at peak times in late spring and early autumn. During the construction phase traffic volumes

on the M-2 highway will increase as a result of the development traffic. However, due to the sporadic nature of herding cattle on the highway, potential impacts are temporary in nature and the construction programme can be maintained to avoid conflict with herding patterns. Therefore, the magnitudes of traffic impacts on the M-2, with respect to seasonal herding, are considered to be Negligible and not significant.

6.19.7 Highways Link Impacts

Construction

Impacts to the following highway links have been assessed:

- Link 1: on H-42 from M-2/H-42 junction to Access A
- Link 2: on H-42 from Access A to Access D
- Link 3: on H-42 from Access D to Jermuk
- Link 4: on M-2 from M-2/H-42 junction to the east

Access B & C would be used by the Project during construction, but the volume of traffic using these junction is not sufficient to be included separately in the impact assessment, because all traffic relates to the H-42.

From Table 6.19.8 the highest % RFC predicted for each highway link during the construction period would be:

	% RFC
• Link 1: on H-42 from M-2/H-42 junction to Access A:	15.4
• Link 2: on H-42 from Access A to Access D:	26.0
• Link 3: on H-42 from Access D to Jermuk:	7.6
• Link 4: on M-2 from M-2/H-42 junction to the east	25.3

Based on these results, all four of the links can continue to operate using the existing priority T-junction arrangements with no channelized lanes for turning traffic. Although the magnitude of the impact is significant during peak hours and while the majority of mine related traffic will arrive and depart from Access A, on to the H-42 at the start and end of shifts, industry applied mitigation measures that include the use of buses to transport workers at shift change reduces the magnitude of the potential impact. In addition, other deliveries of machinery, goods and services would be spread throughout the day and would, therefore, further reduce the magnitude of impact and therefore the significance.

Operations

As illustrated in Table 6.19.10 all the road links will remain to operate satisfactorily and within capacity. As such, with such small operations phase trips and low RFC values, it is robust to assume that the development will have no material impact onto the operational capacity of the junctions on the following links:

	RFC
• Link 1: on H-42 from M-2/H-42 junction to Access A	12.3
• Link 2 & 3: on H-42 from Access A to Jermuk	10.9
• Link 4: on M-2 from M-2/H-42 junction to the east	24.3

This analysis is supported by the fact that the Operations phase would not generate as many trips as those during the Construction Phase and hence the Operations phase is predicted to have less impact and RFC than those identified during the Construction phase. In consequence, the magnitude of the impact is Negligible and not significant.

Closure

As the traffic generation during the closure phase would be less than that during the operational phase there will be a correspondingly lower predicted RFC than those identified during both the construction and operational phases. Therefore, the magnitude of the impact is Negligible and not significant.

6.19.8 Mitigation Measures for Traffic Impacts

There are a range of survey and engineering related infrastructure measures have been identified to mitigate the impact of increased HGV use on the H-42, as a consequence of the Project. These mitigation measures include:

- A formal review of the road network leading to the proposed mine access points is to be undertaken to assess the ability of HGV and low loaders to negotiate the bends and the road network safely.
- Preliminary investigation of the highway network will be undertaken to determine the area of verge that would be lost to implement mitigation measures required for low loaders to negotiate hairpin bends on the H-42.
- Internal road infrastructure will be upgraded to support all required construction activities. Existing gravel surfaced site access roads leading to the mine and HLF will be widened over their entire length and maintained for all weather operation, providing the means of access to the mine site and associated infrastructure. Currently the gravel surfaced roads, off the H-42 to the east of Kechut and Gndevaz,

require upgrading to accept site vehicles and will remain the access roads used for the duration of the Project.

- Formal road signage and potentially the consideration of identifying speed restrictions will be implemented in order to alert general traffic to the possibility of vehicles turning into and out of the junctions on the H-42 (see Appendix 6.19.1).

A Transport Plan (TP) has been prepared (see Appendix 8.10) and includes the formal arrangements to minimise and mitigate the impact on the tourist traffic travelling to Jermuk within summer months. The TP also requires signage on both the M-2 and H-42 to direct Project related traffic to the Junction A, B and D on the H-42.

The TP also describes the measures that Lydian would undertake to minimise disruption, inconvenience and delay to road users, without compromising safety. The TP requires the documenting of details required for temporary traffic management and the period over which they will be in place.

6.19.9 Monitoring and Audit (see also TP, Appendix 8.10)

The monitoring and audit planning required to validate the effectiveness of the mitigation strategies have been identified in Table 6.19.12.

Table 6.19.12: Transport Monitoring and Audit		
Transport		
Monitoring approach	Baseline	<ul style="list-style-type: none"> • A programme of traffic counts at junctions on the M-2 and H-42 (see Chapter 4, Section 4.18). • A programme of speed, payload road condition monitoring; • Minimising the number of trips generated by the Project, particularly where staff movement is involved and minimising the impact of all development traffic on community, heritage and environmental receptors; • A programme of drivers / staff training, fatigue management and driver behaviour monitoring; and • Journey Management Plans.
Level 2 Management Plan	A Transport Plan (TP, Appendix 8.10) has been produced, providing the details of mitigation measures to control (a) impact to the highway infrastructure and (b) emissions from Project vehicles using the local and national highway network. This includes driver awareness for all company employees, using their own transport for travel to and from the Project	

Table 6.19.12: Transport Monitoring and Audit

Transport	
Level 3 SOPs	<p>The TP is in force and will be underpinned by four SOPs that will provide specific guidance on monitoring for maintenance of the highway network and traffic counts:</p> <ul style="list-style-type: none"> • Pre construction road survey of the H-42 to establish the condition of the road and identify those areas of the road where specific widening is required and where the access junctions to the mine will be constructed. • Annual roads survey and traffic counts at road links selected for baseline surveys to audit capacity of links and record any variation in road use in comparison to baseline – report back and update TP, as necessary. • Driver awareness surveys, to update all employees on the requirements of the TP. All new employees and contractors and annually for all staff. • Signage for mine traffic (Appendix 6.19.3). • Random audit of Project related traffic, routing, vehicle speed and safety, signage to inform TP and driver awareness surveys

6.19.10 Residual Traffic Impacts

The combined impact of the transport requirements of the construction phase will be low and not significant. The primary mitigating measures will be those which lessen the impact of transporting the construction materials and equipment, and particularly the oversized loads that require access to the Project during the construction phase.

Measures to reduce the traffic impact of transporting workers off site or on shift change over days will also assist with lessening the impact on the H-42 / M-2 highways.

The combined residual impact of most of the transport requirements of the operational phase will be Negligible, increasing to Low at peak hours and not significant. Mitigation measures would be those which lessen the impact of transporting the operational workforce, materials and equipment. The Amulsar Project will require regular transportation of hazardous chemicals, including twice monthly deliveries of cyanide in truck convoys. The delivery of hazardous chemicals will be require specific monitoring and conform to international health and safety standards (considered in the Cyanide Management Plan, Appendix 8.11).

Table 6.19.13 summarises the traffic related impact assessment.

Table 6.19.13: Summary of Project Traffic Related Impacts

Impact	Source	Primary Receptor (1)	Phase (2)		Significance (3)		Mitigation Measures	Management Plan
			C	O	ST	LT		
Highway link assessment Construction Operations Closure	Light vehicle. Heavy goods vehicle	O O O	X	X X	M- M- N	N N N	<ul style="list-style-type: none"> HGVs and oversize vehicles will be subject to management and driver safety awareness training. Hazardous chemicals will be transported appropriately ICMC requirements will be applied for transportation of cyanide Car journeys will be minimised where possible, through use of buses and car sharing. 	Transport Plan, and Cyanide Management Plan (Appendix 8.10 and Appendix 8.11)
Junction link capacity Construction Operations Closure	Light vehicle. Heavy goods vehicle	O O O	X	X X	N N N	N N N	<ul style="list-style-type: none"> Car journeys will be minimised where possible through use of buses and car sharing 	Transport Plan (Appendix 8.10)
Environment – Project Affected Communities Construction Operations Closure	Light vehicle. Heavy goods vehicle	R R R	X	X X	M- M- N	N N N	<ul style="list-style-type: none"> Car journeys will be minimised where possible through use of buses and car sharing 	Transport Plan (Appendix 8.10)
<p>Notes:</p> <p>O – impact associated with the capacity of the highway and associated junctions to accept increase in traffic associated with the Project</p> <p>(1) Primary Receptors: E = employees, R = residents, Fl = flora, Fa = fauna, O = Other, (see notes)</p> <p>(2) Project Phase: C = Construction, O = Operations</p> <p>(3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, MA = major, M - = moderate, Mi = minor, N = negligible</p>								

6.19.11 Conclusion

A Traffic Impact Assessment has been undertaken to assess the effects of the Project by consideration of the construction, operation and closure phases of the mine.

Impacts to the following highway links have been assessed:

- Link 1: on H-42 from M-2/H-42 junction to Access A (Construction and operational phases)
- Link 2: on H-42 from Access A to Access D (Construction phase only)
- Link 3: on H-42 from Access D to Jermuk (Construction phase only)
- Links 2 & 3 from Access A to Jermuk (Operation phase only)
- Link 4: on M-2 from M-2/H-42 junction to the east (Construction and operational phase).

The findings of the assessment are:

- The combined residual impact of most of the transport requirements of the operational phase will be Negligible, increasing to Low at peak hours and not significant.
- Mitigation measures include those which lessen the impact associated with transport at the shift change for the operational workforce and traffic related to the supply of materials and equipment. The Amulsar Project will require regular transportation of hazardous chemicals, including twice monthly deliveries of cyanide in truck convoys. The delivery of hazardous chemicals will require specific monitoring and conform to international health and safety standards, which have been defined in the CMP (see Appendix 8.11).
- As the traffic generation during the closure phase would be significantly less than that during the operational phase there will be significantly lower predicted RFC than those identified during both the construction and operational phases. Therefore, the magnitude of the impact is Negligible.
- A Transport Plan (see Appendix 8.10) has been prepared which describes the measures that Lylian would undertake to minimise disruption, inconvenience and delay to road users, without compromising safety.
- As such, it is concluded that the potential impacts of mine vehicular movements on the highway during construction, operation and closures phases can be mitigated and the residual effects are not significant.

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6.20 Ecosystem Services Review

6.20.1 Introduction

Ecosystem services are the direct and indirect contributions made by ecosystems to human wellbeing and also to Project performance. They are generally classified into four types (adapted from MA 2003): (i) provisioning services, which are the goods or products obtained from ecosystems, such as food, timber, fibre and freshwater; (ii) regulating services, which are the contributions to human well-being arising from an ecosystem's control of natural processes, such as climate regulation, disease control, erosion prevention, water flow regulation, and protection from natural hazards; (iii) cultural services, which are the non-material contributions of ecosystems to human well-being, such as recreation, spiritual values, and aesthetic enjoyment; and (iv) supporting services, which are the natural processes needed to maintain the other services.

Since 1st January 2012, the International Finance Corporation (IFC) has required its clients to address ecosystem services in their assessment and management of environmental and social risks and impacts. Performance Standards (PS) 1, 4, 5, 6, 7 and 8 (IFC 2012) refer to this requirement. PS 6 requires clients to “maintain the benefits from ecosystem services” when designing and implementing Projects, as well as to “implement mitigation measures that aim to maintain the value and functionality of priority services”. The goal is to mitigate Project impacts on “priority” ecosystem services so that the benefits people derive from these services are maintained when the Project is developed, operated and then closed. Similarly, for services used and depended on by a Project, the goal is to ensure that there will be a sustainable supply throughout the Project's planned operational life. The European Bank for Reconstruction and Development (EBRD) has a similar requirement in Performance Requirement (PR) 6 relating to the assessment of “use of, and dependence on, ecosystems by potentially affected communities” (EBRD, 2008).

Some of the benefits people derive from ecosystem services relate directly to their livelihoods in the sense of IFC PS5 and EBRD PR5, and may be affected in the event of land acquisition. Section 6.16 of the ESIA and the associated Land Access and Livelihoods Restoration Plan (LALRP) addresses economic displacement and livelihood restoration. This Section 6.20 is concerned more with the non-financial benefits that people derive from ecosystem services, their level of dependence on them and their ability to maintain them through alternative means, if they lose access to the services that underpin them.

This Review describes the benefits that people get from ecosystems in the Project affected area in the baseline situation. It explains the process for identifying “priority ecosystem services” on which people depend and considers the implications of the social and biophysical changes associated with the Project for these services. In cases where adverse effects are predicted, mitigation measures are suggested to ensure that benefits from these ecosystem services can be maintained. It also describes the priority services on which the Project depends for its operational performance.

6.20.2 Approach and Methods

Explanation of Overall Approach

The approach taken to Ecosystem Services Review was based on guidance and tools developed by the World Resources Institute^{1,2}.

The following steps were followed:

1. Identify ecosystem services for which the Project might affect supply.
2. Identify the users and beneficiaries of these services.
3. Select “priority ecosystem services” (those on which beneficiaries have high levels of dependence, with limited or no available alternatives amongst other criteria).
4. Establish the baseline for the priority ecosystem services, assuming current levels of use.
5. Predict Project impacts on priority ecosystem services (their supply, use or benefits as appropriate), using current levels as the baseline.
6. Mitigate Project impacts on priority ecosystem services to ensure that benefits are maintained.

As well as assessing the impacts of the Project on ecosystem services used or depended on by others, the review also considered the dependence of the Project itself on ecosystem services. The goal in this case was to ensure that operational performance could be maintained throughout the lifetime of the Project. The review therefore involved the

¹ Landsberg, F., S. Ozment, M. Stickler, N. Henninger, J. Treweek, O. Venn, and G. Mock. 2011. *Ecosystem Services Review for Impact Assessment: Introduction and Guide to Scoping*. WRI Working Paper. World Resources Institute, Washington DC. Available at <http://www.wri.org/publication/ecosystem-services-review-for-impact-assessment>.

² Landsberg, F., J. Treweek, N. Henninger, M. Stickler, and O. Venn. 2013. *Weaving ecosystem services into impact assessment: a step-by-step method*. World Resources Institute, Washington DC. Available at http://www.wri.org/sites/default/files/weaving_ecosystem_services_into_impact_assessment.pdf

following steps:

1. Identify priority ecosystem services (services which the Project is strongly dependent on, with limited alternatives).
2. Predict potential changes in the supply of priority ecosystem services and associated benefits over the lifetime of the Project.
3. Assess loss in operational performance as related to changes in priority ecosystem services.
4. Identify measures needed to manage Project dependencies on priority ecosystem services so that operational performance can be sustained.

The information used to carry out the review was obtained from a variety of social and ecological surveys and assessments, carried out between 2008 and 2014, including:

- Land cover and land use mapping;
- Vegetation survey and classification;
- Surveys of biodiversity and ecosystems;
- Ethnobotanical survey;
- Agricultural survey;
- Livelihoods survey, 2014;
- Water studies;
- Census of seasonal herders, August and September 2012; and
- Rapid health impact assessment.

In 2014, stakeholder interviews and focus group meetings were held as part of the social impact assessment process in local villages (Gorayk, Saravan, Gndevaz), with seasonal herders from the village of Xndzoresk, and with residents in the town of Jermuk. Each focus group meeting and interview was conducted in Armenian and simultaneously translated into English. The focus group meetings and interviews were structured using a protocol that led participants to discuss their use of and dependence on ecosystem services and the benefits derived from them. Participants were asked to prioritise services and to identify areas supplying priority services, as described in more detail below. The protocol is provided in Appendix 6.20.1 (Table 4). In 2015, follow-up interviews and focus groups meetings were held with local villagers (Gorayk, Saravan, Gndevaz), Jermuk residents and seasonal herders from the village of Xndzoresk. These focused on improved understanding of land use change for people's ability to access ecosystem services, the extent to which specific mitigation measures might be needed and people's willingness to accept them.

Assessing the Project's Impacts on Ecosystem Services

Project activities and locations of infrastructure were mapped against ecosystems or natural vegetation types supplying services, as part of a scoping exercise, to identify those for which significant changes might be expected as a result of the construction, operation or closure of the Project. Ecosystems might be affected because they are within the Project's physical footprint, or because the Project will induce biophysical or social changes that might alter their use or the extent to which people are able to benefit from them.

Approach to Prioritisation

Even if ecosystem supply changes as a result of the Project, not all of the ecosystem services supplied by ecosystems in the Project affected area will be affected by the Project in ways that will have a significant impact on the wellbeing of beneficiaries. The ESIA therefore focuses on "priority" ecosystem services: those most likely to be affected by Project operations and for which changes could have adverse impacts on the wellbeing of affected communities. Prioritisation requires information on the benefits that people derive from the ecosystems they use, as well as the extent to which they rely on these benefits to maintain their wellbeing and livelihoods. This information was obtained through the focus group meetings. The prioritisation process screened out ecosystem services with readily available alternatives or for which levels of dependence are low.

While some ecosystem services contribute directly to human wellbeing, others do so indirectly by supporting other services. For example, livestock production provides direct value to human wellbeing through income or providing food for subsistence, whereas hay production contributes indirectly, by supporting livestock production. The former are referred to as "final services" and the latter as "intermediate services". In this review, intermediate services have been addressed through the relevant final service.

The protocols used within the focus group meetings and interviews operationalized the criteria used to identify priority ecosystem services:

- i. Identification of ecosystem services that contribute directly or indirectly to livelihood or wellbeing;
- ii. Identification of important ecosystem services;
- iii. Location of ecosystem services (where they are supplied);
- iv. Establishing extent of use, dependence and benefits derived; and
- v. Acceptability of alternatives.

The decision tree illustrated in Figure 6.20.1 reflects the criteria that were used to identify priority ecosystem services:

1. The supply or use of the ecosystem service is affected by Project operations, whether because it is supplied from ecosystems which are located in areas exposed to land use change as a direct or indirect result of the Project, or because the presence of the Project will affect the ability of users to access it.
2. Project impacts on the ecosystem service might lead to a change in the benefits it provides to people.
3. The benefits derived from the service are important to the overall wellbeing of its beneficiaries.
4. The beneficiaries have no or limited viable alternatives to the service to maintain their wellbeing.

The process has focused on services for which the Project has some ability to influence the factors affecting the supply or use of the service through appropriate interventions, for example through its Land Access and Livelihood Restoration Plan and Footprint Management Plan. Services were therefore only prioritised if the Project was considered to have significant influence over their supply or use.

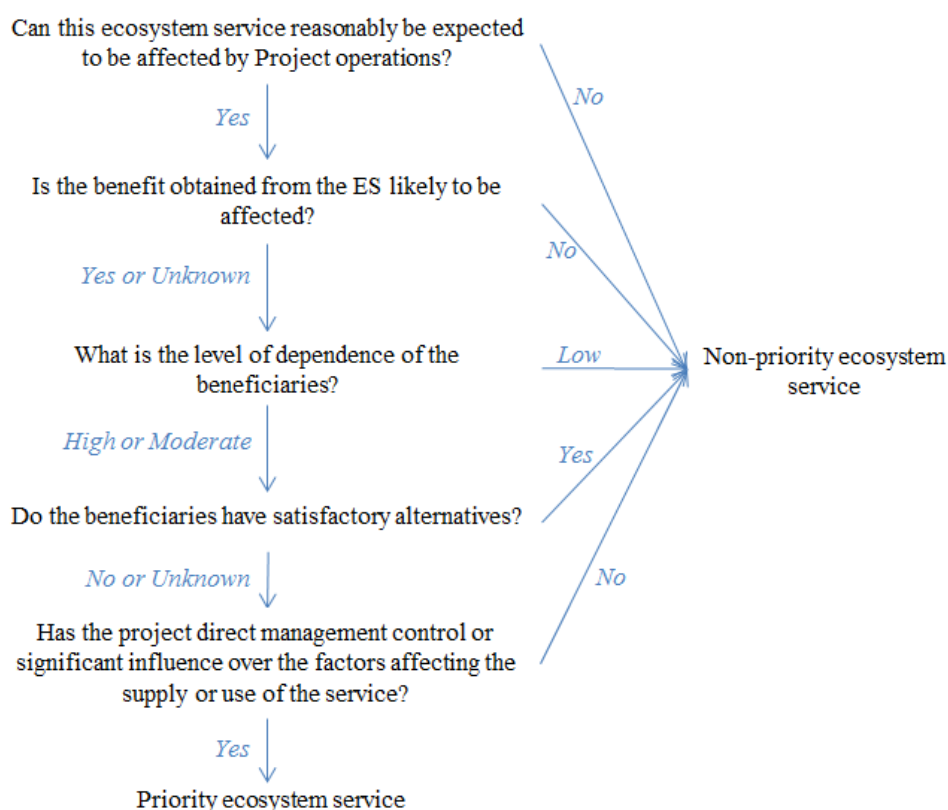


Figure 6.20.1: Decision Tree for Identifying Priority Ecosystem Services Affected by the Project

For each of the priority ecosystem services, the current socio-economic benefits derived by affected stakeholders were established and linked to current levels of use to the extent possible. This was used to extrapolate changes in ecosystem service benefits from the baseline situation resulting from Project-related changes in ecosystem service supply.

