LYDIAN ARMENIA

Amulsar Gold Project

Environmental and Social Management Plan (ESMP)

Air Quality, Noise and Vibration Management Plan

Version 4
December 2017

REVISION HISTORY

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V1	Feb 2016	Draft for v10 ESIA	WAI	AJB
V2	Apr 2016	Update following independent review	WAI	US
V3	Aug 2017	Additional noise modelling & update by WAI	WAI	DB
V4	Dec 2017	Alignment with ESMS	AB	AM

APPROVALS

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GLOSSARY

ADR	Adsorption, Desorption and Recovery
AQNVMP	Air Quality, Noise and Vibration Monitoring Plan
BRSF	Barren Rock Storage Facility
CEMP	Carbon and Energy Management Plan
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Monitoring Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
EU	European Union
GHG	Greenhouse Gas
HLF	Heap Leach Facility
IFC	International Finance Corporation
IWMP	Integrated Waste Management Plan
Lydian Armenia	Lydian Armenia CJSC
MP	Management Plan
NO_2	Nitrogen Dioxide
OHSMP	Occupational Health and Safety Management Plan
PM	Particulate Matter
PMS	Primary Monitoring Station
PPE	Personal Protective Equipment
RA	Republic of Armenia
SMS	Secondary Monitoring Station
SO_2	Sulphur Dioxide
SOP	Standard Operating Procedure
WAI	Wardell Armstrong International Ltd

1 INTRODUCTION

This Air Quality, Noise and Vibration Management Plan (AQNVMP) is a component of the Environmental and Social Management Plan (ESMP) of the Amulsar Gold Project (the Project) being developed by Lydian Armenia CJSC (hereafter Lydian Armenia), a subsidiary of Lydian International Ltd. The AQNVMP is being implemented via the Project Environmental and Social Management System (ESMS) which has been put in place to manage the environmental and social (E&S) aspects of the Project.

For an introduction to the Project, the E&S standards it is committed to, and the background to, and operation of, the ESMS, please refer to the **0-00-MAN-ENV-82043 ESMS Manual**.

This AQNVMP was developed for Lydian Armenia by Wardell Armstrong International Ltd (WAI).

1.1 OBJECTIVES

This AQNVMP has been prepared to define how the emissions from mobile and static plant based at the Project will be managed during construction and operation of the mine. The AQNVMP applies to all aspects of the Project, focusing on those activities that result in emissions to air (dust, particulates, gases, noise and air overpressure) and through the ground (ground vibrations from blasting).

The aims of the AQNVMP are to:

- Prevent or control the emission of combustion gases, particulates and dust into the atmosphere, by suppressing or minimising these emissions at source;
- Prevent or control the emission of noise from mobile and static plant required to construct and operate the mine;
- Reduce the impact of ground vibration and air overpressure from blasting operations during construction and operation of the mine.

The AQNVMP addresses management procedures and application of relevant mitigation measures identified in both the EIA required for state approval, and the ESIA undertaken in compliance with international standards. The ESIA specifies a number of mitigation and management measures that are necessary to ensure that effects on air quality as a result of the Project are not significant. These measures are tabulated in Appendix A.

2 SCOPE, BACKGROUND AND CONTEXT

The AQNVMP applies to all activities undertaken during construction, operation and closure of the Project. This current version is focused mainly on the construction phase of the Project based on the description in the Project Execution Plan (PEP) and the impact assessment and mitigation measures identified in the ESIA.

The AQNVMP addresses potential environmental emissions from the Project which can be categorised as follows:

- Fugitive dust – particulate matter generated from earthmoving, material processing, transport and handling, and traffic on unpaved roads;
- Combustion emissions – gas and particulate matter generated by internal combustion engines (heavy and light vehicles, equipment motors, generators) as well as emissions from the chemical mixing tanks in the ADR plant;
- Greenhouse Gas (GHG) emissions – gas emissions with the potential to affect global atmospheric GHG concentrations;
- Nuisance odours – non-health-related (aesthetic) gas emissions affecting nearby receptors;
- Operational noise – from open pit mining, mobile plant including transport of ore to the crushing plant and waste rock to the BRSF, the ADR and HLF facility operations, and noise from air overpressure resulting from blasting; and
- Ground vibrations – from blasting to break rock for extraction within the open pits and other Project activities (i.e. to allow construction related earthworks).

Potential impacts and mitigation measures for each of these emission types are addressed in this AQNVMP. Baseline monitoring has been ongoing at the Project since 2011 (details of which can be found in ESIA Chapter 4). Figure 1 illustrates the locations of monitoring points in relation to the Project footprint to be used during construction and operational phases of the Project.

2.1 PROJECT EMISSIONS

Atmospheric emissions from the mine will comprise the following:

- Dust – the predominant emission, which can be divided into two general categories: deposited dust, which may lead to nuisance; and suspended particulate matter. Dust contains particles in the size range 1 µm to 75 µm in diameter; however, only particles in the range of 10 µm to 30 µm are generally referred to as nuisance dust. Nuisance dust is accepted as not being harmful to long-term health as it is likely to be too large to be respirable dust; however, this dust tends to be the subject of most complaints from communities. Suspended particulate matter is the smaller size fractions of dust, generally measured as PM_{10} and $PM_{2.5}$ (Particulate Matter with a diameter less than 10 µm and 2.5 µm respectively), and persistent or repeated exposure to high levels of this dust can cause long-term health problems. Dust control measures have been included in the design of the Project, to minimise dust emissions as far as practical. PPE is used to protect workers from dust impacts. Potential sources of particulates will be continuously reviewed and necessary mitigation measures developed.
- Combustion and Point Source Emissions - emitted from blasting, mobile equipment, the gas heating plant and the ADR facility during operations. ADR facility combustion emissions will be minor in comparison to other combustion sources at the project. Mercury concentrations in assays of ore were at or below detection limits of 0.05 g/t; however, mercury was detected on the loaded carbon columns in all column leach tests, therefore there will be the use of retorts to recover small concentrations of volatilized mercury. The volatilized mercury will be condensed in the retorts and collected as part of the processing operation.
- Greenhouse Gas Emissions – produced by heavy equipment, light vehicles, the ADR facility, and ancillary support buildings. These will be minimised by incorporating energy-efficient measures into the engineering design, the use of modern, energy-efficient mobile plant and regular maintenance of mobile plant. These are detailed more fully in the Carbon and Energy Management Plan (CEMP).
- Nuisance Odours – generated from improperly managed domestic waste handling and wastewater treatment and disposal. Odour generation will be minimised by use of appropriate waste reduction and recycling procedures, effective waste disposal practices and sewage treatment facilities. These are detailed in the Integrated Waste

Management Plan (IWMP), and the use of appropriate personal protective equipment and occupational medical monitoring is detailed in the Occupational Health and Safety Management Plan (OHSMP).

2.2 SOURCES OF ATMOSPHERIC EMISSIONS

The ESIA identifies potential sources and impacts of atmospheric emissions. The main concern is particulates, which can be released by natural processes such as wind erosion from bare ground. Certain mining activities also have the potential to produce particulates and, to a lesser extent, gaseous emissions. These activities include:

- Drilling – generating dust and combustion gases;
- Blasting – dust generation;
- Crushing and Conveying – dust generation;
- Heap Leach Facility (HLF) operation – generally maintained wet with leaching solution, although some areas may become susceptible to wind erosion;
- ADR facility – localised point source stack emissions;
- BRSF – dust generation due to exposed surfaces and vehicle movements;
- Haul Roads – dust generation and vehicle exhaust emissions; and
- Disturbed ground – wind erosion and vehicle disturbance.

2.3 SOURCES OF NOISE AND VIBRATION

The ESIA discusses the potential sources and impacts of noise and vibrations. In summary, these comprise:

- Construction activities – from the open pit area, BRSF, HLF, ADR facility, and related support infrastructure and access roads; and
- Operations activities – such as drilling and blasting, product extraction and stockpiling, crushing, conveying, hauling, stacking, and loading activities together with ground vibrations and air over-pressure associated with blasting within the open pit.

2.4 RECEPTORS

The primary potential receptors of air quality, noise and vibration effects are similar and include:

Site Workers - For human health assessment, the composition of gases and the size of the particulate matter personnel may be exposed to is required, as well as predicted noise and vibration levels. The most commonly used size fraction definitions relating to dust are detailed in Table 1. Research has shown that particulates in the $PM_{2.5}$ fraction are respirable and therefore can settle in the deeper parts of the lungs, and therefore have the potential to cause health issues.

