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SOIL, LAND USE AND LAND CAPABILITY ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED EXXARO BELFAST COLLIERY EXPANSION PROJECT MPUMALANGA PROVINCE

Prepared for

Nsovo Environmental Consulting (Pty) Ltd

August 2021

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SAS Environmental Group of Companies

EXECUTIVE SUMMARY

The Zimpande Research Collaborative (ZRC) was appointed by Nsovo Environment Consulting (Pty) Ltd to conduct a soil, land use and land capability and agricultural impact assessment for the proposed Exxaro Belfast Expansion Project (BEP). The investigated area will henceforth be referred to as the "BEP Project area " unless referring to individual infrastructure components.

The Belfast Mining Right Area is located within eMakhazeni Local Municipality and the greater Nkangala District Municipality in Mpumalanga province. It is approximately 10 km south-west of the town Belfast on the farms Leeuwbank, Zoekop and Blyvooruitzicht. Refer to Figures 1 and 2 below.

The proposed expansion project traverses large active agricultural fields and will potentially lead to significant loss of agricultural resources, thus it is imperative to understand the surrounding soils, land uses and land capability as well as the land potential to ensure that the proposed mining related development takes into consideration the high potential agricultural land parallel with the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use, as per Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

Most of the area earmarked for development as part of the BEP is under intensive commercial agriculture, utilising irrigation systems, in some instances, to maximise the yield from the available land. The farms in the area are therefore under both rainfed and irrigated agriculture, with centre pivots as the irrigation mechanism being utilized in most instances where irrigation takes place. Not only is the area subject to intensive commercial agriculture but it is also utilised for sheep, cattle, and dairy farming supplying the local and regional areas.

The local climate can be broadly classified as favorable for good yield for a wide range of adapted crops and a year-round growing season. The Mean Annual Rainfall (MAR) associated with the MRA is estimated to range between 601-800mm per annum while the mean annual total evaporation is estimated to range from 1601-1800mm. These conditions are relatively favorable for rainfed agriculture as the risk of moisture stress and low temperatures during the growing season is low.

The dominant soils occurring within the BEP project area are Hutton, Avalon, Lichtenburg, Mispah and Glencoe forms. Whereas the sub-dominant soil forms were identified as Katspruit, Ermelo, Westleigh and Dresden. The majority of the extent of the BEP project area can be broadly classified as ideal for agriculture (with minor limitations) as well as grazing and wilderness land uses. The above-mentioned soils are considered ideal for agricultural cultivation due to:

- Deep well drained soil characteristics;
- Texture and structure allowing for effective rooting depth;
- Good water holding/storage capacity; and
- Good nutrient holding capacity.

Table A below indicates the dominant soils occurring within the BEP project area, together with the associated land capability and the area covered in hectares (ha).

Table A: Identified soil forms within the BEP project area and their respective land capability.

Soil Form	Land capability	Area (ha)	Percentage
Lichtenburg	Arable (Class II)	146.8	3,87
Hutton		363.7	9,59
Ermelo		57.4	1,51
Glencoe		110.8	2,92
Clovelly		103.5	2,73
Lichtenburg/Glencoe		20.9	0,55
Lichtenburg/Hutton		510.8	13,47
Hutton/Bainsvlei		105.8	2,79
Hutton/Bloemdal		24.3	0,64
Avalon	Arable (Class III)	771.9	20,36
Avalon/Glencoe		83.0	2,189
Bainsvlei		57.6	1,52
Bainsvlei/Bloemdal		180.4	4,76
Wasbank	Grazing (Class V - Wetlands)	46.9	1,24
Westleigh		166.52	4,39
Wasbank/Longlands		83.8	2,21
Longlands/Westleigh		53.7	1,42
Katspruit		397.5	10,49
Katspruit/Rensburg		50.1	1,32
Katspruit/Kroonstad		3.1	0,08
Kroonstad		3.2	0,08
Manguzi		1.1	0,03
Longlands		31.1	0,82
Dresden	Grazing (Class VI)	142.2	3,75
Mispah		245.6	6,48
Mispah/Dresden		11.6	0,31
Witbank	Wilderness (Class VIII)	17.7	0,47
Total Enclosed Area		**3791.0**	**100**

The extent of arable soils to be disturbed by the proposed mining activities can be considered sufficient for viable cultivated large-scale commercial farming. It is acknowledged that the total avoidance of arable soils is not feasible however the impact should be restricted to the project footprint as far as practically possible. The land use change will predominantly be conversion from cultivated agriculture, grazing and wetlands to mining and related activities. However at closure, land capability will, essentially, revert to the approved end land use (agriculture) albeit most likely at a reduced level of functionality. Concurrent rehabilitation will be undertaken, thus reinstating agricultural activities in recently mined out areas. The loss of agricultural activities at any given time will be 10%. Table B presents the summary of the BEP Mining Option 1 at year 11 and the anticipated impact on agriculture (Courtesy of Exxaro Mining Company, 2021). The full mining approach, indicating the concurrent rehabilitation to agriculturally productive land is presented in Appendix B.

Table B: Summary table depicting the BEP Mining Option 1 at year 11 and the anticipated impact on agriculture (Courtesy of Exxaro Mining Company, 2021).

Category -Combined	Indicative %	Hectares
Agricultural area (no mining activities)	**67,9%**	1597,941
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	**0,0%**	0
Concurrently rehabilitated areas (with agricultural activities reinstated)	**22,8%**	537,0839
Mining activities	**9,3%**	217,9694
Total available agricultural area	**90,7%**	

The impact of the proposed Belfast Mine Expansion from a soil, land use and land capability are deemed high during the operational phase, and thus protection of the agricultural resources should be prioritised as far as practically possible. Areas of highest agricultural potential, especially those areas that are managed as irrigated crop lands should be excluded from mining where feasible. The coal from the BEP project will be transported to the Rietkuil/Pieneer siding through an existing route which has already been approved for the BIP project, thus the impact from a soil and land capability point of view is negligible in this instance.

Two (2) shaft alternative options were proposed and a detailed comparative analysis of the two is presented in Section 8.2. Based on the analysis, option 1 is the preferred option from a soil, landuse and land capability point of view. This is due to the ability of option 1 to best support the objective of conserving as much arable and undisturbed land as possible and thus favour agricultural production continuity on the farm situated within the immediate vicinity. The conveyor option 1 is also the preferred option since it is shorter than the alternative conveyor options and it traverses areas which have been previously mined as part of the BIP project, thus poses a low impact from a soil, land use and land capability perspective. It should be noted that although shaft option 1 is the preferred option, the difference in the impact significance between the two options is minor. Based on the outcomes of the study option 1 remains the preferred option from a soil, landuse and land capability management point of view. It is, however acknowledged that, subsequent to the initiation of the study, it was determined that option 1 will not be feasible, from a mining perspective, since this option will likely impact too significantly on the life of mine (LOM). Therefore Alternative 2 is the only viable option as part of the go forward case for the project despite the higher impact on agriculture. This information should be used by the EAP to undertake a comparative and holistic analyses of the total impact on the environment and provide a cogent summary that aligns to the principles of Integrated environmental Management (IEM) that can be provided to the relevant regulating authorities, whom will then be empowered to make an informed decision that aligns the principles of sustainable development.

The proposed Mine Residue Facility (MRF) will be constructed over a backfilled opencast pit where soils have already been impacted through excavation and mechanical handling. Therefore, the impact of the proposed MRF is considered low from a soil and land capability point of view.

The cumulative loss from a soil and land capability point of view is anticipated to be moderate, provided that the key mitigation measures to enable the re instatement of agricultural activities (of a different nature) post closure are carefully implemented inline with the Exxaro net benefit objective to mining.

Following the assessment of the BEP project area and the identified potential impacts as the result of the proposed development; the key mitigation and rehabilitation measures can be summarised as follows:

- This mine should run concurrently, and co-exist with agricultural activities on the site (i.e. mining and farming in areas that have been rehabilitated);
- The mined-out area should be backfilled and rehabilitated concurrently, in order to re-instate agricultural activities;
- Cultivation of alternative crops on rehabilitated areas should be investigated, based on the expected, and later on observed, soil characteristics, to ensure that the agricultural activities resume post mining inline with the Exxaro net benefit approach to mining;
- Excavation and long-term stockpiling of soil should be limited within the demarcated areas as far as practically possible and ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas;
- Use of heavy machinery such as bulldozers should be avoided as far as possible to minimise soil compaction;
- Different soil types and the A and B-horizons should be stripped separately and replaced in the same sequence on top of the spoil material. The relatively higher organic carbon content of the A-horizon provides a buffer against compaction and hardsetting and serves as a seed bank

which will enhance the re-establishing of natural species. B-horizons replaced on the surface tend to seal and compact severely which increases runoff and triggers erosion;

- Stockpile height should be restricted to that which can deposited without vehicles moving over previously dumped topsoil. Typically this would be a maximum height that can be achieved by the model of vehicles moving and dumping the topsoil. This guideline should be juxtaposed with the impact of an increased topsoil dump footprint created due to reducing the height of the dump and the associated impact on agriculture and/or biodiversity The stockpile should be treated with temporary soil stabilisation methods; such as the application of organic matter to promote soil aggregate formation, leading to increased infiltration rate, thereby reducing soil erosion. Also, the use of lime to stabilise soil pH levels. Alternatively the mine must comply to the approved EMP on stockpile heights; and
- A short-term fertilizer programme should be based on the soil chemical status after levelling and should consists of a pre-seeding lime and fertilizer application, an application with the seeding process as well as a maintenance application for 2 to 3 years after rehabilitation or until the area can be declared as self-sustaining by an appropriately qualified soil scientist.

It is the opinion of the specialist that this study provides the relevant information required for the Environmental Impact Assessment phase of the project to ensure that appropriate consideration of the agricultural resources in the study area will be made in support of the principles of Integrated Environmental Management (IEM) and sustainable development.

DOCUMENT GUIDE

This report was compiled according to the following information guidelines for a specialist report in terms of the Environmental Impact Assessment (EIA) Regulation 326 of the National Environmental Management Act, 107 of 1998 (NEMA), as summarised on the Table below.

Table 1: Document guide according to the amended 2017 EIA Regulations (No. R. 326)

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix C
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix C
b)	A declaration that the specialist is independent	Appendix C
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
cA)	An indication of the quality and age of base data used for the specialist report	Section 3
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4 and 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
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 alternative	Section 4
g)	An identification of any areas to be avoided, including buffers	Section 4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.1
j)	A description of the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4 and 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5.2
l)	Any conditions for inclusion in the environmental authorisation	Section 4.1
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	None
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 5 and 6
(iA)	Regarding the acceptability of the proposed activity or activities	Section 6
(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 4 and 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	None
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q)	Any other information requested by the competent authority	None

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GLOSSARY OF TERMS

Albic	Grey colours, apedal to weak structure, few mottles (<10 %).
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Catena	A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic condition, but having different characteristics due to variation in relief and drainage.
Chromic:	Having within ≤150 cm of the soil surface, a subsurface layer ≥30 cm thick, that has a Munsell colour hue redder than 7.5YR, moist.
Ferralic:	Having a ferralic horizon starting ≤150 cm of the soil surface.
Ferralic horizon:	A subsurface horizon resulting from long and intense weathering, with a clay fraction that is dominated by low-activity clays and contains various amounts of resistant minerals such as Fe, Al, and/or Mn hydroxides.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Hard Plinthic	Accumulative of vesicular Fe/Mn mottles, cemented.
Hydrophytes:	Plants that are adaptable to waterlogged soils.
Lithic	Dominantly weathering rock material, some soil will be present.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the “background colour” referred to as the matrix and the spots or blotches of colour referred to as mottles.
Plinthic Catena	South African plinthic catena is characterised by a grading of soils from red through yellow to grey (bleached) soils down a slope. The colour sequence is ascribed to different Fe-minerals stable at increasing degrees of wetness.
Red Apedal	Uniform red colouring, apedal to weak structure, no calcareous.
Runoff	Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.
Orthic	Maybe dark, chromic or bleached.
Salinity:	High Sodium Adsorption Ratio (SAR) above 15% are indicative of saline soils. The dominance of Sodium (Na) cations in relation to other cations tends to cause soil dispersion (deflocculation), which increases susceptibility to erosion under intense rainfall events.
Sodicity:	High Exchangeable Sodium Percentage (ESP) values above 15% are indicative of sodic soils. Similarly, the soil dispersion.
Soil Map Unit	A description that defines the soil composition of a land, identified by a symbol and a boundary on a map.
Soft Plinthic	Accumulation of vesicular Fe/Mn mottles (>10%), grey colours in or below horizon, apedal to weak structure.
Witbank	Man-made soil deposit with no recognisable diagnostic soil horizons, including soil materials which have not undergone paedogenesis (soil formation) to an extent that would qualify them for inclusion in another diagnostic horizon

ACRONYMS

AGIS	Agricultural Geo-Referenced Information Systems
BIP	Belfast Implementation Project
BEP	Belfast Expansion Project
°C	Degrees Celsius.
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ET	Evapotranspiration
IUSS	International Union of Soil Sciences
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GPS	Global Positioning System
m	Meter
MAP	Mean Annual Precipitation
NWA	National Water Act
PAA	Protected Agricultural Areas
PSD	Particle Size Distribution
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
SOTER	Soil and Terrain

1. INTRODUCTION

The Zimpande Research Collaborative (ZRC) was appointed by Nsovo Environment Consulting to conduct a soil, land use and land capability and agricultural impact assessment for the proposed Exxaro Belfast Expansion Project (BEP). The investigated area will henceforth be referred to as the "BEP Project area " unless referring to individual infrastructure.

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The proposed expansion project traverses large active agricultural fields and will potentially lead to significant loss of agricultural resources, thus it is imperative to understand the surrounding soils, land uses and land capability as well as the land potential to ensure that the proposed mining related development takes into consideration the high potential agricultural land parallel with the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use, as per Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land having ''*the soil and terrain quality, growing season and adequate available moisture supply to sustain crop production when treated and managed according to best possible farming practices" (*Land Capability report ARC, 2006*)*. Land Capability Classes (LCC) are used to determine the agricultural potential of soils within the study area due to the positive correlation between the agricultural potential and Land Capability Classification. Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Appendix A.

Two (2) opencast shaft options were considered in efforts to minimise the impact on ongoing agricultural activities. Refer to Figure 4.

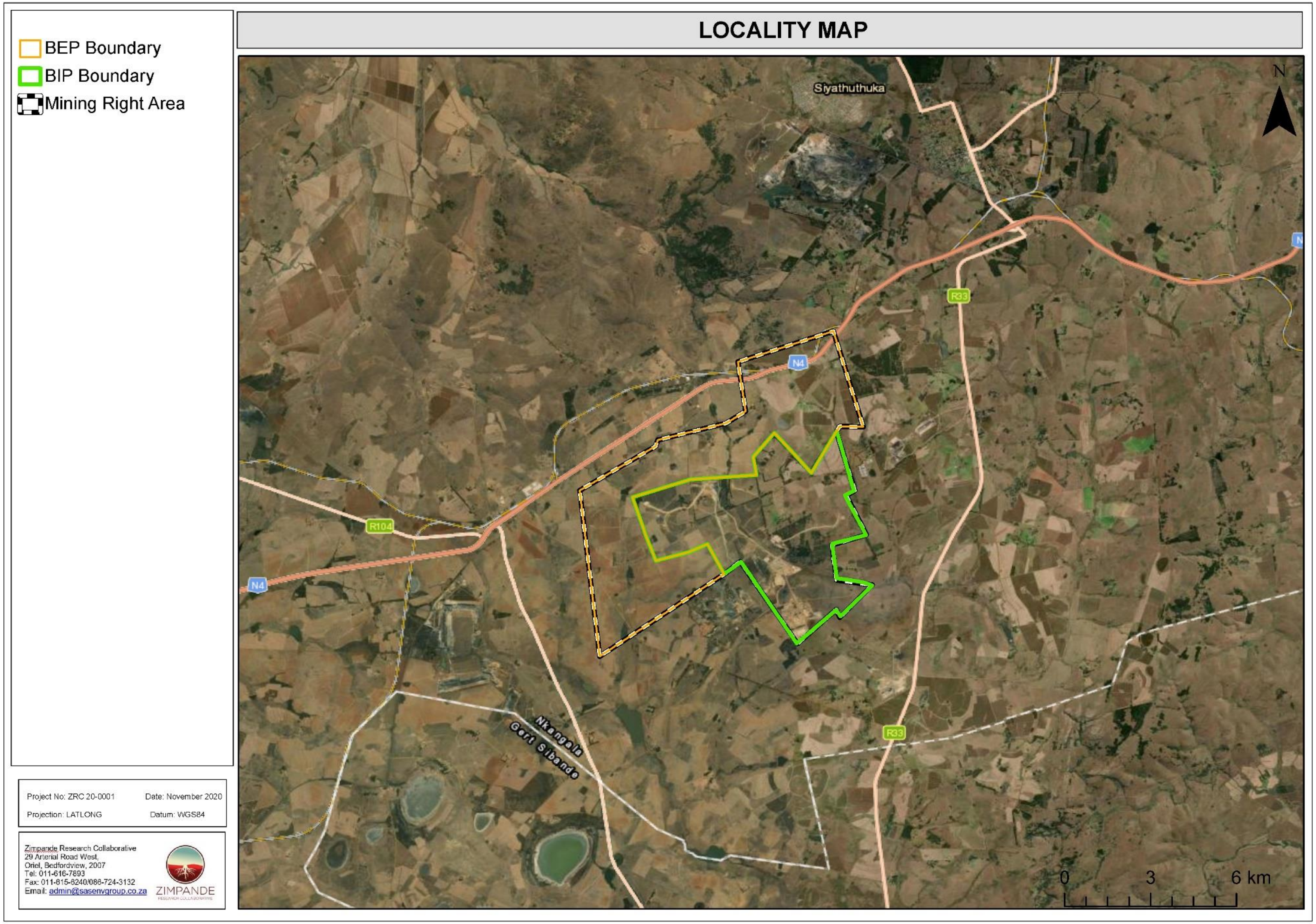

Figure 1: Digital satellite imagery depicting the locality of the BEP project area in relation to the surrounding area

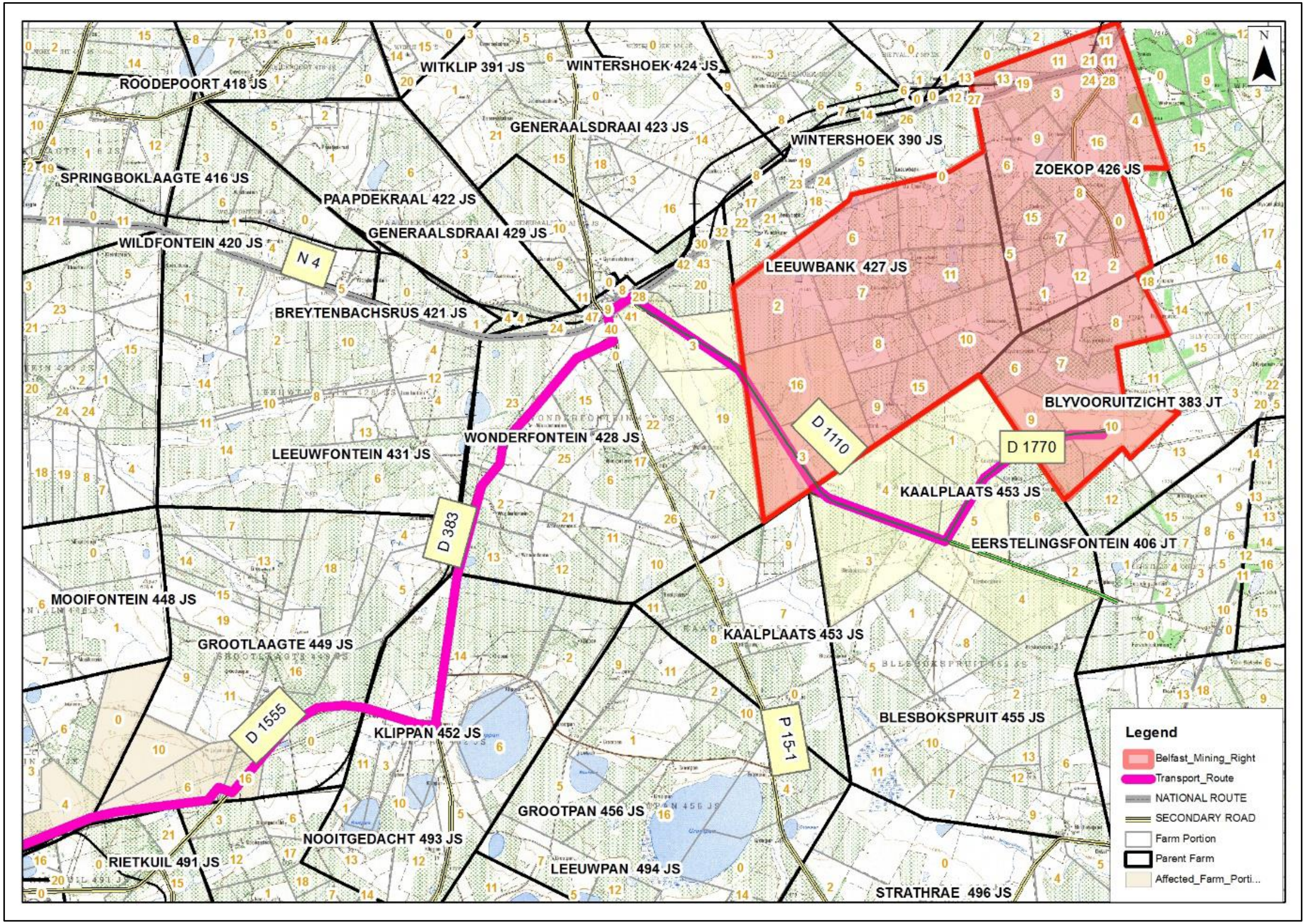

Figure 2: Location of the BEP and MRA depicted on a 1:50 000 topographical map in relation to surrounding area.

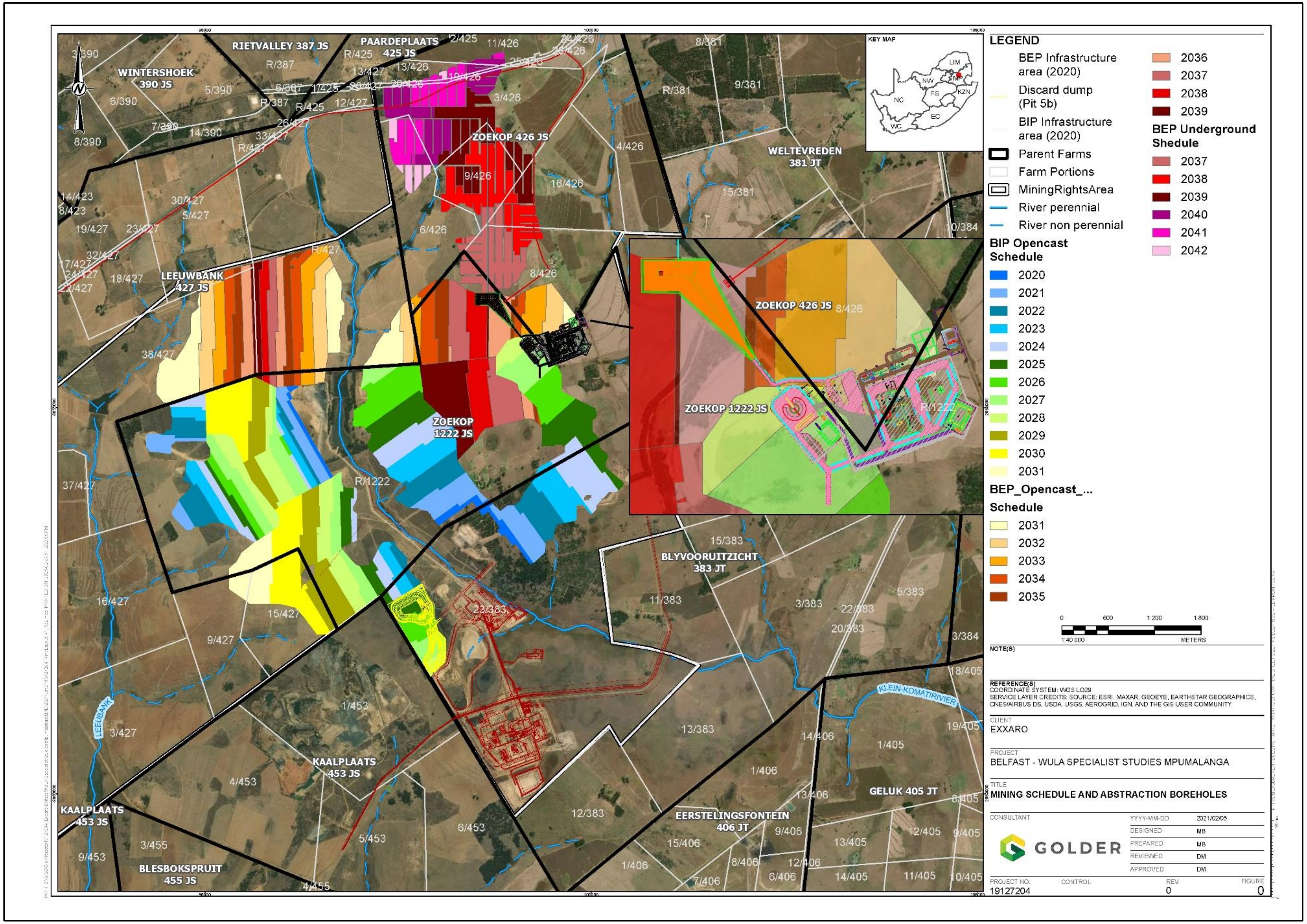

Figure 3: Map Depicting the opencast schedule

1.1 Project Background (Updated August 2021)

The Exxaro Belfast Mining Right (Ref No. MP 30/5/1/2/2/431 MR) is situated in the Mpumalanga Province and is located south of Belfast along the N4. In 2018 the Belfast Implementation Project (BIP) commenced with mining activities and the construction of the associated plant and infrastructure to process 3 Mtpa of Run of Mine (ROM) with a life of mine (LOM) of 17 years. First coal was produced at the processing plant during September 2019.

