Appendix 5.2.2A
Noise Modelling Report

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1.0 CONSTRUCTION NOISE MODELLING

Construction noise emissions are expected to occur during the following activities:

- Levelling and grading;
- Vehicle/heavy equipment traffic;
- Excavation;
- Pile driving;
- Concrete pouring;
- Steel erection;
- Mechanical installation; and
- Commissioning and start-up.

The internal combustion engines of different power are used to provide propulsion for the wheels of trucks and/or operating power for the working mechanisms such as buckets, dozers, etc. Exhaust noise is usually the most important component of internal combustion engine noise. However, noise associated with the air intake, cooling fans, and the mechanical and hydraulic transmission and control systems may also be significant, depending upon the type and size of specific pieces of equipment.

During the construction phase of the proposed project, a large number of machines and trucks would work in a small area. Thus, the site may be disturbed for three years of construction activities by vibration as well as noise.

A maximum A-weighted sound level for construction equipment typically found at mine construction sites is shown in **Table 1** (Holland and Attenborough 1981). The predominant noise sources of construction equipment are associated with internal combustion engines and impact equipment.

Table 1: Typical Maximum Construction Equipment A-Weighted Sound Levels at 5 m from the Source

Noise Source	A-Weighted Sound Level (dBA)
Earth Moving	
Crawler Tractors, Dozers	81-85
Front End Loaders	81-86
Graders	79-83
Earth Haulers	88-90
Dump Trucks	88

Noise Source	A-Weighted Sound Level (dBA)
Materials Handling	
Mobile Cranes	83
Concrete Mixers (Truck)	85
Concrete Pumps	82
Impact Equipment	
Jackhammers	88
Pneumatic Tools	86
Auxiliary Equipment	
Pumps	76
Generators	78
Compressors	87
Paging Systems	80-92
Warning Horns	98-102
Other Equipment	
Saws	78
Vibrators	76

Three typical cases of noise propagation for the construction phase equipment assemblies operating simultaneously are shown in **Table 2**.

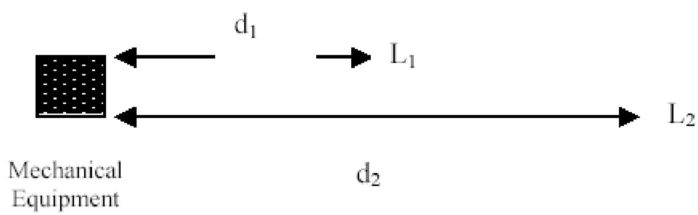
Table 2: Propagation Rate of the Construction Noise

Case	Loudest Equipment	L_{eq} @ 15 m (dBA)	Noise Level (dBA) at Distance (m)					
			15	**100**	**500**	**1000**	**1,500**	**3,000**
A	Truck	88	89	73	59	53	49	43
	Grader	83						
	Backhoe	80						
B	Truck	88	90	74	60	54	50	44
	Backhoe	80						
	Concrete Mixer	85						
C	Front-end Loader	85	89	73	59	54	49	43
	Grader	82						
	Pneumatic Tools	86						

Noise levels at different distances from the equipment units are approximated assuming hemispherical spreading of sound with the attenuation rate at 6 dBA per doubling of distance from the sound source. A daytime permissible sound level of 55 dBA will be met at approximately 1,000 m from the construction site.

The noise level L_2 (in dBA) at distance d_2 can be computed from the noise level L_1 (in dBA) measured at distance d_1 by the equation:

$$L_2 = L_1 - 20 \log (d_2 / d_1)$$



2.0 OPERATIONS NOISE MODELLING

2.1 Noise Sources

Noise sources consist of mine equipment in the quantity based on the annual mine production schedule, the mine work schedule, and equipment shift production estimates. The size and type of mining equipment is consistent with the size of the project: peak run-of-mine material movements of 97 Mt/y.

