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6.6 Air Quality

6.6.1 Introduction

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

6.6.2 Project Activities Related to Air Quality

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

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

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

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

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

6.6.3 Air Quality Significance Criteria

The significance of an environmental impact for air quality emissions is determined by the interaction of magnitude and sensitivity. The methodology for determining the magnitude of impact and sensitivity of the receptor with regard to air quality is shown in Table 6.6.1 and Table 6.6.2.

Table 6.6.1: Methodology for Determining Sensitivity

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

Table 6.6.1: Methodology for Determining Sensitivity	
Sensitivity	**Methodology**
	present character, or is of national importance. For example, hospitals, and commercial / industrial premises, which have a requirement for clean air to maintain operations; and vegetation that is sensitive to changes in air quality and / or the deposition of particulates in terms of species composition and habitat quality.
Very High	The location is of the highest sensitivity to changes in air quality, or is of international importance. For example highly sensitive high-tech operations that require clean air and operate air filtration units; and specific habitats that are of international importance and sensitive to changes in air quality and / or particulate deposition.

Table 6.6.2: Methodology for Determining Magnitude of Impact	
Impact	**Change compared with baseline or difference in predicted level compared to guideline level**
Negligible	Minimal discernible change in the baseline environmental conditions, within margins of error of measurement (annual mean increase or decrease <1%).
Low	Impact resulting in a discernible change in baseline environmental conditions with undesirable/desirable conditions that can be tolerated (annual mean increase or decrease in range of 1 – 5%).
Moderate	Impact resulting in a discernible change in baseline environmental conditions predicted either to cause relevant objectives or guidance levels to be marginally exceeded or to result in undesirable/desirable consequences on the receiving environment (annual mean increase or decrease in range of 5 – 10%).
High	Impact resulting in a substantial change in baseline environmental conditions predicted either to cause relevant objectives or guidance levels to be exceeded or to result in undesirable consequences on the receiving environment (annual mean increase or decrease >10%).
Note: Based on published criteria for assessing the magnitude of change[1]	

For the purposes of this Air Quality assessment, the level of significance for air quality effects will be ultimately determined by using the magnitude criteria detailed in Table 6.6.2, together with the sensitivity of the receptor, as detailed in Table 6.6.1, using the significance matrix detailed in Table 6.1.3.

6.6.4 Potential Impacts to Air Quality

Table 6.6.3 below presents a summary of the various types of emissions that could affect air quality during construction and operations, by Project component.

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

Table 6.6.3: Potential Sources of Emissions

Project Component	Releases and Effects	Fugitive Dust	Combustion Gases	Nuisance Odours	Other	Characteristics
Construction						
Earthworks, site clearance and construction	• Dust and dustblow from exposed surfaces.	X				Fugitive dust generated by truck movements and earth moving equipment; short duration.
	• Vehicle exhaust emissions		X			NO_x, SO_x, CO, CO_2, and diesel particulates; short duration.
Drilling and blasting, (quarries and to develop facilities platforms)	• Dust from drilling	X				Fugitive dust generated during drilling activities, mitigated by dust filters; short duration, intermittent.
	• Dust from blasting	X				Fugitive dust (clouds) generated instantaneously during blasting; intermittent, periodic effects.
Crushing, loading, hauling of aggregates used in construction	• Mobile crushing plant	X				Fugitive dust from mobile crushing plant, controlled by fitting plant with water spray to reduce emissions.
	• Dust generated by loading and vehicle entrainment	X				Fugitive dust generated from haul trucks on haul roads and construction access roads. Controlled with frequent maintenance of haul road surface and water sprays to dampen the surface in potentially dusty conditions.
	• Vehicle exhaust emissions		X			NO_x, SO_x, CO, CO_2, and particulate emissions
Mining						
Drilling and blasting	• Dust from drilling	X				Fugitive dust generated during drilling activities, mitigated by dust filters; short duration, intermittent.
	• Dust from blasting	X				Fugitive dust (clouds) generated instantaneously during blasting; intermittent, periodic effects.
	• Blasting gas		X			Combustion gases from blasting.
Loading, hauling and related mine traffic	• Dust generated by loading and vehicle entrainment	X				Fugitive dust from ore/waste rock may contain low concentrations of metals; only emitted during dry periods; controlled with watering of haul roads and at load out areas
	• Vehicle exhaust emissions		X			NO_x, SO_x, CO, CO_2, and particulate emissions.

Table 6.6.3: Potential Sources of Emissions						
Project Component	**Releases and Effects**	**Fugitive Dust**	**Combustion Gases**	**Nuisance Odours**	**Other**	**Characteristics**
BRSF	• Dust from barren material tipping, grading, and windblow	X				Fugitive dust particles will contain metals; emissions only during dry conditions.
Crushing and Ore Preparation						
ROM stockpile, Fine ore stockpile	• Dust from tipping and rehandling	X				Fugitive dust from wind blow, dependent on weather conditions; will contain low concentrations of metal contaminants; controlled with water sprays.
Primary and secondary crushing	• Dust	X				Fugitive dust escaping from crusher and screening buildings and transfer points; controlled with water sprays and enclosure (dust extraction).
Conveyance to truck loadout	• Dust from transfer points	X				Ore dust will contain low concentration of metal contaminants; controlled with water sprays during dry periods in case of visible dust; conveyor enclosed.
Loading, hauling, and fine ore deposition on HLP	• Dust generated by loading and vehicle entrainment	X				Fugitive dust from fine ore may contain low concentration of metals; only emitted during dry periods; controlled with watering of haul roads, at load out areas and inherent moisture in the heap
	• Vehicle exhaust emissions		X			NO_x, SO_x, CO, CO_2, and particulate emissions.
ADR Plant						
Refining	• Combustion gases from electric furnace		X		X	Releases associated with refining the ore to Doré bullion. Small scale activity, any mercury recovered using retorts
Support Infrastructure						
Domestic wastewater treatment	• Nuisance odours			X		Septic tanks and wastewater treatment plant.
Mine Site Landfill	• Nuisance odours			X		Very small-scale activity, controls identified in the Waste Management Plan.
Storage and reagent	• Fugitive lime dust	X				Dust emissions from leaky seals or spillage during pebble lime transfer