Table 1: Scale classification of airborne particles

Fraction	Size range
PM_{10} (thoracic fraction [a])	<= 10 µm
$PM_{2.5}$ (respirable fraction [b])	<= 2.5 µm
PM_1	< = 1 µm
Ultrafine (UFP or UP)	< = 0.1 µm

Notes:

[a] Thoracic, or inhalable fraction can enter the thorax and is deposited within the upper respiratory tract

[b] Respirable fraction can be deposited in the alveoli (gas exchange region) of the lungs

Local Residents – The ESIA concluded that atmospheric emissions are unlikely to result in nuisance or health impacts at nearby communities. Noise and vibrations from activities that occur near residents may also generate complaints. Over the distances between source and receptors for the Project, dispersion and dilution will reduce the potential effects of these emissions to insignificant levels. It is possible that complaints will be received relating to nuisance dust, noise and vibration, which should be dealt with via the established company grievance procedure.

Structures in local communities – Noise and vibration is not anticipated to affect structures in local communities according to the ESIA.

Vegetation and surrounding land – Should the dust contain heavy metals or other contaminants, windblown dust settling on surrounding soil and vegetation may affect plant growth and changes in soil fertility. In land used for cultivation or grazing, on a commercial or domestic scale, this could be a concern. See the Environmental Monitoring Plan (EMP) for details of the monitoring to be undertaken.

Seasonal herders and ecological receptors – including mammals (including livestock) and birds that contribute to the natural habitat have the potential to be disturbed.

Emissions to atmosphere other than dust are highly unlikely to be in concentrations capable of adversely affecting surrounding soil and vegetation.

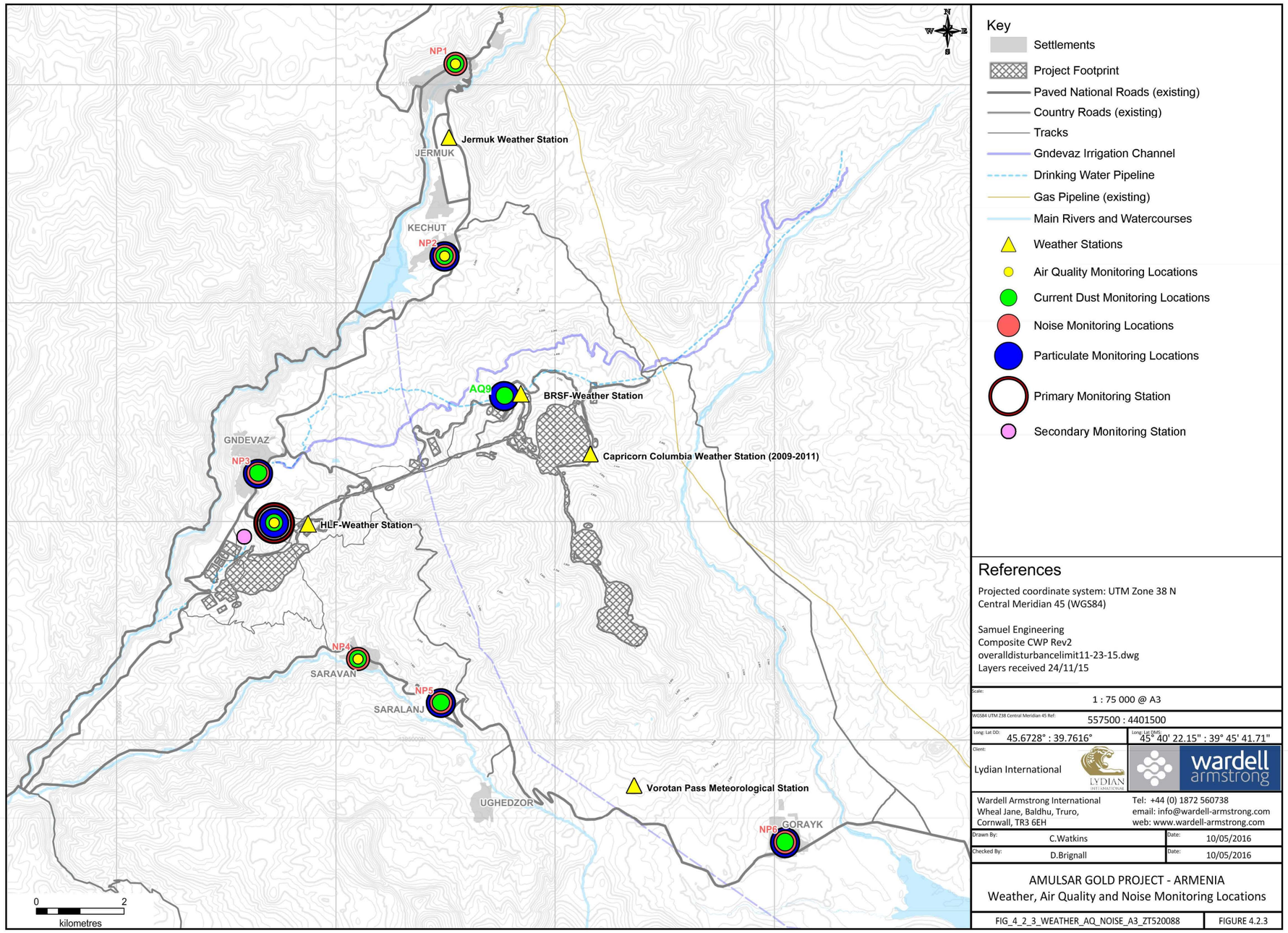


Figure 1: Weather, Air Quality and Noise Monitoring Locations

3 RESPONSIBILITIES

Lydian Armenia, though the Sustainable Development Department, is responsible for the implementation of this AQNVMP. For details of specific roles and responsibilities please refer to the **0-00-MAN-ENV-82043 ESMS Manual**.

4 REQUIREMENTS

4.1 REGULATORY REQUIREMENTS AND PROJECT STANDARDS

4.1.1 Air quality

The air quality standards adopted by the Project are based on the IFC Environmental, Health and Safety (EHS) Guidelines (2007) and EU Directive 2008/50/EC (Table 2).

Table 2: Project standards for air quality

Pollutant	Receptor	Averaging Period	Guideline Value for human health in µg/m³	Critical Level for vegetation in µg/m³
Sulphur Dioxide (SO_2)	Human	24-Hour	20	N/A
	Vegetation	Calendar Year and Winter (1 October to 31 March)	N/A	20
Oxides of Nitrogen (NO_x)	Vegetation	Calendar Year	N/A	30
Nitrogen Dioxide (NO_2)	Human	Calendar Year	40	N/A
Particulate Matter PM_{10}	Human	24-hour	50	N/A
Particulate Matter $PM_{2.5}$	Human	24-hour	25	N/A
Ozone	Human	N/A	N/A	N/A

Notes:
The 24-hour referencing period for human health criteria has been selected for the Project Compliance Target and will be based on the Guideline Values and monitored biannually.
Ambient Air Quality Guidelines for Human Health are from the IFC EHS Guidelines, and Critical Levels for Vegetation are from EU Directive 2008/50/EC.

For monitoring purposes, Project compliance trigger and target levels have been set for NO_2, SO_2, PM_{10}, $PM_{2.5}$ and nuisance dust (Table 3). The more stringent trigger levels represent concentrations at which investigation is required, potentially triggering additional or revised mitigation and management measures.

Table 3: Project compliance criteria for air quality

Parameter	Measuring period	Compliance target	Compliance trigger
NO_2	One month	40 µg/m³	35 µg/m³
NO_2 (vegetation)	One year	30 µg/m³	-

Table 3: Project compliance criteria for air quality			
Parameter	**Measuring period**	**Compliance target**	**Compliance trigger**
SO_2	One month	20 µg/m^3	15 µg/m^3
PM_{10}	24 hours	50 µg/m^3	45 µg/m^3
$PM_{2.5}$	24 hours	25 µg/m^3	22 µg/m^3
Dust	2 weeks	%EAC 2.5 - 5	%EAC above 2.5 for two consecutive monitoring periods

4.1.2 Noise

The Armenian Order No. 138 sets out sanitary norms regarding 'Noise at Workplaces, Residential and Public Buildings and Premises of Housing Development'. Of the norms tabulated in Order No.138, norm 9 and norm 12 are relevant.