There will be sufficient equipment to perform the following duties:

- Constructing additional roads, after preproduction, as needed to support mining activity, including pioneering work necessary for mine and dump expansion;
- Stripping and dumping of topsoil in advance of mining;
- Mining and transporting the mill feed to the crusher (or crusher stockpile);
- Mining and transporting the waste material from the pit areas to the waste storage areas and the TSF construction areas;
- Dozing and compacting with haul trucks the upstream and downstream portion of the TSF embankments as waste tonnages are delivered by the mine truck fleet to the TSF;
- Delivering overburden by the mine fleet to the TSF for construction of the compacted till core by a contractor;
- Maintaining all the mine work areas, in-pit haul roads, waste storage areas, crusher stockpiles, and external haul roads;
- Building and maintaining in-pit and on-dump drainage structures as required; and

- The mine work schedule, the scheduled shifts per year, and the expected shifts available are summarized below:
  - The mine is scheduled to work two shifts per day, 365 days per year.
  - The mine will operate seven days per week with two 12-hour shifts per day.

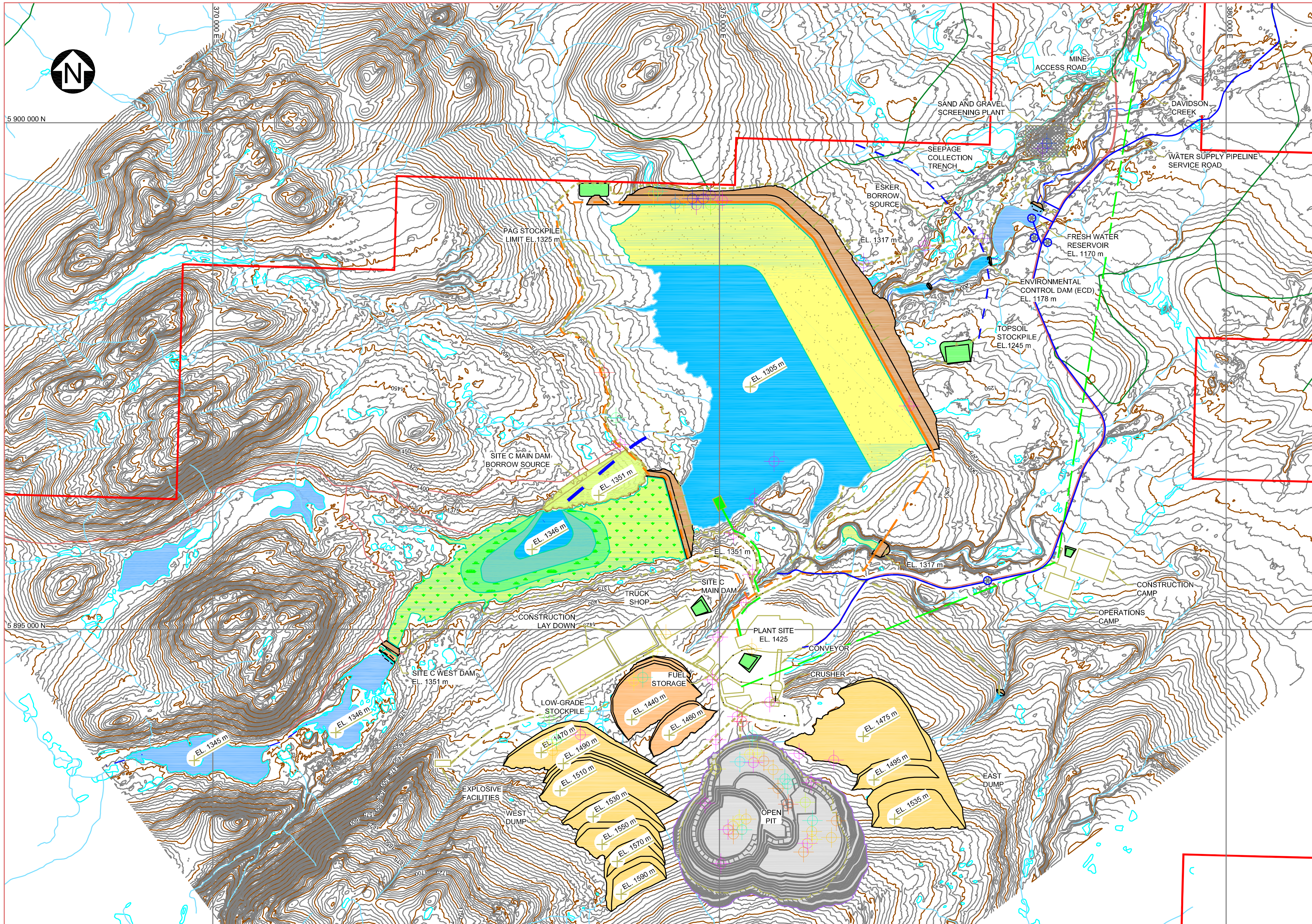
Most of the equipment will operate within the mine pit and the plant area. The equipment type and location is shown in **Table 3**. For clarity and modelling efficiency, the arbitrary coordinates were established with the central point at the primary crusher having UTM location 375533 mE, 5894467 mN. The noise impact assessment considers only equipment which is the noise source of known acoustical properties.

