KOINGNAAS AND SAMSONS BAK COMPLEX DIAMOND MINING PROJECT

NORTHERN CAPE PROVINCE

NOISE IMPACT ASSESSMENT

Prepared by:

Demos Dracoulides

Arrey Ebot

DDA

CAPE TOWN

PO Box 60034, Table View 7439

Tel: +2721 551 1836

Fax: +2721 557 1078

DemosD@xsinet.co.za

Commissioned by:

Myezo Environmental Management Services

Report No WCR-NVI-R01

October 2016

EXECUTIVE SUMMARY

1. Introduction

West Coast Resources (Pty) Ltd (WCR) is a private company owned by Trans Hex Operations (Pty) Ltd (Trans Hex), RE:CM and Calible Limited (RAC), the Government of South Africa, Dinoka Investment Holdings (Pty) Ltd and the Namaqualand Diamond Trust Fund, a broad based community trust representing historically disadvantaged persons from the Namaqualand community.

Trans Hex has entered into an agreement with the other shareholders of WCR to oversee and manage the operations of WCR. WCR is re-establishing a diamond mining operations in the Koingnaas area on the Namaqualand coast, which was previously mined by De Beers and under the existing mining environmental authorisation of July 2012.

DDA Environmental Engineers (DDA) has been appointed by Myezo Environmental Management Services for the determination of the baseline noise levels and the noise impact assessment for the proposed mining activities. The present report describes the noise and vibration impact assessment, which forms parts of the Environmental and Social Impact Assessment (ESIA).

2. Study Approach

The study approach incorporated noise measurements within the areas around the project site, as well as noise calculations for the operational phase of the proposed mine and associated infrastructure.

The noise modelling calculations for the proposed development were utilised for the determination of the resulting noise levels due to the mining operations, the processing plants and the ore transportation. The resulting noise levels were then used for the impact assessment on the surrounding areas and sensitive receptors.

3. Impact Assessment

Based on the noise measurements and the noise modelling results, the following can be concluded:

Baseline Noise Environment

- The noise environment around the WCR mining areas is that of typical Rural districts. The daytime and night-time levels at Koingnaas were close to the SANS guideline levels for Rural districts of 45 dB(A) and 35 dB(A) respectively. At Hondeklip Bay the background noise levels were marginally higher due to the proximity to the ocean.
- The main noise contributors within the Koingnaas and Hondeklip Bay communities are local vehicular traffic, human activities and for the latter also sea waves.

Operational Phase

- The 45 dB(A) daytime and 35 dB(A) night-time noise levels will be primarily contained within the WCR concession area.
- The daytime and night-time noise contribution of the mining activities and processing plants will be below the Rural District guidelines in both the Koingnaas and Hondeklip Bay communities.
- The operational noise impact is considered Insignificant and no additional mitigation measures would be necessary.
- The vibration levels are not expected to exceed the limit for sensitive or historical buildings beyond a 200 m zone and the threshold of human perception beyond a 1 km zone.

4. Recommendations

The main recommendations of the noise and vibration study are outlined below.

Essential Mitigation Measures During Operation:

i. There are no specific mitigations that will be required during the mining activities and plants' operations.

General recommendations for noise minimization and management during operation:

a. Maintain the haul roads at least 1 km away from the Koingnaas and the Hondeklip Bay community boundaries.

b. Any blasting activities should be at least 1.5 km from any communities and 500 m from any building structures.

c. Environmental noise and vibration monitoring should be performed by an independent specialist on an annual basis at three locations within the communities closest to the mining activities and plants.

d. Maintenance of equipment and operational procedures: Proper design and maintenance of silencers on diesel-powered equipment, systematic maintenance of all forms of equipment, training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.

e. Public complaints and actions registry: A formal recording system should be introduced, in order to capture public perceptions and complaints with regard to noise impacts, track investigation actions and introduce corrective measures for continuous improvement.

5. Impact Rating

Based on the modelling results for the proposed mining activities and processing plants, the impacts are summarised in the following table.

Table 1. Operational Noise and Vibration Impact Rating

Nature: The mining zones, haul roads and plants' operations will result in a **negative direct** impact on the noise environment around the mine.

Sensitivity/Vulnerability/Irreplaceability of Resource/Receptor – Low
Sensitivity: The activity will increase the noise and vibration levels in areas in very close proximity to the plants and mining pits. However, the closest receptor is situated more than 2 km away.

Impact Magnitude – Negligible

- Extent: The extent of the impact is **local**.
- Duration: The expected impact will be **long-term** (i.e. the duration of the operation).
- Scale: The impact will **not** result in **notable changes** to the noise levels at receptors situated more than 2 km from the plants and mining pits and 1 km away from haul roads.
- Frequency: The frequency of the impact will be **periodic.**
- Likelihood: The noise and vibration levels during operation are **possible** to increase during the operational period.

IMPACT SIGNIFICANCE (NO MITIGATION REQUIRED) – NEGLIGIBLE
Degree of Confidence: The degree of confidence is **high**.

Essential Measures:

i. None.

General Recommendations:

ii. Maintain the haul roads at least 1 km away from the Koingnaas and the Hondeklip Bay community boundaries.
iii. Any blasting activities should be at least 2.5 km from any communities and 500 m from any building structures.
iv. Environmental noise and vibration monitoring should be performed by an independent specialist on an annual basis at three locations within the communities closest to the mining activities and plants

Table of Contents

List of Figures **page**

List of Tables page

Terminology, Acronyms and Definitions

Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
A-weighted sound level	A frequency weighting filter used to measure of sound pressure level designed to reflect the acuity of the human ear, which does not respond equally to all frequencies.
dB(A)	Unit of sound level. The weighted sound pressure level by the use of the A metering characteristic and weighting.
deciBel (dB)	A measure of sound. It is equal to 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference sound pressure. The reference sound pressure used is 20 micropascals, which is the lowest audible sound.
ESIA	Environmental and Social Impact Assessment
Equivalent A-weighted sound level (L_{Aeq})	A-weighted sound pressure level in decibels of continuous steady sound that within a specified interval has the same sound pressure as a sound that varies with time.
Equivalent continuous day/night rating level	Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a reference time interval of 24 h, including adjustments for tonal character, impulsiveness of the sound and the time of day.
GPS	Global Positioning System
IEC	Independent Electoral Commission
IFC	International Finance Corporation
Impulse time weighting	A standard time constant weighting applied by the Sound Level Meter.
ISO	International Organisation Standardisation
LA_{10}	The noise level exceeded 10% of the measurement period with 'A' frequency weighting calculated by statistical analysis.
LA_{90}	The noise level exceeded 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis. It is generally utilized for the determination of background noise, i.e. the noise levels without the influence of the main sources.
L_{WA}	Sound power level in dB(A), re 10^{-12} W.

Mtpa	Million tonnes per annum
NSR	Noise Sensitive Receivers.
OECD	Organisation for Economic Co-ordination and Development
PPE	Personal Protective Equipment
PPV	Peak Particle Velocity. The peak signal value of an oscillating vibration velocity waveform, usually expressed in mm/second.
PWL	Power level in dB(A).
Residual noise	Sound in a given situation at a given time that excludes the noise under investigation but encompasses all other sound sources, both near and far.
SA	South Africa
SANS	South African National Standard.
SLM	Sound Level Meter
WBG	World Bank Group
WHO	World Health Organisation

1 INTRODUCTION

West Coast Resources (Pty) Ltd (WCR) is a private company owned by Trans Hex Operations (Pty) Ltd (Trans Hex), RE:CM and Calible Limited (RAC), the Government of South Africa, Dinoka Investment Holdings (Pty) Ltd and the Namaqualand Diamond Trust Fund, a broad based community trust representing historically disadvantaged persons from the Namaqualand community.

Trans Hex has entered into an agreement with the other shareholders of WCR to oversee and manage the operations of WCR. WCR is re-establishing a diamond mining operations in the Koingnaas area on the Namaqualand coast, which was previously mined by De Beers and under the existing mining environmental authorisation of July 2012.

As part of their operations, WCR intend to mine deposits that are located on land as well as specific deposits that extend seaward from the land for potentially for several hundred metres. The focus of the Environmental Impact Assessment (EIA) is on the mining-related activities that are proposed and the associated processing activities. Myezo Environmental Management Services were appointed by WCR to manage the Environmental Impact Assessment (EIA) process.

DDA Environmental Engineers (DDA) has been appointed by Myezo Environmental Management Services for the determination of the baseline noise levels and the noise impact assessment for the proposed mining activities. The present report describes the noise and vibration impact assessment, which forms parts of the Environmental and Social Impact Assessment (ESIA).

1.1 Study Area

WCR has existing converted mining rights and prospecting rights over the area, including a number of properties situated approximately 50 kilometres west of Kamieskroon and extending north and south of Hondeklip Bay on the West Coast of the Northern Cape Province, South Africa (see Figure 1-1).

The mining rights comprise of the existing rights, covering the Koingnaas Complex (KNC) and Samsons Bak Complex (SBC), which were converted in July 2012 (under File No. SNC 522 MRC and SNC 525 MRC), respectively, and several farms of the existing prospecting right area, which includes the Namaqualand Prospecting Right (NPR) (File No. SNC 672 PRC).

Figure 1-1. Locality Map

1.2 Terms of Reference

The proposed terms of reference for the baseline and noise and vibration impact assessment study were:

- Establish the baseline noise levels around the proposed site.
- Determine thresholds of acceptable change and relevant noise standards to be complied with.
- Identify sensitive receptors that may potentially be impacted upon by the proposed mining activities and associated infrastructure.
- Build a 3-dimensional noise impact model, in order to predict the future noise levels due to the operation of the proposed project for comparison with regulatory limits and international guidelines.
- Conduct a noise and vibration assessment related to the proposed mining activities and associated infrastructure, according to applicable standards.
- Propose potential mitigation measures, if required.
- Identify and predict the impacts of the proposed mining activities, as well as the assessment of significance before and after mitigation.
- Propose a Noise Monitoring Programme and Management Plan for the proposed mining activities and associated infrastructure.

2 NOISE BASICS GUIDELINES AND LEGAL REQUIREMENTS

2.1 Noise Basics

Sound is created when an object vibrates and radiates part of that energy as acoustic pressure or waves through a medium, such as air, water or a solid. Sound and noise are measured in units of decibels (dB). The dB scale is not linear but logarithmic. This means, for example, that if two identical noise sources, each producing 60 dB, operate simultaneously they will generate 63 dB. Similarly, a 10-decibel increase in sound levels represents ten times as much sound energy.

The human ear can accommodate a wide range of sound energy levels, including pressure fluctuations that increase by more than a million times. The human ear is not equally receptive to all frequencies of sound. The A-weighting of sound levels is a method used to approximate how the human ear would perceive a sound, mostly by reducing the contribution from lower frequencies by a specified amount. The unit for the A-weighted sound levels is dB(A).

Small changes in ambient sound levels will not be able to be detected by the human ear. Most people will not notice a difference in loudness of sound levels of less than 3 dB(A), which is a two-fold change in the sound energy. A 10-dB(A) change in sound levels would be perceived as doubling of sound loudness.

The level of ambient sound usually varies continuously with time. A human's subjective response to varying sounds is primarily governed by the total sound energy received. The total sound energy is the average level of the fluctuating sound, occurring over a period of time, multiplied by the total time period.

In order to compare the effects of different fluctuating sounds, one compares the average sound level over the time period with the constant level of a steady, non-varying sound that will produce the same energy during the same time period. The average of the fluctuating noise levels over the time period is termed L_{eq}, and it represents the constant noise level that would produce the same sound energy over the time period as the fluctuating noise level.

Percentile parameters (L_n) are also useful descriptors of noise. The L_n value is the noise level exceeded for "n" percent of the measurement period. The L_n value can be anywhere between 0 and 100. The two most common ones are L_{10} and the L_{90}, which are the levels exceeded for 10 and 90 percent of the time respectively. The L_{90} has been adopted as a good indicator of the "background" noise level. The L_{10} has been shown to give a good indication of people's subjective response to noise.

Sound levels diminish with distance from the source because of dispersion, and for point noise sources the calculated sound pressure is:

$L_{p2} = L_{p1} – 20 \log(r_2/r_1)$

Where: L_{p2} = sound pressure level in dB at distance r_2 in meters, and L_{p1} = sound pressure level in dB at distance r_1 in meters

In the case of a line source the sound pressure is:

$L_{p2} = L_{p1} – 10 \log(r_2/r_1)$

In simple terms, for point sources, the distance attenuation would be approximately 6 dB(A) per doubling of distance from the source. For line sources the same attenuation is approximately 3 dB(A).

The atmospheric conditions, interference from other objects and ground effects also play an important role in the resulting noise levels. For example, “hard” ground, such as asphalt or cement transmits sound differently than “soft” ground, such as grass. The first ground type promotes transmission of sound, thus producing louder sound levels farther from the source. In general terms, the above effects increase with distance, and the magnitude of the effect depends upon the frequency of the sound. The effects tend to be greater at high frequencies and less at low frequencies.

Typical noise levels for various environments are shown in the following figure.

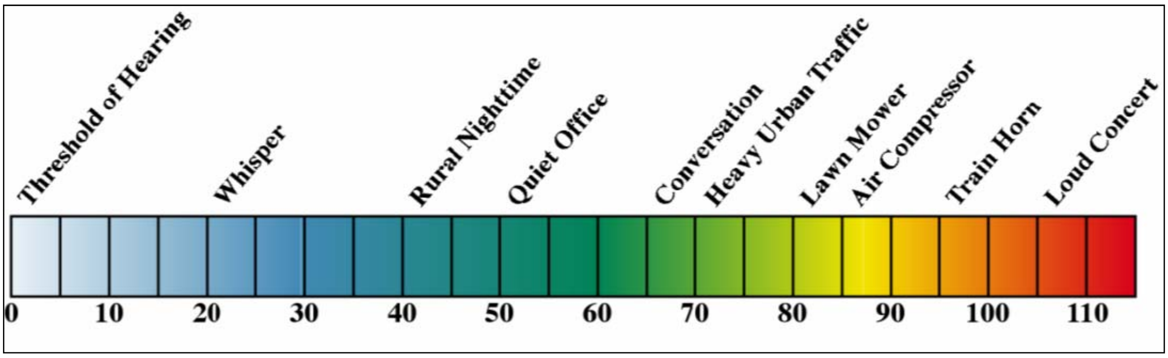


Figure 2-1. Typical Sound Levels (dB(A))

2.2 Noise Standards and Guidelines

In general, the standards applied by the international community are similar for different countries. Internationally, the current trends are to apply more stringent criteria due to the deteriorating noise climate.

The noise impacts due to a proposed project are generally based on the difference between the expected noise level increase and the existing noise levels in the area, as well as on comparisons against area-specific noise guidelines.

2.2.1 International Guidelines

The available international guidelines are presented in the sections below and have taken into consideration the following adverse effects of noise:

- Annoyance.
- Speech intelligibility and communication interference.
- Disturbance of information extraction.
- Sleep disturbance.
- Hearing impairment.

The World Health Organisation (WHO) together with the Organisation for Economic Co-ordination and Development (OECD) have developed their own guidelines based on the effects of the exposure to environmental noise. These provide recommended noise levels for different area types and time periods.

The World Health Organisation has recommended that a standard guideline value for average outdoor noise levels of 55 dB(A) be applied during normal daytime, in order to prevent significant interference with the normal activities of local communities. The relevant night-time noise level is 45 dB(A). The WHO further recommends that, during the night, the maximum level of any single event should not exceed 60 dB(A). This limit is to protect against sleep disruption. In addition, ambient noise levels have been specified for various environments. These levels are presented in the table below.

Table 2-1. WHO Guidelines for Ambient Sound Levels

Environments	Ambient Sound Level L_{Aeq} (dB(A))			
	Daytime		Night-time	
	Indoor	Outdoor	Indoor	Outdoor
Dwellings	50	55	-	-
Bedrooms	-	-	30	45
Schools	35	55	-	-

The WHO specifies that an environmental noise impact analysis is required before implementing any project that would significantly increase the level of environmental noise in a community (WHO, 1999). Significant increase is considered a noise level increase of greater than 5 dB.

World Bank Group (WBG) International Finance Corporation (IFC) has developed a program in pollution management so as to ensure that the projects they finance in developing countries are environmentally sound. Noise is one of the pollutants covered by their policy. It specifies that noise levels measured at noise receptors, located outside the project's property boundary, should not be 3 dB(A) greater than the background noise levels, or exceed the noise levels depicted in Table 2-2.

The Standard also refers to the WHO Guidelines for Community Noise (WHO, 1999) for the provision of guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments.

Table 2-2. World Bank/IFC Ambient Noise Guidelines

Receptor	Maximum Allowable Ambient Noise Levels 1-hour L_{Aeq} (dB(A))	
	Daytime 07:00 – 22:00	Night-time 22:00 – 07:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70
Note: No L_{Aeq} values are stipulated for rural areas.		

2.2.2 SANS Codes of Practice and Guidelines

The SANS 10103 Code of Practice provides typical ambient noise rating levels ($L_{Req,T}$) in various districts. The outdoor ambient noise levels recommended for the districts are shown in Table 2-3 below.

It is probable that the noise is annoying or otherwise intrusive to the community or to a group of persons if the rating level of the ambient noise under investigation exceeds the applicable rating level of the residual noise (determined in the absence of the specific noise under investigation), or the typical rating level for the ambient noise for the applicable environment given in Table 2-3 (Table 2 of SANS 10103).

The expected response from the local community to the noise impact, i.e. the exceedance of the noise over the acceptable rating level for the appropriate district, is primarily based on Table 5 of SANS Code of Practice 10103 (SANS 10103, 2008), but expressed in terms of the effects of impact, on a scale of NONE to VERY HIGH (see Table 2-4 below).

The noise monitoring of the baseline conditions within and around the site will provide the rating level of the residual noise. The noise impact during construction and the noise emission requirements will be determined by comparing:

- the ambient noise under investigation with the measured rating level of the residual noise (background noise levels); and
- the ambient noise under investigation with the typical rating level for the ambient noise for the applicable environment given in Table 2-3.

Table 2-3. Typical Rating Levels for Ambient Noise

Type of district	Equivalent continuous rating level ($L_{Req.T}$) for noise (dB(A))					
	Outdoors			Indoors, with open windows		
	Day-night $L_{R,dn}$ 1)	Day-time $L_{Req,d}$ 2)	Night-time $L_{Req,n}$ 2)	Day-night $L_{R,dn}$ 1)	Day-time $L_{Req,d}$ 2)	Night-time $L_{Req,n}$ 2)
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

Table 2-4. Response Intensity and Noise Impact for Increases of the Ambient Noise

Increase (dB)	Response Intensity	Remarks	Noise Impact
0	None	Change not discernible by a person	None
3	None to little	Change just discernible	Very low
3 ≤ 5	Little	Change easily discernible	Low
5 ≤ 7	Little	Sporadic complaints	Moderate
7	Little	Defined by South African National Noise Regulations as being ‘disturbing’	Moderate
7 ≤ 10	Little - medium	Sporadic complaints	High
10 ≤ 15	Medium	Change of 10dB perceived as ‘twice as loud’, leading to widespread complaints	Very high
15 ≤ 20	Strong	Threats of community/group action	Very high

2.2.3 Health and Safety

In South Africa, any operation that has the potential to generate noise should have a noise survey done, in terms of the Noise Induced Hearing Loss Regulations of the Occupational Health and Safety Act 85 of 1993 (SA).

The regulations require an Approved Inspection Authority to conduct the surveys in accordance with SANS 10083 and submit a report. All people exposed to an equivalent noise level of 85 dB(A) or more must be subjected to audiometric testing. It is required that all records of surveys and audiometric testing must be kept for 40 years.

The sound pressure threshold limits within workshops and plants that could affect employees’ health, quality of life and quality of work are:

- Alert threshold 80 dB(A).
- Danger threshold 85 dB(A).

Site locations are required to meet the following levels of performance at all points accessible by the employees on a regular basis:

- For workshop circulated areas, the maximum levels must not exceed 85 dB(A).
- For work equipment, the maximum levels must not exceed 80 dB(A) at one meter from the equipment and at 1.60 m high.

Exceptions may be considered for areas that should not be accessed on a regular basis. Personal Protective Equipment (PPE) will be required to access those areas, and the noise levels outside should comply with the above-mentioned thresholds.

The employer has a legal duty under the current Occupational Health Regulations (SA) to reduce the risk of damage to his/her employees' hearing. The main requirements apply, where employees' noise exposure is likely to be at or above the danger threshold limit of 85 dB(A). It should be noted that there is an international tendency to regard 80 dB(A) as an informal warning level.

The action level is the value of 'daily personal exposure to noise' ($L_{EP,d}$). This depends on the noise level in the working area and how long people are exposed to the noise. The values take account of an 8-hour noise exposure over the whole working day or shift.

2.3 Vibration Basics

Vibration can be described in terms of displacement, velocity or acceleration. For a vibrating floor, the displacement is defined as the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of that speed.

The vibration levels can also be expressed as a logarithmic scale in decibels, similar to the sound pressure levels for expressing noise. The relevant calculations for the velocity (L_v) and the acceleration (L_a) levels are:

$L_v = 20 \log_{10}(V/V_r)$, and

$L_a = 20 \log_{10}(A/A_r)$

where: $V_r = 10^{-9}$ m/s and $A_r = 10^{-6}$ m/s^2 are the velocity and acceleration reference levels as specified in ISO 1683.

The most commonly used measures of vibration are the peak particle velocity (PPV) in millimetres (mm), the velocity in metres per second (m/s) and acceleration in metres per second squared (m/s^2). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal and is often used in monitoring the stresses that are experienced by buildings.

In this report, when the vibration velocity levels are expressed in decibels, the reference level defined above applies, and the unit is specified as dBV, in order to distinguish it from dB(A), which is used for A-weighted noise levels.

2.3.1 Effects of Vibration on Humans and Structures

Humans are extremely sensitive to low levels of vibration and can detect levels of ground vibration of less than 0.1 mm/s, which is less than one hundredth of the levels which could cause even minor cosmetic damage to a normal building. Complaints and annoyance regarding ground vibration are therefore much more likely to be determined by human perception than by noticing minor structural damage. However, these effects, and the startling effect of sudden impulses of both sound and vibration are often perceived as intrusion of privacy and could be a source of considerable annoyance to the local community.

There is widespread agreement in the industry that the peak particle velocity (PPV) is the parameter which best correlates with observed damage to structures caused by vibration, and is widely applied in assessments. The first observable damage to structures, i.e. the forming of hairline cracks in plaster, begins at a PPV of about 25 mm/s. The US Bureau of Mines recommends twice this value, i.e. 50 mm/s, as a "safe blasting limit" for residential properties. Minor structural damage can occur at values in excess of 100 mm/s, and serious damage occurs at values in excess of 200 mm/s, according to a range of authors (Lear, 1992). Effects on temporary structures are likely to occur at values which are lower than those for masonry structures, even though the high variability in the type and construction quality of such structures renders reliable prediction of these values difficult.

2.3.2 Vibration Criteria and Guidelines

To date, there is no a specific standard or guideline pertaining to the impact of ground-borne vibration in South Africa. As such, international standards and guidelines will be applied for the assessment of the vibration impact on humans and structures.

A considerable amount of research has been done to correlate vibrations from single events such as dynamite blasts with architectural and structural damage. The U.S. Bureau of Mines has set a "safe blasting limit" of 50 mm/s. Below this level there is virtually no risk of building damage. However, since some of the structures in the extended area were in poor condition, the adopted limit utilised in this study was selected to be 12.5 mm/s.

The Transport and Road Research Laboratory in England has researched continuous vibrations to some extent and developed a summary of vibration levels and reactions of people and the effects on buildings (Whiffen and Leonard, 1971). These criteria have been adopted in the present study for the evaluation of the severity of vibration caused by the current railway operations and are presented in Table 2-5.