Table 6.6.3: Potential Sources of Emissions						
Project Component	**Releases and Effects**	**Fugitive Dust**	**Combustion Gases**	**Nuisance Odours**	**Other**	**Characteristics**
handling						from delivery vehicle to storage silo; controlled with water sprays during lime delivery times
Chemical labs and assay	• Nuisance odours			X		Small scale laboratory scale assays, but laboratory building is within Gorayk settlement boundary. Highly amenable to control, with appropriate abatement fitted to flues and air circulation within the design of the labs (note there are no chemical assays currently in the laboratory).
Closure						
Process plant and supporting infrastructure, open pit, HLF, BRSF, traffic movements on roads	• Dust	X				Dust generated from demolition activities, earthworks, reshaping heap and dump sides, and setting up safety berm around pit perimeter. Water spray where necessary.
	• Vehicle exhaust fumes		X			

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

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

Additional localised sources of dust emissions would be associated with:

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

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

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

- Dust emissions from mining (including blasting), haulage, tipping, conveyor transfer points, and crushing activities; and
- Vehicle exhaust gases (mobile and static plant fuelled by diesel), with emissions including NO_x, particulates (PM_{10}) and CO_2.

An estimation of dust emission rates during the operational phase has been carried out. The potential for community health effects associated with fugitive dust emissions have been considered in Chapter 6.18. Significant receptors for potential air quality impacts have been identified in Table 6.6.4.

Table 6.6.4: Receptor Groups and Potential Impact Pathways

Receptor Group	Potential Impact Pathways
Residents of nearby villages: • Gorayk (4.4km south of Tigranes/Artavazdes pit) • Saralanj (3.7km west of Tigranes/Artavazdes pit) • Gndevaz (1.0km west of HLF) • Gndevaz Livestock and Diary Farm (700m west of truck loadout) • Kechut (<1km from the mine access junction	• Fine-particle dust in atmosphere • Fine-particle dust in atmosphere • Nuisance from soiling by deposited dust on surfaces; Fine-particle dust in atmosphere
Residents of Kechut and Jermuk– 2.4km to 6km northwest of HLF	• Fine-particle dust in atmosphere
Mine, plant employees including worker accommodation camp	• Fine-particle dust in atmosphere and direct exposure to PM_{10} within crushing/screening buildings Note: working conditions have been addressed in the Occupational Health and Safety Plan (see Appendix 8.7 and the relevant policies would extend to the workers staying in the worker accommodation camp.
Soils and grazing land near the Project that has the potential to be influenced by mine activities (<1000m)	• Particulates containing heavy metals - with deposition on vegetation and soil surface and potential for livestock ingestion, entering food chain
Critical habitat (as defined by PS6/PR6) and other natural grassland habitats	• Particulate deposition on vegetation and soil surface with potential habitat quality degradation
State Reservations / Sanctuaries and Important	• Particulate deposition on vegetation and soil

Table 6.6.4: Receptor Groups and Potential Impact Pathways	
Receptor Group	**Potential Impact Pathways**
Bird Areas (IBA): • Jermuk Forest • Herher Open Woodland • Jermuk IBA • Gorayk IBA	surface with potential habitat quality degradation

The receptor groups identified in Table 6.6.4 are considered of medium to minor sensitivity. The Critical habitat receptor group is considered to have high sensitivity to change, including that associated with dust deposition.

Of the receptor groups identified in Table 6.6.4, the primary receptors will be soils and vegetation and critical habitats (identified in biodiversity Section 6.11) in a zone up to 1km from construction-related activities and operational infrastructure. Residents of nearby settlements are too distant from particulate and gaseous emission sources to be significantly affected, as these are at least 1km from both construction activities and operational infrastructure.

Fugitive Dust Emissions

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

The next step in assessing potential impacts is to determine the dispersion of Total Suspended Particulate (TSP) dust and particulate material from the emission points, and its subsequent deposition on to land. A screening model, based on assumptions from literature sources and prevailing wind direction data, was applied for TSP dust deposition. USEPA's AERMOD Screen model was applied for PM_{10} particulate dispersion.

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

2 AP-42 Fugitive Dust Emission Factors, USEPA (2006)
3 Emission factors and emission estimation methods, USEPA
4 NPi EET Manual for Mining, 2012, National Pollution Inventory, Emission Estimation Technique Manual for Mining Version 3.1, Australian Government

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

Details of the dust emission and dust dispersion modelling follow.

Dust Emission Estimates

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

The potential dust emission sources for the construction and operational phases are shown in Figure 6.6.1. The potential dust deposition area shown in Figure 6.6.1 demarcates a 1000m zone around the project footprint, with all areas of the project footprint considered potential dust emission sources, as small dust particles are considered to travel up to 1km[5].