The IFC EHS Guidelines (April 2007) state that absolute noise level should not exceed certain guideline limits. In addition, the existing baseline (ambient) noise level should not be increased by more than 3dB at any off-site noise sensitive receptor (such as inhabited areas), because of site noise levels associated with the Project.

To ensure that the noise levels at sensitive receptors are maintained at an acceptable level, noise modelling has been undertaken to establish noise limits at the Primary Monitoring Station (PMS) and Secondary Monitoring Station (SMS). Noise limits for the PMS and SMS have been calculated by reviewing the relationship between the predicted noise levels at Gndevaz with the predicted noise levels at the monitoring locations.

The Primary and Secondary Monitoring Stations are to be located at (553161,4400129) and (552878,4399495) respectively. Any significant change in the location of either Monitoring Station should be reviewed to ensure the assigned noise limit is still valid.

Table 4 lists the compliance criteria that have been adopted for the Project. They are a combination of the Armenian and IFC standards described above; the more stringent criteria have been adopted.

Table 4: Project compliance criteria for noise		
Receptor	**A-weighted broadband sound pressure level, $L_{Aeq,1hr}$ (dB)**	
Edge of community closest to mine	**Daytime (07:00-22:00)**	**Night time (22:00-07:00)**
Absolute noise level (compliance criteria - not to be exceeded)	45 [a]	45 [b]

Table 4: Project compliance criteria for noise		
Receptor **Edge of community closest to mine**	**A-weighted broadband sound pressure level, $L_{Aeq,1hr}$ (dB)**	
	Daytime (07:00-22:00)	**Night time (22:00-07:00)**
Predicted site noise level should not exceed the background (or ambient) by:	+3 [b]	+3 [b]
Notes: Compliance is measured at residential properties within communities Source of compliance criteria: [a] Republic of Armenia Order 138; norm 9 and 12 [b] IFC EHS Guidelines		

Project standards have been derived based on baseline noise monitoring. Individual standards for each surrounding community are provided in Table 5 and Table 6 for day and night, respectively.

Table 5: Day-time noise standards for local communities			
Location	**Measured baseline noise level (dB $L_{Aeq\ (1\ hour,\ free\ field)}$)**	**Predicted site noise level dB $L_{Aeq\ (1\ hour,\ free\ field)}$)**	**Project standard – compliance target dB $L_{Aeq\ (1\ hour,\ free\ field)}$)**
Construction – day			
Primary monitoring station (PMS)	N/A	58	60*
Secondary monitoring station (SMS)	N/A	56	58*
Jermuk (NP1)	50	15	50
Kechut (NP2)	43	25	43
Gndevaz (NP3)	40	39	43
Saravan (NP4)	48	31	48
Saralanj (NP5)	49	28	49
Gorayk (NP6)	47	10	47
Operations - day ('worst case', for Stages 1 to 4)			
Primary monitoring station (PMS)	N/A	44	50*
Secondary monitoring station (SMS)	N/A	50	59*
Jermuk (NP1)	50	22	50
Kechut (NP2)	43	31	43
Gndevaz (NP3)	40	36	41
Saravan (NP4)	48	33	48
Saralanj (NP5)	49	34	49
Gorayk (NP6)	47	24	47
* Noise limits for the PMS and SMS have been calculated by reviewing the relationship between the predicted noise levels at Gndevaz with the predicted noise levels at the monitoring locations.			

Table 6: Night-time noise standards for local communities			
Location	**Measured baseline noise level (dB $L_{Aeq\ (1\ hour,\ free\ field)}$)**	**Predicted site noise level dB $L_{Aeq\ (1\ hour,\ free\ field)}$)**	**Project standard – compliance target dB $L_{Aeq\ (1\ hour,\ free\ field)}$)**
Construction - night			
Primary monitoring station (PMS)	N/A	58	58*
Secondary monitoring station (SMS)	N/A	56	56*
Jermuk (NP1)	42	16	42
Kechut (NP2)	36	26	36
Gndevaz (NP3)	38	33	39
Saravan (NP4)	40	26	40
Saralanj (NP5)	43	27	43
Gorayk (NP6)	38	11	38
Operations - night ('worst case', Stages 1 and 4)			
Primary monitoring station (PMS)	N/A	44	48*
Secondary monitoring station (SMS)	N/A	50	57*
Jermuk (NP1)	42	22	42
Kechut (NP2)	36	31	37
Gndevaz (NP3)	38	36	40
Saravan (NP4)	40	33	41
Saralanj (NP5)	43	34	44
Gorayk (NP6)	38	24	38
* Noise limits for the PMS and SMS have been calculated by reviewing the relationship between the predicted noise levels at Gndevaz with the predicted noise levels at the monitoring locations.			

Section 2.3 of the IFC EHS Guidelines (April 2007) provides guidelines for noise impacts on workers. Armenian Order 138 specifies a maximum equivalent allowable sound pressure level in the workplace. The most stringent of these guidelines are combined in Table 7 and these will be used by the Project as the relevant compliance criteria.

Table 7: Project compliance criteria for occupational noise		
Location / Activity	**Equivalent level LAeq, 8h, dB(A)**	**Maximum LAmax, fast, dB(A)**
Heavy industry (crushing plant, open pit and areas of the Project with mechanical operations, static and mobile equipment)	80 [a]	110
Light industry (Areas within the Project with limited static plant and mobile equipment)	50-65	110
Notes: Details and zones to be based on detailed work place occupation noise assessment (see OHSP) [a] Republic of Armenia Order 138		

4.1.3 Vibration and air overpressure

The Republic of Armenia has not published guidelines or limits for blasting overpressure and vibration. In order to select compliance criteria for the Amulsar Project in this field, a number of international standards were reviewed. These included standards by the US Bureau of Mines, British Standard BS7385 (1993), German DIN 4150 part 3 and the Spanish UNE22 381 93.

The Australian and New Zealand Environment Conservation Council (ANZECC) (1990) "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration" is the most conservative of the standards reviewed, and has been used as the compliance criteria for the Project. Compliance criteria are shown in Table 8.

Table 8: Airblast and ground vibration standards

Criterion	Recommended Limit
Maximum level for airblast	115 dBL [a]
Maximum ground vibration	5 mm/s, Peak Vector Sum (PVS) vibration [b]

Notes:

[a] The level of 115 dBL may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dBL at any time.

[b] PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

More stringent trigger levels have been set for the Project, which if exceeded will require an investigation to be undertaken, potentially resulting in a change in methodology or application of additional management and mitigation measures. They are:

- Vibration: Peak Particle Velocity 1 mm/s
- Air overpressure: 110 dBL

4.2 AIR QUALITY MANAGEMENT

In addition to the management measures identified in the ESIA (Appendix A), further good practice mitigation and management measures identified for the project are:

Minimising dust generation

- Construction footprints will be limited to the extent necessary. Consideration will be given to suspending earthworks in windy conditions. Drop heights will be minimised in all activities (e.g. HLP stacking, soil stockpiling and BRSF rock placement).

- Dust extractors and filters should be fitted to drilling rigs. Water flush, rather than air flush, is preferred.
- Blasting to be designed to minimise over-fragmentation, and fly-rock control measures should be employed during pit pre-stripping.

Monitoring

- A standard operating procedure (SOP) has been developed for routine visual monitoring to identify sources of dust emission (document reference **0-00-PRO-ENV-82131**).
- Visual inspections and assessment of dust analysis results will be reviewed and any necessary changes to the mitigation measures in use made. The introduction of any changes to mitigation measures will be documented. Once implemented any changes will be monitored to determine their effectiveness, and further changes made as required until they are proven successful.

Corrective actions

With the exception of visual monitoring, the nature of the methods used for recording dust and particulate deposition mean that an immediate response to breaches of agreed action levels is unlikely to be possible. However, if analysis is received which indicates that there has been an exceedance of Project standards, then appropriate investigations will be completed and remediation measures taken. These actions could include, but may not be limited to:

- Analysing the weather conditions during the period in which the exceedance occurred;
- Increased regularity of watering haul roads during dry weather;
- Inspecting vegetation near the detected breach to ascertain if major deposition occurred; and
- Checking covers on conveyors to ensure they remain intact.

