APPENDIX 8

SPECIALIST REPORTS

8.1 Soils, Land Use and Land Capability Assessment

8.2 Noise Assessment

8.3 Visual Assessment

8.4 Air quality Assessment

8.5 Paleontological Impact Assessment

8.6 Heritage Impact Assessment

8.7 Biodiversity and Wetland Assessment

8.8 Surface Water Assessment

8.9 Geohydrological Assessment

8.10 Social Impact Assessment

8.11 Blasting Impact Assessment

8.12 Rehabilitation, Decommissioning and Mine Closure Plan, Annual Rehabilitation Plan and Environmental Risk Assessment Report in terms of GNR 1147

8.1 Soils, Land Use and Land Capability Assessment

SOUTH32 SA COAL HOLDINGS (PTY) LTD

VANDYKSDRIFT CENTRAL MINING: INFRASTRUCTURE DEVELOPMENT
SOIL, LAND CAPABILITY AND LAND USE ASSESSMENT
IMPACT ASSESSMENT REPORT

Report No.: JW200/18/G535-07 – Rev 3

July 2019

Jones & Wagener
Engineering & Environmental Consultants
Internet presence: www.jaws.co.za

DOCUMENT APPROVAL RECORD

Report No.: JW200/18/G535-07 – Rev 3

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Environmental Scientist	Konrad Kruger	02 April 2019	
Updated	Environmental Scientist	Konrad Kruger	19 July 2019	
Reviewed and Approved	Environmental Manager	Tolmay Hopkins	05 April 2019	

RECORD OF REVISIONS AND ISSUES REGISTER

Date	Revision	Description	Issued to	Issue Format	No. Copies
26 August 2018	Rev 0	Draft Baseline Report for internal review	Tolmay Hopkins	Electronic	1
10 December 2018	Rev 1	Draft Impact Assessment Report for internal review	Tolmay Hopkins	Electronic	1
2 April 2019	Rev 2	Final Impact Assessment Report	Tolmay Hopkins	Electronic	1
19 July 2019	Rev 3	Updated Final Impact Assessment Report	Tolmay Hopkins	Electronic	1

SYNOPSIS

South32 SA Coal Holdings (Pty) Ltd (South32), is the holder of an amended mining right for coal, granted by the Minister of Mineral Resources, in terms of the Mineral and Petroleum Resources Development Act (MPRDA) and notarially executed on the 21st of May 2015 under DMR reference MP30/5/1/2/2/379MR, in respect of its Wolvekrans Colliery. Wolvekrans Colliery comprises of the following sections:

- Ifalethu Colliery (previously referred to as Wolvekrans North Section[1]) consisting of the Hartbeestfontein, Bankfontein (mining now ceased), Goedehoop, Klipfontein sections and the North Processing Plant; and
- Wolvekrans Colliery (previously referred to as the Wolvekrans South Section) consisting of the Wolvekrans, Vlaklaagte (mining ceased), Driefontein, Boschmanskrans, Vandyksdrift, Albion and Steenkoolspruit sections, as well as the South Processing Plants (Eskom and Export). Some of these areas were previously known as Douglas Colliery.

The Vandyksdrift Central (VDDC) area falls within the footprint of historic underground mining operations at the old Douglas Colliery. In 2007, an amendment of the Environmental Management Programme Report (EMPR) for the Douglas Colliery operations was approved, to allow pillar mining (opencast) of the area previously mined by underground bord and pillar mining. Authorisation of the VDDC mining project included the following:

- Opencast operation on the farm Kleinkopje 15 IS;
- Opencast operation on the farm Steenkoolspruit 18 IS;
- Pillar extraction operation on the farm Vandyksdrift 19 IS;
- Reclamation of existing slurry ponds; and
- Rewashing of existing discard dumps (PHD, 2006).

The water uses associated with the opencast mining has been authorised in terms of water use licence number 24084535 dated 10 October 2008, issued to Douglas Colliery Services Limited.

The No. 2 seam workings are flooded with water and must be dewatered to enable the open pit development to proceed. A dewatering strategy has therefore been developed and an application for Environmental Authorisation (EA) of the dewatering activities was submitted to the Department of Mineral Resources (DMR) (Jaco-K Consulting, 2016(a)); a decision in this regard is pending. The water use activities associated with this upfront dewatering strategy have been authorised by WUL number 06/B11F/GCIJ/7943 dated 19 July 2018.

The 2007 approved EMPR Amendment included limited additional infrastructure in support of the opencast mining operations, as it was assumed at that stage that existing infrastructure will be used. In addition, the applications for authorisation of the activities associated with the dewatering strategy, were limited to the infrastructure to facilitate dewatering (i.e. dewatering boreholes, pumps, pipelines, storage tanks, mechanical evaporators, roads and power lines).

A pre-feasibility investigation has since been conducted, and the need to develop additional infrastructure to support the proposed opencast mining was identified. The additional infrastructure includes the following:

- Storm water management structures (drains and berms);

[1] This was previously referred to as Middelburg Colliery

- Water management measures for the management of mine impacted water;
- Overburden dumps;
- ROM coal stockpile areas;
- Mixed ROM coal and slurry stockpile areas;
- Topsoil stockpiles following clearance of vegetation;
- Pipelines for the conveyance of water;
- Hard park area and brake test ramp; and
- Haul roads and service roads.

The proposed VDDC opencast pit boundary as determined through the pre-feasibility investigation also differs from the mining area approved in the 2007 EMPR amendment. An area of approximately 196 hectares in the latest mine lay-out was not included in the previous mine lay-out and is therefore not approved to be opencast mined.

Jones & Wagener (Pty) Ltd Engineering & Environmental Consultants (J&W) has been appointed to undertake the EA application process for the abovementioned project. As part of the process, specialist studies need to be undertaken. This report details the methods, analysis and findings of the soils, land capability and land use assessment undertaken for the proposed VDDC Infrastructure Development Project.

The status quo assessment is based on the 2006 Douglas EMP (Pulles, Howard & De Lange, 2006) and the 2013 Baseline Soil Specialist Study by Earth Science Solutions. As the scope excluded any further field investigations, this report has extracted large sections from these sources.

A total of twenty (20) soil forms were identified (**Table 2-1**) in the study area pre-mining (Douglas EMP, 2006). The percentage of Witbank (man-made) soils has since increased due to the growth of the existing VDDC discard dump and several other man-made features on site. The distribution of the soils on site (**Figure 2-1** and **2-2**) is closely linked to the topography and parent materials from which they are derived, as well as the flooding regime of the area.

The deeper and more sandy loam soils are considered High Potential materials and are distinguished by the better than average depth of relatively free draining soil to a greater depth (> 1,200mm). This group are recognisable by the subtleness of the mottling (water within the profile for less than 30% of the season), the greater depth of mottling within the profile (>500mm), while the resultant land capability is rated as moderate intensity grazing and/or arable depending on their production potential. These soils are generally much lower in clay than the associated wet based soils and more structured colluvial derived materials, have a distinctly weaker structure and are deeper and better drained (better permeability). The ability for water to move through these profiles is significantly better.

In contrast, the shallower and more structured materials are considered to be more sensitive and will require greater management if disturbed. This group of shallower and more sensitive soils (< 500mm) are associated almost exclusively with the sub outcropping of the parent materials (Karoo Sediments) (geology) at surface or with a ferricrete (ouklip) layer, and they constitute a relatively large percentage of the overall area of study. These materials play an important function in the sustainability of the overall biodiversity of the area.

The third group of soils comprise those that are associated with the hard pan ferricrete layer and perched soil water. This group of soils have a set of distinctive characteristics and nature that are separated out due to their inherently much more difficult management characteristics. These soils are characterised by relatively much higher clay contents (often of a swelling nature), poor intake rates, poor drainage, generally poor liberation of soil water and a restricted depth – often due to the inhibiting barrier within the top 700mm of the soil profile. These soils are generally associated with a wet base. These soils will be more difficult to work in the wet state, store and re-instate at closure. This group of soils comprise the pan like structures and waterholes. Groundwater is generally relatively deep (>15m) for the majority of the area of study and is reported (hydrogeologists) to have little to no influence on the soil water and water found within the vadose zone. No perched aquifers (groundwater) are reported, albeit that a significant area of well-developed ferricrete was mapped within the vadose zone. The development of wet based soils and moist grassland environments are mapped in association with these soil forms.

The land capability of the study area comprises of:

- Arable land (4.6%)
- Grazing land (8%)
- Wilderness/disturbed land (56.3%)
- Wetland (14.5%)
- Water (4.3%)
- Unknown areas (no data) (12.3%)

As per the Chamber of Mines' Mine Closure Guideline.

The dominant land uses on site are cultivated commercial fields and open grasslands. These are followed by industrial development, mostly due to the mining development in the area and wetlands. The minor land uses include trees, dams and infrastructure. Please note that these statistics are from the pre-mining environment. **Figure 2-5** shows the overall landscape changes due to mining over the last 11 years within the larger study area. The scope did not allow for determination of these areas, however the images from Google Earth over the years provide a clear picture of the landscape changing due to opencast mining.

In terms of land use the study area comprises of:

- Water (0.19%)
- Mine Water (1.26%)
- Cultivated fields (6.91%)
- Bush and shrubland (3.49%)
- Grasslands (27.37%)
- Plantation (0.55%)
- Wetlands (5.56%)
- Bare ground (0.68%)
- Mining (51.43%)
- Urban / Infrastructure (2.57%)

The results from the impact assessment are summarised below.

Table 1: Impact Summary

Activity	Impact	Project Rating	Baseline and Project rating	Rating post mitigation
Construction: **Site/ stockpile preparation and construction**	**NEGATIVE IMPACT:** Clearing of soil will result in loss of land capability. Vehicle movement will result in compaction of soils. Soil contamination by hydrocarbons.	MODERATE	HIGH	MODERATE

Activity	Impact	Project Rating	Baseline and Project rating	Rating post mitigation
Operations **Operations of stockpiles, storing of wastes on in-situ soils** **Opencast mining of areas not previously authorised**	**NEGATIVE IMPACT:** Stockpiling on top of soil will continue in loss of soil resource land capability. Vehicle movement will result in compaction of soils. Soil contamination by hydrocarbons, waste stockpiles and evaporators.	**HIGH**	**HIGH**	**HIGH**
Closure **Rehabilitation of VDDC infrastructure project sites and opencast areas.**	**POSITIVE IMPACT** Rehabilitation of soil, land capability and land use by replacing stockpiled soils over disturbed areas and bringing back a form of land capability that can support an alternative end use	**VERY LOW POSITIVE**	**HIGH**	**LOW POSITIVE**

The VDDC mining project will utilise available mineral resources. These resources have been undermined previously, and several impacts have already occurred. Furthermore, the mining area is surrounded by other opencast operations, resulting in a landscape dominated by mining and its associated impacts.

The additional impact of the proposed VDDC infrastructure project is mostly located on existing impacted land. However, the areas that are not previously impacted, will be highly impacted by the project.

It is the opinion of this specialist that the development should proceed, but with the principles of sustainable development and the polluter pays in the forefront. Rehabilitation and closure requirements must be enforced with the final end land use of grazing as the objective.

NEMA Appendix 6 requirements

Regulation: GNR 982, December 2014, as amended	Description	Section in the Report
Appendix 6 (a)	A specialist report prepared in terms of these Regulations must contain— details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 1.10 & App A
Appendix 6 (b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	App B
Appendix 6 (c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 1.2
Appendix 6 (cA)	An indication of the quality and age of base data used for the specialist report;	Section 2.2.1
Appendix 6 (cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 4
Appendix 6 (d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.1.1.2
Appendix 6 (e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2.1.1.2
Appendix 6 (f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a, site plan identifying site alternatives;	Section 4.2
Appendix 6 (g)	An identification of any areas to be avoided, including buffers;	Section 2
Appendix 6 (h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 4.2
Appendix 6 (i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.11
Appendix 6 (j)	A description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 4 and 6
Appendix 6 (k)	Any mitigation measures for inclusion in the EMPr;	Section 4.4
Appendix 6 (l)	Any conditions for inclusion in the environmental authorisation;	Section 6.2
Appendix 6 (m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 5
Appendix 6 (n)	A reasoned opinion— i.whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii.if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 6
Appendix 6 (o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Refer main BA/EIA report
Appendix 6 (p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Refer main BA/EIA report
Appendix 6 (q)	Any other information requested by the competent authority.	None

SOUTH32 SA COAL HOLDINGS (PTY) LTD

VANDYKSDRIFT CENTRAL MINING: INFRASTRUCTURE DEVELOPMENT
SOIL, LAND CAPABILITY AND LAND USE ASSESSMENT
IMPACT ASSESSMENT REPORT REPORT NO: JW200/18/G535-07 – Rev 3

CONTENTS PAGE

APPENDIXES

LIST OF TABLES

LIST OF FIGURES

Acronyms and Abbreviations

DEA ..... Department of Environmental Affairs
DMR ..... Department of Mineral Resources
DWS ..... Department of Water and Sanitation
EA ..... Environmental Authorisation
EAP ..... Environmental Assessment Practitioner
EE ..... Employment Equity
EIA ..... Environmental Impact Assessment
EIS ..... Ecological Importance and Sensitivity
ELM ..... Emalahleni Local Municipality
GDP ..... Gross Domestic Product
IDP ..... Integrated Development Plan
J&W ..... Jones & Wagener (Pty) Ltd Engineering & Environmental Consultants
km ..... kilometres
km^2 ..... square kilometres
kPa ..... kilopascals
LED ..... Local Economic Development
m ..... metres
m^2 ..... square metres
m^3 ..... cubic metres
LOM ..... Life-of-Mine
MPRDA ..... Mineral and Petroleum Resources Development Act (Act No 28 of 2002)
NEMA ..... National Environmental Management Act (Act No 107 of 1998)
NEM: WA ..... National Environmental Management Waste Act (Act No 59 of 2008)
NWA ..... National Water Act (Act No 36 of 1998)
South32 ..... South32 SA Coal Holdings (Pty) Ltd
SKS ..... Steenkoolspruit
VDDC ..... Vandyksdrift Central
WML ..... Waste Management Licence
WUL ..... Water Use Licence

Glossary of Terms

Term	Explanation
Alluvium	Refers to detrital deposits resulting from the operation of modern streams and rivers
Base status	A qualitative expression of base saturation
Black turf	Soils included by this lay-term are the more structured and darker soils such as the Bonheim, Rensburg, Arcadia, Milkwood, Mayo, Sterkspruit, and Swartland soil forms.
Buffer capacity	The ability of soil to resist an induced change in pH
Calcareous	Containing calcium carbonate
Catena	A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage
Clast	An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass
Cohesion	The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon interparticle friction. Attraction within a soil structural unit or through the whole soil in apedel soils
Concretion	A nodule made up of concentric accretions
Crumb	A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil
Cutan	Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clay skin, clay film, argillan
Denitrification	The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen
Erosion	The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface
Fertilizer	An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.
Fine sand	1) A soil separate consisting of particles 0,25-0,1mm in diameter 2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction
Fine textured soils	Soils with a texture of sandy clay, silty clay or clay
Hardpan	A massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate-horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.
Land capability	The ability of land to meet the needs of one or more uses under defined conditions of management
Land type	1) A class of land with specified characteristics. 2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.
Land use	The use to which land is put
Mottling	A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes inter alia hydromorphy, illuviation, biological activity, and rock

Term	Explanation
	weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling. The latter is given in terms of abundance (few, common 2 to 20% of the exposed surface, or many), size (fine, medium 5 to 15mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important
Nodule	Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron-manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50%; many, more than 50%), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5mm in diameter, coarse).
Overburden	A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock
Ped	Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance
Pedocutanic diagnostic B-horizon	The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic Bhorizon, the transition to the overlying A-horizon is clear or abrupt
Pedology	The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution
Slickenslides	In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickenslides. They occur in clayey materials with a high smectite content
Sodic soil	Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15)
Swelling clay	Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils
Texture, soil	The relative proportions of the various size separates in the soil as described by the classes of soil texture. The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand subseparates
Vertic, diagnostic A-horizon	A-horizons that have both, a high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet

Jones & Wagener
Engineering & Environmental Consultants
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
tel: 00 27 11 519 0200 www.jaws.co.za email: post@jaws.co.za

SOUTH32 SA COAL HOLDINGS (PTY) LTD

VANDYKSDRIFT CENTRAL MINING: INFRASTRUCTURE DEVELOPMENT
SOIL, LAND CAPABILITY AND LAND USE ASSESSMENT
IMPACT ASSESSMENT REPORT REPORT NO: JW200/18/G535-07 – Rev 3

1. INTRODUCTION

1.1 Background Information

South32 SA Coal Holdings (Pty) Ltd (South32), is the holder of an amended mining right for coal, granted by the Minister of Mineral Resources, in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA) and notarially executed on the 21st of May 2015 under DMR reference MP30/5/1/2/2/379MR, in respect of its Wolvekrans – Ifalethu Colliery. This mining right comprises of the following areas:

- Ifalethu Colliery (previously referred to as Wolvekrans North Section[2]) consisting of the Hartbeestfontein, Bankfontein (mining now ceased), Goedehoop, Klipfontein sections and the North Processing Plant; and
- Wolvekrans Colliery (previously referred to as the Wolvekrans South Section) consisting of the Wolvekrans, Vlaklaagte (mining ceased), Driefontein, Boschmanskrans, Vandyksdrift, Albion and Steenkoolspruit sections, as well as the South Processing Plants (Eskom and Export). Some of these areas were previously known as Douglas Colliery.

The Vandyksdrift Central (VDDC) area falls within the footprint of historic underground mining operations at the old Douglas Colliery. In 2007, an amendment of the Environmental Management Programme Report (EMPR) for the Douglas Colliery operations was approved, to allow pillar mining (opencast) of the area previously mined by underground bord and pillar mining. Authorisation of the VDDC mining project included the following:

- Opencast operation on the farm Kleinkopje 15 IS;
- Opencast operation on the farm Steenkoolspruit 18 IS;
- Pillar extraction operation on the farm Vandyksdrift 19 IS;
- Reclamation of existing slurry ponds; and
- Rewashing of existing discard dumps (PHD, 2006).

[2] This was previously referred to as Middelburg Colliery

The water uses associated with the opencast mining have been authorised in terms of Water Use Licence (WUL) number 24084535 dated 10 October 2008, issued to Douglas Colliery Services Limited.

The No. 2 seam workings are flooded with water and must be dewatered to enable the open pit development to proceed. A dewatering strategy has therefore been developed and an application for Environmental Authorisation (EA) of the dewatering activities was submitted to the Department of Mineral Resources (DMR) (Jaco-K Consulting, 2016(a)); a decision in this regard is pending. The water use activities associated with this upfront dewatering strategy have been authorised by WUL number 06/B11F/GCIJ/7943 dated 19 July 2018.

The 2007 approved EMPR Amendment included limited additional infrastructure in support of the opencast mining operations, as it was assumed at that stage that existing infrastructure will be used. In addition, the applications for authorisation of the activities associated with the dewatering strategy, were limited to the infrastructure to facilitate dewatering (i.e. dewatering boreholes, pumps, pipelines, storage tanks, mechanical evaporators, roads and power lines).

A pre-feasibility investigation has since been conducted, and the need to develop additional infrastructure to support the proposed opencast mining was identified. The additional infrastructure includes the following:

- Storm water management structures (drains and berms);
- Water management measures for the management of mine impacted water;
- Overburden dumps;
- ROM coal stockpile areas;
- Mixed ROM coal and slurry stockpile areas;
- Topsoil stockpiles following clearance of vegetation;
- Pipelines for the conveyance of water;
- Hard park area and brake test ramp; and
- Haul roads and service roads.

The proposed VDDC opencast pit boundary as determined through the pre-feasibility investigation also differs from the mining area approved in the 2007 EMPR amendment. An area of approximately 196 hectares in the latest mine lay-out was not included in the previous mine lay-out and is therefore not approved to be opencast mined.

1.2 Scope and Purpose

Jones & Wagener Engineering and Environmental Consultants (J&W) was appointed by South32 as an independent Environmental Assessment Practitioner (EAP) to undertake an Integrated Regulatory Process (IRP) to obtain the required approvals/authorisations for the proposed infrastructure and mining development at the VDDC section.

The environmental applications foreseen include:

- Application for EA through a Scoping and Environmental Impact Assessment Report (S&EIAR) process and the compilation of an Environmental Management Programme (EMPr) in terms of the National Environmental Management Act, 1998 (Act 107 of 1998; NEMA) and its 2014 Regulations, as amended in 2017;
- Waste Management Licence Application (WMLA) in terms of the National Environmental Management: Waste Act, 2008 (Act 59 of 2008; NEM:WA); and

- Integrated Water Use Licence Application (IWULA) in terms of the National Water Act, 1998 (Act 36 of 1998; NWA), including an Integrated Water and Waste Management Plan (IWWMP).

A Heritage Impact Assessment in terms of the National Heritage Resources Act, 1999 (Act 25 of 1999, NHRA) will also be undertaken.

This report details the methods, analysis and findings of the Soil, Land Capability and Land Use impact assessment undertaken for the proposed project.

The objectives of the study are to:

- Provide a consolidated baseline assessment for the entire VDDC site in terms of soils, land capability and land use;
- Assess the potential impact from the proposed infrastructure associated with the mining of VDDC on the baseline soil, land capability and land uses;
- Where relevant, suggest mitigation measures or alternatives that reduce potential significant impacts to acceptable levels; and
- Provide a concise report that captures the findings and recommendations mentioned above.

To achieve the objectives listed above, the scope of work for this study includes the following:

South32 has indicated that there is a number of specialist studies that have been completed for each of the various sections of the site. These however were specific to the project at the time. Thus, J&W would like to approach the project in a phased approach as follows:

1) Baseline Assessment: (review of existing Soils, Land Use and Land Capability reports and gap analysis);

2) Impact Assessment: (once the infrastructure layout plans and drawings are available undertake a Soils, Land Use and Land Capability).

1.3 Site Location

The VDDC mining and infrastructure development project is a brownfields project within the greater Wolvekrans Colliery mining right area. Wolvekrans Colliery is located between the towns of eMalahleni and Kriel, within the jurisdictional area of the eMalahleni Local Municipality (ELM) and the Nkangala District Municipality (NDM) of the Mpumalanga Province. The mine is situated approximately 30 km south-east of the town of eMalahleni, in close proximity to the Duvha Power Station (refer to **Figure 1-1**).

VDDC is located on the western boundary of Wolvekrans Colliery. The Olifants River determine the southern boundary. The proposed infrastructure development will take place on the farms Kleinkopje 15 IS, VanDyksdrift 19 IS, Wolvekrans 17 IS and Steenkoolspruit 18 IS.

1.4 Project Description

The infrastructure development forms part of the VDDC mining project. The construction phase will commence after authorisation for the infrastructure components has been obtained and is expected to commence in 2020. The construction period is expected to be 18 – 24 months. The operational phase is expected to commence 2022.

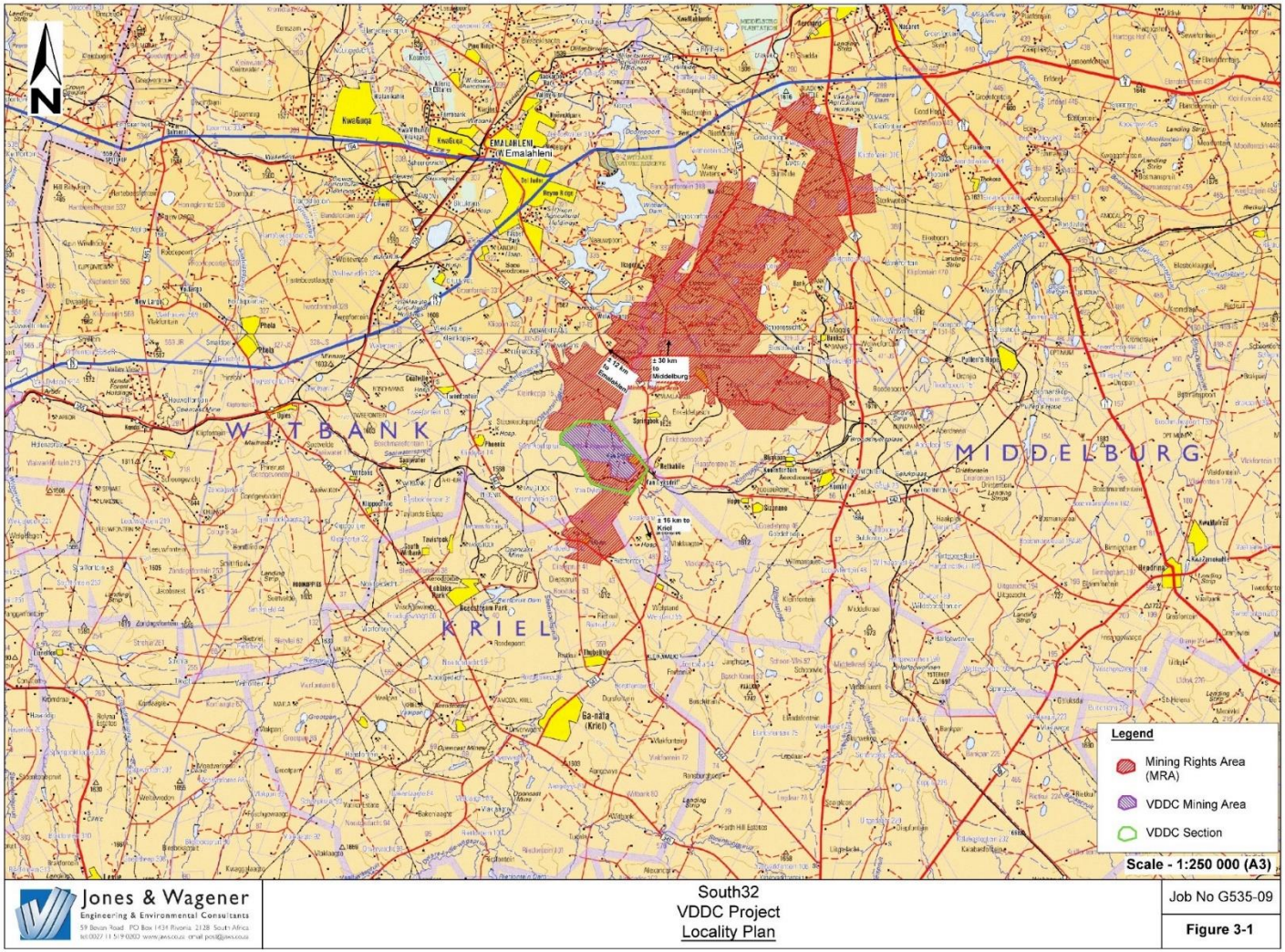


Figure 1-1:Site Locality

1.5 Coal reserves

The VDDC area has been identified as the most likely coal source to replace the Steenkoolspruit (SKS) operations, and to fulfil the current contracts and market obligations of the mining complex (South32 CSA, 2017a).

Coal produced will be mainly exported through the Richards Bay coal terminal.

Limited opencast mining was done before 1990 in the top shallower No. 5 seam. The No. 4L, No. 2, No. 2A and No. 1 coal seams were exploited in the past by means of underground mining. All underground operations were terminated during October 2008. The No. 2 Seam is the principal seam in the project area and its thickness can exceed 9 m, but only the lower select horizon of higher quality 2.5 m – 4.5 m was previously extracted. The targeted mineable seams are the No. 5, No. S4UA, No. S4L, No. S2RP, No. S2A and No. S1 seams respectively (South32, 2017a).

As a result of the previous mining of the No. 2 Seam horizon by bord and pillar means, the following has resulted:

- The majority of the underground No. 2 seam workings are flooded because of water ingress from both surface and underground aquifers. A dewatering programme will be implemented before opencast mining operations commence.
- An area of the No. 2 Seam was historically used for placement of slurry from the processing plant. It is believed to be contained in the southeast portion of the deposit by underground seals and barrier.

1.6 Existing infrastructure

Existing infrastructure in the VDDC area is shown on **Figure 1-2** and described below.

1.6.1 Access, transport and logistics

Access to the VDDC project area is via one of three existing approaches, depending on the size of the transport, namely:

- Current SKS main entrance;
- Current Wolvekrans main entrance (via BMK workshops); and
- Current VDD main entrance (opposite Springbok village).

All personnel transport and light delivery vehicles will enter the site via the current SKS main entrance. Personal vehicles will park in the existing personnel vehicle parking, whilst busses will drop personnel off at the existing bus turnaround.

Light delivery vehicles and heavy delivery vehicles up to 10 t single body trucks will also enter via the existing SKS main entrance and deliver to the required location, or to the existing store facilities (South32, 2017b).

The heavy delivery vehicles and lowbeds will access the site via either the WVK main entrance or the VDD main entrance, depending on the destination within the VDDC Project area (South32, 2017b).

A number of existing haul roads have been developed within the mining area (refer to **Figure 1-2**).

1.6.2 Steenkoolspruit (SKS) facilities

Existing facilities at the SKS operations include the ROM tip and the overland conveyor system to the South Export Plant, the SKS complex offices, warehouse, change houses, workshops, wash bays, laydown areas, a sewage treatment plant and fuelling facilities.

The southern SKS facilities currently in use by the Vandyksdrift North (VDDN) operation include contractors' offices, laydown areas, as well as a fuel, lube, air and coolant (FLAC) station.

1.6.3 Topsoil dump

An existing topsoil dump is located on the north-eastern boundary of the VDDC section.

1.6.4 Surface dumps

Surface discard dumps exist on the southern portion of the VDDC resource area, namely the PSS and LAC dumps. These dumps are in the process of being reclaimed and it is expected that approximately 40% of the material will be recovered. Final rejects from the reclamation process is disposed of on the southern portion of the PSS dump. This Final Rejects Dump will remain in future and the VDDC mining area has been changed to exclude this footprint from the mine plan.

1.6.5 Storm water management measures

A number of clean and dirty water management berms and canals have been constructed to ensure that runoff is managed. This includes a clean water diversion dam which contains clean runoff from the undisturbed areas to the north-east.

A number of dirty water canals drain dirty runoff to dirty water facilities. The Vleishaft Dam is an existing Pollution Control Dam (PCD) with a capacity of 600 000 m^3, that has been authorised for the disposal of mine impacted water in terms of WULs issued to the mine.

Dirty runoff from the discard reclamation and processing plant drains to the Bob Henry dam and silt paddocks.

Existing water management measures at the PSS dump comprises of a clean water canal which collects clean water west of the PSS Dump Extension, as well as a system of unlined canals which collects dirty runoff from the PSS Dump and conveys the water to four PCD's. Excess water from the PCD's is pumped to the underground workings via a borehole. Water is abstracted from the workings via boreholes for re-use in the processing plant.

1.6.6 ROM coal stockpiles

Two Run-of-mine (ROM) coal stockpiles have been developed:

- A ROM coal pad located between the SKS void and the haul road, from where it is taken to the South Export Processing Plant via conveyors from the SKS crushing plant;
- A ROM stockpile area to the south of the Vleishaft Dam, of which a portion is currently used as a hard park area.

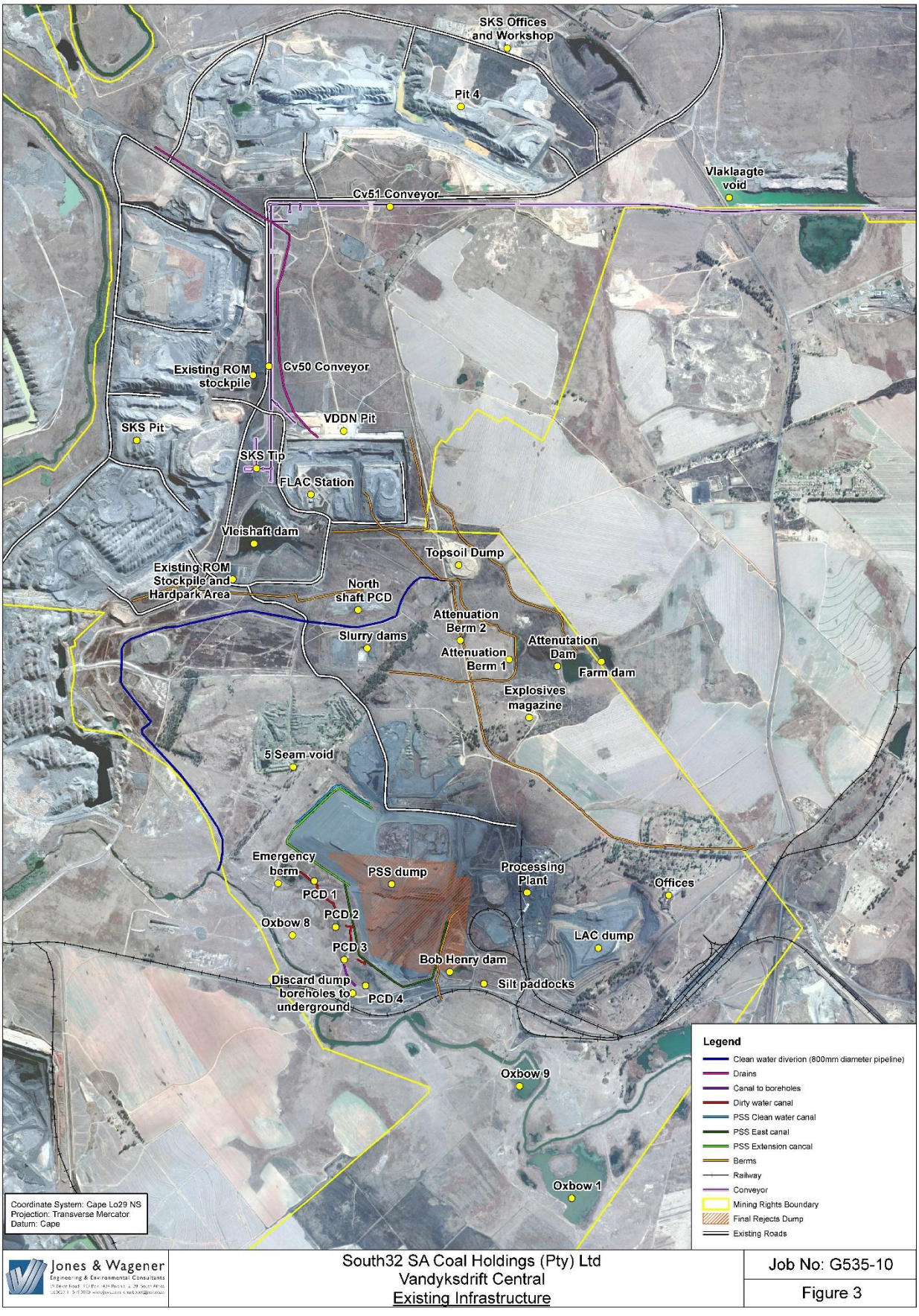


Figure 1-2:Existing infrastructure

1.6.7 Power supply

The VDDC section is supplied from Eskom's Klein 132 kV Substation, which feeds the DMO Klein Olifant 132 kV Substation. The voltage is stepped down to 22 kV via two 20 MVA power transformers feeding the 22 kV switchgear located in the Klein Olifant Substation (South32, 2017b).