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

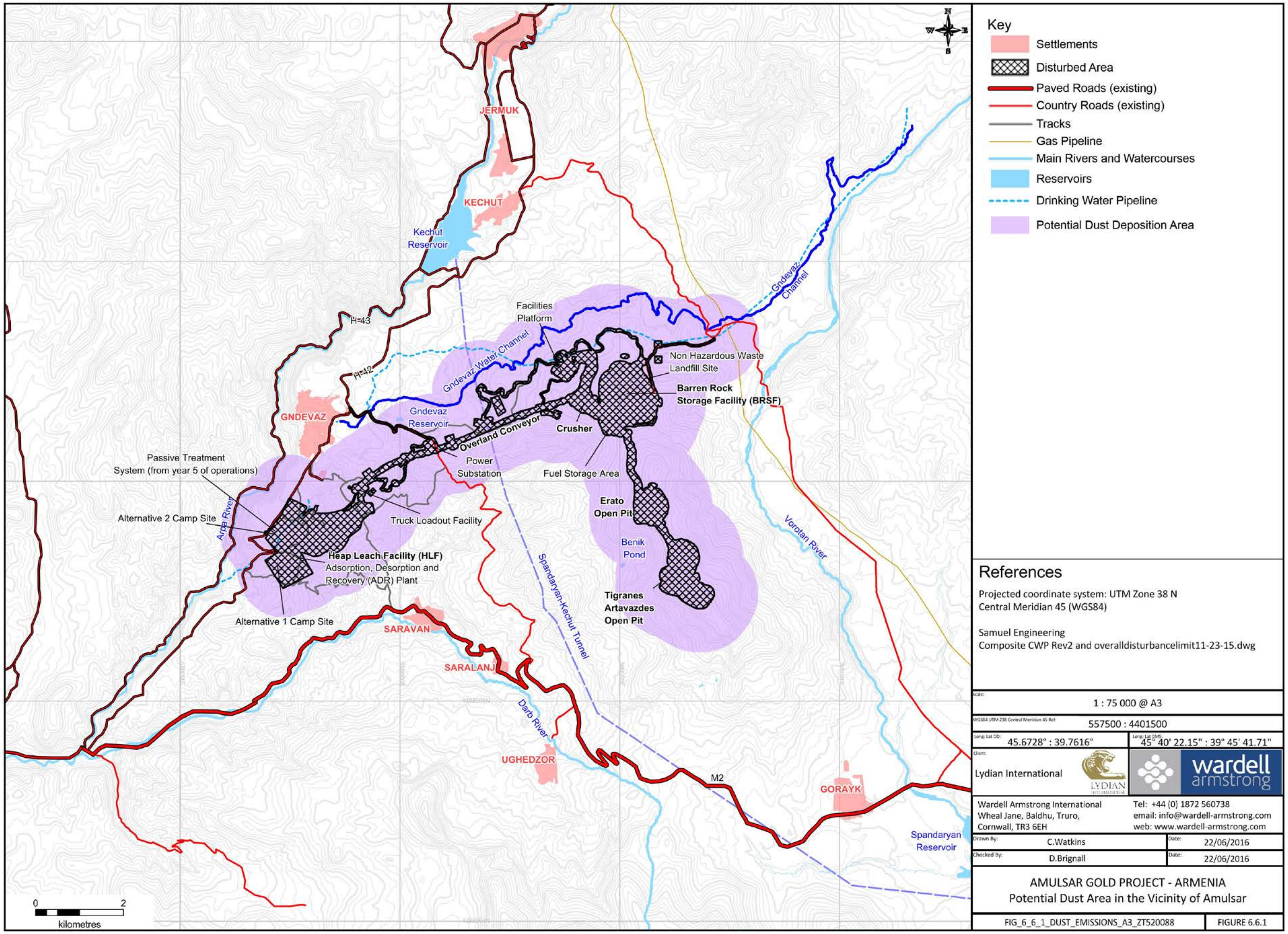

Figure 6.6.1: Potential Dust Emission Sources

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

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

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

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

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

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

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

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

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

The far right column set in Table 6.6.5identifies the adjusted predicted particulate emission rates, taking into account local climate and mitigation measures. The annual total for dust emission in Year 3 of operation has been calculated for the number of days when emissions are considered likely.

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

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

Table 6.6.5: Estimated Dust Emission Rates								
		Uncontrolled kg/day		Suppression factor			Controlled kg/day	
Source Area	Source Activity	TSP	PM_{10}	Wet and snow days	Dust control measures	Cumulative	TSP	PM_{10}
ArtavazdesPit	blasting	71.047	36.944	55%	50%	77.5%	15.986	8.312
BRSF	bulldozer	6.861	0.781	55%	50%	77.5%	1.544	0.176
HLF	bulldozer	10.590	1.662	55%	50%	77.5%	2.383	0.374
LowGradeStockpile1	bulldozer	6.861	0.781	55%	50%	77.5%	1.544	0.176
LowGradeStockpile2	bulldozer	6.861	0.781	55%	50%	77.5%	1.544	0.176
ArtavazdesPit	drilling	60.180	31.620	55%	50%	77.5%	13.541	7.115
Arts_to_BRSF	haul roads (per 100m)	435.246	111.838	55%	50%	77.5%	97.930	25.163
Arts_to_Crusher	haul roads (per 100m)	156.400	40.187	55%	50%	77.5%	35.190	9.042
Arts_to_LowGrade1	haul roads (per 100m)	36.013	9.254	55%	50%	77.5%	8.103	2.082
Arts_to_LowGrade2	haul roads (per 100m)	36.013	9.254	55%	50%	77.5%	8.103	2.082
Truck load-out to HLF	haul roads (per 100m)	206.422	44.159	55%	50%	77.5%	46.445	9.936
LimeStorage	material handling	0.306	0.123	55%	83%	92.4%	0.023	0.009
PrimaryCrusher	material handling	1730.762	865.381	55%	50%	77.5%	389.421	194.711
ScreeningPlant	material handling	1730.762	865.381	55%	99%	99.6%	7.788	3.894
TruckLoadOutTower	material handling	1730.762	865.381	55%	83%	92.4%	132.403	66.202
PrimaryCrusher	primary crusher	576.921	576.921	55%	99%	99.6%	2.596	2.596
SecondaryCrusher	secondary crusher	1730.762	346.152	55%	99%	99.6%	7.788	1.558
BRSF	stockpile wind erosion	245.558	122.779	55%	50%	77.5%	55.251	27.625
FineOreStockpile	stockpile wind erosion	5.315	2.658	55%	65%	84.3%	0.837	0.419
HLF	stockpile wind erosion	213.927	106.963	55%	50%	77.5%	48.134	24.067
LowGradeStockpile1	stockpile wind erosion	226.649	113.325	55%	50%	77.5%	50.996	25.498
LowGradeStockpile2	stockpile wind erosion	172.971	86.486	55%	50%	77.5%	38.919	19.459
ROM Stockpile	stockpile wind erosion	39.561	19.781	55%	65%	84.3%	6.231	3.115
Artavazdes Pit	truck loading	99.518	47.070	55%	50%	77.5%	22.392	10.591