4.3 MONITORING PLAN

Air quality and noise and vibration monitoring is managed under the EMP. The monitoring requirements are summarised below, with the specifications of the required equipment and method of use included in Appendix B.

The primary monitoring station for noise, air quality (including dust and particulates), air overpressure and ground vibration will be located to the west of the livestock farm at Gndevaz and in the curtilage of an apartment block acquired by Lydian Armenia. Monitoring locations at the nearest residential receptors (settlements) and the primary monitoring station are shown in Figure 1. This location is easily accessible from the H-42 and has the benefit of a power supply. Therefore, long term monitoring of noise and particulates can be maintained, with results displayed for participatory monitoring consultations. The monitoring station will also be included as a monitoring station for periodic monitoring, as identified in the following sections.

4.3.1 Visual Assessment

Visual assessment is important for the day-to-day management of dust on site. The monitoring stations discussed below provide back-dated data to measure the success of the processes implemented through visual inspections of operations.

Visual inspections should be undertaken at least once a day, and preferably more often especially if wind direction or strength changes during the working day. In order for visual inspections made by different staff members to be comparable, training of environmental staff, shift supervisors and mine management to develop a consistent approach to auditing dust emissions will be carried out. A record is to be made of any exceptional events that trigger additional dust management.

4.3.2 Air Monitoring

Dust monitoring is to be conducted at a number of locations on site, determined by current operations and prevailing wind direction. Climate data should be analysed in conjunction with dust and noise monitoring results.

As operations develop the location of the monitoring points will be reviewed to ensure adequate coverage is maintained. All reviews and the rationale for any changes will be recorded in an Environmental File Note.

Gaseous pollutants NO_2 and SO_2 will be monitored and a representative baseline has been established at the communities around the project area using passive samplers. Details of the monitoring equipment are provided in Appendix B.

4.3.3 Stack Emission Monitoring

The processing plant will incorporate a stack to remove the gaseous products associated with the heating of the ore during the processing operation. This stack will be provided with a monitoring port to facilitate intermittent isokinetic monitoring of the flue gases within the stack. The determinants to be monitored and the frequency of monitoring will be agreed and presented in annual reports.

4.3.4 Noise Monitoring

Monitoring of noise and reporting of results will take place using the pro-forma in Appendix C. During the construction and operational phase of the development, ambient noise level surveys will be undertaken quarterly at locations considered representative of nearest identified sensitive receptors to the Project boundary. Long term noise compliance monitoring will take place at the Primary and Secondary Monitoring Stations located between the site operations and Gndevaz community. Additional monitoring of noise levels will take place in response to any complaints received through the established company complaints and grievance procedure.

4.3.5 Vibration Monitoring

Vibration monitoring will be undertaken during each blast and as required in response to complaints relating to vibration from site operations. Qualified subcontractors or suitably trained staff will undertake the vibration monitoring using appropriate equipment that meets relevant guidance. Calibration certificates for equipment used will be required in accordance with current guidance and a copy kept on file.

4.3.6 Record Keeping and Reporting

Reporting records will be retained on site in accordance with the ESMS Document Control Procedure (**0-00-PRO-ENV-82014**).

5 REFERENCES

British Standards Institute OHSAS 18001:2007 Occupational Health and Safety Management Systems – Requirements.

International Organization for Standardization ISO 14001:2015 Environmental Management Systems – Requirements with Guidance for Use.

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

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

British Standard BS7385 (1993). Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration German DIN 4150 part 3 (2016). Vibrations in buildings - Part 3: Effects on structures

Spanish UNE 22-381-93. (1993) Control de vibraciones producidas por voladuras

The Australian and New Zealand Environment Conservation Council (ANZECC) (1990) Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration.

Appendix A

Air Quality, Noise and Vibration Management Commitments

Key to project phase(s)to which commitment applies

P Pre-construction
Const Construction
Ops Operations
Clo Closure, rehabilitation and aftercare

Air Quality Commitments

Commitment	ESIA page	Project Phase
Enclosure of primary and secondary crusher and screens with dust extraction and filtration devices.	6.6.24	P
The transfer of crushed ore between the crushing plants, screening plant, transfer stations, and truck loadout facility will be via enclosed conveyor from the crushing/screening building to the loadout area for the HLF	6.6.24	P
Use of water sprays at conveyor discharge points and other identified dust emission points, updated as required by the AQNVMP (Appendix 8.14);	6.6.24	Ops
Use of dripper application system at the HLF (see Section 3.10.3).	6.6.24	P, Ops
Lydian will carry out appropriate dust suppression techniques including spraying roads with water and/or application of stabilising agents such as salt (winter), gravel, or environmentally inert chemicals, as appropriate. In addition, Lydian will supply adequate equipment and personnel to maintain road surfaces to control dust on the haul and access roads	6.6.24	Ops
The primary access junctions will be surfaced with tarmac to mitigate the spread of dust onto the public highway and reduce the potential impact of dust on the communities of Kechut and Gndevaz.	6.6.24	P, Const
Speed limits will be posted and enforced on haul and access roads, and off-road travel will be restricted to the maximum practical extent. Instruction on driving safety and observation of speed limits will be included in the new employee orientation, annual refresher training, and task training for specific job assignments.	6.6.24	Const, Ops
Operations will be optimized to limit the number of vehicle movements.	6.6.30	P, Const, Ops
Truckloads of dust-generating material will be damped down.	6.6.30	Const, Ops
The gravel/laterite layer on unpaved roads and traffic areas will be maintained.	6.6.30	Const, Ops
This work will proceed concurrently with operations, and the BRSF will be progressively capped and re-vegetated	6.6.25	Ops
To supplement the dust suppression measures outlined above, shrubs may be planted in appropriate locations between the HLF and Gndevaz (see Section 6.5). Vegetative barriers will only be used in circumstances where the public consultation program has indicated that such additional measures are needed and acceptable to stakeholders	6.6.25	Const, Ops
Use of modern, energy efficient electrical equipment and mobile plant with fuel-efficient engines and fleet management to ensure timely maintenance and notification of equipment malfunction that may result in an increase in emissions.	6.6.25	P, Const, Ops

Commitment	ESIA page	Project Phase
Exhaust controls on mobile equipment must be properly installed, maintained, and replaced as needed throughout the useful life of the equipment. Procurement of updated equipment with emissions controls and proper operation, care, and maintenance of the equipment will reduce combustion emissions to acceptable levels for vehicles and generators, as well as allowing the equipment to run more efficiently and increasing its operational lifespan	6.6.25	Const, Ops
Use stack control equipment on ADR Plant emissions. Monitor ADR Plant emissions	6.6.31	P, Ops
The small quantity of collected mercury (estimated to be less than 60kg per year) will be kept in a closed container. The recovered mercury will be sold as a by-product to certified consumers as it is generated	6.6.26	Ops
Project facilities will incorporate appropriate waste handling and disposal procedures	6.6.26	Const, Ops
Waste disposal facilities will be operated in a manner that includes the regular covering of exposed refuse with soil or gravel	6.6.26	Const, Ops
Consider installing a gas relief system for solid waste disposal area	6.6.31	P, Const, Ops
Sewage treatment facilities will be operated properly and monitored for operational performance, including nuisance odours	6.6.26	Const, Ops
Visual inspection – routine visual monitoring to identify sources of dust emission, these inspection position will be determined to demonstrate coverage of identified sources of dust, including open pits, haul roads, crushing plant, BRSF and conveyor load out points	6.6.26	P, Const, Ops
This dynamic audit would be undertaken through a schedule to be developed in the air quality management plan and will require the training of environmental staff, shift supervisors and mine management to develop a consistent approach to auditing dust emissions	6.6.27	Const, Ops
Meteorological station – location, download procedures, analysis of results and persons responsible for data collection and dissemination	6.6.26	P, Const, Ops
Location, collection, replacement and analysis of diffusion tubes (NOx and SOx), to include the procedures for the collection of active tubes (sample number, date, time and location reference), procedure to ensure that tubes are not contaminated between the sampling location and site offices, and procedures for shipment to accredited laboratory. Chain of custody documentation. Location, collection and replacement of DustScan sticky pads, to follow similar procedures as those for the diffusion tubes. Environmental sampling and maintenance procedures for Osiris and EPAM 500 monitors	6.6.27	P, Const, Ops
The location of the monitoring instruments will be determined in a revision of the Level 2 AQNVMP. Dependent on suitable positions, this SOP will therefore be informed by an audit of the site at the onset of the operational phase, when the final details of the plan will be designed. The SOP will define the monitoring requirements and periods for the use of the equipment, which will be directed towards areas of the operation where the effectiveness of mitigation measures can be determined, thus providing feedback to the aims and objectives of the AQNVMP	6.6.27	P, Const, Ops
Use employee personnel protective equipment where required and occupational medical monitoring	6.6.31	Const, Ops

