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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.

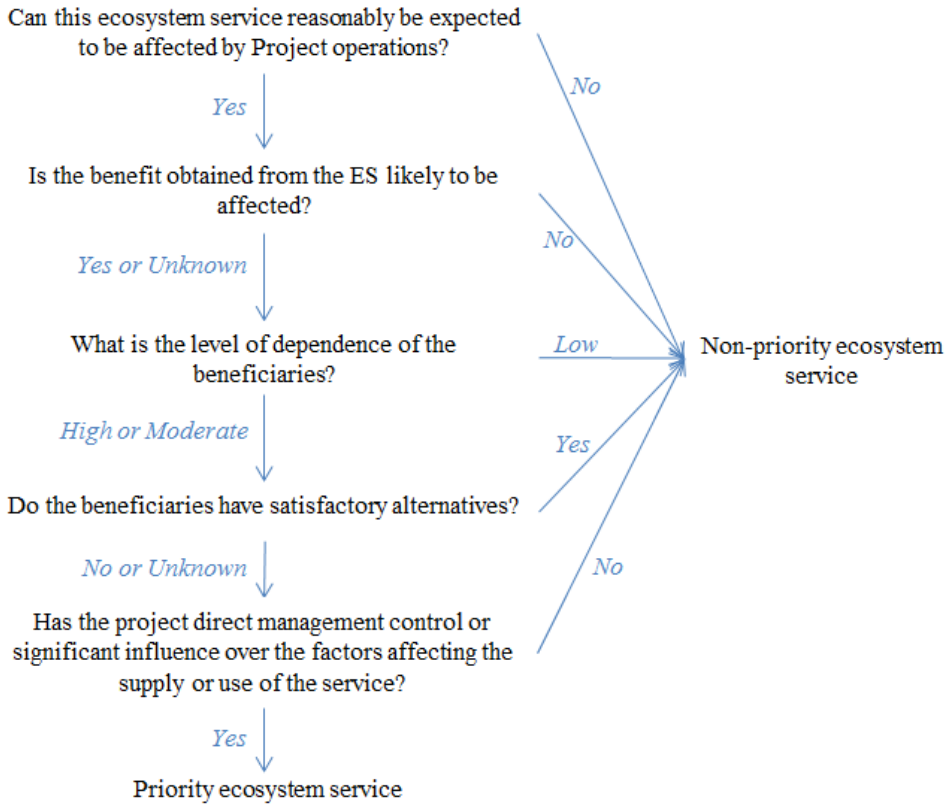

Figure 6.20.1: Decision Tree for Identifying Priority Ecosystem Services Affected by the Project

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.

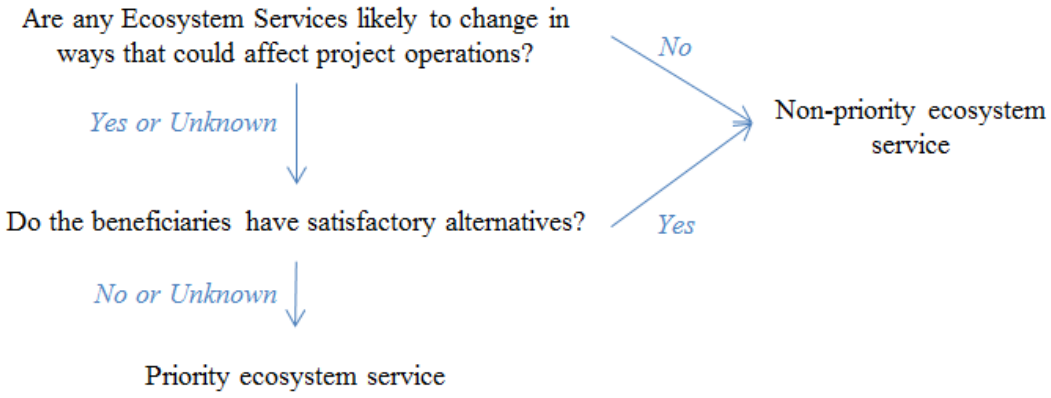

Figure 6.20.2: Decision Tree for Identifying Priority Ecosystem Services which the Project depends on

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	*Milk, milk products, and meat from livestock*
	• 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	*Hay produced to sell for income*
	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	*Apricots grown for own use and income in village orchards*

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	*Freshwater for drinking, domestic supply and crop irrigation*
	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	*Erosion control*
	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	*Cultural identity from herding and other traditional ways of life including apricot production*
	From Sub-alpine Meadows, Montane Meadows and Montane Meadow Steppes and the foothills of Amulsar (modified pastures and farmland). In focus groups, seasonal herders re-iterated 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	*Reference landscape and sense of place*
	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 Categorisation[4]

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 winter[5] (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, Megrhri 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 (Appendix 8.23) 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	• Sales of meat and milk. • Some sale of mushrooms and herbs. • Income from sale of livestock including horses.	• Meat from livestock, fish. • Milk and dairy products. • Mushrooms and herbs. • Berries. • Water from River Vorotan and streams so that livestock can drink.	• Medicinal plants. • Therapeutic springs. • Relative isolation from non-herding people/ diseases. • Safety from traffic risk for people and livestock. • Access to unpolluted water.	• Herding way of life. • Social identity & cohesion. • Continuity with the past. • Tombs & ancestral worship. • Recreational hunting and fishing.
Local herders	• 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.	• Meat from livestock, Fish. • Crops and garden vegetables. • Wild mushrooms and herbs. • Honey. • Freshwater for livestock. • Wild animals (pigs, rabbits).	• Regulation of land slips. • Medicinal plants. • Safety from traffic risk for people and livestock. • Access to unpolluted water.	• 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	• Mushrooms and herbs. • Garden vegetables. • Honey. • Fruit (apples, apricots).	• Water. • Mushrooms and herbs. • Garden vegetables. Honey. • Fruit (apples, apricots).	• Medicinal plants and herbs. • Mushrooms • Access to free, healthy food harvested from "common" resources.	• 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	• Export value of Gndevaz apricots. • Thriving livestock sector	• Fruit (apricots and apples) • Wild food, healthy herbs	• Restorative and therapeutic natural environment • Safe access to the landscape for walking and recreation	• 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).