Table 6.6.5: Estimated Dust Emission Rates								
		Uncontrolled kg/day		**Suppression factor**			**Controlled kg/day**	
Source Area	**Source Activity**	**TSP**	**PM_{10}**	**Wet and snow days**	**Dust control measures**	**Cumulative**	**TSP**	**PM_{10}**
BRSF	truck loading	96.180	45.491	55%	50%	77.5%	21.640	10.235
HLF	truck loading	9.190	4.347	55%	50%	77.5%	2.068	0.978
Lime Storage	truck loading	0.073	0.035	55%	83%	92.4%	0.006	0.003
Low Grade Stockpile 1	truck loading	7.437	3.517	55%	50%	77.5%	1.673	0.791
Low Grade Stockpile 2	truck loading	7.437	3.517	55%	50%	77.5%	1.673	0.791
Primary Crusher	truck loading	66.708	31.551	55%	50%	77.5%	15.009	7.099
ROM Stockpile	truck loading	12.671	5.993	55%	50%	77.5%	2.851	1.348
Truck Load Out Tower	truck loading	66.708	31.551	55%	83%	92.4%	5.103	2.414

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

Table 6.6.6 provides a summary of the total controlled emissions from each source area.

Table 6.6.6: Summary of Total Dust Emission Estimates (Year 3 of operations)		
Fugitive source area	**Controlled emissions, kg/day**	
	TSP	**PM_{10}**
Artavazdes (excluding hauling within the pit)	51.9	26.0
BRSF (include low grade stockpiles)	175	84.9
Crushing and screening plants (including ROM stockpile)	432	214
HLF (including truck loadout and fine ore stockpile)	191	94.0
Total (excluding haul roads), kg/day	**850**	**419**
Haul Roads (maximum per 100m travelled)	149	38.4

Dust Dispersion and Deposition– TSP 'Nuisance Dust'

The potential for dust arising from mineral sites is generally a matter of public concern. There may be the perception that the annoyance created during works could affect local amenity value and quality of life for the period during operations. The amount of dust that might cause complaint or nuisance in a particular circumstance is however very difficult to determine and there is little consensus about possible nuisance dust levels. Various national standards for nuisance dust range from 133 to 350 $mg/m^2/day$[7]. For the purpose of the assessment of TSP dust dispersion from the Project, the extents of this range have been selected as a good indicator of the presence of nuisance dust levels.

Dispersal of gases and fugitive dust via atmospheric dispersion is dependent on atmospheric conditions. The main emission from mining activities is dust. Emission rates, based on USEPA AP-42, indicate that the percentage of PM_{10} particles in dust emissions varies depending on the source of the dust. About 95% of dust particles emitted from materials handling activities are greater than 10μm in diameter, while blasting, drilling, and wind erosion contains roughly 50% particles smaller than 10μm. Approximately 72% of fugitive dust emitted because of vehicle entrainment on haul roads is greater than 10μm in diameter. The typical relationship between particle size and dispersion distance has been summarised in Table 6.6.7.

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

Table 6.6.7: Typical Dispersion of Particulates5		
Particle Size, µm	**Category**	**Effective maximum dispersion distance from source (m)**
> 30	Large particles, soiling of surfaces	300
10 to 30	Intermediate	500
< 10	Inhalable, small	1000
<2.5	Respirable, very small	>1000

The distances in Table 6.6.7 indicate effective maximum dispersion distances for different particles sizes. The majority of particles in each size group will settle out long before reaching the maximum distance (depending on prevailing winds and weather conditions). Whilst dust may be observed from many mining activities, only a very small proportion will travel any distance from the source and the great majority deposits within a few hundred metres.

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

- Emission rates based on USEPA AP-42, Fugitive Dust Emission Factors, as detailed in Table 6.6.5;
- Deposition values based on deposition rates are for a typical dry day (24hours);
- Consideration of each site specific source and operations as a single combined emission;
- Dust disperses in proportion to the frequency of dry-day winds from each direction. For the purposes of this assessment the Vorotan weather station meteorological data has been used to obtain wind direction. The percentages of dry winds from twelve wind sectors has been used (Figure 6.6.2); and
- For the dust dispersing in each direction, deposition is estimated assuming exponential decay, with the exponential decay rate based on research undertaken by US EPA and other authors5, and particle size distribution based on ISO12103-1[8]. The model estimates that:
    - 82.6% of the TSP dust deposits within 100m of the source;
    - 16.7% of the TSP dust deposits between 100m and 500m of the source; and
    - 0.7% of the TSP dust deposits between 500m and 1km of the source.