The Belfast Expansion Project (BEP) area falls within the Belfast mining right area and subsequently forms part of the resource pertaining to Belfast. The project area falls outside the current mining area. A desktop study was done to evaluate the potential of both open cast and underground operation within the current Belfast mining right area. The objective of such an operation would be to access high quality coal for export.

The exploitation analysis of the Belfast Resource outside the current BIP layout area revealed during the Concept Phase that there is potential for a 5,200 kcal/kg (five thousand two hundred kilocalorie/kilogram) open cast and underground mining scenario as well as a 5,800 kacl/kg (five thousand eight hundred kilocalorie/kilogram) underground scenario. A potential of 39.7 Mt (thirty-nine point seven million tonnes) of RoM can be additionally mined at a yield of 69% (sixty nine percent) resulting in 27.4 Mt (twenty-seven point four million tonnes) of product.

1.2 Proposed Mining Method

1.2.1 Open Pit

For the open pit areas at BEP, a similar mining method will be employed as with BIP. The BIP site is currently using Strip Mining with a mixed hybrid of benching and doze-over. Strip Mining as a basis is used as it has been proven as the method of choice for relatively shallow coal seams in the Witbank coal region. The reason it is so successful is that the waste is moved as short a distance as possible, minimizing the cost impact of the mining process. To further reduce the waste mining costs, doze-over mining is used, as the cost per unit moved over a relatively small distance is cheaper than loading and hauling. An example of the benching and doze-over method is illustrated below.

It consists of:

- Topsoil – Load and haul topsoil to the low-wall side where backfilling has already been completed where the topsoil is spread and re-vegetated.
- Soft Overburden – Load and haul to the low-wall side where backfilling of hard overburden and parting has already been completed.

- Hard Overburden – Drill, blast, load, and haul to the low-wall side where backfilling of parting and parting has already been completed.
- Top Coal Seam – Drill, blast, load, and haul to the crusher or where required.
- Parting – Drill, cast blast, doze, load and haul towards the low-wall side.
- Bottom Coal Seam – Drill, blast, load, and haul to the crusher or where required.

At the Belfast mine there will be three different variants to the sequence described above; only mining seam 2, mining seam 2 and 3, mining seam 2 and 4 and lastly mining seam 2, 3 and 4.

- Seam 2 – When only mining Seam 2, the topsoil and softs will be mined as described initially, but the hard rock above seam 2 will be cast blasted, dozed over and the coal will be cleaned.
- Seam 2 & 3, Seam 2 & 4 – Will be as described initially
- Seam 2, 3 & 4 – When mining all three seams, the sequence will be the same as described initially, except, when the top coal seam has been removed, the parting between seam 4 and 3 will be drilled and blasted, loaded and hauled to the spoil area, and be backfilled. Once seam 3 has been removed, the sequence is similar as with only seam 2, where the parting will be cast blasted, dozed over and the coal will be cleaned.

With all these options, the topsoil will be removed one cut in front of the softs, and the softs will always be mined one cut in front of the hards and coal.

1.2.1 Underground Mining and Infrastructure

For the identified underground areas at BEP, a traditional board and pillar (B&P) mining method was decided upon. The B&P method allows for medium to high extraction of underground coal seams while being able to navigate difficult and varying ground conditions. It also requires less initial capital investment than the longwall method with smaller increments in production.

Civil infrastructure for the BEP underground mine includes the following:

- Earthworks / Platforms, including cut and fill embankments;
- Roads and traffic design; including LDV and haul roads;
- Stormwater management, including clean and dirty water separation and pollution control dams;
- Cable ducts;
- Sewer system; and

- Fencing.

The water supply, i.e. potable, fire and wash water are included in the Mechanical Design Criteria.

The link between the surface infrastructure and the underground mine is the incline conveyor as indicated in figure 5 that will feed the ROM stockpile on surface from the main underground conveyor, approximately 3km long. Various options will be possible to reclaim from the stockpile and to transfer the ROM material to the overland conveyor belt to enter the plant.

The reclaim options are:

a) Option 1: FEL to road truck 30t side tipper

b) Option 2: FEL via few ramps to haul road truck, Cat 773 or similar 50t

c) Option 3: stockpile tunnel with reclaim conveyor feeding surge truck loading bin

d) Option 4: stockpile tunnel with reclaim / sacrificial conveyor feeding new overland conveyor

Road transport options from ROM stockpile at inclined shaft to existing plant:

a) Option 1: Haul truck to existing tip (most probably modifications will be required to bypass primary crusher to reduce generation of fines). This proposed route is shown on drawing ECN-P01-INF-CL-LO-0006

b) Option 2: Side tipper (road truck) to new tip next to existing tip (via district road). This proposed route via the district road is indicated on drawing ECN-P01-INF-CL-LO- 0006.

Interface and battery limit with Plant operations:

Conveyor options from the ROM stockpile at inclined shaft to existing plant:

a) Option 1: New curved overland conveyor from underground section ROM stockpile across the existing Klein Komati crossing, with transfer stations and then onto existing overland conveyor.

b) Option 2: New overland curved conveyor crossing the Klein Komati at a new position and then onto the overland belt before the secondary crusher without a transfer station. This solution might cross environmentally sensitive areas.

c) Option 3: New overland curved conveyor crossing the Klein Komati at a new position and then onto the overland belt after the secondary crusher without a transfer station. This solution might cross environmentally sensitive areas.

1.2.3 Mine Residue Facility (MRF)

A Trade-off analysis was undertaken to decide on the location of the proposed MRF which considered the following locations:

- A greenfields site across the Klein Komati River on the Eastern side of the current MRF;
- Adjoining the current facility; and
- Adjacent to the current facility over a backfilled opencast pit (Pit 5 – proposed).

The preferred go-forward solution selected comprises locating the MRF adjacent the current facility on the footprint of the proposed pit 5. The footprint will be rehabilitated prior to implementation of the MRF.

The proposed layout of the MRF is dictated and constrained by:

- The extent and footprint of the proposed Pit 5 area
- Existing and proposed roads to the south west and south
- The existing wetland located along the eastern boundary and edge of the pit 5 footprint
- The plant layout to the north east

Design parameters and criteria

The design criteria for the new MRF are documented in the J&W technical note dated 02 November 2020 (Reference no. BCX-000003-ENG-EDC-0001) and briefly summarised below in the following sections.

Life of mine

The coarse discard deposition tonnages for the proposed MRF are shown below in Table 2. All tonnages indicated are dry tonnages. Deposition is expected to commence on the new MRF in year 2031 to end in year 2039. A total of 5.805 Mt (discard) will be placed on the MRF over the 9-year LoM period.

<table>
<tr><th>Component</th><th>Source</th><th>Design criteria</th><th>Impact/ Input to</th></tr>
<tr><td colspan="4">Facility operation</td></tr>
<tr><td colspan="4">LoM discard quantities</td></tr>
<tr><td>Life of mine discard tonnages</td><td>Environmental application schedule [BCX-000003-MIN-SCH-0001]</td><td><table>
<tr><th>Year</th><th>Dry tonnages [t]</th></tr>
<tr><td>YEAR 1</td><td>393 990</td></tr>
<tr><td>YEAR 2</td><td>419 595</td></tr>
<tr><td>YEAR 3</td><td>580 608</td></tr>
<tr><td>YEAR 4</td><td>857 434</td></tr>
<tr><td>YEAR 5</td><td>972 873</td></tr>
<tr><td>YEAR 6</td><td>744 044</td></tr>
<tr><td>YEAR 7</td><td>672 646</td></tr>
<tr><td>YEAR 8</td><td>757 175</td></tr>
<tr><td>YEAR 9</td><td>406 251</td></tr>
<tr><td>TOTAL</td><td>5 804 615</td></tr>
</table></td><td>Geometric modelling</td></tr>
<tr><td>Capacity</td><td>Client</td><td>5.804 Mt discard</td><td>Geometric modelling
Facility phases</td></tr>
</table>

Table 2 below provides an excerpt of the operational criteria applicable to the proposed MRF. The discard on the new MRF will be compacted and transported to the facility using trucks.

Table 2: MRF operational criteria.

Component	Source	Design criteria	Impact/ Input to
Facility operation			
Deposition method	Specifications and guidelines for the operation of the discard disposal facility (194-001-01_Ops)	• Discard conveyed to MRF by trucks utilising haul roads. • Discard to be compacted	Geometric modelling Implementation phases
Return water infrastructure			
Return water		Not applicable (dry discard)	

Barrier system (liner requirement)

A waste classification for the discard has not been provided. However, coal discard usually classifies as Type 3 waste which requires a disposal facility for the waste to be constructed with a Class C liner as described in the National Norms and Standards for Disposal of Waste to Landfill as per Government Gazette No. R636 of 23 August 2013 (DEA,2013B).

The proposed MRF will be constructed on the footprint of pit 5, which will be open cast mined and backfilled prior to construction of the proposed MRF. A risk-based (source-path-receptor) approach will therefore be adopted to confirm that an alternative to the Class C liner for the facility will be acceptable for the design. This entails that the facility will not be provided with a liner. Contaminated seepage from the MRF reports to the pit water make and will be managed by Exxaro as part of the pit water and decant management. The risk-based approach requires a detailed geohydrological study to be undertaken which must confirm that seepage from the MRF does not adversely impact existing underground water conditions.

Geotechnical Design

The stability assessment for the MRF will consider two conditions, namely, (i) during construction (Temporary) and (ii) end-of-construction (Permanent). The permanent (static) condition will comply with Government Notice No. 632, which stipulates a minimum FoS of 1.5, unless valid technical reasons are provided for deviating. The assessment will be carried out for drained conditions using effective strength parameters.

Water management infrastructure

The design of clean and dirty water management infrastructure relies on the prevailing topography for canal slopes, as well as the near surface geology and soil profiles for determining the canal cross sections. The canals will be developed to conceptual level and the design will be based on the post mining topography.

1.2 Terms of Reference and Scope of Work

The Environmental Authorisation process of the soil, land use and land capability assessment entailed the following aspects:

- As part of the desktop study various data sets were consulted which includes by not limited to: Soil and Terrain dataset (SOTER), land type and capability maps and soil 2001, to establish broad baseline conditions and sensitivity of study area both on environmental and agricultural perspective;
- Compile various maps depicting the on-site conditions based on desktop review of existing data;
- Classification of the climatic conditions occurring within the MRA;
- Conduct a soil classification survey within the BEP;
- Assess the spatial distribution of various soil types within the study area and classify the dominant soil types according to the South African Soil Classification System: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018);
- Identify restrictive soil properties on land capability under prevailing conditions;

- Identify and assess the potential impacts in relation to the proposed development using pre-defined impact assessment methodology; and
- Compile soil, land use and land capability report under current on-site conditions based on the field finding data.

1.3 Assumptions and Limitations

For the purpose of this assessment, the following assumptions are applicable:

- The soil survey conducted as part of the land capability assessment was confined within the BEP area. This includes surface infrastructure, open pit areas as well as underground mining areas. Consideration was however given to regional and adjacent agricultural activities;
- The climate change studies by Golder Associates were not available to the specialist during the time of compilation of this report. The climate change section presented in this document was adopted from the Department of Agriculture (2013) and provides a consideration of climate change on a high level based on what is anticipated for different regions. This information will be incorporated into this report once climate change studies have been completed and data is made available to the specialist; and
- Sampling by definition means that not all areas are assessed, and therefore some aspects of soil and land capability may have been overlooked in this assessment. However, it is the opinion of the specialist that this assessment was carried out with sufficient sampling and in sufficient detail to enable the proponent, the Environmental Assessment Practitioner (EAP) and the regulating authorities to make an informed decision regarding the proposed mining activities.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

Prior to commencement of the field assessment, a background study, including a literature review, was conducted to collect the pre-determined soil, land use and land capability data in the vicinity of the investigated study area. Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were utilised to fulfil the objectives for the assessment.

2.2 Soil Classification and Sampling

A soil survey was conducted in August 2020, at which time the identified soils within the study area classified into soil forms according to the Soil Classification System: A Natural and Anthropogenic System for South Africa Soil Classification System (2018). This survey period is deemed appropriate since seasonality does not have an effect on the soil characteristics. Subsurface soil observations were made using a manual hand auger in order to assess individual soil profiles, which entailed evaluating physical soil properties and prevailing limitations to various land uses.

2.3 Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table 2 below; with Classes I to III classified as prime agricultural land that is well suited for annual cultivated crops, whereas, Class IV soils may be cultivated under certain circumstances and specific or intensive management practices, and Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of C1 to C8, as illustrated in Table 3 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table 2: Land Capability Classification (Smith, 2006)

Land Capability Class	Increased Intensity of Use									Land Capability Groups	Limitations
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable land**	No or few limitations
II	W	F	LG	MG	IG	LC	MC	IC			Slight limitations
III	W	F	LG	MG	IG	LC	MC	IC			Moderate limitations
IV	W	F	LG	MG	IG	LC					Severe limitations
V	W	F	LG	MG						**Grazing land**	Water course and land with wetness limitations
VI	W	F	LG	MG							Limitations preclude cultivation. Suitable for perennial vegetation
VII	W	F	LG								Very severe limitations. Suitable only for natural vegetation
VIII	W									**Wildlife**	Extremely severe limitations. Not suitable for grazing or afforestation.

W- Wildlife	MG- Moderate grazing	MC- Moderate cultivation	
F- Forestry	IG- Intensive grazing	IC- Intensive cultivation	
LG- Light grazing	LC- Light cultivation	VIC- Very intensive cultivation	

Table 3: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

The land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of agricultural land potential and knowledge of the geographical distribution of agricultural viable land within an area of interest. This is of importance for making an informed decision about land use. Table 4 below presents the land potential classes, whilst Table 5 presents a description thereof, according to Guy and Smith (1998).

Table 4: Table of Land Potential Classes (Guy and Smith, 1998)

Land Capability Class	Climate Capability Class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Wetland	Wetland	Wetland	Wetland	Wetland	Wetland	Wetland	Wetland
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table 5: The Land Capability Classes Description (Guy and Smith, 1998)

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

2.4 Soil Analyses

All sampled soils were sent to WaterLab (Pty) Ltd. as a SANAS accredited laboratory for selected soil and water chemical analyses. The samples were prioritised for selected analyses of specific contaminants of potential concern (CPCs) according to the conceptual source-pathway-receptor linkages. The chemical analyses included the following selected constituents, micro nutrients and contaminants of potential concern (CPCs) to determine the need for amelioration:

- pH;
- Electrical conductivity (EC);

- Alkalinity;
- Anions; and
- Inorganic heavy metals and metalloids.

2.5 Soil Data Analysis and interpretation

Analytical data was interpreted quantitatively, as mass of contaminant per mass of dry weight (DW) of soil (mg/kg), pH values and/or milli-Siemens per meter (µS/cm) for electrical conductivity (EC). Table 6 below was used as reference guide to interpret pH results in terms of acidity.

Table 6: pH classification with reference of common foods and other substances

pH range	Description	pH range of common foods and other substances	
<4,5	Extremely acid	Battery acid	<2.0
4,5 – 5,0	Very strongly acid	Lemon juice	2.0-2.6
5,1 – 5,5	Strongly acid	Vinegar	2.4-3.4
5,6 – 6,0	Medium acid	Wine	4-5
6,1 – 6,5	Slightly acid	Normal rain	5-6
6,6 – 7,3	Neutral	Distilled water	7
7,4 – 7,8	Mildly alkaline	Baking soda	8-9
7,9 – 8,4	Moderately alkaline	Soap	9-10
8,5 – 9,0	Strongly alkaline	Ammonia	10-12
>9,0	Very strongly alkaline	Lye	12-14

Note: pH Values of Common Foods and Ingredients obtained from (Anon, 1962), and (Bridges and Mattice 1939).

This assessment was conducted as a baseline for future analysis to be undertaken in the advanced stages of the mining operations.

3. DESKTOP ASSESSMENT RESULTS

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**It should be noted that most of the database used in this assessment were compiled prior to mining, thus inaccuracies exist in the data present. However, the data presented gives useful information of the surrounding soils.*

The following data is applicable to the study area according to various data sources including but not limited to the Agricultural Geo-referenced Information System (AGIS).

- The Mean Annual Rainfall (MAR) Associated with the MRA is estimated to range between 601-800mm per annum while the mean annual total evaporation is estimated to range from 1601-1800mm;
- According to the geological map of South Africa 2001, the dominant geology associated with the BEP project area is Arenite. The remainder of the area is

underlined by Basalt and Quartzite located to the west and south respectively. Refer to Figure 5;

- According to SOTER database the dominant soil form associated with the entire BEP and MRA is Haplic Acrisols (ACh). The soils are dystrophic and/or mesotrophic; red soils widespread;
- The dominant landform type associated with the MRA landscape is Plain landform. The means that the landscape is suitable for cultivated agriculture. Refer to Figure 6;
- The dominant soil depth associated with the proposed BEP project ranges between 450mm to 750mm. This means that the surrounding soils have sufficient depth for most crop cultivation;
- The land capability of the soils based on the Soil 2001 database is Arable Group II which is regarded as high potential arable land. This is purely based on the existing database consulted, however this may not the case for all the areas during the field verification exercise;
- The natural soil pH of most soils is estimated to range between 5.5 and 6.4, indicating that the soils are acidic to slightly acidic. The remaining soils located to the northwest and southwest can be classified as acidic as they have a natural pH ranging between 0 and 5.5, as interpolated from topsoil pH values obtained from the National Soil Profile Database (AGIS database), as depicted in Figure 7;
- The AGIS database indicates that the livestock grazing capacity potential is estimated to range between 2.5 to 4.5 hectares per large animal unit (Morgenthal et.al., 2005), as depicted on Figure 8. This means that these areas can be considered ideal for commercial grazing;
- The susceptibility of the surrounding soils to water erosion ranges between low and very high erodibility, as depicted on Figure 9. This means that erosion control measures should be implemented during all phased of development as a minimum requirement to prevent soil loss. Whereas the wind erosion ranges between somewhat susceptible to susceptible, as depicted on Figure 10; and
- From a visual observation using digital satellite images the dominant land uses within and surroundings of the BEP areas are cultivated agriculture (rainfed and pivot irrigation), livestock farming, dairy farming, and mining.
- The screen tool results for the agricultural theme indicated that the sensitivity of BEP project area is high. This is due to the high land capability of soils occurring with the area as well as the cultivation of annual crops and planted pastures. Refer to Figure 11.

Figure 4: Geology associated with the MRA and BEP, and surrounding areas

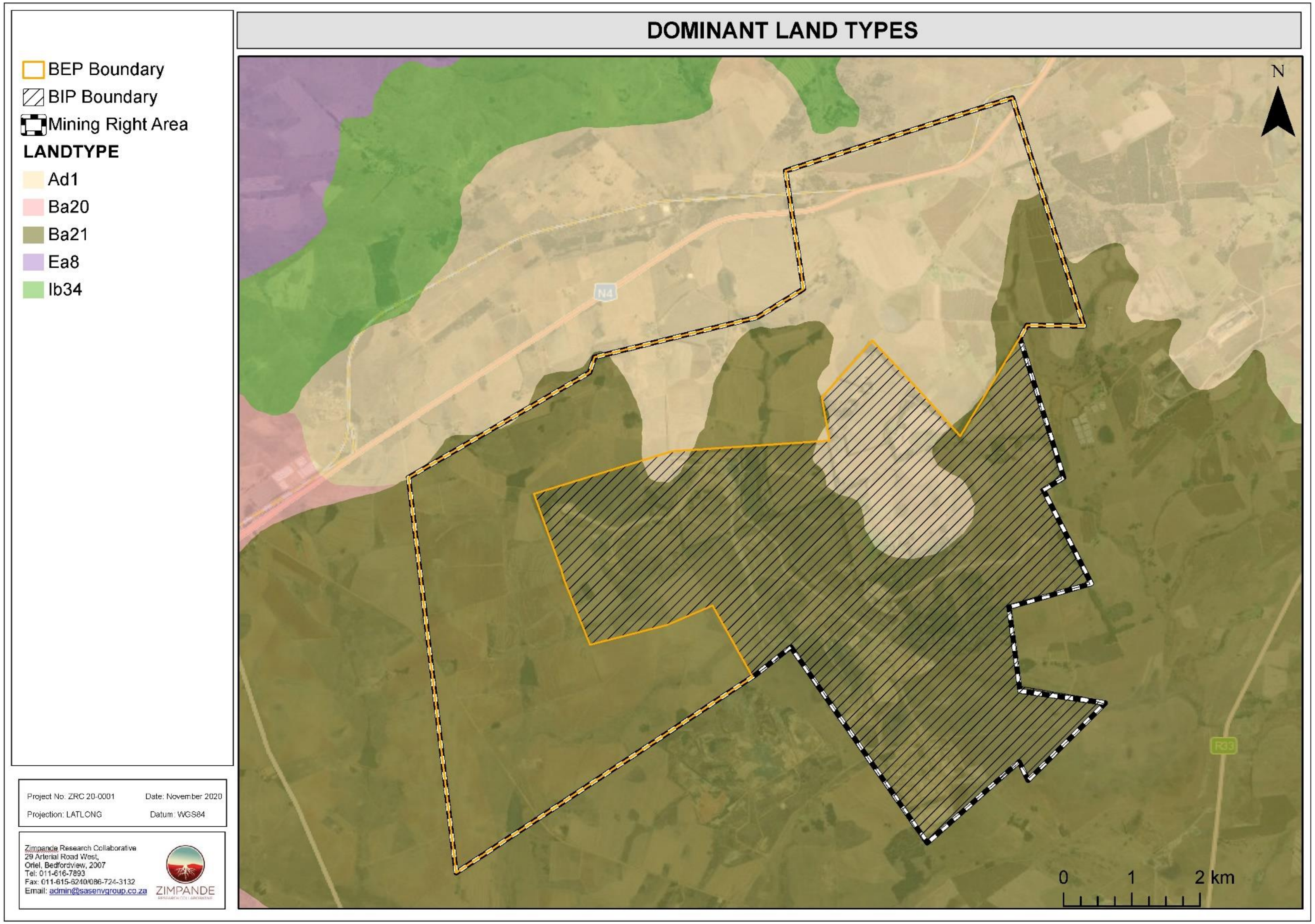

Figure 5: Land Types associated with the BEP and MRA as well as the surrounding areas

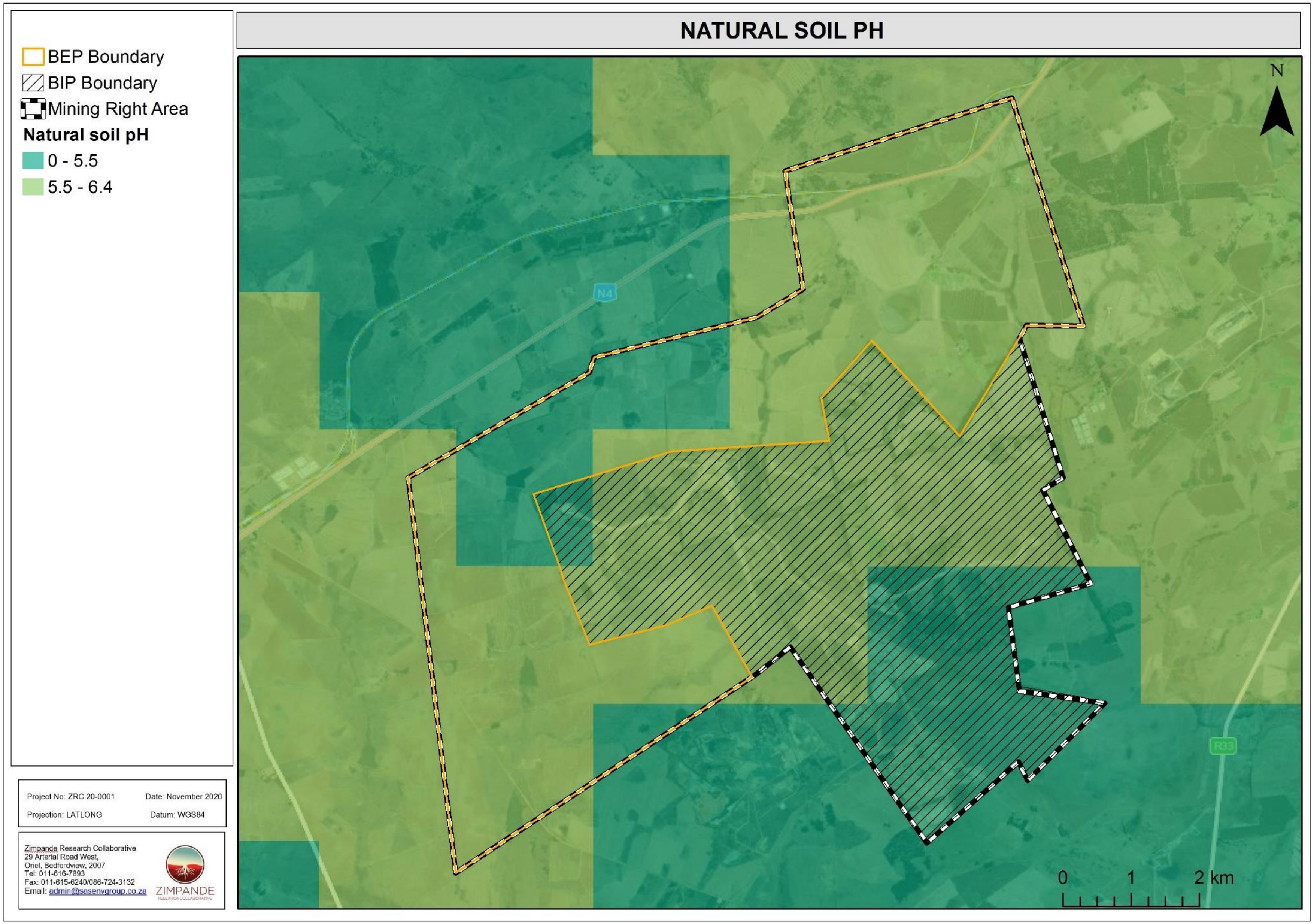

Figure 6: Natural Soil pH associated with the MRA.