Table 3: Inventory and Location of Equipment Considered as Noise Source

Item	Symbol	UTM, mE	X Model	UTM, mN	Y Model
930E 4SE Komatsu Truck	Tr1	374950	-583	5892688	-1779
930E 4SE Komatsu Truck	Tr2	375874	341	5892842	-1625
930E 4SE Komatsu Truck	Tr3	375073	-460	5892996	-1471
930E 4SE Komatsu Truck	Tr4	374827	-706	5893273	-1194
930E 4SE Komatsu Truck	Tr5	375874	341	5893489	-978
930E 4SE Komatsu Truck	Tr6	375320	-213	5893550	-917
930E 4SE Komatsu Truck	Tr7	376120	587	5893704	-763
930E 4SE Komatsu Truck	Tr8	375782	249	5893766	-701
930E 4SE Komatsu Truck	Tr9	374919	-614	5893920	-547
930E 4SE Komatsu Truck	Tr10	373564	-1969	5893951	-516
930E 4SE Komatsu Truck	Tr11	375166	-367	5894135	-332
930E 4SE Komatsu Truck	Tr12	375474	-59	5894289	-178
930E 4SE Komatsu Truck	Tr13	374888	-645	5894505	38
930E 4SE Komatsu Truck	Tr14	374950	-583	5894936	469
930E 4SE Komatsu Truck	Tr15	375227	-306	5895275	808
930E 4SE Komatsu Truck	Tr16	375320	-213	5895583	1116
930E 4SE Komatsu Truck	Tr17	375104	-429	5896014	1547
930E 4SE Komatsu Truck	Tr18	375320	-213	5896322	1855
930E 4SE Komatsu Truck	Tr19	375504	-29	5896723	2256
930E 4SE Komatsu Truck	Tr20	373964	-1569	5896846	2379
930E 4SE Komatsu Truck	Tr21	376860	1327	5897246	2779
930E 4SE Komatsu Truck	Tr22	374981	-552	5899310	4843
Blasting Loader	L1	375628	95	5893519	-948
Cat 14M Grader	Gr1	377014	1481	5898848	4381
Cat 735 Dump Truck	DT1	376398	865	5898694	4227
Cat 735 Dump Truck	DT2	377599	2066	5898940	4473

Item	Symbol	UTM, mE	X Model	UTM, mN	Y Model
Cat 735 Dump Truck	DT3	374888	-645	5899341	4874
Cat 735 Dump Truck	DT4	378184	2651	5899833	5366
Cat 825 Compactor	C1	374704	-829	5899895	5428
Cat 988 Wheel Loader	L2	378246	2713	5899895	5428
Cat D8 Bulldozer	Dz1	374488	-1045	5899248	4781
Cat CS76 Compactor	C2	374858	-675	5899248	4781
Dozer 370 kW Wheeler	Dz2	375166	-367	5893704	-763
Dozer 450 kW	Dz3	375196	-337	5892996	-1471
Dozer 450 kW	Dz4	375905	372	5893088	-1379
Dozer 450 kW	Dz5	375289	-244	5893981	-486
Dozer 450 kW	Dz6	374211	-1322	5894536	69
Dozer 450 kW	Dz7	374334	-1199	5899371	4904
Dozer 650 kW	Dz8	373348	-2185	5893889	-578
Dozer 650 kW	Dz9	373934	-1599	5897123	2656
Excavator 150 kW	Ex1	373256	-2277	5894135	-332
Excavator 300 kW	Ex2	374888	-645	5899217	4750
Grader 200 kW	Gr2	374303	-1230	5894813	346
Grader 397 kW	Gr3	374950	-583	5893612	-855
Grader 397 kW	Gr4	376890	1357	5896723	2256
P&H 4100XPC Shovel	Sh1	375289	-244	5893766	-701
PC8000 Komatsu Shovel	Sh2	375874	341	5892996	-1471
PC8000 Komatsu Shovel	Sh3	375104	-429	5893057	-1410
PV271 Diesel Drill	Dr1	375812	279	5892780	-1687
PV271 Diesel Drill	Dr2	375104	-429	5892965	-1502
PV271 Diesel Drill	Dr3	376151	618	5893088	-1379
ROC F9 Diesel Drill	Dr4	375658	125	5893273	-1194
Primary Crusher	PC	375562	29	5894271	-196
Pebble Mill	PM	375604	71	5894792	325
Plant Building	MB	375570	37	5894812	345