Assessing the Project's Dependence on Ecosystem Services

Priority ecosystem services are “those services on which the Project is directly dependent for its operations”³. A project can compromise its own future viability or performance if it undermines the services on which it depends or if these services are at risk of being undermined by others within the proposed lifetime of the project. The availability and level

³ International Finance Corporation (IFC). 2012. *IFC Performance Standards on Environmental and Social Sustainability*. DC: IFC. Available at http://www1.ifc.org/wps/wcm/connect/c8f524004a73daeca09afdf998895a12/IFC_Performance_Standards.pdf?MOD=AJPERES (last access: 05/22/2013).

of supply of services needed by the Project was therefore reviewed. Figure 6.20.2 illustrates the process for identifying priority services with respect to the dependence of the Project on ecosystem services.

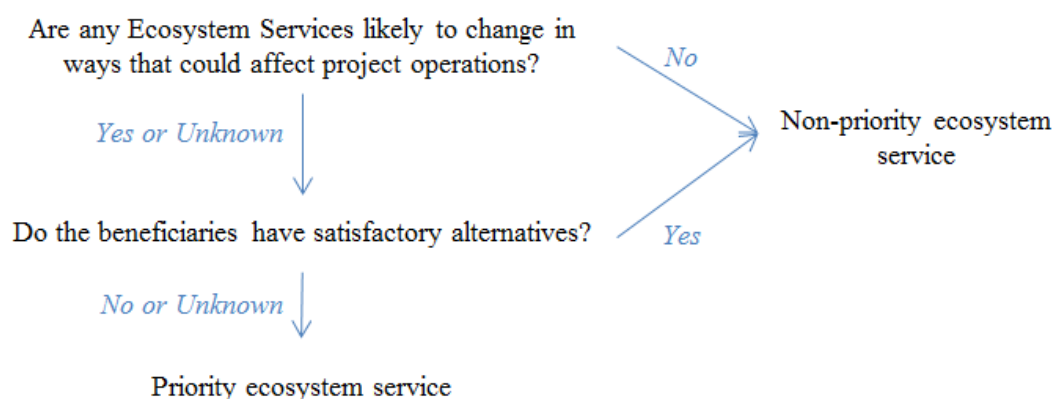


Figure 6.20.2: Decision Tree for Identifying Priority Ecosystem Services which the Project depends on

Figure 6.20.2 reflects the following criteria that were used to identify priority ecosystem services:

1. The service contributes directly to the Project's operations;
2. The ecosystem service could change over the life of the Project in ways that could lead to operational risks; or
3. The Project has no viable alternatives to this service to achieve planned operational performance.

For each of the priority ecosystem services, future supply and benefits to the Project were predicted based on expected ecosystem change driven by factors both external to the Project and by the Project itself.

6.20.3 Potential Impacts of the Project on Ecosystem Services

Overview of Ecosystem Services in the Project affected area

An overview of the various ecosystem services provided by the Project affected area is given in Table 1 of Appendix 6.20.1 to this report.

In general, dependence on benefits from ecosystem services in the baseline situation is relatively high because of the rural context and predominance of traditional or low input agriculture as a source of employment and livelihood. Nationwide, agriculture, hunting and

forestry account for 76% of employment in rural areas and in the Project affected area the importance of agriculture is even more pronounced. The Project affected area is particularly important for supplying provisioning services: it is rural and has been farmed for many centuries in a traditional way, apart from the Soviet era, when production intensified and became more mechanised. Local communities keep livestock for meat and milk. There is an ancient tradition of transhumance, with a complex system for allocating land for summer grazing. Livestock are herded onto montane pastures each day from villages around the Amulsar Mountain and grazing leases are also let (largely in the Vorotan Valley) to other cattle owners, some of whom live considerable distances away. Herders are often hired by animal owners to look after the livestock during the summer, with some herders based locally and others living in seasonal camps and bringing their families with them. Seasonal herding is largely of cattle for milk production, with a daily collection of milk from Gorayk by Ashtarak Kat, one of the largest dairy companies in the country. The Vorotan Valley and surrounding pastures on Amulsar are generally considered to be of high quality, being nutritious and productive. Hay is harvested for use as winter fodder for livestock, some being sold to other livestock owners in less productive areas. Hay is generally produced from grassland areas too far from villages or too high up to walk livestock there every day.

There is a tradition of harvesting snowmelt to boost hay production, as well as for irrigation of food crops. Drinking water for humans and animals is sourced from natural springs (these are groundwater-fed) (see Section 4.8 – Groundwater Baseline). Other foods produced in the wider Project affected area include honey and a variety of vegetable and fruit crops, especially apricots, which are grown commercially. Wild herbs (“greens”) and mushrooms are traditionally harvested from Montane Meadows, Sub-alpine Meadows and Montane Meadow Steppes. Nuts, berries, fish and some wood for fuel are all collected. Whilst much of the produce is consumed or traded as fresh produce, there are various ways in which products are preserved for use out-of-season e.g. pickling, drying, canning and salting. There is some licensed hunting, e.g. of wild boar and also hunting which is technically illegal (whether because it takes place outside the licensed period, or because protected species are taken).

Amulsar Mountain provides regulating services such as soil erosion control and water cycling. The Project affected area is at the confluence of three river catchments and snowfall on Amulsar Mountain makes a significant contribution to surface water supply. More detailed information on surface water and groundwater in the Project affected area can be found in Chapters 6.10 and 6.9, respectively.

Cultural services provided by Amulsar Mountain include recreational use, e.g. walking or bathing. The mountain is also a source of inspiration and a place where tombs and artefacts reflecting the local heritage are found. People express a strong sense of place-attachment, as well as being proud of their agricultural identity.

A support service identified by focus group participants was the role of species, e.g. wolves, foxes, raptors and ants, in ‘sanitising’ the environment and regulating pest (rodent) numbers to benefit pasture production.

Priority Ecosystem Services

Appendix 6.20.1 (Table 2) summarises the results of the prioritisation process with respect to the dependence of beneficiaries on the ecosystem services they use, and the extent to which they would have access to alternatives if these services declined or disappeared as a result of the Project. Levels of dependence do vary between services, but the majority of participants in focus group discussions emphasised their dependence on many different services to maintain their wellbeing and struggled to prioritise them, even when pressed to do so. Services considered a priority by villagers in Gorayk, Saravan and Gndevaz even included the presence of animals such as wolves and foxes that ‘sanitise’ the area by consuming dead or diseased animals or controlling crop pests. Villagers stressed the fact that their wellbeing came from access to a wide range of ecosystem services, all of which they value and wouldn’t want to do without. However seven ecosystem services were prioritized because the Project may cause a decline in supply, potentially preventing their beneficiaries from deriving benefits which they depend on heavily, or for which they have no viable or acceptable alternatives. These are described in Table 6.20.1, with more detail about the prioritisation process provided as Appendix 6.20.1 (Table 2).

Some services were considered a priority by participants in focus groups, but have not been prioritised for the purposes of this assessment because they do not meet all the criteria in Figure 6.20.1. “Greens” and herbs harvested from the Project affected area, for example, were considered a priority, but despite some negative impacts from the Project on supply, most beneficiaries are expected to be able to sustain their current levels of use and benefit because current levels of use are well within available supply limits. Herb sellers in Jermuk reported that they are already avoiding collection of herbs from the vicinity of the mine (within approximately 1km radius) due to the possibility of perceived negative impacts on the quality or “health” of plants harvested there. However they also indicated that they were

having no difficulty in procuring adequate supplies from elsewhere. Preliminary assessment of impacts on ecosystem services concluded that there could be a very small minority of local people who rely partially on income from selling herbs and who have regularly used the Project affected area to source produce for sale. If these people are elderly, they might struggle to travel the longer distances needed to supplement their supply from areas perceived to be unaffected by the mine and therefore “healthy”.

Other services that were not prioritised included the “sanitary” role of wild animals in controlling prey populations, as there are potential alternatives to this service that could be used, such as use of small mammal traps or domesticated predators to reduce biomass of “pest species”.

Table 6.20.1: Priority Ecosystem Services	
Benefits from Priority Ecosystem Services and the Ecosystems Supplying them	
Provisioning services	
1	<i>Milk, milk products, and meat from livestock</i>
	<ul style="list-style-type: none"> Produced from Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppe, including some within the Project footprint. Some affected beneficiaries rely on this service for their livelihood and currently have limited or no alternatives. This is particularly the case for villagers with a long-standing tradition of local daily herding from the village, as in Gndevaz, as other areas of grazing areas could be too far away for daily herding from the village. Seasonal herders are also dependent on this service and the extent to which alternative locations could be used to gain the same service has not yet been established. Some seasonal herders also rely heavily on this service to produce their food, a proportion of which is consumed by their families. A smaller number of local daily herders are affected.
2	<i>Hay produced to sell for income</i>
	Supplied by Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppes including some within the Project footprint. Hay produced for winter feed is an intermediate service supporting production of milk, milk products and meat from livestock; it is the sale of hay for income that is prioritized here. Levels of dependence vary, with sale of hay for income being more important in Gndevaz than in other villages. Most farmers should be able to find alternative land suitable to produce hay, but this could be challenging for farmers from Gndevaz who have a greater proportion of their hay fields affected.
3	<i>Apricots grown for own use and income in village orchards</i>

Table 6.20.1: Priority Ecosystem Services	
Benefits from Priority Ecosystem Services and the Ecosystems Supplying them	
Provisioning services	
	Apricots grown on suitable land within the Project footprint are considered to be premium quality. They are a significant component of income, particularly for Gndevaz Village and also have cultural importance (pride and associations with cultural identity). They are grown on land which is relatively frost-free, has abundant water supply and is at a suitable altitude. Almost all of the apricot trees that will be acquired are young trees (less than seven years old) and have not yet started producing apricots; as such, current production levels will not be impacted but there could be reduced capacity for the future if replacement land is not found. Loss of livelihood impacts are addressed in detail in the LALRP and in Section 6.16.
4	<i>Freshwater for drinking, domestic supply and crop irrigation</i>
	Villages and herders use groundwater springs for their freshwater supply. Surface water from the catchment including Amulsar Mountain is also used occasionally and by livestock, as well as being used to irrigate crops by the villages round the Mountain. There are local concerns about impacts of the Project on water quality, so a precautionary approach is needed, together with ongoing monitoring.
Regulating services	
5	<i>Erosion control</i>
	From Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppes. There is no existing infrastructure that can provide the same level of protection, particularly to higher elevation hay meadows and pastures as currently provided by long-established vegetation.
Cultural services	
6	<i>Cultural identity from herding and other traditional ways of life including apricot production</i>
	From Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppes and the foothills of Amulsar (modified pastures and farmland). In focus groups, seasonal herders reiterated the heritage value of herding and villagers from Gndevaz emphasized the traditions associated with apricot production and the part played by apricots in contributing to local pride and sense of place.
7	<i>Reference landscape and sense of place</i>
	From Amulsar Mountain and surrounding landscape and villages. Interviewees and focus group participants expressed strong place attachment and place identification. There was complex understanding and high value placed on 'nature' that was represented in different cultural forms including poetry, songs and paintings.

Potential Sources of Impact on Ecosystem Service Supply

Project infrastructure and activities will give rise to land use changes that may alter the condition of ecosystems and therefore the levels of priority ecosystem services that they supply. If the Project will not affect the benefits that people derive from a service, because there are alternative sources of supply, or because supply remains within limits of use, impacts on supply will not be significant. As well as the implications of the Project for level of ecosystem service supply, it is also necessary to consider the ability of people to access the supply. This may be influenced by restrictions on land use and access and primarily affects access to services by people from Gndevaz.

The main components of the Project are outlined in Chapter 3. The affected land straddles the Vayots Dzor Marz and Syunik Marz province boundaries and occupies land holdings of three rural communities: Gorayk, Saravan and Gndevaz (see Section 6.16). The proportion of land taken varies considerably between the communities. Gndevaz will experience restricted access over approximately 15% of its land (925 ha) and Saravan and Gorayk 3% and 1% (199 and 274 ha) respectively. Table 6.15.1 provides a summary of the disturbed and restricted land within each community.

The infrastructure footprint is 599ha. Vegetation changes are possible within a further 691ha buffer zone including land where dust deposition and other changes are envisaged adjacent to roads (see Section 6.11.4). In total this equates to 1288ha of land that will be disturbed. An additional restricted area of 477ha represents a zone in which land will not be physically changed, but land use will be controlled. This means that the supply of ecosystem services may be affected over an area of approximately 1766 ha. Table 6.20.2 identifies the areas of different land cover types that will be disturbed within the Project's physical footprint, buffer zone and additional restricted area. This shows that supply of services from a range of natural habitat types will be affected.

Table 6.20.2: Areas of Different Vegetation Disturbed by the Project (Footprint plus Buffer Zone and Additional Disturbed Area)		
Land Cover Type	Area in hectares disturbed	Project Implications for Ecosystem Service Supply (Provisioning Services)
Cultivated land including orchards	138	Affects production of food from crops particularly for Gndevaz community.
Sub-alpine Meadows with Alpine Elements		Not used to a significant extent.
Sub-alpine Meadows	900	Affects supply of hay from meadows used by seasonal and local herders and some grazing.
Montane Meadows	126	Affects supply of pasture used by seasonal and local herders from Gorayk and Gndevaz and also hay production. Also collection of herbs and mushrooms.
Montane Meadow Steppe	269	
Vegetation with shrubs	150	Affects supply of pasture used by seasonal and local herders from Gndevaz.
Wetlands	8	Important for biodiversity, wetter areas grazed in dry periods, important for harvesting herbs.
Gorge	8	Not used to a significant extent.
Rocks	46	Not used to a significant extent.
Total	Approx. 1766	Including physical footprint, disturbed and restricted zones.
Notes: The remaining land is generally grassland for pasture. Does not include 1ha of urban structures		

Table 6.20.2 shows the areas of land taken for the Project from the three villages in relation to different land uses (in this case, “land take” refers to the Project Disturbed Area, i.e. footprint plus buffer zone, plus the Additional Restricted Areas). Land-take is highest for pastureland, and in the case of Gndevaz Village, includes apricot orchards. The proportion of land used by different herder groups that will be affected is not currently possible to estimate.

Losses of different categories of agricultural land have been quantified per rural community for Chapter 6.15, drawing on information reported by the Cadastre in 2014 and the Project physical footprint, disturbed and restricted zones. Some pastureland has already been re-classified as “mining land” in the Cadastre, so this was also included. Based on this analysis, (summarised in Table 6.20.3), overall losses of land used for farming or gardening approach 20% for Gndevaz and are less than 2 and 1% for Gorayk and Saravan respectively. The agricultural implications of this are discussed in Chapter 6.15, but this reduced access to land

also has implications for access to ecosystem services. In addition to percentage loss of agricultural land “supply”, it is also important to consider the extent to which any replacement land is readily accessible on a daily basis to allow continuation of current use patterns. This has been challenging to establish due to changes in layout and will therefore need to be monitored. However, for grazing in particular, both supply and access are affected, with consequences for the benefits people are able to derive, not all of which are addressed through financial compensation.

Table 6.20.3: Loss of Agricultural Land per Cadastre Categorisation⁴				
Type of land	Ha available or % disturbed/restricted	Community		
		Gndevaz	Gorayk	Saravan
Arable land	Available (ha)	461.2	1727.76	381.81
	% loss	17.5	-	-
Hayfields	Available (ha)	115.6	860	400
	% loss	21.8	-	-
Garden	Available (ha)	24.3		
	% loss	35.6		
Irrigated arable land	Available (ha)	124.3	-	10.0
	% loss	12.7		
Pasture	Available (ha)	4501.1	13477.8	4323.2
	% loss	11		
Pasture previously taken within mining concession	Available (ha)	324.4	1646.2	1010.6
	% loss	62.0	16.6	19.3
Other agricultural land	Available (ha)	421.9	3324.8	1249.3
	% loss	25	-	-
Pasture plus “mining”	Available	4825.5	15124.0	5333.7
	% loss	14.4	1.8	3.7

The loss of access (including disturbed and restricted access areas) to arable land, hayfields,

⁴ Calculations completed by Lydian based upon Cadastre data

pasture (including land classified as mining in 2014) and irrigated arable land is less than 20% in Gndevaz.

Changes Following Mine Closure

Construction is planned to take approximately 2 years and mining is currently projected to last for 10 years. However there will be some long-term or effectively permanent impacts on the supply and use of some ecosystem services and therefore on the benefits derived, due to irreversible or long term changes in land-form, soil quality and ecosystem processes. The extent of these changes depends on the success of post-mining reclamation. As outlined in the preliminary Mine Reclamation, Closure and Restoration Plan (pMRCRP, Appendix 8.18), some areas will be re-vegetated post mining and may be restored to agricultural use. Grazing and hay making at higher elevations on Amulsar Mountain may be possible when access restrictions are removed, but the Erato Pit will remain as a partially back-filled pit and will not be available for agricultural use. Some low-intensity grazing may be possible on the restored Tigranes/Artavazdes Pit. However the HLF would not be suitable for apricot growing following restoration as the post-mine landscape would not be amenable to economic agricultural or horticultural uses. It is also unlikely that tree-growing will be a permitted land use. The BRSF will be re-vegetated and re-contoured and it is anticipated that some grazing will be possible there in future. Land within the buffer zone (Project Disturbed Area) is expected to return to pre-existing agricultural condition within a few years of the cessation of haul road use and dust generated by the Project. There could be a long time before restoration to agricultural use occurs, in some cases up to 16 years. This could mean that relevant management expertise is lost, eroding future capacity to produce premium apricots in particular, but also livestock.

6.20.4 Potential Project Impacts on Priority Ecosystem Services and Proposed Mitigation

The main implications of the Project for the supply and use of services and the benefits that people will be able to derive from them, in relation to their current use, are considered for each priority service below. This provides a basis for identification of any mitigation measures needed to ensure that benefits can be maintained.

Milk, Milk Products and Meat from Livestock

Description of Impact

The supply, use and benefits associated with this ecosystem service are all expected to change to some extent as a result of the Project. This service is produced from grasslands affected by

the Project, including Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppes. They occur partially within the Project's physical footprint and their condition may decline further due to pollution by fugitive dust and hydrological change, amongst other impacts. Restricted access arrangements and barriers that result from the presence of infrastructure may mean that some access to traditional production areas is lost for the duration of the Project. For Gndevaz in particular, these barriers may interrupt traditional seasonal pasture "rotations". Participants in focus group meetings in the villages were more concerned about this than they were about loss of pasture area *per se* (see Appendix 6.20.2).

This ecosystem service was identified as a priority service for the following specific beneficiaries:

- Some seasonal and local herders who use pasture or have grazing licences within areas proposed for mine infrastructure or whose access to pasture may be restricted.
- Herders who produce hay to feed their cattle in winter⁵ (hay is a supporting service to this priority service). These herders are largely resident in Gndevaz.
- Herders (identity currently unknown) currently using potential replacement grazing areas.

Meat from the Project affected ecosystems is sold in Goris, Sisian, Kapan, Meghri and even Yerevan. Benefits are therefore income from selling milk and meat as well as food and protein needed for good nutrition.

Local herders from Gndevaz could be significantly affected by both reduced supply of grazing and reduced access to grazing that remains. Access roads and the conveyor will create barriers to daily movements of livestock from the village to grazing areas. Crossing points are being discussed to reduce this impact to an acceptable level. In addition to formal leaseholders there are five or six informal land users who are normally resident in Gndevaz and use the Project-affected area for grazing. Scope to provide alternative grazing, which is accessible on a daily basis from the village, is being reviewed with all affected beneficiaries.