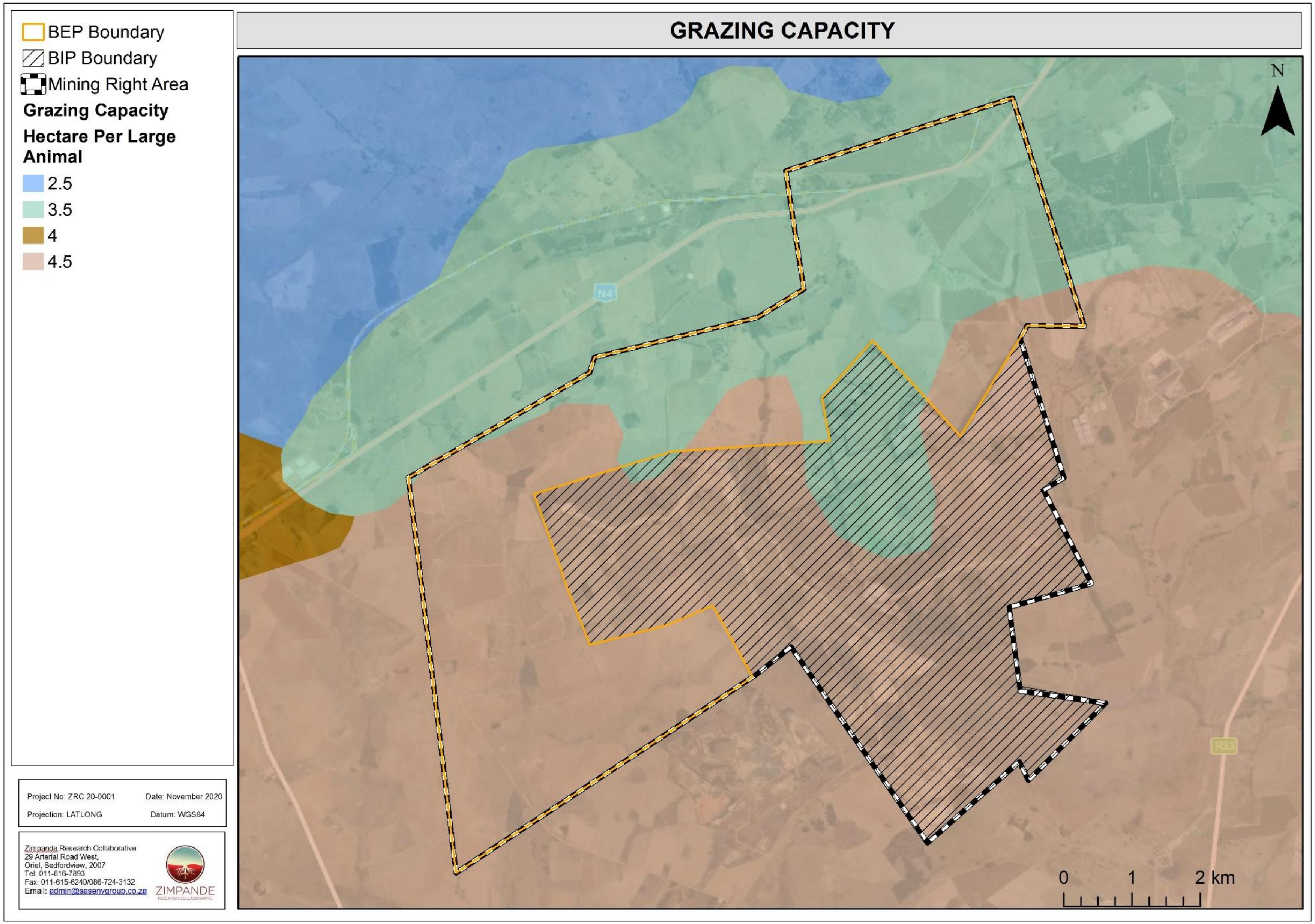

Figure 7: Grazing Capacity associated with the MRA and the immediate surrounding areas.

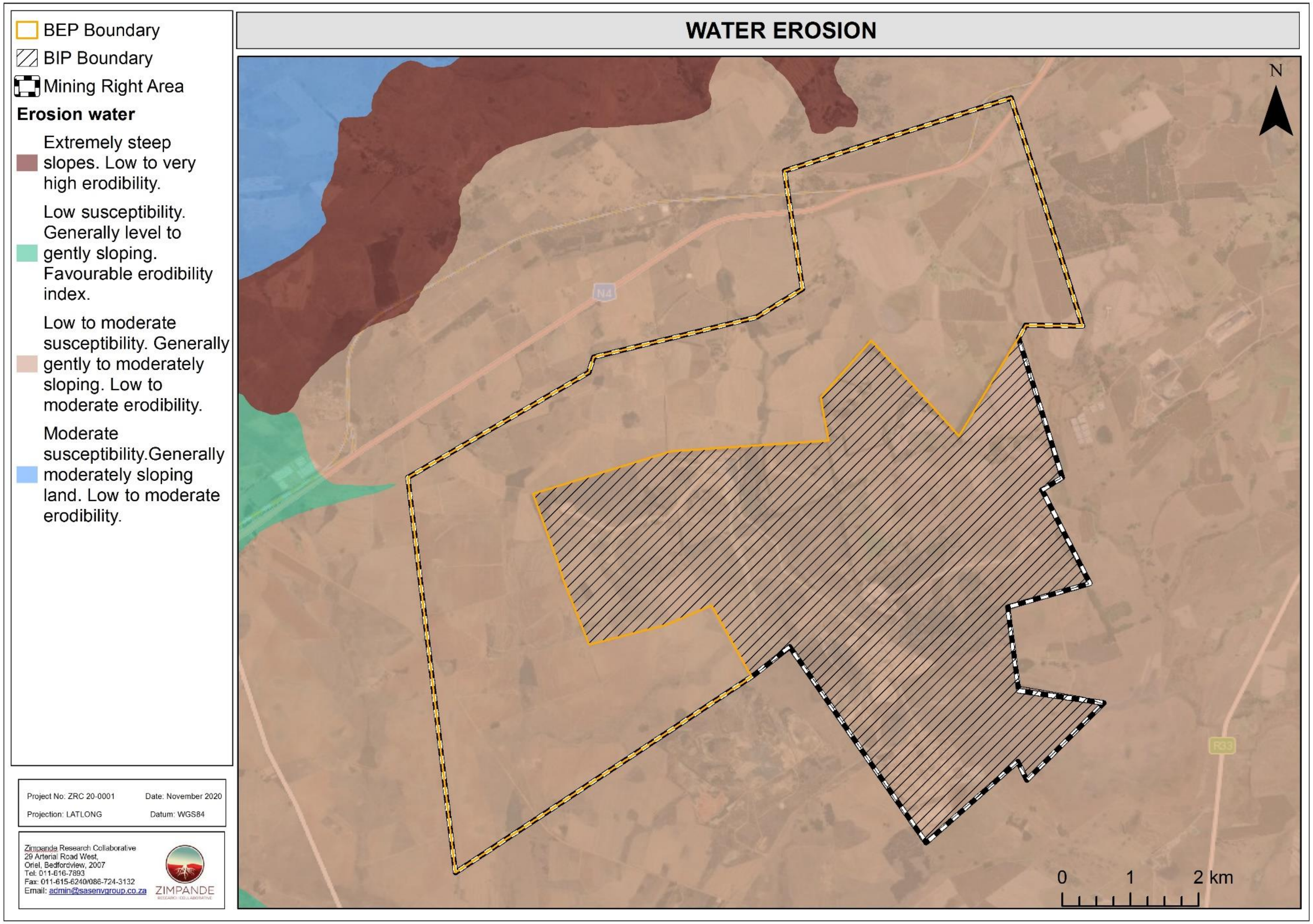

Figure 8: Soil susceptibility to water erosion associated with the MRA and logistics route options

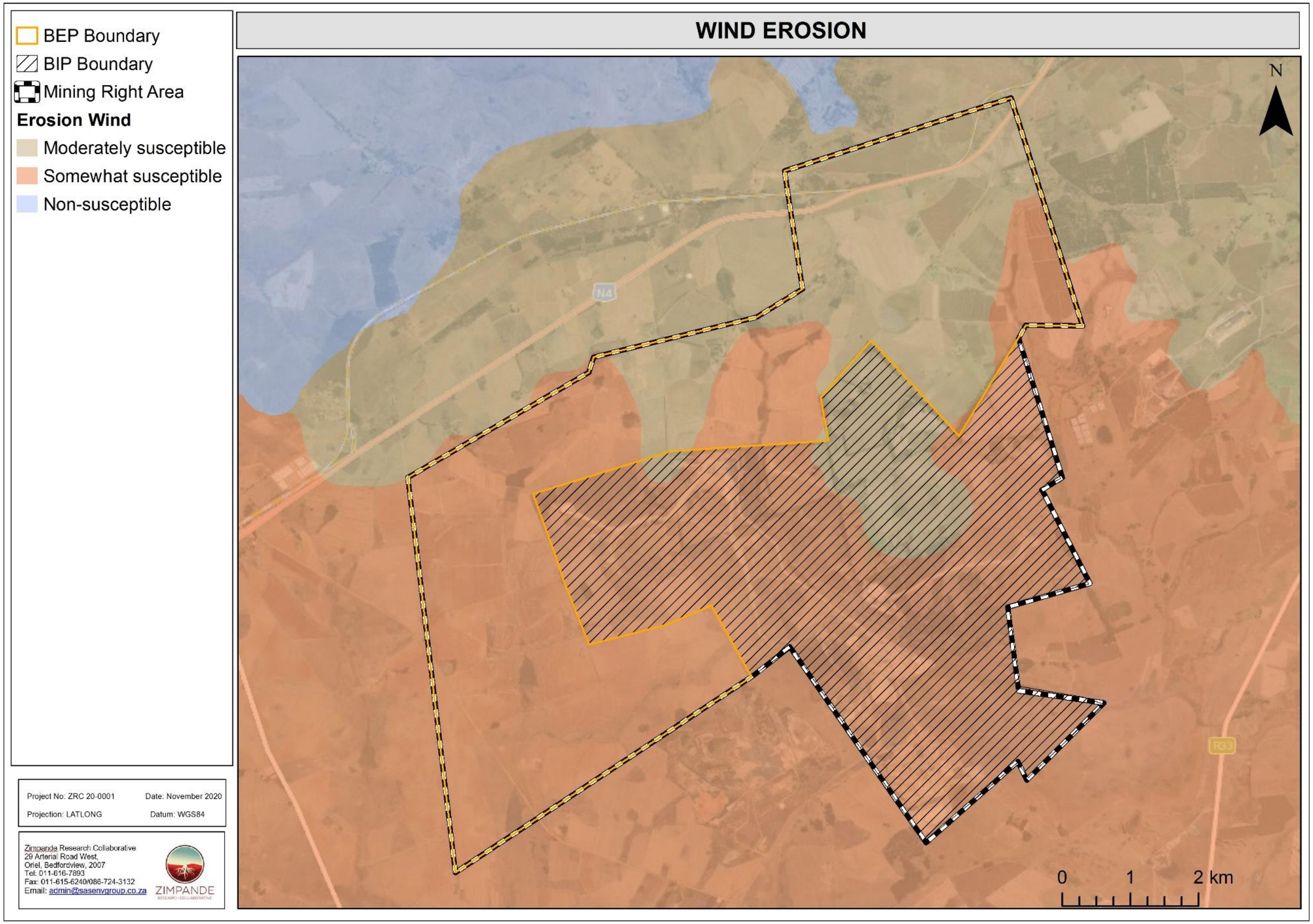

Figure 9: Soil susceptibility to wind erosion associated with the BEP project and MRA

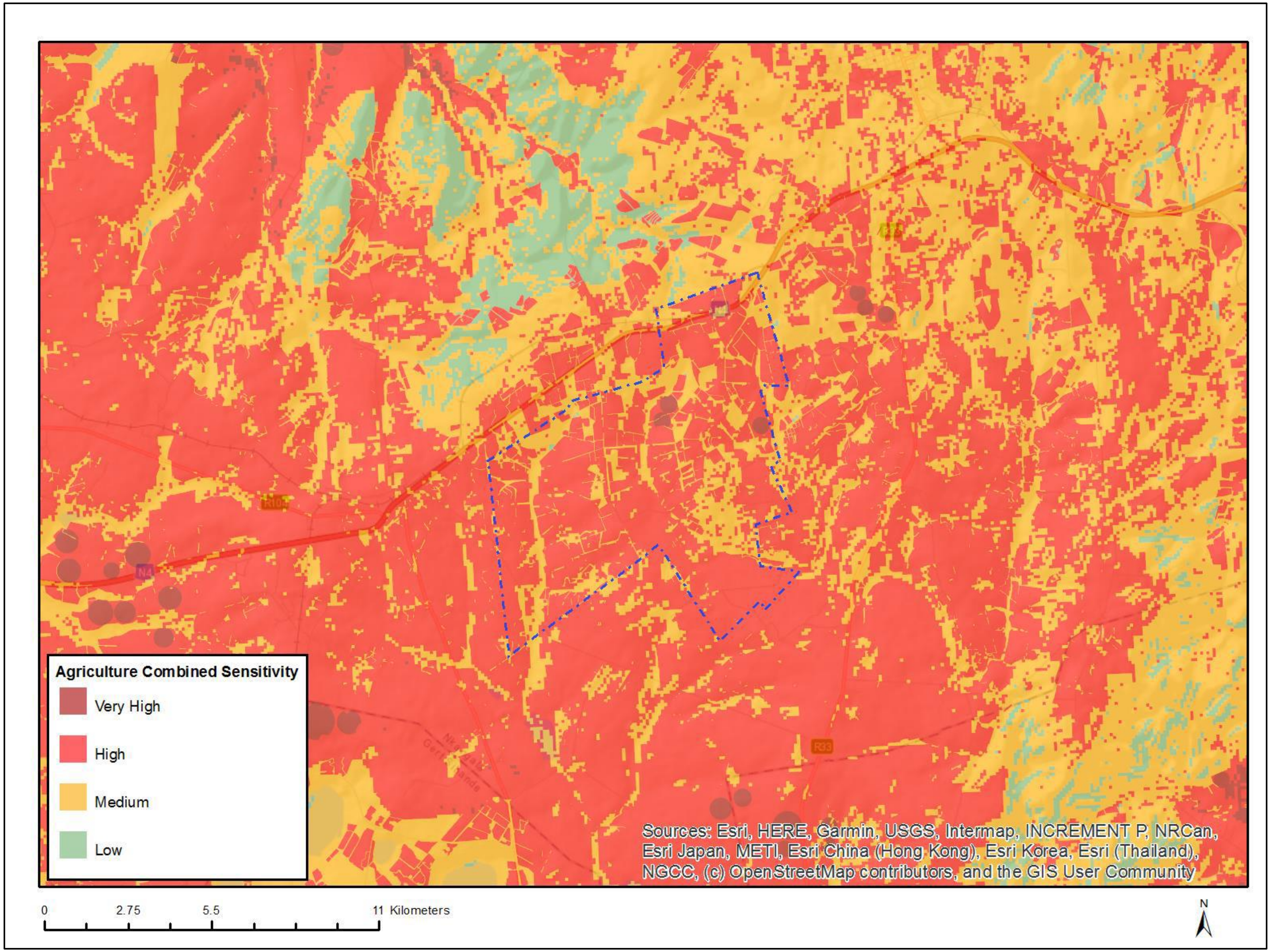

Figure 10: Screening tool results depicting the combined agricultural sensitivity for the Exxaro Belfast MRA

4. ASSESSMENT RESULTS

4.1 Current Land Use

The local climate can be broadly classified as favourable for good yield for a wide range of adapted crops and a year-round growing season. The Mean Annual Rainfall (MAR) Associated with the MRA is estimated to range between 601-800mm per annum while the mean annual total evaporation is estimated to range from 1601-1800mm.Moisture stress and risk of lower temperatures are relatively low.

Most of the area earmarked for development as part of the Belfast Expansion Project (BEP) is under intensive commercial agriculture, utilising irrigation systems in some instances to maximise the yield from the available land. The farms in the area are therefore under both rainfed and irrigated agriculture, with centre pivots as the irrigation mechanism being utilized in most instances where irrigation takes place. Not only is the area under subject to intensive commercial agriculture but it is also utilised for sheep, cattle, and dairy farming supplying the local and regional areas. Refer to Figure 11 below for images of some of the landuses within the BEP project area.

According to the Department of Agriculture, Rural Development, Land and Environmental Affairs department the areas with irrigation systems are classified as unique and high agriculture potential areas, especially since the yield of various crops is exponentially increased and of high importance with regards to food security. The soils within the BEP area can generally be classified as high potential soils due to their inherent physical properties (i.e. good drainage, sufficient depth) which are ideal for cultivation. The land capability of the surrounding soils as well as the land potential are high due to adequate climatic conditions (i.e. rainfall, temperature) and appropriate slope which allows for intensive commercial agricultural practices.

Figure 11: Photographs illustrating the dominant land use within the BEP project

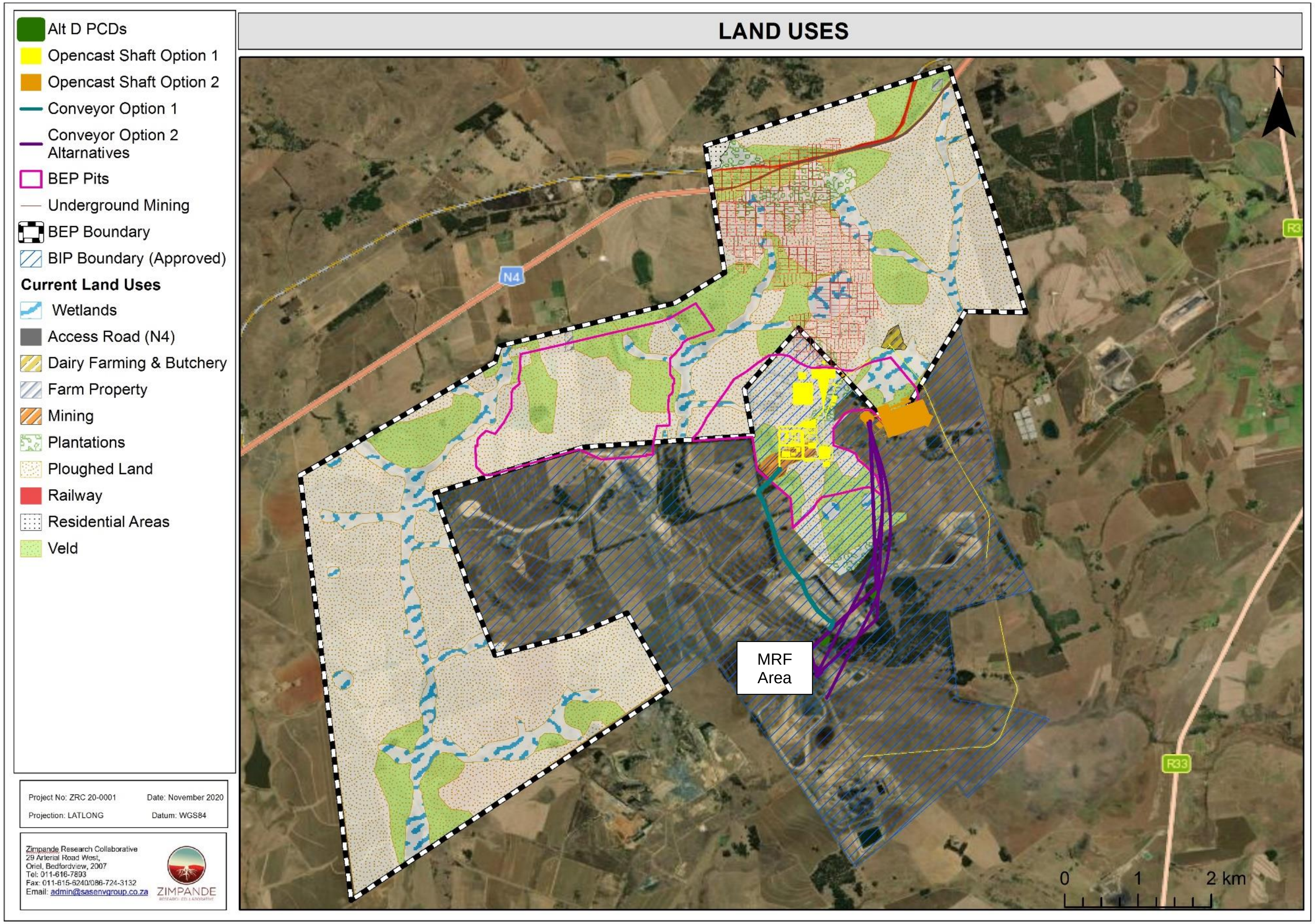

Figure 12: The dominant land uses associated with the BEP project

4.2 Dominant Soil Forms

The dominant soil forms occurring within the BEP project area are Longlands/Wasbank, Witbank, Lichtenburg, Avalon and Glencoe. These soils account for 81.7% of the soils occurring within the BEP project area. The remaining sub-dominant soil forms were identified as Dresden, Hutton, Wasbank, Avalon/Glencoe, Lichtenburg/Hutton, Wasbank, Lichtenburg/Glencoe and Westleigh/Glencoe. These soils account for 18.3% of soils occurring within the BEP project area.

The dominant soils occurring within the BEP project area can be broadly classified as soils ideal for agriculture (with minor limitations) as well as grazing and wilderness land uses. These ideal soil forms include Lichtenburg, Avalon, Hutton and Glencoe. The above-mentioned soils are considered ideal for agricultural cultivation due to:

- Deep well drained soil characteristics;
- Texture and structure allowing for effective rooting depth;
- Good water holding/storage capacity; and
- Good nutrient holding capacity.

The soils which support wetland conditions such as Longlands/Wasbank soils tend to have a low nutrient status and this can be attributed to the loss of colloidal matter in the albic horizon due to lateral movement of water in the horizon. These soils are also prone to waterlogging conditions due to the underlying impermeable layer below the albic horizon thus resulting in anaerobic conditions not favourable for most cultivated crops. These soils require intensive management for cultivation and as a result more suitable for grazing and subsistence farming.

The Westleigh soil form is characterised by long periods of saturation leading to formation of plinthic and gleyic properties in the subsoil. These soils have high clay content which can be a limiting factor for root growth and high moisture content leading to anaerobic conditions not suitable for most cultivated crops.

The Dresden and Mispah soil forms are shallow in nature with the topsoil underlain by the hard plinthic and hard rock horizons respectively. These soils have a limitation in terms of the effective depth and the water holding or storage capacity. Consequently, these soils are not suitable for most cultivated crops.

The Witbank (Anthrosols) soil forms are soils which have been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are not ideal for agricultural cultivation.

Table 6 and Figure 14 below represents the soil forms identified during the site visit within the BEP project area as well as their diagnostic horizons, respectively. Figure 15 depicts the investigated soil points during the site visit.