Graphical representation of equipment location is shown in **Figure 1** which presents the general arrangement of the mine site at end of year 8.



LEGEND:

- UPLAND BEACH
- BOG / WETLAND AREA
- EMERGENT VEGETATION WETLAND
- UPLAND SLOPE
- TAILINGS BEACH
- POND
- EMBANKMENT FILL
- PAG WASTE ROCK
- NAG WASTE ROCK / OVERBURDEN
- LOW-GRADE ORE
- TOPSOIL
- RECLAIM SYSTEM
- WATER SUPPLY PUMPSTATION
- CONSTRUCTION HAUL ROAD
- MINE HAUL ROAD
- MINE ACCESS ROAD
- PIPELINE SERVICE ROAD
- FRESH WATER FLOW DIRECTION
- WATER RECLAIM PIPEL NE
- NEW GOLD PROPERTY BOUNDARY
- TRANSMISSION LINE
- SPILLWAY
- SEEPAGE COLLECTION TRENCH
- TAILINGS PIPELINE
- TAILINGS DEPOSITION

NOTES:

1. CONTOUR INTERVAL IS 5 METRES.
2. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

400 200 0 400 800 1200 1600 2000 m
SCALE A

Notes:
-Equipment locations added to KP plan drawing
-No mechanical/electrical/welding trucks included

NEW GOLD INC

BLACKWATER GOLD PROJECT

Location of Noise Emitting Equipment

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-457/6	VA13-01109

FIGURE 1	REV A

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
A	31MAY'13	ISSUED FOR EIA INFORMATION PACKAGE	DDF	AN	-	-

2.2 Noise Modelling

The computer based model SPM9613 developed by Power Acoustics, Inc. was used to predict the noise levels for the worst case scenario of the operations phase of the project.

The SPM9613 model requires definition of the following input data:

- Source identification;
- Source size and location;
- Source elevation above or below the reference level;
- Choice of 6 points or 54 points per source;
- Sound power level (PWL) spectrum data;
- Source directivity; and
- Terrain elevation.

An octave frequency spectrum (Hz) sound power level (PWL) for the anticipated noise sources are presented in **Table 4**.

Table 4: Noise Sources Sound Power Levels at Octave Frequencies

Major Noise Source	No. of Units	Sound Power Level (dB)								
		32	63	125	250	500	1k	2k	4k	8k
930E 4SE Komatsu Truck	25		90	96	104	115	113	112	108	99
Blasting Loader	1		104	108	98	99	97	92	86	80
Cat 14M Grader	1		103	115	106	107	103	101	97	87
Cat 735 Dump Truck	4		80	94	93	99	99	96	100	81
Cat 825 Compactor	1	70	87	99	106	111	113	108	101	93
Cat 988 Wheel Loader	1		102	110	101	102	99	93	89	82
Cat D8 Bulldozer	1		103	115	106	107	103	101	97	87
Cat CS76 Compactor	1	70	87	99	106	111	113	108	101	93
Dozer 370 kW Wheeler	1		81	100	103	107	108	103	100	90
Dozer 450 kW	5		90	107	104	107	105	102	98	87
Dozer 650 kW	2		103	115	106	107	103	101	97	87
Excavator 150 kW	1		100	105	108	104	101	97	84	80
Excavator 300 kW	1		104	109	112	107	105	102	86	80
Grader 200 kW	1		103	115	106	107	103	101	97	87
Grader 397 kW	2		103	115	106	107	103	101	97	87
P&H 4100XPC Shovel	1		104	108	98	99	97	92	86	80
PC8000 Komatsu Shovel	2		104	108	98	99	97	92	86	80