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

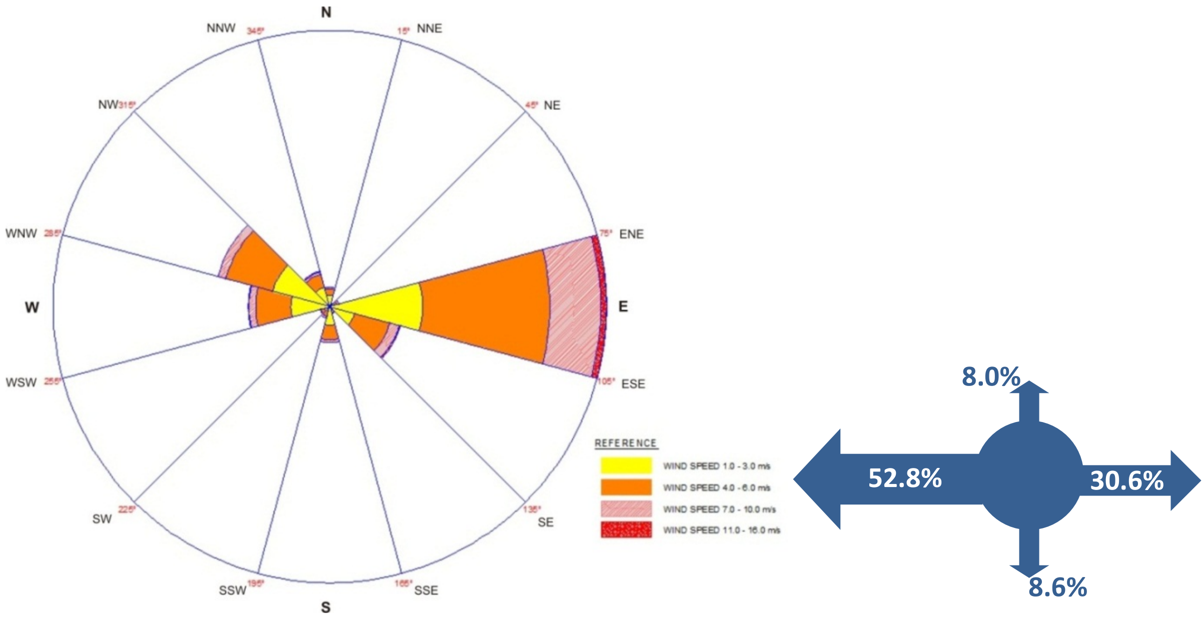

Figure 6.6.2: Frequency Distribution of Dry Winds, Long Term Met Data, Vorotan Pass - Simplified Wind Distribution for Dispersion

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

A screening assessment undertaken for the project identified that for operations associated with mine activities a 1km buffer zone around the primary operational dust sources would be sufficient to identify whether further more detailed modelling would be required. This analysis is shown on Figure 6.6.23. It is predicted that the majority of the dust (between 95% and 100% of airborne particulates) would settle out within this zone.

Figure 6.6.3 identifies the total estimated deposition of dust around the mine site during the operational phase, based on these assumptions and using GIS to map the extent of the area influenced.

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

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

The dust screening assessment detailed in Figure 6.6.3 shows two regions potentially affected by nuisance dust, demarcated by a 350 $mg/m^2/day$ and a 133 $mg/m^2/day$ contour. More sensitive human receptors would tend to experience an effect at dust deposition rates of 133 $mg/m^2/day$, while less sensitive receptors may only experience a nuisance effect at rates of 350 $mg/m^2/day$ or greater. The distance from dust emission sources where nuisance effects may be felt varies with the prevailing wind direction, but the maximum distance nuisance dust could affect human receptors is estimated to a maximum distance of up to 850m from the emission sources, with most deposition taking place to the west of the emission source. Visible dust emissions may be experienced by receptors at Gndevaz, and road users of the H-42. With the exception of the livestock and dairy farm, nearby residential and community receptors are too distant to be influenced by the potential impacts of dust dispersal during construction and therefore the significance is considered low. Sensitive receptor groups of Gndevaz, and the other neighbouring settlements, lie beyond this zone of potential nuisance, and so potential impacts of dust deposition on community receptors is considered low for both construction and operational phases.

The model output identifies that the livestock and dairy farm lies beyond the zone of potential nuisance (133$mg/m^2/day$), being located approximately 700 m of the potential dust sources at the overland conveyor discharge and truck loadout. The livestock and dairy farm receptor is considered to have Minor sensitivity, because it is an agricultural operation, utilising intensive (housed) livestock rearing techniques fed with hay and imported cattle feed. Therefore, there is no direct pathway between fugitive dust dispersion and uptake in feed to the cattle at the farm. In addition, there are no residential quarters at the agricultural premises, therefore no residential receptors. The overall impact of dust on the livestock and dairy farm receptor is Minor, and not significant.