Seasonal herders (approximately 15 or 16) use grazing licenses in the Vorotan Valley, some of which include land that will be occupied by the BRSF, and spend the summers in a semi-

⁵ See Map Land Use in Affected Area for Gndevaz

permanent herder camp in this area. The main benefit for this group is regular income and exchange "money" gained from employment. Herders typically earn 500,000AMD per annum at most. "We are not hungry but this is nothing for all our hard work." (Xhndoresk herder, 2015 focus group). Their use of grazing land may be disrupted to some degree by light traffic during construction and operation but they will also benefit from improved access. Herders based in this area come predominantly from the village of Xndzoresk. They rely on their animals as their main source of food and their only source of income and have limited or no alternatives to herding to obtain this.

The proportion of grazing area affected, and therefore the implication for production and income, varies between herders. Quality of grazing may decline adjacent to roads where there is heavy dust deposition and milk yields may decline, due to noise and disturbance. These effects cannot be quantified at this stage and will be monitored.

Prior to mitigation, the impact on milk, milk products and meat from livestock derived as an ecosystem service is anticipated to be a major negative impact.

Mitigation Measures

To the extent possible, impacts on seasonal herders have been avoided through design of the Project footprint. Impacts on herders located in the Vorotan Valley have been minimized by removing infrastructure from that area and reducing its use for access. The revised Project layout avoids most of the grazing leases identified during the ESIA process. Impacts may occur associated with transport of personnel to the Mine, but the Mine Access Plan now prioritises access from the West. For affected seasonal herders, the tradition of summer herding is a long-established one. The presence of the Mine and a large workforce in the area is likely to affect perceptions about livelihood and lifestyles. In focus group meetings, some herders indicated a willingness to relocate if needed, as well as an interest in selling produce to the Project. Impacts upon these herders will be monitored, with mitigation measures, potentially including relocation, identified as required if impacts prove more significant than anticipated.

Impacts on daily herders from Gndevaz, however, are significant under all alternatives and have been increased by the inclusion of additional infrastructure in important grazing areas (for example, electrical substation, lay down area and quarries). Despite plans to restore grassland on much of the Project footprint, long term or permanent residual impacts are expected on some or all of the affected pastureland (see Section 6.15). Measures such as

livestock crossings allowing some access to otherwise restricted land will reduce barrier effects, but overall the supply of grazing will go down, as will the ability of grazers to access it. The need for mitigation measures to address longer-term residual impacts on this service will be monitored and livelihood interventions identified in consultation with beneficiaries, if needed. To initiate this process, the Project has established dialogue with daily herders in Gndevaz with the assistance of the Mayor to ensure that herders are aware of restrictions on the lands they use and to discuss crossings over the Conveyor. Meetings were also held with seasonal herders in Xndzoresk (late November 2015), with participation of Gorayk and local Mayors, to discuss the BRSF area pastures, restrictions of use due to construction and project start; as well suggested alternate areas. A follow up meeting is planned with the same herders to walk in the suggested alternate area and finalize it in coordination with the Mayor of Gorayk.

The livelihoods impact assessment (see Section 6.16) addresses the potential economic displacement of herders and includes the following measures which will be implemented as part of the LALRP:

- Herders will be contacted to inform them about planned construction activities before they commence and in time for them to make alternative arrangements for land use or management.
 - The Company and local municipalities (Gorayk, Saravan and Gndevaz) will organise a meeting before spring 2016 at which herders can access information about areas that can safely be used for grazing and haymaking in the spring and summer of 2016. Similar updates and meetings will be needed regularly and at least annually;
 - All herders will be contacted to propose assistance in negotiations with local municipalities to identify and obtain allocation of replacement pasture land under a secure, formal lease agreement; Geoteam will cover any transaction cost associated with these formal agreements;
- ☐ Herders will be individually monitored during 2016 and further to check that they experience no disturbance as a result of construction activities and to facilitate the signing of lease agreements for grazing land with the Gorayk municipality.
- ☐ Where structures are lost (e.g. buildings used as part of the pasture camps), Lydian will provide compensation for the shelters, either as like-for-like replacements, or monetary compensation following consultation with the affected herders;
- ☐ Opportunities to support agricultural improvements in the region through technical assistance enhancing milk and meat production of animals through improving animal

husbandry practices or improving water supply and irrigation will be reviewed in collaboration with herders. Some improvements to the Gndevaz irrigation channel are already being implemented but it will be necessary to monitor outcomes for people depending on reliable water supply to support their livelihood activities.

Residual Impact

On the basis of currently available information, monitoring will be needed to confirm that affected herders and their families will be able to maintain their current levels of benefit from milk, milk products or meat from livestock. This has been considered in negotiating compensation, but changes in Project layout have increased impacts on daily herders from Gndevaz and it has become more challenging to maintain viable land holdings and grazing systems. Taking a precautionary approach, it is concluded that there could be a moderate residual impact on the benefits that affected herders can obtain from this priority ecosystem service, pending results of monitoring.

Hay to Sell for Income

Hay is harvested from Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppes. The Project will reduce supply from all these vegetation types, but the implications of this reduction vary for different beneficiaries. Hay sold for income is largely produced on Gndevaz land and Gndevaz village will lose access to approximately 22% of its traditional, current hay fields. No Gorayk or Saravan hayfields will be affected. The livelihood implications of losing this source of income for affected farmers will be addressed through the LALRP (Appendix 8.23). Prior to mitigation this is considered a moderate impact, however through the actions outlined in the LALRP this is reduced to a residual minor impact.

Apricots

Premium quality apricots, produced for export, are grown in orchards, a proportion of which are situated under the proposed HLF at Gndevaz. The altitude of these orchards makes them less prone to frost damage and leads to the production of late apricots that command a particularly high price (100 AMD per kilo). Gndevaz apricots are considered important for health and are an important source of pride for local people. There is a perception that the Project will significantly impact upon both the quantity and quality of apricots produced. Potential impacts on apricot quality have not yet been assessed. However the LALRP addresses economic displacement and compensation specifically and includes compensation for the years required for new apricot plants to fruit. Prior to mitigation this is considered a

major impact, however with implementation of the actions in the LALRP, this is considered a moderate residual impact.

Freshwater

Demands of the Project for freshwater supply are considered by specialists to be well within the capacity of the Arpa River ecosystem (less than 0.5% and less than 4.0% of river volume will be abstracted from the Arpa during construction and operation respectively) (see Section 6.10.10). Significant impacts on the supply of freshwater to other users for drinking, domestic use and irrigation of crops are not anticipated and stringent controls on discharges including passive treatment and monitoring are proposed which would make risks of deterioration in drinking water highly unlikely.

However, the importance of water supply and the possibility of perceived risks means that a precautionary approach is needed, including ongoing monitoring. In Gndevaz and herder focus group meetings, participants referred to concern about natural springs used as a source of drinking water. The Project already has a participatory water-monitoring programme in place and this will be continued, with participation from Gndevaz and herder representatives (to the extent that they are available). The results are made available through Annual Monitoring Reports submitted to the IFC, and an initiative is underway to publish quarterly reports in the local communities so that trust can be built through transparency. A number of actions could be triggered in case the water quality falls below expected levels, for example implementation of an emergency response plan (see Surface Water Management Plan (SWMP), Appendix 18.22). Prior to mitigation this is considered a moderate impact, which is reduced to a residual minor impact by the described mitigation measures.

Erosion Control

Vegetation cover on Amulsar Mountain provides protection for thin, friable soils, which are prone to erosion and slippage. Weakly structured mountain and meadow steppe soils are at risk from sheet and rill erosion where vegetation cover is reduced. The project will involve massive earthworks and extensive removal of vegetative cover that could result in soil erosion and landslips, some of which could affect land used for grazing, hay production or crops. Soil erosion could also increase sediment loadings in streams, irrigation channels and ponds used by livestock for drinking and by herders for washing.

The magnitude of these impacts depends significantly on the effectiveness of vegetation restoration measures, which will be implemented progressively throughout Project

construction and operation and are summarised in the Footprint Management Plan (FMP, Appendix 8.8) and in Section 6.8. Monitoring will be required through the Biodiversity Monitoring and Evaluation Programme (BMEP; see Section 6.11) and the need for additional arrangements in future to ensure that access is maintained to good quality grazing and hay meadows during the construction and operational phases will be reviewed. Post closure, access and management of grazing and hay meadows will be an integral component of annual restoration and aftercare planning. Prior to mitigation, this is a major impact, which is reduced to a moderate impact post mitigation.

Cultural Identity from Herding Way of Life

There could be significant impacts on this service for two particular groups, the seasonal herders who could potentially be displaced by the Project from traditional lease areas, and livestock owners and herders from Gndevaz who maintain traditional practices of sharing the responsibility and costs of taking livestock out to pasture each day to graze. Cultural identity from herding is at risk for both seasonal herders and daily herders from Gndevaz. It may not be possible to provide alternative pasture, which is readily accessible for daily herders from Gndevaz Village. Substitution by alternative livelihood interventions may maintain income but not preserve cultural identity associated with traditional culture and a transhumant way of life, with potential loss of social cohesion and sense of affinity with the land. This is not a priority service according to PS6 but is nevertheless considered important by local communities.

In the herder survey carried out in 2012 (see Appendix 4.16.1), herders were asked the question: “If you were given a chance to do something else, would you rather do that? Are you happy herding?” A relatively small proportion did not want to change their way of life. These were predominantly paid herders. In the Herder focus group meeting in 2014, seasonal herders from Xndzoresk said, ‘[we have been] herding here generation by generation. We have been coming here for years.’ In the herder survey and in the herder focus groups some herders mentioned that they would prefer to be able to use land nearer to their homes. Many travelled back every 10 days or so to see their families. These herders might benefit from access to alternative land, allowing them to retain cultural identity without the negative impact of working a long distance from Xndzoresk. In the herder focus group it was suggested that suitable alternative land could be found between their village and the Project affected area, but also pointed out that ‘the Vorotan stays green longer’ which could mean alternative sites might be less productive (see Appendix 6.20.2). A number of herders are therefore

potentially at risk of losing their cultural identity and way of life and specific interventions may be needed to ensure that this service is sustained, noting that the extent to which this is valued varies between individuals.

The revised Project layout avoids most of the areas used by seasonal lease holders from Xndzoresk identified during the ESIA process. However the traditional daily herding by Gndevaz villagers is likely to be significantly affected. Therefore the overall impact is considered to be moderate both prior to and after mitigation.

Reference Landscape and Place Attachment

The landscape and visual assessments carried out for the Project (see Section 6.5) show that there will be significant impacts on the reference landscape for some people, notably residents of local communities, but also people visiting Jermuk or resident there. Focus group participants in Gorayk (2014) quoted a popular saying by the poet, Hamosahyan: “How can I leave this place and live?” People expressed a sense of custodianship of the land both now and for future generations. “In this village it will be difficult to leave because we feel attached to Gorayk. We know every stone, every bush and they are all important to us. It is like this for Armenians in general...They love their village and they want to stay.” (Gorayk residents, 2015). High mountains such as Amulsar Mountain define geographic, administrative and social boundaries. “We have our borders, we have our space” (Saravan residents, 2014). Residents of Gndevaz voiced similar feelings.

Considerable efforts have been made through design to minimise these impacts, but it will not be possible to remove them altogether. A detailed landscape and visual impact assessment has been conducted, the results of which are presented in Section 6.5. Assessing people’s levels of concern about these impacts will be explored through public participation based on the results of the ESIA and comprehensive visual materials and models have been prepared to support this process that will be made available in the Amulsar Information Centre (AIC). Prior to the design considerations built into the Project, this would have been a major impact, however it has a moderate residual impact.

In-combination Effects on Affected Stakeholders

Many people in the Project affected area rely on multiple ecosystem services to maintain their wellbeing or livelihood. Trading of produce is common to obtain the full range of food items needed. Many people have multiple sources of income and a high dependence on income

from provisioning services. As shown in Table 6.20.4, seasonal herders, local herders and villagers without livestock all depend on multiple ecosystem services, not all of which were identified as priority services when considered on an individual basis. Risks of cumulative impacts are particularly high for these groups. Further focus-group meetings will be held in Gndevaz and with seasonal herders during the construction phase to review the extent to which the range of ecosystem services available has changed, the adequacy of alternatives and to review implications for livelihood and wellbeing.

Table 6.21.1 summarises the impacts of the Project on the Supply, Use and Benefits derived from priority ecosystem services.

Table 6.20.4: Combined Impacts on Affected Stakeholders

Affected stakeholders	Income	Food & Water	Health and Safety	Culture
Seasonal herders	<ul style="list-style-type: none"> • Sales of meat and milk. • Some sale of mushrooms and herbs. • Income from sale of livestock including horses. 	<ul style="list-style-type: none"> • Meat from livestock, fish. • Milk and dairy products. • Mushrooms and herbs. • Berries. • Water from River Vorotan and streams so that livestock can drink. 	<ul style="list-style-type: none"> • Medicinal plants. • Therapeutic springs. • Relative isolation from non-herding people/ diseases. • Safety from traffic risk for people and livestock. • Access to unpolluted water. 	<ul style="list-style-type: none"> • Herding way of life. • Social identity & cohesion. • Continuity with the past. • Tombs & ancestral worship. • Recreational hunting and fishing.
Local herders	<ul style="list-style-type: none"> • Sale of meat, milk and dairy products, hay, fruit from orchards. • Also to a lesser extent sale or bartering of mushrooms and herbs, garden vegetables, honey, breeding animals. 	<ul style="list-style-type: none"> • Meat from livestock, Fish. • Crops and garden vegetables. • Wild mushrooms and herbs. • Honey. • Freshwater for livestock. • Wild animals (pigs, rabbits). 	<ul style="list-style-type: none"> • Regulation of land slips. • Medicinal plants. • Safety from traffic risk for people and livestock. • Access to unpolluted water. 	<ul style="list-style-type: none"> • Herding way of life. • Social inclusion due to communal herding practice. • Reference landscape. • Place attachment and sites of 'inspiration'. • Recreation (walking, hunting). • Festivals of food. • Local distinctiveness, e.g. 'premium' apricots'.
Villagers with no livestock	<ul style="list-style-type: none"> • Mushrooms and herbs. • Garden vegetables. • Honey. • Fruit (apples, apricots). 	<ul style="list-style-type: none"> • Water. • Mushrooms and herbs. • Garden vegetables. Honey. • Fruit (apples, apricots). 	<ul style="list-style-type: none"> • Medicinal plants and herbs. • Mushrooms • Access to free, healthy food harvested from "common" resources. 	<ul style="list-style-type: none"> • Reference landscape. • Inspirational landscape. • Recreational use. • Educational use.

Table 6.20.4: Combined Impacts on Affected Stakeholders

Affected stakeholders	Income	Food & Water	Health and Safety	Culture
Armenian society	<ul style="list-style-type: none"> • Export value of Gndevaz apricots. • Thriving livestock sector 	<ul style="list-style-type: none"> • Fruit (apricots and apples) • Wild food, healthy herbs 	<ul style="list-style-type: none"> • Restorative and therapeutic natural environment • Safe access to the landscape for walking and recreation 	<ul style="list-style-type: none"> • Endangered species. • Study of rare plants. • Endangered transhumant way of life. • National pride – Gndevaz apricots. • Archaeological resources • Artistic inspiration, art galleries in Jermuk have many paintings of Amulsar Mountain and poems are written about the landscape.

Table 6.21.1: Combined Summary of Impacts on Supply and Use/Benefit from Priority Ecosystem Services

	Priority Ecosystem Service	Impact on Supply	Impact on use or benefit	Impact Significance	Residual Impact Significance after mitigation measures
1.	Milk, milk products, and meat from livestock	↓ (Varies)	↓ (Varies)	Significance: Major Potential significant residual impact for local and seasonal herders. Local herders from Gndevaz could be significantly affected both by reduced supply of grazing and reduced access to grazing that remains. Scope to provide alternative grazing which is accessible on a daily basis from the village is being reviewed with affected beneficiaries.	Significance: Moderate Monitoring will be implemented to determine scale of impact and to identify suitable mitigation measures as needed. Monitoring results will be used to assess implications of land use changes for access to grazing and levels of benefit. Interventions will be designed accordingly. This may be based on livelihood interventions, but practical measures to maintain access to grazing at key times of year may also be needed. Impacts on herders will be monitored during construction and early operation and the need for specific interventions discussed with them.
2.	Hay to sell for income	↘	↘	Significance: Moderate Potential significant impact on hay production from Gndevaz land: approximately 26% of hay fields lost (30 ha restricted out of 116ha).	Significance: Minor Access to good quality grazing and hay meadows will be monitored. Livelihood implications for affected landowners are addressed through the LALRP (Note that any potential impacts on people who currently purchase hay have not been considered.)
3.	Apricots to sell locally, nationally and for export	↓	↓	Significance: Major Some of Gndevaz's apricot orchards will be lost as they are in the footprint of the HLF. An estimated 5500-30000kg of apricots are produced in the Project-affected area that retail at 100 AMD/kg. However negligible loss of interim production is expected as affected	Significance: Moderate Loss of income will be addressed through the LALRP (Appendix 8.23) and efforts are being made to provide alternative locations, though these are not at the same altitude and may not produce apricots of similar quality. The possibility of providing irrigation water from the River Vorotan is under investigation.

Table 6.21.1: Combined Summary of Impacts on Supply and Use/Benefit from Priority Ecosystem Services

	Priority Ecosystem Service	Impact on Supply	Impact on use or benefit	Impact Significance	Residual Impact Significance after mitigation measures
				trees are not yet at production age.	
4.	Freshwater with suitable quality for drinking or irrigation	↘	→	Significance: Moderate Overall freshwater supply and quality is anticipated to be sustainable. However there could be impacts on water quality for livestock drinking, bathing etc, due to soil erosion and sediment deposition in water bodies or localized pollution, which are considered to be significant by some beneficiaries.	Significance: Minor Stringent measures to control erosion, dust and other impacts will be implemented; however, some localized reduction in quality of small streams, ponds and other surface water bodies is likely despite these measures. As indicated below, this will be monitored through the FMP (Appendix 8.8) and the SWMP (Appendix 8.22). Monitoring of water quality impacts will also take place, including specific receptor locations.
5.	Erosion control	↓	↘	Significance: Major There is already extensive soil erosion following exploration activities, some of which is outside the proposed mine footprint. Wash out of soil downslope has reduced quality of some areas of grassland and increased sediment loadings in ponds.	Significance: Moderate The Project will implement strategies to manage soil erosion and risks of land-slips for specific beneficiaries, though it is unlikely that these impacts will be avoided completely. Measures are being developed through the Project's FMP (Appendix 8.8) and long term monitoring will be undertaken.
6.	Cultural identity from herding way of life	↓	↓	Significance: Moderate Potential risk to traditional way of life for seasonal herders. Gndevaz traditional grazing practices are likely to be significantly disrupted with limited scope for mitigation.	Significance: Moderate Specific interventions may be needed to ensure that these practices can be sustained, noting that the extent to which these are valued varies between individuals. It may not be possible to identify mitigation for loss of cultural identity or traditional practices for some herders who value their traditional way of life. Others are open to new opportunities. These interventions have not yet been identified, making

Table 6.21.1: Combined Summary of Impacts on Supply and Use/Benefit from Priority Ecosystem Services

	Priority Ecosystem Service	Impact on Supply	Impact on use or benefit	Impact Significance	Residual Impact Significance after mitigation measures
					monitoring necessary.
7.	Reference landscape and Sense of Place	↓	↘	Significance: Major Visual and landscape impacts will be significant for some receptors including residents of Gndevaz village, Jermuk City, Kechut Village, Saravan Village, Gorayk Village and also herders or other users (e.g. artists selling local landscape paintings) spending time on Amulsar. Impacts are likely to be most significant during construction and initial operation due to awareness of change (see Section 6.5).	Significance: Moderate As far as possible the design of the Project has been developed to minimize landscape and visual impacts but some residual impacts are inevitable. This visual impact, combined with changes in land use and the character of Gndevaz village in particular, could affect people's sense of place and attachment to the local landscape. The pMRCRP (Appendix 8.18) makes provision for comprehensive re-vegetation and landscaping post-closure so that long-term impacts are minimized.