Major Noise Source	No. of Units	Sound Power Level (dB)								
		32	63	125	250	500	1k	2k	4k	8k
PV271 Diesel Drill	3	98	107	114	114	114	119	119	121	118
ROC F9 Diesel Drill	1		109	118	113	113	113	112	110	104
Primary Crusher	1	111	120	121	121	120	117	115	111	105
Pebble Crusher	1	84	96	101	106	110	111	109	104	91
Mill Bldg	1	72	100	94	90	88	79	74	70	57
SAG Mill	2		118	117	118	114	111	108	110	95
SAG Mill			118	117	118	114	111	108	110	95
Ball Mill	2		113	113	115	119	111	106	98	93
Ball Mill			113	113	115	119	111	106	98	93
Leach Feed Screen	2	84	96	101	106	110	111	109	104	91
Leach Feed Screen		84	96	101	106	110	111	109	104	91
Cumulative Inside Bldg		87	122	122	123	124	119	116	114	101
Bldg Wall TL		15	22	28	33	36	40	42	44	44
Cumulative Outside Bldg		72	100	94	90	88	79	74	70	57

The noise model output includes:

- Noise contours within defined modelled rectangular area;
- Table of noise levels (in dBA and dBC) and frequency spectra at point receptor;
- 3-D graph of frequency spectrum from 16 Hz to 8 kHz for defined receptor;
- Contour points, sources, barriers/reflectors, foliage and industrial sides; and
- Possibility of model field calibration when practical.

Project effects were assessed by using the same background conditions as the baseline to determine actual incremental noise attributable to project activities. Using alternative conditions/modelling scenarios (e.g., higher wind speeds or stormier weather) would not result in a more conservative prediction as the highest potential number of equipment units was used and background noise would not affect project related noise.

Details of noise modelling with the SPM9613 model are available in professional literature (Parzych 2001, Palczynski 2005) and on the Internet at http://poweracoustics.com/Software.html.

2.3 Results

The sound level modelling results as generated by SPM9613 model are shown as noise level contour plots for three representative domains. The colour scale corresponds to sound levels in 5 dBA intervals. Location of the 0-0 coordinates is at the primary crusher.

The modelling results show that the major noise sources at the proposed operation will be the pit area where equipment extracting the ore (e.g., shovels, loaders, trucks, drills, etc.) would operate. Due to the close proximity of the major items of equipment, the combined noise levels will be higher than the individual equipment noise levels detailed in **Table 4**. **Figure 2** shows noise levels in dBA within pit and plant areas with the primary crusher at the centre.

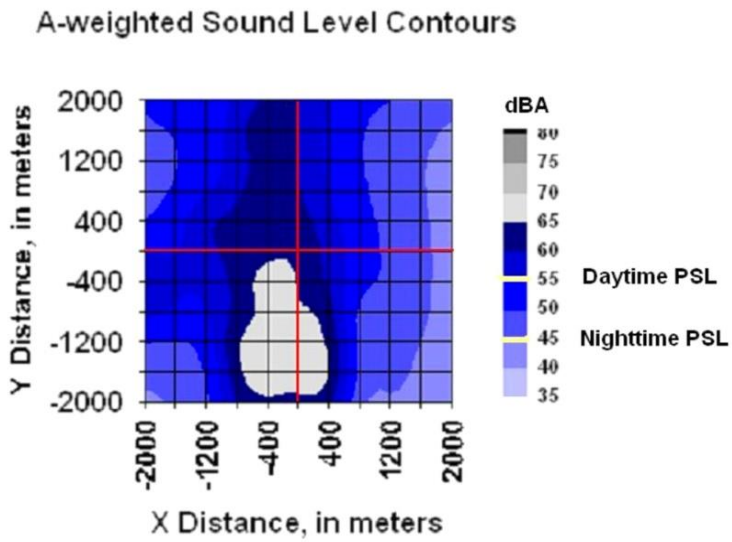


Figure 2: ***Noise Contours at Pit and Plant Areas***

Noise contours in 14 km x 10 km modelling domain is shown in **Figure 3**. In addition to the mining and processing facilities, the area encompasses local and regional study areas for noise.