Traffic, train and most construction vibrations (with the exception of pile driving, blasting, and some other types of construction/demolition) are considered continuous. The "architectural damage risk level" for continuous vibrations (peak vertical particle velocity of 5 mm/sec) shown in Table 2-5 is one tenth of the maximum “safe” level of 50 mm/sec for single events. The recommended level for historical buildings or buildings that are in poor condition is 2.0 mm/s.

Table 2-5. Vibration Levels for Reactions of People and Effects on Buildings

Vibration Level PPV (mm/s)	Human Reaction	Effect on Buildings
0.15-0.30	Threshold of perception; possibility of intrusion.	Vibrations unlikely to cause damage of any type.
2.0	Vibrations readily perceptible.	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected.
2.5	Level at which continuous vibrations begin to annoy people.	Virtually no risk of “architectural” damage to normal buildings.
5.0	Vibrations annoying to people in buildings (for relatively short periods of vibration).	Threshold at which there is a risk of “architectural” damage to normal dwellings, i.e. houses with plastered walls and ceilings.
10-15	Vibrations considered unpleasant by people subjected to continuous vibration.	Vibrations at a greater level than normally expected from traffic, but which would cause “architectural” damage and possibly minor structural damage.

2.3.3 Blasting Vibration Basics

Blasting operations affect their surroundings in the form of ground vibration, air blast, fumes, fly rock etc. Ground vibration is a natural result of blasting activities. The shock wave energy that travels beyond the zone of rock breakage could cause damage and annoyance. This energy is transmitted through the ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. Once the vibration reaches a building, it is transferred through the foundations into the structure. Any structural resonances that may be excited will increase the effect of the vibration.

Factors influencing the ground vibration due to blasting are the charge mass per delay, distance from the blast, the delay period and the geometry of the blast. These factors are controlled by planned design and proper blast preparation.

The blast energy is transmitted to the ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. Once the vibration reaches a building, it is transferred through the foundations into the structure. Any structural resonances that may be excited will increase the effect of the vibration.

3 AMBIENT NOISE AND VIBRATION MEASUREMENTS

3.1 Noise Monitoring

3.1.1 Methodology

The baseline noise monitoring was based on noise measurements obtained via the use of a Type 1 Precision Impulse Integrating Sound Level Meter, in accordance with international standards for sound level meter specifications IEC 61672:1999, IEC 61260:1995 and IEC 60651., as well as ISO 19961:2003 and ISO 3095:2001 for the measurement and assessment of environmental noise.

The most common noise metric used to assess the dose-response relationship has become the L_{Aeq} based on the A-weighted sound level, although the L_{10} measured against the L_{90} is also used (ISO 1999, 1990). L_{Aeq} is now widely utilised in standards and legislation throughout the world as the basis on which to develop a dose-response relationship for community noise annoyance. It is particularly useful where the noise is relatively steady and broadband.

Because L_{Aeq} is defined in energy rather than straight numerical terms, it is not simply related to the level of exceedance of a guideline value, but also provides information regarding the nature and extent of the noise source. Other noise parameters such as the L_{10}, L_{50} and L_{90} also provide useful information. The L_{10} represents the higher noise levels during the measurement interval and together with L_{50} and L_{90} are generally utilised for traffic noise impacts. The L_{90} gives an indication of the underlying noise level, or the level that is almost always there in between intermittent noisy events. It is generally utilized for the determination of background noise, i.e. the noise levels without the influence of the main sources.

An assessment of the site was performed during an initial site visit, and noise measurements were performed in order to determine the existing noise environment and the selection of representative monitoring points.

A total of 7 monitoring points were selected for the determination of the existing background noise levels and the noise comparisons between the modelling and the measurements. The number of the measuring points covered the assessment of the representative background noise levels, the project site, as well as the sensitive receptors around the site.

The noise measurements were performed over a twenty-four hour period and were categorised in terms of daytime (07:00-22:00) and night-time (22:00-07:00), in order to generate results suitable for comparison to international guidelines.

At each location at least two measurements were performed for both daytime and night-time periods. In each period the continuous A-weighted equivalent sound pressure level (L_{Aeq}) of at least a 10-minute duration was taken. Abnormal disturbances, such as loud noise generation in close proximity or sudden noise bursts that affect the measurement, were discarded.

In addition to the L_{eq}, L_{10}, L_{50}, and L_{90}, the occurring maximum (L_{max}) and minimum levels (L_{min}) during the measurement period were also recorded. These measurements were appropriate for the determination of:

a) The noise levels with existing and future operations in progress.

b) The background noise, i.e. when no activities are contributing to the ambient noise levels.

c) The nature and extent of the noise.

All the noise measurements were performed in compliance with the weather condition requirements specified by the SANS and ISO codes. Therefore, measurements were not performed when the steady wind speed exceeded $5ms^{-1}$ or wind gusts exceeded $10\ ms^{-1}$. The wind speed was measured at each location with a portable meter capable of measuring the wind speed and gusts in meters per second.

3.1.2 Monitoring Equipment

The measurements were performed via two 01dB DUO, which are Type 1 Data-logging Precision Impulse Integrating Sound Level Meters (see Table 3-1). The Sound Level Meters was calibrated before and after the measurement session with a 01dB Type 1, 94dB, 1 kHz field calibrator. The above-mentioned equipment, i.e. sound level meters and calibrator, have valid calibration certificates from the testing laboratories of the De Beer Calibration Services and the manufacturer (calibration certificates are available on request), and comply with the following international standards:

- IEC 651 & 804 – Integrating sound level meters.
- IEC 942 – Sound calibrators

Table 3-1. Sound Level Measurement Instrumentation

Instrument	Type	Serial No.
1. Precision Integrating Sound Level Meter	01dB DUO	10372
2. Precision Integrating Sound Level Meter	01dB DUO	10373
3. Field Calibrator 01dB Cal01	CAL01	11243

All the noise measurements complied with the weather condition requirements, as specified by the SANS Codes and the Noise Control Regulations:

- the SOUTH AFRICAN NATIONAL STANDARD - Code of Practice, SANS 10103:2008, *The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication*;
- The Noise Control Regulations.

The coordinates of each monitoring point were recorded with the GARMIN iQue 3600, and the local weather parameters were measured with an AZ 8910 portable weather meter.

3.1.3 Noise-sensitive Receptors

The identified receptors that are in close proximity to the mining sites are depicted in Figure 3-1 below. These receptors are the residential areas of Koingnaas and Hondeklip Bay. In order to determine the expected noise contribution of the proposed mine operations, discrete receptors were placed at the above-mentioned sensitive receptors at the locations shown in Table 3-2. The modelled noise levels at these receptors, as well as the modelled noise contours around the mining operations can be found in the noise modelling section further below.

Table 3-2. Noise-Sensitive Receptors and GPS Locations

No.	Description	Coordinates (UTM)	
		X	Y
R01	Koingnaas Town	141658	6653070
R02	Koingnaas Town	142697	6653931
R03	Marais Gedenk Primêre Skool	142255	6639993
R04	Police Station in Hondeklip Bay	141701	6639564
R05	Farm House in Hondeklip Bay	141889	6640245

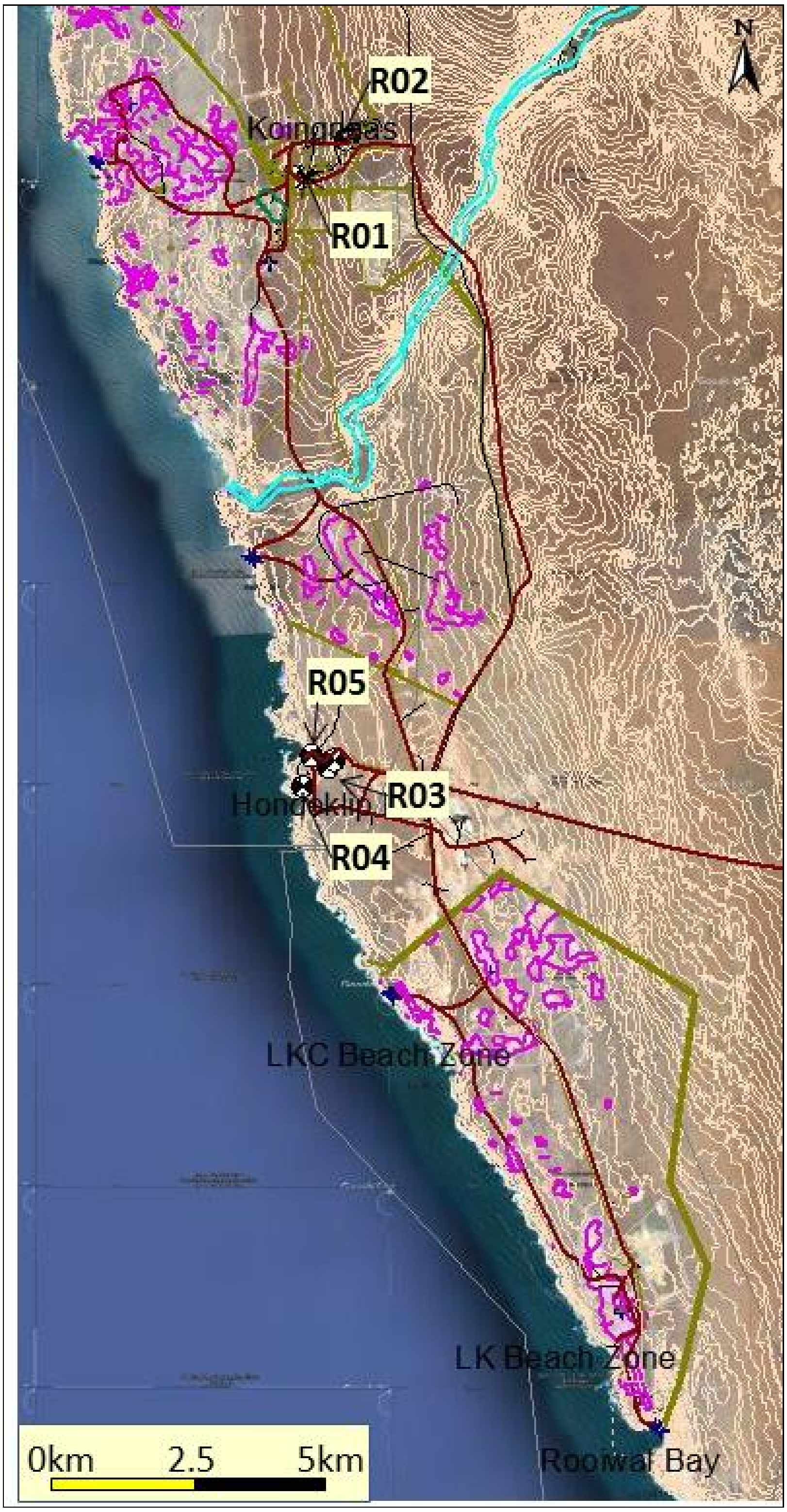


Figure 3-1. Noise-Sensitive Receptors in Study Area

3.1.4 Noise Monitoring Points

The selected monitoring points MP01-MP03 were (see Table 3-3).

MP01: Located at the beginning of Koingnass village approximately 2.2 km north-east from the mining area.

MP02: Located at Hondeklip bay approximately 1.3 km south of the mining area.

MP03: Located at Barratini street, Koingnass about 3 km north-east of the project site

The noise measurements were performed intermittently from the 18th to the 20th of July 2016 at Koingnass and Hondeklip bay and continuously for 2 days within the Koingnass town. These locations can be seen in Figure 3-2 further below and were chosen for the following reasons:

- Representative of the current noise levels of the different areas where noise-sensitive receptors are located.
- Areas in close proximity to the WCR mining activities.
- Easy accessibility under the current conditions.
- Safety in terms of demining operations and possible night-time measurements.
- Likelihood of continuing to exist after the development of the site and therefore to be used for future comparison purposes.

Table 3-3. Noise Monitoring Locations

Point	Location	Coordinates (UTM)		
		X	Y	Z
		(m)	(m)	(m)
MP01	Koingnaas	141477	6653090	63.8
MP02	Hondeklip Bay	142384	6640150	22.0
MP03	Koingnaas	142647	6653908	93.3

Figure 3-2. Locations of the Noise Monitoring Positions

3.1.5 Ambient Noise Measurements

As indicated in Section 3.2, the noise measurements were performed intermittently at two locations (MP01 and MP02) and continuously at MP03. The noise level (L_{Aeq}) for each monitoring point and can be seen in Table 3-4. The additional parameters recorded during the measurements, such as the L_{max}, L_{min}, L_1, L_{10}, L_{50} and L_{90} can be found in Appendix B.

Table 3-4. Measured Noise Levels per Location

Measurement Points	Type of Area	Noise Level (dB(A))	
		Day-time	Night-time
MP01	Residential	47.0	35.3
MP02	Residential	50.1	40.3
MP03	Residential	43.7	38.9
SANS Guidelines: Rural districts: Daytime: 45 dB(A), Night-time: 35 dB(A) Suburban districts with little road traffic : Daytime: 50 dB(A), Night-time: 40 dB(A) Urban districts: Daytime: 55 dB(A), Night-time: 45 dB(A) Industrial areas: Daytime: 70 dB(A), Night-time: 60 dB(A)			
World Bank Guidelines: Residential: Daytime: 55 dB(A), Night-time: 45 dB(A) Industrial: Daytime: 70 dB(A), Night-time: 60 dB(A)			

Based on observations during the site visit and the measurement results, the following can be indicated regarding the baseline noise environment at each monitoring location.

1) MP01:

The noise sources were dominated by the traffic noise, people conversing, dogs barking and insect activities. The average noise levels during day-time and night-time were 47.0 dB(A) and 35.3 dB(A) respectively. The measured ambient noise levels at this point were below the SANS Guidelines for Suburban Districts with little traffic of 50 dB(A) and 40 dB(A) for daytime and night time respectively.

2) MP02:

This point was located at Hondeklip Bay approximately 1.3 km south of the mining area. The noise environment at this point was dominated by sea waves and human activities. The average noise levels during day-time and night-time were 50.1 dB(A) and 40.3 dB(A) respectively. The measured noise levels for the time periods were below the SANS and the World Bank/IFC Ambient Noise Guidelines for urban residential areas.

3) MP03:

This point was located at Barratini Street in Koingnaas Town. The measurement at this point was performed continuously over two days and nights. The noise environment at this point was primarily dominated by human activities and the vehicular traffic on the local roads. The average noise levels during daytime and night-time were 43.7 dB(A) and 38.9 dB(A) respectively. The measured noise levels for the time periods were well below the SANS Guidelines for Urban Districts of 55 dB(A) and 45 dB(A) for daytime and night time respectively. The hourly L_{Aeq} levels at MP03 can be seen in Figure 3-3. The additional parameters and the time series of the measurements for each day can be found in Appendix B. It is evident from Figure 3-3, that the noise levels in the Koingnaas Town were below the SANS levels for Suburban Districts with little road traffic of 50 dB(A) and 40 dB(A) for most of the daytime and night-time respectively.

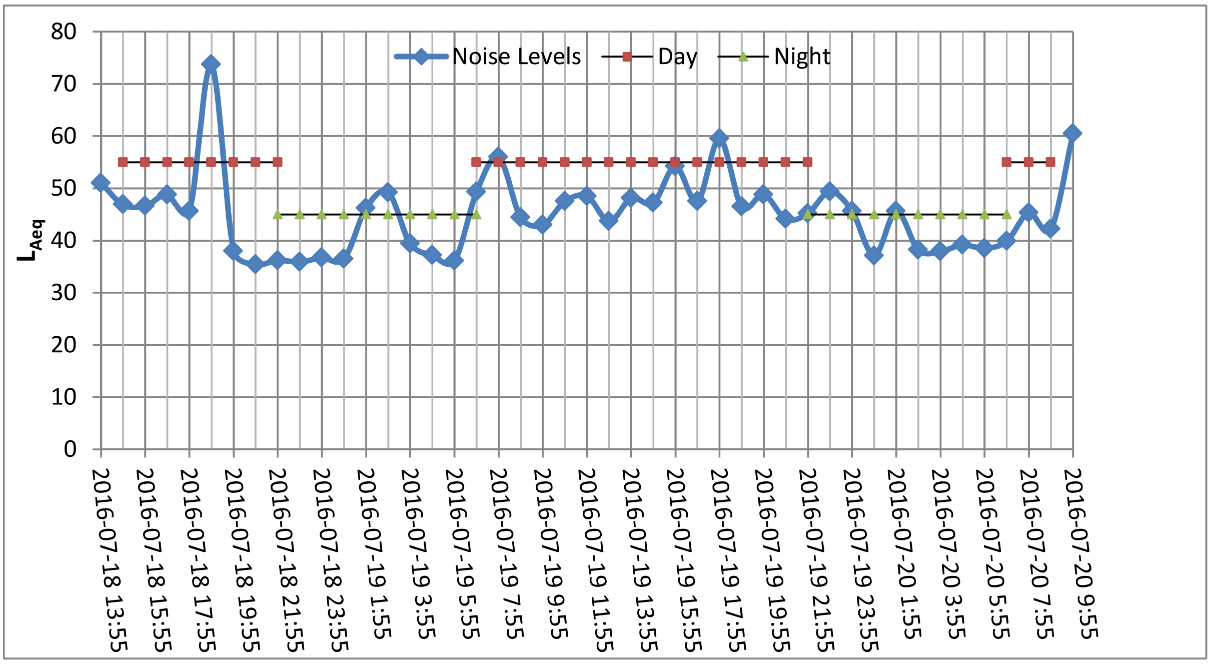


Figure 3-3 Noise Levels at MP03 (18/07/2016-20/07/2016)

3.2 Ambient Vibration Measurements

The vibration levels were measured with a Nomis Mini Supergraph II vibration logger with a triaxial geophone transducer. The Geophone was placed in a dug hole and weighted with a sandbag. The Nomis logger measures vibration in radial, transverse and vertical directions. The direction of the radial axis was aligned with the direction towards the mine. The Peak Vector Sum (PVS) for the three directions is also calculate automatically and is reported in the table below for each day and time of measurement.

The measurements were performed intermittently from the 30th of June to the 1st of July 2016 at the monitoring locations MP01 and MO02 (see Figure 3-2).

Table 3-5 shows the measured ground vibration levels (PPV) at the days and times of the measurements. From this table, it is evident that the human perception threshold of 0.3 mm/s was not reached at any time at these locations. As such, the baseline environment at these locations has very low levels of vibration.

The vibration monitoring sheets can be found in Appendix D.

Table 3-5. Ground Vibration Monitoring Results

Date	Location	PPV (mm/s)	Comments
2016-06-30 18:12	MP01	0.06	
2016-06-30 18:18	MP01	0.07	
2016-06-30 18:26	MP01	0.08	
2016-07-01 12:28	MP01	0.13	Car drove passed about 150 m from MP01
2016-07-01 12:38	MP01	0.06	
2016-07-01 12:49	MP01	0.07	
2016-07-01 14:59	MP01	0.06	
2016-07-01 15:07	MP01	0.08	
2016-07-01 15:12	MP01	0.06	
2016-07-01 10:49	MP02	0.05	
2016-07-01 10:49	MP02	0.15	Car drove passed about 100 m from MP02
2016-07-01 11:02	MP02	0.11	
2016-07-01 15:59	MP02	0.11	
2016-07-01 16:12	MP02	0.07	

4 NOISE AND VIBRATION MODELLING METHODOLOGY AND INPUT

4.1 Proposed new mining operations

The proposed mining operations are located below the low water mark and focus on beach and off-shore channel mining. These operations are not covered under the current EMP and are therefore subject to the EIA.

4.1.1 Beach and offshore channel mining

Beach and offshore channel mining operations of mineralized gravel deposits found in various places between the low and high water marks along the coast has been on-going for many years. Apart from mining favorable sandy beaches the focus will be particularly on the extensions of high-grade fluvial channels crossing the surf-zone to deeper water environments. Previous mining, drilling and sampling of these channels to the beach zone by DBCM provide confirmation of the economic viability of these channel deposits. Their presence, dimensions and positions on the beaches have been confirmed by means of beach-resistivity surveys. Exploration and past mining results indicate that these deposits extend offshore to as yet undetermined extent and current planning is for these channels to be mined by means of coffer dam mining techniques to the 250 m water mark and beyond as determined by circumstances. Surf-zone, beach and offshore channel mining will be both in-house and partly contract-based.

Two alternative approaches have been identified to access and mine the diamond resources seaward of the low water mark, namely:

I. Temporary accretion of the beach in the immediate vicinity of the mining target using overburden material available on the beach or from adjacent onland mining sites; or;

II. The construction of a rock berm or coffer dam using non-native rocks and boulders sourced from rock stockpiles near Koingnaas. This approach offers the only technically feasible approach for mining the area of the coastline that is exposed to high energy wave action. As indicated the area protected by the berm would extend up to 250-300m into the sea below the low water mark. Once the berm is in place and the mining block is enclosed overburden stripping and gravel extraction can be undertaken using conventional open-cast mining approaches. Once the area has been mined out, the rock berm would be progressively extended offshore to enclose the next mining block, potentially enabling mining up to 300 m seawards of the low water mark. The design-life of such berms is typically 1-2 years and they can thus be considered temporary structures.

For the current project, WCR is intending to implement this mining approach at the sandy beach target sites known as Koingnaas 68/69, Somnaas and Langklip Central (see Figure 4-1).

In addition to these areas off-shore mining is also proposed for Mitchells Bay. Mitchell's Bay (Rooiwal Bay) is a small protected bay located north of the Spoeg River. The mouth of the bay is some 700 m across (see Figure 4-2). The bay hosts a narrow sandy beach backed by steep soil cliff and a shallow reef in the mouth. Two alternative approaches have been proposed for off-shore mining in Mitchells Bay.

The first approach involves accretion of the beach using overburden sands stripped from adjacent onland mine operations (block LKB-04). Using this approach, three stages of beach accretion are being considered, with the shoreline moving seawards by 150 m during each successive stage. While this alternative for Mitchell's Bay is considered feasible from an engineering perspective, it is dependent on the mining of the inland deposits for a source of the accretion material.

The second approach involves the construction of a dynamically stable rock berm across the mouth of the bay and perpendicular to the predominant wave action. This would require a berm crest of 14 m in height to protect the mining area from extreme wave conditions. While considered technically feasible, this alternative has high costs associated with it and the high loss rate of material off the partly completed berm during construction may result in the structure being impossible to build.

In addition, a more generic design involving either statistically stable rock berms, or these in combination with dynamically stable berms, is being considered for other potential mining sites characterised by either a rocky shoreline or a shoreline of mixed sand and rock. The generic design is proposed for the Noup, Visbeen, Koingnaas, Langklip Central and Langklip target areas. The generic designs assume an initial mining area of 200 x 200 m, with sequential extension into adjacent blocks as mining progresses and the resource in a block is mined out. The type of design applied is determined largely by the depth of the seabed at the seaward extreme of the shore parallel berm.