6.21.1 Project Dependence on Ecosystem Services

Achieving planned project operational performance depends on three ecosystem services: provision and regulation of freshwater and erosion control. The three services were prioritized because they could change over the life of the Project in ways that could lead to operational risks and the Project has no viable alternatives to these services to achieve planned operational performance. Table 6.21.2 presents the services prioritized and the benefits the Project derives.

This shows that, while the Project relies on an external supply of freshwater during construction and the early years of operation, for a variety of uses including water for processing, its demand for water is well within the limits of available supply, even during low flow periods (see Section 6.10). This has been confirmed through a series of assessments and modelling exercises for surface water and groundwater. There are also several alternative sources of supply, which have been investigated and which are considered to be more or less cost-neutral.

Erosion regulation provided by topsoil and vegetative cover on Amulsar is considered to be a priority service in terms of Project dependence because of the potential costs of managing soil erosion impacts and landslips, possibly over quite a long period of time. Mountain and meadow steppe soils from which vegetation will be stripped are at risk from sheet and rill erosion, resulting in undercutting or exposure of the soil profile on vulnerable steep slopes. The Project-induced changes in vegetation and landform put the soil at higher risk of erosion over extensive areas (see also Section 6.8), which can be costly to manage in order to repair the Project's own infrastructure and avoid reputational risks or damage to other land users which requires compensation.

To manage some of these risks, the strategy of the Project is to:

- Route runoff to ponds and collection sumps in order to minimise the release of sediment;
- Minimise natural ground runoff and non-contact water from entering disturbed areas and mixing with contact water;
- Capture contact water runoff from the mine facilities, for re-use in the process; and
- Minimise erosion of disturbed areas, and when erosion does occur, minimise suspended sediment flow to streams.

In addition to these dependencies the Project's local license to operate may be influenced by local communities' "Strength of place attachment". This is strong and plays a part in people's likely willingness to accept environmental damage. In all of the Focus Group Discussions carried out for this ESR, people emphasised the fact that their "in principle support" for the Project was contingent on "good environmental management".

Table 6.21.2: Priority Ecosystem Services on which the Project Depends for its Operational Performance

Ecosystem services on which the Project depends	Ecosystem service benefit to the Project	Reference from Project Description	Could the ecosystem, service change in ways that could affect Project Operations?	Does the Project have alternatives?	Priority ecosystem service
Freshwater	Avoided/ limited costs for obtaining construction and operation water	Operational water sourced from the Arpa: Max: 170,000 m ³ /month Avg: 80,000 to 120,000 m ³ /month	Unknown Over-abstraction in combination with others could potentially compromise supply but estimates of proportion of flow needed are considered insignificant even in low flow periods. Flow into the Arpa is regulated from the Kechut Reservoir.	Yes Options include tapping into the groundwater aquifer. Getting water from another source is considered to be realistic and all options are considered to be viable for the lifetime of the Project.	NO
		Haul roads (from dewatering mine pit) - Prioritise suppression of dust over 0.7 km from open pit to crusher and 4.2 km from pit to BRSF - Suppress dust from primary crushing circuit. (Total water requirements of <611 m ³ / day)	No The Project is not estimated to have any significant impact on groundwater recharge or sources used for dust suppression.		NO
	Avoided/ limited costs for having potable water	Potable water for staff during construction (1500 l/day) to be sourced from the Vorotan springs.	No It is estimated that the capacity of the community potable water supply is up to 60 l/s which is well in excess of requirement	Yes Alternative sources may be available from various other community supplies and more broadly from potential surface water and groundwater sources in the Vorotan and Arpa catchments.	NO

Table 6.21.2: Priority Ecosystem Services on which the Project Depends for its Operational Performance

Ecosystem services on which the Project depends	Ecosystem service benefit to the Project	Reference from Project Description	Could the ecosystem, service change in ways that could affect Project Operations?	Does the Project have alternatives?	Priority ecosystem service
Regulation of water timing and flows	Intermediate service to freshwater; see its benefits to the Project				NO
Erosion regulation	Avoided costs from damages to the Project's own facilities and to others' properties	Weakly structured mountain and meadow steppe soils are at risk from sheet and rill erosion, where vegetation cover is reduced. Exploration activities have already caused extensive erosion.	Yes There will be a lot of cuts on steep slopes during construction along with vegetation clearing, which might increase the risk of sheet erosion and sediment run-off.	No Building sufficient erosion control structures could entail significant costs. There are potential reputational risks and large-scale restoration of soils and vegetation may be needed for some time during mine operation and closure.	YES

6.21.2 Conclusions

A large number of ecosystem services are supplied and used in the Project affected area. These include services needed for the operational performance of the Project as well as services on which others depend for their wellbeing. The implications of the Project for these services have been reviewed. One service is considered a priority service in terms of dependence of the Project and seven are considered to be priority services for local beneficiaries (see Appendix 6.20.1, Table 2), though the importance of maintaining the current wide range of services was emphasised in focus group meetings held in local villages. Local residents indicated that their acceptance of impacts on ecosystem services would depend on the Project's standard of environmental management.

The most significant residual impacts identified relate to loss of access to grazing and hay meadows for seasonal and daily herders and local farmers, which could affect benefits derived from production of meat and milk. Some producers from Gndevaz will also lose land currently used to produce premium quality apricots. Impacts on livelihoods and on access to provisioning services will be managed through the LALRP (Appendix 8.23) and the FMP (Appendix 8.8).

There could be significant impacts on traditional ways of life, particularly for a small number of seasonal herders and for daily herders from Gndevaz as well as impacts on the reference landscape for local communities. Some of these impacts could be long-term or effectively permanent. They are particularly significant for Gndevaz Village, will be challenging to manage and will require ongoing stakeholder engagement during construction and operation. Priority ecosystem services will be monitored through the BMEP during construction and operation as a basis for this engagement, and some potential indicators that could be used are provided in Appendix 6.20.1 (Table 3).

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6.21 Worker Accommodation

6.21.1 Scope and Purpose of this Document

The present Section has been developed in April 2016 as an update to the ESIA, to take into account the findings of the Worker Accommodation Study (WAS) completed in April 2016.

The WAS evaluated the option of housing the Project's non-local construction workforce in existing hotel accommodations in the town of Jermuk and other communities within a reasonable driving distance from the Project site.

The IFC/EBRD guidance note, *Workers' Accommodation: Processes and Standards* calls for assessment of the likely impacts of worker accommodation options on local communities to be conducted. In this Section, the possible social impacts of the Project's accommodation arrangements have been assessed and mitigation measures proposed.

This Section contains an assessment of a "hybrid" of the two main workforce accommodation options presented in the WAS. It is assumed that up to a maximum 397 hotel beds will be utilized in high season and 561 hotel beds in low season to house the Project's construction workforce, and that a camp will be constructed to house at least 500 persons and up to 920 persons (the estimated size of the non-local workforce at peak of the construction phase)..

As the focus of this assessment is on the use of hotels and a camp to house the Project's workforce, its scope has not included an evaluation of the Project's possible impacts on the local housing market (assumed to not be affected by use of a self-contained camp and/or hotel rooms). Notwithstanding this, changes in the composition of the local population and/or their incomes resulting from the development of the Mine are likely to influence the local housing market – those impacts are considered elsewhere within the ESIA (e.g., chapter 6).

Amulsar Project Description

The Project is located in central south-east Armenia approximately 170km from Yerevan in an area commonly known as the Caucasus.

The Project footprint is bounded by the coordinates: 39.7824° North, 45.6108° East and 39.7210° North, 45.7416° East (**Error! Reference source not found.**).

The wider area is characterised by mountains, undulating hills, river valleys and gently inclined plateaus at lower elevations. Surface water run-off from the slopes of the Project-affected area contributes to the catchments of the Arpa, Darb and Vorotan rivers. The Vorotan River flows

to the east of the Project and the Darb River flows to the south of the Project, and joins the Arpa River flowing west.

The gold ore deposits are located on the ridge peaks in the region of Amulsar Mountain, within the Northern Zangezur mountain chain at an altitude of 2,500 - 2,988 metres above sea level (masl).

The land within the Project-affected area is characterised by sub-alpine and mountain meadow landscape which typically supports grasslands used for summer grazing. At lower elevations agricultural use is more diverse and supports a range of crops.

Regional climate variation is pronounced, with the foothills at lower altitudes having longer and hotter summers, averaging around 25°C, and winter temperatures at an average of -5°C compared to the average of -12°C which can be recorded in the mountains. Annual rainfall is also influenced by the mountains and more rainfall is experienced at higher elevations; an average of approximately 800mm of rainfall per year would be typical for Amulsar (elevation of up to 3000 masl). Snow cover is present on the mountain in the period November to April and can exceed a depth of 3m, depending on weather conditions.

The Project-affected area straddles Vayots Dzor Marz (the capital of which is Yeghegnadzor) and Syunik Marz (the capital of which is Kapan). The closest town to the Project is Jermuk, which is situated approximately 10 km northwest from the gold-silver ore deposit and 7 km from the closest piece of Project infrastructure.

There are four rural communities in proximity to the Project, namely: Kechut (a rural community associated with the town of Jermuk), Saravan (including Saralanj and Ughedzor) and Gndevaz in Vayots Dzor Marz; and Gorayk, located in Syunik Marz. Gndevaz is the community closest to the footprint of infrastructure associated with the Project (the Heap Leach Facility (HLF) located > 1 km from the outer edge of the village).

The duration of the Project comprises two years of construction followed by a further 11 years of operation. In the event that further viable resources be found, the life of the Project could be extended. At the present stage of the Project development, however, the ESIA has only considered the exploitation of the ore deposit that has been proven through the programme of exploration to date.

Project Phases

The Project consists of the following main phases:

- **Exploration:** surface mapping, exploration drilling, and soil geochemistry, which has been used to define the geological resource to support a future mine development. Exploration at Amulsar has been ongoing since 2006. There will be continued and ongoing exploration at the site during the mine construction and operation activities to identify possible additional ore.
- **Construction:** the infrastructure required for the operation of the mine, processing of ore and refining of precious metals will be constructed, including ancillary infrastructure such as maintenance workshops and site offices.
- **Operations:** the production of gold and silver (as Doré) which comprises the phased mining of ore and barren rock from the open pits together with the processing of ore, and placement of barren rock in the storage facility.
- **Closure:** post operations, which includes the reclamation of the open pits, BRSF, and the HLF. Topsoil stockpiles established during construction will be used during site reclamation and closure. Infrastructure will be dismantled and disturbed areas will be restored to grasslands or other habitats similar to those currently present within the Project footprint.

Project Components

Accommodation facilities are a major Project component that will be developed during the construction phase of the Project.

6.21.2 Profile of the Amulsar Project Workforce

Lydian has developed a Project Execution Plan (PEP) in January 2016. It provides useful detail on the expected characteristics of the Project workforce based on estimated resources following recent Feasibility Studies.

The PEP is a series of excerpts from the Amulsar PEP Draft Rev. L. The excerpts contained here should be considered in draft form and are for general background to some of the environmental and socio-economic issues associated with the Amulsar gold project.

Household Profile

The average household size in Armenia consists of 4 people¹. Rural households are moderately larger than urban households (4.4 vs. 3.7 persons)⁸. Armenian households often comprise related family units, common in both rural and urban areas.

¹ Armstat, (2014) Preliminary Data for 2011 Population Census www.armstat.am (in Armenian) accessed May 2 2014

In Gorayk, Gndevaz and Saravan, the average household sizes are between 5 - 7 members, usually as a result of two or more related families residing within a household. Reasons for coalesced families in households centre on housing affordability, availability of labour for subsistence agriculture, culture and tradition.

Approximately 75% of Jermuk town households have three or more members, with 35% having five to seven members². This is linked to the lack of affordable housing choices for young people of marriageable age. Kechut showed greater tendency to larger households, with over 55% households having five to seven members.

Family life and inter-family allegiances are the cornerstones of local communities. Often family units consist of different generations, with sons bringing their wives into the family home. Mother and daughter-in-law relationships are prominent with mothers-in-law managing the household assisted by daughters and daughters in law.

Although women have an important role in the household, men are generally regarded as the head of households. High levels of migration by men searching for work have however led to a significant proportion of female-headed households (27% of Armenian households were headed by women in 2007)³. Community affairs are predominantly managed by men.

6.21.3 Workforce Profile

Nationality of the Workforce

The Amulsar workforce is expected to consist mainly of Armenian Nationals. A large proportion of the permanent workforce will be sourced from the local communities of Gorayk, Saravan, Gndevaz, Kechut, and Jermuk; and from other communities within a 45km radius of the Project. However, given the lack of extractive industries experience in these communities, it is expected that a significant percentage of the highly skilled workforce, i.e. engineers, geologists, metallurgists, and mechanical and electrical tradesmen with mining and processing experience, will need to be recruited from Yerevan and other regional centres of the country. Positions that cannot be filled by Armenians will be staffed with suitably qualified expatriates on fixed term contracts. It is anticipated that within 3 – 5 years the local workforce will have gained sufficient experience and competency to replace the majority of the expatriate job roles.

² MPG, (2010), Jermuk and Kechut Baseline Study

³ International Fund for Agricultural Development (2007). Armenia Gender Profile, viewed 13 May 2012.

<http://www.ifad.org/english/gender/cen/profiles/arm.htm>

Expected Project Workforce and Accommodation Requirements

The total workforce during operations is estimated at 657 employees. The peak workforce during construction could be as high as 1,300, of whom up to approximately 400 will be local. Figure 3 shows the expected workforce curve for the construction phase, with an estimate of the local and non-local composition of the construction workforce, whereby the estimated non-local workforce represents the number of accommodation beds required.

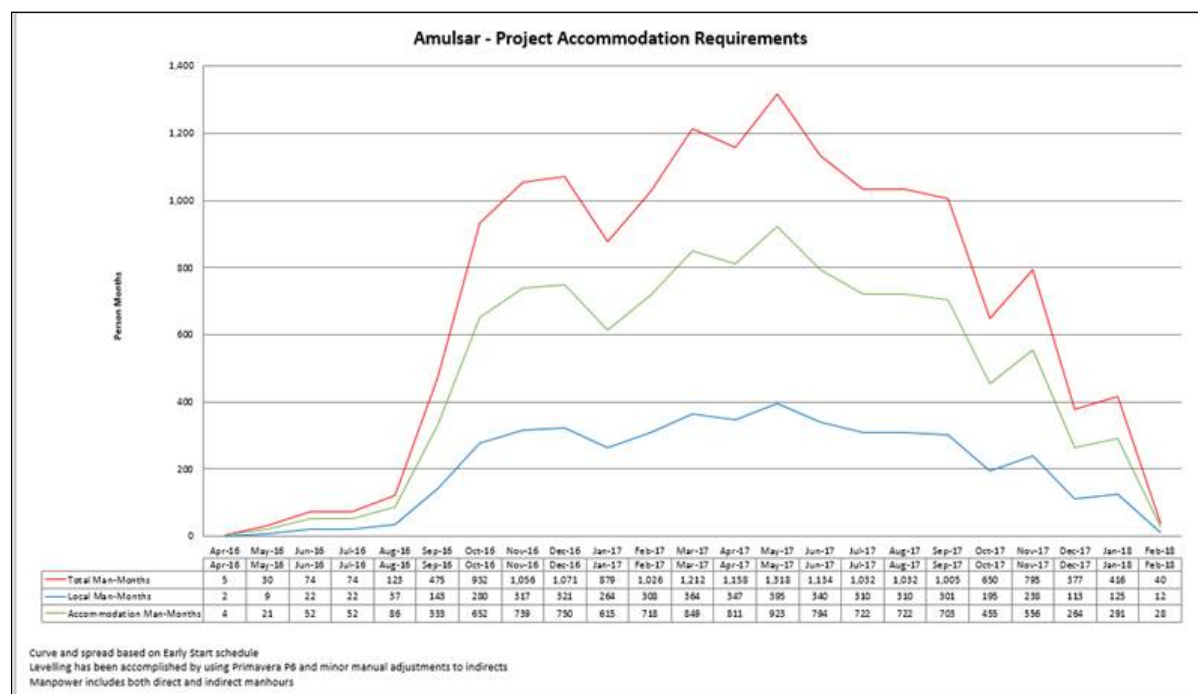


Figure 6.21.1: Estimated accommodation requirements for non-local construction workforce (in green)

The heavy industrial nature of the facilities will require significant expatriate supervision during construction. An international firm (or firms) will be awarded Engineering, Procurement, and Construction Management contracts to complete the design and manage Project construction. The appointed firm(s) will employ the bulk of the expatriates required for the construction of the Project. A part of their mandate will be to maximize the employment of local personnel and to utilise local sub-contractors where suitable skills exist. It is anticipated that approximately 30% of the construction workforce will be from the local area. The non-local Armenians and expatriate construction workforce will reside in hotels a temporary construction camp.

During operations, some of the accommodation arrangements for non-local Armenians and expatriate employees will remain the same. The bulk of the workforce during operations, approximately 85%, will be employed in the mining and processing departments.

Upon closure, about 20 workers will be employed in monitoring and maintenance activities of the decommissioned plant. Salaries have been benchmarked against comparable operations in Armenia.

Depending on the nature of work and the origin of the employee, the duty roster for the Amulsar Project during operations could be as indicated in Table 2 below. Armenian employees have a shorter roster in order to adhere to local labour legislation (maximum 48 hours in a working week).

Table 6.21.1: Duty Roster for Amulsar Project Employees		
Employee Type	On duty	Off duty
Armenian shift worker, 12 hour shifts	4 days	4 days
Armenian day workers, 8/9 hour shifts	5 days	2 days
Expatriates	5 weeks	2 weeks

6.21.4 Migration of Potential Workforce

International labour migration

By the 1980s the practice of seasonal migration for work had spread to urban centres of Armenia, with between 30,000 to 40,000 seasonal labourers migrating, predominantly to Russia, between spring and fall each year⁴. The practice of seasonal labour migration remains common, with over 14% of households engaged in the activity in 2006, approximately 100,000 labour migrants per annum. By 2007, labour migrants constituted 94% of all migrants, with only 3% leaving Armenia with an intention to permanently reside abroad and 2% with an intention to study internationally⁵.

The overwhelming majority of Armenian labour migrants are married men between the ages of 21 and 50, with only 6.5% of the migration pool made up by women. The ILO estimated that this level of migration comprised 13% of the economically active men and just over 1% of economically active women in 2006¹⁷.

The decision to migrate seasonally for labour is driven primarily by the job scarcity. Opportunity to improve salaries and a greater range of job types exist further afield, often abroad. Young men from villages often leave to work abroad after completing their military service, without necessarily first seeking opportunities within Armenia. The tradition of *khopan*, refers to the practice where in some villages men have been continuously leaving to work abroad over a long period of time.

⁴ UNDP, (2009), Migration and Human Development: Opportunities and Challenges, Armenia, 2009, www.undp.org (accessed 4th September 2012)

⁵ ILO, (2009), Migration and Development – Armenia Country Study

The global financial crisis of 2009 has impacted migration patterns in Armenia, with a small reduction (approximately 2%) of seasonal labourers from both rural and urban areas⁶.

Local migration

Within the neighbouring villages out-migration is prevalent but of less significance than it is at a national level. Anecdotal evidence suggests that local seasonal migration is dynamic and that it has been variable between villages during the period 2009 to 2015.

While Saravan, Jermuk and Kechut show a decrease in migration, Gorayk shows a marginal increase. Gndevaz shows high variability with a significant increase in 2014. According to a core strategy for Jermuk developed by USAID in 2008, many former Jermuk residents have moved abroad permanently, mainly to Russia, as migrant labourers. On the other hand, a large number of Jermuk residents with relatively high educational attainment are believed to have moved to Yerevan to pursue better work opportunities.

Table 6.21.2: Number of Seasonal Migrants in 2009, 2014 and 2015			
Village	Number of seasonal migrants		
	2009	2014	2015
Gorayk	7	12	15
Gndevaz	20	71	22
Saravan	20	15	7
Jermuk and Kechut	no data	560 (2013 data)	230

Inward migration during summer months is associated with seasonal herding activities. Seasonal herders, who are predominantly residents of Vayk, Sisian, Xndzoresk and Yeghegnadzor, migrate to the Project area to graze their livestock (cattle and sheep) on the pastures and to grow hay. In 2012, 58 seasonal herders migrated to the Project area to graze cattle and grow hay. The Project has mapped the approximate locations of the camps in the ESIA.