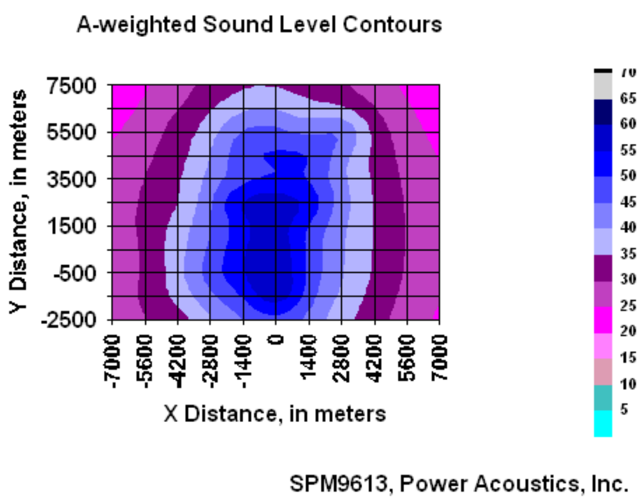


Figure 3: ***Noise Contours at Pit and Plant Areas***

The model output confirms elevated sound levels at the pit and plant areas as displayed in the above figure. Also, the model shows noise predictions beyond the RSA. The purple coloured contours indicate noise levels at the background level of 30 dBA which is attained approximately 5,600 m in each east and west direction.

The next modelling run was completed for the extended area of 14 km x 16 km. This was required to the distances to the north and south where the project noise would be attenuated to the baseline level. The results are shown in **Figure 4**.

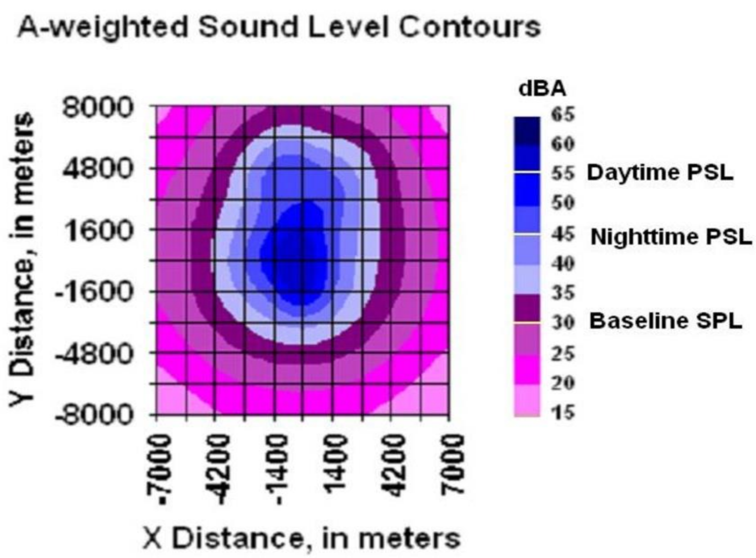


Figure 4: Noise Contours at Pit and Plant Areas

The baseline noise will equal the baseline noise at 8 km north and 5 km south from the mine central point.

2.4 Blasting Noise and Vibration

Blast noise contains predominantly low frequency sound with most of the audible sound energy below 50 Hz. For this reason (low attenuation in air) it is omni-directional. Although localized "shadow zones" will occur behind topographic features such as berms and hills, low frequency sound will readily refract/bend around any such obstacles so that noise levels beyond the shadow zone will be much the same as they would have been without the localized barrier.

During the initial development of each pit, blasts will be close to the original elevation of the ground. However, the pits will be developed as a series of 15 m wide benches, each at the base of a near-vertical, 15 m high rock face. These rock faces will act as sound barriers with the result that blast noise outside the perimeter of the pit will be attenuated by an amount that will depend upon the depth of the pit. According to Griffiths and Oates (1978), the additional attenuation to be expected for blast noise originating on the first and second benches below original ground level would be about 2 dB and 6 dB, respectively. Although additional shielding can be expected for blasts on lower benches, it is unlikely that the additional attenuation would ever exceed 15 dB even for very deep pits because of reflection of sound off the opposing faces of the pit.

Several empirical formulas have been developed for predicting the unweighted peak noise level from a blast. The prediction formula adopted for the project is one derived by Linehan and Wiss (1980) for the US Bureau of Mines. The constants derived for the formula vary somewhat between mine sites, so to take a conservative approach, those constants that result in the highest predicted noise levels have been used for this project. The prediction formula is as follows:

$$P = 6.31\, e^{-B} (D/W^{1/3})^{-1.16}$$

where:

P = peak overpressure, kPa
e = base of natural logarithm (e = 2.7183)
D = distance from blast to receiver
W = maximum charge weight per delay (TNT equivalent), kg
B = scaled depth of burial ($C/W^{1/3}$), $m/kg^{1/3}$
C = depth to center of gravity of charge, m

The peak overpressures predicted by the formula above can be converted to unweighted peak sound pressure levels (SPL), in decibels, using the following equation:

$$SPL = 20 \log P + 154$$

The maximum charge weight per delay represents the equivalent weight of TNT, an explosive. As per typical mining practice, the explosives are about 70% ammonium nitrate. Hence, an actual charge weight of 1,000 kg will be equivalent to about 411 kg of TNT. The above formula was derived from blast noise measurements ranging from 30 to 3,000 m.

The Linehan and Wiss equation has been used to predict blast noise at distances up to 3 km. The primary predictions assume sound propagation over ground. **Table 5** shows unweighted peak sound pressure levels at different distances caused by the explosion of 1,000 kg of ANFO charge at a depth of 15 m.

Table 5: Predicted Blasting Noise Levels

Distance (m)	**30**	**100**	**500**	**600**	**1,000**	**1,500**	**2,000**	**3,000**
SPL (dBA)	137	125	109	107	102	98	95	91

All blasting operations will be done in accordance with the project’s Blasting Management Plan. Immediately before any blast occurs, the area within 500 m of the blast location will be cleared of all personnel and visible wildlife. Hence, the closest distance of concern for blast noise is 500 m.

The noise from a blast can be quite loud if the listener is within a few hundred meters of the blast. Airborne pressure waves can cause annoyance because of hearing and feeling (particularly the low frequency component) the noise at levels above peak linear values of around 115 dBA. However, at a distance it is usually heard as a low rumble or "popping" sound that lasts one or two seconds. If the wind is blowing away from the listener there may be no audible sound. Some atmospheric conditions, such as low cloud cover, cause the sound waves to propagate over a greater distance and results in a more noticeable "bang" referred to as an "air blast." Development and implementation of a Blasting Management Plan, in combination with blasting in-pit location well below the ground level, will minimize the air blast noise effect.

Vibration is caused by shock waves emanating from the blast point. The vibrations can be felt easily close to the blast but decrease in strength as they radiate outwards. The explosives in a blast pattern are never fired simultaneously but are sequenced over a second or two. Therefore, limiting the amount of explosives that are fired at any one instance can minimize the vibrations caused by blasting. Ground-borne vibration can cause annoyance above levels of about 5 mm/sec because of the perception of movement. Structural damage may also occur but at significantly higher levels, i.e., about 50 mm/sec. There are no structures that could be subjected to damage in the blasting vibration zone.

Vibration caused by trucks will be negligible. Trucks are supported on flexible suspension systems and pneumatic tires, therefore they are not an efficient source of ground vibration. However, when a truck travels over potholes or other discontinuities in the road surface it can be the primary source of localized, intermittent vibration peaks. These peaks typically last no more than a few seconds and often for only a fraction of a second. Because vibration drops off rapidly with distance, there is rarely a cumulative increase in ground vibration from the presence of multiple trucks. At the pit and plant sites trucks will travel with a low speed which is vibration deterrent (CDT 2004).

