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4.18 Transport Assessment

4.18.1 Introduction

The Traffic Impact Assessment (TIA) covers a desk-based assessment of the transport impacts associated with the construction, operation and closure phases of Amulsar mine. This chapter considers the baseline conditions and sets the context of the assessment from a national, regional and local perspective. Baseline conditions have been obtained from sources, including the Ministry of Transportation and Communications (MoTC) and the Armenian Roads Directorate (ARD). Other, secondary data sources have been referenced including World Bank Reports on transport infrastructure in Armenia. Primary data included traffic counts obtained from road junctions over a number of 24 hour periods during 2013 following initial snap-shot surveys undertaken in 2012. A further baseline survey was undertaken in June 2014.

4.18.2 Methodology

The TIA develops an analysis of present traffic conditions to establish the capacity of supporting infrastructure, current levels of service, existing traffic related conditions on the highway network and predicted future baseline growth in travel demand.

TIA methodology conforms to current good practice and in the absence of standards relating to transport assessment for the RA, traffic impacts have been considered and analysed in line with the following published international and UK guidance:

- IFC Performance Standards;
- EBRD Performance Requirements;
- Institute of Environmental Assessment (IEA) (UK) Guidelines for the Environmental Assessment of Road Traffic (1991);
- Institution of Highways and Transportation (UK) Guidelines for Traffic Impact Assessment (1994); and
- Department for Transport (UK) Guidance on Transport Assessments (2007).

Baseline conditions have been established using a combination of sources including detailed site mapping, field-based observations, site photographs and data sources supplied by Geoteam during 2011/2012. The data obtained in 2013/14 followed a scope of work, prepared by iPRT Transport Planning, which will be used as the basis for ongoing monitoring during the life of the Project (see Appendix 8.10). An important element to establish the

baseline conditions is the identification of the geographic boundaries of the assessment. These were established during initial fieldwork undertaken by WAI and Geoteam during 2011. Further fieldwork and site observations were undertaken by WAI staff during a 3 day site visit in February 2013. Over this period, data was collected on the transportation aspects of the Amulsar Project as well as field observation at road junctions that would be used for the Project.

Four 24 hour traffic counts were undertaken in March / April 2013 by Geoteam staff to provide an understanding of the nature of the traffic conditions at identified highway links within the assessment boundary. These surveys were undertaken between 00:00 and 23:59 and timed to coincide with the busy Easter weekend which attracts visitors, hence, higher volumes of traffic to the Jermuk area. This methodology has been adopted because it presents the potential worst case conditions on the highway network when it is at its busiest, augmented by holiday traffic. During the survey periods the weather was fine and the driving conditions were good (refer to Appendix 4.18.1). A further survey was undertaken during 2014 on the M-2 Highway to Gorayk, using the same methodology as the previous year (refer to Appendix 4.18.1). The highway network within which the surveys were undertaken (Appendix 4.18.1) are shown on Figure 4.18.3.

Following a review of the baseline data and survey data obtained at highway links relevant to the Project (the M-2 and H-42 highways), this data was used to determine the level of 'available' capacity on these links. The use of highway link capacity assessments conforms to advice within the IEA Guidelines for the environmental assessment of road traffic and is a standard tool for assessing traffic impacts within Environmental Impact Assessments of development projects. A link capacity assessment is used in this instance as 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 or social terms.

For each highway link, a baseline case in terms of link capacity was established which accords with the standards set out within the Armenia: Transport Sector Development Strategy (ADB, November 2008) and the UK's Design Manual for Roads and Bridges Volume 5, Section 1, Part 3, TA 46/97. One hour baseline traffic flows, extrapolated from the traffic counts, have then been developed to provide an indication of the volume of traffic using highway links influenced by the Project. Using this data, the baseline ratio of flow to capacity has been

calculated to determine the level of 'available' capacity on the main highway links within the assessment area.

Junction turning movement has been extrapolated from the survey information provided by Geoteam for the surveyed junctions within the study area, the M-2/H-42 Highways. As a result, the traffic survey data has been used to establish the baseline conditions at both existing and new junctions, which would be required to access the Project from the highway. The surveys provide a robust baseline of existing traffic movement to assess the impacts of the construction, operational and closure phases of the Project.

4.18.3 National road network

Introduction

This section outlines the existing road and transportation infrastructure in the context of Armenia and with particular reference to the local area within which the Amulsar Project is situated.