6.21.5 Methodology

To evaluate the potential social impact associated with housing workers in hotel accommodations and in a self-contained camp, data collected for the worker accommodation study (WAS) are considered. The WAS team visited and inspected hotels in Jermuk with the purpose of assessing their suitability for housing workers for the Project. Interviews with hotel owners or managers were conducted to gather information about the hotels' capacity to house Project workers as well as perceptions about the possible effects that housing Project workers in hotels might have on the hotels and on other local businesses.

⁶ National Institute of Labour and Social Research, (2010), Impact of the Global Financial Crisis on Households
ZT520088
May 2016

In addition, interviews with key persons from the community of Jermuk (e.g., Community Liaison Committee, the Mayor, health care officials, and representatives from civil society organizations) were conducted in which the accommodation options as well as the influx of Project workers were discussed. Perceptions about potential impacts of the Project and its workforce on the community were explored during these interviews.

A set of questions intended for hotel owners/managers and community representatives was prepared in advance of the visits. Based on the level of knowledge of interview respondents and the type of information being provided, ad hoc follow on questions were also asked. Questions related to various types of community capital – including community infrastructure, social capital, and economic capital. The questions included in the interview guides were designed to gather information about existing socio-economic conditions and to elicit views about possible impacts of the Project's accommodation arrangements on the local community.

The impact assessment methodology utilized in this chapter is discussed in section 4.3, and is presented in more detail in Appendix 6.21.1.

6.21.6 Baseline Conditions

Areas of Influence

The national area of influence is the entire country of Armenia. The regional area of influence includes the two *Marzer* (provinces) straddled by the mine layout and footprint, Vayots Dzor and Syunik. The local area of influence is defined as the settlements most likely to experience changes from environmental and social impacts. The local area of influence covers “project affected communities”, which refers to residents in the three closest rural settlements – Gorayk, Gndevaz and Saravan (including Saralanj and Ughedzor), the town of Jermuk (including Kechut) and seasonal herders resident on Project land during summer months.

Vayots Dzor *Marz* comprises the following districts: Jermuk, Yeghegnadzor and Vayk, with populations of 4,346, 7,421 and 5,067 respectively (according to the 2011 Census). Syunik *Marz* comprises four districts: Kapan (34,713), Goris (17,881), Meghri (4,282) and Sisian (12,074). The Project site is located in Jermuk, Vayk and Sisian districts.

The Project's local area of influence is predominantly rural, with Jermuk being the only urban centre in the area. According to the 2011 Census, the population of Jermuk was 4,346 and the neighbouring community of Kechut had a population of 884. In both communities, full-time employment is the main source of income of the local population. The largest employers are Jermuk Mineral Water Bottling Factory, Mayr Gortsaran Bottling Factory, and hotels and other

businesses linked to the tourism sector in Jermuk.

The tourism sector is the mainstay of the economy of the town of Jermuk. In the 1940s the town was established, due to its mineral waters, as a tourist destination within the Soviet Union. At its height in the late 1980s, the town had a population of 10,000. This number greatly diminished after the breakup of the Soviet Union, and the 2001 Census recorded a population of around 6,300 residents.

6.21.7 Existing Hotel Facilities

The WAS identified 15 hotels in Jermuk, of which all were visited and inspected by the study team. Various criteria (i.e., technical, safety, and socio-economic) were applied by the WAS team in the assessment of their viability for use by the Project to house its workforce. A key factor in the socio-economic criteria applied was the hotels' typical occupancy rates during the high tourist season and their existing arrangements with various clients. Thus, potential use of hotels by the Project was "capped" in such a way as to minimize impacts on the traditional tourist trade in Jermuk.

Of the hotels identified and inspected, some were excluded from further consideration by the Project due to their state of repair and/or the need for extensive renovations (in some instances, renovations are not expected to be completed within the timeframe of the anticipated ramp-up period in the Project's construction phase). Although the WAS identified a total hotel capacity in Jermuk and area of 1,306 beds (based on double occupancy), the maximum number of hotel beds potentially utilized by the Project was estimated to be 397 in high season to 561 in low season.

6.21.8 Potential Social Impacts – Workforce Accommodation Options

This section presents the assessment of the potential social impacts of each of the worker accommodation options under consideration.

Fieldwork Undertaken

Following completion of review and fine-tuning of procedures, criteria, expectations and logistics, the Worker Accommodation Study (WAS) team travelled to the study area in March 2016.

Field investigations were conducted over the course of six days by methodically visiting each potential hotel accommodation. During this time the WAS team was based in Jermuk. For field activities the team would typically split into two groups; one to conduct visual inspections

of hotel facilities, and other to complete interviews with hotel managers and community representatives. As noted in 6.21.5, interviews with hotel managers and community representatives were conducted to collect data about existing socio-economic conditions including levels of employment in the local community as well as trends in the hospitality and tourism sector – and to understand perceptions of the possible impacts of the Project on the local community.

6.21.9 Workforce Accommodation Arrangements

The two main workforce accommodation options identified in the worker accommodation study (WAS) conducted in April 2016 were as follows:

- Option 1: upper end of estimated socially acceptable use of hotels, 370 hotel beds, 550 camp beds.
- Option 2: a range of hotel utilization from zero up to 370 beds in Jermuk and Arpa Valley resulting in camp size between 550 and 920 people.

The maximum camp size of 920 people is equal to the size of the non-local workforce which will be required and is necessary if no hotels are utilized. If the maximum high season hotel availability of 370 beds is utilized, a 550-person camp will be required during Project construction ramp-up.

It should be noted that this scenario also covers the use of selected hotels which will be required to facilitate initial camp construction. In this scenario Management may determine if and how many hotel beds are used for the duration of Project construction. With both options presented above it is important to note that the hotel usage quoted is the usage at peak accommodation demand (May 2017) at approximately 1,300 people and is reflective of availability at that time. To meet requirements during the initial fall 2016 manpower ramp up, however, it should be assumed that the Project will utilize between 370 and 561 estimated maximum socially acceptable hotel beds as camp construction occurs (pushing demand above 1,000 people where it remains until construction nears completion in March 2018. This need for this is driven by the Project's steep manpower ramp up applicable with either presented option.

6.21.10 Impact Assessment

The potential social impacts arising out of the accommodation options under consideration have been identified drawing on knowledge of the socioeconomic environment and the proposed Project activities, as well as the results of fieldwork – namely, the input provided regarding perceptions of Project impacts explored during interviews conducted with hotel

owners and community representatives (i.e., CLC members, Mayor of Jermuk, and representatives of civil society organizations). Each of the impacts has been evaluated according to the predefined assessment criteria in order to determine their likely significance.

Assuming effective implementation of the measures designed to avoid, minimize, reduce or compensate for any adverse impacts as well as to enhance any positive impacts, each impact was re-evaluated using the same assessment criteria to determine the significance of the residual impacts following mitigation. Details regarding the Social Impact Assessment Methodology are presented in Appendix 6.21.1.

As noted above, it is likely that a hybrid form of workforce accommodations will be utilised. Thus, it is anticipated that the impacts identified under each of the two accommodation components (i.e., hotels and camps) will materialize under the hybrid. The anticipated social impacts of the workforce accommodation arrangements, as well as their likely significance before and after mitigation and management measures are put in place, are presented in Tables 3 and 4 below.

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Temporary Influx of Project Workers (occupying a considerable number of hotel beds), with potentially negative impact on traditional tourism	Construction	Construction phase Project workers take up part of the hotel capacity in the town of Jermuk, potentially affecting the availability of accommodations for more “traditional” visitors during the high tourist season.	Moderate Negative	It is proposed that hotels will be used selectively, and with reasonable limits on occupancy by the Project – in particular during the high tourist season.	Minor Negative
	Operation		Negligible		Negligible
	Closure	While this may represent a negative impact from the point of view of a segment of the tourism and hospitality sector, it is largely limited to the high tourist season (June to September and early January in Jermuk; May to October elsewhere) when hotels operate at close to full occupancy and the Project would be “competing” for beds with tourists.	N/A	Specifically, two large hotels (the Moscow and Jermuk Ashkharh) would be used for 250 people and a number of smaller hotels for another 120 people. This means that no hotel would become completely unavailable to other visitors.	N/A
Change in Visitors’ perceptions of Jermuk as a “spa town”, with negative impact on traditional tourism	Construction	A considerable presence of the Project’s construction workforce in Jermuk (in addition to the presence of the mine itself nearby) may affect the “spa” character of the town and tourists’ perception of the destination – normally associated with fresh air, tranquil surroundings, and spa/medical treatments. Although this change in perceptions is an impact of a qualitative nature, it may in the medium to long-term lead to other, more tangible, effects such as reductions in the numbers of visitors.	Major Negative	Minimize the number of workers housed in Jermuk hotels.	Moderate Negative
	Operation		Moderate Negative	Support tourism. development efforts.	Minor Negative
	Closure		Negligible	Enforce Code of Conduct.	Negligible

⁷ It is assumed that during the operations phase of the Project use of hotels would be reduced.

⁸ This table is focused on the impacts of using hotels to house the Project’s workforce.

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Change in Local Residents' Perceptions of Own Community (Sense of Place)	Construction	The presence of a construction workforce (and the mine nearby) may affect how local residents perceive their own community. This may include sense of place and perceptions of safety in the community. This is a qualitative effect, and may have some positive aspects if residents associate the presence of a mining project with increased employment and other opportunities for local people.	Moderate Negative	Frequent and proactive communication with local community stakeholders.	Minor Negative
	Operation		Minor Negative		Negligible
	Closure		N/A	Enforce Code of Conduct.	N/A
Increased Pressure on Community Infrastructure and Facilities	Construction	The presence of the Project's workforce in hotels would not have a discernible impact on municipal infrastructure and services during the high tourist season, as typically during that time most hotels operate at or near capacity (and the municipality is prepared accordingly). However, for the low tourist season the municipality would need to	Moderate Negative	Increase capacity of local hospital.	Minor Positive
	Operation		Minor Negative	Make upgrades to municipal landfill. Coordinate with (and, where necessary, provide support for) the	Minor Positive

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
	Closure	<p>increase staffing to adjust to a higher than normal demand for services (due to the presence of Project workers in hotels) and may need to increase the rates for garbage collection charged to hotel operators. Resources would also need to be made available for snow removal and street lighting.</p> <p>This impact implies higher costs for the municipality of Jermuk, which may be offset by fees levied on the hotels (already benefiting from higher occupancy in the low season) or on the Project itself. The hiring of additional personnel by the municipality during the low (winter) season – if resources are made available to the Municipality – would represent a benefit or positive impact from the point of view of local employment.</p> <p>The provision of health services in the community may also be moderately affected if at specific times the Jermuk hospital finds itself overwhelmed by a large increase in cases. However, the Project may contribute to enhancing the capacity of the hospital – thus offsetting some of the negative impacts of increased demand for the services.</p>	N/A	Municipality.	N/A
Increase in Local Employment	Construction	During the high tourist season, it is not expected that Project workers being housed in hotels would	Moderate Positive	N/A	Moderate Positive

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
(Direct and Indirect)	Operation	generate new or additional employment, as hotels generally operate at or near capacity during those months (June to September and early January). However, by housing construction phase workers in hotels, the Project has the potential to contribute to increased year-round employment for some workers in the town (both those directly employed by hotels and others involved in the service sector). This is a positive effect, although it is temporary due to the duration of the construction phase and seasonal (discernible mostly during the low tourist season).	Negligible		Negligible
	Closure		N/A		N/A
Increase in Local Procurement (Goods and Services)	Construction	There could be an increase in the procurement of local goods and services during the low tourist season (with the high tourist season likely unchanged) if the hotels' supply chain normally includes a considerable number of local businesses. However, the positive impact on local procurement of housing workers in hotels may be increased if the Project requires – as part of its contractual arrangements with hotels – the maximization of procurement from local businesses.	Minor Positive	Include local procurement provisions in the contracts of Project contractors.	Moderate Positive
	Operation		Negligible		Negligible
	Closure		N/A	Implement supplier development programs.	N/A
Increased Skills Development	Construction	Increased year-round employment for some hotel workers and others may result in greater	Moderate Positive	N/A	Moderate Positive

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
(and Experience) of Local Workforce	Operation	opportunities for skills enhancement through on the job training. Enhanced skills and greater experience may lead to improved future employability of some workers. As the Project will likely house some expatriate workers in hotels during the construction period, this will likely provide more opportunities for hotel workers to enhance their foreign language capabilities – a critical skill needed for employment in the hotel and hospitality industry. This impact is positive, although it is expected to be of short duration (primarily during construction phase).	Minor Positive		Minor Positive
	Closure		N/A		N/A
Adverse Effects on Community Health, Safety,	Construction	Housing part of the construction workforce in hotels within the community of Jermuk has potential negative effects on community health,	Major Negative	Implement awareness programs (e.g., re: STDs).	Moderate Negative
	Operation		Minor Negative		Negligible

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
and Security	Closure	safety, and security. The influx of a construction workforce has the potential to result in increased transmissions of communicable diseases (e.g., STDs, flu, etc.). The need to transport a large number of workers from site to their accommodations would likely result in increased traffic and the presence of large vehicles in the community, possibly resulting in an increase in traffic incidents and/or changes in air quality.	N/A	Offer confidential testing for STDs and other communicable diseases. Increase the capacity of local health services. Minimize interactions of workers with community (enforce code of Conduct). Implement a traffic safety/control measures.	N/A
Potential Conflicts between Community and Project Workers	Construction	The potential for conflict between members of the local community and construction phase Project workers is enhanced if the workers are housed in hotels within the community and interactions are not minimized. Although the communities such as Jermuk are accustomed to visitors, it has been indicated that if local people perceive that unskilled and semi-skilled jobs are being offered to outside workers without considering local workers first, there may be conflicts as result of resentment generated among potential local workers.	Major Negative	Maximize local employment through the use of local job registry and training programs. Minimize interactions of workers with community (enforce Code of Conduct).	Minor Negative
	Operation		Minor Negative		Negligible
	Closure		N/A		N/A
Potential Tensions in	Construction	Tensions between the community and the Project may increase if there is at least a perception that	Major Negative	Frequent and proactive communication with local	Minor Negative

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Community-Project Relationship	Operation	the housing of construction phase workers in hotels within the community is not being managed properly and/or is resulting in detrimental effects for the community. A potential negative impact is a deterioration in the perceptions of the Project, ongoing interactions, and levels of collaboration. In extreme cases, a poor relationship between the Project and host communities could result in a loss of a social license to operate and/or a disruption of project activities and even stoppages.	N/A	community stakeholders, with updates on Project activities.	N/A
	Closure		N/A		N/A
Increased Revenue for Local Hotels	Construction	The housing of construction phase Project workers in local hotels would, at least for the duration of the construction phase (short-term), result in steady and possibly increased revenues for hotels. Arrangements between the Project and hotels could result in a guaranteed full occupancy during the high tourist season, and higher than usual occupancy during the low season. Revenues would therefore be more evenly distributed throughout the year. The overall impact is highly positive, although of short duration (likely limited to the construction phase).	Moderate Positive	N/A	Moderate Positive
	Operation		Minor Positive		Minor Positive
	Closure		N/A		N/A
Loss of Clientele for Some Hotels After	Construction	High or full occupancy of hotels represents a short-term gain for hotel owners. However, the inability of hotels to cater to some of their	Moderate Negative	Communicate Project plans and expected dates of construction phase completion with Project	Minor Negative
	Operation		Minor Negative		Negligible

Table 6.21.3 Summary of Impacts Pre-Mitigation and Post Mitigation - Hotels ⁷⁸					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Construction Peak	Closure	“traditional” clientele (e.g., tour companies with which there are longstanding agreements) may result in loss of business if a perception develops that hotels are always full due to the presence of Project workers.	N/A	owners. Selective (and limited) use of hotels. Support the development of long-term tourism development strategies and plans.	N/A
Reduction in Trade for Some Goods and Service Providers	Construction	Tourist-oriented oriented activities such as outdoor guided tours, the sale of regional products, souvenirs, art, and restaurants would likely experience a loss in business activity in the usual high tourist season if a considerable number of hotel beds are occupied by workers (instead of tourists) – as workers’ expenditures on such goods and services would likely be modest. This is a negative impact for some local businesses.	Moderate Negative	Provide business training to local enterprises.	Minor Negative
	Operation		Minor Negative	Implement supplier development programs. Provide support to local businesses’ advertising and promotional efforts (e.g., local festivals and events).	Negligible
	Closure		Minor Negative		Negligible

Table 6.21.4: Summary of Impacts Pre-Mitigation and Post Mitigation –Worker Camp ⁹					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Change in Visitors' perceptions of Jermuk as a "spa town", with negative impact on traditional tourism	Construction	The presence of the Project's construction workforce in Jermuk (in addition to the presence of the mine itself nearby) may affect the "spa" character of the town and tourists' perception of the destination – normally associated with fresh air, tranquil surroundings, and spa/medical treatments. It is thought that the construction of a camp for the Project's workforce may limit the extent to which the character of the town of Jermuk will be changed.	Moderate Negative	Minimize the presence of Project vehicles and workforce in Jermuk. Support tourism. development efforts. Enforce Code of Conduct.	Minor Negative
	Operation		Minor Negative		Negligible
	Closure		Negligible		Negligible
Change in Local Residents' Perceptions of Own Community (Sense of Place and Community Safety)	Construction	The presence of a construction workforce nearby may affect how local residents perceive their own community. This may include sense of place and perceptions of safety in the community. This is a qualitative effect, and may have some positive aspects if residents associate the presence of a mining project with increased employment and other opportunities for local people.	Minor Negative	Frequent and proactive communication with local community stakeholders. Enforce Code of Conduct.	Negligible
	Operation		Negligible		Negligible
	Closure		Negligible		Negligible
Increased Pressure on Community	Construction	The housing of the Project's workforce in a self-contained camp should not have a discernible impact on municipal infrastructure and services.	Minor Negative	Increase capacity of local hospital. Coordinate with (and, where	Minor Positive

⁹ This table is focused on the impacts of constructing and operating a camp to house the Project's workforce.

Table 6.21.4: Summary of Impacts Pre-Mitigation and Post Mitigation –Worker Camp ⁹					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Infrastructure and Facilities	Operation	However, the Project's workforce may need to avail of medical services in Jermuk hospital – thus adding demand for services (increase in cases) at local medical facilities.	Minor Negative	necessary, provide support for) the local hospital.	Minor Positive
	Closure	The provision of health services in the community may also be moderately affected if at specific times the Jermuk hospital finds itself overwhelmed by a large increase in cases (particularly during high tourist season, when demand may be at peak). However, the Project may contribute to enhancing the capacity of the hospital – thus offsetting some of the negative impacts of increased demand for the services.	Negligible		Negligible
Increase in Local Employment (Camp Construction and Services)	Construction	Construction of a camp to house the Project's workforce will generate employment opportunities for local people, both in relation to the construction of the camp and for the provision of camp services. If camp accommodations are used during the operation phase of the Project, the employment generated would be a long-term benefit (lasting for the operational life of the Project).	Major Positive	N/A	Major Positive
	Operation		Moderate Positive		Moderate Positive
	Closure		Negligible		Negligible
Increase in Local Procurement (Goods and	Construction	There could be an increase in the procurement of local goods and services if the Project, through the management of the camp, makes efforts to	Minor Positive	Include local procurement provisions in the contracts of Project contractors operating in	Major Positive
	Operation		Minor Positive		Moderate Positive

Table 6.21.4: Summary of Impacts Pre-Mitigation and Post Mitigation –Worker Camp ⁹					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Services)	Closure	maximize procurement from local businesses and service providers.	Negligible	camp (e.g., catering services companies). Maximize use of local contractors for the construction of the camp. Implement supplier development programs.	Negligible
Adverse Effects on Community Health, Safety, and Security	Construction	The presence of the Project's external workforce near to the community of Jermuk has potential negative effects on community health, safety, and security.	Moderate Negative	Implement awareness programs (e.g., re: STDs).	Minor Negative
	Operation		Minor Negative		Negligible
	Closure	The influx of workforce has the potential to result in increased transmissions of communicable diseases (e.g., STDs, flu, etc.). Housing the Project's workforce in a camp limits the level of interaction with the local community and potentially reduces the likelihood of the above.	Negligible	Offer confidential testing of STDs and other communicable diseases. Increase the capacity of local health services. Minimize interactions of workers with community (enforce code of Conduct).	Negligible
Potential Loss of Staff from Hotels or Other Local	Construction	As construction and operation of a camp housing the Project's workforce will require hiring experienced personnel, both for building	Moderate Negative	Develop a local employment plan which addresses the needs of both the local workforce and local	Minor Negative
	Operation		Minor Negative		Negligible

Table 6.21.4: Summary of Impacts Pre-Mitigation and Post Mitigation –Worker Camp ⁹					
Socio-Economic Impact	Project Phase	Description of Impact	Pre-Mitigation Significance Rating	Mitigation Measures (Proposed)	Post-Mitigation Significance Rating
Businesses to the Camp	Closure	construction/maintenance and accommodation/hospitality services, it is possible that the Project will recruit workers currently employed by the hotels or other local businesses. This may have adverse effects for some local businesses, as these may be required to offer higher wages (to “compete” with the Project) and/or engage in new recruitment and training efforts.	Negligible	businesses. A possible measure may be to focus on the hiring of people not currently employed.	Negligible

6.21.11 *Mine Construction Phase Impacts*

Potential Impacts

The Project's use of existing hotel capacity in Jermuk, specifically during the high tourist season, may affect the availability of accommodations for other visitors and has the potential to temporarily have adverse effects on the tourism sector which has been a mainstay for the local economy for decades. High or full hotel occupancy during the Project's construction phase may create a perception of hotels always being full, potentially resulting in the partial loss of the hotels' traditional clientele.