The existing electricity infrastructure is shown on **Figure 1-3**.

A section of the Klein-Kromfontein 132 kV powerline must be relocated to allow opencast mining to proceed. This is the subject of a separate application that is undertaken by South32 in terms of a self-build agreement with Eskom. The EA for the powerline will be transferred to Eskom on completion of the construction phase.

1.7 Upfront dewatering infrastructure

In order to mine the VDDC reserve, the water contained in the underground workings must be removed prior to mining. This will be achieved by drilling a number of boreholes into the old underground workings and to abstract the water via these boreholes.

Water will be pumped from the boreholes accessing different underground compartments and will be transferred via borehole connector pipelines to the Vleishaft Dam and/or directly to the evaporation tanks that will be located at the evaporation sites where water will be evaporated using mechanical evaporators. Three evaporators sites have been identified, namely No. 5 Seam void, Vleishaft Dam and Vlaklaagte Void.

In addition, some water will be pumped and stored in the Steenkoolspruit Pit void (Jaco-K Consulting, 2016(b)).

The following evaporators systems have been installed:

- Eight evaporators at Vleishaft Dam (2 Mℓ);
- Twenty evaporators at Vlaklaagte void (2 Mℓ); and

An additional 12 new evaporators (3 Mℓ) will be installed at the No. 5 Seam void by the end of 2019.

1.8 Project description: Proposed new infrastructure

The new infrastructure to be developed (and which will be the subject of the IRP) is shown on a **Figure 1-4** and discussed below.

1.8.1 Topsoil dumps

The topsoil excavated from the box cut areas and areas cleared for the development of infrastructure will be relocated to a topsoil stockpile area to be located adjacent to the existing topsoil stockpile in the east of the project area. In addition, provision has been made for a topsoil stockpile area in between the ramps.

The box cut topsoil will be stockpiled due to the lack of direct placement option at the start of the opencast mining operations.

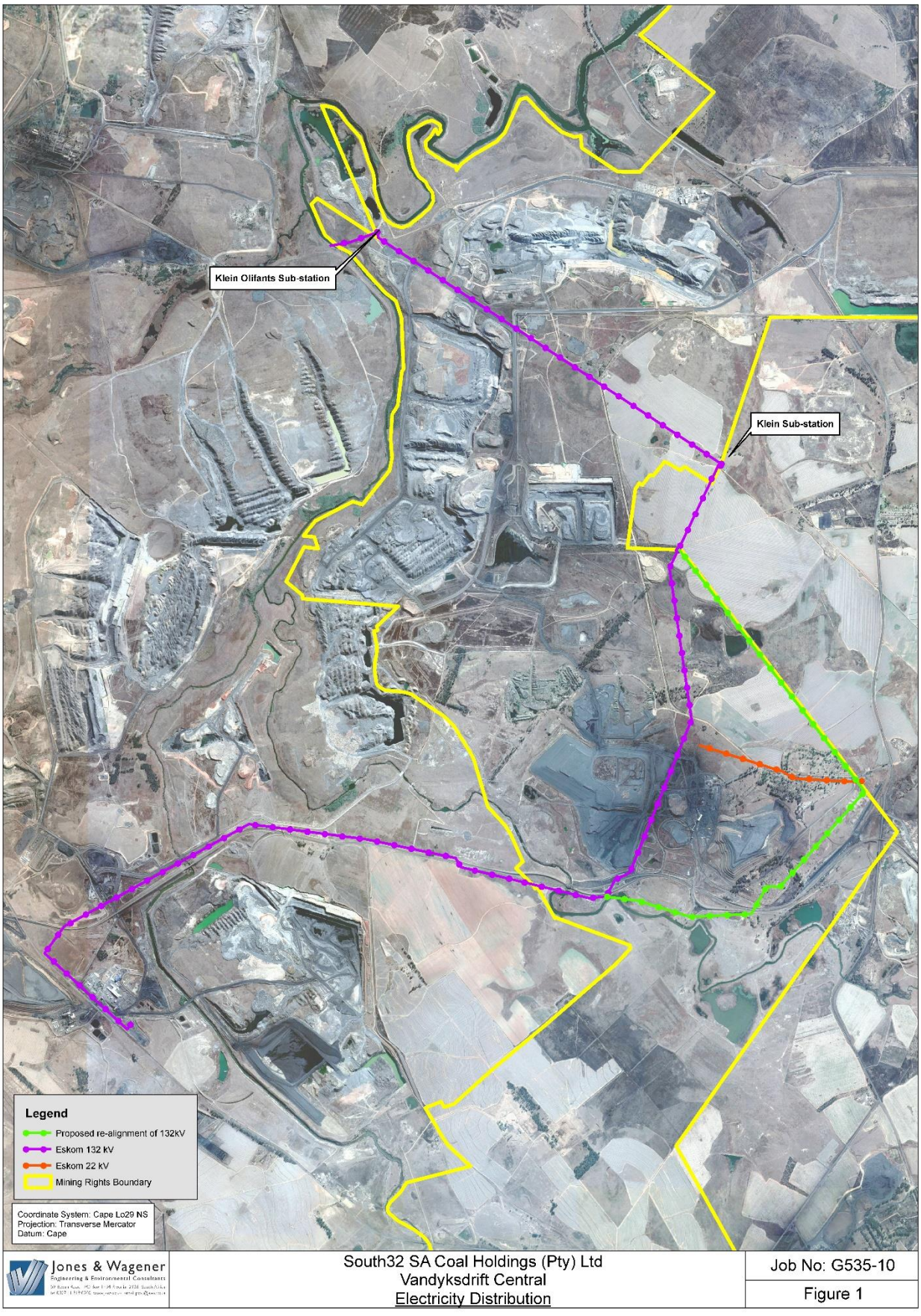


Figure 1-3:Existing electricity distribution network

1.8.2 Overburden dumps

The boxcut will be done using a combination of dragline and truck and shovel. Overburden from the boxcut will be placed on four overburden dumps located in between the proposed ramps.

In addition, provision has been made for two overburden dumps. A new overburden dump will be developed in the south-east of the project area and the existing overburden dump at the SKS pit will also be used.

Upon steady state mining being achieved, rehabilitation activities can commence safely behind the active dynamic window of operations and the in-pit backfilling of overburden can advance. As the mine pit expand, there will be more opportunity to excavate overburden and apply it directly to re-contoured areas, thus avoiding stockpiling. It has been assumed that overburden stockpiling will be during the initial stages of mining and that direct placement will commence when sufficient placement areas are available (South32, 2017a).

1.8.3 ROM stockpiles and Mixed ROM coal and slurry stockpile areas

An area of the underground No. 2 Seam was historically used for placement of slurry from the processing plant. It is believed to be contained in the southeast portion of the deposit by underground seals and barrier pillars..

Slurry will be mined with the ROM coal and the blended coal and slurry will be transferred to mixed ROM coal and slurry stockpile areas, located to the south of the Vleishaft Dam. The mixed material will be allowed to dewater, before it is removed to the existing SKS tip, from where it will be taken to the South Export Processing Plant[3]. Water will be collected and conveyed via a silt trap to the Vleishaft Dam.

ROM coal from the No. 4 and No. 5 seams will be placed on transfer stockpiles. These stockpiles will be located on a partially reclaimed area of the PSS dump footprint. The stockpile positions will be moved as mining progresses but will remain within the footprint of the existing PSS dump or other previously mined out or disturbed areas.

1.8.4 Water consumption requirements

Potable water and wash water for vehicles and workshops will be supplied from the existing water supply at the SKS complex.

Water for dust suppression will be sourced from mine impacted water.

[3] Processing of the slurry at the existing South Plant may require changes to the processing plant. This, however, falls outside of this application process

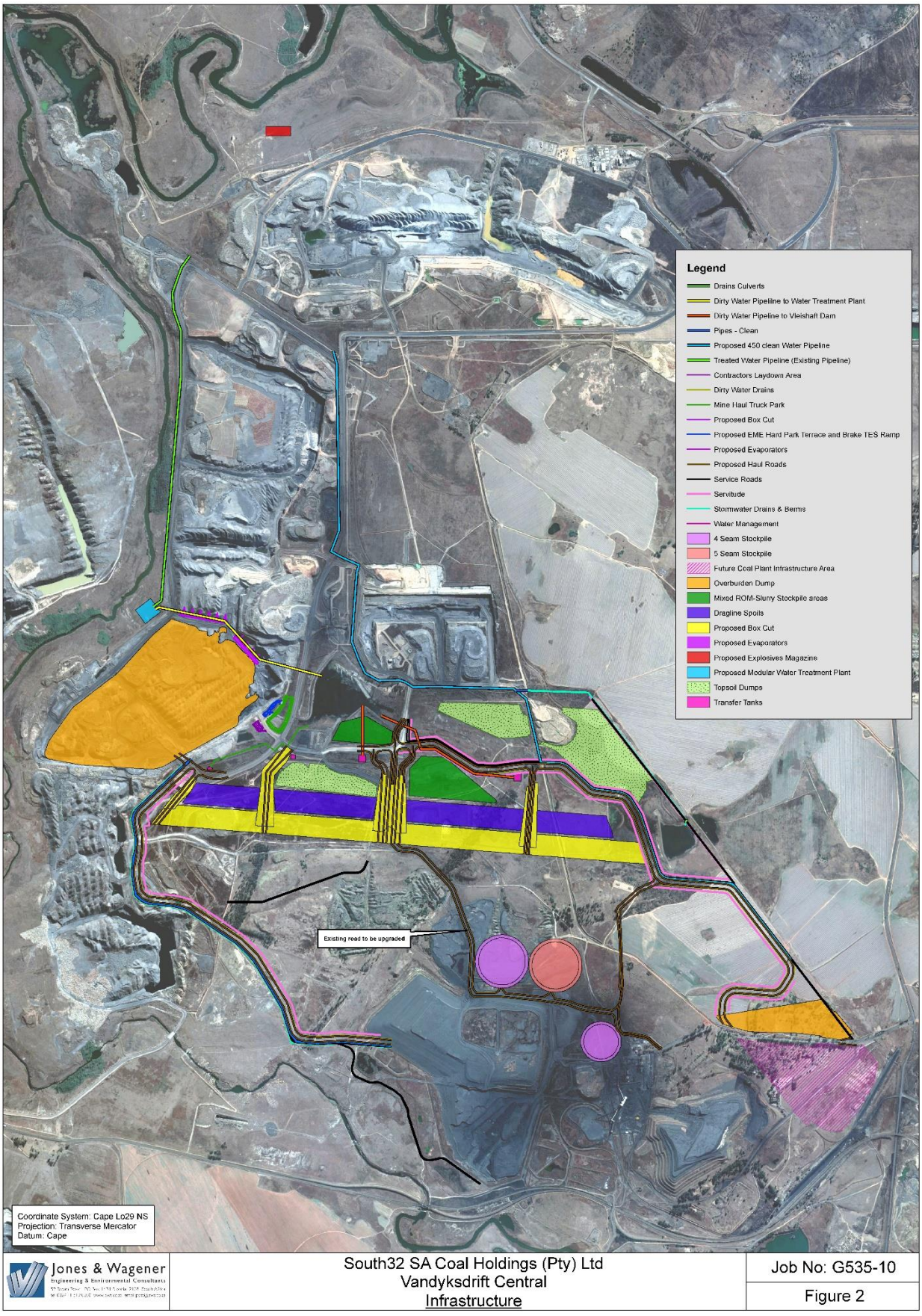


Figure 1-4:Proposed new infrastructure at VDDC

1.8.5 Management of mine impacted water

The proposed mining operations require the management of mine impacted water. Dirty areas that have been identified and included in the water management strategy are:

- Opencast pit;
- Mixed ROM coal and slurry stockpile areas;
- Overburden dumps;
- ROM stockpiles; and
- Hard park area.

Opencast pit

In order to manage the inflow of water into the mining operations, sumps will be constructed in the pit floor where the water will be collected at the bottom of the pit (at lowest points) and pumped out of the pit. These temporary sumps will be situated at the bottom of each access ramp and the piping routed in a berm servitude on the side of the access ramp, up to transfer tanks situated at the top of the ramp. Once the water reaches the transfer tanks, it will join the polluted water management system. Water will be pumped from the pit with self-priming diesel driven pumps mounted on trailers or skids to allow for easy movement (South32, 2017a). Water will be pumped to the Vleishaft Dam and from there, to one of the evaporator sites, or to the proposed modular water treatment plant (WTP) or to Vlaklaagte void,

Mechanical evaporator sites are as follows:

- Three sites will be established as part of the upfront dewatering strategy (refer to section 1.7):
    - 8 evaporators at Vleishaft Dam (2 Mℓ);
    - 20 evaporators at Vlaklaagte void (2 Mℓ); and
    - 12 evaporators (3 Mℓ) at the No. 5 Seam void.
- As part of the VDDC infrastructure development, eight (8) new evaporators (3 Mℓ) will be established at the SKS void.
- As mining progresses at VDDC, the 12 evaporators at No. 5 Seam void will move to the SKS void, bringing the number of evaporators at the SKS void to a total of 20.

Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile, modular water treatment plant (WTP) with a maximum treatment capacity of 20 Mℓ/day.

Brine from the WTP will be conveyed to the evaporators on the SKS void.

Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water pipeline to the existing northern clean water canal, from where it will discharge via a wetland area into the Olifants River. Water will be treated to comply with Resource Quality Objectives for the Olifants River catchment as published in GN 466 in April 2016.

Mixed ROM coal and slurry stockpile areas

Mine impacted water from the Mixed ROM coal and slurry stockpile areas will be collected and conveyed to the Vleishaft Dam via silt traps.

Overburden dumps

The overburden dump located at the SKS void will drain to the void and no additional measures are foreseen.

Pollution control measures will be required at the new overburden dump located on the south-eastern boundary to collect dirty runoff and seepage. Mine impacted water will be conveyed via suitable diversion structures to the dirty water management infrastructure and re-used in the existing plant for the reprocessing of material from the PSS and LAC dumps, or pumped into the underground via an existing borehole.

1.8.6 Dust Suppression

Dust on haul roads will be controlled using water bowsers. Bowsers will fill up at filling stations that will be located in close proximity to VDDC pit. The use of chemical dust suppressants will also be considered.

1.8.7 Clean water management

Clean run-off water from the area to the east of the VDDC mining area will be diverted away from the mining areas so that it will not become contaminated by the mining operations.

The existing VDDN clean water diversion canal will be diverted around the proposed new topsoil dumps on the eastern boundary of the mining right area.

High wall drains will be installed to divert clean water away from the mining area where practical. These drains will move as mining progresses.

Two 450 mm diameter clean water diversion pipeline will be installed from the existing clean water diversion dam, to the existing northern canal from where water will be discharged from a proposed WTP via a wetland area into the Olifants River.

1.8.8 Explosives magazine

The existing explosives magazine will be relocated to the north of Pit 4.

1.8.9 New roads

New roads required for the VDDC project include:

- Temporary high wall roads and dragline walkways which will be re-established as mining progresses;
- Earth Moving Equipment (EME) haul roads (40 m width) from the bottom of box cut ramps to the existing haul roads;
- Additional maintenance/service and access roads within the VDDC project area from the existing infrastructure to the box-cut;
- New haul road to the No. 4 seam and No. 5 seam stockpiles.

1.8.10 EME Hard park and Brake Test Ramp

A hard park will be developed between the Vleishaft Dam and the SKS pit. The hard park will include perimeter drains that convey polluted water runoff (primarily polluted with silt) to the SKS void.

A brake test ramp will be provided for EME traffic at the hard park area. The brake test ramp is positioned such that all vehicles will need to traverse the ramp before entering the pit areas. The ramp has been designed to enable the longest expected vehicle entering the mining areas to stop on the inclined sections, with both axles or all wheels. The incline sections are to the steepest recommended grade of these vehicles or to the incline of the ramps to the pits.

In-pit vehicle ramps are of similar construction to the remainder of the haul roads including safety berms.

1.8.11 Access control and security fencing

Access control will be through the existing control measures.

Triple security fencing will be provided at the explosives magazine. Triple fencing includes a triple barrier of 2.4 m high clear mesh, electric and normal security fencing. Electric fencing is connected to the local security system (South32, 2017b).

1.8.12 Other supporting infrastructure

The remainder of the supporting infrastructure is mostly catered for by the existing SKS complex facilities. Existing change houses, stores facilities, office facilities, tracked vehicle workshops, LDV workshops will be used.

No additional fuel or lube storage area, servicing bays or tyre bays are required.

1.8.13 Future coal plant infrastructure area

As indicated earlier, the PSS and LAC dumps are currently reclaimed and processed within the existing VDD processing plant. As mining progresses, this plant will need to be relocated. An area has been allocated for this purpose and is situated to the south of the proposed new overburden dump in the south-eastern corner of the VDDC area.

1.9 Project description: Changes to opencast mining

The VDDC mine lay-out as determined through the pre-feasibility investigation, as well as the mine-lay-out included in the approved 2007 EMPR Amendment is shown on **Figure 1-5.** The area where the existing LAC dump is located, as well as a small area further north-east, were not included in the approved 2007 EMPR Amendment, and therefore requires authorisation for opencast mining.

1.10 Specialist Project Team

The following personnel were involved in the compilation of this report. Refer to **Appendix A** for copies of the curricula vitae (CV's)

Table 1-1: Specialist Team Members.

Name	Organisation	Highest Qualifications	Experience	Role
Konrad Kruger	Jones & Wagener	BSc Honours Geography	14 Years	Specialist
Tolmay Hopkins	Jones & Wagener	MSc (Agric) Microbiology	20 Year	Pr. Sci Nat Reviewer

1.11 Assumptions and Limitations

The following assumptions/limitations were relevant during the assessment:

- The information collected in the previous soil reports for VDDC are correct and do not require verification. Thus, the information was used as published previously.
- No field verifications were undertaken as part of this assessment.

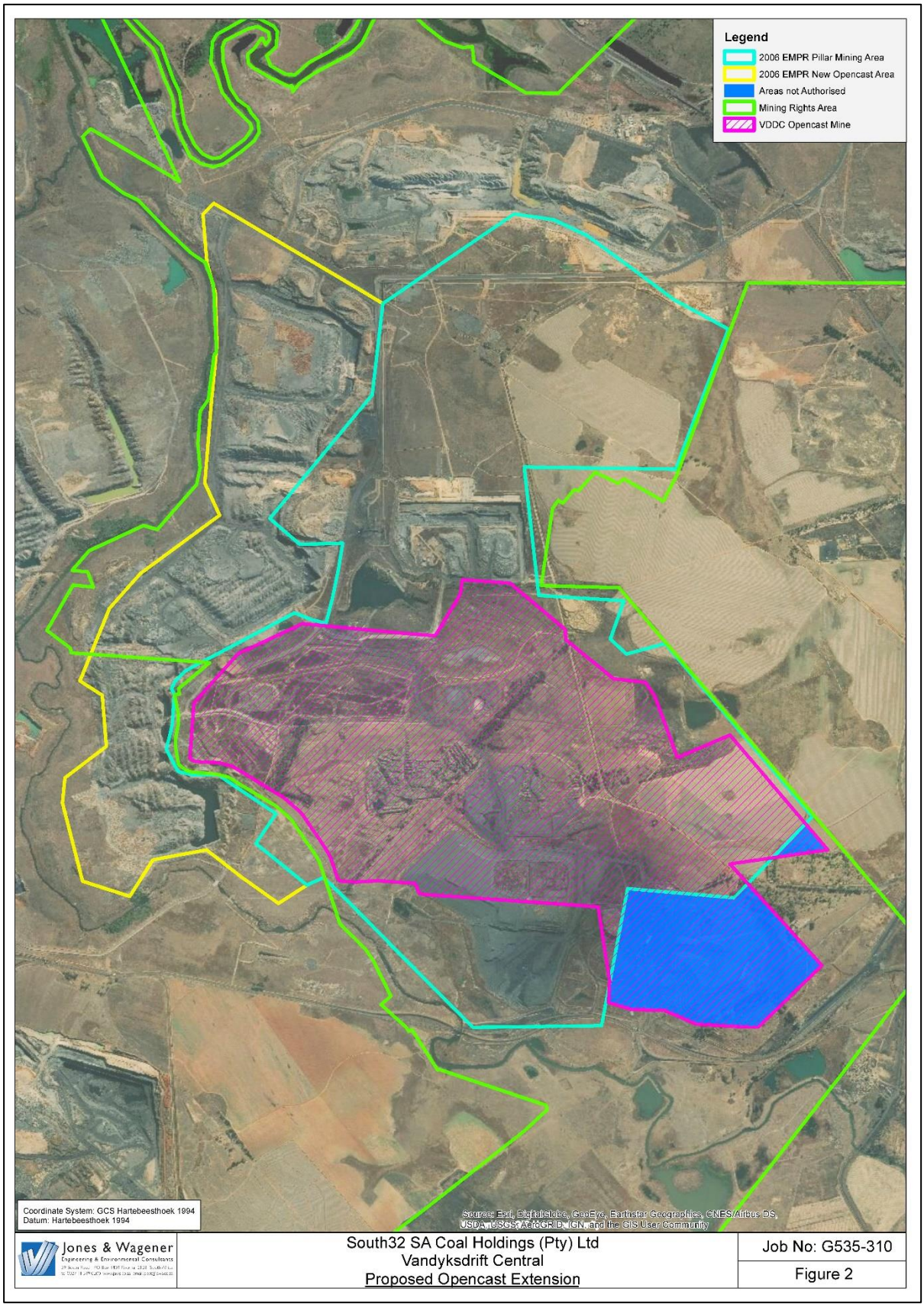


Figure 1-5: VDDC opencast pit compared to mine layout in 2007

2. BASELINE ASSESSMENT

2.1 Approach and Methodology

2.1.1 Soil Baseline Determination

2.1.1.1. Review of Existing Data/Reports

The first step of the baseline determination was to undertake a desktop review of all the available soil, land capability and land use reports for the mines under consideration. These reports are the main source of data for this report. The information is collated and combined into a single dataset for the VDDC area. It was not part of the scope of this project to verify or update any of the existing reports, and it was assumed that the information contained in the existing reports were accurate and correct.

It should be noted that the scope for the soil assessment is based on review of existing information without any supplementary fieldwork. Therefore, large sections of the existing reports are quoted at length. Any references to fieldwork refer to the work undertaken in 2013 by Earth Science Solutions (ESS).

2.1.1.2. Soil Mapping

Soils were classified according to Taxonomic Soil Classification, a System for South Africa (Mac Vicar et al, 2nd edition 1991). The following soil characteristics were documented:

- Soil form and family;
- Soil horizons;
- Soil colour;
- Soil depth;
- Soil texture (Field determination);
- Wetness;
- Occurrence of concretions or rocks;
- Land Use; and
- Underlying material (if possible).

2.1.2 Land Capability Baseline

The above information was used to determine the land capability units as prescribed by the Chamber of Mines. The main land capability classes are agriculture, wilderness, wetland and grazing land. The criteria for this classification are set out below:

- Criteria for Wetland
    - Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water determined.
- Criteria for Arable land
    - Land, which does not qualify as a wetland.

- The soil is readily permeable to a depth of 750 mm.
- The soil has a pH value of between 4.0 and 8.4.
- The soil has a low salinity and Sodium Absorption Ratio (SAR).
- The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100 mm in the upper 750 mm.
- Has a slope (in %) and erodibility factor (K) such that their product is <2.0.
- Occurs under a climate of crop yields that are at least equal to the current national average for these crops.

- Criteria for Grazing land
  - Land, which does not qualify as wetland or arable land.
  - Has soil, or soil-like material, permeable to roots of native plants, that is more than 250 mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100 mm.
  - Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants utilisable by domesticated livestock or game animals on a commercial basis.
- Criteria for Wilderness land
  - Land, which does not qualify as wetland, arable land or grazing land.

2.1.3 Land use spatial planning integration

Available local and district municipal Integrated Development Plans (IDPs) and/or Spatial Development Frameworks (SDFs) was reviewed to determine the land use needs in the area and highlight potential present and future land use clashes.

2.1.4 Baseline Reporting

The abovementioned data were included in this soils report. Using the results from the above the soil form, land capability and land use maps were generated and described in this report.

2.1.5 Impact Assessment Reporting

Once the infrastructure has been located and designed, an impact assessment was undertaken using the methodology prescribed in the EIA. This assessment is included in the Impact Assessment Section of this report and covers the construction, operational, closure and post closure phases.

2.2 Soil Baseline

2.2.1 Data Collection

2.2.1.1. Review of previous studies undertaken

The assessments listed below have been reviewed and extracts included in this assessment:

- 2006 Douglas EMP Amendment by Pulles Howard & De Lange Incorporated;
- 2013 Baseline Specialist Soils, Land Use and Land Capability Studies Impact Assessment and Management Plan by Earth Science Solutions; and
- 2013 Vandyksdrift Central (VDDC) Project Preliminary Mine Closure Plan by SRK.

The specialist pedological and land capability studies have been undertaken in phases, with the baseline assessment being undertaken between December 2012 and February of 2013. The mapping was based on the information made available.

In addition to the site observations, a representative selection of the soil forms mapped were sampled and analysed to determine their chemistry and physical attributes. The soil mapping was undertaken on a 1:10,000 scale orthophotographic base.

The majority of observations used to classify the soils were made using a hand operated bucket auger and Dutch (clay) auger.

2.2.2 Soil Distribution

The major soil forms are closely associated with the lithologies from which the soils are derived (in-situ formation) as well as the topography and general geomorphology of the site, with the effects of slope and attitude of the land forms and the pedogenetic processes involved affecting the soil formation and ultimately the soil forms mapped.

The generally flat to slightly undulating topography has resulted in the in-situ formation of many of the soils, and a moderately predictable pedogenisis for the site. The attitude of the lithologies is important in understanding the development of the ferricrete horizon that underlies a significant proportion of these sites. The inhibiting nature of these evaporite layers is important to the overall functioning of the system and contributes to the sensitivity of the area. The semi-arid nature of the climate and the resultant net negative water balance is the prime driver of the evaporite development. However, the ability of these layers to restrict water infiltration results in water being held within the vadose zone where it is more utilisable by plants and animals.

The retention of soil water within the vadose zone (lack of preferred horizontal flow) has resulted in the creation of inhibiting layers (calcrete/ferricrete) within some of the soil profile and wetness features.

This inhibiting layer or barrier to water movement enhances the inhibiting character to vertical flow within the profile, a factor that is considered important to the ecology and biodiversity of the area.

The occurrence of extensive calcrete and/or ferricrete horizons within the soil profile classify as “relic” land forms for the most part, albeit that significant area of more recent laterite development was mapped in association with the large alluvial river and stream flood plains and the wetlands that make up many of the soils associated with the major rivers and their primary tributaries and floodplain environments.

These ferricrete layers occasionally outcrop at surface as ouklip or hardpan ferricrete and are the basis for many of the pan structures found within the sedimentary profile and landscape of the coalfields in this region. These features are important to the ecological and biodiversity cycle and are regarded as sensitive to highly sensitive features. In addition, and as part of these sensitive systems, are the “transition zones” that contribute (soils within the pan catchment) to the wetland catchment systems. These areas also need to be evaluated as part of the sites of high sensitivity.

The dominant soils classified are described in terms of their physical and chemical similarities and to some extent their topographic position and resultant pedogenisis, with their spatial distribution being of importance to the management recommendations (refer to **Figure 2-1**). The major soil groupings are described in more detail later in this section.

The soils mapped range from shallow sub-outcrop and outcrop of hard plinthite and parent materials (Sediments and intrusive dolerite) to moderately deep sandy loams and sandy clay loams. The saprolitic horizons are generally quite thin, with soil occurring on hard bedrock in most instances mapped. Of significance to this study area is the large proportion of wet based soils that were classified and mapped. The sensitivity of these soils is to be considered as a risk to the project in terms of the legal requirements that pertain to wetlands and wetland environments.

When considering the sensitivity of a wet based soil, the depth to the inhibiting layer and the amount of redox reaction present (noted in the degree of mottling and more importantly the greyness of the matrix soil) within the profile dictates the degree of wetness in terms of the “wetland delineation classification” and will have an effect on the ecological sensitivity of the site.

The shallow, to very shallow soil profiles are generally associated with an inhibiting layer at or close to surface, and as already alluded to, is the defining feature that controls the ability (or not) of water to flow vertically down and through the profile (restrictive layer).

The degree to which the plinthite layer has been cemented (friability of the ferricrete) will determine the effectiveness of the layer as a barrier to infiltration, while the depth of overlying soil will dictate how easily or difficult it is for the soil water to be accessed by the fauna and flora, and in the extreme case weather water is held at surface as a pan.

The friability of the ferricrete will also have an effect on the amount of clay mineralisation that the soil contains within this horizon and will in turn influence the water holding characteristics of the soil and the degree of structure.

In contrast, the deeper and more sandy profiles, although associated with a similar lithological system have distinctly differing pedogenetic processes that are associated with lower clay contents, better drainage of the soils and a deeper weathering profile. These features are generally more easily worked with and more easily managed.

As with any natural system, the transition from one system to another is often complex with multiple facets and variations over relatively small/short distances. However, in simplifying the trends mapped, the following major soil groupings pertain (refer to **Table 2-1**):

- The deeper and more sandy loam soils are considered High Potential materials and are distinguished by the better than average depth of relatively free draining soil to a greater depth (> 1,200mm). This group are recognisable by the subtleness of the mottling (water within the profile for less than 30% of the season), the greater depth of mottling within the profile (>500mm), while the resultant land capability is rated as moderate intensity grazing and/or arable depending on their production potential. These soils are generally much lower in clay than the associated wet based soils and more structured colluvial derived materials, have a distinctly weaker structure and are deeper and better drained (better permeability). The ability for water to move through these profiles is significantly better. The more sandy texture of this soil group renders them more easily worked and renders then of a lower sensitivity (Deep >750mm).
- In contrast, the shallower and more structured materials are considered to be more sensitive and will require greater management if disturbed. This group of shallower and more sensitive soils (< 500mm) are associated almost exclusively with the sub outcropping of the parent materials (Karoo Sediments) (geology) at surface or with

a ferricrete (ouklip) layer, and they constitute a relatively large percentage of the overall area of study. These materials play an important function in the sustainability of the overall biodiversity of the area.

- The third group of soils comprise those that are associated with the hard pan ferricrete layer and perched soil water. This group of soils have a set of distinctive characteristics and nature that are separated out due to their inherently much more difficult management characteristics. These soils are characterised by relatively much higher clay contents (often of a swelling nature), poor intake rates, poor drainage, generally poor liberation of soil water and a restricted depth – often due to the inhibiting barrier within the top 700mm of the soil profile. These soils are generally associated with a wet base. These soils will be more difficult to work in the wet state, store and re-instate at closure. This group of soils comprise the pan like structures and waterholes. Groundwater is generally relatively deep (>15m) for the majority of the area of study and is reported (hydrogeologists) to have little to no influence on the soil water and water found within the vadose zone. No perched aquifers (groundwater) are reported, albeit that a significant area of well-developed ferricrete was mapped within the vadose zone. The development of wet based soils and moist grassland environments are mapped in association with these soil forms.

Again, it is noted as important to the baseline study, that these soil groupings are moderately extensive in spatial area, and cover a moderately large and sensitive area in terms of the proposed development plan (both mining and its infrastructure encroach).

- In addition, but not separated from the wet based structured soils are the group of soils that reflect wetness within the top 500mm. These soils are easily recognised by the mottled red and yellow colours on low chroma background to the soil. These soils are regarded as high sensitive zones that will require authorisation/permission if they are to be impacted. The legal implications (licensing) will need to be considered if these soils are to be considered within the development.
- The concentrations of natural salts and stores of nutrients within these soils are again a sensitive balance due to the extremes of rainfall, wind and temperature. The ability of a soil to retain moisture and nutrients, and in turn influence the sustainability of vegetative growth and dependence of animal life is determined by the consistency and degree of soil moisture retention within the profile but out of the influence of evaporation.
- These conditions and associated sensitivities should be noted in terms of the overall bio-diversity balance if the sustainability equation is to be managed and mitigation engineered. Pan structures and the associated shallow wet based soils is an important contributor to the ecological cycle.

All areas included in the study have been captured in a GIS format and mapped according to their soil classification nomenclature and soil depth (decimetres), while the similar soil forms have been combined and mapped as “dominant groupings” for ease of management.

2.2.2.1. Soil Forms Identified

A total of twenty (20) soil forms were identified (**Table 2-1**) in the study area pre-mining (Douglas EMP, 2006). The percentage of Witbank (man-made) soils has since increased due to the growth of the existing south eastern discard dump and several other man-made features on site. The updated soil mapping is shown below in **Figure 2-1.** The ESS study did not give coverages for each soil type, hence **Table 2-1** only includes updated figures from the 2006 report.