Table 6: Dominant soil forms within the BEP project

Soil Form	Code	Diagnostic Horizon Sequence
Longlands/Wasbank	Lo/Wa	Orthic/Albic/Soft Plinthic or Hard Plinthic
Lichtenburg	Lc	Orthic/ Red Apedal/Hard Plinthic
Lichtenburg/Hutton	Lc/Hu	Orthic/Red Apedal/or Hard Plinthic
Lichtenburg/Glencoe	Lc/	Orthic/Red Apedal or Yellow Apedal/Hard Plinthic
Hutton	Hu	Orthic/Red Apedal
Ermelo	Er	Orthic/Yellow-Brown Apedal (thick)
Bainsvlei	Bv	Orthic/Red Apedal/Soft Plinthic
Wasbank	Wa	Orthic/Albic/Hard Plinthic
Manguzi	Mg	Orthic/Albic
Avalon	Av	Orthic/Yellow Brown/Soft Plinthic
Avalon/Glencoe	Av/Gc	Orthic/Yellow Brown/Soft Plinthic or Hard Plinthic
Glencoe	Gc	Orthic/Yellow Brown/Hard Plinthic
Glencoe/Westleigh	Gc/We	Orthic/Yellow Brown or Soft Plinthite/Hard Plinthite
Dresden	Dr	Orthic/Hard Plinthic
Mispah	Ms	Orthic/Hard Rock
Katspruit	Ks	Orthic/Gley
Kroonstad	Kd	Orthic/Albic/Gley
Witbank	Wb	Transported Technosols

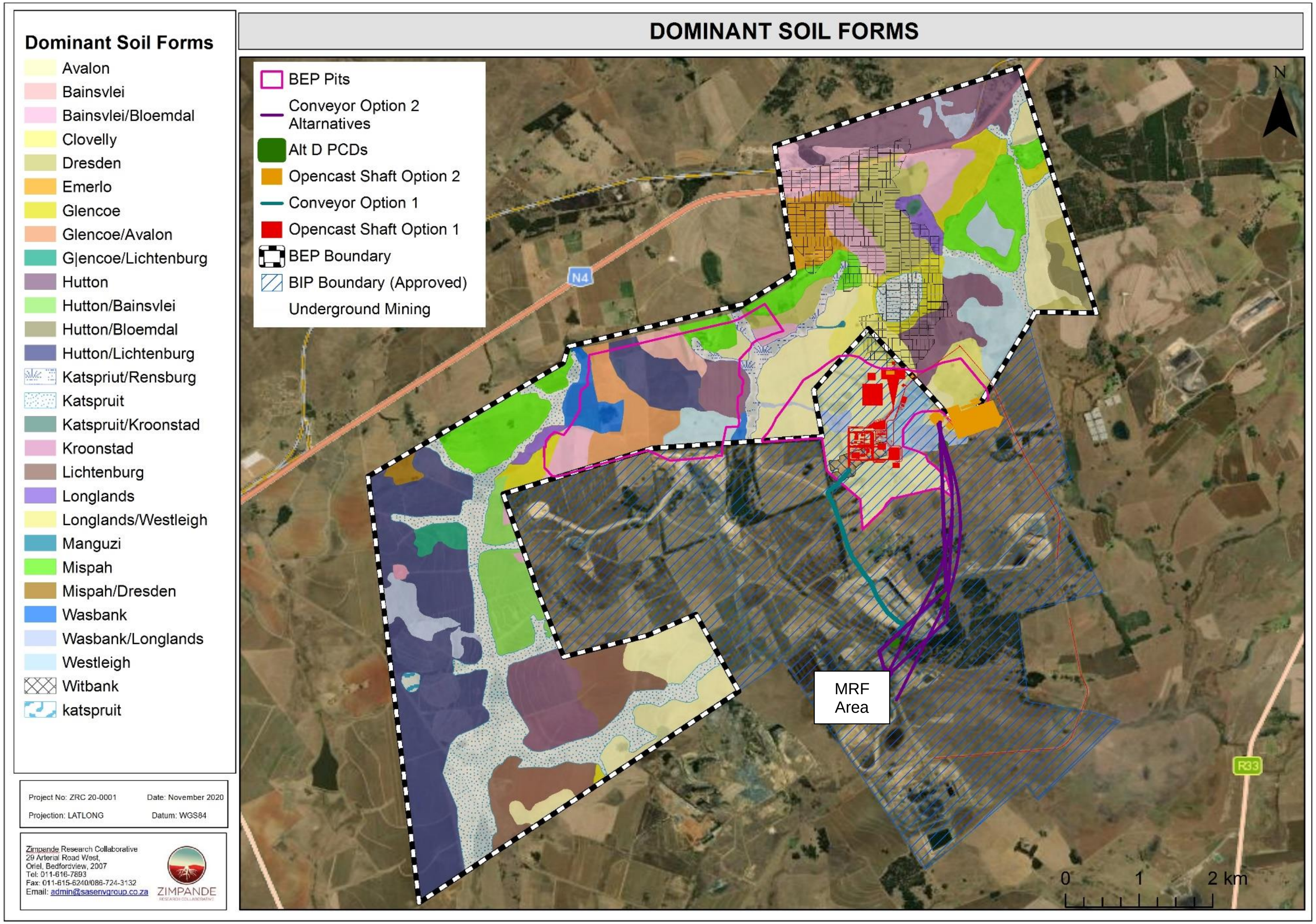

Figure 13: Dominant soil forms identified within the BEP project area during the field verification.

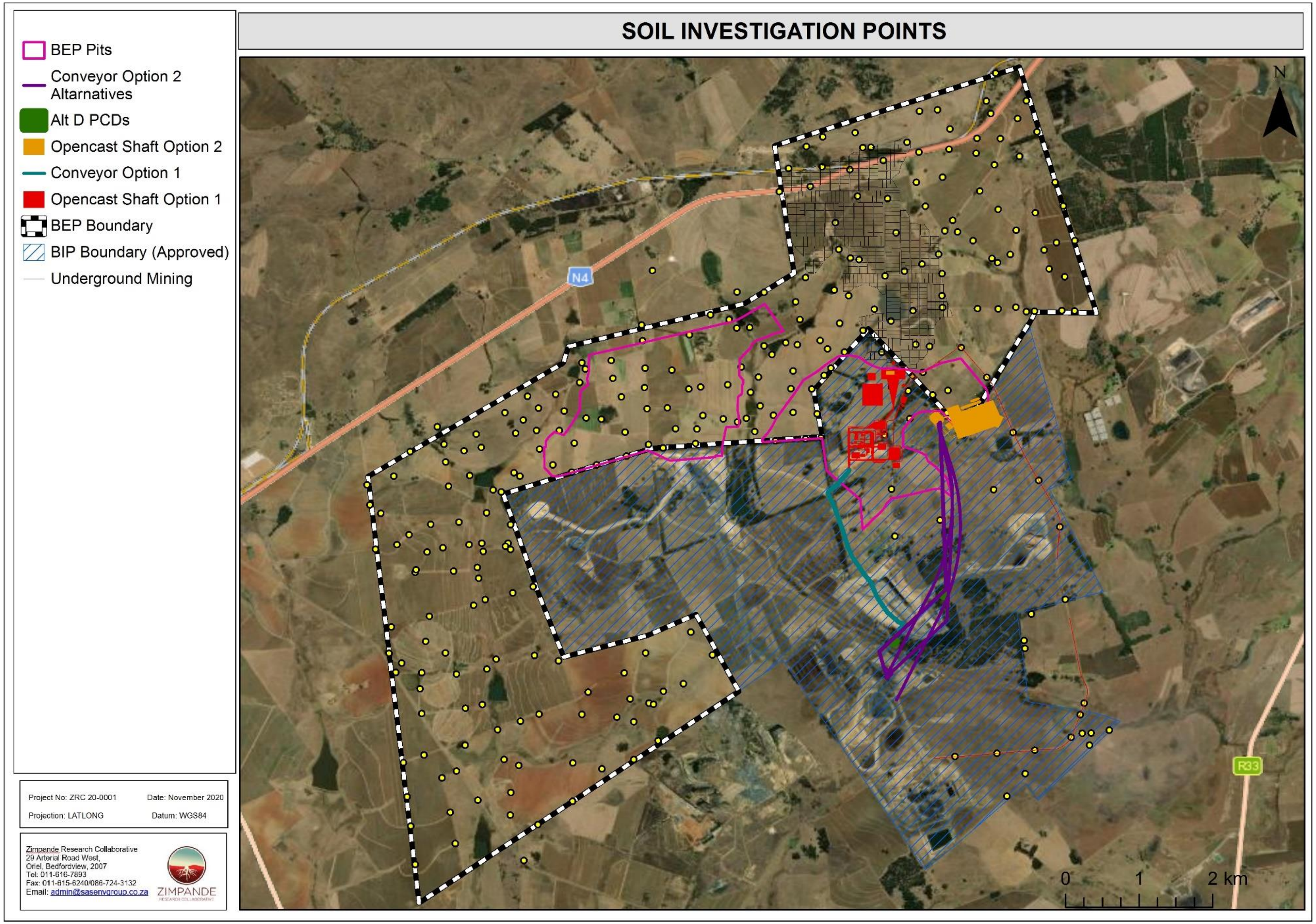

Figure 14: Soil investigation points

4.3 Land Capability Classification

Agricultural land capability in South Africa is generally restricted by climatic conditions, with specific mention to water availability (Rainfall). Even within similar climatic zones, different soil types typically have different land use capabilities attributed to their inherent characteristics. High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crops yields when treated and managed according to best possible farming practices (Scotney *et al*., 1987).

For the purpose of this assessment, land capability was inferred in consideration of observed limitations to land use due to physical soil properties and prevailing climatic conditions. Climate Capability (measured on a scale of 1 to 8) was therefore considered in the agricultural potential classification. The study area falls into Climate Capability Class 3 due to seasonal temperatures variation with good yield potential for a moderate range of adapted crops.

The identified soils were classified into land capability and land potential classes using the Camp *et. al*, and Guy and Smith Classification system (Camp *et al.,* 1987; Guy and Smith, 1998), as presented from Figure **16** below. The identified land capability limitations for the identified soils are discussed in comprehensive “dashboard style” summary tables presented from Tables **8, 9, 10, 11** and **12** below. The dashboard reports aim to present all the pertinent information in a concise and visually appealing fashion. **Table 7** below presents the dominant soil forms and their respective land capability as well as areal extent expressed as hectares as well as percentages.

Table 7: Identified soil forms within the BEP project area and their respective land capability.

Soil Form	Land capability	Area (ha)	Percentage
Lichtenburg	Arable (Class II)	146.8	3,87
Hutton		363.7	9,59
Ermelo		57.4	1,51
Glencoe		110.8	2,92
Clovelly		103.5	2,73
Lichtenburg/Glencoe		20.9	0,55
Lichtenburg/Hutton		510.8	13,47
Hutton/Bainsvlei		105.8	2,79
Hutton/Bloemdal		24.3	0,64
Avalon	Arable (Class III)	771.9	20,36
Avalon/Glencoe		83.0	2,189
Bainsvlei		57.6	1,52
Bainsvlei/Bloemdal		180.4	4,76
Wasbank	Grazing (Class V - Wetlands)	46.9	1,24
Westleigh		166.52	4,39
Wasbank/Longlands		83.8	2,21
Longlands/Westleigh		53.7	1,42
Katspruit		397.5	10,49
Katspruit/Rensburg		50.1	1,32
Katspruit/Kroonstad		3.1	0,08
Kroonstad		3.2	0,08
Manguzi		1.1	0,03
Longlands		31.1	0,82
Dresden	Grazing (Class VI)	142.2	3,75
Mispah		245.6	6,48
Mispah/Dresden		11.6	0,31
Witbank	Wilderness (Class VIII)	17.7	0,47
Total Enclosed Area		**3791.0**	**100**

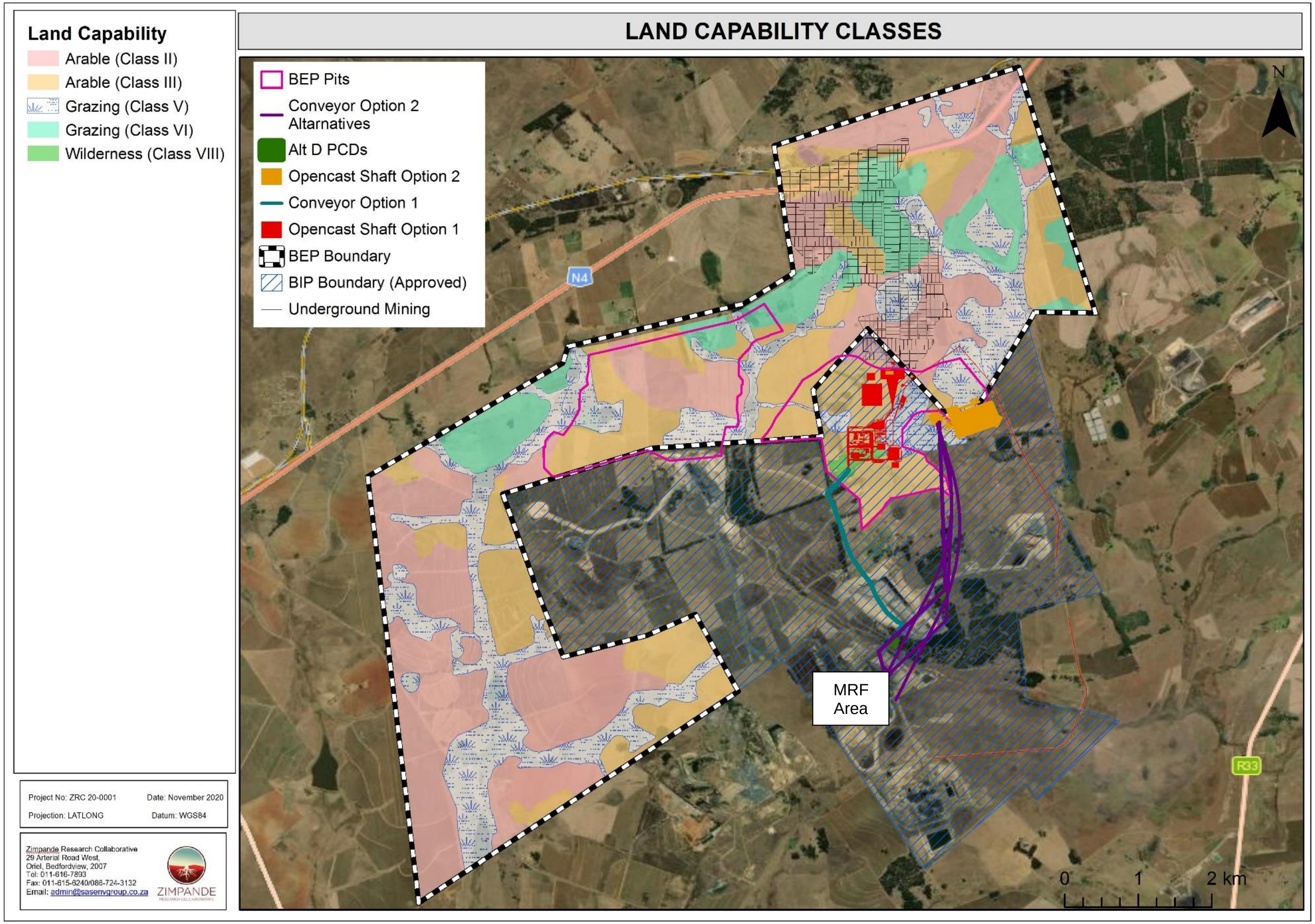

Figure 15: Map depicting Land capability of soils occurring within the BEP project area

Table 8: Summary discussion of the Arable (Class II) land capability class

<table>
<tr><th colspan="5">Land Capability: Arable (Class II) and High potential land potential</th></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">1.4% Relatively flat slope to moderately sloping</td><td>Photograph notes</td><td>View of the red apedal, yellow brown apedal and soft plinthic horizons associated with the Avalon and Hutton soils occurring within the study area</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Hutton/Avalon/ Lichtenburg</td><td>Area Extent</td><td>1258ha (36%)</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">None. These soils have enough depth (greater than 60cm) for most cultivated crops and good drainage characteristics.</td><td colspan="2" rowspan="2">Land Capability and Land Potential
These soil forms are considered high potential agricultural soils with high (Class II) land capability, suitable for arable agricultural land use with minimal management interventions. Therefore, these soils are considered suitable for use for crop cultivation, and are also well-suited for other less intensive land uses such as grazing, forestry, etc. However, emphasis is directed to their agricultural crop productivity due to the scarcity of such soil resources on a national scale and food security concerns.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L2: Very infrequent and/or minor limitations due to soil, slope, temperatures, or rainfall.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>H</td><td rowspan="2">The overall impact of the proposed open cast pits and related infrastructure development on land capability and land potential is anticipated to be High (H) prior to mitigation measures and Medium High (MH) post mitigation, due to the inherently high land capability of the identified dominant soil forms. The proposed developments will result in a permanent change of land use. Thus, the loss of agricultural soils and agriculturally productive land will be somewhat significant considering the scarcity of arable soils in South Africa.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:

These soils are under intensive commercial agriculture, utilising irrigation systems in some instances to maximise the yield from the available land. The farms in the area are therefore under both rainfed and irrigated agriculture, with centre pivots as the irrigation mechanism being utilized in most instances where irrigation takes place. it is the opinion of the specialist that the mine should go through the optimisation process in efforts to minimise the impact on the agricultural resources.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>MH</td></tr>
</table>

Table 9: Summary discussion of the Arable (Class III) land capability class (High potential with moderate limitations)

<table>
<tr><th colspan="5">Land Capability: Arable (Class III) and High potential with moderate limitations</th></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2"><0.3% Relatively flat</td><td>Photograph notes</td><td>View of the yellow brown apedal, soft plinthic and hard plinthic horizons associated with the Dresden, Glencoe and Avalon soils occurring within the BEP project area</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Dresden/Glencoe/Westleigh</td><td>Area Extent</td><td>988.7ha (28.3%)</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">The occurrence an impermeable layer at somewhat shallow depth is the primary land capability limitation of the Glencoe and Dresden soil forms as this horizon cannot be cut with a spade even when wet.</td><td colspan="2" rowspan="2">Land Capability and Land Potential
The identified soil forms are of moderate (Class III) land capability, and suitable for arable agricultural land use with restrictions. Therefore, these soils are considered to make a moderate contribution to agricultural productivity on a regional and national scale.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L3: Good potential: Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>H</td><td rowspan="2">The overall impact of the proposed opencast pits and associated developments on land capability and land potential is anticipated to be Medium High (MH) prior to mitigation measures and Medium Low (ML) post mitigation, due to the inherently high land capability of the identified dominant soil forms. The proposed mining developments will result in a change of land use during all phases of mining. Thus, the loss of agricultural soils and agriculturally productive land will be somewhat significant considering the scarcity of arable soils in South Africa.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:

These soils are under intensive commercial agriculture, utilising irrigation systems in some instances to maximise the yield from the available land. The farms in the area are therefore under both rainfed and irrigated agriculture, with centre pivots as the irrigation mechanism being utilized in most instances where irrigation takes place. it is the opinion of the specialist that the mine should go through the optimisation process in efforts to minimise the impact on the agricultural resources.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>ML</td></tr>
</table>

Table 10: Summary discussion of the Grazing (Class V) land capability class (Wetlands)

<table>
<tr><th colspan="5">Land Capability: Grazing (Class V)</th></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Relatively flat to moderately sloping land of <1.5% slope</td><td>Photograph notes</td><td>View of the albic and clay enriched horizons of the Longlands and Wasbank soil forms</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Longlands/Wasbank</td><td>Areal Extent</td><td>853ha (24.5%)</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Longlands soils have limitations in terms of nutrient holding capacity due to the loss of colloidal matter. In addition, these soils are prone to waterlogging conditions which are not suitable for most cultivated crops.</td><td colspan="2" rowspan="2">Land Capability
The identified soils are of poor (Class V) land capability due to wetness limitations during the rainy season associated with the underlying semi-impermeable soft plinthic material. These soils, at best are suitable for grazing but are sometimes ploughed for subsistence farming due to their limiting factors such as poor nutrient holding capacity. Thus, require intensive management practises. These soils are therefore not considered to contribute significantly to provincial and/or national agricultural productivity.</td></tr>
<tr><td>Land Potential</td><td colspan="2">Wetland: Due to the signs of wetness</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed developments on land capability and land potential is anticipated to be Low (M) both with and without mitigation measures in place, due to the inherently poor land capability of the identified dominant soil forms. The proposed developments in this instance will not impact on high potential soils and will be somewhat significant considering the scarcity of arable soils in South Africa.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
While these soils are not considered prime agricultural production soils, historical cultivation activities have occurred as well as livestock grazing which has therefore qualified these soils for cultivation under intensive management. Thus, protection of these soils is deemed essential, given the rapid decrease in the availability of soil resources in South Africa.</td></tr>
<tr><td>Overall impact significance post to mitigation</td><td>M</td></tr>
</table>

Table 11: Summary discussion of the Grazing (Class VI) land capability class

<table>
<tr><th colspan="5">Land Capability: Grazing (Class VI) and Restricted land potential.</th></tr>
<tr><td colspan="5">  </td></tr>
<tr><td colspan="2">Terrain Morphological Unit (TMU)</td><td>Gently landscapes of < 0.5% slope gradient</td><td>Photograph notes</td><td>View of the Glenrosa/Mispah horizon occurring within the soil profiles of watercourse/wetland related soil forms</td></tr>
<tr><td colspan="2">Soil Form(s)</td><td>Glenrosa/Mispah (Lithic soil forms)</td><td>Area Extent</td><td>387.8ha (11.1%)</td></tr>
<tr><td colspan="2">Physical Limitations</td><td>Lithic soils are normally referred to as young soils due to their shallow effective rooting depth which is the primary limitation of this soil group of land capability</td><td colspan="2" rowspan="2">Land Capability and Land Potential
The Lithic soils (Glenrosa/Mispah) are also considered to be of poor (Class VI) land capability and are not suitable for arable agriculture. These soils are therefore considered to have restricted land potential.</td></tr>
<tr><td colspan="2">Land Potential</td><td>L5 (Restricted potential): Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>ML</td><td rowspan="2">The overall impact of the proposed development and related activities on the land capability of these soils is anticipated to be relatively medium-low with mitigation due to their inherently poor land capability. If this area is clearly demarcated the impact could potentially be reduced to low since the adjacent area could potentially be used as grazing land by subsistence farmers in the neighbouring communities.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The identified Lithic soils are generally not considered to be of significant agricultural productivity. These soils, at best are suited for grazing. The proposed mining development is viable on these soils due to their low agricultural potential although their importance in terms of biodiversity support must be considered. Mitigation measures should this put in place to minimise further disruption of other adjacent soils which can potentially be used for grazing.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>ML</td></tr>
</table>

Table 12: Summary discussion of the Wildlife/Wilderness (Class VIII) land capability class

<table>
<tr><th colspan="5">Land Capability: Wildlife/Wilderness (Class VIII) and Low land potential</th></tr>
<tr><td colspan="5"> </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Not applicable; highly disturbed areas</td><td>Photograph notes</td><td>View of the identified Witbank soil forms</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Witbank (Anthrosols)</td><td>Area Extent</td><td>17.7 ha (0.5%)</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Comprises of significantly disturbed areas due to anthropogenic activities (i.e. excavation and dumping of waste) to an extent that no recognisable diagnostic soil horizon properties could be identified. These soils are characterised by various limitations, primarily the absence of the A horizon as a growth medium.</td><td colspan="2" rowspan="2">Land Capability
These identified Witbank soils have very poor (Class VIII) land capability and Low land potential class attributed to historic construction activities. In addition, some of these soils have been subjected to long term compaction and erosion. This land capability class also includes areas where the original soil has been buried and/or extensively modified by anthropogenic activities. These soils are not considered to make contribution to agricultural productivity even on a local scale.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L7 (Low potential): Severe limitations due to soil, slope, temperature, or rainfall. Non-arable.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>L</td><td rowspan="2">The overall impact of the proposed haul road development and related activities on the land capability of these soils is anticipated to be low due to their very poor land capability and Low land potential</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The current state of these soils requires significant rehabilitation already. The proposed development are not anticipated to cause a loss of agricultural resources since these soils have been excavated and mixed with waste material and therefore are not ideal for cultivation and support limited land use options</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>VL</td></tr>
</table>

5. SOIL CHEMICAL DATA ANALYSIS

Note: The purpose of this soil analysis is to provide baseline data of the current soil chemical status to monitor potential future change brought about by mining. These results can be used to compare the pre- and post-mining conditions and used as a benchmark during the soil rehabilitation and amelioration.

While soil functionality cannot be directly measured, physio-chemical parameters such as pH and Electrical Conductivity (EC) are sensitive to disturbance and responsive to management practices. These parameters can be used as indicators of the response of the soil, and ecosystem to current (and/or former) management practices. Soil pH measurement is useful since it is a predictor of various chemical activities within the soil. The soil chemistry is likely to be altered during the mining phase and these soil-lab results can be used as a baseline for future soil ameliorations post mining activities. Potential impacts include:

- Soil quality deterioration including:
    - Changes in chemical characteristics;
    - Loss of fertility characteristics;
    - Loss of moisture holding capability and organic carbon;
- Soil contamination; and
- Introduction of toxicants to soil.

The sections below present a discussion of the various parameters analysed. These discussions can be used as reference data for future assessments to define and understand areas of concern which require attention in the future. The sampling localities are illustrated on Figure 9 below

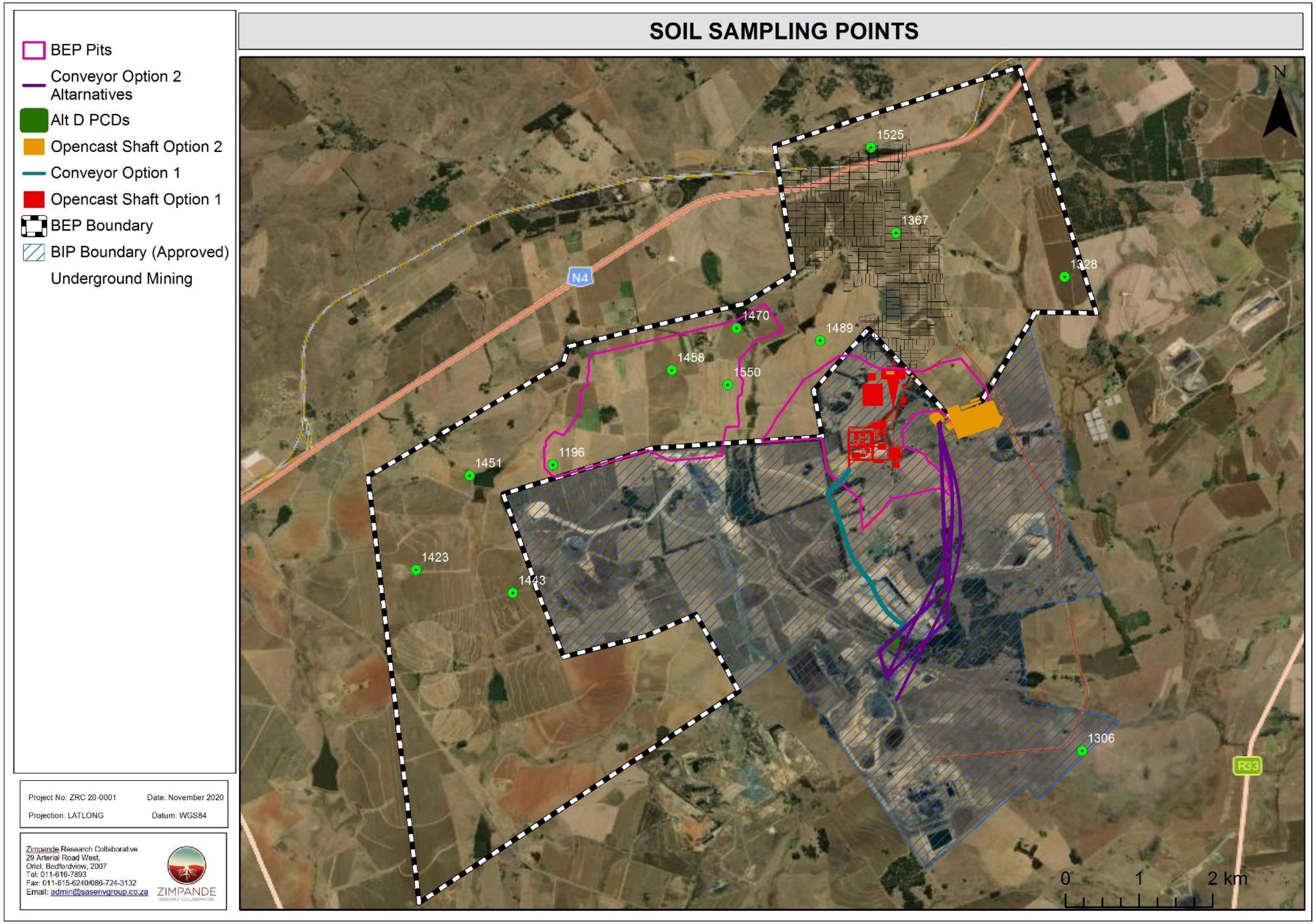

Figure 16: Location of sampling point

pH Analysis,

Based on the laboratory result analysis presented on the table below it can be noted that the pH ranges between 4.5 and 6 which can be interpreted as varying between strongly acid and medium acid following the pH interpretations depicted on Figure 18 below. Most of the nutrients which support plant growth are anticipated to be absent and with a possible increase in Aluminium (Al) to toxic levels. However, this can be corrected with the application of agricultural lime to favourable levels suitable for plant growth.

