Introduction

Company Northern Cape Property Holdings are planning a property development in Kimberley in the vicinity of Kamfers Dam. As part of the construction of the property development limited rock blasting will be necessary for the excavation of trenches for installation of services. This report deals with the controls which need to be put in place to minimise the disturbance of the local population, wildlife and existing structures by the proposed blasting operations.

The following sites have been identified which need to be considered for protection when planning and conducting blasting operations:

? A recently established breeding colony of lesser flamingos is situated on an island in Kamfers Dam.
? The Booth residence, a farm house and associated buildings is situated immediately adjacent to the boundary of the proposed property development.
? The existing school and residences in Roodepan, to the West of the proposed development.

The flamingo breeding island lies 1200 m due East of the proposed property development. The minimum distance between proposed trench blasting operations and the flamingo breeding island is 1500 m. There is an existing national road (N12) 1400 m from the island and a railway line 1100 m from the island.

The Booth residence lies South East of the proposed blast site approximately 300 m from the away from the nearest position of proposed blasting operations.

The Roodepan buildings are situated approximately 700 m to the West of the western edge of the proposed blast site.

The prevailing wind is North/ North East and the terrain is predominantly flat with a low ridge formed by harder rock, where the blasting operations are proposed.

Blast related disturbance

The disturbance of people and animals from blasting operations can occur in one or more of the following forms:

? Fly rock
? Ground vibration
? Noise
? Air overpressure
? Dust

In order to conduct blasting operations on this site without causing disturbance to either the residents of the Booth Residence, Roodepan, or the flamingos controls will need to be implemented during the planning and conducting of blasting operations.

Blasting Controls

Although conditions differ at each site where blasting is carried out, experience over many thousands of blasting operations and empirical studies of the disturbance to people , structure and wildlife has allowed guidelines to be developed for minimising such disturbance. The most commonly followed guidelines are those published by the United States Bureau of Mines (USBM). The British Quarry association has also developed a set of guidelines similar to the USBM guidelines. Where the two guidelines do not agree the more stringent one will be applied in the recommendations that follow in this report.

Flyrock

In order to eliminate flyrock caused during blasting the following procedures should be applied:

1. Holes must be measured prior to charging to ensure that they are drilled to the correct depth.
2. Holes must not be over charged, with a stemming length at least equal to the hole burden.
3. The blast should be covered with a 30 cm thick layer of topsoil or sand, prior to initiation.
4. Hole timing must be adequate to ensure only 2 holes are initiated per delay.
5. The blast must be initiated from the furthest point away from the site being protected, with the blast advancing towards the site.

Ground vibration

The USBM guidelines state that to protect public property from damage due to ground vibrations the peak particle velocity (PPV) that the structure should be subjected to must be less than 12mm/s at a frequency of more than 10Hz. Vibrations caused by blasting of small blast holes on close spacings and with relatively fast timing, such as typical trench blasting will result in relatively high frequency vibrations, greater than 10 Hz.

The relationship between charge per delay and the resultant PPV is not linear. The relationship is usually represented as a logarithmic curve between the scaled distance ($m/kg^{1/2}$) and the PPV. Although the slope of the curve and consequently the relationship between charge per delay, distance from the blast and PPV is different for each site and is usually established by conducting test blasts to establish the site constants, an estimate can be made of the expected PPV at various distances from the blast using average site constants.

Figure 2 shows the relationship between scaled distance and PPV.

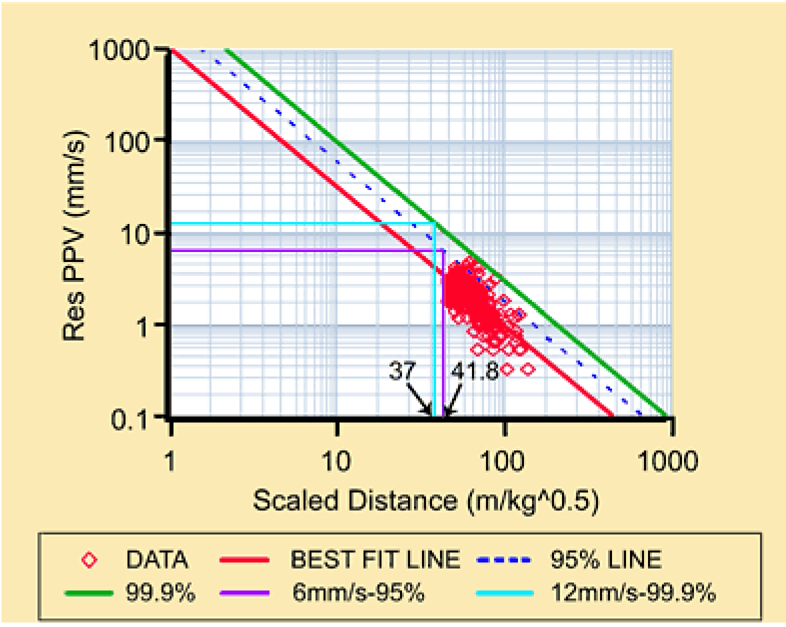

FIGURE 2 - RELATIONSHIP BETWEEN SCALED DISTANCE AND CHARGE PER DELAY

Although detailed engineering design of the trenches has not been completed typical trenches for laying cables an pipes are 1.0 m to 1.5 m deep and 1.0 to 1.5 m wide.