Commitment	ESIA page	Project Phase
A Primary Monitoring Station (PMS) will be established prior to commencement of construction to continuously monitor particulates; to monitor vehicle exhaust gases; to record dust deposition (to be summarised monthly); and to monitor day and night-time noise levels, air overpressure and ground vibration.	6.6.29	

Noise and Vibration Commitments

Commitment	ESIA page	Project Phase
Blasting will occur during daylight hours only up to 3 times a week	6.7.3	P, Ops
Lydian will investigate the optimal technology to be used for reversing alarms on haul trucks, to balance the requirement of occupational health and safety, for workers deployed on the HLF and to minimise/remove the audibility of alarms within the nearest community of Gndevaz.	6.7.3	P
Standard noise mitigation and best practices will be adopted from the Occupational Health and Safety Plan (OHSP, Appendix 8.7) to protect workers. Appropriate mitigation measures will be required to ensure that residual impact on workers is safe and minimised in accordance with international best practice	6.7.10	Const, Ops
The static plant located in the crusher and ADR facility processing areas will be housed within a building, and breakout points in the facade of these buildings (i.e. doors, windows etc.) will be minimised, as well as minimising the reverberant noise inside the buildings, which will be controlled through sound absorptive material	6.7.24 6.7.25	P, Const
Soil mounds constructed adjacent to haul roads should be located to provide additional attenuation between the haul trucks and the nearest community	6.7.24	P, Const
Construct closed conveyor from crushing plant to HLF, test and prepare for operational use following commissioning of the crushers, as the use of the conveyor for transportation of crushed rock is a significant noise abatement measure, compared to use of dump trucks on haul routes	6.7.24	P, Const
During detailed construction design, consider the use of noise barriers, baffles, or enclosures to provide abatement for noisy equipment such as generators, compressor, pumps, gearboxes; and maintain an adequate distance between the stationary noise sources from nearby communities	6.7.24	P
Position containers for use as temporary noise barriers when possible	6.7.30	Const
All mobile plant should undergo regular inspection and maintenance; to ensure that they have designed mufflers are perform to an adequate standard and that worn parts are replaced	6.7.24	Const, Ops
Schedule noisy construction activities, so that when new activities commence, local communities can be made aware of the activity in advance, through existing stakeholder engagement mechanisms	6.7.24	Const, Ops
Where practical, noisy construction related activity should be undertaken during the “normal working” daytime period	6.7.24 6.7.33	Const, Ops
Maintain the surface of haul roads in good condition and impose a speed limit	6.7.24	Const, Ops

Commitment	ESIA page	Project Phase
Workers will be trained in noise abatement best practices, including avoiding unnecessary revving of engines and switching off equipment when it is not required	6.7.24	Const, Ops
Haul routes will be well maintained and where steep gradients are required operatives will be trained to minimize engine noise through avoiding unnecessary revving, etc	6.7.24	Ops
Drop height for materials will be minimised	6.7.24	Ops
Vehicle and plant start-ups will be sequenced to avoid simultaneous noise bursts	6.7.24	Const, Ops
All vehicles will be fitted with reversing alarms that take account of use and area of activity within the footprint of the Project, such that the requirements for occupational health and safety and environmental noise control are achieved	6.7.25	Ops
Provide an air inlet silencer and exhaust silencers for stationary combustion engines and other units (for example generators)	6.7.25	Ops
Perform regular inspection and maintenance of material handling vehicles and equipment to ensure that they have quality mufflers installed, worn parts are replaced, and lubricants are applied so that the design noise-output specifications continue to be met	6.7.25	Ops
When plant equipment has to be replaced, the selected plant will have a sound power level equal to or less than the plant that it is replacing	6.7.25	Ops
Blast design will include face profiling and explosive packing to maintain high level of environmental performance for each blast	6.7.25	Ops
Lydian employees and contractors involved in mining and blasting operations will be issued and will wear appropriate hearing protection in high-noise areas. Such areas will be designated by signage in the appropriate language, and employees and contractors will be trained in hearing protection procedures	6.7.25	Ops
Consultation will be held with herders to ensure they are aware of the presence of the restricted access zone around the BRSF to minimise their noise exposure	6.7.25	Ops
Complaints related to noise or vibrations related to mining and blasting activities will be monitored through the stakeholder engagement activities and the Project's complaints and grievance process, including the use of drop boxes to encourage comments on performance	6.7.25	Ops
Noise monitoring will be undertaken in accordance with the AQNVMP (Appendix 8.14) and following any complaints from within the affected community receptors	6.7.25	Const, Ops
All measured data will be logged and maintained as a record for the site ESMS, which should be available on request and published annually for the duration of the Project	6.7.25	Const, Ops
Enforce speed limits in relation to road conditions and location of sensitive receptors such as local communities	6.7.26	Const, Ops
Maintain access road surfaces in good repair to reduce tire noise	6.7.26	Const, Ops
Ensure continuous traffic flow to avoid prolonged idling	6.7.26	Const, Ops

Commitment	ESIA page	Project Phase
To minimise the impact of the perception of blasting on nearby residents, community engagement publicity will include providing information to the residents in affected communities identifying when blasts are likely to occur (periods during each working day); how long each blasting schedule will last; and how frequently the blasting will take place. The public engagement will commence prior to the construction phase in order to identify where blasting will take place for construction, the periods when these activities will take place over and a schedule of blast frequency and times for each of the activities.	6.7.26	Ops
All blasts will have an exclusion (or evacuation) zone established prior to firing of the shot. The size of the exclusion zone shall be such that all fly rock and associated debris is contained within the zone, as well as consideration on impacts of blast environmental limits on humans and where required, animals	6.7.26	Ops
A 500m restricted area will be established around the pits	6.7.26	P, Ops
Prior to the start of construction activities, the Project will conduct a crack and damage survey of structures within the defined potential area of influence of blasting and heavy equipment traffic vibrations, to document baseline structural conditions for sensitive receptors. This survey to be conducted by Lydian and independent surveyors commencing in spring 2015	6.7.26	P
During the early stages of operation, it is good practice to monitor both ground vibration and air overpressure at the nearest sensitive receptors to ensure compliance with the air overpressure and vibration criteria outlined in this assessment. A record of the crack and damage survey and monitoring programme results, together with blast design and mine plan geometry at the time will be maintained. This information will identify suitable monitoring locations and programmes in the event of a complaint at any stage of the operational life of the mine. Should the measured data indicate that the criteria are not being met, the blasting design will be modified to ensure compliance	6.7.26	P
All air overpressure and vibration monitoring will be carried out in accordance with the relevant guidance and the AQNVMP	6.7.26	Ops
Type 1 Cirrus noise meters with environmental monitoring kits will be used for noise monitoring and suitable maintenance requirements and non-conformance procedures will be identified	6.7.27	Const, Ops
The SOP will define the monitoring requirements and periods for the use of the equipment, which will be directed towards areas of the operation where the effectiveness of mitigation measures can be determined. The procedure will ensure that representative data is collected, and suitable records retained throughout the duration of the Project	6.7.27	Const, Ops
The SOP will define the vibration monitoring requirements and periods for use of the equipment	6.7.27	Const, Ops
The procedure will detail actions to be undertaken in the event that noise specific complaints are received by the operator either directly or through the dedicated liaison mechanisms implemented as part of the project	6.7.27	Const, Ops
A Primary Monitoring Station (PMS) will be established prior to commencement of construction to continuously monitor particulates; to monitor vehicle exhaust gases; to record dust deposition (to be summarised	6.7.27 6.7.28	

Commitment	ESIA page	Project Phase
monthly); and to monitor day and night-time noise levels, air overpressure and ground vibration.		

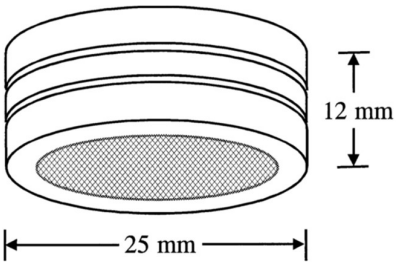
Appendix B

Monitoring equipment

Air quality monitoring

IVL passive samplers

IVL diffusive samplers are designed for passive sampling of airborne gases. The disc contains an adsorbent material which is then analysed in a laboratory accredited to EN ISO/IEC 17025:2005. Recommended exposure length is typically in the order of four weeks, after which time they are removed from their sampling location and returned to the laboratory for analysis. Monitoring is to be continuous (based on four-week sampling periods) throughout construction phase and during the first year of operations. The requirement for subsequent monitoring should then be determined following a review of historical data collected.



IVL sampler

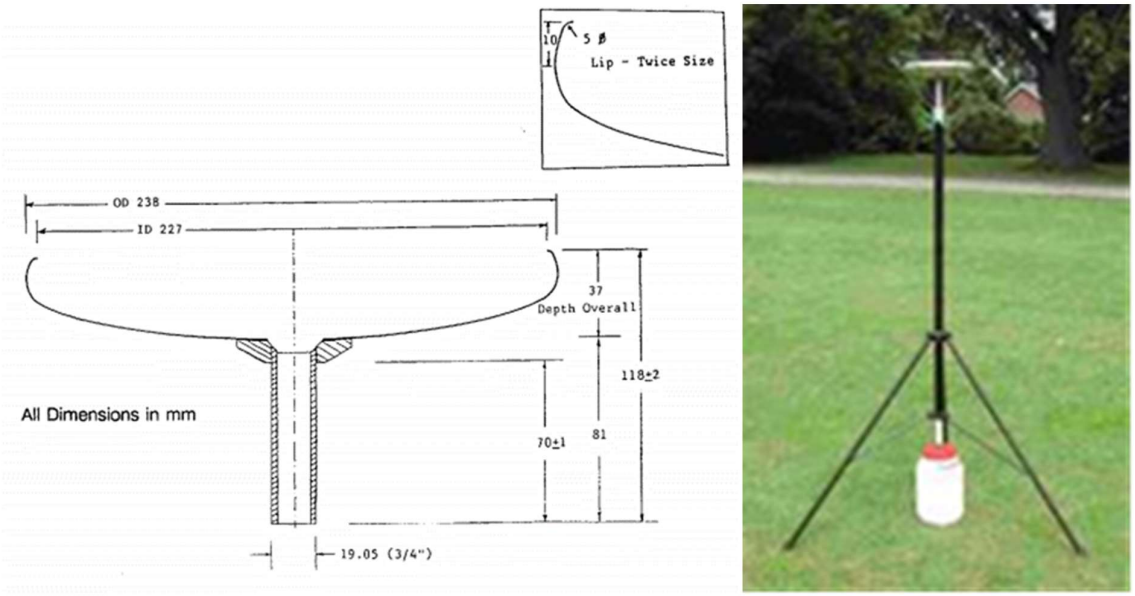
Frisbee dust deposit gauge

In addition to the monitoring infrastructure in place for the construction phase, Frisbee Gauges may be required during the Operational life of the mine and will enable the analysis of the deposited dust for its chemical components some of which, respirable silica for example, may have an impact on the Occupational Health & Safety of mine workers.

The Frisbee Gauge is a static monitoring point which can be positioned at suitable locations around the site. It gives a measure of the total wet and dry deposition (mg/m^2/day) at that location, and the sample can be collected for analysis of constituents. This allows for an assessment of the composition of the dust as well a generalised assessment of the direction.

Frisbee gauges consist of an upturned Frisbee with a loose-weave foam insert, mounted on a tube which feeds a 5 – 10 litre collection pot. The dust gets caught in the foam and washed through into the pot by precipitation. The contents of the collection pot are filtered, and the

particulate on the filter can then analysed to provide a size range and chemical composition of the dust collected.



DustScan DS100

The DS100 directional gauge is a static monitoring point which can be situated at suitable locations around the site. The equipment measures "dust flow" from different directions and gives an indication of the relative contribution; it does not give an actual measurement of dust deposition.

DS100 Directional Dust Gauge

The gauges have two sticky pads which collect airborne dust as it passes over them. They are held in place and protected with a removable rain cap at the top of a post, which can be strapped to a site structure or sited independently. The sampling head has a North marker which is aligned

to magnetic North and the sample cylinders are fitted with North markers to ensure directional information is retained after the sample is collected. Once removed, the sample cylinders are packed in the supplied transport flasks and shipped back to DustScan in the UK for analysis.

The percentage Effective Area Covered (%EAC) monitored over a period of two weeks can be used to determine whether a soiling or dust nuisance is likely to be a factor of concern (see table below).

%EAC/period	Nuisance potential*
<2.5	Very low
2.5 - 5	Low
5 - 15	Medium
15 - 25	High
>25	Very high
* Based on Dustscan Guidance Note No.3 Directional Dust Data Assessment	

Turnkey Osiris particulate monitor

The Osiris monitor measures suspended particulates and can be used either as a portable instrument or deployed as a semi-permanent installation. Osiris can provide a continuous indication of total suspended particulates (TSP), PM10, PM2.5 and PM1 particles. In the "workplace" mode it can indicate inhalable, thoracic and respirable concentrations.

The equipment can be operated manually or automatically depending on its location. The unit draws an air sample by using a pump, at a rate of 10cc per second. The analysis is carried out using a light scattering technique and can detect particles from 0.4 microns to 20 microns in size. The heated TSP inlet means that the accurate operational range is increased although in very wet weather or prolonged outdoor use, the manufacturers recommend the addition of a Weather Shield to the instrument. It is also possible to collect a gravimetric sample from the instrument's filter if this is required. This instrument is to be located at the Primary Monitoring Station for continuous use with data availability for participatory monitoring consultations.

EPAM 5000 particulate monitor

The EPAM 5000 is a portable monitor for ambient and environmental monitoring. Interchangeable size-selective sampling heads for PM10, PM2.5, PM1.0 and TSP provide for different size fractions. The instrument must be operated manually and is to be used for periodic compliance monitoring at community monitoring locations.

EPAM 5000 monitor

Noise monitoring

Environmental noise monitoring will be undertaken using type-1 Cirrus noise meters. The meters will be maintained and calibrated in accordance with the manufacturer's recommendations and the requirements of the relevant noise guidelines.

The noise meters will measure noise levels in decibels (dB). Each will be protected with an

environmental monitoring kit, which will keep the meter dry and can be strapped to a site structure or sited independently. Once removed, the noise results can be downloaded to a computer and analysed using proprietary software provided by the equipment manufacturer. One instrument will be located at the Primary Monitoring Site for long term use with other instruments available for compliance monitoring at community monitoring locations.

Cirrus Type 1 Noise Meter

Blast vibration and air overpressure monitoring

Environmental monitoring for airborne overpressure will be carried out at locations between the mine site and the local communities and existing infrastructure. Monitoring of ground vibration during blasting will take place at residential receptors to be selected prior to commencement of blasting.

Air overpressure will be monitored using the Cirrus noise meters used for environmental monitoring purposes which will be maintained and calibrated in accordance with the manufacturer's recommendations. Vibration monitoring will be carried out using specialist instruments to be identified and purchased/hired prior to commencement of blasting operations.