The effect of vibration on fish is analyzed with reference to Fisheries and Oceans Canada's (DFO 1998) Guideline for the Use of Explosives In or Near Canadian Fisheries Waters provided under the Fisheries Act. The DFO guideline recommends a setback distance from the centre of detonation of a confined explosive to spawning habitat to achieve 13 mm/sec guideline criteria to be at least 150.9 m for 100 kg explosive charge. The nearest occupied fish habitat to the open pit is in the headwaters of Creek 661 directly east of the pit and just outside of the mine site boundary. The distance to the upstream extent of fish-bearing habitat in that headwater stream is 3,100 m. Therefore, vibration from blasting is unlikely to have an effect on fish, based on the DFO guideline.

2.5 Tatelkuz Lake Pump Station Noise Modelling

The pump station will be a permanent two-level concrete structure constructed on the shore line of Tatelkuz Lake. The lower level will be a wet well chamber fed by two pipeline intakes. The upper level of the concrete structure will serve as the pump house floor. This above grade concrete and steel structure will be 10.7 m wide, 13.5 m long and 7 m high located onshore 15 m from the lake. It will accommodate four 525 kW electric motors coupled with vertical turbine pumps equipped with variable-speed drives (VSDs). Three motor-pump sets will continuously operate and one as stand-by. Power will be supplied by a pad mounted transformer located behind the pump station. The transformer will operate at 25 kV with NEMA (the National Electrical Manufacturers Association) rating of 45 dBA (Class 10-50 kV, Standard ST-20).

Indoor and ambient noise modelling was completed using the SPM9613 computer based model described above in Section 2.2. The electric motor sound power level (PWL) in 16 Hz to 8 kHz octave band frequency range and the transmission losses (TL) of noise penetrating concrete walls of the pump station are shown in **Table 6**.

The noise levels inside the structure are predicted with the SPM9613 model and are shown in Figure 5. The drawing conforms to the determined building dimensions and refers to three operating motors and pumps. The model accounted for most sound reflected by walls so only a small portion of the sound is transmitted through the wall. The wall's ability to block transmission is indicated by its transmission loss (TL) rating, measured in a decibel and is shown in **Table 6**.

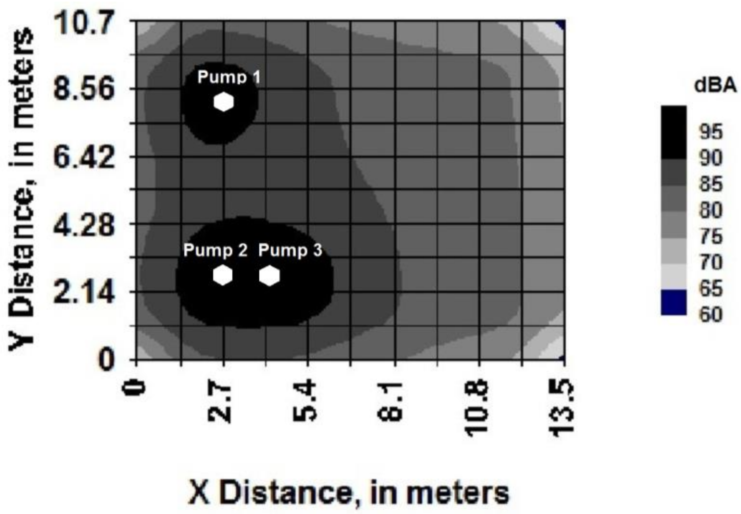


Figure 5: Noise Contours Inside Pump Station

Table 6: Pump Station Sound Data.

Indoor Electric Motors	Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	W (m)	D (m)	H (m)
	Electric Motor #1 PWL (dB)	91	93	95	95	95	95	95	92	85	13.5	10.7	7.0
	Electric Motor #2 PWL (dB)	91	93	95	95	95	95	95	92	85			
	Electric Motor #3 PWL (dB)	91	93	95	95	95	95	95	92	85			
	Cumulative PWL (dB)	96	98	100	100	100	100	100	97	90			
	Transmission Loss TL (dB)	26	32	32	31	40	49	58	67	74			
	Outside Wall PWL (dB)	70	66	68	69	60	51	42	30	16			
Outdoor Transformer	Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	1.7	1.3	1.4
	PWL (dB)	53	59	61	56	56	50	45	40	33			

PWL (dB) – Sound Power Level in decibels
W, D, H (m) – Wirth, Depth, Height of pump station and transformer in meters
Hz – sound wave frequency in 1/second

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