A typical blast design for this size of trench would be a pattern of 2 rows 38 mm diameter blast holes, with a burden of 0.75 m between holes. Blast holes will be sub -drilled to a maximum of 0.30 m below the planned trench bottom to ensure a clean break.

Assuming that holes are charged to 0.5 m from the collar, as is typical practice in this type of blasting that the charge per hole will be approximately 1.2 kg.

If a maximum of two holes are initiated per delay, the charge per delay will be 2.4 kg.

Table 1 shows the predicted PPV at varying distances from a blast with varying charge per delay, assuming average site constants.

TABLE 1 - PREDICTED PPV ASSUMING AVERAGE SITE CONSTANTS

Mass per Delay	Distance (m)	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
1	Expected Vector Sum (mm/s)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.5		0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5		0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10		0.7	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25		1.8	0.8	0.5	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
50		3.5	1.6	0.9	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
100		7.0	3.1	1.8	1.1	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1
150		10.4	4.7	2.6	1.7	1.2	0.9	0.7	0.5	0.4	0.4	0.3	0.3	0.2	0.2

Assuming average site constants and a maximum charge per delay of 2.4 kg, the predicted PPV at distance of 300 m from the blast site is less than 0.2 mm/s. This is well below the minimum vibration perceptible by humans. Vibrations below 1mm/s are imperceptible and barely perceptible up to 5mm/s. Damage to property, even minor plaster cracks usually occur with PPV levels of over 12 mm/s.

Provided good, controlled blasting procedures are followed, ground vibrations from blasting are not expected to cause disturbance at any of the identified sites, namely the flamingo island, the Booth residence or Roodepan.

Noise and overpressure (Airblast)

Noise and overpressure are similar disturbances except that overpressure refers to pressure waves in air which are outside of the audible range of frequencies. Noise and overpressure can be considered as one disturbance type and referred to as airblast. The reduction of noise from a blast will result in the reduction of overpressure as well.

Guidelines by the USBM state that noise and overpressure should be kept to below 134 dB. The British Quarry Association have not stated a guideline but they do point out that overpressure of 120 dB will cause minor disturbance such as rattling of windows. Table 2, bellows shows the levels of airblast and general acceptability in South Africa (AEL Blasting News).

TABLE 2 LEVELS OF AIRBLAST ACCEPTABILITY IN SOUTH AFRICA

Level	Description
100 dB (2.0 Pa)	Barely noticeable
110 dB (6.3 Pa)	Readily acceptable
128 dB (50.2 Pa)	Currently accepted by South African authorities as being a reasonable level for public concern. (No more than 10% of measurements should exceed this value.)
134 dB (100.2 Pa)	Currently accepted by South African authorities that damage will not occur below this level. (No measurements should exceed this value outside of the mining boundaries.)

The airblast (noise) produced by blasting can be estimated using the following formulae (Orica Explosives).

Confined Charge

$$Airblast\ Level\ dB\ L_{Linear\ peak} = 20\log\left(\frac{P_B}{P_0}\right)$$

$$where:$$

$$P_B = 3.3\left(\frac{R}{W^{\frac{1}{3}}}\right)^{-1.2}$$

$$P_0 = 2x10^{-8}$$

$$R = distance\ from\ blast$$

$$W = maximum\ charge\ mass\ per\ delay$$

Based on this equation and the blast design described above the noise level that can be expected at a distance of 1500 m of the blast, the position of the flamingo island, is 90 dB. This is only an estimate as actual noise propagation is highly dependant on the current meteorological conditions.

Based on the planned blast size and the controls detailed above to reduce blast vibration and flyrock, noise and overpressure from blasting will be minimal and is highly unlikely to cause any disturbance to humans at the identified sites All the controls listed above under Flyrock and Blast Vibration will assist to reduce noise and overpressure. In addition detonating cord should not be used as the surface initiation system for blasting.

In order to minimise the chances of the flamingos on the breeding island in Kamfers Dam being disturbed by the noise of the blasts the blasting operation should take place in the middle of the day when ambient noise in the area is at its highest. Blasting should not take place when the wind direction is Easterly, blowing from the blast site to the island. Blasting should not take place when low cloud cover is present as this typically results in high noise transmission levels. Blasting should not take place in the months from September to April, when the birds are actively breeding.

Although limited studies have been done on the effects of blast noise on bird life some work has been done by the military on the effects of noise on wildlife. Experimentation with the sonic boom, which is a purely acoustic stimulus (with no associated visual or odour stimuli), shows that the behavior of domestic and also some traditionally shy wild species was unaffected as the result of repeated sonic booms (see Casaday & Lehmann, 1967, Welch, 1970).

Dust

The formation of a dust cloud by the detonation of explosives is inevitable, particularly in dry conditions. The covering of the blast with topsoil, as described above as well as wetting down of the area, prior to blasting will minimize the production of dust. The planned blast size is relatively small and the production of dust is not expected to be seen as a significant disturbance risk, provided the controls discussed throughout this report are adhered to.

Conclusion

In order to protect the identified sites from blast related disturbance from the blasting operations carried out for the purposes of trenching, controls need to be implemented during the planning and conducting of blasting operations.

If these controls are implemented disturbance of the people and wildlife in the vicinity should be kept to a minimum.