Appendix C

Noise and vibration survey pro-forma

Noise and Vibration Monitoring Record

Survey Date:	**Survey Time:** *Monitoring Start and End Time*	**Staff name:**
Monitoring Location: *location within site / distance from site activities and other noise/vibration sources. Reference to plan showing location of monitoring where possible*		
Weather Conditions		
Temperature *eg: data from site weather station*	Wind speed & direction *eg: data from site weather station or description from observations.*	Precipitation *eg: current conditions and previous precipitation events (i.e. within 2hrs)*
Cloud Cover *eg: full, partial, none – in % if possible*	Snow cover *eg: high altitude only, all levels, partial*	
Noise monitoring should not be undertaken during precipitation events or when wind speeds exceed the working range of the microphone windshield (5m/s)		
Noise Monitoring Observations		
observations about specific monitoring points eg: dominant noise and vibration sources, disturbance/damage to equipment, missing equipment, any other relevant noise/vibration comments including dominant sources, duration of each activity per day (or as a proportion of the monitoring period) and distance from monitoring location (nearest point and average distance if source is mobile)		
Noise Monitoring Equipment:		
Noise and Vibration Levels: *Report noise levels in dB and vibration levels (PPV / acceleration (m/s^2) as appropriate* *(L_{Aeq} and $L_{Amax, fast}$ dB levels required as a minimum)*	dB L_{Aeq}	dB $L_{Amax, fast}$

Appendix D

Noise Modelling Memo

A review of the Amulsar noise modelling assessment and proposed Primary and Secondary Monitoring Station

Wardell Armstrong LLP have undertaken a noise modelling assessment to establish the potential noise impact at the closest sensitive receptors and to establish noise limits for Monitoring Stations. During the modelling process, it was identified that due to the expanse of the site operations, two Monitoring Stations would be required to ensure that the noise limits at sensitive receptors are met. These are the Primary Monitoring Station (PMS) and the Secondary Monitoring Station (SMS).

The assessment concentrates on the most sensitive receptor of Gndevaz. In addition to the PMS and SMS, periodic monitoring checks will be undertaken at all sensitive receptor locations.

Noise Modelling

Noise Modelling has been undertaken to establish the potential noise impact from the construction and operational phases of the Amulsar Gold Project. The noise modelling will predict the noise impact at the most sensitive receptor location and indicate suitable day and night-time noise limits at a Primary Monitoring Station (PMS) and Secondary Monitoring Station (SMS), for all phases of the project.

Receptor and Monitoring Locations

The following locations have been considered within the noise modelling assessment.

Receptor;

- Gndevaz 2 – (552940,4400605);

Monitoring Stations;

- Primary Monitoring Station (PMS) – (553161,4400129); and,
- Secondary Monitoring Station (SMS) – (552878,4399495).

The co-ordinates for Gndevaz 2 and the PMS have been provided by Lydian International. The SMS have been selected by Wardell Armstrong. Following review of the suggested SMS location, any significant alterations to the SMS location would need to be checked by Wardell Armstrong to confirm the noise limits.

Modelling Scenarios

To establish the potential noise impact during the construction and operation phases of the Amulsar Gold Project, the worst-case noise impact for the construction and operational phases was established. The noise modelling indicated that the following scenarios have the potential to cause the highest noise impact at sensitive receptors. Therefore, the following scenarios have been considered;

- Scenario 1 - Stage 1 Construction Days 1 – 15 (worst-case); and,
- Scenario 2 - Stage 1 Operational.

Assumptions

Prior to commencement with the noise modelling, Lydian International provided a revised Equipment Mobilization and Build Up Plan for the Construction Phases of Stage 1 (Appendix 1). However, noise

data for each plant item was unavailable. Therefore, in the absence of noise data, the following assumptions with regards to plant has been made for each of the three modelling scenarios;

Stage 1 Construction Days 1 – 15

Table 1 – Construction Days (1-15) Primary Sound Sources Assumptions			
Source	**Quantity**	**Sound Power Level L_w (dB)**	**Reference**
30t Dump Truck	12	108	Lydian email (18th November 2015)
CAT 6018 Excavator	5	113	
CAT 336 Back Hoe	2	106	
CAT 992G Wheel Loader	1	116	
CAT D10 Dozer	1	123	
12t Vibratory Roller	2	112	Table C.4 24 BS5228-1
Mobile Crane	1	110	Table C.4 45 BS5228-1
Water Pump	2	107	Table C.4 89 BS5228-1
Diesel Generator	2	94	Table C.4 78 BS5228-1

The plant information used for operational scenario has been taken from the ESIA. The data contained in the ESIA for Year 4 has been used for Scenarios 2.

Assessment Criteria

The Noise and Vibration Management Plan dated February 2016 sets out the project compliance criteria in Table 4. This criterion is shown below;

Daytime

- Absolute noise level (compliance criteria – not to be exceeded) 45dB $L_{Aeq,\ 1hr}$ (Republic of Armenia Order 138; norm 9 and 12); and,
- Predicted site noise level should not exceed the ambient background by +3dB $L_{Aeq,\ 1hr}$ (IFC EHS Guidelines).

Night-time

- Night-time absolute noise level (compliance criteria – not to be exceeded) 45dB $L_{Aeq,\ 1hr}$ (IFC EHS Guidelines); and,
- Predicted site noise level should not exceed the ambient background by +3dB $L_{Aeq,\ 1hr}$ (IFC EHS Guidelines).

Results

Construction

The activities associated with the construction phase of Stage 1 will have the potential to generate noise and create an impact on the local sensitive receptors. Noise level limits for the Project have been defined for the daytime (0700-2300) and night-time (2300-0700).

The noise level likely to be generated during construction days 1-5 at Gndevaz 2, are compared to the daytime limits in Table 2;

Table 2 – Construction Days (1-15) Predictions				
Receptor Location	**Predicted Noise Level L_{Aeq} (dB)**	**Absolute Criteria L_{Aeq} (dB)**	**Background Criteria L_{Aeq} (dB)**	**Difference Compared to the Lower Limit**
Daytime				
Gndevaz 2	41	45	43	-2
Night-time				
Gndevaz 2	41	45	41	0

The predicted noise levels indicted that the proposed construction activities will not exceed the noise limits during any period of the day and night-time. However, to ensure that the limits are met a monitoring program will be undertaken through the life of the construction phases to ensure noise levels are controlled at sensitive receptor locations.

Operational

The activities associated with operational Stage 1 will have the potential to generate noise and create an impact on the local sensitive receptors. Noise level limits for the Project have been defined for the daytime (0700-2300) and night-time (2300-0700) periods.

The noise level likely to be generated during the operational Stages at Gndevaz 2 is compared to the daytime limits in Table 3;

Table 3 – Operational Stage 1 Predictions				
Receptor Location	**Predicted Noise Level L_{Aeq} (dB)**	**Absolute Criteria L_{Aeq} (dB)**	**Background Criteria L_{Aeq} (dB)**	**Difference Compared to the Lower Limit**
Daytime				
Gndevaz 2	37	45	43	-6
Night-time				
Gndevaz 2	37	45	41	-4

The predicted noise levels indicted that the proposed operational activities will not exceed the noise limits during any period of the day and night-time. However, to ensure that the limits are met a monitoring program will be undertaken through the life of the project to ensure noise levels are controlled at sensitive receptor locations.

Monitoring Stations - Noise Limits

To ensure that the noise levels at sensitive receptors are maintained at an acceptable level, noise modelling has been undertaken to establish noise limits at the PMS and SMS.

Noise limits for the both monitoring stations have been calculated by correlating the predicted noise levels at Gndevaz with the predicted noise levels at the PMS and SMS. The resultant limits can be found in Table 4 below, full calculations are detailed in Appendix 2;

Table 4 – Calculated PMS and SMS Noise Limits				
Description	**PMS Construction Days 1-15**	**SMS Construction Days 1-15**	**PMS Stage 1**	**SMS Stage 1**
Background Limit Day	60	58	50	59
Background Limit Night	58	56	48	57

Comparison Between PMS and Quarter 1 2017 Noise Monitoring

The noise monitoring data at the PMS for Quarter 1 2017 indicates the maximum noise levels recorded at the PMS was 56 dB(A) during the day and night-time periods (Appendix 3). This noise level is below the day and night-time noise limits at the PMS for construction days 1-15.

It should be noted that for most the monitoring periods, the measured noise levels were significantly lower than the maximum level identified above.

PMS location recommendations

The noise modelling undertaken within this assessment assumes the PMS to be located at (553161,4400129) and the Secondary Monitoring Location to be located at (552878,4399495). It is understood that the PMS location is close to the Dairy Farm and is due to be relocated. It should be noted that the PMS and SMS noise limits shown in Table 4 should be checked following any significant changes in location.