The sections of the road network included within this assessment have been determined on the basis of the potential effect of increased traffic associated with the Project on the junctions and road links within which baseline have been defined (see Appendix 4.18.1).

Strategic context

Figure 4.18.1 illustrates the location of the Amulsar site in relation to the international transport network for RA, which is a land-locked country with closed borders to Turkey and Azerbaijan. As a result, border access is concentrated on access to and from Georgia to the north and to a lesser extent Iran from the south.

RA has a continental climate, located in the Caucasus Mountains, with the potential for very low temperatures and heavy snowfall in the winter (see Section 4.2). This has the potential, at times, to limit access to parts of the country and affect economic and trading potential.

The country is approximately 29,800 square kilometres in area, with a population of more than 3 million people. The demographics of RA have been identified in Table 4.12.1.

Figure 4.18.1: International transport context for the Amulsar Gold Mine

Cross-border and international links

Prior to independence Armenia had unrestricted access to other countries within the Caucasus Region of the former Soviet Union, although routes to Turkey and Iran were less well developed. Border issues have lead to the closure of all routes to Turkey and Azerbaijan. This includes the main railway link through Azerbaijan, the main highway from Yerevan to Tbilisi and Russia through Azerbaijan, as well as the rail connection with Turkey, linking Ghumri and Kars, and the road connection to Turkey from Yerevan to Karakala.

Currently there are rail and road connections only with Georgia via Yerevan-Gyumri-Akhalkalak-Batumi and the Yerevan-Vanadzor-Tbilisi-Poti routes to the Black Sea ports of Batumi and Poti respectively. The southern road route to Iranian ports is a greater distance, passing through difficult mountainous terrain. Yerevan is approximately 650 km travel distance to the Black Sea ports and approximately 2,000 km from the Iranian ports. The Georgia-Russian Federation Border was closed in 2006, but in April 2007 a ferry service started operation between Poti and Russia.

Armenia's rail network plays a key role in providing mobility for people and freight in the northern part of the country. Armenian Railways was established in 1991 and prior to independence was part of the Trans-Caucasus Railway with headquarters in Tbilisi, Georgia. However, there is no rail infrastructure within the vicinity of the Project. Armenia has three main airports: Zvartnots, Shirak and Erebuni. Of these, Zvartnots International Airport (serving Yerevan) is the principal gateway into the country.

National highway network

The national transport context is shown in Figure 4.18.2. The Interstate Network of 1,561 kilometres (km) connects all Marzes and provides international links. A further 1,832 km of republican roads connect district centres and 4,122 km of local roads provide access for the rural population.

About 1,000 km of local road is under the responsibility of local communities, the remainder being under state and Marz responsibility. Daily traffic volumes on interstate roads range from 1,000 to 25,000 vehicles. M-roads (Magisterial) leading to Georgia in the north and Iran in the south are part of international corridors.

Most of the M-roads converge on the capital Yerevan. However, Yerevan has no bypass

and through traffic has to transit through the centre of the city.

The primary road network is well developed and consists of:

- M-roads – magisterial roads, and
- H-roads – republic roads.

The M-road network is fully paved and approximately 90% of republican roads are paved. The Armenia Roads Directorate estimates magisterial/republican surface conditions to be 15% good, 75% fair and 10% poor.

Figure 4.18.2: National transport context

Note: National roads are M-roads, other roads are H-roads

4.18.4 Road network, study area

Amulsar Mountain is located on the main M-2 highway network, some 170 km from the capital city of Yerevan. The Project will be accessed from the H-42 that connects the city of Jermuk with the M-2 approximately 7km east of Vayk. The M-2 continues south past Gorayk, to the border city of Agarak, approximately 104km to the south east of the Project.