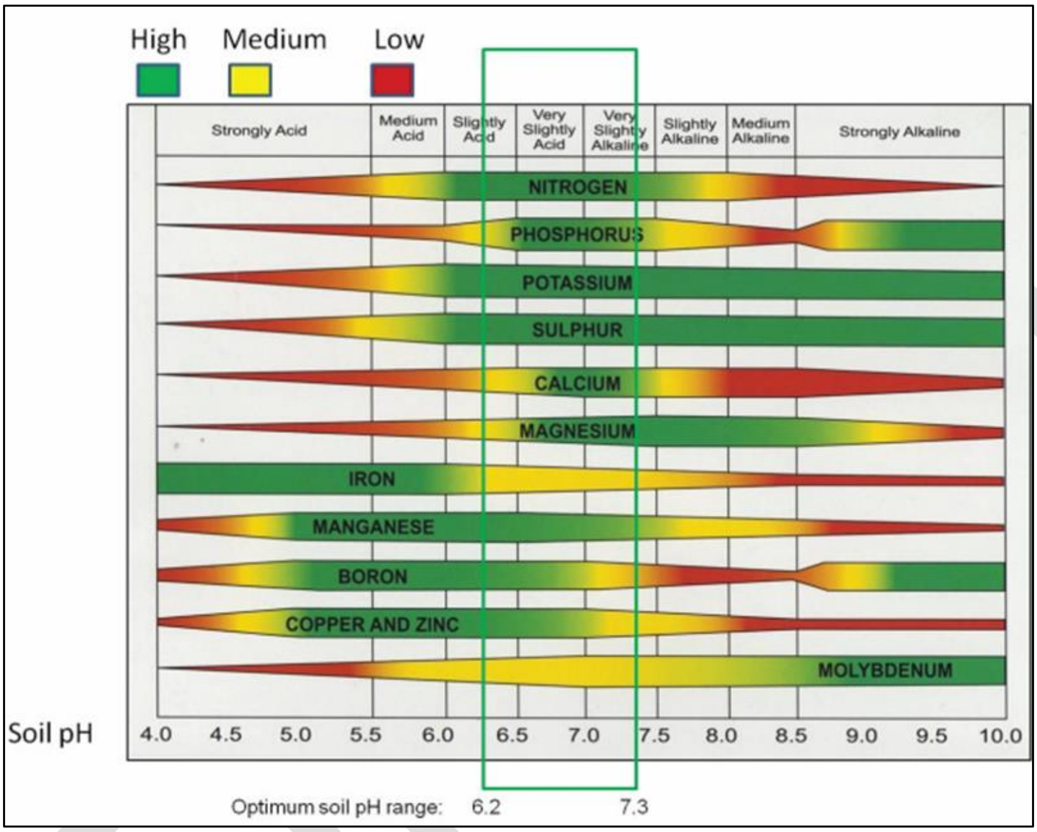

Figure 17: Influence of soil pH on nutrient availability.

Electrical Conductivity

Electrical Conductivity (EC) is a measure of the concentration of soluble salts in the soil solution. However, there is no formally derived guideline value for EC. The EC ranged between 2 mS/m and 43.3 mS/m. The low EC values indicates that the soils are neither saline or sodic and thus the salinity of these soils is not anticipated to have a detrimental effect on plant growth. This can potentially be attributed to the quality of irrigation water since some of the areas which depicted high EC concentrations are under pivot irrigation. This can also be as a result of the parent material which has highly soluble salts. Although the EC is high in some areas it is unlikely that it may be detrimental to crop growth.

Metal Toxicity

All samples showed low levels of both copper and zinc. All samples for copper fell below the detection limit set at 0.004 mg/kg. All samples except for sample 1423 fell below the detection limit set at 0.1 mg/kg. Therefore, these elements are not anticipated to cause toxic conditions for plant growth.

Table 13: Summary of the measured physico-chemical parameters

Sample Point	Analyses			
	pH Value at 25˚C	Electrical Conductivity in mS/m at 25˚C	Copper (mg/kg)	Zinc (mg/kg)
1196	4.8	5.1	<0.100	<0.100
1306	4.5	2	<0.100	<0.100
1328	5.2	8.6	<0.100	<0.100
1351	5.6	6.6	<0.100	<0.100
1367	6.0	13.4	<0.100	<0.100
1423	5.9	10.6	<0.100	0.198
1443	6.2	43.3	<0.100	<0.100
1458	5.8	30.6	<0.100	<0.100
1470	6.7	13.2	<0.100	<0.100
1489	5.6	13.4	<0.100	<0.100
1525	5.5	10	<0.100	<0.100
1550	5.9	14.1	<0.100	<0.100

Macronutrients Analysis

Macronutrients are required in relatively large quantities by plants; however, plants also show a great deal of variation in their requirements of these elements. These elements are critical to numerous plant components including proteins, nucleic acids and chlorophyll, and are essential for processes such as energy transfer and the functioning of enzymes (Fertilizer Society of South Africa, 2007).

The required soil nitrate as nitrogen (NO3-N) for specific crops varies from crop to crop but in general, a concentration range of 10-50 mg/kg is desired. Sample 1550, 1443, 1196, 1489, 1458 and 1367 fell within the desired range of 10-50 mg/kg. However, sample 1443 fell above the desired range while sample 1351, 1328, 1423, 1525, 1470 and 1306 fell below the desired range of 10-50 mg/kg and thus additional fertilisation may be required for samples which fell below the desired level for optimum crop production. The lower nitrate concentration can be attributed to the sandy textural class of soils and nitrate ions being highly mobile in the soils and thus more prone to leaching away from the root zone. The leaching of nitrates in the soil may lead to requirement of additional of nitrogenous fertilizers which may reduce the cost benefits for the farmers. This means that the post closure soil rehabilitation programme may be expensive as more fertilizer inputs may be required to reinstate the premining soil chemical status or sufficient nutrients to support post closure grazing capacity.

Plant available phosphorus is often low in soils and unlike nitrogen, phosphorus is highly immobile and only the portion which is in the immediate vicinity of the plant root can be taken up by the plant. Phosphorus content less than 15 mg/kg is considered very low for grain and vegetable production. All samples had very low phosphorus content of less than 5 mg/kg. High acidity of the soils is likely the cause of the low phosphate concentration. This can be rectified by the accumulation of phosphates in the soil through additional fertilisation.

Potassium (K) is an essential plant nutrient and is required in large amounts for proper growth and reproduction of plants. Potassium is considered second only to nitrogen, when it comes to nutrients needed by plants, and is commonly considered as the “quality nutrient”. In Photosynthesis, potassium regulates the opening and closing of stomata, and therefore regulates CO2 uptake. It also plays a major role in the regulation of water in plants (osmo-regulation). Both uptake of water through plant roots and its loss through the stomata are affected by potassium. The most common symptom of potassium deficiency is an area of yellowed tissue around some leaf edges. Potassium deficiency can also cause entire leaves to develop a light-green colour. A potassium concentration of 40 mg/kg is considered very low for cultivation. Although a potassium content between 80 mg/kg and 160 mg/kg is considered optimal for most cultivated crops and vegetables. All samples fell below the optimal potassium concentration and thus additional potassium is required before cultivation. This means that additional potassium fertilizers are required to increase the potassium to the desired concentration which may reduce the cost benefits for the farmers. This means that the post closure soil rehabilitation programme may be expensive as more fertilizer inputs may be required to reinstate the premining soil chemical status.

Table 14: Summary results of the macronutrient analysis

Sample Number	1351	1550	1328	1423	1525	1470	1443	1196	1306	1489	1458	1367
Nitrate as N (mg/kg)	2.4	15	6.0	2.4	5.6	5.6	112	12	1.6	25	48	17
Ortho-Phosphate as P (mg/kg)	0.4	4.4	0.4	1.6	<0.4	1.2	<0.4	<0.4	<0.4	<0.4	0.4	1.2
Potassium (mg/kg)	9.9	49.5	7.6	17.9	19.1	38.0	55.4	8.2	<2.0	28.1	79.7	25.2

Micronutrients Analysis

Micronutrients are essential elements for plant growth and are required by plants in minute quantities. Each essential element can only perform its role in plant nutrition properly if other necessary elements are available in balanced ratios for plants. For the purposes of this study, only essential trace elements were selected for analysis.

Aluminium (Al) is major constituent of most soils but is not required for plant growth. Aluminium can only influence plants when it moves into a soluble or exchangeable form. Soluble or exchangeable aluminium levels will increase because of decreasing acidity (pH below 4.5), typically due to land management practices. The aluminium content varied widely between the soil samples with sample 1423 registering the highest aluminium content of 40 mg/kg and the samples 1196 and 1489 aluminium content falling below the detection limit despite having low pH values.

Manganese (Mn) is an essential plant mineral nutrient, playing a key role in several physiological processes, particularly photosynthesis. All the samples were characterised by low manganese concentration.
Magnesium (Mg) is also an essential plant nutrient. It plays an important role in the photosynthesis process, as it is a building block of the Chlorophyll, which makes leaves appear green. Magnesium deficiencies on acidic, sandy soils are common occurrence. Magnesium concentration below 50 mg/kg is considered low for cultivation of most crops. All the samples fell below the threshold value of 50 mg/kg and thus additional fertilisation may be required.

Calcium promotes protein formation and is essential for cell growth. It plays a role in the quality and keeping quality of fruits and vegetable. A calcium concentration below 200 mg/kg is considered low for the cultivation of most crops. All samples fell below the threshold value of 200 mg/kg and thus additional fertilization may be required. Figure 17 below depicts the soil sampling localities.

Based on the micronutrient analysis the addition of fertilizer will be required to achieve the desired concentrations for plant uptake to improve crop yield, which reduces the cost benefit for farmers. This means that the post closure soil rehabilitation programme may be expensive as more fertilizer inputs may be required to reinstate the premining soil chemical status.

Table 15: Summary results of selected micronutrients as discussed above

Sample Number	1351	1550	1328	1423	1525	1470	1443	1196	1306	1489	1458	1367
Aluminium (mg/kg)	23	10	4.5	40	3.1	21	1.0	<0.400	<0.400	1.1	17	2.2
Manganese (mg/kg)	<0.100	<0.100	<0.100	0.732963	<0.100	0.2	<0.100	0.2	<0.100	<0.100	0.1	<0.100
Magnesium (mg/kg)	8	12	8	16	8	8	36	4	<4	8	28	4
Calcium (mg/kg)	24	44	28	48	28	56	152	12	<4	36	88	28

6. MPUMALANGA PROTECTED AGRICULTURAL AREAS (2019)

The Protected Agricultural Areas (PAA) have been mapped out according to their agricultural potential within the Mpumalanga areas (Department of Agriculture, Forestry and Fisheries, 2019). According to DAFF (2019), land with a capability to be used for sustained long-term production is a very limited resource in South Africa. Therefore, it is of the imperative to identify and demarcate agricultural land, based on its inherent capability and suitability (agricultural potential), for it to be preserved for exclusive agricultural use.

Preservation and Development of Agricultural Land Bill (PDALB) defined the "*Protected Agricultural Areas*" as a:
"cartographic delineated area of agricultural land –

- preserved for purposes of ensuring high value agricultural land is protected against non- agricultural land uses in order to promote long-term agricultural production and food security;
- includes all areas demarcated as such;"

According to the Mpumalanga Department of Agriculture official (2020), most of the cultivated areas associated with Belfast project are utilising irrigation systems. This is based on a field survey which was conducted, and several centre pivots were recorded. Therefore, it is important that an area with irrigation systems is classified as unique and high agriculture potential areas, especially due to the fact that the yield of various crops is exponentially increased and of high importance with regards to food security and . Figure 19 and 20 below presents these major classes to give an indication of the available PAA and the land capability on a high level for planning purposes. This is in line with the CARA, 1983 (Act No. 43 of 1983) which advocates for the protection of the scarce agricultural resources.

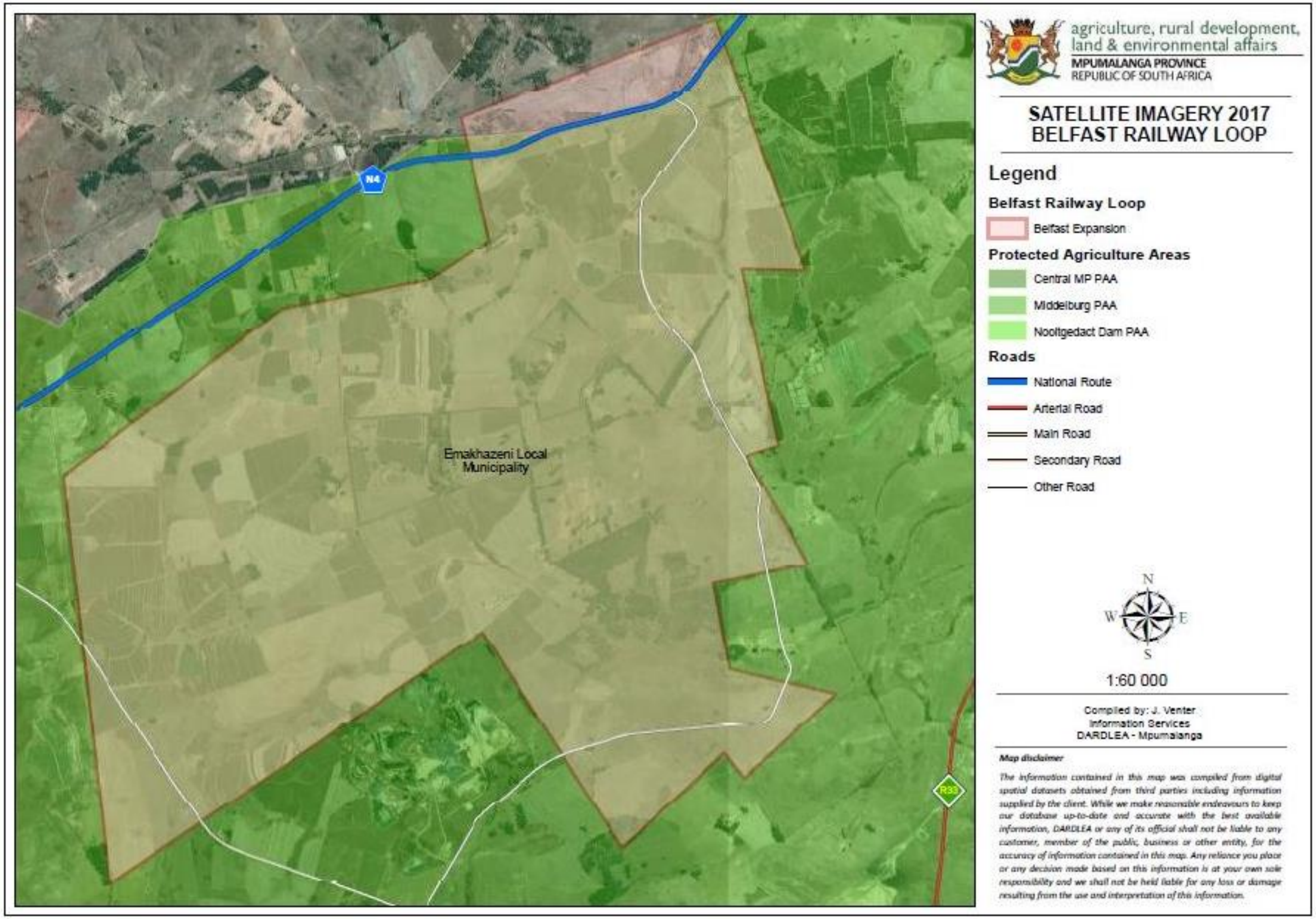

Figure 18: A graphical presentation of Protected Agricultural Areas (PAAs) associated with the logistics route options and expansion project

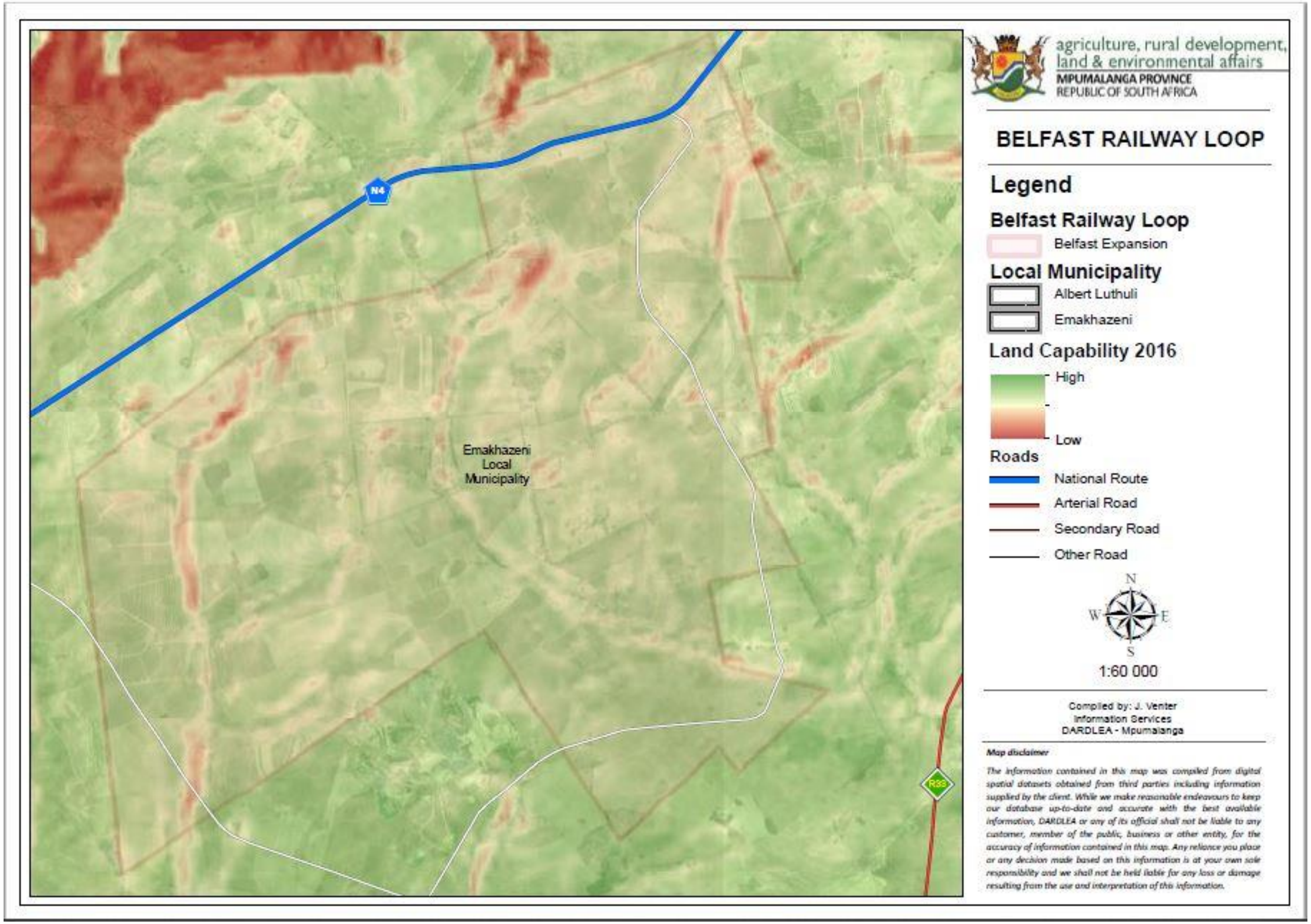

Figure 19: A graphical presentation of the soil land capability (2016) associated with the expansion project

7. IMPACT OF CLIMATE CHANGE ON AGRICULTURE

Climate change is defined as a change in global or regional climate patterns, due to natural or human activities that result in a change in the climatic condition (weather conditions in an area over a period of time) (Intergovernmental Panel on Climate Change (IPCC), 2014). According to the latest science, this change has been accelerated through human-related activities on both local and global scale. These activities release greenhouse gases (i.e. notably carbon dioxide) at a quick rate into the atmosphere which is responsible for trapping the heat from the sun in our atmosphere, resulting in warmer temperatures.

According to DEA, 2013 Southern Africa has been identified as a region that will experience increasing vulnerability to the impacts associated with climate change. South Africa according to the projections is likely to experience temperature increases almost double the global average which means that the risks and impacts are amplified (DEA, 2013).

As a result, the BEP area is most likely to be impacted by higher temperatures and changes to precipitation distribution and patterns. Different parts of the BEP area are likely to experience the following Climate changes at their local climatic conditions, and this may include:

- Increased drought frequency;
- Increased humidity;
- More Intense rainfall events;
- Increase of flooding events;
- An increase in tropical diseases; and
- More frequent heatwaves.

These changes could result in significant impacts on agricultural food production and security within the region Ultimately the contribution of the COM on the South Africa food production and security contribution will significantly decrease.

According to SANBI (2013), adapting agricultural practices in South Africa requires an integrated approach that addresses multiple stressors, and combines indigenous knowledge and experience with the latest scientific insights. Adaptation strategies for large-scale commercial farmers should focus on maximising output in a sustainable manner and maintaining a competitive edge in changing climatic conditions. Whereas for rural livelihoods, adaptation should focus on vulnerable groups and areas and include promoting climate-resilient agricultural practices and livelihoods.

The shape of the land can have a significant influence on microclimates. Therefore, the change in topography through opencast mining operations will potentially disrupt the climate on a localised scale. The effect of soils on microclimate is considerable. Sandy soils and other coarse, loose, and dry soils are subject to high maximum and low minimum surface temperatures. The surface reflection characteristics of soils are also important; soils of lighter colour reflect more and respond less to daily heating. Another feature of the microclimate is the ability of the soil to absorb and retain moisture, which depends on the composition of the soil and its use. The degree to which a soil retains moisture affects the humidity and temperature of the air above it (Rodriguez, 2020).

Vegetation is also integral as it controls the flux of water vapour into the air through transpiration. In addition, vegetation can insulate the soil below and reduce temperature variability and reduce the loss of soil moisture. Once the vegetation has been cleared as part of the construction phase, the soil will be exposed and thus the temperature variability in the area (Rodriguez, 2020).

Excavation and stockpiling will likely limit the amount of moisture retained in the soil and thus potentially changing the local climate. In addition, the stockpiling of carbonaceous spoil material when exposed to air may lead to combustion, although this is deemed unlikely, which will ultimately emit greenhouse gases and thus changing the local climate.

8. IMPACT ASSESSMENT AND MITIGATION MEASURES

In addition to the loss of growth medium (stripped soils), the soils are anticipated to be exposed to erosion, dust emission, and potential soil contamination impacts during the construction phase of the proposed development; and these impacts may persist for the duration of the operational phase if not mitigated adequately. The significance of the impacts is summarised on Tables presented below the proposed development.

8.1 Activities and Aspect Register

The impact assessment rating is applicable to the following activities:

Table 16: Activities associated with proposed development during different phases

ACTIVITIES AND ASPECTS REGISTER
Pre-Construction Phase
- Planning and design of the footprint areas. - Preparation for the construction activities - **Impact:** Excessive vegetation clearance within infrastructure leading to soil erosion Soil Compaction leading to disruption of soil physical characteristics (i.e. Structure, porosity) Soil Contamination leading to alteration of the soil chemical characteristics and subsequent impact on fertility
Construction Phase
- Land and footprint clearing and soil stripping.

ACTIVITIES AND ASPECTS REGISTER
- **Impact:** Increased soil erosion and subsequent soil loss. Loss of organic matter Soil Compaction leading to disruption of soil physical characteristics (i.e. Structure, porosity) Soil Contamination leading to alteration of the soil chemical characteristics and subsequent impact on fertility
- Topsoil stripping and stockpiling. - **Impact:** Vehicle/equipment movement leading to soil erosion and compaction. Reduction in biodiversity. Modification of existing landscape and hydrological functioning.
- Establishment of surface infrastructure - **Impact:** Spillage of hydrocarbons leading to soil contamination. Increased run-off (and erosion) in compacted areas and modification of natural infiltration.
Operational and Maintenance Phases
- Operation of the surface infrastructure. - **Impact: I**ncreased soil erosion, compaction and spillage of hydrocarbons
Decommissioning and Closure Phases
- Dismantling and decommissioning of infrastructure and buildings. - Backfilling and reshaping of the topography - Revegetation - **Impact:** Soil erosion, compaction, and soil contamination - Loss of land capability

8.1.1 *Soil Erosion*

Soil erosion is largely dependent on land use and soil management and is generally accelerated by anthropogenic activities. In the absence of detailed South African guidelines on erosion classification, the erosion potential and interpretation are based on field observations as well as observed soil profile characteristics. In general, soils with high clay content have a high-water retention capacity, thus less prone to erosion in comparison to sandy textured soils, which in contrast are more susceptible to erosion.