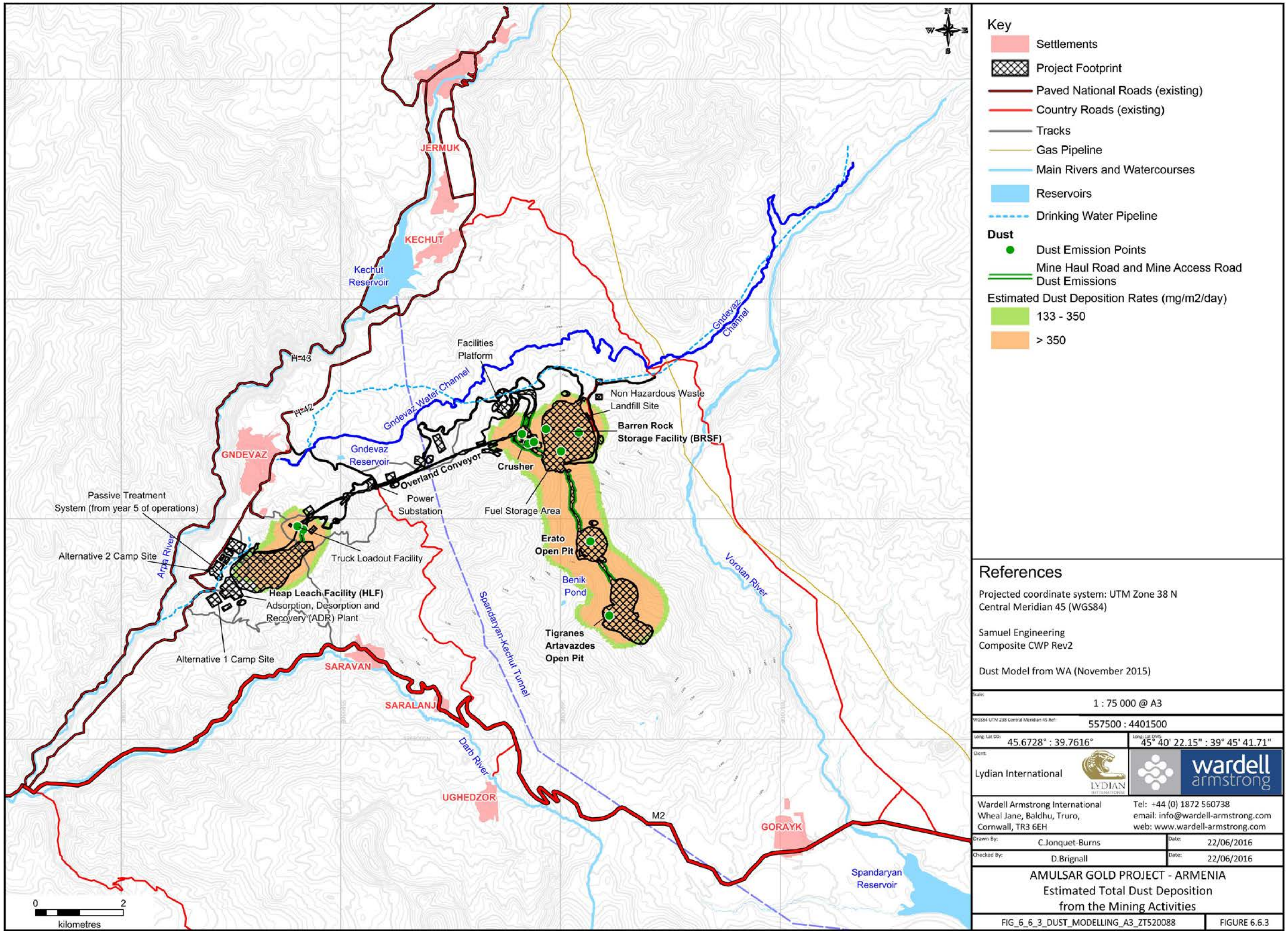

Figure 6.6.3: Estimated Total Dust Deposition from the Mining Activities

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

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

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

Most of the receptors in the State Reservations group are too distant from the Project to be impacted by dust deposition (i.e. greater than the 815m nuisance dust deposition range), either during construction or operations. The Jermuk IBA is the exception and, during construction of the ADR plant, could experience some dust deposition on its eastern edge. The construction time period for the whole project is approximately two years, so construction of the ADR plant will take less time than this. Given the short duration of the construction period and the area of affect (less than 0.5% of the Jermuk IBA), the magnitude of potential impact is low and the effect not significant.

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

There is the potential for impact associated with dust emissions from mine related traffic on roads passing through or near to communities. Traffic associated with the Project will mainly comprise workers and supply vehicles. The Traffic Assessment (Section 6.19) identifies that baseline traffic flows along the roads likely to be used by traffic associated with the Project are low, with the main road links considered operating at less than 5% of capacity in 2013 and 2015. A transport service will be provided, taking account of shift patterns, to reduce the volume of traffic from the mine workers' accommodation, including shuttle buses from local villages to the Project. Mitigation measures will be implemented to mitigate the potential for dust emissions as detailed in Table 6.6.9 below. With the proposed mitigation measures in place it is considered that the significance of effect of dust emissions from mine related traffic on roads passing through or near to communities will be minor and amenable to mitigation, through use of tarmac for the primary access junctions.

Dust Dispersion – Respirable Size Fraction PM_{10}

The USEPA dispersion screening model AERMOD Screen[9] was used to estimate the potential maximum short-term fine particulate levels (PM_{10}) which are considered a suitable indicator of inhalable and respirable dust concentrations for sensitive receptors. The controlled emission rates for PM_{10}, given in the right hand column of Table 6.6.5, were used as input parameters, together with 'worst case' high winds combined with dry atmospheric conditions. The model thus provides conservative dispersion patterns for PM_{10}, assuming that these conditions persist continuously for a 24-hour period, to give worst case conditions and the rate of fallout has been shown in Figure 6.6.4.

[9] http://www.epa.gov/scram001/

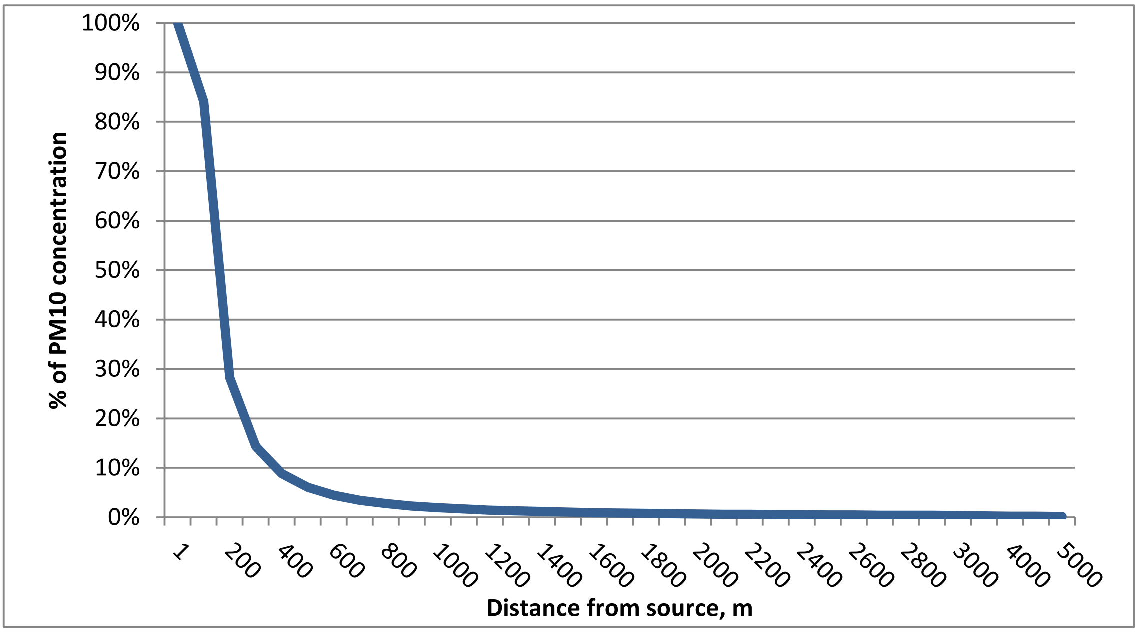

Figure 6.6.4: Relative Inhalable Dust Levels with Distance from Source

Figure 6.6.4 identifies that in worst case conditions the majority of PM_{10} emitted from the Project (over 95%) will be deposited within 1km from the site, with over 90% deposited within 500m of the source. The nearest residential communities are located approximately 1.0km from the nearest source and therefore the fine particulate levels will have reduced to a very low proportion (less than 1% of emitted levels) as shown on Figure 6.6.4. Based on the distance from Project activities, PM_{10} and $PM_{2.5}$ concentrations, would not exceed the guideline values of (see also Table 2.12):