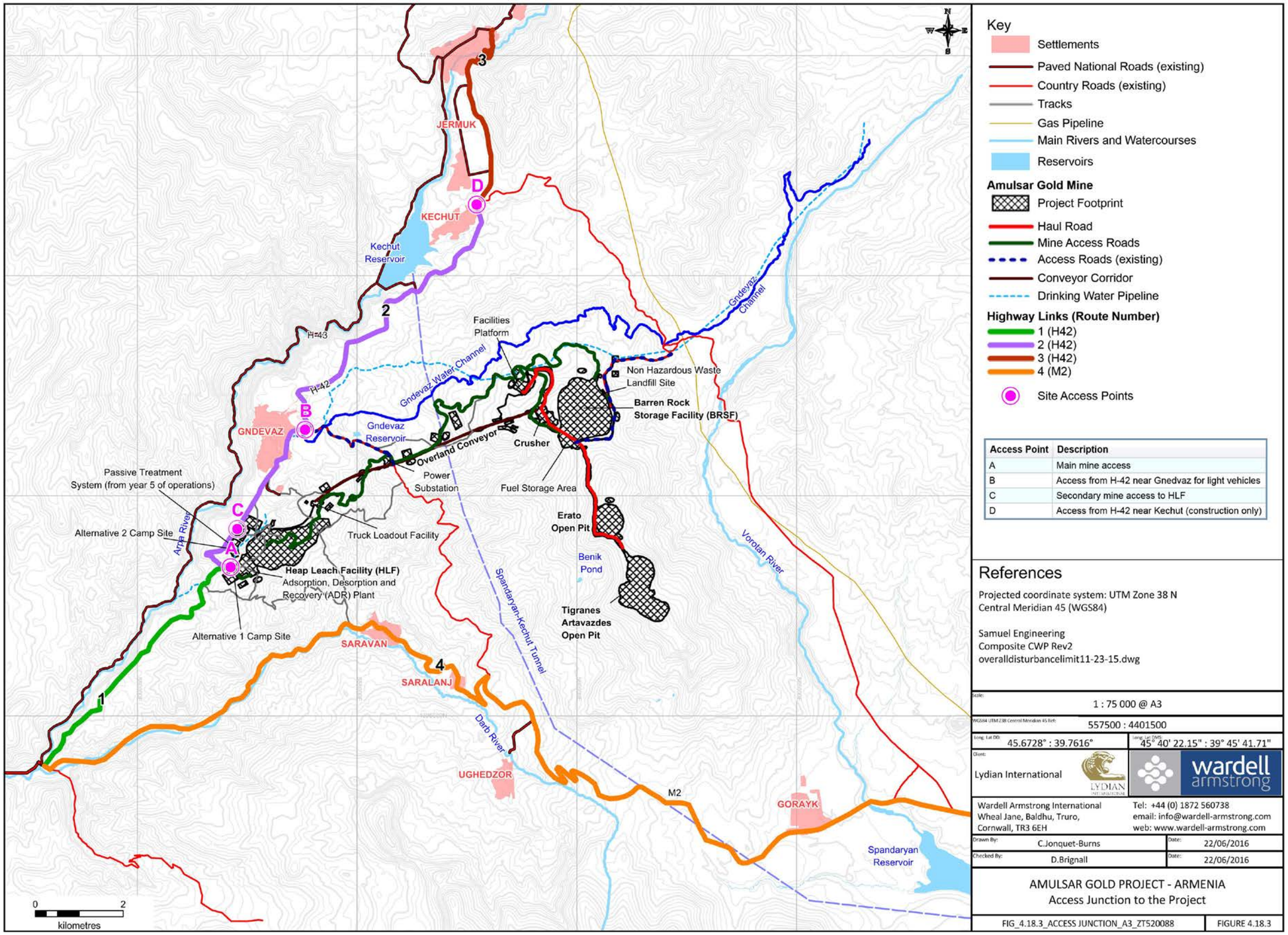

Figure 4.18.3: Highways Links, Local Settlements and the Amulsar Project Site

M-2 Highway

This route forms part of the North-South Route Corridor and Asian Highway Network (AHN), routes AH81/82, which obliges partners to adopt AHN road classifications and design standards. The M-2 (see Figure 4.18.3) is also part of north-south European route E-117 from the Russia/Georgia border via Tbilisi, Dzoramut and Vanadzor.

The M-2 is a key strategic route connecting Yerevan with Meghri / Agarak on the Iranian border. It is single carriageway (2-lane) throughout with the exception of the section between Yerevan and Ararat, which is dual 2-lane. The M-2 is also the main route for tourist traffic between Yerevan, Jermuk and Tatev. The M-2 highway provides the only land connection with Iran.

The M-2 highway provides a direct road route from Yerevan to the Project (see Figure 4.18.2which illustrates the Project in relation to the strategic and local road network).

M-2 Highway Road Surface Conditions

The surface condition of the interstate network is generally fair, with an average international roughness index (IRI) of 4.9. A sample survey of republican roads (report by Armenia Roads Directorate) illustrates worse road conditions, with an average IRI of 8.6 in 2008. Table 4.18.1 identifies the road surface conditions for the M-2 Highway. Notably, the sections of the M-2 closest to Jermuk are indicated, by the Armenia Roads Directorate, to have poorer road surface conditions than elsewhere.

Table 4.18.1: M-2 Highway International Roughness Index 2008[1]

M-2 Section	IRI 2008	Length Km
M-2/M-15 (km15) – Yeraskh (km65)	4.10	50
Yeraskh (km65) – M-2/M-10 (km 120)	5.45	55
M-2/M-10 (km120) – M-2/Jermuk (km 147)	6.07	27
M-2/Jermuk (km147) – Goris (km 238)	5.51	91
Goris (km 238) – Kapan (km 300)	4.95	62
Kapan (km 300) – Iran border (km 383)	4.6	83

[1] Asian Development Bank TA7208-ARM, Ministry of Transport and Communication Republic of Armenia (2010) Preparing the North-South Road Corridor Development Project, PADECO co Ltd

Local context

The Project is located within two separate Marzes (administrative areas) – Vayots Dzor and Synik Marz. The Project is located to the north of the M-2 Highway in a section of the highway that passes the villages of Saravan, Saralanj and Gorayk (see Figure 4.18.3 that illustrates the Project in relation to the local road network). The majority of the route is single carriageway following along the north bank of the Arpa River through hilly terrain with short sections of hairpin bends over the Vorotan Pass. Sections of the M-2 are in poor condition, however some of these sections have recently been improved under a $50M World Bank project. Improvement consisted of overlays and limited rehabilitation, which was completed on the M-2 road south of Yerevan in 2011 where the pavement was in critical condition, thus improving the IRI on the M-2 within the sections that have been subject to these works.

Jermuk, which is located to the north west of the Project, is 24 km north of the M-2 Highway along the single carriageway H-42 Highway (see Figure 4.18.3). The M-2 Highway/ H-42 Highway junction is a standard 'give way' priority T-junction. The Project is located to the north east of this junction. Jermuk is a tourist resort with a resident population of 4,346 (see Table 4.12.2); the city is located on a lava plateau at a height of 2,070 m. With visitor attractions that include spas with warm springs, a 60m waterfall and access to winter sports facilities, tourism contributes to the volume of traffic on both the H-42 and M-2. Outside of tourism, Jermuk's main industry is bottled mineral water, which is widely distributed across Armenia by road. The main road into Jermuk is via a roundabout junction on the H-42, which is the main tourist route to the centre of the city, with its hotels and visitor attractions. A second access to the west of the H-42 and approximately 0.5km to the south of the roundabout junction provides the access to Jermuk airstrip and then onto the residential area of the City. A third, small junction, approximately 2.5km south of the roundabout junction provides direct access to the residential area of Jermuk. Kechut is a residential village to the south of Jermuk, with a main road access off the H42, approximately 1km south of the southern Jermuk junction (see Figure 4.18.3,

Main access to mine

Approximately 1.3 km to the south of the Gndevaz junction on the H-42, the main junction into the Project would give access to internal roads within the HLF and associated operational area (see Figure 4.18.3**Figure 4.18.6**). From the HLF, this internal road network would also link with to the conveyor load out. A separate light vehicle access to the HLF would also be constructed to the north of Access A (see Figure 4.18.3).

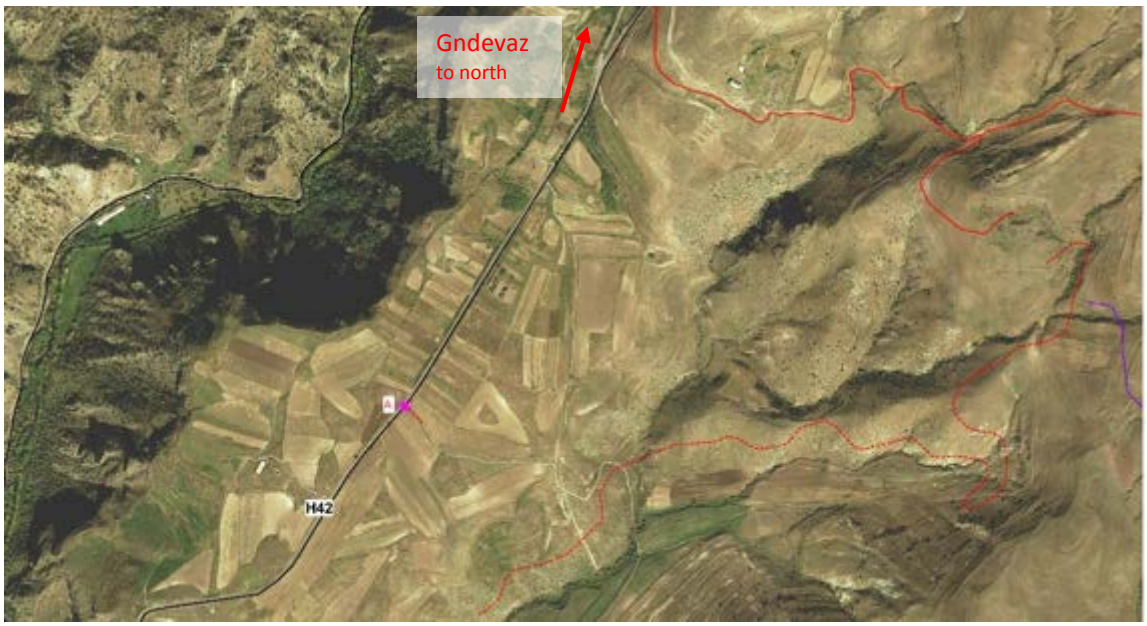

Figure 4.18.4: Access (A) Main Site Access (south of Gndevaz)

Figure 4.18.3 identifies the highway links in relation to the Project and local settlements.

Secondary mine access

Midway between the junction of the M-2 / H-42 and Jermuk is the village of Gndevaz, which is accessed by traffic via a junction off the H-42 to the south of the village.

An existing gravel access road to the east of the village of Gndevaz will provide at Access (B) to the conveyor and via access roads to the mine (see Figure 4.18.5). This access will be used to deliver lime to the truck loadout station, where the overland conveyor terminates. Access via this junction will be required during the construction and operational period of the Project but not as a main site access (see Figure 4.18.4).

Figure 4.18.5: Access (B) to conveyor infrastructure and mine access roads north of Gndevaz

Secondary access to mine during the construction phase

The existing gravel track to the north of the village of Kechut, which has been the main access to the exploration camp for the Project's exploration activities will continue to be a primary access during the construction phases of the Project (Access D, on Figure 4.18.6). This gravel road is used by residents of Jermuk to gain access to the informal landfill site, approximately 2 km from the junction to the H-42.

Figure 4.18.6: Access (D), the current access to the exploration camp, north of Kechut

Link description

The primary junctions that would provide access to the Project as identified in are:

- Main site access, to south of Gndevaz (Access A);
- Access to mine, north of Gndevaz (Access B);
- Light vehicle access to mine site, to the north of HLF (Access C); and
- Existing exploration camp access and junction to be used during construction, north of Kechut (Access D).

The sections of the Highway leading to these junctions are (also Figure 4.18.3):

- Link 1 M-2 / H-42 junction northwards to Junction A;
- Link 2 Junction A northwards on the H-42 to the Junction D, north of Kechut;
- Link 3 north of Junction D on the H-42 to Jermuk; and
- Link 4 south east of the M-2 / H-42 junction, on the M-2 past Saravan, Saralanj and Gorayk (which has been included in the baseline traffic surveys).

Links 1 - 3 are the sections of the H-42 north of the junction with the M-2 Highway. This section of the H-42 is a single carriageway local road paved to reasonable standard. North of the junction with the M-2 Highway the road climbs rapidly. The initial sections of the route have sharp hairpin bends. The road levels off as it reaches higher altitude and is generally straight, with the exception of a hairpin bend 3km to the south of Gndevaz and a further steep section of road approximately 1km to the north of Gndevaz. The village of Gndevaz is located at a midway point to Jermuk and is set back to the west of the carriageway.

The H-43 forms a T Junction with the H-42 to the north of Gndevaz (midway along Link 2, see Figure 4.18.3) and approximately 1.5km south of Kechut.

The M-2 highway from the H-42 junction to east of Gorayk, also has been surveyed for traffic counts (Link 4), which had the highest base flow (including the contribution of Heavy Goods Vehicles HGVs to the baseline conditions).

Baseline traffic flows

Baseline traffic flows have been derived from 24hr traffic counts undertaken in March / April 2013 and June 2014. These traffic counts provide an understanding of the nature of the traffic conditions along the key highway links within the assessment boundaries. The 2013 surveys were undertaken simultaneously between 00:00 and 23:59 in good driving conditions during the busy Easter holidays where the vehicular movements along the H-42 were considered to represent peak volumes of traffic. The 2014 surveys were undertaken over the same time period in June 2014, on the M-2 highway.

Four survey locations were included:

- The H-42 at the junction of the M-2 Highway and H-42 Highway;
- From M-2 on H-42 to Gndevaz (Link 1 and 2)
- From Gndevaz to Jermuk on the H-42 (Link 2 and 3); and
- M-2 to Vorotan Road, east of Gorayk (Link 4).

All surveys were undertaken during 2013, with the exception of the M-2 to Vorotan Road survey that was completed in June 2014.

The traffic conditions along the M-2 Highway are fairly constant through the day as this route acts as the main route between Yerevan and the Iranian border at the border city of Agarak / Meghri. Observations during the site visit confirmed that a high percentage of traffic along this route relates to truck movements. These conditions were further confirmed through discussion with local residents.

Temporal/ seasonal variations

The March / April surveys in 2013 on the H-42 represent a peak in Jermuk due to the importance of the Easter holiday for tourism combined with a weekend break. However, to be robust and to present a worst case for baseline traffic flow, a seasonality factor was applied to all baseline flows to determine appropriate traffic volumes for summer months. The Armenian Road Directorate have indicated that traffic flows outside of summer months are 18% lower than those in summer months. Therefore, a seasonality factor of 1.18 has been applied to all baseline traffic volumes for future year assessments of highway link and junction capacity to account for growth in background traffic in particular during summer months.

The development programme for the Project (see Chapter 3.1) identifies that construction would commence in 2016. Construction of the Project will occur over two years (2016 – 2017). The mine is expected to commence full production in 2018 and has been assigned as the appropriate base year against which to assess construction traffic impacts. Operational traffic impacts have been assessed against a 2017/18 opening year for operations. It is therefore necessary to apply a growth factor to surveyed traffic flows to generate baseline traffic conditions for 2013 and 2014. Discussions with Geoteam have identified that there are no other major committed developments relevant to the study

area. Therefore, baseline flows need to take account of temporal and seasonal variations for future assessment years but no other large-scale developments that generate traffic.

The Asia Development Bank (ADB) Transport Sector Development Strategy for Armenia includes three future growth scenarios: low, medium and high traffic growth (5.5%, 7.2% and 8.3% respectively). For the purpose of a robust assessment, the 8.3% high traffic growth scenario has been used when calculating the compound (i.e. 8.3% year on year) annual growth in background traffic levels for all future year assessment scenarios.

Link capacity assessment

Reference to the baseline traffic flows illustrates that the links on the H-42 will experience very low volumes of traffic. Where existing traffic flows are very low, any increase in traffic flow would result in a predicted increase in traffic levels which would be high when compared to the baseline condition. Where this situation is identified, it is necessary to consider any increase both in terms of the relative increase in respect of existing traffic flows, as well as the overall total flow in respect of the available capacity of the section of road being considered. For example, a relatively small numerical increase in traffic could be seen as an increase of major magnitude when considered against very low background flow, but when considered against link capacity, the capability of the junction to accept a major increase in traffic flow is also high, i.e. there is little or no deterioration in the operating capacity of the junction itself. Therefore, such an increase would be unlikely to cause a major environmental effects given the road's overall capacity.

A highway capacity analysis for the highway links has been undertaken using the UK Design Manual for Roads and Bridges (DMRB) Volume 5, Section 1, Part 3, TA 46/97. This section defines the current baseline capacity on the M-2 highway using this methodology. Chapter 6.18 considers the effects on highway capacity of the construction and operational phases of the Project. The DMRB capacity information was published in February 1997. While this information is fourteen years old, TA 46/97 is still a current document and is used as best practice by the UK Highways Agency. The calculation of link capacity using this method is generalised for Principal roads; this is considered appropriate for the H-42 highway. The H-42 has a standard carriageway width for most of its length; however there are a number of hair-pin bends on some sections as indicated previously.

The UK Design Manual for Roads and Bridges (DMRB) calculates traffic capacity for rural

roads using the method of Congestion Reference Flows (as indicated in DMRB TA 46/97). Link capacity in this instance defined as the 'maximum sustainable hourly lane throughput'. The Congestion Reference Flow (CRF) of a link is an estimate of the traffic flow at which the carriageway is likely to be congested in the peak periods on an average day. For the purposes of calculating the CRF, 'congestion' is defined as the situation when the hourly traffic demand exceeds the maximum sustainable hourly throughput of the link. At this point the effect on traffic will be one of the following:

- Flow breaks down with speeds varying considerably;
- Average speeds drop significantly; or
- Sustainable throughput is reduced and queues are likely to form.

In reality capacity varies day to day due to the prevailing conditions (for example, day/night, wet/dry, percentage of heavy vehicles, regular/holiday traffic) and as a result the values used must be an average. DMRB TA 46/97 identifies that capacity for existing links not currently experiencing congestion can be estimated from the following relationship:

CAPACITY	[A - B * Pk%H]
Where:	A = 1380 (for single lane carriageway)
	B = 15 (for single lane carriageway)
	Pk%H is the percentage of heavy vehicles in the hour

Capacities for the links 1 to 4 have been calculated using this methodology. Both the M-2 and H-42 local roads are considered to equate to rural road classification. Site observations have suggested that the M-2 and H-42 have a higher capacity than the existing traffic flows that have been surveyed on the highway. The proportion of HGVs on the M-2 is, however, greater than that on the H-42 which is currently generally light traffic (compare Link 4 to Links 1 to 3 in Table 4.18.2).

Table 4.18.2 summarises the seasonally adjusted baseline traffic flows and the baseline at 2016 together with the baseline ratio of flow to capacity for each link; the flow to capacity being the recorded flow as a percentage of the theoretical capacity of the link.

Table 4.18.2: Baseline Link Capacity Assessment

Link Description	Season Factor	Direction	Seasonally adjusted Baseline (2014)[1,3] (PCU/hr)	% HGV	Link Capacity	Baseline 2016[2] (PCU/hr)	RFC %	Baseline 2017[3] (PCU/hr)	RFC %
Link 1 M-2 / H-42 junction to Junction A	1.18	NB	14	0	1380	16	1.2	18	1.3
		SB	40	3.3	1330	46	3.5	50	3.6
Links 2 & 3: Junction A – to Jermuk		NB	55	4.9	1307	64	4.9	70	5.1
		SB	60	0	1380	70	5.1	76	5.5
Link 4: M-2/H-42 junction to east of Gorayk		EB	137	23.7	1025	178	17.0	188	18.4
		WB	95	35.0	855	121	14.1	131	15.3

Notes:

[1] In line with best practice the highways link capacity assessment has been undertaken in Passenger Car Units (PCUs) to reflect the greater environmental impact of heavy vehicles on public highways than a private car. A private car has a PCU value of 1, while a heavy vehicle has a value of 2.

[2] 8.3% compound growth has been applied to the baseline traffic flows to reflect increases in background traffic.

[3] The hourly baseline flow was taken as the highest number of vehicles counted during the four periods. This scenario is exaggerated as, based on the data available, (a) all the peak hours do not coincide (b) predominantly the peaks were exhibited during the busy Easter break rather than a neutral day. However, by assuming all peak hours coincide and selecting the busiest period, this would produce a robust assessment.

See Figure 4.18.3 to identify the links in relation to the footprint of the Project.

Table 4.18.2 confirms that the baseline local traffic flows on the H-42 are very low. In the survey years of 2013, 2014 and predicted baseline at 2017/8 the Ratio of Flow to Capacity (RFC) on each link is at or below 10% of their overall capacity.

The hourly traffic flows on Link 4 (the M-2) are the highest surveyed. In the westbound direction, these are just below 20% of link capacity (RFC) in both 2016 and 2017.

4.18.5 Summary

The baseline has considered traffic flows on two roads which Project-related traffic would use:

- M-2, which is a magisterial road that connects to Yerevan in the north and the Iranian border to the south; and

- H-42, a republic road that connects Jermuk to the M-2 and on which the primary junctions to the Project would be located.

The baseline surveys that have been completed in 2013 (H-42) and 2014 (M-2) have identified that the ratio of flow to capacity (RFC) for construction and at the initial years for operation on each road would be at or below 20% on the M-2 and 10% on the H-2. Therefore, both the M-2 and H-2 are lightly trafficked.