The proposed development footprint is located on a relatively flat to a moderately sloping terrain, which may increase the erosion hazard. Most of the soils occurring withing the various footprint areas are susceptible to soil erosion due to the sandy loam textural class and the moderately sloping terrain. The soils will become more susceptible to erosion during the construction phase once the vegetation has been cleared and are if not vegetated when in stockpile areas before the rainy season; thus, exposed to wind and storm water. This will most likely lead to:

- Reduced soil fertility status of soils and subsequently loss of valuable arable land;
- Reduced farm yields due to loss of arable land; and
- Possible pollution and sedimentation of nearby water sources consequently affecting the water quality for livestock.

The severity of this impact is anticipated to be Medium High for most of the soils and with the appropriate mitigation measures the significance of this impact may be low.

Impact Register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive or unnecessary placement of infrastructure outside the BEP PROJECT AREA boundary or the demarcated infrastructure areas leading to increased soils erosion.	Site clearing, removal and associated disturbances to soils, leading to, increased runoff, erosion and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of erosion
	Potential frequent movement of digging machinery within lose and exposed soils, leading to excessive erosion	

Table 17: Summary of the impact significance on potential soil erosion for the BEP project area

Issue		Corrective Measures	Impact rating criteria					Significance
			Status of Impact	Extent	Duration	Magnitude	Probability	
Soil Erosion	**Construction**							
	Shaft Option 1	No	Negative	2	4	8	5	**70** (**High**)
		Yes		1	1	6	3	**24** (**Low**)
	Shaft Option 2	No		2	5	8	5	**75** (**High**)
		Yes		1	1	6	3	**24** (**Low**)
	Open Pits	No		2	5	8	5	**75** (**High**)
		Yes		1	1	6	3	**24** (**Low**)
	Operational							
	Option 1	No	Negative	4	5	8	3	**51** (**Medium**)
		Yes		1	1	4	3	**18** (**Low**)
	Option 2	No		4	5	8	3	**51** (**Medium**)
		Yes		1	1	4	3	**18** (**Low**)
	Open Pits	No		2	4	8	5	**70** (**High**)
		Yes		1	1	4	3	**18** (**Low**)
	Closure							
	Option 1	No	Negative	2	4	8	5	**70** (**High**)
		Yes		1	1	4	3	**18** (**Low**)
	Option 2	No		2	4	8	5	**70** (**High**)
		Yes		1	1	4	3	**18** (**Low**)
	Open Pits	No		2	5	8	5	**75** (**High**)
		Yes		1	1	6	3	**24** (**Low**)

Corrective Action

- Any disturbance of high potential agricultural soils must be actively avoided, should this be not feasible, the footprint of the proposed mining areas should be clearly demarcated to restrict the planned activities within infrastructure footprint as far as possible, thus minimising edge effects and reducing the extent and overall significance of impact;
- An appropriate storm water management plan must be carefully designed and implemented in order to avoid erosion of topsoil on adjacent arable soils throughout all the mining phases. In this regard, special mention is made of:
  - Sheet runoff from cleared areas, paved surfaces and access roads needs to be curtailed;
  - Runoff from paved surfaces should be slowed down by the strategic placement of berms; and
  - All overburden stockpiles and waste stockpiles must have berms and/catchment paddocks at their toe to contain runoff of the facilities;
- If possible, commencement of clean and dirty water separation structures can be scheduled to coincide with low rainfall conditions when the erosive runoffs and wind are anticipated to be low;
- As the footprints of the proposed development are unvegetated it is best to be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- Bare soils adjacent to the infrastructural areas can be vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission; and
- Erosion control is regarded critical as the majority of the soils are susceptible to erosion, as they have finer particles, due their sandy texture and continuous tillage practises taking place.
- The footprint of the proposed development and construction activities should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible;

	➢ Bare soils within the access roads can be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast; ➢ All disturbed areas adjacent to the proposed development areas should be re-vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission; ➢ Temporary erosion control measures should be used to protect the disturbed soils during the construction phase until adequate vegetation has established.

8.1.2 Impact: Soil compaction

Heavy equipment traffic during construction and activities is anticipated to cause soil compaction. The severity of this impact is anticipated to be High for most of the soils due to significant disturbance that could occur due to the sandy and clayey texture of these soils. The soils associated with the footprint areas will be most impacted due to sandy loam nature. The impact significance can be medium-low, should the proposed activities be restricted to access roads, vehicle hard stand areas and equipment and machinery laydown areas. Soil compaction will potentially lead to:

- ➢ Increased bulk density and soil strength, reduced aeration and lower infiltration rate
- ➢ Consequently, it lowers crop performance via stunted aboveground growth coupled with reduced root growth
- ➢ Destroyed soil structure, causing it to become more massive with fewer natural voids with a high possibility of soil crusting. This situation can lead to stunted, drought-stressed plants because of restricted water and nutrient uptake, which results in reduced crop yields.
- ➢ Soil biodiversity is also influenced by reduced soil aeration. Severe soil compaction may cause reduced microbial biomass. Soil compaction may not influence the quantity, but the distribution of macro fauna that is vital for soil structure including earthworms due to reduction in large pores.

Impact Register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive or unnecessary placement of infrastructure outside the BEP PROJECT AREA or the demarcated infrastructure areas leading to	Site clearing and associated disturbances to soils, leading to, increased runoff, soil compaction and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of compaction
	Potential frequent movement of digging machinery and construction vehicles within lose and exposed soils, leading to excessive soil compaction	Using of excessively heavy equipment which leads to a more severe impact on soils

Table 18:Summary of the impact significance on soil compaction for the BEP project area

Issue		Corrective Measures	Impact rating criteria					Significance
			Status of Impact	Extent	Duration	Magnitude	Probability	
	Construction							
Compaction	Shaft Option 1	No	Negative	1	5	10	5	**80** (High)
		Yes		1	1	4	3	**18** (Low)
	Shaft Option 2	No		2	4	8	5	**70** (High)
		Yes		1	1	4	3	**18** (Low)
	Open Pits	No		4	5	8	5	**85** (High)
		Yes		1	1	6	3	**24** (Low)
	Operational							
	Shaft Option 1	No	Negative	2	4	8	5	**70** (High)
		Yes		1	1	4	3	**18** (Low)
	Shaft Option 2	No		1	5	6	5	**60** (High)
		Yes		1	1	4	3	**18** (Low)
	Open Pits							
	Closure							
	Shaft Option 1	No	Negative	1	5	6	5	**60** (High)
		Yes		1	1	4	3	**18** (Low)
	Shaft Option 2	No		1	5	6	5	**60** (High)
		Yes		1	1	4	3	**18** (Low)
	Open Pits	No		4	5	8	5	**85** (High)
		Yes		1	1	6	3	**24** (Low)
Corrective Action		➢ Soil Compaction is usually greatest when soils are moist, so soils should be stripped when moisture content is as low as possible. If they have to be moved when wet, shovel and truck should be used as bowlscrapers create excessive compaction when moving wet soils; ➢ Stockpile height should be restricted to that which can deposited without vehicles moving over previously dumped topsoil. Alternatively the mine should comply to the approved EMP on stockpile heights; ➢ Compaction should be minimised by use of appropriate equipment and replacing soils to the greatest possible thickness in single lifts; ➢ Heavy equipment movement over replaced soils should be minimised; ➢ Minimise compaction during smoothing of replaced soils by using dozers rather than graders; ➢ Following placement, compacted soils should be ripped to full rooting depth (at least 60 cm or 30cm as the bare minimum seedbed) to allow penetration of plant root); ➢ All vehicular traffic should be restricted to the existing service roads and the selected road servitude as far as practically possible; to avoid unnecessary compaction of the surrounding soils; ➢ Direct surface disturbance of the identified high clay content/wetland (i.e., Rensburg, Arcadia and Rustenburg etc.) soils should be limited within demarcated areas where possible to minimise the intensity of compaction due to the susceptibility of these soils to prolonged waterlogging conditions (inundation); ➢ Compacted soils adjacent to the mining project foot prints and associated infrastructure footprint can be lightly ripped to at least 25 cm below ground surface to alleviate compaction prior to re-vegetation, and ➢ Compaction of soil can be mitigated by ripping the footprint and introducing both organic and inorganic fertilizers.						

8.1.3 Potential Soil Contamination

Contamination sources are mostly unpredictable and often occur as incidental spills or leaks during both the construction and operational phase. Thus, all the identified soils are considered equally predisposed to potential contamination. The significance of soil contamination is considered to be high for all identified soils without mitigation, largely depending on the nature, volume and/or concentration of the contaminant of concern as well as the rate at which contaminants are transported by water in the soil. Therefore, strict waste management protocols as well as product stockpile management and activity specific

Environmental Management Programme (EMP) and monitoring guidelines should be adhered to during the construction and operational activities. If the management protocols are not well managed this will more likely lead to:

- Contaminants leaching into the soil and thus potentially rendering the soil sterile. reducing the yield potential of soils.
- Potential reduction of water quality used for irrigation and for livestock use.

Impact Register

Pre-Construction	Construction	Operational
Poor designs of pollution control infrastructures, leading to leakages of hydrocarbons and petroleum substances resulting in the contamination of soil resources	Spillage of petroleum hydrocarbons during construction of associated infrastructure	Leaching of hydrocarbons chemicals into the soils, leading to alteration of the soil chemical status as well as contamination of ground water
	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.

Table 19: Summary of the impact significance on soil contamination for the BEP project area

Issue		Corrective Measures	Impact rating criteria					Significance
			Status of Impact	Extent	Duration	Magnitude	Probability	
Contamination	**Construction**							
	Shaft Option 1	No	Negative	2	5	10	4	**68 (High)**
		Yes		1	1	6	3	**24 (Low)**
	Shaft Option 2	No		2	5	10	4	**68 (High)**
		Yes		1	1	6	3	**24 (Low)**
	Open Pits	No		1	5	10	5	**80 (High)**
		Yes		1	1	4	3	**18 (Low)**
	Operational							
	Shaft Option 1	No	Negative	4	5	8	3	**51 (Medium)**
		Yes		1	1	6	3	**24 (Low)**
	Shaft Option 2	No		4	5	8	3	**51 (Medium)**
		Yes		1	1	6	3	**24 (Low)**
	Open Pits	No		1	5	10	5	**80 (High)**
		Yes		1	1	4	3	**18 (Low)**
	Closure							
	Shaft Option 1	No	Negative	4	5	8	3	**51 (Medium)**
		Yes		1	1	6	3	**24 (Low)**
	Shaft Option 2	No		4	5	8	3	**51 (Medium)**
		Yes		1	1	6	3	**24 (Low)**
	Open Pits	No		1	5	10	5	**80 (High)**
		Yes		1	1	4	3	**18 (Low)**
Corrective Action		• Contamination prevention measures should be addressed in the Environmental Management Programme (EMP) for the proposed development, and this should be implemented and made available and accessible at all times to the contractors and construction crew conducting the works on site for reference; • A spill prevention and emergency spill response plan, as well as dust suppression, and fire prevention plans should also be compiled to guide the construction works;						

	➢ An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent contamination; and ➢ Burying of any waste including rubble, domestic waste, empty containers on the site should be strictly prohibited and all construction rubble waste must be removed to an approved disposal site.

8.1.4 Loss of Agricultural Land Capability

The potential loss of agricultural land capability is anticipated to be high in the footprint areas. This is based on the size of the footprint (>500 ha) where the proposed activities will occur. The proposed activities will occur on highly productive soils and may perhaps lead to a permanent change of land use if not properly mitigated. Thus, the loss of agricultural soils and agriculturally productive land will be somewhat significant considering the scarcity of arable soils in South Africa.

Table 20: Summary of the impact significance on loss of agricultural capability for the BEP project area

Issue		Corrective Measures	Impact rating criteria					Significance
			Status of Impact	Extent	Duration	Magnitude	Probability	
Land Capability	**Construction**							
	Shaft Option 1	No	Negative	4	5	8	3	**51** (**Medium**)
		Yes		1	1	6	3	**24** (**Low**)
	Shaft Option 2	No		3	4	10	5	**85** (**High**)
		Yes		1	1	6	3	**24** (**Low**)
	Open Pits	No		4	5	10	5	**95** (**High**)
		Yes		4	5	8	4	**68** (**High**)
	Operational							
	Shaft Option 1	No	Negative	4	5	8	3	**51** (**Medium**)
		Yes		1	1	6	3	**24** (**Low**)
	Shaft Option 2	No		4	5	8	5	**85** (**High**)
		Yes		4	5	8	3	**51** (**Medium**)
	Open Pits	No		4	5	8	5	**85** (**High**)
		Yes		4	5	8	3	**51** (**Medium**)
	Closure							
	Shaft Option 1	No	Negative	4	5	8	5	**85** (**High**)
		Yes		1	1	6	3	**24** (**Low**)
	Shaft Option 2	No		4	5	8	5	**85** (**High**)
		Yes		1	1	6	3	**24** (**Low**)
	Open Pits	No		4	5	10	5	**95** (**High**)
		Yes		4	5	8	3	**51** (**Medium**)

Corrective Action	➢ Direct surface disturbance of the identified arable soils can be avoided where possible to minimise loss of arable soils; ➢ During the decommissioning phase the footprint should be thoroughly cleaned, and all building material should be removed to a suitable disposal facility; ➢ The footprint should be ripped to alleviate compaction; ➢ Revegetate with an indigenous grass mix, to re-establish a protective cover, in order to minimise soil erosion and dust emissions; ➢ Soils of different characteristics should be stockpiled separately and clearly demarcated. ➢ Define cut-off horizons in simple terms that the stripping operator can understand and demarcate boundaries of different soil types. ➢ Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly. ➢ Strip a suitable distance ahead of mining at all times, to avoid loss and contamination. ➢ Soils should be replaced in catenal (i.e. position on the slope) locations similar to where they were stripped. ➢ Stockpiles that will remain in location for more than one growing season and that have not revegetated naturally, should be revegetated to avoid erosion losses. ➢ The dumping of waste materials next to or on the stockpiles should be prohibited. Contamination by fly-rock from blasting and the pumping out of contaminated waters from the pit are all hazards faced by stockpiles should be minimised.

8.1.5 Cumulative Impacts

It is worth noting that most of the area earmarked for development as part of the Belfast Expansion Project (BEP) is under intensive commercial agriculture, utilising irrigation systems in some instances to maximise the yield from the available land. The farms in the area are therefore under both rainfed and irrigated agriculture, with centre pivots as the irrigation mechanism being utilized in most instances where irrigation takes place. Not only is the area under subject to intensive commercial agriculture but it is also utilized for sheep, cattle, and dairy farming supplying the local and regional areas.

According to the Agriculture, Rural Development, Land and Environmental Affairs department the areas with irrigation systems are classified as unique and high agriculture potential areas, especially since the yield of various crops is exponentially increased and of high importance with regards to food security. The soils within the BEP area can be generally be classified as high potential soils due to their inherent physical properties (i.e. good drainage, sufficient depth) which are ideal for cultivation. The land capability of the surrounding soils as well as the land potential are high due to adequate climatic conditions (i.e. rainfall, temperature) and appropriate slope which allows for intensive commercial agricultural practices.

The proposed Mine Residue Facility (MRF) will be constructed over a backfilled opencast pit where soils have already been impacted through excavation and mechanical handling. Therefore, the impact of the proposed MRF is considered low from a soil and land capability point of view.

The cumulative loss from a soil and land capability point of view is anticipated to be moderate, provided that the key mitigation measures to enable the re instatement of agricultural activities (of a different nature) post closure are carefully implemented inline with the Exxaro net benefit objective to mining.

8.2 Opencast Shaft Alternative Analysis

Two (2) shaft alternative options were proposed with the advantages and disadvantages presented on Table 21 below.

Table 21: Advantages and disadvantages of the proposed opencast shaft options

	Opencast Shaft Option 1	Opencast Shaft Option 2
Advantages	*Some portions of this infrastructure are located within and near some of the disturbed areas; *The impact is more localised since there is existing mining activities in the immediate vicinity; *Bulk of the surface infrastructure is located approximately 1.3 km from the dairy farm; *Slightly smaller footprint size (51.9 ha) *Short distance of the rope conveyors; and *Bulk of the conveyor route follows existing roads	*Smaller arable land affected within the BEP area (5.8 ha); and *A large portion of the footprint is located within soils which are more suitable for grazing as compared to, cultivated crops (Based on the land capability classes). *A Large portion will be constructed on the BIP mined out areas and the conveyor routes will also be over mined out areas, thus reducing impact footprint.
Disadvantages	*High potential of land fragmentation; and *Larger arable land affected within the BEP area (37.4 ha).	*Option is in a sensitive area (high arable soils) since there are no mining activities in the immediate vicinity, therefore this will introduce new impacts (i.e., soil contamination and loss of high potential soils); *Larger footprint area (60.8 ha); and *Located near the diary farm (743 m) compared to option 1. *Longer distance for rope conveyors *Additional service roads would be required since some portions of the conveyor route is not located along existing roads.

Based on the analysis, option 1 is the preferred option from a soil, landuse and land capability point of view. This is due to the ability of option 1 to best support the objective of conserving as much arable and undisturbed land as possible and thus favour agricultural production continuity on the farm situated within the immediate vicinity. The conveyor option 1 is also the preferred option since it is shorter than the alternative conveyor options and it traverses areas which have been previously mined as part of the BIP project, thus poses a low impact from a soil, land use and land capability perspective. It should be noted that although shaft option 1 is the preferred option, the difference in the impact significance between the two options is minor. Based on the outcomes of the study option 1 remains the preferred option from a soil, landuse and land capability management point of view. It is, however acknowledged that, subsequent to the initiation of the study, it was determined that option 1 will not be feasible, from a mining perspective, since this option will likely impact too significantly on the life of mine (LOM). Therefore Alternative 2 is the only viable option as part of the go forward case for the project despite the higher impact on agriculture. This information should be used by the EAP to undertake a comparative and holistic analyses of the total impact on the environment and provide a cogent summary that aligns to the principles of Integrated environmental Management (IEM) that can be provided to the relevant regulating authorities, whom will then be empowered to make an informed decision that aligns the principles of sustainable development.

Overall, the impact of the proposed Belfast Mine Expansion from a soil, land use and land capability are deemed high during the construction and operational phase of development, and thus protection of the agricultural resources should be prioritised as far as practically possible. Table 22 presents the summary of the BEP Mining Option 1 at year 11 and the anticipated impact on agriculture (Courtesy of Exxaro Mining Company, 2021)

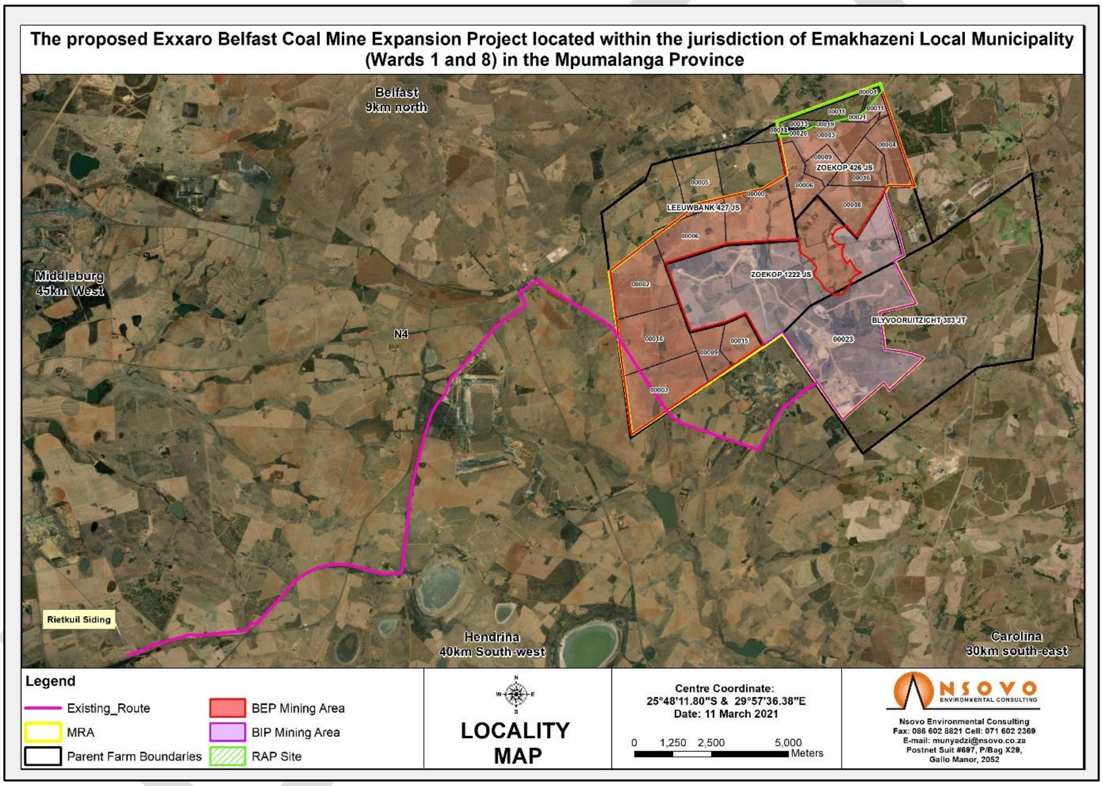

Figure 20: Existing route for coal transportation to the Rietkuil siding

Table 22: Summary table depicting the BEP Mining Option 1 at year 11 and the anticipated impact on agriculture (Courtesy of Exxaro Mining Company, 2021).

Category -Combined	Indicative %	Hectares
Agricultural area (no mining activities)	**67,9%**	1597,941
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	**0,0%**	0
Concurrently rehabilitated areas (with agricultural activities reinstated)	**22,8%**	537,0839
Mining activities	**9,3%**	217,9694
Total available agricultural area	**90,7%**	

8.3 Stockpile Management

- Excavation and long-term stockpiling of soil should be limited within the demarcated areas;
- Ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas;
- Restrict the amount of mechanical handling, as each handling event increases that compaction level and the changes to the soil structure. Wherever possible, the 'cut and cover' technique (where the stripped soils is immediately placed in an area already prepared for rehabilitation, thus avoiding stockpiling) should be used;
- Separate stockpiling of different soil to obtain the highest post-mining land capability;
- Stockpile height should be restricted to that which can deposited without additional traversing by machinery. Stockpiles should be treated with temporary soil stabilisation methods, such as the application of organic matter to promote soil aggregate formation, leading to increased infiltration rate, thereby reducing soil erosion. Also, the use of lime to stabilise soil pH levels;
- Soil erosion should be controlled on stockpiles by having control measures to reduce erosion risk such as erosion control blankets, soil binders, revegetation, contours, diversion banks and spillways;
- Stockpiled soils should be stored for a maximum of 3-5 years to ensure that the soil quality does not deteriorate. In addition, concurrent rehabilitation must strongly be considered to reduce the duration of stockpile storage to ensure that the quality of stored soil material does not deteriorate excessively; especially with regard to leaching and acidification;
- The topsoil stockpile should be vegetated and while vegetating, measures will be needed to contain erosion of the stockpile during rain events;
- Temporary berms can be installed, around stockpile areas whilst vegetation cover has not established to avoid soil loss through erosion;
- The recovered soils should be re-used to rehabilitate the mine footprint following mine closure;
- A short-term fertilizer program should be based on the soil chemical status after levelling and should consists of a pre-seeding lime and fertilizer application, an application with the seeding process as well as a maintenance application for 2 to 3 years after rehabilitation or until the area can be declared as self-sustaining by an appropriately qualified soil scientist.

The existing Exxaro topsoil stripping guidelines compiled by Viljoen & Associates (2013) should be consulted to guide the topsoil stripping process during the construction phase to ensure that soil resources are available for rehabilitation to allow pre mining land uses to commence post closure.

8.4 Estimation of Available Topsoil (soft material) for Rehabilitation

This section aims to provide indication of the available soft material (soil medium) for rehabilitation phase. It should be noted the volumes of soil provided below are estimated, hence the calculations were based on the average depth of the occurring soils. The following approach was used:

$$\textbf{Soil Volume} = \textbf{Area} \times \textbf{Average Depth}$$

Table 23: Estimation of available soft material for soils to be directly impacted by the proposed open cast pits

Land capability	Area (m2)	Average Depth (m)	Volume (m3)	Level of confidence (%)
Arable (Class II)	1144000	1.2	1 372 800	80
Arable (Class III)	3453000	0.8	2 762 400	80
Grazing (Class V - Wetlands)	1461000	0.7	1 022 700	60
Grazing (Class VI)	246000	0.35	86 100	80
Wilderness (Class VIII)	164000	1	164000	50
Total	**6 468 000**		**5 408 000**	**70**

9. CONCLUSION

The Zimpande Research Collaborative (ZRC) was appointed by Nsovo Environment Consulting CC to conduct a soil, land use and land capability and agricultural impact assessment for the proposed Exxaro Belfast Expansion Project (BEP). The investigated area will henceforth be referred to as the "BEP Project area" unless referring to individual infrastructure components.

Most of the area earmarked for development as part of the Belfast Expansion Project (BEP) is under intensive commercial agriculture, utilising irrigation systems, in some instances, to maximise the yield from the available land. The farms in the area are therefore under both rainfed and irrigated agriculture, with centre pivots as the irrigation mechanism being utilized in most instances where irrigation takes place. Not only is the area subject to intensive commercial agriculture but it is also utilised for sheep, cattle, and dairy farming supplying the local and regional areas.

The local climate can be broadly classified as favorable for good yield for a wide range of adapted crops and a year-round growing season. The Mean Annual Rainfall (MAR) associated with the MRA is estimated to range between 601-800mm per annum while the mean annual total evaporation is estimated to range from 1601-1800mm. Moisture stress and risk of lower temperatures are relatively lower.

The dominant soils occurring within the BEP project area are Hutton, Avalon, Lichtenburg, Mispah and Glencoe forms. Whereas the sub-dominant soil forms were identified as Katspruit, Ermelo, Westleigh and Dresden. The majority of the extent of the BEP project area can be broadly classified as ideal for agriculture (with minor limitations) as well as grazing and wilderness land uses. The above-mentioned soils are considered ideal for agricultural cultivation due to:

- Deep well drained soil characteristics;
- Texture and structure allowing for effective rooting depth;
- Good water holding/storage capacity; and
- Good nutrient holding capacity.