- PM_{10} 20 µg/m^3 (1yr average) 50 µg/m^3 (24hr average)
- $PM_{2.5}$ 10 µg/m^3 (1yr average) 25 µg/m^3 (24hr average)

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

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

Respirable dust is an issue of consideration for human receptors. The soils and grazing, critical habitat, and State Reservation receptor groups are not impacted by fine particles suspended in the atmosphere. The impacts occur when PM_{10} dust is deposited on surfaces. This is a subset of TSP dust deposition and was discussed in the previous section.

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

Combustion Emissions

The significance of vehicle exhaust gasses from vehicles operating within the Project footprint was considered with regard to the DMRB[10] screening methodology which examines potential air quality impacts of vehicle emissions. It has been used because it provides a relevant methodology for assessing the impact of Project related transportation, on air quality.

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

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

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

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

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

pits and the BRSF and primary crusher, amounting to around 54 haul vehicle movements per hour. Haul vehicle movements at the HLF amount to around 80 per hour, using the smaller capacity <30 tonne trucks. The closest point on the HLF haul road to Gndevaz lies 1.2km south east of Gndevaz. Although the increase in number of vehicles exceeds the DMRB methodology, sensitive human receptors lie considerably beyond 200m of the haul vehicle routes. The impact of vehicle emissions is therefore considered neutral in accordance with DMRB and therefore the magnitude of the impact can be considered negligible. The communities surrounding the Project are considered of moderate sensitivity in accordance with Table 6.6.1 and, therefore, the effect of vehicle emissions is considered to be negligible and not significant.

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

- SO_2 20 µg/m^3 (24hr average from monthly readings); and
- NO_2 40 µg/m^3 (1yr average, summed from monthly readings).

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

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

Nuisance Odours

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

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

6.6.5 Mitigation Measures for Air Quality Impacts

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

Fugitive Dust Mitigation Measures

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

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

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

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

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

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

Combustion Mitigation Measures

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

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

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

Nuisance Odour Mitigation Measures

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

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

6.6.6 Monitoring and Audit

The monitoring and audit planning required to validate the effectiveness of mitigation strategies have been identified in Table 6.6.8.

Table 6.6.8: Air Quality Monitoring and Audit		
Air quality, Monitoring and Audit programme and procedures		
Monitoring approach	Baseline	A developing programme of ambient air-sampling commenced in 2009 in order to establish baseline conditions at key locations within the Project licence area and at local settlements (see Chapter 4.4).
Level 2 Management Plan	The AQNVP (Appendix 8.14) provides the details of mitigation measures to control emissions of dust, particulates and combustion gases, associated with mobile plant	
Level 3 Standard Operating Procedures	The AQNVP (Appendix 8.14) will be underpinned by five SOPs that will provide specific guidance on sampling locations and procedures during the construction, operational and closure phases. The level 3 procedures will include the following: • Visual inspection – routine visual monitoring to identify sources of dust emission, these inspection position will be determined to demonstrate coverage of identified sources of dust, including open pits, haul roads, crushing plant, BRSF and conveyor load out points. • Meteorological station – location, download procedures, analysis of results and persons responsible for data collection and dissemination. The maintenance requirements for the met station will also be identified together with non-conformance procedures. • Location, collection, replacement and analysis of diffusion tubes (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.	

Table 6.6.8: Air Quality Monitoring and Audit			
Air quality, Monitoring and Audit programme and procedures			
	• Location, collection and replacement of DustScan sticky pads, to follow similar procedures as those for the diffusion tubes. • Environmental sampling and maintenance procedures for Osiris and EPAM 500 monitors. • The location of the monitoring instruments will be determined in a revision of the Level 2 AQN&VP. Dependent on suitable positions, this SOP will therefore be informed by an audit of the site at the onset of the operational phase, when the final details of the plan will be designed. The SOP will define the monitoring requirements and periods for the use of the equipment, which will be directed towards areas of the operation where the effectiveness of mitigation measures can be determined, thus providing feedback to the aims and objectives of the AQMP.		
Monitoring strategy			
Visual inspection	Environmental staff	Routine observations developed against a graded system for inspecting and determining whether dust suppression techniques are sufficient or require further action.	This dynamic audit would be undertaken through a schedule to be developed in the air quality management plan and will require the training of environmental staff, shift supervisors and mine management to develop a consistent approach to auditing dust emissions. A record to be made of any exceptional events that trigger additional dust management should be kept together with approach to mitigation.
NO_x and SO_x	Diffusion tubes	Acrylic tubes designed for passive sampling of airborne gases. The tube contains an adsorbent material which can then be analysed by UV/Visible Spectrophotometry with reference to a UKAS (United Kingdom Accreditation Service) calibration curve, appropriate to this methodology.	Recommended exposure length typically in the order of 4 weeks, after which time they are removed from their sampling location and returned to the manufacturer's accredited laboratory for analysis.
Dust	DustScan DS100	Multi-directional sticky pad gauge which collect airborne dust as it passes over them. They are held in place and protected with a removable rain cap. The sampling head has a North marker which is aligned to magnetic North and the sample cylinders are fitted with North markers to ensure directional information is obtained. Dust deposition is measured as a % of the effective area covered (EAC), over the sampling period.	%EAC is monitored over a period of 1 month after which the pads are returned to an accredited laboratory for analysis. The resultant measurement will be expressed as %EAC/day. Comparison of the monitoring data, compared to the baseline condition can be used to determine whether a soiling, or significant dust impact has occurred.

Table 6.6.8: Air Quality Monitoring and Audit			
Air quality, Monitoring and Audit programme and procedures			
Particulates	Osiris Turnkey Monitor	The Osiris monitor measures total suspended particulates (TSP) and will be deployed as a semi-permanent installation at two locations – Gndevaz and Kechut	In its semi-permanent configuration, with a mains power supply, the meter continuously measures particulate levels and can determine trends when used long term. Results are data logged in the unit and are usually expressed as mg/m^3/hr. The monitor is MCERTS accredited and requires regular maintenance and calibration. Two monitors are to be used for the AQNVP at the Primary Monitoring Station.
	EPAM 5000 Monitor	Portable monitor for PM_{10}, and $PM_{2.5}$ concentrations. In the "workplace" mode it can indicate inhalable, thoracic and respirable concentrations.	Two monitors will be deployed to rotate around 8 locations to provide ambient, prior to construction, and environmental PM_{10}, and $PM_{2.5}$, near to communities and on the edge of the Project area (approximately 50 to 100 m from the Project footprint. Sampling period will be 24 hours and the data will be report as 1 hour, monthly and annual averages for each sampling point (see AQNVMP, Appendix 8.14).

The monitoring programme commencing during construction will be augmented with the introduction of a Primary Monitoring Station (for noise, vibration and air quality), located to the west of the livestock and dairy farm, adjacent to the apartment block that has been acquired by the Project. The monitoring affords a power supply and therefore the ability to undertake continuous monitoring of particulates (PM_{10} and $PM_{2.5}$). The monitoring location (see Figure 4.2.3), can be accessed from the H-42 and therefore will be included in the community participatory monitoring programme.

6.6.7 Residual Impacts to Air Quality

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

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

Table 6.6.9 presents a summary of the anticipated air quality impacts, relevant operational phase and planned mitigation measures. The potential impact of metals in dust deposited onto critical habitats is considered in Section 6.11.

<table>
<tr><th colspan="9">Table 6.6.9: Impact Summary - Air Quality</th></tr>
<tr><th rowspan="2">Impact</th><th rowspan="2">Source</th><th rowspan="2">Primary Receptor (1)</th><th colspan="2">Phase (2)</th><th colspan="2">Significance(3)</th><th rowspan="2">Mitigation Measures</th><th rowspan="2">Management Plan</th></tr>
<tr><th>C</th><th>O</th><th>ST</th><th>LT</th></tr>
<tr><td rowspan="2">Fugitive Dust / Particulate</td><td>Blasting
Drilling
Conveying
Loading
Haulage
Crushing</td><td>R, F a Fl</td><td>X</td><td>X</td><td>Mi</td><td>N</td><td>• Speed limits for heavy equipment and general traffic on unpaved roads.
• Restrict off-road travel unless absolutely necessary.
• Limit number of trips with efficient loading procedures for material transport.
• Apply stabilizing agents on high dust areas.
• Top-wet truckloads of dusty material.
• Spray water on unpaved roads and traffic areas.
• Maintain gravel/laterite cover on unpaved roads and traffic areas.
• Install dust suppression / control equipment at loading/unloading, storage, and material transfer points.
• Crusher contained within a purpose designed building.
• Provide enclosed overland conveyor between crusher and HLF.</td><td>AQNVMP
(Appendix 8.14)</td></tr>
<tr><td>Blasting
Drilling
Conveying
Loading
Haulage
Crushing</td><td>E</td><td>X</td><td>X</td><td>Mi</td><td>N</td><td>• All of the above mitigation measures.
• Use employee personnel protective equipment where required and occupational medical monitoring.</td><td>AQNVMP
(Appendix 8.14)
OHSP
(Appendix 8.7)</td></tr>
</table>

Table 6.6.9: Impact Summary - Air Quality								
Impact	**Source**	**Primary Receptor (1)**	**Phase (2)**		**Significance(3)**		**Mitigation Measures**	**Management Plan**
			C	**O**	**ST**	**LT**		
Combustion Engine and Point Source Emissions	Construction and Haul vehicles Refining	E, R	X	X	N	N	• Speed limits for heavy equipment and general traffic on unpaved roads. • Train operators and drivers about maximum idling times. • Install appropriate emissions control equipment on vehicles. • Perform regular maintenance and inspection of vehicles and mobile equipment, including their emissions control systems. • Use stack control equipment on ADR Plant emissions. • Monitor ADR Plant emissions.	AQNVMP (Appendix 8.14)
Nuisance Odours	Waste facilities	R	X	X	N	N	• Practice appropriate waste reduction and recycling procedures to minimize waste generation. • Incorporate appropriate waste handling and disposal procedures. • Operate waste disposal facilities such that exposed refuse is covered with soil or gravel. • Consider installing a gas relief system for solid waste disposal area. • Operate sewage treatment facilities properly and monitor operational performance (including odours).	IWMP (Appendix 8.13)
	Waste facilities	E	X	X	N to Mi	N	• All of the above odour mitigation measures. • Use employee personnel protective equipment where required and occupational medical monitoring.	IWMP (Appendix 8.13) OHSP (Appendix 8.7)

Notes:
(1) Primary Receptors: E = employees R = residents, Fl = flora, Fa = fauna,,
(2) Project Phase: C = Construction, O = Operations,
(3) Expected Significance Rankings: ST = short-term with mitigation, LT = long-term with mitigation, MA = major, M - = moderate, Mi = minor, N = negligible

6.6.8 Conclusions

An impact assessment has been undertaken to assess the effects of construction, operation and closure of the Project with regard to sensitive air quality receptors. The findings of the impact assessment are summarised in Table 6.6.9.

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

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

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