Some local businesses which rely considerably on seasonal trade with tourists (e.g., vendors of local/regional products, tour guides, restaurants, etc.) may experience temporary negative effects as result of the Project's workforce "replacing" tourists in some hotels, as Project workers may be less likely to purchase their goods or services.

Use of local hotels by the Project may contribute to a change in visitors' perception of Jermuk as "spa town". This change in perception may lead to more tangible effects, such as an eventual reduction in the number of visitors in Jermuk – representing a negative effect for the local tourism and hospitality sector and more broadly for the local economy.

Local people's perception of their own community may be affected by development of the Mine, particularly with the workforce having a constant presence in the community. This may affect social capital (sense of place) and people's perception of safety in the community. Use of a camp is likely to mitigate this some of this possible effect.

Irrespective of the accommodation arrangements selected, the presence of a non-local Project workforce may affect the incidence of communicable diseases, e.g., STDs, in the community.

According to local community representatives interviewed, the housing of workers in hotels may present some challenges from the point of view of municipal resources and provision of services, particularly rubbish collection and snow removal. The municipality may need more resources and/or resort to higher fees/taxes to (to be levied on hotels) fund additional workloads and salaries for additional personnel.

Construction and operation of a camp would generate net employment increases and business contracting opportunities in the local community. Furthermore, the use of a camp would minimize or avoid any adverse effects on the hospitality and tourism sector as it would minimize the need to use existing hotel capacity in Jermuk.

The use of a camp minimizes some of the adverse effects identified above, as the housing of the Project's workforce within a self-contained camp would result in reduced interactions between the non-local workforce and members of the community. Use of the camp can also result in more opportunities to maximize local procurement, as the management of the camp and its contractors would be fully under the Project's control.

Both accommodation arrangements would result in increases in employment in the local community, with year-round employment for more individuals in the community being a highly valued positive effect.

Mitigation and Enhancement Measures

Selective (i.e., limited) use of hotels is a proposed mitigation measure which would ensure that the Project does not unduly affect the supply of tourist accommodations in the town of Jermuk.

Negative effects to the local tourism-based economy in Jermuk can be minimized by limiting the number of workers housed in local hotels. Enforcement of a code of conduct for Project workers will be aimed to preventing worker behaviours from affecting other visitors.

Supporting tourism development efforts (including promotional activities and capacity-building in business practices) may be an opportunity for the Project to mitigate some of the negative impacts and contribute to the long-term viability of the sector.

Some of the positive impacts or benefits of both accommodation arrangements – i.e., increases in local employment and procurement – can be enhanced or maximised through the implementation of local employment and supplier development programs.

Residual Impacts

Use of part of the hotel capacity in Jermuk may be necessary during the Project's construction phase, potentially affecting the availability of tourist accommodations in Jermuk during the high tourist season (particularly in 2017). Nevertheless, as it is proposed that only a relatively small portion of the local hotels' capacity will be used by the Project the residual impact is expected to be minor.

A negative change in people's perception of Jermuk as a "spa town" can have long-term effects in terms of number of visitors arriving in the town and on overall economic activity and opportunities for tourist sector growth. This is potentially one of the most serious possible impacts which the Project will have to manage with a suite of measures and monitor appropriately.

The increases in local employment that would accrue under either of the two accommodation arrangements could be enhanced or maximized through the deliberate implementation of measures as those described above. The employment impacts are expected to be discernible and significant.

6.21.12 Mine Operations Phase Impacts

Potential Impacts

The possible change in people's perceptions about the "spa town" of Jermuk identified for the construction phase can persist into the operations phase of the Project and beyond, if not managed appropriately from the start.

Local employment increases and development of local businesses may be noticeable Project impacts in the operations phase, particularly if targeted measures are implemented appropriately during the construction phase. Another related benefit is an increase in skills development likely to be experienced by many members of the local labour force.

Mitigation and Enhancement Measures

Generally, the same suite of mitigation measures identified for the construction phase shall apply during operations.

Selective use of hotels is a proposed mitigation measure for the operations phase which would ensure that the Project does not unduly affect the supply of tourist accommodations in the town of Jermuk.

Supporting tourism development efforts (including promotional activities and capacity-building in business practices) shall continue to be used as a measure to mitigate some of the negative impacts and contribute to the long-term viability of the sector.

Some of the positive impacts or benefits of both accommodation arrangements – i.e., increases in local employment and procurement – can be enhanced or maximised through the continued implementation of local employment and supplier development programs during the operations phase.

Residual Impacts

Many of the impacts identified for the construction phase of the Project would likely persist throughout the life of the Project. Of some concern is the possible change in perceptions about the character of the "spa town" of Jermuk. This will have to be managed very effectively during the construction phase in order to avoid long-term effects which could affect the local tourism

sector in the long-term. Measures proposed in the preceding section shall contribute to minimising the negative effects on the tourism sector of Jermuk.

Although the employment impacts of the Project (and in particular of the accommodation arrangements) are expected to be more pronounced during the construction phase of the Project, it may be reasonable to expect greater participation of the local workforce (as a proportion of the Project's total workforce) during the operations phase of the Project. Furthermore, local supplier development programs may result in long-lasting business development impacts locally.

Mine Closure Impacts

It is expected that by the time the Project reaches closure there will not be any significant use of hotel accommodations by the Project workforce, and only a small number of workers – if any – will be housed in camp or hotels during this phase. The Project workforce is expected to be drastically reduced at closure and may consist of approximately 20-30 workers. Therefore, it is expected that the overall impact of the workforce accommodation arrangements at this stage will be negligible.

Conclusions

The IFC/EBRD guidance note, *Workers' Accommodation: Processes and Standards* calls for assessment of the likely impacts of worker accommodation options on local communities to be conducted. In this Section, the possible social impacts of the Project's accommodation arrangements have been assessed and mitigation measures proposed.

The selected workforce accommodation arrangements for the Project will have impacts on the local economy; community health and safety; community infrastructure; and likely on aspects of social capital in the town of Jermuk.

Negative social impacts include potential changes in people's perceptions about the town of Jermuk, which may have implications for both the local economy and social capital. The presence of the Project's non-local workforce in Jermuk could also affect local people's perception about their own community – including their perceptions of safety; this may occur irrespective of where the workforce is housed, although the camp arrangements would help to mitigate this by limiting interactions of the non-local workforce with the community. An increase in cases of communicable diseases, including STDs, as result of the presence of a non-local workforce is also possible, and would require culturally-appropriate communication and awareness-raising measures (as well as adequate training of local public health professionals) for its prevention.

Some potentially negative impacts can, through the use of appropriate mitigation measures, be transformed into positive impacts. Thus, for example, actual or perceived low levels of uptake of local workers or suppliers by the Project could be considerably increased if efforts are made to develop and implement local employment and supplier development plans.

The construction and operation of a camp presents tangible economic benefits in the form of direct and indirect employment and local procurement. Use of local hotels would only present clear (net) local business and employment benefits during the low tourist season, a time during which most hotels normally experience low occupancy.

In general, the use of a self-contained camp creates fewer potential negative social impacts than the extensive use of existing hotel accommodations in the town of Jermuk. This assessment was based on the premise that the option chosen will involve both use of hotels and the construction of a camp.

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APPENDICES

Appendix 6.21.1:	Social Impact Assessment Methodology
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6.22 Impact Assessment Summary

Table 6.22.2 to Table 6.22.19 present summaries of potential environmental and social impacts and Project benefits, by discipline. The summary impact tables are provided to facilitate use of the ESMP and to provide context for the various initial management plans developed during the ESIA preparation and presented as appendices to this chapter. Where necessary, monitoring plans have been or will be developed to verify that impact mitigation and benefit enhancement activities are complying with design goals and regulatory requirements.

The summary of impacts have been assessed in accordance with the matrix in Table 6.22.1

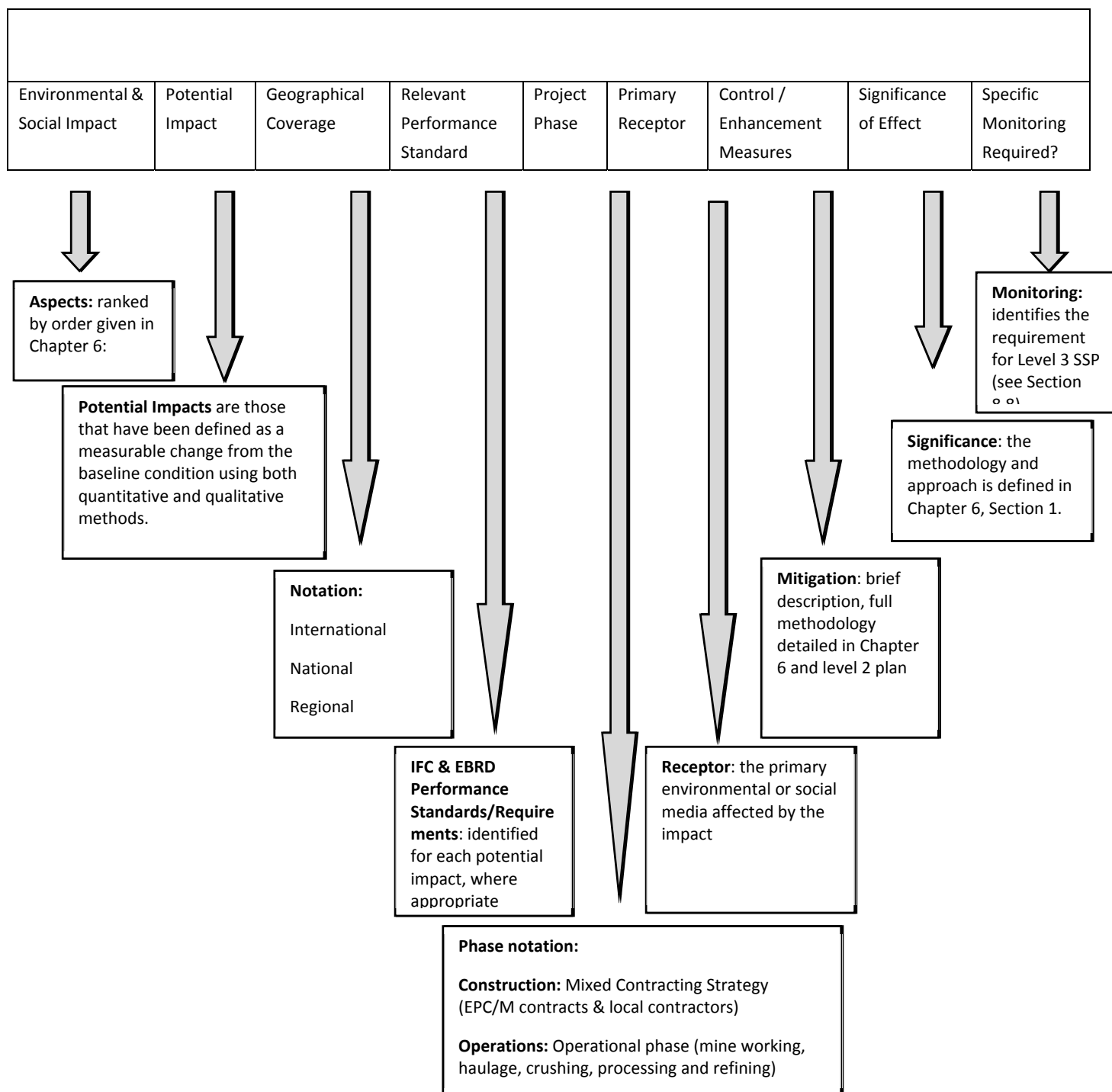


Table 6.22.1: Approach to the Summary Analysis of Impacts and Effects

Table 6.22.2: Greenhouse and Climate Change – Summary of Potential Impacts and Effects

Table 6.22.2: Greenhouse and Climate Change – Summary of Potential Impacts and Effects																											
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Construction	Operations	Closure and Rehabilitation																					
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate			Minor/ negligible	Positive
Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)															
Greenhouse Gas Emissions	GHG including Carbon dioxide equivalent emissions (CO ₂ e)	Local - Site Wide	PS1, PS3	X	X		Atmosphere	Energy efficiency measures in engineering design; energy efficient mobile plant; reduced idling in construction vehicles and , continued maintenance of construction vehicles and machinery; use of biofuels, renewable energy and green electricity (when available) to power some facilities, review energy intensive uses for energy efficiency opportunities during detailed design																Yes	Energy & Carbon audit To be developed after Year 1 A greenhouse gas emissions monitoring programme will be established as part of a carbon and energy management plan		
Climate Change	Temperature Increase	Site Wide/Region wide	PS1, PS3, PS4	X	X		Project (impacts to the project from a changing climate)	Tolerance to changes already built into the design and operational proposal																No specific monitoring	n/a		
Abbreviations:		GHG: Greenhouse Gas																									

Abbreviations: GHG: Greenhouse Gas

Table 6.22.3: Landscape and Visual Impact – Summary of Potential Impacts and Effects

Table 6.22.3: Landscape and Visual Impact – Summary of Potential Impacts and Effects																																								
Receptor	Viewpoint	Direction of Effect (neutral infers both adverse and positive)	Relevant Performance Standard / Requirement	Project Phase			Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference																
				Very High	Major	Moderate		Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive																			
																						Construction - Year 2						Operations - Year 7						Closure phase - Year 15						
																						Construction			Operations	Closure and Rehabilitation														
Landscape Receptors	Settled Lowland and Rocky Gorges	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP																
	Lower Farmed and Settled Foothills	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP																
	Forested Upper Gorge and Foothills	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP																
	High Steppe and Plateau Grassland	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP																
	Highland Hills and Grazing	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP																
	High Rocky Peaks	Adverse	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP																
Representative Viewpoints – Visual Receptors	VP 1: Top of Jermuk Ski Lift	Adverse (neutral post closure)	PS1	X	X	X	*HLF design modified to reduce visual impact.																Yes	FMP, EMP, pMRCRP and BMP																
	VP 2: Hotel Olympia, Jermuk	Adverse (neutral post closure)	PS1	X	X	X	*HLF design modified to reduce visual impact.																Yes	FMP, EMP, pMRCRP and BMP																
	VP 3: Hotel Armenia, Jermuk	Adverse (neutral post closure)	PS1	X	X	X	*HLF design modified to reduce visual impact.																Yes	FMP, EMP, pMRCRP and BMP																
	VP 4: Deer Sculpture west of Jermuk	Adverse (neutral post closure)	PS1	X	X	X	*HLF design modified to reduce visual impact.																Yes	FMP, EMP, pMRCRP and BMP																
	VP 5: Western edge of Gndevaz Village	Adverse (neutral post closure)	PS1	X	X	X	*HLF design modified to reduce visual impact.																Yes	FMP, EMP, pMRCRP and BMP																
	VP 6: H-42 Road south of Gndevaz	Adverse / neutral post closure	PS1	X	X	X	*HLF design modified to reduce visual impact.																Yes	FMP, EMP, pMRCRP and BMP																
	VP 7: Road South-west of Heap Leach Facility																					Yes	FMP, EMP, pMRCRP and BMP																	

Table 6.22.3: Landscape and Visual Impact – Summary of Potential Impacts and Effects

Table 6.22.3: Landscape and Visual Impact – Summary of Potential Impacts and Effects																								
Receptor	Viewpoint	Direction of Effect (neutral infers both adverse and positive)	Relevant Performance Standard / Requirement	Project Phase			Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
				Very High	Major	Moderate		Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive			
				Construction - Year 2						Operations - Year 7						Closure phase - Year 15								
				Construction	Operations	Closure and Rehabilitation																		
Representative Viewpoints – Visual Receptors	VP 8: Armenian Silk Road (M2 Road) near Junction with the H-42 Road	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
	VP 9: Armenian Silk Road (M2 Road) in Saralanj village	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
	VP 10: North end of Ughedzor Village	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
	VP 11: Syunik Gates on the Vorotan Pass (M2 Road) between Saravan and Goryak	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
	VP 12: Armenian Silk Road (M2 Road) between Tsguyk and Gorayk	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
	VP 13: Minor road through Vorotan Valley	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
	VP 14: Little Erato	Adverse (neutral post closure)	PS1	X	X	X	*																Yes	FMP, EMP, pMRCRP and BMP
Abbreviations:		*Progressive reclamation and rehabilitation so bare un-vegetated area are minimised. Storage of topsoil. Design of project infrastructure, including haul roads, to minimise visibility. Vegetated earth bund screening. Use of muted colours for buildings and non-reflective surfaces. Tree planting to screen site. Sensitive positioning of night time lighting.																						

Table 6.22.4: Air Quality – Summary of Potential Impacts and Effects

Table 6.22.4: Air Quality – Summary of Potential Impacts and Effects																									
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
				Very High	Major	Moderate			Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive			
				Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)									
Construction	Operations	Closure and Rehabilitation																							
Air Quality	Fugitive dust / Particulate (Blasting, Drilling, Conveying, Loading, Haulage and Crushing)	Local - site-wide	PS1, PS2, PS4	X	X		Nearby neighbours, Grazing lands/local flora, fauna, employees	Road watering, speed control, chemical dust control, proper vehicle maintenance, complaint monitoring, berms to shield sensitive areas, PPE, infrastructure design e.g. covered crusher and enclosed conveyor, cover truckloads of fill material, dust suppression/contr ol equipment at loading and unloading, storage and transfer points.															Yes	AQNVMP (Appendix 8.14) and OHSP (Appendix 8.7)	
	Combustion Engine and Point Source Emissions	Local - site-wide	PS1, PS2, PS4	X	X	X	Nearby neighbours, employees	Regular vehicle maintenance, speed control, emission control devices (e.g. catalytic converters, etc.), reduce vehicle idling times															Yes	AQNVMP (Appendix 8.14) and OHSP (Appendix 8.7)	
	Nuisance odours from sewage treatment	Local - site-wide	PS1, PS2, PS3	X	X	X	Nearby neighbours, employees	Cover waste regularly (daily); gas relief system, Maintain sewage treatment system in good working order, PPE, waste reduction and recycling,															Yes	SoWaMP (Appendix 8.13) and OHSP (Appendix 8.7)	
Abbreviations:		PPE: Personal Protective Equipment																							

Table 6.22.5: Noise – Summary of Potential Impacts and Effects																									
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
				Very High	Major	Moderate			Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive			
				Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)									
Noise	Noise from vehicle traffic, heavy equipment, mobile equipment, supply traffic, diesel generators, concrete plant, general construction activities	Local - Entire site	PS3, PR3	X	X	X	Nearby neighbours	Equipment / sound control/enclosures on high noise equipment; Noise barriers (berms, barriers), grievance mechanism, speed control, post signage denoting areas of high noise, regular vehicle maintenance																Yes	TP (Appendix 8.10), AQNVMP (Appendix 8.14) and SEP (Appendix 8.6)
			PS2, PR2	X	X	X	Workers	PPE (hearing protection in high noise areas); signs where hearing protection required; training; occupational medical monitoring																Yes	OHSP (Appendix 8.7) and AQNVMP (Appendix 8.14)
	Noise from topsoil/soil cover stripping and replacement. Drilling, blasting, product extraction and stockpiling, crushing and loading activities		PS3, PR3	X	X	X	Nearby neighbours	Blasting control speed controls, noise barriers, appropriate signage denoting areas of high noise, regular vehicle maintenance, grievance mechanism																Yes	AQNVMP (Appendix 8.14) and SEP (Appendix 8.6)
			PS2, PR2	X	X	X	Workers	PPE (hearing protection in high noise areas); signs where hearing protection required; training; occupational medical monitoring,																Yes	OHSP (Appendix 8.7) and AQNVMP (Appendix 8.14)

Table 6.22.5: Noise – Summary of Potential Impacts and Effects																											
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate			Minor/ negligible	Positive
									Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)						
Noise	Mobile equipment	Local - Entire site	PS3, PR3	X	X	X	Nearby neighbours	Vehicle maintenance, mufflers on equipment; speed limits; training in driving techniques; post signage denoting areas of high noise noise monitoring, grievance mechanism														Yes	AQNVMP (Appendix 8.14) and SEP (Appendix 8.6)				
			PS2, PR2				Workers	PPE (hearing protection in high noise areas); signs where hearing protection required; training; occupational medical monitoring														Yes	OHSP (Appendix 8.7) and AQNVMP (Appendix 8.14)				
	General Project Operations		PS3, PR3		X	X	Nearby neighbours	Vehicle maintenance, mufflers on equipment; speed limits; training in driving techniques; noise monitoring, post signage denoting areas of high noise, grievance mechanism														Yes	AQNMVP (Appendix 8.14) and SEP (Appendix 8.6)				
			PS2, PR2				Workers	PPE (hearing protection in high noise areas); signs where hearing protection required; training; occupational medical monitoring															OHSP (Appendix 8.7) and AQNVMP (Appendix 8.14)				
	Abbreviations:		PPE: Personal Protective Equipment																								

Table 6.22.6: Vibration – Summary of Potential Impacts and Effects

Table 6.22.6: Vibration – Summary of Potential Impacts and Effects																											
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate			Minor/ negligible	Positive
									Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)						
Vibration	Vehicles, Heavy Equipment	Local - Site, Access Roads and Nearby Receptors	PS2, PS3, PR2, PR3	X	X	X	Employees, Residents, Buildings	Enforce speed limits for heavy equipment. Schedule high-vibration activities to daytime hours																Yes	AQNVMP (Appendix 8.14) and SEP (Appendix 8.6)		
	General Project Operations	Local - Site, Access Roads and Nearby Receptors	PS2, PS3, PR2, PR3	X	X		Employees, Residents, Buildings	Schedule high-vibration activities to daytime hours; Perform regular maintenance and inspection of equipment; Grievance mechanism - monitor vibration related complaints																Yes	AQNVMP (Appendix 8.14) and SEP (Appendix 8.6)		
Abbreviations:																											

Table 6.22.7: Soils – Summary of Potential Impacts and Effects																											
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate			Minor/ negligible	Positive
									Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)						
Loss of Soil Resource	Loss of Natural soils	Local – construction activities	PS1, PS3, PS6, PR1, PR3, PR6	X	X		Land	Clearly delineate footprint of soil disturbance before moving top and sub soils arrange soil storage area in advance, define haul routes between strip and stockpile areas															FMP (Appendix 8.8)				
	Soil erosion	Local – construction activities	PS1, PS3, PR3	X			Land, surface water, groundwater	Implement erosion/sediment control measures, salvage as much topsoil as possible, revegetate cleared land as soon as possible, use appropriate drainage measures															FMP (Appendix 8.8) and EPSRP (Appendix 8.9)				
	Handling and storage	Local – construction activities	PS3, PR3	X			Land	Handle soil during dry conditions, avoid traffic on soil surfaces, maximum height of soil mounds no greater than 5m for topsoil and 10m for subsoil, grass soil mounds															FMP (Appendix 8.8) and pMRCRP (Appendix 8.18)				
Contamination of Soils	Dust deposition from Haul road traffic	Local - site wide	PS3, PR3		X		Land	Dust suppression measures identified in air quality section													Yes	AQNMVP (Appendix 8.14)					

Table 6.22.7: Soils – Summary of Potential Impacts and Effects																									
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
				Very High	Major	Moderate			Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive			
																							Without Mitigation		
				Construction	Operations	Closure and Rehabilitation																			
Contamination of Soils	Changes to the soil chemistry and quality from equipment and vehicle use and materials handling through spills and leaks from handling materials	Local - site wide	PS3, PR3	X	X	x	Land, surface water, groundwater	Follow spill prevention and response plan, ICMC guidance – including training personnel on site, line all chemical and fuel storage areas and bund them, PPE, containment and cleanup supplies readily available															Yes	EPSRP (Appendix 8.9), CMP (Appendix 8.11), FMP (Appendix 8.8) and Environment Policy (Appendix 8.1)	
	ARD	Local - site Wide	PS3, PR3		X	X	Land, surface water , groundwater	ARD management plan															Yes	ARDMP (Appendix 8.19) EPSRP (Appendix 8.9) and SoWaMP (Appendix 8.13)	
Loss of soil and soil structure during rehabilitation and restoration	Soils handling and reclamation creates soil loss	Local – site-wide	PS1, PS6, PR1, PR6		X	X	Land, surface water, groundwater	Implement soil erosion control measures, save topsoil, revegetate land as soon as possible after construction, perform reclamation and rehabilitation activities in accordance with established closure plan															Yes	FMP (Appendix 8.8), EPSRP (Appendix 8.9) and pMRCRP (Appendix 8.18)	
	Revegetation during post closure activities creates soil loss	Local – site-wide	PS1, PS6, PR1, PR6		X	X	Land, surface water	Soil handling programme for restoration and aftercare management programme															Yes	pMRCRP (Appendix 8.18)	
Abbreviations:		PPE: Personal Protective Equipment, WDF: Waste Dump Facility, WTP: Water Treatment Plant																							

Table 6.22.8: Groundwater – Summary of Potential Impacts and Effects																					
Environmental/ Social Impact	Potential Impact	Receptor Importance	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)										Specific Monitoring Requirements	Management Plan Reference	
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive
									Without Mitigation						With Mitigation						
Construction and Operation (where temporary, Pre- closure)	Perched water / Ephemeral springs in open pit areas, HLF and BRSF areas.	Local	PS1, PS3, PS4, PR1, PR3, PR4	X	X		Ground water	See Section 6.9 and relevant Management Plans (appendix 8.23 Surface Water Management Plan and 8.19 ARD Management Plan)										Yes	SWMP (Appendix 8.23) and ARDMP (Appendix 8.19)		
	Perennial Springs, open pit area, HLF and BRSF areas	Local	PS1, PS3, PS4, PR1, PR3, PR4	X	X		Ground water											Yes	SWMP (Appendix 8.23)		
	Hydrothermal Springs Jermuk	Regional	PS1, PS3, PS4, PR1, PR3, PR4	X	X		Ground water											Yes	SWMP (Appendix 8.23)		
	Groundwater used for supply purposes Kechut Springs, Springs North of Gorayk, Spandaryan- Kechut Tunnel.	Local	PS1, PS3, PS4, PR1, PR3, PR4	X	X		Ground water											Yes	SWMP (Appendix 8.23)		
Ground water quality impacts in pit area and crushing plant - Construction and Operation (where permanent, Post- closure)	Groundwater Component of surface water baseflow – Darb River catchment.	Local	PS1, PS3, PS6, PR1, PR3, PR6		X	X	Groundwater – quality of base flow to river												Yes	SWMP (Appendix 8.23)	
	Groundwater component of surface water baseflow to Arpa River catchment.	Regional	PS1, PS3, PS6, PR1, PR3, PR6		X	X	Groundwater – quality of base flow to river											Yes	SWMP (Appendix 8.23)		
	Groundwater component of surface water baseflow to Vorotan River catchment.	Regional	PS1, PS3, PS6, PR1, PR3, PR6		X	X	Groundwater- quality of flow to river	See Section 6.10 and Water Management Plan										Yes	SWMP (Appendix 8.23)		
23Groundwater impacts from WDF - Construction	Impacts of groundwater due to blasting – likely to be temporary and restricted to operational phase only, attenuating rapidly following cessation of blasting.	Local	PS3, PR3		X		Groundwater – base flow to Vorotan River	See Section 6.9 and Technical Appendix 6.9.2.										Yes	SWMP (Appendix 8.23)		
Abbreviations:		HLF: Heap Leach Facility, BRSF: Barren Rock Storage Facility, ARD: Acid Rich Drainage																			

Table 6.22.9: Surface Water – Summary of Potential Impacts and Effects																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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Table 6.22.9: Surface Water – Summary of Potential Impacts and Effects																					
Environmental/ Social Impact	Potential Impact	Receptor importance	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)										Specific Monitoring Requirements	Management Plan Reference	
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive
									Without Mitigation						With Mitigation						
	Voratan River Tributaries	Local	PS3, PS4, PS6, PR3, PR4, PR6	X			Agriculture, stock watering, Ecosystem Services										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
Impacts from construction of surface water diversions and sediment ponds resulting in reduction of surface water catchment area	Kechut Reservoir	National	PS1, PS3, PS4, PR4	X			National water supply, hydro- electric power generation, ecosystem services										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
	Spandaryan Reservoir	National	PS1, PS3, PS4, PR4	X			National water supply, hydro- electric power generation, ecosystem services										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
	Gndevaz Reservoir	Local	PS1, PS3, PS4, PR4	X			Agriculture stock watering										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
	Wetland Ponds within Darb Tributaries including Benik’s Pond	Local	PS1, PS3, PS4, PR4PS1, PS3, PS4	X			Ecosystem services										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
	Wetlands within Vorotan Catchment	Regional	PS1, PS3, PS4, PR4	X			Ecosystem services										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
	Wetlands within Ketchut Reservoir Tributaries	Local	PS1, PS3, PS4, PR4	X			Ecosystem services										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15) and SEP (Appendix 8.6)			
Impacts as a result of accidental uncontrolled release of contact water from the BRSF, HLF detention pond and non contact water from the haul roads, pit and crusher area discharging into the receiving	Kechut Reservoir Tributaries	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Agriculture, stock watering, ecosystem services	Project designed for zero discharge of contact water during operations, contact water management system sized to manage extreme precipitation events, settlement of runoff prior to discharge through provision of sediment control ponds and										Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)		
	Arpa River downstream of Kechut Reservoir	Regional	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Stock watering from Arpa river, fisheries habitat and wildlife water supply, fish farms											Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)		
	Arpa River Tributaries Downstream of Ketchut Reservoir	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Stock watering from streams within the catchment, wildlife water supply											Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)		

Table 6.22.9: Surface Water – Summary of Potential Impacts and Effects																					
Environmental/ Social Impact	Potential Impact	Receptor importance	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)										Specific Monitoring Requirements	Management Plan Reference	
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive
									Without Mitigation						With Mitigation						
environment	Arpa River Tributaries HLF Area	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Stock watering from streams within the catchment, wildlife water supply	sediment control measures, backfill of the Tigranes / Artavzades pits and partial backfill of the Erato pit during closure with no permanent water in the open pits, passive water treatment for drainage from BRSF and HLF, ET cover on the BRSF and HLF, encapsulation of PAG barren rock within BRSF, ensure regular monitoring of water quality downstream											Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)	
Impacts as a result of accidental uncontrolled release of contact water from the BRSF, HLF detention pond and non contact water from the haul roads, pit and crusher area discharging into the receiving environment	Darb River	Regional	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Agriculture, stock watering, ecosystem services													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Darb River Tributaries	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Agriculture, stock watering, ecosystem services													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Vorotan River	Regional	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Agriculture, stock watering, ecosystem services, hydro-electric power generation													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Vorotan River Tributaries	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Agriculture, stock watering, Ecosystem Services													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Kechut Reservoir	National	PS1, PS3, PS4, PR1, PR3, PR4		X	X	National water supply, hydro-electric power generation, ecosystem services													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Spandaryan Reservoir	National	PS1, PS3, PS4, PR1, PR3, PR4		X	X	National water supply, hydro-electric power generation, ecosystem services													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Gndevaz Reservoir	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Agriculture stock watering													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)
	Wetland Ponds within Darb Tributaries including Benik’s Pond	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Ecosystem services													Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and

Table 6.22.9: Surface Water – Summary of Potential Impacts and Effects																					
Environmental/ Social Impact	Potential Impact	Receptor importance	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)										Specific Monitoring Requirements	Management Plan Reference	
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive
									Without Mitigation						With Mitigation						
																				pMRCRP (Appendix 8.18)	
	Wetlands within Vorotan Catchment	Regional	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Ecosystem services												Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)	
Impacts as a result of accidental uncontrolled release of contact water from the BRSF, HLF detention pond and non contact water from the haul roads, pit and crusher area discharging into the receiving environment	Wetlands within Kechut Reservoir Tributaries	Local	PS1, PS3, PS4, PR1, PR3, PR4		X	X	Ecosystem services												Yes	SWMP (Appendix 8.23), EPSRP (Appendix 8.9), CHSP (Appendix 8.15), SEP (Appendix 8.6) and pMRCRP (Appendix 8.18)	
Abbreviations:																					

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects																									
Receptor Category	Receptor	Impact	Relevant Performance Standard / Requirement	Project Phase			Ecological Effects	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
									Significant/ Not Offsetable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsetable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsetable	Significant	Moderate		
				Without Mitigation																					
				Construction	Operations	Closure and Rehabilitation																			
Sites and areas of conservation importance/ National Protected Areas	Caucasus Biodiversity Hotspot (Conservation International)	Impact due to presence of Project as a whole.	IFC PS6 EBRD PR6	x	x	x	Loss / degradation of natural habitat.	No specific mitigation necessary.																None. No-net-loss strategy should mean hotspot is not compromised.	n/a
	Caucasus Mixed Forest Ecoregion	No direct impacts on any features of importance. Possible indirect effects due to concentration of grazing and other activities outside Project area.	IFC PS6 EBRD PR6	x	x	x	Small, degraded fragments of shrubby vegetation in the HLF location, but not high quality examples.	Project designed to avoid remaining individual shrubs; small number affected to be translocated.																None. Offset for natural habitat in proposed Jermuk National Park will benefit Juniper scrub.	n/a
	State Sanctuaries (Jermuk Forest, Herher Open Woodland and Jermuk Hydrological)	No direct impacts on any features of importance.	IFC PS6 EBRD PR6	x	x	x	Not exposed to impacts.	No mitigation required.																None.	n/a
	Sevan National Park	No direct impacts on any features of importance.	IFC PS6 EBRD PR6	x	x	x	Not exposed to impacts.	No mitigation required.																None.	n/a
	Proposed Jermuk National Park	No direct impacts on any features of importance.	IFC PS6 EBRD PR6	x	x	x	Not exposed to impacts.	Planned natural habitat offset in the Park should improve regional conservation and nature protection.																Offset will be monitored	BAP (Appendix 8.20)
	Jermuk IBA	Potential indirect effect due to loss of feeding area for resident species.	IFC PS6 EBRD PR6	x	x	x	Project-affected area provides foraging habitat for some birds which breed in the IBA.	No mitigation required.																None (but see requirements for individual bird species below).	n/a
	Gorayk IBA	Potential indirect effect due to loss of supporting habitat for	IFC PS6 EBRD PR6	x	x	x	Potential loss of preferred hunting areas for Lesser Kestrel and undisturbed feeding areas.	No mitigation required.																None (but see requirements for individual bird species below).	n/a

Significance of Effect

Significance of Effect

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects																											
Receptor Category	Receptor	Impact	Relevant Performance Standard / Requirement	Project Phase			Ecological Effects	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Construction	Operations	Closure and Rehabilitation			Significant/ Not Offsetable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsetable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsetable	Significant	Moderate			Neutral	Positive
									Without Mitigation					With Mitigation (Short Term)					With Mitigation (Long Term)								
Biodiversity and Ecosystems: Plants and Vegetation	Amulsar sub-population of <i>Potentilla porphyrantha</i> (Tier 1 critical habitat - IFC PS6)	A large part of the Project footprint, including the open pits, is on critical habitat for <i>Potentilla porphyrantha</i> .	IFC PS6 EBRD PR6	x	x	x	An estimated 33% of the population at Amulsar will be lost. Other plants could be damaged due to infrastructure (roads or tracks), deposition of fugitive dust, or localized changes in microclimate that might affect availability of water.	Arshak Peak set-aside preserves a proportion of the population. Efforts made to locate infrastructure to avoid the species. Plants within the mine pits will be translocated. . A significant research programme has been established to determine optimum restoration conditions and allow plants to be restored and numbers increased post-mining. The residual population is predicted to remain viable albeit with reduced numbers. Net gain will be achieved through an offset if restoration is not successful.															Monitoring of plant locations including within the set-aside; comprehensive research programme to inform restoration.	BMP (Appendix 8.21) and BAP (Appendix 8.20)			
	Other vegetation and plant species considered resilient and widespread	Loss and disturbance.	IFC PS6 EBRD PR6	x	x	x	Induced impacts might include increased harvesting of herbs, vegetables and medicinal plants.	No mitigation required.															None.	n/a			
Biodiversity and Ecosystems: Birds	Egyptian Vulture	The breeding site in Jermuk Gorge will not be exposed to any impacts as a result of the Project, but BRSF and HLF are preferred feeding areas.	IFC PS6 EBRD PR6	x	x	x	Feeding of the breeding pair could be affected, and exposure to poisoning is possible.	No specific mitigation necessary.															Although no impacts are predicted, precautionary monitoring will be carried out due to its Endangered status.	BMP (Appendix 8.21)			
	Saker Falcon	Loss off feeding habitat over the Project area in general.	IFC PS6 EBRD PR6	x	x	x	Feeding of the small number of individuals considered potentially resident may be affected.	No specific mitigation necessary.															Although no impacts are predicted, precautionary monitoring will be carried out due to its	BMP (Appendix 8.21)			

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects																											
Receptor Category	Receptor	Impact	Relevant Performance Standard / Requirement	Project Phase			Ecological Effects	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Construction	Operations	Closure and Rehabilitation			Significant/ Not Offsetable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsetable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsetable	Significant	Moderate			Neutral	Positive
									Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)						
																				Endangered status.							
Biodiversity and Ecosystems: Birds	Lesser Kestrel	Disturbance due to presence of construction camp.	IFC PS6 EBRD PR6	x	x	x	Preferential hunting area could deteriorate due to dust deposition, suppressing vegetation and numbers of the grasshopper larvae on which they feed.	No specific mitigation necessary. However, mitigation will be implemented if adverse impacts are observed during monitoring.														Monitoring of the breeding colony.	BMP (Appendix 8.21)				
	Other species included in RA Red Book and which breed in the Project-affected area	Presence of Project in general, but particularly conveyor, service road, mine access road and HLF.	IFC PS6 EBRD PR6	x	x	x	High quality bird habitat occurs in a rocky gorge north of the HLF; presence of the conveyor and mine road may affect breeding birds.	Options for reducing impact to be investigated during detailed Project design. Distribution and signs of breeding will be monitored. Establishment of offset for natural habitat will benefit these species.														Distribution and signs of breeding will be monitored.	BMP (Appendix 8.21)				
	Migratory birds, especially raptors	Loss off feeding habitat over the Project area in general, and HLF and BRSF in particular.	IFC PS6 EBRD PR6	x	x	x	Loss of habitat might reduce small mammal populations and food availability. Lighting and overhead power lines could be a cause of mortality through collisions.	The project will aim to support and promote, where possible, traditional grazing management practices because of their role in maintaining small mammals and other prey. Precautionary monitoring will be undertaken.														Precautionary monitoring will be undertaken.	BMP (Appendix 8.21)				
	Other birds considered resilient and widespread	General land use changes and disturbance.	IFC PS6 EBRD PR6	x	x	x	Loss of breeding and feeding habitat.	The monitoring programme for priority bird species will be extended to include other representative species in order to detect any unforeseen impacts on birds, particularly in the long term.														Monitoring programme for priority bird species to be extended to include other representative species in order to detect any unforeseen impacts on birds, particularly in the long term.	BMP (Appendix 8.21)				

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects																									
Receptor Category	Receptor	Impact	Relevant Performance Standard / Requirement	Project Phase			Ecological Effects	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
									Significant/ Not Offsettable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsettable	Significant	Moderate	Neutral	Positive		Significant/ Not Offsettable	Significant	Moderate		
				Without Mitigation																					
				Construction	Operations	Closure and Rehabilitation																			
Biodiversity and Ecosystems: Mammals	<i>Ursus arctos</i> Brown Bear (critical habitat - EBRD PR6)	The open pit footprint is currently used by up to seven individuals.	IFC PS6 EBRD PR6	x	x	x	Loss of feeding area, breeding habitat and food supply. Displacement may place bears at threat of hunting or competition with other bears. Noise, light and presence of people is likely to affect the bears.	Arshak Peak set-aside will protect known breeding location. Conveyor and linear infrastructure will be designed to maintain mobility for Brown Bear, including installation of crossings. A detailed baseline survey is planned to complete assessment and consider the need for further mitigation, including offsetting, to achieve net gain for the species.																Detailed monitoring as part of baseline assessment; monitoring during all Project phases.	BMP (Appendix 8.21) and BAP (Appendix 8.20)
	Bezoar Goat	Population centred in Jermuk Gorge not exposed to direct effects.	IFC PS6 EBRD PR6	x	x	x	None expected.	None required.																None.	n/a
	Other mammal species considered widespread and resilient	General presence of Project.	IFC PS6 EBRD PR6	x	x	x	Potential loss of habitat, barrier effects, habitat fragmentation and disturbance.	None required.																None.	n/a
Biodiversity and Ecosystems: Invertebrates	Dorcadion Beetles (<i>Dorcadion sevangense</i> , <i>D. sisianum</i> Lazar and <i>D. bistratum</i>)	Project footprint.	IFC PS6 EBRD PR6	x	x	x	Possible loss and degradation of suitable habitat in some areas.	Due to their national importance, monitoring and pre-construction checks for these species will be undertaken.																Due to their national importance, monitoring and pre-construction checks for these species will be undertaken.	BMP (Appendix 8.21)
	Other invertebrates (terrestrial and aquatic)	General presence of Project.	IFC PS6 EBRD PR6	x	x	x	The Project could exacerbate existing baseline impacts on water quality by removing vegetation from large areas, mobilizing sediment and fugitive dust, which could be deposited on surface water bodies.	No specific mitigation required, unless surface water quality monitoring programme indicates deterioration, in which case aquatic invertebrate survey will be undertaken.																Surface water monitoring may trigger aquatic invertebrate survey.	BMP (Appendix 8.21)

Table 6.22.10: Biodiversity – Summary of Potential Impacts and Effects																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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Biodiversity and Ecosystems: Reptiles and Amphibians	Radde's/ Armenian Rock Viper <i>Montivipera (Vipera) radeii</i> and Armenian Mountain-Steppe Viper <i>Pelias (Vipera) eriwanensis</i>	Project footprint.	IFC PS6 EBRD PR6	x	x	x	Potential loss of habitat, particularly on the western flank of Amulsar Mountain.	Arshak Peak set-aside contains suitable habitat.																	Monitoring and pre-construction checks.	BMP (Appendix 8.21)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								

Table 6.22.11: Demographics – Summary of Potential Impacts and Effects																					
Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)											Specific Monitoring Requirements	Management Plan Reference
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Not Acceptable	Major	Moderate	Minor/ negligible	Positive		
									Without Mitigation						With Mitigation						
Influx – disruption to communities	Disruption to local communities through influx during construction and operation, Influx created by the Project causes changes to the social fabric of local communities	Local	PS1, PS2, PR1, PR2	X	X		Residents	Maximise local employment, provide clear information on employment opportunities that are advertised widely, training to communities in local area of influence to increase skills, support SME development and agricultural assistance in affected communities, implement employee grievance mechanism, maintain and enhance CLC meetings, regular meetings with community administrators, central office to be located at ADR plant											Yes	SEP (Appendix 8.6)	
Social maladies - crime and Vice	Influx of new people, particularly men with higher incomes, leads to increases in crime and vice	Local	PS1, PS2, PR1, PR2	X	X		Residents	provide induction on employee code of conduct and require compliance, develop clear policy to establish non-discrimination for employees with HIV/AIDS, provide information on preventing the transmission of STIs to employees, use of community system and reporting											Yes	ESMP, CHSP (Appendix 8.15) and SEP (Appendix 8.6)	
Abbreviations:																					

Table 6.22.12: Economics – Summary of Potential Impacts and Effects																					
Socio-economic Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)											Specific Monitoring Requirements	Management Plan Reference
									Very High	Major	Moderate	Negligible / Minor	Positive		Not Acceptable	Major	Moderate	Negligible / Minor	Positive		
				Without Mitigation																	
				Construction	Operations	Closure and Rehabilitation															
Macro-economics (royalties, taxes and profit sharing)	Job creation predominantly for local people. Some job creation for, non-local Armenian people, expatriates and contractors	National	PS1, PR1	X	X		Residents, Government	Managing macro-economic contributions, disclosure and transparency in financial transactions and accountability e.g. adhering to EITI principles and reporting, IFC reporting on taxes and government payments												Yes	ESMP
Local inflation	Inflation of local goods e.g. food, groceries	Local	PS1, PR1	X	X		Residents	Monitor the cost of goods, improve local agricultural capacity, identify vulnerable groups sensitive to increases in the cost of goods, monitor impact of local salary levels, consider technical support for small producers to access better markets for their goods												Yes	ESMP
Local rents and land payments	Project footprint and security restrictions for safety	Local	PS1, PS5, PR1, PR	X	X		Residents	Training of community administrators on financial management, brining NGO partners to host communities to increase the development budgets in communities												Yes	ESMP
Abbreviations:																					

Table 6.22.13: Labour and Working Conditions – Summary of Potential Impacts and Effects																					
Socio-economic Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)											Specific Monitoring Requirements	Management Plan Reference
									Construction	Operations	Closure and Rehabilitation	Very High	Major	Moderate	Minor / Negligible	Positive		Not Acceptable	Major		
				Without Mitigation									With Mitigation								
Direct employment	Job creation predominantly for local people. Some job creation for, non-local Armenian people, expatriates and contractors	Regional	PS1, PS2, PR1, PR2	X	X		Residents	Maximise local employment, provide skills training to local people and scholarships to local students in host communities, implement HR Policy and ensure supply chains do not use child or forced labour, use of grievance mechanism		Closure (-ve)	Operations (+ve)	Construction (+ve)				Operations (+ve)	Operations (-ve)	Construction (+ve)	Yes	ESMP, Human Resources Policy (Appendix 8.4) and SEP (Appendix 8.6)	
Indirect employment and procurement	Job creation from multiplier effect and through establishing supply chains to procure goods and services	National	PS1, PS2, PR1, PR2	X	X		Residents	SME development, prioritise Armenian contractors, develop ‘how to do business with Lydian’ guide that is widely disseminated, and implement technical assistance programmes			Operations (+ve)	Construction (+ve), Closure (+ve)				Operations (+ve)		Construction (+ve), Closure (+ve)	Yes	ESMP	
Working Conditions	Accommodation standards to ensure employees have access to appropriate lodging, and services and a safe and healthy living environment	Regional	PS1, PS2, PR1, PR2	X	X	X	Residents	Accommodation standards defined and maintained, no more than 4 people per room, no hot bunking, separate quarters for male and female employees, camp is dry and closed, catering provided for camp and hotel residents											Yes	ESMP	
Abbreviations:																					

Table 6.22.14: Land Use, Agriculture and Natural Resources – Summary of Potential Impacts and Effects

Environmental Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference		
				Very High	Major	Moderate			Negative / Minor	Positive		Very High	Major	Moderate	Minor / Negligible	Positive		Very High	Major	Moderate	Minor / Negligible	Positive					
																							Without Mitigation				
Construction	Operations	Closure and Rehabilitation																									
Soil disturbance and physical barriers around agricultural land	Construction and operation of the Project	Local	PS1, PS3, PS4, PS5, PS6	X	X	X	Residents, Herders	Minimise project footprint, maintain access to land adjacent to the project where safe to do so, rehabilitation trials to determine how best to enhance soil quality and return land to grazing post closure																	Yes	FMP (Appendix 8.8) and LALRP (Appendix 8.24)	
Restriction of access	Land conversion for Project development	Local	PS1, PS3, PS4, PS5, PS6	X	X	X	Residents, Herders	Minimisation of restricted access where safe to do so, monitor land users to assess impacts caused by restricted access to pasture and grazing lands and identify mitigation measures																	Yes	FMP (Appendix 8.8) and pMRCRP (Appendix 8.18)	
Abbreviations:																											

Table 6.22.15: Livelihoods – Summary of Potential Impacts and Effects																					
Socio-economic Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (positive have been highlighted in a blue scale)											Specific Monitoring Requirements	Management Plan Reference
									Very High	Major	Moderate	Minor / Negligible	Positive		Not Acceptable	Major	Moderate	Minor / Negligible	Positive		
				Construction	Operations	Closure and Rehabilitation			Without Mitigation					With Mitigation							
Economic displacement of land users and land owners	Land required for project infrastructure located on private and state owned lands in the communities of Gndevaz and Saravan	Project Footprint	PS5, PR5	X	X		Residents	No physical displacement necessary, compensation for private land and crops paid prior to being taken and compensated at replacement value orphan land is compensated, all sale purchase agreements registered, normal sale-purchase transactions with private landowners, use of grievance mechanism, vulnerable people identified and provided assistance during and after land acquisition process, impacts are monitored.											Yes	LALRP (Appendix 8.24) and Guide to Land access and Compensation	
Economic displacement of herders	Project footprint and security restrictions for safety	Regional	PS1, PS2, PS5, PR1, PR2, PR5	X	X		Residents	Carry out a herder census, support herders with new land agreements (including illegal herders), replace lost assets at equal/improved level, monitor herders livelihoods, expand Lydian agricultural programmes to herders, provide similar support to for technical assistance to seasonal herders											Yes	SEP (Appendix 8.6), LALRP (Appendix 8.24) and CDP (Appendix 8.16)	
Abbreviations:																					

Table 6.22.16: Cultural Heritage- Summary of Potential Impacts and Effects

Table 6.22.16: Cultural Heritage- Summary of Potential Impacts and Effects																																							
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference														
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate			Minor/ negligible	Positive												
				Without Mitigation																								With Mitigation (Short Term)					With Mitigation (Long Term)						
				Construction	Operations	Closure and Rehabilitation																																	
Direct physical impacts to cultural heritage	Excavation, grading and other ground disturbing activities; passage of heavy vehicles on top of archaeological sites, especially in wet weather	Local – site-wide	PS1, PS4, PS8	X	X		Known cultural heritage,	Additional surface reconnaissance surveys to evaluate sites of unknown importance than can't be avoided by project re-design, implement chance finds procedure, training of employees and staff, excavation of cultural heritage sites by national authorities, marking of known sites or high potential areas with high visibility establish appropriate buffer zones and no go areas around known archaeological sites and high potential areas															Yes	CHMP, including Chance Finds Procedure (Appendix 8.17)															
Indirect physical impacts to cultural heritage	Blasting, vibration; transit of heavy vehicles in close proximity to archaeological sites	Local – site-wide	PS1, PS4, PS8	X	X		Known cultural heritage,																Yes	CHMP, including Chance Finds Procedure (Appendix 8.17)															
Abbreviations:																																							

Abbreviations:

Table 6.22.17: Community Health and Safety – Summary of Potential Impacts and Effects																					
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (if positive it is has been highlighted)											Specific Monitoring Requirements	Management Plan Reference
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		
				Without Mitigation																	
Communicable disease linked to the living environment	Influx from the Project, particularly of men, increasing the spread of communicable diseases	Local	PS1, PS2, PS4	X	X		Residents, employees	Management of influx generated by Project, monitor housing inflation, support development of a community health information system, review WHO Pandemic influenza alerts, screening of employees for communicable diseases, community health awareness programmes											Yes	HIV and Communicable Diseases Policy (Appendix 8.4) and CHSP (Appendix 8.15)	
Vector related diseases	Transportation of products and personnel increasing the spread of vector related diseases	Local	PS1, PS2, PS4	X	X		Residents, employees	On-going monitoring of health records and health profiles in the region											Yes	CHSP (Appendix 8.15)	
Soil, water and waste related diseases	Earthworks activities for the Project affecting soil, water and waste related diseases, increased pressure on facilities	Local	PS1, PS2, PS3, PS4	X	X		Residents, employees	Monitor water quality, on-going environmental management, communication of findings to stakeholders, effective waste management on site (including associated facilities) and in the community											Yes	ESMP and SWMP (Appendix 8.23)	
High risk sexual practices, STIs including HIV/AIDS	Influx from workforce brings more men into the area with higher disposable incomes who change their sexual practices	Regional	PS1, PS2, PS4	X	X	X	Residents, employees	Increasing employee awareness of STIs and preventative measures, implementation of employee code of conduct, monitor commercial sex work activity, particularly in Jermuk, develop support programme, employee code of conduct											Yes	HIV and Communicable Diseases Policy (Appendix 8.4) and CHSP (Appendix 8.15)	

Table 6.22.17: Community Health and Safety – Summary of Potential Impacts and Effects																													
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (if positive it is has been highlighted)										Specific Monitoring Requirements	Management Plan Reference									
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive								
				Without Mitigation																			With Mitigation						
				Construction	Operations	Closure and Rehabilitation																							
Food and nutrition	Loss of pasture land, food hygiene/health associated with mine camp food and higher incomes, inflation of food prices	Local	PS1, PS2, PS4	X			Residents, employees	Monitor food inflation, nutritional surveillance and awareness programmes and support local agricultural programmes												Yes	CHSP (Appendix 8.15)								
Non-communicable Diseases linked to lifestyle changes	Mine camp catering and increased incomes changing diet	Local	PS1, PS2, PS4	X	X	X	Residents, employees	Support IEC campaigns on nutrition and well-being, medical surveillance programme of employees and well-ness programme in workforce, develop partnerships with NGOs who can deliver health programmes												Yes	CHSP (Appendix 8.15)								
Environmental health determinants - including hazardous chemical substances	Risks associated with cyanide, hydrocarbon, other chemicals	Regional	PS1, PS2, PS3, PS4	X	X	X	Residents, employees	Implement HCS management programmes, compliance with ICMC, employee health and safety training, PPE, monitor exposure to HCS, emergency response and preparedness plan, medical surveillance and site facilities, complete detailed risk assessment of all HCS, effective communication with communities on use, handling and risks of cyanide												Yes	ESMP								
Social determinants of health	Job creation and economic benefits improve livelihoods and well being	Local	PS1, PS2, PS4	X	X		Residents, employees	Support local economic development and communication at a local level												Yes	CDP (Appendix 8.16) and CHSP (Appendix 8.15)								

Table 6.22.17: Community Health and Safety – Summary of Potential Impacts and Effects																					
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (if positive it is has been highlighted)										Specific Monitoring Requirements	Management Plan Reference	
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive
				Construction	Operations	Closure and Rehabilitation			Without Mitigation					With Mitigation							
Cultural health issues and health seeking behaviour	Project reduce land to foragers collecting plants, cultural health practices change	Local	PS1, PS4, PS5	X	X	X	Residents	Improve local health systems relating to: affordability, access to local people and range of services offered, evaluate access to local herbs and plants used for medicinal purposes on the project site										(Note: does not account for social)		No	
Health services and systems	Influx of people putting pressure on health systems	Regional	PS1, PS4	X	X		Residents, employees	Monitor demographic changes in community health, improve health services locally, develop occupational health and emergency infirmary, enhance health information management, develop CHIS, develop partnerships with NGOs												Yes	CHSP (Appendix 8.15)
Injuries and accidents, including road accidents	Increased road traffic accidents	Regional	PS1, PS2, PS4	X	X	X	Residents, employees	Compulsory alcohol testing for employees, develop emergency, Adhere to Voluntary Principles of Security and Human Rights, response plans for accidents, minimise additional traffic volume, partner local authority in improving road traffic safety												Yes	Drug and Alcohol Testing Procedure (tbd), OH&SP

Table 6.22.17: Community Health and Safety – Summary of Potential Impacts and Effects																					
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (if positive it is has been highlighted)										Specific Monitoring Requirements	Management Plan Reference	
				Construction	Operations	Closure and Rehabilitation			Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible			Positive
									Without Mitigation						With Mitigation						
Security conflicts	Potential conflicts developing between private and public security guards impacting on community safety	Local	PS1, PS2, PS4	X	X		Residents	Comply with Voluntary Principles on Security and Human Rights, award local security contracts, maintain access to land where possible and training of security guards, memorandum of understanding will be developed with the Armenian Police to establish the use of force, armed guards will be used to protect the <i>doré</i> product and to secure the explosives magazine												Yes	CHSP (Appendix 8.15)
Abbreviations:		*Includes negligible																			

Table 6.22.18: Transport - Summary of Potential Impacts and Effects																									
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect															Specific Monitoring Requirements	Management Plan Reference
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate		
				Without Mitigation						With Mitigation (Short Term)						With Mitigation (Long Term)									
				Construction	Operations	Closure and Rehabilitation																			
Highway links	Heavy Goods and light vehicle passenger traffic	Local highway – H-42 and M-2	PS1, PS3, PS4	X	X	X	The highway network – capacity and integrity	Driver safety awareness course for transport of hazardous chemicals, and ICMC regulations including cyanide																Short term construction – traffic management Long term Driver safety/ awareness	TP (Appendix 8.10), CMP (Appendix 8.11) and EPSRP (Appendix 8.9)
Junction capacity	Heavy Goods and light vehicle passenger traffic	Local junctions on highway network – serving affected communities	PS1, PS3, PS4	X	X	X	Junction capacity - degree of saturation	Minimise car journeys Project buses																Signage (see Appendix 6.19.1)	TP (Appendix 8.10)
Project environment – affected communities	Heavy Goods and light vehicle passenger traffic	Local – affected communities	PS1, PS4	X	X	X	Residents living within project affected communities	Minimise car journeys Project buses Signage																Signage (see Appendix 6.19.1)	TP (Appendix 8.10)
Abbreviations:																									

Table 6.22.19: Ecosystem Services – Summary of Potential Impacts and Effects																				
Environmental / Social Impact	Potential Impact	Geographical Coverage	Relevant Performance Standard / Requirement	Project Phase			Primary Receptor	Control / Enhancement Measures	Significance of Effect (if positive it is has been highlighted)										Specific Monitoring Requirements	Management Plan Reference
									Very High	Major	Moderate	Minor/ negligible	Positive		Very High	Major	Moderate	Minor/ negligible		
				Without Mitigation																
				Construction	Operations	Closure and Rehabilitation														
Ecoservices – milk, milk products and meat from livestock	Quality of Product	Local	PS3, PS4		X		Herders	Operation according to Management Plans											YES	
Ecoservices - Hay production	Yield/Quality	Local	PS3, PS4		X	X	Farmers	Operation according to Management Plans											YES	LALRP (Appendix 8.24)
Ecoservices – Commercial Apricot production	Yield/Quality	Local	PS3, PS4		X		Farmers												YES	LALRP (Appendix 8.24)
Freshwater with suitable quality for drinking water or irrigation	Agricultural Surface Water	Local	PS1, PS2, PS3, PS4	X	X	X	Ground and Surface Water	Operation according to Management Plans and SOP’s.											YES	EPSRP (Appendix 8.9), SWMP (Appendix 8.23) and ARDMP (Appendix 8.19)
Priority Ecosystem – Erosion control	Soil and Surface Water	Local	PS3, PS4, PS5, PS6		X		Surface Water	Erosion Control											YES	SWMP (Appendix 8.23)
Cultural identity from herding way of life	Landscape character/way of life	Local	PS2, PS5, PS8		X	X	Residents	Project Design											YES	CHMP (Appendix 8.17)
Abbreviations:																				