The extent of arable soils to be disturbed by the proposed mining activities can be considered sufficient for viable cultivated large-scale commercial farming. It is acknowledged that the total avoidance of arable soils is not feasible however the impact should be restricted to the project footprint as far as practically possible. The land use change will predominantly be conversion from cultivated agriculture, grazing and wetlands to mining and related activities. However at closure, land capability will, essentially, revert to the approved end land use (agriculture) albeit most likely at a reduced level of functionality. Concurrent rehabilitation will be undertaken, thus reinstating agricultural activities in recently mined out areas. The loss of agricultural activities at any given time will be 10%. Table B presents the summary of the BEP Mining Option 1 at year 11 and the anticipated impact on agriculture (Courtesy of Exxaro Mining Company, 2021). The full mining approach, indicating the concurrent rehabilitation to agriculturally productive land is presented in Appendix B.

Table B: Summary table depicting the BEP Mining Option 1 at year 11 and the anticipated impact on agriculture (Courtesy of Exxaro Mining Company, 2021).

Category -Combined	Indicative %	Hectares
Agricultural area (no mining activities)	67,9%	1597,941
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	0,0%	0
Concurrently rehabilitated areas (with agricultural activities reinstated)	22,8%	537,0839
Mining activities	9,3%	217,9694
Total available agricultural area	90,7%	

The impact of the proposed Belfast Mine Expansion from a soil, land use and land capability are deemed high during the operational phase, and thus protection of the agricultural resources should be prioritised as far as practically possible. Areas of highest agricultural potential, especially those areas that are managed as irrigated crop lands should be excluded from mining where feasible. The coal from the BEP project will be transported to the Rietkuil siding through an existing route which has already been approved for the BIP project, thus the impact from a soil and land capability point of view is negligible in this instance.

Two (2) shaft alternative options were proposed and have been analysed in Section 8.2. Based on the analysis, option 1 is the preferred option from a soil, landuse and land capability point of view. This is due to the ability of option 1 to best support the objective of conserving as much arable and undisturbed land as possible and thus favour agricultural production continuity on the farm situated within the immediate vicinity. The conveyor option 1 is also the preferred option since it is shorter than the alternative conveyor options and it traverses areas which have been previously mined as part of the BIP project, thus poses a low impact from a soil, land use and land capability perspective. It should be noted that although shaft option 1 is the preferred option, the difference in the impact significance between the two options is limited. This information should be used by the EAP to undertake a comparative and holistic analyses of the total impact on the environment and provide a cogent summary that aligns to the principles of Integrated environmental Management (IEM) that can be provided to the relevant regulating authorities, whom will then be empowered to make an informed decision that aligns the principles of sustainable development.

The proposed Mine Residue Facility (MRF) will be constructed over a backfilled opencast pit where soils have already been impacted through excavation and mechanical handling. Therefore, the impact of the proposed MRF is considered low from a soil and land capability point of view.

The cumulative loss from a soil and land capability point of view is anticipated to be moderate, provided that the key mitigation measures to enable the re instatement of agricultural activities (of a different nature) post closure are carefully implemented inline with the Exxaro net benefit objective to mining.

Following the assessment of the BEP project area and the identified potential impacts as the result of the proposed development; the key mitigation and rehabilitation measures can be summarised as follows:

- This mine should run concurrently, and co-exist with agricultural activities on the site (i.e. mining and farming simultaneously);
- The mined-out area should be backfilled and rehabilitated concurrently, in order to re-instate agricultural activities;
- Cultivation of alternative crops on rehabilitated areas should be investigated to ensure that the agricultural activities resume post mining inline with the Exxaro net benefit approach to mining;

- Excavation and long-term stockpiling of soil should be limited within the demarcated areas as far as practically possible and ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas;
- Use of heavy machinery such as bulldozers should be avoided as far as possible to minimise soil compaction;
- Different soil types and the A and B-horizons should be stripped separately and replaced in the same sequence on top of the spoil material. The relatively higher organic carbon content of the A-horizon provides a buffer against compaction and hardsetting and serves as a seed bank which will enhance the re-establishing of natural species. B-horizons replaced on the surface tend to seal and compact severely which increases runoff and triggers erosion;
- Stockpile height should be restricted to that which can deposited without additional traversing by machinery. The stockpile should be treated with temporary soil stabilisation methods; such as the application of organic matter to promote soil aggregate formation, leading to increased infiltration rate, thereby reducing soil erosion. Also, the use of lime to stabilise soil pH levels;
- All seepage from the MRF facility must be contained as far as practically possible to avoid contamination of the surrounding soils; and
- A short-term fertilizer programme should be based on the soil chemical status after levelling and should consists of a pre-seeding lime and fertilizer application, an application with the seeding process as well as a maintenance application for 2 to 3 years after rehabilitation or until the area can be declared as self-sustaining by an appropriately qualified soil scientist.

It is the opinion of the specialist that this study provides the relevant information required for the Environmental Impact Assessment phase of the project to ensure that appropriate consideration of the agricultural resources in the study area will be made in support of the principles of Integrated Environmental Management (IEM) and sustainable development.

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APPENDIX A: ASSESSMENT METHODOLOGY

Desktop Screening

Prior to commencement of the field assessment, a background study, including a literature review, was conducted in order to collect the pre-determined soil and land capability data in the vicinity of the investigated area Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were used for the assessment.

Soil Classification and Sampling

A soil survey was conducted by a qualified soil specialist, at which time the identified soils within the infrastructure areas and associated access roads were classified into soil forms according to the Soil Classification Working Group for South Africa (2018). Subsurface soil observations were made using a manual hand auger in order to assess individual soil profiles, which entailed evaluating physical soil properties and prevailing limitations to various land uses.

Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table **A1** below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Whereas, Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Table **A2** below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table A1: Land Capability Classification (Smith, 2006)

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable land**
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC	IC		
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						**Grazing land**
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**

W- Wildlife	MG- Moderate grazing	MC- Moderate cultivation
F- Forestry	IG- Intensive grazing	IC- Intensive cultivation
LG- Light grazing	LC- Light cultivation	VIC- Very intensive cultivation

Table A2: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

The land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of land potential and knowledge of the geographical distribution within an area of interest. This is of importance for making an informed decision about land use. **Table A3** below presents the land potential classes, whilst Table 4 presents description thereof, according to Guy and Smith (1998).

Table A3: Land Potential Classes (Guy and Smith, 1998)

Land Capability Class	Climate Capability Class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table A4: The Land Capability Classes Description (Guy and Smith, 1998)

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

Impact Assessment Methodology

The assessment of impacts is largely based on the Department of Environmental Affairs and Tourism's (1998) Guideline Document: Environmental Impact Assessment Regulations. The assessment will consider impacts arising from the proposed activities of the project both before and after the implementation of appropriate mitigation measures.

The impacts are assessed according to the criteria outlined in this section. Each issue is ranked according to extent, duration, magnitude (intensity) and probability. From these criteria, a significance rating is obtained, the method and formula is described below. Where possible, mitigation recommendations have been made and are presented in tabular form.

The criteria given in the tables below will be used to conduct the evaluation. The nature of each impact will be assessed and described in relation to the extent, duration, intensity, significance and probability of occurrence attached to it. This will be assessed in detail during the EIA phase.

Status of Impact

The impacts are assessed as either having a:
Negative effect (i.e. at a `cost' to the environment),
Positive effect (i.e. a `benefit' to the environment), or
Neutral effect on the environment.

Extent of the Impact

Site (site only),	**1**
Local (site boundary and immediate surrounds),	**2**
Regional,	**3**
National, or	**4**
International.	**5**

Duration of the Impact

The length that the impact will last for is described as either:

Immediate (<1 year)	1
Short term (1-5 years),	2
Medium term (5-15 years),	3
Long term (ceases after the operational life span of the project),	4
Permanent.	5

Probability of Occurrence

The likelihood of the impact actually occurring is indicated as either:

None (the impact will not occur),	0
Improbable (probability very low due to design or experience)	1
Low probability (unlikely to occur),	2
Medium probability (distinct probability that the impact will occur),	3
High probability (most likely to occur), or	4
Definite	5

Significance of the Impact

Based on the information contained in the points above, the potential impacts are assigned a significance rating (**S**). This rating is formulated by adding the sum of the numbers assigned to extent (**E**), duration (**D**) and magnitude (**M**) and multiplying this sum by the probability (**P**) of the impact.

S= (E+D+M) P

The significance ratings are given below

Low (i.e. where this impact would not have direct influence on the decision to develop in the area);	(**<30**)
Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated);	(**30-60**)
High (i.e. where the impact must have an influence on the decision process to develop in the area).	(**>60**)

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develop or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for prospecting activities and decommissioning and rehabilitation;
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur after rehabilitation.

APPENDIX B: BEP MINING APPROACH

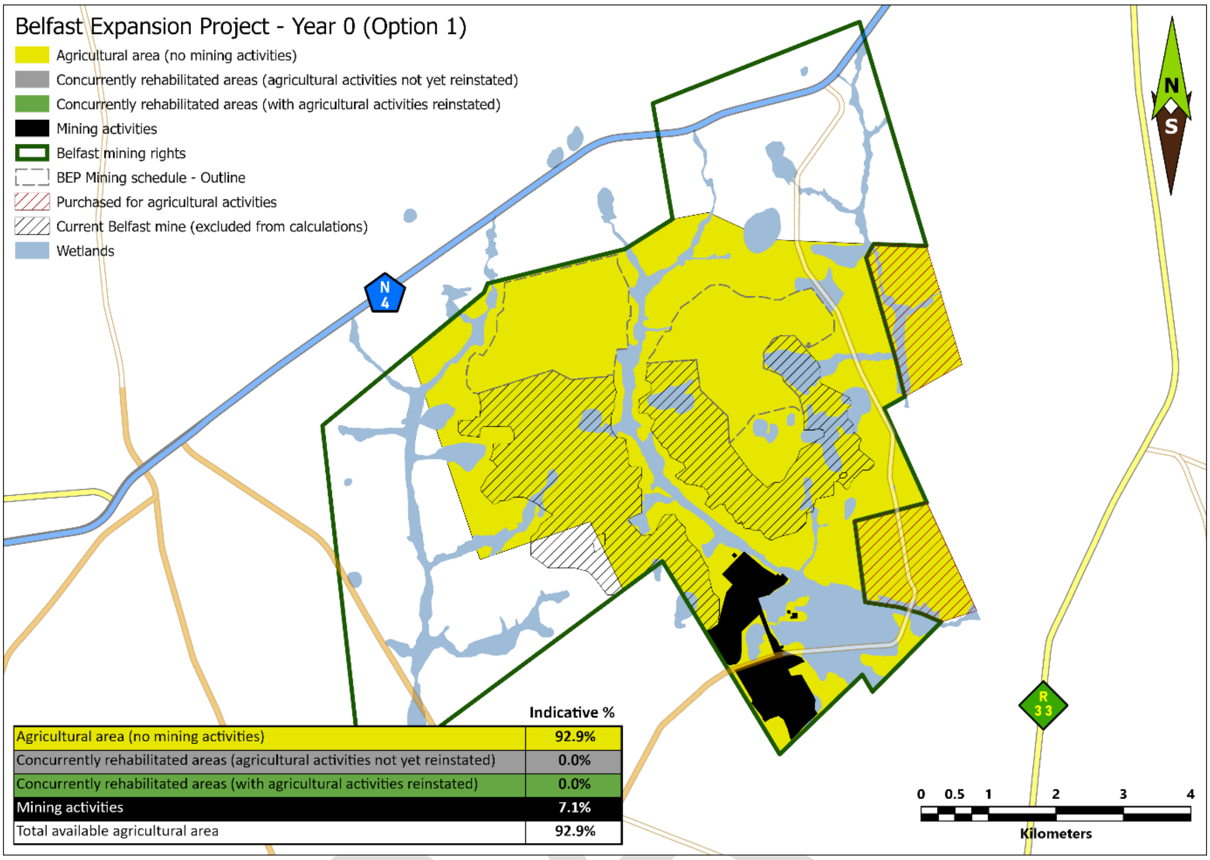


Figure B1: BEP Mining option 1: Year 0

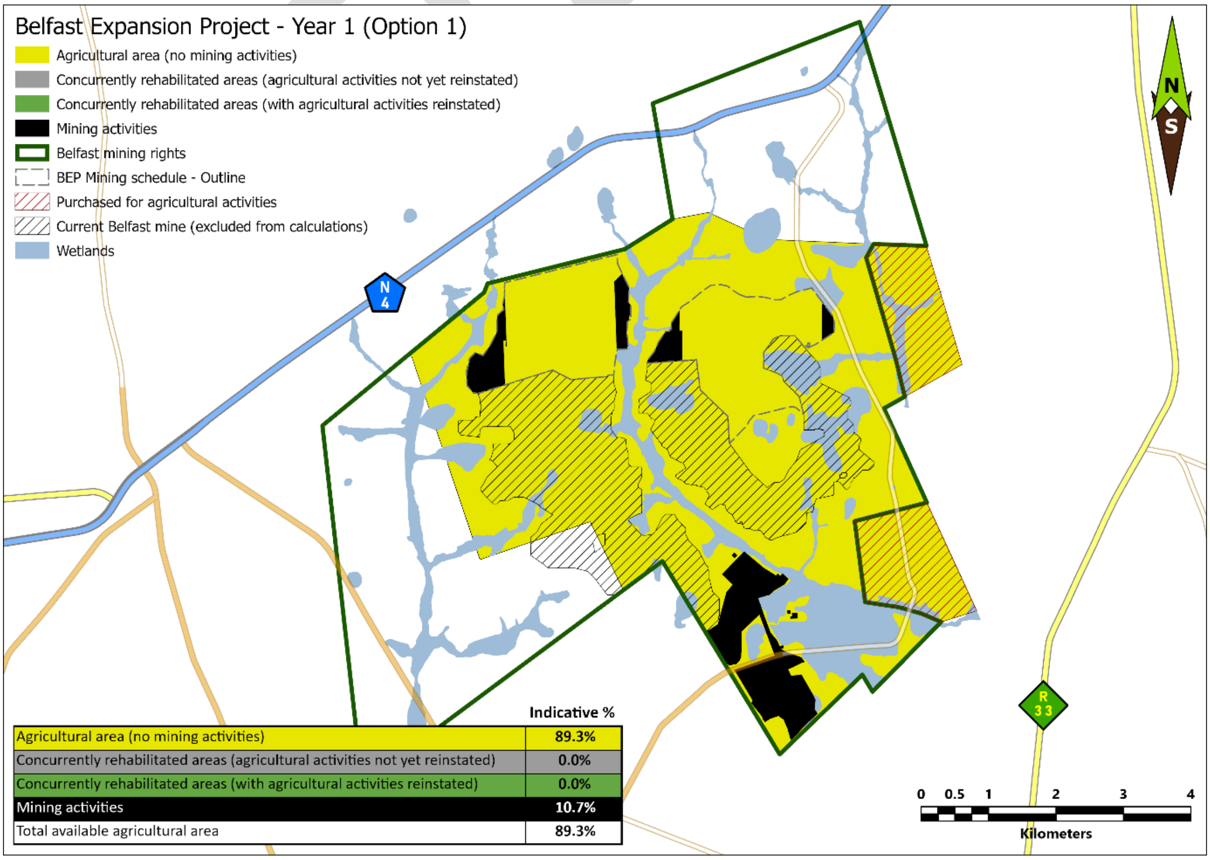


Figure B2: BEP Mining option 1: Year 1

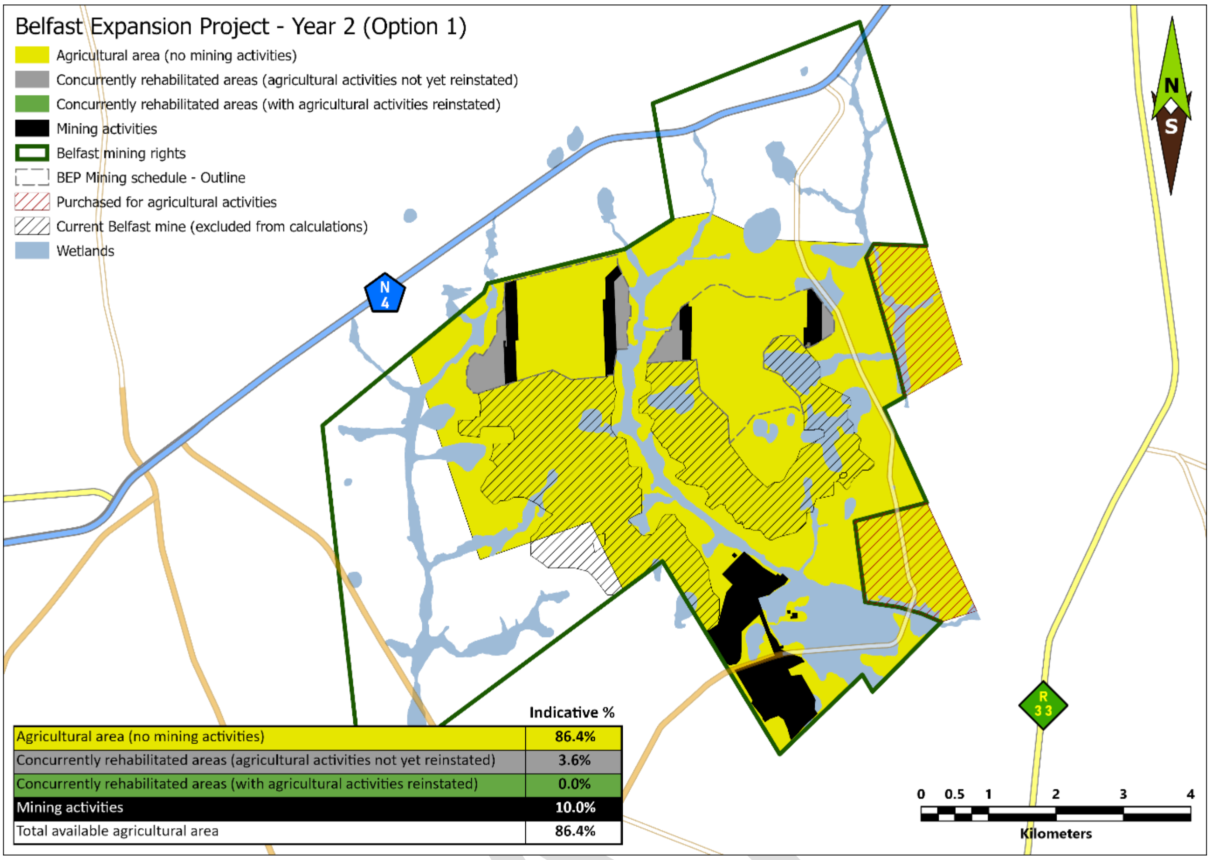


Figure B3: BEP Mining option 1: Year 2

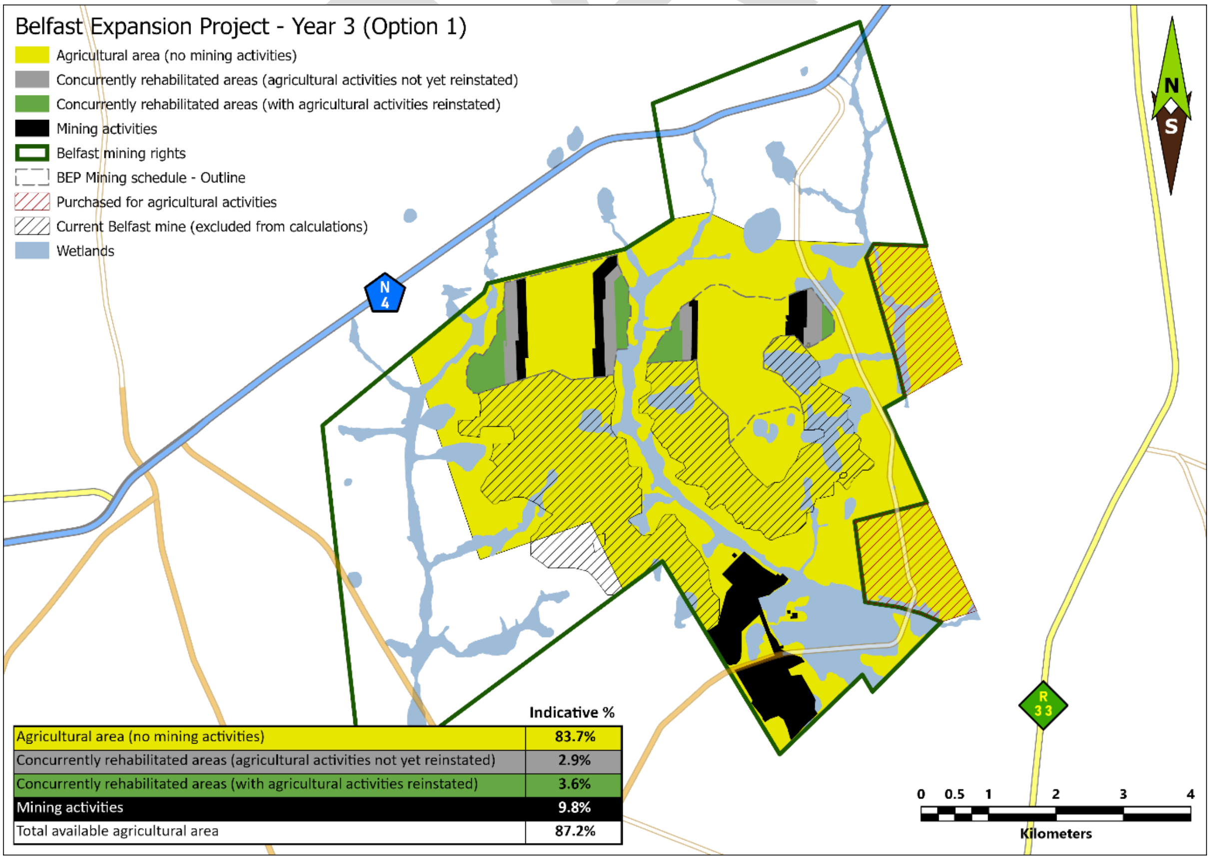
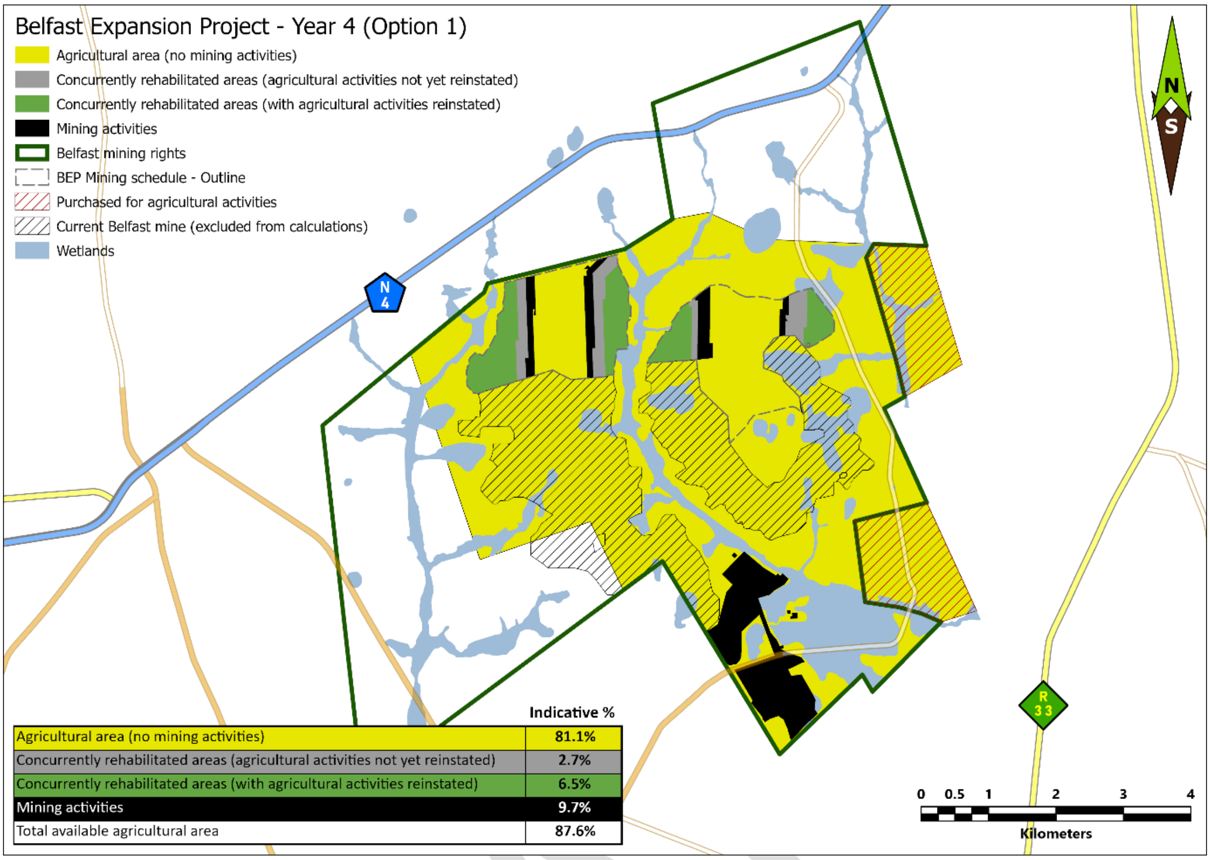
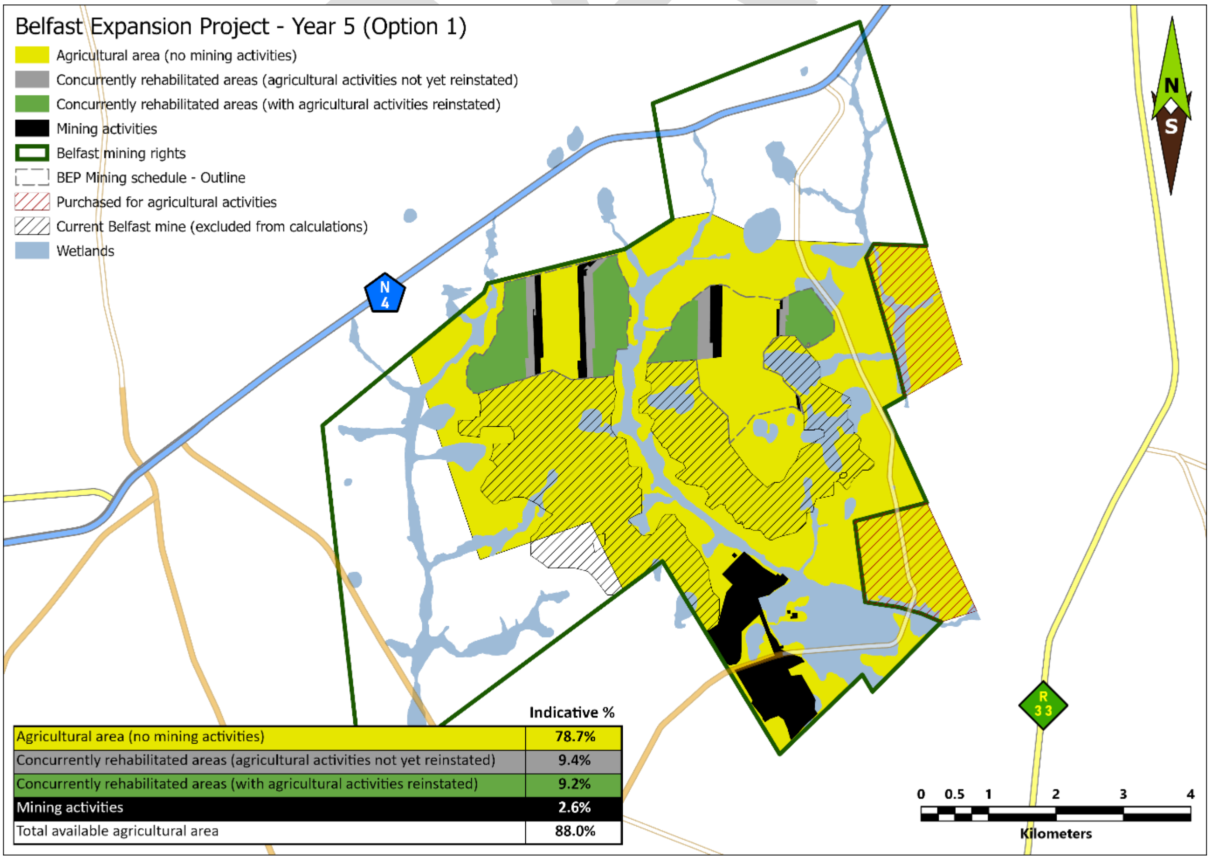