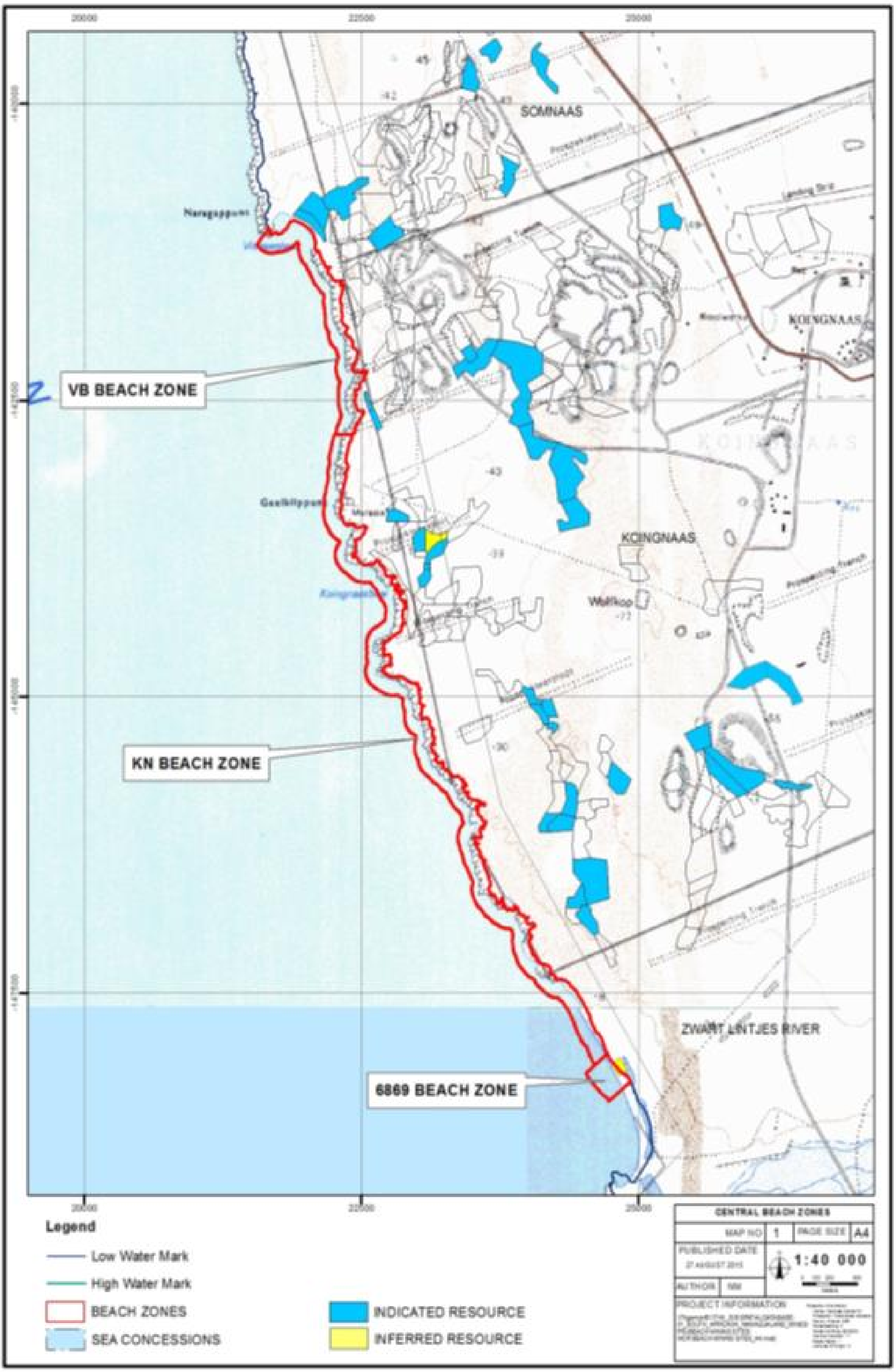


Figure 4-1 Locations of Surf-zone, Beach and Offshore Channel Resource Areas (Somnaas to Koingnaas)

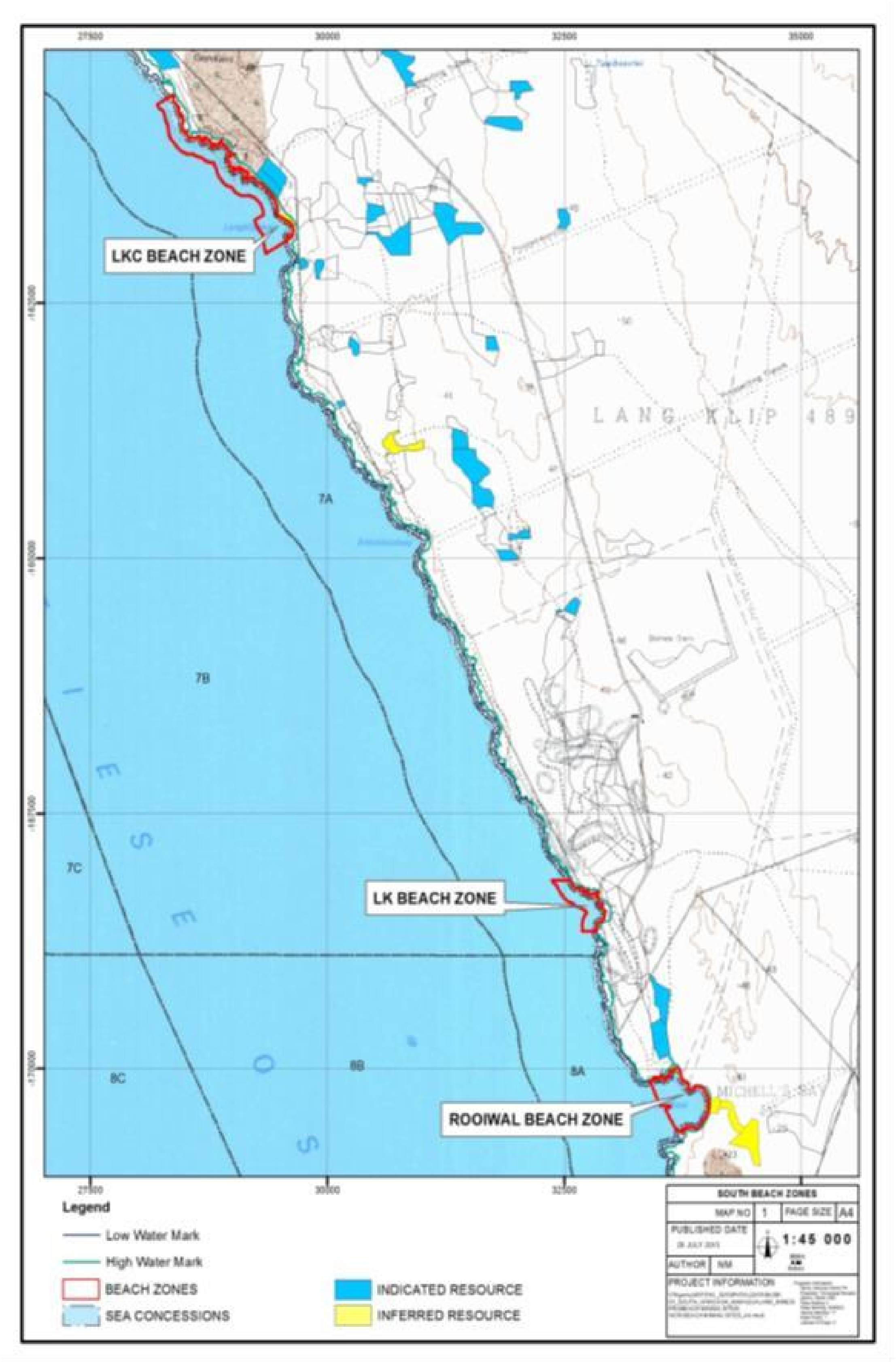


Figure 4-2 Locations of Surf-zone, Beach and Offshore Channel Resource Areas (Langkip to Rooiwal Bay)

For each site, the most economically and technically viable concept/s will be selected bearing in mind the temporary nature of the mining, the quantity and characteristics of available construction materials (rock, sand and clay), possible phasing of the mining to facilitate recovery of diamonds at an early stage, the need to minimise seepage into the mining area and the costs of protective measures.

4.1.2 Processing Infrastructure

The processing infrastructure associated with the proposed beach and off-shore channel mining will include the construction of a new 200 tonne per hour (tph) screening and scrubbing plant at Michell's Bay. Concentrate from the Michell's Bay Dense Media Separator (DMS) will be treated through the Kleinzee Final Recovery (KFR) at Kleinzee. A second 200 tph screening plant may be deployed as and if required. Additional mobile scalping screens and Finlay type screens may also be required and will be deployed as necessary. At beach mining sites Articulated Dump Trucks (ADT's) will transport the gravel to a nearby scalping and screening plant, fed by seawater, where the gravel may be fed directly to the feeding screen or stockpiled and fed by front-end loader to the screen. Sand and seawater will be released back to the sea. The screened material is transported to the nearest DMS plant.

For the noise modelling, it was assumed that two processing plants are established, one at Michell's Bay and one at Koingnaas. The provided locations of the plants can be seen in Figure 4-3.

Figure 4-3 Locations of the Proposed Processing Plants

4.2 Noise Modelling of the Processing Plant and Mining Activities

Noise modelling was utilised for the sound propagation calculations and the prediction of the sound pressure levels around the processing plants and mining faces. A modelling receptor grid was utilised for the determination of the expected noise contours, as a result of the proposed mining operations. In addition, the noise levels were estimated at several discrete receptors placed at residential areas of Koingnaas and Hondeklip Bay.

The noise modelling was performed via the CADNA (Computer Aided Noise Abatement) noise model. The latter was selected for the following reasons:

- It incorporates the ISO 9613 in conjunction with the CONCAWE noise propagation calculation methodology.
- It provides an integrated environment for noise predictions under varying scenarios of operation.
- The cumulative effects of line sources, such as roads and haul routes, as well as point noise sources, can be determined in a three-dimensional environment.
- The ground elevations around the entire site can be entered into the model, and their screening effects taken into consideration.
- The noise propagation influences of the meteorological parameters of a specific area can also be accounted for.

The main assumptions adopted in the noise modelling were:

<u>Acoustically semi-hard ground conditions</u>: This assumes that partial attenuation due to absorption at the ground surface takes place. This assumption represents a somewhat pessimistic evaluation of the potential noise impact. It should be noted that the area over the water was assigned zero ground absorption.

<u>Meteorological conditions:</u> For the noise propagation in the extended area, the temperature and humidity for daytime was set in the model to 25°C and 50% respectively, and for night-time 15°C and 70% respectively. The effects of frequency-dependent atmospheric absorption were taken into consideration.

<u>Screening effect of temporary stockpiles, buildings and other barriers</u>: The effect of these temporary structures on the noise climate has been ignored, representing a pessimistic evaluation of the potential noise impact. However, the ground elevations of the entire area were utilised in the modelling set-up.

<u>Worst-case operational noise level assumption</u>: The highest noise level of mining and plant equipment was used as the criterion value for the noise predictions of the proposed project, representing a pessimistic evaluation of the potential noise impact.

Worst-case operational assumption: All mining, handling and processing equipment was assumed to operate simultaneously, which is considered a pessimistic evaluation of the potential noise impact.

Two modelling scenarios were generated for the noise impact assessment. The first considered the mine and plant in full operation under daytime conditions and the second under nigh-time conditions. These two modelling scenarios were:

Scenario 1: Mine and plants in full operation during daytime conditions.
Scenario 2: Mine and plants in full operation during night-time conditions.

Based on the provided information, at peak production, the proposed mine will process material from the mining areas at a rate of 5.6 Mtpa. For the mining activities, the number of heavy equipment was based on the peak production capacity in accordance with the following table. The WCR mine engineers indicated that the mining activities and material hauling will take place during daytime and night-time. As a worst-case scenario, it was assumed that all equipment within the mining pit and waste dumps operate simultaneously.

Table 4-1. WCR Mining Heavy Equipment Based on Peak Production

Equipment	Number
Haul Trucks (HD325 and HM400)	7
Dump Trucks (BELL)	4
Water Tanker (H400W)	1
Dozers (D275)	3
Front End Loaders (WA250 and CAT966)	4
Motor Grader (GD675)	1
Excavators (PC200, PC1250, CAT365 and CAT375)	6

The processing plant area will consist of the following:

- Vibrating grizzly feeder
- Oversize stockpile
- Primary jet pump module
- Conveyor belts
- Scrubbing and screening module
- DMS feed stockpile
- Sizing screen oversize stockpile

A block flow schematic diagram, for the ore extraction, processing and transportation is shown in Figure 4.4 below. A conceptual diagram of the Michell's Bay processing plant that was used in the positioning of the noise sources at the modelling locations can be seen in Figure 4.5

The sound power data utilised in the noise modelling for the mining operations and processing plant can be found in Table C-6-3 of Appendix C. The layout and locations of the noise sources can be seen in Figure 4-6. The plant, mining sites and waste dump positions were set up in the model and the noise sources positioned at the appropriate locations. In this manner, the ground screening effects were taken into consideration.

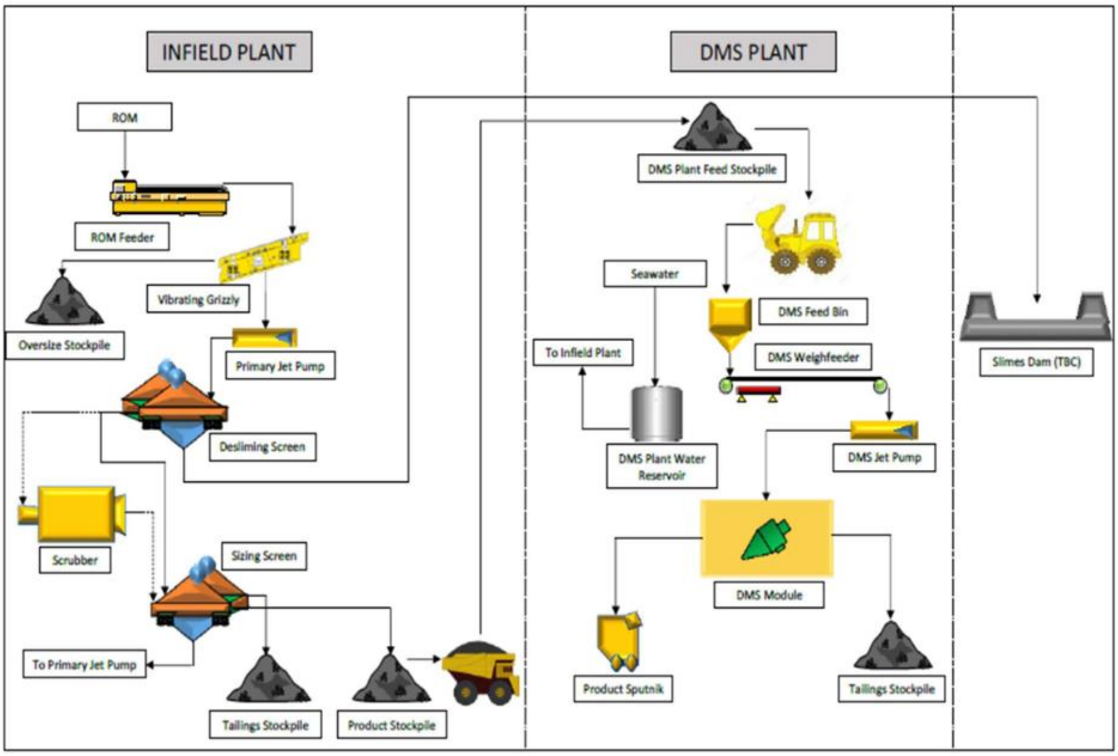


Figure 4.4. WCR Mine and Processing Flow Diagram

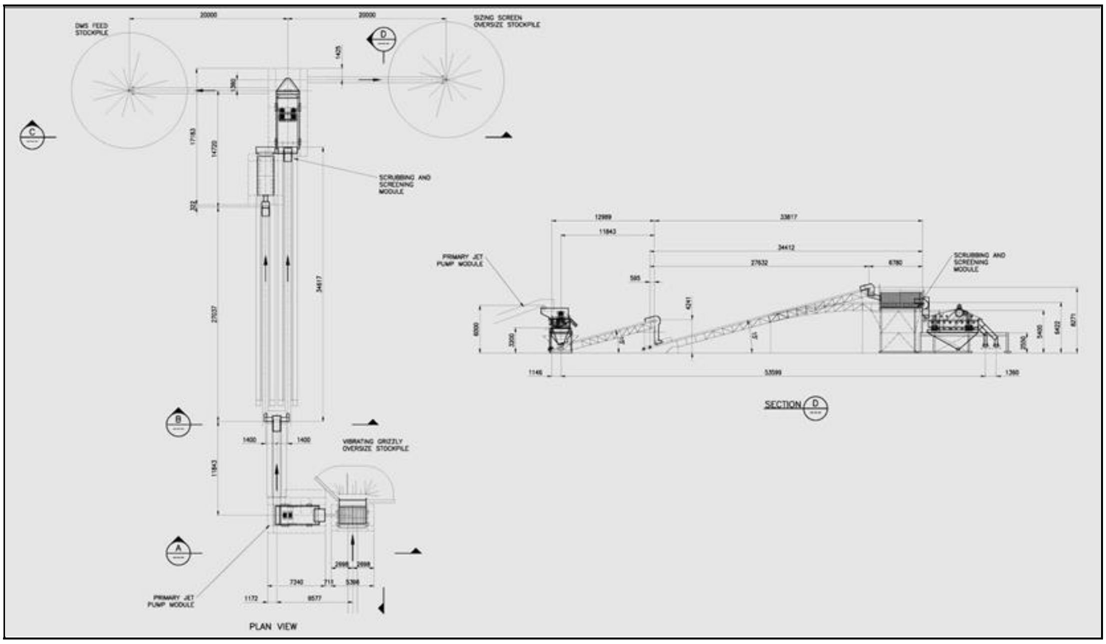


Figure 4.5. WCR Processing Plant Layout

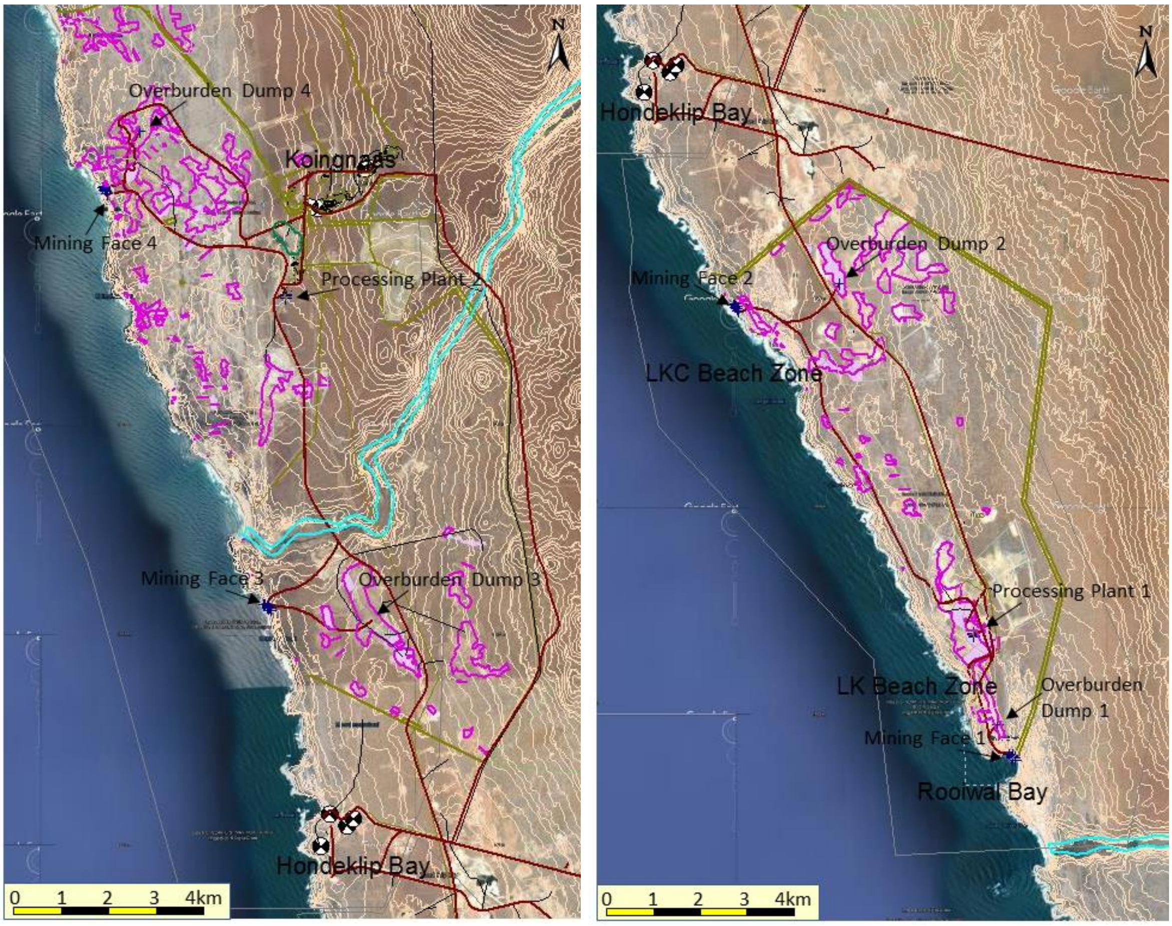


Figure 4-6. WCR Mine Layout

4.3 Vibration During Operation

With respect to vibration, there are no standards that provide a methodology to predict levels of vibration from mining activities, other than that contained within BS 5228: Part 4, which relates to percussive or vibratory piling only.

It is generally accepted that for the majority of people vibration levels of between 0.15 and 0.3 mm/s peak particle velocity are just perceptible. None of the activities during operation are likely to take place outside the mining areas or closer than 300 m to any sensitive receptors.

The Threshold of Perception for Human Reaction level of 0.3 mm/s is not expected to be exceeded outside 100 m zone from the working face and haul roads. As such, the vibration impacts from the mining activities, other than the blasting, are unlikely to impact negatively any sensitive receptors in the study area.

During the operational period of the WCR mine, the most significant vibration source will be the blasting for the ore extraction. For the prediction of the blast vibration, the scaled distance prediction formula was utilised (Oriard, L.L., 2002):

$$\mathbf{PPV = a\ (D\ /\ Q^{0.5})^{b}} \qquad \textbf{(4-1)}$$

Where:

PPV: peak particle velocity (mm/s),

D: distance between the blast and the point of interest (m),

Q: the maximum charge per delay (kg), and

a, b: site constants. The conservative values of 534 and -1.65 were used in the current study.

For the vibration estimations, the calculations were based on the assumption that there will be no simultaneous detonations and that the maximum instantaneous charge (MIC)[a] will not exceed 77 kg.

[a] The Maximum Instantaneous Charge is the amount of explosive in kilograms which is detonated at a given moment in time. Blasts are usually made up of multiple holes with a delay of a few milliseconds between each one. In this way, the amount of energy entering the rock at a single moment is reduced, which lowers the vibration level.

5 PREDICTED NOISE AND VIBRATION LEVELS

5.1 Blast Vibration Modelling Results

From Equation (4-1) and the information on the blast design, the expected ground vibration levels were calculated for various distances from the blast area. Table 5-1 shows the expected PPV at various distances calculated for the estimated charge mass. It should be noted that it was assumed there would be no simultaneous detonation of blast holes. If this was to change, it would influence the resulting vibration at the various distances.

From Table 5-1, it is evident that the adopted PPV limit of 12.5 mm/s for architectural and structural damage to structures in poor condition will not be exceeded beyond a 100 m zone around the charge. Since the main local sensitive receptors are located more than 3 km away from the mining areas, the vibration impact will be negligible at these receptors.

Table 5-1. Blasting Ground Vibration at Various Distances

No.	Distance (m)	PPV (mm/s)
1	100	9.7
2	200	3.1
3	300	1.6
4	400	1.0
5	500	0.7
6	600	0.5
7	700	0.4
8	800	0.3
9	900	0.3
10	1000	0.2
11	2000	0.1
12	2500	0.0

5.2 Proposed Mining and Plant Noise Levels

Based on the noise modelling methodology and input data outlined in Section 4, the noise contours around the mining areas, processing plants and hauling routes were estimated for day- and night-time conditions. For the noise modelling the worst-case scenario of 5.6 Mtpa of ore throughput was utilised.

The noise impact assessment was carried out in accordance with the South African National Standard - Code of Practice SANS 10103:2008 for rural districts, i.e. 45 dB(A) during daytime and 35 dB(A) during night-time. It should be noted that the guideline levels from the WHO for residential areas is 55 dB(A) during daytime and 45 dB(A) during night-time.

The noise contours around the mining areas, processing plants and haul roads can be seen in Figure 5-1 and Figure 5-2 for the norther and southern mining sections respectively for daytime. The same noise contours for night-time can be seen in Figure 5-3 and Figure 5-4.

It is evident that for the daytime conditions, the 45 dB(A) contour extended approximately 350 m from the plant at both locations, i.e. the Koingnaas and the Michell's Bay areas. The same contour reached 750 m around the mining working faces and approximately 200 m from the haul roads.

As such the rural daytime guideline of 45 dB(A) will not be exceeded as a result of the new mining activities beyond 400 m around the processing plants, beyond 800 m away from the mining working face and 300 beyond the haul roads.

Under night-time conditions, the 35 dB(A) extended to a maximum of 1,300 m around the processing plants. Around the mining areas the same zone extended approximately 1,100 m and around the haul roads 800 m.

Similarly, the night-time rural guideline of 35 dB(A) will not be exceeded as a result of the proposed operations at a distance of 1,400 m around the plants, 1,200 away from the mining working face and 900 m away from the haul roads.

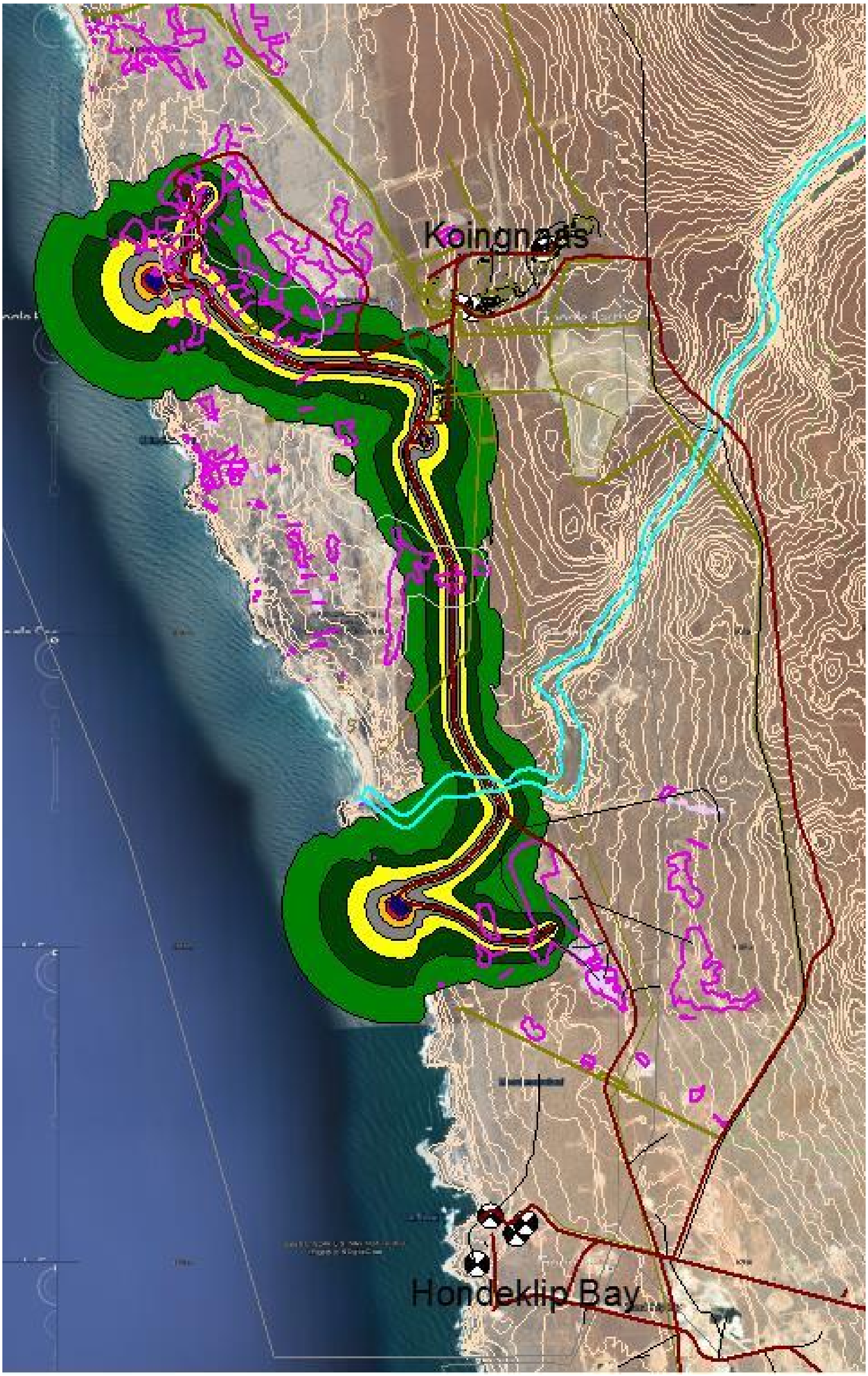


Figure 5-1. Future Daytime Noise Contours Around the WCR Mine (North Section)

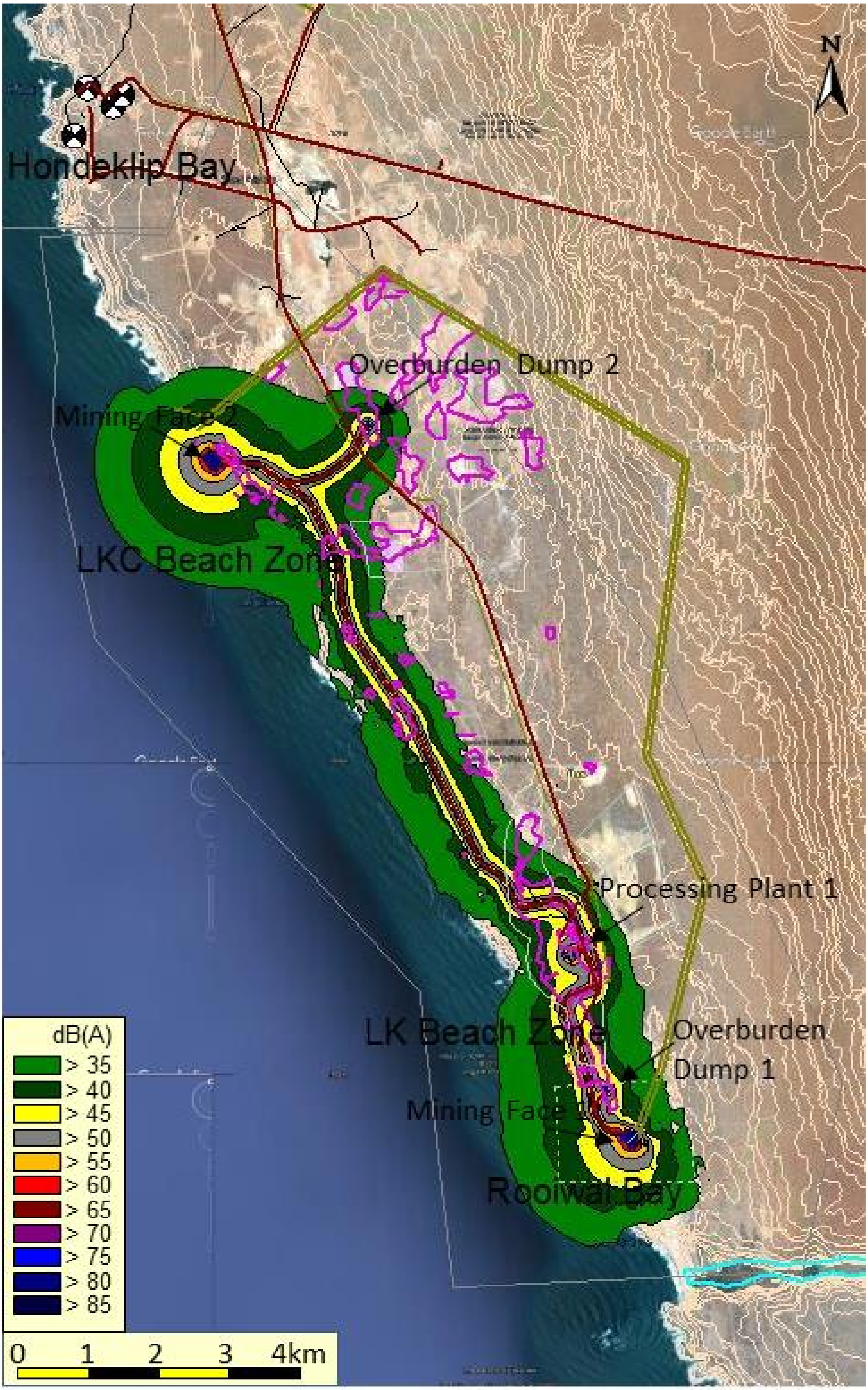


Figure 5-2. Future Daytime Noise Contours Around the WCR Mine (South Section)

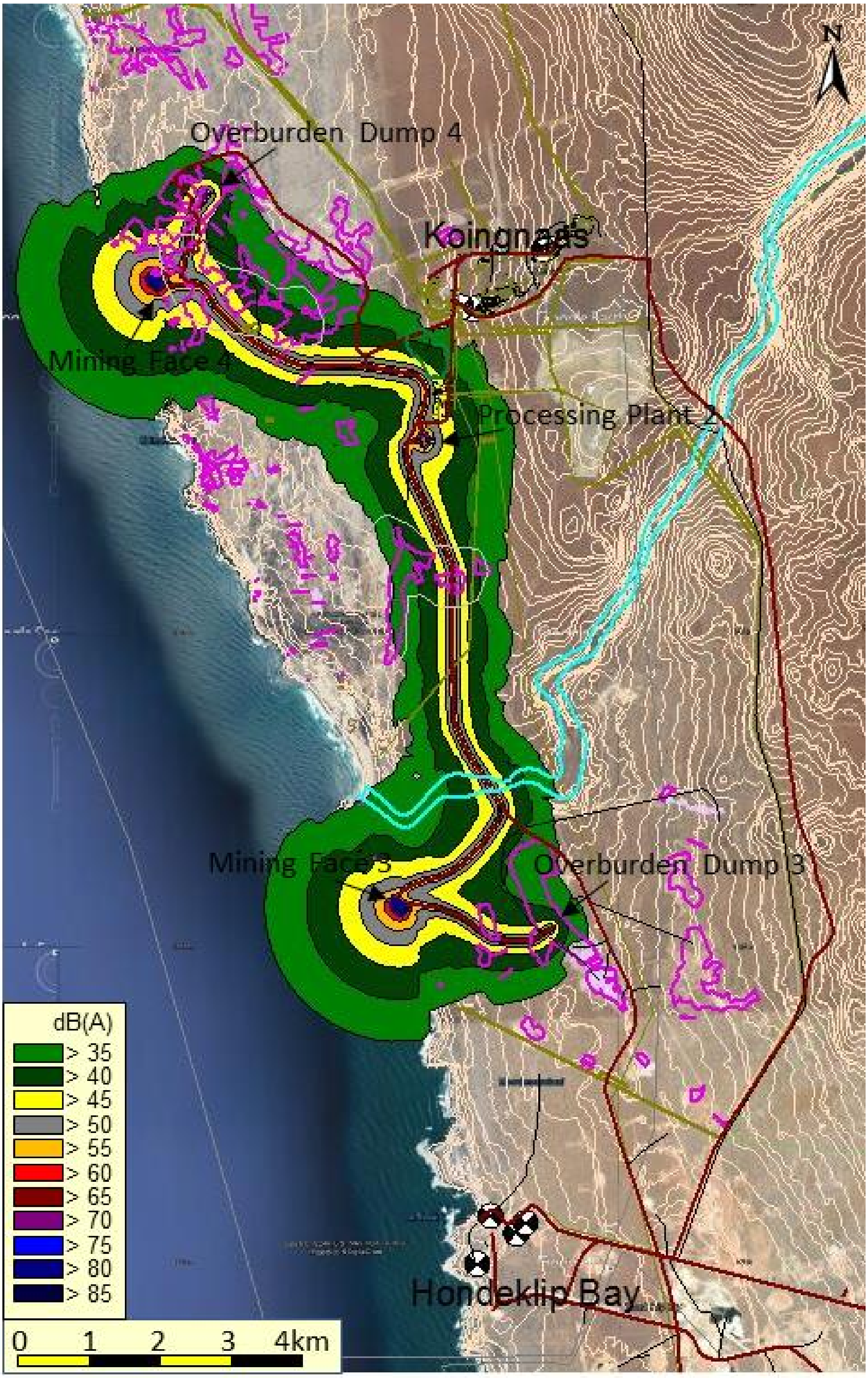


Figure 5-3. Future Night-time Noise Contours Around the WCR Mine (North Section)

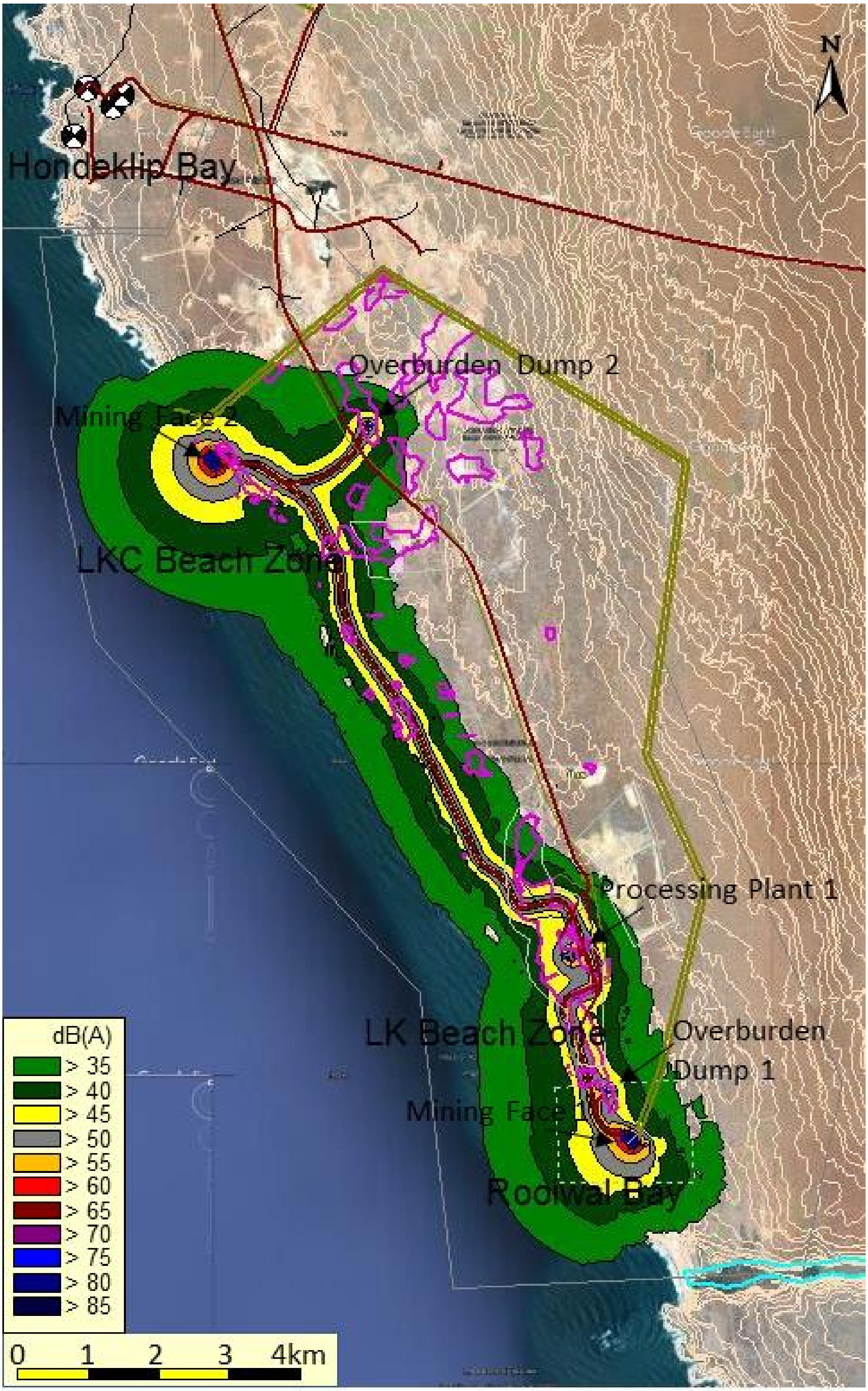


Figure 5-4. Future Night-time Noise Contours Around the WCR Mine (South Section)

5.3 Discrete Receptor Calculations

Several discrete receptors were placed at the Koingnaas Town and the Hondeklip Bay communities, in order to assess the source contribution, compare the predicted noise levels against the measured values and identify possible mitigation measures. The location of the receptors can be seen in Figure 3-1. These calculations were performed for Scenario 1 (daytime), as well as for night-time conditions (Scenario 2).

Table 5-2 below shows the calculated values for each receptor and scenario. It can be seen that at all locations the daytime and night-time noise levels were below 35 dB(A). This indicates that the noise contribution of the proposed mining activities will be negligible at these locations during daytime and a insignificant during night-time.

As such it is not expected that the noise emissions from the mining activities and the processing plants are not expected to have any significant effect on the Koingnaas and Hondeklip Bay communities.

Table 5-2: Calculated Noise Levels at Discrete Receptors

Point	Location	Level Lr		UTM Coordinates		
		Day	Night	X	Y	Z
		(dBA)	(dBA)	(m)	(m)	(m)
MP01	Koingnaas	29.8	32.5	141477	6653090	63.8
MP02	Hondeklip Bay	<20	<20	142384	6640150	22.0
MP03	Koingnaas	<20	22.4	142647	6653908	93.3
R01	Koingnaas	30.5	32.8	141658	6653070	72.0
R02	Koingnaas	<20	<20	142697	6653931	94.8
R03	Hondeklip Bay	<20	<20	142255	6639993	22.0
R04	Hondeklip Bay	<20	<20	141701	6639564	21.9
R05	Hondeklip Bay	<20	<20	141889	6640245	7.5

6 IMPACT ASSESSMENT

The noise impact assessment was focused on three issues related to the proposed WCR mining project. The first was the noise levels around the processing plant sites, the second the mining working faces and the third the relevant haul roads.

6.1 Processing Plants

The proposed plants, as can be seen from Figure 5-1 and Figure 5-2 for daytime and Figure 5-3 and Figure 5-4 for night-time, will generate daytime noise levels that do not extend beyond the WCR concession boundaries, i.e. the daytime 45 dB(A) and the night-time 35 dB(A) noise contour is contained well inside the boundaries. This is attributed primarily to the fact that the position of the plants and the mining pits within the site are positioned at least 3 km from these boundaries, as well as the ground formations around the pits.

The expected noise level increase above the rural district guideline of 45 dB(A) for daytime can be seen in the following Figure 6-1 and Figure 6-2 for the north section and the south section respectively. It is evident that during daytime the expected 3 dB increase above the 45 dB(A) level will not reach any of the concession boundaries, and will be well away the Koingnaas and the Hondeklip Bay communities.

During night-time the noise level increase above the guideline of 35 dB(A) around the plants will extend further (see Figure 6-3 see Figure 6-4), but the 3 dB(A) level increase contour will be well away the two above-mentioned communities.

The noise increase due to the plant's operation beyond a 0.5 km zone will be below 1 dB for the daytime. During night-time a 3 dB noise increase is expected to reach 1.5 km around the plant. There are no sensitive receptors within these zones. This impact is considered Insignificant.

6.2 Mining Activities

For the mining activities, the expected 3 dB noise level increase above the rural district guideline of 45 dB(A) for daytime will extend up to 600 m from the working face (see Figure 6-1 and Figure 6-2).

During night-time the 3 dB increase above the 35 dB(A) guideline will reach 1.7 km from the working face (see Figure 6-3 see Figure 6-4).

When the mining zones move closer to the northern and southern concession boundaries the above-mentioned noise level increases above the guidelines may reach these boundaries. However, there are no sensitive receptors in these areas.

Therefore, due to the fact that the mining zones are well away, i.e. greater than 4 km, from any potential sensitive receptors, the noise impacts are considered Insignificant.

6.3 Haul Roads

From Figure 6-1 and Figure 6-2 it can be seen that the impact zone of 3 dB above the daytime guideline will extend approximately 150 m from the road. During night-time the zone with 3 dB above the 35 dB(A) Rural District guideline will be 600 m (see Figure 6-3 see Figure 6-4).

There are no sensitive receptors around the haul routes and provided that stay at least 1 km away from the Koingnaas and the Hondeklip Bay boundaries, their impact is considered Insignificant.

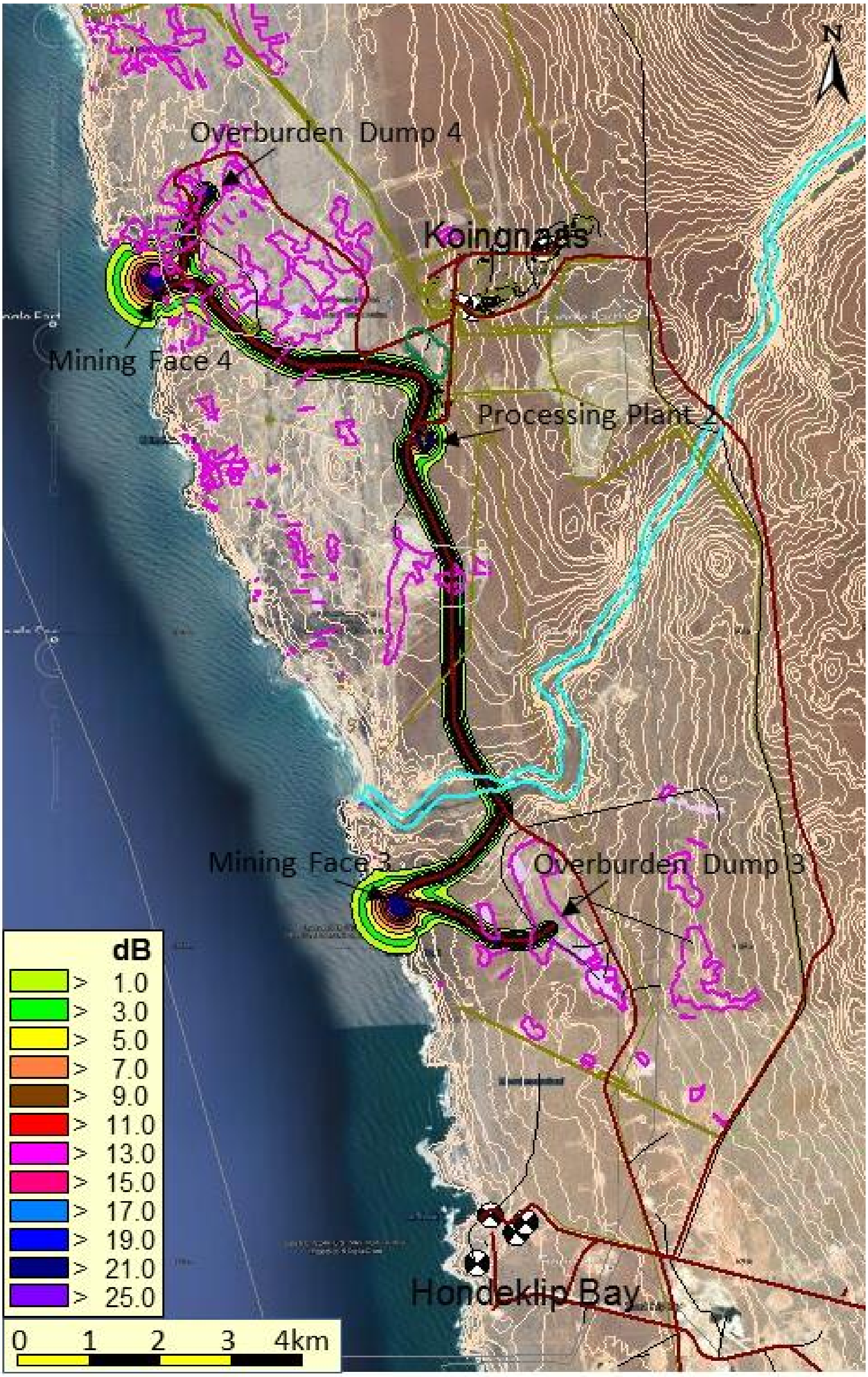


Figure 6-1. Noise Levels Above Daytime Rural Guideline of 45 dB(A): North Section

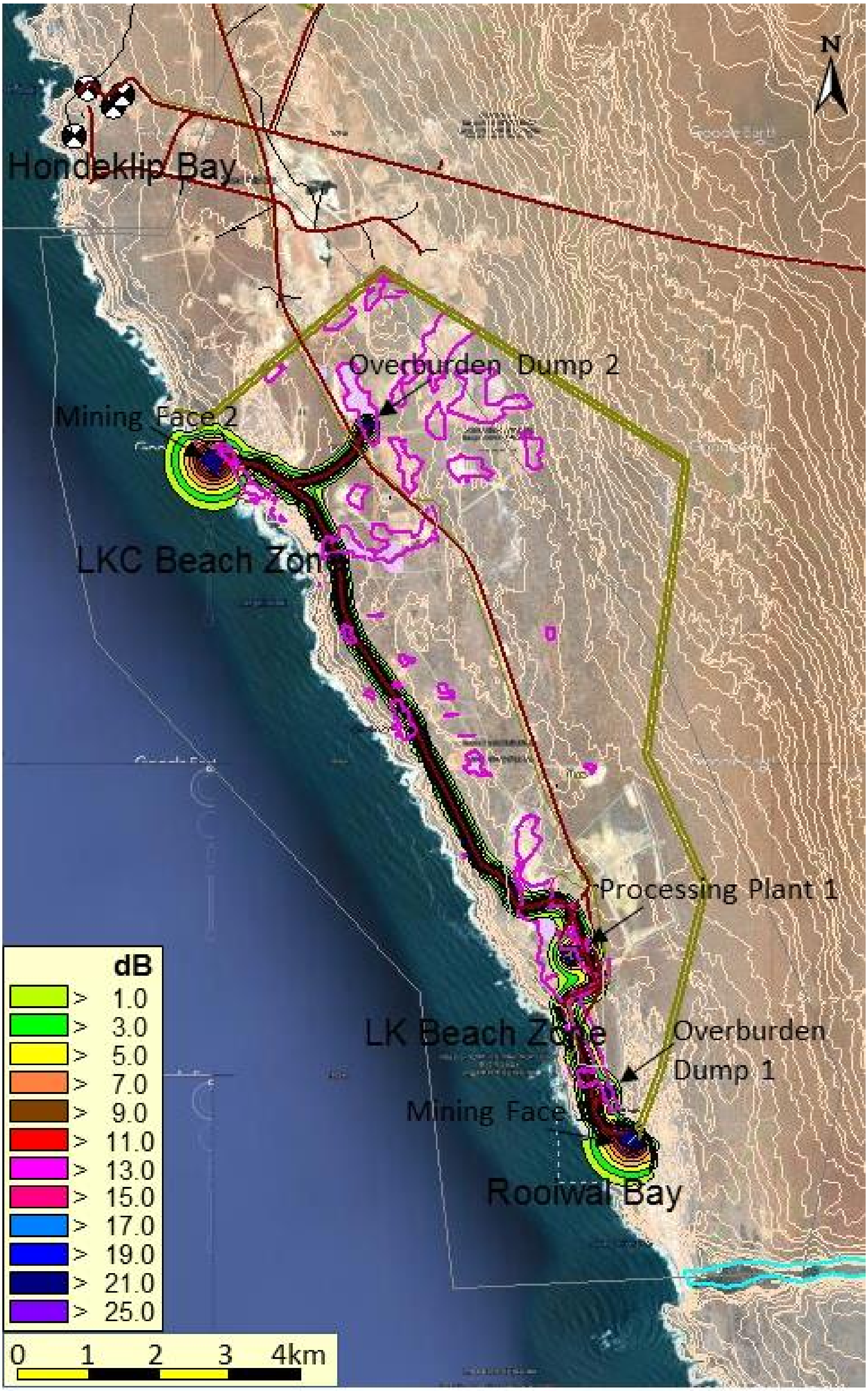


Figure 6-2. Noise Levels Above Daytime Rural Guideline of 45 dB(A): South Section

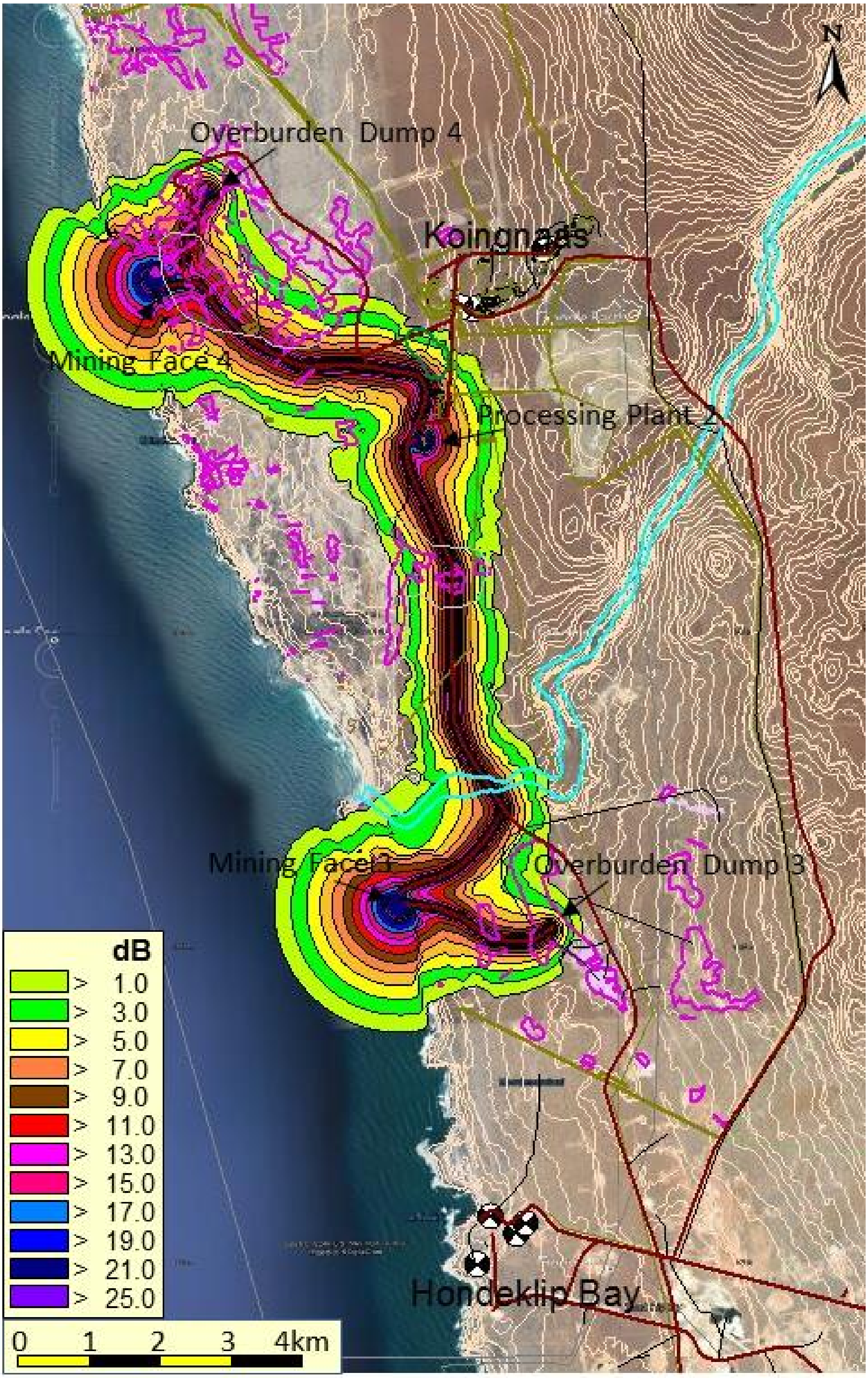


Figure 6-3. Noise Levels Above Night-time Rural Guideline of 35 dB(A): North Section

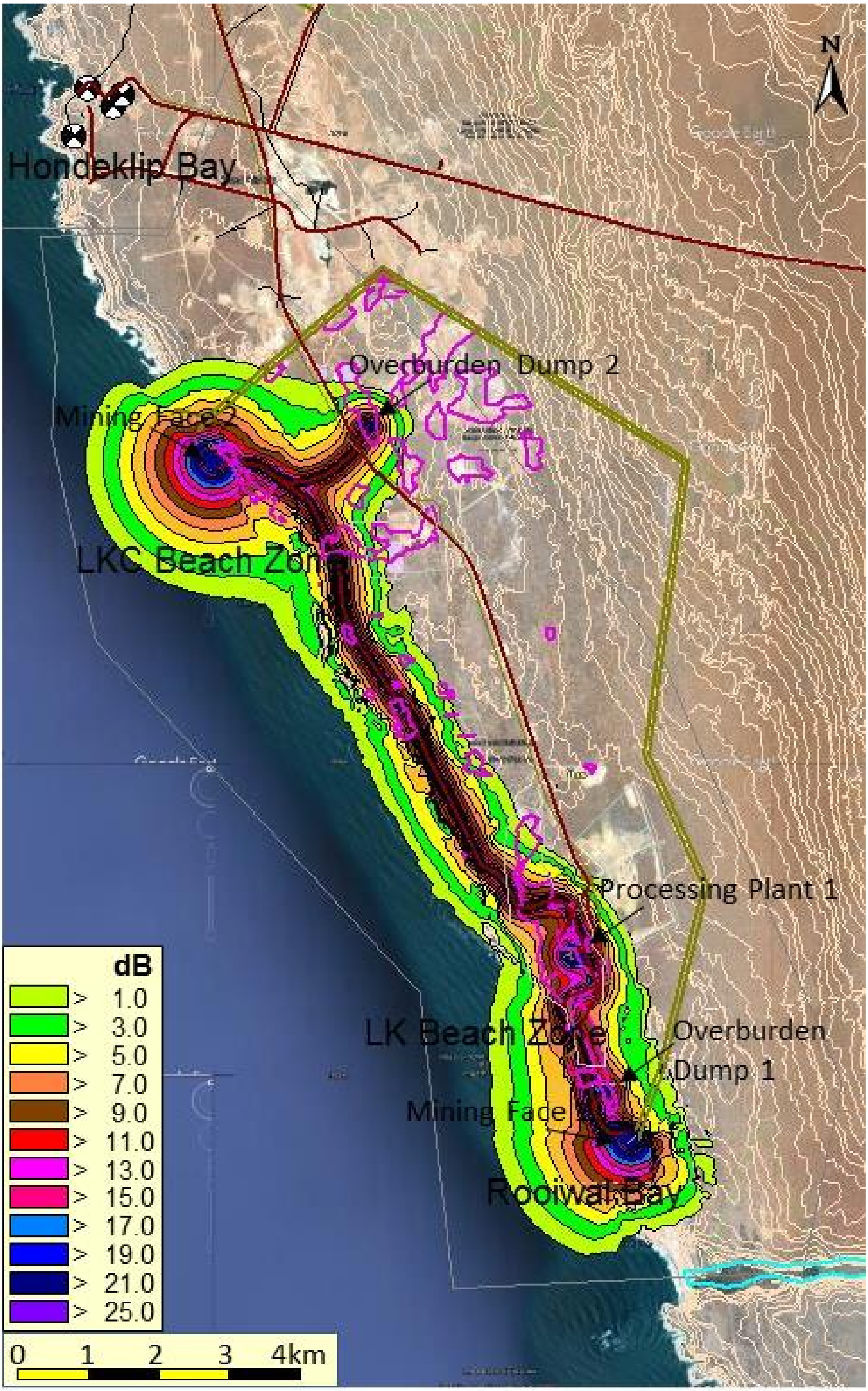


Figure 6-4. Noise Levels Above Night-time Rural Guideline of 35 dB(A): South Section

6.4 Conclusions and Recommendations

6.4.1 Conclusions

The main conclusions of the baseline noise measurements were:

i. The noise environment around the WCR mining areas is that of typical Rural districts. The daytime and night-time levels at Koingnaas were close to the SANS guideline levels for Rural districts of 45 dB(A) and 35 dB(A) respectively. At Hondeklip Bay the background noise levels were marginally higher due to the proximity to the ocean.

ii. The main noise contributors within the Koingnaas and Hondeklip Bay communities are local vehicular traffic, human activities and for the latter also sea waves.

Based on the modelling of the noise and vibration levels due to the proposed mining operations, the main findings of the noise and vibration impact study were:

Operation:

i. The 45 dB(A) daytime and 35 dB(A) night-time noise levels will be primarily contained within the WCR concession area.

ii. The daytime and night-time noise contribution of the mining activities and processing plants will be below the Rural District guidelines in both the Koingnaas and Hondeklip Bay communities.

iii. The operational noise impact is considered Insignificant and no additional mitigation measures would be necessary.

iv. The vibration levels are not expected to exceed the limit for sensitive or historical buildings beyond a 200 m zone and the threshold of human perception beyond a 1 km zone.

Decommissioning and Residual:

i. No significant noise impacts are expected during the Decommissioning Phase of the proposed project. This impact is expected to be Negligible and of short duration.

ii. With the termination of the mining activities, the noise levels within and around the site are expected to revert back to those that existed prior to the operations. Therefore, no residual or latent noise impacts are expected.

6.5 Recommendations

Based on the noise and vibration study, the noise performance indicator to be adopted for the rural area around the mine and plants should be that the noise levels at Koingnaas do not exceed 45 dB(A) and 35 dB(A) during day- and night-time respectively. At Hondeklip Bay the noise levels should not exceed 50 dB(A) during daytime and 40 dB(A) during the night.

The performance indicator for vibration should be that the ground vibration level at general houses of proper construction do not exceed 25 mm/s and at houses of lesser proper construction 12.5 mm/s. In the local communities the vibration should not exceed 0.3 mm/s.

The main recommendations of the noise and vibration study are outlined below. The essential measures are included in the impact tables.

Essential Mitigation Measures During Operation:

ii. There are no specific mitigations that will be required during the mining activities and plants' operations.

General recommendations for noise minimization and management during operation:

f. Maintain the haul roads at least 1 km away from the Koingnaas and the Hondeklip Bay community boundaries.

g. Any blasting activities should be at least 1.5 km from any communities and 500 m from any building structures.

h. Environmental noise and vibration monitoring should be performed by an independent specialist on an annual basis at three locations within the communities closest to the mining activities and plants.

i. Maintenance of equipment and operational procedures: Proper design and maintenance of silencers on diesel-powered equipment, systematic maintenance of all forms of equipment, training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.

j. Public complaints and actions registry: A formal recording system should be introduced, in order to capture public perceptions and complaints with regard to noise impacts, track investigation actions and introduce corrective measures for continuous improvement.

6.6 Impacts Rating

Based on the modelling results for the proposed mining operations and processing plants, the impacts are summarised in Table 6-1.

Table 6-1. Operational Noise and Vibration Impact Rating

Nature: The mining zones, haul roads and plants' operations will result in a **negative direct** impact on the noise environment around the mine.

Sensitivity/Vulnerability/Irreplaceability of Resource/Receptor – Low
Sensitivity: The activity will increase the noise and vibration levels in areas in very close proximity to the plants and mining pits. However, the closest receptor is situated more than 2 km away.

Impact Magnitude – Negligible

- Extent: The extent of the impact is **local**.
- Duration: The expected impact will be **long-term** (i.e. the duration of the operation).
- Scale: The impact will **not** result in **notable changes** to the noise levels at receptors situated more than 2 km from the plants and mining pits and 1 km away from haul roads.
- Frequency: The frequency of the impact will be **periodic.**
- Likelihood: The noise and vibration levels during operation are **possible** to increase during the operational period.

IMPACT SIGNIFICANCE (NO MITIGATION REQUIRED) – NEGLIGIBLE
Degree of Confidence: The degree of confidence is **high**.

Essential Measures:
v. None.

General Recommendations:
vi. Maintain the haul roads at least 1 km away from the Koingnaas and the Hondeklip Bay community boundaries.
vii. Any blasting activities should be at least 2.5 km from any communities and 500 m from any building structures.
viii. Environmental noise and vibration monitoring should be performed by an independent specialist on an annual basis at three locations within the communities closest to the mining activities and plants

REFERENCES

British Standard 4142, (1997). Method for rating industrial noise affecting mixed residential and industrial areas.

IFC, (2007). General Environmental, Health and Safety Guidelines.

ISO 1996-1, (2003). Acoustics – Description, assessment and measurement of environmental noise – Part 1: Basic quantities and assessment procedures. Geneva, Switzerland: International Organization for Standardization, International Standard.

ISO 1996-2, (2000). Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels. Geneva, Switzerland: International Organization for Standardization, International Standard.

ISO 1996-3, (1987). Acoustics – Description and measurement of environmental noise -- Part 3: Application to noise limits. Geneva, Switzerland: International Organization for Standardization, International Standard.

ISO 1999, (1990). Acoustics – Determination of occupational noise exposure and estimation of noise-induced hearing impairment. Geneva, Switzerland: International Organization for Standardization, International Standard.

OECD, (1996). Environmental Criteria for Sustainable Transport, Report on Phase 1 of the Project on Environmentally Sustainable Transport (EST), Organization for Economic Co-Operation and Development, OCDE/GD(96)136. Paris, 1996.

South African National Standard SANS10103, (2003). The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication.

WHO, (1999). Guidelines for Community Noise, Edited by Birgitta Berglund, World Heath Organization, Thomas Lindvall, and Dietrich Schwela. Geneva, April 1999.

World Bank Group, (1998). Pollution Prevention and Abatement Handbook, General Environmental Guidelines. July 1998.

Appendix A

A.1 Impact Assessment Methodology for EIAs - Instructions to Specialists

A definition of each impact characteristic is provided to contextualise the requirements. The designations for each of the characteristics are defined below.

Table 1.1 Defining Impact Characteristics

Characteristic	Definition	Designation
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	**Direct -** Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected). **Indirect -** Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land). **Induced -** Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Duration	The time period over which a resource / receptor is affected.	**Temporary** (negligible/ pre-construction) **Short-term** (period of less than 5 years i.e. production ramp up period) **Long-term** (period of more than 5 years and less than 19 years i.e. life of project) **Permanent** (a period that exceeds the life of the project – i.e. irreversible.)
Extent	The reach of the impact (i.e. physical distance an impact will extend to)	**On-site** – impacts that are limited to the project site. **Local** – impacts that are limited to the project site and adjacent properties. **Regional** – impacts that are experienced at a regional scale, e.g. District or Province. **National** – impacts that are experienced at a national scale. **Trans-boundary/International** – impacts that are experienced at an international scale, e.g. extinction of species resulting in global loss.
Scale	The size of the impact (e.g. the size of the area damaged or impacted the fraction of a resource that is lost or affected).	1 - functions and/ or processes remain ***unaltered*** 2 - functions and/ or processes are ***notably altered*** 3 - functions and/ or processes are ***severely altered***
Frequency	Measure of the constancy or periodicity of the impact.	1 - Periodic 2 - **Once off**

The terminology and designations are provided to ensure consistency when these characteristics are described in an Impact Assessment deliverable.

An additional characteristic that pertains only to unplanned events (e.g., traffic accident, accidental release of toxic gas, community riot, etc.) is likelihood. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale.

Table 1.3 Definitions of likelihood

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely/ Certain	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred. It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, not the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as uncertainty, and this is typically dealt with in a contextual discussion in the Impact Assessment deliverable, rather than in the impact significance assignment process.

Assessing Significance

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a magnitude. Magnitude is a function of the following impact characteristics:

- Extent [(a)]
- Duration [(b)]
- Scale
- Frequency
- Likelihood

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. The magnitude designations are as follows:

- Positive
- Negligible
- Small
- Medium
- Large

The methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/irreplaceability in order to assign impact significance.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum from

(a) Important in defining 'extent' is the differentiation between the spatial extent of impact (i.e. the physical distance of the impact in terms of on-site, *local*, *regional, national* or *international*) and the temporal extent/ effect of an impact may have (i.e. a localised impact on restricted species may lead to its extinction and therefore the impact would have global ramifications).
(b) Duration must consider irreversible impacts (i.e. permanent).

negligible to large. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a negligible magnitude.

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability/ irreplaceability of the resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/ irreplaceability of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is *physical* (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is *biological or cultural* (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is *human*, the vulnerability of the individual, community or wider societal group is considered.

As in the case of magnitude, the sensitivity/vulnerability/ irreplaceability designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/irreplaceability [c] of resource/receptor is:

- Low
- Medium
- High

Once magnitude of impact and sensitivity/vulnerability/irreplaceability of resource/receptor have been characterised, the significance can be assigned for each impact. The following provides a context for defining significance.

Table 1.4 Context for Defining Significance

• An impact of ***negligible*** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.
• An impact of ***minor*** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.
• An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

(c) Irreplaceable (SANBI, 2013): "*In terms of biodiversity, irreplaceable areas are those of highest biodiversity value outside the formal protected area network. They support unique biodiversity features, such as endangered species or rare habitat patches that do not occur anywhere else in the province. These features have already been so reduced by loss of natural habitat, that 100% of what remains must be protected to achieve biodiversity targets.*"

- An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts remaining even after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

Based on the context for defining significance, the impact significance rating will be determined, using the matrix below.

Table 1.5 Impact Significance Rating Matrix

		Sensitivity/Vulnerability/Irreplaceability of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Once the significance of the impact has been determined, it is important to qualify the **degree of confidence** in the assessment. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence can be expressed as low, medium or high.

Appendix B

B.1 Noise Monitoring Record Sheets

- **Position MP01**

Located at the beginning of Koingnaas village approximately 2.2 km north east from the mining area. GPS coordinates – S 30°12'3.15" E 17°16'35.39"

View West towards the Mine

View east

Figure B-1. MP01 Images

- **Position MP02**

This point was located at Hondeklip bay approximately 1.3 km south of the mining area

GPS coordinates – S 30°11'37.89" E 17°17'20.08"

View North

View South

Figure B-2. MP02 Images

- **Position MP03**

This point was located at Barratini Street in Koingnaas Town. The measurement at this point was performed continuously over two days and nights.

GPS coordinates – S 30°11'37.89" E 17°17'20.08"

View West

View North

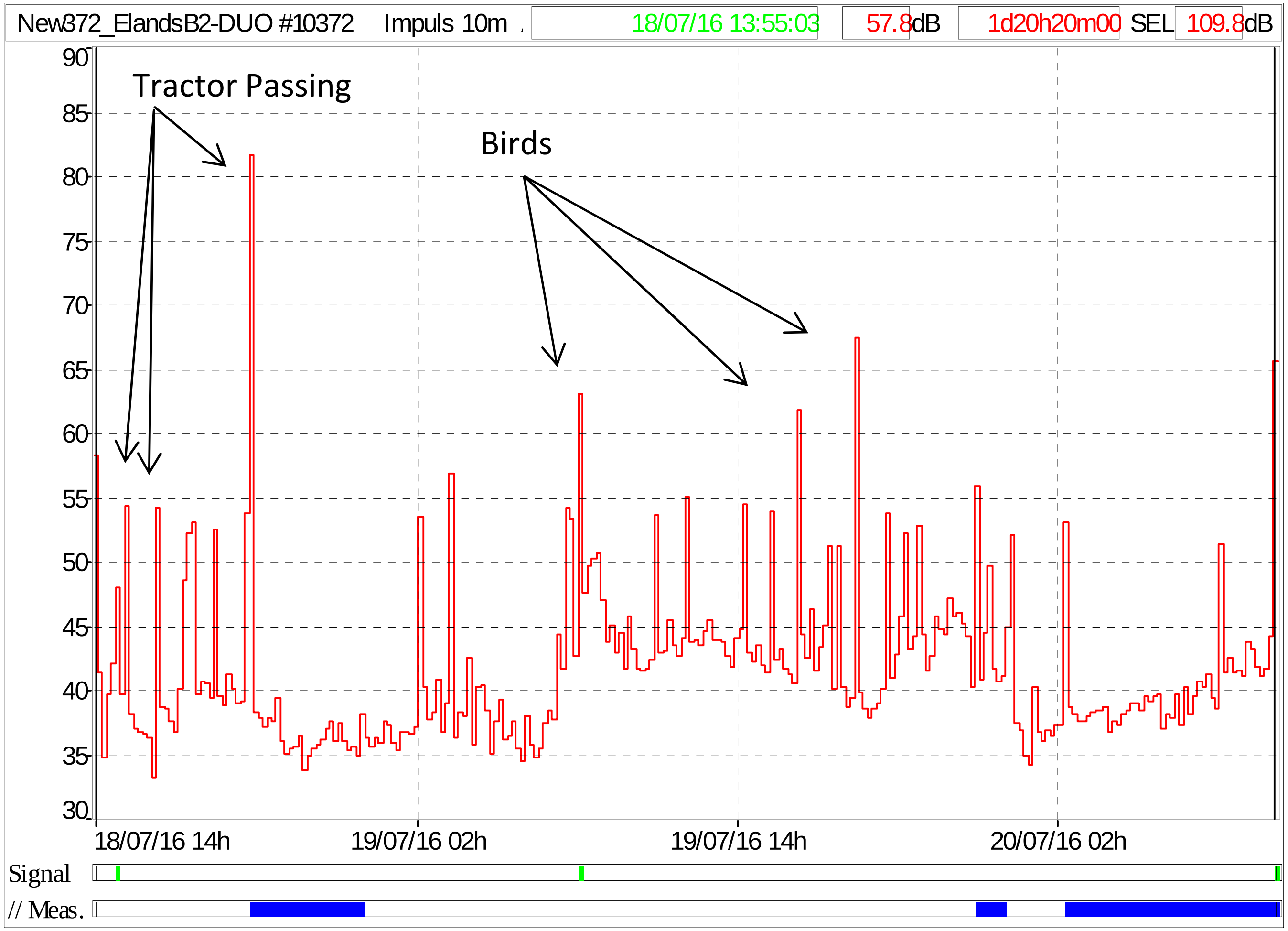
Figure B-3. MP03 Images

Table B-6-2: Noise Measurements Results

Date - Time	Measurement Position	Location	WS (m/s)	$L_{Aeq,I}$ (dBA)	L_{Amin} (dBA)	L_{Amax} (dBA)	L_{99} (dBA)	L_{90} (dBA)	L_{50} (dBA)	L_{10} (dBA)	Comments
2016-06-30 18:15	MP01	Residential	1.5	36.1	28.4	55.4	28.7	30.3	31.9	35.8	Human activities audible
2016-06-30 18:25	MP01	Residential	1.8	40.1	29.6	55.3	30.2	31.2	33.3	45.3	
2016-06-30 19:15	MP02	Residential	1.6	47.5	41.3	51.5	41.2	42.4	46.2	50.8	Human activities, Sea waves audible
2016-06-30 19:25	MP02	Residential	2.5	40.9	32.6	57.8	32.7	33.6	37.7	40	
2016-06-30 19:35	MP02	Residential	2.3	61.9	29.1	82.3	29.7	33.1	39	53	
2016-06-30 19:45	MP02	Residential	2.4	39.9	27.6	58.3	30.4	32.6	36.4	39.7	
2016-06-30 22:15	MP02	Residential	1.2	38.1	24.8	64.5	24.8	25.8	38.2	50.5	Sea waves and birds audible
2016-06-30 22:25	MP02	Residential	0.8	44.8	25	57.8	25.1	25.8	37.8	47.8	
2016-06-30 22:55	MP01	Residential	1.8	39.8	25.2	53.3	25.3	25.8	27.6	44.4	Dogs barking, birds and insects activities audible
2016-06-30 23:05	MP01	Residential	1.2	37.4	25.2	54.2	25.2	25.5	26.1	36.3	
2016-06-30 23:15	MP01	Residential	0.8	26.6	25.1	33.9	25.1	25.6	26.3	27.1	
2016-06-30 23:25	MP01	Residential	0.6	34.5	26.4	51.3	26.5	26.8	27.7	29.6	
2016-07-01 10:35	MP02	Residential	2.4	50.5	45.7	66.5	46	46.8	48.5	51.4	
2016-07-01 10:45	MP02	Residential	2.5	51.3	45.9	60.5	46.2	47.5	49.7	53.1	Human activities, Sea waves audible
2016-07-01 10:55	MP02	Residential	3.2	51	46.1	64.3	46.4	48.1	49.9	52	
2016-07-01 11:05	MP02	Residential	4.2	52.7	41.3	68	46.7	48.3	50.7	53.4	
2016-07-01 12:05	MP01	Residential	1.6	44.8	40.8	47.7	40.7	41.9	43.9	47.2	
2016-07-01 12:15	MP01	Residential	1.6	44.5	35.9	57.6	36.5	37.4	40.7	46.8	Human activities, Traffic, audible
2016-07-01 12:25	MP01	Residential	1.8	43.9	35.8	61.8	35.8	36.6	38	43	
2016-07-01 12:35	MP01	Residential	1.9	46.4	35.8	60	36.4	37.6	40.6	50.2	
2016-07-01 14:35	MP02	Residential	3.8	47.7	34.2	60.6	34.2	37.2	41.6	51.1	Human activities, Sea waves audible
2016-07-01 14:45	MP02	Residential	3.9	52.6	34	73.8	35.6	39.9	44.4	50.8	
2016-07-01 14:55	MP02	Residential	4.5	45.1	34.8	53.3	35.5	38.5	43.1	48.2	
2016-07-01 15:05	MP02	Residential	3.6	59.5	34.4	82.3	36.4	40.8	47.3	54.1	
2016-07-01 15:15	MP02	Residential	2.2	50.9	37.8	61.2	38.4	41.5	47.1	55.3	
2016-07-01 15:35	MP01	Residential	1.8	50.3	49.8	50.6	49.7	49.7	50.2	50.5	Human activities
2016-07-01 15:45	MP01	Residential	2.4	47.7	44.3	55.7	44.6	45.9	47.2	48.9	
2016-07-01 15:55	MP01	Residential	3.6	52.2	44	67.6	44.4	45.9	47.4	52.5	
2016-07-01 16:05	MP01	Residential	2.2	50.5	44.3	69.1	44.6	46	47.4	50	

Date - Time	Measurement Position	Location	WS (m/s)	$L_{Aeq,I}$ (dBA)	L_{Amin} (dBA)	L_{Amax} (dBA)	L_{99} (dBA)	L_{90} (dBA)	L_{50} (dBA)	L_{10} (dBA)	Comments
2016-07-01 22:15	MP02	Residential	0.8	48.6	28.1	60.9	28	28.7	31.4	53.3	Sea waves and birds audible
2016-07-01 22:25	MP02	Residential	2.4	31.6	27.2	41	27.5	29	30.6	33.2	
2016-07-01 22:35	MP02	Residential	2.9	32	27.2	70.9	27.9	29	30.8	34.9	
2016-07-01 22:45	MP02	Residential	2.2	43	27.1	59.8	27.6	29.2	31	43.1	
2016-07-01 23:05	MP01	Residential	1.6	37.9	28.1	51.9	28.7	29.7	31.5	39.3	
2016-07-01 23:15	MP01	Residential	0.5	36	27.2	52.6	27.8	29	30.9	35.7	
2016-07-01 23:25	MP01	Residential	0.6	35.1	28.3	53.3	28.8	29.7	31.2	33.8	

B.2 Noise Survey Results for Continuous Monitoring at MP03



Appendix C

C.1 Sound Power Ratings

Table C-6-3: Plants and Mining Sources Sound Power Emission Levels

POINT SOURCES						
Id	Source Type	Sound Power Level		Coordinates		
		Day	Night	X	Y	Z
		(dB(A))	(dB(A))	(m)	(m)	(m)
P1Vibrating Gr	Plant 1 Vibrating Grizzly	98.2	98.2	148757.2	6627949.4	32.3
P1Prim Jet Mod	Plant 1 Jet Pump Module	95.8	95.8	148750.9	6627946.5	32.2
P1Screen Module	Plant 1 Screen	98.2	98.2	148764.4	6627897.8	34.4
P1Scrub Module	Plant 1 Scrub Module	87.1	87.1	148761.1	6627905.9	36.0
P1Screen b	Plant 1 Screen b	102.5	102.5	148754.2	6627965.2	29.4
PL1 FEL	FEL at Plant 1	106.7	106.7	148756.7	6627974.8	29.5
Dozer1SS	Dozer at South Working Face for Plant 1	111.9	111.9	149573.9	6625319.9	3.3
Dozer2NS	Dozer at North Working Face for Plant 1	111.9	111.9	143682.5	6634925.0	2.6
FEL3NS	FEL at North Working Face for Plant 1	109.7	109.7	143651.9	6635019.4	5.0
FEL4NS	FEL at North Working Face for Plant 1	109.7	109.7	143708.2	6634876.2	2.0
FEL2SS	FEL at South Working Face for Plant 1	109.7	109.7	149588.1	6625347.6	20.3
FEL1SS	FEL at South Working Face for Plant 1	109.7	109.7	149518.1	6625371.9	9.9
TruckL01SS	Truck Loading at South Working Face for Pl 1	102.5	102.5	149507.3	6625371.9	8.1
TruckL03NS	Truck Loading at North Working Face for Pl 1	102.5	102.5	143711.5	6634871.7	2.0
Excav1SS	Excavator at South Working Face for PL1	110.4	110.4	149588.3	6625293.5	8.0

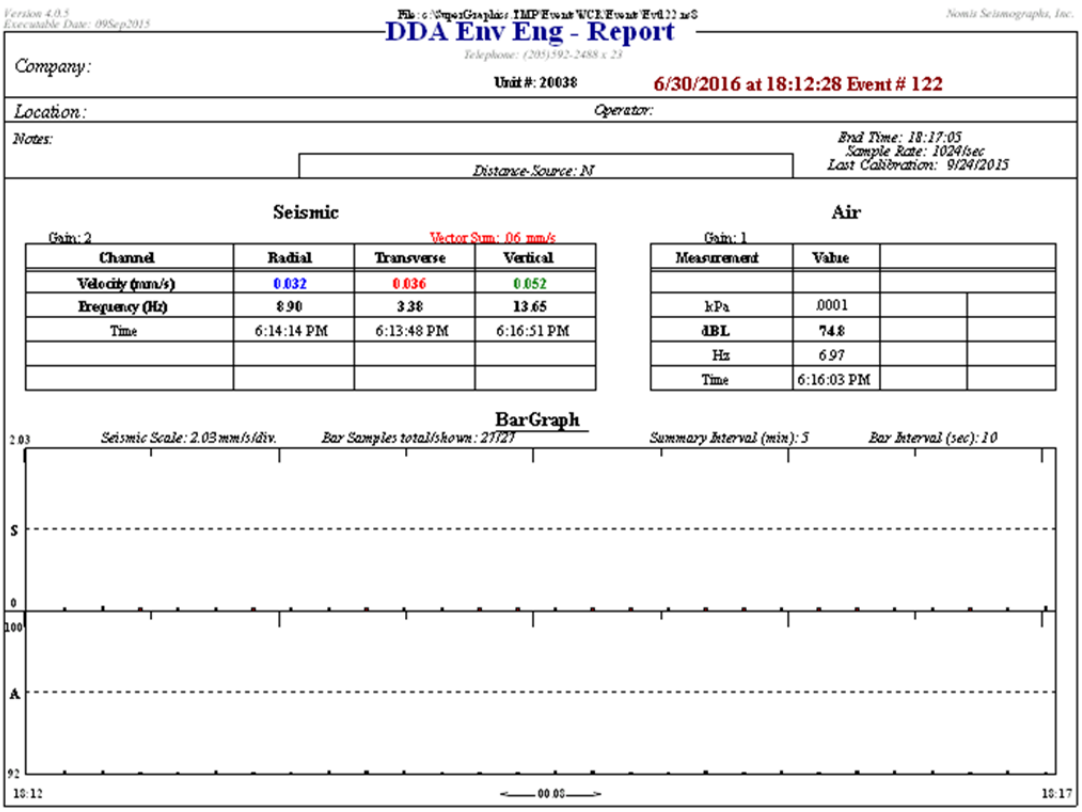
Excav2SS	Excavator at South Working Face for PL1	112.1	112.1	149635.5	6625310.1	19.7
Excav3SS	Excavator at South Working Face for PL1	110.4	110.4	149650.3	6625259.6	6.1
Excav4NS	Excavator at North Working Face for PL1	110.4	110.4	143652.9	6634957.6	3.5
Excav5NS	Excavator at North Working Face for PL1	110.4	110.4	143679.2	6634974.5	5.1
Excav5NS	Excavator at North Working Face for PL1	112.1	112.1	143611.0	6634998.4	3.2
Overb Loading SS	Overburden Loading at South Working Face	102.5	102.5	149593.3	6625352.9	24.0
OverbOLoading SS	Overburden Offloading at South Working Face	102.5	102.5	149263.4	6626003.5	25.5
OverbLoadingNS	Overburden Loading at North Working Face	102.5	102.5	143645.4	6635027.4	6.2
OverbOLoadingNS	Overburden Offloading at North Working Face	102.5	102.5	145870.3	6635451.9	34.3
P2Vibrating Gr	Plant 2 Vibrating Grizzly	98.2	98.2	140959.2	6651209.4	61.4
P2Prim Jet Mod	Plant 2 Jet Pump Module	95.8	95.8	140952.9	6651206.5	61.2
P2Screen Module	Plant 2 Screen	98.2	98.2	140966.4	6651157.8	61.9
P2Scrub Module	Plant 2 Scrub Module	87.1	87.1	140963.1	6651165.9	63.8
P2Screen b	Plant 2 Screen b	102.5	102.5	140956.2	6651225.2	58.9
PL2 FEL	FEL at Plant 2	106.7	106.7	140958.7	6651234.8	59.1
Dozer2NN	Dozer at North Working Face for Plant 2	111.9	111.9	137164.5	6653425.0	13.6
FEL3NN	FEL at North Working Face for Plant 2	109.7	109.7	137133.9	6653519.4	9.3
FEL4NN	FEL at North Working Face for Plant 2	109.7	109.7	137190.2	6653376.2	14.4
TruckL03NN	Truck Loading at North Working Face for Pl 2	102.5	102.5	137193.5	6653371.7	14.5
Excav4NN	Excavator at North Working Face for PL2	110.4	110.4	137134.9	6653457.6	12.4
Excav5NN	Excavator at North Working Face for PL2	110.4	110.4	137161.2	6653474.5	14.2
Excav5NN	Excavator at North Working Face for PL2	112.1	112.1	137093.0	6653498.4	3.0
OverbLoadingNN	Overburden Loading at North Working Face	102.5	102.5	137127.4	6653527.4	10.1
OverbLoading2NN	Overburden Offloading at North Working Face	102.5	102.5	137875.9	6654689.6	41.3
Dozer1NS	Dozer at South Working Face for Plant 2	111.9	111.9	140575.9	6644619.9	5.8
FEL2NS	FEL at South Working Face for Plant 2	109.7	109.7	140590.1	6644647.6	8.9

FEL1NS	FEL at South Working Face for Plant 2	109.7	109.7	140520.1	6644671.9	5.4
TruckL01NS	Truck Loading at South Working Face for Pl 2	102.5	102.5	140509.3	6644671.9	5.3
Excav1NS	Excavator at South Working Face for PL2	110.4	110.4	140590.3	6644593.5	6.8
Excav2NS	Excavator at South Working Face for PL2	112.1	112.1	140637.5	6644610.1	11.6
Excav3NS	Excavator at South Working Face for PL2	110.4	110.4	140652.3	6644559.6	6.6
Overb Loading NS	Overburden Loading at South Working Face	102.5	102.5	140595.3	6644652.9	11.3
LINE SOURCES						
Id	Source Type	Sound Power Level		Sound Power Level		
		Day	Night	Day	Night	
		(dB(A))	(dB(A))	(dB(A)/m)	(dB(A)/m)	
Plant1 Conv Belt	Plant 1 Conveyor Belt 1	98.6	98.6	85.5	85.5	
Plant1 Conv Belt2	Plant 1 Conveyor Belt 2	98.3	98.3	85.5	85.5	
Plant1 Conv Belt3	Plant 1 Conveyor Belt 3	96.3	96.3	85.5	85.5	
Plant1 Conv Belt4	Plant 1 Conveyor Belt 4	100	100	85.5	85.5	
Plant1 Conv Belt5	Plant 1 Conveyor Belt 5	100.9	100.9	85.5	85.5	
Plant1 Conv Belt6	Plant 1 Conveyor Belt 6	96.6	96.6	85.5	85.5	
Plant2 Conv Belt	Plant 2 Conveyor Belt 1	98.6	98.6	85.5	85.5	
Plant2 Conv Belt2	Plant 2 Conveyor Belt 2	98.3	98.3	85.5	85.5	
Plant2 Conv Belt3	Plant 2 Conveyor Belt 3	96.3	96.3	85.5	85.5	
Plant2 Conv Belt4	Plant 2 Conveyor Belt 4	99.9	99.9	85.5	85.5	
Plant2 Conv Belt5	Plant 2 Conveyor Belt 5	100.9	100.9	85.5	85.5	
Plant2 Conv Belt6	Plant 2 Conveyor Belt 6	96.5	96.5	85.5	85.5	

ROAD SOURCES									
Id	Source Type	Sound Power Level		Vehicles Number		Heavy Vehicles		Maximum Speed	
		Day	Night	Day	Night	Day	Night	Auto	Heavy
		(dB(A)/m)	(dB(A)/m)	(veh/hr)	(veh/hr)	(%)	(%)	(km/hr)	(km/hr)
Road1S	Trucks to Plant 1 from South WF	77.3	77.3	12	12	100	100	35	35
Road1N	Trucks to Plant 1 from North WF	75.6	75.6	8	8	100	100	35	35
Overburden1N	Truck to Overburden Dump from North WF	74.3	74.3	6	6	100	100	35	35
Overburden1S	Truck to Overburden Dump from South WF	74.3	74.3	6	6	100	100	35	35
Road2N	Trucks to Plant 2 from South WF	77.3	77.3	12	12	100	100	35	35
Overburden2N	Truck to Overburden Dump from North WF	74.3	74.3	6	6	100	100	35	35
Overburden2S	Truck to Overburden Dump from South WF	74.3	74.3	6	6	100	100	35	35
Road2S	Trucks to Plant 2 from North WF	75.6	75.6	8	8	100	100	35	35

Appendix D

D.1 Vibration Monitoring Sheet



Version 4.0.5
Executable Date: 09Sep2015

Nomis Seismographs, Inc.

DDA Env Eng - Report

Telephone: (205)592-2488 x 23

Company:

Unit #: 20038

6/30/2016 at 18:12:28 Event # 122

Location:

Operator:

Notes:

Distance-Source: N

End Time: 18:17:05
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Seismic

Gain: 2

Vector Sum: .06 mm/s

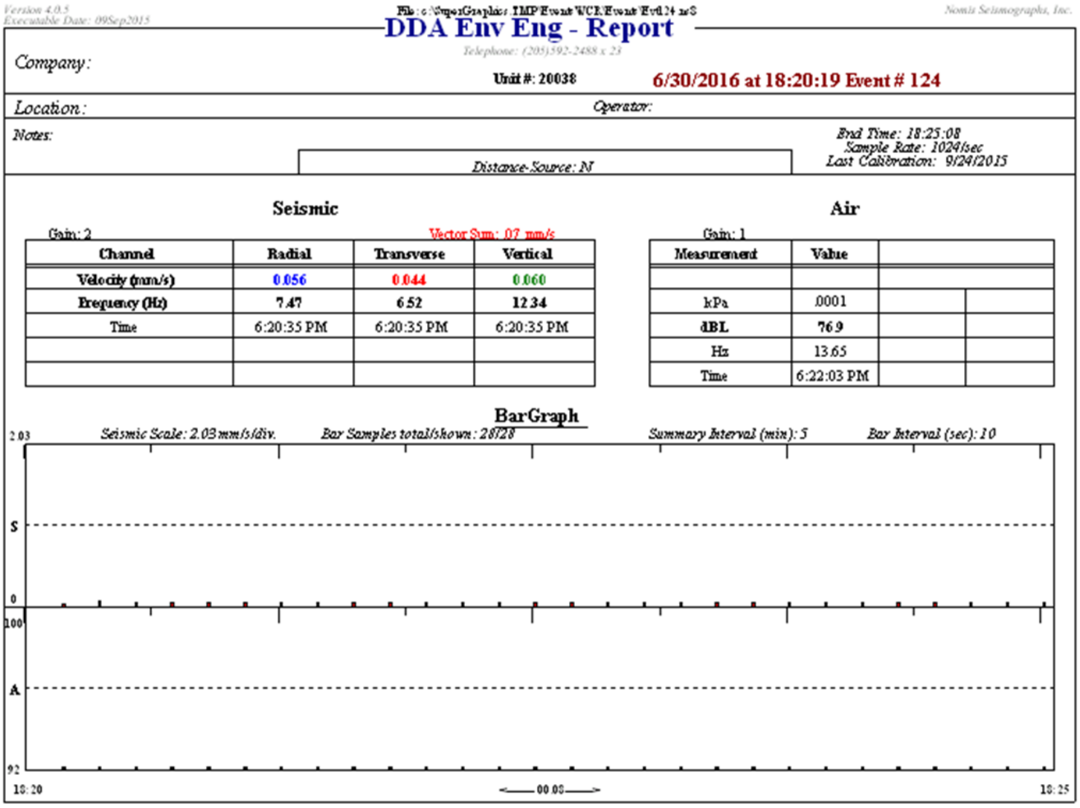
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.032	0.036	0.052
Frequency (Hz)	8.90	3.38	13.65
Time	6:14:14 PM	6:13:48 PM	6:16:51 PM

Air

Gain: 1

Measurement	Value		
kPa	.0001		
dBL	74.8		
Hz	6.97		
Time	6:16:03 PM		

BarGraph


Version 4.0.5
Executable Date: 09Sep2015

File: c:\SuperGraphics.IMP\Event WCR\Event\Evt124.xS

DDA Env Eng - Report

Nomis Seismographs, Inc.

Telephone: (205)592-2488 x 23

Company:

Unit #: 20038 6/30/2016 at 18:20:19 Event # 124

Location: Operator:

Notes:

Distance-Source: N

End Time: 18:25:08
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Seismic

Gain: 2 Vector Sum: .07 mm/s

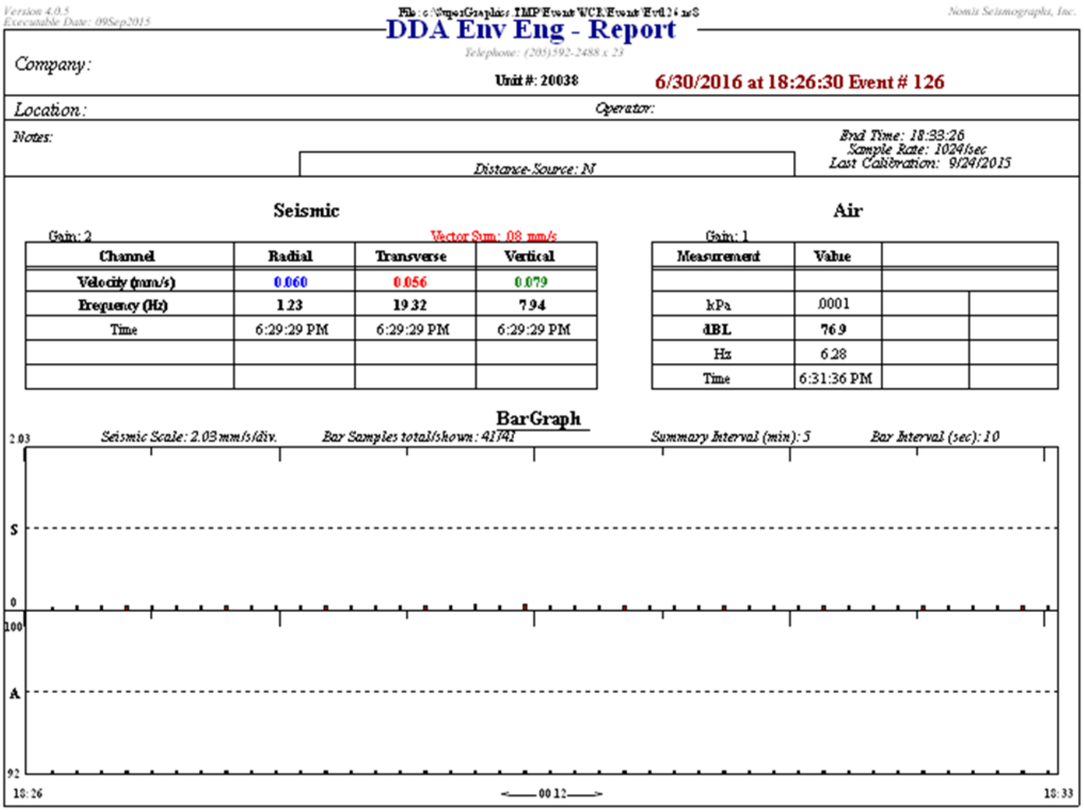
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.056	0.044	0.060
Frequency (Hz)	7.47	6.52	12.34
Time	6:20:35 PM	6:20:35 PM	6:20:35 PM

Air

Gain: 1

Measurement	Value
kPa	.0001
dBL	76.9
Hz	13.65
Time	6:22:03 PM

BarGraph


Version 4.0.5
Executable Date: 09Sep2015

File: c:\SuperGraphics.IMP\Event WCR\Event\Evt126.xS

DDA Env Eng - Report

Nomis Seismographs, Inc.

Telephone: (205)592-2488 x 23

Company:

Unit #: 20038 6/30/2016 at 18:26:30 Event # 126

Location: Operator:

Notes:

Distance-Source: N

End Time: 18:33:26
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Seismic

Gain: 2 Vector Sum: .08 mm/s

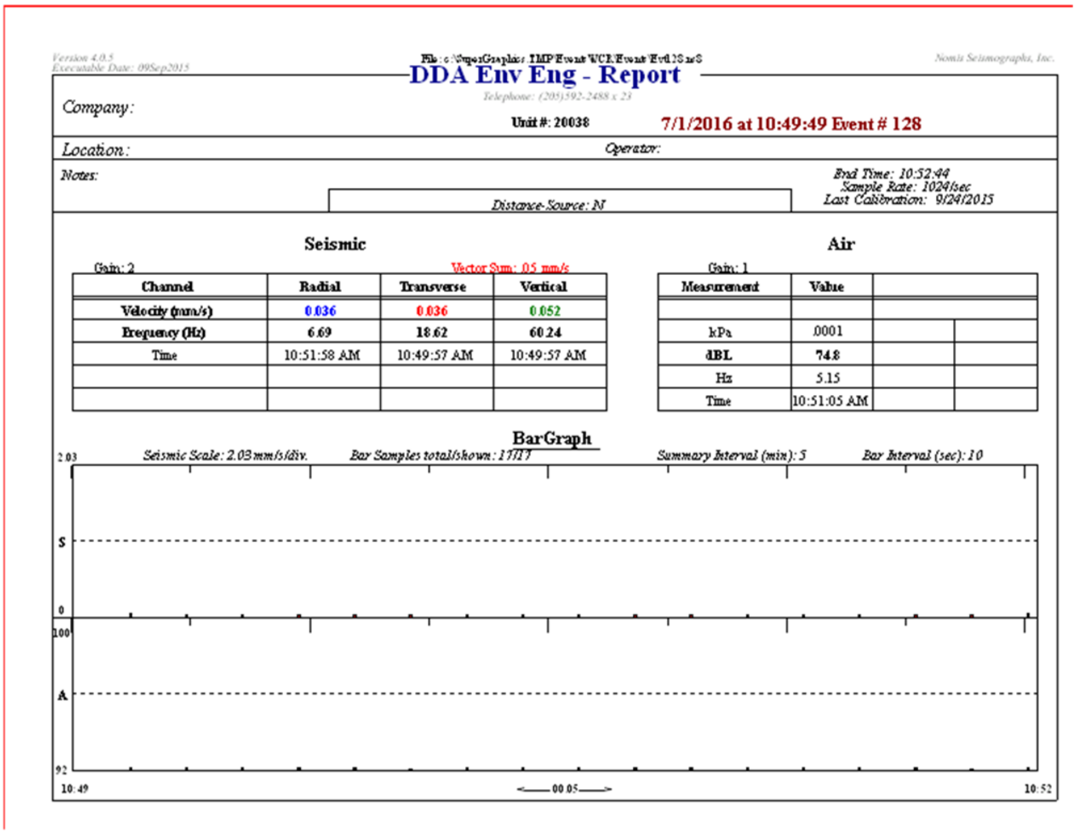
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.060	0.056	0.079
Frequency (Hz)	1.23	19.32	7.94
Time	6:29:29 PM	6:29:29 PM	6:29:29 PM

Air

Gain: 1

Measurement	Value
kPa	.0001
dBL	76.9
Hz	6.28
Time	6:31:36 PM

BarGraph



Version 4.0.5
Executable Date: 09Sep2015
File: c:\SuperGraphics.IMP\Event\WCR\Event\Evt128.s\S
Nomis Seismographs, Inc.

DDA Env Eng - Report
Telephone: (205)592-2488 x 23

Company:
Unit #: 20038 **7/1/2016 at 10:49:49 Event # 128**

Location: Operator:

Notes:
Distance-Source: N
End Time: 10:52:44
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Seismic

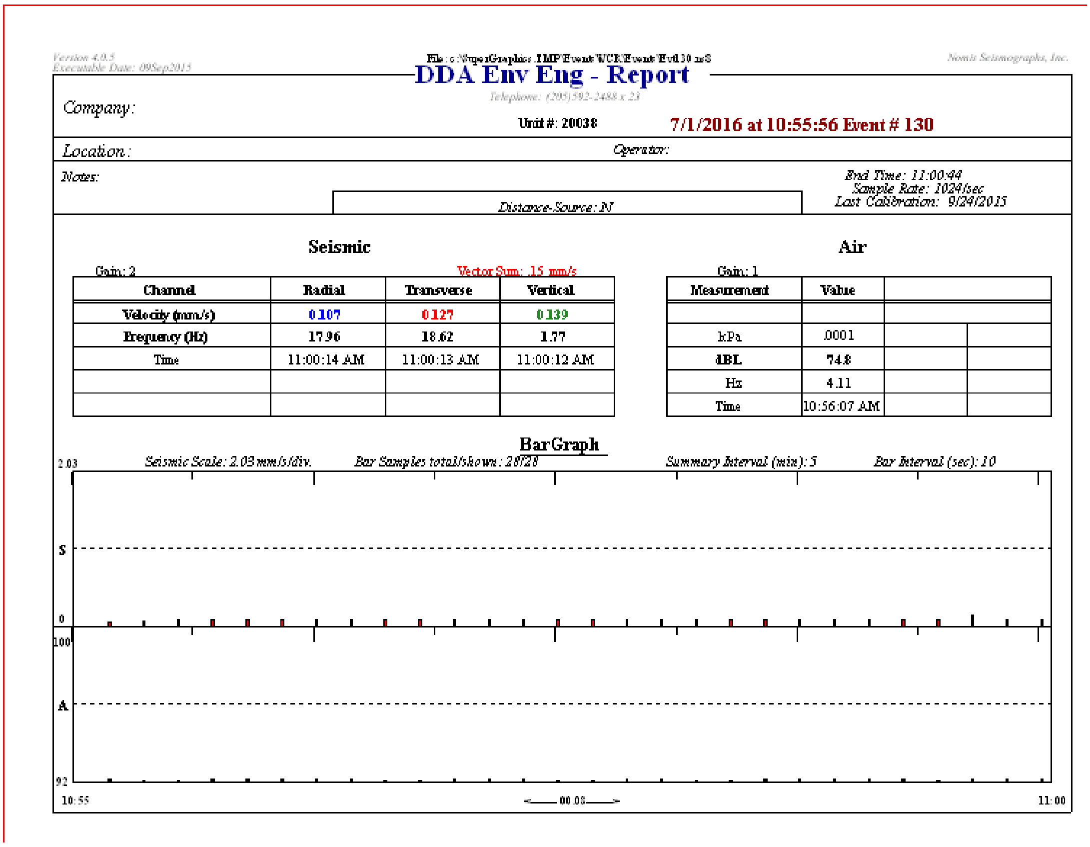
Gain: 2 Vector Sum: .05 mm/s

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.036	0.036	0.052
Frequency (Hz)	6.69	18.62	60.24
Time	10:51:58 AM	10:49:57 AM	10:49:57 AM

Air

Gain: 1

Measurement	Value
kPa	.0001
dBL	74.8
Hz	5.15
Time	10:51:05 AM



Version 4.0.5
Executable Date: 09Sep2015
File: c:\SuperGraphics.IMP\Event\WCR\Event\Evt130.s\S
Nomis Seismographs, Inc.

DDA Env Eng - Report
Telephone: (205)592-2488 x 23

Company:
Unit #: 20038 **7/1/2016 at 10:55:56 Event # 130**

Location: Operator:

Notes:
Distance-Source: N
End Time: 11:00:44
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Seismic

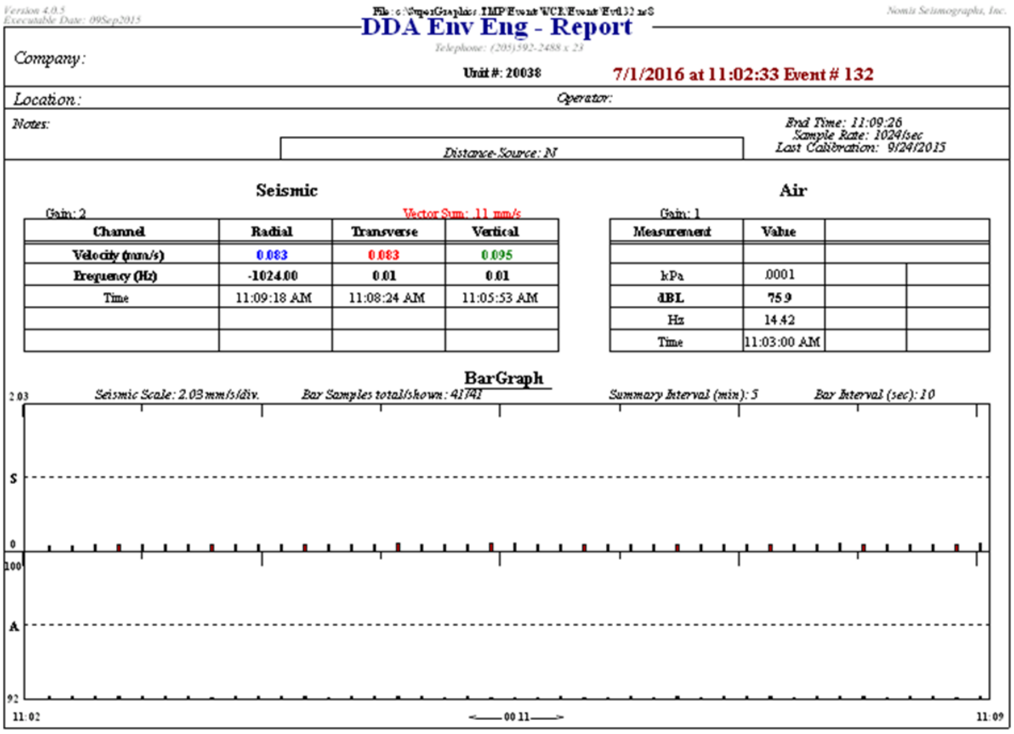
Gain: 2 Vector Sum: .15 mm/s

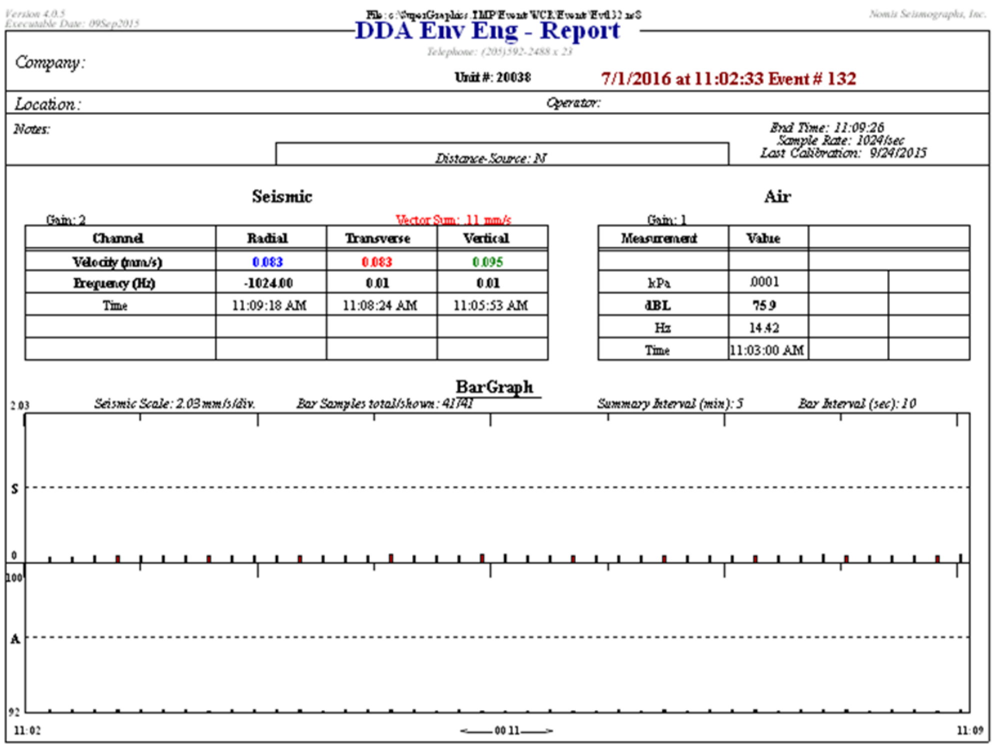
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.107	0.127	0.139
Frequency (Hz)	17.96	18.62	1.77
Time	11:00:14 AM	11:00:13 AM	11:00:12 AM

Air

Gain: 1

Measurement	Value
kPa	.0001
dBL	74.8
Hz	4.11
Time	10:56:07 AM


DDA Env Eng - Report
Company:
Unit #: 20038
7/1/2016 at 11:02:33 Event # 132
Location:
Operator:
Notes:
End Time: 11:09:26
Sample Rate: 1024/sec
Last Calibration: 9/24/2015
Distance-Source: N
Seismic
Air
Gain: 2
Vector Sum: 11 mm/s
Gain: 1
Channel | Radial | Transverse | Vertical
Velocity (mm/s) | 0.083 | 0.083 | 0.095
Frequency (Hz) | -1024.00 | 0.01 | 0.01
Time | 11:09:18 AM | 11:08:24 AM | 11:05:53 AM
Measurement | Value
kPa | .0001
dBL | 75.9
Hz | 14.42
Time | 11:03:00 AM
BarGraph
Seismic Scale: 2.03 mm/s/div.
Bar Samples total/shown: 41741
Summary Interval (min): 5
Bar Interval (sec): 10
11:02
00:11
11:09


DDA Env Eng - Report
Company:
Unit #: 20038
7/1/2016 at 11:02:33 Event # 132
Location:
Operator:
Notes:
End Time: 11:09:26
Sample Rate: 1024/sec
Last Calibration: 9/24/2015
Distance-Source: N
Seismic
Air
Gain: 2
Vector Sum: 11 mm/s
Gain: 1
Channel | Radial | Transverse | Vertical
Velocity (mm/s) | 0.083 | 0.083 | 0.095
Frequency (Hz) | -1024.00 | 0.01 | 0.01
Time | 11:09:18 AM | 11:08:24 AM | 11:05:53 AM
Measurement | Value
kPa | .0001
dBL | 75.9
Hz | 14.42
Time | 11:03:00 AM
BarGraph
Seismic Scale: 2.03 mm/s/div.
Bar Samples total/shown: 41741
Summary Interval (min): 5
Bar Interval (sec): 10
11:02
00:11
11:09

Version 4.0.5
Executable Date: 09Sep2015

File: c:\SuperGraphics\TMP\Event\WCR\Event\Evt136.msS

Nomis Seismographs, Inc.

DDA Env Eng - Report

Telephone: (205)592-2488 x 23

Company:

Unit #: 20038 **7/1/2016 at 12:38:50 Event # 136**

Location: Operator:

Notes:

End Time: 12:47:50
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Distance-Source: N

Seismic

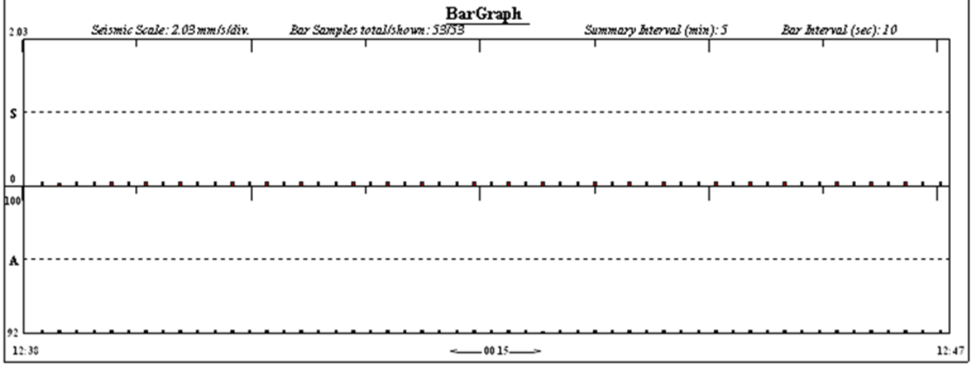
Gain: 2 Vector Sum: .06 mm/s

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.040	0.044	0.044
Frequency (Hz)	0.38	1.16	0.25
Time	12:40:31 PM	12:39:33 PM	12:47:14 PM

Air

Gain: 1

Measurement	Value		
kPa	.0001		
dBL	75.9		
Hz	4.21		
Time	12:39:59 PM		



Version 4.0.5
Executable Date: 09Sep2015

File: c:\SuperGraphics\TMP\Event\WCR\Event\Evt134.msS

Nomis Seismographs, Inc.

DDA Env Eng - Report

Telephone: (205)592-2488 x 23

Company:

Unit #: 20038 **7/1/2016 at 12:28:54 Event # 134**

Location: Operator:

Notes:

End Time: 12:37:31
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

Distance-Source: N

Seismic

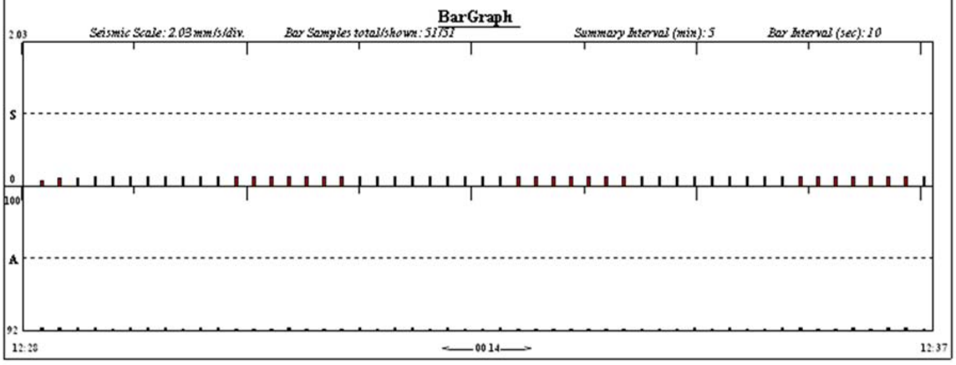
Gain: 2 Vector Sum: .13 mm/s

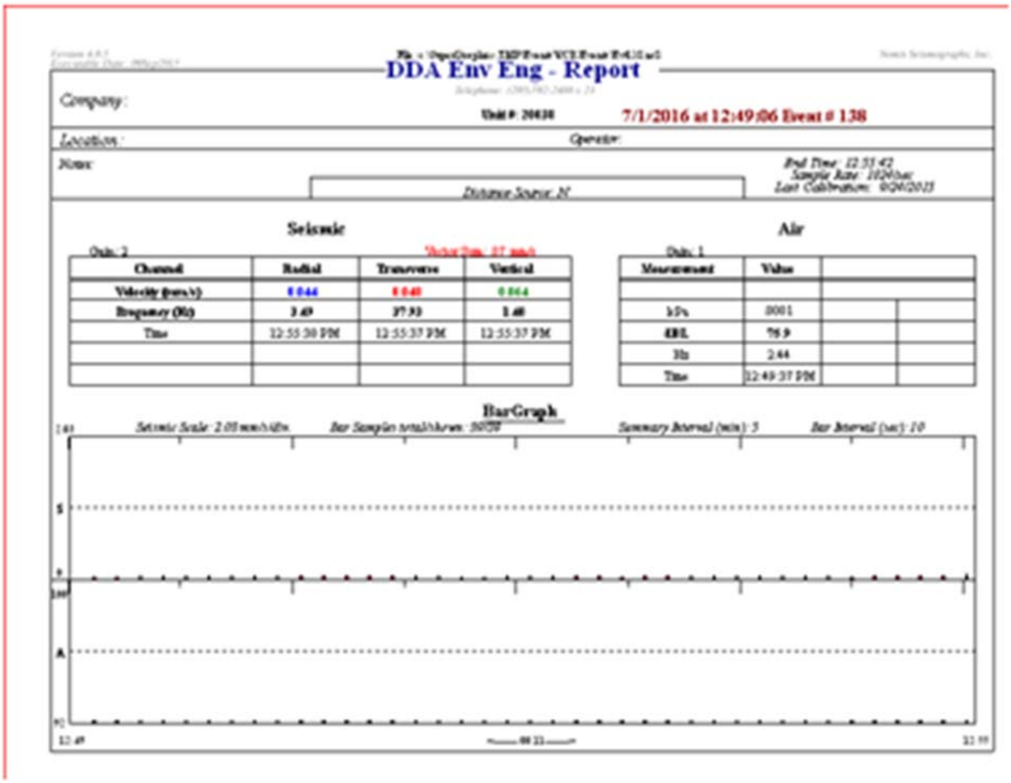
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.095	0.099	0.087
Frequency (Hz)	3.42	-1024.00	-1024.00
Time	12:29:36 PM	12:37:24 PM	12:37:24 PM

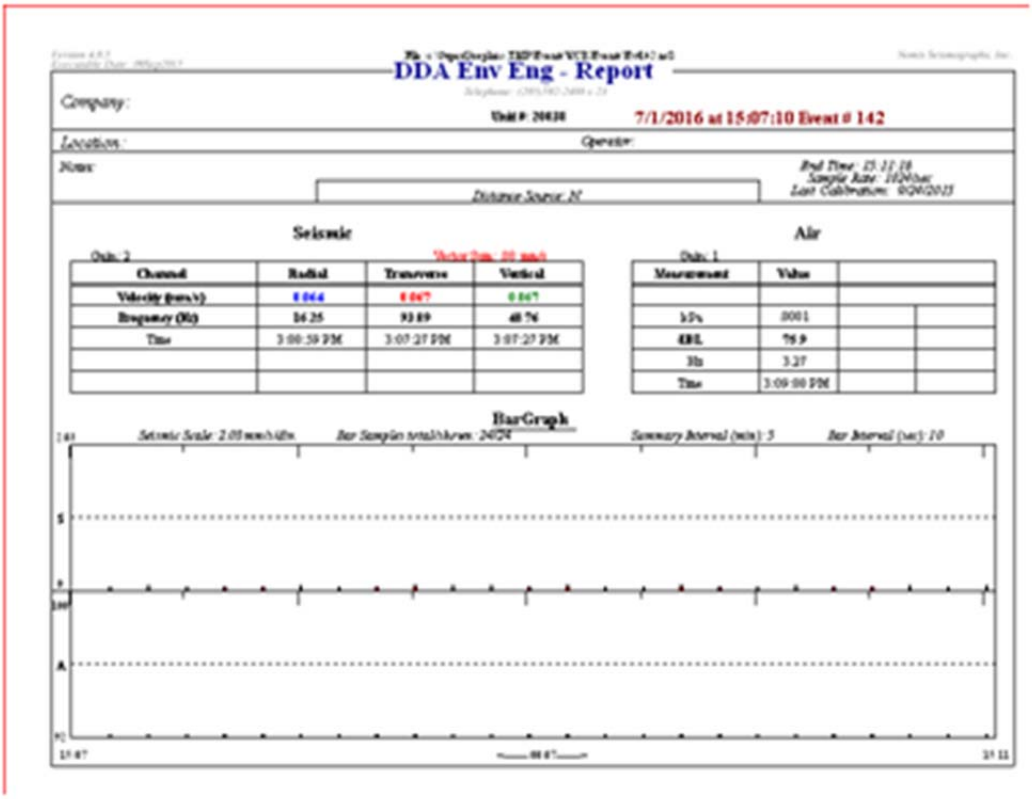
Air

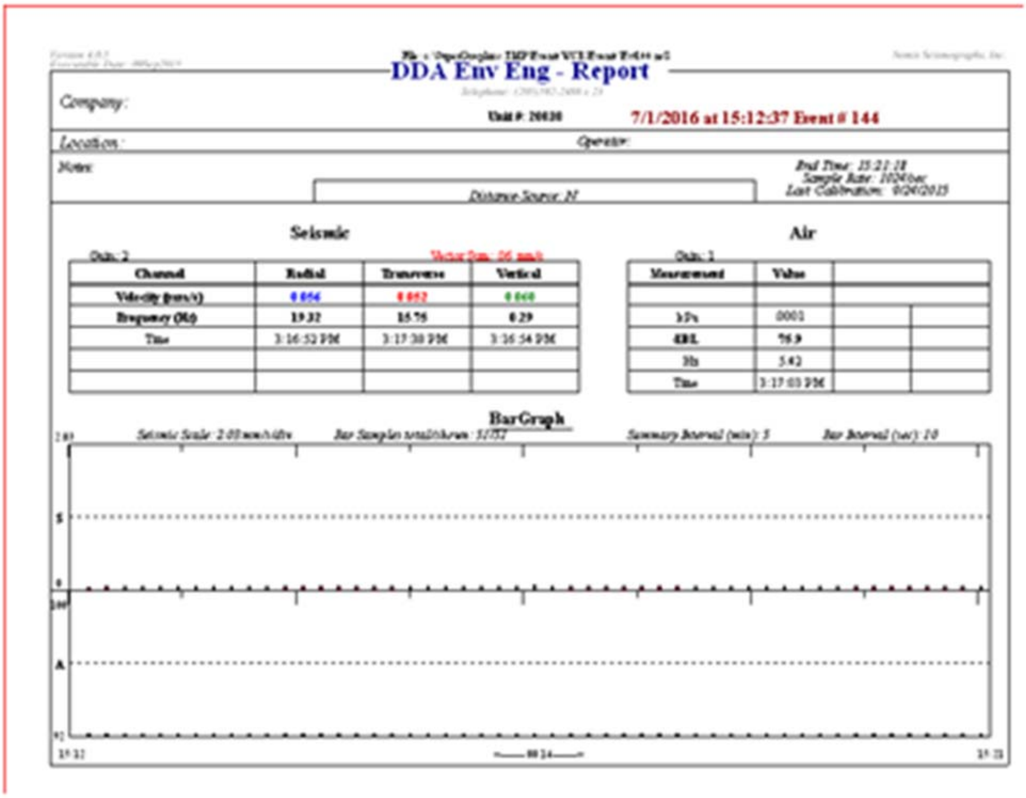
Gain: 1

Measurement	Value		
kPa	.0001		
dBL	75.9		
Hz	31.03		
Time	12:37:05 PM		




DDA Env Eng - Report
Company:
7/1/2016 at 12:49:06 Event # 138
Location:
Seismic
Air
BarGraph


DDA Env Eng - Report
Company:
7/1/2016 at 15:07:10 Event # 142
Location:
Seismic
Air
BarGraph



DDA Env Eng - Report

Company:

Unit #: 20038 — 7/1/2016 at 15:12:37 Event # 144

Location: — Operator:

Notes: — Distance Source: N

End Time: 15:21:18
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

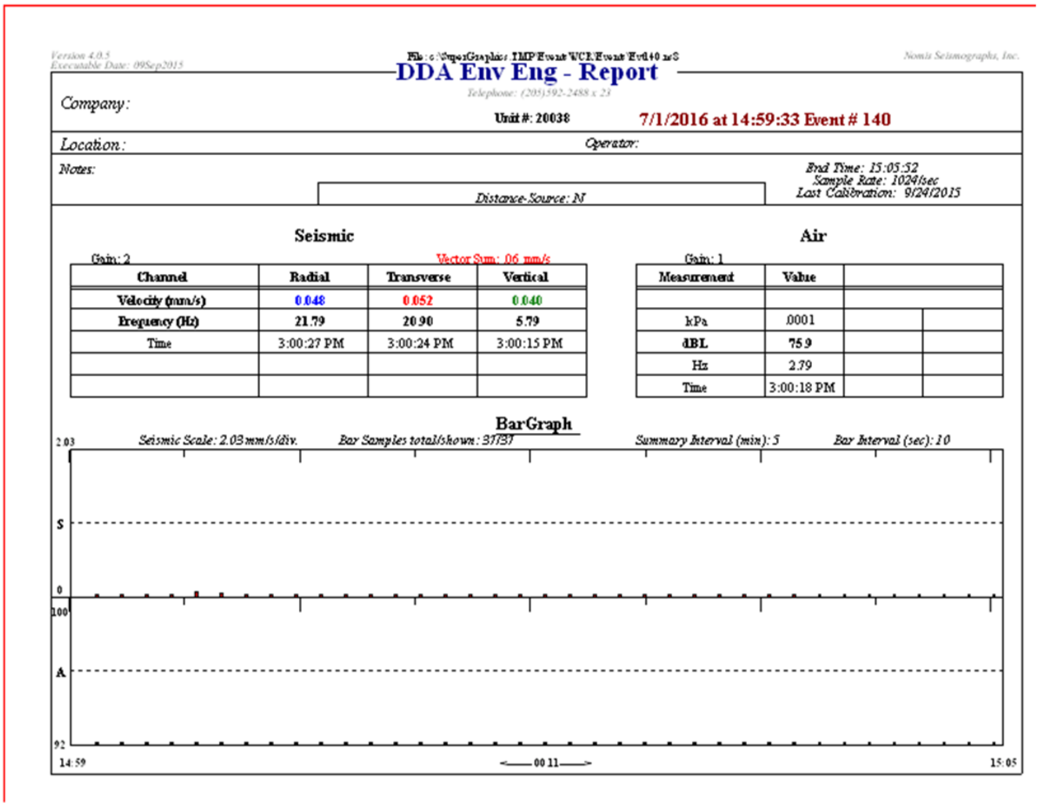
Seismic (Gain: 2; Vector Sum: .06 mm/s)

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.056	0.052	0.060
Frequency (Hz)	19.32	15.75	6.29
Time	3:16:52 PM	3:17:30 PM	3:16:54 PM

Air (Gain: 1)

Measurement	Value
kPa	.0001
dBL	75.9
Hz	5.42
Time	3:17:03 PM

BarGraph



Version 4.0.5
Executable Date: 09Sep2015

Nomis Seismographs, Inc.

DDA Env Eng - Report

Telephone: (205)592-2488 x 23

Company:

Unit #: 20038 — 7/1/2016 at 14:59:33 Event # 140

Location: — Operator:

Notes: — Distance Source: N

End Time: 15:05:52
Sample Rate: 1024/sec
Last Calibration: 9/24/2015

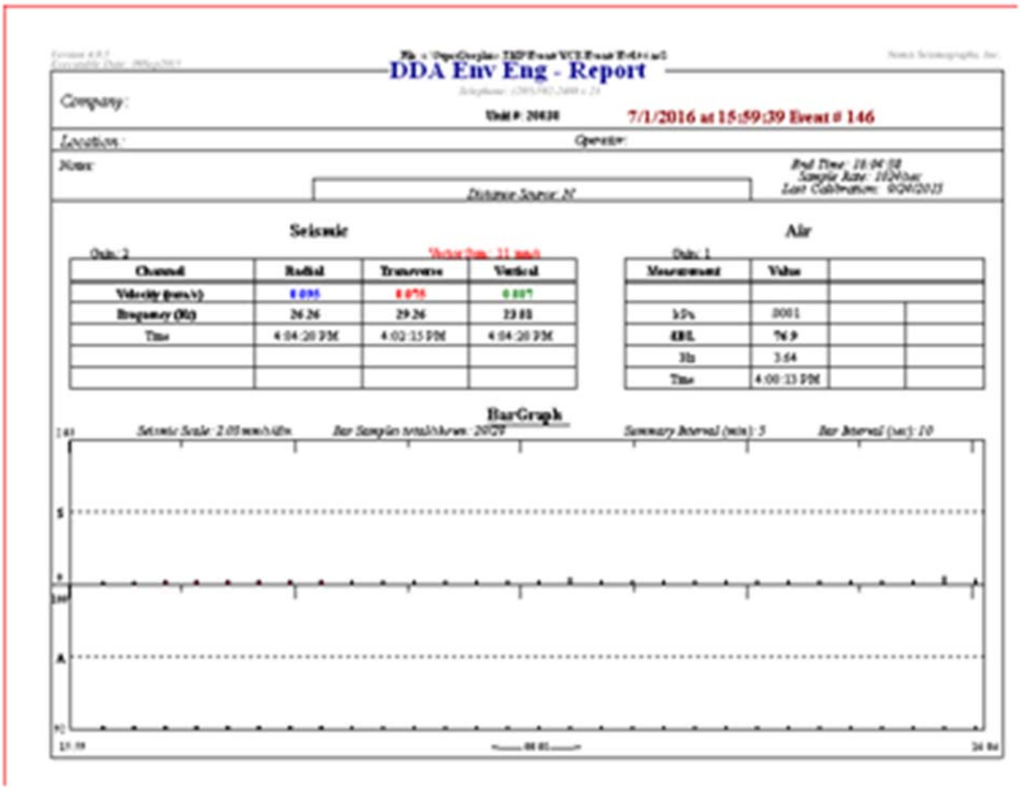
Seismic (Gain: 2; Vector Sum: .06 mm/s)

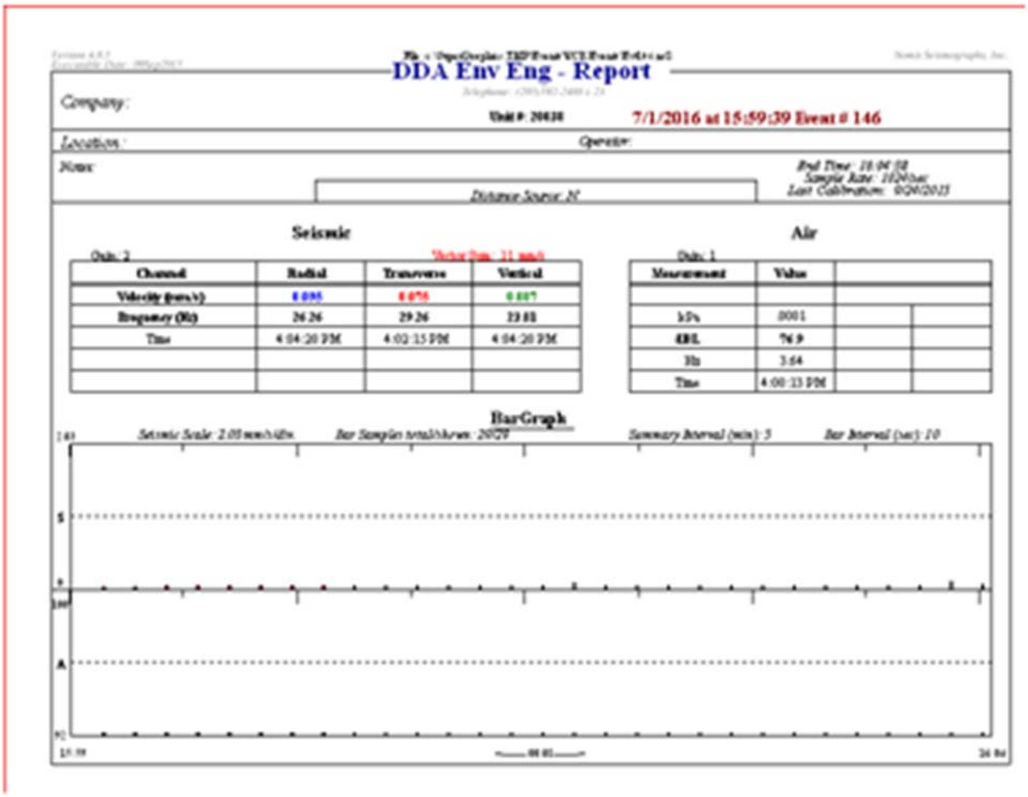
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.048	0.052	0.040
Frequency (Hz)	21.79	20.90	5.79
Time	3:00:27 PM	3:00:24 PM	3:00:15 PM

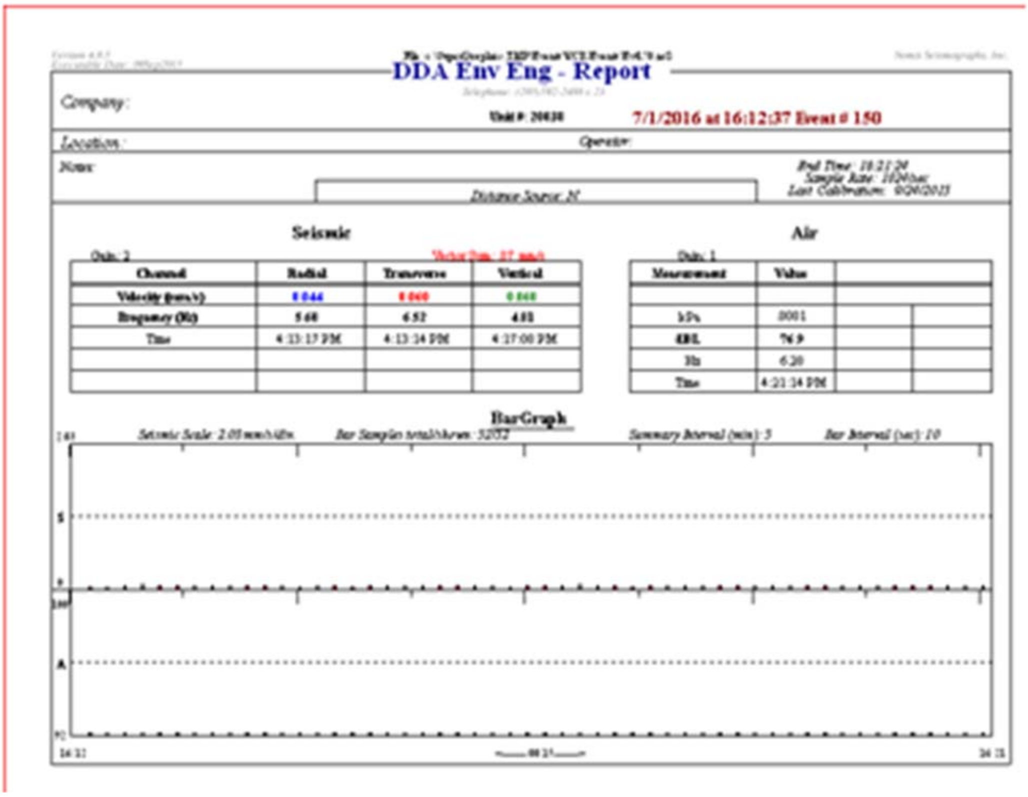
Air (Gain: 1)

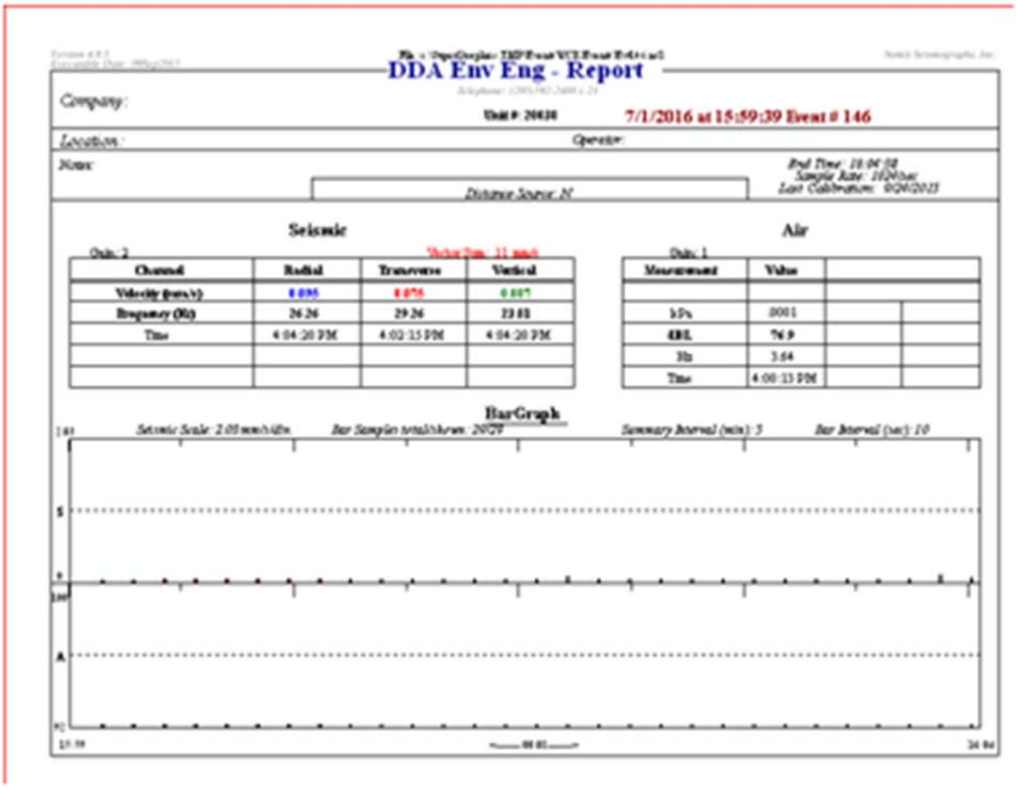
Measurement	Value
kPa	.0001
dBL	75.9
Hz	2.79
Time	3:00:18 PM

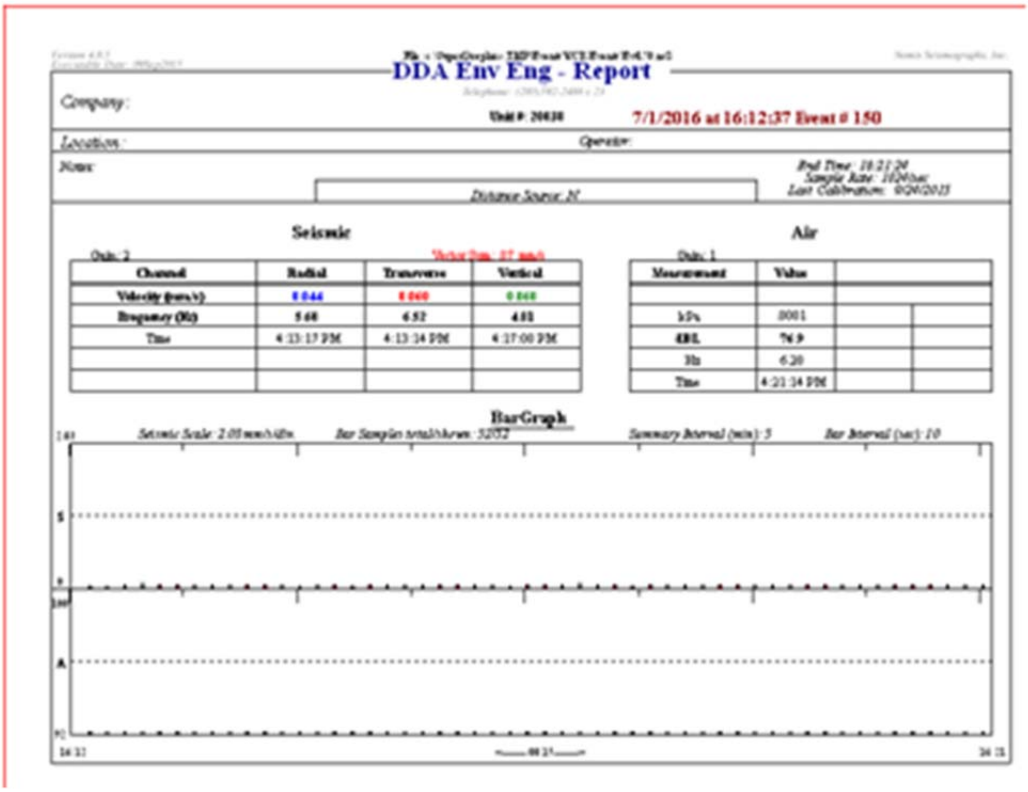
BarGraph


DDA Env Eng - Report
Company:
7/1/2016 at 15:59:39 Event # 146
Location:
Seismic
Air
BarGraph


DDA Env Eng - Report
Company:
7/1/2016 at 15:59:39 Event # 146
Location:
Seismic
Air
BarGraph


DDA Env Eng - Report
Company:
7/1/2016 at 16:12:37 Event # 150
Location:
Seismic
Air
BarGraph


DDA Env Eng - Report
Company:
7/1/2016 at 15:59:39 Event # 146
Location:
Seismic
Air
BarGraph


DDA Env Eng - Report
Company:
7/1/2016 at 16:12:37 Event # 150
Location:
Operator:
Notes:
Seismic
Air
Channel
Radial
Transverse
Vertical
Velocity (mm/s)
Frequency (Hz)
Time
4:13:17 PM
4:13:14 PM
4:17:00 PM
Measurement
Value
kPa
dBL
76.9
Hz
6.20
Time
4:21:34 PM
BarGraph
Summary Interval (min): 5
Bar Interval (sec): 10

Appendix E

E.1 Declaration of Consultant's Independence

The author of this report, Demos Dracoulides, does hereby declare that he is an independent consultant appointed by ERM and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of the specialist performing such work. All opinions expressed in this report are his own.

Demos Dracoulides:

October 2016