When undertaking long-term noise monitoring and selecting a location for the PMS and SMS, we would recommend following the guidance;

- Noise monitoring should be undertaken with a Class 1 integrated sound level meter;
- The sound level meter microphone should be mounted vertically on a tripod 1.5m above the ground;
- The sound level meter should be located at a minimum of 3.5m from any other reflective surfaces;
- The PMS should be located away from any noise sources, not attributed to the mining project. For example, any mechanical sources of noise at the Dairy Farm. This is vital to ensure that the noise measured at the PMS is representative of the noise impact from the mining project;
- The PMS should not be screened by any man-made structures. The noise modelling process assumes the PMS to be in a free field location. Therefore, there should be no man-made obstructions between the PMS and the project areas;
- The weather station should be located in close proximity of the PMS to provide localised weather data. Weather condition could have an impact on the measured noise levels at the PMS. Therefore, insuring the weather data is reliable and local to the PMS is important;
- Field calibrate the Noise monitoring equipment on a regular Basis. We would recommend that the noise monitoring equipment is calibrated every month to ensure the accuracy of the data. Any change in calibration should be recorded, were significant changes occur the noise meter should be replaced and sent for laboratory calibration; and,
- We would recommend that the noise meter is laboratory calibrated annually. Or as a minimum bi-annually.

Summary

Wardell Armstrong LLP have undertaken a noise modelling assessment to establish the potential noise impact at the closest sensitive receptors and to establish noise limits for Monitoring Stations.

The modelling process identified that due to the expanse of the site operations, two fixed Monitoring Stations would be required.

The modelling assessment has indicated that the proposed construction and operational activities will not exceed the noise limits during any period of the day and night-time.

To ensure that the limits are met a monitoring program will be undertaken through the life of the project to ensure noise levels are controlled at sensitive receptor locations. The monitoring

programme will use a Primary and Secondary Monitoring Location with fixed noise level limits, along with periodic monitoring of all receptor locations

Noise limits for the PMS and SMS have been calculated for the worst-case construction and operational phases respectively.

The noise management plan should include limits set out in Table 4 for the construction and operational phases.

Any relocation of the PMS or SMS should be supported by a review of the PMS and SMS noise limits to insure correlation remains with the receptor location of Gndevaz.

Equipment Mobilization and Build Up Plan

Status	Equipment Description	Equipment Capacities		Phase 1: Day 1-15	Phase 2: Day 15-30	Phase 3: Day 30-45	Phase 4: Day 45-60	Total
	Dump Trucks	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
Own	Kamaz	20 ton	12m3	12			10	22
Rent	Iveco, Man, or HOWO	35 ton	17 m3		10	8	10	28
	sub-total Dump Trucks							***50***
	Excavators	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
Own	Komatsu PC 200	20 Ton	1.2 m3	2				2
Own	Komatsu PC 300	30 ton	1.5 m3	2				2
Own	Komatsu PC 400	40 ton	1.8 m3	1	2			3
Rent	New Holand	30 ton	1.5 m3			2		2
Rent	Cat	30 ton	1.5m3				2	2
Rent	Cat	40 Ton	1.8 m3				1	1
	Sub-total: Excavators							***12***
	Back Hoe	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
Rent	JCB			2				2
own	Komatsu WB93R-5	9 ton	0.4m3/1.8m3		1			1
	Sub-total: Back Hoes							***3***
	Front Wheel Loader	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
own	Komatsu WA320-5	**13 ton**	2.8m3		1			1
	Skid Steer	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
own	Case	4 ton	0.5 m3	1				1
	Buldozer	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
Own	Komatsu D275A	50 ton		1				1
Own	Komatsu D355A	60 ton			1			1
Rent	Cat D9					1		1
Rent	Cat D10						1	1
	Sub-Total: Buldozers							***4***
	Grader DS 122			1				1
	Rollers	Weight/Capacity	Bucket Capacity	# of Units	# of Units	# of Units	# of Units	
rent	Dynapac CA150	8-9 ton		1		1		2
rent	Bomag BW 216 D-4	15-17 ton	2.13meters width	1			1	2
own	Dynapac CA2500PD	12 ton	2.13meters width		2			2
own	CAT CB 224E	3 ton				1		1
own	Wacker Neuson/Trench Compact	1.8 tons					1	1
	Sub-Total: Rollers/Compactors							***8***
	Mobile Crane							
own	Maz	12 ton	14 meters	1				1
own	**Water Pumps**	various		2	1	2		5
own	**Generator**	various		2	1	2		5
rent	**Crusher**	100-150 ton/hour				1		1
own	**Office Containers**			100 sq meters	100 sq meters	50 sq meters		250 sq meters

Appendix 2

Model Results

Receiver Location	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Dairy Farm	57.9	57.9	43.1	43.1
Monitoring Station	58.3	56	44.3	50.1
Gndevaz 2	41.4	41.4	37.3	33.7

Noise Limits Gundevaz

Absolute Limit	45	45	45	45
Background Limit Day	43	43	43	43
Background Limit Night	41	41	41	41

Comparision with Absolute Limits

Receiver Location	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Dairy Farm	12.9	12.9	-1.9	-1.9
Monitoring Station	13.3	11	-0.7	5.1
Gndevaz 2	-4	-4	-8	-11

Comparision with Daytime Background Limits

Receiver Location	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Dairy Farm	14.9	14.9	0.1	0.1
Monitoring Station	15.3	13	1.3	7.1
Gndevaz 2	-2	-2	-6	-9

Comparision with Night-time Background Limits

Receiver Location	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Dairy Farm	16.9	16.9	2.1	2.1
Monitoring Station	17.3	15	3.3	9.1
Gndevaz 2	0	0	-4	-7

Monitoring Station to Gundevaz Diffrence

Receiver Location	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Monitoring Station	58.3	56	44.3	50.1
Gndevaz 2	41.4	41.4	37.3	33.7
Diffrence	**16.9**	**14.6**	**7**	**16.4**

Daytime Limits

Gndevaz 2	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Measured	41.4	41.4	37.3	33.7
Day Limit	-2	-2	-6	-9
Diffrence	16.9	14.6	7	16.4
Limit at MS	**60**	**58**	**50**	**59**

Night-time Limits

Gndevaz 2	PMS Construction Day 1-15	SMS Construction Day 1 - 15	PMS Stage 1	SMS Stage 1
	Ld dB(A)			
Measured	41.4	41.4	37.3	33.7
Day Limit	0	0	-4	-7
Diffrence	16.9	14.6	7	16.4
Limit at MS	**58**	**56**	**48**	**57**

Quarter 1 2017

Noise data, Primary Monitoring Station, near Gndevaz

Date	Average Daytime* Leq (dBA)	Average Night-time* Leq (dBA)
06/02/2017	43.38696	
07/02/2017	43.8875	41.64444
08/02/2017	46.44545	42.92821
09/02/2017	42.80606	44.84615
10/02/2017	40.91818	40.59189
11/02/2017	44.64545	39.98108
12/02/2017	50.35758	49.61053
13/02/2017	43.49394	49.68421
14/02/2017	42.68788	43.85789
15/02/2017	43.98182	39.35789
16/02/2017	41.51212	40.86053
17/02/2017	56.33636	40.80789
18/02/2017	43.09091	55.54722
19/02/2017	40.67273	39.96111
20/02/2017	41.06667	39.86667
21/02/2017	43.80909	39.39189
22/02/2017	45.09091	42.89737
23/02/2017	44.69697	42.66667
24/02/2017	48.34242	46.31795
25/02/2017	44.82424	46.96316
26/02/2017	47.29091	48.32778
27/02/2017	46.65455	49.51081
28/02/2017	45.20909	43.86316
02/03/2017	45.39259	44.14583
03/03/2017	43.88889	41.35217
04/03/2017	44.2875	41.65
05/03/2017	44.69394	45.13684
06/03/2017		44.11633

* Daytime is 07:00 – 22:00; Night-time 22:00 - 0700

“Spot” noise measurements*

Location	Date	Average Daytime* Leq (dBA)	Average Night-time* Leq (dBA)
Kechut	04/03/2017	44.22	
Kechut	05/03/2017	43.54	39.57
Kechut	06/03/2017	41.76	42.04
Kechut	07/03/2017		35.70
Saravan	08/03/2017	34.33	
Saravan	09/03/17		34.10
Gndevaz	09/03/2017	37.27	
Jermuk	10/03/2017	41.64	
Saralanj	10/03/2017	31.14	33.63

* not necessarily full daytime (15 hour) or night-time (9 hour) measurements