Table 2-1: Natural Soil Forms Identified (2006)

Soil	Soil Form	Area (ha)	% of Area
Red apedal	Hutton	117.6	4.6
	Bainsvlei		
Yellow-brown apedal	Avalon	104.8	4.1
	Glencoe		
	Clovelly		
	Griffin		
	Pinedene		
Neocutanic	Tukula	57.0	2.2
	Oakleaf		
Shallow	Mispah	11.0	0.4
	Dresden		
E-horizon (albic)	Longlands	33.6	1.3
	Wasbank		
	Kroonstad		
	Fernwood		
	Vilafontes		
Wetland	Westleigh	365.3	14.4
	Katspruit		
	Champagne		
Man-made	Witbank	1425.3	56.3
Unknown	No-data	421.6	16.7
Total		**2536**	**100**

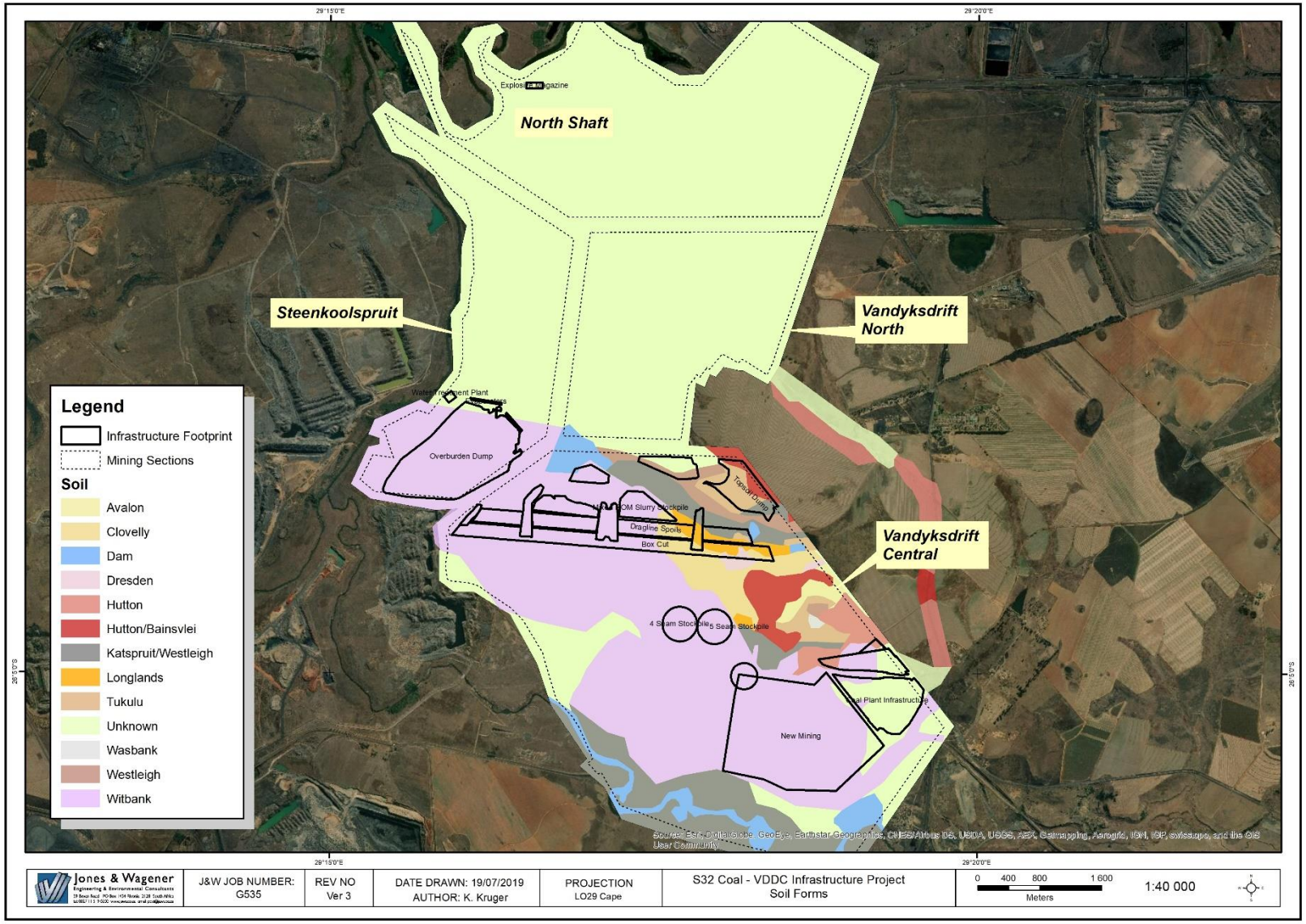


Figure 2-1: Soil forms identified in the VDDC study area (updated from ESS 2013)

2.2.3 Soil Chemical Properties

Sampling of the soils for nutrient status was confined where possible to areas of undisturbed land. However, some of the better soil exposure is associated with land that has or could have been disturbed by farming activities. These results are representative indications of the pre-construction conditions. However, these results are at best a reconnaissance representation of the baseline conditions and will need to be verified for particular sites as and when rehabilitation is started.

On-going sampling and monitoring of the in-situ conditions will be necessary throughout the operational phase to accurately define the post operational conditions if the rehabilitation is to be successful. The variation in the results of the laboratory analysis is related to the range of differing soil forms sampled.

The soils range from very well sorted sandy loams with lower than average nutrient stores and moderate clay percentages (<20% - B2/1) to soils with a moderately stratified to weak blocky structure, sandy loam to clay loam texture and varying degrees of utilizable nutrients, generally associated with the colluvial derived materials, while soil with high clays and extremes of structure were sampled from the bottomlands and lower slope positions where the soils are generally wet based and wetland derived.

In general, the pH ranges from acid at 5.8 to neutral and slightly alkaline at 7.5 (extremes of highly acid at 4 and relatively alkaline at 8), a base status ranging from 2.3me% to 22me% (Eutrophic (slight leaching status) to Dystrophic (high leaching status)), and nutrient levels reflecting generally moderate to good reserves of calcium and magnesium but deficiencies in the levels of sodium, potassium, phosphorous and zinc, with low stores of organic carbon matter.

The more structured (moderate crumby to blocky) and associated sandy and silty clay loams returned values that are indicative of the more iron rich materials and more basic lithologies that have contributed to the soils mapped. They are inherently low in potassium reserves and returned variable but generally lower levels of phosphorous.

The growth potential on soils with these nutrient characteristics is at best moderate to poor and additions of nutrient and compost are necessary if commercial returns are to be achieved from these soils. They are at best moderate grazing lands. The chemistry of the dominant soil forms is given in **Table 2-2**. The results are from the report by ESS in 2013 and did not include a map of the location of the sampling points.

Table 2-2: Soil Chemistry of the Main Soil Forms (ESS, 2013)

Sample No.	VD1	VD2	VD3	VD4	VD5	VD6	VD7	VD8	VD9	VD10	VD11	VD12	VD13	VD14	VD15	VD16	VD17	VD18	VD19
Soil Form	Hu	Cv	Av	Sd/Hu	Gc	Gc	Ms	Pn	Av	Ka	Hu	Ka/Kd	Cv/Gf	Kd	Dr	We	Lo	Lo/Ka	Rg
Constituents																			
pH	6.2	6.25	8	6	6.1	5.5	4.5	6.5	6	5.2	6.4	7.1	5	6.4	6.1	6.4	5	6.4	5.5
"S" Value	2.3	11.2	3.1	22.8	1.2	22.1	0.6	14.8	8.9	31	11	22.4	3.8	22	5.2	5.8	1.17	7.34	33
Ca Ratio	102	59	132	68	126	66	52	65	70	62	65	54	66	49	70	65	89	201	62
Mg Ratio	51	16	49	34	36	30	26	32	24	34	22	33	22	28	28	10	37	92	34
K Ratio	6	18	4	4	0.3	1	6	1	4	7	4	10	5	8	1	12	10	1	9
Na Ratio	0.3	0.2	0.3	0.4	0.3	0.2	1.3	1.6	0.3	1.1	0.5	0.4	0.3	0.3	1.4	0.2	0.5	1	0.8
P	31	111	9	12	14	8	32	6	22	17	10	18	11	15	5	82	22.4	20.9	20
Zn	4.5	7.2	2.4	2	1.5	1	1.3	1.1	2	1.4	1.5	1.7	1.4	1.4	1	1.6	1.4	1.8	1.1
Organic Carbon	0.25	0.28	0.29	0.20	0.14	0.20	0.25	0.40	0.49	0.35	0.60	0.26	0.18	0.25	0.30	0.55	0.30	0.45	0.40
Sand	72	45	74	42	78	34	80	46	42	18	52	21	45	21	58	44	86	18	16
Silt	9	39	9	26	6	38	9	46	36	22	30	24	43	27	34	35	9	13	26
Clay	19	16	17	32	16	28	11	8	22	60	18	55	12	52	8	21	5	69	58

2.2.3.1. Soil Fertility

The soils mapped returned at best moderate levels of some of the essential nutrients required for plant growth with sufficient stores of calcium and magnesium. However, levels of Na, Zn, P, and K are generally lower than the optimum required.

These conditions are important in better understanding the land capability ratings that are recorded, with the majority of the study area being rated as moderate to low intensity grazing land.

These poor conditions for growth were further compounded by the low organic carbon (<1.0%). There are no indications of any toxic elements that are likely to limit natural plant growth in the soils mapped within the study area

2.2.3.2. Nutrient Storage and Cation Exchange Capacity (CEC)

The potential for a soil to retain and supply nutrients can be assessed by measuring the cation exchange capacity (CEC) of the soils.

The inherently low organic carbon content is detrimental to the exchange mechanisms, as it is these elements which naturally provide exchange sites that serve as nutrient stores. The moderate clay contents will temper this situation somewhat with at best a moderate to low retention and supply of nutrients for plant growth.

Low CEC values (“S” Values) are an indication of soils lacking organic matter and clay minerals. Typically, a soil rich in humus will have a CEC of 300 milli equivalents (me)/100g soil, while a soil low in organic matter and clay may have a CEC of 1-5 me/100g soil. Generally, the CEC values for the soils mapped in the area are moderate (15me/100g) to low (<5me/100g).

2.2.3.3. Soil Organic Matter

The soils mapped are generally low in organic carbon. This factor coupled with the moderate to high clay contents for the majority of the soils mapped will adversely affect the erosion indices for the soils.

2.2.4 Soil Physical Properties

The majority of the soils mapped exhibit apedal to weak crumby structure, low to moderate clay content and a dystrophic to mesotrophic leaching status.

The texture comprises sandy to silty sands for the most part, with much finer silty loams and clay loams associated with the colluvial and alluvial derived materials mapped on the lower slope and bottom land stream and river environs respectively.

Of significance to this study, and a feature that is moderately common across the site where the soils are associated with the sedimentary host rocks is the presence of a hard pan ferricrete (plinthite) layer within the soil profile (1,5m).

The semi-arid climate (negative water balance) combined with the geochemistry of the host rock geology are conducive to the formation of evaporites, with the development of ferruginous layers or zones within the vadose zone. The accumulation of concentrations of iron and manganese rich fluids in solution will result in the precipitation of salts and cements the metals due to high evaporation (negative water balance). This process results in the development of a restrictive or inhibiting layer/zone within the profile over time.

The negative water balance is evidenced by the generally low rainfall of 700mm/year or less, and the high evaporation that averages 1,350mm/year. These are the driving mechanisms behind the ouklip or hard pan ferricrete mapped.

The degree of hardness of the evaporite is gradational, with soft plinthic horizons (very friable and easily dug with a spade or shovel), through hard plinthite soil (varying in particle size from sand to gravel – but no cementation) to nodular and hard pan ferricrete or hard plinthic (cementation of iron and manganese into nodules) that are not possible to free dig or brake with a shovel.

The soil classification system takes cognisance of ferricrete and has specific nomenclature for these occurrences (Refer to The South African Taxonomic Soil Classification – See list of references).

The variation in the consistency of the evaporite layer, its thickness and extent of influence across/under the site are all important to the concept of a restrictive horizon or barrier layer that is formed at the base of the soil profile and/or close to the soil surface. Where this horizon develops to a nodular form or harder (Nodular, Honeycomb and Hard Pan) the movement of water within the soil profile is restrict from vertical movement and is forced to move laterally or perch within the profile. It is this accumulation of soil water and the precipitation of the metals from the metal and salt rich water that adds progressively to the ferricrete layer over time.

Important to an understanding of the development of the ferricrete is the geological time and presence of the specific soil and water chemistry under which the horizon forms. This situation will be very difficult to emulate or recreate if impacted or destroyed.

2.3 Land Capability Baseline

2.3.1 Data Collection

The following data was obtained and studied for the desktop study and literature review in addition to the reports listed in Section 2.2:

- Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC);
- Broad geological, soil depth and soil description classes were obtained from the Department of Environmental Affairs and studied. This data forms part of the Environmental Potential Atlas (ENPAT) of South Africa;

2.3.2 Baseline Land Capability Description

The “land capability classification” (Chamber of Mines and Canadian Land Inventory) as described above was used to characterise and classify the soil polygons or units of land identified during the pedological survey.

These variables (depth, structure, texture etc.) combined with the geomorphological aspects (ground roughness, topography, climate etc.) of the site were then employed to rate the capability of the land in question.

The area to be disturbed by mining and surface infrastructure development comprises a range of soil and geomorphological attributes with a resultant range of land capability classes. There are significant areas of friable and good grazing potential class soil and large

contiguous areas of highly sensitive sites that returned wet based soils, while sites with good potential arable rating were less evident.

The colluvial derived soils are at best considered to have a low intensity grazing land potential or wilderness status due to either their strong structure and/or the presence of wetness within 500mm of surface (wetland soils). The sites of potential infrastructure development/construction and/or relocation cover almost the full suite of soil sensitivities and land capability, with a significantly large spatial area of the highly sensitive wetland soil ratings included in the proposed development. It should be noted, that the ecological sensitivity will need to be considered along with these ratings if a meaningful understanding of the risk to the environment is to be achieved. The fauna and flora play a role in this equation.

The rivers and associated transition zone wet based soils, sensitive to moderately sensitive sandy loams and sandy clay loams associated with the middle and upper midslope positions and the more sensitive to high sensitivity shallow soils associated with the ridge slopes and erosive environment.

Figure 2-2 illustrates the distribution of land capability classes across the study areas and the area of each is summarised in **Table 2-3**.

Table 2-3: Pre-mining land capability (updated from Douglas EMP, 2006)

Land Capability	Area (ha)	% of total area
Arable	117.6	4.6
Grazing	204.1	8.0
Wetlands	367.6	14.5
Wilderness / Disturbed Land	1425.3	56.3
Water	110.3	4.3
Unknown areas (no data)	311.3	12.3
Total	**2536**	**100**

2.3.2.1. Arable Land

There are only limited areas of arable land potential soils associated with this area. Although some soil depths are reflective of an arable status (>750mm), the growth potential (nutrient status and soil water capabilities) and ability of these soils to return a cropping yield equal to or better than the national average is lacking with the ambient nutrient status measured. This is due mainly to the poor soil depths (depth to wetness or saprolite) and the semi-arid climate, with soil nutrition being an issue that is also problematic. These variables reflect the natural conditions, and do not include any man induced additives such as fertilizers or water.

2.3.2.2. Grazing Land

The classification of grazing land is generally confined to the shallower and transitional zones that are well drained. These soils are generally darker in colour and are not always free draining to a depth of 750mm but are capable of sustaining palatable plant species on a sustainable basis, especially since only the subsoil's (at a depth of >500mm) are

periodically wetted. In addition, there should be no rocks or pedocrete fragments in the upper horizons of this soil group. If present it will limit the land capability to wilderness land.

A small but significant proportion of the study area comprises soils with a grazing land potential.

2.3.2.3. Wilderness / Disturbed Land

The shallow rocky areas and soils with a structure stronger than strong blocky (vertic etc.) are characteristically poorly rooted and support at best very low intensity grazing, or more realistically are of a Wilderness character and rating.

In addition, the areas that are currently disturbed by mining have also been grouped into this category, covering the majority of the area.

2.3.2.4. Wetland

Wetland areas in this document (soils and land capability) are defined in terms of the wetland delineation guidelines, which use both soil characteristics, the topography as well as flora and fauna criteria to define the domain limits (Separate Wetland Delineation has been undertaken). Only the soils aspects are described and considered here.

These zones (wetlands) are dominated by hydromorphic soils (wet based) that often show signs of moderately strong to strong structure and have plant life (vegetation) that is associated with seasonal wetting or permanent wetting of the soil profile (separate study). All of these aspects are significant and render the majority of the wet based soils sensitive to being disturbed.

The wetland soils are generally characterised by dark grey to black (organic carbon) in the topsoil horizons and are often high in transported clays and show variegated signs of mottling on gleyed backgrounds (pale grey colours) in the subsoil's. Wetland soils occur within the zone of soil water influence.

These should not be mistaken as wetlands in terms of the delineation document but should be highlighted as potential zones of sensitivity with the potential for highly sensitive areas within the areas of wet based soils.

The site specifics of this area returned shallow wet based soils, many of which classify as wetlands in terms of the delineation criteria.

These zones are considered very important, highly sensitive and vulnerable due to their ability to contain and hold water for periods through the summers and into the dry winter seasons.

2.4 Land Use Baseline

2.4.1 Data Collection

Desktop land cover data was visually assessed using the orthophotographs and during the site visit as part of the ground truthing, and general land use for the area. In terms of land use planning, the site falls within the eMalahleni Local Municipality. Additional information was obtained from the SANBI/CSIR National Land Cover Dataset 2014.

2.4.2 Land Use Baseline Description

The land use of the VDDC area is shown in **Figure 2-3** and listed in **Table 2-4** below. The dominant land uses on site are mining and open grasslands. These are followed by wetlands, cultivation, bush and urban development. The minor land uses include water, shrubland, plantations, bare ground and mine buildings. **Figure 2-4** shows the overall landscape changes due to mining over the last 11 years within the larger study area.

Table 2-4: VDDC Land Use (updated from Douglas EMP, 2006)

Land Use	Ha	%
Water Seasonal	1.3	0.05%
Water permanent	3.7	0.14%
Wetlands	146.6	5.56%
Bush	80.7	3.06%
Grassland	721.2	27.37%
Shrubland	11.3	0.43%
Cultivation	182.0	6.91%
Plantations	14.6	0.55%
Mining	1355.3	51.43%
Mine Water	33.2	1.26%
Mine Buildings	9.4	0.36%
Bare Ground	17.8	0.68%
Urban	58.1	2.21%
Total	**2635.2***	**100%**

**The boundaries of the land capability and land use assessment differ slightly, hence the difference in the total hectares for each when comparing Table 2-3 and 2-4.*

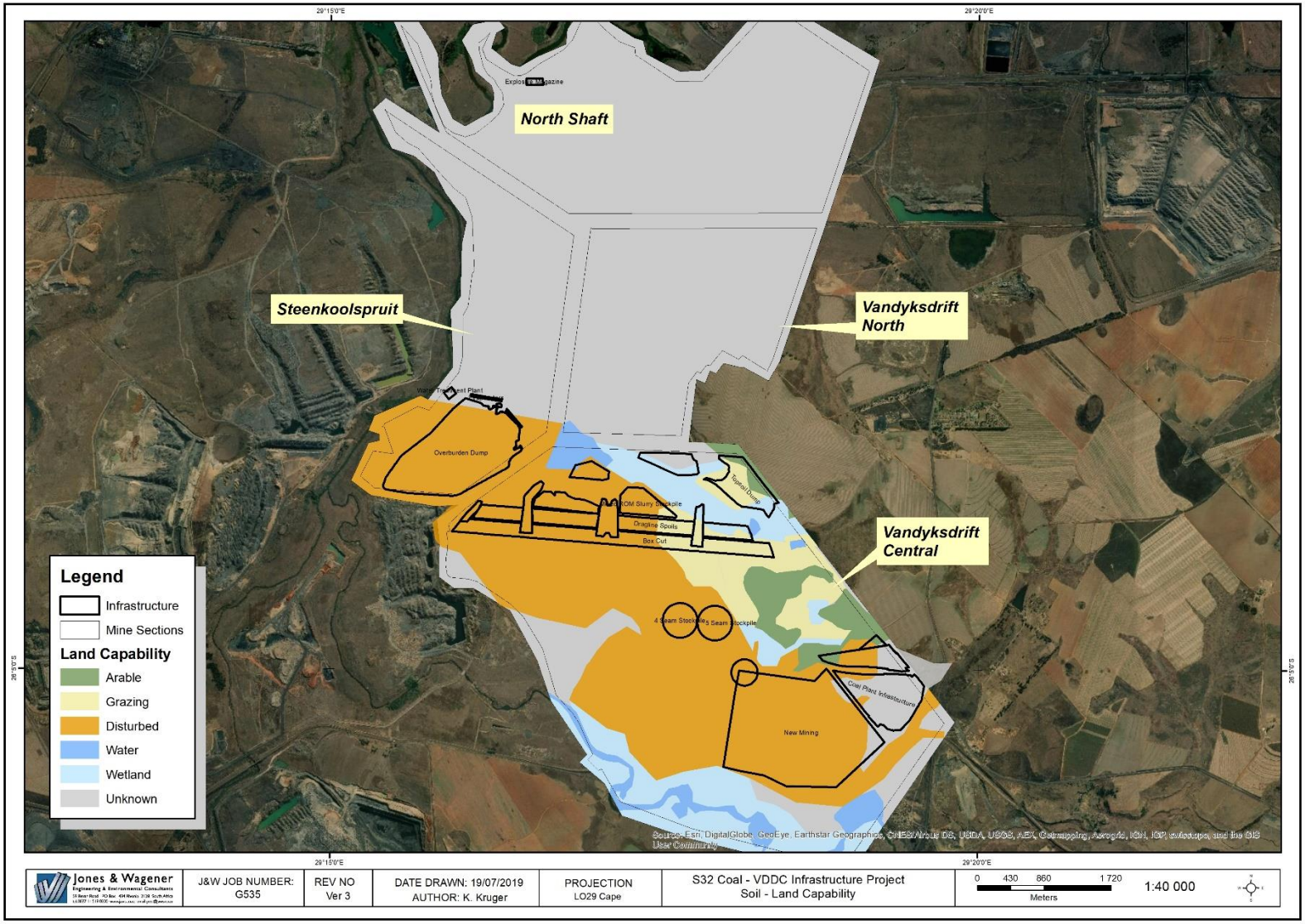


Figure 2-2:Land Capability for the Soils on VDDC (updated from Douglas EMP 2006)

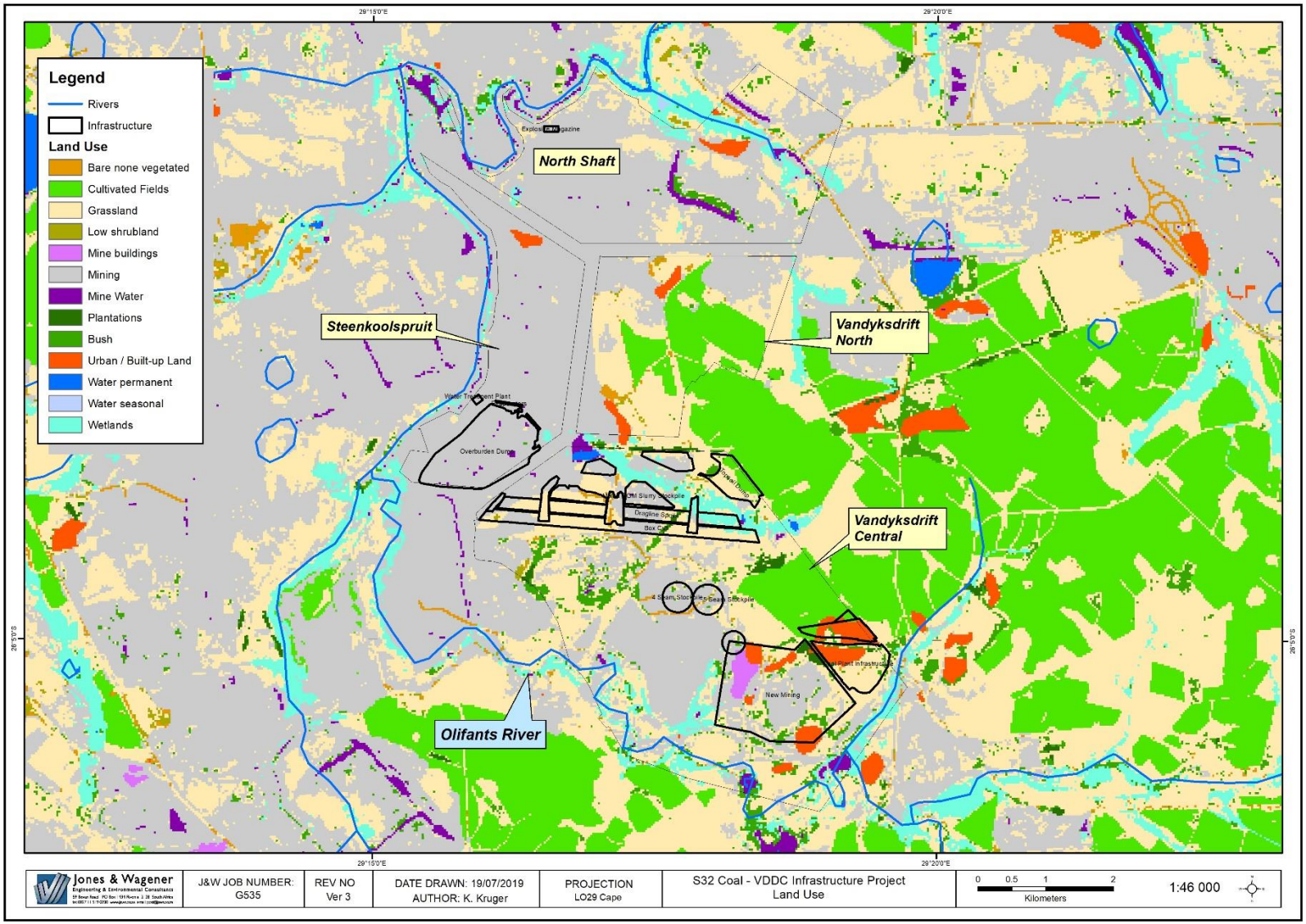


Figure 2-3:Land use within the VDDC study area (CSIR/SANBI 2014)

2001	
2013	
2019	

Figure 2-4:Land use changes from 2001 – 2019 at VDDC (Google Earth)

3. IMPACT ASSESSMENT METHODOLOGY

In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology will be used to describe the impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in **Table 3-1**.

Table 3-1: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	EXTENT SCALE	TEMPORAL SCALE
1	VERY LOW	*Isolated corridor / proposed corridor*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

3.1 Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1000km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in **Table 3-2** below.

Table 3-2: Description of the significance rating scale

RATING		DESCRIPTION
5	VERY HIGH	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	HIGH	Impact is of substantial order within the bounds of impacts, which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	MODERATE	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	LOW	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	VERY LOW	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity is needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	NO IMPACT	There is no impact at all - not even a very low impact on a party or system.

3.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in **Table 3-3**.

Table 3-3: Description of the spatial rating scale

RATING		DESCRIPTION
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of impacts possible and will be felt at a regional scale (District Municipality to Provincial Level). The impact will affect an area up to 50km from the proposed site / corridor.
3	Local	The impact will affect an area up to 5km from the proposed route corridor / site.
2	Study Area	The impact will affect a route corridor not exceeding the boundary of the corridor / site.
1	Isolated Sites / proposed site	The impact will affect an area no bigger than the corridor / site.

3.3 Duration Scale

In order to accurately describe the impact, it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in **Table 3-4**.

Table 3-4: Description of the temporal rating scale

RATING		DESCRIPTION
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium term	The environmental impact identified will operate for the duration of life of the project.
4	Long term	The environmental impact identified will operate beyond the life of operation.
5	Permanent	The environmental impact will be permanent.

3.4 Degree of Probability

The probability or likelihood of an impact occurring will be described, as shown in **Table 3-5** below.

Table 3-5: Description of the degree of probability of an impact occurring

RATING	DESCRIPTION
1	Practically impossible
2	Unlikely
3	Could happen
4	Very Likely
5	It's going to happen / has occurred

3.5 Degree of Certainty

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used as discussed in **Table 3-6**. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 3-6: Description of the degree of certainty rating scale

RATING	DESCRIPTION
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

3.6 Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus, the total value of the impact is described as the function of significance, spatial and temporal scale as described below.

$$\textit{Impact Risk} = \frac{(\text{SIGNIFICANCE} + \textit{Spatial} + \text{Temporal})}{3} \times \frac{\text{Probability}}{5}$$

An example of how this rating scale is applied is shown in **Table 3-7**.

Table 3-7: Example of Rating Scale

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	LOW	*Local*	Medium Term	*Could Happen*	
Impact to air	**2**	***3***	**3**	**3**	**1.6**

Note: The significance, spatial and temporal scales are added to give a total of 8, that is divided by 3 to give a criteria rating of 2,67. The probability (3) is divided by 5 to give a probability rating of 0,6. The criteria rating of 2,67 is then multiplied by the probability rating (0,6) to give the final rating of 1,6.

The impact risk is classified according to 5 classes as described in **Table 3-8**.

Table 3-8: Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
0.1 – 1.0	1	Very Low
1.1 – 2.0	2	Low
2.1 – 3.0	3	Moderate
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High

4. IMPACT ASSESSMENT

The impact assessment was undertaken for the project components described in Section 1 above. Please note that this assessment includes the infrastructure described in Section 1 and 2 and only mining area not previously assessed and approved by the DMR. The sections below described the various soil impacts per project phase, prior to assessing the impacts. The impact assessment is summarised in **Table 4-3** at the end of this section.

4.1 Initial Impact (Baseline)

The area of assessment includes the study areas shown in **Figure 2-3** above. The sites fall within the existing Wolvekrans mining area of South32, within the Vandyksdrift section. As this is an active opencast and underground mining area, the soils have been widely impacted. As noted in **Table 2-1**, at least 56% of the soils within the study area have been impacted by mining and associated structures.

4.2 Additional Impact (Project only)

4.2.1 Construction Phase

During the construction phase the work carried out will mainly be the construction of the opencast mine supporting infrastructure. This will entail the clearing of areas and the disturbance of the topsoil through excavations as well as the construction of a soil stockpile. The topography and natural drainage lines will be disturbed. The overall impact will be loss of topsoil as a result of soil removal, erosion and possible contamination of the soil by fuel and oils from machinery. Soil compaction caused by heavy vehicles and machinery surrounding the pit areas could also be a problem.

Construction activities will change the land use to mining causing unsuitable conditions for any further commercial farming.

Tables 4-1 and 4-2 below summarises the impact of each anticipated infrastructure on the soils and land capability. The bulk of the structures are located on existing impacted soils (542ha out of 716ha, 75.6%) with only 12.2ha of agriculturally producing soils being impacted. The potential impacts to wetland soils will be 19ha in extent, with a further 62ha of impact on grazing land.

Note that roads and pipelines are also included as part of the infrastructure project, and the bulk of their footprints are within infrastructure areas assessed below or within existing roads/pipeline alignments.

Table 4-1: Impacts to Soil Forms

Impact Area	Cv	Dr	Hu/Bv	Ka/We	Lo	Tu	We	Wb	Unk	Total
4 Seam Stockpile								24.6		**24.6**
5 Seam Stockpile								15.6		**15.6**
Box Cut	13.8	2.8	1.1	1.9	11.8			63.5		**93.8**
Future Coal Plant area								4.9	49.1	**54**
Dragline Spoils	5.6			5.4	6.9	1.4		34.7	0.2	**54.2**
Evaporator								0.5		**0.5**
Explosive Magazine									2	**2**
Mixed ROM coal and Slurry stockpile areas	2				0.1			23.4		**25.8**
New Mining			1.1					219	9.1	**229.3**

Impact Area	Cv	Dr	Hu/Bv	Ka/We	Lo	Tu	We	Wb	Unk	Total
Overburden Dump			2.7					142	9.1	**153.6**
Topsoil Stockpiles			8.3	4.7		18.2	6.7	14.3	9.1	**61.2**
Water Treatment Plant									1	**1**
Grand Total (ha)	**21.3**	**2.8**	**12.1**	**12**	**18.8**	**19.6**	**6.7**	**542**	79.4	**715.7**

Table 4-2: Impacts to Land Capability

Impact Area	Arable	Disturbed	Grazing	Unknown	Wetland	Grand Total
4 Seam Stockpile		24.55				24.6
5 Seam Stockpile		15.58				15.6
Box Cut		63.49	28.47		1.87	93.8
Future Coal Plant Area		4.94		49.11		54
Dragline Spoils		34.73	13.88		5.72	54.2
Evaporator		0.55				0.55
Explosive Magazine				2		2
Mixed ROM coal and Slurry stockpile areas		23.45	2.04		0.36	25.8
New Mining	1.15	219.05		9.13		229.3
Overburden Dump	2.72	141.79		9.08		153.6
Topsoil Stockpiles	8.3	14.27	18.15	9.09	11.39	61.2
Water Treatment Plant				1		1
Grand Total	**12.2**	**542.4**	**62.5**	**79.4**	**19.2**	**715.7**

The initial impact during the construction phase is rated as probable, HIGH, long term impact on the *proposed infrastructure and mining sites*. This impact is going to happen and is rated as a Moderate impact (3.0).

4.2.2 Operational Phase

Opencast mining destroys the soil profile, the material is removed and stockpiled. Stockpiled soils will deteriorate over time, organic material will be lost and the seedbank in the soil will become sterile. Compaction and potential anaerobic conditions inside the stockpile can further impact on stockpiled soils. The soils under stockpiles, discard and other dumps will be compacted, and potentially contaminated from the overlying waste material.

The water evaporators proposed as part of the project will results in salinization of the soils, with increased salt and sulphate concentrations due to salty mine water evaporating on the surface. Previous studies at Wolvekrans indicated an approximate area of impact for 12 evaporators to be estimated 12ha. For this project the evaporators will be placed at the backfilled SKS pit. If the pit backfill is rehabilitated, the salinization will be an impact on the rehabilitated soils. If the backfill is not rehabilitated, the salinization will add to the salt load of the water make in the pit.

Soil erosion through wind and storm water run-off, and soil pollution by means of hydrocarbon contamination and potentially coal dust, may be encountered during the operational phase. Water runoff from roads must be controlled and managed by means of proper storm water management facilities in order to prevent soil erosion. Diesel and oil spills are common at mine sites due to the large volumes of diesel and oil consumed

by mine vehicles. Pollution may however be localised. Small pockets of localised pollution may be cleared up easily using commercially available hydrocarbon emergency clean-up kits.

The initial impact during the operational phase is rated as definite, HIGH, long term impact on the *study area*. This impact is going to happen and is rated as a High impact (3.3).

4.2.3 Rehabilitation and Closure Phase

Soil quality deteriorates during stockpiling and replacement of these soil materials into soil profiles during rehabilitation cannot imitate pre-mining soil quality properties. Depth however can be imitated but the combined soil quality deterioration and resultant compaction by the machines used in rehabilitation, leads to a net loss of land capability. A change in land capability then forces a change in land use. Typically, the Mpumalanga experience taught us that arable land capability changes to grazing land capability.

The initial impact during the rehabilitation and closure phase is rated as probable, VERY LOW POSITIVE, medium term impact on the *proposed infrastructure sites*. This impact could happen and is rated as a Very Low positive impact (1.0).

4.3 Cumulative Impact (Project with Baseline)

The cumulative impact assessment combines the project only impact (additional impact) with the baseline (initial impact) per project phase.

4.3.1 Construction phase

The baseline impact rated as a High Impact. With the additional Moderate Impact of the construction phase, the overall cumulative impact to soils will remain a High Impact.

4.3.2 Operational Phase

Both the baseline and operational impacts rated as a High Impact. The cumulative rating is also a High Impact, as neither the severity, nor the spatial or temporal ratings will change when combined.

4.3.3 Rehabilitation and Closure Phase

The aim of the rehabilitation and closure phase is to reduce the effects of the impacts of the proposed project. In this case it will be the removal of the stockpiles, the discard and the use of the topsoil dumps for rehabilitation of the larger mining area. The Very Low positive impact of the rehabilitation will replace the soil in layers, but it will not be sufficient to bring back agricultural production or soil sustainability. Therefore, the impact remains a High Impact.

4.4 Mitigation Measures

The aim of mitigation measures is twofold, they either prevent an impact from occurring, or they reduce the significance/duration/extent of the impact once it occurs. The following mitigation measures are proposed for the project to assist in mitigating the impacts on soils, land capability and land use.

As noted above, this report focusses on the supporting structures for the VDDC mining operation as well as small opencast areas not previously authorised. The largest extent of the VDDC mining area, and the soil stripping thereof, has already been authorised by DMR.

4.4.1 Construction and Operational Phase

- Foundation excavated soil should also be stockpiled;
- Stockpiles are to be clearly demarcated on site layout plans. Also indicate the material in each stockpile to ensure that discard, overburden, spoils and topsoil are not mixed;
- Soil stockpiles are to be maintained in a fertile, vegetated, and erosion free state. If this can't be achieved due to design of stockpiles, then financial provision must be made to reinstate soil chemistry (fertilizer, lime, organic material) and physical structure (placement of topsoil, no compaction);
- Ensure proper storm water management designed structures are in place;
- Compaction of the removed topsoil should be avoided by prohibiting traffic on stockpiles;
- Stockpiled soil to be reserved for rehabilitation purposes only;
- If erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- Prevent major spills from occurring. If a spill occurs, it will be cleaned up immediately and reported to the appropriate authorities;
- All vehicles are only to be serviced in designated areas;
- Leaking vehicles should have drip trays place under them where the leak is occurring, and repaired as soon as possible; and
- Adhere to the Land and Rehabilitation Management Plan (OLD_WVK_PROD_SOP_035) for Wolwekrans Colliery. This SOP will be replaced with the site-specific Annual Rehabilitation Plan as per the Financial Provision Regulations. Up and till that report is finalised, the SOP is to be adhered to. The relevant sections are listed below.
    - 7.1 Recording Rehabilitation Progress
    - 7.2 Topsoil Removal
    - 7.3 Topsoil Stockpiles
    - 7.4 Levelling
    - 7.5 Topsoil Replacement
    - 7.6 Levelling and Topsoil Control Procedures
    - 7.8 Lime and Fertiliser Requirements
    - 7.9 Seeding and Revegetation
    - 7.10 Maintenance
    - 7.12 Records
    - 7.13 Not permitted
    - 7.14 Monitoring

- 7.15 Measurements.

4.4.2 Rehabilitation and Closure Phase

- Ensure that the rehabilitation changes the land use for the VDDC infrastructure area from mining to grazing;
- The spoil should be shaped taking the pre-mining landscape into consideration;
- The designed post mining landforms should be modelled to establish the post mining landscape stability by using a combination of GIS and erosion modelling techniques by a suitably qualified expert using site specific soil quality data;
- Soil compacted under stockpiles to be ripped at least 300mm deep and rehabilitated as per the end land use requirements;
- The soil quality should be investigated once stockpiled material will be used as part of rehabilitation, but prior to establishing vegetation through representative sampling and laboratory analysis;
- The analytical data should be evaluated by a suitably qualified expert and vegetation fertility and or soil acidity problems should be corrected;
- Clear targets incorporating medium to long term post mining land capability influencing land use, should be part of a potentially successful closure plan;

4.5 Residual Impact (Implemented Mitigation Measures)

The residual impact assesses the impact considering that the mitigation measures mentioned above have been successfully implemented.

4.5.1 Construction phase

The construction phase residual impact will probably remain a HIGH, medium term impact on the *proposed infrastructure sites*. This impact is going to happen and is rated as a Moderate impact (2.67).

4.5.2 Operational Phase

The operational phase residual impact will probably remain a HIGH, long-term impact on the *study area*. This impact will occur and cannot be avoided hence the rating remains a High impact (rating 4.0).

4.5.3 Rehabilitation and Closure Phase

The effects of ripping, fertilizing, and ameliorating the soil will probably have a MODERATE POSITIVE impact, in the medium term on the *proposed infrastructure sites.* This impact could happen and is rated as a Low positive impact (1.4)

Table 4-3: Impact Assessment Table:

Activity	Aspect	Impact	Mitigation	Criteria	Project rating prior to mitigation (Additional Impact)		Cumulative rating (with baseline)		Rating post mitigation (Residual Impact)	
Site/ stockpile preparation and construction	Soils, Land Capability and Land Use	**NEGATIVE IMPACT:** Clearing of soil will result in loss of land capability. Vehicle movement will result in compaction of soils. Soil contamination by hydrocarbons.	• Foundation excavated soil should also be stockpiled; • Stockpiles are to be clearly demarcated on site layout plans. Also indicate the material in each stockpile to ensure that discard, overburden, spoils and topsoil are not mixed; • Soil stockpiles are to be maintained in a fertile, vegetated, and erosion free state. If this can't be achieved due to design of stockpiles, then financial provision must be made to reinstate soil chemistry (fertilizer, lime, organic material) and physical structure (placement of topsoil, no compaction); • Ensure proper storm water management designed structures are in place; • Compaction of the removed topsoil should be avoided by prohibiting traffic on stockpiles; • Prevent unauthorised borrowing of stockpiled soil; • If erosion occurs, corrective actions must be taken to minimise any further erosion from taking place • The stockpiles should be vegetated in order to reduce the risk of erosion, prevent weed growth and to reinstitute the ecological processes within the soil; • Prevent any major spills from occurring. If a spill occurs, it is to be cleaned up immediately and reported to the appropriate authorities; • All vehicles are to be serviced in designated areas; and • Leaking vehicles should have drip trays place under them where the leak is occurring and repaired as soon as possible.	Significance	4	**MODERATE**	5	**HIGH**	4	**MODERATE**
				Spatial	1		3		1	
				Temporal	4		4		3	
				Probability	5		5		5	
Operations of stockpiles, storing of wastes on in-situ soils Opencast mining of areas	Soils, Land Capability and Land Use	**NEGATIVE IMPACT:** Stockpiling on top of soil will continue in loss of soil resource land capability. Vehicle movement will result in compaction of soils.	• Same as measures for construction	Significance	4	**HIGH**	5	**HIGH**	4	**HIGH**
				Spatial	2		3		2	
				Temporal	4		4		4	

Activity	Aspect	Impact	Mitigation	Criteria	Project rating prior to mitigation (Additional Impact)		Cumulative rating (with baseline)		Rating post mitigation (Residual Impact)	
not previously authorised		Soil contamination by hydrocarbons, waste stockpiles and evaporators.		Probability	5		5		5	
Rehabilitation of VDDC infrastructure project sites and opencast area	Soils and land capability	**POSITIVE IMPACT** Rehabilitation of soil, land capability and land use by replacing stockpiled soils over disturbed areas and bringing back a form of land capability that can support an alternative end use	• Ensure that the rehabilitation changes the land use from mining back to grazing; • The spoil should be shaped taking the pre-mining landscape into consideration; • The designed post mining landforms should be modelled to establish the post mining landscape stability by using a combination of GIS and erosion modelling techniques by a suitably qualified expert using site specific soil quality data; • Soil compacted under stockpiles to be ripped at least 300mm deep and rehabilitated as per the end land use requirements; • The soil quality should be investigated on the rehabilitated soil through representative sampling and laboratory analysis; • The analytical data should be evaluated by a suitably qualified expert and vegetation fertility and or soil acidity problems should be corrected; • Clear targets incorporating medium to long term post mining land capability influencing land use, should be part of a potentially successful closure plan;	Significance	1	**VERY LOW POSITIVE**	5	**HIGH**	3	**LOW POSITIVE**
				Spatial	1		3		1	
				Temporal	3		4		3	
				Probability	3		5		3	

5. MONITORING REQUIREMENTS

As the bulk of the infrastructure is in the form of stockpiles, the critical parameters to monitor would be the following:

- Topsoil stockpiles:
    - Soil fertility (Macro nutrients, pH, EC) – annually;
    - Erosion and stormwater control – weekly.
- Operational stockpiles (Overburden):
    - Soil fertility (Macro nutrients, pH, EC) –prior to rehabilitation;
    - Soil contamination (Sulphates, Salts) –prior to rehabilitation;
    - Soil compaction – post closure, and post ripping as part of rehabilitation.
- If the evaporator site is placed on rehabilitated (top-soiled and vegetated) backfill spoils:
    - Previous studies at Wolvekrans were limited to the proximity to Pit 4, and samples could only be taken adjacent and behind the machines.
        - It is recommended that at least 2 monitoring points are placed within 50m of the front of the proposed evaporators, with an additional 2 points at 100m and a further 2 at 150m.
    - Metals (As, Cr, Cu, Pb, Mn, Hg, Ni, Zn) – bi-annual (6-monthly);
    - Anions (Chlorides, Fluoride, Nitrates – Nitrite, Sulphates) – bi-annual;
    - All results compared against the National Norms and Standards for the remediation of contamination land and soil quality in the RSA (GN 467 of 10 May 2013).
- If the evaporators are placed on unrehabilitated spoils, the monitoring mentioned above can be completed as a once off test prior to the top-soiling and vegetating of the area.

Once a soil resource has been identified for use in rehabilitation, the soil analyses and results mentioned above will be interpreted by a qualified (Pr. Sci Nat) soil scientist for recommendations in terms of fertilizers and soil ameliorants to be utilised as part of rehabilitation. Similarly, if any of the monitored constituents exceed any relevant legislation / guideline limits, the same type of specialist should be brought in to advise on the mitigations.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Opinion on Proceeding with Project

The Vandyksdrift Central mining project will utilise available mineral resources. These resources have been undermined previously, and several impacts have already occurred. Furthermore, the mining area is surrounded by other opencast operations, resulting in a landscape dominated by mining and its associated impacts.

The additional impact of the proposed VDDC mining and infrastructure project is mostly located on existing impacted land. However, the areas that are not previously impacted, will be highly impacted by the project.

It is the opinion of this specialist that the development should proceed, but with the principles of sustainable development and the polluter pays in the forefront. Rehabilitation and closure requirements must be enforced with the final end land use as the objective.

6.2 Conditions for approval

It is recommended that the mitigation measures proposed in this report, be seen as the minimum conditions for approval. In addition, the Final Rehabilitation, Decommissioning and Mine Closure Report compiled as part of the Financial Provisioning Regulation requirements should:

- Use the information contained in this report when considering end land use options. It is anticipated that the post-mining land capability will be limited to grazing,
- Stipulate measurable objectives for achieving that end use; and
- Stipulate the requirements in terms of land capability to support that end use.

7. REFERENCES

- Earth Science Solutions, 2013. *Baseline Specialist Soils, Land Use and Land Capability Studies Impact Assessment and Management Plan.*
- Jaco – K Consulting cc, 2016(a). *VDDC Dewatering Environmental Impact Report.*
- Jaco – K Consulting cc, 2016(b). *Water Use Licence Application for Vandyksdrift Central Dewatering.*
- Pulles, Howard & De Lange, 2006. *Douglas EMP Amendment, New Opencast and Pillar Mining Operations on the farms Kleinkopje 15 IS, Steenkoolspruit 18 IS and Vandyksdrift 19 IS.*
- South32, 2017a. *Van Dyksdrift (VDDC) Project, Pre-Feasibility Mining Report.*
- South32, 2017b. *Van Dyksdrift (VDDC) Project, Pre-Feasibility Report: Infrastructure, Transport and Logistics.*

Konrad Kruger
Specialist

Tolmay Hopkins
Project Manager

for Jones & Wagener

19 July 2019
Document source: https://joneswagener.sharepoint.com/JonesWagenerProjects/G535VDDCIRP/Shared Documents/PRJ/REP/Soil/G535-07-r3-SoilsImpact-kkth_20190719.docx
Document template: Normal.dotm

APPENDIX A

CURRICULUM VITAE

Jones & Wagener
Engineering & Environmental Consultants
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
tel: 0027 11 519 0200 www.jaws.co.za email: post@jaws.co.za

CURRICULUM VITAE

01 January 2019
kruger_specialistcv_jan2018

KONRAD KRÜGER

Profession	Environmental Scientist
Date of Birth	20 November 1981
Position in firm	Senior Environmental Scientist
Years with the firm	6 years 2 months
Nationality	South African
Education / Qualifications	BSc Honours (Geography) University of Pretoria 2003 (cum laude) BSc Environmental Sciences, University of Pretoria 2002
Languages	Afrikaans, English
Employers	
2005 – 2009	Cymbian Enviro-Social Consulting Services (Randburg) - Environmental Consultant
2009 – 2012	Zitholele Consulting (Pty) Ltd (Midrand) - Environmental Consultant
2012 – Current	Jones & Wagener (Pty) Ltd - Senior Environmental Scientist

About Konrad Krüger

Konrad graduated from the University of Pretoria with a BSc in Environmental Science in 2002 and BSc Honours in Geography in 2003. He has been involved in a variety of environmental projects in the last twelve years and has undertaken a variety of specialist studies, mapping and environmental consulting. The specialist studies included vegetation assessments, soil mapping and agricultural assessments, wetland delineations, visual assessments and terrestrial ecological assessments.

Areas of Expertise

<u>Specialist Assessments:</u>

- Soils and Land Capability / Agricultural Potential;
- Wetland Delineation;
- Flora Assessments;
- Terrestrial Ecological Assessment;

- Visual Impact Assessment; and
- GIS (ArcGIS 10)

Professional Affiliations

- International Association of Impact Assessors (South Africa)
- Land and Rehabilitation Society of South Africa (LARSSA)

Relevant Experience

Wetland Delineation

1. Wetland Assessment for the proposed Era Stene expansion – Delmas, South Africa – Era Stene - 2016
2. Wetland delineation for the proposed Pongola-Candover 132 kV powerline – Pongola, South Africa – Eskom Eastern Regions - 2014
3. Wetland delineation for the proposed Ndumo-Gezisa 132 kV powerline – Pongola, South Africa – Eskom Eastern Regions - 2014
4. Wetland delineation for EnviroServ Holfontein – Holfontein, South Africa – EnviroServ - 2012
5. Wetland delineation for the extension of the Camden Power Station Ash Dump - Ermelo, South Africa - Eskom Generation – 2012
6. Wetland delineation for the proposed Solar Integration Project and the CSP amendment - Upington, South Africa - Eskom Transmission - 2012
7. Dragline Relocation Wetland Assessments and GIS mapping - Kriel, South Africa - Xstrata Coal South Africa – Rietspruit - 2007
8. Conducted the wetland assessment and associated GIS for the integration of the Bravo (Kusile) power station into the Eskom grid. Five EIAs for the proposed construction of overhead power lines and associated infrastructure for the Bravo Integration Project. - Gauteng and Mpumalanga, South Africa - Eskom – Bravo Integration Project – 20009
9. Conducted the wetland assessment and associated GIS for the proposed railway line to the Kusile power station. - Gauteng and Mpumalanga, South Africa - Eskom – Kusile Railway Line - 2010
10. Wetland delineation for the proposed Braamhoekspruit Bridge upgrade WUL. - KwaZulu Natal, South Africa - Eskom – Ingula bridge - 2010
11. Wetland Delineation for the proposed Ingula burial grounds near Van Reenen. - KwaZulu Natal, South Africa - Eskom – Ingula burial ground - 2011
12. Wetland risk assessment for the proposed substation alternatives and connecting power lines. - Gauteng, South Africa - Eskom – Bapsfontein - 2010
13. Wetland risk assessment for the proposed substation and connecting power lines. - Limpopo, South Africa - Eskom – Tabor - 2011
14. Route selection report and associated wetlands assessment for 2 power line route alternatives in Wilgeheuwel. - Gauteng, South Africa - Johannesburg City Power - 2007
15. Wetland delineation for the proposed storm water system upgrade in Soweto - Gauteng, South Africa - Johannesburg Road Agency - 2010
16. Wetland delineation for the proposed Teak Place Estate Development in the Cradle of Humankind. - Cradle of Humankind, South Africa - Teak Place Estate Development – 2007
17. Wetland delineation for the Pala Meetse Eco Estate, Modimolle. - Limpopo Province, South Africa - Pala Meetse Eco Estate - 2008
18. Wetland delineation for the N17 borrow pit application, SANRAL - Mpumalanga, South Africa – SANRAL - 2008

19. Wetland delineation for the proposed development on Farm Nooitgedacht Portions 8 and 32 - Gauteng, South Africa - Viva Construction – Portion 8 and 36 - 2008
20. Wetland assessment for the proposed lodge development in the Vredefort Dome - North West, South Africa - Wesplan Town and Regional Planners - 2006
21. Wetland delineation for the proposed Randfontein Golf Estate. - Gauteng, South Africa - Randfontein Golf Estate – 2008

Soil and Land Capability Assessment

1. Soil, Land Capability and Land Use Assessment for the Vandyksdrift Central extension – South32, Middelburg – 2019
2. Soil, Land Capability and Land Use Assessment for the Chloorkop Landfill Expansion Project – EnviroServ, Johannesburg - 2019
3. Soil, Land Capability and Land Use Assessment for the Syferfontein Alexander Project – Sasol Mining, Secunda – 2018-2019
4. Rehabilitation Assessment for the Schoonoordt Mine – Exxaro Coal, Arnot - 2018
5. Soil, Land Capability and Land Use Quantitative Risk Assessment for the closure of Sasol Sigma – Sasolburg, South Africa – 2017 - 2018
6. Soil, Land Capability and Land Use Quantitative Risk Assessment for the closure of Sasol Twistdraai, Middelbult and Brandspruit Mines – Secunda, South Africa – 2016 and 2019
7. Soil and Land Capability Assessment for the proposed Era Stene expansion – Delmas, South Africa – Era Stene - 2016
8. Long term soil impact monitoring and assessment for the Wolwekrans Evaporator Project – Emalahleni, South Africa – South32 – 2015-16
9. Soil and Land Capability Assessment for the proposed 400kv KIPower powerlines – Delmas, South Africa – KIPower - 2016
10. Soil and Land Capability Assessment for the Boschmanspoort EMPR – Hendrina, South Africa – Xstrata Coal - 2013
11. Soil and Land Capability Assessment for the extension of the Camden Power Station Ash Dump - Ermelo, South Africa - Eskom Generation – 2012
12. Soil and Land Capability Assessment for the proposed Solar Integration Project and the CSP amendment - Upington, South Africa - Eskom Transmission - 2012
13. Dragline Relocation Soil Assessments - Kriel, South Africa - Xstrata Coal South Africa – Rietspruit - 2007
14. Compilation of the Soil Assessments for the EMPR update project - Cullinan, South Africa - De Beers Consolidated Mines – Cullinan - 2005
15. Soil specialist assessments for the proposed Metal Recovery and Slag Processing Plant at Metalloys - Meyerton, South Africa - Samancor Manganese, Metalloys – MRSPP - 2007
16. Soil and Land Capability Assessment for the proposed Sinter Plant at the Mamatwan Mine. - Hotazel, South Africa - Samancor Manganese – Sinter - 2009
17. Conducted the soil and land capability assessment for the integration of the Bravo (Kusile) power station into the Eskom grid. Five EIAs for the proposed construction of overhead power lines and associated infrastructure for the Bravo Integration Project. - Gauteng and Mpumalanga, South Africa - Eskom – Bravo Integration Project – 2009
18. Conducted the soil and land capability assessment for the proposed railway line to the Kusile power station. - Gauteng and Mpumalanga, South Africa - Eskom – Kusile Railway Line - 2010
19. Soil assessment for the proposed Tutuka Power Station general waste disposal site, Standerton. - Mpumalanga, South Africa - Eskom – Tutuka Domestic Waste Site - 2011
20. Soil and Land Capability Assessment for the proposed Ingula burial grounds near Van Reenen. - KwaZulu Natal, South Africa - Eskom – Ingula burial ground - 2011
21. Soil and Land Capability risk assessment for the proposed substation alternatives and connecting power lines. - Gauteng, South Africa - Eskom – Bapsfontein - 2010

22. Soil and Land Capability risk assessment for the proposed substation and connecting power lines. - Limpopo, South Africa - Eskom – Tabor - 2011
23. Route selection report Soil Assessment for 2 power line route alternatives in Wilgeheuwel. - Gauteng, South Africa - Johannesburg City Power - 2007
24. Agricultural feasibility study for the Ramasega development project. - Gauteng, South Africa - Ramasega Agricultural Development Project - 2006
25. Soil and Land Capability Assessment for the proposed Teak Place Estate Development in the Cradle of Humankind. - Cradle of Humankind, South Africa - Teak Place Estate Development – 2007
26. Soil assessment for the Pala Meetse Eco Estate, Modimolle. - Limpopo Province, South Africa - Pala Meetse Eco Estate - 2008
27. Soil and Land Capability assessment for a residential development in Noordheuwel, Krugersdorp. - Gauteng, South Africa - Noordheuwel Ext 17 and 19 - 2008
28. Soil Assessment for Holding 68 and 67 Morningside. - Gauteng, South Africa - Bernard Glazer Trust - 2007
29. Soil mapping for the proposed Harmony Mega Tailings Facility, Welkom. - Free State, South Africa - Harmony Gold – Welkom - 2009
30. Soil assessment for the proposed 3rd bypass line, Richards Bay Coal Terminal. - KwaZulu Natal, South Africa - Transnet, RBCT - 2008
31. Soil assessment for the proposed industrial development of the Farm Nooitgedacht Portion 215. - Gauteng, South Africa - Viva Construction – Portion 215 - 2008
32. Soil assessment for the proposed development of Portions 16, 17 and 18 of the Mostyn Park Smallholdings. - Gauteng, South Africa - Viva Construction – Mostyn Park - 2008
33. Soil assessment for the proposed lodge development in the Vredefort Dome - North West, South Africa - Wesplan Town and Regional Planners - 2006

Terrestrial Ecology Assessment

1. Terrestrial Ecological Assessment for the proposed 400kv KIPower powerlines – Delmas, South Africa – KIPower - 2016
2. Biodiversity Assessment for the extension of the Camden Power Station Ash Dump - Ermelo, South Africa - Eskom Generation – 2012
3. Biodiversity Assessment for the proposed Solar Integration Project and the CSP amendment - Upington, South Africa - Eskom Transmission - 2012
4. Dragline Relocation Vegetation Assessments - Kriel, South Africa - Xstrata Coal South Africa – Rietspruit - 2007
5. Vegetation Assessments for the CDM EMPR update project - Cullinan, South Africa - De Beers Consolidated Mines – Cullinan - 2005
6. Vegetation Assessment for the proposed Metal Recovery and Slag Processing Plant at Metalloys - Meyerton, South Africa - Samancor Manganese, Metalloys – MRSPP - 2007
7. Land use and Fauna and Flora Assessment for the proposed Sinter Plant at the Mamatwan Mine. - Hotazel, South Africa - Samancor Manganese – Sinter - 2009
8. Vegetation Assessment for the proposed day visitor's facility at the Olifants Camp, Kruger National Park - Limpopo & Mpumalanga, South Africa - Kruger National Park – Olifants - 2007
9. Conducted the Ecology assessment and associated GIS) for the integration of the Bravo (Kusile) power station into the Eskom grid. Five EIAs for the proposed construction of overhead power lines and associated infrastructure for the Bravo Integration Project. - Gauteng and Mpumalanga, South Africa - Eskom – Bravo Integration Project – 20009
10. Conducted the Ecology assessment for the proposed railway line to the Kusile power station. - Gauteng and Mpumalanga, South Africa - Eskom – Kusile Railway Line - 2010
11. Terrestrial Ecology Assessment for the proposed Ingula burial grounds near Van Reenen. - KwaZulu Natal, South Africa - Eskom – Ingula burial ground - 2011

12. Biophysical risk assessment (Fauna, Flora) for the proposed substation alternatives and connecting power lines. - Gauteng, South Africa - Eskom – Bapsfontein - 2010
13. Biophysical risk assessment (Fauna, Flora) for the proposed substation and connecting power lines. - Limpopo, South Africa - Eskom – Tabor - 2011
14. Route selection report and associated Fauna and Flora Assessment for 2 power line route alternatives in Wilgeheuwel. - Gauteng, South Africa - Johannesburg City Power - 2007
15. Terrestrial ecology assessment for the proposed storm water system upgrade in Soweto - Gauteng, South Africa - Johannesburg Road Agency - 2010
16. Ecological Assessment for the proposed Teak Place Estate Development in the Cradle of Humankind. - Cradle of Humankind, South Africa - Teak Place Estate Development – 2007
17. Vegetation, Tree Identification and Fauna survey for Holding 68 and 67 Morningside. - Gauteng, South Africa - Bernard Glazer Trust - 2007
18. Vegetation Assessment for the proposed development on Portion 105, 106 and 331 of the Farm Knoppjeslaagte. - Gauteng, South Africa - Vibro Brics - 2008
19. Vegetation assessment for the proposed 3rd bypass line, Richards Bay Coal Terminal. - KwaZulu Natal, South Africa - Transnet, RBCT - 2008
20. Ecological site assessment for the proposed development of Portions 16, 17 and 18 of the Mostyn Park Smallholdings. - Gauteng, South Africa - Viva Construction – Mostyn Park - 2008
21. Vegetation and fauna assessment for the proposed lodge development in the Vredefort Dome - North West, South Africa - Wesplan Town and Regional Planners – 2006

Visual Impact Assessment

1. Visual Assessment for the proposed 400kv KIPower powerlines – Delmas, South Africa – KIPower - 2016
2. Visual Assessment for the proposed Middelburg Colliery extension – Middelburg, South Africa, South32 – 2016
3. Visual Assessment for the proposed Wolwekrans Evaporator Project – Emalahleni, South Africa, South32 - 2015
4. Visual Assessment for the proposed Klipfontein Colliery extension – Middelburg, South Africa, South32 - 2015
5. Visual Assessment for the proposed Pongola-Candover 132 kV powerline – Pongola, South Africa – Eskom Eastern Regions - 2014
6. Visual Assessment for the proposed Ndumo - Gezisa 132 kV powerline – Pongola, South Africa – Eskom Eastern Regions - 2014
7. Visual Assessment for the extension of the Camden Power Station Ash Dump - Ermelo, South Africa - Eskom Generation – 2012
8. Visual Assessment for the proposed day visitor's facility at the Olifants Camp, Kruger National Park - Limpopo & Mpumalanga, South Africa - Kruger National Park – Olifants - 2007
9. Conducted the Visual Specialist Studies for the integration of the Bravo (Kusile) power station into the Eskom grid. Five EIAs for the proposed construction of overhead power lines and associated infrastructure for the Bravo Integration Project. - Gauteng and Mpumalanga, South Africa - Eskom – Bravo Integration Project – 20009
10. Conducted the Visual Specialist Studies for the proposed railway line to the Kusile power station. - Gauteng and Mpumalanga, South Africa - Eskom – Kusile Railway Line - 2010
11. Visual Assessment for the proposed Ingula burial grounds near Van Reenen. - KwaZulu Natal, South Africa - Eskom – Ingula burial ground - 2011
12. Visual Assessment for the proposed substation and connecting power lines - Limpopo, South Africa - Eskom – Tabor - 2011
13. Visual Assessment for the proposed Teak Place Estate Development in the Cradle of Humankind. - Cradle of Humankind, South Africa - Teak Place Estate Development – 2007

Summary of other Training/Courses attended

Centre for Environmental Studies	March 2007	NEMA EIA Regulations and their application
Cameron Cross	May 2008	National Environmental Management Waste Act Seminar
Africa Land-Use Training	April 2010	Tree Identification
Africa Land-Use Training	June 2010	Soil Classification and Mapping

Declaration

I confirm that the above CV is an accurate description of my experience and qualifications.

Signature of Staff Member

2 January 2019

Date

APPENDIX B

DECLARATION OF INDEPENDANCE

I, Konrad Krüger, hereby declare that:

- I act as the independent specialist in this application.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations and all other applicable legislation.
- I have not, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority.
- All the particulars furnished by me in this form are true and correct.
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Konrad Krüger

A detailed CV of the author is included in **Appendix A**.

8.2 Noise Assessment

AIRSHED
PLANNING PROFESSIONALS

Vandyksdrift Central (VDDC) Infrastructure: Noise Impact Assessment

Project done for **Jones & Wagener**

Report Compiled By:
Reneé von Gruenewaldt

Fieldwork Completed By:
Jeffrey Moletsane

Report No: 17JAW07N | **Date:** September 2019

Address: 480 Smuts Drive, Halfway Gardens | Postal: P O Box 5260, Halfway House, 1685
Tel: +27 (0)11 805 1940 | Fax: +27 (0)11 805 7010
www.airshed.co.za

Report Details

Report Title	Vandyksdrift Central (VDDC) Infrastructure: Noise Impact Assessment
Client	Jones & Wagener
Report Number	17JAW07N
Report Version	Rev 1.2
Date	September 2019
Prepared by	Renee von Gruenewaldt, (Pr. Sci. Nat.), MSc (University of Pretoria)
Fieldwork conducted by	Jeffrey Moletsane, BSc (University of Pretoria)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality and noise impacts, ranging from nearby neighbourhood concerns to regional impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.
Copyright Warning	

Revision Record

Version	Date	Comments
Rev 0	December 2018	For client review
Rev 0.1	January 2019	Incorporation of client's comments
Rev 0.2	April 2019	Incorporation of client's comments
Rev 1.0	July 2019	Change in infrastructure with re-modelling
Rev 1.1	July 2019	Incorporation of client's comments
Rev 1.2	September 2019	Incorporation of client's comments

NEMA Regulation (2014), Appendix 6

NEMA Regulations (2014) - Appendix 6 (as amended)	Relevant section in report
Details of the specialist who prepared the report.	Report details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Section 1.3: Specialist Details Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority.	Report details (Executive Summary)
An indication of the scope of, and the purpose for which, the report was prepared.	Introduction and background (Executive Summary) Section 1.3: Specialist Details
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 3.3: Baseline Noise Survey and Results
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 1.6: Approach and Methodology
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 3.1: Noise Sensitive Receptors
An identification of any areas to be avoided, including buffers.	Not applicable
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 3.1: Noise Sensitive Receptors
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 1.7: Limitations and Assumptions
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Section 4: Impact Assessment. Alternatives were not assessed.
Any mitigation measures for inclusion in the environmental management programme report	Section 5: Management Measures
Any conditions for inclusion in the environmental authorisation	Section 5: Management Measures
Any monitoring requirements for inclusion in the environmental management programme report or environmental authorisation.	Section 5: Management Measures
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 7: Conclusion
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the environmental management programme report, and where applicable, the closure plan.	Section 5: Management Measures
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable.
A summary and copies if any comments that were received during any consultation process.	No comments received.
Any other information requested by the competent authority.	Not applicable.

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
ASG	Atmospheric Studies Group
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
Hz	Frequency in Hertz
HV	Heavy vehicle
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
kW	Power in kilowatt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{AIeq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
$L_{Req,n}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
$L_{R,dn}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
L_{me}	Sound power level 25 m from a road, 4 m above ground (in dBA)
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)

L_{PZ}	Un-weighted sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
MasI	Meters above sea level
m^2	Area in square meters
m/s	Speed in meters per second
NLG	Noise level guideline
NSR	Noise sensitive receptor
P	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
SABS	South African Bureau of Standards
SANS	South African National Standards
SLM	Sound Level Meter
SoW	Scope of Work
STRM	Shuttle Radar Topography Mission
USGS	United States Geological Survey
WG-AEN	Working Group – Assessment of Environmental Noise (EC)
WHO	World Health Organisation
%	Percentage

Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Jones & Wagener to undertake a specialist environmental noise impact study for the infrastructure development associated with the opencast mining of the pillars at the Vandyksdrift Central (VDDC) section of the Wolvekrans Colliery (hereafter referred to as the project).

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the development of the proposed project and to recommend suitable management and mitigation measures. To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NSRs from available maps and field observations;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from surveys conducted on 3 and 4 July 2018.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of simulated noise levels, reference was made to the South African National Standard (SANS) 10103 and IFC guidelines (55 dBA during the day and 45 dBA during the night).

The baseline acoustic environment was described in terms of the location of NSRs, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels. The following was found:

- Noise sensitive receptors (NSRs) include individual homesteads and small residential areas within the study area.
- Birds, insects, community activity and vehicles are the main contributors to the baseline acoustic environment of the area.
- The lowest baseline noise levels (as measured during the survey) were 39.4 dBA during the day and 35.8 dBA during the night.

Noise emissions from equipment for the project were estimated using L_W predictions for industrial machinery (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine.

Evaporators and pump L_W's were obtained from the database of Airshed Planning Professionals (Pty) Ltd for similar operations. Values from the database are based on source measurements.

The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 18.7 km east-west by 15.8 km north-south. The area was divided into a grid matrix with a 50-m resolution and NSRs were included as discrete receptors.

The main findings of the impact assessment are:

- A management and mitigation plan is recommended to minimise noise impacts from the project on the surrounding area.
- The noise levels from the project operations did not exceed the selected noise criteria at NSRs in the study area.
- Construction and closure phase impacts are expected to be similar or slightly lower than simulated noise impacts of the operational phase.

The following key recommendations should be included in the project environmental management programme:

- A monitoring programme as per the requirements of the International Finance Corporation (IFC) and SANS 10103:
    - Once during the construction phase at R5, R7, R10 and R11;
    - Annually during the operational phase at R5, R7, R10 and R11; and
    - In response to complaints received.

Based on the findings of the assessment and provided the measures planned and recommended are in place, it is the specialist opinion that the project may be authorised.

Table of Contents

List of Tables

List of Figures

1 Introduction

South32 SA Coal Holdings (Pty) Ltd (South32) is the holder of an amended mining right for the Wolvekrans Colliery. The mine is located between the towns of eMalahleni and Kriel in the Nkangala District Municipality of the Mpumalanga Province (Figure 1). The mine has an original Environmental Authorisation (EA) dated February 2006 for opencast mining operations on the farms Steenkoolspruit 18 IS, Kleinkopje 15 IS and Vandyksdrift 19 IS.

Additional infrastructure is required in support of opencast mining of the pillars at the Vandyksdrift Central (VDDC) section of the Wolvekrans Colliery as well as opencast mining not previously authorised (hereafter referred to as the project).

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Jones & Wagener to undertake a specialist environmental noise impact study for the project.

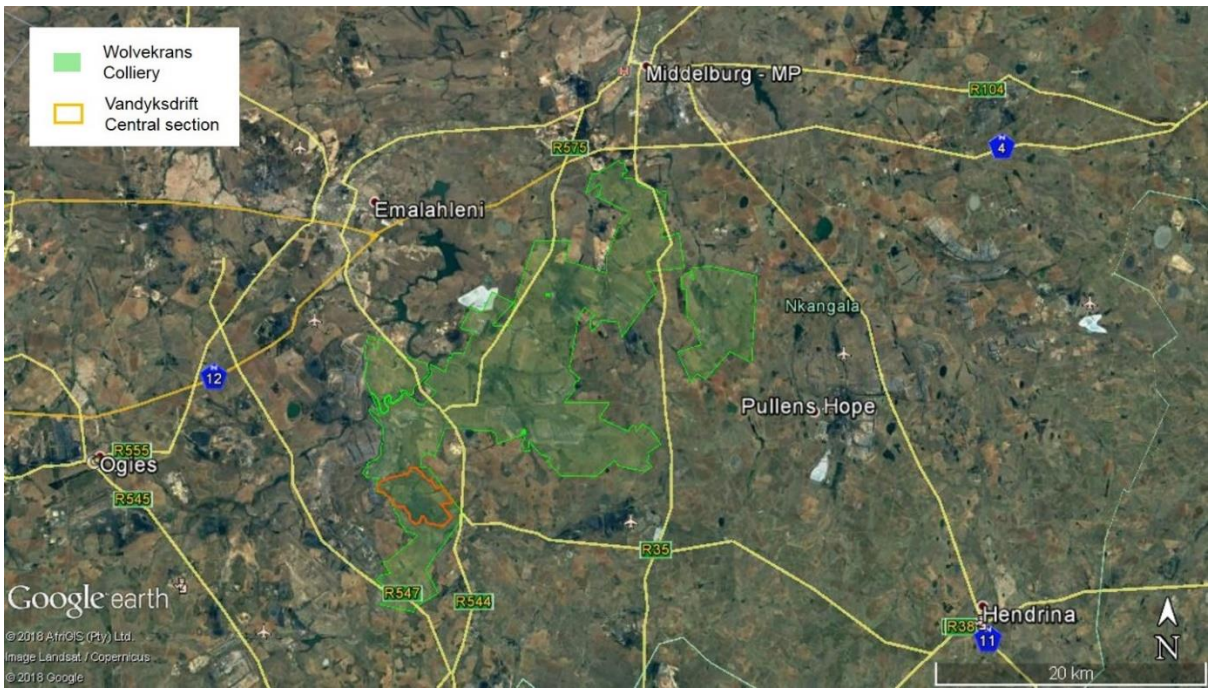


Figure 1: Locality map

1.1 Study Objective

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the operations at the project site and to recommend suitable management and mitigation measures.

1.2 Scope of Work

To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NSRs from available maps and field observations;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from survey conducted on 3-4 July 2018.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project activities.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

1.3 Specialist Details

1.3.1 Specialist Details

Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.

1.3.2 Competency Profile of Specialist

Reneé von Gruenewaldt is a Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP) and a member of the National Association for Clean Air (NACA).

Following the completion of her bachelor's degree in atmospheric sciences in 2000 and honours degree (with distinction) with specialisation in Environmental Analysis and Management in 2001 at the University of Pretoria, her experience in air pollution started when she joined Environmental Management Services (now Airshed Planning Professionals) in 2002. Reneé von Gruenewaldt later completed her Master's Degree (with distinction) in Meteorology at the University of Pretoria in 2009.

Reneé von Gruenewaldt became partner of Airshed Planning Professionals in September 2006. Airshed Planning Professionals is a technical and scientific consultancy providing scientific, engineering and strategic air pollution impact assessment and management services and policy support to assist clients in addressing a wide variety of air pollution related risks and air quality management challenges.

She has extensive experience on the various components of air quality management including emissions quantification for a range of source types, simulations using a range of dispersion models, impacts assessment

and health risk screening assessments. Reneé has been the principal air quality specialist and manager on several Air Quality Impact Assessment between 2006 to present and Noise Assessment projects between 2015 and present and her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to air quality and noise impacts.

A comprehensive curriculum vitae of Reneé von Gruenewaldt is provided in Appendix B.

1.4 Description of Activities from a Noise Perspective

As is typical of opencast mining and ore processing facilities, sources of noise at the project site will include the following:

- Drilling
- Blasting;
- Ore and waste handling (loading, unloading, pushing, dozing) in open pits and on waste rock dumps;
- Haul truck traffic in open pits and haul roads;
- Diesel mobile equipment use (including reverse warnings); and,
- Access road traffic.

Whereas ore processing activities generate noise fairly constantly; drilling, blasting, ore and waste handling, transport activities and operating diesel mobile equipment generate noise that is intermittent and highly variable spatially even over 24 hours. Intuitively, the extent of noise impacts from a source point of view is a function of:

- Mining rates (activity levels);
- Fleet size;
- Spatial distribution of activities; and
- Source type.

The biggest determinant of noise impacts from operations will be the spatial distribution of noise sources and to a lesser extent mining rates and fleet size due to the non-linear cumulative nature of sound pressure levels (see Section 1.5.3).

Although not assessed as part of this study, the character of noise generated by blasting is mentioned. Blasting can cause noise and vibration, which can have an impact upon neighbouring noise receptors. Blasting usually results in both ground and airborne vibration. The latter includes both audible noise and vibration known as airblast, which can cause objects to rattle and make noise. Annoyance and discomfort from blasting can occur when noise startles individuals or when airblast or ground vibration causes vibration of building elements such as windows. The degree of annoyance is influenced by the level of airblast and vibration as well as factors such as the time of day, the frequency of occurrence and the sensitivity of individuals. The generation and transmission of airblast and ground vibration is affected by a number of factors including blast design, meteorology (particularly wind speed and direction and temperature inversions), topography, geology and soil water content (Earth Resources | Victoria State Government, 2015). Whereas the audible part of the airblast (acoustic) is characterized by frequencies ranging from 20 to 20 000 Hz the non-audible part, consist of sound energy below 20 Hz and is referred to as an

'over pressure' when the air blast pressure exceeds atmospheric pressure. Airblast over pressure exerts a force on structures and may in turn cause secondary and audible rattles within structures such as windows (Aloui, et al., 2016).

1.5 Background to Environmental Noise and the Assessment Thereof

Before more details regarding the approach and methodology adopted in the assessment is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

A direct application of linear scales (in pascal (Pa)) to the measurement and calculation of sound pressure leads to large and unwieldy numbers. As the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in Figure 2. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (µPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

As explained, noise is reported in dB. "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in this equation.

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

Where:

L_p *is the sound pressure level in dB;*
p *is the actual sound pressure in Pa; and*
p_{ref} *is the reference sound pressure (p_{ref} in air is 20 µPa).*

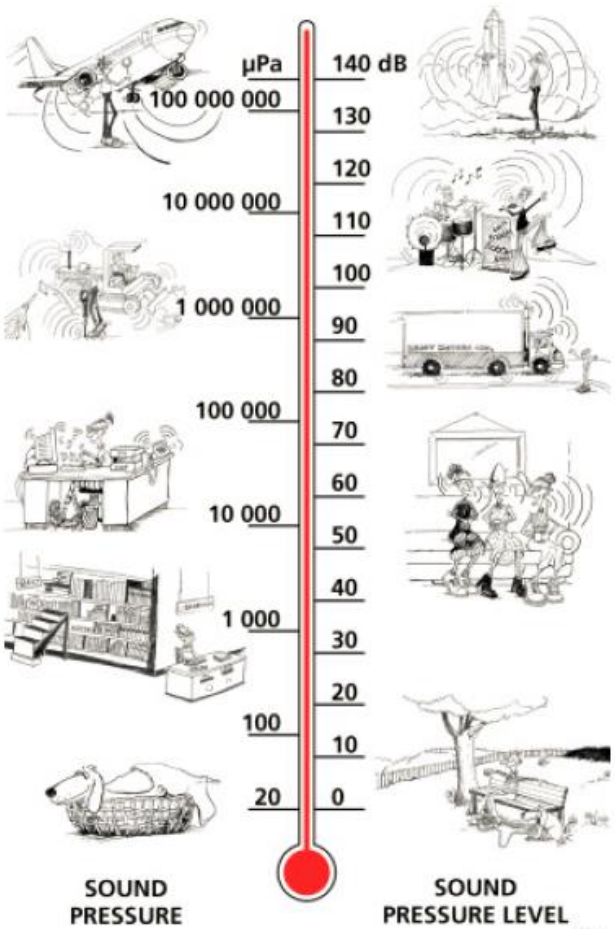


Figure 2: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.5.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing frequency of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8 to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 3). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units (in this case sound pressure) and have been A-weighted.

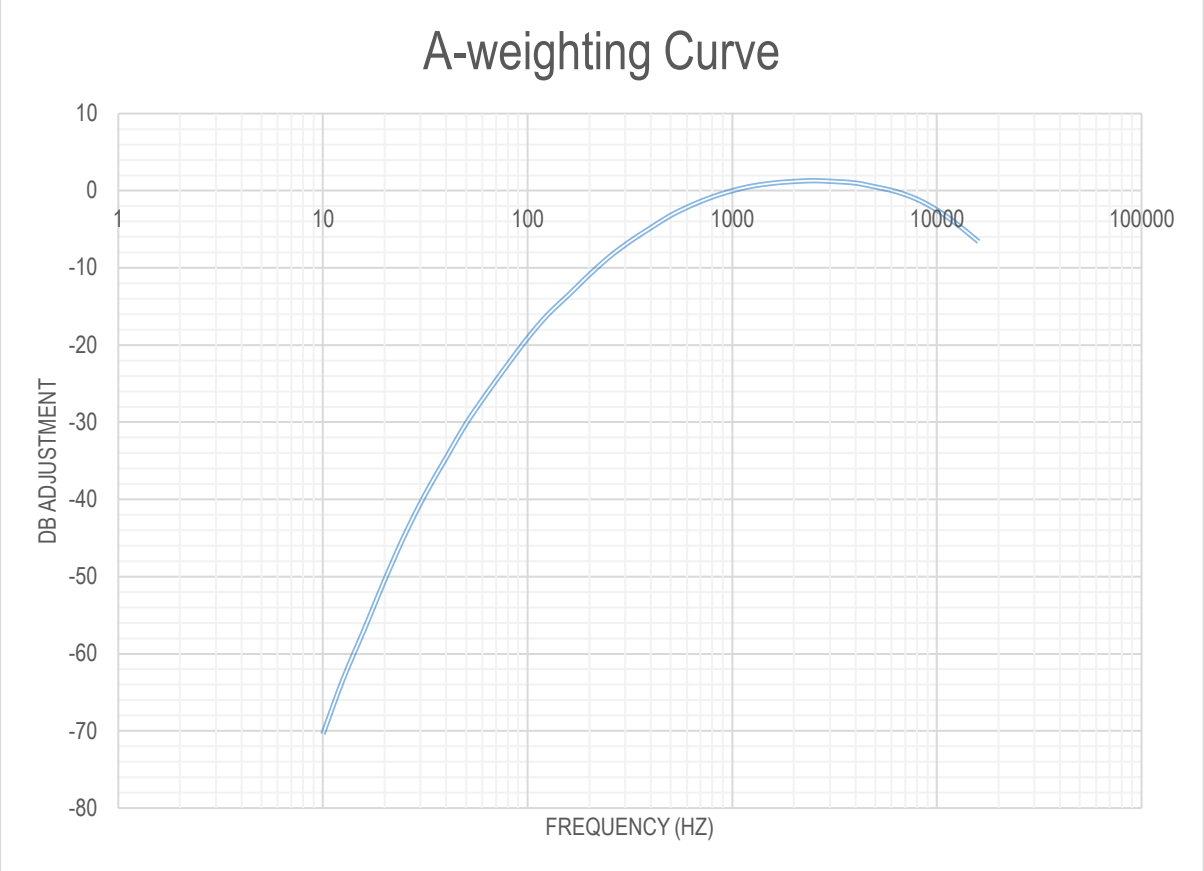


Figure 3: A-weighting curve

1.5.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p\_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power (L_W);
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections.

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is made to the following indices:

- **L_{Zeq} (T)** – The unweighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **L_{A90}** – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.
- **L_{AFmax}** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.

1.6 Approach and Methodology

The assessment included a study of the legal requirements pertaining to environmental noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the operational phase. The findings of the assessment components informed recommendations of management measures, including mitigation and monitoring. Individual aspects of the noise impact assessment methodology are discussed in more detail below.

1.6.1 Information Review

An information requirements list was submitted to Jones & Wagner. In response to the request, the following information was supplied:

- Layout maps;
- Process descriptions;
- Material throughputs;
- Mobile mining equipment fleet; and
- Non-mobile mining equipment details.

1.6.2 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication'*. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General EHS Guidelines* and World Health Organisation (WHO) *Guidelines for Community Noise*, were considered in the assessment.

1.6.3 Study of the Receiving Environment

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside an industrial facility's property.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/). A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise surveys conducted on 3-4 July 2018 was studied to determine current noise levels within the area.

The survey methodology, which closely followed guidance provided by the IFC (2007) and SANS 10103 (2008), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to calibration by an accredited laboratory (Appendix A). Equipment details are included in Table 1.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- Samples, 15 to 30 minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken. SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008).
- L_{Aleq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{90} and 3rd octave frequency spectra were recorded.

- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer.
- A detailed log and record were kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site (Appendix C).

Table 1: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 30-minute sampling.	10 May 2017
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 30-minute sampling.	10 May 2017
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 57649	Testing of the acoustic sensitivity before and after each daily sampling session.	29 May 2018
Kestrel 4000 Pocket Weather Tracker	S/N 559432	Determining wind speed, temperature and humidity during sampling.	Not Applicable

1.6.5 Source Inventory

To determine the change in noise impacts associated with the project, a source inventory had to be developed. A list of diesel mobile mining equipment and processing plant mechanical equipment was made available for study. L_W's for these were calculated using either predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998) or information for similar operations.

Evaporators and pump L_W's were obtained from the database of Airshed Planning Professionals (Pty) Ltd for similar operations. Values from the database are based on source measurements.

Construction and decommissioning activities are expected to result in noise impacts similar to or less significant than impacts associated with the operational phase. A source inventory was therefore only developed for the operational phase of the project.

1.6.6 Noise Propagation Simulations

The propagation of noise from proposed activities was simulated with the DataKustic CadnaA software. Use was made of the International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources.

1.6.6.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5, K_6]$$

Where;

L_P *is the sound pressure level at the receiver;*
L_W *is the sound power level of the source;*
K_1 *is the correction for geometrical divergence;*
K_2 *is the correction for atmospheric absorption;*
K_3 *is the correction for the effect of ground surface;*
K_4 *is the correction for reflection from surfaces; and*
K_5 *is the correction for screening by obstacles.*

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources.

To apply the method of ISO 9613, several parameters need to be known with respect to the geometry of the source and of the environment, the ground surface characteristics, and the source strength in terms of octave-band sound power levels for directions relevant to the propagation.

1.6.6.2 Simulation Domain

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources were quantified as point sources or areas/lines represented by point sources. The sound energy from a point source spreads out spherically, so that the sound pressure level is the same for all points at the same distance from the source and decreases by 6 dB per doubling of distance. This holds true until ground and air

attenuation noticeably affect the level. The impact of an intruding industrial noise on the environment will therefore rarely extend over more than 5 km from the source and is therefore always considered “local” in extent.

The propagation of noise was calculated over an area of 18.7 km east-west by 15.8 km north-south and encompasses the proposed project site. The area was divided into a grid matrix with a 50 m resolution. NSRs and survey locations were included as discrete receptors. The model was set to calculate L_P's at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.6.7 Presentation of Results

Noise impacts were calculated in terms of:

- The day-time noise level (L_{Aeq});
- The night-time noise level (L_{Aeq}); and
- The equivalent day/night noise level (L_{Aeq}).

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case sound pressure, L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, the increase in noise levels above the baseline at NSRs were calculated and compared to guidelines published in SANS 10103.

1.6.8 Recommendations of Management and Mitigation

The findings of the noise specialist study informed the recommendation of suitable noise management and mitigation measures.

1.6.9 Impact Significance Assessment

The significance of environmental noise impacts was assessed according to the methodology adopted by Jones & Wagener and considered both an unmitigated and mitigated scenario. Refer to Appendix E of this report for the methodology.

1.7 Limitations and Assumptions

The following limitations and assumptions should be noted:

- Estimates of road traffic were made with the provided mobile equipment specifications and the mining throughput. Trucks were assumed to travel at 40 km/h.

- The quantification of sources of noise was limited to the operational phase of the project. Construction and closure phase activities are expected to be similar or less significant and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- All activities were assumed to be 24 hours per day, 7 days per week.
- Although other existing sources of noise within the area were identified, such sources were not quantified but were taken into account during the baseline survey.

2 Legal Requirements and Noise Level Guidelines

2.1 South African National Standards

SANS 10103 (2008) successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa, and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). It should be noted that the values given in Table 2 are typical rating levels that it is recommended should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be annoying to the community.

Table 2: Typical rating levels for outdoor noise

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise		
	Day/night $L_{R,dn}$[c] (dBA)	Day-time $L_{Req,d}$[a] (dBA)	Night-time $L_{Req,n}$[b] (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following; business premises; and main roads.	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

Notes

(a) $L_{Req,d}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

(b) $L_{Req,n}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.

(c) $L_{R,dn}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.

SANS 10103 also provides a useful guideline for estimating community response to an increase in the general ambient noise level caused by intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- "$\Delta \leq 0$ dB: There will be no community reaction;
- 0 dB < $\Delta \leq$ 10 dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < $\Delta \leq$ 15 dB: There will be a 'medium' reaction with 'widespread complaints'. Δ = 10 dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < $\Delta \leq$ 20 dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

2.2 International Finance Corporation Guidelines on Environmental Noise

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts **should not exceed the levels presented in Table 3**, or result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

It is further important to note that the IFC noise level guidelines for residential, institutional and educational receptors correspond with the SANS 10103 guidelines for urban districts.

Table 3: IFC noise level guidelines

Area	One Hour L_{Aeq} (dBA) 07:00 to 22:00	One Hour L_{Aeq} (dBA) 22:00 to 07:00
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

2.3 Criteria Applied in This Assessment

Reference is made to the IFC noise level guidelines for residential receptors (which is in line with the SANS 10103 rating for urban districts) and the increase in noise levels of 3 dBA above background levels.

3 Description of the Receiving Environment

This chapter provides details of the receiving acoustic environment which is described in terms of:

- Local NSRs;
- The local environmental noise propagation and attenuation potential; and
- Current noise levels and the existing acoustic climate.

3.1 Noise Sensitive Receptors

Noise sensitive receptors generally include places of residence and areas where members of the public may be affected by noise generated by processing and transport activities.

As mentioned in Section 1.5.4, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. Noise sensitive receptors within 5 km of the project (indicated in Figure 4), include individual homesteads and small residential areas.

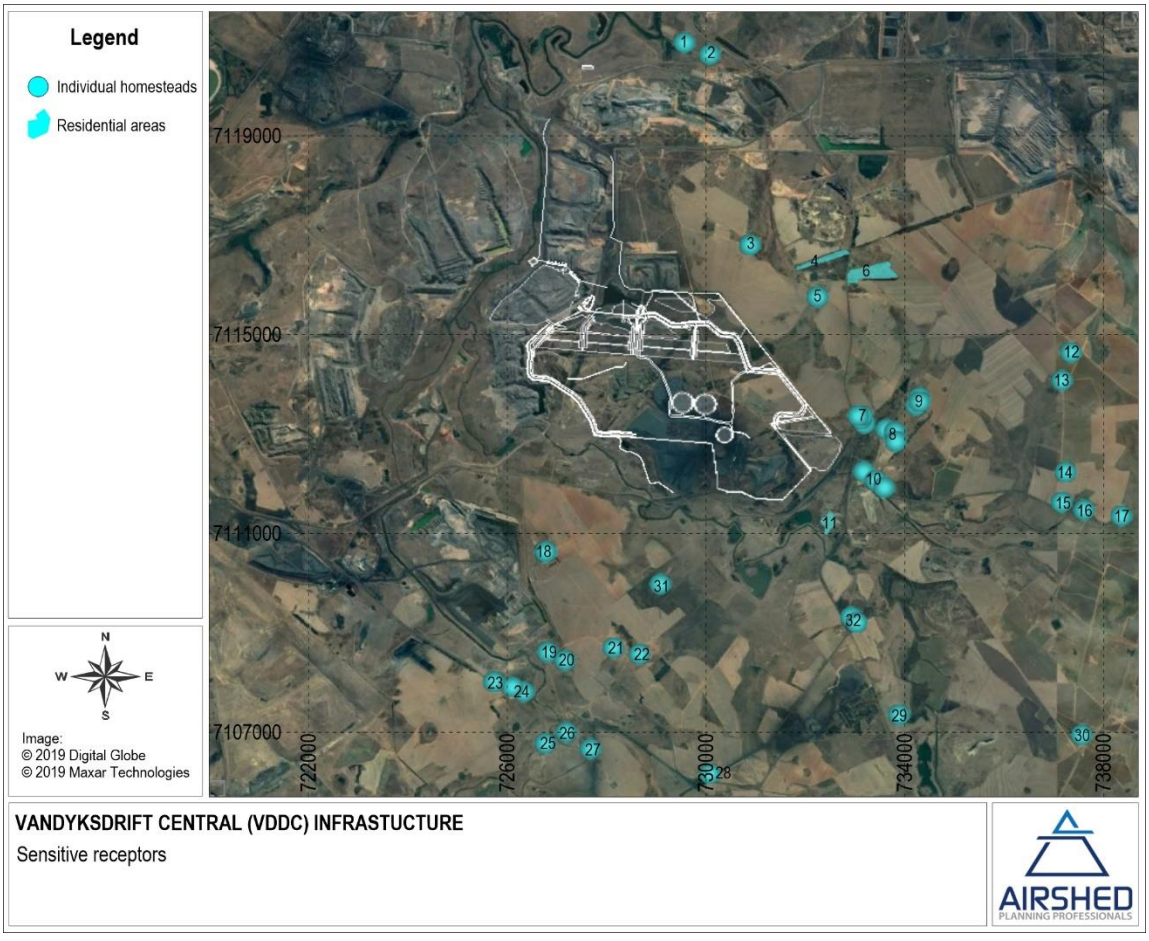
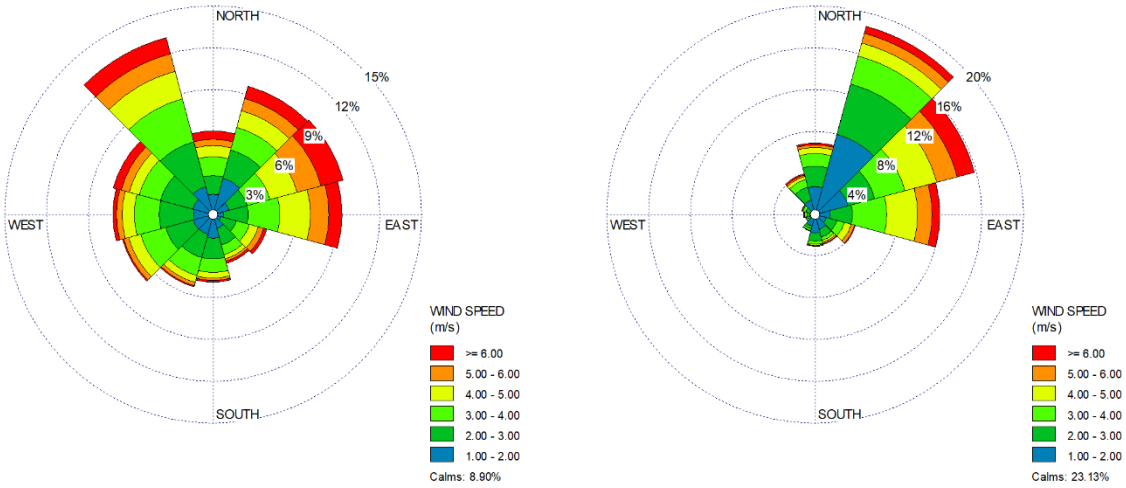


Figure 4: Location of potential NSRs and noise sampling points

Wind speed increases with altitude. This results in the 'bending' of the path of sound to 'focus' it on the downwind side and creating a 'shadow' on the upwind side of the source. Depending on the wind speed, the downwind level

may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s, ambient noise levels are mostly dominated by wind generated noise.

Data from the Eskom operated Komati monitoring station for the period 2013 to 2015 was used for the assessment. During the day, wind is mostly from the north northwest, shifting to north northeast during the night (Figure 5). On average, noise impacts are expected to be more notable to the south and west of the project activities.



(a) Day-time wind rose (06:00 – 22:00) (b) Night-time wind rose (22:00 – 06:00)

Figure 5: Wind rose for Komati monitoring station data, 2013 to 2015

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night. CadnaA allows the input of the average temperature and relative humidity. Use was made of average temperatures of 16°C in simulations, as obtained from the Komati monitoring station for the period 2013 to 2015 and an average relative humidity of 60% was assumed.

3.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature depends on two factors namely the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/). A study made use of Shuttle Radar Topography Mission (STRM) 1 arc-sec data (Figure 6).

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Based on observations made during the visit to site, ground cover was found to be acoustically mixed.

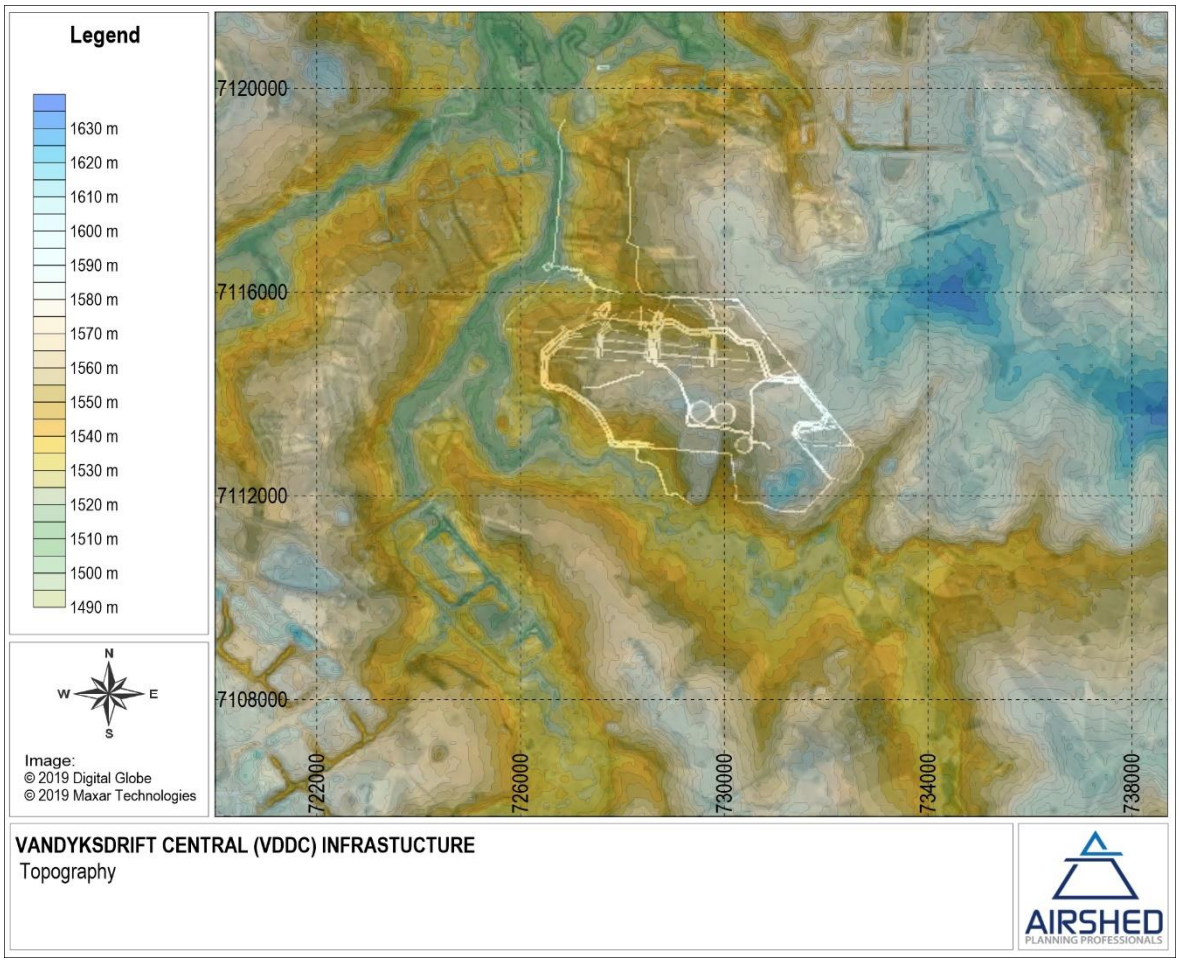


Figure 6: Topography for the study area

3.3 Baseline Noise Survey and Results

Sampling points were selected based on proposed project activities and position of sensitive receptors (Table 4 and Figure 7).

Table 4: Location of the baseline noise survey sites

Site ID	Latitude	Longitude	Description
Site 2	29.324796°S	26.099138°E	Sampling location at NSR 11
Site 3	29.330654°S	26.090437°E	Sampling location at NSR 10
Site 4	29.330125°S	26.080677°E	Sampling location at NSR 7

Site ID	Latitude	Longitude	Description
Site 5	29.334661°S	26.084931°E	Sampling location at NSR 8
Site 6	29.326453°S	26.055784°E	Sampling location at NSR 6

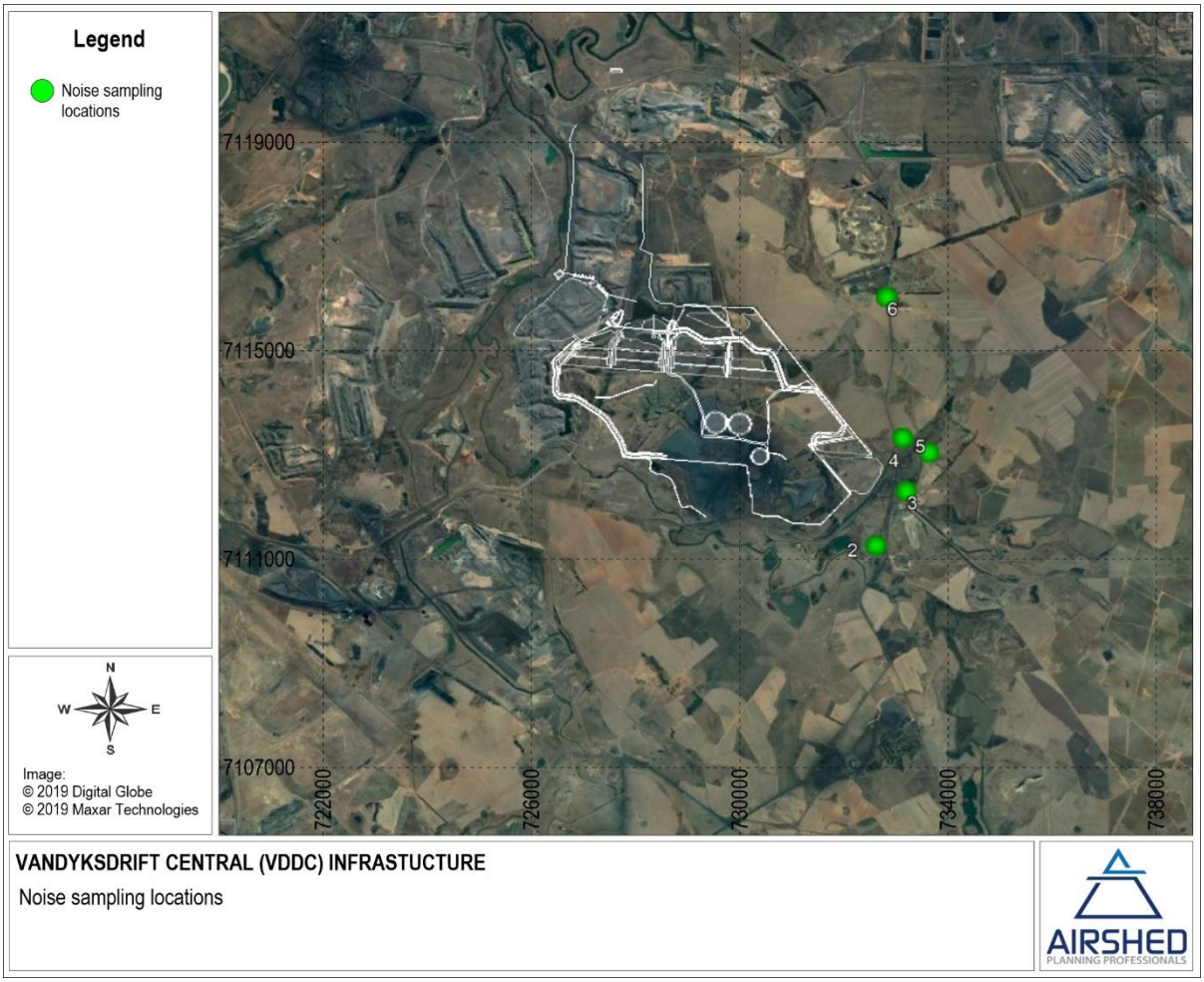


Figure 7: Locations of environmental baseline noise survey sites

Survey results for the campaign undertaken on the 3 and 4 July 2018 are summarised in Table 5 and for comparison purposes, visually presented in Figure 8 (day-time results) and Figure 9 (night-time results) with the noise level guidelines (NLG). Fieldwork log sheets, photographs of the sampling sites and microphone placement are included in Appendix C.

The following is noted:

- Measurements were conducted on 3 and 4 July 2018.
- Weather conditions:
    - During the day weather conditions had no cloud cover, with temperatures between 10.8 °C and 20°C. Slight to moderate wind conditions with wind speeds between 1 and 2.5 m/s mostly from the north-easterly direction.

- At night, skies were clear with temperatures between 5.3°C and 7.2°C. Slight wind conditions with wind speeds between 0.1 and 1.5 m/s mostly from the east and north-easterly direction, prevailed.

- Through subjective observations during measurements and frequency analysis of recorded 3rd octave frequency spectra, it was determined that pure tones were present at Site 3 during the day.
- Day-time baseline noise levels:
  - The highest day-time ambient noise levels were measured at Site 2, comparative to industrial areas according to SANS 10103.
  - L_{Aeq}'s for Site 4 and Site 5 were quiet and considered typical of rural areas according to SANS 10103 with higher noise levels at Site 3 and Site 6 typical of urban areas.
  - Recorded L_{Aeq}'s during the day were within IFC guidelines for residential, institutional and educational receptors (55 dBA) at Site 4 and Site 5.
- Night-time baseline noise levels:
  - Measurements indicate night-time ambient noise levels at Site 4 and Site 5 are quiet.
  - Mining activities were clearly audible at Site 2 and Site 6 during the night.
  - On-site L_{Aeq}'s ranged between 30 dBA and 52 dBA which is considered typical of rural to urban areas according to SANS 10103.
  - Recorded L_{Aeq}'s during the night were within IFC guidelines for residential, institutional and educational receptors (45 dBA) at Site 2, Site 4 and Site 5.

For detailed time-series, frequency spectra and statistical results, the reader is referred to Appendix D.

Table 5: Project baseline environmental noise survey results summary

Site	Date and time	Dura-tion	L_{AFmax} (dBA)	L_{Aleq} (dBA)	L_{Aeq} (dBA)	L_{A90} (dBA)	C_t (dBA)	Observations
Day-time								
Site 2 Small village	03/07/2018 13:49	30:00	93.54	79.98	70.4	38.33	0	Traffic audible.
Site 3 In an open field near a road and petrol station	03/07/2018 13:02	30:00	80.65	63.65	55.55	41.52	5	Traffic audible.
Site 4 Small village	03/07/2018 11:10	30:00	62.7	49.06	44.44	33.2	0	Community activity.
Site 5 Open, uncultivated, field	03/07/2018 12:16	30:00	57.01	42.14	39.35	31.98	0	Birds, traffic, aeroplanes.
Site 6 Open land next to main road	03/07/2018 10:10	30:00	73.42	60.76	59.23	48.08	0	Traffic from road audible.
Night-time								
Site 2 Small village	04/07/2018 0:08	15:00	68.35	48.48	43.91	32.28	0	Traffic and mining audible.
Site 3 In an open field near a	03/07/2018 23:43	15:00	67.56	50.68	49.71	31.64	0	Traffic audible.

Site	Date and time	Dura-tion	L_{AFmax} (dBA)	L_{Aleq} (dBA)	L_{Aeq} (dBA)	L_{A90} (dBA)	C_t (dBA)	Observations
road and petrol station								
Site 4 Small village	03/07/2018 22:48	15:00	62.66	44.55	36.21	30.09	0	Community activity.
Site 5 Open, uncultivated, field	03/07/2018 23:17	15:00	63.27	43.73	35.77	31.5	0	Traffic audible.
Site 6 Open land next to main road	03/07/2018 22:14	15:00	74.49	59.2	51.24	36.98	0	Traffic and mining audible.

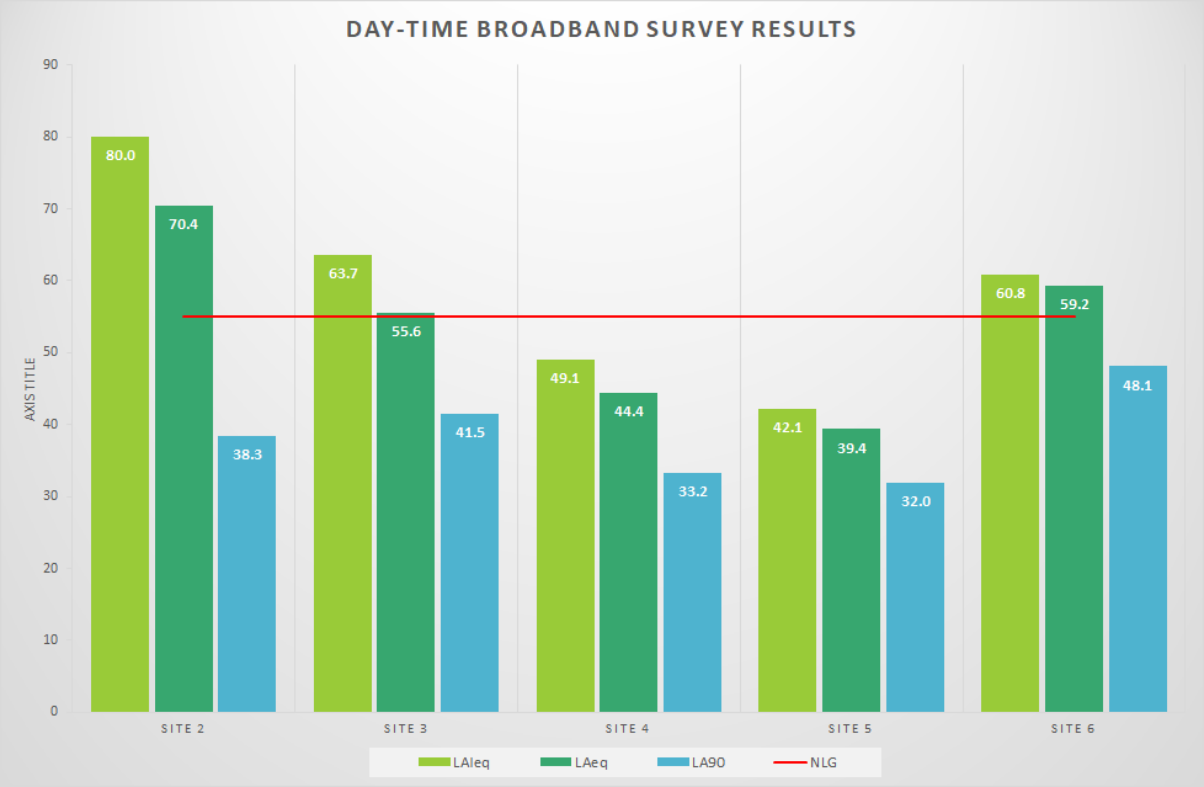


Figure 8: Day-time broadband survey results

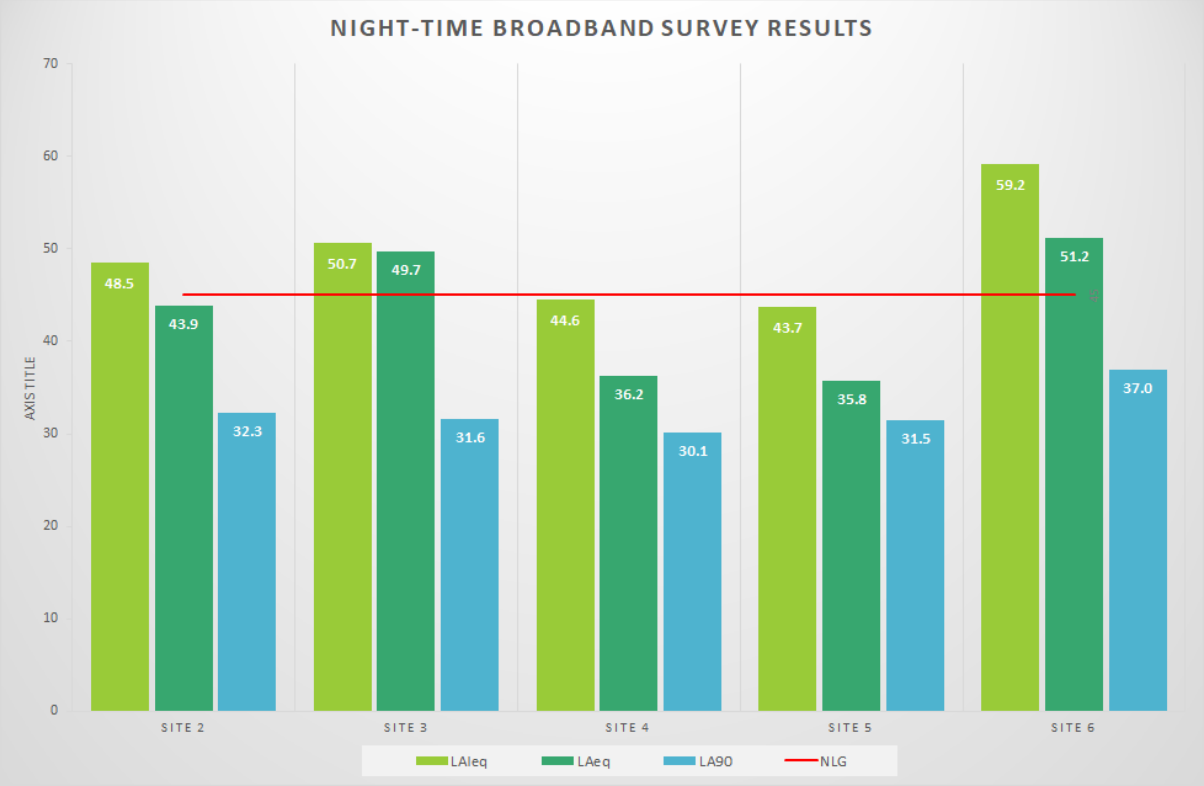


Figure 9: Night-time broadband survey results

4 Impact Assessment

The noise source inventory, noise propagation modelling and results are discussed in Section 4.1 and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

Noise sources for the mobile equipment is summarised in Table 6 with the octave band frequency spectra L_W's included in Table 7.

A detailed list of equipment was provided. Noise sound pressure levels were calculated for all the equipment with the total octave band frequency spectra L_W's provided in Table 7.

Table 6: Noise source inventory for equipment at the project

Source Name	Equipment	Source type	Equipment ID	Qty.	Vehicles per hour	Speed (km/h)	Operating time, day and night-time hours		Lw (dB)
CAT D9 T equivalent	Topsoil Equipment	Area	DOZER1	1	0	0	16	8	125.0
Back actor		Area	BACTOR	1	0	0	16	8	118.1
ADT Cat 740 "25 Ton		Area	ADT	2	0	40	16	8	125.4
Dragline	Overburden and interburden equipment	Area	DRAGLINE	2	0	0	16	8	130.5
Cable realer		Area	CABLEREALER	1	0	0	16	8	129.3
CAT D9 T equivalent		Area	DOZER1	2	0	0	16	8	125.0
G14 Grader		Area	GRADER1	2	0	0	16	8	120.9
Hydraulic Excavator - 600 T (40 Cube Bucket)		Area	EXCAVATOR1	2	0	0	16	8	124.7
Rear Dump Truck (CAT 789 D equivalent)		Area	DUMPTRUCK1	4	0	40	16	8	131.6
CAT 834 H equivalent (1 per 2 shovels)		Area	DOZER2	3	0	0	16	8	125.3
Grader CAT 16M equivalent		Area	GRADER2	3	0	0	16	8	123.0
Water Bowser CAT 777 F equivalent		Area	WBOWSER	2	0	0	16	8	128.4
CAT D11 T equivalent		Area	DOZER3	3	0	0	16	8	127.7
CAT D10 T equivalent		Area	DOZER4	3	0	0	16	8	126.1
Pre strip hydraulic excavator - 6050 size		Area	EXCAVATOR2	6	0	0	16	8	132.4
Rear Dump Truck (CAT 789 D equivalent)		Area	DUMPTRUCK1	21	0	40	16	8	131.6
CAT 834 H equivalent (1 per 2 shovels)		Area	DOZER2	4	0	0	16	8	125.3
Grader CAT 16M equivalent		Area	GRADER2	4	0	0	16	8	123.0
CAT 993 K equivalent	Coal extraction equipment	Area	LOADER	3	0	0	16	8	128.6
Rear Dump Truck (CAT 785 D equivalent)		Moving point source	DUMPTRUCK2	8	8.53	40	16	8	130.0
CAT 777 F equivalent		Area	DBOWSER	2	0	0	16	8	128.4
Pit Viper 274 equivalent	Drills	Area	DRILL1	4	0	0	16	8	128.1
Atlas Copco DM 30 equivalent		Area	DRILL2	2	0	0	16	8	124.8
Evaporator Unit	Evaporators	Point sources	EVAPO	16	0	0	16	8	116.5
Pump Unit	Pumps	Point sources	PUMP	12	0	0	16	8	99.7

Table 7: Octave band frequency spectra L_W's for the project equipment

Equipment	Equipment ID	Equipment details	Type	L_W octave band frequency spectra (dB)								L_W (dB)	L_{WA} (dBA)	Source
				63	125	250	500	1000	2000	4000	8000			
Topsoil Equipment	DOZER1	CAT D9 T equivalent	L_W	113.4	118.4	121.4	116.4	114.4	111.4	105.4	99.4	125.0	119.7	L_W Predictions (Bruce & Moritz, 1998)
	BACTOR	Back actor	L_W	106.5	111.5	114.5	109.5	107.5	104.5	98.5	92.5	118.1	112.8	L_W Predictions (Bruce & Moritz, 1998)
	ADT	ADT Cat 740 "25 Ton	L_W	113.8	118.8	121.8	116.8	114.8	111.8	105.8	99.8	125.4	120.0	L_W Predictions (Bruce & Moritz, 1998)
Overburden and interburden equipment	DRAGLINE	Dragline	L_W	118.9	123.9	126.9	121.9	119.9	116.9	110.9	104.9	130.5	125.2	L_W Predictions (Bruce & Moritz, 1998)
	CABLEREALER	Cable realer	L_W	117.7	122.7	125.7	120.7	118.7	115.7	109.7	103.7	129.3	124.0	L_W Predictions (Bruce & Moritz, 1998)
	DOZER1	CAT D9 T equivalent	L_W	113.4	118.4	121.4	116.4	114.4	111.4	105.4	99.4	125.0	119.7	L_W Predictions (Bruce & Moritz, 1998)
	GRADER1	G14 Grader	L_W	109.3	114.3	117.3	112.3	110.3	107.3	101.3	95.3	120.9	115.5	L_W Predictions (Bruce & Moritz, 1998)
	EXCAVATOR1	Hydraulic Excavator - 600 T (40 Cube Bucket)	L_W	113.1	118.1	121.1	116.1	114.1	111.1	105.1	99.1	124.7	119.4	L_W Predictions (Bruce & Moritz, 1998)
	DUMPTRUCK1	Rear Dump Truck (CAT 789 D equivalent)	L_W	119.9	124.9	127.9	122.9	120.9	117.9	111.9	105.9	131.6	126.2	L_W Predictions (Bruce & Moritz, 1998)
	DOZER2	CAT 834 H equivalent (1 per 2 shovels)	L_W	113.7	118.7	121.7	116.7	114.7	111.7	105.7	99.7	125.3	120.0	L_W Predictions (Bruce & Moritz, 1998)
	GRADER2	Grader CAT 16M equivalent	L_W	111.3	116.3	119.3	114.3	112.3	109.3	103.3	97.3	123.0	117.6	L_W Predictions (Bruce & Moritz, 1998)
	WBOWSER	Water Bowser CAT 777 F equivalent	L_W	116.8	121.8	124.8	119.8	117.8	114.8	108.8	102.8	128.4	123.1	L_W Predictions (Bruce & Moritz, 1998)

Equipment	Equipment ID	Equipment details	Type	L_W octave band frequency spectra (dB)								L_W (dB)	L_{WA} (dBA)	Source
				63	125	250	500	1000	2000	4000	8000			
	DOZER3	CAT D11 T equivalent	L_W	116.0	121.0	124.0	119.0	117.0	114.0	108.0	102.0	127.7	122.3	L_W Predictions (Bruce & Moritz, 1998)
	DOZER4	CAT D10 T equivalent	L_W	114.5	119.5	122.5	117.5	115.5	112.5	106.5	100.5	126.1	120.8	L_W Predictions (Bruce & Moritz, 1998)
	EXCAVATOR2	Pre strip hydraulic excavator - 6050 size	L_W	120.7	125.7	128.7	123.7	121.7	118.7	112.7	106.7	132.4	127.0	L_W Predictions (Bruce & Moritz, 1998)
	DUMPTRUCK1	Rear Dump Truck (CAT 789 D equivalent)	L_W	119.9	124.9	127.9	122.9	120.9	117.9	111.9	105.9	131.6	126.2	L_W Predictions (Bruce & Moritz, 1998)
	DOZER2	CAT 834 H equivalent (1 per 2 shovels)	L_W	113.7	118.7	121.7	116.7	114.7	111.7	105.7	99.7	125.3	120.0	L_W Predictions (Bruce & Moritz, 1998)
	GRADER2	Grader CAT 16M equivalent	L_W	111.3	116.3	119.3	114.3	112.3	109.3	103.3	97.3	123.0	117.6	L_W Predictions (Bruce & Moritz, 1998)
Coal extraction equipment	LOADER	CAT 993 K equivalent	L_W	116.9	121.9	124.9	119.9	117.9	114.9	108.9	102.9	128.6	123.2	L_W Predictions (Bruce & Moritz, 1998)
	DUMPTRUCK2	Rear Dump Truck (CAT 785 D equivalent)	L_W	118.3	123.3	126.3	121.3	119.3	116.3	110.3	104.3	130.0	124.6	L_W Predictions (Bruce & Moritz, 1998)
	DBOWSER	CAT 777 F equivalent	L_W	116.8	121.8	124.8	119.8	117.8	114.8	108.8	102.8	128.4	123.1	L_W Predictions (Bruce & Moritz, 1998)
Drills	DRILL1	Pit Viper 274 equivalent	L_W	116.5	121.5	124.5	119.5	117.5	114.5	108.5	102.5	128.1	122.8	L_W Predictions (Bruce & Moritz, 1998)
	DRILL2	Atlas Copco DM 30 equivalent	L_W	113.2	118.2	121.2	116.2	114.2	111.2	105.2	99.2	124.8	119.4	L_W Predictions (Bruce & Moritz, 1998)
Evaporators	EVAPO	Evaporator Unit	L_W	100.7	112.7	109.8	103.9	99.2	96.2	110.5		116.5	112.7	L_W Database
Pumps	PUMP	Pump Unit	L_W	86.2	95.8	90.8	87.5	85.7	85.5	94.2		99.7	96.7	L_W Database

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated with CadnaA in accordance with ISO 9613. Site specific acoustic parameters as discussed in Section 3.2 along with source data discussed in 4.1, were applied in the model.

Table 8 provides a summary of simulated noise levels at NSRs. Results are also presented in isopleth form (Figure 10 to Figure 12). The simulated equivalent continuous day-time rating level ($L_{Req,d}$) due to project operations of 55 dBA (guideline level) extends ~120 m from the pit and ~80m from the haul road. The simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (guideline level) due to project operations extends ~900 m from the pit and ~400 m from the haul road. The simulated continuous day- and night-time rating levels do not exceed the noise guideline levels at any of the identified sensitive receptors.

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. According to SANS 10103 (2008); 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints expected from the community for increased noise levels up to 10 dBA. 'Very strong' reaction with 'vigorous community action' is expected from the community for increased noise levels of more than 15 dBA. With the approach adopted for the assessment (detailed in Section 1.6), the predicted increase in noise levels are expected to result in 'little' reaction with 'sporadic' complaints from NSRs R2, R3 and R8 during the night and 'medium' reaction with 'sporadic' to 'widespread' complaints from R7 during the night.

Table 8: Summary of simulated noise levels (provided as dBA) due to the project (which includes the associated mining activities) and baseline noise measurements at NSR within the study area

Noise Sensitive Receptor	Project operations		Baseline		Increase Above Baseline [e]	
	Day	Night	Day	Night	Day	Night
R1	27	28	39.4 [b]	35.8 [b]	0.2	0.7
R2	36.5	37.4	39.4 [b]	35.8 [b]	1.8	3.9
R3	39.1	38.5	39.4 [b]	35.8 [b]	2.9	4.6
R4	32.2	31.7	59.2 [a] [c]	51.2 [a] [d]	0.0	0.0
R5	35.2	34.6	39.4 [b]	35.8 [b]	1.4	2.5
R6	0	0	59.2 [c]	51.2 [d]	0.0	0.0
R7	42.5	41.9	44.4	36.2	2.2	6.7
R8	38.5	38	39.4	35.8	2.6	4.2
R9	28.4	27.7	39.4 [b]	35.8 [b]	0.3	0.6
R10	39.4	39.2	55.6 [c]	49.7 [d]	0.1	0.4
R11	39.7	39.7	70.4 [c]	43.9	0.0	1.4
R12	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R13	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R14	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R15	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R16	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R17	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R18	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R19	0	0	39.4 [b]	35.8 [b]	0.0	0.0

Noise Sensitive Receptor	Project operations		Baseline		Increase Above Baseline [e]	
	Day	Night	Day	Night	Day	Night
R20	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R21	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R22	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R23	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R24	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R25	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R26	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R27	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R28	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R29	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R30	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R31	0	0	39.4 [b]	35.8 [b]	0.0	0.0
R32	0	0	39.4 [b]	35.8 [b]	0.0	0.0

Notes:

(a) Assumed based on closest noise sampling location

(b) Assumed based on lowest sampled noise levels in the study area (conservative approach)

(c) Exceeds day-time IFC guideline of 55 dBA for residences

(d) Exceeds night-time IFC guideline of 45 dBA for residences

(e) Likely community response:

0 to 1 dBA – No reaction, increase not detectable

1 to 3 dBA – Increase just detectable to persons with average hearing acuity, annoyance unlikely.

3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.

5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.

10 to 15 dBA – There will be a 'strong' reaction with 'threats of community action'.

> 15 dBA – There will be a 'very strong' reaction with 'vigorous community action'.

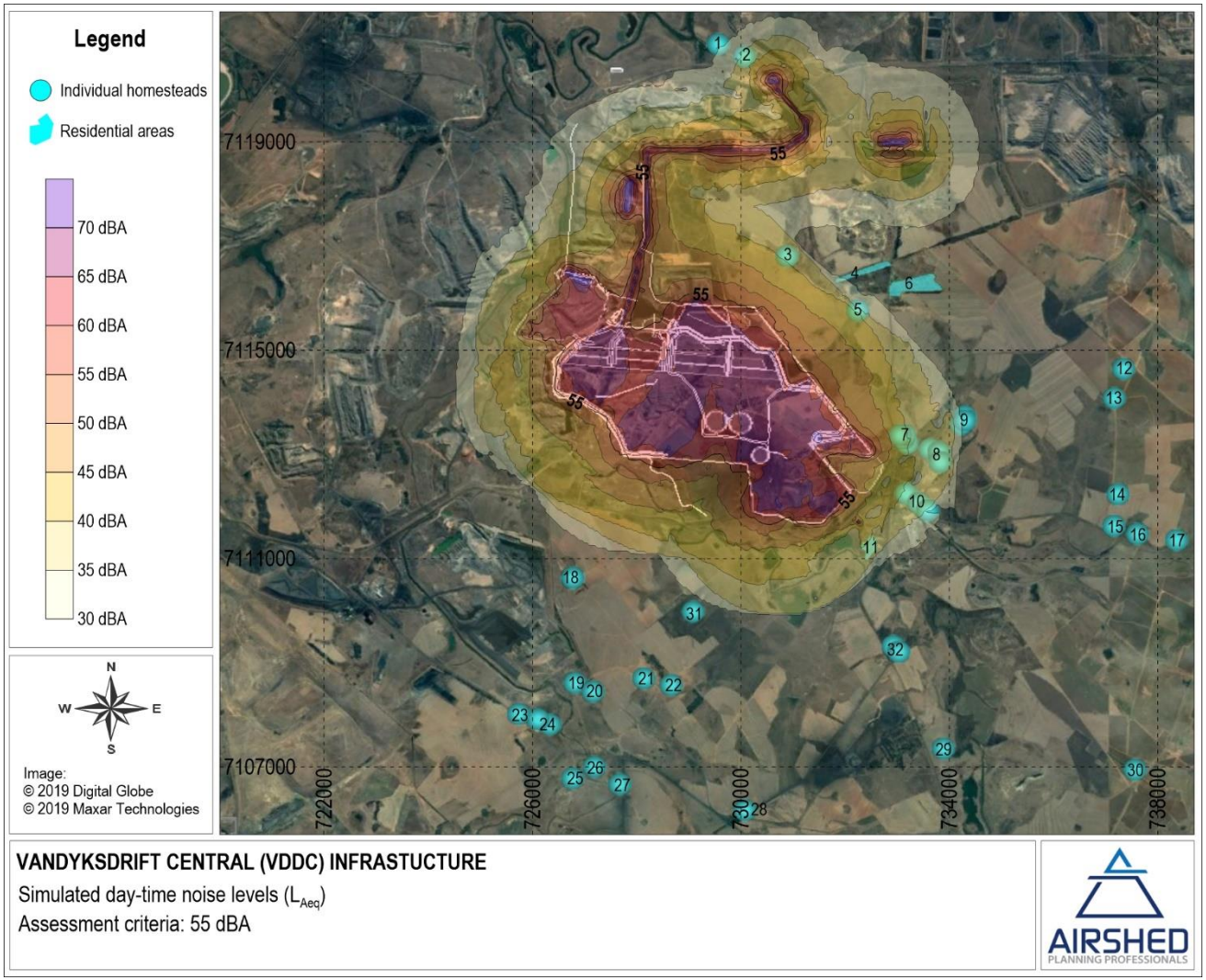


Figure 10: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities

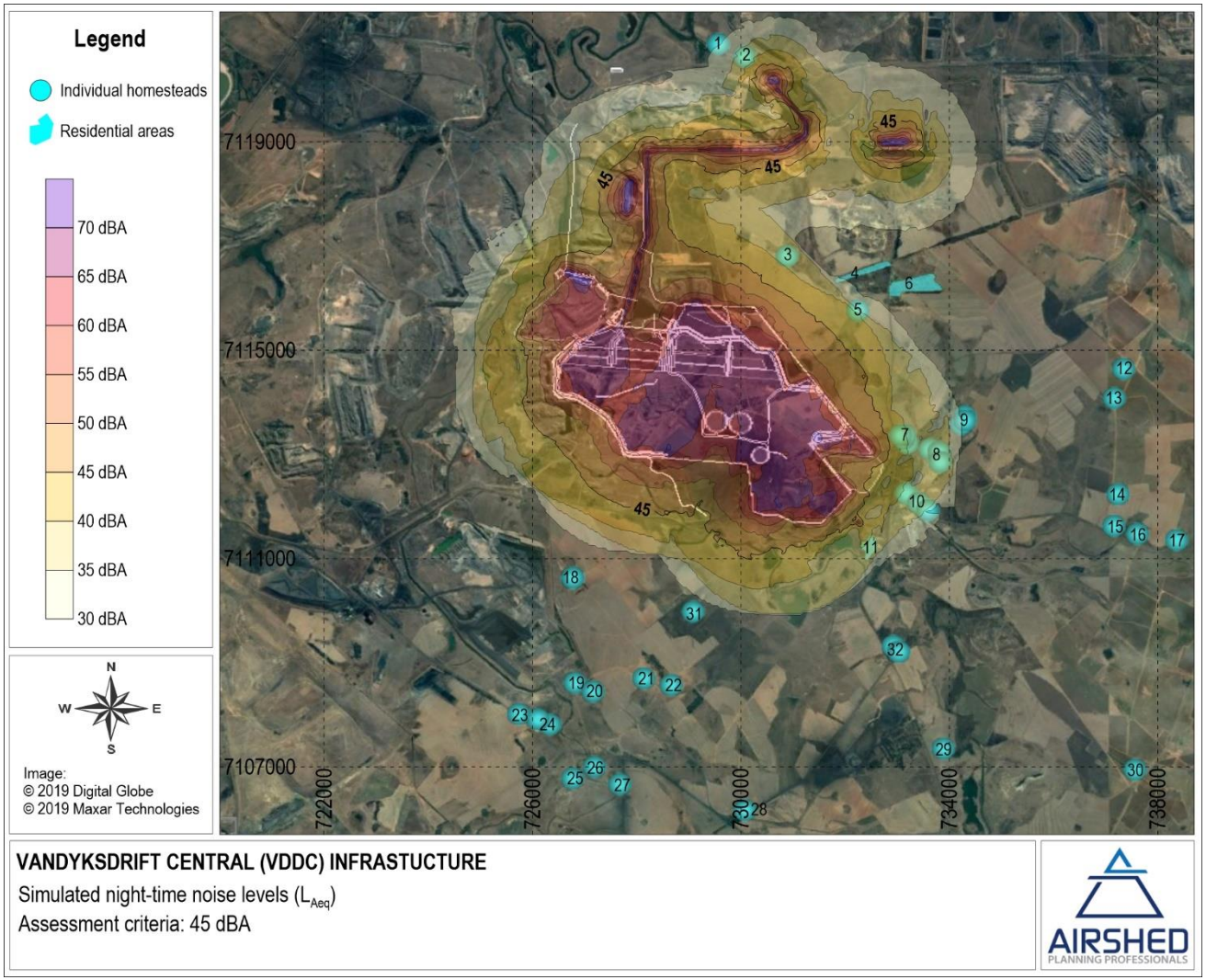


Figure 11: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for project activities

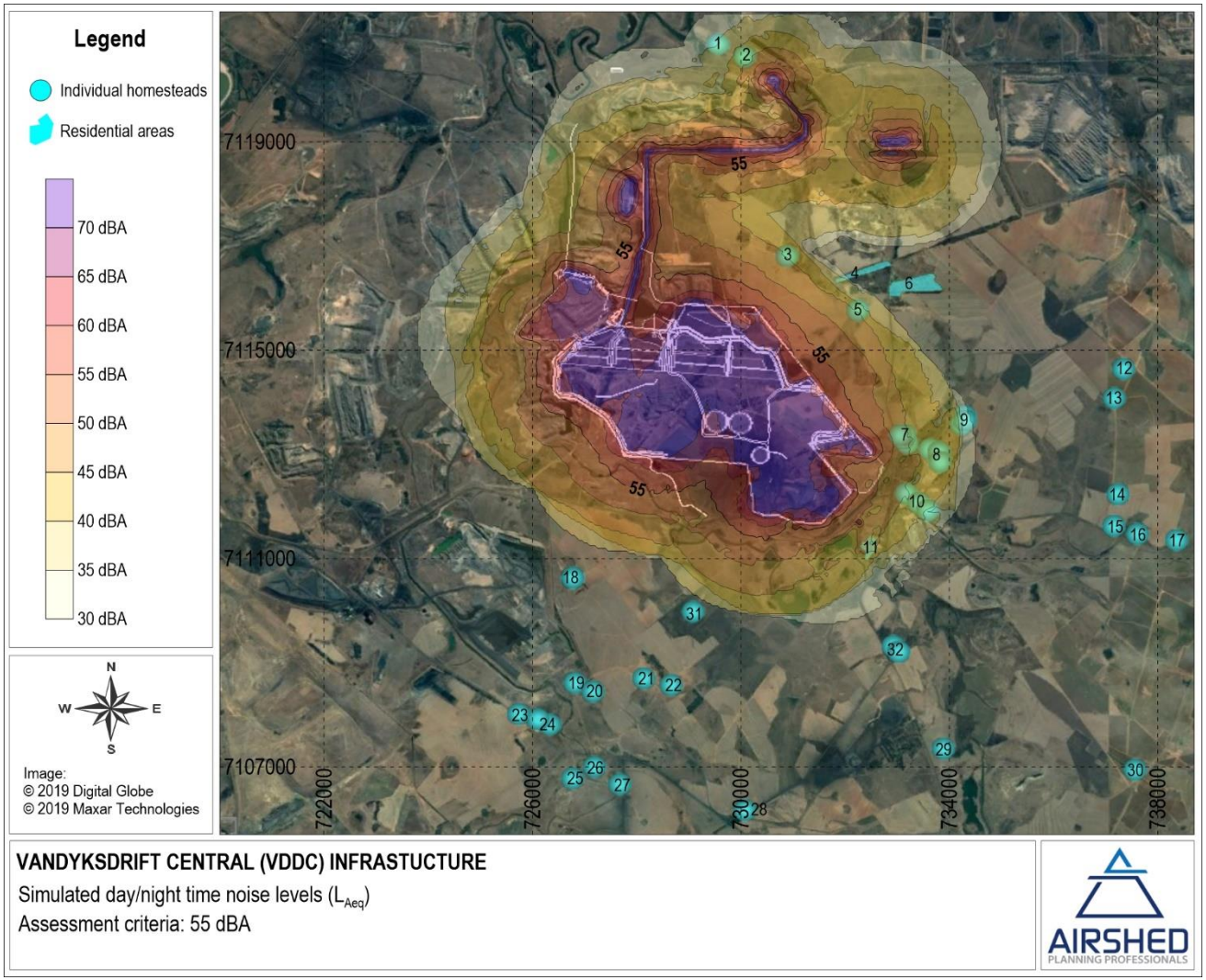


Figure 12: Simulated equivalent continuous day/night-time rating level ($L_{Req,dn}$) for project activities

5 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the proposed project, it was calculated that ambient noise evaluation criteria for human receptors will not be exceeded at NSRs. 'Little' to 'medium' reaction can be expected from members of the community within this impact area.

From a noise perspective, the project may proceed. It is recommended, however, that mitigation measures be implemented to ensure minimal impacts on the surrounding environment.

5.1 Engineering and Operational Practices

For general activities, the following good engineering practice **should** be applied to **all project phases**:

- All diesel-powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- Equipment with lower sound power levels must be selected. Vendors should be required to guarantee optimised equipment design noise levels.
- In managing noise specifically related to truck and vehicle traffic, efforts **should** be directed at:
    - Minimising individual vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
    - Maintain road surface regularly to avoid corrugations, potholes etc.
    - Avoid unnecessary idling times.
- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A **complaints register must be kept**.

5.2 Monitoring

An environmental noise monitoring survey should be conducted once during construction to determine baseline and once during the operational phase to ensure that evaluation limits are not exceeded at NSRs. It is recommended that the noise monitoring surveys be conducted at the following NSRs: R5, R7, R10 and R11. The duration of the noise sampling will be 15 – 30 minutes per site and should only be conducted if safe to do so.

Also, In the event that noise related complaints are received short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions. The sampling sites selected for complaint investigations will be selected based on safety and security.

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), L_{Aleq} (T), statistical noise level L_{A90}, L_{AFmin} and L_{AFmax}, octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

The investigation of complaints should include an investigation into equipment or machinery that likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

6 Impact Significance Rating

2014 EIA Regulations (as amended) require that impacts be assessed in terms of the nature, significance, consequence, extent, duration and probability of the impacts including the degree to which these impacts can be reversed, may cause irreplaceable loss of resources, and can be avoided, managed or mitigated. The significance ranking methodology used in this scoping report is provided in Appendix E.

The noise impacts during construction and decommissioning phase will be similar to operational phase. The significance of the noise impacts is provided in Table 9 and are moderate for unmitigated operations and low for mitigated operations.

No noise impacts are expected post-closure.

Table 9: Significance rating for noise impacts due to project activities including construction, operation and decommissioning phases for the mining and infrastructure development

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Construction and Demolition Phase (without mitigation)					
	MODERATE	Local	Short Term	Very Likely	**MODERATE**
Noise impact	3	3	2	4	2.1
Construction and Demolition Phase (with mitigation)					
	LOW	Study Area	Short Term	Could Happen	**LOW**
Noise impact	2	2	2	3	1.2
Operation Phase (without mitigation)					
	MODERATE	Local	Medium Term	Very Likely	**MODERATE**
Noise impact	3	3	3	4	2.4
Operation Phase (with mitigation)					
	LOW	Study Area	Medium Term	Could Happen	**LOW**
Noise impact	2	2	3	3	1.4

7 Conclusion

Based on the findings of the assessment and provided the recommended management and mitigation measures are in place, it is the specialist opinion that the project may be authorised.

8 References

Aloui, M., Bleuzen, Y., Essefi, E. & Abbes, C., 2016. Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia. *Journal of Geology and Geophysics,* 5(3).

Bruce, R. D. & Moritz, C. T., 1998. Sound Power Level Predictions for Industrial Machinery. In: M. J. Crocker, ed. *Handbook of Acoustics.* Hoboken: John Whiley & Sons, Inc, pp. 863-872.

Brüel & Kjær Sound & Vibration Measurement A/S, 2000. *www.bksv.com.* [Online] Available at: http://www.bksv.com [Accessed 14 October 2011].

BSI, 2008. *Code of practice for noise and vibration control on construction and open sites - Part 1: Noise.* s.l.:s.n.

Burgess, M. & McCarty, M., 2009. *Review of Alternatives to 'Beeper' Alarms for Construction Equipment,* Canberra: University of New South Wales.

Earth Resources | Victoria State Government, 2015. *Ground Vibration and Airblast Limits for Blasting in Mines and Quarries.* [Online] Available at: http://earthresources.vic.gov.au/earth-resources-regulation/licensing-and-approvals/minerals/guidelines-and-codes-of-practice/ground-vibration-and-airblast-limits-for-blasting-in-mines-and-quarries [Accessed 5 January 2018].

IFC, 2007. *General Environmental, Health and Safety Guidelines,* s.l.: s.n.

SANS 10103, 2008. *The measurement and rating of environmental noise with respect to annoyance and to speech communication,* Pretoria: Standards South Africa.

WHO, 1999. *Guidelines to Community Noise.* s.l.:s.n.

Appendix A – Sound Level Meter Calibration Certificates

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250-L, 4950
Serial number:	2731851, 2709293
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Midrand
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	10 – 11 May 2017

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-52)
Inline Capacitor	(AS-98)
Madgetech PRHTemp 2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **11 May 2017**	**Page 1 of 3**	Certificate number **AV\AS-4634**

Your measure of excellence

2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)		U = 0,20 dB
Electrical self generated noise		
A-weighted	(12,9 dB)	U = 0,30 dB
C-weighted	(13,7 dB)	U = 0,30 dB
Linear	(19,2 dB)	U = 0,30 dB
Linearity range (primary indicator range) (SANS clause 9.9, table 11)		
1 kHz		U = 0,12 dB
4 kHz		U = 0,12 dB
8 kHz		U = 0,12 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)		
A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)		
Slow and Fast		U = 0,11 dB
Impulse		U = 0,11 dB
Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)		U = 0,12 dB
Impulse weighted time averaging, L_{Aleq} (SANS 658 Annex C, table C1)		U = 0,12 dB
Overload indication (SANS 656 clause 11.3)		U = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response (SANS 656 clauses 8.1, tables 4 & 5)	
31,5 Hz – 12,5 kHz	U = 0,20 dB @ 1 kHz

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of Issue **11 May 2017**	**Page 2 of 3**	Certificate number **AV\AS-4634**

2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation — U = 0,10 dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation — U = 0,10 dB @ f_m
(IEC 61260 clause 4.4, 5.3)
12,5 Hz - 16 kHz

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of k = 2, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware versions of the sound measuring device at the time of calibration were: BZ7130 V4.4; BZ7131 V4.4; BZ7132 V4.4.

---------- *end of certificate* ----------

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of Issue		Certificate number
11 May 2017	**Page 3 of 3**	**AVIAS-4634**

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND CALIBRATOR
Manufacturer:	SVANTEK
Model number:	SV33
Serial number:	43170
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Midrand
Calibration procedure:	AV\AS-0008
Period of calibration:	29 May 2018

1 PROCEDURE

The sound calibrator was calibrated according to IEC 60942: 2003 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 2673 preamplifier	(AS-146)
MadgeTech PRHTemp2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)
Brüel & Kjær 4228 Pistonphone	(AS-WSTD-13)
Brüel & Kjær 4192 Pressure Microphone	(AS-WSTD-15)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **29 May 2018**	**Page 1 of 2**	Certificate number **AV\AS-4723**

Your measure of excellence

2 RESULTS

2.1 The following parameters of the sound calibrator were calibrated and conformed to IEC 60942: 2003 specification, class 1:

Frequency (IEC 60942 clause B.3.5) 1 000 Hz	U = 0,10 Hz
Sound Pressure Level (IEC 60942 clause B.3.4) 114 dB	U = 0,15 dB
Total Distortion (IEC 60942 clause B.3.6)	U = 0,13 %

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

---------- *end of certificate* ----------

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **29 May 2018**	**Page 2 of 2**	Certificate number **AV\AS-4723**

Appendix B – Specialist Curriculum Vitae

CURRICULUM VITAE RENÉ VON GRUENEWALDT

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	René von Gruenewaldt (*nee* Thomas)
Profession	Air Quality Scientist
Date of Birth	13 May 1978
Years with Firm	More than 15 years
Nationalities	South African

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP)
- Member of the National Association for Clean Air (NACA)

KEY QUALIFICATIONS

René von Gruenewaldt (Air Quality Scientist): René joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over fifteen (15) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and three (3) years of experience in the field of noise assessments. As an environmental practitioner, she has provided solutions to both large-scale and smaller projects within the mining, minerals, and process industries.

She has developed technical and specialist skills in various modelling packages including the AMS/EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), EPA Regulatory puff based model (CALPUFF and CALMET), puff based HAWK model and line based models. Her experience with emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of waste water treatment works) and GasSim (for the quantification of landfill emissions). Noise propagation modelling proficiency includes CONCAWE, South African National Standards (SANS 10210) for calculating and predicting road traffic noise.

Having worked on projects throughout Africa (i.e. South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt) René has developed a broad experience base. She has a good understanding of the laws and regulations associated with ambient air quality and emission limits in South Africa and various other African countries, as well as the World Bank Guidelines, European Community Limits and World Health Organisation.

RELEVANT EXPERIENCE

Mining and Ore Handling

René has undertaken numerous air quality impact assessments and management plans for coal, platinum, uranium, copper, cobalt, chromium, fluorspar, bauxite, manganese and mineral sands mines. These include: compilation of emissions databases for Landau and New Vaal coal collieries (SA), impact assessments and management plans for numerous mines over Mpumalanga (viz. Schoonoord, Belfast, Goedgevonden, Mbila, Evander South, Driefontein, Hartogshoop, Belfast, New Largo, Geluk, etc.), Mmamabula Coal Colliery (Botswana), Moatize Coal Colliery (Mozambique), Revuboe Coal Colliery (Mozambique), Toliera Sands Heavy Minerals Mine and Processing (Madagascar), Corridor Sands Heavy Minerals Mine monitoring assessment, El Burullus Heavy Minerals Mine and processing (Egypt), Namakwa Sands Heavy Minerals Mine (SA), Tenke Copper Mine and Processing Plant (DRC), Rössing Uranium (Namibia), Lonmin platinum mines including operations at Marikana, Baobab, Dwaalkop and Doornvlei (SA), Impala Platinum (SA), Pilannesburg Platinum (SA), Aquarius Platinum, Hoogland Platinum Mine (SA), Tamboti PGM Mine (SA), Sari Gunay Gold Mine (Iran), chrome mines in the Steelpoort Valley (SA), Mecklenburg Chrome Mine (SA), Naboom Chrome Mine (SA), Kinsenda Copper Mine (DRC), Kassinga Mine (Angola) and Nokeng Flourspar Mine (SA), etc.

Mining monitoring reviews have also been undertaken for Optimum Colliery's operations near Hendrina Power Station and Impunzi Coal Colliery with a detailed management plan undertaken for Morupule (Botswana) and Glencor (previously known as Xstrata Coal South Africa).

Air quality assessments have also been undertaken for mechanical appliances including the Durban Coal Terminal and Nacala Port (Mozambique) as well as rail transport assessments including BHP-Billiton Bauxite transport (Suriname), Nacala Rail Corridor (Mozambique and Malawi), Kusile Rail (SA) and WCL Rail (Liberia).

Metal Recovery

Air quality impact assessments have been carried out for Highveld Steel, Scaw Metals, Lonmin's Marikana Smelter operations, Saldanha Steel, Tata Steel, Afro Asia Steel and Exxaro's Manganese Pilot Plant Smelter (Pretoria).

Chemical Industry

Comprehensive air quality impact assessments have been completed for NCP (including Chloorkop Expansion Project, Contaminated soils recovery, C3 Project and the 200T Receiver Project), Revertex Chemicals (Durban), Stoppani Chromium Chemicals, Foskor (Richards Bay), Straits Chemicals (Coega), Tenke Acid Plant (DRC), and Omnia (Sasolburg).

Petrochemical Industry

Numerous air quality impact assessments have been completed for Sasol (including the postponement/exemption application for Synfuels, Infrachem, Natref, MIBK2 Project, Wax Project, GTL Project, re-commissioning of boilers at Sasol Sasolburg and Ekandustria), Engen Emission Inventory Functional Specification (Durban), Sapref refinery (Durban), Sasol (at Elrode) and Island View (in Durban) tanks quantification, Petro SA and Chevron (including the postponement/exemption application).

Pulp and Paper Industry

Air quality studies have been undertaken or the expansion of Mondi Richards Bay, Multi-Boiler Project for Mondi Merebank (Durban), impact assessments for Sappi Stanger, Sappi Enstra (Springs), Sappi Ngodwana (Nelspruit) and Pulp United (Richards Bay).

Power Generation

Air quality impact assessments have been completed for numerous Eskom coal fired power station studies including the ash expansion projects at Kusile, Kendal, Hendrina, Kriel and Arnot; Fabric Filter Plants at Komati, Grootvlei, Tutuka, Lethabo and Kriel Power Stations; the proposed Kusile, Medupi (including the impact assessment for the Flue Gas Desulphurization) and Vaal South Power Stations. René was also involved and the cumulative assessment of the existing and return to service Eskom power stations assessment and the optimization of Eskom's ambient air quality monitoring network over the Highveld.

In addition to Eskom's coal fired power stations, various Eskom nuclear power supply projects have been completed including the air quality assessment of Pebble Bed Modular Reactor and nuclear plants at Duynefontein, Bantamsklip and Thyspunt.

Apart from Eskom projects, power station assessments have also been completed in Kenya (Rabai Power Station) and Namibia (Paratus Power Plant).

Waste Disposal

Air quality impact assessments, including odour and carcinogenic and non-carcinogenic pollutants were undertaken for the Waste Water Treatment Works in Magaliesburg, proposed Waterval Landfill (near Rustenburg), Tutuka Landfill, Mogale General Waste Landfill (adjacent to the Leipardsvlei Landfill), Cape Winelands District Municipality Landfill and the Tsoeneng Landfill (Lesotho). Air quality impact assessments have also been completed for the BCL incinerator (Cape Town), the Ergo Rubber Incinerator and the Ecorevert Pyrolysis Plant.

Cement Manufacturing

Impact assessments for ambient air quality have been completed for the Holcim Alternative Fuels Project (which included the assessment of the cement manufacturing plants at Ulco and Dudfield as well as a proposed blending platform in Roodepoort).

Management Plans

René undertook the quantification of the baseline air quality for the first declared Vaal Triangle Airshed Priority Area. This included the establishment of a comprehensive air pollution emissions inventory, atmospheric dispersion modelling, focusing on impact area "hotspots" and quantifying emission reduction strategies. The management plan was published in 2009 (Government Gazette 32263).

René has also been involved in the Provincial Air Quality Management Plan for the Limpopo Province.

Other Experience (2001)

Research for B.Sc Honours degree was part of the "Highveld Boundary Layer Wind" research group and was based on the identification of faulty data from the Majuba Sodar. The project was THRIP funded and was a joint venture with the University of Pretoria, Eskom and Sasol (2001).

EDUCATION

M.Sc Earth Sciences	University of Pretoria, RSA, Cum Laude (2009) Title: *An Air Quality Baseline Assessment for the Vaal Airshed in South Africa*
B.Sc Hons. Earth Sciences	University of Pretoria, RSA, Cum Laude (2001) Environmental Management and Impact Assessments
B.Sc Earth Sciences	University of Pretoria, RSA, (2000) Atmospheric Sciences: Meteorology

ADDITIONAL COURSES

CALMET/CALPUFF	Presented by the University of Johannesburg, RSA (March 2008)
Air Quality Management	Presented by the University of Johannesburg, RSA (March 2006)
ARCINFO	GIMS, Course: Introduction to ARCINFO 7 (2001)

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Malawi, Liberia, Kenya, Angola, Democratic Republic of Congo, Lesotho, Namibia, Madagascar, Egypt, Suriname and Iran.

EMPLOYMENT RECORD

January 2002 - Present

Airshed Planning Professionals (Pty) Ltd, (previously known as Environmental Management Services cc until March 2003), Principal Air Quality Scientist, Midrand, South Africa.

2001

University of Pretoria, Demi for the Geography and Geoinformatics department and a research assistant for the Atmospheric Science department, Pretoria, South Africa.

Department of Environmental Affairs and Tourism, assisted in the editing of the Agenda 21 document for the world summit (July 2001), Pretoria, South Africa.

1999 - 2000

The South African Weather Services, vacation work in the research department, Pretoria, South Africa.

CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- Understanding the Synoptic Systems that lead to Strong Easterly Wind Conditions and High Particulate Matter Concentrations on The West Coast of Namibia, H Liebenberg-Enslin, R von Gruenewaldt, H Rauntenbach and L Burger. National Association for Clean Air (NACA) conference, October 2017.
- Topographical Effects on Predicted Ground Level Concentrations using AERMOD, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2011.
- Emission Factor Performance Assessment for Blasting Operations, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2009.
- Vaal Triangle Priority Area Air Quality Management Plan – Baseline Characterisation, R.G. Thomas, H Liebenberg-Enslin, N Walton and M van Nierop. National Association for Clean Air (NACA) conference, October 2007.
- A High-Resolution Diagnostic Wind Field Model for Mesoscale Air Pollution Forecasting, R.G. Thomas, L.W. Burger, and H Rautenbach. National Association for Clean Air (NACA) conference, September 2005.
- Emissions Based Management Tool for Mining Operations, R.G. Thomas and L.W. Burger. National Association for Clean Air (NACA) conference, October 2004.
- An Investigation into the Accuracy of the Majuba Sodar Mixing Layer Heights, R.G. Thomas. Highveld Boundary Layer Wind Conference, November 2002.

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Fair	Good	Good

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

Signature of staff member

22/11/2017

Date (Day / Month / Year)

Full name of staff member: René Georgeinna von Gruenewaldt

SITE NUMBER: VDDC 001 (site 6)		SLM DATA RECORD:
Longitude/Easting: 29.326453°	Latitude/Northing: -26.055784°	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	± 2.5	N	10.8	44.8	0/10	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☒ Constr.	☐ Other

Description: Open land, near to main road ± 20m, Windy area, Noise background ± 69dB Traffic
Semi-Cultivated land

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
10:11:10	Car passing	22:21	"	35:05	Car passing		
11:31	"	22:47	"	36:04	Const Wind		
11:47	"	23:31	Constr	-36:53	"		
12:04	"		Vehicle	37:05	Car passing		
12:56	"	25:02	Const	38:06	"		
13:41	"	-25:50		39:44	Constr passing		
14:52	"	27:39	Const Wind				
17:59	Construction Vehicle	28:38	"				
14:18	"	-29:16	"				
-19:33	"	29:32	Constr				
21:13	"	-30:11	"				
21:29		31:34	"				
21:53	Constr	31:36	Wind				
-56	Vehicle	33:10	Car passing				

E

Page of

SITE NUMBER: vddc002 (site 4)		SLM DATA RECORD:
Longitude/Easting: 29.330125°	Latitude/Northing: -26.080677°	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	± 2.2	N. Easterly	15	~~34~~ 40	0/10	
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☒ Dogs	☐ Music	☒ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Small village, little open, windy area, ~~wind~~ gust wind @ ± 53 dB, with houses Background noise

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
11:10.58	Gust wind	27:51	Birds	11:39:26	Kids playing		
12:07	Dog bak	29:06	Dog	3940	Wind		
14:08	Baby crying	-29:35	Dog				
15:11	Gust wind	30:34	Gust wind				
17:18	Dog	32:07	Kids playing				
20:05	Wind	-32:53	"				
20:59	Dog	33:16	"				
21:29	Kids		Bird				
-22:00	playing	35:48	Kids playing				
22:21	Dog	-36:29					
25:02	Kids	37:08	Rooster				
-24:43	playing	37:27					
26:32	Gust wind	38:43	Kids				
-27:08							

E

SITE NUMBER: vddc 004 (site 5)		SLM DATA RECORD:
Longitude/Easting: 29.334661°	Latitude/Northing: -26.084931	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	±2.2	N. EastNy	15.7	34.6	0/10	
Middle						
End						

NOISE CLIMATE	☑ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Open field, little tress, uncultivated land, Birds

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
12:16:55	Bird	24:02	Car passing	36:52	Birds	45:18	Car passing
17:19	Gust wind	29:02	Aeroplane	37:07	"	-45:36	"
-18:23	"	-29:15		37:40	Birds	46:30	"
19:13		29:44		38:24			
20:43	Aeroplane	-30:20	Birds	38:45	Wind		
-21:51	"	30:33	Gust wind	39:38	"		
23:00	Birds	31:53		-40:33	"		
-23:37	"	-32:32	Gust wind	41:08	Wind		
24:17	Gust wind	33:06	Birds	-42:08			
-25:21		34:14	Wind	42:09	Aeroplane		
26:03	Birds	-34:40		-42:57			
		12:35:16	Birds	43:19	Car passing		
26:20	Bird	-35:57		43:39	"		
26:52	Car passing by			44:37	Bird		

E

SITE NUMBER:	Vddc005 (site3)	SLM DATA RECORD:	
Longitude/Easting:	29.330654	Latitude/Northing: -26.090437	Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	± 1	Eastely	16.6	30.8	0/10	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☒ Constr.	☒ Other

Description: Next road, semi-open field, close to petrol station ± 20m, Cars coming in petrol intersection Trucks & cars @ ± 60dB Trucks

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
13:03:48	Truck passing	15:54	Truck passing	28:26	Car passing		
04:08	Car passing	- 16:23	"	29:24	Truck passing		
04:30	"	18:29	"	29:44			
05:46	"	20:01	Truck hooter	30:24	Car passing		
07:35	"	20:30	Const passing				
08:03	Truck (constr vehicle) passing	21:52	"				
		13:33:46	"				
08:59	"	24:14	Constr vehicle				
10:17 -	Cars passing	24:59	passing				
10:20		25:23	person screaming				
11:23	Truck passing	26:08	hooter (truck)				
13:23	Trucks	26:49	Truck				
- 14:06	passing						
		27:19	Truck hooter				

E

SITE NUMBER: VddC 006 (Site 2)		SLM DATA RECORD:
Longitude/Easting: 29.324796°	Latitude/Northing: -26.099138°	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2	N. Easterly	20°C	26.3	0/10	
Middle						
End						

NOISE CLIMATE	☒ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☒ Other

Description: Open field, small village, uncultivate land, ~~Main~~ road 1 50m
Truck passing @ 1 80dB

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
13:51:42	Car passing	09:17	Dust wind	15			
55:30	Truck passing	- 10:51	"				
55:51	Car passing	11:03	"				
57:34	Roosters	- 11:16	"				
	Roosters	12:17	Car passing				
59:12	Car passing	13:40 -	"				
14:00:03	Truck passing	- 14:43	Trucks passing				
00:29	"	15:34	"				
14:01:46	"	- 15:55	"				
- 03:00	"	16:39	Car passing				
03:51-		17:22	Constr V.				
06:03		- 17:36	Car passing				
07:46	- Car. passing	18:34	"				
		- 18:50	"				

Page of

SITE NUMBER:	vddc007 (site 6) Night	SLM DATA RECORD:	
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.8	08	6.8	691	0	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other

Description: Could hear Anglo operations, Traffic Noise @ ± 60dB
@ ± 40dB

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
22:15:07	Car passing	26:40	Anglo operations				
15:50		27:25	Car passing				
17:03		25:14	Anglo operations				
15:02		- 28:55	"				
15:54		24:23	Anglo operat				
-19:53							
22:35							
22:53							
23:25	Anglo operations						
24:20	Truck passing						
-25:01							
25:43	Hammer						
25:57	Car passing						

E

SITE NUMBER:	vddc 008 (Site 4) Night	SLM DATA RECORD:	
Longitude/Easting:	Latitude/Northing:	Elevation:	
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1	Easterly	5.3	75.2%	0/10	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22:48:30	Dog Bak	59:24	Gust wind				
22:49	Gust wind	-23:00	"				
22:50	Traffic	01	"				
22:50	Wind	23:00:43	"				
22:51	"	23:01:12	Dogs				
53:	Traffic	23:01:					
54		33	People				
22:55:	Dog	23:01:55					
56:17	Gust wind	02:30	"				
56:50	Dog						
57:34	Wind						
58:06	"						
58:46	People						

Page of

SITE NUMBER: Site 5 (vddoo9) Night			SLM DATA RECORD:
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.3	N E	7.2	71.3	0	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other

Description: Background noise @ 135dB

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
23:17:20	Gust wind						
-17:47							
18:14	"						
-18:52							
19:25	hooter car						
4:04							
23:22:	- car passing						
55							
23:28:01	Car passing						

SITE NUMBER: VddC01.0 (site 3) Night		SLM DATA RECORD:
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.5	N-E	6.5	67.7		
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other

Description: Background noise @ I 36dB

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
23:43:43	Truck passing	53:47	Truck passing				
46:04	Car passing	-54:02					
47:15	"						
-~~56~~		55:17	car passing				
48:02-	Truck passing	~~57~~:05	Car passing				
48:19	"	57:12					
~~48:44~~	"						
49:03	"						
~~49:40~~	"						
49:40							
50:00	Car passing						
~~5~~2:25	"						
53:25	Truck						

E

Page of

SITE NUMBER: VddCon. (site 2) Night		SLM DATA RECORD:
Longitude/Easting:	Latitude/Northing:	Elevation:
Short Location Description & Notes:		

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.1		7.1	57.8	0	
Middle						
End						

NOISE CLIMATE	☐ Birds	☐ Insects	☐ Dogs	☐ Music	☐ Community	☐ Air Traffic	☒ Road Traffic	☐ Constr.	☐ Other

Description: Background noise @ ± 40 dB

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
00:08:36	Hooter						
08:36							
09:14	Hooter car						
00:10:00	} Car passing						
11:56	}						
14:00	} Car passing						
14:15	}						
00:16	Car						
:30							
17:11							
19:48	Anglo operations						
20:33	Car passing						
22:14	"						

E

Facing north

Facing east

Facing south

Facing west

Figure 13: Photographs of environmental noise survey Site 2

Facing north

Facing east

Facing south

Facing west

Figure 14: Photographs of environmental noise survey Site 3

Facing north

Facing east

Facing south

Facing west

Figure 15: Photographs of environmental noise survey Site 4

Facing north

Facing east

Facing south

Facing west

Figure 16: Photographs of environmental noise survey Site 5

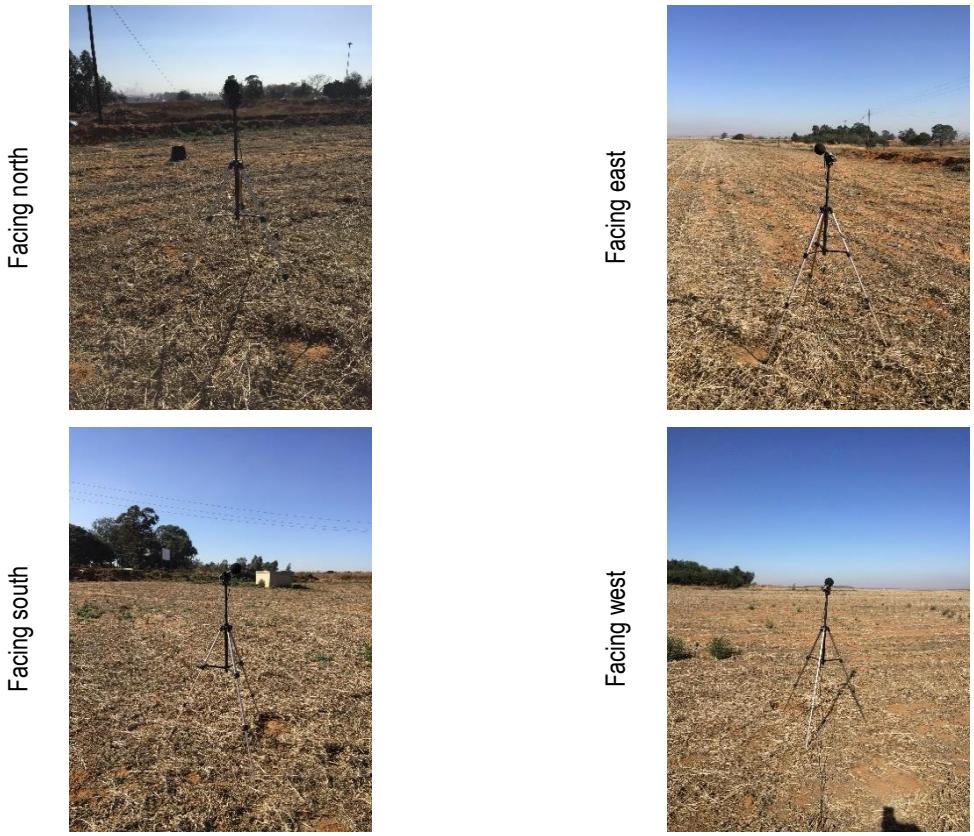


Figure 17: Photographs of environmental noise survey Site 6

Appendix D – Time-series, Statistical, and Frequency Spectrum Results

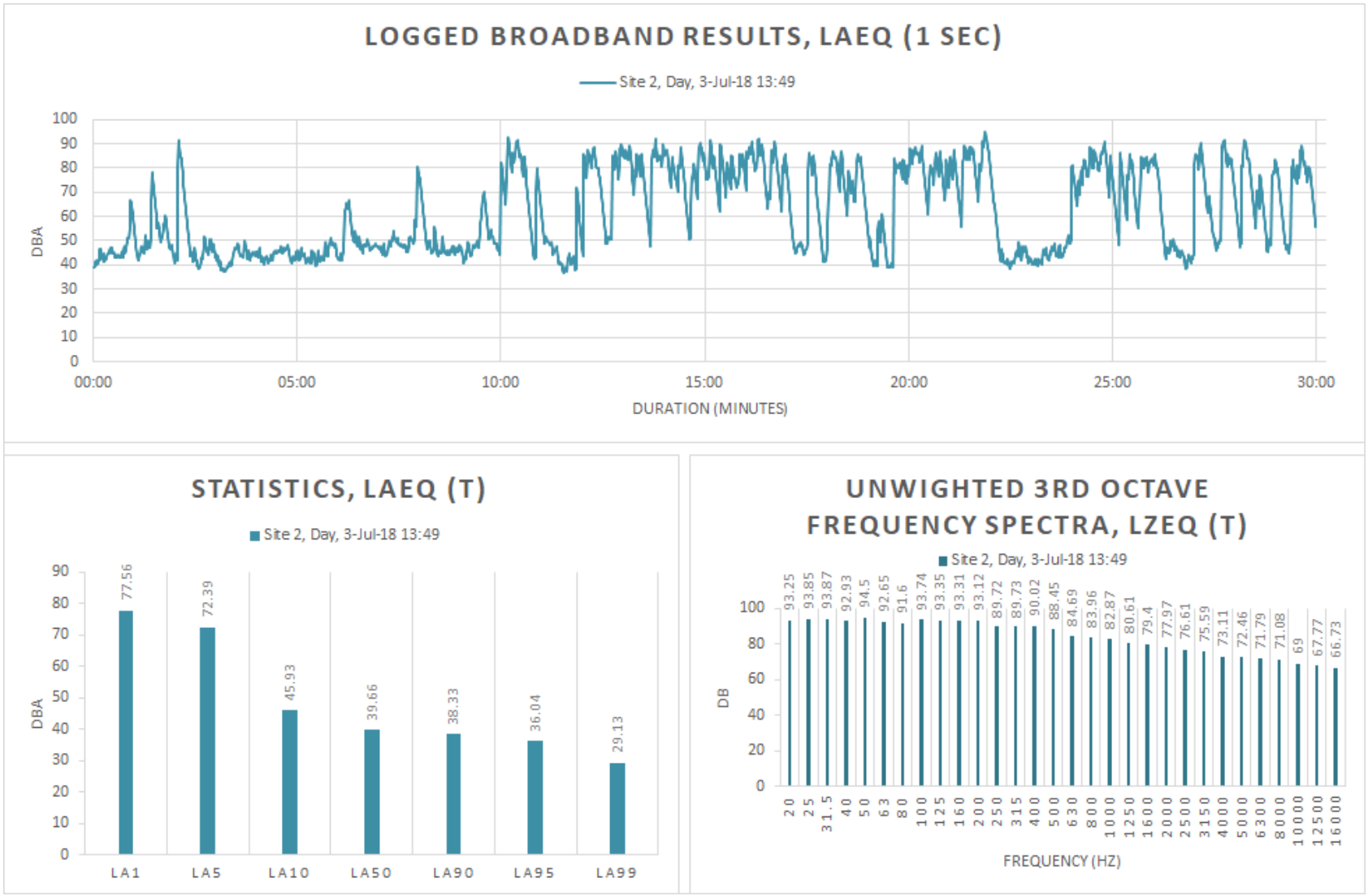


Figure 18: Detailed day-time survey results for Site 2

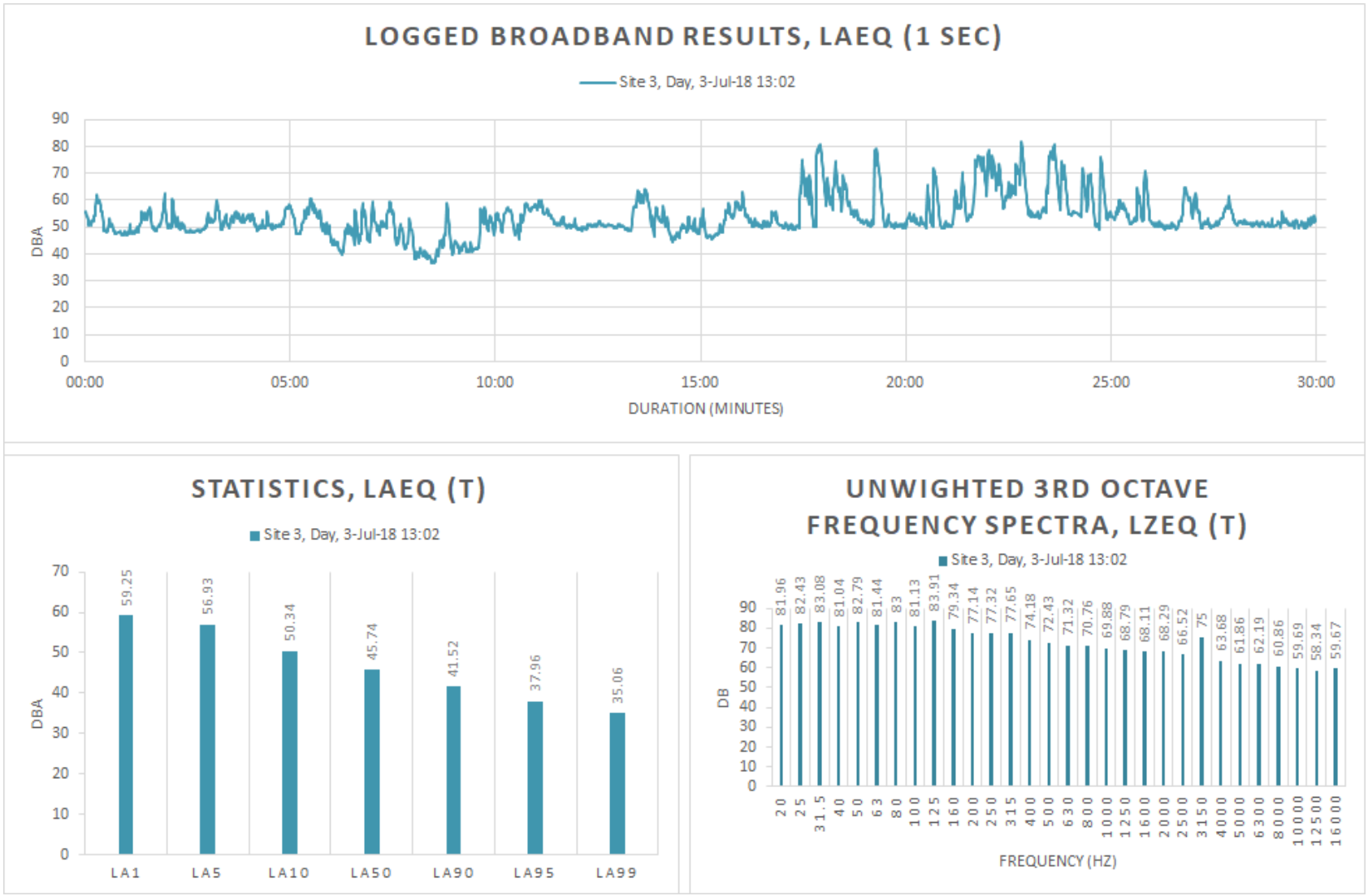


Figure 19: Detailed day-time survey results for Site 3

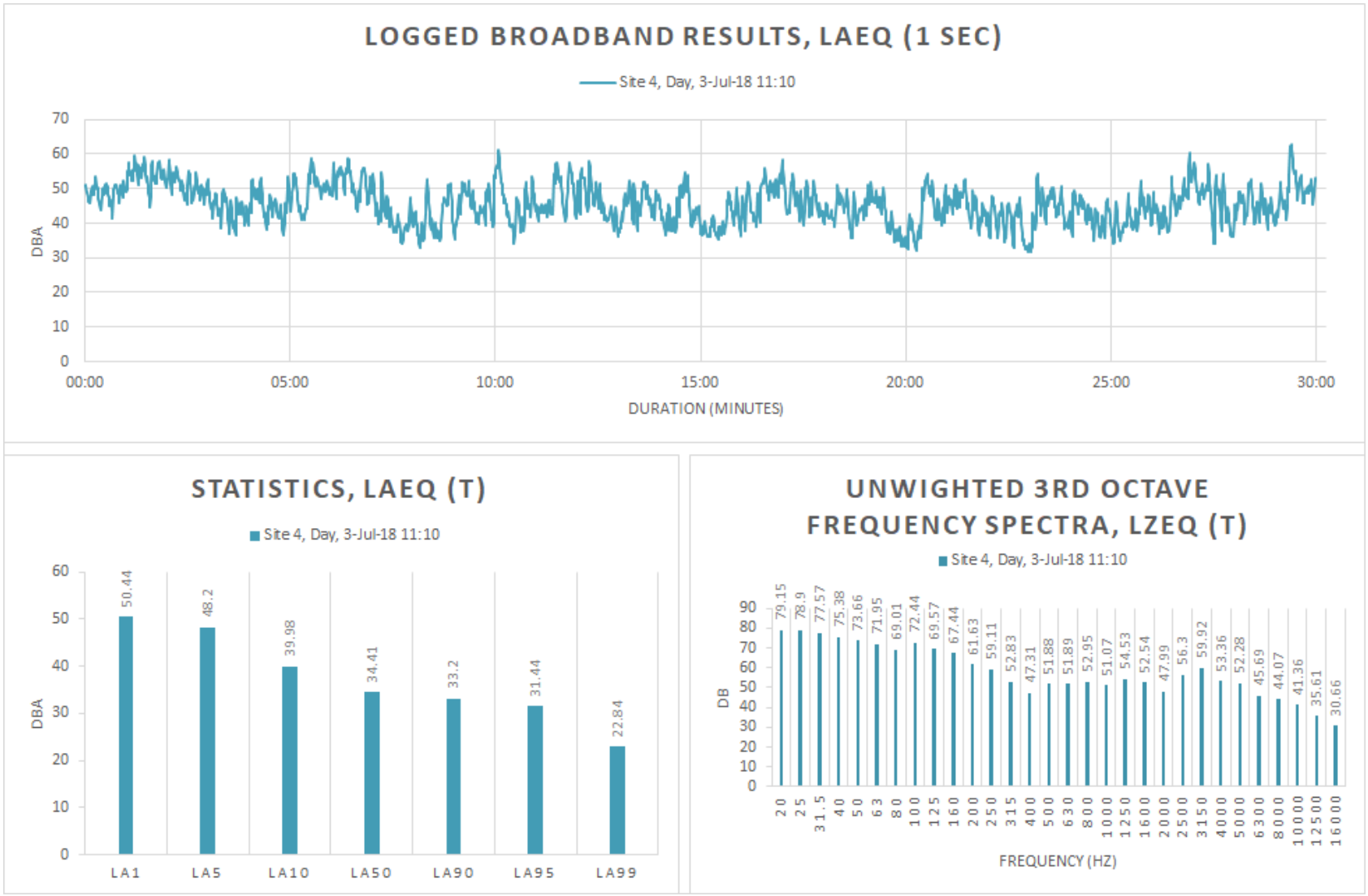


Figure 20: Detailed day-time survey results for Site 4

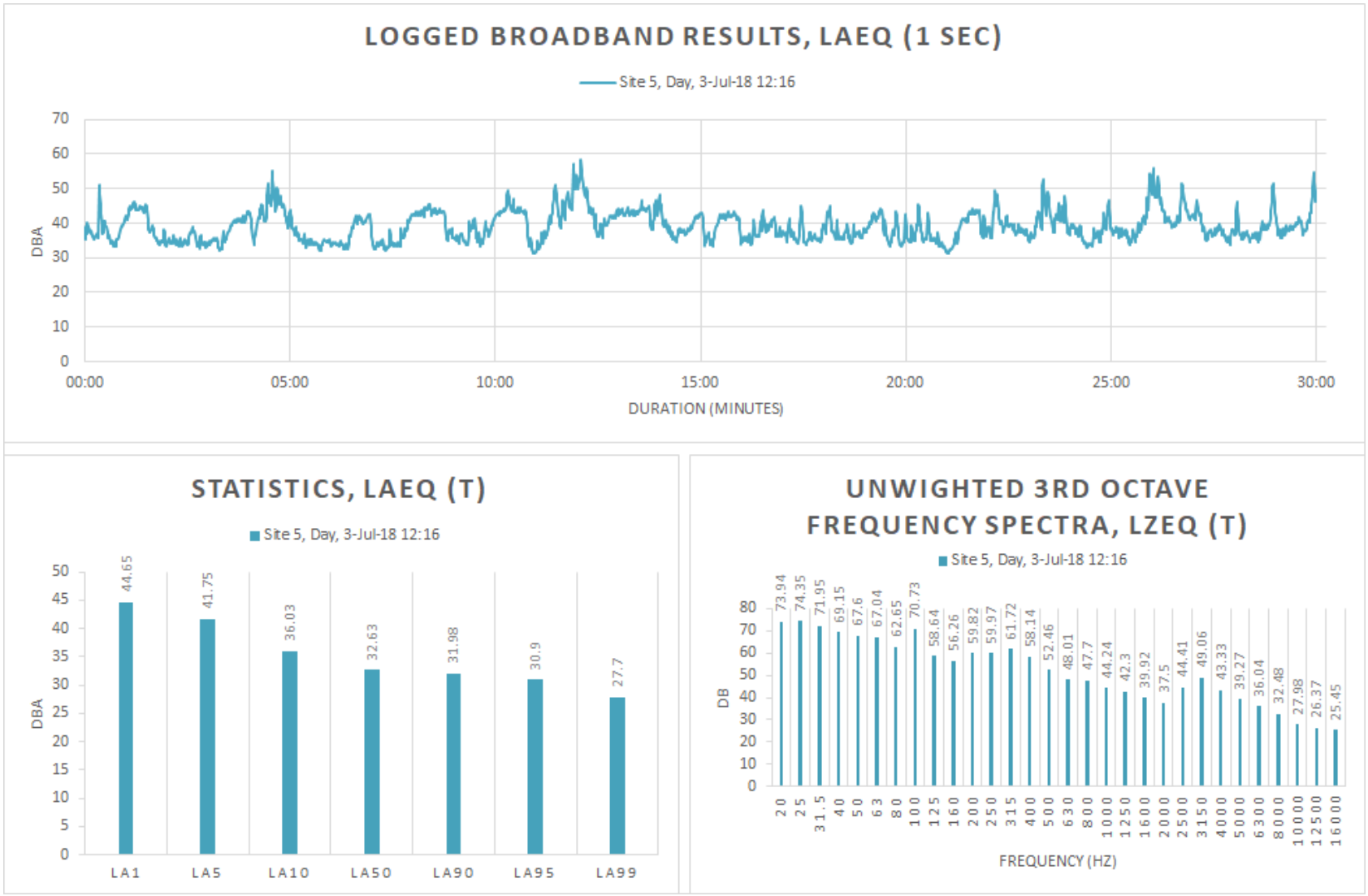


Figure 21: Detailed day-time survey results for Site 5

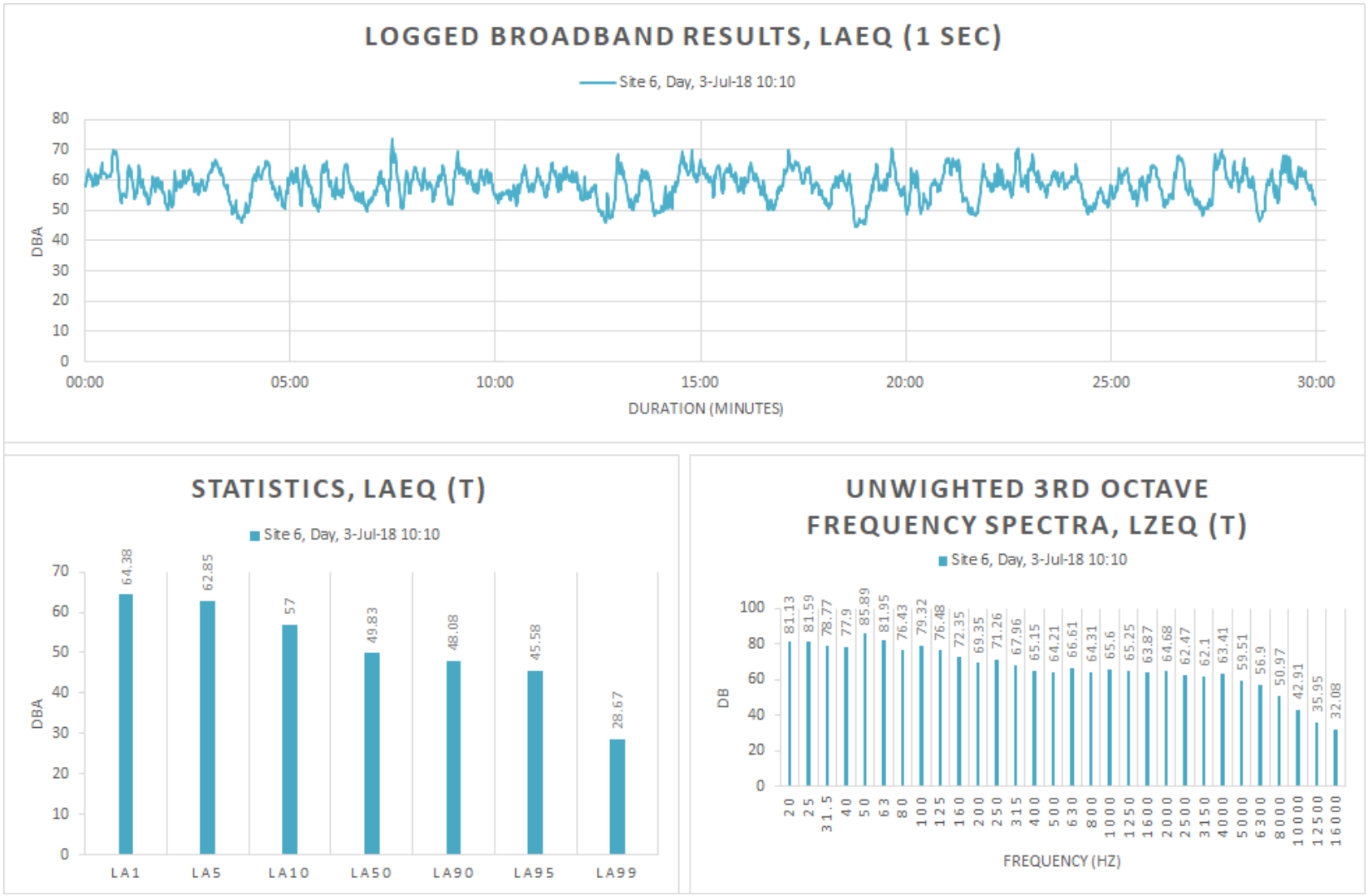


Figure 22: Detailed day-time survey results for Site 6

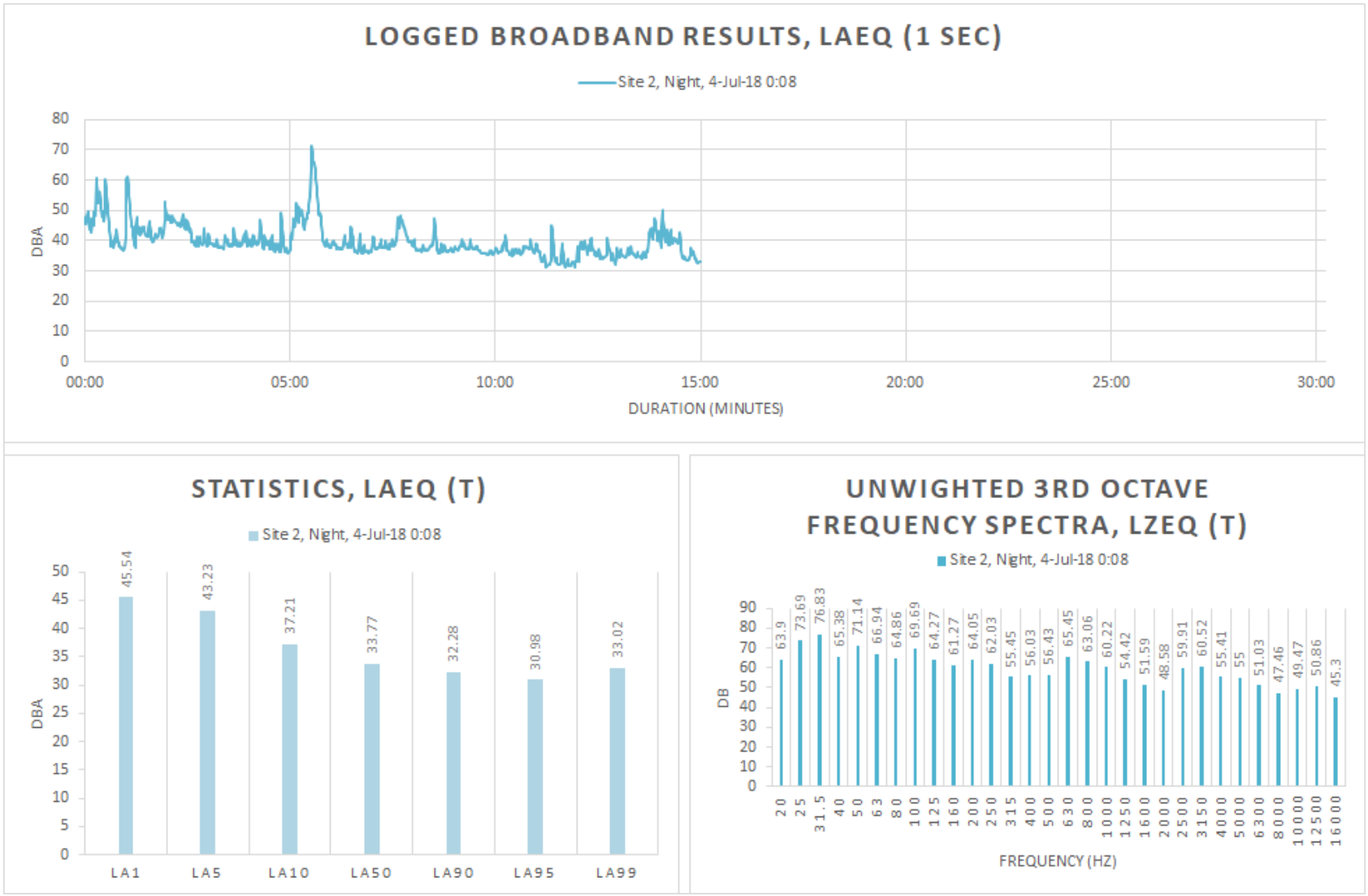


Figure 23: Detailed night-time survey results for Site 2

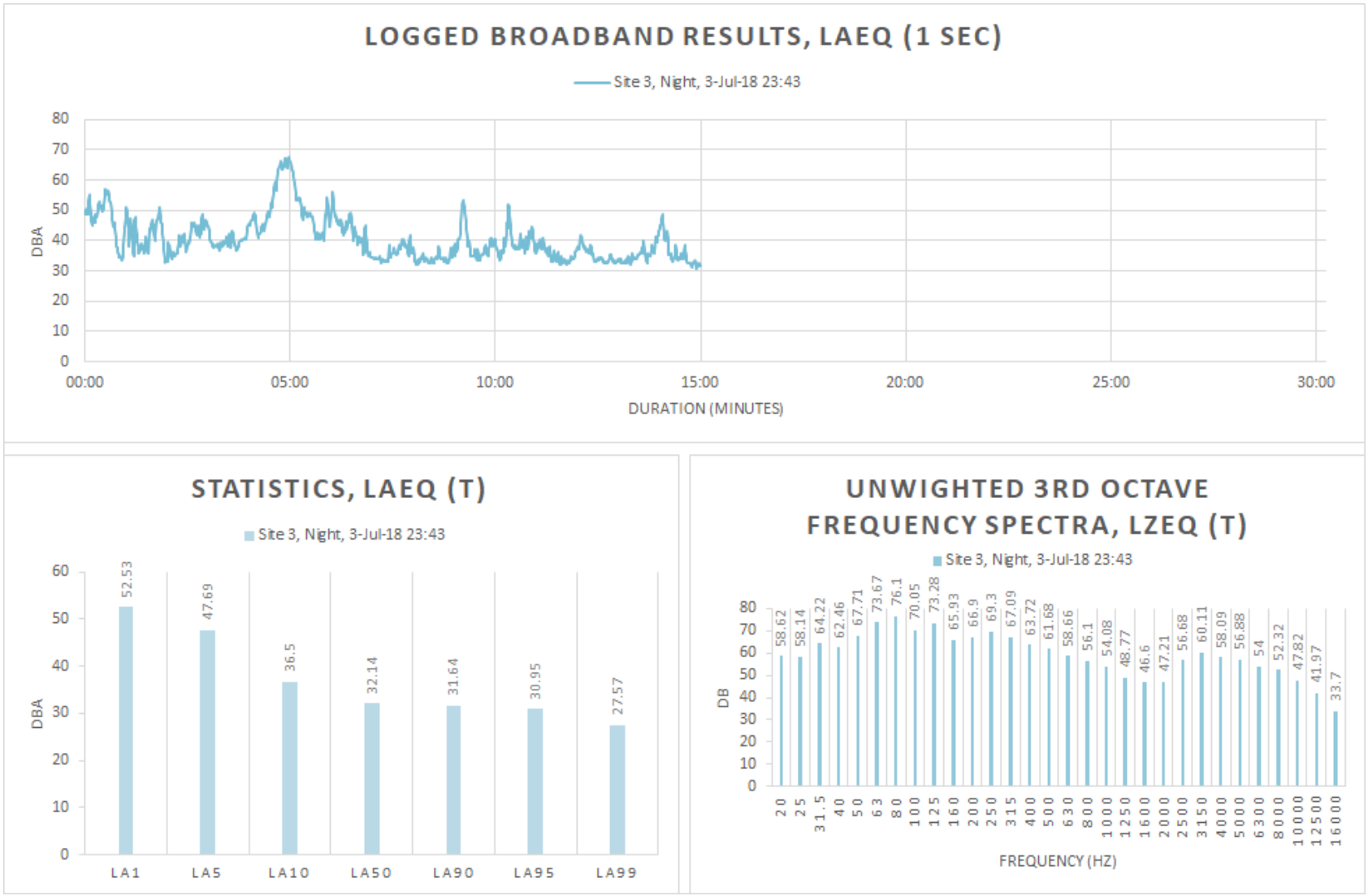


Figure 24: Detailed night -time survey results for Site 3

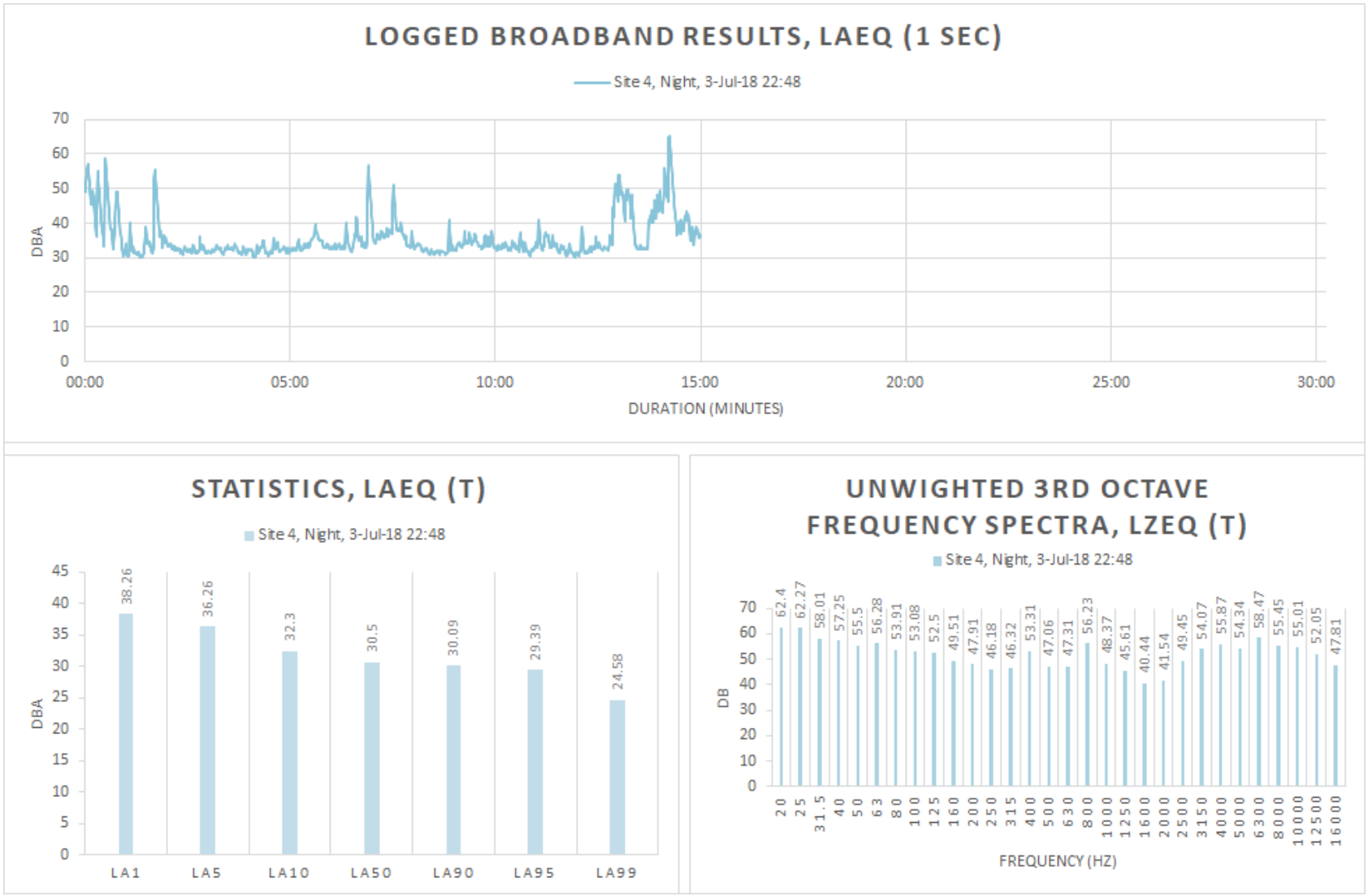


Figure 25: Detailed night -time survey results for Site 4

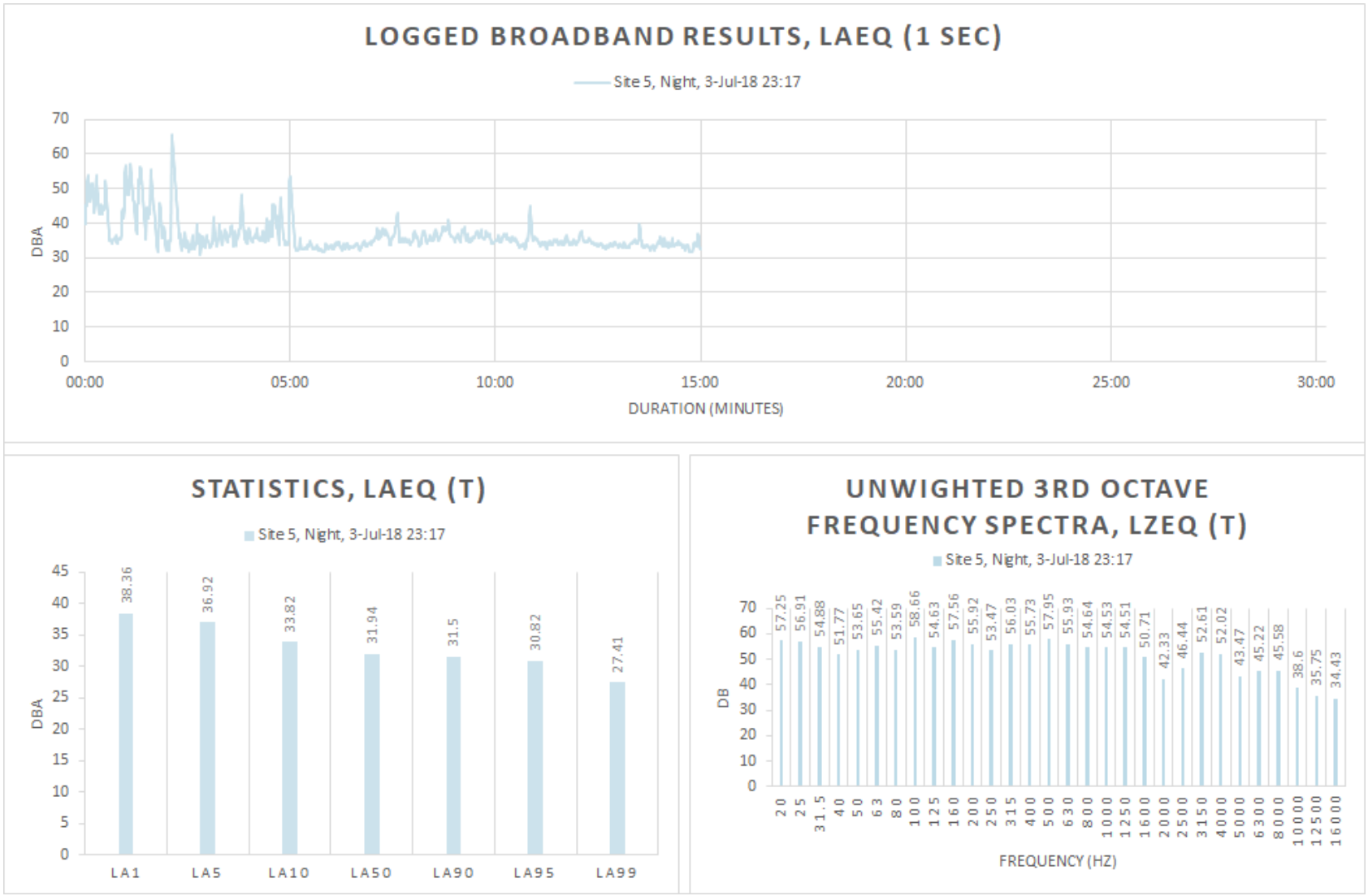


Figure 26: Detailed night -time survey results for Site 5

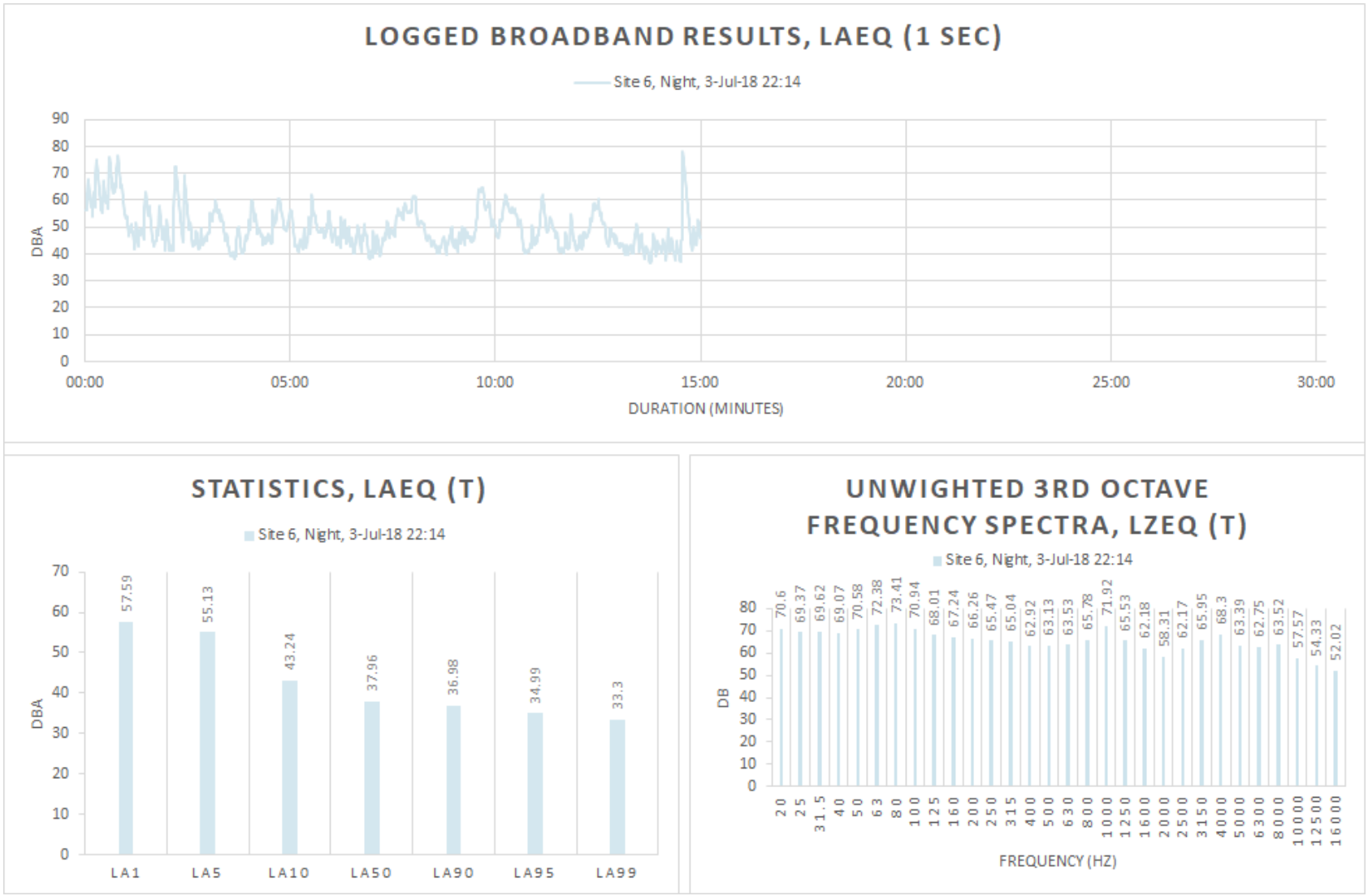


Figure 27: Detailed night -time survey results for Site 6

Appendix E – Jones & Wagener Environmental Impact Assessment Significance Rating Methodology

THE IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology is used to describe the impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in Table 10.

Table 10: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	EXTENT SCALE	TEMPORAL SCALE
1	VERY LOW	*Isolated corridor / proposed corridor*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in Table 11 below.

Table 11: Description of the significance rating scale

RATING		DESCRIPTION
5	VERY HIGH	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	HIGH	Impact is of substantial order within the bounds of impacts, which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	MODERATE	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	LOW	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	VERY LOW	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity is needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	NO IMPACT	There is no impact at all - not even a very low impact on a party or system.

Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in Table 12.

Table 12: Description of the significance rating scale

RATING		DESCRIPTION
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a regional scale (District Municipality to Provincial Level). The impact will affect an area up to 50km from the proposed site / corridor.
3	Local	The impact will affect an area up to 5km from the proposed route corridor / site.
2	Study Area	The impact will affect a route corridor not exceeding the boundary of the corridor / site.
1	Isolated Sites / proposed site	The impact will affect an area no bigger than the corridor / site.

Duration Scale

In order to accurately describe the impact, it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in Table 13.

Table 13: Description of the temporal rating scale

RATING		DESCRIPTION
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium term	The environmental impact identified will operate for the duration of life of the project.
4	Long term	The environmental impact identified will operate beyond the life of operation.
5	Permanent	The environmental impact will be permanent.

Degree of Probability

The probability or likelihood of an impact occurring will be described, as shown in Table 14 below.

Table 14: Description of the degree of probability of an impact occurring

RATING	DESCRIPTION
1	Practically impossible
2	Unlikely
3	Could happen
4	Very Likely
5	It's going to happen / has occurred

Degree of Certainty

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used as discussed in Table 15. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 15: Description of the degree of certainty rating scale

RATING	DESCRIPTION
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale as described below.

$$Impact\ Risk\ = \left(\frac{SIGNIFICANCE + Spatial + Temporal}{3}\right) \times \left(\frac{Probability}{5}\right)$$

The impact risk is classified according to 5 classes as described in Table 16.

Table 16: Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
0.1 – 1.0	1	Very Low
1.1 – 2.0	2	Low
2.1 – 3.0	3	Moderate
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High