Figure B4: BEP Mining option 1: Year 3



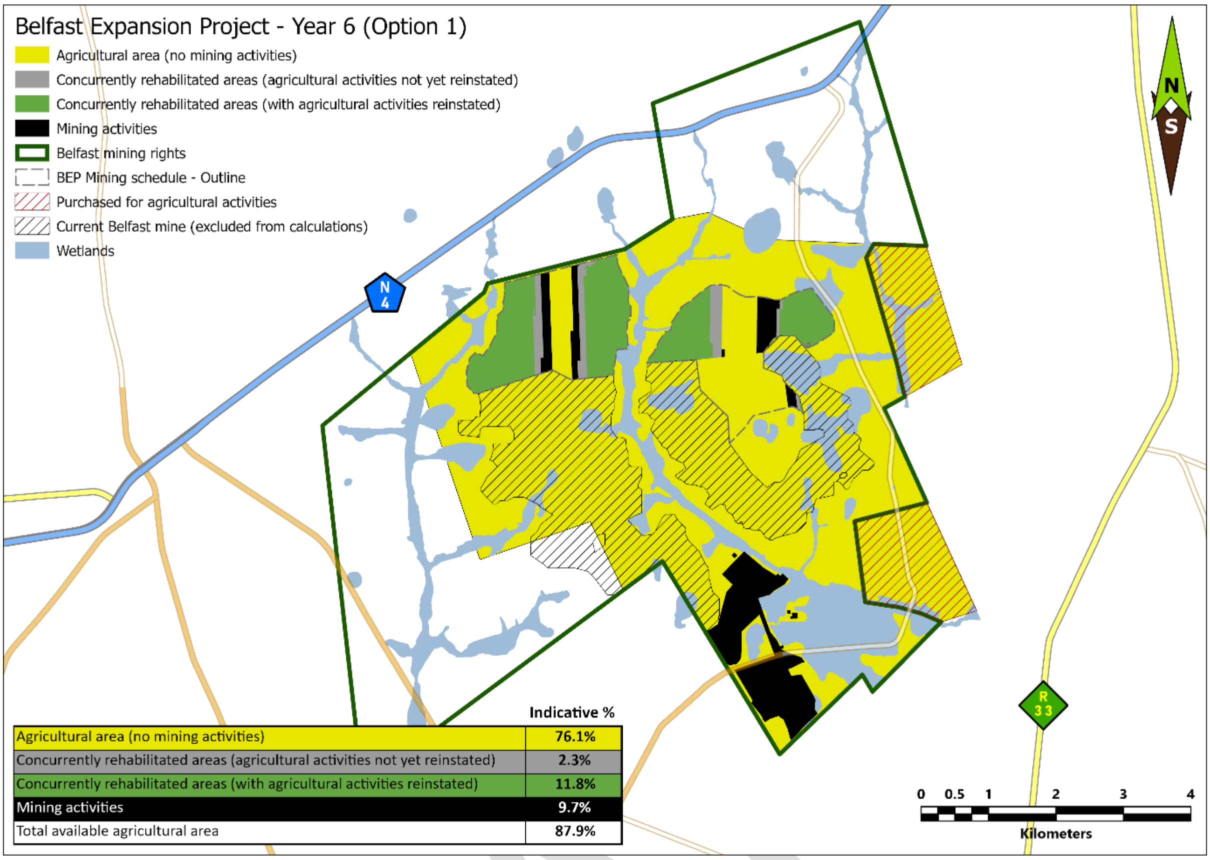
	Indicative %
Agricultural area (no mining activities)	81.1%
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	2.7%
Concurrently rehabilitated areas (with agricultural activities reinstated)	6.5%
Mining activities	9.7%
Total available agricultural area	87.6%

Figure B5: BEP Mining option 1: Year 4



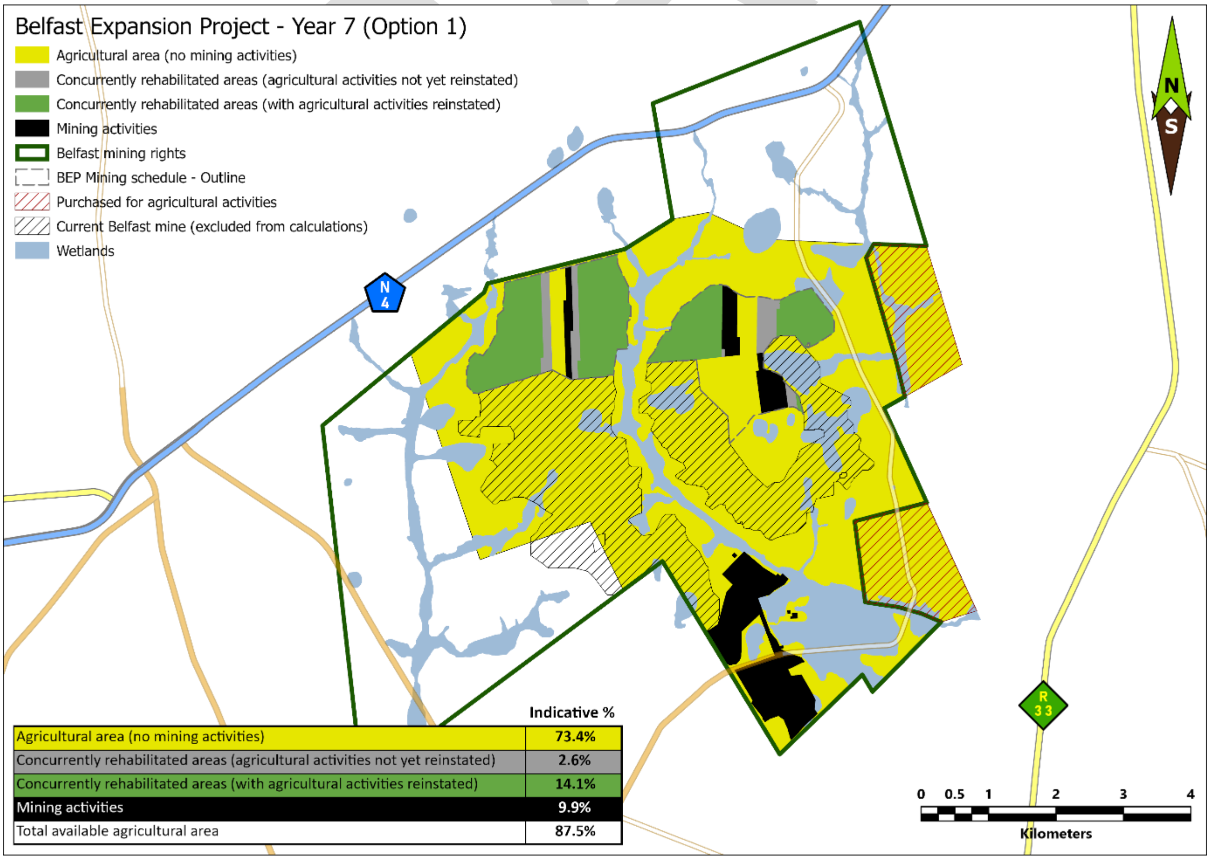
	Indicative %
Agricultural area (no mining activities)	78.7%
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	9.4%
Concurrently rehabilitated areas (with agricultural activities reinstated)	9.2%
Mining activities	2.6%
Total available agricultural area	88.0%

Figure B6: BEP Mining option 1: Year 5



	Indicative %
Agricultural area (no mining activities)	76.1%
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	2.3%
Concurrently rehabilitated areas (with agricultural activities reinstated)	11.8%
Mining activities	9.7%
Total available agricultural area	87.9%

Figure B7: BEP Mining option 1: Year 6



	Indicative %
Agricultural area (no mining activities)	73.4%
Concurrently rehabilitated areas (agricultural activities not yet reinstated)	2.6%
Concurrently rehabilitated areas (with agricultural activities reinstated)	14.1%
Mining activities	9.9%
Total available agricultural area	87.5%

Figure B8: BEP Mining option 1: Year 7

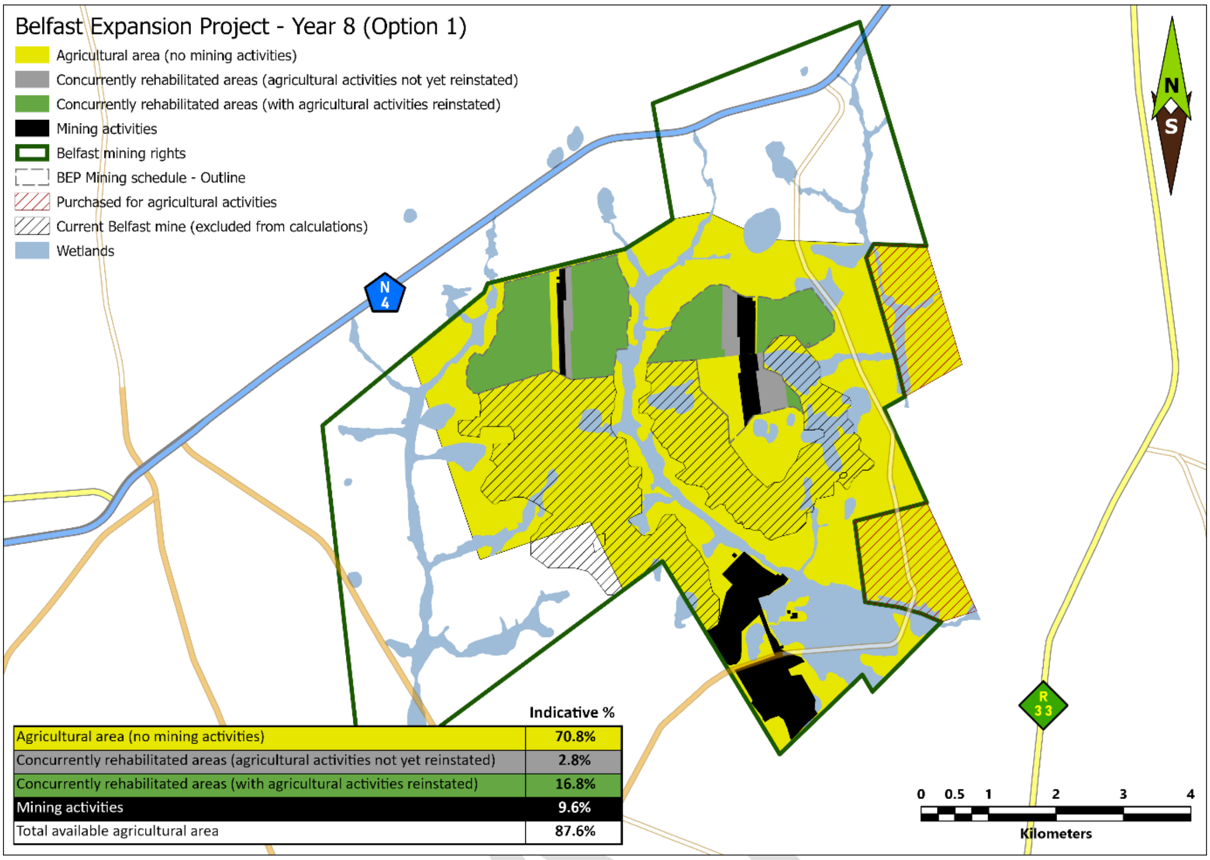


Figure B9: BEP Mining option 1: Year 8

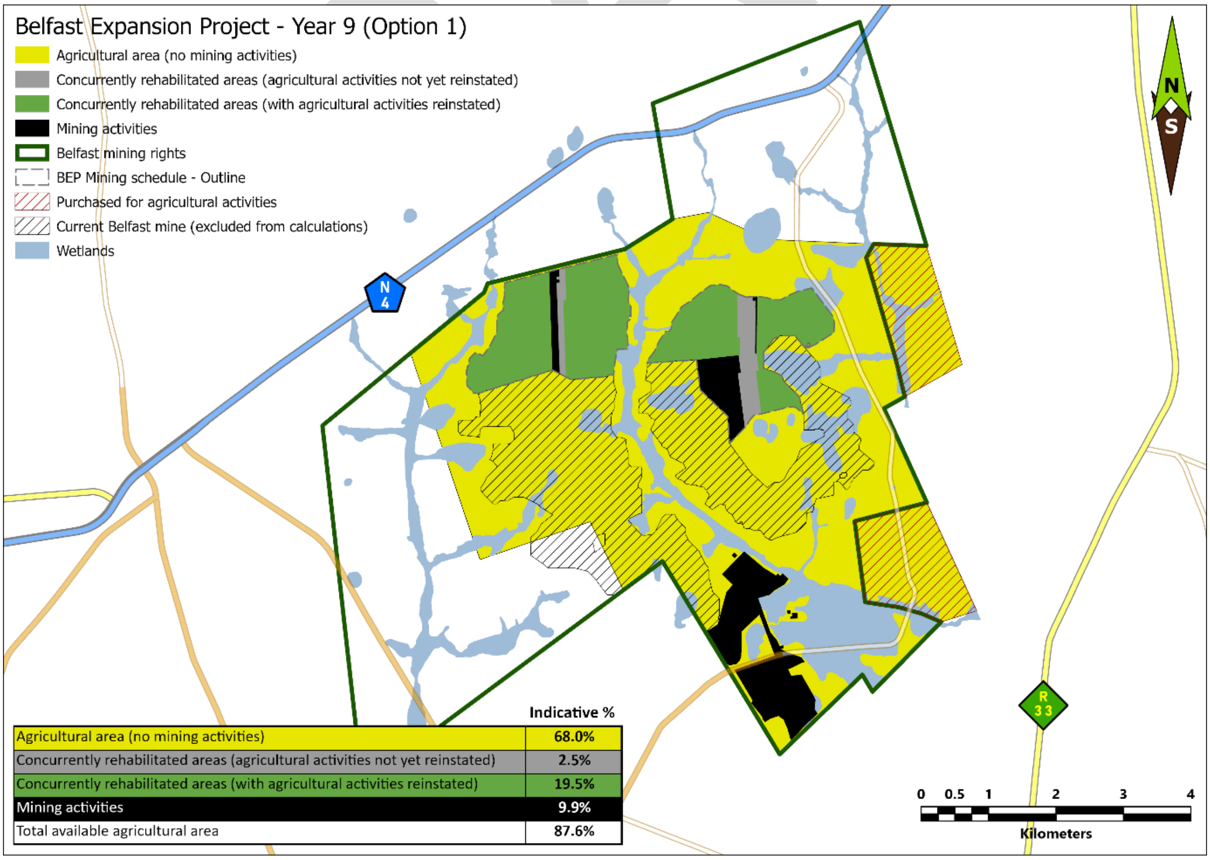


Figure B10: BEP Mining option 1: Year 9

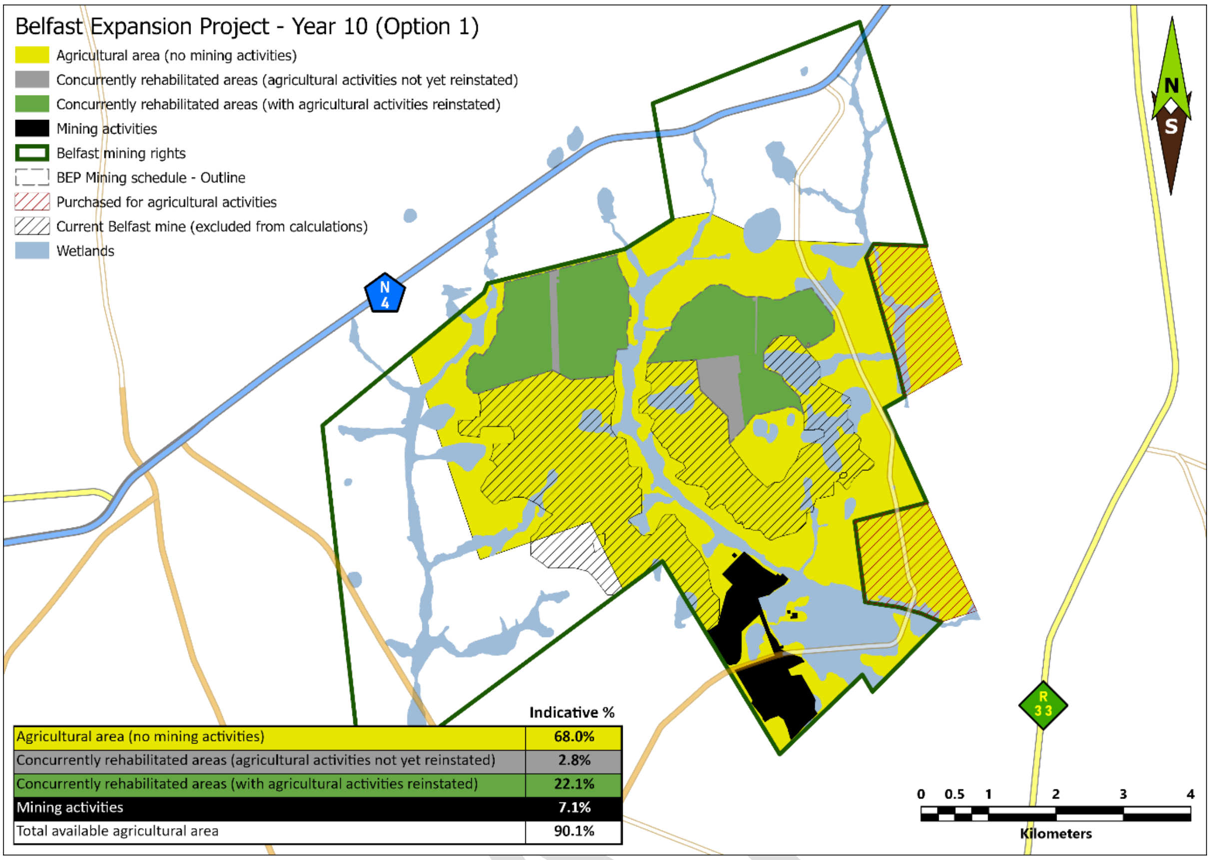


Figure B11: BEP Mining option 1: Year 10

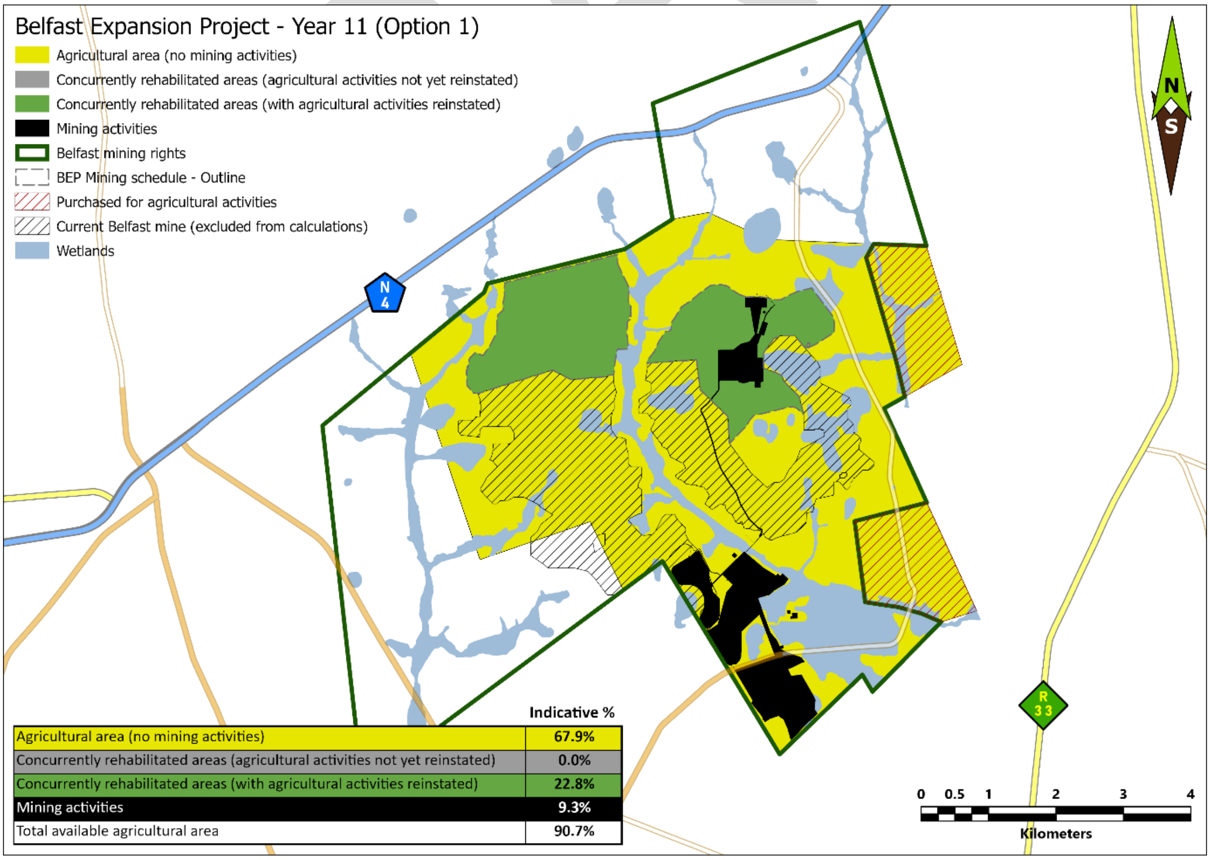


Figure B12: BEP Mining option 1: Year 11

APPENDIX C: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

Tshiamo Setsipane MSc (Agric.) (Soil Science) (University of Free State)

Braveman Mzila BSc (Hons) Environmental Hydrology (University of KwaZulu-Natal)

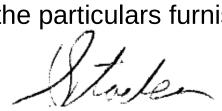
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Zimpande Research Collaborative		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the 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



Signature of the Specialist

1.(b) A declaration that the specialist is independent in a form as may be specified by the competent authority

I, Braveman Mzila, 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 relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the 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

Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –
SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

**SAS ENVIRONMENTAL GROUP OF COMPANIES (SEGC) –
SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF TSHIAMO SETSIPANE**

PERSONAL DETAILS

Position in Company	Soil Scientist/ Hydropedologist
Joined SAS Environmental Group of Companies	2020

MEMBERSHIP IN PROFESSIONAL SOCIETIES

South African Council for Natural Scientist Professions (SACNASP)

EDUCATION

Qualifications

M.Sc. (Agric) Soil Science (*Cum Laude*)	(University of the Free State)	2019
B.Sc. (Agric) Honours Soil Science	(University of the Free State)	2014
B.Sc. (Agric) Soil Science & Agrometeorology	(University of the Free State)	2013

COUNTRIES OF WORK EXPERIENCE

South Africa – Kwa-Zulu Natal, Mpumalanga and Free State

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments

SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Wetland Ecologist and Soil Scientist
Joined SAS Environmental Group of Companies	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Soil Science Society (SASSO)

Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications	
BSc (Hons) Environmental Hydrology (University of Kwazulu-Natal)	2013
BSc Hydrology and Soil Science (University of Kwazulu-Natal)	2012

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape, KwaZulu-Natal

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments