DRAFT EIA / EMP REPORT

July 2018

MAFUBE COAL MINING (PTY) LTD

Mafube Coal Mining (Pty) Ltd Proposed Road Realignment Draft EIA/EMPr

DMR Reference Number: MP 30/5/1/2/3/2/1 (10026) EM

DARDLEA Reference Number: 17/2/6/3 (101) N-1

Due date for public comment: Monday 6 August 2018

Submitted to:
Department of Mineral Resources (DMR)
Interested and Affected Parties (I&APs)

Report Number: 1776031-319712-10

Distribution:

1 x copy Department of Mineral Resources (DMR)
1 x copy Interested and Affected Parties (I&APs)
1 x copy Relevant Commenting Authorities
1 x electronic copy GAA Project File
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Golder Associates

PURPOSE OF THIS DOCUMENT

Mafube Coal Mining (Pty) Ltd (Mafube) is a Joint Venture between Anglo American Thermal Coal (AATC) and Exxaro Coal Mpumalanga (Pty) Ltd. The existing Mafube opencast operation, currently mining the Springboklaagte reserve, produces power station and A-grade thermal export coal. Mafube plan to expand their operations to the Nooitgedacht reserves and it is anticipated that the expanded operation will continue to produce power station and A-Grade thermal export coal. All coal mined at the Nooitgedacht reserve will be transferred to the existing beneficiation (washing) plant located at Springboklaagte for processing. The operations are currently in the construction phase and the operational phase was scheduled to commence in May 2018.

During the project feasibility phase investigations, it was assessed that sections of D684 and D1048 district roads traverse the Nooitgedacht Coal Reserve and their closure and/or realignment are required before mining of these sections can commence (Figure 2). These roads fall under the jurisdiction of the Mpumalanga Department of Public Works, Roads and Transport (DPWRT), and their approval will ultimately be required to re-align these roads.

The application for environmental authorisation on the farms Springboklaagte, Nooitgedacht and Roodepoort, was submitted to the Mpumalanga Regional Office of the Department of Mineral Resources (DMR). In terms of the EIA Regulations GN R.326, GN R.327, GN R.325 and GN R.324, which commenced on 7 April 2017, Mafube LifeX is required to submit a Scoping Report, followed by an Environmental Impact Assessment Report and an Environmental Management Programme (EMPr), which describe the environmental impacts of the proposed road realignment project and how they will be managed and mitigated. The EMPr must be based on an Environmental Impact Assessment (EIA). The proposed road realignment will require a water use licence application (WULA) and an integrated water and waste management plan (IWWMP) to be submitted to the Department of Water and Sanitation (DWS).

Golder Associates Africa (Pty) Ltd, an independent environmental and engineering company, is conducting the Scoping and Environmental Impact Assessment and licensing process for the proposed road realignment project.

The first phase of an EIA is the Scoping Phase, during which interested and affected parties are given the opportunity to comment on the proposed activities and the proposed scope of the EIA specialist studies. The Final Scoping Report was submitted to the DMR on **26 April 2018**.

This Draft EIA|/EMPr Report is presented to stakeholders so that they may confirm that the comments they made during the scoping phase have been recorded be informed about the findings of the impact assessment studies and be provided with an additional opportunity to provide comment and/or raise issues of concern. We draw your attention to the smart optimisation of the favoured route that has occurred since scoping. In the view of the EAP these changes in principle reduce the environmental impact while easing road construction and use. Consequently it is our view that these changes are not substantive.

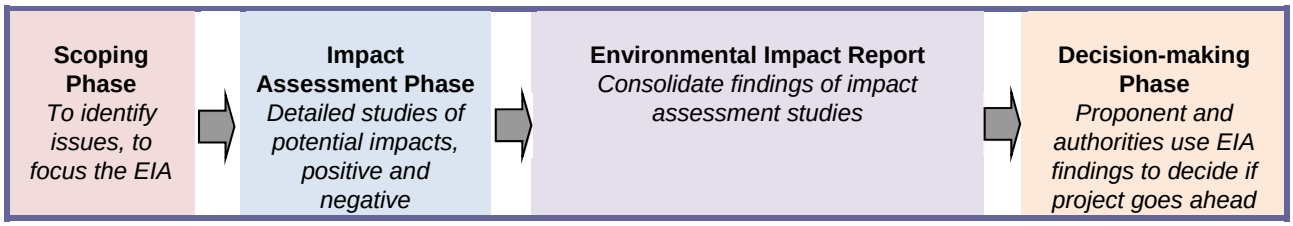
The due date for comment on the Draft EIA/EMPr Report is **6 August 2018**.

Summary of what the EIA/EMPr Report contains

This report contains:

- A description of the proposed mining activities;
- An overview of the EIA process, including public participation;
- A description of the existing environment in the proposed project area;
- The identified environmental issues and impacts;
- The findings of the specialist studies undertaken during the Impact Assessment phase;
- A list of interested and affected parties and their comments; and

- A draft Environmental Management Programme (EMPr), based on the findings of the specialist studies



The figure above shows the various phases of an Environmental Impact Assessment. The Impact Assessment Phase, during which interested and affected parties comment on the findings of the impact assessment studies, has been completed.

PUBLIC REVIEW OF THE EIA/EMP REPORT

This Draft EIA/EMPr Report was available for comment for a period of 30 days from **6 July 2018 to 6 August 2018** at the public places in the project area listed in the table below, and upon request from the Public Participation Office of Golder Associates.

Public Place	Contact Person	Contact Number	Public Place
Mafube LifeX Project Office	Mrs Chantelle Gerber	(011) 638 3479	Mafube LifeX Project Office
eMalahleni Main Library	Ms Johanette Rozmiarek	(013) 690 6232	eMalahleni Main Library
Golder Associates Africa, Midrand	Mrs Antoinette Pietersen	(011) 254 4800	Golder Associates Africa, Midrand
The Golder Associates Africa website	www.golder.com/public		

OPPORTUNITIES FOR PUBLIC REVIEW

Stakeholders who wished to comment on the EIA/EMPr Report could do so in any of the following ways:

- Completing the comment sheet enclosed with the report or on-line via the Golder website (www.golder.com/public);
- Additional written submissions; and
- Comment by e-mail or telephone.

DUE DATE FOR COMMENT ON THE EIA/EMPR REPORT IS MONDAY 6 AUG 2018

Comments could be submitted to the Public Participation Office:

Antoinette Pietersen

Golder Associates

P O Box 6001

HALFWAY HOUSE, 1685
Tel: (011) 254 4800 / 4805
Fax: 086 582 1561
Email: ppoffice@golder.co.za

Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery

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PART A
SCOPE OF ASSESSMENT AND ENVIRONMENTAL IMPACT ASSESSMENT REPORT

1.0 INTRODUCTION AND BACKGROUND

1.1 Background

Golder Associates Africa (Pty) Ltd (Golder) was appointed by Mafube Coal Mining (Pty) Ltd (Mafube) in 2011 to conduct the Environmental Impact Assessment (EIA) process for the proposed Mafube Life Expansion project (Mafube LifeX), which included the mining operations at Nooitgedacht and Wildfontein in the Mpumalanga province of South Africa. An Environmental Management Programme (EMPr) was also submitted to the Department of Mineral Resources (DMR) for approval as part of Mafube's mining right application, as required in terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA).

Mafube is a 50/50 Joint Venture involving Anglo American Thermal Coal (AATC) and Exxaro Coal Mpumalanga (Pty) Ltd. Environmental Authorisation for the Mafube LifeX EIA/EMPr was granted by the Mpumalanga Department of Environmental Affairs and Tourism (MDEDET) in April 2013. The approval of the mining right application was received in September 2013.

In terms of the National Water Act (Act No. 36 of 1998) (NWA), a Water Use Licence application (WULA) and an Integrated Water and Waste Management Plan (IWWMP) were also required, this application was submitted in December 2013, and currently a waste management licence application is being compiled by Golder.

During the feasibility phase investigations, it was assessed that sections of district road D684 and district road D1048 traverse the Nooitgedacht Coal Reserve and their closure and/or re-alignment would be required before this operation can commence. These roads fall under the jurisdiction of the Mpumalanga Department of Public Works, Roads and Transport (DPWRT), and their approval will ultimately be required to re-align these roads.

Mafube has appointed Golder to conduct the EIA/EMP and public participation process.

An EIA application was submitted to the Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) in terms of Regulations 544, 545 and 546 published under NEMA. This proposed project triggers a full scoping and environmental impact assessment (EIA) process for certain listed activities under the NEMA, an Environmental Management Programme (EMPr) based on the findings of the EIA, and an Integrated Water Use Licence Application (IWULA). The public participation process will provide stakeholders with information about the proposed project, and several opportunities to comment throughout the EIA/EMPr/IWULA process.

Contents of this Report

This document has been structured as follows to meet the requirements of the South African environmental legislation:

1) **Introduction and overview** – Introduces the Project and the Project proponent, gives an overview of the Project, provides the details of the environmental practitioner, and explains the ESHIA/EIA process;

2) **Project Motivation** – Provides an indication of the need for and desirability of the Project;

3) **EIA Process** – Summarises the process being undertaken with respect to Environmental, Social and Health Impact Assessment for the Project, inclusive of the methodology utilised for Scoping;

4) **Description of the Proposed Project** - Provides a summary of the key Project components, the Project location, scale, nature and design, production process, main inputs and outputs, schedule and activities during different phases of the Project, inclusive of a description of the Project location and the properties on which the Project will take place;

5) **Project Alternatives** – Summarises alternatives considered by the Project proponent;

6) **Policy, Legal and Administrative Framework** – Discusses the environmental policy, legal, and administrative framework applicable to the Project. This includes a summary of relevant South African regulations, the applicable administrative framework, and the environmental permitting process;

7) **Description of the Environment that may be affected** – Describes the current pre-project biophysical, socio-economic, and cultural status of the area, key characteristics (sensitive or vulnerable areas), important heritage resources, current land use and livelihoods;

8) **Environmental Issues and Potential Impacts of the Project** - Summarises the identified impacts and issues and Proposed mitigation measures that were assessed in the EIA;

9) **Public Consultation** – This section provides a summary of the public consultation activities proposed and carried out as part of the EIA process;

10) **Next Steps in the Process** – Indicates what the next steps in the process are;

11) **References** – References to literature consulted; and

12) **Appendices** – Material supporting the EIA/EMPr Report, including the database of interested and affected parties, project announcement documents, comments and response report and specialist reports.

2.0 PROPONENT AND PRACTITIONER DETAILS

2.1 Details of the Proponent

For the purposes of this EIA, the following person may be contacted at Mafube Coal Mining:

Table 1: Proponent's contact details

Contact Person:	Chantelle Gerber
Name of Proponent:	Mafube Coal (A joint venture between Anglo Operations Limited (AOL) and Exxaro)
Name of Mine:	Mafube Coal Mining (Pty) Ltd
Address:	Mafube LifeX project office, D684 Road, Farm Springboklaagte
Telephone No.:	011 638 3479
Email address:	chantelle.gerber@angloamerican.com

2.2 Details of the Environmental Impact Assessment Practitioner

Mafube has appointed Golder as an independent Environmental Assessment Practitioner (EAP) to undertake the scoping phase of the Environmental Impact Assessment (EIA) that is required for the proposed road realignment project.

Golder Associates Africa is a member of the world-wide Golder Associates group of companies, offering a variety of specialised engineering and environmental services. Employee owned since its formation in 1960, the Golder Associates group employs more than 8 000 people who operate from more than 180 offices located throughout Africa, Asia, Australasia, Europe, North America and South America. Golder Associates Africa has offices in Midrand, Pretoria, Florida, Durban, Rustenburg, Cape Town, Maputo and Accra, with more than 300 skilled employees, and is able to source additional professional skills and inputs from other Golder offices around the world.

Golder Associates Africa has no vested interest in the proposed project and hereby declares its independence as required by the South African EIA Regulations.

For purposes of this EIA, the following persons may be contacted at Golder Associates Africa:

Table 2: Contact details of the environmental assessment practitioner

Contact Persons:	Mariëtte Weideman	Antoinette Pietersen
Purpose:	Technical	Public Participation
Address:	PO Box 6001 Halfway House 1685	PO Box 6001 Halfway House 1685
Telephone:	011 254 4883	011 254 4805
Fax:	086 582 1561	086 582 1561
Cell phone:	084 515 6965	083 280 5024
E-mail:	mweideman@golder.co.za	apietersen@golder.co.za

2.3 Expertise of environmental assessment practitioner

2.3.1 Qualifications of EAP

Mariëtte Weideman

Education

- B.Sc. Biological Sciences in Botany and Biochemistry - North West University (Potchefstroom Campus);
- B.Sc. (Hons) Environmental Sciences and Development - North West University (Potchefstroom Campus);
- B.Sc. (Hons) Environmental Management - University of South Africa (UNISA); and
- AVCASA Crop Protection Diploma - Tshwane University of Technology.

Career Enhancing Courses

- Planning for Effective Public Participation - IAP2;
- Communications for Effective Public Participation - IAP2;
- Microsoft Project 2007 Essentials - BYTES Technology Group;
- Project Management Fundamentals - Golder Associates (internal training); and
- Environmental Law for Environmental Managers - Centre for Environmental Management (CEM), Potchefstroom.

Professional Affiliations

- Professional Natural Scientist (Pr.Sci.Nat) (Reg. No.400107/17) - South African Council for Natural Scientific Professions (SACNASP).

2.3.2 Summary of past experience

Mariëtte has 6 and a half years' work experience in Environmental Management, specialising in Environmental and Social Impact Assessments (ESIAs), Basic Assessments (BAs), Environmental Management Programme reports (EMPr's) for mining and industry, Emergency Response Plans, Section 24G applications, Legal Compliance Auditing, and the Public Participation Processes.

Mariëtte has experience with Southern African legislation as well as IFC Performance Standards and Equator Principles. Mariëtte has been involved in international ESIA projects in the following countries; South Africa, DRC, Botswana and Mozambique, and as such she has a good track record of understanding the local regulatory and permitting processes in other countries. Mariëtte also has experience in conducting technical and quality reviews of specialist reports (copy of CV appended to this Report).

Mariette Weideman past employment

- Ocean Agriculture (Pty) Ltd. – Johannesburg, South Africa (November 2007 to August 2011) as an **Agronomist:**

  Responsibilities:

  - Advisory agronomic support to emerging farmers and commercial farmers in South Africa and Kenya, on agricultural crop production aspects, agricultural production planning, and developing specific nutritional plant production (feeding) programs.

- MGK Obaro (Pty) Ltd – Brits, South Africa (February 2007 to August 2007) as an **Assistant Technical Advisor:**

  Responsibilities:

  - Client visits and consulting with farmers on different products and general problem solving;
  - Organizing and participating in farmers' day; and
  - Assist with writing fertilizer application programs.

2.4 Description of the Property

This is a linear development that affects a number of properties indicated in Table 3.

Table 3: Details of the properties

Aspect	Description	
Application area	Approximately 75 ha (for entire length of the proposed road)	
Magisterial District	Steve Tshwete and Emakhazeni Local Municipalities	
Distance and direction from nearest town	39 km east of the town of Middelburg via the R104 regional road and 30 km west of Belfast	
SG Codes		
Farm Name	**Portion Number**	**21-Digit Key**
Properties affected by Preferred Route Alternative F		
Springboklaagte 416 JS	1	T0JS00000000041600001
Springboklaagte 416 JS	12	T0JS00000000041600012
Nooitgedacht 417 JS	4	T0JS00000000041700004
Nooitgedacht 417 JS	14	T0JS00000000041700014
Nooitgedacht 417 JS	15	T0JS00000000041700015
Roodepoort 418 JS	8	T0JS00000000041800008
Roodepoort 418 JS	9	T0JS00000000041800009
Roodepoort 418 JS	10	T0JS00000000041800010
Roodepoort 418 JS	11	T0JS00000000041800011
Roodepoort 418 JS	13	T0JS00000000041800013

2.5 Locality Map

Mafube Coal Mining (Pty) Ltd is situated approximately 39 km east of the town of Middelburg via the R104 regional road, and 45 km west of Belfast, in the Mpumalanga Province (Figure 2). The mining operation is located within the jurisdiction of the Nkangala District Municipality and falls within the Tshwete Local Municipality.

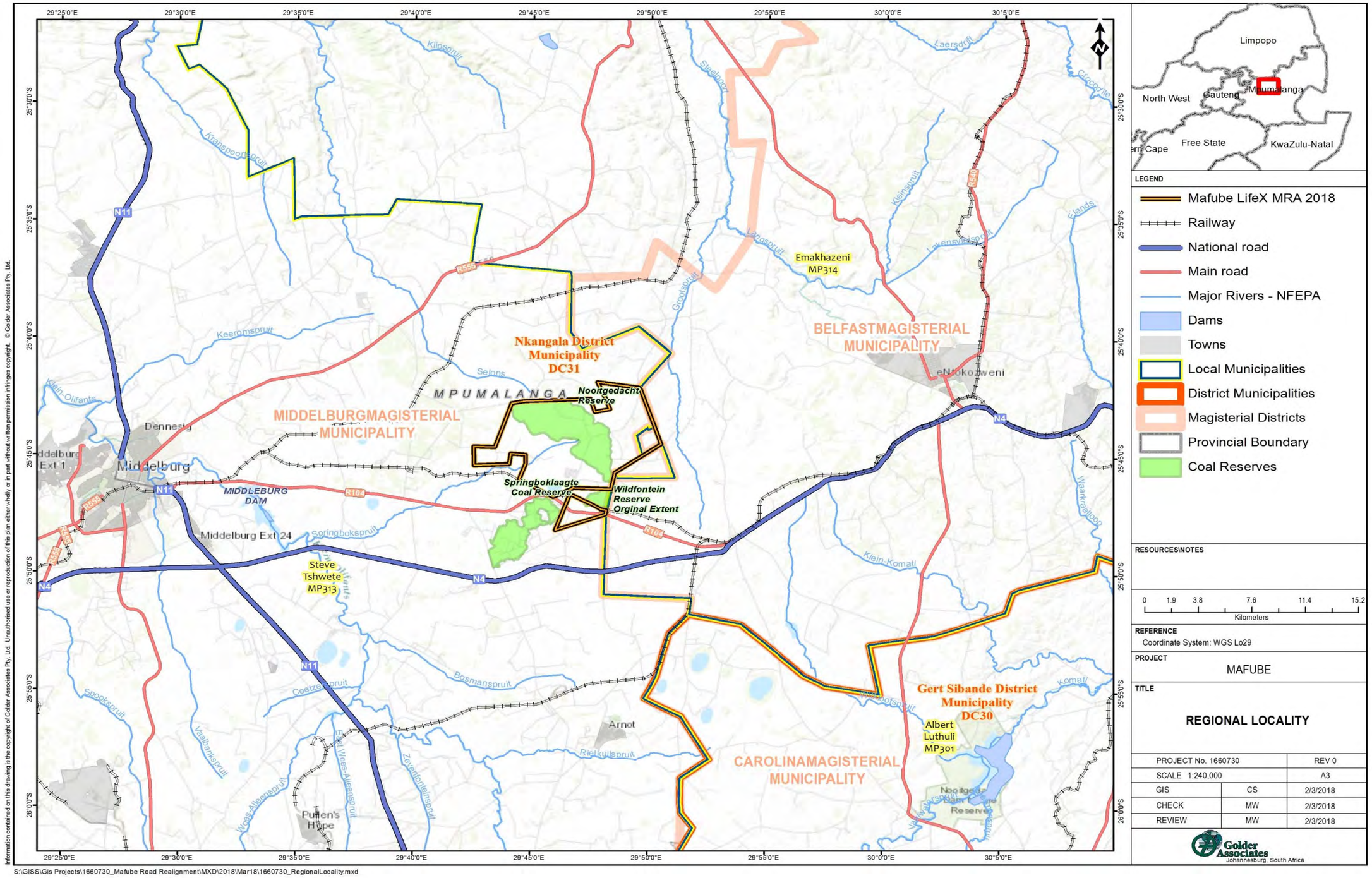


Figure 1: Regional locality map

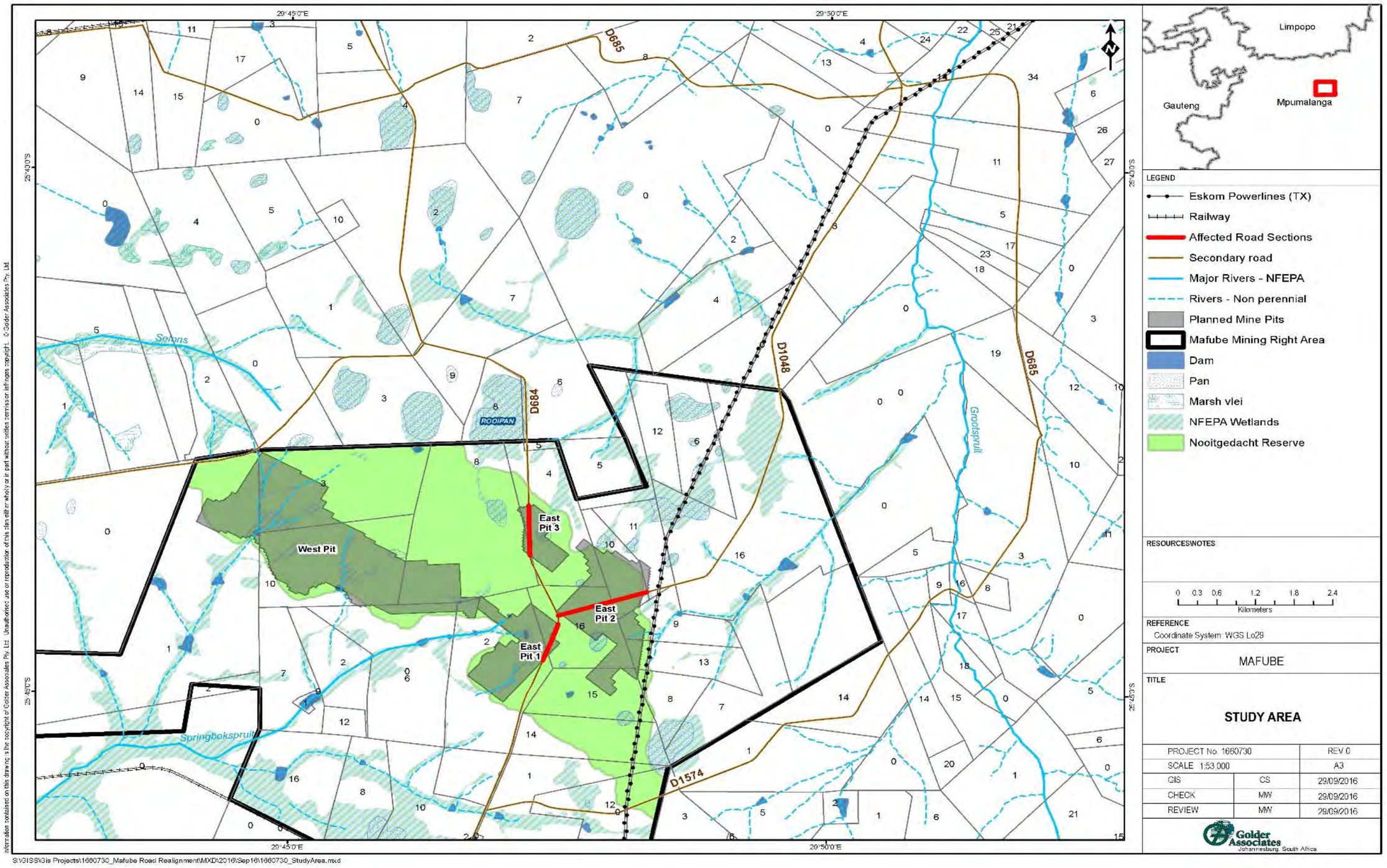


Figure 2: Locality Map for the Mafube Road Realignment Project

3.0 DESCRIPTION AND SCOPE OF THE PROPOSED OVERALL ACTIVITY

Golder was appointed by Mafube in 2011 to conduct the Environmental Impact Assessment (EIA) process for the proposed Mafube LifeX operations, which included the mining operations at Nooitgedacht and Wildfontein. An Environmental Management Programme (EMPr) was also submitted to the Department of Mineral Resources (DMR) for approval as part of Mafube's mining right application, as required under the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA).

Environmental authorisation (EA) under the National Environmental Management Act 107 of 1998 (NEMA) for the Mafube LifeX operations was received from the Mpumalanga Department of Environmental Affairs and Tourism (MDEDET) in April 2013 (17/2/6/3 (101) N-1). An approval for the mining right application was granted by the Mpumalanga Department of Minerals Resources (DMR) on 30 August 2013 (MR 30/5/1/2/2/10026 MR) and the EMPr was approved on 14 November 2013.

In terms of the National Water Act (Act No. 36 of 1998) (NWA), a Water Use Licence application (WULA) and an Integrated Water and Waste Management Plan (IWWMP) were also required for the Mafube LifeX operations, and these applications were submitted in December 2013 and approved on 1 December 2014. Subsequent amendments to these licences were issued on 1 February 2016. A WUL authorising a number of section 21 (c) & (i) water uses associated with wetland interventions as part of an extensive wetland rehabilitation programme was issued on 13 April 2017, Licence No 03/B12C/CI/5006.

The Mafube LifeX project is in the construction phase and operations were scheduled to commence in May 2018.

During the feasibility phase investigations, it was assessed that sections of district road D684 and district road D1048 traverse the Nooitgedacht Coal Reserve and their closure and/or realignment are required before this operation can proceed in that area (Figure 4). These roads fall under the jurisdiction of the Mpumalanga Department of Public Works, Roads and Transport (DPWRT), and their approval will ultimately be required to re-align these roads.

3.1 Listed and Specified Activities

Golder identified the activities listed in Table 4 as activities that require environmental authorisation in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA) regulations, GN R.326, GN R.327, GN R.325 and GN R.324 gazetted on 7 April 2017, for the proposed realignment of the district roads.

Table 4: Listed activities requiring environmental authorisation

Relevant Government Notice	Number of Listed Activity	Aerial extent of the Activity Ha or m²	Description of the Activity	Legislation Text
GN R.327	12(ii)	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	Proposed road construction/development physical footprint of 100 square metres or more within a watercourse	*"The development of—* *(i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or* *(ii) infrastructure or structures with a physical footprint of 100 square metres or more;* *where such development occurs—* *(a) within a watercourse;* *(b) in front of a development setback; or* *(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse."*
GN R.327	19	Entire length of the proposed road (including servitude) covers an area of Approx.75 ha.	During road construction over watercourses there may be a requirement to dredge, excavate or remove more than 10 cubic metres of material from a watercourse.	*"The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse;* *but excluding where such infilling, depositing, dredging, excavation, removal or moving—* *will occur behind a development setback;* *is for maintenance purposes undertaken in accordance with a maintenance management plan;* *falls within the ambit of activity 21 in this Notice, in which case that activity applies;* *occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or* *where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies."*

Relevant Government Notice	Number of Listed Activity	Aerial extent of the Activity Ha or m²	Description of the Activity	Legislation Text
GN R.327	24(ii)	Listed Activity will cover sections within the 75 ha.	Road being constructed may be wider than 8 metres.	*"The development of a road—* *(i) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Government Notice 545 of 2010; or* *(ii) with a reserve wider than 13,5 metres, or where no reserve exists where the road is wider than 8 metres;* *but excluding a road—* *(a) which is identified and included in activity 27 in Listing Notice 2 of 2014;* *(b) where the entire road falls within an urban area; or* *(c) which is 1 kilometre or shorter."*
GN R.327	56(i)	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha.	Road being constructed may be widened by more than 6 metres and lengthened by more than 1 kilometre.	*"The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre—* *(i) where the existing reserve is wider than 13,5 metres; or* *(ii) where no reserve exists, where the existing road is wider than 8 metres;* *excluding where widening or lengthening occur inside urban areas."*
GN R.325	24	Listed Activity will cover sections within the 75 ha.	Road being constructed in wetland areas that might contain peat soils.	*"The extraction or removal of peat or peat soils, including the disturbance of vegetation or soils in anticipation of the extraction or removal of peat or peat soils, but excluding where such extraction or removal is for the rehabilitation of wetlands in accordance with a maintenance management plan."*

Relevant Government Notice	Number of Listed Activity	Aerial extent of the Activity Ha or m²	Description of the Activity	Legislation Text
GN R.325	27(i)	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha.	Road being constructed may have a reserve wider than 30 metres.	*"The development of a road-* *(i) with a reserve, wider than 30 metres; or* *(ii) catering for more than one lane of traffic in both directions;* *but excluding [the development and related operation of] a road—* *(a) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Government Notice 545 of 2010, in which case activity 24 in Listing Notice 1 of 2014 applies;* *(b) which is 1 kilometre or shorter; or* *(c) where the entire road falls within an urban area."*
GN R.324	4	Listed Activity will cover sections within the 75 ha.	The development of a road wider than 4 metres with a reserve less than 13,5 metres.	*f. Mpumalanga* *i. Outside urban areas:* *(aa) A protected area identified in terms of NEMPAA, excluding disturbed areas;* *(bb) National Protected Area Expansion Strategy Focus areas;* *(cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;* *(dd) Sites or areas identified in terms of an international convention;* *(ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;* *(ff) Core areas in biosphere reserves; or*

Relevant Government Notice	Number of Listed Activity	Aerial extent of the Activity Ha or m²	Description of the Activity	Legislation Text
				(gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve, excluding disturbed areas, where such areas comprise indigenous vegetation; or *ii. Inside urban areas:* *(aa) Areas zoned for use as public open space; or* *(bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose.*
GN R.324	12	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha.	The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.	*f. Mpumalanga* *i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004;* *ii. Within critical biodiversity areas identified in bioregional plans; or* *iii. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning or proclamation in terms of NEMPAA.*
GN R.324	14	Listed Activity will cover sections within the 75 ha.	The development of (i) dams or weirs, where the dam or weir, including infrastructure and water surface area exceeds 10 square metres; or (ii) infrastructure or structures with a	*f. Mpumalanga* *i. Outside urban areas:* *(aa) A protected area identified in terms of NEMPAA, excluding conservancies;* *(bb) National Protected Area Expansion Strategy Focus areas;* *(cc) World Heritage Sites;*

Relevant Government Notice	Number of Listed Activity	Aerial extent of the Activity Ha or m²	Description of the Activity	Legislation Text
			physical footprint of 10 square metres or more;	*(dd) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;* *(ee) Sites or areas identified in terms of an international convention;* *(ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;* *(gg) Core areas in biosphere reserves; or* *(hh) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve, where such areas comprise indigenous vegetation."*
GN R.324	18	Entire length of the proposed road (including servitude) covers an area of Approx.75 ha.	The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre.	*f. Mpumalanga* *i. Outside urban areas:* *(aa) A protected area identified in terms of NEMPAA, excluding conservancies;* *(bb) National Protected Area Expansion Strategy Focus areas;* *(cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;* *(dd) Sites or areas identified in terms of an international convention;* *(ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;* *(ff) Core areas in biosphere reserves; or*

Relevant Government Notice	Number of Listed Activity	Aerial extent of the Activity Ha or m²	Description of the Activity	Legislation Text
				(gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve, where such areas comprise indigenous vegetation; or *ii. Inside urban areas:* *(aa) Areas zoned for use as public open space; or* *(bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose.*

3.2 Description of the activities to be undertaken

The project activities include those during the pre-construction (setting up servitudes and site camps before construction), construction, and operational phases of the proposed road realignments and closure development. Each activity has potential impacts on the environment and is summarised in Table 5 below.

Table 5: Summary of project activities

Activity	Description
Pre-construction phase	
Demarcation of servitudes	■ *Surveying*: all sections of the proposed route must be surveyed in detail; ■ *Fencing:* the surveyed sections will be temporarily fenced in order to confine construction activities; ■ *Search-and-rescue:* any species of flora of high conservation status within these servitudes will be removed by a suitably qualified person and stored for relocation; ■ *Clearing:* the removal of all vegetation and topsoil in preparation of stable foundations for new construction works as well as along proposed access routes and in areas set aside for construction camps; ■ *Topsoil stripping:* topsoil within the servitudes will be stripped and stockpiled or removed as part of the Nooitgedacht mining operation schedule; and ■ *Access road construction:* this will involve the construction of the various roads required to access the construction areas, construction camps and other surface infrastructure sites.

Activity	Description
Transport of material to site	■ *Road transport:* materials sourced outside of the study area will be transported to the servitude by road. The existing district D1574 road and farm roads will be utilised as a means of delivering these materials to site, with potential temporary impacts on the transport infrastructure and local road users in the area.
Establishment of construction camps	■ *Construction of temporary camps:* these will involve clearing of the vegetation, fencing of camps and the construction of houses, workshops, store-rooms and vehicle parking areas. The camps will be electrified and ablution and potable water will be provided. An Environmental Management Plan (EMP) will be compiled as part of this EIA, which will describe parameters such as the following: ▪ The contractor will provide a plan detailing the layout of camp site facilities, such as chemical toilets, areas for stockpiling of materials, storage of hazardous materials and provision of containers; ▪ Stockpiles for concrete materials will comprise side-restrained triangular bin-type structures. Bund walls will be constructed. High quality materials with low dust generating characteristics will be used; ▪ Hazardous waste will be disposed of at an approved landfill site; ▪ All hazardous materials will be stored in a secured, appointed area that is fenced and has restricted access; ▪ Liquid fuel will be stored in a bunded and secure area in steel tanks supplied and maintained by the fuel suppliers. Fuel storage will generally occur in the workshop areas of site camps, which are generally fenced and paved. Bund walls will be built around an impermeable substratum; ▪ Workshops will be equipped with grease traps in the drainage collection system. Used oil will be collected in drums from these traps and disposed of at an appropriately licensed site; ▪ Domestic waste will be collected in drums and removed to the nearest municipal waste site for disposal; ▪ Suitable washing facilities and sanitary arrangements at site offices, workshops and construction sites will be provided. Sanitary facilities for the site camps will comprise either prefabricated septic tanks or stand-alone bucket-systems; and ▪ Water for human consumption will be available at the site offices and at other convenient locations on site.
Establishment of crusher plants	■ Possible need for a temporary crusher plant to crush rock obtained from road cuttings to be used for the construction.
Construction phase	
Structures	The proposed road will require the construction of some new drainage structures, such as pipe and box culverts.
Earthworks	■ *Clearing of vegetation:* Vegetation along the route will be cleared and uprooted; ■ *Cuttings:* Cuttings will be initiated using bulldozers and back actors to remove the softer material; and

Activity	Description
	■ *Blasting:* Possible drilling and blasting will occur where rock is encountered that cannot be ripped. These activities will be strictly controlled.
Road construction	■ Road construction activities will be done in accordance with legislative district road specifications.
Site removal and rehabilitation	Site removal encompasses the removal of all building material, temporary structures and any other waste material generated during construction. All such material must be removed from site and disposed of appropriately once construction is complete. The following will be removed from site where: ■ Storage structures; ■ Wayleaves required for earth moving vehicles; ■ All construction material, including concrete slabs and braai areas; ■ Accommodation structures; ■ Workshop structures; ■ Waste material generated by the workforce and during construction; ■ Extra construction material not used or required on site; ■ Stripped vegetation; ■ Stockpiled topsoil; and ■ Rock and other material generated during construction (e.g. during blasting and excavations), which cannot be utilised on site.

4.0 POLICY AND LEGISLATIVE CONTEXT

This section summarises the legal, policy, and administrative framework within which the EIA is being undertaken and identifies the regulatory authorities involved in deciding on the application for authorisation.

4.1 Relevant South African Legislation

As shown in Table 5, Golder has identified activities that require environmental authorisation that were not included in the EIA and EMP process undertaken by Golder Associates in 2012 (Golder Associates, 2012). The activities identified by Golder, as listed in Table 5, include Activity 15 and 18 of Regulation GN R.545, which requires a full EIA, encompassing a Scoping phase and an Impact Assessment phase, in support of an application for Environmental Authorisation in terms of the National Environmental Management Act 1998 (Act No. 107 of 1998). It also requires a Water Use Licence application for the proposed relocations of the D1048 and D684 roads and will be applied for in terms of the National Water Act 1998 (Act No. 36 of 1998).

In summary the following key legislation is relevant to the Mafube LifeX Road Realignment EIA/EMP Process:

- National Environmental Management Act (Act No. 107 of 1998) (NEMA) and applicable Regulations; and
- National Water Act (Act No. 36 of 1998) (NWA).

Other legislation applicable to the project includes:

- National Heritage Resources Act (Act No. 25 of 1999);
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004);
- National Environmental Management: Air Quality Act (Act No. 39 of 2004) and applicable Regulations, Standards and Notices published in terms of NEMAQA;
- Environment Conservation Act (Act No. 73 of 1989);
- Conservation of Agricultural Resources Act (Act No. 43 of 1983); and
- Municipal by-laws.

The following documents have been used for guidance:

- Institute of Environmental Assessment (IEMA), 1993. Guidelines for the Environmental Assessment of Road Traffic;
- International Finance Corporation (IFC), 2007. Traffic Safety Guidelines in the General EHS Guidelines: Community Health and Safety;
- International Finance Corporation (IFC), 2007. Performance Standard 2: Assessment and Management of Environmental and Social Risks and Impacts;
- South African National Ambient Air Quality Standards (NAAQS) for common pollutants;
- National Dust Control Regulations were promulgated under NEMAQA and published in the Government Gazette No. 36974; and
- Sections 18 to 20 of NEMAQA, that deal with the establishment of Priority Areas in so-called “hot-spot” areas of South Africa where ambient air quality standards are often exceeded or may often be exceeded.

4.1.1 National Environmental Management Act (Act 107 of 1998)

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), as amended and the EIA Regulations, an application for environmental authorisation for certain listed activities must be submitted to the provincial environmental authority, the national authority (Department of Environmental Affairs, DEA), depending on the types of activities being applied for or, when mining and mineral processing activities are involved, the Department of Mineral Resources (DMR).

The current EIA regulations, GN R.326, GN R.327, GN R.325 and GN R.324, promulgated in terms of Sections 24(5), 24M and 44 of the NEMA and subsequent amendments, commenced on 7 April 2017. GN R.327 lists those activities for which a Basic Assessment is required, GN R.325 lists the activities requiring a full EIA (Scoping and Impact Assessment phases) and GN R.324 lists certain activities and competent authorities in specific identified geographical areas. GN R.326 defines the EIA processes that must be undertaken to apply for Environmental Authorisation.

The activities requiring environmental authorisation in terms of the NEMA are included in Table 4.

4.1.2 National Water Act (Act 36 of 1998)

The National Water Act, 1998 (Act No. 36 of 1998) (NWA) is the primary legislation regulating both the use of water and the pollution of water resources. It is applied and enforced by the Department of Water and Sanitation (DWS).

Section 19 of the National Water Act regulates pollution, which is defined as *"the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it:*

- *less fit for any beneficial purpose for which it may reasonably be expected to be used; or*
- *harmful or potentially harmful to -*
  - *the welfare, health or safety of human beings;*
  - *any aquatic or non-aquatic organisms;*
  - *the resource quality; or*
  - *property."*

The persons held responsible for taking measures to prevent pollution from occurring, recurring or continuing include persons who own, control, occupy or use the land. This obligation or duty of care is initiated where there is any activity or process performed on the land (either presently or in the past) or any other situation which could lead to or has led to the pollution of water.

The following measures are prescribed in section 19(2) of the NWA to prevent pollution:

- Cease, modify or control any act or process causing the pollution;
- Comply with any prescribed standard or management practice;
- Contain or prevent the movement of pollutants;
- Eliminate any source of the pollution;
- Remedy the effects of pollution; and
- Remedy the effects of any disturbance to the bed or banks of a watercourse.

The NWA states in Section 22 (1) that a person may only use water:

- without a licence –
  - i) if that water use is permissible under Schedule 1;
  - ii) if that water use is permissible as a continuation of an existing lawful use; or
  - iii) if that water use is permissible in terms of a general authorisation issued under section 39;
- if the water use is authorised by a licence under this Act; or

- if the responsible authority has dispensed with a licence requirement under subsection (3).

Water use is defined in Section 21 of the NWA. Mafube's proposed road realignment activities may involve the following water uses:

a) impeding or diverting the flow of water in a watercourse; and

b) altering the bed, banks, course or characteristics of a watercourse.

Water resources classification

The classification of significant water resources in the Olifants Catchment in accordance with the Water Resource Classification System (WRCS) was undertaken in 2011/ 2012 and finalised in 2013 (Department of Water Affairs, 2013). Classification of water resources aims to ensure that a balance is reached between the need to protect and sustain water resources on the one hand and the need to develop and use them on the other. The WRCS places the following principles at the forefront of implementation:

- Maximising economic returns from the use of water resources;
- Allocating and benefits of utilising the water resources fairly; and
- Promoting the sustainable use of water resources to meet social and economic goals without detrimentally impacting on the ecological integrity of the water resource.

Each quaternary catchment is classified as a Class I, II or III, defined as:

- Class I - Minimally used: Water resource is one which is minimally used and the overall condition of that water resource is minimally altered from its pre-development condition;
- Class II - Moderately used: Water resource is one which is moderately used and the overall condition of that water resource is moderately altered from its pre-development condition; and
- Class III - Heavily used: Water resource is one which is heavily used and the overall condition of that water resource is significantly altered from its pre-development condition.

4.1.3 National Environmental Management: Air Quality Act (Act No. 39 of 2004)

The NEM: AQA has shifted the approach of air quality management from source-based control to the control of the receiving environment. The Act also devolved the responsibility of air quality management from the national sphere of government to the local municipal sphere of government (district and local municipal authorities). Local municipalities are thus tasked with baseline characterisation, management and operation of ambient monitoring networks, licensing of listed activities, and emission reduction strategies. The main objectives of the Act are to protect the environment by providing reasonable legislative and other measures that (i) prevent air pollution and ecological degradation, (ii) promote conservation and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development in alignment with Sections 24a and 24b of the Constitution of the Republic of South Africa.

4.1.3.1 Ambient air quality standards

The South African National Ambient Air Quality Standards (NAAQS) for common pollutants prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area (Table 6). If the standards are exceeded, the ambient air quality is defined as poor and potential adverse health impacts are likely to occur.

Table 6: South African National Ambient Air Quality Standards

Pollutant	Averaging Period	Limit Value (µg/m^3)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
Nitrogen dioxide -NO_2 (a)	1 hour	200	106	88	Immediate
	1 year	40	21	0	
Particulate matter - PM_{10} (b)	24 hours	75	-	4	Immediate
	1 year	40	-	0	

Pollutant	Averaging Period	Limit Value (µg/m^3)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
Ozone - O_3 (c)	8 hours (running)	120	61	11	Immediate
Lead - Pb (d)	1 year	0.5	-	0	Immediate
Carbon monoxide - CO (e)	1 hour	30 000	26 000	88	Immediate
	8 hours (calculated on 1 hourly averages)	10 000	8 700	11	
Benzene (C_6H_6) (f)	1 year	5	1.6	0	Immediate
Sulphur dioxide - SO_2 (g)	10 minutes	500	191	526	Immediate
	1 hour	350	134	88	
	24 hours	125	48	4	
	1 year	50	19	0	
Particulate matter $PM_{2.5}$ (h)	24 hours	40		4	Immediate
	24 hours	25		4	1 January 2030
	1 year	20		0	Immediate
	1 year	15		0	1 January 2030

Notes:

a. *The reference method for the analysis of NO_2 shall be ISO 7996;*
b. *The reference method for the determination of the particulate matter fraction of suspended particulate matter shall be EN 12341;*
c. *The reference method for the analysis of ozone shall be the UV photometric method as described in ISO 13964;*
d. *The reference method for the analysis of lead shall be ISO 9855;*
e. *The reference method for analysis of CO shall be ISO 4224;*
f. *The reference methods for benzene sampling and analysis shall be either EPA compendium method TO-14 A or method TO-17;*
g. *The reference method for the analysis of SO_2 shall be ISO 6767; and*
h. *The reference method for the analysis of PM2.5 shall be EN14907.*

4.1.3.2 National Dust Control Regulations

On 1 November 2013, the National Dust Control Regulations were promulgated under NEM: AQA and published in the Government Gazette No. 36974. The dust fall standard defines acceptable dust fall rates in terms of the presence of residential areas (Table 7).

Table 7: Acceptable dust fall rates

Restriction areas	Dust fall rate (mg/m^2/day over a 30-day average)	Permitted frequency of exceedance
Residential areas	Dust fall < 600	Two per annum (not in sequential months)
Non-residential areas	600 < Dust fall < 1 200	Two per annum (not in sequential months)

4.1.3.3 Priority area

Sections 18 to 20 of NEM: AQA deal with the establishment of Priority Areas in so-called “hot-spot” areas of South Africa where ambient air quality standards are often exceeded or may often be exceeded. The establishment of a Priority Area is intended to achieve the following:

- It effectively allows for the concentration of limited air quality management capacity (human, technical and financial) for dealing with acknowledged problem areas to obtain measurable air quality improvements in the short, medium and long term;
- It prescribes a cooperative governance regime by effectively handing-up air quality management authority to the tier of government that can provide leadership and coordination; and
- It allows for “cutting edge” air quality management methodologies that consider all contributors to the air pollution problem, i.e. air-shed air quality management.

The Mafube LifeX operations are located within the Highveld Priority Area (HPA) (Figure 3). The Highveld area in South Africa is widely accepted as having a poor air quality with elevated concentrations of criteria pollutants. The elevated concentrations are attributed to the dense concentration of industrial and non-industrial sources within the Highveld area. The Minister of Environmental Affairs and Tourism therefore declared the Highveld Priority Area (HPA) on 23 November 2007. Since the declared area overlaps provincial boundaries, the Department of Environmental Affairs (DEA) functions as the lead agent in the management of the priority area (DEA, 2011).

Figure 3: Location of Mafube within the HPA

4.1.4 National Heritage Resources Act (Act No. 25 of 1999)

4.1.4.1 Palaeontological Reference

The National Heritage Resources Act (Act No. 25 of 1999) (NHRA) requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa’s unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. A palaeontological impact assessment (PIA) identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources. For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

A Palaeontological Impact Assessment is generally warranted where rock units of LOW to VERY HIGH palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate, large scale projects with high potential heritage impact are planned, and where the distribution and nature of fossil remains in the proposed area are unknown. The specialist will inform whether further monitoring and mitigation are necessary.

Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No. 25 of 1999):

(i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.

The phase 1 and 2 Palaeontological Impact Assessment within this report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999) (NHRA). Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

4.1.4.2 Cultural Heritage Reference

The National Heritage Resources Act (Act No 25 of 1999, Art 3) outlines the following types and ranges of heritage resources that qualify as part of the National Estate, namely:

a) places, buildings structures and equipment of cultural significance;

b) places to which oral traditions are attached or which are associated with living heritage;

c) historical settlements and townscapes;

d) landscapes and natural features of cultural significance;

e) geological sites of scientific or cultural importance;

f) archaeological and palaeontological sites;

g) graves and burial grounds including-

   i) ancestral graves;

   ii) royal graves and graves of traditional leaders;

   iii) graves of victims of conflict;(iv) graves of individuals designated by the Minister by notice in the Gazette;

   iv) historical graves and cemeteries; and

   v) other human remains which are not covered by in terms of the Human Tissues Act, 1983 (Act No 65 of 1983).

h) sites of significance relating to the history of slavery in South Africa;

i) movable objects, including -

a) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;

b) objects to which oral traditions are attached or which are associated with living heritage;

c) ethnographic art and objects;

d) military objects;

e) objects of decorative or fine art;

g) objects of scientific or technological interest; and

h) books, records, documents, photographs, positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

The National Heritage Resources Act (Act No. 25 of 1999, Art 3) also distinguishes nine criteria for places and objects to qualify as 'part of the national estate if they have cultural significance or other special value…'. These criteria are the following:

a) its importance in the community, or pattern of South Africa's history;

b) its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;

c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;

d) its importance in demonstrating the principal characteristics of a class of South Africa's natural or cultural places or objects;

e) its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;

f) its importance in demonstrating a high degree of creative or technical achievement at a particular period;

g) its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;

h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and

i) sites of significance relating to the history of slavery in South Africa.

According to Section 38 of the National Heritage Resources Act (Act No. 25 of 1999) a Heritage Impact Assessment (HIA) process must be followed under the following circumstances:

- The construction of a linear development (road, wall, power line, canal, etc.) exceeding 300 m in length;
- The construction of a bridge or similar structure exceeding 50 m in length;
- Any development or activity that will change the character of a site and which exceeds 5 000 m^2 or which involves three or more existing erven or subdivisions thereof;
- Re-zoning of a site exceeding 10 000 m^2; and
- Any other category provided for in the regulations of SAHRA, a provincial or local heritage authority or any other legislation such as NEMA, MPRDA, etc.

4.1.5 Mpumalanga Roads Act (Act No. 1 of 2008)

The legal framework for the declaration and de-declaration of Provincial roads is provided for in Section 7 of the Act. The Member of the Executive Council must make regulations prescribing the requirements for Provincial roads declaration and de-declaration, provide details relating to any changes to routes, and consult with the Municipality affected by any changes.

The legal framework for construction and maintenance of Provincial roads is provided for in Section 9 of the Act. The Member of the Executive Council is responsible for the construction and maintenance of Provincial roads. If a Municipality, entity or person wishes to undertake construction and/or maintenance of Provincial roads, written approval must be obtained from the Member of the Executive Council, the construction and maintenance should adhere to Provincial standards and requirements, and if the Member of the Executive Council has given written approval to any Municipality, entity or person for any works on a Provincial road, he/she must specify the terms or reference and any payment for works performed.

The legal framework for access to main roads and district roads and closure of Provincial roads is provided for in Section 10 of the Act. A person may only gain access to a main road or district road at an entrance or exit authorised by the Member of the Executive Council. The Member of the Executive Council may, as may be necessary, designate, authorise or otherwise provide for access to and from a main road or district road.

The legal framework for fencing on Provincial roads is provided for in Section 14 of the Act. The Member of the Executive Council may authorise the erection of fencing adjacent to a Provincial road. An owner of land adjacent to a Provincial road is responsible for all maintenance of any fence adjacent to his/her property.

The legal framework for public right-of-way is provided for in Section 31 of the Act. A public right-of-way must be registered by the Member of the Executive Council as well as constitute a reasonable means of access to a public road or public amenity. A Municipality, entity or person applying for the registration or de-registration of a public right-of-way will bear the costs thereof.

The legal frameworks for environmental policy, environmental obligations, and environmental impact assessment are provided for in Sections 34, 35 and 36, respectively, of the Act. The Member of the Executive Council must regulate the operations of the Department to minimise the impact of transport infrastructure and operations on the environment. Environmental management must constitute an integral part of the planning, construction, operation and maintenance of the Provincial road network. The Member of the Executive Council must comply with any National or Provincial requirement for an environmental impact assessment in the construction of Provincial transport infrastructure and operations.

4.1.6 South African National Standard (SANS)

The SANS Method for environmental noise impact assessment (SANS 10328:2008) provides a method for evaluating the noise impact of a proposed development. It is an umbrella document and makes many references to SANS 10103:2008 The measurement and rating of environmental noise with respect to annoyance and to speech communication (SANS 10103:2008).

The SANS 10103 Code of Practice provides typical ambient noise rating levels ($L_{Req,T}$) in various districts. The outdoor ambient noise levels recommended for the districts are shown in Table 8 below. It is probable that the noise is annoying or otherwise intrusive to the community or to a group of persons if the rating level of the ambient noise under investigation exceeds the applicable rating level of the residual noise (determined in the absence of the specific noise under investigation), or the typical rating level for the ambient noise for the applicable environment given in Table 2 of SANS 10103.

Table 8: Typical Rating Levels for Ambient Noise

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

Notes:

1) If the measurement or calculation time interval is considerably shorter than the reference time intervals, significant deviations from the values given in the table might result;

2) If the spectrum of the sound contains significant low frequency components, or when an unbalanced spectrum towards the low frequencies is suspected, special precautions should be taken, and specialist advice should be obtained. In this case the indoor sound levels might significantly differ from the values given in Column 5 to 7;

3) In districts where outdoor $L_{R,dn}$ exceeds 55 dB, residential buildings (e.g. dormitories, hotel accommodation and residences) should preferably be treated acoustically to obtain indoor $L_{Req,T}$ values.

4) For industrial districts, the $L_{R,dn}$ concept does not necessarily hold. For industries legitimately operating in an industrial district during the entire 24 h day/night cycle, $L_{Req,d}$ =, $L_{Req,n}$ = 70 dB can be considered as typical and normal;

5) The values given in columns 2 and 5 in this table are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day;

6) The values given in columns 3, 4, 6 and 7 in this table are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise.

7) The noise from individual noise sources produced, or caused to be produced, by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries should not exceed a maximum A-weighted sound pressure level of 50 dBA at a distance of 15 m from each individual source.

SANS 10103 provides criteria, for evaluating the community or group response to a noise source, these are presented in Table 9.

Table 9: SANS 10103 Categories of community or group response

Excess, $\Delta L_{Req,T}$ dB(A)	Category	Description
0 to 10	Little	Sporadic complaints
5 to 15	Medium	Widespread complaints
10 to 20	Strong	Threats of community or group action
>15	Very Strong	Vigorous community or group action

SANS 10103 provides three methods for determining the excess level ($\Delta L_{Req,T}$) of a proposed development:

- $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the Residual noise (determined in the absence of the Rated noise, i.e. the specific noise under investigation);
- $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical Rating level for the applicable district as determined from SANS 10103:2008; or
- $\Delta L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in an area because of a proposed development under investigation.

4.2 Administrative Framework

This section summarises the key administrative bodies relevant to the project.

4.2.1 Mpumalanga Department of Mineral Resources (DMR)

Mafube's mining operations are covered by an existing approved Environmental Management Programme (EMPr) and associated Addenda lodged with the Department of Mineral Resources (DMR). This application for environmental authorisation will be submitted to DMR as the competent authority during this EIA/EMP process.

4.2.2 Department of Water and Sanitation (DWS)

The Department of Water and Sanitation (DWS) is the custodian of South Africa's water resources. It is primarily responsible for the formulation and implementation of policy governing the water sector. It also has overall responsibility for water services provided by local government.

The National Water Act 1998 (Act 36 of 1998) provides the DWA with the authority and the tools for the optimal management of South Africa's water resources. The registration of water use is one of these tools and is required for the proposed project.

4.2.3 Mpumalanga Department Agriculture, Rural Development, Land and Environmental Affairs (M-DARDLEA)

- Mpumalanga Department Agriculture, Rural Development, Land and Environmental Affairs (M-DARDLEA), will be consulted to comment on this application for Environmental Authorisation.

5.0 NEED AND DESIRABILITY OF PROPOSED ACTIVITIES

Environmental Authorisation was granted for the Mafube LifeX Nooitgedacht opencast operations in April 2013. Sections of the D684, D1574 and D1048 district roads traverse the Nooitgedacht coal reserve (Figure 2) and their closure and/or realignment are required before the mining operations at those locations can commence, which will be by 2022 as per the current scheduled mine plan.

Mafube LifeX operations will produce power station and A-Grade thermal export coal. The Nooitgedacht operations will exploit a mineable coal reserve comprising about 120 million mineable in-situ tons of thermal coal located within an area of approximately 2 957.12 ha. Mining will be by opencast methods. Mining of these opencast reserves will take place over a period of approximately 20 years, an average of 540,000 tons of ROM per month will be mined (6.484 mtpa).

Thus, due to its economic and local importance and to make the project feasible in its entirety, the total coal reserve would need to be exploited, and so these sections of the district roads mentioned above would need to be realigned and/or closed.

6.0 MOTIVATION FOR THE PREFERRED DEVELOPMENT FOOTPRINT WITHIN THE APPROVED SITE INCLUDING A FULL DESCRIPTION OF THE PROCESS FOLLOWED TO REACH PREFERRED ROUTE ALTERNATIVE

6.1 Closure of Sections of the D684 and D1048

During the 2012 Mafube LifeX EIA/EMP authorisation process, a traffic impact assessment was conducted by Techworld Consulting Engineers (TW553 - Traffic Report_Mafube Opencast Coal Expansion_25Jun12) to assess the likely impact of the closure and/or re-alignment of the abovementioned roads. From this study, it is evident that the roads that traverse the coal reserves do not serve a mobility function but rather provide access to the farms in the area. The re-alignment of these roads will therefore not have a significant impact on traffic flows and transportation in the area (Techworld Consulting Engineers, June 2012).

A further study was conducted in 2016 (Golder, 1650906 – 304345 – 3) to assess the impacts of using the D684 as access to the Nooitgedacht operations area during construction. The methodology for the study was a combination of qualitative and quantitative data gathering approach to generate a baseline and assess impacts. Data was gathered through secondary sources in the desktop review, verified by a site visit and sample traffic survey undertaken on 18 May 2016. The results were analysed through content analysis techniques (Golder Associates Africa (Pty) Ltd, 2016).

All the route realignment alternatives identified in Section 6.0 would also need to include the closure of D684 over a distance of approximately 2.8 km from the start of East Pit 1 in the South to the Northern boundary of East Pit 3 in the North, and the closure of D1048 over a distance of approximately 1.6km from the T-junction with D684 in an eastern direction to the Eskom Powerline intersection to the east of East Pit 2. These road closures are required because of the location of the Nooitgedacht East Pits 1, 2 and 3 (Figure 4).

Two route realignment alternatives (Alternatives A and B), as discussed in this report, were identified by Kruger in 2012 as part of the traffic impact assessment study and additional route realignment alternatives (Alternatives C, D, E and F) were identified by the Golder project team.

6.2 Identified Route Realignment Alternatives

During the Scoping phase of this EIA/EMP various route alternatives were identified through a site selection process completed by Golder. Alternative F was identified as the favoured route, (Figure 4 below) (see APPENDIX G for the complete route selection report).

6.2.1 Optimisation of the Preferred Alternative Route F

With regards to the preferred alternative route F, it is important to note that since finalisation of the scoping phase and the compilation of the draft EIA, the alignment of the preferred alternative route F has been slightly optimised through engineering and design modifications that will facilitate several efficiencies associated with the construction of the road, crossings over wetlands areas, as well as making use of existing roads (see Figure 5 below).

Given the nature of the latest route optimisation, it is the opinion of the EAP that the baseline information, impact assessment and mitigation measures as outlined in this report remain applicable and unchanged.

As part of the assessment of the draft EIA, the following further considerations with regards to the optimised alternative route F are important to note:

Wetland crossings

The optimised route reduces the length off crossings over wetland areas. The first optimisation to the route (Figure 5, insert A) avoids a lengthy wetland crossing by deviating slightly to the north-east to connect with an existing access road to the adjacent farmhouse. This now sees the optimised route across the wetland area on an area already affected by a farm access road.

The second optimisation of the route (Figure 5, and including insert B) sees the road turned to the north-west slightly earlier to follow a straight line before reconnecting with the existing D684. This optimisation improves long-term road safety by avoiding multiple sharp turns. It sees the road cross two small drainage lines (see between Insert A and Insert B) at a position slightly to the south of the original position before crossing a third wetland area at the confluence between two branches of the wetland. This is a slightly less optimal crossing point but, given the overarching benefits to long-term road safety and the close proximity to the originally assessed crossing, is in the view of the EAP that this is an acceptable and sensible compromise.

The combined effect of these route optimisations sees an overall reduction in length of wetland crossings of just under 500 m.

Homestead/farm house

The first point of optimisation (Figure 5, in the area of Insert A) brings the road closer to an existing farm house, with the potential to see a slight increase in impacts on occupants in relation to noise and dust from road use. However, these impacts are not considered a significant change over those initially assessed. Furthermore, they need to also be considered in light of the generally low traffic volumes on the road in question. Lastly, the current occupants of the farmhouse work for the previous owner of the agricultural property. This property has now been acquired by AATC and the occupants stay under short-term lease which will expire prior to the commencement of construction of the road re-alignment. Consequently, the house is not expected to be occupied at the time that construction commences. Any further developments in this regard, will be included into the final EIA report.

6.2.2 The no-action alternative

As shown in Figure 4, the D684 road traverses the middle of the Eastern pit of the Mafube LifeX Nooitgedacht mining operations. Should the road not be realigned, the operations will not commence and thus the coal reserves will not be mined. The complete Mafube Nooitgedacht LifeX expansion project will then not be feasible and would not commence.

Not mining the coal reserve available in the Nooitgedacht reserve, will prevent the use of a valuable coal reserve for the generation of electricity at a time when there is a growing shortage of electricity limiting economic growth in the country. A-grade coal export volumes will also be negatively impacted, which will affect the revenue flow and financial performance of Mafube Coal Mining (Pty) Ltd.

As long as there is a demand for coal that makes the mining of these reserves economically viable, there will be a push to mine them.

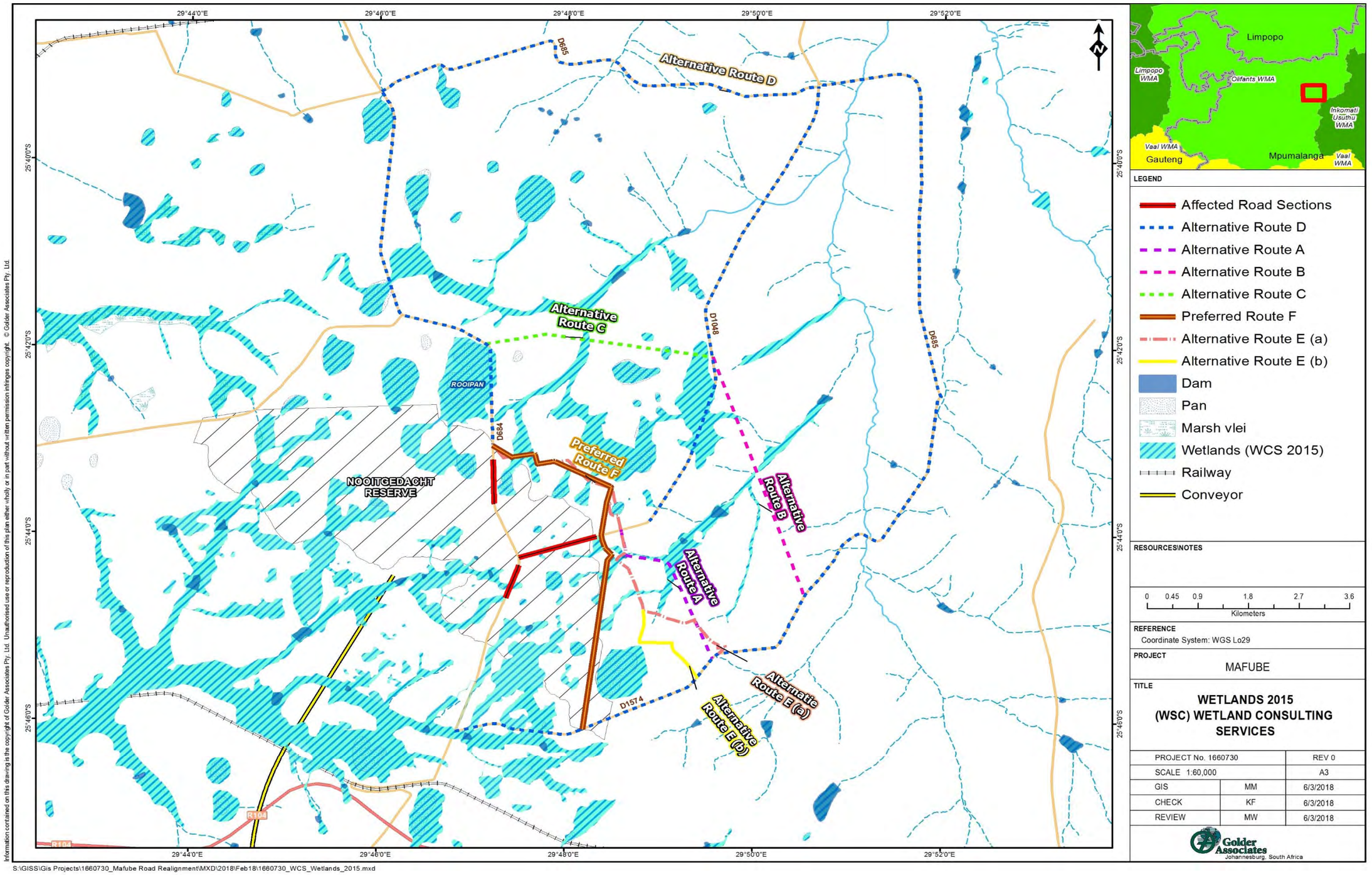


Figure 4: Mafube LifeX Road Realignment – Alternative Routes Identified

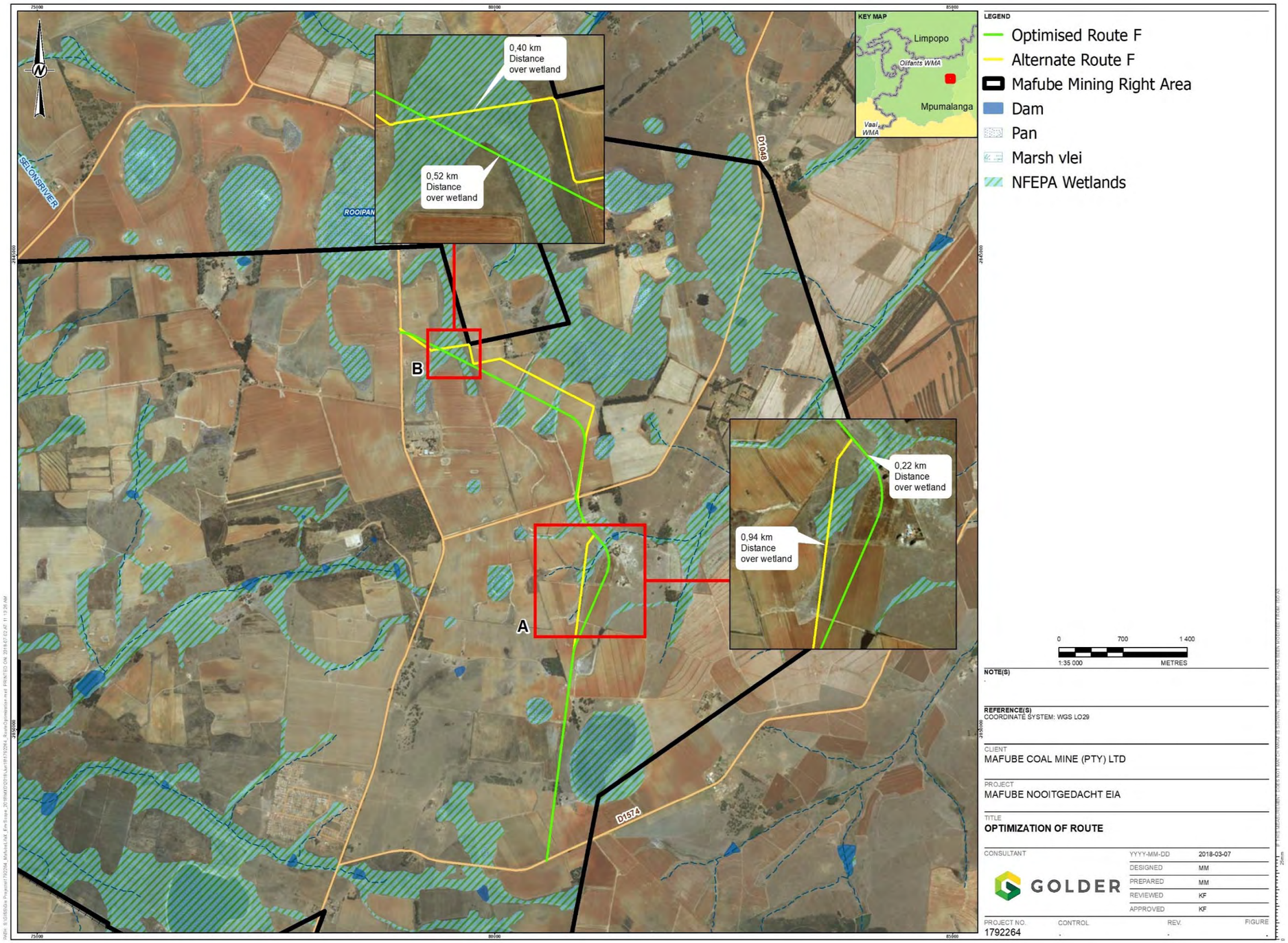


Figure 5: Alternative route F optimisation

7.0 DETAILS OF THE PUBLIC PARTICIPATION PROCESS FOLLOWED

7.1 Objectives of public participation process

The public participation process is designed to provide sufficient, accessible and objective information to interested and affected parties (I&APs) or stakeholders to assist them to participate in the EIA.

During the Scoping Phase I&APs should:

- Raise issues of concern and suggestions for enhanced benefits;
- Verify that their issues have been captured;
- Assist in identifying reasonable alternatives;
- Comment on the plan of study of specialist studies to be undertaken during the impact assessment phase; and
- Contribute relevant local information and traditional knowledge to the environmental assessment.

During the Impact Assessment Phase they should:

- Contribute relevant information and local and traditional knowledge to the environmental assessment;
- Verify that their issues have been considered in the environmental investigations; and
- Comment on the findings of the environmental assessments.

During the decision-making phase:

- The EAP must advise I&APs of the outcome, i.e. the authority decision, and describe how the decision can be appealed.

7.2 Identification of I&APs

I&APs were initially identified through a process of networking and referral, obtaining information from Golder's existing stakeholder database, liaison with potentially affected parties in the study area, newspaper advertisements and a registration process involving completion of a registration and comment sheet. The registration sheet encouraged I&APs to indicate the names of their colleagues and friends who may also be interested in participating in the public participation process.

- The initial stakeholder database used to announce Mafube Coal Mining's proposed project for the mining of coal on the farm Nooitgedacht 417JS near Middelburg comprised a total of approximately 116 I&APs representing the various sectors of society listed below.
    - Government (national, provincial and local);
    - Environmental NGOs;
    - Conservation Agencies;
    - Agricultural Bodies;
    - Community Representatives and CBOs;
    - Business and Commerce; and
    - Other.

7.3 Register of I&APs

The NEMA Regulations (GN R.982) distinguish between I&APs and registered I&APs.

I&APs, as contemplated in Section 24(4)(d) of the NEMA include: "(a) any person, group of persons or organisation interested in or affected by an activity; and (b) any organ of state that may have jurisdiction over any aspect of the activity".

In terms of the Regulations:

- *"An EAP managing an application must open and maintain a register which contains the names, contact details and addresses of:*

  a) All persons who; have submitted written comments or attended meetings with the applicant or EAP;

  b) All persons who; have requested the applicant or EAP managing the application, in writing, for their names to be placed on the register; and

  c) All organs of state which have jurisdiction in respect of the activity to which the application relates.

Stakeholders are encouraged to register as I&APs and participate in the consultation processes by completing the Registration and Comment sheet and returning it to the Golder Public Participation office. The Registration and Comment sheet can also be completed online via Golder's website (www.golder.com/public). Contact details are also supplied on page ii of this report.

As per the EIA Regulations, **registered I&APs** will be kept informed of developments during the Impact Assessment and Decision-making phases. Stakeholders who were involved in the initial consultation and who attended the public open house during the Scoping Phase have been added to the register. The I&AP register will be updated throughout the EIA process.

7.4 Public participation during Scoping

This section provides a summary of the public participation process followed during the Scoping Phase of the EIA.

7.4.1 Announcement of the proposed project

The proposed process to realign the D684 road was announced on Friday **16 March 2018** and stakeholders were invited to participate in the EIA and public participation process, to register as I&APs and to pass the information on to friends/colleagues/neighbours who may be interested.

The proposed project was announced as follows:

- Distribution of the Draft Scoping Report (DSR) and a letter of invitation to participate to all I&APs on the database, accompanied by a registration, comment and reply sheet that was mailed/emailed to the entire stakeholder database. Copies of the announcement documents are attached as APPENDIX B;
- The abovementioned documents were made available at the public places listed on page ii of this report and posted to the Golder website (www.golder.com/public);
- An advertisement was published in the Middelburg Observer newspaper on 16 March 2018 (APPENDIX C); and
- Site notices were placed at the entrance to the proposed project site and at visible places at the boundary of the property see APPENDIX E for detailed locality map and photographic evidence.

7.4.2 Scoping Report

The Draft Scoping Report (DSR) was available for public review for 30 days from **16 March 2018 until 18 April 2018.** Due to the extensive public consultation that was undertaken during the EIA of 2012/2013, no focus group meetings were held, but a **public meeting** was held on **Wednesday 4 April 2018** (11:00 – 13:00) at the Arnot Vroue Landbou-Unie Hall, Farm Springboklaagte, Middelburg district. The minutes taken at the public meeting are appended to this report as APPENDIX J.

7.4.3 Final Scoping Report

The DSR was updated after the expiry of the public review period and submitted to the Department of Mineral Resources (DMR) on **26 April 2018**.

7.4.4 Summary of issues raised by I&APs

To date, no issues were raised during the scoping phase of the proposed road realignment project.

7.5 Public participation during the Impact Assessment Phase

Public participation during the impact assessment phase of the EIA entails a review of the findings of the EIA, presented in the Draft EIA Report and Environmental Management Programme (EMPr), and the volume of specialist studies.

The report was available for public comment from **Friday 6 July 2018 until Monday 6 August 2018**. I&APs were encouraged to comment either in writing (mail or email), or by telephone. No focus group or public meetings were held during the impact assessment phase of this process.

7.6 Announcement of Lead Authority's Decision

Once the DMR has taken a decision about the granting of an environmental authorisation, the Public Participation Office will immediately notify I&APs of this decision and of the opportunity to appeal. This notification will be provided as follows:

- A letter will be sent, personally addressed to all registered I&APs, summarising the DMR's decision and explaining how to lodge an appeal should they wish to; and
- An advertisement to announce the Lead Authority's decision will be published in the Middelburg observer newspaper, if so required by the authorities.

8.0 ENVIRONMENTAL ATTRIBUTES AND DESCRIPTION OF THE BASELINE RECEIVING ENVIRONMENT

This section of the report provides a summarised description of the receiving environment and existing conditions on and in the vicinity of the proposed project area. For more detail, the specialist reports in APPENDIX G should be consulted.

Please note: The scoping and EIA reports produced by Golder Associates Africa (GAA. 2012) provided a comprehensive, in-depth description of the receiving environment. Only the salient points applicable to the affected land portions of Springboklaagte 416 JS, Roodepoort 418 JS, Nooitgedacht 417 JS, and Panplaats 395 JS are summarised in this draft environmental impact assessment report, with extensive references to the previous reports.

8.1 Topography

The proposed road realignment project area lacks any pronounced geomorphological features but lies on undulating topography between 1 480 m to 1 900 m above mean sea level (mamsl). Pans are a distinctive feature of the landscape, particularly to the north of the project area. Local watercourses drain into the Klein-Olifants River, which in turn drain into the Middelburg Dam.

8.1.1 Land use and sensitive receptors

The air quality study area extends approximately 10 km from the proposed road sections (including alternatives) and Mafube operations (Figure 8). This area is predominantly farm land with numerous homesteads distributed throughout. Fifteen (15) schools were identified within the study area, most notable are the following located along the proposed Alternative D route:

- Sulimyembezi Primary;
- Olifantslaagte Primary; and

- Nodaga Primary.

No healthcare facilities were identified within this area.

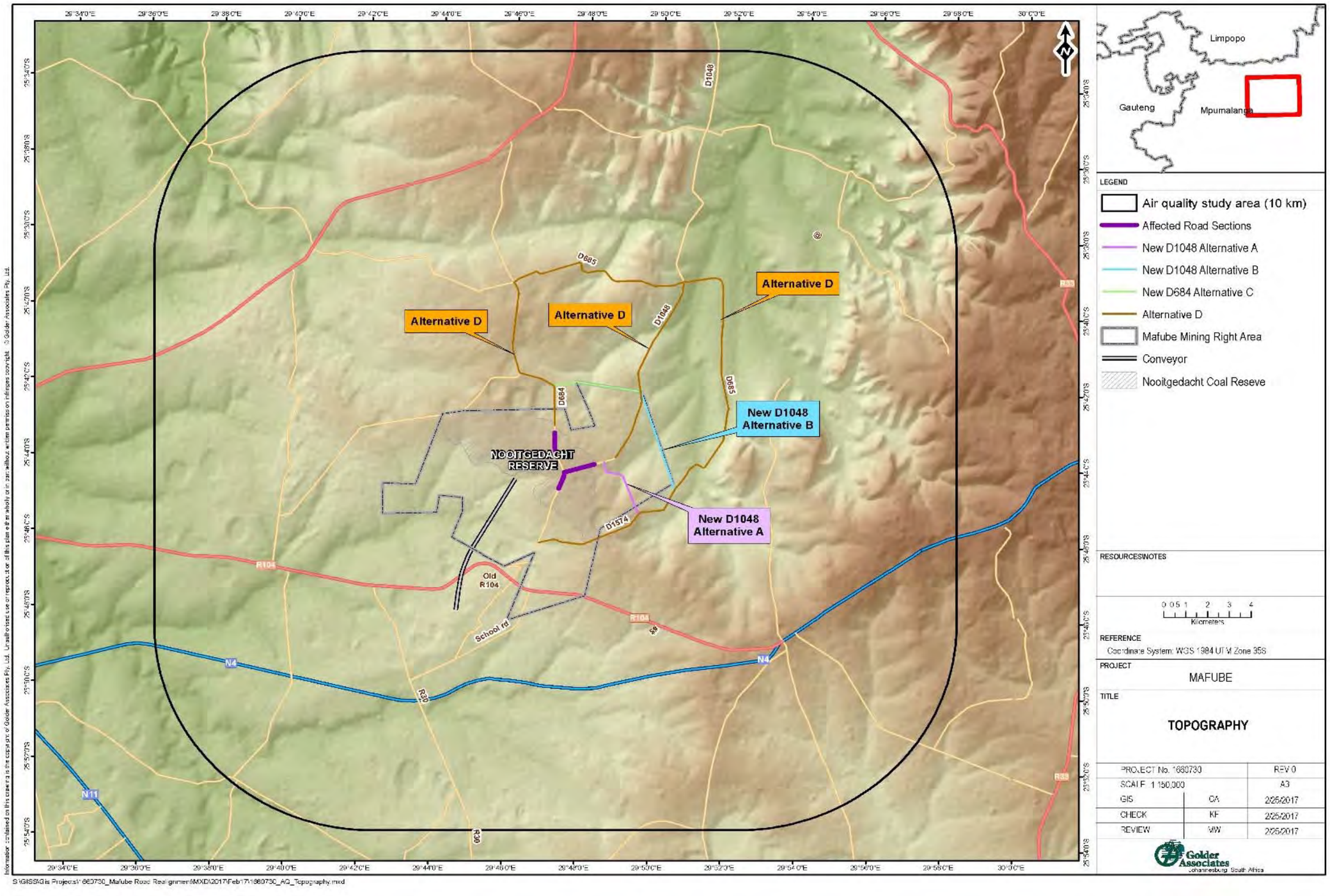


Figure 6: Topography in the vicinity (within 10 km) of the proposed routes

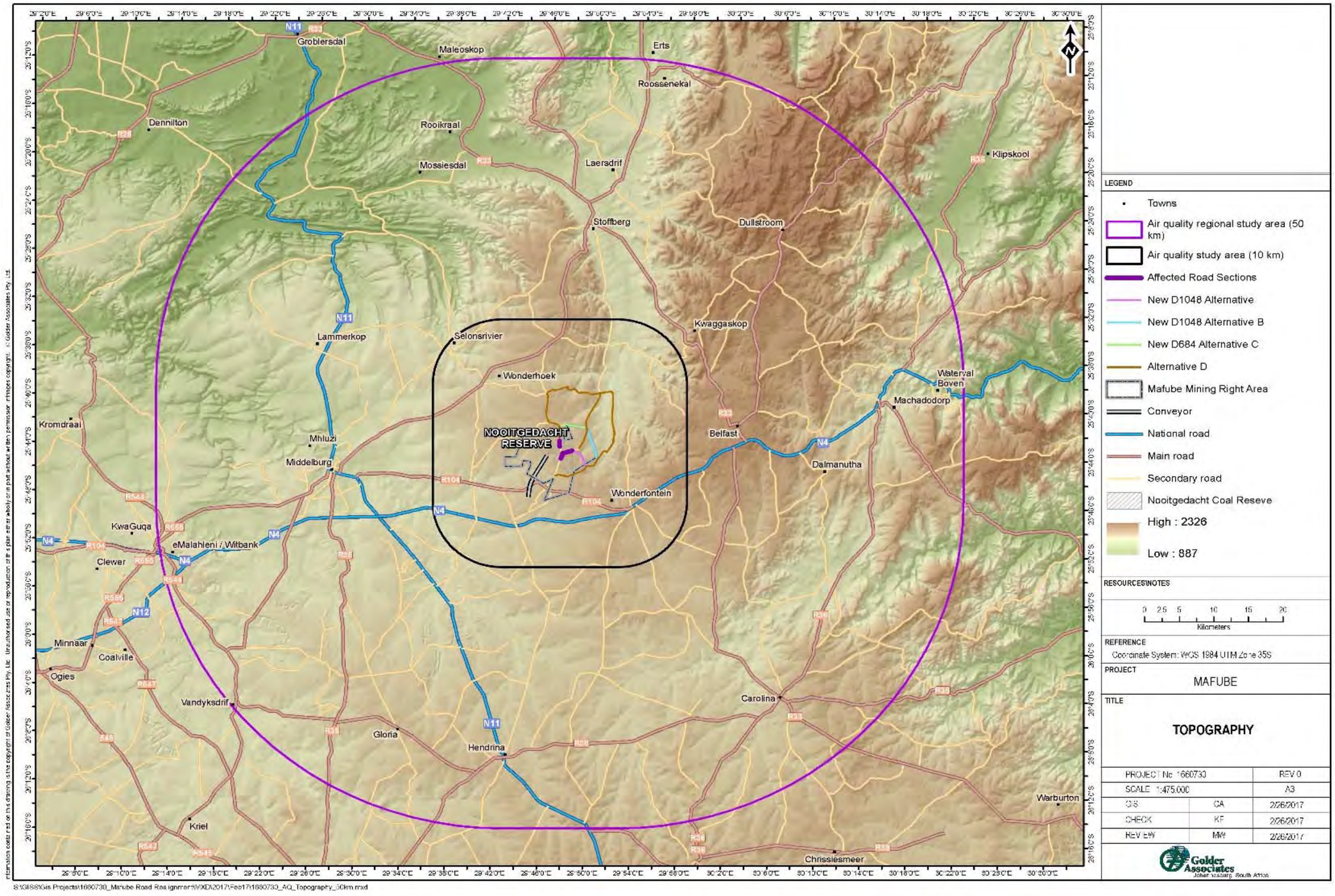


Figure 7: Topography within 50 km of the proposed routes

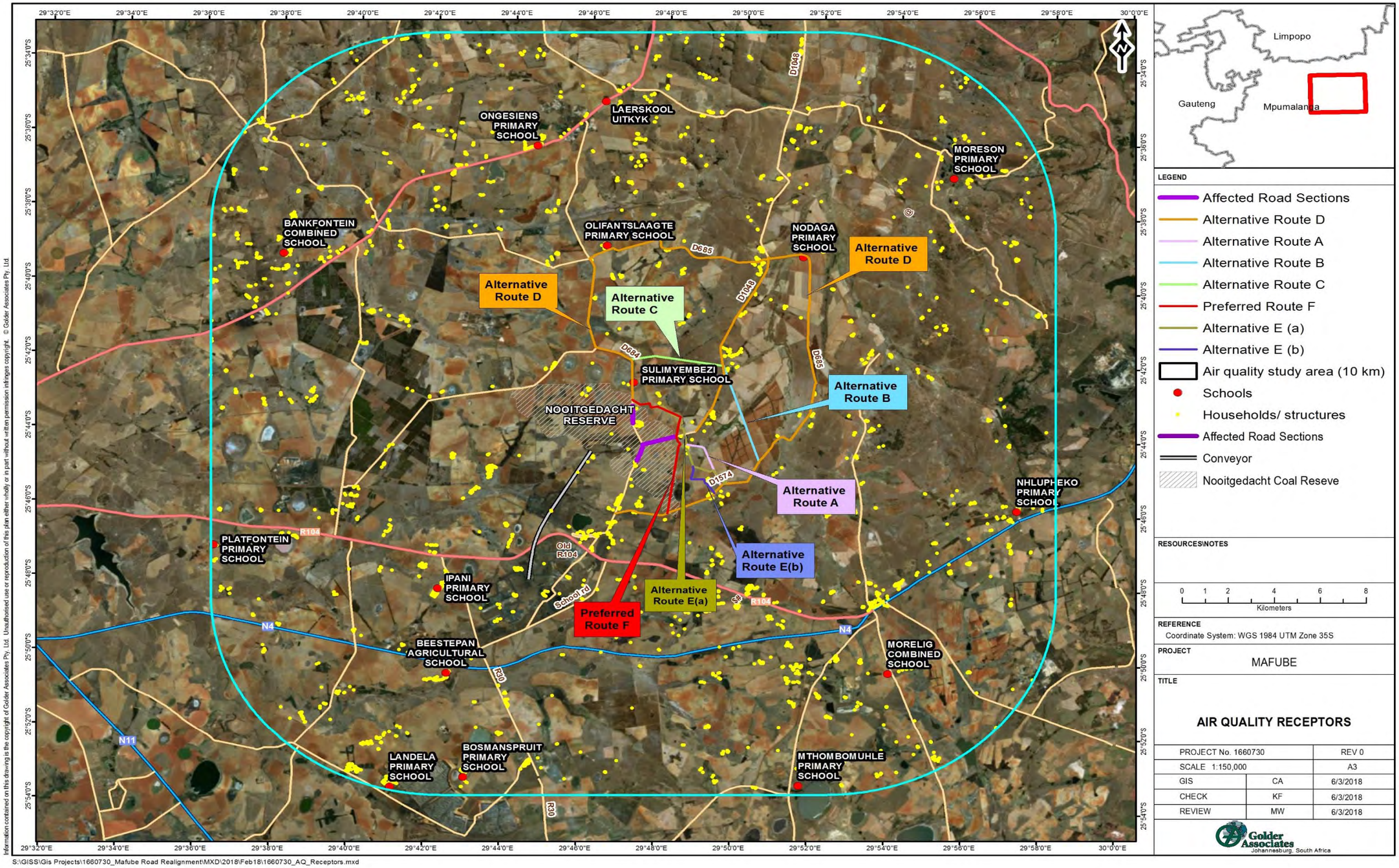


Figure 8: Receptors in the vicinity of the proposed routes

8.2 Regional climate

The Mafube LifeX project is situated in the subtropical high-pressure belt. The mean circulation of the atmosphere over the subcontinent is anticyclonic throughout the year (except for near the surface). The synoptic patterns affecting the typical weather experienced in the region owe their origins to the subtropical, tropical and temperate features of the general atmospheric circulation over Southern Africa.

The subtropical control is brought via the semi-permanent presence of the South Indian Anticyclone (HP cell), Continental High (HP cell) and the South Atlantic Anticyclone (LP cell) in the high pressure belt located approximately 30°S of the equator. The tropical controls are brought via tropical easterly flows (LP cells) (from the equator to the southern mid-latitudes) and the occurrence of the easterly wave and lows (Preston-Whyte and Tyson, 1997). The temperature control is brought about by perturbations in the westerly wave, leading the development of westerly waves and lows (LP cells) (i.e. cold front from the polar region, moving into the mid-latitudes) (Preston-Whyte and Tyson, 1997).

Seasonal variations in the positioning and intensity of the HP cells determine the extent to which the westerly waves and lows impact the atmosphere over the region. In winter, the high pressure belt intensifies and moves northwards while the westerly waves in the form of a succession of cyclones or ridging anticyclones move eastwards around the South African coast or across the country. The positioning and intensity of these systems are thus able to significantly impact the region. In summer, the anticyclonic HP belt weakens and shifts southwards and the influence of the westerly wave and lows weakens.

Anticyclones (HP cells) are associated with convergence in the upper levels of the troposphere, strong subsidence throughout the troposphere, and divergence near the surface of the earth. Air parcel subsidence, inversions, fine conditions and little to no rainfall occur as a result of such airflow circulation patterns (i.e. relatively stable atmospheric conditions). These conditions are not favourable for air pollutant dispersion, especially with regard to emissions emitted close to the ground.

Westerly waves and lows (LP cells) are characterised by surface convergence and upper-level divergence that produce sustained uplift, cloud formation and the potential for precipitation. Cold fronts, which are associated with the westerly waves, occur predominantly during winter. The passage of a cold front is characterised by pronounced variations in wind direction and speed, temperature, humidity, pressure and distinctive cloud bands (i.e. unstable atmospheric conditions). These unstable atmospheric conditions bring about atmospheric turbulence which creates favourable conditions for air pollutant dispersion.

The tropical easterlies and the occurrence of easterly waves and lows affect Southern Africa mainly during the summer months. These systems are largely responsible for the summer rainfall pattern and the north easterly wind component that occurs over the region (Schulze, 1986; Preston-Whyte and Tyson, 1988).

In summary, the convective activity associated with the easterly and westerly waves disturbs and hinders the persistent inversion which sits over Southern Africa. This allows for the upward movement of air pollutants through the atmosphere leading to improved dispersion and dilution of accumulated atmospheric pollution.

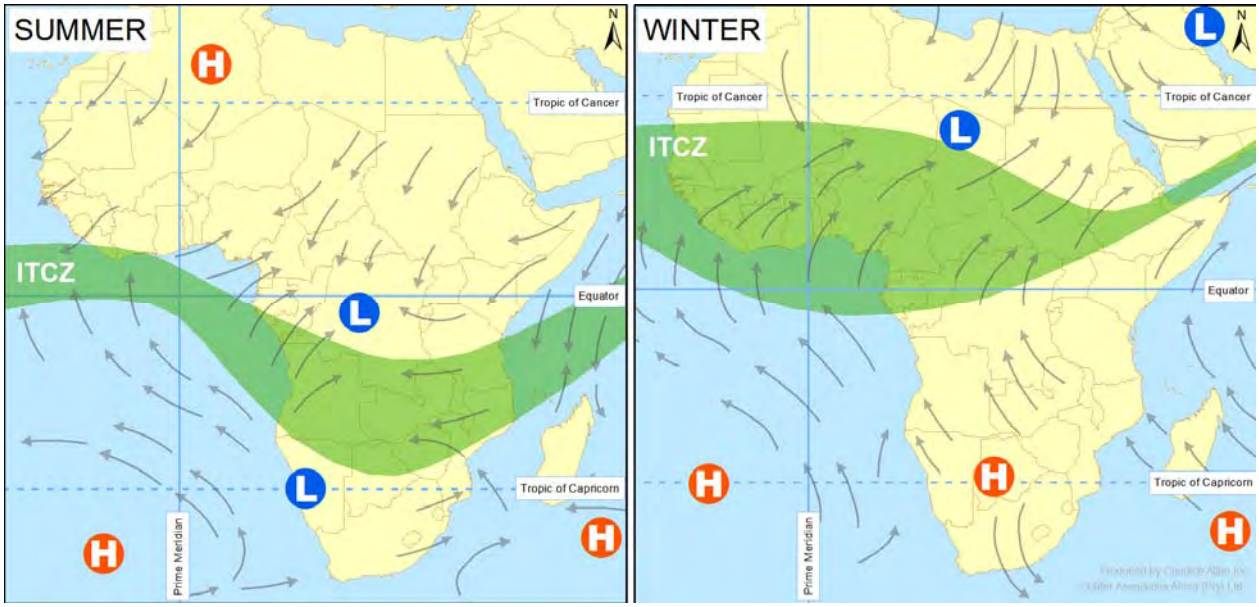


Figure 9: Seasonal circulation patterns affecting the regional climate

8.2.1 Boundary layer conditions

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere and is directly affected by the earth's surface. The earth's surface affects the boundary layer through the retardation of air flow created by frictional drag, created by the topography, or as result of the heat and moisture exchanges that take place at the surface.

During the day, the atmospheric boundary layer is characterised by thermal heating of the earth's surface, converging heated air parcels and the generation of thermal turbulence, leading to the extension of the mixing layer to the lowest elevated inversion. These conditions are normally associated with elevated wind speeds, hence a greater dilution potential for the atmospheric pollutants.

During the night, radiative flux divergence is dominant due to the loss of heat from the earth's surface. This usually results in the establishment of ground based temperature inversions and the erosion of the mixing layer. As a result, night times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential.

The mixed layer ranges in depth from a few metres during night time to the base of the lowest elevated inversion during unstable, daytime conditions. Elevated inversions occur for a variety of reasons, however typically the lowest elevated inversion on the Highveld is located at a mean height above ground of 1 550 m during winter months with a 78% frequency of occurrence. During summer, the mean subsidence inversion occurs at about 2 600 m with a 40% frequency. Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in Table 10.

Table 10: Atmospheric stability classes

Designation	Stability Class	Atmospheric Condition
A	Very unstable	Calm wind, clear skies, hot daytime conditions
B	Moderately unstable	Clear skies, daytime conditions
C	Unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the intensity of solar radiation, growing gradually from sunrise to reach a maximum at about 5 to 6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

For elevated releases, the highest ground level concentrations would occur during unstable, daytime conditions. The wind speed resulting in the highest ground level concentration depends on the plume buoyancy. If the plume is considerably buoyant (high exit gas velocity and temperature) together with a low wind, the plume will reach the ground relatively far downwind. With stronger wind speeds, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it would be more diluted. A wind speed between these extremes would therefore be responsible for the highest ground level concentrations. In contrast, the highest concentrations for ground level, or near-ground level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions.

8.2.2 Trends in temperature and precipitation

Average monthly maximum and minimum temperatures for Middelburg (approximately 30 km's from the project site) are given in Figure 10. The temperature profile depicts what is typically expected for the Highveld. The highest temperatures in the region are experienced during the summer months of December, January, February and the lowest during the winter months of June, July and August. The average daily maximum temperatures range from approximately 27.2°C in January to approximately 18.5°C in June, with minima ranging from approximately 13.7°C in January to approximately -1.8C in June (Schulze, 1989).

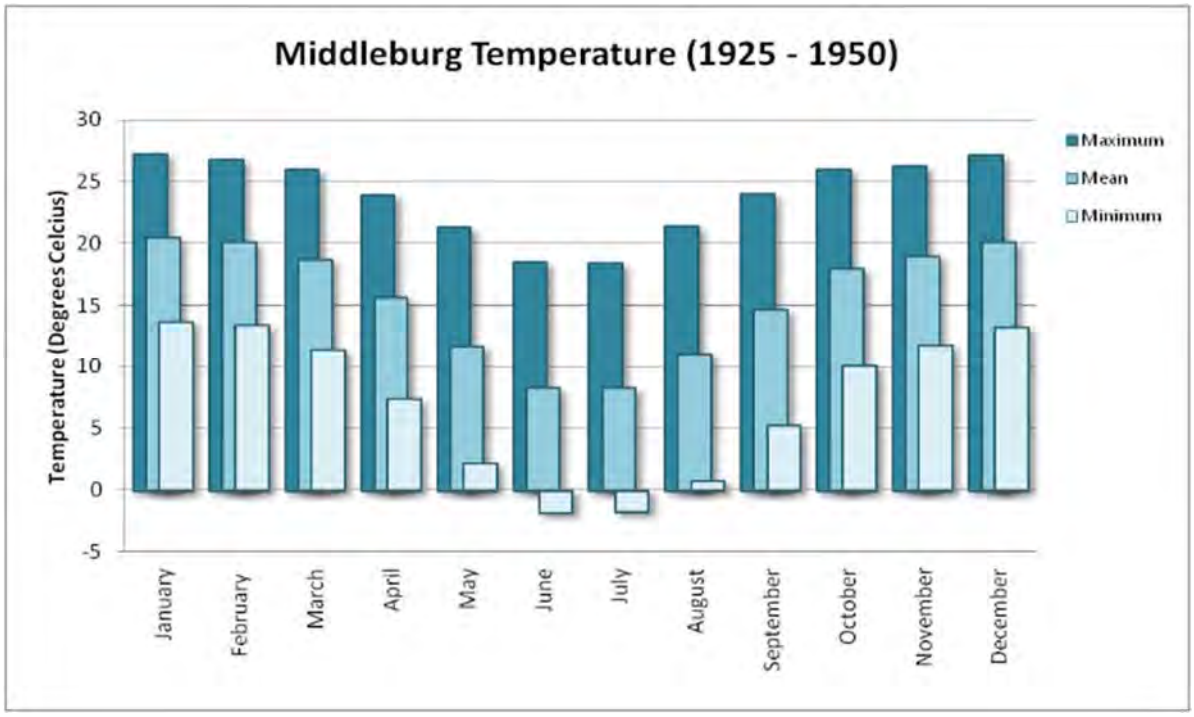


Figure 10: Long-term maximum, mean and minimum temperatures for Middelburg (1925 – 1950)

Middelburg is located in the summer rainfall region of South Africa and thus receives most of its rainfall during this period. Long-term monthly average rainfall is represented graphically in Figure 11. The mean annual precipitation is approximately 735 mm (Schulze, 1989).

Precipitation in the Highveld is often characterised by intense thunderstorms, which occur mainly in the late afternoon, from October to March, with the maximum in January.

These thunderstorms, although brief, are accompanied by thunder, lightning and occasional hail, and are generally followed by clear skies (DEA, 2012).

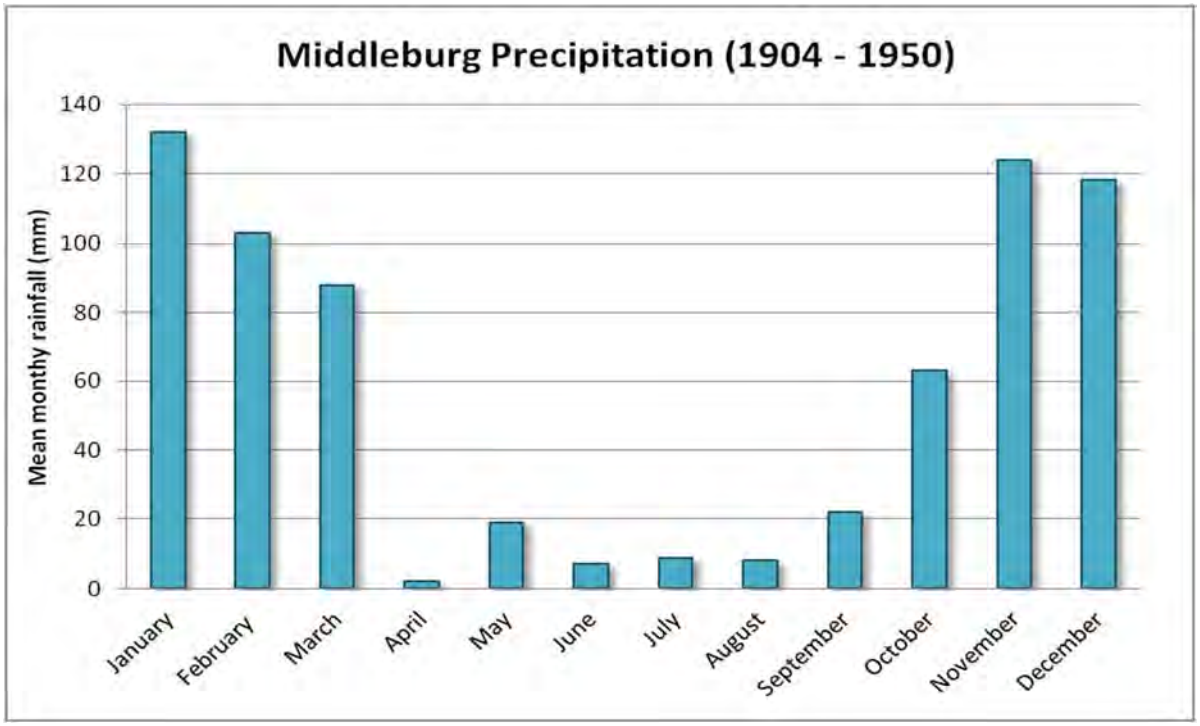


Figure 11: Long-term mean monthly precipitation in Middelburg (1904 – 1950)

8.2.3 Wind speed and direction

8.2.3.1 Meteorological overview

The meteorological overview was based on the analysis of South African Weather Service (SAWS) meteorological data from the DEA Highveld station in Middelburg (25°47'45.87"S 29°27'46.08"E) from 2013 - 2015[1]. The station is located approximately 30 km from the Mafube. Typically, data is considered representative within 20 km, however due to the relatively simple terrain between the Mafube LifeX project and Middelburg and the lack of an alternative data source; it is assumed the Middelburg data is representative of the local conditions at Mafube.

8.2.3.2 Wind roses for 2013 - 2015

Wind roses summarize the characteristics of the wind field at a specified location by representing their strength, direction and frequency (Figure 12). Calm conditions are defined as wind speeds of less than 1 m/s which are represented as a percentage of the total winds in the centre circle. Each directional branch on a wind rose represents wind originating from that specific cardinal direction (16 cardinal directions). Each cardinal branch is divided into segments of different colours which represent different wind speed classes. For the current wind roses, wind speed is represented on a scale from blue to red, with dark blue indicating low wind speeds (1 – 2 m/s) and red representing high wind speeds (in excess of 10 m/s)[2]. Each circle in the wind rose represents a percentage frequency of occurrence.

Winds predominantly originate along the north-westerly and south-easterly sectors in the region. Wind speeds are low, averaging 1.6 m/s with calm conditions (<1 m/s) 32% of the time.

[1] 96% data availability for the period 01/01/2013 to 31/12/2015

[2] These wind speed classes and associated colours are specific to the MM5 modelled data wind roses only

8.2.3.3 Diurnal wind roses

Diurnal variations in wind speed and direction are shown in Figure 13.

8.2.3.4 Seasonal wind roses

Seasonal variations in wind speed and direction are shown in Figure 14.

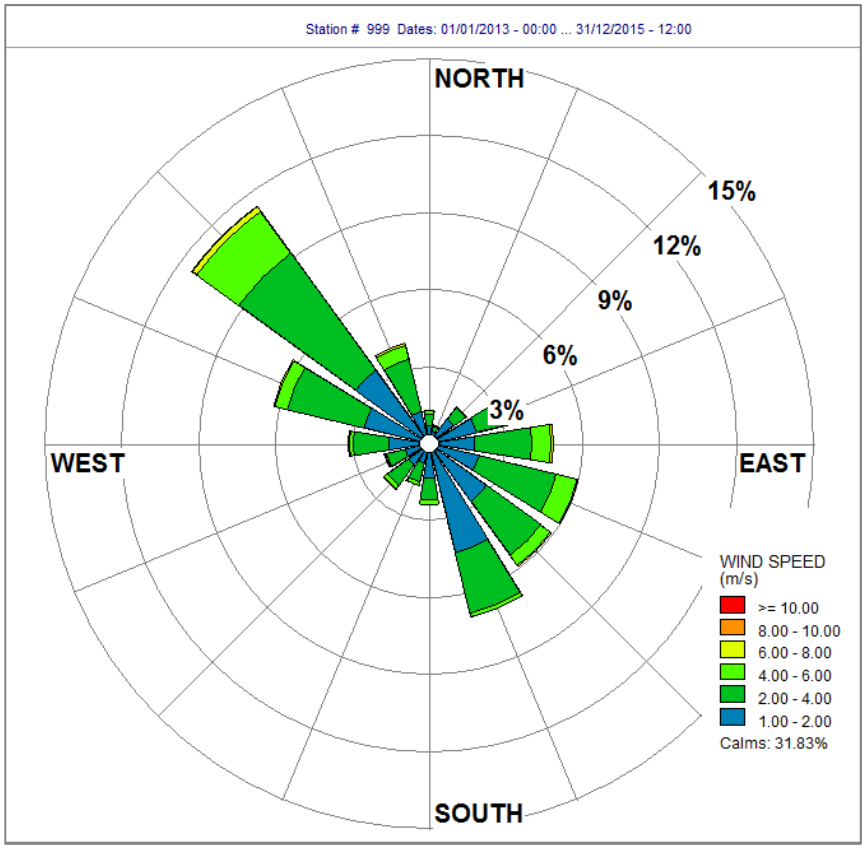
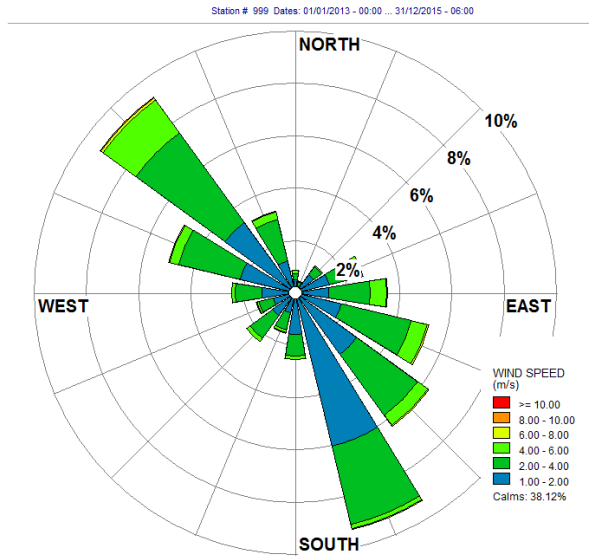
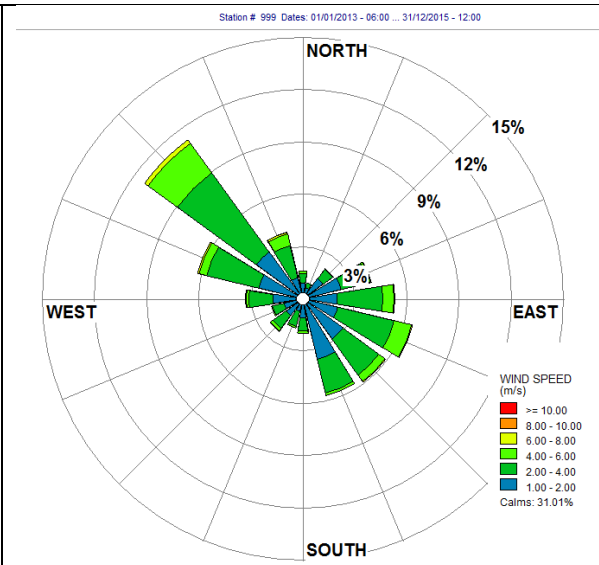


Figure 12: Average wind rose for Middelburg for 01 January 2013 to 31 December 2015



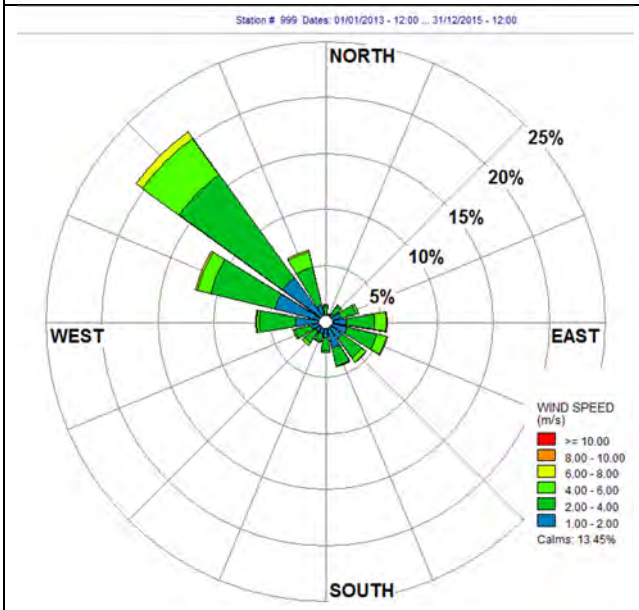
00:00 to 05:59

Wind dominant NW and SE sectors



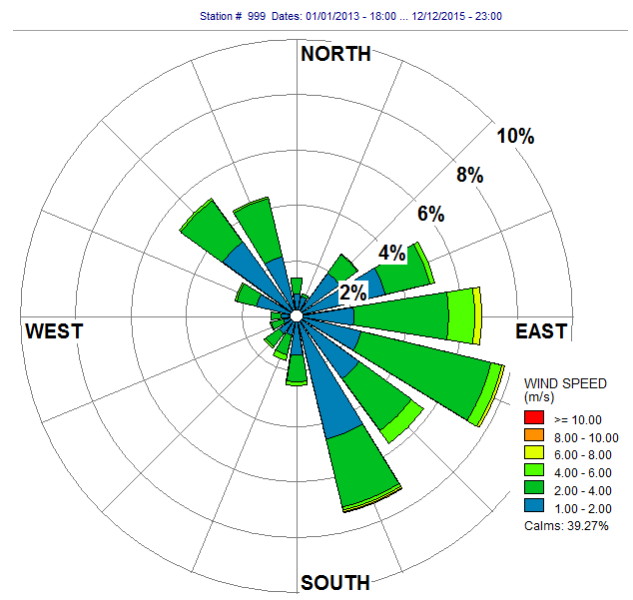
06:00 to 11:59

Wind dominant NW SE sectors



12:00 to 17:59

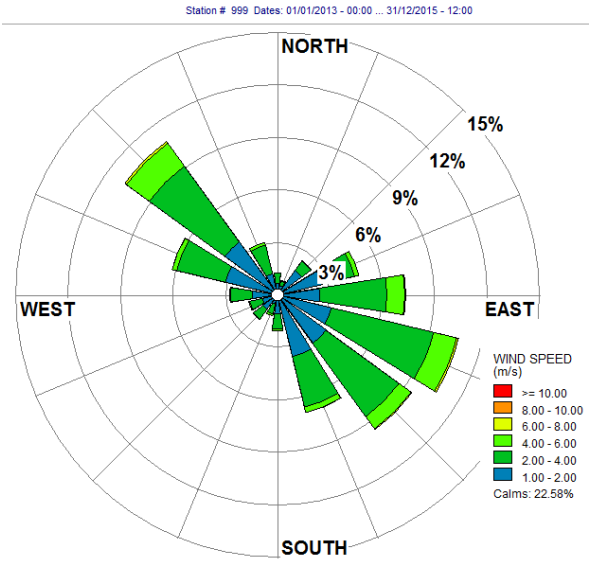
Wind dominant NW sector and to a lesser degree and SE sector



18:00 to 23:59

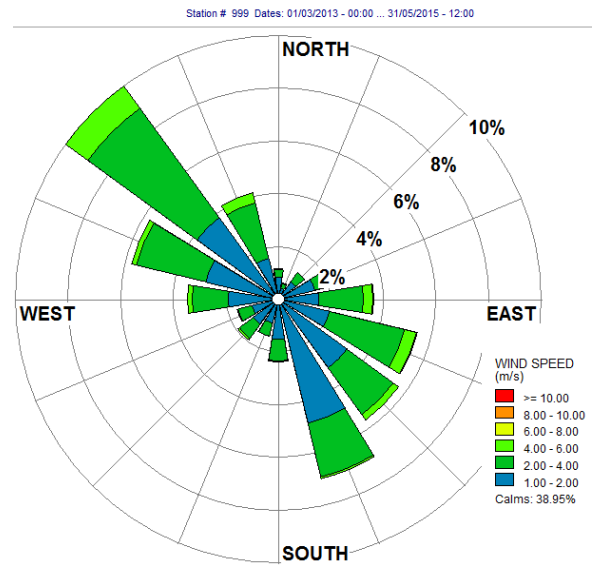
Wind dominant SE to E sectors and to a lesser degree and NW sector

Figure 13: Diurnal wind roses for Middelburg with predominant wind directions for 01 January 2013 to 31 December 2015



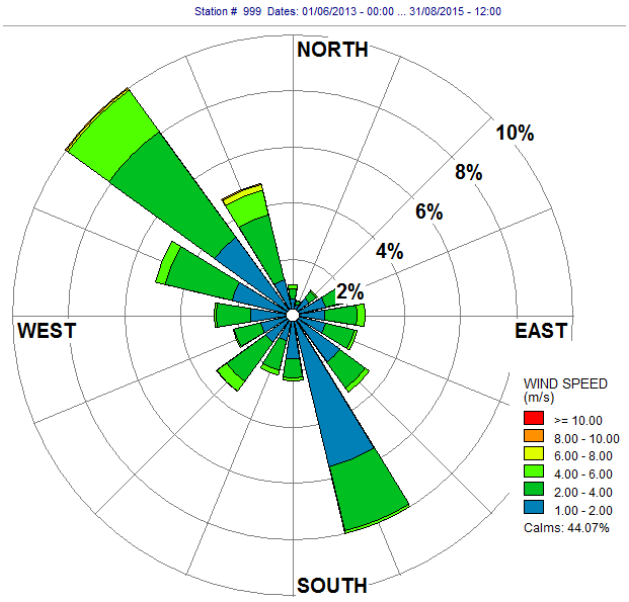
Summer (December, January and February)

Wind dominant SE and NW sectors



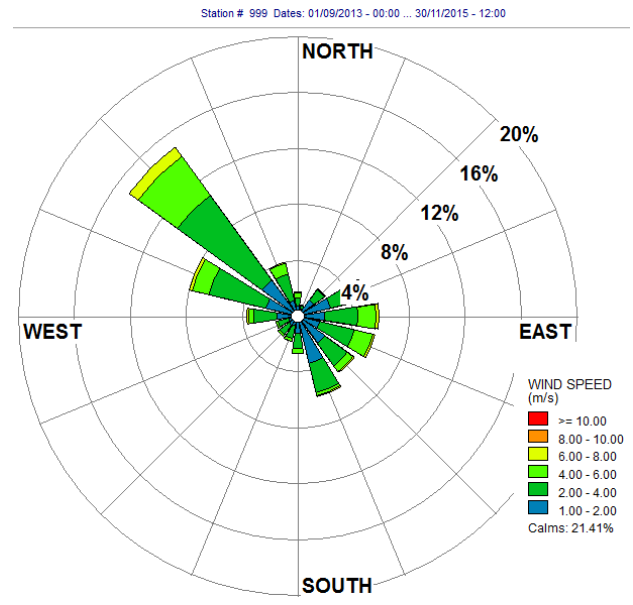
Autumn (March, April and May)

Wind dominant SE and NW sectors



Winter (June, July and August)

Wind dominant NW and to a lesser degree from the SE sector



Spring (September, October and November)

Wind dominant NW and to a lesser degree from the SE sector

Figure 14: Seasonal wind roses for Middelburg with predominant wind directions for 01 January 2013 to 31 December 2015

8.3 Geology

The area is underlain by thin sequences of sedimentary rocks of the Dwyka Group and the Vryheid Formation of the Ecca Group of the Karoo Supergroup, which rest uncomformably on an uneven floor of older rocks composed of rhyolite and granophyre of the Upper Transvaal Supergroup. Intrusive dolerite dykes and sills are common.

The Nooitgedacht coal reserves fall within the Witbank coalfield, comprising sediments of the coal-bearing Ecca Group of the Karoo Supergroup that were deposited on a volcanic pre-Karoo floor. Five coal seams are present in the Witbank coalfield.

The Karoo sediments in the study area are predominantly preserved on the higher elevations and have been eroded in the valley floors to expose the older basement rocks comprising of older diorite and/or gabbro of the Mokolian erathem, more specifically rocks of the Lebowa Granite Suite and gabbro of the Timbavati Formation. The Mokolian rocks in turn overlie older Transvaal Supergroup Rocks of the Vaalian erathem (Figure 15).

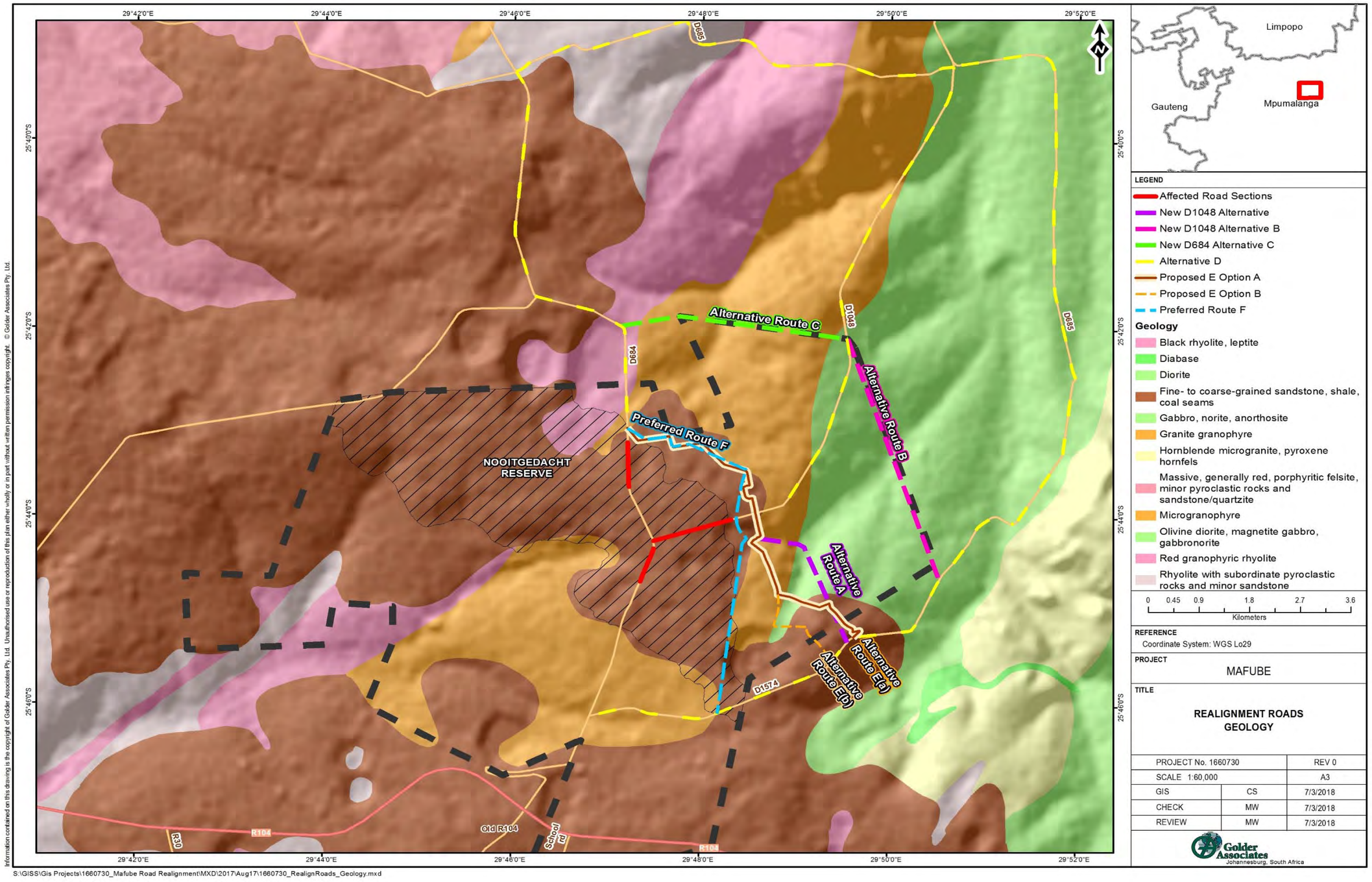


Figure 15: Local Geology of the project area

8.4 Soils, Land Use and Land Capability

Soils in the proposed road realignment area are typical of the Highveld catena with deeper soils of moderate to high agricultural potential on the upper slope and heavy soils with higher clay content on the lower slope.

The distribution of soils is closely linked to topography and parent materials from which they are derived. Free-draining soils (Clovelly, Hutton, and Griffin) are generally derived from the sediments (sandstone and shales) of the Ecca group, while the more structured and clayey soils are associated with the intrusive dolerite dykes and sills. The heavier, dark grey and mottled clay rich colluvium and hydromorphic soils dominate the low-lying, gently sloping, stream and pan environments.

The following documents were reviewed at a desk-top level in order to obtain an understanding of the soil and land capability along the Route Alternatives. Since Route Alternative D is along an existing dirt road, it was not included in the baseline soil assessment.

The desk-top assessment also served to collect relevant data on the soil. The following documents and information sources were used:

- Soil, land capability and land use assessment of the proposed Nooitgedacht and Wildfontein opencast areas of Mafube Coal Mining (Pty) Ltd Report compiled by Steenkamp (2012);
- Land type map for South Africa;
- Erosion susceptibility maps for Mpumalanga; and
- National Land Capability map.

The soils and land capability assessment was focused on the proposed Route Alternatives.

8.4.1 Land type description

The land type survey was conducted in the early 1970s in order to compile inventories of the natural resources of South Africa in terms of soil, climate and terrain and it was conducted as a reconnaissance survey at a scale of 1:250 000. The survey reflects the dominant soils in each land type by percentage. The land type information is not a substitute for a detailed soil map but gives a very good indication of where certain soil patterns are located.

The land type memoirs and associated maps of 2528 Pretoria, (Land type Survey Staff, 1976 - 2006) indicates that the site lies within the Ea8, Ea5, Ba20, Ba17 and Ib24 land types. The estimated percentages of each land type for the Route Alternatives are provided in Table 11.

Land type unit Ea indicates *"land with high base status, dark coloured and/or red soils, usually clayey, associated with basic parent materials. A land type, more than half of which is covered by soil forms with vertic, melanic and red structured diagnostic horizons. Land types in which these soils cover less than half of the area may also qualify for inclusion (i) where duplex soils occur in the non-rock land but where unit Ea soils cover a larger area than the duplex soils, or (ii) where exposed rock covers more than half the land type."* (AGIS, 2016).

The Ea 8 land type unit comprises 28.5% of the Hutton soil form, 26.5% of the Shortlands soil form, 17.0% of the Mayo soil form, 15% Glenrosa soil form, 8% of the Arcadia soil form, 3.5% of the Bonheim soil form and 1.5% of the Rensburg soil form. The Hutton soil form is medium sandy loam to sandy clay loam, with a clay content of 10 - 20% in the topsoil, 15 – 35% clay in the B horizon and has an effective depth of 500 – 1 200 mm. Depth limiting material associated with the Hutton soil form in the Ea 8 land type unit includes saprolite. The majority (75%) of soils of this land type unit are found in the midslope terrain position with 20% occurring in the footslope position and 5% occurring in the valley position. The dominant geology represented by land type Ea8 is ferrogabbro, ferrodiorite and diorite of the Upper zone; gabbro, norite and anorthosite of the Main zone, Bushveld Complex; hornblende microgranite and piroxene hornfels (AGIS, 2016).

The Ea 5 land type unit comprises 52% of the Shortlands soil form, 34% of the Hutton soil form, 7% of the Bonheim soil form, 4% of the Arcadia soil form, 2% of the Rensburg soil form and 1% are stream beds. The Shortlands soil form is fine sandy clay to clayey soils with clay content of 30 - 40% in the topsoil, 35 – 60% clay in the B horizon and has an effective depth of 500 – 800 mm. Depth limiting material associated with the Shortlands soil form in the Ea 5 land type unit includes saprolite. The majority (50%) of soils of this land type unit is found in midslope terrain position, 25% occurring in the crest position, 20% occurring in footslope position and 5% occurring in the valley position. The dominant geology represented by land type Ea5 is Mainly ferrogabbro and ferrodiorite of the Upper zone, Rustenburg Layered Suite; some gabbro, norite, anorthosite and magnetite gabbro of the Main zone, Rustenburg Layered Suite, Bushveld Complex; hornblende microgranite and pyroxene hornfels of Vaalian age in places (AGIS, 2016).

Land type unit Ba represents *"a catena that in its perfect form is represented by (in order from highest to lowest in the upland landscape) Hutton, Bainsvlei, Avalon and Longlands forms. The valley bottom is occupied by one or other gley soil (e.g. Rensburg, Willowbrook, Katspruit, Champagne forms)."*

The Ba 20 land type unit comprises 32.3% of the Hutton soil form, 16% of the Glencoe soil form, 15% of the Avalon soil form, 9.5% Wasbank soil form, 7% of the Longlands soil form, 5.5% of the Clovelly soil form, 4.3% of the Katspruit soil form, 5.5% of the Mispah soil form and 5% consisting of pans. The Hutton soil form is medium sandy loam to sandy clay loam, with a clay content of 15 - 25% in the topsoil, 20 - 35% clay in the B horizon and has an effective depth of 600 – 1 200 mm. Depth limiting material associated with the Hutton soil form in the Ba 20 land type unit includes saprolite and hardpan ferricrete. The majority (50%) of soils of this land type unit is found in crest position, 30% in the midslope terrain position with 15% occurring in footslope position and 5% occurring in the valley position. The dominant geology represented by land type Ba20 is mainly sandstone, shale, shaly sandstone and grit of the Ecca Group, Karoo Sequence; some gabbro, norite and granophyre of the Bushveld Igneous Complex, as well as rhyolite of the Damwal Formation, Rooiberg Group, Transvaal Sequence (AGIS, 2016).

The Ba 17 land type unit comprises 44.3% of the Hutton soil form, 29.3% of the Shortlands soil form, 15% of the Glencoe/Avalon soil forms, 5.5% Swartland soil form, 5% Mispah soil form and 1% of the Oakleaf soil form. The Hutton soil form is fine sandy clay loam with a clay content of 20 – 35% in the topsoil, 30 - 45% in the subsoil and has an effective depth of 450 – 1 200 mm. Depth limiting material associated with the Hutton soil form in the Ba 17 land type unit includes saprolite and hardpan ferricrete. The majority (95%) of soils of this land type unit is found in midslope position and 5% occurring in the valley position. The dominant geology represented by land type Ba17 is mainly ferrogabbro and ferrodiorite of the Upper zone, Rustenburg Layered Suite, Bushveld *Complex (AGIS, 2016).*

Land type unit Ib indicates "land types with exposed rock (exposed country rock, stones or boulders) covering 60 – 80% of the area." (AGIS, 2016).

The Ib24 land type unit comprises 60% Rock, 16.2% of the Hutton soil form, 15% of the Clovelly soil form, 7% of the Mispah soil form and 1.2% stream beds. The Hutton soil form is medium/coarse sand clay loam, with a clay content of 20 – 30% in the topsoil, 20 – 40% clay in the subsoil and has an effective depth of 600 – 1 200 mm. Depth limiting material associated with the Hutton soil form in the Ib24 land type unit includes hard rock and saprolite. The majority (50%) of soils of this land type unit is found in midslope terrain position with 45% occurring in crest position, 3% in the footslope position and 2% occurring in the valley bottom position. The dominant geology represented by land type Ib24 is mainly granophyre of the Rashoop Suite; leptite of the Bushveld Complex; granophyric rhyolite of the Damwal Formation, Rooiberg Group (AGIS, 2016).

Table 11: Land types of Route Alternatives

Routes	Land type occupied by route
Alternative A	**Ba20 (± 14%)** - Plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils widespread **Ea8 (± 86%)**- one or more of: vertic, melanic, red structured diagnostic horizons; Undifferentiated

Routes	Land type occupied by route
Alternative B	**Ea8 (± 57.5%)** - one or more of: vertic, melanic, red structured diagnostic horizons; Undifferentiated **Ea5 (± 16.9%)** – one or more of: vertic, melanic, red structured diagnostic horizons; Undifferentiated **Ib24 (± 13.5%)** – miscellaneous land classes; Rock areas with miscellaneous soils **Ba17 (± 11.5%)** – plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils widespread
Alternative C	**Ba20 (± 72%)** – Plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils widespread **Ib24 (± 28%)** – miscellaneous land classes; Rock areas with miscellaneous soils
Alternative D	No new roads constructed - Existing district roads will be used by locals
Alternative E	**Ba20 (± 100%)**- Plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils widespread
Preferred Alternative F	**Ba20 (± 100%)**- Plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils widespread

Table 12: Land types for Route Alternatives and dominant soil form (Land type Survey Staff, 1976-2006)

Route Alternative	Land type	Dominant Soil form/feature
A	Ea8	Hutton
	Ba20	Hutton
B	Ea8	Hutton
	Ea5	Shortlands
	Ib24	Rocks
	Ba17	Hutton
C	Ba20	Hutton
	Ib24	Rocks
E	Ba20	Hutton
F	Ba20	Hutton

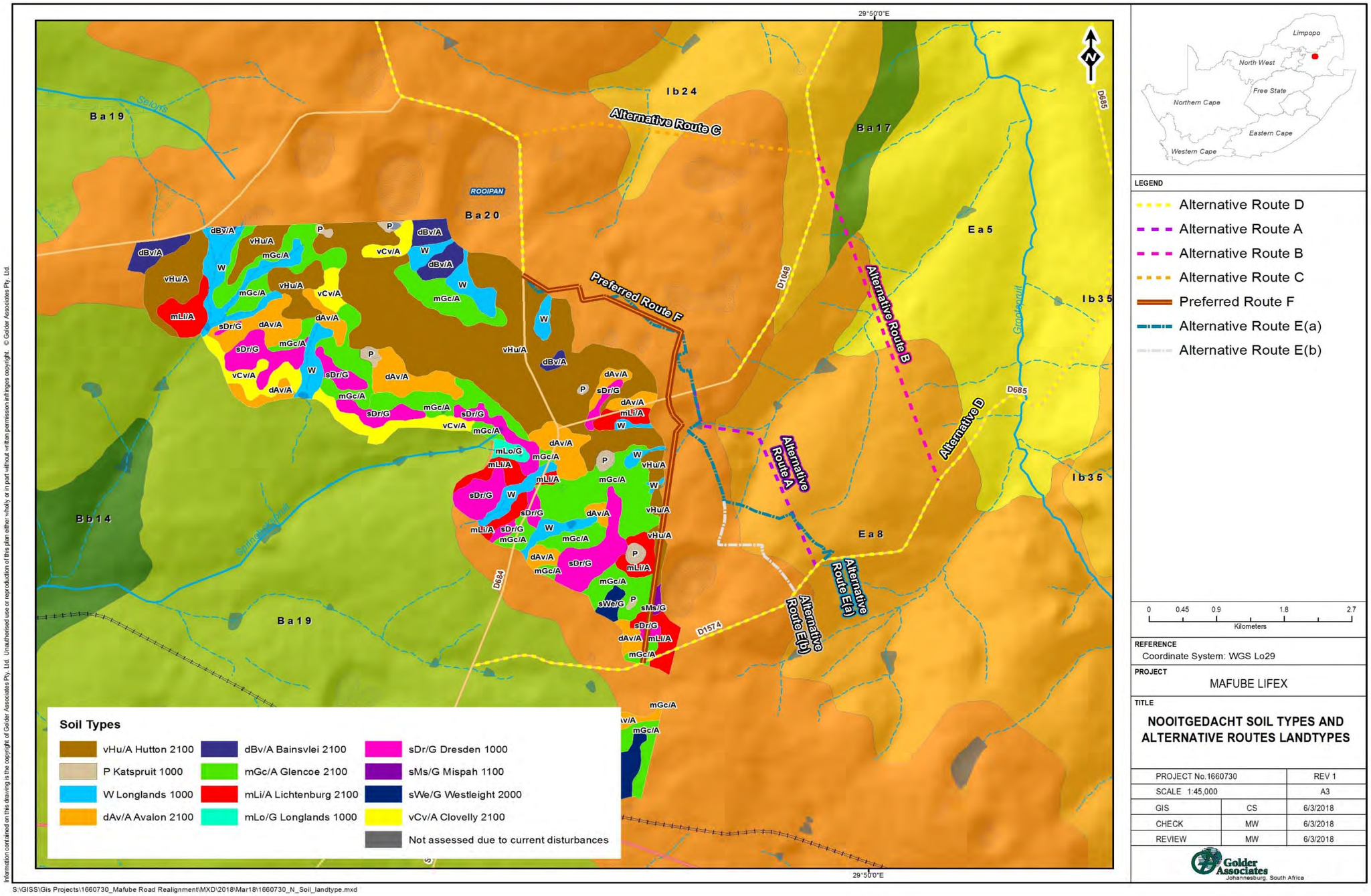


Figure 16: Nooitgedacht soil types and Land types intersected by Alternative Routes

8.4.2 Dominant soils characteristics

The soils occurring along each of the Route Alternatives is the Hutton soil form (as defined in the land type survey). A soil survey conducted on the farms Nooitgedacht and Wildfontein (located east to south east of the Route Alternatives) at a scale of 1:40 000, indicate that the following soil forms occur in the area: Hutton (31.11%), Bainsvlei (3.01%), Lichtenburg (5.80%), Clovelly (4.64%), Avalon (9.80%), Glencoe (21.14%), Westleigh (4.15%), Dresden (9.47%), Mispah (0.21%), Longlands (0.81%) and Katspruit (1.53%). The soil forms identified in the soil survey conducted by Steenkamp (2012), are similar to what is recorded in the Land type memoirs for the areas of Route Alternatives. Both the soil survey by Steenkamp (2012) and the Land type data indicate that the Hutton soil form is the dominant soil form in the study area.

Hutton soils are characterised by relatively uniform red, apedal (structureless) subsoil. The red soil colour is attributed to hematite. Hutton soils very seldom become saturated with water, thus reducing conditions that may change the soil colour never occur. These soils occur in better drained positions in the landscape and on better drained underlying material. Fine sand variants of this form are sensitive to wind erosion and are easily compacted by cultivation. The wind erosion hazard of the topsoil is low to moderate, based on the clay content.

8.4.3 Soil erodibility

The soil erodibility, the tendency of the soil to be detached and transported by wind or water, becomes increasing important as the slope increases. Silt and fine sandy soils are usually more easily erodible than more clayey soils. The soils' susceptibility to wind and water erosion based on textural class and slope in the study area is listed below (Table 13 and Table 14) and shown in Figure 17 and Figure 18. The erosion susceptibility maps were generated using the Land type survey data (Schoeman & van der Walt, 2006).

Table 13: Water erosion susceptibility classes per Route Alternative

Route Alternative	Water erosion class	Description	Area (ha)*
Alternative A	4a	Sandy loams strongly dominant. Somewhat susceptible.	1.2
Alternative A	5	Sandy clay loams. Non-susceptible.	7.6
Alternative B	5	Sandy clay loams. Non-susceptible.	15.0
Alternative C	4a	Sandy loams strongly dominant. Somewhat susceptible.	8.6
Alternative C	5	Sandy clay loams. Non-susceptible.	3.4
Alternative D	5	Sandy clay loams. Non-susceptible.	86.7
Alternative D	3c	Loamy sands sub-dominant. Moderately susceptible.	4.7
Alternative D	4a	Sandy loams strongly dominant. Somewhat susceptible.	45.3
Alternative D	4a	Sandy loams strongly dominant. Somewhat susceptible.	0.2
Alternative D	4b	Sandy loams dominant. Somewhat susceptible.	3.7
Alternative E (A)	5	Sandy clay loams. Non-susceptible.	5.6
Alternative E (A)	4a	Sandy loams strongly dominant. Somewhat susceptible.	16.8
Alternative E (B)	5	Sandy clay loams. Non-susceptible.	1.4
Alternative E (B)	4a	Sandy loams strongly dominant. Somewhat susceptible.	21.2
Alternative F	4a	Sandy loams strongly dominant. Somewhat susceptible.	22.2

Notes: * Area occupies 15m buffer along route

Table 14: Wind erosion susceptibility of land for Route Alternatives

Route Alternative	Wind erosion class	Description	Area (ha)
Alternative A	1	Land with low susceptibility to water erosion. Generally, level to gently sloping. Soils have favourable erodibility index.	1.2
Alternative A	3	Land with moderate susceptibility to water erosion. Generally moderately sloping land. Soils have low to moderate erodibility.	7.6
Alternative B	2	Land with low to moderate susceptibility to water erosion. Generally, gently to moderately sloping. Soils have low to moderate erodibility.	4.6
Alternative B	3	Land with moderate susceptibility to water erosion. Generally moderately sloping land. Soils have low to moderate erodibility.	10.4
Alternative C	1	Land with low susceptibility to water erosion. Generally, level to gently sloping. Soils have favourable erodibility index.	8.6
Alternative C	2	Land with low to moderate susceptibility to water erosion. Generally, gently to moderately sloping. Soils have low to moderate erodibility.	3.4
Alternative D	1	Land with low susceptibility to water erosion. Generally, level to gently sloping. Soils have favourable erodibility index.	45.5
Alternative D	2	Land with low to moderate susceptibility to water erosion. Generally, gently to moderately sloping. Soils have low to moderate erodibility.	27.5
Alternative D	3	Land with moderate susceptibility to water erosion. Generally moderately sloping land. Soils have low to moderate erodibility.	25.0
Alternative D	5	Land with low to moderate water or wind erosion hazard. Generally, level to gently sloping land; soils may have low to very high erodibility.	4.7
Alternative E (a)	1	Land with low susceptibility to water erosion. Generally, level to gently sloping. Soils have favourable erodibility index.	16.8
Alternative E (a)	3	Land with moderate susceptibility to water erosion. Generally moderately sloping land. Soils have low to moderate erodibility.	5.6
Alternative E (b)	1	Land with low susceptibility to water erosion. Generally, level to gently sloping. Soils have favourable erodibility index.	21.2
Alternative E (b)	3	Land with moderate susceptibility to water erosion. Generally moderately sloping land. Soils have low to moderate erodibility.	1.4
Alternative F	1	Land with low susceptibility to water erosion. Generally, level to gently sloping. Soils have favourable erodibility index.	22.2

Notes: * Area occupies 15m buffer along route

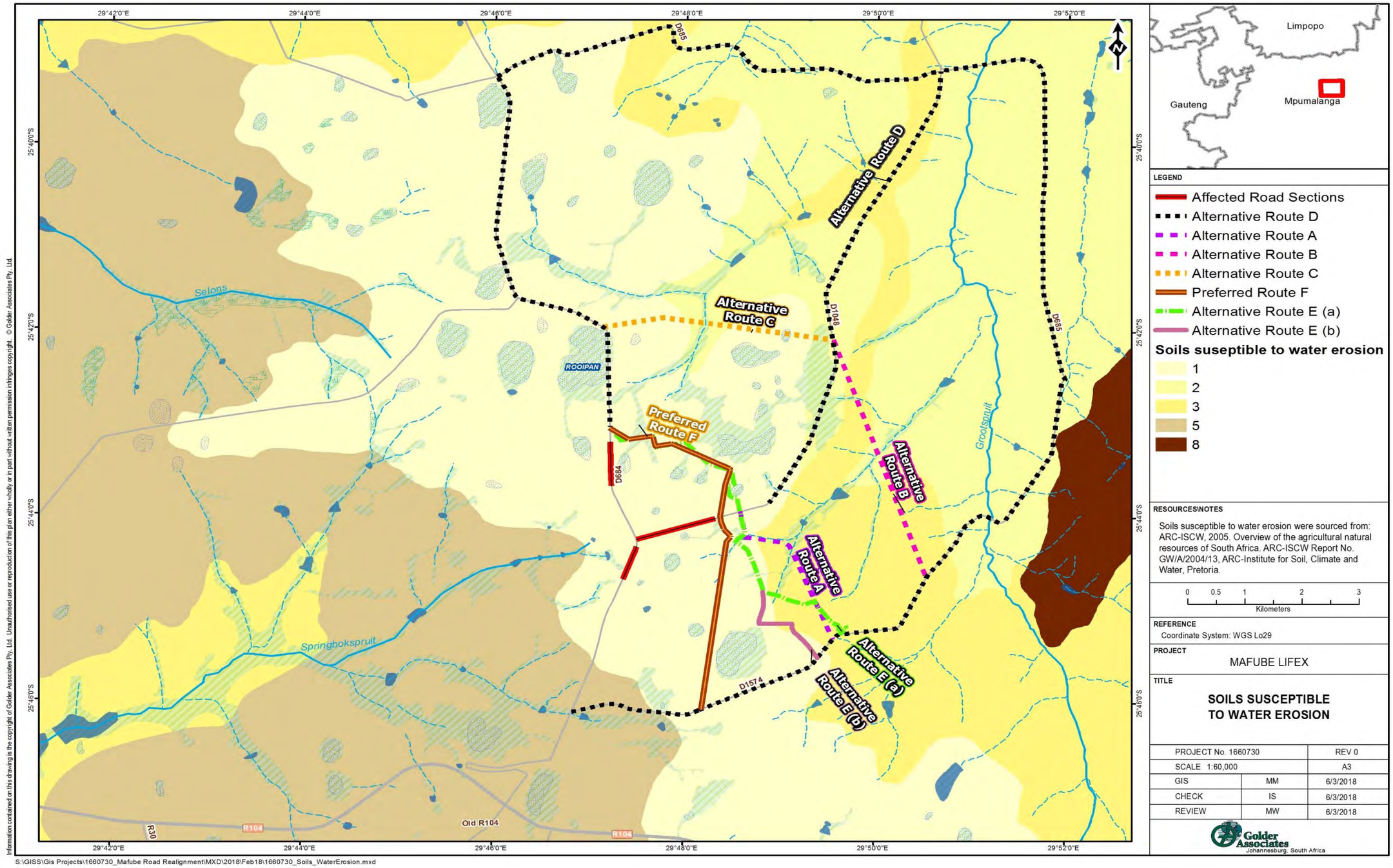


Figure 17: Soils susceptibility to water erosion

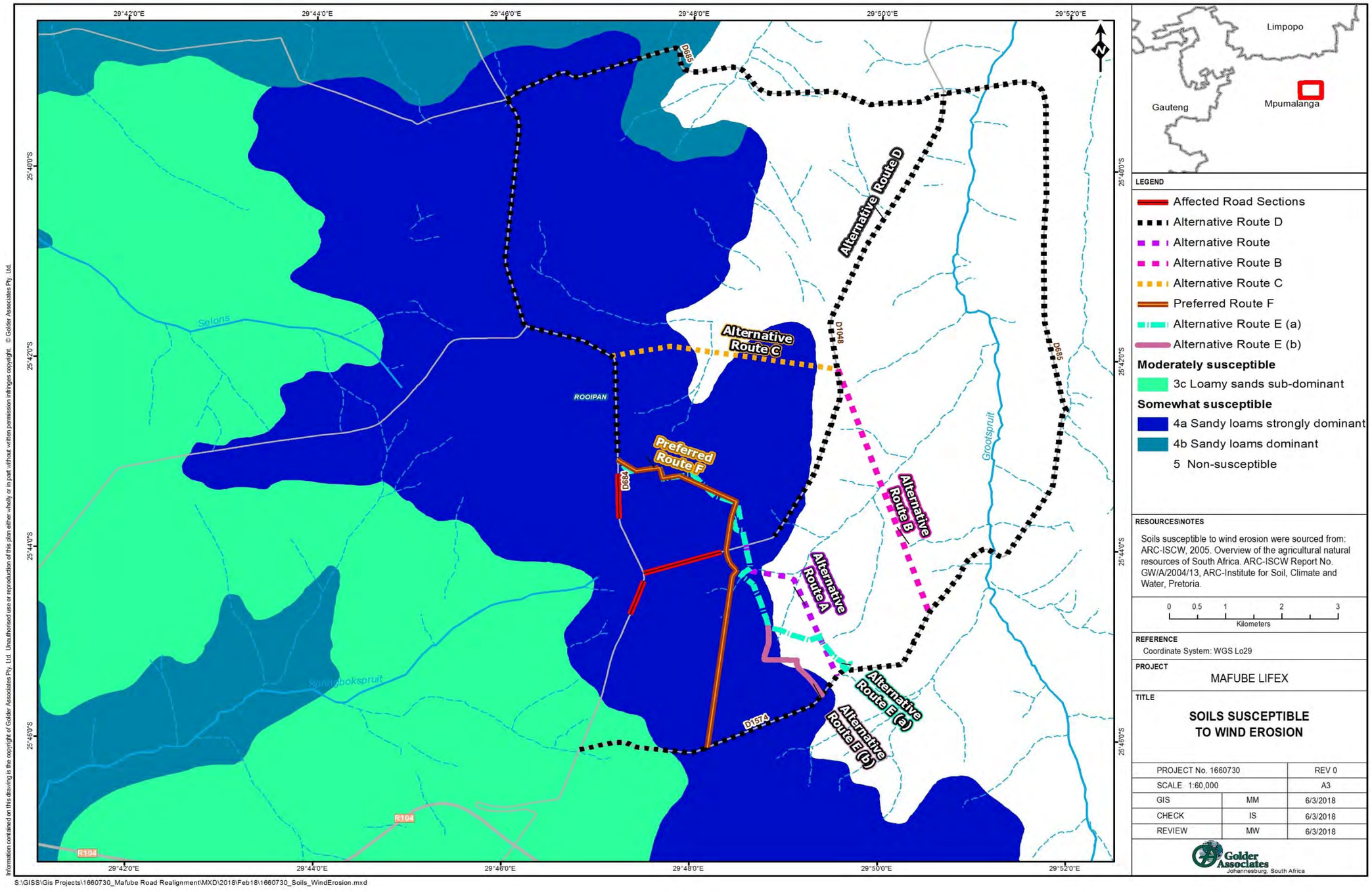


Figure 18: Soils susceptibility to wind erosion

8.4.4 Baseline Land Capability

Land capability classification (LCC) is a system of grouping soils into map units based on the ability of the land to sustain rain-fed arable crops (Klingebiel & Montgomery, 1961). The map units are classed as *arable* (classes I – IV) or *non- arable* (class VI - VIII) depending on the degree of physical limitations and therefore also indicates the potential of the soil for agricultural use. The LCC does not indicate soil fertility status, a chemical feature of the soil which can be ameliorated. The parameters evaluated during land capability assessment may include combinations of the following:

- Soil textural and structural properties (sand, silt and clay content), as these are known to be co-variants with a number of other more complex soil properties (hydraulic conductivity, CEC, moisture retention; plasticity; susceptibility to compaction);
- Susceptibility to erosion as determined by the type of soil and *slope* (to be considered if changes in land cover and changes in slope may result from a developmental initiative);
- Continuous or periodic waterlogging, caused by low permeability of underlying material, the presence and duration of water tables, or flooding (to be considered in infrastructure placement);
- Depth of soils relative to limiting materials/layers, specifically inhibiting root penetration;
- Soil Salinity, specifically regarding plant sensitivity to saline conditions;
- Mechanical (Physical) limitations such as rocky outcrops or deep gullies, which prevent access to areas; and
- Climatic conditions, temperature and rainfall are the key determinant in land arability.

The national land capability classification for the project area was evaluated. The land capability classification was undertaken at a national scale, using the land type data on a scale of 1:250 000. The classification is as follows: "*The land capability is assigned to each land type by applying the table for soil and climate classes constituting land capability classes, to each soil entry. Land types in which a particular class occupies more than 50%, are assigned to that class, starting with Class I. If the land type does not comply with this requirement, components belonging to the next class in the sequence are added to the components from higher classes. If the sum occupies more than 50%, the land type is assigned to that class*."

The land capability for the Route Alternative A is classified as Class II and Class III, for Alternative B as class III and class VIII, and for Alternative C as class II and class VIII.

The classes have the following capabilities as defined in the land capability system for South Africa (*Schoeman et al.*, 2000):

- **Class II**: *"Land in Class II have some limitations that reduce the choice of plants or require moderate conservation practices. It may be used for cultivated crops, but with less latitude in the choice of crops or management practices than Class I. The limitations are few and the practices are easy to apply. Limitations may include singly or in combination the effects of:*
  - *Gentle slopes;*
  - *Moderate susceptibility to wind and water erosion;*
  - *Less than ideal soil depth;*
  - *Somewhat unfavourable soil structure and work ability;*
  - *Slight to moderate salinity or sodicity easily corrected but likely to recur;*
  - *Occasional damaging flooding;*
  - *Wetness correctable by drainage but existing permanently as a moderate limitation; and*

- *Slight climatic limitations on soil use and management.*

Limitations may cause special soil-conserving cropping systems, soil conservation practices, water-control devices or tillage methods to be required when used for cultivated crops".

- **Class III** – *"Land in this class has severe limitations that reduce the choice of plants or require special conservation practices, or both. It may be used for cultivated crops but has more restrictions than Class II. When used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain. The number of practical alternatives for average farmers is less than that for soils in Class II. Limitations restrict, singly or in combination, the amount of clean cultivation, time of planting, tillage, harvesting, and choice of crops. Limitations may result from the effects of one or more of the following:*
  - *Moderately steep slopes;*
  - *High susceptibility to water or wind erosion or severe adverse effects of past erosion;*
  - *Frequent flooding accompanied by some crop damage;*
  - *Very slow permeability of the subsoil;*
  - *Wetness or some continuing waterlogging after drainage;*
  - *Shallow soil depth to bedrock, hardpan, fragipan or claypan that limit the rooting zone and the water storage;*
  - *Low water-holding capacity;*
  - *Low fertility not easily corrected;*
  - *Moderate salinity or sodicity; and*
  - *Moderate climatic limitations."*
- **Class VIII:** *"Land in this class have limitations that preclude its use for commercial plant production and restrict its use to recreation, wildlife, water supply or aesthetic purposes. Land in Class VIII cannot be expected to return significant on-site benefits from management for crops, grasses or trees, although benefits from wildlife use, watershed protection or recreation may be possible. Badlands, rock outcrop, sandy beaches, river wash, mine tailings and other nearly barren lands are included in Class VIII. Limitations that cannot be corrected may result from the effects of one or more of:*
  - *Erosion or erosion hazard;*
  - *Severe climate;*
  - *Wet soil;*
  - *Stones;*
  - *Low water-holding capacity; and*
  - *Salinity or sodicity."*

The land capability for the different Route Alternatives is shown in Table 15 and Figure 19. The approximate land capability of and area occupied by each Route is listed below.

Table 15: Land capability classes (ha) occupied by each Route Alternative

Route Alternative	Class II	Class III	Class VIII
Alternative A	21.7	3.4	
Alternative B	2.2	7.9	
Alternative C		12.8	2.2
Alternative D	45.5	67.6	27.2
Alternative E (A)	16.8	5.7	
Alternative E (B)	21.2	1.3	
Alternative F	19.2		

Notes: * Area occupies 15m buffer along route

8.4.5 Soil agricultural potential

The agricultural potential is dependent on the characteristics of the land and management input and reflects the production capacity of a land under a specific management regime. The various land capability classes also have different agricultural potentials. At the desktop level of the assessment, the land capability classes were assigned soil agricultural potentials. For the different route alternatives, these are – Soils in Land Capability (LC) Class II as high potential, soils in Class III having a moderate potential and soils in Class VIII having a low potential. These ratings however need to be confirmed during the soil survey of the Route Alternative selected.

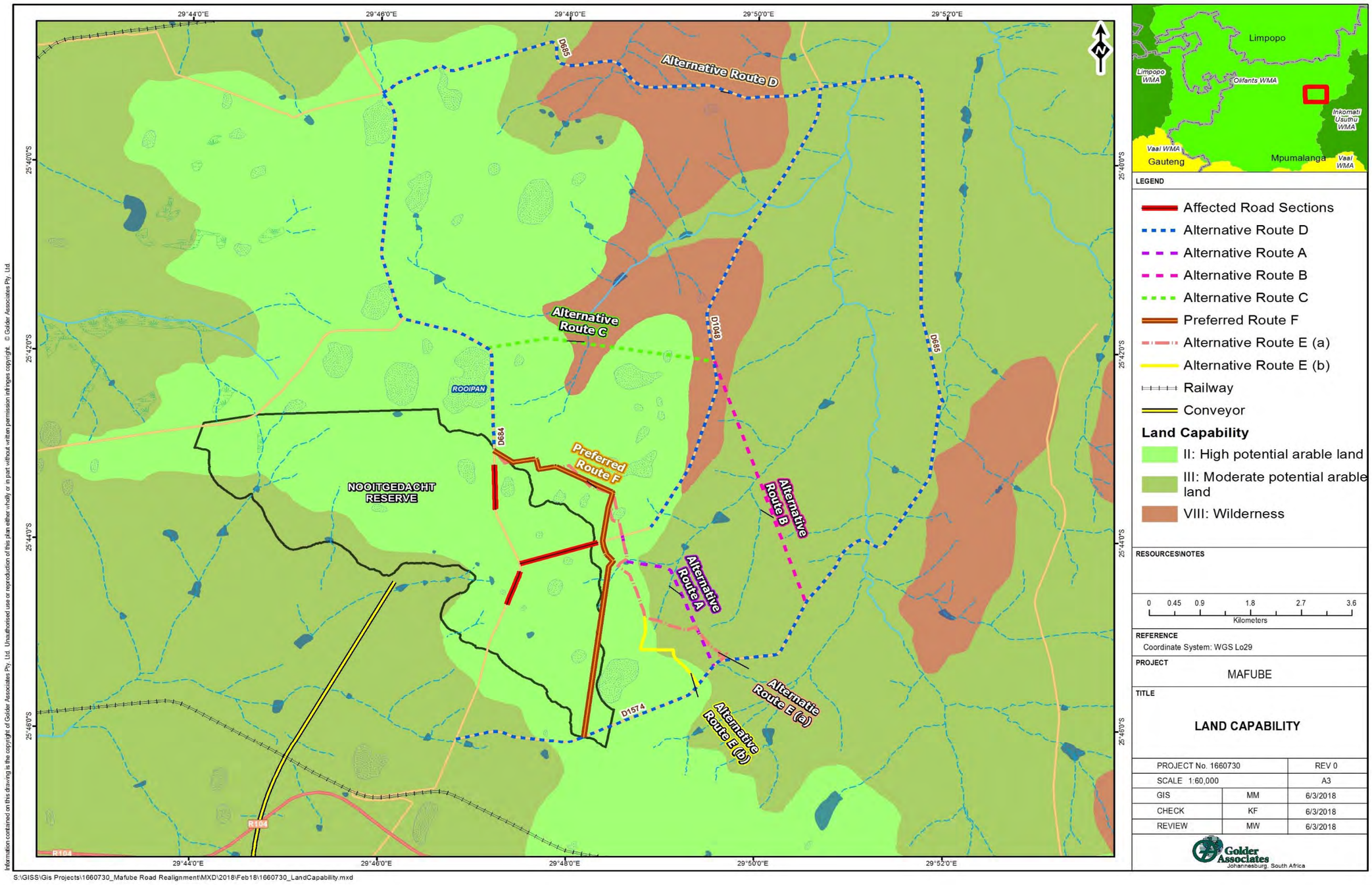


Figure 19: Land capability of Route Alternatives

8.5 Surface Water

The proposed road realignment area is situated within the upper reaches of the Olifants Catchment Water Management Area (WMA), and is located in the Middelburg Dam sub-catchment, forming part of the Loskop Dam catchment, and within quaternary sub-catchment B12C of the Limpopo-Olifants primary drainage region (Figure 20). Local watercourses drain into the Klein-Olifants River, which in turn drains into Middelburg Dam. Thereafter the Klein-Olifants flows into the Olifants River, which drains into the Loskop Dam.

The water users in the catchment are varied and include agriculture (irrigation), municipal (including commercial and domestic uses) and natural aquatic ecosystems. The water quality in the Middelburg Dam has deteriorated steadily since the 1970s when mining started in the catchment.

8.5.1 Catchment Description

Regionally the Nooitgedacht and Wildfontein opencast coal mine expansion project as well as the associated road realignment alternatives are situated in the upper reaches of the Olifants Water Management Area (WMA) and span over two quaternary catchments, namely:

- The Klein-Olifants quaternary catchment B12C which is drained by the Mooifonteinspruit, the Springbokspruit and ultimately the Klein Olifants River; and
- The Steelpoort River quaternary catchment B41A which is drained mainly by the Grootspruit, Hartebeeshoekspruit, Langspruit and ultimately the Steelpoort River.

The location of road realignment alternatives is shown in Figure 4. The project could potentially impact on the Middelburg Dam located on the Klein Olifants River. The predominant land use in the study area is commercial agriculture. Grassland is the dominant vegetation type in the region, with patches of forest occurring as an interrupted, thin band towards the eastern boundary.

8.5.2 Classification of the resources

The Department of Water and Sanitation (DWS) has completed the classification process for the significant water resources of the Olifants WMA (DWA, 2013). The process included stakeholder engagement for input in recommending the classes for the Integrated Units of Analysis (IUA) defined for the WMA.

The Springbokspruit and Grootspruit rivers are in a moderately modified state (Category C) with less developed areas present in the catchment. Impacts within the catchments are related to urban areas, agriculture, dams and some mining. The importance of the resources is moderate, especially in terms of good water quality in that the Springbokspruit drains into Klein-Olifants River above Middelburg Dam and in that the Grootspruit drains into the Steelpoort River.

The management class for both the Springbokspruit and the Steelpoort catchments has been set as a Class II with an overall ecological category of a B/C for the Integrated Units of Analysis (IUA). This class implies moderate usage of the water resource in future and the status quo in the river system has to at least be maintained.

8.5.2.1 Water Quality Planning Limits

During 2016 a study was undertaken to develop an integrated water quality management plan (IWQMP) for the Olifants River System. As part of the study, the catchment was divided into Management Units (Mus). Proposed Water Quality Planning Limits (WQPLs) were set for each of the MUs. Mafube falls within MU 14 and 59. The WQPLs for MU 14 and 59 as set out in Table 16 were used in the surface water quality assessments.

Table 16: Proposed WQPL for the Olifants Catchment, Management Unit 14 and 59

Water Quality Variables	Units	14	59
Calcium (dissolved)	mg/L	80	15
Chloride (dissolved)	mg/L	100	25
Total Dissolved Solids	mg/L	500	260

Water Quality Variables	Units	14	59
Electrical Conductivity	mS/m	90	30
Fluoride (dissolved)	mg/L	0.8	0.7
Potassium (dissolved)	mg/L	20	50
Magnesium (dissolved)	mg/L	70	30
Sodium (dissolved)	mg/L	60	70
Ammonium (NH_4-N)	mg/L	0.05	0.05
Nitrate	mg/L	0.5	0.5
Total Phosphorus	mg/L	0.25	0.25
pH		6.5 - 8.4	6.5 - 8.4
Ortho-phosphate	mg/L	0.025	0.01
Sulphate (dissolved)	mg/L	400	20
Total Alkalinity	mg/L	130	70
Dissolved Organic Carbon	mg/L	10	5
Dissolved Oxygen	mg/L	9	9
SAR		2	2
Suspended Solids	mg/L	25	25
Chlorophyll a	µg/L	1.5	1
Escherichia coli	CFU/100 mL	130	130
Faecal coliforms	CFU/100 mL	130	130
Aluminium	mg/L	0.02	0.01
Boron	mg/L	0.5	0.5
Chromium (VI)	µg/L	14	7
Iron	mg/L	0.1	0.1
Manganese	mg/L	0.02	0.02

8.5.2.2 Present Ecological State and Ecological Importance and Sensitivity

The Present Ecological State (PES) is defined as the current state or condition of a water resource in terms of its biophysical components (drivers) such as hydrology, geomorphology and water quality and biological responses viz. fish, invertebrates and riparian vegetation. The degree to which ecological conditions of an area have been modified from the natural (reference) condition and the Ecological Importance and Sensitivity (EIS) relate to the presence, representativeness and diversity of species of biota and habitat. Ecological Sensitivity relates to the vulnerability of the habitat and biota to modifications that may occur in flows, water levels and physico-chemical conditions.

PES and EIS were determined for the Springbokspruit and Steelpoort, which were found to be in a moderately modified state (category B/C) within less developed areas present in the catchment. The importance of the resource is moderate, especially in terms of good water quality contributed to the main stem Olifants River above Loskop Dam. Therefore it was proposed to maintain the current PES category within the catchments. A management class II was recommended for both quaternary catchment B12C and B41A (DWA, 2013). In this respect, mitigation implemented must be such that it will protect the water resources so that an ecological category of B/C is maintained.

8.5.3 Local Drainage Network

The Road Realignment Alternatives for the proposed Nooitgedacht and Wildfontein operations cross several streams. These alternatives include both existing roads as well as proposed roads. The streams include both perennial and non-perennial streams.

As per the requirements of Sections 21 (c) and (i) of the NWA, a surface water impact assessment for all road-river crossings needs to be carried out. A total of three (3) road-river/wetland/water course crossings have been identified along the proposed road realignment routes.

8.5.4 Baseline Water Quality Monitoring Programme

Mafube LifeX operations maintains forty-one (41) surface water monitoring sites (Figure 21) which have been aligned with aquatic monitoring sites and their locations (Table 17) not situated on wetlands, but in flowing streams. A monthly monitoring programme is conducted and there are nearly 15 constituents that are currently monitored.

The importance of a monitoring programme is to provide a baseline data set to detect any changes in the water quality profile potentially due to impacts from mining activities. If there is a large increase or decrease in certain constituent values in a short period it is important to assess the reason for the change and implement the necessary mitigation measures. A monitoring programme is also important when the monitoring site is a point of discharge to the environment from the mine. This allows the mine to determine the impacts that the discharge could have on the downstream users and to implement mitigation measures.

The sites sampled in February to January 2018 included the following 18 sites related to the updated integrated water use licence:

- KO3; KO4; KO6; KO7;
- Stream S2; Stream S4; Stream S8;
- C3 Upstream;
- SP1; SP2; SP4; SP5;
- Pan 12; Pan13; Pan 25; Pan 29 (Now Pan 11); and
- Downstream of Wildfontein.

8.5.5 Description of the preferred route alternative F

The preferred Road Realignment Alternative for the proposed Nooitgedacht and Wildfontein opencast coal mine expansion project cuts through a few water courses. The alternatives form part of both existing roads as well as an extension of the proposed road. The water courses that would be impacted include two non-perennial streams and wetlands. As per the requirements of Sections 21 (c) and (i) of the NWA, a surface water impact assessment for all road-river crossings needs to be carried out.

8.5.6 Klein Olifants River area

The chemical water quality within the study area is generally good. However, most sample points indicate high levels of iron (Fe), aluminium (Al), manganese (Mn), ammonium (NH_4-N), nitrate ($N0_3$-N) and orthophosphate ($P0_4$). Fluctuations in concentrations were recorded for sodium, chloride, sulphate and manganese, with a general increase in Aug 2017. Dissolved oxygen levels were below the stipulated WQPL values throughout the monitoring period, apart from August 2017, for most samples.

8.5.7 Steelpoort River area

SP1, SP2, SP4, SP5 and Pan11 are located in the Steelpoort River area that drains towards the north of the study area. These samples indicated high levels of conductivity (EC), total alkalinity, iron (Fe), aluminium (Al), and manganese (Mn). These parameters are indicators of mining activities within the area.

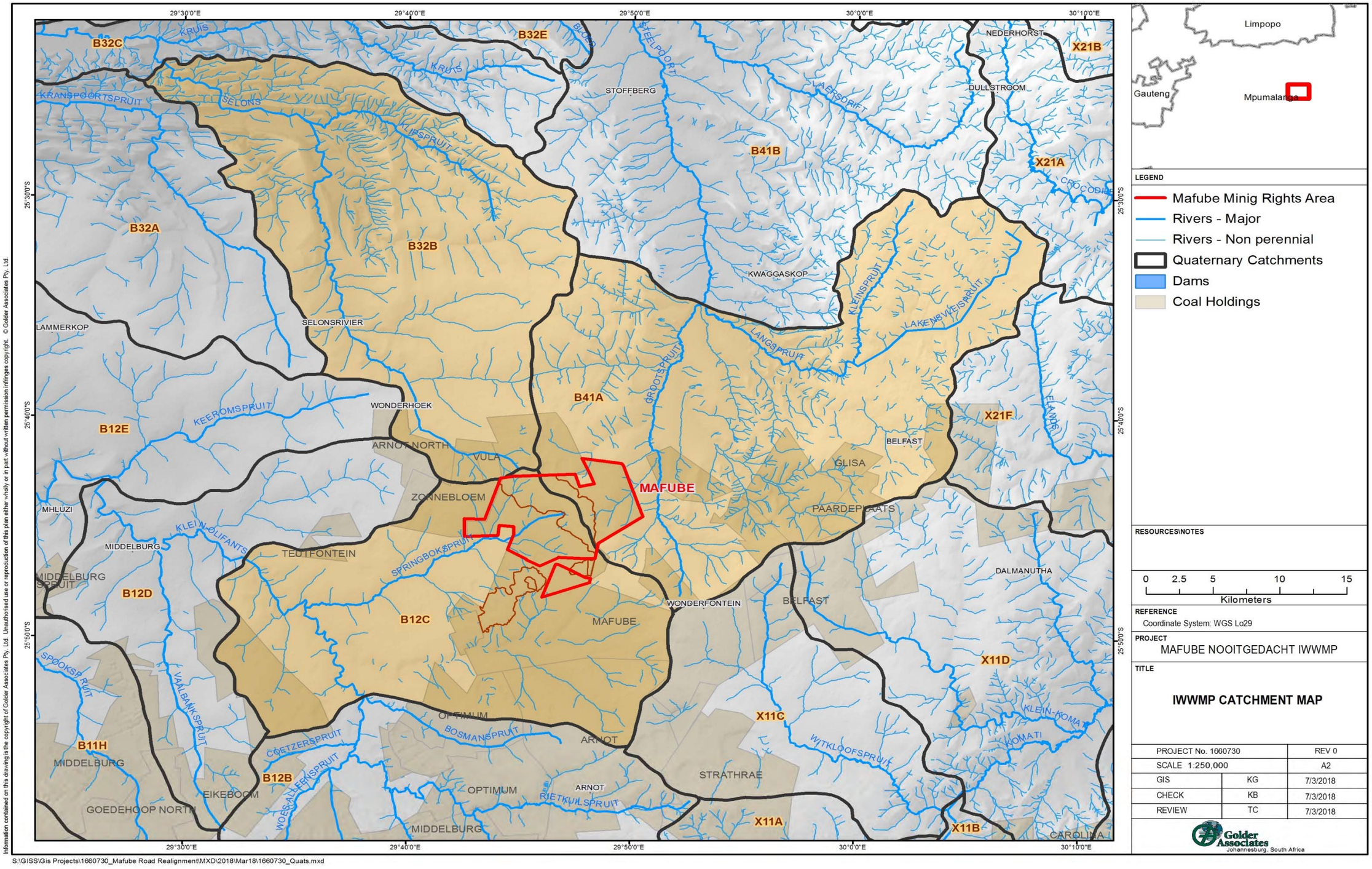


Figure 20: Quaternary catchments of the study area

Table 17: Water quality monitoring points

Description	Monitoring Point	Co ordinates	
		Latitude	Longitude
Klein Olifants System	KO1	S25°46'7.98"	E29°46'49.20"
Klein Olifants System	KO3	S25°44'20.81"	E29°44'09.45"
Klein Olifants System	KO4	S25°44'39.534"	E29°43'07.518"
Klein Olifants System	KO5	S25°45'31.47"	E29°43'44.22"
Klein Olifants System	KO6	S25°45'41.103"	E29°43'9.737"
Klein Olifants System	KO7	S25°47'06.79"	E29°40'52.00"
Steelpoort System	Stream S2	S25°44'21.30"	E29°44'10.20"
Klein Olifants System	Stream S3	S25°44'50.10"	E29°45'36.10"
Klein Olifants System	Stream S4	S25°46'7.90"	E29°46'32.50"
Steelpoort System	Stream S6	S25°42'19.80"	E29°48'3.90"
Steelpoort System	Stream S7	S25°42'43.90"	E29°48'10.30"
Steelpoort System	Stream S8	S25°43'58.70"	E29°49'20.40"
Klein Olifants System	C1 Upstream	S25°44'33.90"	E29°46'12.30"
Klein Olifants System	C1 downstream	S25°44'36.50"	E29°45'57.40"
Klein Olifants System	C2 Upstream	S25°45'1.10"	E29°45'57.40"
Klein Olifants System	C2 downstream	S25°44'53.30"	E29°45'51.70"
Klein Olifants System	C3 Upstream	S25°45'43.60"	E29°45'48.80"
Klein Olifants System	C3 downstream	S25°45'35.80"	E29°45'17.40"
Klein Olifants System	C4 Upstream	S25°46'11.80"	E29°45'17.40"
Klein Olifants System	C4 downstream	S25°46'3.60"	E29°45'0.10"
Klein Olifants System	C5 Upstream	S25°46'56.60"	E29°44'53.60"
Klein Olifants System	C5 downstream	S25°46'55.50"	E29°44'43.70"
Klein Olifants System	Upstream of Wildfontein Mine	S25°46'15.90"	E29°48'24.30"
Klein Olifants System	Downstream of Wildfontein Mine	S25°46'7.98"	E29°46'49.20"
Klein Olifants System	Impacted Wetland Upstream	S25°46'37.50"	E29°48'19.80"
Steelpoort System	SP1	S25°44'5.700"	E29°51'12.266"
Steelpoort System	SP2	S25°43'22.080"	E29°49'58.738"
Steelpoort System	SP4	S25°40'51.150"	E29°49'2.803"
Steelpoort System	SP5	S25°39'8.776"	E29°51'7.297"
Pan System	Pan 26 (now Pan11)	S25°42'19.143"	E29°46'56.091"
Pan System	Pan 4	S25°43'13.99"	E29°48'36.56"
Pan System	Pan 5	S25°45'30.70"	E29°48'31.84"
Pan System	Pan 10	S25°43'37.58"	E29°48'10.24"
Pan System	Pan 10W	S25°42'7.42"	E29°45'32.53"
Pan System	Pan 11	S25°43'44.73"	E25°43'44.73"
Pan System	Pan 12	S25°46'35.85"	E29°44'19.24"
Pan System	Pan 13	S25°46'56.71"	E29°44'22.27"
Pan System	Pan 20	S25°42'34.91"	E29°45'7.50"
Pan System	Pan 23	S25°46'57.95"	E29°46'29.96"
Pan System	Pan 25	S25°42'24.03"	E29°46'13.40"
Pan System	Pan 29	S25°46'24.34"	E29°45'54.71"

Table 18 - Table 26 below show the results of the water quality analyses as compared against the IWUL limits. The values that are highlighted in red are values that are above (or below in the case of pH and dissolved oxygen) the recommended IWUL limit guidelines.

The following were noted through the water quality analysis:

- Benzene and naphthalene were recorded at low concentrations (0.002 mg/L and 0.004 mg/L) in January 2017 for sites K06 and K07. This shows a slight increase when compared to previous months;
- K01 shows non-compliance in concentrations of suspended solids, dissolved oxygen, turbidity and ammoniacal nitrogen (as NH_3);
- Exceedance in iron IWUL limits at sites K04, SP2 and SP4;
- Exceedance in chloride and sodium IWUL limits at sites K01, and Pan11;
- Pan 11 shows non-compliance throughout February 2017 to December 2017 with the IWUL limits for most constituents. This is to be expected, since pan water chemistry is typically quite different from flowing/fresh surface water;
- All the samples collected were above IWUL limits for ammoniacal nitrogen (as NH_3); and
- All the samples collected were above IWUL limits for orthophosphate with the exception to SP4 and SP5.

The results appear to indicate that the impacts are from agricultural activities in the area.

Table 18: Water quality results K01 and KO3 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	KO1 12/2017	KO1 01/2018	KO1 02/2018	KO1 03/2018	KO1 04/2018	KO3 02/2017	KO3 05/2017	KO3 06/2017	KO3 08/2017	KO3 08/2017	KO3 09/2017	KO3 10/2017	KO3 12/2017	KO3 01/2018	KO3 02/2018	KO3 03/2018	KO3 04/2018
pH	pH units	6.5 – 8.4	0.7	6.95	6.71	7.2	7.2	7.76	7.08	7.65	7.31	7.6	7.41	7.41	7.03	7.08	6.44	6.7	7.37
Electrical conductivity (EC)	mS/m	40	52.6	17.1	17.9	17.6	35.3	10.3	8.8	10.7	8.51	8.64	9.48	9.21	8.79	10.2	6.5	10.9	9.7
Suspended Solids	mg/l	25	60	69	<10	40	586	<10	14.4	16	<10	<10	<10	<10	20	11	139	61	39
Dissolved oxygen	mg/l	>6	<1	3	9	7	4	8	7	8	10	10	8	9	8	8	9	8	9
Sulphate as SO_4^{2-}	mg/l	30	21.8	3.6	<0.5	6.7	3.8	2.5	3.3	4.3	4.5	3	2.7	3.4	2.9	3.5	1.3	4.7	2.7
Sodium as Na	mg/l	20	46.9	12.5	21.4	19.7	41.1	12.9	8.9	10.3	10.5	10.8	12.1	11.9	10.6	10.2	9.9	12.3	9.7
Chloride as Cl^-	mg/l	30	32.7	8.5	13.7	12.3	46.7	4.2	7.4	8	7.8	7.1	4.7	7	5.2	6.2	6.1	11.4	7.9
Turbidity	NTU	5	154	40.2	35.5	66.6	350	831	14.4	15.4	15	15.5	17.4	15	15.2	10.4	83.7	34.1	15
Alkalinity as $CaCO_3$	mg/l	120	184	42	132	60	92	40	22	22	24	26	34	28	30	54	62	28	31
Iron as Fe	mg/l	1	0.104	0.399	2.007	0.244	0.465	1.16	0.28	0.414	0.4	0.237	0.5	0.344	0.449	0.77	0.416	0.629	0.252
Aluminium as Al	mg/l	1	0.023	<0.020	<0.02	0.053	<0.02	0.026	0.46	0.526	0.259	0.041	0.073	0.145	0.165	0.12	0.05	0.105	<0.02
Manganese as Mn	mg/l	1	6.267	0.055	268	0.128	0.575	0.133	0.028	0.016	0.032	0.033	0.071	0.052	0.05	0.05	59	0.123	0.032
Ammoniacal Nitrogen as NH_3	mg/l	0.007	3.61	0.54	0.07	0.42	1.34	1.2	0.15	0.15	0.22	0.04	0.08	<0.03	0.12	0.17	0.04	0.08	0.17
Ammoniacal Nitrogen as NH_4	mg/l	1	3.82	0.57	0.07	0.45	1.42	1.27	0.16	0.16	0.23	0.04	0.09	<0.03	0.13	0.18	0.04	0.09	0.18
Nitrite as N*	mg/l	6	<0.006	<0.006	<0.02	0.052	<0.006	0.055	<0.02	<0.006	0.043	0.049	<0.006	<0.006	<0.006	<0.006	<0.02	0.052	<0.006
Nitrate as N*	mg/l	6	<0.05	0.34	<0.2	0.23	0.27	0.81	1.8	0.45	0.66	0.54	0.7	0.38	0.54	0.38	0.7	0.45	0.43
Orthophosphate as PO_4	mg/l	0.05	0.39	<0.06	<0.06	0.45	<0.06	0.08	0.14	-	-	-	<0.06	<0.06	0.38	0.19	<0.06	<0.06	0.34
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPH (C8-C40)	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 19: Water quality results K04 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	KO4 02/2017	KO4 05/2017	KO4 06/2017	K04 08/2017	K04 08/2017	KO4 09/217	KO4 10/2017	KO4 12/2017	KO4 01/2018	KO4 02/2018	KO4 03/2018	KO4 04/2018
pH	pH units	6.5 – 8.4	7.32	6.83	7.22	6.84	7.15	6.72	7.15	6.49	6.88	7.43	6.41	6.65
Electrical conductivity (EC)	mS/m	40	5.1	4.6	4.37	3.67	3.6	8.6	4.53	4.2	5.4	3.7	5.6	4.2
Suspended Solids	mg/l	25	<10	16	10	<10	<10	10	<10	<10	<10	<10	11	<10
Dissolved oxygen	mg/l	>6	7	7	5	9	10	7	8	7	7	9	8	8
Sulphate as SO_4^{2-}	mg/l	30	1.9	2.3	3.2	3.7	2.4	15.3	2.3	2.3	2.2	0.9	3.2	2.2
Sodium as Na	mg/l	20	5.6	5.1	4.9	4.9	4.6	10.7	5.9	5.1	5	4.6	5.7	4.7
Chloride as Cl^-	mg/l	30	3.9	4.1	4.7	5	4.1	3.5	4	2.1	1.5	3.4	6.9	3.6
Turbidity	NTU	5	15.1	10.3	13.5	7.8	7.8	8.7	5.7	10.3	17	10.1	11.1	5.4
Alkalinity as $CaCO_3$	mg/l	120	16	12	7	8	8	18	12	15	22	62	14	14
Iron as Fe	mg/l	1	4.052	1.197	0.745	0.726	0.801	1.454	0.946	1.348	2.205	0.831	0.68	0.481
Aluminium as Al	mg/l	1	0.05	0.059	0.59	0.144	0.134	0.266	0.133	0.133	0.088	0.16	0.268	<0.02
Manganese as Mn	mg/l	1	0.217	0.042	0.014	0.017	0.024	0.067	0.041	0.081	0.206	50	0.033	0.024
Ammoniacal Nitrogen as NH_3	mg/l	0.007	1.43	0.06	0.12	0.07	<0.03	0.07	0.11	0.19	0.28	<0.03	0.06	0.07
Ammoniacal Nitrogen as NH_4	mg/l	1	1.51	0.06	0.13	0.07	<0.03	0.07	0.12	0.2	0.3	<0.03	0.06	0.07
Nitrite as N*	mg/l	6	<0.006	<0.02	<0.006	0.04	<0.006	<0.006	<0.006	<0.006	<0.006	<0.02	0.049	<0.006
Nitrate as N*	mg/l	6	0.23	0.7	0.23	0.36	<0.05	0.38	<0.05	0.32	0.34	<0.2	0.23	0.27
Orthophosphate as PO_4	mg/l	0.05	0.09	0.13	-	-	-	<0.06	0.14	0.45	0.19	<0.06	<0.06	0.33
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
EPH (C8-C40)	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-

Table 20: Water quality results K06 (February 2017 to April 2018)

	Units	IWUL Limit	KO6 02/2017	KO6 05/2017	KO6 07/2017	KO6 08/2017	KO6 08/2017	KO6 09/2017	KO6 10/2017	KO6 12/2017	KO6 01/2018	KO6 02/2018	KO6 03/2018	KO6 04/2018
pH	pH units	6.5 – 8.4	7.71	7.48	7.71	7.46	7.66	7.69	7.56	7.49	7.64	6.57	7.18	7.47
Electrical conductivity (EC)	mS/m	40	10.5	10.1	9.84	9.37	18.15	9.76	9.74	10.03	11	8.6	11.2	11.2
Suspended Solids	mg/l	25	22	24	<10	<10	12	12	12	14	11	18	74	<10
Dissolved oxygen	mg/l	>6	7	7	9	10	10	8	8	8	7	9	8	8
Sulphate as SO_4^{2-}	mg/l	30	2.3	3.6	3.7	4.2	3.3	2.2	2.8	2.7	3.1	3.1	3.8	2.8
Sodium as Na	mg/l	20	9.5	9	10.6	10.8	10.2	10.8	11.1	10.8	10.5	10.3	12.2	11
Chloride as Cl^-	mg/l	30	3.9	5.9	7.2	7.2	6	5	7	5.8	4.8	4.7	6.7	7.4
Turbidity	NTU	5	44.4	16.5	12.6	11.3	15.2	22.8	22.2	24.9	8.6	32.9	54.3	7.7
Alkalinity as $CaCO_3$	mg/l	120	42	30	27	29	31	40	32	36	42	84	40	40
Iron as Fe	mg/l	1	0.829	0.692	0.551	0.495	0.438	0.828	0.924	0.835	0.72	0.905	1.027	0.608
Aluminium as Al	mg/l	1	0.129	0.062	0.231	0.108	0.053	0.115	0.027	0.153	0.024	0.18	0.047	<0.02
Manganese as Mn	mg/l	1	0.069	0.028	0.021	0.024	0.031	0.042	0.023	0.035	0.036	34	0.048	0.031
Ammoniacal Nitrogen as NH_3	mg/l	0.007	1.2	0.24	<0.03	0.13	0.38	0.07	0.14	0.08	0.18	0.06	0.07	0.27
Ammoniacal Nitrogen as NH_4	mg/l	1	1.27	0.25	<0.03	0.14	0.4	0.07	0.15	0.09	0.19	0.06	0.07	0.29
Nitrite as N*	mg/l	6	0.055	3.6	<0.006	0.082	<0.006	<0.006	0.043	<0.006	0.046	<0.02	0.052	<0.006
Nitrate as N*	mg/l	6	0.77	<0.02	0.81	0.9	0.93	0.75	0.43	0.45	0.68	0.8	0.47	0.54
Orthophosphate as PO_4	mg/l	0.05	0.1	0.17	-	-	-	<0.06	0.14	0.39	0.19	<0.06	0.46	<0.06
Benzene	mg/l	0.1	<0.0005	-	<0.00005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.002	<0.0005	<0.002	<0.002
Toluene	mg/l	0.1	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ethylbenzene	mg/l	0.1	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
p/m-Xylene	mg/l	0.1	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	mg/l	0.1	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphathalene	mg/l	0.1	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	-	<0.004	<0.004
EPH (C8-C40)	mg/l	0.1	<0.01	-	<0.01	<0.01	-	<0.01	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01

Table 21: Water quality results K07 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	KO7 02/2017	KO7 05/2017	KO7 06/2017	KO7 08/2017	KO7 08/2017	KO7 09/2017	KO7 10/2017	KO7 12/2017	KO7 01/2018	KO7 02/2018	KO7 03/2018	KO7 04/2018
pH	pH units	6.5 – 8.4	7.83	7.38	7.81	7.44	7.88	7.75	7.78	7.49	7.13	7.79	7.19	7.37
Electrical conductivity (EC)	mS/m	40	29.8	20.83	18.75	30.3	20.73	23	25.4	27.1	18.3	62.8	16.3	15.5
Suspended Solids	mg/l	25	19	14	64	10	26	26	55	83	23	<10	<10	21
Dissolved oxygen	mg/l	>6	6	6	8	9	9	6	8	7	7	8	7	9
Sulphate as SO_4^{2-}	mg/l	30	6.3	25.9	32.9	27.3	17.3	10.4	27.3	23.3	28.8	65	22.2	16
Sodium as Na	mg/l	20	19.2	13.1	13.4	19.1	17.4	18.9	19.8	17.1	14.7	20.1	14.6	12.7
Chloride as Cl^-	mg/l	30	11.3	7.6	7.3	11.7	10	8.2	9.1	10.9	7.9	11.3	7.5	6.9
Turbidity	NTU	5	9	18	49.5	15.2	17.1	21.1	83.6	285	34.9	11.9	8.1	12.5
Alkalinity as $CaCO_3$	mg/l	120	132	52	37	100	72	88	76	88	40	322	44	40
Iron as Fe	mg/l	1	0.322	0.313	0.456	1.134	0.0494	0.754	0.338	0.41	0.63	0.02	0.081	0.358
Aluminium as Al	mg/l	1	<0.02	0.091	0.257	0.083	<0.020	0.03	<0.020	0.058	0.402	<0.02	<0.02	0.023
Manganese as Mn	mg/l	1	2.779	0.472	0.094	3.375	1.223	0.742	0.773	0.698	0.022	1651	0.013	0.203
Ammoniacal Nitrogen as NH_3	mg/l	0.007	0.16	0.56	0.37	2.99	1.13	0.76	1.17	1.14	0.14	1.31	0.05	0.12
Ammoniacal Nitrogen as NH_4	mg/l	1	0.17	0.59	0.39	3.17	1.2	0.8	1.24	1.21	0.15	1.39	0.05	0.13
Nitrite as N*	mg/l	6	<0.006	1.7	<0.006	0.11	<0.006	0.043	0.091	0.085	<0.006	0.51	0.049	<0.006
Nitrate as N*	mg/l	6	0.23	<0.02	0.32	0.68	<0.05	0.52	0.45	0.47	0.34	1.8	0.23	0.32
Orthophosphate as PO_4	mg/l	0.05	<0.06	<0.06	-	-	-	<0.06	<0.06	0.39	<0.06	<0.06	<0.06	<0.06
Benzene	mg/l	0.1	0.0005	-	<0.00005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.002	<0.0005	<0.002	<0.002
Toluene	mg/l	0.1	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ethylbenzene	mg/l	0.1	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
p/m-Xylene	mg/l	0.1	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	mg/l	0.1	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphathalene	mg/l	0.1	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	-	<0.004	<0.004
EPH (C8-C40)	mg/l	0.1	<0.01	-	<0.01	<0.01	-	<0.01	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01

Table 22: Water quality results SP1 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	SP1 02/2017	SP1 05/2017	SP1 06/2017	SP1 08/2017	SP1 08/2017	SP1 09/2017	SP1 11/2017	SP1 12/2017	SP1 01/2018	SP1 04/2018
pH	pH units	6.5 – 8.4	8.29	8.22	8.35	8.02	8.26	8.11	7.9	7.69	7.59	7.88
Electrical conductivity (EC)	mS/m	40	34.7	36.7	39.1	41.2	40.8	39.8	42	45.4	26.5	35.3
Suspended Solids	mg/l	25	<10	10	10	<10	<10	<10	<10	14	50	<10
Dissolved oxygen	mg/l	>6	7	8	8	10	10	9	8	8	7	9
Sulphate as SO_4^{2-}	mg/l	30	9.3	12.1	18.9	18.8	16.6	10.6	12.5	33.9	7.4	12.4
Sodium as Na	mg/l	20	17.2	15.5	17.3	18.8	18	18.7	19.1	17.9	12.9	15.7
Chloride as Cl^-	mg/l	30	17.8	17.8	21.5	21.9	22.1	20.3	22.8	25.3	11.5	16
Turbidity	NTU	5	2	4.4	3.9	3.5	4.2	4.1	3.8	8	34.2	3.2
Alkalinity as $CaCO_3$	mg/l	120	148	140	148	160	164	166	165	155	103	139
Iron as Fe	mg/l	1	0.078	0.098	0.1	0.156	0.139	0.105	0.126	0.105	0.297	0.101
Aluminium as Al	mg/l	1	<0.02	<0.02	<0.020	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	<0.02
Manganese as Mn	mg/l	1	0.77	0.047	0.039	0.061	0.072	0.108	0.101	0.095	0.065	0.047
Ammoniacal Nitrogen as NH_3	mg/l	0.007	1.57	0.14	0.14	0.08	0.13	<0.03	0.19	0.2	0.25	0.16
Ammoniacal Nitrogen as NH_4	mg/l	1	1.66	0.015	0.15	0.08	0.14	<0.03	0.2	0.21	0.27	0.17
Nitrite as N*	mg/l	6	<0.006	2	<0.006	0.043	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Nitrate as N*	mg/l	6	0.25	<0.02	0.66	0.84	0.47	0.52	0.47	0.41	0.38	0.34
Orthophosphate as PO_4	mg/l	0.05	0.08	<0.06	<0.06	<0.03	<0.03	<0.06	<0.06	<0.06	0.19	<0.06
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-
EPH (C8-C40)	mg/l	0.1	-	-	-	-		-	-	-	-	-

Table 23: Water quality results SP2 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	SP2	SP2	SP2	SP2	SP2	SP2	SP2	SP2	SP2
			08/2017	08/2017	09/2017	11/2017	12/2017	01/2018	02/2018	03/2018	04/2018
pH	pH units	6.5 – 8.4	7.89	8	7.98	8.02	7.78	6.89	6.51	7.16	7.16
Electrical conductivity (EC)	mS/m	40	26.4	25.7	23.8	22.1	23	12.3	9.6	13.4	17
Suspended Solids	mg/l	25	20	16	<10	40	61	11	13	36	45
Dissolved oxygen	mg/l	>6	10	9	9	8	8	6	8	7	8
Sulphate as SO_4^{2-}	mg/l	30	6.7	3.9	2.8	3.2	6.4	5.7	7	11.5	5
Sodium as Na	mg/l	20	18.1	17.1	15.4	15.4	17.4	8	9	10.7	13
Chloride as Cl^-	mg/l	30	9.9	8.2	6.5	3.2	4.3	6.1	5.5	8.2	8.3
Turbidity	NTU	5	17.2	8.8	12	26.6	32.2	13.8	17.8	21.1	56.6
Alkalinity as $CaCO_3$	mg/l	120	113	116	116	107	101	42	88	40	65
Iron as Fe	mg/l	1	0.106	0.112	0.225	0.236	0.318	1.252	0.325	0.521	0.401
Aluminium as Al	mg/l	1	<0.02	<0.020	<0.020	<0.020	<0.020	0.12	<0.02	0.051	<0.02
Manganese as Mn	mg/l	1	0.042	0.054	0.124	0.033	0.057	0.061	66	0.058	0.172
Ammoniacal Nitrogen as NH_3	mg/l	0.007	0.08	0.06	0.1	0.15	0.17	0.15	0.04	0.07	0.35
Ammoniacal Nitrogen as NH_4	mg/l	1	0.08	0.06	0.11	0.16	0.18	0.16	0.04	0.07	0.37
Nitrite as N*	mg/l	6	0.043	<0.006	<0.006	0.043	<0.006	<0.006	<0.02	0.049	<0.006
Nitrate as N*	mg/l	6	0.38	<0.05	<0.05	0.2	0.32	<0.05	<0.2	<0.05	0.29
Orthophosphate as PO_4	mg/l	0.05	0.08	<0.03	<0.06	0.14	0.38	<0.06	<0.06	<0.06	<0.06
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-
EPH (C8-C40)	mg/l	0.1	-		-	-	-	-	-	-	-

Table 24: Water quality results SP4 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	SP4 02/2017	SP4 05/2017	SP4 06/2017	SP4 08/2017	SP4 08/2017	SP4 09/2017	SP4 11/2017	SP4 12/2017	SP4 01/2018	SP4 02/2018	SP4 03/2018	SP4 04/2018
pH	pH units	6.5 – 8.4	7.78	7.43	7.63	7.34	7.46	7.02	7.3	7.3	6.77	6.4	6.99	7.22
Electrical conductivity (EC)	mS/m	40	8.9	7.67	8.18	7.8	7.79	9.8	8.45	6.97	7.8	6.6	6.8	8.7
Suspended Solids	mg/l	25	<10	14	10	<10	<10	16	<10	11	20	<10	48	<10
Dissolved oxygen	mg/l	>6	7	8	9	10	10	8	8	7	7	9	8	8
Sulphate as SO_4^{2-}	mg/l	30	2.1	3.1	3.2	4	3.4	4	2.6	2.9	3.3	1.8	5.4	3.1
Sodium as Na	mg/l	20	9.2	8.6	9.6	9.3	9.3	9.9	9.9	7.7	7.8	8.5	8.6	9.3
Chloride as Cl^-	mg/l	30	5.1	6.7	7	7.2	6.8	6.9	7.1	4.2	5.9	6	6.2	7.6
Turbidity	NTU	5	9	12.8	9.7	5.5	5.5	6.2	8.2	10.6	30.2	15	26	4.6
Alkalinity as $CaCO_3$	mg/l	120	34	18	17	20	22	29	25	24	21	58	16	24
Iron as Fe	mg/l	1	1.142	0.627	0.414	0.346	0.336	0.317	1.026	0.522	1.032	0.95	0.627	0.21
Aluminium as Al	mg/l	1	0.069	0.029	0.172	0.054	0.051	0.049	0.035	0.097	0.309	0.08	0.649	<0.02
Manganese as Mn	mg/l	1	0.128	0.022	0.021	0.017	0.017	0.121	0.033	0.047	0.039	42	0.045	0.033
Ammoniacal Nitrogen as NH_3	mg/l	0.007	1.28	0.28	0.12	0.07	<0.03	0.28	0.17	0.07	0.16	0.08	0.1	0.25
Ammoniacal Nitrogen as NH_4	mg/l	1	1.36	0.3	0.13	0.07	0.03	0.3	0.18	0.07	0.17	0.08	0.11	0.26
Nitrite as N*	mg/l	6	<0.006	3.3	<0.006	0.055	0.043	<0.006	<0.006	0.055	<0.006	<0.02	0.052	0.037
Nitrate as N*	mg/l	6	0.36	<0.02	1.13	1.11	1.04	0.7	0.43	0.47	0.5	2.2	0.41	0.7
Orthophosphate as PO_4	mg/l	0.05	0.11	<0.06	<0.06	0.08	<0.03	<0.06	<0.06	0.39	0.2	<0.06	<0.06	0.31
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
EPH (C8-C40)	mg/l	0.1	-	-	-	-		-	-	-	-	-	-	

Table 25: Water quality results SP5 (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	SP5	SP5	SP5	SP5	SP5	SP5	SP5	SP5	SP5	SP5	SP5	SP5
			02/2017	05/2017	06/2017	08/2017	08/2017	09/2017	11/2017	12/2017	01/2018	02/2018	03/2018	04/2018
pH	pH units	6.5 – 8.4	8.03	7.84	8.21	7.97	8.13	7.84	8.12	7.93	7.37	6.67	7.62	7.77
Electrical conductivity (EC)	mS/m	40	29.9	26.7	29.4	32.2	33.1	35.1	34	29.5	17.6	13.6	24.8	28.6
Suspended Solids	mg/l	25	11	12	24	51	<10	27	87	14	29	12	52	<10
Dissolved oxygen	mg/l	>6	5	7	7	9	9	8	8	7	8	5	8	9
Sulphate as SO_4^{2-}	mg/l	30	11.6	10.3	14	15.2	14.9	14.2	12.5	14.5	7.5	10	22.3	11.6
Sodium as Na	mg/l	20	15.4	13.9	16	16.3	17.5	17.7	17.3	14.5	10.5	10.4	13.9	14.5
Chloride as Cl^-	mg/l	30	11.7	11.9	13.8	14.2	14.5	13.5	15.3	11.2	8.1	8.2	13.7	12.8
Turbidity	NTU	5	2.9	5.8	18.8	15.1	5.3	10.4	25.8	10	35.3	8	50.5	6.7
Alkalinity as $CaCO_3$	mg/l	120	126	96	108	120	132	148	137	116	62	120	77	104
Iron as Fe	mg/l	1	0.069	0.245	0.102	0.115	0.116	0.048	0.122	0.183	0.442	0.419	0.24	0.13
Aluminium as Al	mg/l	1	<0.02	0.023	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020	0.073	<0.02	0.053	<0.02
Manganese as Mn	mg/l	1	0.076	0.018	0.019	0.028	0.039	0.57	0.066	0.05	0.027	28	0.029	0.025
Ammoniacal Nitrogen as NH_3	mg/l	0.007	0.19	0.17	0.12	0.28	0.35	0.05	0.58	0.15	0.21	0.04	<0.03	0.09
Ammoniacal Nitrogen as NH_4	mg/l	1	0.2	0.18	0.13	0.3	0.37	0.05	0.61	0.16	0.22	0.04	<0.03	0.1
Nitrite as N*	mg/l	6	<0.006	3.5	<0.006	0.04	0.043	<0.006	<0.006	<0.006	0.049	0.03	0.052	<0.006
Nitrate as N*	mg/l	6	0.29	<0.02	1.13	1.27	0.75	0.5	0.41	0.45	0.56	1.5	0.77	0.66
Orthophosphate as PO_4	mg/l	0.05	0.16	0.15	<0.06	0.09	<0.03	<0.06	<0.06	0.38	0.19	0.64	<0.06	<0.06
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	
EPH (C8-C40)	mg/l	0.1	-	-	-	-		-	-	-	-	-	-	

Table 26: Water quality results Pan26(11) (February 2017 to April 2018)

Water quality constituent	Units	IWUL Limit	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan26 (Pan11)	Pan 26 (Pan 11)	Pan 26 (Pan 11)
			02/2017	05/2017	06/2017	08/2017	08/2017	09/2017	10/2017	12/2017	01/2018	02/2018	03/2018	04/2018
pH	pH units	6.5 – 8.4	8.7	7.36	8.65	8.14	8.49	8.89	8.97	9.02	7.11	7.65	7.73	7.48
Electrical conductivity (EC)	mS/m	40	375	71.9	283	477	581	124.6	994	1250	193	55.3	305	153.4
Suspended Solids	mg/l	25	14	28.6	42	57	1376	1928	1364	468	176	21	18	30
Dissolved oxygen	mg/l	>6	5	1	8	4	6	<1	1	1	1	7	5	4
Sulphate as SO_4^{2-}	mg/l	30	110.1	39.7	105.6	160.3	267.5	609.9	477	739.1	72.9	15	70.4	8.8
Sodium as Na	mg/l	20	931.8	126.5	561.2	1061	1339.2	2994.1	2250.8	2917.5	374.2	101.7	624.9	279.5
Chloride as Cl^-	mg/l	30	796.8	96.4	598.4	1134.8	1367.3	3070.7	2425.1	3282.7	379.9	42.4	656.2	238.3
Turbidity	NTU	5	592	28.6	317	530	1454	2065	2223	3551	289	16.1	40.1	3.2
Alkalinity as $CaCO_3$	mg/l	120	592	159	356	636	773	1596	1206	1245	262	346	447	387
Iron as Fe	mg/l	1	0.079	0.807	0.666	0.48	0.147	0.111	<0.020	0.074	1.041	0.059	0.142	0.074
Aluminium as Al	mg/l	1	0.047	0.543	0.899	0.486	0.203	0.066	<0.020	0.053	1.184	<0.02	0.021	<0.02
Manganese as Mn	mg/l	1	0.003	0.031	0.004	0.11	0.034	0.7	0.005	0.013	0.135	14	0.021	0.019
Ammoniacal Nitrogen as NH_3	mg/l	0.007	-	0.66	-	-	-	-	1.13	-	-	0.08	-	-
Ammoniacal Nitrogen as NH_4	mg/l	1	-	0.7	-	-	-	-	1.2	-	-	0.08	-	-
Nitrite as N*	mg/l	6	<0.006	<0.2	<0.006	<0.006	<0.006	<0.006	<0.006	211.722	<0.006	<0.02	<0.006	<0.006
Nitrate as N*	mg/l	6	0.36	<0.02	0.54	<0.05	0.38	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05
Orthophosphate as PO_4	mg/l	0.05	1.79	0.25	2.97	1.09	1.49	<0.06	8.98	8.88	1.48	<0.06	1.01	<0.06
Benzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
p/m-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Naphathalene	mg/l	0.1	-	-	-	-	-	-	-	-	-	-	-	-
EPH (C8-C40)	mg/l	0.1	-	-	-	-		-	-	-	-	-	-	-

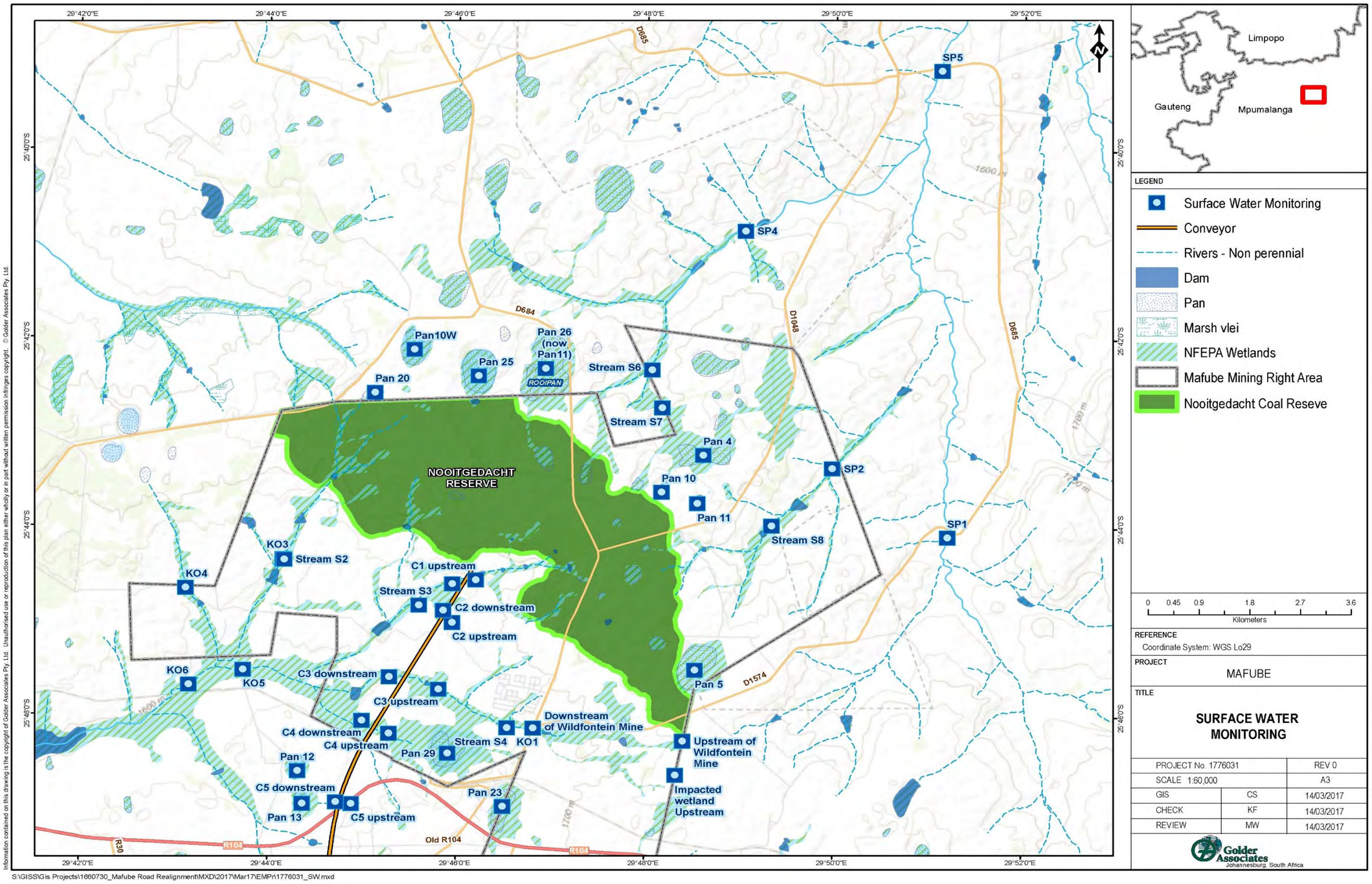


Figure 21: Surface water monitoring sites

8.6 Groundwater

Groundwater is the main source of water for domestic use and, to a lesser extent, for stock watering. The groundwater resource is accessed through boreholes and occasional springs. Borehole yields may average between 1 to 2 litres per second. The depth of the groundwater table varies with the season and may be anywhere between surface and a depth of about 16 m. The quality of the groundwater within the study area is generally very good.

8.7 Regional Ambient air quality

According to the HPA Baseline Assessment (2010), Steve Tshwete Local Municipality is considered a hotspot area where ambient air quality is poor and ambient PM_{10} and SO_2 concentrations regularly exceed the national ambient air quality standards (NAAQS). These exceedances are the cumulative result of emissions from industries, domestic fuel burning, motor vehicle emissions, mining and cross-boundary transport of pollutants (into the HPA). According to the Baseline document (2010), The Mafube LifeX project falls in an area where on average fewer than 3 exceedances of the daily PM_{10} air quality standard are predicted, (less than the allowable 4 exceedances per year) (Figure 22).

A cumulative study conducted for Eskom in 2006 predicted elevated PM_{10} concentrations to occur in the region, with background maximum daily concentrations between 25 µg/m³ and 75 µg/m³ and an annual average concentration of about 10 µg/m³.

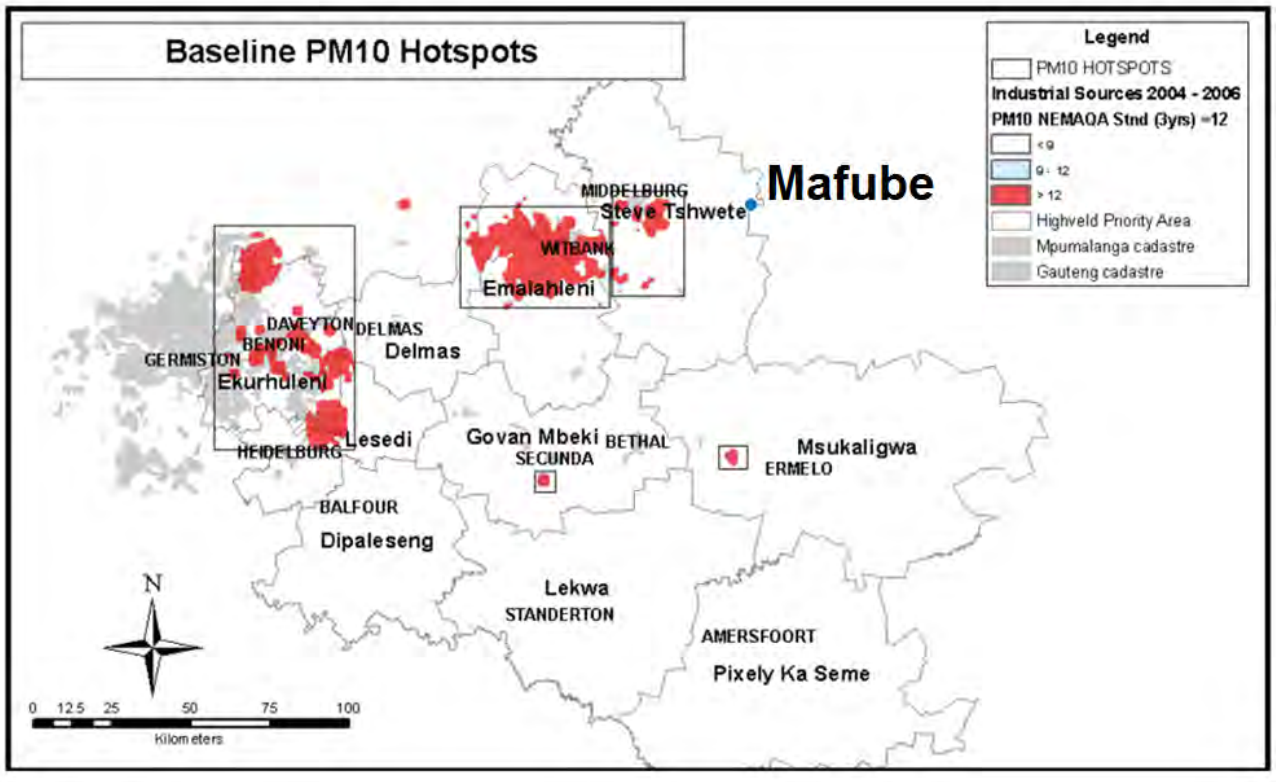


Figure 22: Baseline PM_{10} hotspots within the HPA (adapted from the HPA Baseline Assessment, 2010)

8.7.1 Sources of emissions

The current air pollution sources of concern in the vicinity of the Mafube LifeX project include:

- Other mines and quarries;
- Heavy vehicles using dirt roads;
- Vehicles' exhaust emissions;

- Coal fired power stations;
- Domestic fuel burning; and
- Agriculture.

These sources and associated emissions are further discussed in the sections that follow.

8.7.1.1 Mining activities

Coal mining operations are prominent emission sources in the HPA. Mining operations include activities that result in the entrainment/suspension of particulate matter, including but not limited to:

- The use of vehicles on unpaved and paved roads for transporting coal, personnel, waste rock etc.;
- Blasting;
- Overburden stripping;
- Coal and overburden materials handling;
- Crushing and screening of coal; and
- Wind entrainment from stockpiles, waste rock dumps and tailings storage facilities.

Dust emissions occur at several points in the storage cycle, such as coal loading onto haul trucks in the mine, discharge onto the Run of Mine (RoM) stockpile, and disturbances by strong wind currents, and load-out from the stockpile (Cowherd et al., 1988). Factors which influence the rate of wind erosion include surface compaction, moisture content, vegetation, and shape of storage pile, particle size distribution, wind speed and rain.

The potential for particulate emissions is at a maximum when fresh coal is loaded onto a stockpile. Fine coal particles are easily disaggregated and released to the atmosphere upon exposure to air currents, either from the coal transfer itself or from wind erosion (USEPA, 2006).

Gases emitted from coal stockpiles include volatile organic compounds (VOC's); carbon oxides, hydrocarbons, sulphurous gases and hydrogen. The potential sources of these gases include degassing, low temperature oxidation and, in extreme cases, spontaneous combustion.

Coal beds contain reservoirs of gases, mainly carbon dioxide (CO_2) and methane (CH_4). These gases are stored on the internal surfaces of organic matter or within the layered structure of the coal. From the moment that coal is exposed to air, it is subject to low temperature oxidation (weathering) by atmospheric oxygen. This process can be sustained if the heat produced by the exothermic oxidation cannot be sufficiently dissipated by heat transfer within the stockpile. Temperatures are therefore generally higher and atmospheric pressures lower than those occurring in the coal beds. These conditions are ideal for degassing. In addition to the CO_2 and CH_4 emitted in the degassing process, dimethylsulphide (DMS) is emitted from lignite (IEA Clean Coal Centre, 2013).

Spontaneous combustion is caused when coal oxidizes and airflow is insufficient to dissipate the heat. During combustion, the reaction between the coal and the air produces oxides of carbon, including CO_2, oxides of sulphur (SO_x), and various oxides of nitrogen (NOx). Because of the hydrogenous and nitrogenous components of coal, hydrides and nitrides of carbon and sulphur are also produced during the combustion process. These include hydrogen cyanide (HCN), sulphur nitrate (SNO_3) and other toxic substances including: arsenic, lead, mercury, nickel, vanadium, beryllium, cadmium, barium, chromium, copper, molybdenum, zinc, selenium and radium (World Coal Institute, 2008).

8.7.1.2 Vehicle emissions

Air pollution generated from vehicle emissions may be grouped into primary and secondary pollutants.

Primary pollutants are those emitted directly to the atmosphere as exhaust emissions, whereas secondary pollutants are formed in the atmosphere as a result of atmospheric chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The primary pollutants emitted typically include CO_2, CO, hydrocarbons (including benzene, 1.2-butadiene, aldehydes and polycyclic aromatic hydrocarbons (PAHs)), SO_2, NO_x and particulates. Secondary pollutants formed in the atmosphere typically include NO_2, photochemical oxidants such as O_3, hydrocarbons, sulphuric acid, sulphates, nitric acid, and nitrate aerosols (USEPA, 1995).

The quantity of pollutants emitted by a vehicle depends on specific vehicle related factors such as vehicle weight, speed and age; fuel-related factors such as fuel type (petroleum or diesel), fuel formulation (oxygen, sulphur, benzene and lead replacement agents) and environmental factors such as altitude, humidity and temperature (Samaras and Sorensen, 1999).

Pollutants emitted from heavy off-highway vehicles include: particulate matter (PM), NO_X, CO and SO_2. CO is produced as a result of incomplete combustion, while NO_x results from the oxidation of nitrogen at high temperature and pressure in the combustion chamber. SO_2 is derived from the combustion of sulphur in diesel. PM is produced from the incomplete combustion of the diesel, additives in fuels and lubricants, and oil breakdown products that accumulate in the engine lubricant.

8.7.1.3 Vehicle entrainment of dust on unpaved roads

Dust entrainment on unpaved roads is a significant source of local dust emissions in the region Figure 23. Particulate emissions from paved roads occur when loose, spilt material on the road surface becomes suspended as vehicles travel across the road surface and/or when fine particulates are blown from the transported load. At industrial and construction sites the surface loading is continually replenished by carry-over of material from unpaved roads and spillage from vehicles. Various field studies have shown that even paved roadways can be major sources of atmospheric particulate matter (USEPA, 1995).

Figure 23: Dust generated on D648 by heavy (left) and light (right) motor vehicles (Golder, 2016)

8.7.1.4 Power generation

As a result of the high temperature combustion process, air pollutants released by coal-fired power stations primarily include fine particulates (PM_{10} and $PM_{2.5}$), SO_2, NO_x, nitric oxide (NO), NO_2, CO, CO_2, nitrous oxide (N_2O), and trace amounts of mercury.

The non-combustible portion of the fuel remains as solid waste. The coarser, heavier waste is called bottom ash and is extracted from the burner, and the lighter, finer portion is fly ash, usually emitted as particulates through the stack and resulting in the formation of particulate matter which is liberated to the atmosphere via a stack (post scrubbing at most power stations).

8.7.1.5 Domestic fuel burning

Both formal and informal housing are noted throughout the region. It is therefore highly likely that households within these communities will use coal, wood and paraffin for space heating and/or cooking purposes. Emissions from these communities are therefore anticipated to impact the region, especially during the winter period due to the increased demand for space heating and occasional temperature inversion conditions.

Domestic fuel burning of coal emits a large amount of gaseous and particulate pollutants, including sulphur dioxide, heavy metals, total and respirable particulates, inorganic ash, carbon monoxide, polycyclic aromatic hydrocarbons (PAHs), and benzo(a)pyrene. Pollutants arising from the combustion of wood include respirable particulates, NO_2, CO, PAHs, particulate benzo(a)pyrene and formaldehyde. The main pollutants emitted from the combustion of paraffin are NO_2, particulates, CO and PAHs.

8.7.1.6 Agriculture

The area largely comprises large-scale, commercial crop farming. Crop farming may result in increased particulate emissions during the dry winter period due to seasonal wild fires, fallow farmlands, and large scale field ploughing.

8.7.2 Land use and sensitive receptors

Current land use in the vicinity of the proposed route comprises cultivated land and pasture. With the development of the LifeX project, large portions of the cultivated land west of the proposed route will be mined (Figure 24: East Pit 2 and 3).

Receptors in the vicinity of the proposed route include wetlands, low density (dispersed) households and farm complexes. A school is located approximately 1 km north of the proposed route, adjacent to the existing route D684. Sikhululiwe is the closest village, approximately 2 km east of the proposed route.

8.7.3 Local ambient air quality monitoring

Dust fallout monitoring has been undertaken in the vicinity of the Mafube mining operations since 2014. Table 27 and Figure 25 display annual average dust fallout results measured at Mafube between 2014 and 2017. Results show annual average dust fallout remained below the 600 mg/m^2/day residential area threshold at all locations, with the exception of D7 (2016), D9 (2015 and 2016) and D13 (2016 and 2017).

Table 28 below displays the results of the dust fallout and particulate monitoring results for December 2017. There was one measured exceedance of the Residential Dust-fallout Standard Limit (600 mg/m^2/day) during the monitoring period. There were no measured exceedances of the NEM: AQA standards or WHO/IFC guidelines for particulates (Note: these results need to be gravimetrically validated).

Table 27: Annual average dust-fallout results 2014 – 2017.

Site	2014	2015	2016	2017
MZ	245	405	N/A	N/A
MX	168	314	N/A	N/A
D3-N	121	138	389	N/A
D3-E	131	148	386	N/A
D3-S	127	190	453	N/A
D3-W	135	187	566	N/A
MA	414	155	N/A	N/A
MB	434	159	N/A	N/A
MC	500	235	N/A	N/A
MD	365	80	N/A	N/A
ME	92	52	N/A	N/A
MY	303	291	N/A	N/A
MV	N/A	280	N/A	N/A

Site	2014	2015	2016	2017
D3	188	268	435	N/A
D10	N/A	324	545	N/A
D6	N/A	525	448	304
D7	N/A	305	**840**	441
D8	N/A	229	368	314
D9	N/A	**1328**	**1201**	N/A
D11	N/A	316	384	154
D12	N/A	161	289	229
D13	N/A	N/A	**1061**	**1191**
D14	N/A	N/A	478	356
D8-E	N/A	112	554	216
D8-W	N/A	114	481	215
D8-N	N/A	98	447	208
D8-S	N/A	119	476	176
D6-E	N/A	309	334	228
D6-W	N/A	279	355	307
D6-N	N/A	275	304	222
D6-S	N/A	325	324	205
D14-E	N/A	N/A	396	192
D14-W	N/A	N/A	407	174
D14-N	N/A	N/A	265	173
D14-S	N/A	N/A	472	158
Network Recovery	98%	91%	87%	84%

Notes:
Red indicates exceedances.

Figure 24: Potential receptors in close proximity (<1 km) to the preferred route alternative F (optimised route not shown, refer to Figure 5)

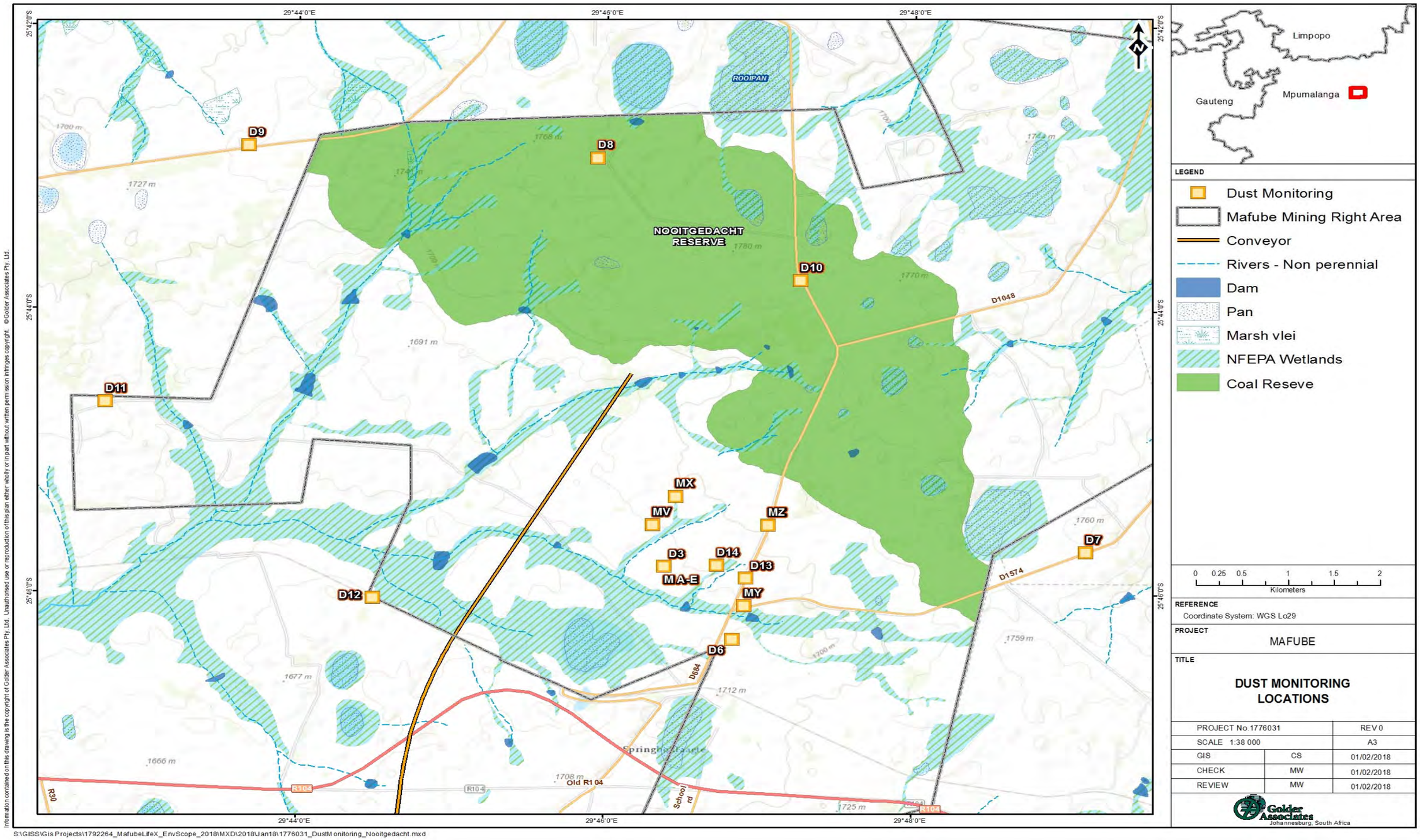


Figure 25: Location of the dust fallout monitoring network

Table 28: Dust fallout results (previous 12 months included for comparison)

Dust-fallout (mg/m²/day)	2016/12/21 to 2017/01/24	2017/01/24 to 2017/02/24	2017/02/24 to 2017/03/23	2017/03/23 to 2017/05/03	2017/05/03 to 2017/06/22	2017/06/22 to 2017/08/01	2017/08/01 to 2017/08/29	2017/08/29 to 2017/09/29	2017/09/29 to 2017/10/30	2017/10/30 to 2017/12/04	2017/12/04 to 2018/01/09	2017/12/04 to 2018/01/09	2018/01/09 to 2018/02/07	2018/02/07 to 2018/03/01	2018/03/01 to 2018/03/29	2018/03/29 to 2018/04/25	Average
D6	502	394	283	130	211	279	471	490	560	264	163	163	163	350	539	204	323
D7	257	No Data	No Data	777	288	704	No Data	592	638	506	915	915	126	No Data	No Data	256	543
D8	No Data	357	655	144	101	739	373	235	367	224	No Data	No Data	No Data	115	643	189	345
D9	No Data	No Data	No Data	No Data	No Data	No Data	1169	1422	2750	1591	No Data	No Data	293	No Data	405	3618	1607
D11	No Data	No Data	No Data	No Data	154	234	188	302	759	461	No Data	No Data	854	1127	508	805	539
D12	No Data	No Data	No Data	332	127	172	292	589	379	304	415	415	120	No Data	301	299	312
D13	1135	1341	2045	939	494	No Data	1861	1444	1242	2347	No Data	No Data	464	2891	236	1023	1343
D14	403	494	341	312	229	355	940	555	480	No Data	138	138	1438	439	No Data	239	464
D8-E	171	363	71	306	167	568	939	287	361	213	238	238	226	164	227	187	295
D8-W	95	401	296	85	195	711	780	243	368	209	388	388	77	451	157	393	327
D8-N	281	56	486	95	120	577	752	266	317	178	260	260	64	250	362	292	289
D8-S	144	120	333	166	118	633	713	322	440	199	168	168	310	226	379	172	288
D6-E	526	83	186	187	157	277	1116	383	488	309	220	220	93	167	No Data	401	321
D6-W	774	155	160	248	196	225	502	377	521	254	127	127	71	98	No Data	221	270
D6-N	523	99	182	173	133	224	401	412	433	265	209	209	106	717	355	200	290
D6-S	558	74	104	141	146	217	427	425	467	249	326	326	88	249	355	378	283
D14-E	130	222	341	92	174	266	458	182	320	No Data	188	188	127	621	346	225	259
D14-W	113	255	207	136	157	314	489	397	290	No Data	204	204	184	899	251	311	294
D14-N	No Data	175	256	97	164	210	313	239	185	No Data	209	209	186	275	266	170	211
D14-S	104	143	280	130	134	166	398	341	162	No Data	178	178	180	205	344	155	206
Network Average	**381**	**296**	**389**	**249**	**182**	**382**	**662**	**475**	**576**	**505**	**272**	**272**	**272**	**544**	**355**	**487**	**394**
Network Recovery	**75%**	**80%**	**80%**	**90%**	**95%**	**90%**	**95%**	**100%**	**100%**	**75%**	**80%**	**0%**	**95%**	**85%**	**80%**	**100%**	

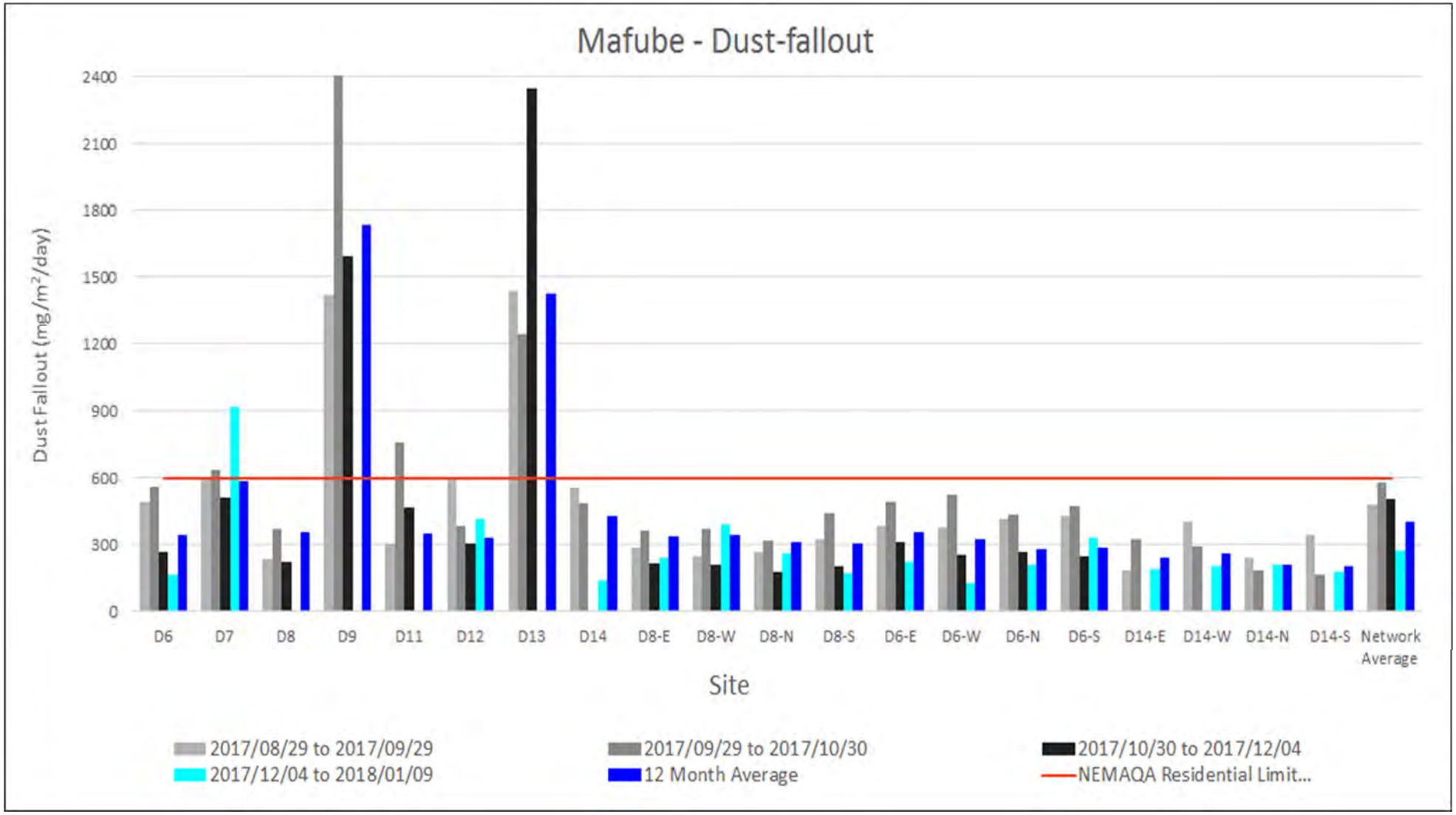


Figure 26: Dust-fallout results (previous 3 months included for comparison)

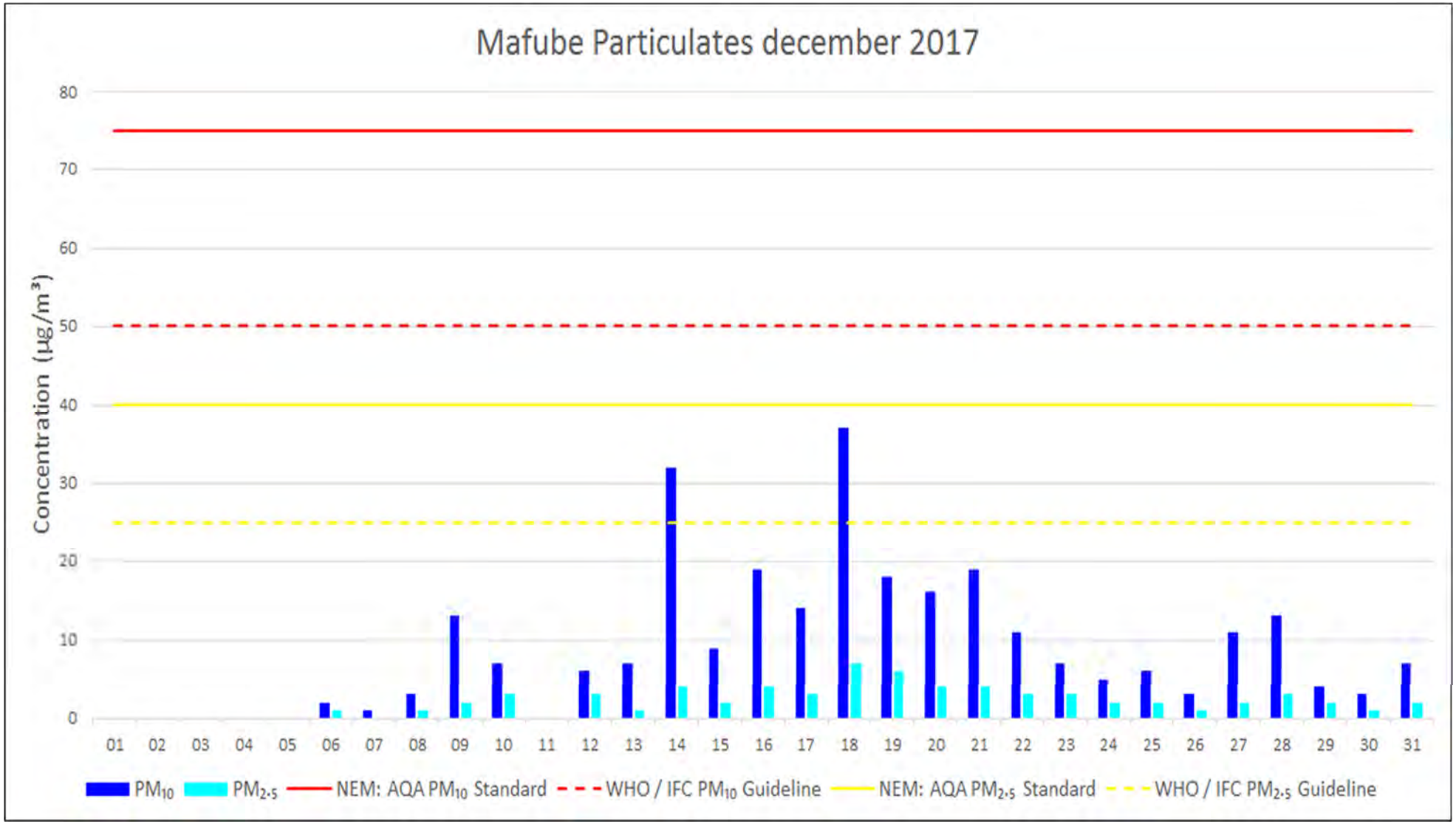


Figure 27: Particulate results (December 2017)

Table 29: Particulate results (December 2017)

Date	TSP (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	PM_1 (µg/m^3)
2017/12/01	-	-	-	-
2017/12/02	-	-	-	-
2017/12/03	-	-	-	-
2017/12/04	-	-	-	-
2017/12/05	-	-	-	-
2017/12/06	2	2	1	0
2017/12/07	1	1	0	0
2017/12/08	5	3	1	0
2017/12/09	21	13	2	0
2017/12/10	9	7	3	1
2017/12/11	-	-	-	-
2017/12/12	7	6	3	1
2017/12/13	10	7	1	0
2017/12/14	53	32	4	1
2017/12/15	13	9	2	0
2017/12/16	29	19	4	1
2017/12/17	23	14	3	1
2017/12/18	54	37	7	1
2017/12/19	24	18	6	1
2017/12/20	21	16	4	1
2017/12/21	30	19	4	1
2017/12/22	17	11	3	1
2017/12/23	10	7	3	1
2017/12/24	8	5	2	0
2017/12/25	10	6	2	0
2017/12/26	4	3	1	0
2017/12/27	19	11	2	0
2017/12/28	21	13	3	1
2017/12/29	6	4	2	0
2017/12/30	5	3	1	0
2017/12/31	11	7	2	1
Average	17	11	3	1

8.8 Biodiversity (Terrestrial, Aquatic and Wetland Ecology)

Aquatic Ecology Methodology

This Baseline Assessment Report from an aquatic ecology perspective was based on the following two components:

- Literature Review – The literature review was based on a desktop study of existing ecological specialist reports, GIS maps and expected fish lists (Kleynhans *et al.,* 1999, IUCN, 2016.3). The aim of the literature review was to develop a broad historical characterisation of the study area, including the presence and potential presence of species of conservation importance, (i.e. Red Data and protected species); and
- Existing data – as a number of aquatic assessments and biomonitoring surveys have been, and continue to be, conducted in the study area by Golder for Mafube (Golder Report No's.: 11616366-11381-8, 1412454-13511-4, 1660730-312402-3), data were retrieved from these studies. Data from the most recent survey conducted during December 2016, which formed part of the wet season aquatic biomonitoring programme for the Mafube LifeX Project, was used, coupled with historical data taken from surveys conducted in September 2011, March 2012, November 2014 and May 2015, also for the Mafube LifeX Project and Mafube Nooitgedacht Environmental Impact Assessment Project.

Wetland Study Methodology

Information presented on wetlands and pans in the study area is based on the 2011/2012 study (see Golder Report No. 11616366-11460-13) and a 2014 report by Wetland Consulting Services (Pty) Ltd. Both studies included a field programme and associated sampling.

Terrestrial Ecology Methodology

Terrestrial ecology data presented is based on the 2011/2012 study (see Golder Report No. 11616366-11332-6) but has been updated to reflect current conservation status.

The terrestrial ecology study for the original Mafube LifeX Project was conducted during 2011 and 2012. The study comprised two components; a literature review and a field programme. The tasks associated with these components are briefly summarised below:

- Literature Review – The literature review was based on a desktop study of existing ecological specialist reports, biodiversity and conservation databases and guidelines, as well as legislation relevant to the area. The aim of the literature review was to develop a broad historical characterisation of the study area, with an emphasis on identifying and delineating preliminary vegetation communities/land units and compiling lists of flora and fauna potentially occurring on site. The presence and potential presence of species of conservation importance, (i.e. Red Data and protected species) were also highlighted; and
- Field Programme – the field programme consisted of two field surveys; a dry season field survey was conducted in September 2011 and a wet season survey in February 2012. Field surveys comprised both flora and fauna sampling. Vegetation was sampled using line-transects selected in the various vegetation communities/land units. Fauna were sampled using a combination of traps, spot counts and direct (opportunistic encounters) and indirect observations (identification of burrows, tracks, faeces).

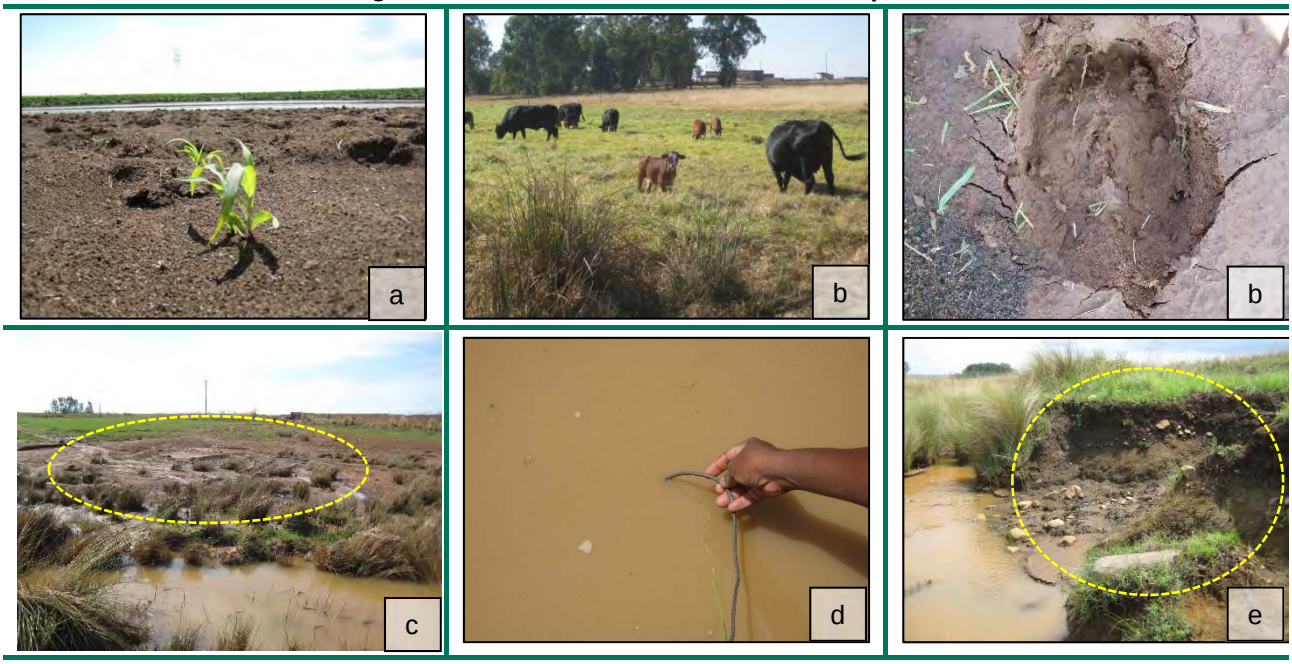
8.8.1 Aquatic Ecology

8.8.1.1 Aquatic Study Area – Regional Context

The study area falls within the Olifants Water Management Area (WMA4), Quaternary Drainage Region B12C (Klein-Olifants River) and B41A (Steelpoort River) within the Highveld (11) – Lower Level 1 Ecoregion and the Grassland Biome (Mucina and Rutherford, 2006 and Dallas, 2007). The rivers which have been assessed previously, and which may be affected by the proposed road re-alignment project, include the Steelpoort system and pan systems (Figure 28). In accordance with the Department of Water and Sanitation (DWS, 2013) the Present Ecological Status (PES) of the Steelpoort River is a Class C (moderately modified) (Figure 28). It is important to note that the Steelpoort River falls within a fish sanctuary for *Enteromius anoplus* (Figure 28). Furthermore, the river falls under the Mpumalanga Biodiversity Conservation Pan (MBCP) for rivers, as it is a highly significant strategic water resource area (Figure 28).

There are a number of surrounding impacts in the study area namely, natural and man-made barriers, land use and utilisation of resources (Table 30). It is important to take note of these as any modification or disturbance to the sites or surrounding catchment may have an effect on the biological results previously collected in the aquatic system. As the study area falls within an economic hub for agricultural and mining activities, there are a range of anthropogenic impacts on the Steelpoort River, adjoining tributaries and pan systems.

Table 30: Resource utilization and surrounding impacts in the study area

Illustration and Discussion
Agricultural Activities and Associated Impacts

Agricultural activities (a) within the direct project area are substantial with free roaming cattle (b) have been observed through-out. Overgrazing results in exposed ground cover and promotion of increased runoff velocities (c) that transport particulates (d) into the receiving rivers, and further resulting in erosion (e). Large commercial maize fields (a) are located within and surrounding the project area. The pesticides and herbicides used for the management of these crops, further have direct impacts on the rivers in the project area.
Nutrient Inputs

Visible nutrient inputs have been noted. However, high nutrient input has been noted during previous surveys, particularly in November 2014.

Illustration and Discussion
This may have been attributed to the high level of agricultural activities within the project area. High nutrient input (in the form of nitrates and phosphates) contributed to large volumes of algae blooms at various sites, a sign of eutrophic conditions. The sources of such nutrients may be from the surrounding land-use in the area, potentially from mining and agricultural activities.

The rivers drain the study area in a north-easterly direction and thus may potentially be directly or indirectly impacted upon.

The sites assessed included 4 sites in the Steelpoort system and 9 pans (Figure 28). Co-ordinates of these sampling sites, coupled with site descriptions, are listed in Table 31. A map of the study area showing the selected aquatic sampling sites is presented in Figure 29.

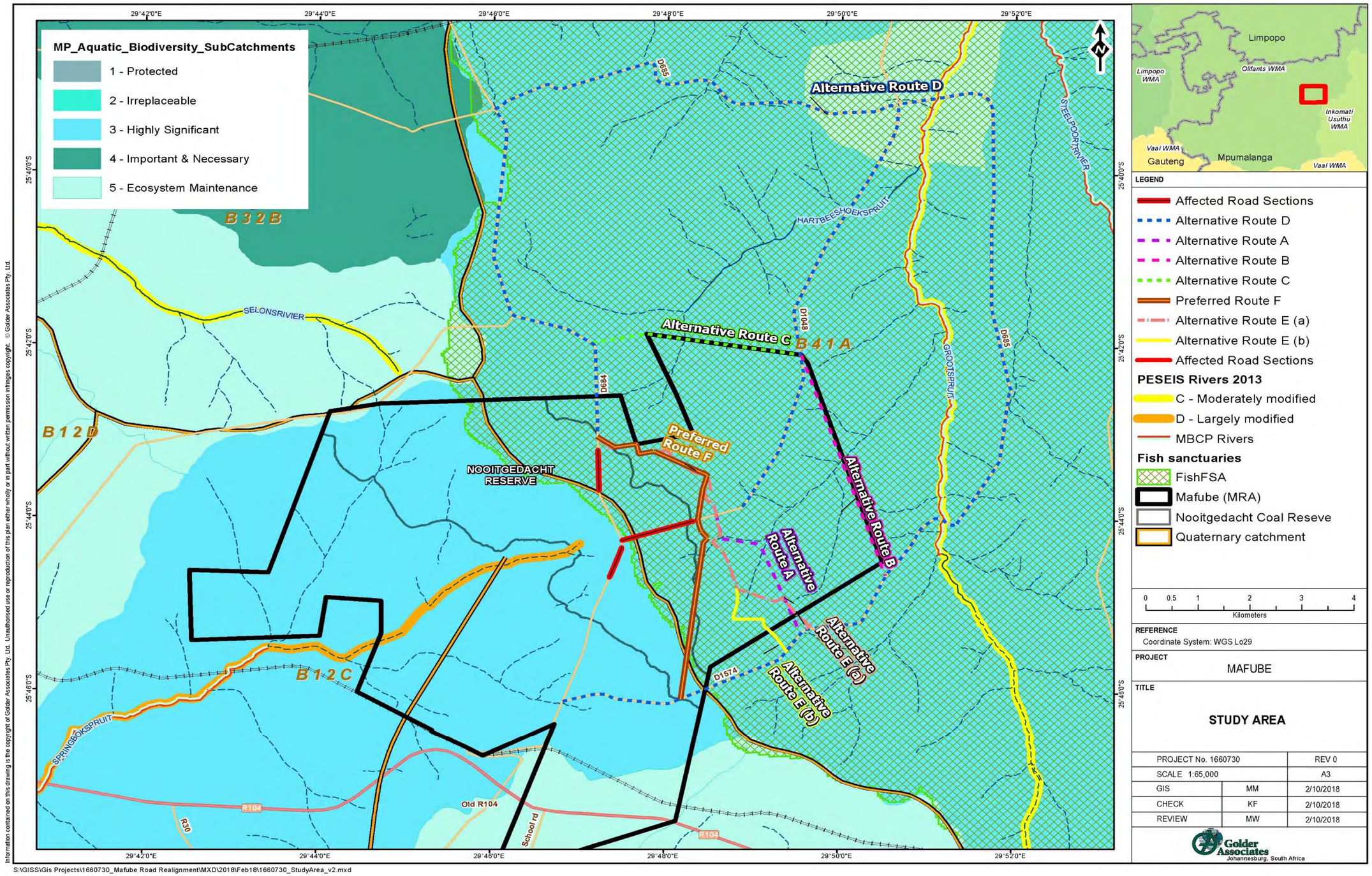


Figure 28: Aquatic study location

Table 31: Selected aquatic sampling sites previously monitored for the Mafube LifeX Project, with three additional pan sites potentially affected by the proposed road realignment project (*WGS_84 Datum co-ordinate system represented in decimal degrees)*

River/pan name	Site Name	Longitude	Latitude	Aquatic System	Description	Flow Conditions at the time of the December 2016 survey
Rivers						
Steelpoort	SP1	29.853407	-25.734917	River	This site is located upstream on the Steelpoort River, west of the proposed new D1048 alternative B road realignment.	Slow Shallow Limited flow conditions
	SP2	29.832983	-25.7228	River	Located within a very deep channel in the Steelpoort River on a farm on the proposed new D1048 alternative B road realignment.	Slow Deep Limited flow conditions
	SP4	29.817445	-25.680875	River	The site is located downstream, north of the proposed new D684 alternative C road realignment.	Slow Shallow Moderate flow conditions
	SP5	29.852027	-25.652438	River	This site is the only downstream site located north-east of the proposed new D684 alternative C road realignment situated on the Steelpoort River. The site is further located beyond the Mafube LifeX mining lease area, north-east of the mining infrastructure.	Slow Deep Limited flow conditions
Pans						
Pans	Pan 5	29.808845	-25.758527	Pans	Located upstream from the proposed new D1048 alternative A road realignment.	Shallow water level following rainfall event Sampled Pan (Aquatics)
	Pan 4	29.810156	-25.720554		Located downstream from the proposed new D1048 alternative A road realignment.	Dry (Grass Pan/Seep)
	Pan 10	29.802845	-25.727105			Dry (Grass Pan/Seep)
	Pan 11	29.809186	-25.72909			Dry (Grass Pan/Seep)

River/pan name	Site Name	Longitude	Latitude	Aquatic System	Description	Flow Conditions at the time of the December 2016 survey
	Pan 26 (now Pan 11)	29.782248	-25.705318		Located upstream from the proposed new D684 alternative C road realignment.	Shallow water level following rainfall event Sampled Pan (Aquatics)
	Pan C1	29.817431°	-25.701212°		Located adjacent to the proposed new D1048 alternative A road realignment.	Dry (Grass Pan / Seep).
	Pan C2	29.810748°	-25.705177°			
	Pan C3	29.813902°	-25.698461°			

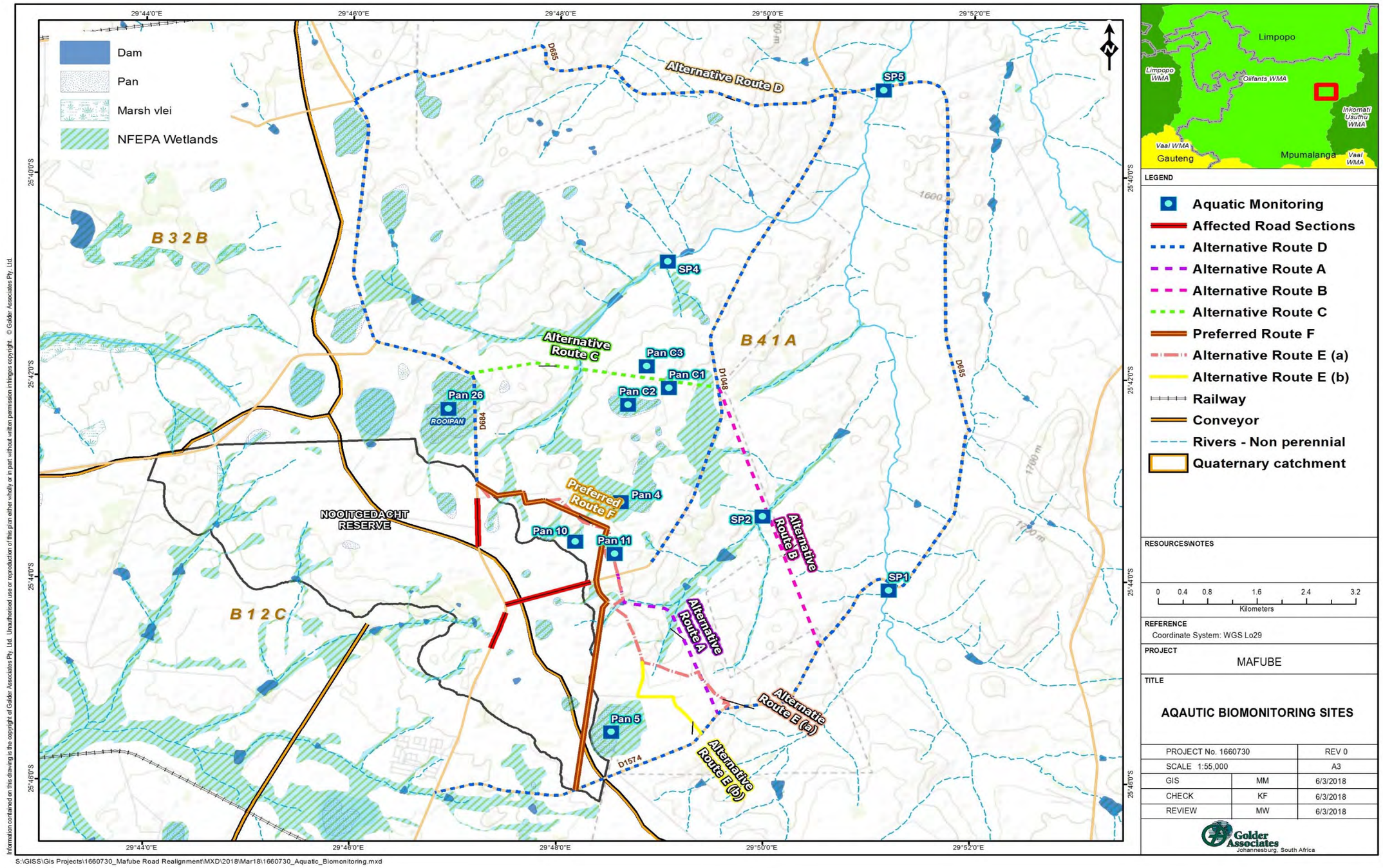


Figure 29: Aquatic biomonitoring sampling sites

8.8.1.2 In situ Water Quality

The *in situ* water quality results within the study area have exhibited both spatial and temporal fluctuations. The Steelpoort River's water quality has mostly been acceptable in terms of aquatic ecosystem standards. The percentage saturation levels of dissolved oxygen have however fluctuated within the Steelpoort River system, which were below the guideline value of 80% during some surveys (Golder report No. 1660730-312402-3). The low saturation levels recorded at the time of all the previous surveys, including the most recent survey, were probably linked to limited flow conditions at the sites, coupled with decaying organic matter on the stream bed. During the decay of the organic material, the microbes involved consume oxygen in the water column and this will result in hypoxic conditions that can increase respiratory stress, changes in behaviour and consequently elevated mortality rates amongst aquatic biota (Davies and Day, 1998). According to Davies and Day (1998) DO fluctuations can occur in polluted water where salinity can cause an increase in the concentration, while salinity, decomposition of organic pollutants and chemical pollutants can lower the available oxygen in the water. In terms of the pans, pH, TDS concentrations and oxygen saturation at some sites either exceeded or fell below the guideline values. However, as pans are closed systems, with no 'flushing' of water taking place, these results were expected.

In general, the current state of the *in situ* water quality within the study area may be a consequence of the surrounding agricultural and mining practices taking place within the surrounding area. Furthermore, the physical stream characteristics such as limited flow, channelization, instream and bank erosion further contribute to the results observed in the past.

8.8.1.3 Habitat Availability

Overall, the aquatic systems within the study area are homogenous with limited habitat availably. Historically, habitat availability, particularly within the Steelpoort River (site SP5), has been recorded as *good* to *poor* (Table 32). This site is characterised by stones-in-current, likely contributing to the *good* and *adequate* habitat availability recorded during the September 2011 and March 2012 surveys respectively (Table 32). The *poor* habitat availability recorded since November 2014, was likely attributed primarily to its deep and wide channel and limited flow conditions. Habitat availability within the adjoining tributaries of the Steelpoort River (visually assessed during previous surveys) would more than likely reflect poor habitat diversity. This may further be as a result of the study area being located high up in the catchment, whereby valley bottom systems have become eroded and thus resulting in naturally poor habitat conditions.

Overall it can be said that the limited habitat availability within this system, including surrounding aquatic systems, is not a consequence of the mining activities, but is rather attributable to agricultural activities in the project area. Cattle activity, such as trampling and overgrazing, is resulting in bank and head cut erosion (Table 30 b, c and e) and thus having an effect on the aquatic habitat.

Table 32: Historical Integrated Habitat Assessment System scores for site SP5 on the Steelpoort River (Golder Report No. 1660730-312402-3)

River	Site	IHAS Score (%)				
		Sep'11	Mar'12	Nov'14	May'15	Dec'16
Steelpoort	SP5	64	75	47	32	48

8.8.1.4 Aquatic Macroinvertebrates

Historically, the aquatic macroinvertebrate assemblages within the Steelpoort system have been relatively low. This is primarily attributed to the *poor* habitat availability (limited biotopes) and homogenous nature of the river system which supports far less biota in the study area. Similar taxa, namely tolerant air breathing taxa and taxa not highly sensitive to pollution impacts, are consistently being recorded within the Steelpoort system and surrounding tributaries. The biotic integrity of the aquatic macroinvertebrate communities in the study area range from slightly impaired (PES Class B – site SP1 and SP2) to severely impaired (PES Class E – site SP4) within the Steelpoort River (Golder Report No. 1660730-312402-3). In general, the relatively low biotic integrity in the study area is not a direct influence of the mining activities in the study area, but more from agricultural practices as mentioned in Section 8.8.1.2. Furthermore, the fact that these river systems have poor habitat availability and no riparian canopy, further contributes to poor biotic integrity.

Cattle trampling and grazing adjacent to the aquatic systems is resulting in exposed soils, increasing the run-off into the rivers, coupled with bank erosion. This has resulted in instream modification temporally, having a direct impact on the aquatic macroinvertebrate assemblages in the study area. Furthermore, high nutrient load into the aquatic systems is resulting in high algae growth. This reduces habitat availably, smothers habits and results in a more homogenous layer over what would have been a more complex substrate. This therefore negatively impacted the taxa which are regarded as mostly intolerant.

During the recent December 2016 survey, aquatic macroinvertebrates were sampled within the pans in the study area. However, owing to the recent drought conditions experienced in the country (end-2015), the biota within the pans were exposed to a suite of adverse environmental conditions/stressors during that period (Hussain and Pandit, 2012). Pans 4, 5, 10, 11, C1, C2 and C3 were dry at the time of that survey, with the exception of Pan 26 (now pan 11) which was inundated by the recent rainfall events. As the survey took place relatively soon after the rains, the aquatic macroinvertebrate communities did not have sufficient time in which to re-colonise owing to this natural disturbance, resulting in low species richness within the pans. In particular, no aquatic macroinvertebrates were recorded in Pan 26 (now Pan 11).

8.8.1.5 Ichthyofauna

A total of 10 indigenous fish species are expected to occur within the study area. One is currently unlisted on the IUCN Red List and nine are least concern. Species in this category are considered to be widespread and abundant (IUCN, 2016.3). Refer to Table 33 below for the expected fish list for the study area.

The most recent fish surveys conducted in the study area were in September 2011, March 2012 and May 2015. Overall, due to the study area being located within the upper reaches of the Steelpoort River catchment area, low fish diversity is expected. *Enteromius anoplus* (Chubbyhead Barb),*E. paludinosus* (Straightfin Barb), *Clarias gariepinus* (Sharptooth Catfish) and *Pseudocrenilabrus philander* (Southern Mouthbrooder) are the only fish species which have been recorded in the study area during the surveys conducted in September 2011, March 2012, November 2014 and May 2015 (Golder Report No. 11616366-11381-8). As displayed in Figure 28, the Steelpoort River falls within a fish sanctuary for *E. anoplus*. This fish species was the most abundant species recorded in the study area during the aquatic surveys (Golder Report No. 11616366-11381-8).

Generally, there is no significant trajectory of change within the fish communities in the study area that can be attributed to the mining or anthropogenic activities within the upper catchment. The low fish diversity within the study area is further compromised by the presence of *Micropterus salmoides* (Largemouth bass) (Figure 30) occurring within the dams that have been constructed within the study area. Bass are a species often stocked for recreational fishing purposes. This may be cause for concern as this invasive species threatens the native fishes and aquatic macroinvertebrates and consequently may have a negative impact on the community structure and potentially fragment the indigenous fish populations in the study area. No IUCN red data fish species were sampled in the study area during those sampling events (IUCN, 2016.3, Golder Report number 11616366-11381-8, 1412454-13511-4).

Figure 30: Micropterus salmoides (Largemouth Bass)

Table 33: Fish species expected to occur within the study area (Kleynhans, 1999, IUCN, 2016.3)

Species	Fish Code	Common Name	Likely abundance within project sites	Habitat Preference and Biology	IUCN Status	Species Intolerance Rating	Intolerance Decryption
Amphilius uranoscopus	AURA	Stargazer (Mountain catfish)	Rare	Clear, flowing water in rocky habitats. Feeds on macroinvertebrates and other small organisms of rock surfaces. Breeds in summer.	Least Concern	4.8	Intolerant
Enteromius anoplus	BANO	Chubbyhead Barb	Abundant	Cool waters in a variety of habitats, with good cover. Omnivorous, feeding on insects, seeds, algae and diatoms. Breeds in summer after rain.	Least Concern	2.6	Moderately tolerant
Enteromius neefi	BNEE	Sidespot Barb	Moderate	Cool waters in a variety of habitats, with good cover. Omnivorous, feeding on insects, seeds, algae and diatoms. Breeds in summer after rain.	Least Concern	3.4	Moderately intolerant
Enteromius paludinosus	BPAU	Straightfin Barb	Moderate	A hardy species with a preference for slow-flowing, well-vegetated waters or margins. Omnivore.	Least Concern	1.8	Tolerant
Enteromius trimaculatus	BTRI	Threespot Barb	Moderate	A hardy and common species. A wide variety of well-vegetated habitats. Omnivore. Breeds in summer.	Least Concern	3.0	Moderately intolerant
Labeo umbratus	LUMB	Moggel	Rare	Favours slow-flowing rivers, impoundments and dams. Feeds on soft sediments and detritus. Breeds in summer after rains.	Least Concern	2.3	Moderately tolerant
Labeobarbus polylepis	BPOL	Bushveld Smallscale Yellowfish	Rare	A cool water species. Favours deep pools, dams, and flowing waters. Omnivore with distinct seasonal diets. Breeds in spring and summer.	Least Concern	3.1	Moderately intolerant

Species	Fish Code	Common Name	Likely abundance within project sites	Habitat Preference and Biology	IUCN Status	Species Intolerance Rating	Intolerance Decryption
Clarias gariepinus	CGAR	Sharptooth Catfish	Moderate	Occurs in any habitat but favours large floodplains, sluggish rivers, lakes and dams. Completely omnivorous and eats available organic food source. Breeds in summer after rains.	Least Concern	1.2	Tolerant
*Cyprinus carpio**	CCAR	Carp	Moderate	Wide variety of habitats, but favours large, slow-flowing waters with soft substrates or sediments. Omnivorous. Breeds in spring and summer. Introduced species.	Exotic	1.4	Tolerant
*Gambusia affinis**	GAFF	Mosquitofish	Abundant	Requires slow-slowing waters with plant cover. Carnivorous. Tolerant species. Introduced species.	Exotic	2.0	Moderately tolerant
*Micropterus salmoides**	MSAL	Largemouth Bass	Moderate	Favours clear, slow-flowing waters with emergent vegetation. Thrives in dams. Primarily piscivorous, but also carnivorous and cannibalistic. Breeds in spring. Introduced species.	Exotic	2.2	Moderately tolerant
Pseudocrenilabrus philander	PPHI	Southern Mouthbrooder	Abundant	Wide variety of habitats, but favours vegetated zones. Breeds from early spring to late summer.	Unlisted	1.3	Tolerant
Tilapia sparrmanii	TSPA	Banded Tilapia	Moderate	Quiet, slow-flowing waters with emergent vegetation. Omnivore.	Least Concern	1.3	Tolerant

8.8.2 Wetland Ecology

A wetland study and impact assessment of the proposed Mafube LifeX Project was undertaken in 2011/2012 as part of the Environmental Impact Assessment (EIA) process. Several subsequent studies on wetlands and pans associated with the project area have also been conducted. These studies focused primarily on the Mafube Prospecting Rights Area.

8.8.2.1 Regional Context

Mafube is situated within the Highveld DWA Level 1Ecoregion. This Ecoregion boundary is determined by plains with a moderate to low relief. This region is the source of several large rivers. Moist grassland vegetation types are situated towards the east, with dryer areas towards the west and south. The wetlands of the study area are further situated within quaternary catchment B12C. The region in which the study area occurs experiences strong seasonal summer rainfall, with very dry winters. Mean annual precipitation is between 650 – 900 mm (average: 726 mm) (Golder Report No. 11616366-11460-13).

8.8.2.2 Wetland Systems at Mafube

The wetland systems associated with the study area include various open water pans, shallow grass dominated depressions, valley head and hill-slope seeps, as well as valley bottom wetlands with well-defined stream channel and unchannelled valley bottom wetlands. These have generally already been negatively impacted on by various historic and current activities such as *inter alia*, cultivation, overgrazing, artificial dams and the encroachment of exotic invasive plant species.

The original 2011/2012 wetland study and impact assessment identified about 21 pans in the Mafube Prospecting Rights Area. The characteristics of the various pans vary; a number are small grass dominated depressions, many of which have been disturbed by cultivation, while others such as Rooipan are fairly large. Pans are generally surrounded by modified land and/or other forms of disturbance and these can have associated negative impacts on pan seepage zones and broader catchments.

Several wetland systems are also present in the area. These are generally closely flanked by cultivation and often negatively impacted by *inter alia*; roads (gravel and tarred), soil borrowing, erosion, farm fences, ploughing, alien invasive species encroachment and the construction of artificial dams/weirs. Refer to Figure 31 and Figure 34 for photograph examples of wetland habitats in the study area.

The most recent field-based delineations for the area were conducted in 2015 by Wetland Consulting Services Pty (Ltd) (WCS). Figure 35 shows a delineation of wetlands in the study area based on an overlay of the NFEPA database and the WCS 2015 delineations. We note that the detailed WCS 2015 delineations do not extend to the areas potentially affected by the road realignment. However, according to the NFEPA delineations, both proposed options (A and B) for the D1048 road alternatives affect two wetland areas. The New D684 Alternative C option affects 3 wetlands.

Figure 31: Large water-filled pan

Figure 32: Small grass and sedge pan

Figure 33: Channelled valley-bottom wetland

Figure 34: Wetland encroached upon by exotic Salix babylonica (willow trees) and flanked by exotic Acacias

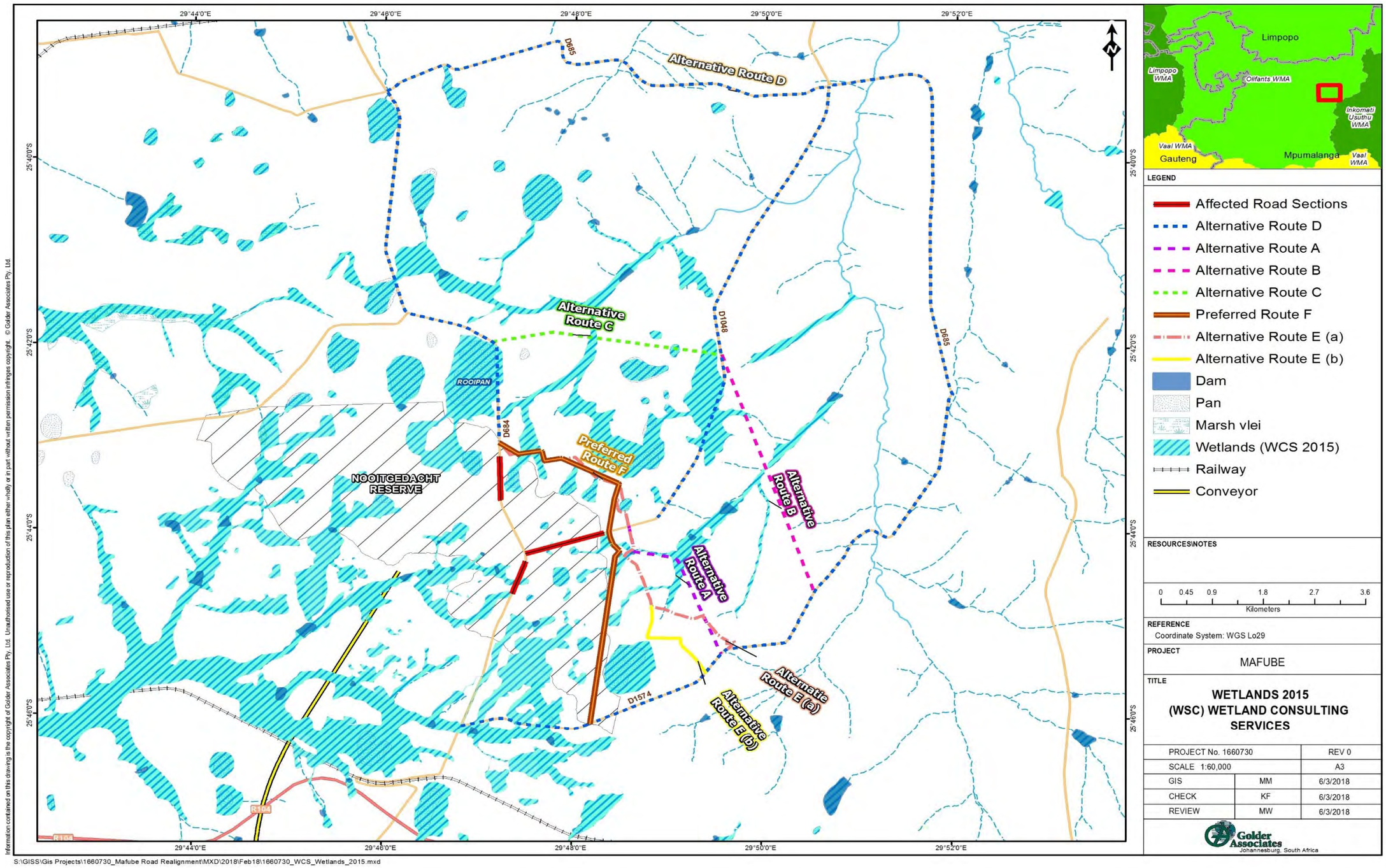


Figure 35: Overlay of the WCS wetland delineations and the NFEPA wetlands showing the various road realignment options (see Figure 5 for Route F optimised)

8.8.2.3 Wetland delineation and classification

A description of the wetlands within the study area in terms of their classification, the assessment of their health (PES), level of ecosystem service provision, and ecological importance and sensitivity (EIS) are outlined in the sections that follow.

The wetlands within the Study Area are shown on Figure 35, and are numbered and classified in Table 34. Of these, seven wetlands, including six hillslope seepages and one pan, will be directly affected by the route alignment as currently proposed (Figure 36). Photographs of wetlands directly affected by the route corridor are provided in APPENDIX G.

Table 34: Classification of wetlands within the Study Area

No.	Wetland Classification	Wetland ID	Position Relative to Route	
			Crossed by route corridor	Within 500 m of route corridor
1	Pan	(Ma_Pan_15)	✓	
2	Depression	(Ma_Dep_15)		Approx. 200 m west of route
3	Pan	(Ma_Pan_01)		Approx. 170 m west of route
4a	Hillslope seepage	(Ma_HS_63)	✓	
4b	Depression	(Ma_Dep_57)		Approx. 50 m east of route
5	Hillslope seepage	(Ma_HS_62)	✓	
6	Hillslope seepage	(Ma_HS_61)	✓	
7	Pan	(Ma_Pan_29)		Approx. 130 m east of route
8	Hillslope seepage	(Ma_HS_57)	✓	
9	Hillslope seepage	(Ma_HS_56)	✓	
10	Hillslope seepage	(Ma_HS_53)	✓	

8.8.2.4 Present Ecological State (PES)

The PES scores for each of the wetlands in the Study Area, based on the original baseline studies (WCS 2013, WCS 2015) and the walkover done in 2017 are presented in Table 35.

Most of the wetlands are Category C Moderately Modified, or Category D Largely Modified, which means that a moderate to large loss of natural habitat and basic ecosystem function has occurred in the wetlands. Factors contributing to the modified state of the wetlands within the Study Area and surrounding sub-catchments include:

- Intensive crop cultivation;
- Alien vegetation encroachment;
- Impoundments including earthen dam walls and roads;
- Confined flow through spillways and culverts;
- Soil erosion and eroding surfaces such as head-cuts and nick-points; and
- Livestock grazing and trampling.

No significant new drivers of change affecting wetland health were observed within the wetlands or their immediate catchments during the 2017 survey, therefore the PES categories for all of the hillslope seepage wetlands remain unchanged since the baseline work completed for the Mafube wetland mitigation and management strategy (WCS, 2015).

Table 35: PES categories of wetlands within the Study Area (WCS, 2015)

Wetland No.	HGM Unit	Wetland ID	PES Category	Crossed by Route Corridor
1	Pan	(Ma_Pan_15)	D	✓
2	Depression	(Ma_Dep_15)	C	
3	Pan	(Ma_Pan_01)	C	
4a	Hillslope seepage	(Ma_HS_63)	C	✓
4b	Depression	(Ma_Dep_57)	C	
5	Hillslope seepage	(Ma_HS_62)	C	✓
6	Hillslope seepage	(Ma_HS_61)	D	✓
7	Pan	(Ma_Pan_29)	D	
8	Hillslope seepage	(Ma_HS_57)	C	✓
9	Hillslope seepage	(Ma_HS_56)	C	✓
10	Hillslope seepage	(Ma_HS_53)	C	✓

8.8.2.5 Ecological Importance and Sensitivity (EIS)

The EIS categories for each of the wetlands in the Study Area, based on the most recent baseline updates (WCS 2013, WCS 2015), are presented in Table 36. The EIS categories are low/marginal for the two smallest pans and depressions in the Study Area, neither of which will be directly affected by the proposed route. All other wetlands being crossed by the proposed route corridor are of moderate ecological importance and sensitivity, largely as a result of their location within the upper catchment of the Grootspruit, which is listed as a "Fish Support Area" (NFEPA, 2011).

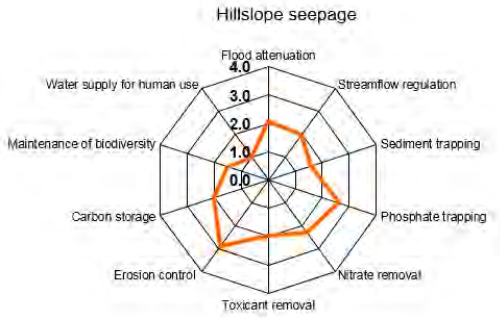
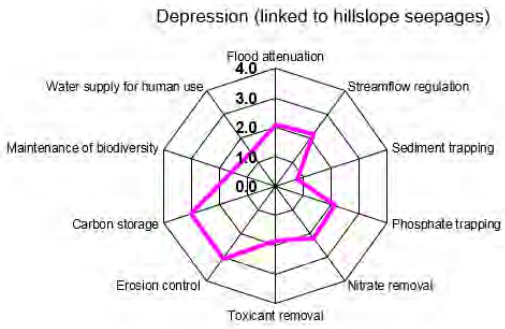
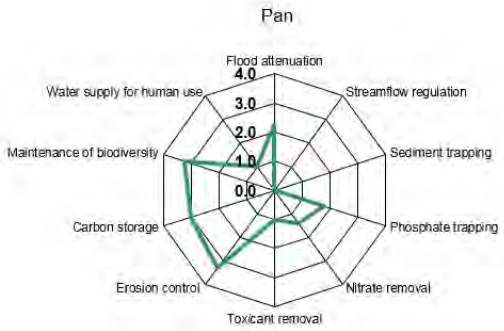
Table 36: EIS categories of wetlands within the Study Area (WCS, 2015)

Wetland No.	HGM Unit	Wetland ID	EIS	Crossed by Route Corridor
1	Pan	(Ma_Pan_15)	Moderate	✓
2	Depression	(Ma_Dep_15)	Low/marginal	
3	Pan	(Ma_Pan_01)	Moderate	
4a	Hillslope seepage	(Ma_HS_63)	Moderate	✓
4b	Depression	(Ma_Dep_57)	Moderate	
5	Hillslope seepage	(Ma_HS_62)	Moderate	✓
6	Hillslope seepage	(Ma_HS_61)	Moderate	✓
7	Pan	(Ma_Pan_29)	Low/marginal	
8	Hillslope seepage	(Ma_HS_57)	Moderate	✓
9	Hillslope seepage	(Ma_HS_56)	Moderate	✓
10	Hillslope seepage	(Ma_HS_53)	Moderate	✓

8.8.2.6 Wetland Ecosystem Services

The provision of ecosystem services varies according to wetland type within the Study Area. A summary of the roles that the wetlands play in ecosystem service delivery is given in Table 37.

Table 37: Ecosystem services supplied by wetlands in the study area

Spider diagram of ecosystem service importance	Wetland role in delivery of ecosystem services
	■ Hillslope seepages within the study area play an intermediate role in streamflow regulation and sediment trapping; ■ Their role in phosphate trapping and nitrate removal is pronounced, given the context of agricultural cultivation of their catchment; and ■ Maintenance of their integrity is important for control of erosion towards downstream areas.
	■ Depressions linked to hillslope seepages have a moderately high contribution to streamflow regulation; ■ Their role in phosphate trapping and nitrate removal is pronounced, given the context of agricultural cultivation of the catchment; and ■ Increased surface roughness and vegetation cover associated with depressions makes a moderately high contribution to carbon storage and erosion control.
	■ Play a limited role in flood attenuation through capture of runoff and reduction of surface water that would otherwise reach stream systems; ■ Limited importance for sediment trapping reduces opportunity to contribute meaningfuly to phosphate trapping or nitrate removal; and ■ Increased surface roughness and vegetation cover associated with depressions makes a moderately high contribution to carbon storage and erosion control, and also contributes to biodiversity support.

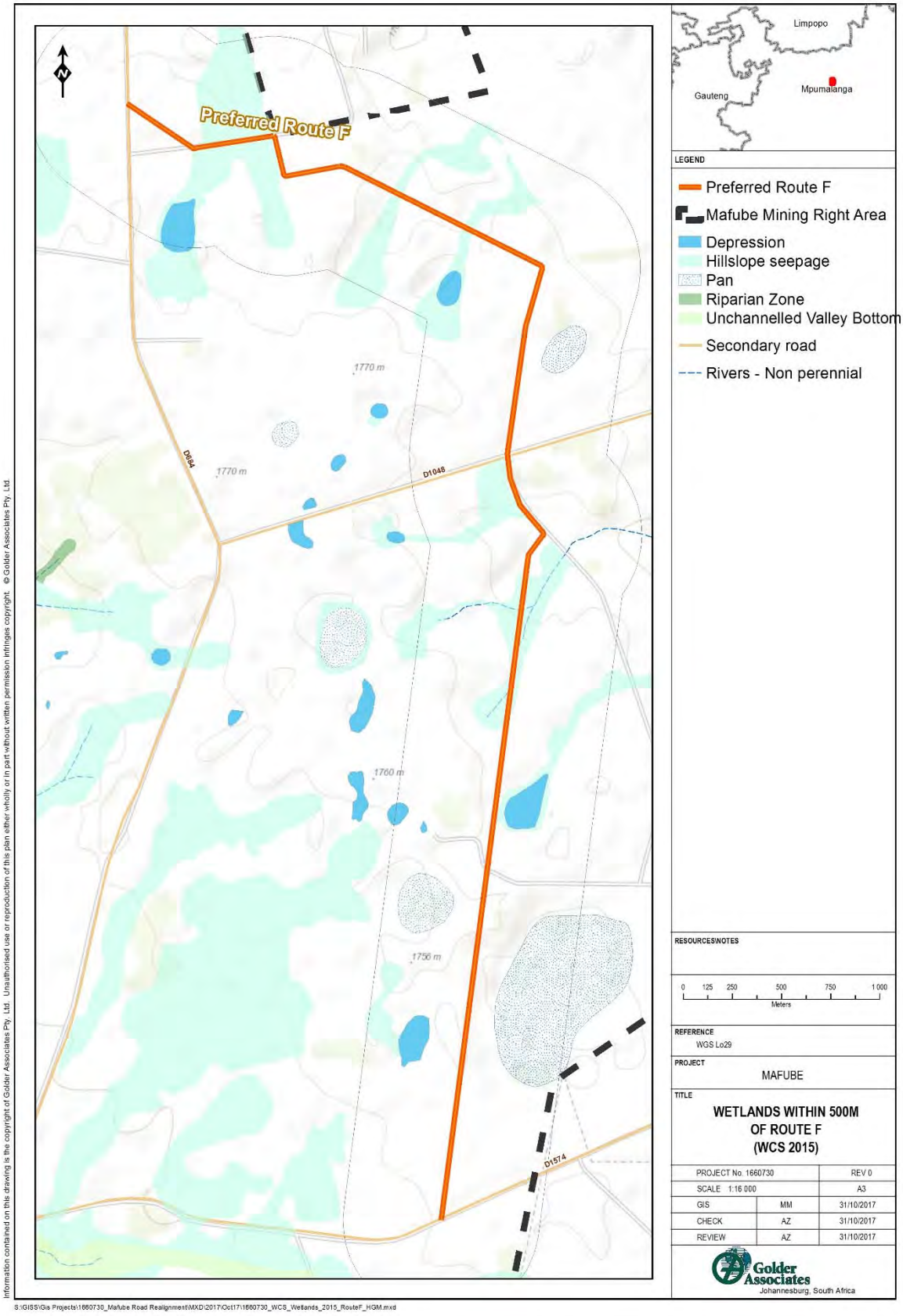


Figure 36: Wetland HGM Units within 500 m of preferred route alternative F (see Figure 5 for optimised route)

8.8.3 Terrestrial Ecology

8.8.3.1 Biophysical Environment – Regional Context

The study area is located in the grassland biome, which covers approximately 28% of South Africa and is the dominant biome of the central plateau and inland areas of the eastern subcontinent (Manning, 2009; SANBI, 2013). Grasslands are typically situated in moist, summer rainfall regions that experience between 400 mm and 2 000 mm of rainfall per year. Vegetation consists of a dominant field-layer comprising grasses and herbaceous perennials, with little to no woody plants.

South Africa's grassland ecosystems are aggregated into five groups, with the study area forming part of the 'Mesic Highveld Grasslands' grouping (*sensu* SANBI 2013). These grasslands occur at mid-altitudes and experience warm, wet summers (MAP 700 -1 200 mm) and cold winters. They are typically highly productive sourveld[3] grasslands that are dominated by long-lived perennial grasses (SANBI, 2013). Fire is common in Mesic Highveld Grasslands and, coupled with frequent winter frost, maintains these ecosystems in a relatively treeless form (SANBI, 2013; Tainton, 1999). Apart from their importance as rich stores of biodiversity, grasslands are critically important water production landscapes, constituting about half of South Africa's Strategic Water Source Areas (SANBI, 2013).

Based on Mucina and Rutherford (2006) delineation of South Africa's vegetation, the study area is characterised by five vegetation types, namely:

- Rand Highveld Grassland;
- Eastern Highveld Grassland;
- Eastern Temperate Freshwater Wetlands;
- Lydenburg Montane Grassland; and
- Sekhukhune Montane Grassland.

8.8.3.2 National and Provincial Conservation Considerations

- In line with the Mpumalanga Biodiversity Sector Plan (2013) and the identification of Critical Biodiversity Areas (CBA), much of the study area comprises 'Modified Land' (both old and current agricultural fields) and 'Other Natural Areas'. Small patches of CBA Optimal and CBA Irreplaceable are present– Figure 38;
- At a national level, the NEMBA Threatened Ecosystems, (2011) recognises both Rand Highveld Grassland and Eastern Temperate Freshwater Wetlands as Vulnerable ecosystems (Figure 39); and
- The Steenkampsberg Important Bird Area (IBA) is located to the east of the study area.

[3] Grasslands where vegetation becomes unacceptable to grazers during the dry season and thus do not provide year-round grazing, unless supplemented by salt licks (Tainton, 1999).

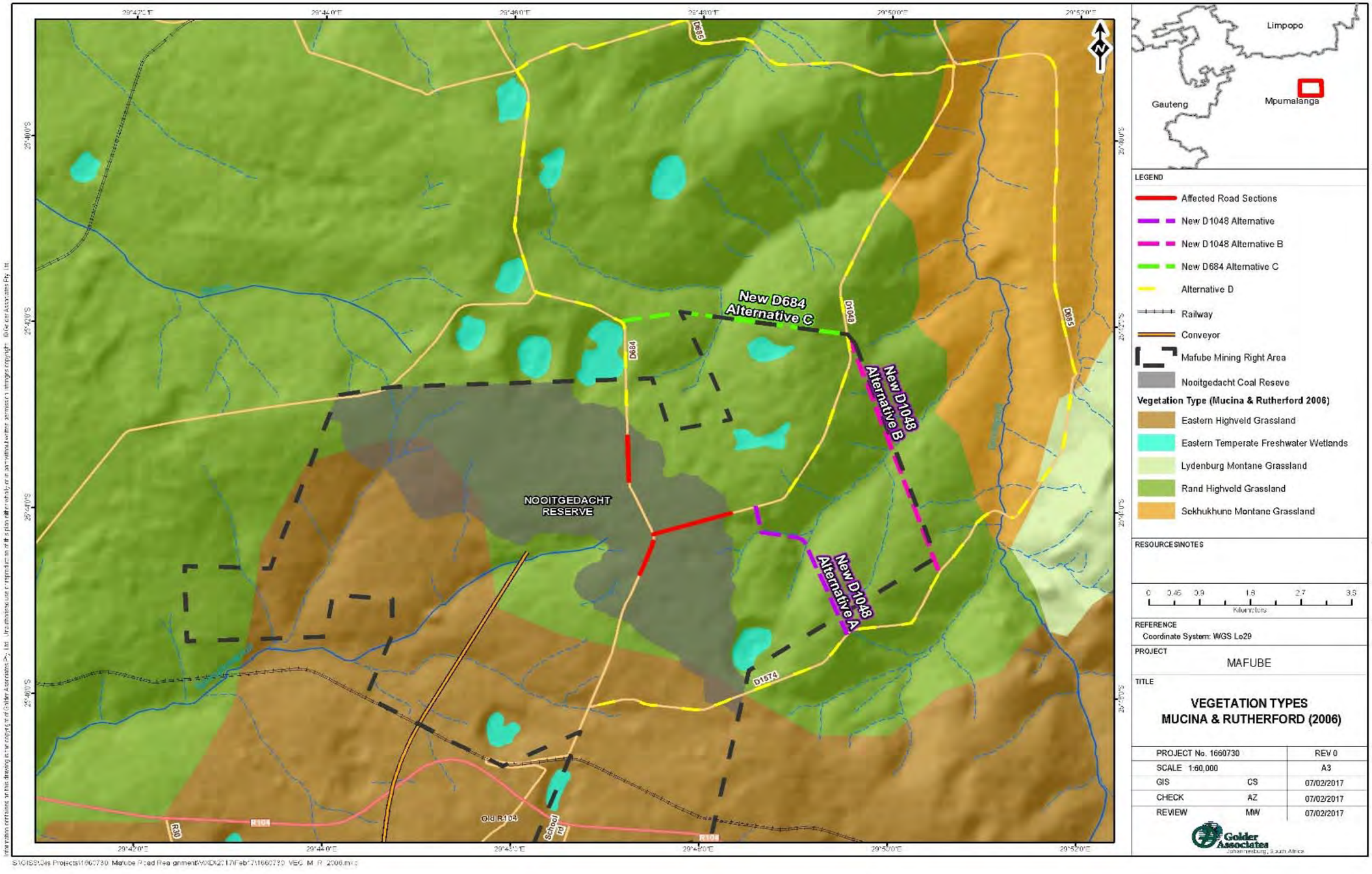


Figure 37: Study area in relation to the regional vegetation types (Mucina & Rutherford, 2006)

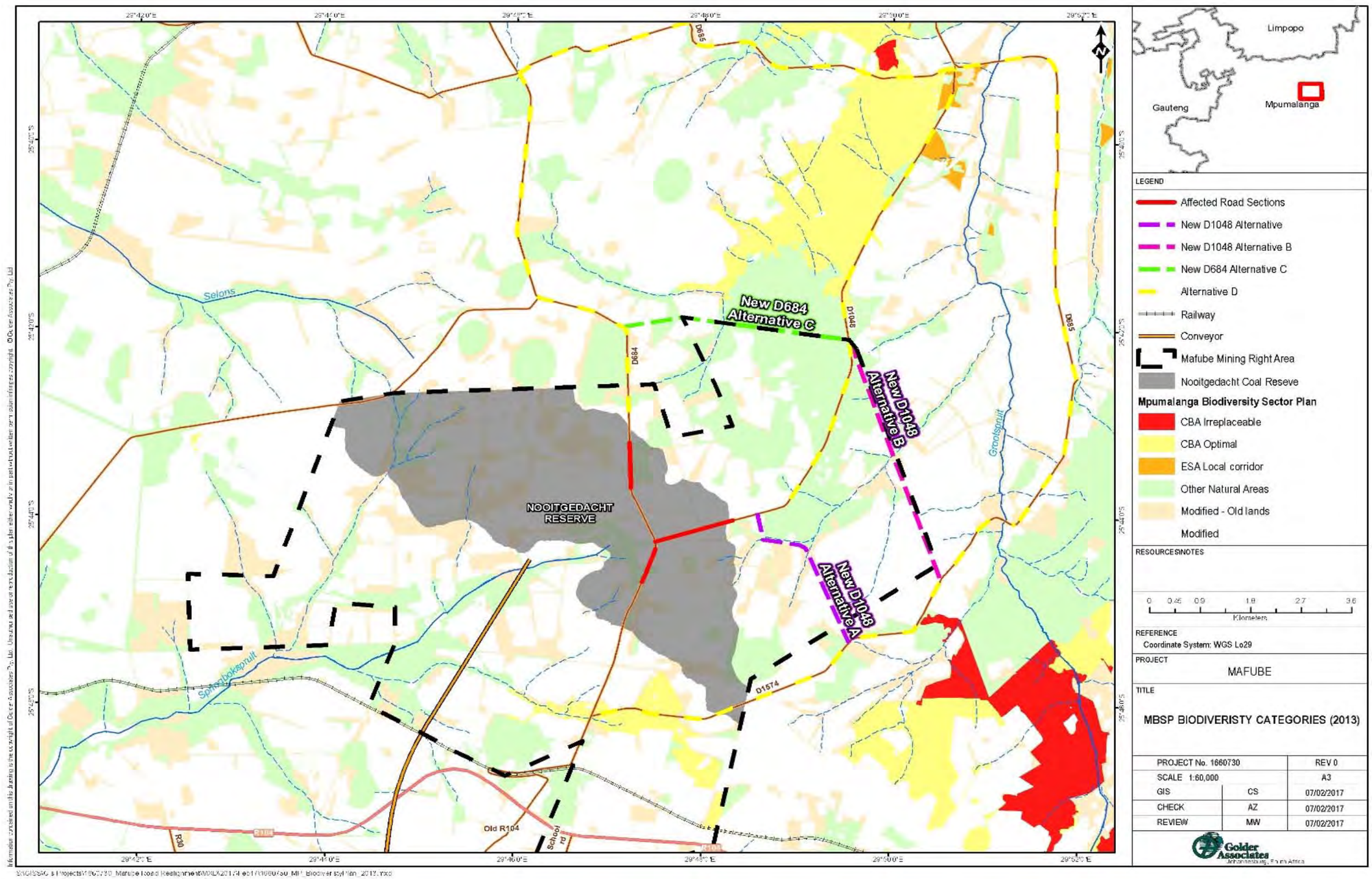


Figure 38: Characterisation of the study area and surrounds in terms of the Mpumalanga Biodiversity Sector Plan (2013)

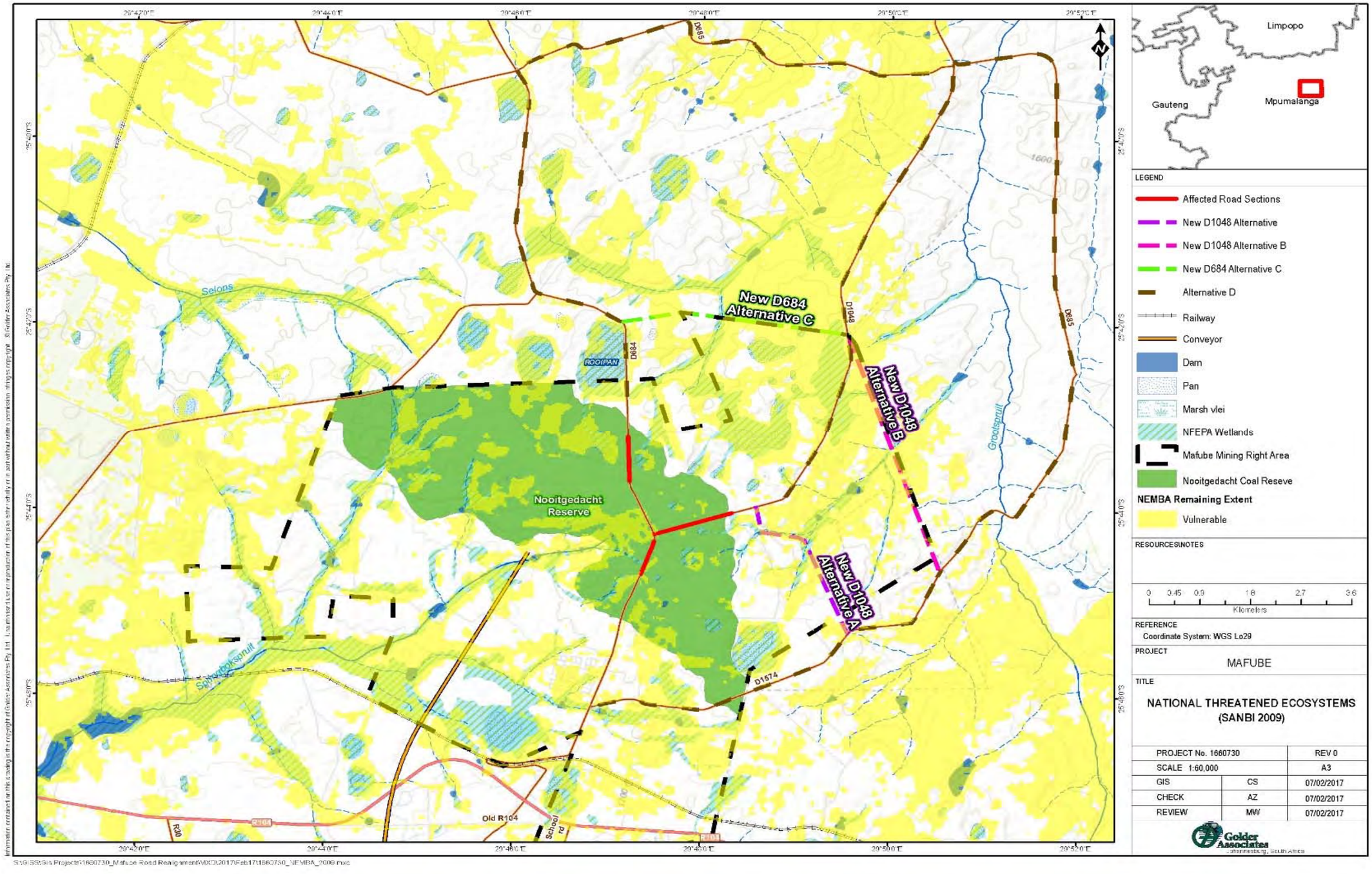


Figure 39: Study area in relation to the NEMBA South African threatened ecosystems

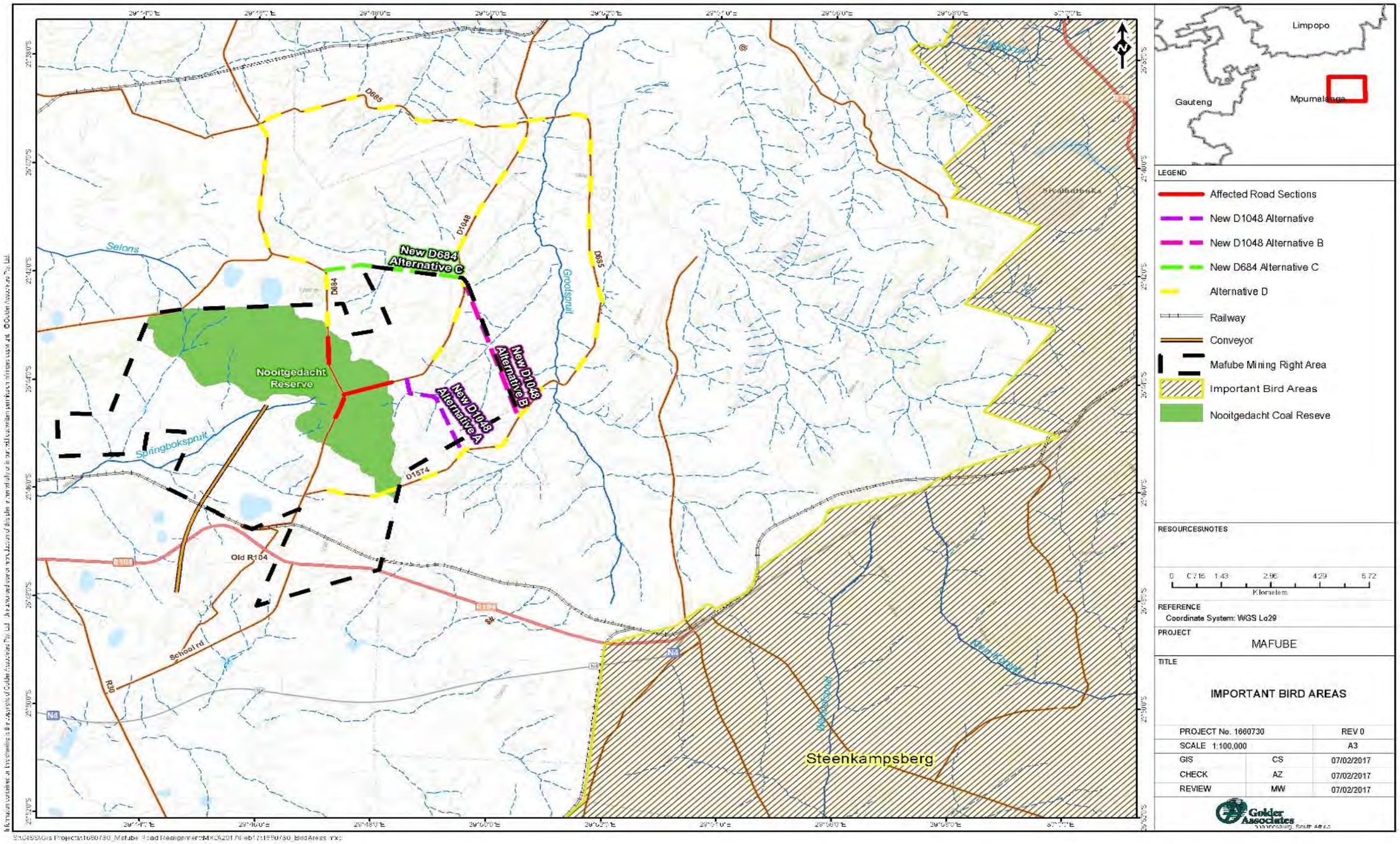


Figure 40: Important Bird Areas in the Mafube LifeX Region

8.8.3.3 Flora Assessment

Five broad vegetation communities/land units were identified in the study area during the 2011/2012 field programme:

- Eucalyptus-Acacia woodlots;
- Disturbed grassland;
- Dry mixed grassland;
- Moist mixed grassland community; and
- Cultivated land.

The characteristics of the vegetation communities/land units are detailed below:

8.8.3.3.1 Eucalyptus-Acacia Woodlots

Eucalyptus-Acacia woodlots are found in isolated patches throughout the study area. These areas are depauperate of indigenous vegetation and are dominated by the exotic trees *Eucalyptus* (gums) and *Acacia* (Wattle) and in some areas *Populus* x *canescens* (poplar). Species present in the herbaceous layer include grasses such as *Hyparrhenia hirta*, *Sporobolus africana* and the exotic forbs *Bidens pilosa, Verbena bonariensis, Conyza bonariensis* and *Taraxacum officinale*.

8.8.3.3.2 Disturbed Grassland

Large areas of the study area consist of open grasslands dominated by tall grass species, most notably by *Eragrostis* species and *Hyparrhenia hirta*. The shift in grass composition from a diverse species assemblage to that dominated by *Eragrostis* and *Hyparrhenia* species is typical of Highveld grasslands that have been subjected to some form of disturbance, most often cultivation and/or overgrazing.

Figure 41: Disturbed Grassland

8.8.3.3.3 Dry Mixed Grassland

The Dry Mixed Grassland vegetation community typically occurs in regions of the study area where shallow, rocky soils preclude ploughing and cultivation. These areas are less disturbed and have a higher biodiversity than the Disturbed Grassland vegetation community. In the context of the surrounding landscape matrix, areas of Dry Mixed Grassland act as important refuge and corridor habitats for fauna.

Figure 42: Dry Mixed Grassland

8.8.3.3.4 Moist Mixed Grassland

Moist Mixed Grasslands occur along streams and wetlands, and around pans, artificial dams and seeps in the study area. This vegetation community is characterised by grasses including wetland-type species such *as Agrostis spp., Andropogon eucomus, Arundinella nepalensis, Imperata cylindrica, Eragrostis gummiflua, Eragrostis plana.* Forbs, reeds and rushes are also common including various *Cyperus* spp., *Juncus* spp., *Typha capensis.* Woody species recorded include the exotic the common exotics *Acacia and Eucalyptus* species, as well as *Populus* x *canescens* and *Salix babylonica.*

Figure 43: Moist Mixed Grassland

8.8.3.3.5 Cultivated Land

The majority of the study area has been cleared for cultivation, most notably maize (*Zea mays*) production. Cultivated lands that are in current use have no natural vegetation, while lands that have been left fallow are often invaded by pioneer weeds and invasive species such as *inter alia*, *Argemone ochroleuca, Bidens pilosa, Conyza bonariense, Conyza canadensis*, *Datura ferox, Taraxacum officinale* and *Verbena bonariensis,* as well as grasses including *Cynodon dactylon, Eleusine coracana,* various *Hyparrhenia* species and *Melinis repens.*

8.8.3.3.6 Listed Alien Invasive Species

An alien invasive species assessment of the entire Mafube LifeX project was undertaken in March 2017. The assessment identified 42 alien invasive plant species listed under Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983) and the National Environmental Management: Biodiversity Act (2004) (NEMBA)(Act No. 10 of 2004) (Table 38).

Of these, a number were recorded along the proposed road corridor during the walk down, including *Acacia dealbata, Argemone ochroleuca* subsp. *ochroleuca, Datura* spp., *Eucalyptus grandis, Verbena bonariensis* and *Xanthium strumarium.*

Table 38: Inventory of CARA and NEMBA listed alien invasive species recorded in the Mafube LifeX Study Area

Scientific Name	Common Name	Afrikaans Name	Growth Form	CARA Category	NEMBA Category
Acacia baileyana	Bailey's Wattle	Bailey-se-wattel	Tree	3	3
Acacia melanoxylon	Blackwood	Swarthout	Tree	2	2
Acacia dealbata	Silver Wattle	Silwerwattel	Tree	1	2
Acacia decurrens	Green Wattle	Groenwattel	Tree	2	2
Acacia elata	Pepper Tree Wattle	Elataboom	Tree	3	1b
Acacia mearnsii	Black Wattle	Swartwattel	Tree	2	2
Acer buergerianum	Chinese maple	Chinese esdoring	Tree	X3	3
Agave americana	American Aloe	Blou-aalwyn	Succulent	X2	-
Argemone ochroleuca subsp. *ochroleuca*	White-flowered Mexican Poppy	Witblom-bloudissel	Herbaceous plant	1	1b
Callistemon viminalis	Weeping Bottlebrush	-	Tree	-	1b
Canna indica	Garden Canna	Tuinkanna	Herbaceous plant	1	1b
Cereus jamacaru	Queen of the Night	Nagblom	Cactus	1	1b
Cinnamomum camphora	Camphor Tree	Kanferboom	Tree	1	1b
Cotoneaster franchetii	Orange Cotoneaster	Pronkbessiebossie	Shrub	1	1b
Datura ferox	Large thorn apple	Grootstinkblaar	Herbaceous plant	1	1b
Datura stramonium	Common thorn apple	Gewone stinkblaar	Herbaceous plant	1	1b
Eriobotrya japonica	Loquat	Lukwart	Tree	3	-
Eucalyptus grandis	Saligna Gum	Bloekom	Tree	2	1b, 2 or not listed
Gleditsia triacanthos	Honey locust	Soetpeulboom	Tree	2	1b
Ligustrum japonicum	Japanese Wax-leaved Privet	Japanse Liguster	Tree	1	1b
Melia azedarach	Syringa	Sering	Tree	3	1b
Mirabilis jalapa	Four-o'clocks	Vieruurtjies	Herbaceous plant	X3	1b
Morus alba	White Mulberry	Witmoerbei	Tree	3	3
Opuntia ficus-indica	Sweet prickly Pear	Boereturksvy	Cactus	1	1b
Phytolacca dioica	Belhambra	Bobbejaandruifboom	Tree	3	3
Phytolacca octandra	Inkberry	Inkbessie	Herbaceous plant	1	1b
Pinus patula	Patula Pine	Treurden	Tree	2	2

Scientific Name	Common Name	Afrikaans Name	Growth Form	CARA Category	NEMBA Category
Pinus pinaster	Cluster Pine	Trosden	Tree	2	1b or 2
Populus alba (*P.* x *canescens*)	White/Grey Polar	Wit/Vaalpopulier	Tree	2	2
Populus deltoides	Match Polar	Vuurhoutjiepopulier	Tree	X3	-
Pyracantha angustifolia	Yellow-fire Thorn	Geelbranddoring	Shrub	3	1b
Pyracantha coccinea	Red Firethorn	-	Shrub	3	1b
Robinia pseudoacacia	Black Locust	Witakasia	Tree	2	1b
Salix babylonica	Weeping Willow	Treurwilger	Tree	2	-
Schinus molle	Pepper tree	Peperboom	Tree	X3	-
Sesbania punicea	Red Sesbania	Rooisesbania	Tree	1	1b
Tamarix sp.	Tamarisk	Tamarisk	Woody shrub/tree	3	1b
Tipuana tipu	Tipua Tree	Tipoeboom	Tree	3	3
Ulmus parviflora	Chinese Elm	Chinese Iep	Tree	X3	-
Verbena bonariensis	Wild Verbena	-	Herbaceous plant	-	1b
Xanthium strumarium	Large Cocklebur	Kankerroos	Herbaceous plant	1	1b
*Celtis australis**	Nettle Tree	Netelboom	Tree	X3	3
X indicates a proposed category					
*Possible hybrid with the indigenous *Celtis africana*.					

8.8.3.3.7 Plants of Conservation Importance

Plant species of conservation importance that occur or potentially occur in the study area as per available literature and the field programme are listed in Table 39.

Table 39: Plant species of conservation importance that occur or potentially occur in the study area

Family	Scientific name	Conservation Status		
		Regional IUCN Red List (2015)	NEMBA ToPS List (2013)	Mpumalanga Protected Species (1998)
AGAPANTHACEAE	*Agapanthus campanulatus* subsp. *patens*	Least Concern	-	Protected
AMARYLLIDACEAE	*Brunsvigia radulosa*	Least Concern		Protected
AMARYLLIDACEAE	*Boophone disticha*	Declining	-	Protected
AMARYLLIDACEAE	*Crinum bulbispermum*	Declining		Protected
AMARYLLIDACEAE	*Crinum graminicola*	Least Concern	-	Protected
AMARYLLIDACEAE	*Nerine gracilis*	Near Threatened	-	Near Threatened
APOCYNACEAE	*Brachystelma chloranthum*	Least Concern	-	Protected
APOCYNACEAE	*Ceropegia rendallii*	Least Concern	-	Protected
APOCYNACEAE	*Miraglossum davyi*	Vulnerable	-	Protected

Family	Scientific name	Conservation Status		
		Regional IUCN Red List (2015)	NEMBA ToPS List (2013)	Mpumalanga Protected Species (1998)
ASPHODELACEAE	*Aloe ecklonis*	-	-	Protected
ASPHODELACEAE	*Aloe greatheadii* var. *davyana*	Least Concern	-	Protected
ASPHODELACEAE	*Aloe lineata*	-	-	Protected
ASPHODELACEAE	*Aloe longibracteata*	-	-	Protected
ASPHODELACEAE	*Aloe masculata*	-	-	Protected
ASPHODELACEAE	*Aloe mutabilis*	-	-	Protected
ASPHODELACEAE	*Aloe reitzii* var. *reitzii*	Near Threatened	-	Near Threatened
ASPHODELACEAE	*Kniphofia typhoides*	Near Threatened	-	Protected
AQUIFOLIACEAE	*Ilex mitis* var. *mitis*	Declining	-	Protected
ARACEAE	*Zantedeschia albomaculata* subsp. *albomaculata*	Least Concern	-	Protected
ASTERACEAE	*Callilepis leptophylla*	Declining	-	-
GESNERIACEAE	*Streptocarpus latens*	Rare	-	Rare
GESNERIACEAE	*Streptocarpus denticulatus*	Vulnerable	-	Vulnerable
HYACINTHACEAE	*Drimia altissima*	Declining	-	Declining
HYACINTHACEAE	*Eucomis autumnalis*	Declining	-	Protected
HYACINTHACEAE	*Eucomis montana*	Declining	-	Protected
HYACINTHACEAE	*Eucomis pallidiflora* subsp. *pallidiflora*	Least Concern	-	Protected
HYACINTHACEAE	*Merwilla plumbea*	Near Threatened	-	Near Threatened
IRIDACEAE	*Gladiolus longicollis* subsp. *longicollis*	Least Concern	-	Protected
IRIDACEAE	*Gladiolus paludosus*	Least Concern	-	Protected
IRIDACEAE	*Gladiolus papilio*	Least Concern	-	Protected
IRIDACEAE	*Gladiolus elliotii*	Least Concern		Protected
IRIDACEAE	*Gladiolus crassifolius*	Least Concern		Protected
IRIDACEAE	*Gladiolus pole-evansii*	Rare	-	Protected
IRIDACEAE	*Gladiolus vernus*	Least Concern	-	Protected
IRIDACEAE	*Gladiolus woodii*	Least Concern	-	Protected
IRIDACEAE	*Hesperantha coccinea*	Least Concern	-	Protected
MESEMBRYANTHEMACEAE	*Delosperma lydenburgense*	Least Concern	-	Protected
MESEMBRYANTHEMACEAE	*Delosperma obtusum*	Least Concern	-	Protected
MESEMBRYANTHEMACEAE	*Khadia carolinensis*	Vulnerable	-	Protected
OLEACEAE	*Olea capensis* subsp. *enervis*	Least Concern	-	Protected
ORCHIDACEAE	*Disa cooperi*	Least Concern	-	Protected

Family	Scientific name	Conservation Status		
		Regional IUCN Red List (2015)	NEMBA ToPS List (2013)	Mpumalanga Protected Species (1998)
ORCHIDACEAE	*Disa versicolor*	Least Concern	-	Protected
ORCHIDACEAE	*Eulophia ovalis var. bainesii*	Least Concern	-	Protected
ORCHIDACEAE	*Eulophia ovalis var. ovalis*	Least Concern	-	Protected
ORCHIDACEAE	*Eulophia zeyheri*	Least Concern	-	Protected
ORCHIDACEAE	*Habenaria dregeana*	Least Concern	-	Protected
ORCHIDACEAE	*Habenaria bicolor*	Near Threatened	-	Protected
ORCHIDACEAE	*Habenaria kraenzliniana*	Near Threatened	-	Protected
ORCHIDACEAE	*Satyrium hallackii* subsp. *ocellatum*	Least Concern	-	Protected
ORCHIDACEAE	*Satyrium parviflorum*	-	-	Protected
ORCHIDACEAE	*Eulophia cooperi*	Least Concern	-	Protected
SCROPHULARIACEAE	*Jamesbrittenia macrantha*	Near Threatened	-	Near Threatened
ZAMIACEAE	*Encephalartos lanatus*	Vulnerable	Protected	Specially protected

Conservation statuses: SANBI (2015), NEMBA ToPS List (2013) and Mpumalanga Nature Conservation Act (1998).

8.8.3.4 Fauna Communities

8.8.3.4.1 Mammals

Based on available literature, 63 mammal species potentially occur in the central grasslands of Mpumalanga Province. Eleven species were recorded in the study area during the 2011/2012 field programme, including Scrub Hare (*Lepus saxatilis*), Porcupine *(Hystrix africaeaustralis*), Black-backed Jackal *(Canis mesomelas*), Slender Mongoose (*Atiliax paludinosus*), Yellow Mongoose (*Cynictis penicillata*), African Wild Cat (*Felis lybica*), Aardvark (*Orycteropus afer*), Common Duiker (*Sylvicapra grimmia*), Steenbok (*Raphicerus campestris*), Red Veld Rat (*Aethomys chrysophilus*) and Four-striped Mouse (*Rhabdomys pumilio*).

The low diversity, particularly of small mammals, is attributed to the disturbed nature of much of the study area.

Table 40: Red Data and protected mammal species that may occur in the study area

Scientific name	Common name	Conservation Status		
		Red List (2016)	NEMBA TOPS List (20137)	Mpumalanga Protected Species (1998)
Chrysospalax villosus	Rough-haired Golden Mole	Vulnerable	Critically Endangered	-
Amblysomus robustus	Robust Golden Mole	Vulnerable	Endangered	-
Amblysomus septentrionalis	Highveld Golden Mole	Near Threatened	-	-
Dasymys incomtus	Water Rat	Near Threatened	-	-
Vulpes chama	Cape Fox	-	Protected	-
Aonyx capensis	Cape-clawless Otter	Near Threatened	Protected	Protected
Leptailurus serval	Serval	Near Threatened	Protected	
Proteles cristatus	Aardwolf	-	-	Protected
Parahyaena brunnea	Brown Hyaena	Near Threatened	Protected	-
Mellivora capensis	Honey Badger	-	Protected	Protected
Ourebia ourebi	Oribi	Endangered	Endangered	Protected
Raphicerus campestris	Steenbok	-	-	Protected
Pelea capreolus	Grey Rhebok	Near Threatened	Protected	Protected
Lutra maculicollis	Spotted-necked Otter	Vulnerable	Protected	Protected
Felis nigripes	Black-footed Cat	Vulnerable	Protected	Protected
Atelerix frontalis	South African Hedgehog	Near Threatened	Protected	Protected
Orycteropus afer	Aardvark	-	Protected	Protected
Redunca fulvorufula	Mountain Reedbuck	-	-	Protected

8.8.3.4.2 Birds

Approximately 305 bird species have been recorded in the relevant quarter degree squares in which the study area is located according to SIBIS:SABIF (2009) database. Common birds recorded in the grassland and woodlot communities in the study area include Longtailed Widow (*Euplectes progne*), Hadeda Ibis (*Bostrychia hagedash*), Familiar Chat (*Cercomela familiaris*), Pied crow (*Corvus albus*), Black-shouldered kite (*Elanus caeruleus*), Red-billed Quelea (*Quelea quelea*), Fiscal Shrike (*Lanius collaris*), Laughing Dove (*Streptopelia senegalensis*) and the Cape Turtle Dove *(Streptopelia capicola*). In the pan and wetland environments water birds such as the Red-knobbed Coot (*Fulica cristata*), White-breasted Cormorant (*Phalacrocorax carbo*), Yellow-billed Duck (*Anas undulata*), Willow Warbler (*Phylloscopus trochilus*), Spurwinged Goose (*Plectropterus gambensis*) and the Knob-billed Duck (*Sarkidiornis melanotos*) were common. Greater flamingo (*Phoenicopterus ruber*) were also recorded in the study area. This species is listed as Near Threatened. Some additional birds of conservation importance that may occur in the study area are listed in Table 41.

Table 41: Red data and protected bird species that may occur in the study area

Scientific name	Common name	Conservation Status		
		Red List (2016)	NEMBA TOPS List (2013)	Mpumalanga Protected Species (1998)
Alcedo semitorquata	Half-collared Kingfisher	Near Threatened	-	Protected
Anthropoides paradiseus	Blue Crane	Near Threatened	Vulnerable	Protected
Balearica regulorum	Grey Crowned Crane	Endangered	Vulnerable	Protected
Bugeranus carunculatus	Wattled Crane	Critically Endangered	Critically Endangered	Protected
Ciconia nigra	Black Stork	Vulnerable	-	Protected
Circus ranivorus	African Marsh Harrier	Endangered	-	Protected
Eupodotis caerulescens	Blue Korhaan	-	-	Protected
Geronticus calvus	Southern Bald Ibis	Vulnerable	Vulnerable	Protected
Glareola nordmanni	Black-winged Pratincole	Near Threatened	-	Protected
Lissotis melanogaster	Black-bellied Korhaan	-	-	Protected
Neotis denhami	Denham's Bustard	Vulnerable	Vulnerable	Protected
Phoenicopterus minor	Lesser Flamingo	Near Threatened	Protected	Protected
Phoenicopterus ruber	Greater Flamingo	Near Threatened	Protected	Protected
Sagittarius serpentarius	Secretary bird	Vulnerable	-	Protected
Spizocorys fringillaris	Botha's Lark	Endangered	-	Endangered
Tyto capensis	Grass Owl	Vulnerable	-	Protected

8.8.3.4.3 Herpetofauna

Based on available literature, 48 reptile and 18 amphibian species potentially occur in the study area. Two species potentially occurring in the study area; namely Breyer's Long-tailed Seps (*Tetradactylus breyeri*) and the Striped Harlequin Snake (*Homoroselaps dorsalis*), are listed as Vulnerable and Near Threatened, respectively (Bates *et al.*, 2014), while 13 species are considered endemic (Bates *et al.*, 2014) - listed in Table 42.

The Giant Bullfrog (*Pyxicephalus adspersus*) is listed as Near Threatened on the regional IUCN Red List (Minter *et al.*, 2004) and as protected in Mpumalanga Province. Although not recorded during this study, Giant Bullfrog have been recorded at sites designated as highly significant by the MBSP, which occur in the south-west of the study area (Pers. comm. M. Lotter 2012).

Table 42: Reptiles of conservation importance potentially occurring in the study area

Family	Scientific name	Common name	Status	Red List (2014)
Agamidae	*Agama aculeata distanti*	Eastern Ground Agama	Endemic	-
Colubridae	*Philothamnus natalensis*	Natal Green Snake	Endemic	-
Cordylidae	*Pseudocordylus melanotus melanotus*	Common Crag Lizard	Endemic	-
	Smaug vandami	Van Dam's Dragon Lizard	Endemic	-

Family	Scientific name	Common name	Status	Red List (2014)
	Platysaurus orientalis orientalis	Sekhukhune Flat Lizard	Endemic	-
	Chamaesaura aenea	Coppery Grass Lizard	Endemic	Near threatened
Gekkonidae	*Lygodactylus nigropunctatus*	Black-spotted Dwarf Gecko	Endemic	-
	Lygodactylus ocellatus ocellatus	Spotted Dwarf Gecko	Endemic	-
	Pachydactylus affinis	Transvaal Gecko	Endemic	-
Gerrhosauridae	*Tetradactylus breyeri*	Breyer's Long-tailed Seps	Endemic	Vulnerable
Lamprophiidae	*Homoroselaps lacteus*	Spotted Harlequin Snake	Endemic	-
	Lamprophis aurora	Aurora House Snake	Endemic	-
	Lycodonomorphus inornatus	Olive Ground Snake	Endemic	-
	Duberria lutrix lutrix	South African Slug-eater	Endemic	-
	Homoroselaps dorsalis	Striped Harlequin Snake	Endemic	Near Threatened
Scincidae	*Acontias gracilicauda*	Thin-tailed Legless Skink	Endemic	-

Source: Bates *et al.*(2014)

8.8.3.5 Affected Habitat Units – Findings of the site walk over

Three primary habitat types were identified during the walk down of the proposed preferred route F corridor. These are briefly discussed in Sections 8.8.4 and 8.8.5, with accompanying photographs. A habitat unit map of the road corridor is provided in Figure 47.

8.8.4 Modified Habitat

Modified habitats are defined as areas that have been altered by human activity and may contain large portions of non-native plants and animals (e.g. agricultural landscapes).

Cultivated Land

Cultivated fields characterise the majority of the proposed road corridor. At the time of the walk down, maize had recently been harvested from the fields and they were standing fallow (Figure 44). Accordingly, they were almost completely denuded of vegetation.

The senescent remains of several alien weeds were observed, including *Amaranthus hybridus, Cosmos bipinnatus* and *Xanthium strumarium.* This is a modified habitat unit, with low ecological integrity and low conservation importance.

Figure 44: Cultivated field currently lying fallow

Eucalyptus – Acacia Woodlots

The proposed road corridor bisects, or traverses in close proximity to, four woodlots that are dominated by alien invasive tree species, mostly *Acacia dealbata* (Figure 45), but also *Eucalyptus grandis*.

Acacia dealbata, commonly known as Silver wattle, is highly invasive and listed under the National Environmental Management: Biodiversity Act (NEMBA) as a Category 2 invasive species. It produces large quantities of seed, germinates easily after fire, and can rapidly establish in both terrestrial and riparian habitats. *Eucalyptus grandis* is also a NEMBA listed species (Category 1b, 2 or not listed) [4].

Other flora taxa recorded included grasses such as *Eragrostis chloromelas, Eragrostis curvula* and *Eragrostis plana,* and pioneer alien weeds including mostly *Bidens pilosa, Riccardia brasiliensis* and *Tagetes minuta.*

Considering the dominance of listed alien invasive species, this habitat unit is considered modified and has a low ecological integrity and low conservation importance.

Figure 45: Patch of Acacia dealbata trees occurring along the preferred route alternative F, on the edges of a cultivated field

[4] Category1b in riparian areas; Category 2 in plantations/woodlots; Not listed in cultivated fields (> 50 m from untransformed land) or within 50 m of farm house.

8.8.5 Natural Habitat

Historic agricultural activities have caused some degree of disturbance across the broader Mafube LifeX study area, and very little pristine habitat remains. This notwithstanding, we define natural habitats where key processes, composition, and structure are largely intact.

Open Grassland/Wetland

The proposed road traverses across several patches of natural habitat that are characterised by dry terrestrial grassland and moist grassland (wetland) (Figure 46). These habitat patches are generally associated with areas where either high soil moisture levels or rocky/shallow soils prevent or hamper cultivation. As such, they are typically small, often elongated and surrounded by transformed or modified land.

Based on the dry season walk down, grass species common in areas of moist grassland on hillslope seeps include *Andropogon huilensis, Arundinella nepalensis, Cynodon dactylon, Eragrostis gummiflua, E. plana* and *Imperata cylindrica.*

In drier areas, frequently recorded grasses include *inter alia*, *Eragrostis chloromelas, E. curvula, E. racemosa, Hyparrhenia hirta* and *Themeda triandra,* while the woody encroaching shrub *Seriphium plumosum* is also commonly scattered throughout grassland areas.

The senescent leaf remains of a *Gladiolus* plant were noted during the walk down - all *Gladiolus* species are protected in Mpumalanga Province (Mpumalanga Nature Conservation Act, 1998). No other plants of conservation importance were observed during the dry season road corridor walk down.

Patches of grassland/wetland are grazed by cattle, and often show signs of overgrazing - the proliferation of *Seriphium plumosum* and *Eragrostis* grasses is often indicative of overgrazed grassland. Moreover, as many patches are surrounded by cultivated fields they have also been impacted at their periphery by ploughing and alien weeds (*Bidens pilosa* and *Tagetes minuta* common) establishment.

Despite these disturbances, patches of natural grassland/wetland are important habitat for flora and fauna. This is especially so considering the highly modified and fragmented nature of the local landscape.

Figure 46: Hillslope seeps supporting moist grassland that are being crossed in places by the preferred route alternative F corridor, are generally heavily grazed and trampled by cattle

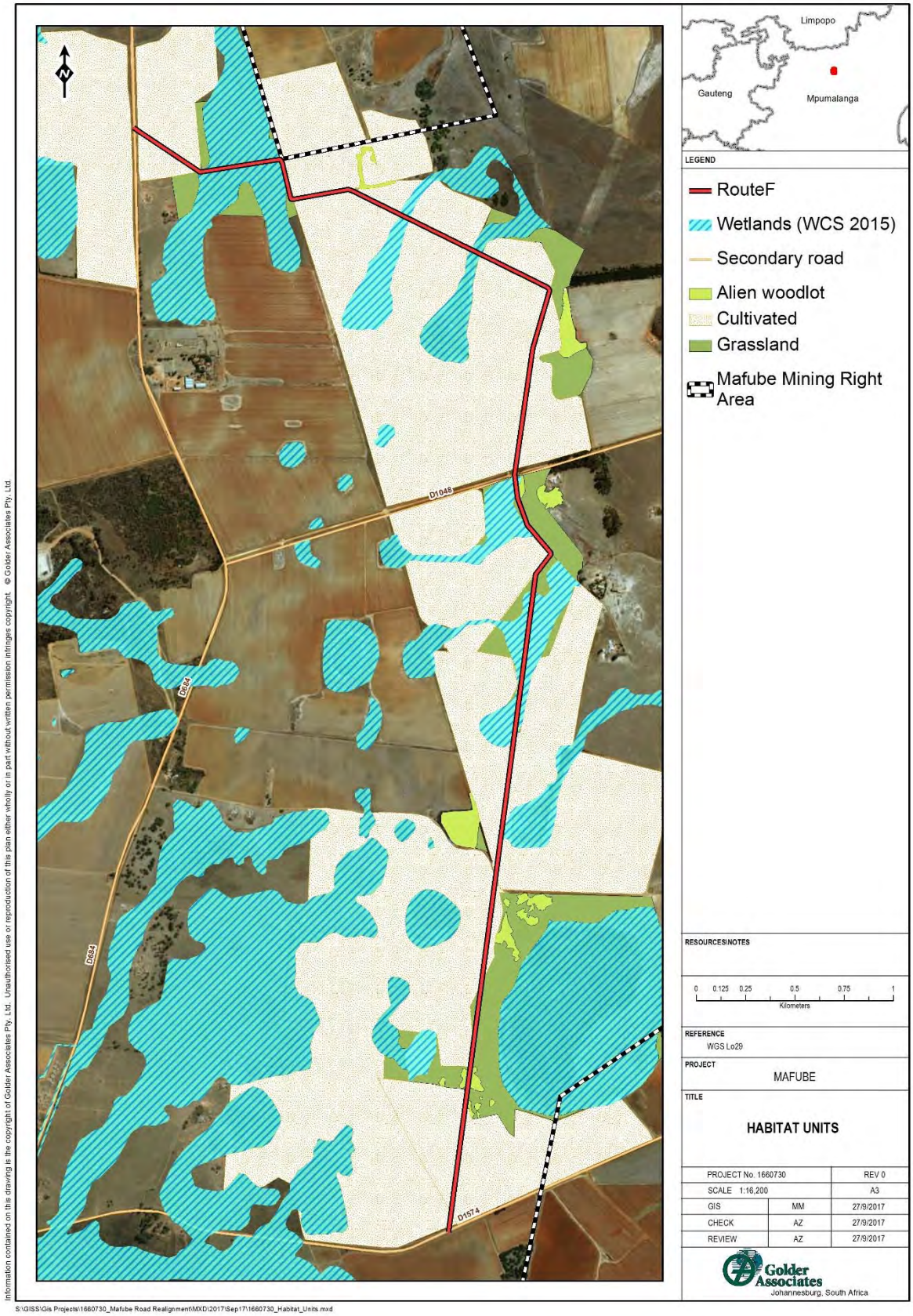


Figure 47: Habitat units along the preferred route alternative F corridor (see Figure 5 for optimised alignment)

8.9 Visual

8.9.1 Landscape Character

The proposed route realignment area lacks any prominent topographical features and is characterised by gently undulating plains. Seasonally, pans and inundated wetlands are a distinctive feature in the landscape, particularly in the northern part of the area. Local watercourses drain into the Klein-Olifants River, which in turn drains into the Middelburg Dam. The study area itself is representative of the local topography and does not include any distinctive topographical features. The vegetation in the area is dominated by Highveld grasses with an abundance of cosmos within the surrounding areas. The vegetation in the area has been severely impacted by agricultural activities, resulting in natural vegetation being limited to areas unsuitable for ploughing. These areas are however heavily utilized for livestock grazing, predominately by cattle for the beef market.

Land use in the study area includes Eskom power stations, coal and platinum mining activities and a strong agricultural sector comprising cultivation and livestock grazing, with supporting infrastructure such as grain silos and the Arnot railway siding located in the south-eastern section of the study area. Subsistence farming is limited to small areas surrounding commercial agricultural operations. Other land uses include isolated nodes of forestry. Middelburg is now the largest commercial and residential centre in the Steve Tshwete Local Municipality. Businesses include a general dealer, farming cooperative and silos located next to the Arnot siding. The residential component includes farmsteads and workers' housing, scattered through the study area, as well as the Sikhululiwe village, located in the south-eastern section of the study area and built to accommodate relocated families within the area. The main road and rail infrastructure in the area includes the N4, which runs east-west approximately 1 km south of the project, the R104, running more or less parallel to the N4 just to the north of it as well as other local tarred and dirt roads, and the Mozambique railway line. Other support infrastructure includes ESKOM power lines and telecommunication lines.

8.9.2 Sense of Place and Aesthetic Value

The Project is located within an area dominated by gently undulating plains. The sense of place is established by the 'openness' of the topography, enhancing the rural character of the agricultural activities. The farmsteads and associated structures also add to the rural character of the study area. Another element contributing to the sense of place is the existing mining activities. These are mostly open cast activities with supporting structures and infrastructure. Landscapes with greater diversity or containing "distinctive" features are classified as having a higher scenic value than landscapes with low diversity, few distinctive features, or more "common" elements. Generally, the greater the diversity of form, line, texture, and colour in a landscape unit or area, the greater the potential for high scenic value. Scenic quality classifications are:

- High - distinctive landscape, often with a strong sense of place;
- Moderate - common landscape; and
- Low - minimal landscape, often with a weak sense of place.

'Land types', each with its dominant landscape characteristic, sense of place and aesthetic value within the study area, have been identified as follows: Land types with a low scenic quality classification include roads, the railway, power and telecommunication infrastructure as well as the infrastructure and structures associated with the mining activities. A moderate rating was assigned to farmsteads and agricultural support facilities such as grain silos. Agricultural activities, crop production and grazing as well as the natural grassland vegetation were assigned a high scenic quality.

The scenic quality of the landscape within the study area is rated as moderate to high within the context of the sub-region. A summary of the scenic quality of the various landscape types is contained in Table 43 below.

Table 43: Value of the Visual Resource - Scenic Quality

High (agricultural activities and natural grassland vegetation)	Moderate farmsteads and agricultural support facilities	Low (roads, railway, power and telecommunication infrastructure as well as mining infrastructure)
These landscape types are considered to have a high value because they are: Distinct landscapes that exhibit a very positive character with valued features that combine to give the experience of unity, richness and harmony. They are landscapes that may be considered to be of particular importance to conserve and which have a strong sense of place. They may be sensitive to change in general and may be detrimentally affected if change is inappropriately dealt with.	These landscape types are considered to have a *moderate* value because they are: Common landscapes that exhibit some positive character, but which have evidence of alteration/ degradation/erosion of features, resulting in areas of more mixed character. They are potentially sensitive to change in general and change may be detrimental if inappropriately dealt with but change may not require special or particular attention to detail.	These landscape types are considered to have a *low* value because they are: Minimal landscapes generally negative in character with few, if any, valued features due to their inherent characteristics or due to major negative man-made impacts. Scope for positive enhancement could occur.

The combination of the above described features results in a mixed agricultural/industrial landscape character. The positive agricultural character is affected negatively by the mining component. Although the landscape has been impacted by the existing mining operation, the sense of place of the study area is established with the combination of natural grassland plains with extensive agriculture. The study area has a distinct pastoral sense of place derived from the expansive agricultural fields, scattered farmsteads and rural character. This rural character is still very much intact, supporting its spacious sense of place despite the existence of the mining activities.

As stated above, the visual context is characterised by the openness of the gently undulating topography, which allows for expansive views towards the proposed development. Travellers along public roads in the vicinity of the Project, the R104 and other local tarred and dirt roads mostly include farmers, labourers and people visiting or working at the mine. The R104 is however considered to be a 'quiet' road. The proposed study area can only be partially viewed from the public roads in the area as the topography screens it in most places. The most sensitive viewing areas, as far as the Project is concerned, are from high points on nearby farms located within the study area.

8.9.3 Aesthetics

The intended mining area on Nooitgedacht and Wildfontein reserves may be visible from the district road, from several farmhouses and from topographical high points in the surrounding area. It is not located along any recognised tourist route and the visual quality of the wider area has already been affected adversely by the current mining activities, the power station and local infrastructure such as power lines, railways and roads.

The pre-mining visual appearance of Nooitgedacht and Wildfontein reserves and the adjacent areas is determined by the current vegetation cover (including maize fields and clumps of exotic trees), surface water features and power lines.

8.10 Noise

Measurements and auditory observations were taken in May 2007 and December 2011 by Jongens Keet Associates at 13 locations in order to establish the ambient noise conditions of the study area (The following results were presented in the Final Report (JKA602r005 dated 28 June 2012):

- Residual noise levels at the various farmhouses and farm labourers' dwellings are relatively low (quiet). Daytime ambient conditions across the area range from about 38 dBA to 48 dBA near the main road.

Evening conditions range from about 30 dBA to 39 dBA, while the night-time ambient levels fall even lower to about 25 dBA in places. These are acceptable rural residential conditions (SANS 10103); and

- Residual noise levels at the schools meet the noise standards required for educational purposes, namely not exceeding 50dBA during school hours.

The monitoring results from Points 4, 5 and 6 are particularly relevant to this study. Point 5 provides an indication of the baseline noise levels at Route F, while points 4 and 6 provide an indication of the potential future noise regime likely to be experienced during the operational phase of Route F (Table 44).

The average L_{Aeq} at points 4 and 6 was 42.1 dBA, approximately 3 dB lower than the typical rural residential noise level rating of 45 dBA.

Noise levels at point 5 were comparatively higher, averaging 43.8 dBA.

Table 44: Noise measurements made by Jongens Keet Associates in 2007 and 2011

Site	Location	Dates	Daytime			Night time		
			L_{Aeq}	L_{max}	L_{min}	L_{Aeq}	L_{max}	L_{min}
4	At Sikhululiwe Village, just west of Road D684	May 2007	38.8	47.6	29.6	35.5	41.2	29.9
		December 2011	43.8	58.4	28.5	-	-	-
5	At a farm house on farm Roodepoort 418-JS, approximately 600 m east of Road D684	May 2007	40.8	58.0	31.1	34.8	44.7	31.7
		December 2011	46.8	64.9	31.4	-	-	-
6	At school and houses just east of Road D684	May 2007	40.2	53.7	29.7	-	-	-
		December 2011	45.6	57.5	29.3	-	-	-

In addition to the baseline monitoring, Jongens Keet Associates also calculated the prevailing 24-hour residual noise level related to the average daily traffic (ADT) flows on the main roads through the area. The noise levels generated from the traffic on these roads were calculated using the *South African National Standard SANS 10210 Calculating and Predicting Road Traffic Noise* and 2011 traffic data. The results for the D684 are shown in Table 45.

According to these calculations, the road traffic along the D684 results in the degradation of the noise climate at up to 100 m from the road centreline.

Table 45: Calculated noise climate alongside the D684 (Jongens Keet Associates, 2012)

Road	Offset from D684 centreline														
	25 m			50 m			100 m			250 m			500 m		
	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
D684N	46	37	47	43	34	44	40	31	40	36	27	36	32	23	32
D684S	51	42	51	48	39	48	45	36	45	40	31	41	36	27	37

Note: Red text indicates exceedance of the typical noise level rating for a rural residential district during the day (Ld = 45 dB) or night (Ln = 35 dB) period.

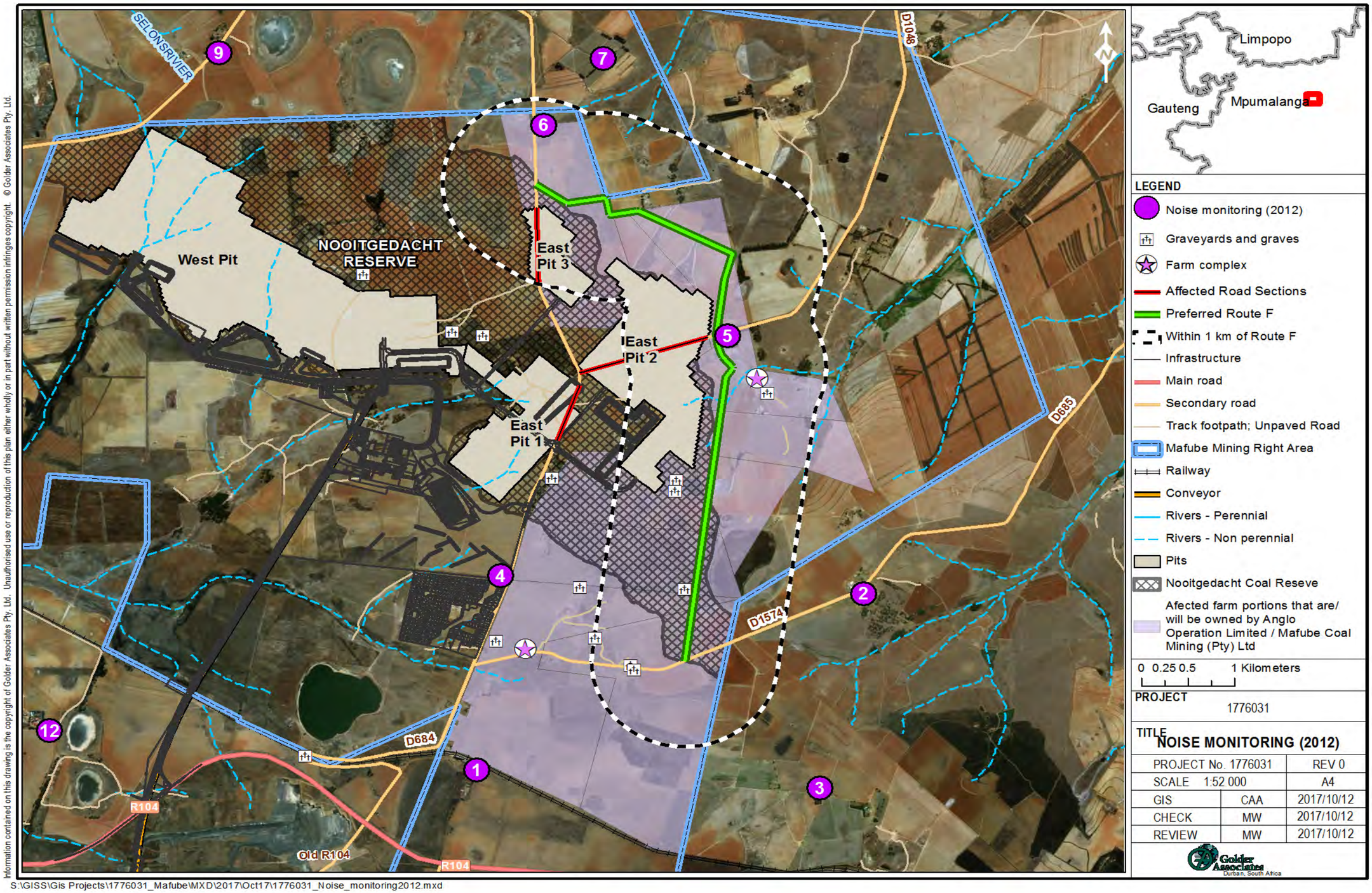


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Figure 48: Baseline noise monitoring locations (Jongens Keet Associates, 2012) See Figure 5 for optimised alignment

8.11 Traffic

Road D684 is an unpaved road, approximately 8 m in width (Figure 49 and Figure 50). It is located in a rural area that consists predominantly of farming and some coal mining. It provides access to Sikhululiwe Village that is located adjacent to the road reserve.

Figure 49: Northerly view of D648 from survey point

Figure 50: Southerly view of D648 from survey point

8.11.1 Traffic Flow

The intersection of road D684 and D1048 was surveyed by Techworld in 2012 (Techworld Consulting Engineers, June 2012). This intersection is located 3 km north of the follow-up sample count site (conducted by Golder in May 2016). The 2012 data indicated that 22 light vehicles, 2 buses and 5 HGVs travelled south past Sikhululiwe Village on the D648 over a 12 hour period. In addition, 29 light vehicles, 5 buses and 3 HGVs travelled North on the D648 past Sikhululiwe Village over the same 12 hour period. This equates to a vehicle passing Sikhululiwe Village every ~11 minutes.

The sample count carried out in May 2016 was done over a four hour period (9:45 to 13:45). Over this period 19 light vehicles and one HGV moved North on the D684 past Sikhululiwe Village and 23 light vehicles and 2 HGVs moved south. This compares with the 2012 dataset as follows:

Table 46: Comparison of 2012 and 2016 traffic count datasets for four hour period (9:45 to 13:45)

Flow direction	**North (2012)**		**North (2016**		**South (2012)**		**South (2016)**	
Vehicle Type	Light	HGV	Light	HGV	Light	HGV	Light	HGV
Number of Vehicles	7	3	19	1	10	1	23	2

There were no buses or taxis counted during this period for both the 2012 and 2016 datasets. The figures indicated that HGV traffic is largely the same as it was in 2012, over this time period, but light vehicle traffic has increased by 63% northbound and 56% southbound. From the 2016 sample dataset it was calculated that a vehicle moves past Sikhululiwe Village every ~5 minutes.

The meeting with the Sikhululiwe residents and the Ward 7 Councillor indicated that HGV traffic is highest in the mornings and evenings when children and workers are transported to school and work respectively.

Figure 51: School buses in Sikhululiwe Village

According to the Sikhululiwe residents, a total of seven school buses utilise the D648 for transporting children and adolescents to and from schools. Three school buses transport children to and from Arnot Primary School in Sikhululiwe Village (Figure 51). Two buses use the road to transport children to Morelig Combined School. One bus transports children to the Ipan Primary School and one bus to the Beestepan Agricultural High School. In addition, a further three buses use D648 to transport farm workers- two trucks drive to and from Beestepan Farm and one to and from Van Wyk Farm. It was stated that HGV traffic worsens during the harvesting season (April to August) due to trucks transporting agricultural produce. Road D684 is also used by pedestrians to access the Arnot Station Shopping Centre.

8.11.2 Traffic Safety

The Sikhululiwe residents and the Ward 7 Councillor mentioned that road safety awareness among the villagers is good, however drivers can be negligent. They estimated that approximately ten accidents have been reported in the area over the past 15 months. There have been no fatalities.

8.11.3 Infrastructure

The signage on the road appears to be adequate. As it is an unpaved road, there are no formal pedestrian crossings, but there is signage indicating that children cross the road (Figure 52 and Figure 53).

Figure 52: Signage for vehicles turning on to D648 from Sikhululiwe Village

Figure 53: Sign warning of children crossing

There are culverts installed at road junctions on the D684 (Figure 54). There are existing drainage lines running the length of the road which appear to be sufficient, however, for certainty the road would need to be revisited in the wet season.

Figure 54: Culvert installed at Sikhululiwe Village entrance

8.11.4 Environmental Disturbance

Dust has been identified as being a nuisance to Sikhululiwe Village residents as well as being dangerous to road users in terms of visibility. It is particularly problematic in the dry season. Dust generated by vehicles passing on the D684 can be seen in Figure 55 and Figure 56. Noise and vibration emanating from vehicles on route D648 was not identified by the Sikhululiwe Village representatives as being problematic.

Figure 55: Dust generated on D648 by an HGV

Figure 56: Dust generated on D648 by a light vehicle

8.12 Palaeontological aspects

The new proposed road realignment will be situated on Nooitgedacht 419-JS and Panplaats 395-JS, in the Mpumalanga Province. Depth will be determined by the road construction. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

The development is taking place in an area covered by the Vryheid Formation. The Bushveld Complex (surrounding area) is a massive body of igneous origin and it is intrusive in the Transvaal Supergroup (Kent, 1980). It covers an area of 65 000 km² and is chrome and platinum rich (Visser, 1989). The age is Vaalian (2,100 – 1,920 Ma). The Rustenburg Layered Suite is so termed as it is intrusive in origin and the term is to be equivalent to a 'group'. It consists of mafic and ultramafic rocks and is rich in platinum, chrome and vanadium. The layered rocks of the Bushveld Complex are generally believed to be the result of crystals settling out of magma during slow cooling. The magmatic events petrogenetically related to and generally considered part of the whole magmatic evolution of the Complex are, the diabase sills and the Rooiberg Group. The Complex consists of three main units or suites of which the Rustenburg Layered Suite is one (Kent, 1980), the other two are the Rashoop and Lebowa Granite Suites (Visser, 1989). This region is covered by the 'Bushveld' vegetation.

The Bushveld Complex rocks are classified as mafic and ultramafic because of the iron and magnesium (and/or calcium) rich content, such as norite, gabbro and pyroxenite. The heaviest minerals, such as olivine and pyroxene, and any sulphide minerals concentrate towards the base of each layer. Lighter minerals, such as feldspar and quartz, tend to form at the top (Norman and Whitfield, 2006). It is believed that the Bushveld Complex looked like the Yellowstone National Park in the States of Wyoming, Idaho and Montana, United States of America, when it formed. The Rustenburg Layered Suite formed first. Erosion caused the Bushveld Complex to shrink in size. The Complex crops out at surface in three very long arcs, from Thabazimbi to Pretoria in the west, from Mokopane to Middelburg in the east, and north of Mokopane (McCarthy and Rubidge, 2005).

The Bushveld Complex is economically very important. By far the most important metal mined from the Rustenburg Layered Suite is platinum. Gold is also present, other minerals are nickel, copper, chrome, vanadium, tin, fluorspar and cobalt. Quarries provide dimension stone and granite (Visser, 1989). The Transvaal Supergroup fills an east-west elongated basin in the south-central part of the old Transvaal (now North – West, Gauteng and Mpumalanga Provinces) as far south as Potchefstroom. It is Vaalian in age, approximately 2 600 Ma to 2100 Ma. A maximum thickness of the Transvaal Supergroup reaches 2 000 m in the north-eastern section. An east-west elongated basin is filled with clastic, volcanic and chemical sedimentary rocks. Three groups based on lithological differences have been established: they are the Rooiberg, Chuniespoort, and Pretoria Groups as well as other smaller groups (Kent 1980). It is the Bushveld Complex that is responsible for the tilting of the Transvaal sediments and the heat of its intrusion having created andalusite crystals (Norman and Whitfield 2006).

This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group. The Rooiberg Group is divided into the Formations Damwal and Selonsrivier in the Loskop dam area (Visser 1989). The Vryheid Formation present is part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth. The Vryheid Formation (Pe,Pv), Ecca Group is rich in plant fossils such as the Glossopteris flora represented by stumps, leaves, pollen and fructifications. This formation is early to mid-Permian (Palaeozoic) in age and consists of sandstone, shaly sandstone, grit, conglomerate, coal and shale. Coal seams are present in the Vryheid Formation within the sandstone and shale layers.

Fossils are mainly present in the grey shale, which is interlayered between the coal seams (Kent 1980, Visser 1989). Borehole logs in the coalfields show the following layers; soil, shale and sandstone, shale and sandstone interbedded, sandstone, coal, conglomerate reworked diamictite, Dwyka Tillite, and the Pre-Karoo Basement.

The Vryheid Formation is named after the type area of Vryheid-Volksrust. In the north-eastern part of the basin the Vryheid Formation thins and eventually wedges out towards the south, southwest and west with increasing distance from its source area to the east and northeast (Johnson 2009). The Vryheid Formation consists essentially of sandstone, shale, and subordinate coal beds, and has a maximum total thickness of 500 m. It forms part of the Middle Ecca (Kent 1980). This formation has the largest coal reserves in South Africa. The pro-delta sediments are characterised by trace and plant fossils (Snyman 1996).

This development includes one preferred route Alternative F, which will transect Panplaats 395-JS in a northerly direction and then the route will turn west through Nooitgedacht 395-JS. Ecca rocks are stable and lend themselves well to developments. It is only unstable in or directly above mining activities (Snyman 1996). The site itself is situated on the flat-lying Vryheid Formation, Ecca Group, Karoo Supergroup. Dolerite dykes do occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport.

The typical colours for the Vryheid Formation are grey and yellow for the sediments and black for the coal seam. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

8.13 Sites of cultural importance

Archaeological and cultural resources refer to resources having prehistoric, palaeontological, historical, cultural, artistic or religious values, as well as unique natural environmental features that embody cultural values, such as sacred groves and forests (International Finance Corporation (IFC), 2006). The National Heritage Resources Act (Act No. 25 of 1999) (NHRA) stipulates that all cultural heritage resources are the property of the State and may not be disturbed without authorization from the relevant heritage authority. Section 34 (1) of the NHRA states that “no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…” Mpumalanga encompasses some of the richest geological, archaeological and cultural heritage in the world.

The Phase I HIA study for the Mafube LifeX Project, completed in 2012 by Dr Julius Pistorius revealed the following types and ranges of heritage resources in and near the Mafube LifeX Project Area (Pistorius, 2012):

- Farmstead complexes with farm houses and outbuildings which are older than sixty years and which therefore qualify as historical structures;
- A number of formal and informal graveyards. Several of the graveyards are older than sixty or hundred years and therefore qualify as historical graveyards;
- Rural dwelling complexes, some of which may be older than sixty years and which therefore may qualify as historical remains;
- Remains from the recent past which are younger than sixty years and which therefore have no outstanding cultural or historical significance; and

- Modern farm-houses and farm homestead complexes which have no historical significance.

The historical farmstead complexes and graveyards qualify as significant heritage resources. Some of the rural dwelling complexes may have historical affinities as some of these complexes or individual dwellings in these family homesteads may be older than sixty years.

The remains from the recent past as well as the modern farm-houses or farm homestead complexes have no historical significance. The significance of the heritage resources was determined by means of stipulations from the National Heritage Resources Act (Act No. 25 of 1999) and by means of various other criteria. Mitigation measures are proposed for those heritage resources that may be affected by the proposed Mafube LifeX Project. It must be noted that some of the farmstead complexes, graveyards and rural village complexes fall outside the Mafube Project Area where they need not be affected by the Mafube LifeX Project.

Figure 57: Large stretches of grass veld mostly used for grazing

Figure 58: The larger part of the project area is covered with agricultural fields

Figure 59: Preferred alternative route F runs along Eskom's existing 400 kV power lines

Figure 60: Short stretches of existing roads such as D1574, D685, D1048 and D684 cross the project area

8.14 Socio-Economics

The Steve Tshwete Local Municipality area covers 3,993 km², and it has an estimated population of 173,800 residents which is largely based in Middelburg, Mhluzi, smaller mining towns and rural areas. Land-use within this municipality is characterized by high intensity crop production, cultivated grazing and open cast coal mining. In the northwest of the municipality it is game farms supported by the eco-tourism industry. The high natural resource potential creates employment opportunities within the primary sector, which is comprised of agriculture and mining. It is almost twice as high in Steve Tshwete Local Municipality as at the national level. However, Steve Tshwete's Local Municipality Spatial Development Framework (SDF) notes the existence of competing interests between the two sectors. Despite this, the economic value of mining cannot be ignored. Mining is well-established as the largest economic contributor in the municipality. It also impacts on the economic status of Mpumalanga province. The employment opportunities associated with the primary sector have resulted in an influx of people, which resulted in an above average population growth in the last 10 years. This has increased the levels of informal housing in the local municipality area.

The Mafube LifeX operations and the associated road re-alignment route options are located within the Nkangala District Municipality.

The Nooitgedacht coal reserve is situated in the Steve Tshwete Local Municipality and the road network options span into the neighbouring eMakhazeni Local Municipality. This section describes the social baseline of the project area at a provincial, district and local municipal level and further in terms of the Ward area and local community or settlement level.

8.14.1 Overview of the Regional Area

8.14.1.1 Mpumalanga Province

The Mpumalanga Province is entirely landlocked and shares a border with Swaziland and Mozambique. The geographical area of the province is 79 511 km^2. The province consists of four district municipalities and 20 local municipalities.

Mbombela LM (previously Nelspruit LM) is the administrative and business hub of the Lowveld. Mpumalanga is highly accessible, with a network of excellent roads and railway connections, as well as some small airports, including the Kruger Mpumalanga International Airport.

About a third of the people speak siSwati, the language of neighbouring Swaziland, with isiZulu, Xistonga and isiNdebele commonly heard.

Mpumalanga is rich in coal reserves, and home to South Africa's major coal-fired power stations, three of which are the biggest in the southern hemisphere. Mpumalanga produces about 80% of the country's coal and remains the largest production region for forestry and agriculture.

8.14.1.2 Nkangala District Municipality

The Nkangala DM is one of the three districts of the Mpumalanga Province. The Mafube Mining Right Area is situated within the Nkangala DM which consists of 160 towns and villages and covers an area of 16 758 km^2.

The Nkangala DM is the economic hub of Mpumalanga and is rich in minerals and natural resources. The district economy is dominated by the power, manufacturing and mining sectors. These sectors are followed by community services, trade, finance, transport, agriculture and construction.

A strong point of the district is the Maputo Corridor, which brings increased potential for economic growth and tourism development. The proximity to Gauteng opens opportunities to access a larger market, which is of benefit to the district's agricultural and manufacturing sectors. The potential inherent in exporting goods has been identified as an area that warrants further investigation (Nkangala DM IDP, 2015 - 2016).

8.14.1.3 Steve Tshwete Local Municipality

Steve Tshwete LM is a category B[5] municipality situated in Nkangala district in Mpumalanga Province. Steve Tshwete LM can be regarded as one of the commercial hubs in Mpumalanga with a higher household income compared to other municipalities. Its local economy is one of the largest in the district, dominated by the mining and manufacturing sectors. It is positioned approximately 150 km east of Pretoria on the way to Mbombela and covers a geographical area of 3 993 km².

The municipality is well located as it is traversed by the Maputo Development Corridor, the Middelburg/ Steelpoort mining resource link, as well as the Middelburg/Bethal/Ermelo/Richards Bay Corridor.

Provincial roads traverse the area of jurisdiction of Steve Tshwete LM. The most prominent of these are the N4 National route crossing the area from east to west and the N11, traversing the area from north to south (Steve Tshwete LM IDP, 2016 - 17).

8.14.1.4 eMakhazeni Local Municipality

eMakhazeni LM is also a category B[6] municipality situated in Nkangala district in Mpumalanga Province.

[5] **Category B municipality** is a type of **municipality** that serves as the third, and most local, tier of local government (Nkangala DM IDP, 2015-2016)

[6] **Category B municipality** is a type of **municipality** that serves as the third, and most local, tier of local government (eMakhazeni DM IDP, 2016-2017)

Although its contribution to the overall Mpumalanga economy is relatively small, with mining and transport being the main contributors, it is regarded as an important gateway to major tourist attractions in both Mpumalanga and Limpopo Provinces. It has a geographical area of 4 736 km² and is strategically located between the Pretoria/Johannesburg complex in Gauteng and Nelspruit in Mpumalanga. It is an important gateway along the N4 Maputo Corridor, which is the main link between Gauteng Province, Mpumalanga Province and Mozambique. The R540, which runs in a northern direction from the N4 Freeway through eMakhazeni and Dullstroom, provides an important link to Lydenburg and other centres in the Lowveld, particularly Hoedspruit, Pilgrim's Rest and Graskop. Railway lines from Gauteng stretch through this area and provide linkages with the Maputo and Richards Bay harbours respectively. The main contributors to the eMakhazeni LM economy are mining, transport and community services (eMakhazeni LM IDP, 2016 - 17).

8.14.2 Population Demographics

A comparison of population and gender distribution within the regional area is presented in Table 47. Mpumalanga Province has a total population of 4 949 885 of which 52% is female and 48% male. This trend is carried through in the Steve Tshwete LM and also to Ward level where the same gender distribution is evident in the study area. Within the Nkangala DM, the gender distribution evens out with 50% being female and 50% being male (Stats SA, 2011).

The Mpumalanga Province has an average population density of 64.7 people per km^2. Within the Nkangala DM, the average population density increased compared to the provincial average of 78.1 people per km^2. Within the Steve Tshwete LM there is an average population density of 57.6 people per km^2. However, at Ward level, the population density decreases to 17.0, 9.6 and 4.1 people per km^2 within Wards 7, 9 and 2 respectively.

The Nkangala DM has approximately 356 911 households and a population growth rate of 2.5% per annum. Nkangala DM has a total population of 1 308 150 (Nkangala DM Final Draft IDP 2016/17 - 2020/21).

Table 47: Population and Gender Distribution

Region	Total	Total Female	%	Total Male	%	Area in km^2	Population Density
Mpumalanga Province	4 949 885	2 558 980	52	2 390 905	48	76 495	64.7
Nkangala DM	1 308 150	651 897	50	656 253	50	16 758	78.1
Steve Tshwete LM	229 839	110 425	48	119 414	52	3 993	57.6
Steve Tshwete LM Ward 7	5 821	2 647	45	3 174	55	342	17.0
Steve Tshwete LM Ward 9	6 629	3 133	47	3 496	53	690	9.6
eMakhazeni LM Ward 2	5 117	2 460	48	2 657	52	1 255	4.1

Over the ten year period from 2001 to 2011, the population of the Steve Tshwete LM increased by 4.76%. This could be attributed to the number of industries that were opened within the 10 years (2001 - 2011) that attracted workers into Middelburg (Stats SA, 2011).

Steve Tshwete LM exhibits the second highest urbanisation rate in the Nkangala DM at 72.1% (Steve Tshwete ITP, Draft 2013). This high urbanisation rate is coupled with the depopulation of rural areas. The northern boundary of the Steve Tshwete LM bisects Loskop Dam, with the Loskop Dam Nature Reserve surrounding the dam. To the east of Middelburg Town is the Middelburg Dam, and to the north-west thereof is the Botshabelo Nature Reserve (Steve Tshwete LM IDP, 2016 - 17).

eMakhazeni LM, by contrast, has the smallest population in the district. It has however seen a population increase of 9.78% between 2001 and 2011 (eMakhazeni LM IDP, 2016 - 17). This could be attributed to an increase in industries in the Belfast and Machadodorp areas.

8.14.2.1 Ethnicity

The African/black population continues to constitute the highest group followed by the white population since 1996 to date. The Asian and coloured populations constitute the minor population groups (Steve Tshwete LM IDP, 2016 - 17). A similar trend is evident in the eMakhazeni LM (eMakhazeni LM IDP, 2016 - 17).

8.14.2.2 Education

Educational attainment is a key indicator of capacity development in a population. Basic education is the foundation to securing employment and furthering one's skills levels.

Table 48 depicts the educational levels attained in the region.

Within the Steve Tshwete LM a third of the regional and local populations have completed some secondary education. Steve Tshwete LM has the highest percentage (11%) of tertiary education successfully completed.

In Mpumalanga, 15% of the population received no formal schooling. In Nkangala DM, 12% of the population received no formal schooling. The figure for Steve Tshwete LM improves slightly at 7% but at a Ward level in the study area, the percentage of residents with no formal schooling is 14%, 23% and 28% for Wards 7, 8 and 2 respectively.

The literacy rate in Mpumalanga Province is approximately 68% and in the Nkangala DM it is 74% (Stats SA, 2011).

Table 48: Education Distribution of the Population

Region	No Schooling	Completed Some Primary	Completed Primary	Completed Some Secondary	Completed Secondary	Higher (Tertiary)
Mpumalanga Province	15%	12%	4%	33%	28%	8%
Nkangala DM	12%	11%	4%	35%	30%	8%
Steve Tshwete LM	7%	9%	3%	33%	36%	11%
Steve Tshwete Ward 7	14%	10%	3%	30%	33%	10%
Steve Tshwete Ward 9	23%	17%	4%	29%	24%	3%
eMakhazeni Ward 2	28%	15%	5%	29%	18%	3%

Source: Stats SA, 2011

The Human Development Index (HDI) is defined as a standard measure of determining whether an area is developed or developing. According to the United Nations, the HDI is considered high when it is 0.8 and higher, medium when it ranges between 0.5 to 0.8 and an index value of 0.5 and lower, will be considered as a low rating. In 2013, Nkangala DM had a HDI of 0.609 compared to Mpumalanga with a HDI of 0.59 and 0.632 of the National Total. The Steve Tshwete LM has one of the highest municipal HDIs, with an index value of 0.659. eMakhazeni LM, scored in the lower range which indicates that improvements are required in the areas of literacy, life expectancy and per capita income if the HDI levels are to reach an acceptable range comparable with that of the rest of the rest of South Africa (Nkangala DM IDP, 2015 - 2016).

8.14.2.3 Employment

Employment rates within an area are linked to the size of the economy as well as the personal income, education level and skills. This section provides a brief overview of employment rates and income levels within the region.

An employment breakdown across the region is presented in Table 49. Mpumalanga has the majority of its workforce (41%) falling into the other or inactive category, while 35% are recorded as being employed, and 18% are unemployed. In the Nkangala DM, 41% of the workforce is employed, 37% fall in the other or inactive category and 18% are unemployed. The other or inactive category describes individuals such as children or pensioners who are outside of the employable group.

In the Steve Tshwete LM, 53% of the workforce is recorded as being employed, 33% are in the other or inactive category and 13% are unemployed. Wards 7 and 9 have relatively high employment rates of 56% and 54% respectively and corresponding lower unemployment rates of 7% and 13% respectively. The high employment rate, particularly in Ward 7, can be linked to the relatively high tertiary education level (10%) and indicates that higher education levels provide the foundation to attaining employment. eMakhazeni Ward 2 displays similar employment trends as Mpumalanga Province and Nkangala DM.

Table 49: Employment

Region	Employed	Unemployed	Work Seeking	Other or Inactive
Mpumalanga Province	35%	18%	6%	41%
Nkangala DM	41%	18%	5%	37%
Steve Tshwete LM	53%	13%	3%	31%
Steve Tshwete Ward 7	56%	7%	4%	33%
Steve Tshwete Ward 9	54%	13%	4%	30%
eMakhazeni Ward 2	39%	15%	4%	42%

Source: Stats SA, 2011

Table 50 below sets out a comparison of employment status over the 10 years period from 2001 until 2011 in the Steve Tshwete LM. Out of the 107 069 economically active population in the Steve Tshwete LM, 21 101 are unemployed while 85 968 are employed. The unemployment rate has dropped from 35.4% in 2001 to 19.7% in 2011. Youth unemployment remains a major challenge regionally. It is predicted that current economic trends and cumulative mining industry retrenchments have led to an increase in the number of unemployed individuals (Steve Tshwete LM IDP, 2016 - 17).

Table 50: Employment Status

Labour Indicators	Steve Tshwete LM (2001)	Steve Tshwete LM (2011)
Employment		
Economically Active Population/Labour Force	64 474	107 069
Number of Employed	41 679	85 968
Unemployment		
Number of Unemployed	22 795	21 101
Official Unemployment	35.4%	19.7%
Unemployment amongst people with disabilities	38%	-
Youth Unemployment	46.1%	26.5%
Women Unemployment	49.2%	27.8%

Source: Stats SA, 2001-2011

The above trends are also evident within the eMakhazeni LM where an overall decline in unemployment from 30% in 2001 to 25.92% in 2011 is recorded.

However, as mining remains a large contributor to GDP in the region, the recent retrenchments and mine closures (e.g. Assmang Chrome Machado Works in 2015) are of concern to the local authorities as current levels of unemployment will no doubt rise (eMakhazeni LM IDP, 2016-17).

Mpumalanga is rich in various mineral resources, including coal, gold, platinum group metals, silica, chromite, vanadiferous magnetite, argentiferous zinc, antimony, cobalt, copper, iron, manganese, tin, andalusite, chrysotile asbestos, kieselguhr, limestone, magnesite, talc and shale. It is therefore not surprising that mining and manufacturing are the largest employment sectors within the region as reflected in Table 51 below. Within the Nkangala DM and Steve Tshwete LM, mining and quarrying contribute 28% and 26% respectively. Within the eMakhazeni LM the largest employment sector is manufacturing at 21%.

As the region serves as an important transport hub linking provinces and neighbouring states, transport, storage and communication also contribute to employment creation in a meaningful way as evidenced by a 15% employment rate in eMakhazeni and 11% in Steve Tshwete LM for this sector. Further important contributors are wholesale and retail trade, catering and accommodation and finance, insurance, real estate and business services.

Table 51: Employment Sectors (2010)

Sector	Mpumalanga	Nkangala DM	Steve Tshwete LM	eMakhazeni LM
Agriculture, forestry and fishing	3%	2%	2%	5%
Mining and quarrying	19%	28%	26%	15%
Manufacturing	21%	19%	22%	21%
Electricity, gas and water	5%	7%	10%	1%
Construction	2%	3%	3%	2%
Wholesale and retail trade, catering and accommodation	11%	8%	7%	11%
Transport, storage and communication	10%	10%	11%	15%
Finance, insurance, real estate and business services	13%	11%	9%	15%
Community, social and personal services	6%	5%	3%	7%
General government	10%	8%	6%	9%

Source: Quantec data, 2010

8.14.3 Social Infrastructure and Services

Provision of basic municipal infrastructure and community services within the Nkangala is a challenge due to its predominantly rural character and scattered settlements. The Nkangala DM has a dispersed spatial structure with population densities varying from very high (urban areas) to very low (small settlements in the rural areas). Most people are located in settlements adjacent to urban towns and there is a high demand for basic services such as adequate housing and sanitation. Within the less densely populated rural settlements, the need for adequate housing, sanitation and water supply is equally prevalent. Backlogs are the highest in the area of sanitation, followed by electricity and water. Electricity backlogs are most severe in rural areas and amongst households on farms (Nkangala DM IDP, 2015 - 2016).

8.14.3.1 Municipal services

Municipal services provided to residents in the region include water (access to piped water), waste removal and sanitation. Figure 61 presents the level of access to piped water in the regional and local area. The majority of the residents of the Steve Tshwete LM have access to piped water either inside their dwellings, yards or within 200 m from dwellings. In eMakhazeni LM Ward 2, 75% of residents have access to piped water either inside their dwellings, yards or within 200 m from dwellings. Of concern however is the fact that 20% of residents in this Ward have no access to piped water.

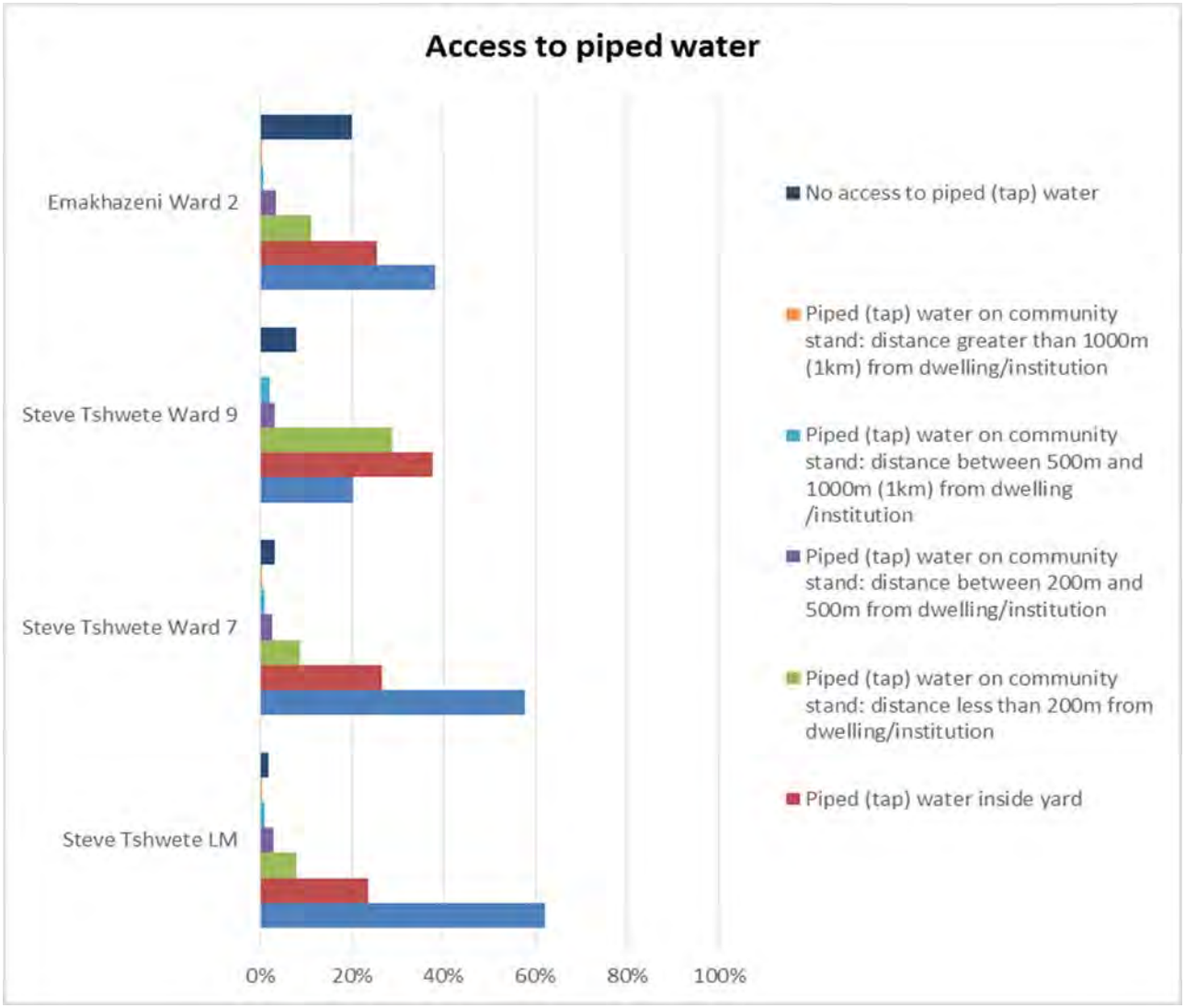

Figure 61: Provision of piped water (Stats SA, 2011)

Waste removal in the non-urban areas is problematic, and the findings of the Census 2011 indicated that many people made use of their own disposal sites (illegal dumps) or did not have access to a permitted landfill site (see Figure 62), resulting in littering and pollution. The majority of residents in the Steve Tshwete LM have their refuse removed by a local authority/private company at least once a week. However, in Ward 9, 83% of residents make use of their own refuse dumps with only 3% having access to waste removal by local authorities/private companies. In eMakhazeni Ward 2, only 25% of residents have access to municipal waste removal facilities with 55% of residents relying on their own refuse disposal methods.

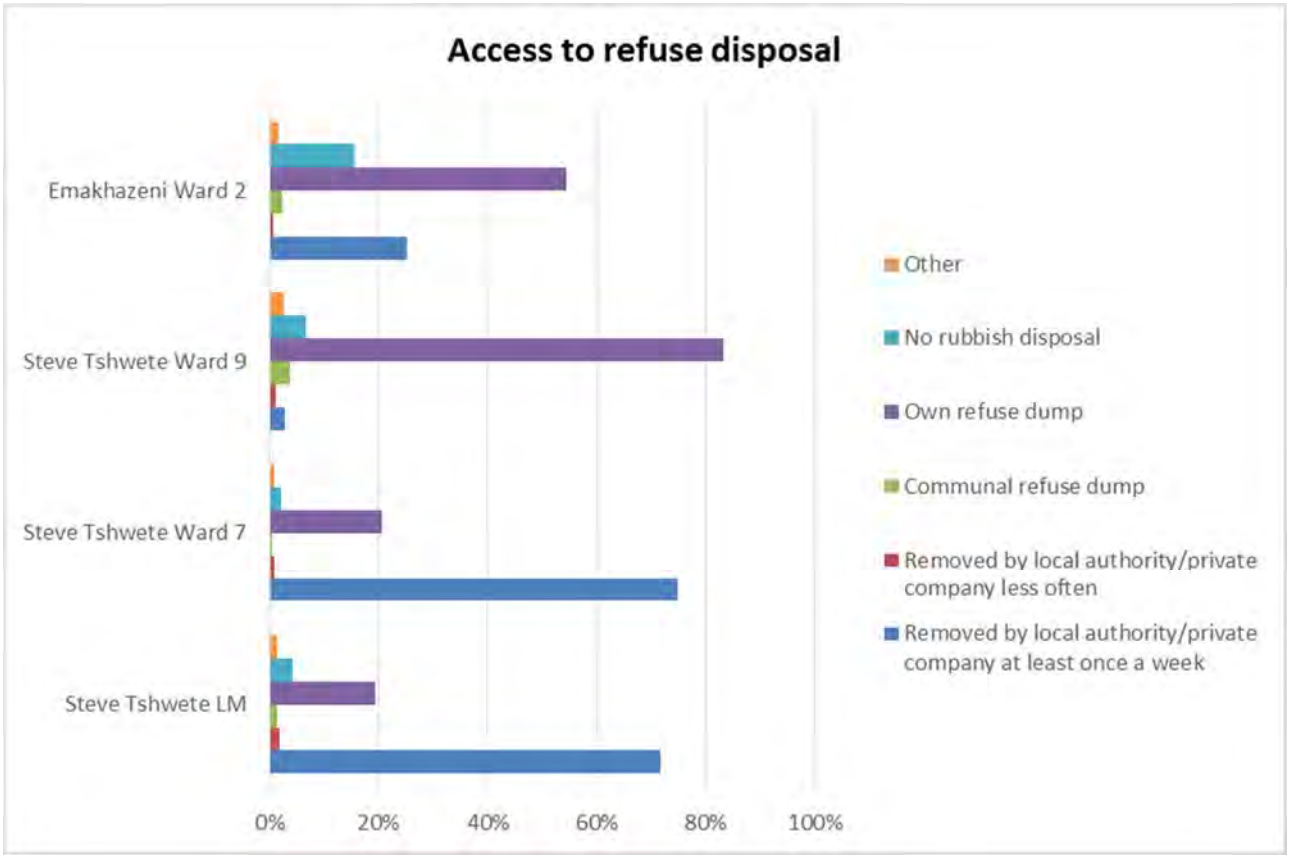

Figure 62: Refuse disposal (Stats SA, 2011)

The availability of sanitation facilities not only improves the dignity of people but also promotes their health. Areas without proper sanitation systems give rise to water-borne diseases like cholera, diarrhoea, and typhoid. It is therefore important that as a municipality, prioritisation should be given to this service.

The provision of adequate sanitation follows the same trend as the afore listed municipal services. Figure 63 presents the various sanitation methods used within the region.

The majority of the inhabitants within Steve Tshwete LM Ward 7 have access to a flush toilet (connected to a sewerage system). In Steve Tshwete Ward 9 and eMakhazeni Ward 2, access to adequate sanitation is an area that requires attention, as in both regions almost half of the population rely on facilities ranging from a pit toilet without ventilation, bucket toiles, other or no facilities at all.

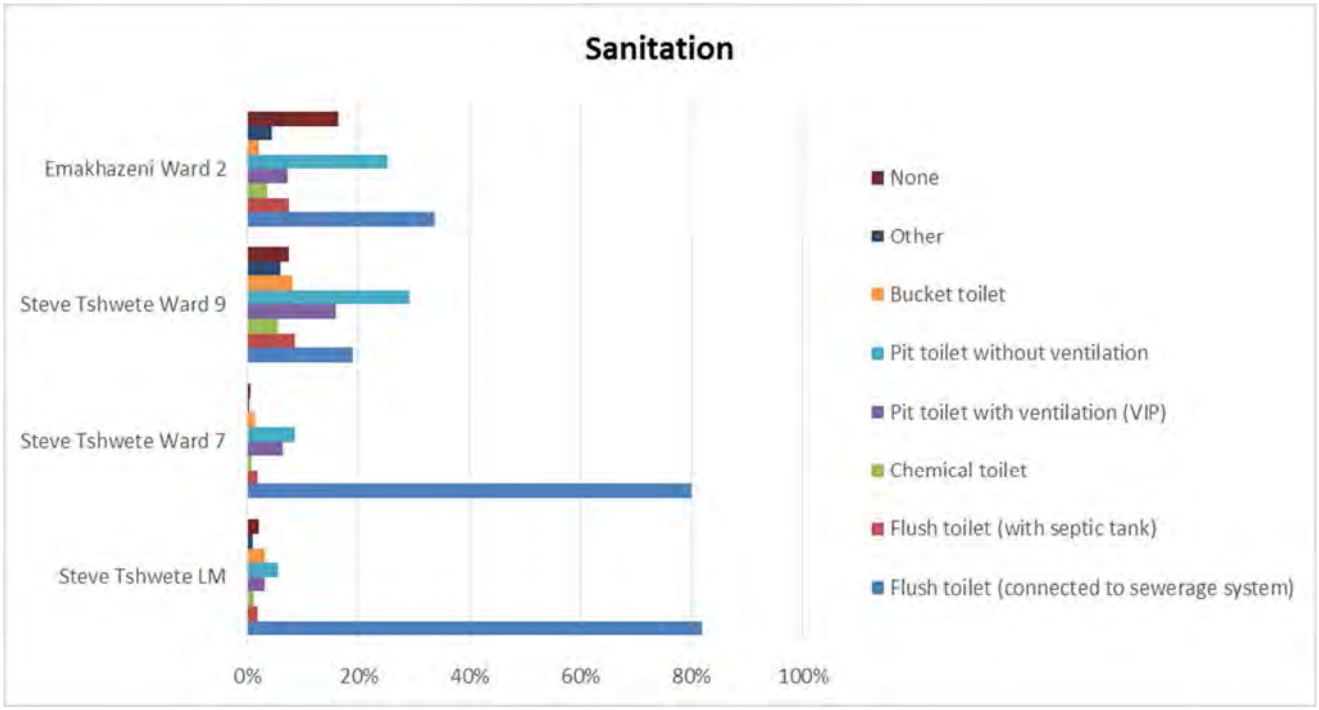

Figure 63: Sanitation (Stats SA 2011)

8.14.3.2 Public infrastructure

The local social public infrastructure consists of clinics, schools, community halls and libraries. Table 52 presents a list of social infrastructure within the Steve Tshwete LM. There are 14 clinics in the local area. The co-ordination of health facilities is planned at a district level and is therefore not directly the responsibility of the local municipalities. There are 32 hospitals in the Nkangala DM (Steve Tshwete LM IDP, 2015 - 16/17).

Table 52: List of all community facilities Steve Tshwete LM

Facilities	Total Number of Facilities	Middelburg	Hendrina	Rietkuil	Pullenshope	Komati	Doornkop	Eastden	Nasaret	Mhluzi
Library	11	1	2	1	1	-	1	1	1	3
Community Hall	7	3	1	1	1	1	1	1		
Sport Stadium	5	3	1	0	0	-				
Police Station	6	2	2	0	1	1				
Clinic	14	8	2	0	1	1	1			
Post Office	5	1	1	1	1	1				
Crèche	20	3	3	1	2	1				
Primary School	25	17	3	1	1	1				
Secondary School	19	7	4	-	-	-				
Technical college	1	1	0	0	-	-				
Cemetery	11	8	3	0	-	-				

Steve Tshwete LM IDP, 2015-16/17

The local community has 20 crèches, 25 primary schools, 19 Secondary Schools and one Technical College.

The Mpumalanga Department of Education has stated that there are 32 637 teaching posts for the 2014 academic year to service a total public school learner enrolment of 975 580 in grades 1 to 12, resulting in an overall educator - learner ratio for public schools in Mpumalanga of 1:29 (Nkangala DM IDP, 2015 - 2016).

Residents of eMakhazeni LM have access to 23 educational institutions ranging from a boarding school, a TVET college, 4 private schools, 1 school for learners with special educational needs, 7 primary schools and 9 secondary schools. Within Ward 2, the only educational institution is a primary school in Siyathuthuka Village on the outskirts of Belfast Town. Ward 2 residents also have access to medical facilities at the HG Grove Hospital Public Hospital located in Belfast, Belfast Gate Clinic and a mobile clinic. The closest library is located within Belfast Town (eMakhazeni LM IDP, 2016 - 17).

8.14.3.3 Roads

The Steve Tshwete LM is well located as it is traversed by the Maputo Development Corridor, the Middelburg/Steelpoort mining resource link, as well as the Middelburg/Bethal/Ermelo/Richards Bay Corridor. Furthermore, some National and Provincial roads traverse the area of jurisdiction of the Steve Tshwete Local Municipality (Steve Tshwete LM IDP, 2016-17).

The most prominent of these are the N4 National route crossing the area from east to west and the N11, traversing the area from north to south. Other roads that traverse the area include the following:

- P154 Middelburg to eMalahleni and Wonderfontein;
- P127 Middelburg to Van Dyksdrift;
- P180 eMalahleni to Van Dyksdrift;
- P182 Hendrina to Van Dyksdrift;
- P30 Middelburg to Bethal;
- P51 Groblersdal to Stoffberg and Middelburg;
- P62 Stoffberg to Belfast; and
- P169 Stoffberg to Roossenekal.

These Provincial roads are important communication routes along which the majority of activities at a local scale and movement are concentrated.

The municipality is comprised of two primary nodal points: Middelburg/Mhluzi that is the main commercial and administrative centre, and the much smaller Hendrina/Kwazamokuhle near the south/east boundary (Steve Tshwete LM IDP, 2016 - 17).

The eMakhazeni LM is strategically located along the following main connecting roads (eMakhazeni LM IDP, 2016-17):

- N4 Pretoria/Johannesburg complex in Gauteng and Nelspruit in Mpumalanga;
- N4 Maputo Corridor which traverses the region from West to East;
- R555 from Middelburg;
- R33 from eMakhazeni which converge at Stoffberg Road in the northwest;
- P81-1 (R540) which connects eMakhazeni and Dullstroom with Lydenburg north of the eMakhazeni area;
- Road R216 which connects Dullstroom and Entokozweni;
- Road R36 linking Entokozweni with Carolina to the southwest;
- R541 linking Entokozweni with Badplaas to the southeast;

- R36 linking Entokozweni and Waterval-Boven with Lydenburg; and
- R33 linking eMakhazeni with Ermelo;

8.14.3.4 Rail

Running parallel to the N4 is a rail line that connects Gauteng through the Steve Tshwete and eMakhazeni Local Municipalities to Maputo harbour in Mozambique. This significant rail infrastructure has been identified as part of the Southern African initiative to connect Walvis Bay (on the west coast) to Maputo (on the east coast). Once established, the rail infrastructure will be called the Maputo Corridor (Steve Tshwete LM IDP, 2016 - 17).

Rail transport is restricted to carrying long distance goods, with very few passenger services and no daily commuting service. The importance of the railway line in terms of export potential via Maputo-Richards Bay harbours should be promoted (Steve Tshwete LM IDP, 2016 - 17).

8.14.3.5 Housing

Housing in the study area is comprised primarily of farm houses and traditional dwellings located in a rural setting (refer to Figure 64). Steve Tshwete Ward 7 has the highest concentration of farm houses at 89%, followed by Ward 9 at 66% and eMakhazeni Ward 2 at 60%. Traditional dwellings feature prominently in Steve Tshwete Ward 9 at 26% and eMakhazeni Ward 2 at 31% with the remainder of residents in the study area being housed in semi-detached dwellings, informal dwellings and squatter settlements.

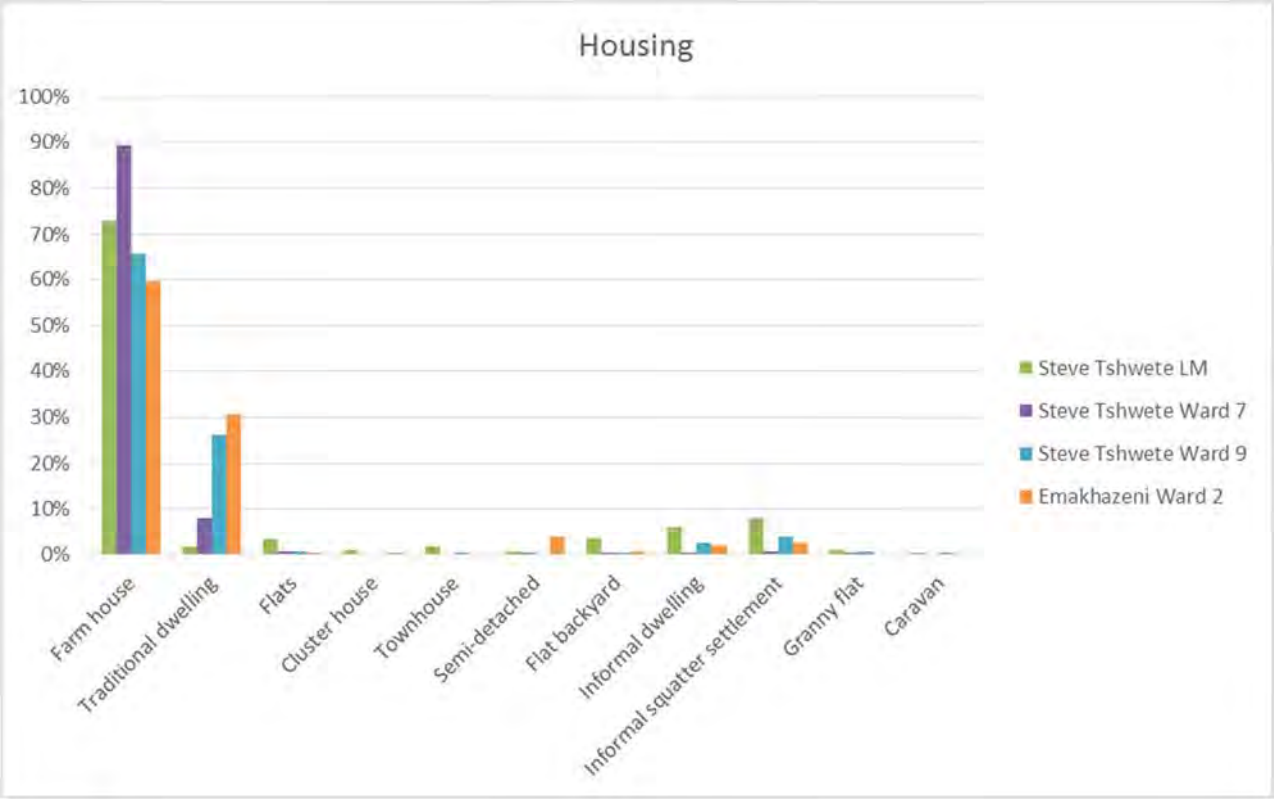

Figure 64: Housing, Stats SA 2011

Towns associated with the mines and power stations in the Steve Tshwete LM area of jurisdiction have been developed by Eskom, namely Rietkuil, Pullenshope and Komati. Mining villages, namely Blinkpan/ Koornfontein, Naledi and Lesedi were developed to accommodate mine employees. Kanhym, a farming company, developed Thokoza and Eikeboom villages. Social services and amenities are usually better developed in the settlements mentioned. The Steve Tshwete LM exhibits the second highest urbanisation rate in the Nkangala DM at 72.1% (Steve Tshwete LM IDP, 2016 - 17).

8.14.3.6 Major Economic Activities

8.14.3.6.1 Income

In order to understand people's living standards as well as their ability to pay for essential services such as water, sanitation and health care, the income levels of the population are analysed and compared to the provincial and national averages. The average annual national household income according to the Income and Expenditure Survey (IES) 2010/2011 statistics was R 119 542. As presented in Figure 65 the majority of households at Ward level earn between R 38 201 - R 76 400 per annum, i.e. below the average national annual household income. In 2011 about 9% of households in Steve Tshwete Ward 7, 7% in Steve Tshwete Ward 9 and 7% in eMakhazeni Ward 2 reported no income.

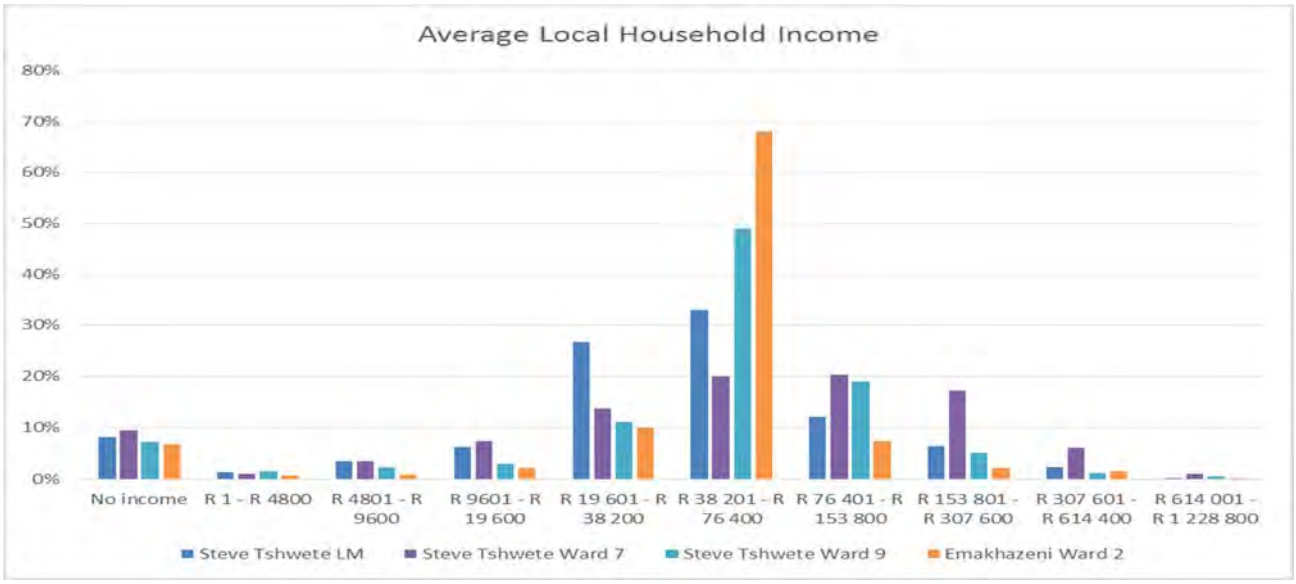

Figure 65: Income (Stats SA 2011)

The Gini coefficient is a summary statistic of income inequality. It varies in range from 0 to 1. If the Gini coefficient is equal to zero, income is distributed in a perfectly equal manner, in other words, there is not much variance between the high and low-income earners within the population. In contrast, if the Gini coefficient equals 1, income is entirely inequitable (i.e. one individual in the population is earning all the income, and the rest have no income). Generally, this coefficient lies in the range between 0.25 and 0.70. In 2013 income inequality as measured by the Gini coefficient in the Nkangala DM was at 0.59. The Steve Tshwete LM has the highest Gini coefficient in the district, with an index value of 0.60 (Nkangala DM IDP, 2015 - 2016).

8.14.3.6.2 Poverty

In the last ten years, the Steve Tshwete LM has made huge investments in infrastructure and housing development, as a result of which poverty and inequality have been decreasing steadily. However, the current rate of unemployment and poverty remain key factors contributing to high inequality levels.

Table 53: Poverty in Steve Tshwete 2001 to 2011

Indicators	2001	2011
Poverty rate	31.6%	25.9%
Number of people in poverty	48 865	59 929
Poverty gap (R million)	R 54	R 110

Source: Statistics South Africa Census 2001 and 2011

The poverty rate was at 25.9% in 2011 showing a decreasing trend from 31.6% in 2001.

The Steve Tshwete LM had approximately 59 929 people living below the poverty line in 2011 and had the lowest number of people living in poverty. With the current decline in mining in Mpumalanga, this rate is expected to increase drastically due to the number of people who will no longer have jobs in the mining industry. The increase in unemployment will trigger an increase in social grant applications (Steve Tshwete LM IDP, 2016 - 17).

To alleviate the problem of poverty in the eMakhazeni LM, social grants have been made available by the Department of Social Development. The distribution of grants in this municipality for the 2011 period is reflected below:

Table 54: Number of recipients of social grants in 2011

Grant type	Number receiving grant
Old age pension	2 183
Disability grant	1 410
Child support grant	8 274
Care dependency grant	139
Foster care grant	502
Grant in aid	6

Source: Stats SA 2011

8.14.3.6.3 Economic activities

Mpumalanga's highest contributors are manufacturing (21%) and mining and quarrying (19%). The Nkangala DM has a 28% contribution from mining and quarrying and a 19% contribution from the manufacturing sector (Nkangala IDP, 2011/2012).

According to Stats SA 2011, leading sectors in terms of percentage (%) contribution to the Steve Tshwete local economy are mining (31.3%), manufacturing (26.3%) and finance (13.4%). These sectors' contributions resulted in the Steve Tshwete LM being the second largest contributor to the Nkangala economy at 38.7%. These industries generate mass employment opportunities that mainly draw workers from the rural parts of this local municipality. Regarding the strongest main economic generator, the stainless steel manufacturing industry dominates in the Steve Tshwete LM. On the other hand, mining continues to grow despite key economic sectors being on the decline (Steve Tshwete IDP, 2016 - 2017).

Middelburg also forms the main commercial centre of the Steve Tshwete LM where the majority of people conduct their shopping activities. This includes the eMhluzi Mall and new Middelburg Mall, with approximately 20 000 m^2 of retail space, which has expanded commercial and shopping activities to the outskirts of the local municipality. Moreover, the recent opening of the carbonated soft drink factory (Twizza) has contributed to a large number of job opportunities (Steve Tshwete IDP, 2016 - 2017).

The Steve Tshwete LM economy and contribution towards the provincial Growth Domestic Product (GDP) continues to grow significantly. According to the 2011 census, the Steve Tshwete LM contributes 14.7% towards the Mpumalanga Economy with an estimated growth of about 4% from 2011 until 2016 (Steve Tshwete IDP, 2016 - 2017).

Leading sectors in terms of % contribution to eMakhazeni economy are mining (27.1%), transport (26%) trade (8.4%) and community services (14.7%). Mining has remained the biggest contributor to GDP in the municipality in the 2001 to 2012 period. eMakhazeni LM is expected to record a GDP growth of 2.8% per annum over the period 2013 - 2018 which is down from the 4.7% growth rate over the 1996 - 2013 period. Its contribution to the Mpumalanga overall economy in 2013 was 1.4%, making it one of the smallest economies in the region. In order to prevent further job losses and a decline in growth in the region, support for the efforts of social partners in the area such as Nkomati Mine, Assmang Chrome and Exxaro Belfast operations is expressly encouraged by the local municipality (eMakhazeni LM IDP, 2016 - 17).

The Maputo Corridor runs through the Nkangala DM, bringing with it increased potential for economic and tourism development. The corridor connects the primary economic nodes of the Nkangala DM, the Mpumalanga Kruger International Airport and Maputo to Gauteng (Nkangala IDP, 2011/2012).

The south-western regions of the district are referred to as the "Energy Mecca" of South Africa, due to the large deposits of coal reserves and associated power stations, such as Kendal, Matla, Duvha and Ga-Nala (Kriel). The southward road and rail network connect the Steve Tshwete area to the Richards Bay and Maputo harbours, offering export opportunities for coal reserves. The refurbishment of some of the mothballed power stations poses opportunities for the mining and energy sectors, as well as the revitalisation of some of the smaller towns in the district such as Delmas, Hendrina and Arnot (Nkangala IDP, 2011/2012; Stats SA 2011).

9.0 POTENTIAL IMPACTS AND RISKS IDENTIFIED

The following potential impacts were identified during the scoping phase (see also section 11.13):

1) **Socio-economic:** At this stage, the impacts listed below are for all the alternative options of the road realignment. The impact assessment phase will consider only the preferred option. Potential impacts for the road realignment options could include:

   - Loss of access to the D684 and part of the D1048 roads in and out of the area:

   There is potential for a loss of access into and out of the area due to the closure of the D684 and the D1048 roads. Two homesteads situated north of the D684 and D1048 split will be affected as their only access south bound is on the D684. They travel on foot at least once a week to the centre, south past the railway line. There is available public transport to take people to Middelburg which is the nearest town.

   - Loss of land due to construction of road alternative A, B, C, E and F:

   The construction of alternative A, B, C, E and F requires the extension of the existing farm road or a new cut of a district road respectively. Where these options impact private farmers, the public consultation process will engage with these landowners on the options for the road realignment.

   - Growing pressure on existing road access should people migrate to the project area:

   In cases where new roads have to be constructed where there was no previous access to these areas, this will create an avenue for movement of people to utilise the road through the farm areas. This issue comes with associated impacts like increased pedestrian and vehicular traffic.

   - Construction of new alternative roads:
     - Potential employment opportunities for construction companies to construct new road alternatives;
     - Environmental aspects while constructing the alternative roads, e.g. air pollution and contamination of water resources (groundwater), which could impact on residents;
     - The economic costs for residents to take longer travel routes due to road closures; and
     - Crops and land belonging to adjacent landowners may be at risk of dust contamination due to increased vehicle movement through areas which had no previous access roads (alternative B, C and E).

   Given the total number of people who live adjacent to the road, the impact is expected to be of ***moderate*** significance.

2) **Air Quality**: The impacts will remain the same regardless of the preferred route chosen for the realignment, although different receptors will be affected. Potential impacts are likely to include:

- Increased local PM_{10}, SO_2 and NO_2 concentrations from vehicle exhaust emissions as a result of the increased traffic volumes; and
- Increased dust emissions associated with dust entrainment.

With the current existing information about the traffic volumes, the overall impact is expected to be ***moderate to low***.

3) **Noise:** Noise generated as a result of project activities during the construction and operation stage of the development will result in an increase in ambient noise levels. The effects of this increase in noise will depend on the level of increase.

   An increase in ambient noise levels of over 3 dB(A) will be noticeable to most people, although such an increase is unlikely to cause disturbance to leisure activities or sleep. An increase of 10 dB(A), however, is likely to cause disturbance or require people to modify their behaviour to avoid that disturbance, depending on the absolute level of noise. With the current existing information about the traffic volumes, the overall impact is expected to be ***moderate*** during the construction phase and ***low*** during the operational phase***.***

4) **Traffic:** Increase in travel distance and time along the main road links, but the overall length of the proposed preferred route will be shorter than the sections of Roads D684 and D1048 that will be closed. Possible new access roads to affected properties in the area needs to be considered. With the current existing information, the overall impact is expected to be ***moderate*** during the construction phase and low during the ***operational*** phase.

5) **Palaeontological:** The impact of the road realignment on fossil heritage could be very high, low, insignificant or zero and therefore mitigation or conservation measures may be necessary for this development. The topsoil, subsoil, overburden, inter-burden and bedrock may have to be surveyed for fossiliferous outcrops.

   Impacts from earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic, mining activities, and human disturbance, are some possible identified impacts. Alternative A, E and preferred Alternative F traverse the Vryheid Formation, and a phase 1 palaeontological assessment will be included in the impact assessment phase of this project.

6) **Cultural and heritage**: The informal cemetery to the South of the preferred Route Alternative F (GY07 on Figure 70) is located approximately 100 m from the centre of the proposed road but is unlikely to be affected by the activities. Unless unknown graves are unearthed during construction, the expected impact on cultural and heritage resources is likely to be of ***low*** significance.

7) **Ecology**: The road realignment will involve the removal of vegetation (mostly crops) from the combined footprint area (entire length of the road) of about 75 ha. Due to the destruction of their habitat, the current faunal population in the project area will have to relocate until suitable habitat has been restored by the rehabilitation programme (should the road be closed when the mining activities cease). The long-term impact is expected to be ***moderate to low***.

10.0 IMPACT ASSESSMENT PROCESS AND METHODOLOGY

The overall process and methodology that was followed during the EIA was based on best practice guidelines and the requirements of South African legislation (specifically NEMA and MPRDA).

The scoping phase included the following activities:

- Gap Analysis of existing information against the Project compliance criteria;
- Meetings with the Mpumalanga Department of Public Works, Roads and Transport;
- Project definition and analysis of road route alternatives – inclusive of data review, input to alternatives analysis and preferred route layout planning and project description;

- Screening (legal and process review) – review of all applicable compliance criteria;
- Environmental and Social Baseline Studies – carrying out monitoring, data collection and fieldwork to determine the baseline conditions of the environment that could be affected by the Project;
- Stakeholder Engagement – was undertaken throughout the Scoping process to record issues and comments received from the public. These issues and comments were integrated into the process and were considered in the impact assessment phase of the EIA; and
- Scoping (identification of key issues and development of plan of study for carrying out the impact assessment). During March and April 2018, the Scoping Report was presented to the public and the South African government departments dealing with mining and environmental authorisations for comment. The final Scoping Report was submitted to the DMR on **26 April 2018**.

The following activities were undertaken during the impact assessment phase of the EIA:

- Impact Assessment – evaluation of potential impacts and benefits of the Project, utilising qualitative and quantitative evaluation of environmental aspects and issues identified during the scoping phase;
- Environmental and Social Management Systems Development – establishment of a system for the management of environmental, social impacts supported by action plans;
- Preparation of an EIA/EMPr report – documenting all processes and presenting the findings of the impact assessment. The draft EIA/EMPr report is available to the public and the relevant South African Government departments for comment from **29 June 2018 until 30 July 2018**. The final EIA/EMPr report will be submitted to the DMR on or before **21 September 2018** for a decision on whether the project may proceed and if so under what conditions; and
- Stakeholder Engagement – will continue throughout the remainder of the EIA process to record issues and comments received from interested and affected parties. All issues and comments will be integrated into the process and considered during the EIA.

The overarching principles that guide the EIA include:

- Sustainability – development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs;
- Mitigation hierarchy – The mitigation hierarchy describes a step-wise approach that illustrates the preferred approach to mitigating adverse impacts as follows (the governing principle is to achieve no net loss and preferably a net positive impact on people and the environment as a result of the Project):
  - The preferred mitigation measure is **avoidance;**
  - Then **minimisation;**
  - Then **rehabilitation** or **restoration**; and
  - Finally, **offsetting** residual unavoidable impacts.
- Duty of care towards the environment and affected people.

The assessment of the impacts of the proposed activities was conducted within the context provided by these principles and objectives.

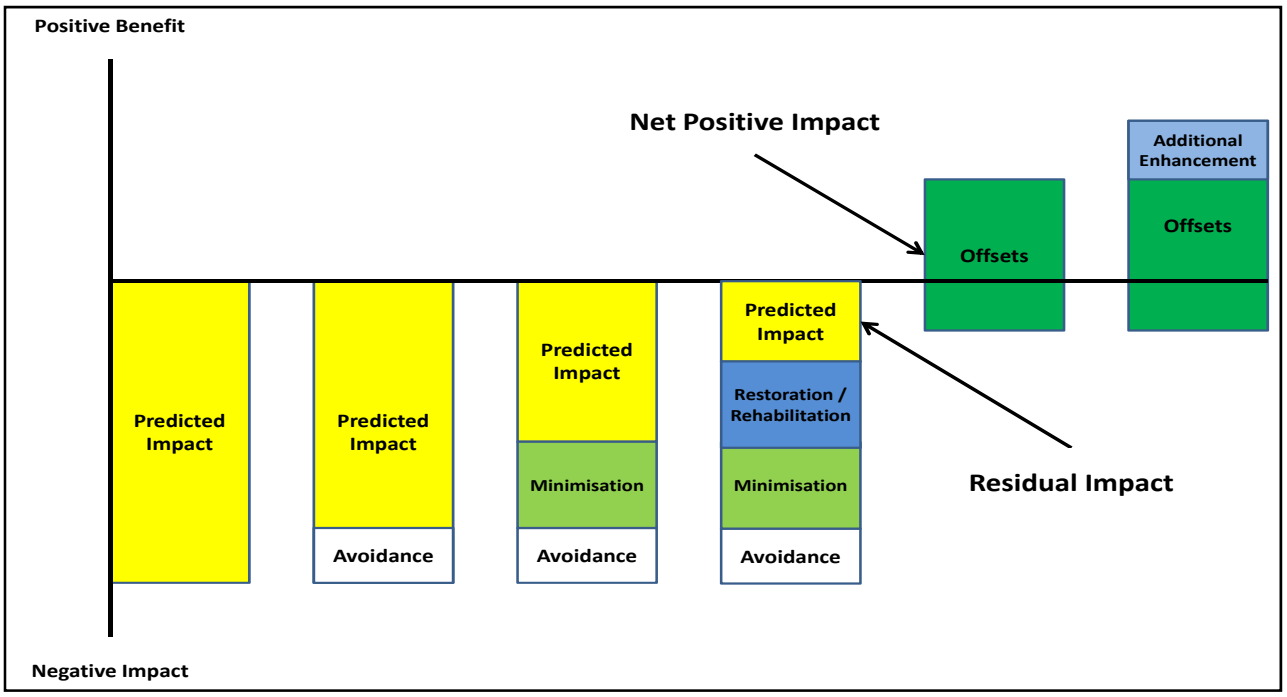

Figure 66: Mitigation Hierarchy Adapted from BBOP, 2009

10.1 Scoping Methodology

The methodology specifically adopted for the scoping phase included the following:

- Stakeholder consultation as described in section 7.0;
- Review of existing data;
- Fieldwork by the EIA specialist team to obtain additional baseline data;
- Workshops with the specialist team to identify key impacts and issues and to outline the plan of study; and
- Compiling the Scoping report.

10.2 Impact Assessment Methodology

The significance of the identified impacts was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Occurrence		**Severity**	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude (severity) of impact

To assess each of these factors for each impact, the following four ranking scales are used:

Probability	**Duration**
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term

Probability	Duration
3 - Medium probability	3 - Medium-term (8 - 15 years)
2 - Low probability	2 - Short-term (0 - 7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 - None	
Scale	**Magnitude**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance was then rated as follows:

SP >75	Indicates high environmental significance	An impact which could influence the decision about whether to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

10.3 Assessment of potential impacts and risks

The findings of the specialist studies, which guided the selection of the preferred route alternative, are presented in section 11.0 of this EIA/EMPr report. The complete specialist reports are attached as APPENDIX G. The specialists' findings were used to assess the project's impacts and risks during its respective project phases.

10.4 Positive and negative impacts of initial site layout and alternatives

The identified route alternative layouts must avoid the sterilisation of the open cast minable coal reserves. The preferred route realignment location was chosen to be the shortest, parallel route to the existing road, located on properties owned by AOL so as to reduce the impact of the proposed route realignment on the local residents utilising the road on a daily basis.

See section 10.6 for a discussion on the alternative layouts and their positive and negative impacts.

10.5 Possible mitigation measures and levels of risk

The issues discussed with I&APs during the scoping process were as follows:

1) ***Air Quality***: The project's main potential effect on air quality will be increased PM_{10}, SO_2 and NO_2 concentrations from vehicle exhaust emissions as a result of the traffic volumes, and dust along the new proposed route and its surrounding areas. As this is a public district road, wet suppression for the entire LOM is not feasible. The preferred route alternative F falls within the current Mafube LifeX dust fallout monitoring (sampling) area (see Figure 25). Monitoring of these points will continue as per the approved Mafube LifeX monitoring programme.

2) **Socio-economic:** The preferred route alternative F is the shortest, parallel road to the existing D684 road. Given the number of people utilising the existing road, the impact is likely to be of ***moderate*** significance.

3) **Noise:** Noise generated as a result of project activities during the construction and operation stage of the development will result in an increase in ambient noise levels. The risk of people being exposed to unacceptable levels of noise is ***moderate*** to ***low***.

4) **Cultural and heritage**: The informal cemetery to the Southern point of the preferred Route Alternative F (GY07 on Figure 70) is located approximately 100 m from the centre of the proposed road, but is unlikely to be affected by the activities. Unless unknown graves are unearthed during construction, the expected impact on cultural and heritage resources is likely to be of ***low*** significance.

5) **Palaeontological aspects**: Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and/or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

   Should further fossil material be discovered during the course of the development (e. g. during bedrock excavations), this must be safeguarded, where feasible in situ, and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered paleontologically sensitive (e. g. Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

10.6 Motivation for not considering alternative sites

Not applicable. Alternative sites were considered as discussed in section 10.7 below.

10.7 Site selection matrix and final site layout plan

10.7.1 Route Selection Criteria

The main route selection criteria were identified as engineering/technical, constructability, usability, environmental, social/public acceptance and legal/regulatory criteria.

The procedure followed for the rating and ranking of alternative routes in terms of the main criteria included the following:

- Assigning a relative weight to the main categories of criteria;
- Identification of various sub-criteria under the main categories of criteria;
- Defining the sub-criteria; and
- Rating and ranking based on the sub-criteria.

10.7.2 Weighting of the Main Criteria

The following weights (Table 55 were given to the main route selection criteria:

Table 55: Weighting allocated to main criteria

Criterion category	Weighting
Engineering/Technical	20
Regulatory (Complexity of Permitting)	20
Constructability	15
Usability (Accessibility)	10
Environmental	15
Social/Public	15
Time to Implement/Construct	5
Total Assigned Weights:	**100**

10.7.3 Identification of the Sub-criteria

10.7.3.1 Engineering/Technical Criteria

The following **engineering/technical** sub-criteria were used to identify suitable criteria to conduct the rating and ranking assessment:

- Route setting suitability:
  - Suitability of topography for the development of a road;
  - Road following property boundary lines;
  - Proximity of households making use of the road;
  - Location of existing servitudes, and proximity of pans and other water bodies; and
  - Land use not being affected by the road development and location.
- Interference with mining:
  - Potential to sterilize coal deposit; and
  - Distance from the buffer zone of the active mining activities (such as blasting).
- Geohydrological and hydrological suitability:
  - Presence of pans and water bodies;
  - Presence of rivers (crossings); and
  - The need for stormwater management and drainage systems.
- Route constructability:
  - Availability of borrow material; and
  - Ease of staged construction.
- Route Usability:
  - Accessibility of the route for local road users.

10.7.3.2 Environmental Criteria

Environmental criteria relate to the potential threat to the ecosystem and the geophysical environment. They include the following considerations:

- Ecological impact (Terrestrial, Aquatics and Wetlands):
  - Impact on vegetation, wildlife, wetlands and aquatic life;
  - The sensitivity of the local ecosystems to impacts;
  - The impact of the change in land use on the local ecosystem;
  - Presence of and impact on species of conservation importance (i.e. Red List, Protected and/or endemic species); and
  - Proximity to ecologically significant features such as a wetlands and pans.
- Surface water impact:
  - Potential surface water pollution; and
  - The impact on the local surface waters.
- Soil impact:
  - Potential impact and contamination of the soil due to the road construction activities;
  - Possible soil contamination associated with hydrocarbon spillages; and
  - Potential impact on Land use and Land capability.
- Air quality impact:
  - Prevailing wind direction and potential dust generation that may impact the adjacent residents.

10.7.3.3 Social/Public Criteria

Social/public criteria relate to issues such as the possible adverse impacts on public health, quality of life, local land and property values. They also relate to potential public opposition to the proposed road realignment.

It is important to note that no consultation process with affected landowners, or communities has taken place during this route selection process.

The following are important considerations:

- Archaeological/heritage Impact:
  - Possible impacts on areas of historical, archaeological or cultural significance.
- Noise impact:
  - Potential noise impact for local residents adjacent to the road; and
  - The distance from farm houses and farm communities.
- Proximity to people:
  - Distance from farm houses, farm communities, informal settlements and areas of human activity and
  - Public acceptability of the proposed road realignment project.

- Land use impact:
  - Acceptability of changing agricultural land to a public (district) road;
  - Acceptability of changing privately owned land into a public (district) road; and
  - Potential impact of the change in land use on neighbouring communities.
- Relocation of communities/settlements:
  - The displacement of farm houses, farm communities, informal settlements; and
  - Perception of local residents with respect to relocation and/or compensation.
- Land ownership/property rights:
  - The need for land acquisition.

10.7.3.4 Economic Criteria

Economic criteria relate to the cost of developing, maintaining and possible closure/rehabilitation of the selected route. The rating of the economic criteria did not form part of this route selection process.

10.7.3.5 Legal and Regulatory Criteria

Legal and regulatory criteria include the following considerations:

- Acceptance of project:
  - Acceptance from the Mpumalanga Roads Department;
  - Completion of legal and town planning processes for the closure of public roads; and
  - Completion of legal and town planning processes to register servitudes for proposed new district road.

10.7.4 Route Selection Matrix

A project specific route selection matrix was developed to assist with qualitative rating and ranking of the identified alternative routes.

The rating of all the alternative route options was based on the following values:

Table 56: Road realignment route selection rating values

Description	Score
Excellent	5
Above Average	4
Below Average	2
Poor	1

The route selection criteria were weighted according to pre-determined weighting values consisting of:

Table 57: Route selection weighting values

Route Selection Criteria	Weighting Value
Engineering/Technical	20
Legal/Regulatory (Complexity of Permitting)	20
Constructability	15

Route Selection Criteria	Weighting Value
Usability (Accessibility)	10
Environmental	15
Social/Public	15
Time to Implement Construct	5

10.7.5 Route Selection Workshop and Site Visit

10.7.5.1 Route Selection Workshop Participants

The semi-qualitative rating and ranking was carried out in a workshop held at the Golder Associates Midrand offices on 25 August 2016. Following the workshop, a site visit was held on 1 September 2016 and all the identified alternative route options were visited and viewed by the specialists.

The workshop and site visit were attended by the following Golder project team members:

Table 58: Participants in the route selection workshop and site visit

Team Member	Designation
Michael Whitfield	Mafube LifeX client contact and overall Project Manager
Mariëtte Weideman	Mafube LifeX Road Realignment - Project Manager
Adam Bennett	Air Quality Specialist and Noise Assessment Specialist
Ilse Snyman	Soil Scientist
Warren Aken	Senior Aquatic Ecologist
Andrew Zinn	Terrestrial Ecologist
Kylie Farrell	Aquatic Ecologist
Priya Ramsaroop	Social and Traffic
Osborne Gwamanda	Hydrologist
Gareth Isenegger	Environmental Practitioner - Water Resource Specialist

The route selection matrix was populated during the workshop and the alternative sites were rated and ranked. Following the site visit, the ratings were reviewed and adjusted by the abovementioned specialists.

10.7.5.2 Route Selection Rating/Ranking Outcome

Each of the identified route alternatives was rated and ranked within the route selection matrix by the Golder team members.

The outcome of the route selection rating process is summarised in Table 59 below and the detailed matrix is appended to this report in APPENDIX G.

Table 59: Route selection rating and ranking outcome

Identified Route Alternatives	Route Selection – Main Criteria							Score	Rank
	Engineering / Technical	Legal / Regulatory	Constructability	Usability	Environmental	Social / Public	Time to Implement		
Alternative A	2.4	0.4	1.2	0.4	1.5	1.8	0.1	7.80	**5**
Alternative B	2.6	0.4	1.2	0.4	1.95	1.8	0.1	8.45	**4**
Alternative C	1.4	0.4	1.2	0.2	1.5	1.8	0.1	6.60	**6**
Alternative D	3.6	0.4	0.9	0.5	2.7	2.55	0.2	10.85	**1**
Alternative E	2.4	0.4	1.2	0.4	2.25	2.1	0.1	8.85	**2**
Alternative F	2.4	0.4	1.2	0.5	1.95	2.25	0.1	8.80	**3**

**lower numbers preferable*

10.8 Statement motivating the preferred site and layout

The proposed road realignment layout shown on Figure 67, represent the best overall option as determined via the site selection and layout process, as it is the shortest parallel route to the existing D684 road, and will not affect any private property owners, as all the affected properties are either already owned by AOL or are in the process of being purchased.

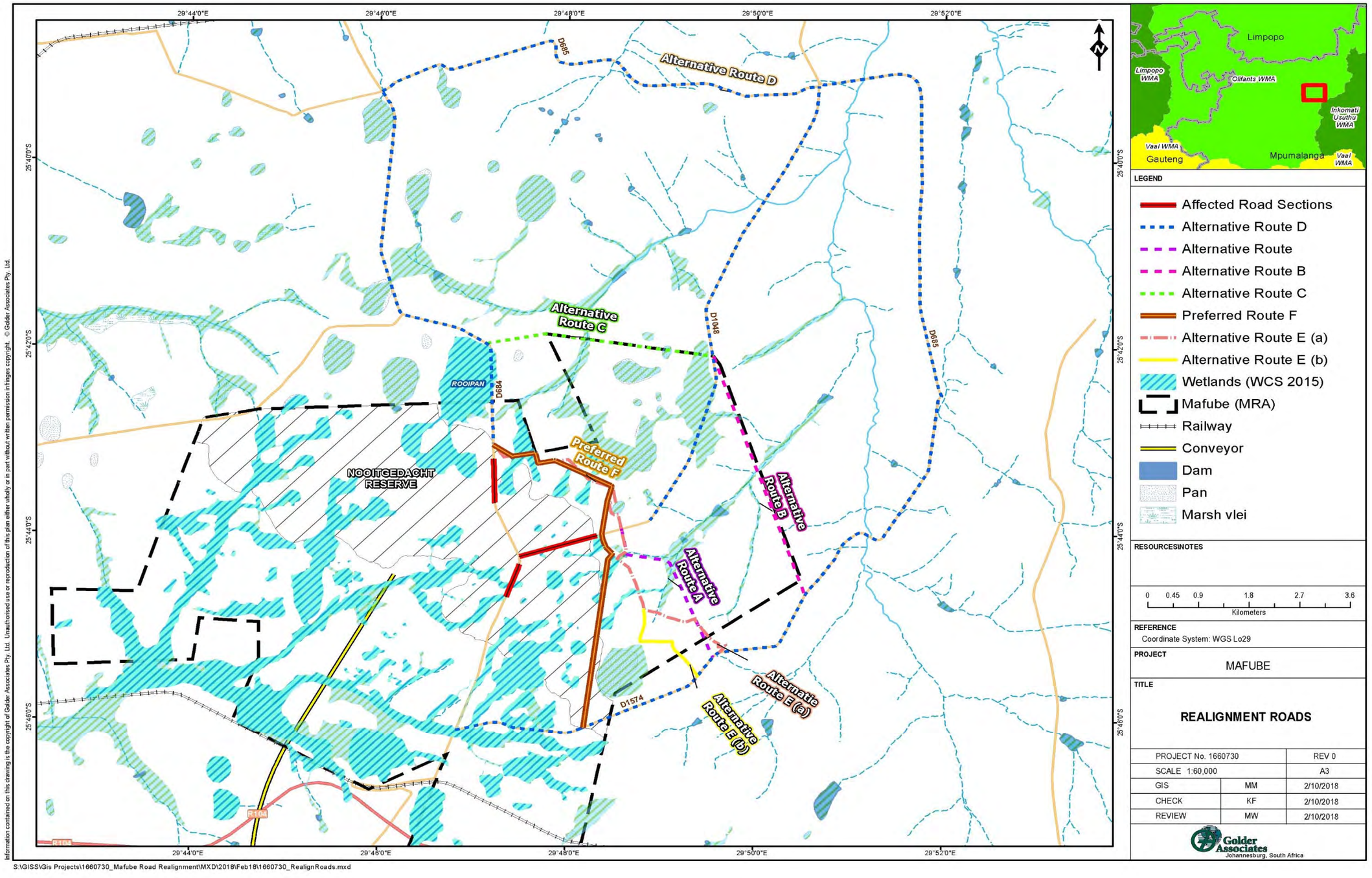

Figure 67: Identified route alternatives A, B, C, D, E and Preferred Route Alternative F

11.0 ENVIRONMENTAL IMPACT ASSESSMENT

The proposed road realignment has a potential to impact on some biophysical and socio-economic aspects of the local environment.

One of the main purposes of the EIA process is to understand the significance of these potential impacts and to determine to what extent they can be minimised or mitigated. Based on experience with and past studies, supported by site-specific specialist studies, the impacts on soils, surface water, air quality, the ecology and the local socio-economic fabric can be predicted and appropriate mitigation measures can be formulated.

The EIA process for this project has been designed to comply with the requirements of the MPRDA and the EIA Regulations that commenced on 7 April 2017 (see section 4.1.1). Cognisance has also been taken of the following key principles contained in the National Environmental Management Act (Act No. 107 of 1998) (NEMA), which is South Africa's framework environmental legislation:

- Sustainability – development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs;
- Mitigation hierarchy – avoidance of environmental impact, or where this is not possible, minimising the impact and remediating the impact; and
- The duty of care of developers towards the environment.

The assessment of the impacts of the Mafube LifeX proposed road realignment was conducted in accordance with these principles.

Based on the findings of the EIA, a comprehensive Environmental Management Programme (EMPr) has been developed and will be implemented to control and minimise the impacts during construction, operation and possible decommissioning of the proposed district road.

11.1 Summary of Specialist Reports

Table below reflects a summary of the specialist reports that informed the impact assessment and final preferred route alternative selection process. Copies of these reports are appended to this document as APPENDIX G.

Table 60: Summary of specialist reports

Specialist Studies Undertaken	**Specialist recommendations that have been included in the EIA Report** ***(Mark with an X where applicable)***	**Reference to applicable section of report where specialist recommendations have been included**
Air Quality Impact Assessment	X	Section 11.3, Table 72, Table 67, Table 76, Table 77, and Table 78
Noise Impact Assessment	X	Section 8.11, Table 72, Table 67, Table 76, Table 77, and Table 78
Traffic Impact Assessment	X	Section 11.12, Table 72, Table 67, Table 76, Table 77, and Table 78
Biodiversity (Terrestrial, Aquatic and Wetland Ecology) Impact Assessment	X	Section 11.3.1, Table 72, Table 67, Table 76, Table 77, and Table 78
Soils, Land Use and Land Capability Impact Assessment	X	Section 11.9.1, Table 72, Table 67, Table 76, Table 77, and Table 78

Specialist Studies Undertaken	Specialist recommendations that have been included in the EIA Report *(Mark with an X where applicable)*	Reference to applicable section of report where specialist recommendations have been included
Socio-Economic Impact Assessment	X	Section 11.7, Table 72, Table 67, Table 76, Table 77, and Table 78
Surface Water Impact Assessment	X	Section 11.6, Table 72, Table 67, Table 76, Table 77, and Table 78
Cultural and Heritage Resources Impact Assessment	X	Section 11.9, Table 72, Table 67, Table 76, Table 77, and Table 78
Palaeontological Impact Assessment	X	Section 11.8, Table 72, Table 67, Table 76, Table 77, and Table 78

11.2 Project Phases and Activities

The environmental impacts of the project were assessed for the:

- Construction phase; and
- Operational phase.

The closure and rehabilitation phases were not assessed as the proposed road will be a permanent road. All future maintenance and repairs to the road will form part of the responsibilities of the Mpumalanga Department of Public Works, Roads and Transport (DPWRT).

Potential cumulative impacts were also identified and assessed, where applicable.

11.2.1 Construction

The **Construction Phase** marks the beginning physical changes to the site. During this phase the following activities will take place:

- Surveying and pegging out of the route for the road construction;
- Clearing land of surface vegetation and obstacles for the construction of the new route;
- Setting up temporary contractor construction laydown areas and moving correct machinery to site with experienced machine operators;
- Preparation of road surface (incl. grading, and soil compaction);
- Construction of road with properly shaped crown and shoulder, ditches, culverts and drains to ensure proper drainage and channelling of water away from the road surface; and
- Applying a bituminous surface treatment (BST) to provide a hard, all-weather, water-resistant surface.

It is anticipated that the construction phase will take approximately **12 months** to complete.

11.2.2 Operation

On completion of the construction of the road, it will be used as a permanent, public district road (for vehicle and pedestrian use), all future maintenance and repair obligations of the road will form part of the responsibilities of the Mpumalanga Department of Public Works, Roads and Transport (DPWRT).

11.2.3 Decommissioning

It is assumed that the road will not be decommissioned and will remain open to the public after closure of the Mafube LifeX project. All operational impacts will therefore continue so long as the road is in use.

11.3 Air Quality

11.3.1 Construction phase

Degeneration of the ambient air quality due to increased nuisance dust and fine particulate levels is likely to occur as a result of land clearing, ground excavation and materials handling activities (tipping, loading and offloading) associated with the construction of the road. Daily dust emissions will vary according to the level of activity, the type of operation and the meteorological conditions. The construction phase impacts may be intense, but short-lived and largely limited to the immediate vicinity of the activity. It is for these reasons that the impact is likely to have a moderate environmental significance before mitigation. With mitigation, these impacts may be reduced to a low environmental significance.

Similarly, the movement of construction vehicles is likely to cause an increase in the entrainment of dust and fine particulate matter on unpaved roads. These emissions are likely to be short lived and largely restricted to the construction site, although nearby receptors are likely to be impacted. This impact was therefore assigned a moderate environmental significance before mitigation. With mitigation, these impacts may be reduced to a low environmental significance.

An increase in CO, NO_2, SO_2, and fine particulate levels is anticipated to occur as a result of heavy vehicle exhaust emissions. Vehicle exhaust emissions are likely to result in primary and secondary pollutants. Primary pollutants are those emitted directly to the atmosphere as exhaust emissions, whereas secondary pollutants are formed in the atmosphere as a result of atmospheric chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The quantity of pollutants emitted by a vehicle depends on specific vehicle related factors such as vehicle weight, speed and age; fuel-related factors such as fuel type (petrol or diesel), fuel formulation (oxygen, sulphur, benzene and lead replacement agents) and environmental factors such as altitude, humidity and temperature (Samaras and Sorensen, 1999).

The impacts of these emissions are anticipated to have a low environmental significance before mitigation as the impacts will be restricted to the construction phase and site. Due to the limited efficacy of the proposed mitigation measures associated with vehicle emissions at this scale, the environmental significance after mitigation is likely to be only slightly lower.

11.3.2 Operational Phase

Given that the proposed Route F is a new route passing through vegetated (cultivated/pasture) land, it is anticipated that the operation of the route will alter baseline dust fallout levels notably. Considering the results of the baseline monitoring adjacent to the D684 which will be rerouted (at D6 and D10), dust emissions are however likely to remain below the residential area threshold (600 mg/m^2/day) at the receptor locations, provided traffic does not increase significantly. Receptors closest to the proposed route will experience the greatest impacts. It is anticipated that, under normal conditions, the impact radius will be limited to the immediate vicinity of the road (i.e. within 100 m). Dust may travel further during periods of high winds, peak traffic and dry periods.

Elevated ambient dust concentrations are generally considered to be more of a nuisance than a threat to health, but health impacts such as allergic inflammatory reactions, nasal congestion, and respiratory problems may be triggered in vulnerable individuals.

The diversion of traffic away from the Sikhululiwe Village is anticipated to reduce ambient dust loads at the Village. Dust levels at the School (approximately 1 km north of Route F) are not anticipated to change as the D684 route adjacent the school will remain the same.

Proposed mitigation measures

- Continue baseline dust fallout monitoring for a minimum of 3 months prior to construction;

- Contractors should take preventative measures to minimise complaints regarding dust nuisances (e.g. screening, dust control, timing, pre-notification of Interested and Affected Parties (I&APs));
- Drop height reduction during materials handling activities;
- Wet suppression during materials handling activities;
- Wet suppression of materials transported by road (i.e. load spraying) or load covering with tarpaulins to reduce fugitive dust generation;
- Wind speed reduction through sheltering (where possible);
- Wet suppression on construction access roads;
- Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust;
- Avoidance of dust track-on onto paved roads;
- All construction vehicles and other equipment should be maintained and serviced regularly to ensure that exhaust particulate emissions are kept to a minimum;
- Parking construction vehicles off travelled roadways;
- Encouraging the receipt of materials during non-peak traffic hours to avoid traffic build-up;
- Reduction in unnecessary traffic volumes by developing plans to optimise vehicle usage and movement;
- Pave and/or tar the section of the road passing the village;
- Wet suppression with water and a suitable dust palliative to achieve the 95% control efficiency (water alone will only achieve a 75% control efficiency);
- Expand the dust fallout monitoring network by two sampling points, the proposed locations of which are shown in Figure 16. These points will serve to determine the roads impact at the closest receptor locations and wetland areas in the northern portion of the mine rights area; and
- Dust related complaints should be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management.

11.4 Terrestrial and Wetland Ecology

Vegetation clearing and earth works during the construction phase are the major project activities that are likely to affect on-site ecology negatively. The following disturbance footprints have been used to assess potential ecological impacts:

- A temporary 25 m wide construction corridor; and
- A permanent, 8 m wide road footprint (within the 25 m corridor) Description of Potential Ecological Impacts.

Ecological impacts that may result from the proposed road realignment project are discussed in Section 11.4.1 through to Section 11.4.9 below.

11.4.1 Loss and disturbance of terrestrial habitat

Vegetation clearing and earth works during the construction phase will result in the loss and disturbance of grassland patches occurring within the proposed road construction corridor, which will negatively impact the integrity and functioning of remaining grasslands. This impact occurs during the construction phase. Approximately one hectare (1 ha) of dry grassland habitat will be cleared during construction and another 1.9 ha will be disturbed.

Prior to mitigation, the significance of this impact is rated as **moderate**, but with mitigation, it can be reduced to a **low** significance.

11.4.2 Loss and disturbance of wetland habitat

Construction of the conveyor and associated servitude along the preferred route will lead to the permanent loss of 1.2 ha of wetland habitat due to clearing of wetland vegetation, and disturbance of approx. 2.3 ha of wetland habitat adjacent to the road footprint.

Ideally, wetland crossings should be avoided or minimised – this is particularly relevant to the pan Ma_Pan_15, the top of whose basin would be crossed by the route as currently proposed. The potential significance of the loss and disturbance of wetland habitat is considered **moderate** prior to mitigation, as although local in extent, effects will be permanent, remaining for the lifetime of the road use.

Provided that the basin of pan Ma_Pan_15 is avoided, and the remaining mitigation measures are implemented as part of the construction phase and maintained for the operational lifetime of the road, the potential impacts may be reduced to **low** significance post-mitigation.

11.4.3 Interruption of wetland hydrology

The proposed route corridor crosses six wetlands and cuts the top of one wetland. The excavations for road foundations during construction, and the presence of a sealed tar road crossing the wetlands for the lifetime of the road, will interrupt surface and/or subsurface flows, potentially leading to flow concentration (downstream of the crossings), changes in flow pathways, flow impoundment (upstream of the crossings), increased surface water runoff and increased risk of erosion within the wetland via gullies. Additionally, any activity or infrastructure that impedes or alters the natural subsurface flow in the catchments could have indirect, but potentially significant, effects on the wetlands.

The potential significance of such impacts on the affected wetlands is determined to be **high**, as effects would be permanent, local in extent and could affect a larger area of wetland downstream of the road, resulting in a High magnitude score. Provided that the mitigation measures are implemented prior to commencement of construction and are maintained for the operational lifetime of the Project, the extent of impact and impact magnitude can be reduced, resulting in a residual impact of **low** significance post-mitigation.

11.4.4 Wetland erosion

Erosion of wetland soils could occur as a result of vegetation and topsoil removal during construction, which could result in additional loss of wetland habitat in those wetlands being crossed by the proposed road route. Vegetation clearance and removal will lead to reduced surface roughness within the servitude which could further exacerbate soil erosion. The presence of the road and associated surface water runoff could cause flow concentrations that exacerbate wetland erosion downstream/downslope of the road, for the lifetime of the road.

Erosion of wetland soils will lead to habitat deterioration and changes in the natural wetland hydrology. These effects may be expressed as flow concentrations, lowering of the water table and possible desiccation in hillslope seepage wetlands. In affected pan systems, erosion of wetland soils could lead to the development of channels in the pan basin as a result of flow concentrations, with associated increased transport of sediment to the pan floor.

The magnitude of change to wetland health is potentially high, permanent, and may affect wetlands on a local scale, beyond the immediate footprint of the proposed Project activities. This amounts to a potential impact of **high** significance prior to mitigation.

With the application of the recommended mitigation measures, the magnitude of change in wetland health as a result of erosion can be reduced to minor, effects can be restricted to the site only, and the duration of effects will be in the medium term, lasting for the duration of construction and operation. The overall impact post-mitigation is predicted to be one of **low** significance.

11.4.5 Wetland water quality deterioration

During the construction phase, the water quality in the wetland may deteriorate as a consequence of vegetation removal and increased risk of eroded soils and sediments being transported after rainfall events. Contaminants from machinery and materials being used for road construction could enter the wetland and contribute to water quality changes. During operation, sediment-loaded and otherwise contaminated stormwater runoff from the road surface may be discharged to the wetlands that will be crossed by the road.

Potential impacts on water quality in the wetlands have a **moderate** impact score without mitigation, as the effects may be long-term, would occur on a local scale and result in a high magnitude of deterioration as a result of entry of coal and other contaminants into the wetlands and subsequently the downstream water courses. The implementation of the recommended mitigation measures is required to avoid and minimise adverse impacts on water quality of wetlands and associated downstream riparian systems. Provided that the mitigation measures are implemented, the extent of potential impacts can be reduced to a site-only scale; the duration of impacts can be reduced to the length of construction activities, and the probability of the impact ever occurring can be reduced to low. In this scenario, a post-mitigation impact of **low** significance is predicted.

11.4.6 Loss of wetland biodiversity

Construction of the proposed road and its presence during operation will lead to a direct loss of wetland habitat and vegetation communities within the footprint and disturbance of adjacent communities, which is likely to affect flora and fauna species relying on these habitats. The wetlands that will be traversed by the proposed route are mostly considered to be of moderate Ecological Importance and Sensitivity; playing a role in biodiversity support largely as a result of their location within the catchment of the Grootspruit which is listed as a “Fish Support Area”.

The potential significance of the loss of biodiversity is assessed as being **moderate** prior to mitigation, with effects being permanent and occurring on a local scale to the Project. The implementation of the recommended mitigation measures will reduce the magnitude of the impact and the extent of potential impacts to the site only, resulting in a residual impact of **low** significance post-mitigation.

11.4.7 Establishment of alien invasive species

Disturbances caused by vegetation clearing and earth works will create conditions conducive to the establishment and colonisation of alien invasive vegetation. If left uncontrolled, alien species infestations can spread into adjacent natural grassland, suppressing or replacing indigenous vegetation. This impact will persist throughout all phases of the proposed project.

Several highly invasive alien species, including *Datura strumarium* and *Xanthium strumarium* have been documented in the Mafube study area. It is highly likely that these species, amongst others, will colonise disturbed areas, such as the road reserve.

Without mitigation, this impact is rated as **moderate**. However, with active control of alien plant populations, the significance can be reduced to a **low** rating.

11.4.8 Increased dust generation

Vegetation clearing coupled with increased vehicle traffic will result in increased dust entrainment, which can negatively affect flora and fauna communities occurring adjacent to the proposed road. Dust generation can persist through all phases of the proposed project and will be most acute during the dry season. This impact can be maintained at a **low** significance if regular mitigation is implemented.

11.4.9 Loss of flora and fauna species of conservation importance

Vegetation clearing can lead to the destruction of plant species of conservation importance (Red List and protected species) growing in the road corridor. This impact occurs during the construction phase.

The senescent remains of a *Gladiolus* inflorescence were noted during the road walk down - all *Gladiolus* species are listed as protected in Mpumalanga Province (as per the Mpumalanga Nature Conservation Act, 1998). Several other protected plant species have previously been recorded in the Mafube LifeX MRA, and some of these may also occur in the road corridor.

The loss of species of conservation importance is rated as a **moderate** impact prior to mitigation and **low** after successful mitigation.

Proposed mitigation measures

- Vegetation clearing should be restricted to the immediate road construction footprint/corridor (8 m wide) only;
- This area should be clearly marked and no vegetation clearing or earth works should be permitted beyond this demarcated area;
- After construction, active revegetation using locally occurring indigenous plant species should be undertaken to stabilise any wetland crossings;
- An Environmental Control Officer (ECO) should manage the vegetation clearing process;
- Active control of NEMBA and CARA listed alien invasive plants should be undertaken along the length of the road, in line with the provisions of the Mafube AIS Control and Eradication Plan (see Golder Report No. 1776031-314542-1):
  - Control actions should include initial treatment, follow-up treatments and regular monitoring.
- Control actions should include initial treatment, follow-up treatments and regular monitoring;
- A vehicle speed limit of 60 km/h should be enforced to limit dust entrainment;
- During construction, dust suppression using water bowsers should be implemented at a regular frequency on a daily basis;
- A protected plant survey along the road corridor should be conducted during the wet/growing season (November to March) prior to vegetation clearing;
- Based on the results of the survey, rescue and relocation permits should be obtained from the Mpumalanga Parks and Tourism Agency (MPTA) and affected plants should be relocated to adjacent undisturbed grassland patches;
- Minimise impacts on watercourses by limiting construction activities to as small an area as possible;
- All wetlands located within the study area, but not directly crossed by the road should be carefully demarcated and no construction machinery or any other vehicles should be allowed access to these areas other than along existing roads;
- Construction activities should be done in the dry season only;
- Stockpiles, laydown areas and temporary construction infrastructure must be at least 50 m from the edge of delineated wetlands;
- After construction, active revegetation using locally occurring indigenous plant species should be undertaken to stabilise any wetland crossings;
- Wetland crossings should be constructed using engineered designs that ensure that the hydrological integrity of the affected wetlands is preserved upstream and downstream of the road crossings;
- Construct low level water deflection berms;

- Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas, placement of hay bales around the wetland construction areas, and re-vegetation of disturbed areas as soon as possible;
- Implement a stormwater management plan;
- Re-vegetate with indigenous vegetation to reduce run-off and increase infiltration;
- Re-vegetate bare soil areas after construction;
- Store and handle potentially polluting substances and waste in designated, bonded facilities;
- Waste should be regularly removed from the construction site by suitably equipped and qualified operators and disposed of in approved facilities; and
- Keep sufficient quantities of spill clean-up materials on site.

11.5 Noise

11.5.1 Pre-construction (land clearing) and construction phase

The noise levels created by construction equipment will vary greatly depending on factors such as the type of equipment, the specific model, the operation being performed and the condition of the equipment. The equivalent sound level (Leq) of the constriction activity also depends on the fraction of time that the equipment is operated over the time period of construction. Construction equipment can be broken down into two classes (British Standard, 1997; South Australian EPA, 2014, and U.S. Department of Transportation, 2006):

- Stationary Equipment: Stationary equipment consists of equipment that generates noise from one general area and includes items such as pumps, generators, compressors, etc. These types of equipment operate at a constant noise level under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as jackhammering or blasting operations, produce variable and sporadic noise levels and often produce impact-type noises. Impact equipment is equipment that generates impulsive noise, where impulsive noise is defined as noise of short duration (generally less than one second), high intensity, abrupt onset, rapid decay, and often rapidly changing spectral composition. For impact equipment, the noise is produced by the impact of a mass on a surface, typically repeating over time; and
- Mobile Equipment: Mobile equipment such as dozers, scrapers, graders, etc., may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. Other equipment such as compressors, although generally considered to be stationary when operating, can be readily relocated to another location for the next operation.

It is anticipated that the construction of the road will generate noise in excess of the ambient noise standards and pose an annoyance to those in close proximity to the activity, particularly with regard to impact noise, which is considered more intrusive than continuous noise.

11.5.2 Operation

Given that the proposed Route F is a new route passing through vegetated (cultivated/pasture) land, it is anticipated that the operation of the route will alter baseline noise levels notably. Based on the results of the baseline monitoring adjacent to the D684, as well as the calculated current D684 traffic noise, it is anticipated that the deterioration of the noise environment will be limited to within 100 m of the proposed route. Residential area levels1 are expected to prevail beyond 100 m, provided traffic volumes do not increase significantly from the current baseline. Noise may travel further during peak traffic and under certain meteorological conditions.

While elevated noise levels may be considered to be a nuisance within 100 m of the road, there are no receptors identified within this area. Route F will be a public road, therefore the implementation of mitigation measures is restricted by Mafube's limited influence on the vehicles using this route.

The divergence of traffic away from the Sikhululiwe Village is anticipated to have a positive impact on noise levels experienced at the Village.

As the road will be open to the public, options for noise mitigation during the operational phase are limited to screening (such as trees) where receptors experience annoyance; vehicle speed control, and good road maintenance.

A complaints log should be maintained and noise compliance monitoring should be undertaken at receptor locations, should receptors raise concerns regarding Route F noise contributions.

Proposed mitigation measures

- Notify neighbours prior to commencing activities that will generate significant noise. Good communication can prevent complaints from arising and resolve concerns before there is a problem. A phone number where a project representative can be reached should be provided prior to the work commencing;
- A complaints reporting procedure should be established and all complaints logged. Investigations into the cause of the complaints should be initiated and appropriate mitigation measures applied timeously;
- Reroute truck traffic away from residential areas where possible;
- Keep noise generating equipment such as generators and air compressors as far away from noise sensitive receptors as possible;
- Shut down or throttle down equipment (such as backhoes, cranes, bobcats, loaders and generators) whenever they are not in actual use;
- Combine noisy operations to occur in the same time period. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately;
- Avoid night-time construction activities. Sensitivity to noise increases during night-time hours;
- Select quieter equipment where possible. For example, while most compressors are powered by diesel or gasoline engines, many are contained or have baffles to help abate noise levels. Electric compressors are significantly quieter than diesel or gasoline engine powered compressors;
- Use newer equipment where possible as it is generally quieter than old equipment for many reasons, including technological advancements and the lack of worn, loose, or damaged components;
- Ensure equipment is well maintained. Poor maintenance of equipment typically causes excessive noise levels. Faulty or damaged mufflers and loose engine parts such as screws, bolts, or metal plates contribute to increased noise levels. Removal of noise-reducing attachments and devices such as mufflers, silencers, covers, guards, vibration isolators, etc., will, to varying degrees, increase noise emission levels. Old equipment may be made quieter by simple modifications, such as adding new mufflers or sound absorbing materials. Loose and worn parts should be fixed as soon as possible; and
- Ensure personel are trained to carry out their respective tasks. Careless or improper operation or inappropriate use of equipment can increase noise levels. Poor loading, unloading, excavation, and hauling techniques are examples of how lack of adequate guidance and training may lead to increased noise levels.

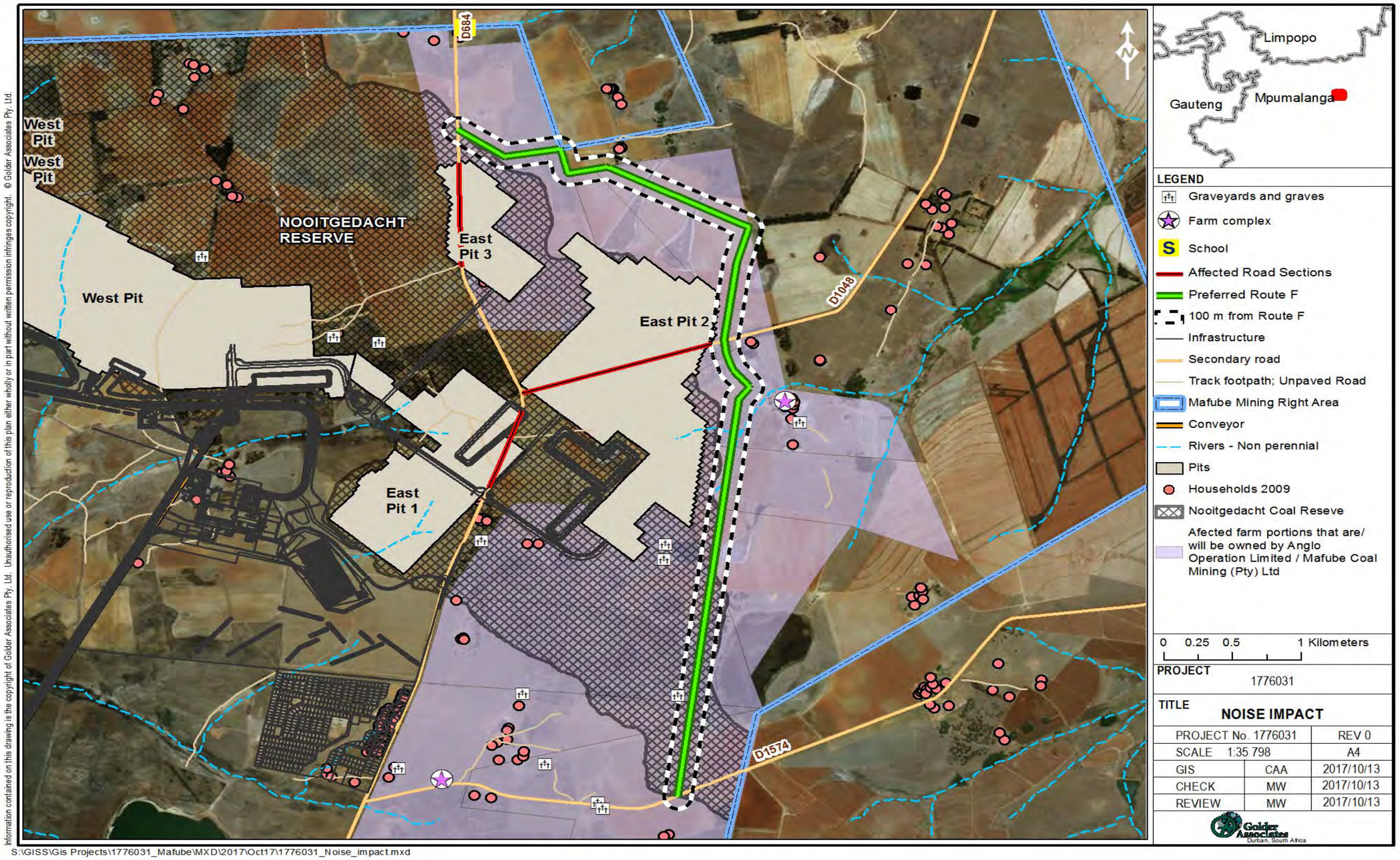

Figure 68: Anticipated noise impact radius (see Figure 5 for optimised route)

11.6 Surface water

The potential surface water impacts from the project, both direct and indirect, are summarised in Table 61. In summary, these potential impacts will contribute to overall surface water impacts and include:

- Change in surface water catchment areas;
- Changes in surface water quality;
- Change in surface water runoff; and
- Erosion.

The surface water quality impacts due to the construction and operation of the proposed road/s will ultimately impact on the downstream water users. This potentially impacted water flows to downstream users via the river system.

Table 61: Summary of potential surface water impacts with respect to road realignment project

Major Aspect	Key Environmental Issues/Potential Impacts
Changes in surface water catchment areas	■ Disruption and reduction in land due to construction of roads and associated infrastructure.
Changes in surface water quality	■ Poor quality runoff from road activities; ■ Possible fuel and lubricants spillage from equipment and other chemical spills; and ■ Pollution of wetlands.
Change in surface water runoff	■ Increased runoff due to vegetation and veld removal therefore decreasing infiltration into soil which may impact on downstream communities; and ■ Increased runoff due to hard road surfaces.
Erosion	■ Erosion along road may be increased due to site clearance of vegetation and veld.

Proposed mitigation measures

- Maintenance of the stormwater management system and compliance to GN 704 to keep clean and dirty water separated;
- Continue with DWS approved water quality monitoring programme;
- Store and handle potentially polluting substances and waste in designated bunded facilities;
- Spoils heaps and overburden should be placed in areas where infiltration will be minimised;
- Rehabilitation of sloped areas to minimise erosion;
- Recommended dust suppression during construction phase;
- Store and handle potentially polluting substances and waste in designated bunded facilities; and
- Any spills should be cleaned up immediately.

11.7 Socio-economics

11.7.1 Construction

During the construction phase of the proposed road, possible creation of employment opportunities could positively impact on the socio-economic environment. A short-term wealth expectation is created by any development project. It is recommended that local labour should be used during the construction process, where possible. This process will facilitate adequate transfer of skills to the local community.

11.7.2 Operation

Increased accessibility to the area could result in a positive impact on the local environment. Maintenance and repair of the affected roads in the area will improve access of local communities to health and education. Easier and more efficient access to these facilities could result in an improvement in quality of life of communities along the road realignments.

Minimal increase in travel distance could result in a negative impact on the local environment, but the new improved road surface infrastructure could reduce travel times for the local communities, depending on their route and destination. This will constitute possible cost savings and production turn-around times. Vehicle operating costs in terms of maintenance and energy inputs should decrease through the upgrade.

The proposed route realignment will have an added positive benefit through the upgrading of the current road infrastructure, as will upgrading the existing poor road infrastructure to an acceptable level through upgrading of existing routes and the construction of new routes. Erosion control measures will be implemented where required and rehabilitation measures will be introduced. The existing poor stormwater management structures can be rehabilitated to improve storm water management.

Upgrading and operation of the proposed realignment routes could positively and negatively impact upon the safety of the local community. The existing poorly maintained and un-surfaced roads impact on the safety of vehicle users, including pedestrians and private vehicles. Upgrading of these routes will increase the design speed of the road, and vehicle travel speeds can be expected to increase. Increased vehicle speeds will impact negatively on current pedestrian road users.

Proposed mitigation measures

- Local unskilled or semi-skilled labour (including women) should be used where practicable during the construction of the road;
- Mechanisms and structures to ensure the appropriate development and transfer of skills to the local community should be established;
- Where possible, labour intensive construction methods should be employed;
- Pavement areas and bridge structures must be regularly maintained;
- Ensure that erosion is minimal during the wet season to improve road safety;
- Areas where the road passes through social or cultural gathering places should be clearly marked with road signage and sufficient road crossings should be introduced where appropriate;
- Erosion control measures should be implemented where required and rehabilitation measures introduced;
- Effective storm water management systems and structures should be put in place and existing structures to be retained must be rehabilitated;
- The road must be maintained regularly; and
- Areas where the road passes through important social or cultural gathering points should be clearly marked with road signage, and sufficient road crossings and traffic calming measures should be introduced where appropriate.

11.8 Palaeontological Assessment

11.8.1 Field observations and site overview


The road will follow the route of the power lines


Area mostly covered in corn fields

The road will follow the route of the existing Eskom power lines in the area and the area is mostly covered in maize fields.

Summary: When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a desktop and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).

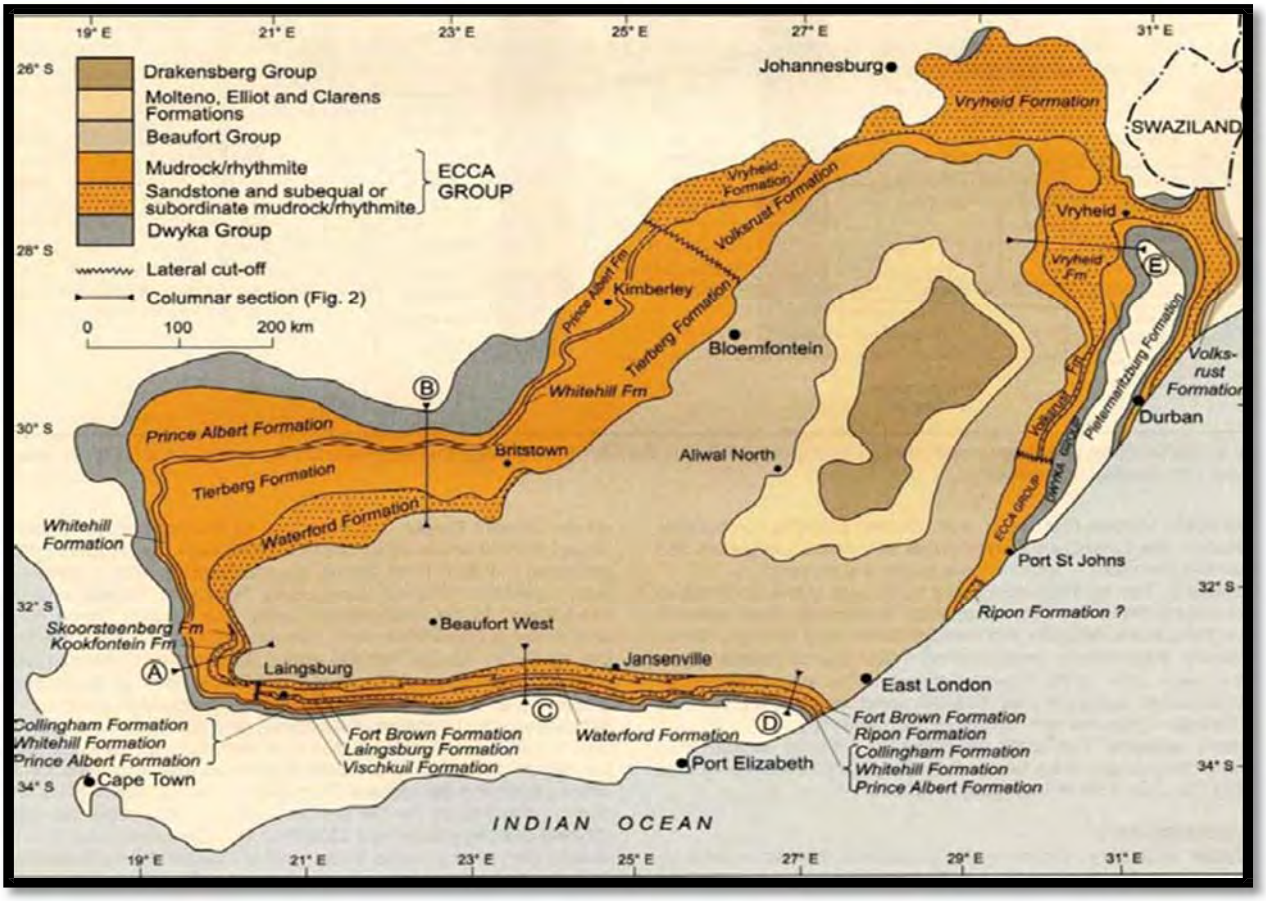

Figure 69: Extent of the Ecca Group (Johnson 2009)

The Ecca Group may contain fossils of diverse non-marine trace, *Glossopteris* flora, *mesosaurid* reptiles, *palaeoniscid* fish, marine invertebrates, insects, and crustaceans (Johnson 2009). Glossopteris trees rapidly colonised the large deltas along the northern margin of the Karoo Sea. Dead vegetation accumulated faster than it could decay, and thick accumulations of peat formed, which were ultimately converted to coal. It is only in the northern part of the Karoo Basin that the *glossopterids* and *cordaitales*, ferns, clubmosses and horsetails thrived (McCarthy and Rubidge 2005).

The Glossopteris flora is thought to have been the major contributor to the coal beds of the Ecca. These are found in Karoo-age rocks across Africa, South America, Antarctica, Australia and India. This was one of the early clues to the theory of a former unified Gondwana landmass (Norman and Whitfield 2006).

Table 62: Criteria used (Fossil Heritage Layer Browser/SAHRA)

Rock unit	Significance/vulnerability	Recommended action
Vryheid Formation	Very High	Field assessment and protocol for finds is required
Bushveld Complex	Insignificant or zero	No paleontological studies are required.
Rooiberg Group	Low	No paleontological studies are required however a protocol for finds is required

Table 63: Taken form palaeotechnical report (Groenewald and Groenewald 2014)

Subgroup/ Supergroup	Group	Formation	Fossil Heritage	Comment
Karoo Supergroup	Ecca	Vryheid	Rich fossil plant assemblages of the Permian Glossopteris flora, rare fossil wood, diverse palynomorphs. Abundant low diversity trace fossils, rare insects, possible conchostracans, non-marine bivalves, fish scales	Globally important and under collected

Impact: VERY HIGH. There are some fossil resources that may be impacted by the development.

The Desktop PIA was undertaken during February 2017. This Phase 1 Field Study was undertaken in October 2017. The walk through of the affected portion was done and photographs were taken. It was not necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. The walk through and drive through did identify the Vryheid Formation.

11.8.2 Description of significant fossil occurrences (Heritage value) (1f)

All Karoo Supergroup geological formations are ranked LOW to VERY HIGH, but here the impact is potentially VERY HIGH, for the Vryheid Formation, Ecca Group. Rocks of Permian age in South Africa are particularly rich in fossil plants (Rayner and Coventry 1985). The fossils are present in the grey shale interlayered with the coal seams. The fossils are not very rare and also occur in other parts of the Karoo stratigraphy. The pollen of the Greenside Colliery also on the Vryheid formation was the focus of a Ph.D study. It is often difficult to spot the greyish fossils as they are the same colour as the grey shale in which they are present as these coalified compressions have been weathered to leave surface replicas on the enclosing shale matrix. A locality close to Ermelo, also Vryheid Formation, has yielded Scutum, Glossopteris leaves, Neoggerathiopsis leaves, the lycopod Cyclodendron leslii, and various seeds and scale leaves (Prevec 2011).

Fossils likely to be found are mostly plants (Appendix 1) such as ‘Glossopteris flora’ of the Vryheid Formation. The aquatic reptile Mesosaurus and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. The marine bivalve Megadesmus is found in the upper part of the Volksrust Formation near Newcastle (Johnson 2009).

During storms a great variety of leaves, fructifications and twigs accumulated and because they were sandwiched between thin films of mud, they were preserved to bear record of the wealth and the density of the vegetation around the pools. They make it possible to reconstruct the plant life in these areas and wherever they are found, they constitute most valuable palaeobotanical records (Plumstead 1963) and can be used in palaeoenvironmental reconstructions.

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. The vast coal mining industry provides palaeontologists with fantastic access to coal- associated plant fossils, while simultaneously resulting in the destruction of important National palaeontological heritage.

Fossils likely to be found are mostly plants such as ‘Glossopteris flora’ of the Vryheid Formation. The aquatic reptile Mesosaurus and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. The marine bivalve Megadesmus is found in the upper part of the Volksrust Formation near Newcastle (Johnson 2009).

The threats are; earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, mining activities, and human disturbance.

11.9 Cultural and Heritage Resources

11.9.1 Field survey

Field surveys were conducted during 3 to 4 April 2017. The field survey for the proposed road deviations was conducted by means of following district and two track roads as well as any other accessible pathways in the project area in order to gain access to the footprint of the proposed new road alternatives. The routes that were followed with a vehicle during the survey were recorded with a mounted GPS instrument. Pedestrian surveys were undertaken from these primary access routes and not all of these tracks were necessarily recorded on a GPS.

All coordinates for heritage resources were recorded with a Garmin Etrex hand set Global Positioning System (instrument) with an accuracy of < 15 m.

Large parts of the project area are covered with maize fields. These fields could not be surveyed as a result of the dense stands of maize.

Google imagery was used as a supplementary source next to the fieldwork to establish the possible presence of heritage resources such as historical farm homesteads with outbuildings.

Ecological indicators such as alternations in vegetation patterns; open or bald spots in the veld covered only with grass or extremely dense patches of vegetation were searched as possible indicators for settlements such as stone walls or as former abodes where farm workers may have settled in the past.

Databases kept and maintained at institutions such as the Provincial Heritage Resources Agency (PHRA), the Archaeological Data Recording Centre at the National Flagship Institute (Museum Africa) in Pretoria and SAHRA's national archive (SAHRIS) were consulted to determine whether any heritage resources of significance had been identified during earlier heritage surveys in or near the project area.

The archaeologist (Dr J Pistorius) is acquainted with the project area at large as he has done several heritage impact assessment studies near the proposed project area. Several earlier heritage impact assessment studies have been done in close proximity to the current project area. These studies provided information regarding the nature and heritage character of the area, namely (see 'Part 9, Bibliography relating to earlier heritage studies'):

Literature relating to the pre-historical and the historical unfolding of the region where the Project Area is located was reviewed (see Part 8, 'Contextualising the Project Area' and Part 10, 'Select Bibliography). The pre-historical and historical context of the larger area assisted with assumptions about the possible types and ranges of heritage resources to be expected in the project area as well as to comprehend the identity and meaning of heritage sites which may be found in and near the project area.

In addition, the project area was studied by means of maps outlining Mafube Coal's prospecting area and the farms Nooitgedacht 417JS and Roodepoort 418JS where the road deviations occur (2529DA Selonsrivier, 2529DB Languitsig, 2529DD Pan; 1:50 000 topographical maps; Pretoria 2528 1: 250 000 map and Google Earth imagery).

11.9.1.1 Types and ranges of heritage resources

The Phase I HIA for the proposed project area revealed the following types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No. 25 of 1999) in and near the project area, namely: A graveyard (previously identified as GY07). The graveyard was geo-referenced and mapped. Its significance is indicated as well as any possible impact on the graveyard. Mitigation measures are outlined to take precautionary measures that the graveyard is not impacted during the construction of the road.

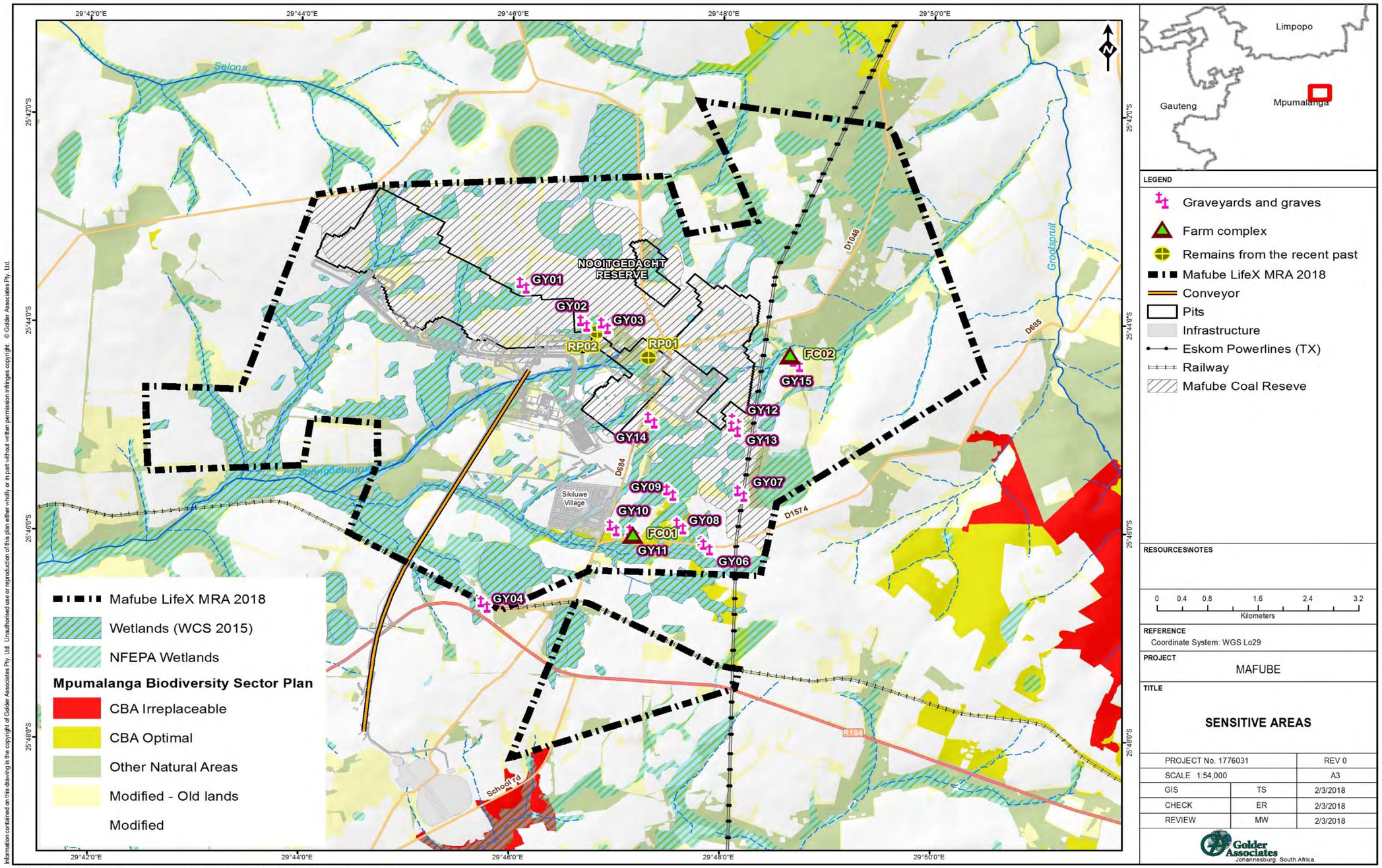

Figure 70: Heritage recourses within the project area

Graveyard 07 is located approximately one hundred metres from Route Alternative F for the proposed Mafube LifeX Road Realignment Project and will not be directly affected by the construction of the road.

Figure 71: Graveyard (GY07)

Graveyard 07 (GY07) is located near Eskom's power lines. During the survey conducted in 2012 it contained approximately eleven graves but it has now grown to approximately twenty eight graves. Many of the graves are older than sixty years and many of these are demarcated with ferricrete stones. Graveyard 07 is located near Eskom's power lines and approximately one hundred metres from Route Alternative F.

Table 64: Coordinates and significance rating for graveyard

Graveyard	Location (Coordinates)	Significance Rating
GY07. Graveyard 07	25˚ 45.629' 29˚ 48.185'	HIGH

The significance of the graveyard is indicated in order to determine the significance of any possible impact on the graveyard and to establish whether any mitigation measures are required for the graveyard.

All graveyards and graves can be considered to be of high significance and are protected by various laws. Legislation with regard to graves includes Section 36 of the National Heritage Resources Act (NHRA) (Act No. 25 of 1999) in instances where graves are older than sixty years. It is highly likely that some of the graves are older than sixty years. Other legislation with regard to graves includes those which apply when graves are exhumed and relocated, namely the Ordinance on Exhumations (Act No. 12 of 1980) and the Human Tissues Act (Act No. 65 of 1983 as amended).

Possible impact on the graveyard

GY07 is located approximately 100 m from the preferred Route Alternative F and therefore it need not be impacted by the new road. The significance of any impact on the graveyard therefore is ***very low*** and will remain low if the mitigation measures outlined in this report are implemented.

Proposed mitigation measures

GY07 need not be affected by the Mafube Project.

However, to ensure that no accidental damage may befall GY07 during the construction of the road, it is recommended that the graveyard be demarcated with red cautionary tape and that the following signage be erected at the graveyard: '*Beware and avoid graveyard. Any damage caused may lead to prosecution'*. Demarcation measures to be done in accordance with community requirements.

There is no reason from a heritage point of view why the preferred Route Alternative F for the Mafube LifeX Road Realignment Project cannot be implemented if the mitigation measures outlined in this report are followed.

11.10 Soils, Land Capability and Land Use

11.10.1 Soil survey results of preferred route alternative F

The soil survey was conducted according to standard soil survey techniques comprising of seven (7) auger holes GPS referenced (WGS 84, decimal degrees). Soil sampling and observation points were positioned along the preferred Route Alternative F. Shapefiles of the road realignment, project boundary, existing and proposed infrastructure, surface water features, terrain, geology and existing land-capability and use were superimposed on Google Earth imagery and a 1:50 000 topographic map sheet. The geographical positions of observation points were loaded onto a handheld Global Positioning System (GPS) to aid in field traversing of the positions. Maps showing the observation points and the proposed route were printed to delineate the observation points.

11.10.1.1 Soil classification

During the field survey of the Route (including the buffer zone), the areas were delineated (into map units) and the natural resources; climate; terrain form; soil type and land use of the project area, were recorded. The entire length of the Route was evaluated along transects. The soil was evaluated at the main terrain units (crest, scarp, midslope, footslope and valley bottom positions) of the main geological groups and land types of the project area. Where access to the indicated observation points was restricted, observation points were shifted to more accessible areas, but on the same terrain position, geology and land type as the original point. The locations of observation points for the transect walks is shown in Figure 72.

At each observation point the soil was augered to a depth of 120 cm (unless an impenetrable layer was encountered restricting sampling depth). Observable soil characteristics such as colour, texture, soil depth, stoniness, and drainage class and parent material were logged. At each observation point the relevant and distinct features were also be recorded, such as signs of erosion, vegetation cover, micro-topography, aspect and fauna. A total of 7 modal profiles were described in detail and soil samples of the topsoil and subsoil horizons were collected. The soil characteristics were described and classified according to the Taxonomic Soil Classification System for South Africa (Soil Classification Working Group, 1991).

A total of five (5) different soil forms were observed along the route alternative F. A detailed legend of the observed soil forms is presented in Table 65 and the distribution of identified soils along the route (including the 25 m survey buffer) is shown in Figure 73. Much of the area across to buy the optimise route is cultivated land and it is evident from the aerial imagery that there is no material change in soil form along the optimised route sections over that reflected.

The proposed realignment route F is dominated by the following soil forms: Pinedene representing 16.95 ha, Hutton representing 8.28 ha, Mispah representing 4.94 ha, Clovelly representing 4.26 ha and Katspruit soil form representing 2.48 ha of the total area (36.91 ha). Areas that are delineated as wetlands comprise the Katspruit soil form, representing 2.48 ha of the total area of the route.

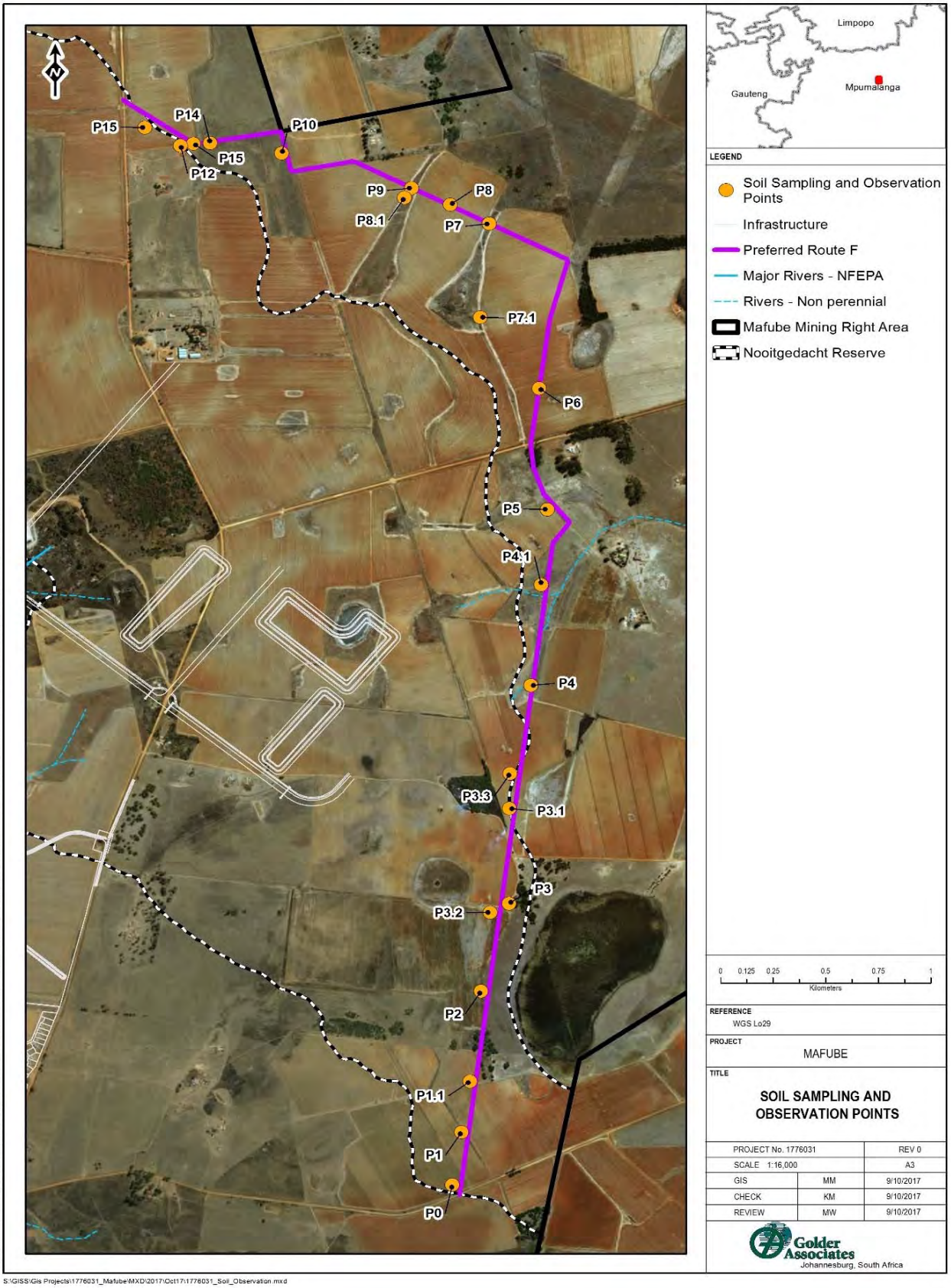

Figure 72: Soil sampling and observation points

Table 65: A detailed soil map of the proposed Route Alterative F

Soil type Code	Dominant and Subdominant soil form and family	Summarised description of soil horizon sequences	Area (ha)	Area (%)
Cv1 Cv2	Clovelly 2200* Clovelly 2100	Yellow brown, apedal (structureless), medium sandy loam topsoil on brown, apedal, medium sandy loam underlain by yellow brown, apedal, moist, medium sandy loam.	4.26	11.54
Hu	Hutton 3100*	Red, apedal, fine sandy loam topsoil on reddish brown fine sandy loam B1 underlain by reddish brown fine to medium silty loam with Mn/Fe concretions	8.28	22.43
Ka	Katspruit 1100*	Dark brown, blotched red, moist silt loam topsoil on dark grey to light grey loamy sand with orange mottles. Weak seepage also observed at 75 cm.	2.48	6.72
Ms	Mispah 1100*	Yellow brown, apedal, medium sandy loam topsoil underlain by reddish brown rocky medium loamy underlain by sandstone.	4.94	13.38
Pe	Pinedene 3100*	Greyish brown, apedal, fine-medium loamy sand topsoil on brown, apedal, medium loamy sand subsoil underlain by yellow brown, apedal, medium loamy sand with black ferric concretions becoming orange mottles with depth.	16.95	45.93

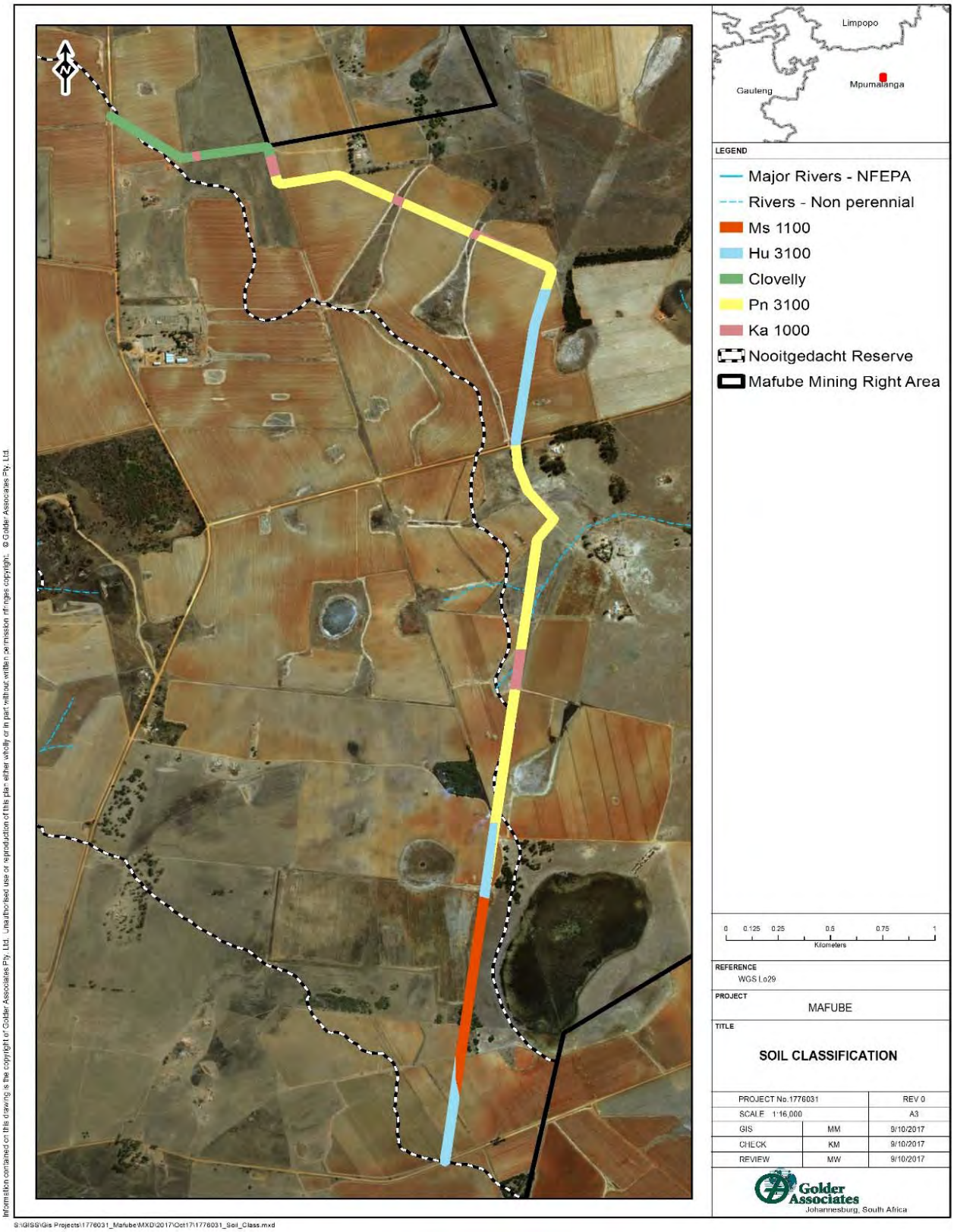

Figure 73: Soil classification map for surveyed route F (see Figure 5 for optimise route)

11.10.1.2 Soil Chemical Analysis

The chemical analyses of sampled representative soils collected along route alternative F are presented in Table 66. The results were evaluated using the guideline for interpretation of soil analysis according to the methodology outlined in the Fertilizer Handbook (Fertilizer Society of South Africa, 2007). The soils along Route F have the following soil fertility related properties:

- The particle size analysis of the representative soils indicates loamy sand for the Clovelly and Hutton forms, sandy loam for the Mispah form, silt loam to loamy sand for the Katspruit and loamy sand to sandy loam for the Pinedene soil form;
- The pH (H_2O) of all the soils analysed was acidic to very acidic, ranging from 4.61 to 5.23. The $EC_{sat\text{-}paste}$ of all soil samples was below 200 mS/m, and thus the salinity of these soils will have no effect on plant growth;
- The cation status of the soils analysed was rated as high, medium or low. Overall the concentration of Ca and K in the soils was medium to low and the levels of Mg were generally medium; and
- The concentration of P in the topsoil of the representative Hutton soil analysed was high (> 35 mg/kg), with the remainder of the soils having medium to low levels of P.

Table 66: Analytical data of representative soil forms

Soil form	Sample no.	Depth	pH(H_2O)	EC	Exchangeable cations				P	Organic carbon
					Ca	Mg	K	Na		
	Units	cm	pH units	(mS/m)	(mg/kg)					%
Hu	P1.1-1	0 – 20	4.61	41	207.5	50.0	72.5	0.5	60.2	0.82
	P1.1-2	20 – 60	5.23	32	309.0	34.0	62.5	0.5	23.2	
	P1.1-3	60 - 120	4.74	27	142.0	52.0	1.5	0.5	4.7	
Ms	P2-1&2	0 - 35	4.65	32	125.0	92.0	105.5	0.5	8.9	1.25
Ka	P4-1	0 – 5	4.73	38	617.5	123.5	118.5	32.5	18.4	4.53
	P4-2	25 – 35	4.62	28	314.5	64.0	2.0	21.0	5.6	
	P4-3	35 – 75	4.70	13	59.5	62.0	0.5	1.0	4.0	
Pn	P12-1	0 – 5/9	5.11	28	202.0	71.5	33.5	0.5	10.7	0.74
	P12-2	5/9 – 60	5.23	23	229.5	82.0	2.0	0.5	7.6	
	P12-3	60 – 75	5.31	21	182.5	88.0	0.5	0.5	3.9	
Nutrient status:		*High*	*Medium*	*Low*						

11.10.1.3 Wetland and Riparian Delineation

The detailed wetland delineation was undertaken as part of the Ecology Baseline and Impact Assessment and is based on the Department of Water Affairs and Forestry Procedure (DWAF, 2006) for identification and delineation of wetlands and riparian areas. The Procedure integrates the terrain, soil form, soil wetness and vegetation indicators to delineate wetland and riparian areas.

The soil form indicator identifies the soil forms which are associated with prolonged and frequent saturation, as defined by the Taxonomic Soil Classification System for South Africa (1991). The soil forms indicative of the various wetland zones are listed in the Table 67 below.

Table 67: Soil form indicators of wetlands (based on DWAF, 2005).

Soil form	Wetland zone (Non-wetland, Temporary and Seasonal, Permanent)	Estimated Percentage occurrence (%) along Route F
Katspruit 1100*	Permanent zone	7
Pinedene 3100*	Temporary and Seasonal zone	46
Clovelly 2200*, Clovelly 2100, Hutton 3100, Mispah 1100	Non-wetland zone	47

11.10.1.4 Land Capability Classification

Land capability along the proposed route alternative F was assessed according to the methodology of Schoeman *et al*. (2000). Field observations and soil properties (Table 66 and Table 68) of representative soil forms were compared to land capability features presented in the methodology to formulate the soil capability classes presented in Table 69.

Table 68: Soil physical properties of representative profiles

Profile ID	pH	Depth (cm)	Slope Percentage	Particle Size Distribution (%< 2 mm)			Soil Texture
				Sand	Silt	Clay	
P1.1-1	4.61	0 – 20	2-5	84.0	6.5	9.6	Loamy sand
P1.1-2	5.23	20 – 60		83.9	6.5	9.6	Loamy sand
P1.1-3	4.74	60 – 120		83.9	7.6	8.5	Loamy sand
P2-1	4.65	0 – 25	5-12	81.1	7.6	11.3	Sandy loam
P2-2	4.65	25 – 35		81.1	7.6	11.3	Sandy loam
P4-1	4.73	0 – 5	5-12	25.5	54.7	19.8	Silt loam
P4-2	4.62	5 – 35		55.9	27.3	16.8	Sandy loam
P4-3	4.70	35 – 75		82.8	6.9	10.3	Loamy sand
P12-1	5.11	0 – 9.5	0-2	86.9	3.9	9.2	Loamy sand
P12-2	5.23	9.5 – 60		86.6	1.6	11.8	Loamy sand
P12-3	5.31	60 – 120		83.5	1.7	14.8	sandy loam

Table 69: Land capability rating and soil capability classes according to Schoeman *et al.* (2000)

Soil form	Profile ID	pH (s)	Effective Depth (D)	Flood Hazard (F)	Erosion Hazard (E)	Mechanical limitations (M)	Drainage (W)	Soil Texture (T)	Soil Capability Class
Hu	P1.1-1	S_3	D_1	F_1	E_1	M_0	W_1	T_{1-2}	2
	P1.1-2	S_{1-2}							
	P1.1-3	S_3							
Ms	P2-1	S_3	D_4	F_1	E_4	M_2	W_2	T_2	4
	P2-2	S_3							
Ka	P4-1	S_3	D_4	F_4	E_2	M_3	W_5	T_{1-2}	5
	P4-2	S_3						T_2	
	P4-3	S_3						T_2	
Pn	P12-1	S_{1-2}	D_1	F_1	E_1	M_0	W_3	T_2	3
	P12-2	S_{1-2}							
	P12-3	S_{1-2}							

The soil capability ratings were compared to climatic factors as outlined in the methodology of Schoeman *et al.* (2000) to formulate land capability classes as shown in Section 8.4.4.

11.10.1.5 Soil agricultural potential

The land capability classification of the soil types (soil mapping units) found four land classes (II, III, V and VI). As mentioned earlier, land with higher LCC typically has lower production input costs producing higher yields than land with lower LCC and subsequently also varying agricultural potentials. The soil agricultural potential ratings determined in terms of the land capability classification for Route F is indicated in the Table 70 below and illustrated in the Figure 75.

The majority (80%) of the route has high soil agricultural potential.

Table 70: Soil agricultural potential classification for Route F

Soil Agricultural Potential	Area (ha)	Estimated Percentage occurrence (%) along Route F
High	29.44	80
Medium	7.4 ha	20
Total	**36.85**	**100**

11.10.1.6 Pre-road Construction Land Use

The land-use practices prior to the road construction were assessed as part of the soil survey and land capability study using aerial photo interpretation and data from field observations. The dominant land-use along the route comprises of agricultural maize fields (22.22 ha), grazing land (14.16 ha) and gravel roads (0.53 ha) as shown on Figure 74. The current land use, unit counts, areal extent and percentage are summarised in Table 71 and presented in Figure 76.

Table 71: Areas and percentages of current land use

Zone	Primary Use	Secondary Use	Unit Count	Area (ha)	Area (%)
Ca1*	Agricultural	Maize Fields	9	22.22	60.20
Ca2	Agricultural	Grazing land	5	14.16	38.36
T	Transport	Local gravel roads	4	0.53	1.43
Total			18	36.91	100

*: Dominant agricultural land-use

Figure 74: General view of maize agricultural fields (left) and open veld grazing areas (right) along route alternative F

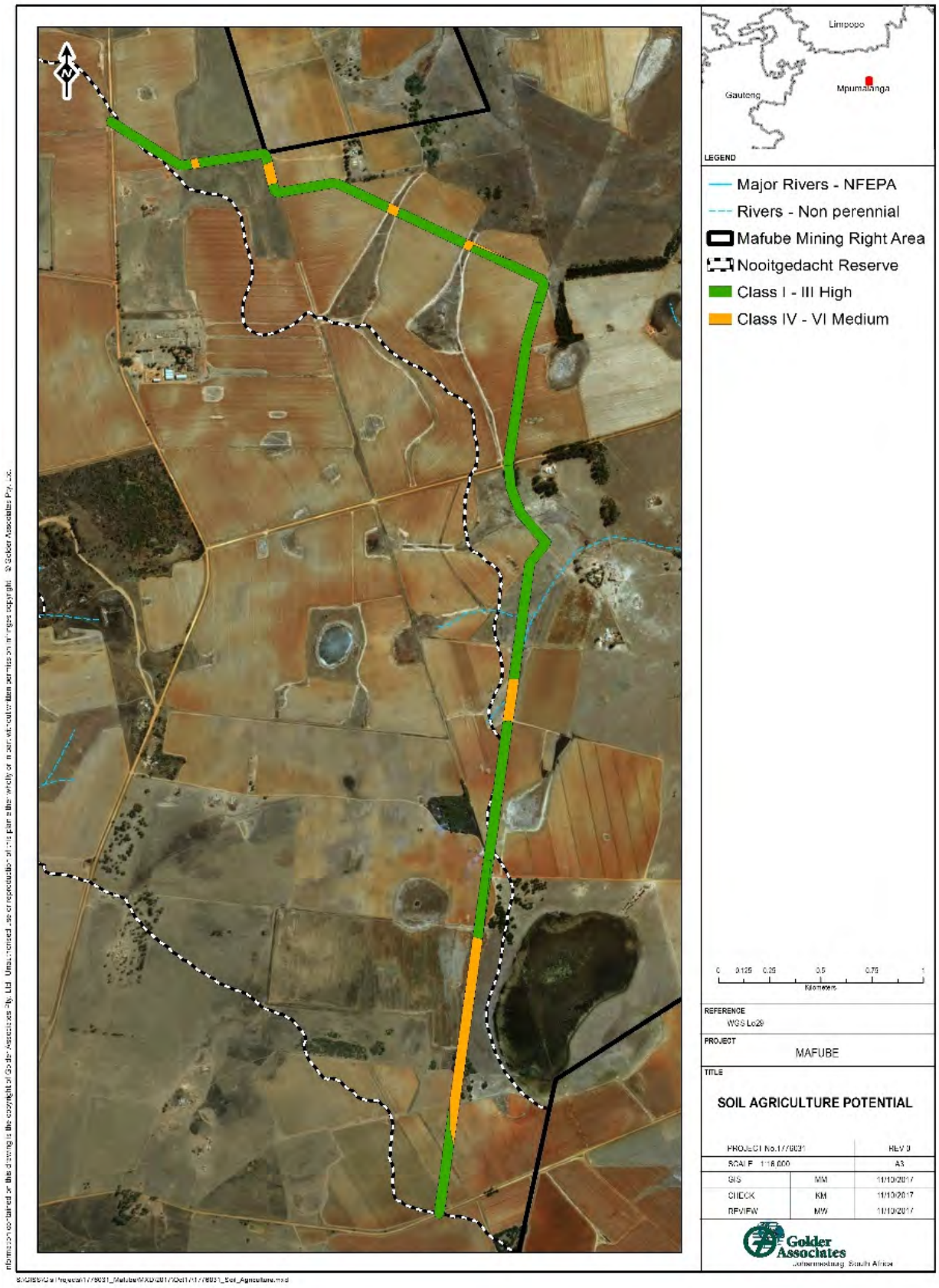

Figure 75: Soil agricultural potential along preferred route alternative F

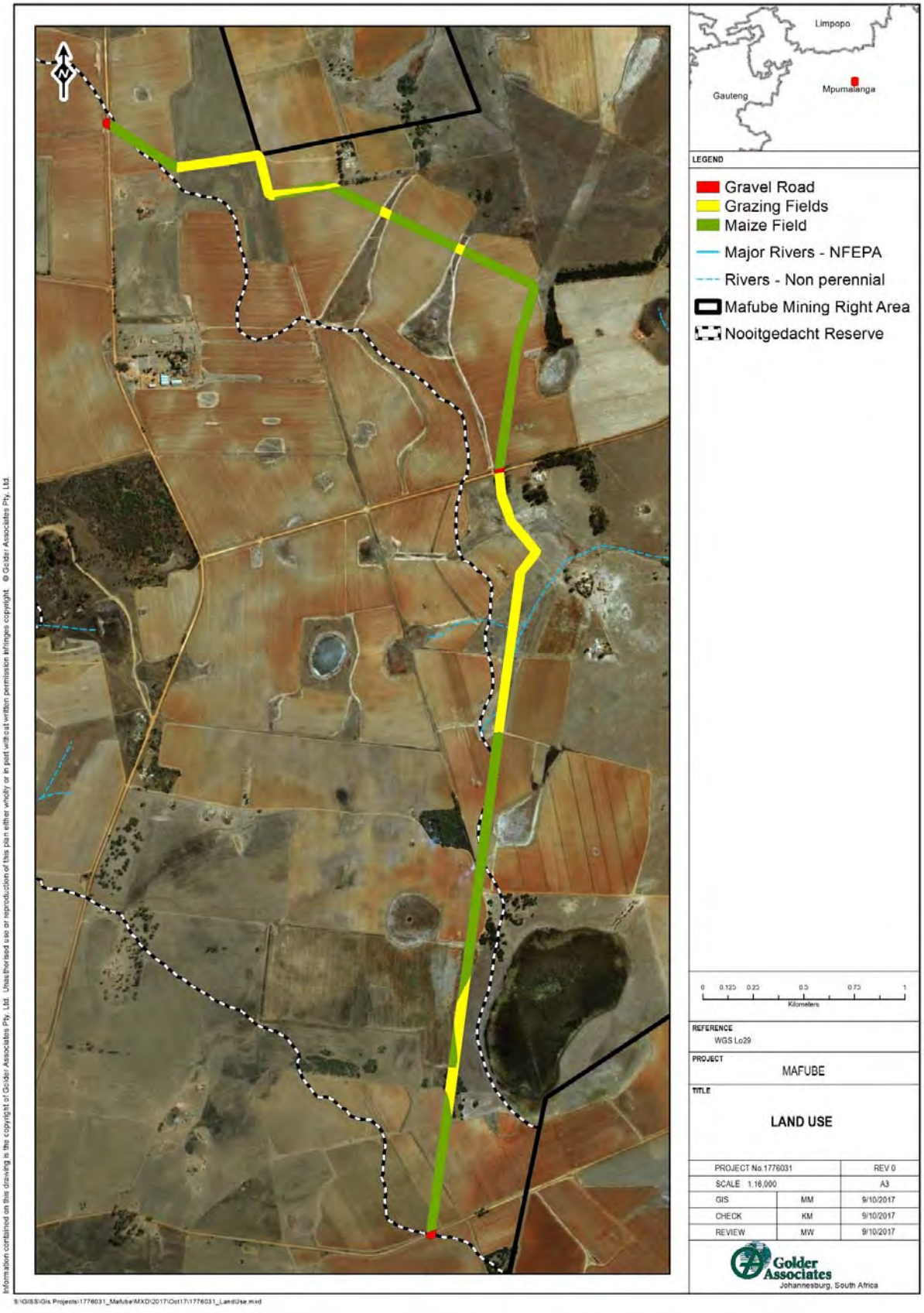

Figure 76: Land use identified along the preferred route alternative F

11.10.2 Construction phase

The following impacts have been identified for the pre-construction and construction phases:

- The **clearance of vegetation** and grubbing will definitely cause **disturbance of soils, resulting in removal of the organic matter** from topsoils. This soil often contains the highest fraction of organic matter in comparison to deeper portions of the soil profile. Loss of this topsoil portion has a high probability of occurring during the pre-construction phase and is therefore considered as a significantly **high** impact on the soil:
  - In the project area, there will be a definite and permanent **loss of the soils with high agricultural potential.** Since the land will not be rehabilitated back to agricultural land, the significance of the impact remains **high**.
- **Loss and change of land use** was rated as a **highly** significant impact as the land uses are likely to remain for transport use as a District road. Since the land use will not be returned to Agriculture, the significance of the impact remains **high**:
  - During the pre-construction and construction phases an increased presence and use of machinery and earthmoving vehicles is expected on site. Potential leakages of **oil and diesel** from the machinery could cause **contamination** of soils and shallow groundwater. This impact has a medium probability of occurring throughout the duration of the pre-construction and construction phases and is expected to occur only on site. The significance of the impact is **moderate at vehicle and equipment storage points** and **low** on the **route** on average. In order to reduce the probability of the leakages of oil and diesel from the machinery and earthmoving vehicles, it is recommended that dedicated laydown areas for equipment are established. With the appropriate mitigation measures, the significance of the impact can be **low**.
- **Soil erosion** may occur when the vegetation and arable soil layers are removed for construction of the road. Site clearance will increase the vulnerability of the soils to erosion, the consequences of which are loss of the original spatial distribution of soil types and natural soil horizon sequences; loss of some original soil fertility; loss of original topography and drainage pattern; loss of original soil depth and soil volume; and loss of the natural functioning of the soil (habitat for fauna and flora). The significance of the impact is **moderate** and with appropriate mitigation the significance of the impact **al**ong the route will be **low**.

11.10.3 Operation phase

- It is understood that during the operational phase, the constructed road will be handed over to the District Municipality.

Proposed mitigation measures

- All vehicles and machinery shall be kept in good working order and inspected on a regular basis for possible leaks and shall be repaired as soon as possible when required;
- Repairs shall be carried out in a dedicated repair area only, unless in-situ repair is necessary as a result of a breakdown;
- Drip trays shall at all times be placed under vehicles that require in-situ repairs;
- Drip trays shall be emptied into designated containers only and the contents disposed of at a licenced hazardous material disposal facility;
- Accidental spills (concrete, chemicals, process water, hydrocarbons, waste) need to be reported immediately so that effective remediation and clean-up strategies and procedures can be implemented; and
- Soil that is contaminated by fuel or oil spills, for example, from vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ, using sand, soil, sawdust or cold coal ash as absorption medium.

11.11 Visual Impact

11.11.1 Construction

During the construction phase, the construction camps and site offices could have a negative visual impact if they are poorly located. Construction and domestic waste generated at the construction camp and site offices could also impact on the fauna and flora of the surrounding area, as well as on the health of construction workers and the local community if these wastes are not removed to a licenced landfill site.

These negative impacts can be eliminated or greatly reduced through effective management of the construction camps and site offices.

Proposed mitigation measures

- The placement of construction camp and site offices should be negotiated with the local land owners and community leaders where applicable;
- The construction camps must be placed on a disturbed piece of land;
- Indigenous vegetation must not be disturbed if possible; and
- The contractor must supply the workers with firewood or preferably gas cooking appliances, to ensure that wood is not harvested from the surrounding vegetation.

11.12 Traffic Impact

11.12.1 Pre-construction phase

The pre-construction phase requires approval from the Mpumalanga Provincial Roads Department and the MEC, the subsequent de-proclamation of the existing road sections that will be closed, the proclamation of the new road reserve, and finally approval of the detailed design and wayleave for the new road alignment before construction can commence.

11.12.2 Construction phase

Standard engineering practices will be followed to ensure traffic safety and normal traffic operations (accommodation of traffic) during the construction phase.

The necessary approvals for the design and construction will be obtained from the Mpumalanga Provincial Roads Department including inter alia the approval of the detailed design drawings for the new road and the necessary wayleave approval before construction can commence.

11.12.3 Operational phase

After the construction of the new road it will be taken over by the Mpumalanga Roads Department which will be responsible for the future maintenance and improvement as required according to standard engineering practices.

Proposed mitigation measures

- Sound engineering principles will be applied during planning and design;
- Construction of adequate drainage structures, such as culverts, at all watercourse crossings and maintenance of these on a regular basis to prevent sediment and debris build-up;
- Minimal disruptions will be achieved by ensuring adequate signage to inform road users of closed roads and the new road realignments;
- Road users will be informed of road closure and re-alignment prior to any construction work being done;
- Construction vehicles and equipment shall be clearly visible at all times;
- Active construction equipment and vehicles shall be operated by competent persons only and not be left unattended;

- Dust and noise levels will be kept to a minimum by applying engineering standards;
- Roads will be inspected and maintained on a periodic basis to ensure no additional delays and road user costs due to poor and unsafe road surface; and
- Road problems reported to authorities will be solved as soon as reasonably possible.

11.13 Summary of Environmental Impacts

Table 72 below summarises the potential impacts of various aspects applicable for road developments through the construction and operation phase of the Mafube LifeX Road Realignment project. Responsibilities for implementing the mitigation measures are identified and the frequencies with which the results of the various measures are to be monitored are stated in further sections of this report.

Table 72: Assessment of each identified potentially significant impact and risk

ACTIVITY ***Whether listed or not listed*** ***(e.g. Excavations, blasting, stockpiles, discard dumps or dams, Loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.)***	**POTENTIAL IMPACT** ***(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)***	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIGNIFICANCE** ***(If not mitigated)***	**Mitigation Type** ***Modify, remedy, control or stop*** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**SIGNIFICANCE** ***(If mitigated)***
Land clearing, ground excavation and materials handling	Dust fallout and particulate emissions resulting from land clearing, ground excavation and materials handling	Air Quality	Construction	Moderate	Control through management and monitoring	Low
Land clearing, ground excavation and materials handling	Trace gas emissions resulting from construction vehicle exhaust	Air Quality	Construction	Low	Control through management and monitoring	Low
Use of the constructed road realignment section	Dust fallout and particulate emissions resulting from vehicle entrainment of dust, affecting ambient air quality along Route F	Air Quality	Operation	Moderate	Control through management and monitoring	Moderate

Use of the constructed road realignment section	Redirection of D684 emissions (Dust fallout and particulate emissions resulting from vehicle entrainment of dust) affecting ambient air quality at Sikhululiwe	Air Quality	Operation	Moderate		Moderate
Land clearing, ground excavation and materials handling	Degeneration of the prevailing noise environment at a receptor due to construction noise	Noise	Construction	Moderate	Control through management and noise control	Moderate
Use of the constructed road realignment section	Degeneration of the prevailing noise environment at a receptor (>100 m from the roadway) due to traffic noise	Noise	Operation	Moderate	Control through management and noise control	Low
Vegetation clearing and earth works	Loss and disturbance of terrestrial habitat	Terrestrial Ecology	Construction	Moderate	Control and Remedy	Low
Vegetation clearing and earth works	Establishment of alien invasive species	Terrestrial Ecology	All Phases	Moderate	Control through active intervention and monitoring	Low
Vegetation clearing followed by vehicle use	Increased dust generation	Terrestrial Ecology	All Phases	Moderate	Control through active intervention and monitoring	Low
Vegetation clearing and earth works	Loss of species of conservation importance	Terrestrial Ecology	Construction	Moderate	Control and Remedy, rescue and relocation operation informed by seasonal survey	Low
Vegetation clearing and earth works	Loss and disturbance of wetland habitat	Wetland Ecology	Construction	Moderate	Control and Remedy	Moderate

Vegetation clearing and earth works Presence of permanent road crossings	Interruption of wetland hydrology	Wetland Ecology	Construction Operation Decommissioning	High	Control and Remedy	Low
Vegetation clearing and earth works Presence of permanent road crossings	Wetland erosion	Wetland Ecology	Construction Operation Decommissioning	Moderate	Control and Remedy	Low
Vegetation clearing and earth works Presence of permanent road crossings	Wetland water quality deterioration	Wetland Ecology	Construction Operation Decommissioning	Moderate	Control and Remedy	Low
Vegetation clearing and earth works	Loss of wetland biodiversity	Wetland Ecology	Construction	Moderate	Control and Remedy	Low
Vegetation clearing and earth works Presence of permanent road crossings	Establishment of alien invasive species	Wetland Ecology	Construction Operation Decommissioning	Moderate	Control through active intervention and monitoring	Low
Removal of vegetation/ Land clearing	Disturbance of soil, resulting in increased decomposition of soil organic matter from topsoil.	Soil degradation	Construction Phase	High	Control through management and monitoring	High
Spills of chemicals (e.g., hydrocarbon) .Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Contamination of soils by hydrocarbon pollutants	Soil contamination	Construction Phase	Moderate	Control through management and monitoring	Low

Preparation of road surface	Loss/ Change of land use	Land use	Construction Phase	High	Control through management and monitoring	High
Preparation of road surface	Loss of potentially arable land	Agricultural potential	Construction Phase	High	Control through management and monitoring	High
Spills of chemicals (e.g., hydrocarbon). Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Contamination of soils by hydrocarbon pollutants	Soil contamination	Operational Phase	Moderate	Control through management and monitoring	Low
Pollution of surface water	Pollution of receiving water resource during the construction of the road. Pollution of receiving water from vehicles used during construction.	Surface Water	Contraction/Operational	Moderate	Control through management and monitoring	Low
Sedimentation and siltation	Increased sediment transport into water resources	Surface Water	construction/Operational	Moderate	Control through management and monitoring	Low
Pollution of wetlands	Pollution of receiving wetlands during the construction of the road. Pollution of receiving wetlands from vehicles used during construction.	Surface Water	construction/Operational	Moderate	Control through management and monitoring	Low

Change in hydrological regime	Changes in the hydrological regime resulting from construction of access roads. Changes in the hydrological regime due to Flow reduction	Surface Water	construction/Operational	Moderate	Control through management and monitoring	Low
Closure and re-alignment of sections of district roads D684 and D1048	Minimal increase in travel distance, time and cost for road users	Traffic	Operational Phase	Moderate		Moderate
Closure and re-alignment of sections of district roads D684 and D1048	Drainage surface disturbance	Traffic	Operational Phase	Moderate		Moderate
Closure of existing road sections	Disruption, rerouting, signage	Traffic	Construction phase	Low	Control through management and availability of required information	Low
Construction of new road sections	Delays, safety hazards	Traffic	Construction phase	Low	Control through application of applicable engineering standards	Low
Construction of new road sections	Dust, noise, inconvenience	Traffic	Construction phase	Low	Control through adequate construction management	Low
Long-term operations of new road sections	Increase in travel distance, time and cost for road users	Traffic	Operational phase	Moderate	Control through management, monitoring and maintenance	Low
Construction of new road sections	Disturbance of graveyard	Heritage Resources	Construction phase	Low	Control through management	Low
Construction of new road sections	Possible short-term employment opportunities	Socio-economic	Construction	Moderate	Control through management	Low
Long-term operations of new road sections	Increased accessibility to the area	Socio-economic	Operational	Moderate	Control through management	Low

Long-term operations of new road sections	Minimal increase in travel distance, but reduced travel time and vehicle maintenance costs for road users	Socio-economic	Operational	Moderate	Control through management	Moderate
Long-term operations of new road sections	Upgrade to existing erosion control measures	Socio-economic	Operational	Positive impact		Positive Impact
Long-term operations of new road sections	Safety of local road users (The existing poorly maintained and un-surfaced roads impact on the safety of vehicle users, including pedestrians and private vehicles)	Socio-economic	Operational	Positive impact		Positive Impact
Long-term operations of new road sections	Upgrading of these routes will increase the design speed of the road, and vehicle travel speeds can be expected to increase. Increased vehicle speeds will impact negatively on current pedestrian road users on the road)	Socio-economic	Operational	Moderate	Control through management	Low

12.0 FINANCIAL PROVISION

The road closures and realignments will be of a permanent nature. As previously stated, all future maintenance and upkeep of the new road sections will be sole responsibility of the Mpumalanga Department of Public Works, Roads and Transport (DPWRT), thus no financial provision is included in the report.

13.0 OTHER INFORMATION REQUIRED BY COMPETENT AUTHORITY

13.1 Impact on socio-economic conditions of any directly affected persons

The most directly affected people will be the residents of the local community village and the landowners adjacent to the road infrastructure.

The impacts on the socio-economic conditions of the above receptors are described in detail in section 11.7 of this report.

13.2 Impact on any national estate

Graveyard GY07 is located approximately 100 m from the preferred Route Alternative F and therefore need not be impacted by the new road. The significance of any impact on the graveyard therefore is very low and will remain low if the mitigation measures outlined in this report are implemented.

GY07 need not be affected by the Mafube Project. However, to ensure that no accidental damage may befall GY07 during the construction of the road, it is recommended that the graveyard be demarcated with red cautionary tape and that the following signage be erected at the graveyard: '*Beware and avoid graveyard. Any damage caused may lead to prosecution'*. Demarcation measures to be done in accordance with community requirements.

There is no reason from a heritage point of view why the preferred Route Alternative F for the Mafube Life X Road Realignment Project cannot be implemented if the mitigation measures outlined in this report are followed.

14.0 OTHER MATTERS REQUIRED IN TERMS OF SECTIONS 24(4)(A) AND (B) OF THE NEMA

This section requires proof of compliance with section 24(4)(b)(i) of the National Environmental Management Act, which section reads as follows:

"24. Environmental authorisations

(4) Procedures for the investigation, assessment and communication of the potential consequences or impacts of activities on the environment –

> *(b) must include, with respect to every application for an environmental authorisation and where applicable-*
>
> *(i) investigation of the potential consequences or impacts of the alternatives to the activity on the environment and assessment of the significance of those potential consequences or impacts, including the option of not implementing the activity;"*

Please note: An application for environmental authorisation for listed activities associated with the proposed road realignment was submitted to the DMR on 16 March 2018 and this EIA process is currently being undertaken.

Much of the information in this EIA/EMPr Report was sourced from the previous EIA process (The proposed Mafube LifeX Nooitgedacht open cast mining activities). Where necessary, the information has been updated.

PART B
ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT

15.0 DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

15.1 Details of the Environmental Assessment Practitioner

The required details have been supplied in PART A, section 2.2 of this report.

15.2 Description of the Aspects of the Activity

See section 3.0 of this document.

15.3 Composite Map

See Figure 77 below, which shows the preferred infrastructure layout and the identified environmental features in the project area and its surrounding areas. The optimisation to this route as indicated in Figure 5 and should be read together with this map. The project area does not coincide with any protected or environmentally sensitive areas.

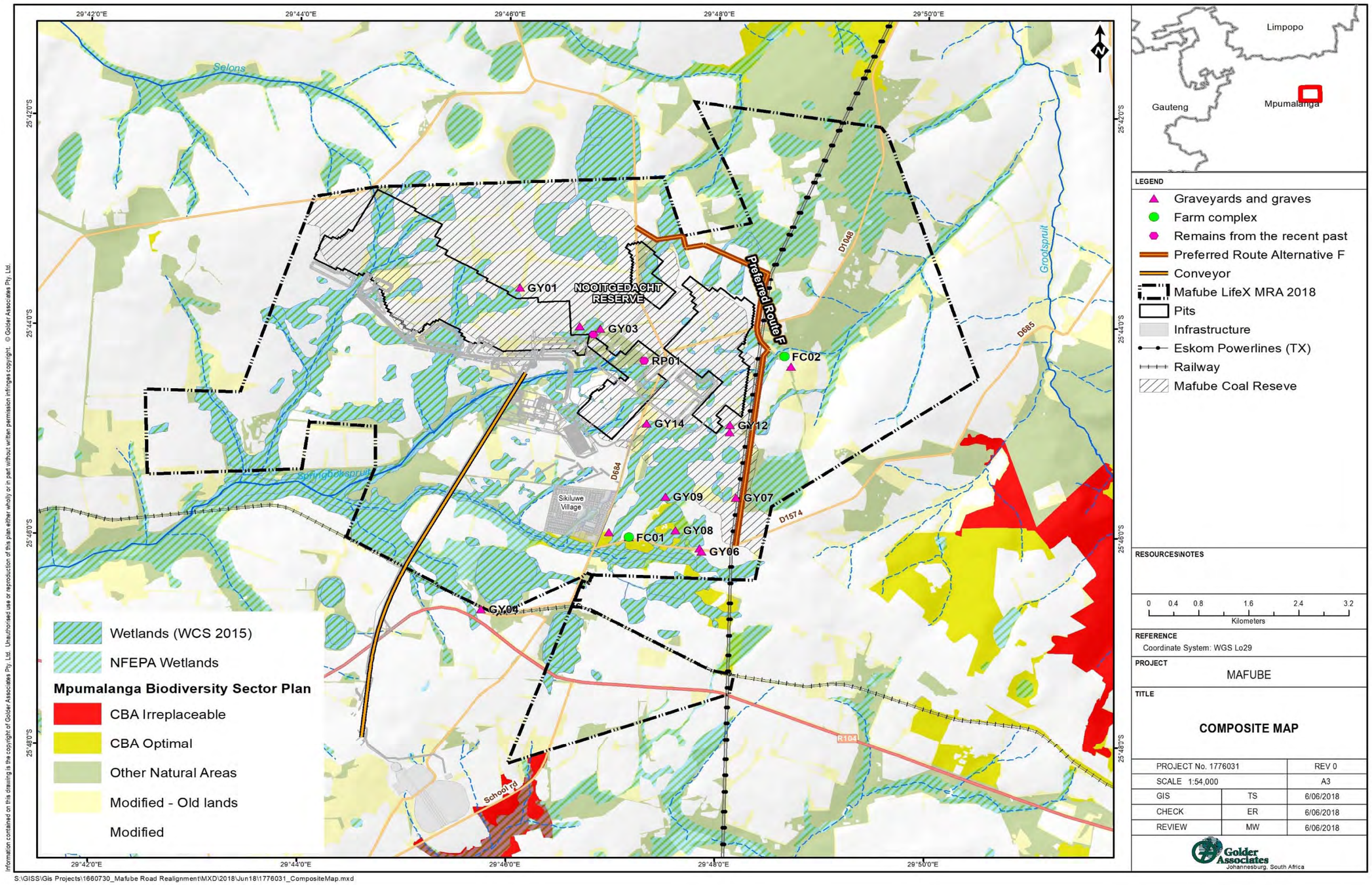

Figure 77: Composite Map

15.4 Description of Impact management objectives, including management statements

15.4.1 Environmental quality and managing environmental impacts

Mafube LifeX will endeavour to ensure that local environmental quality is not adversely affected by the proposed road realignment project, by:

- Limiting the road footprint area and thus reducing the area of vegetation to be cleared for road construction;
- Limiting dust generation during construction that could cause nuisance and/or health effects to surrounding landowners/communities;
- Requiring all contractor vehicles to be maintained in good working order so as to reduce the probability of leakages/spills;
- Cleaning up of any sources of possible soil contamination still present on the site after construction, to protect the downstream receiving environment; and
- Continue with the extended and approved Mafube LifeX environmental monitoring programme, for at least 5 years after closure of the Mafube LifeX Nooitgedacht operations.

15.4.2 Has a water use licence been applied for?

Section 21 of the NWA lists the water uses for which a water use licence (WUL) is required. The following waters uses in terms of section 21 of the NWA will be applied for:

c) *impeding or diverting the flow of water in a watercourse* – The new road sections will intersect some small drainage lines that exhibit ephemeral flow after heavy rainfall events; and

i) *altering the bed, banks, course or characteristics of a watercourse* – The new road sections will intersect several small drainage lines that exhibit ephemeral flow after heavy rainfall events as well as wetland areas.

It is important to note that the WULA process has been initiated and will by large run in parallel with the EIA process.

15.5 Potential impacts to be mitigated in their respective phases

The potential impacts and mitigation measures were described in section 11.0. Only those impacts that require mitigation measures are dealt with in this section. With regard to work outsourced to contractors, all contracts will contain clauses committing the contractors and their personnel to adhere to all relevant stipulations of this environmental management programme (EMPr). The contracts will also contain penalty clauses that will allow Mafube LifeX to impose fines, recover remediation costs from contractors and to terminate contracts for specified transgressions.

15.5.1 Air Quality

15.5.1.1 Construction

Avoid

- Contractors should take preventative measures to minimise complaints regarding dust nuisances (e.g. screening, dust control, timing, pre-notification of Interested and Affected Parties (I&APs)); and
- Avoidance of dust track-on onto paved routes used to transport construction materials.

Minimize

- Wet suppression during materials handling activities;
- Wet suppression on all construction access roads;
- Institute speed control measures to reduce vehicle entrainment of dust;

- Wind speed reduction through sheltering such as trees (where possible); and
- All construction vehicles and other equipment should be maintained and serviced regularly to ensure that exhaust particulate emissions are kept to a minimum.

Potential impacts and the respective mitigation measures are provided in Table 73 and Table 74.

Table 73: Recommendations for mitigation and monitoring during the construction phase

Potential Impact	Mitigation, management and control measure(s)
Degeneration of the ambient air quality due to increased dust and PM_{10} levels from land clearing, ground excavation and materials handling activities (tipping, loading and offloading).	■ Continue baseline dust fallout monitoring; ■ Contractors should take preventative measures to minimise complaints regarding dust nuisances (e.g. screening, dust control, timing, pre-notification of Interested and Affected Parties (I&APs)); ■ Wet suppression during materials handling activities; and ■ Wind speed reduction through sheltering (where possible).
Degeneration of the ambient air quality due to increased dust and PM_{10} levels from the entrainment of dust on unpaved roads.	■ Wet suppression on construction access roads; ■ Rigorous speed control; and ■ Avoidance of dust track-on onto paved routes used to transport construction materials.
Degeneration of the ambient air quality due to increased NO_2, SO_2, CO, and fine particulate levels from primary and secondary vehicle emissions.	■ All construction vehicles and other equipment should be maintained and serviced regularly to ensure that exhaust particulate emissions are kept to a minimum; and ■ Parking construction vehicles off travelled roadways.

Table 74: Recommendations for mitigation and monitoring during the operational phase

Potential Impact	Mitigation, management and control measure(s)
Fugitive dust and fine particulate emissions	■ Speed control; ■ Expand the dust fallout monitoring network by two sampling points, the proposed locations of which are shown in Figure 78. These points will serve to determine the roads impact at the closest receptor locations and wetland areas in the northern portion of the mine rights area; ■ Wind speed reduction through sheltering (where possible); and ■ Dust related complaints should be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management.

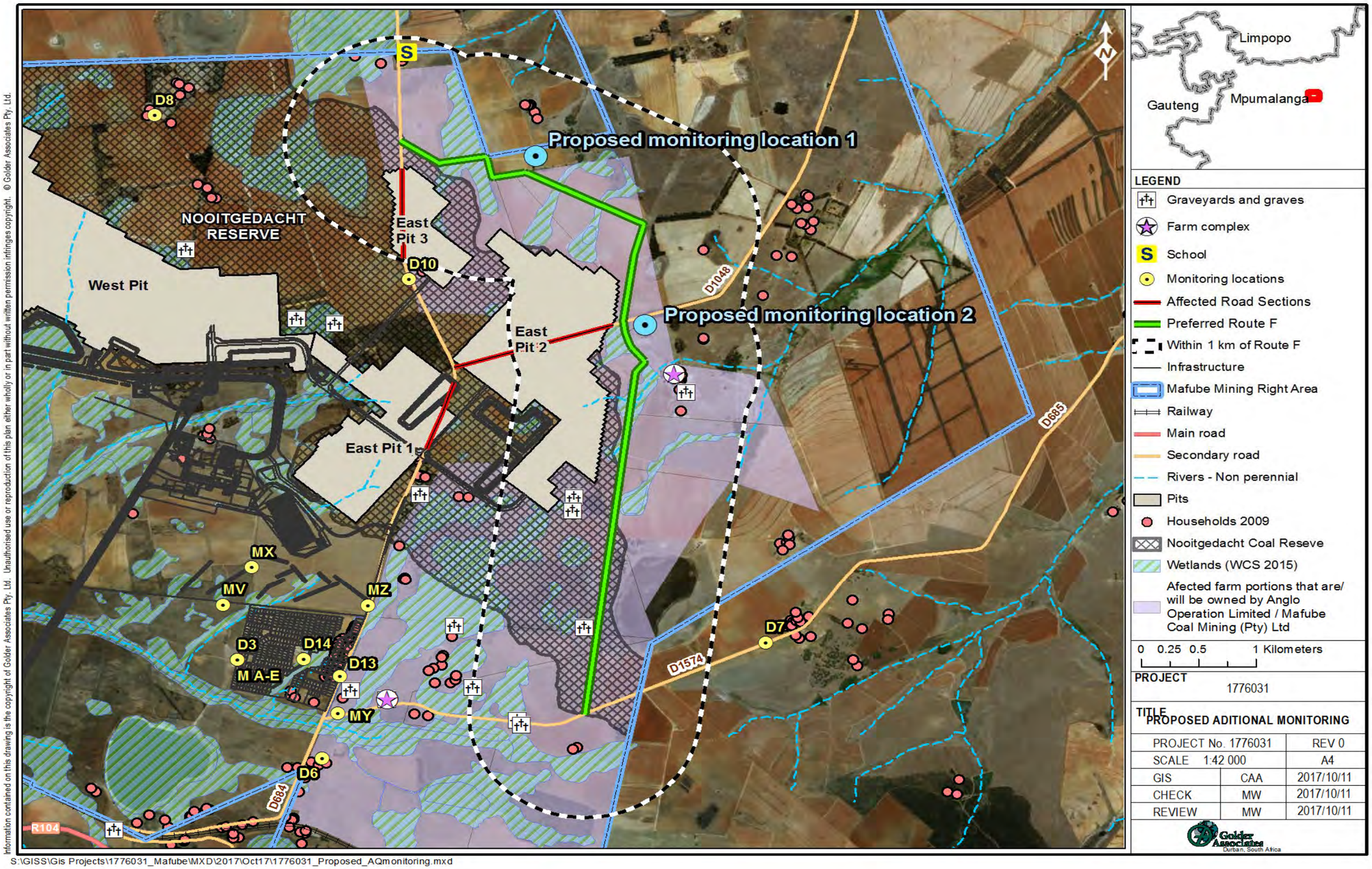

Figure 78: Proposed additional monitoring locations

15.5.1.2 Operation

15.5.1.3 Potential Cumulative Impacts Identified

The Mafube LifeX project will be a significant source of dust emissions in the local environment once operational. Even if the dust emissions resulting from Route F are within the residential area limits, the comparatively significant contribution of the LifeX project may result in exceedances of the NAAQS at receptor locations.

Furthermore, dust and fine particulate emissions associated with open fields during the harvesting season may also contribute to the cumulative ambient atmospheric dust load, potentially resulting in exceedances of the NAAQS at receptor locations.

15.5.2 Biodiversity (Terrestrial, Aquatic, and Wetland Ecology)

15.5.2.1 Construction phase, Operational and Decommissioning phases

15.5.2.1.1 Potential Impacts

- Loss and disturbance of terrestrial and wetland habitat;
- Interruption of wetland hydrology; Wetland erosion;
- Downstream wetland water quality deterioration;
- Establishment of alien invasive species;
- Increased dust generation; and
- Loss of species of conservation importance.

15.5.2.1.2 Proposed mitigation measures

- Vegetation clearing should be restricted to the immediate road construction footprint/corridor (8 m wide) only;
- This area should be clearly marked and no vegetation clearing or earth works should be permitted beyond this demarcated area;
- Minimise any loss of watercourses by limiting construction activities to as small an area as possible;
- All wetlands located within the study area, but not directly crossed by the road, should be carefully demarcated and no construction machinery or any other vehicles should be allowed access to these areas other than along existing roads;
- Construction activities should be undertaken in the dry season as far as practicable;
- Locate all stockpiles, laydown areas and temporary construction infrastructure at least 50 m from the edge of delineated wetlands;
- After construction, active revegetation using locally occurring indigenous plant species should be undertaken to stabilise any wetland crossings;
- An Environmental Control Officer (ECO) should manage the vegetation clearing process;
- Vegetation clearing should be restricted to the immediate road construction footprint/corridor;
- Wetland crossings should be constructed using engineered designs that ensure that the hydrological integrity of the affected wetlands is preserved upstream and downstream of the road crossings;
- No materials should be stockpiled within the wetland areas along the route and driving within the wetland areas should be kept to an absolute minimum. Clearly defined access routes should be used;
- Construction should be done in the dry season and completed before the wet season if possible, so that appropriate water management systems are in place for stormwater management;

- Wetland crossings should be constructed using engineered designs that limit flow concentration downstream and minimise the likelihood of erosion channels being generated within the wetlands by surface water discharge;
- Minimise vegetation clearing to the road footprint only;
- Construct low level water deflection berms;
- Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas and re-vegetation of disturbed areas as soon as possible;
- Implement a stormwater management plan;
- Re-establish indigenous vegetation to reduce run-off and increase infiltration;
- Re-vegetate bare soil areas after construction;
- Store and handle potentially polluting substances and waste in designated, bunded facilities;
- Waste should be regularly removed from the construction site by suitably equipped and qualified operators and disposed of in approved facilities;
- Keep sufficient quantities of spill clean-up materials on site;
- Maintenance of construction vehicles;
- Active control of NEMBA and CARA listed alien invasive plants should be undertaken along the length of the road, in line with the provisions of the Mafube AIS Control and Eradication Plan (see Golder Report No. 1776031-314542-1);
- Control actions should include initial treatment, follow-up treatments and regular monitoring;
- Re-vegetation of bare soil areas with suitable species as soon as practicable, following construction;
- A vehicle speed limit of 60 km/h should be enforced to limit dust entrainment;
- Dust suppression using water bowsers should be implemented at a regular frequency on a daily basis;
- A protected plant survey along the road corridor should be conducted during the wet/growing season (November to March) prior to vegetation clearing; and
- Based on the results of the survey, search and rescue of species of conservation concern should be conducted. Where necessary, relocation permits should be obtained from the Mpumalanga Parks and Tourism Agency (MPTA). Affected plants should be relocated to adjacent undisturbed grassland patches.

15.5.2.2 Potential Cumulative Impacts Identified

Historic agricultural activities, such as cultivation and the planting of woodlots and plantations, have resulted in large-scale habitat modification throughout the Mpumalanga Highveld. More recently, mining has become a significant transformation agent in the region. These activities have all severely affected the coverage and integrity of grassland and wetlands. Conserving grassland and wetland habitats is therefore a land management priority and is addressed at length in the Mafube Biodiversity Action Plan for the mining right area (Golder Associates Africa, 2016).

The aggregated loss and fragmentation of the small patches of grassland and wetland that occur along the road corridor, as well the loss of such habitats caused by the Mafube LifeX mining activities and other mining operations in the region, need to be considered as a cumulative impact of concern.

It is important to note that Mafube has committed to the actioning of a wetland management and mitigation strategy for the entire Mafube mining right area, as part of its commitments under the WUL for the project. The implementation of this strategy will offset the direct loss of some wetlands and indirect effects on other wetlands as a result of the proposed mining operations, resulting in no-net-loss of wetlands overall within the mining right area and larger catchment.

15.5.3 Soils, Land Use and Land Capability

15.5.3.1 Construction phase

15.5.3.1.1 Potential Impacts

- Contamination of soils due to pollution; and
- Soil erosion.

15.5.3.1.2 Proposed mitigation measures

Soil contamination

- To reduce the impact of soil contamination due to leakage or spillage of oil and diesel, ensure that all laydown areas are monitored for spillages and that vehicles and equipment are serviced and well maintained. Emergency spill kits should be provided at the project site. Workers should be trained to be able to respond in case of spills; and
- Ensure that workers or persons accessing the site during these phases are informed on the waste disposal protocol for the site.

Soil erosion

- Contractors (heavy machinery) need to be restricted to designated areas as defined by the Mine Environmental Department;
- The procedures on land clearance and soils handling need to be followed;
- Implement, monitor and control soil erosion minimisation procedures along the route;
- Implement measures to protect soil stockpiles from erosion. Minimise stockpile height to <1.5 m. (if soil is stockpiled on construction site);
- Investigate the use of binding agents for dirt roads as an alternative to wet dust suppression;
- When clearing the site, keep the footprint of site clearance as small as possible and rehabilitate badly eroded areas as soon as they are noticed;
- Stockpile soil in areas where it is not likely to be washed away during a rainfall event;
- The river crossings must be rehabilitated as soon as the construction is complete, to avoid unnecessary erosion and sedimentation;
- Keep on-site spillage of pollutants such as oils to an absolute minimum and clean spillages as they happen to prevent environmental damage; and
- Have an appropriate spillage and environmental protocol and procedures to deal with on-site spillage and environmental damage.

15.5.3.2 Operation

- None anticipated.

15.5.3.3 Operational phase

15.5.3.3.1 Potential Impacts

- Erosion of the road surface due to high rainfall events.

15.5.3.3.2 Proposed mitigation measures

- Flooding from excessive run-off will be mitigated by adequately sized stormwater culverts designed to convey the 50 year flood peak away from the road to avoid flooding;
- The road itself needs to be designed with adequate stormwater drainage along the sides to convey the 50 year flood peak away from the road to avoid flooding; and
- Road runoff will be channelled towards open veld and not towards wetlands.

15.6 Potential Cumulative Impacts Identified

Surface Water

The construction phase, if inadequately mitigated, will have some impact, specifically sedimentation, on the water quality of the local water resources and ultimately the Springbokspruit/Klein Olifants River system and the Steelpoort River system.

Additional project impact (if no mitigation measures are implemented) will increase the significance of the existing baseline impacts. The cumulative unmitigated impact will probably be of a low to moderate negative significance, affecting the study/local area extent. The impact is very likely and will be short term to permanent (where water resources such as streams and pans may be removed).

15.7 Data Gaps and Assessment Shortcomings

Soils, Land Use and Land Capability

- Lack of detailed civil engineering procedures/standards for construction of District Roads.

Air Quality

- This assessment is purely qualitative. In order to increase the confidence level of this assessment, Golder recommends Mafube undertake simple dispersion modelling to gain an understanding of the spatial extent of the impact of the Route F dust emissions.

15.8 Summary of potential impacts to be mitigated in their respective phases

Table 75: Measures to rehabilitate the environment affected by the undertaking of any listed activity

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Air Quality						
Land clearing, ground excavation and materials handling	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Continue baseline dust fallout monitoring for a minimum of 3 months prior to construction; - Contractors should take preventative measures to minimise complaints regarding dust nuisances (e.g. screening, dust control, timing, pre-notification of Interested and Affected Parties (I&APs)); - Drop height reduction during materials handling activities; - Wet suppression during materials handling activities; - Load wet suppression of materials transported by road (i.e. load spraying) or load covering with tarpaulins to reduce fugitive dust generation; and - Wind speed reduction through sheltering (where possible).	Control through management and monitoring	Measures to be implemented during construction phase	NAAQS
Land clearing, ground excavation and materials handling	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Wet suppression on construction access roads; - Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust; - Avoidance of dust track-on onto paved roads; and - Wind speed reduction through sheltering (where possible).	Control through management and monitoring	Measures to be implemented during construction phase	NAAQS
Land clearing, ground excavation and materials handling	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- All construction vehicles and other equipment should be maintained and serviced regularly to ensure that exhaust particulate emissions are kept to a minimum; - Parking construction vehicles off travelled roadways; and - Encouraging the receipt of materials during non-peak traffic hours to avoid traffic build-up.	Control through management and monitoring	Measures to be implemented during construction phase	NAAQS

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Use of the constructed road realignment section	Operation	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Reduction in unnecessary traffic volumes by developing plans to optimise vehicle usage and movement; - Pave and/or tar the section of the road passing the village; - Wet suppression with water and a suitable dust palliative to achieve the 95 % control efficiency (water alone will only achieve a 75 % control efficiency); - Rigorous speed control and the institution of traffic calming measures to reduce vehicle entrainment of dust; - Expand the dust fallout monitoring network by two sampling points, the proposed locations of which are shown in Figure 78. These points will serve to determine the roads impact at the closest receptor locations and wetland areas in the northern portion of the mine rights area; - Wind speed reduction through sheltering (where possible); and - Dust related complaints should be directed to the site management. Complaints and any actions arising from a complaint will be recorded in a complaints register to be maintained by site management.	Control through management and monitoring	Measures to be implemented when required	NAAQS
Noise						
Land clearing, ground excavation and materials handling	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Do not undertake construction at night - Notify neighbours prior to commencing activities that will generate significant noise; - A complaints reporting procedure should be established and all complaints logged; - Reroute truck traffic away from residential areas where possible; - Shut down or throttle down equipment whenever they are not in actual use; - Combine noisy operations to occur in the same time period; - Site noise generating equipment such as generators and air compressors on the construction lot as far away from noise sensitive receptors as possible; - Select quieter equipment where possible;	Control through management and noise control	Measures must be implemented when required	Measures should aim to reduce noise emissions to ensure the noise intrusion is less than 3 dB(A) at the nearest receptor location

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
			- Use newer equipment where possible; - Ensure equipment is well maintained; - Construct temporary walled enclosures around especially noisy activities or clusters of noisy equipment; and - Ensure personnel are trained to carry out their respective tasks.			
Use of the constructed road realignment section	Operation	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Use screening (such as trees) where receptors experience annoyance. - Enforce vehicle speed control. - Ensure the road is well maintained.	Control through management and noise control	Measures must be implemented during the operation phase	Measures should aim to reduce noise emissions to ensure the noise intrusion is less than 3 dB(A) at the nearest receptor location
Terrestrial Ecology						
Vegetation clearing and earth works	Construction	1 ha of dry grassland habitat will be lost and 1.9 ha will be disturbed	- Vegetation clearing should be restricted to the immediate road construction footprint/corridor (8 m wide) only; - This area should be clearly marked and no vegetation clearing or earth works should be permitted beyond this demarcated area; - After construction, active revegetation using locally occurring indigenous plant species should be undertaken to stabilise any wetland crossings; and - An Environmental Control Officer (ECO) should manage the vegetation clearing process.	Control and Remedy	Construction phase	
Vegetation clearing and earth works	All Phases	Patches of natural habitat (grassland and wetland) adjacent to the proposed road corridor	- Active control of NEMBA and CARA listed alien invasive plants should be undertaken along the length of the road, in line with the provisions of the Mafube AIS Control and Eradication Plan (see Golder Report No. 1776031-314542-1); and - Control actions should include initial	Control through active intervention and monitoring	Initiate during construction phase and continue through to decommissioning and closure	

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
			treatment, follow-up treatments and regular monitoring.			
Vegetation clearing followed by vehicle use	All Phases	Flora and fauna communities adjacent to the proposed road corridor	- A vehicle speed limit of 60 km/h should be enforced to limit dust entrainment; and - Dust suppression using water bowsers should be implemented at a regular frequency on a daily basis.	Control through active intervention and monitoring	Initiate during construction phase and continue through to decommissioning and closure	GN R. 827 (NEM:AQA)
Vegetation clearing and earth works	Construction	Individual Red List/protected plants growing in the proposed road corridor	- A protected plant survey along the road corridor should be conducted during the wet/growing season (November to March) prior to vegetation clearing; and - Based on the results of the survey, rescue and relocation permits should be obtained from the Mpumalanga Parks and Tourism Agency (MPTA) and affected plants should be relocated to adjacent undisturbed grassland patches.	Control and Remedy, rescue and relocation operation informed by seasonal survey	Prior to construction (specifically before vegetation clearing)	
Wetland Ecology						
Vegetation clearing and earth works	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Vegetation clearing should be restricted to the immediate road construction footprint/corridor (8 m wide) only; - This area should be clearly marked and no vegetation clearing or earth works should be permitted beyond this demarcated area; - Minimise impacts on watercourses by limiting construction activities to as small an area as possible; - All wetlands located within the study area, but not directly crossed by the road should be carefully demarcated and no construction machinery or any other vehicles should be allowed access to these areas other than along existing roads; - Construction activities should be done in the dry season only; - Stockpiles, laydown areas and temporary construction infrastructure must be at least 50 m from the edge of delineated wetlands;	Control and Remedy	Construction phase	

Activity whether listed or not listed	Phase in which impact is anticipated *(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)*	SIZE AND SCALE OF DISTURBANCE *(volumes, tonnages and hectares or m²)*	Detailed Mitigation Measures	Mitigation Type Modify, remedy, control or stop *(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)*	Time period for implementation *(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)*	Compliance with Standards *(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
			- After construction, active revegetation using locally occurring indigenous plant species should be undertaken to stabilise any wetland crossings; and - An Environmental Control Officer (ECO) should manage the vegetation clearing process.			
Vegetation clearing and earth works Presence of permanent road crossings	Construction Operation Decommissioning	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Vegetation clearing should be restricted to the immediate road construction footprint/corridor; - Wetland crossings should be constructed using engineered designs that ensure that the hydrological integrity of the affected wetlands is preserved upstream and downstream of the road crossings; - No materials should be stockpiled within the wetland areas along the route and driving within the wetland areas should be kept to an absolute minimum. Clearly defined access routes should be used; and - Construction should be done in the dry season and completed by the wet season, so that appropriate water management systems are in place for stormwater management.	Control and Remedy	Construction phase Operation phase	

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Vegetation clearing and earth works Presence of permanent road crossings	Construction Operation Decommissioning	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Wetland crossings should be constructed using engineered designs that limit flow concentration downstream and minimise the likelihood of erosion channels being generated within the wetlands by surface water discharge; - Minimise vegetation clearing to the road footprint only; - Construct low level water deflection berms; - Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas, placement of hay bales around the within wetland construction areas, and re-vegetation of disturbed areas as soon as possible; - Implement a stormwater management plan; - Re-vegetate of indigenous vegetation to reduce run-off and increase infiltration; and - Re-vegetate bare soil areas after construction.	Control and Remedy	Construction phase	
Vegetation clearing and earth works Presence of permanent road crossings	Construction Operation Decommissioning	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Store and handle potentially polluting substances and waste in designated, bonded facilities. - Waste should be regularly removed from the construction site by suitably equipped and qualified operators and disposed of in approved facilities. - Keep sufficient quantities of spill clean-up materials on site. - Maintenance of construction vehicles. - Implement a stormwater management plan for rainwater runoff from the road surface	Control and Remedy	Construction phase Operation phase	

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Vegetation clearing and earth works	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Wetland crossings should be constructed using engineered designs that limit flow concentration downstream and minimise the likelihood of erosion channels being generated within the wetlands by surface water discharge; - Minimise vegetation clearing to the road footprint only; - Construct low level water deflection berms; - Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas, placement of hay bales around the within wetland construction areas, and re-vegetation of disturbed areas as soon as possible; - Implement a stormwater management plan; - Re-vegetate of indigenous vegetation to reduce run-off and increase infiltration; and - Re-vegetate bare soil areas after construction.	Control and Remedy	Construction phase	
Vegetation clearing and earth works Presence of permanent road crossings	Construction Operation Decommissioning	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Active control of NEMBA and CARA listed alien invasive plants should be undertaken along the length of the road, in line with the provisions of the Mafube AIS Control and Eradication Plan (see Golder Report No. 1776031-314542-1); and - Control actions should include initial treatment, follow-up treatments and regular monitoring.	Control through active intervention and monitoring	Initiate during construction phase and continue through to decommissioning and closure	
Soils, land use and land capability						
Removal of vegetation/ Land clearing	Construction Phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	Impact remains high			

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Spills of chemicals (e.g., hydrocarbons) .Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Construction Phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- All vehicles and machinery shall be kept in good working order and inspected on a regular basis for possible leaks and shall be repaired as soon as possible if required; - Repairs shall be carried out in a dedicated repair area only, unless in-situ repair is necessary as a result of a breakdown; - Drip trays shall at all times be placed under vehicles that require in-situ repairs; - Drip trays shall be emptied into designated containers only and the contents disposed of at a licenced hazardous material disposal facility; - Accidental spills (concrete, chemicals, process water, hydrocarbons, waste) need to be reported immediately so that effective remediation and clean-up strategies and procedures can be implemented; and - Soil that is contaminated by fuel or oil spills, for example, from vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ, using sand, soil or cold coal-ash as absorption medium.	- Identify areas where the soil was impacted. - Control through management or remediation options.-Prevent by restricting spillage from construction vehicles; - Control by implementation of storm water management measures; - Remedy by treatment of contaminated soils.	During project	GN R. 704 (NWA)
Preparation of road surface	Construction Phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	Impact remains high			

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Spills of chemicals (e.g., hydrocarbon) .Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Operational Phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Accidental spills (concrete, chemicals, process water, hydrocarbons, waste) need to be reported immediately so that effective remediation and clean-up strategies and procedures can be implemented; and - Soil that is contaminated by fuel or oil spills, for example, from vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ, using sand, soil or cold coal-ash as absorption medium.	- Identify areas where the soil was impacted. - Control through management or remediation options.-Prevent by restricting spillage from construction vehicles; - Control by implementation of storm water management measures; - Remedy by treatment of contaminated soils.	During project	Rehabilitation standards/objectives
Surface water						
Pollution of surface water	Construction/Operational	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Maintenance of the stormwater management system and compliance to GN704 to keep clean and dirty water separated; - Implement water quality monitoring programme; - Store and handle potentially polluting substances and waste in designated bunded facilities; and -Spoils heaps and overburden should be placed in areas where infiltration will be minimised.	Control through management and monitoring		GN704
Sedimentation and siltation	Construction/Operational	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Maintenance of the stormwater management system; - Rehabilitation of sloped areas to minimise erosion; and - Dust suppression during construction.	Control through management and monitoring		
Pollution of wetlands	Construction/Operational	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Store and handle potentially polluting substances and waste in designated bunded facilities -Spills cleaned up immediately; - Stormwater management will be incorporated to limit contaminated water entering water resources; and -Implement water quality monitoring.	Control through management and monitoring		

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Change in hydrological regime	Construction/Operational	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Vegetation clearing only where necessary; - Stabilisation/rehabilitation of exposed areas as soon as possible; and - Stormwater management will be incorporated to limit sediment transport.	Control through management and monitoring		
Traffic Impact Study						
Closure and re-alignment of sections of district roads D684 and D1048	Operational Phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.				
Closure and re-alignment of sections of district roads D684 and D1048	Operational Phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Drainage structures, such as culverts, shall be installed at all watercourse crossings and maintained on a regular basis to prevent sediment and debris build-up.		During operational phase	
Closure of existing road sections	Construction phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Minimal disruptions will be achieved by ensuring adequate signage to inform road users of closed roads and new route.	Control through management and availability of required information	During construction phase	
Construction of new road sections	Construction phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Road users will be informed of road closure and re-alignment prior to any construction work being done; - Construction vehicles and equipment shall be clearly visible at all times; - Active construction equipment and vehicles shall be operated by competent persons only and not be left unattended.	Control through application of applicable engineering standards	During construction phase	Safety standards/objectives
Construction of new road sections	Construction phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Dust and noise levels will be kept to a minimum by applying engineering standards.	Control through adequate construction management	During construction phase	Construction standards

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Long-term operations of new road sections	Operational phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Roads will be inspected and maintained on a periodic basis to ensure no additional delays and road user costs due to poor and unsafe road surface; and - Road problems reported to authorities will be solved as soon as reasonably possible.	Control through management, monitoring and maintenance	During operational phase	Mpumalanga provincial roads standards
Heritage Resources						
Construction of new road sections	Construction phase	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- GY07 need not be affected by the Mafube Project. However, to ensure that no accidental damage may befall GY07 during the construction of the road, it is recommended that the graveyard be demarcated with red cautionary tape and that the following signage be erected at the graveyard: *'Beware and avoid graveyard. Any damage caused may lead to prosecution'*. Demarcation measures to be done in accordance with community requirements	Control through management		
Socio-economic						
Construction of new road sections	Construction	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Local unskilled or semi-skilled labour (including women) should be used where during the construction of the road - Mechanisms and structures to ensure the appropriate development and transfer of skills to the local community should be established; and - Where possible labour intensive construction methods should be employed.	Control through management		
Long-term operations of new road sections	Operational	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Pavement areas and bridge structures must be regularly maintained - Areas where the road passes through social or cultural gathering places should be clearly marked with road signage and sufficient road crossings should be introduced where appropriate; and - Areas where the road passes through important social or cultural gathering points should be clearly marked with road signage, and sufficient road crossings and traffic calming measures should be introduced where appropriate.	Control through management		

Activity whether listed or not listed	**Phase in which impact is anticipated** ***(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)***	**SIZE AND SCALE OF DISTURBANCE** ***(volumes, tonnages and hectares or m²)***	**Detailed Mitigation Measures**	**Mitigation Type** **Modify, remedy, control or stop** ***(e.g. Modify through alternative method; Control through noise control; Control through management and monitoring; Remedy through rehabilitation)***	**Time period for implementation** ***(time period when the measures in the environmental management programme must be implemented Measures must be implemented when required)***	**Compliance with Standards** ***(A description of how each of the recommendations made, will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)***
Long-term operations of new road sections	Operational	Entire length of the proposed road (including servitude) covers an area of Approx. 75 ha. Listed Activity will cover sections within the 75 ha.	- Pavement areas and bridge structures must be regularly maintained; - Ensure that erosion is minimal during the wet season to improve road safety; - Areas where the road passes through social or cultural gathering places should be clearly marked with road signage and sufficient road crossings should be introduced where appropriate; - Erosion control measures should be implemented where required and rehabilitation measures introduced; - Effective storm water management systems and structures should be put in place and existing structures to be retained must be rehabilitated; and - The road must be maintained regularly.	Control through management		

15.9 Impact Management Outcomes

A description of impact management outcomes, identifying the standard of impact management required for the aspects contemplated in paragraph.

Table 76: Description of impact management outcomes

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Land clearing, ground excavation and materials handling	Dust fallout and particulate emissions resulting from land clearing, ground excavation and materials handling	Air Quality	Construction	Control through management and monitoring	< 600 mg/m2/day at the closest receptor
Land clearing, ground excavation and materials handling	Trace gas emissions resulting from construction vehicle exhaust	Air Quality	Construction	Control through management and monitoring	< 600 mg/m2/day at the closest receptor
Use of the constructed road realignment section	Dust fallout and particulate emissions resulting from vehicle entrainment of dust, affecting ambient air quality along Route F	Air Quality	Operation	Control through management and monitoring	< 600 mg/m2/day at the closest receptor
Use of the constructed road realignment section	Redirection of D684 emissions (Dust fallout and particulate emissions resulting from vehicle entrainment of dust) affecting ambient air quality at Sikhululiwe	Air Quality	Operation		

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Land clearing, ground excavation and materials handling	Degeneration of the prevailing noise environment at a receptor due to construction noise	Noise	Construction	Control through management and noise control	Impacts minimised at receptor locations
Use of the constructed road realignment section	Degeneration of the prevailing noise environment at a receptor (>100 m from the roadway) due to traffic noise	Noise	Operation	Control through management and noise control	Impacts minimised at receptor locations
Vegetation clearing and earth works	Loss and disturbance of terrestrial habitat	Terrestrial Ecology	Construction	Control and Remedy	No vegetation cleared beyond the immediate road footprint.
Vegetation clearing and earth works	Establishment of alien invasive species	Terrestrial Ecology	All Phases	Control through active intervention and monitoring	Limited establishment of listed AIS along road verges, and no establishment in adjacent grassland/wetland habitat

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Vegetation clearing followed by vehicle use	Increased dust generation	Terrestrial Ecology	All Phases	Control through active intervention and monitoring	Acceptable dust levels, as per the air quality management recommendations
Vegetation clearing and earth works	Loss of species of conservation importance	Terrestrial Ecology	Construction	Control and Remedy, rescue and relocation operation informed by seasonal survey	Successful relocation of all potentially impacted plants of conservation importance.
Vegetation clearing and earth works	Loss and disturbance of wetland habitat	Wetland Ecology	Construction	Control and Remedy	No disturbance or loss of wetlands beyond the temporary construction corridor

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Vegetation clearing and earth works Presence of permanent road crossings	Interruption of wetland hydrology	Wetland Ecology	Construction Operation Decommissioning	Control and Remedy	No erosion or desiccation of wetlands downstream of road crossings. No flow impoundment upstream of road crossings
Vegetation clearing and earth works Presence of permanent road crossings	Wetland erosion	Wetland Ecology	Construction Operation Decommissioning	Control and Remedy	No disturbance or loss of wetlands beyond the temporary construction
Vegetation clearing and earth works Presence of permanent road crossings	Wetland water quality deterioration	Wetland Ecology	Construction Operation Decommissioning	Control and Remedy	No contamination of wetlands during construction or operation

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Vegetation clearing and earth works	Loss of wetland biodiversity	Wetland Ecology	Construction	Control and Remedy	No disturbance or loss of wetlands beyond the temporary construction corridor
Vegetation clearing and earth works Presence of permanent road crossings	Establishment of alien invasive species	Wetland Ecology	Construction Operation Decommissioning	Control through active intervention and monitoring	Limited establishment of listed AIS along road verges, and no establishment in adjacent grassland/wetland habitat
Removal of vegetation/ Land clearing	Disturbance of soil, resulting in increased decomposition of soil organic matter from topsoil.	Soil degradation	Construction Phase		

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Spills of chemicals (e.g., hydrocarbon). Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Contamination of soils by hydrocarbon pollutants	Soil contamination	Construction Phase	- Identify areas where the soil was impacted. - Control through management or remediation options. -Prevent by restricting spillage from construction vehicles; - Control by implementation of storm water management measures; - Remedy by treatment of contaminated soils.	Contaminant levels below SSV1
Preparation of road surface	Loss/ Change of land use	Land use	Construction Phase		
Preparation of road surface	Loss of potentially arable land	Agricultural potential	Construction Phase		

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Spills of chemicals (e.g., hydrocarbon). Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Contamination of soils by hydrocarbon pollutants	Soil contamination	Operational Phase	- Identify areas where the soil was impacted. - Control through management or remediation options. -Prevent by restricting spillage from construction vehicles; - Control by implementation of storm water management measures; - Remedy by treatment of contaminated soils.	Contaminant levels below SSV1
Pollution of surface water	Pollution of receiving water resource during the construction of the road. Pollution of receiving water from vehicles used during construction.	Surface Water	Contraction/Operational	Control through management and monitoring	
Sedimentation and siltation	Increased sediment transport into water resources	Surface Water	construction/Operational	Control through management and monitoring	

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Pollution of wetlands	Pollution of receiving wetlands during the construction of the road. Pollution of receiving wetlands from vehicles used during construction.	Surface Water	construction/Operational	Control through management and monitoring	
Change in hydrological regime	Changes in the hydrological regime resulting from construction of access roads. Changes in the hydrological regime due to flow reduction.	Surface Water	construction/Operational	Control through management and monitoring	
Closure and re-alignment of sections of district roads D684 and D1048	Minimal increase in travel distance, time and cost for road users	Traffic	Operational Phase		
Closure and re-alignment of sections of district roads D684 and D1048	Drainage surface disturbance	Traffic	Operational Phase		
Closure of existing road sections	Disruption, rerouting, signage	Traffic	Construction phase	Control through management and availability of required information	Minimal additional delay to road users

ACTIVITY ***Whether listed or not listed.*** *(E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage (surface) disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**ASPECTS AFFECTED**	**PHASE** ***In which impact is anticipated*** *(e.g. Construction, commissioning, operational Decommissioning, closure, post- closure)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through (e.g. noise control measures, storm- water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**STANDARD TO BE ACHIEVED** *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives) etc.*
Construction of new road sections	Delays, safety hazards	Traffic	Construction phase	Control through application of applicable engineering standards	Accident avoidance
Construction of new road sections	Dust, noise, inconvenience	Traffic	Construction phase	Control through adequate construction management	Minimal dust and noise levels
Long-term operations of new road sections	Increase in travel distance, time and cost for road users	Traffic	Operational phase	Control through management, monitoring and maintenance	Avoidance of road degradation and failure
Construction of new road sections	Disturbance of graveyard	Heritage Resources	Construction phase	Control through management	
Construction of new road sections	Possible short-term employment opportunities	Socio-economic	Construction	Control through management	
Long-term operations of new road sections	Increased accessibility to the area	Socio-economic	Operational	Control through management	
Long-term operations of new road sections	Minimal increase in travel distance, but reduced travel time and vehicle maintenance costs for road users	Socio-economic	Operational	Control through management	
Long-term operations of new road sections	Upgrade to existing erosion control measures	Socio-economic	Operational		

15.10 Impact Management Actions

A description of impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated in paragraphs (c) and (d) will be achieved.

Table 77: Impact management actions

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Air Quality				
Land clearing, ground excavation and materials handling	Dust fallout and particulate emissions resulting from land clearing, ground excavation and materials handling	Control through management and monitoring	Measures to be implemented during construction phase	NAAQS
Land clearing, ground excavation and materials handling	Dust fallout and particulate emissions resulting from construction vehicle movement	Control through management and monitoring	Measures to be implemented during construction phase	NAAQS
Land clearing, ground excavation and materials handling	Trace gas emissions resulting from construction vehicle exhaust	Control through management and monitoring	Measures to be implemented during construction phase	NAAQS
Use of the constructed road realignment section	Dust fallout and particulate emissions resulting from vehicle entrainment of dust, affecting ambient air quality along Route F	Control through management and monitoring	Measures to be implemented when required	NAAQS

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Use of the constructed road realignment section	Redirection of D684 emissions (Dust fallout and particulate emissions resulting from vehicle entrainment of dust) affecting ambient air quality at Sikhululiwe			
Noise				
Land clearing, ground excavation and materials handling	Degeneration of the prevailing noise environment at a receptor due to construction noise	Control through management and noise control	Measures must be implemented when required	Measures should aim to reduce noise emissions to ensure the noise intrusion is less than 3 dB(A) at the nearest receptor location
Use of the constructed road realignment section	Degeneration of the prevailing noise environment at a receptor (>100 m from the roadway) due to traffic noise	Control through management and noise control	Measures must be implemented during the operation phase	Measures should aim to reduce noise emissions to ensure the noise intrusion is less than 3 dB(A) at the nearest receptor location
Terrestrial Ecology				

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Vegetation clearing and earth works	Loss and disturbance of terrestrial habitat	Control and Remedy	Construction phase	
Vegetation clearing and earth works	Establishment of alien invasive species	Control through active intervention and monitoring	Initiate during construction phase and continue through to decommissioning and closure	
Vegetation clearing followed by vehicle use	Increased dust generation	Control through active intervention and monitoring	Initiate during construction phase and continue through to decommissioning and closure	
Vegetation clearing and earth works	Loss of species of conservation importance	Control and Remedy, rescue and relocation operation informed by seasonal survey	Prior to construction (specifically before vegetation clearing)	
Wetland Ecology				
Vegetation clearing and earth works	Loss and disturbance of wetland habitat	Control and Remedy	Construction phase	
Vegetation clearing and earth works Presence of permanent road crossings	Interruption of wetland hydrology	Control and Remedy	Construction phase Operation phase	

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Vegetation clearing and earth works Presence of permanent road crossings	Wetland erosion	Control and Remedy	Construction phase	
Vegetation clearing and earth works Presence of permanent road crossings	Wetland water quality deterioration	Control and Remedy	Construction phase Operation phase	
Vegetation clearing and earth works	Loss of wetland biodiversity	Control and Remedy	Construction phase	
Vegetation clearing and earth works Presence of permanent road crossings	Establishment of alien invasive species	Control through active intervention and monitoring	Initiate during construction phase and continue through to decommissioning and closure	
Soils, land use and land capability				
Removal of vegetation/ Land clearing	Disturbance of soil, resulting in increased decomposition of soil organic matter from topsoil.			

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Spills of chemicals (e.g., hydrocarbon). Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Contamination of soils by hydrocarbon pollutants	- Identify areas where the soil was impacted. - Control through management or remediation options. -Prevent by restricting spillage from construction vehicles; - Control by implementation of storm water management measures; - Remedy by treatment of contaminated soils.	During project	Rehabilitation standards/objectives
Preparation of road surface	Loss/ Change of land use			
Preparation of road surface	Loss of potentially arable land			

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Spills of chemicals (e.g., hydrocarbon). Soil contamination on adjacent land potentially occurring due to inappropriate waste disposal and potential oil and diesel leakages from vehicles and machinery	Contamination of soils by hydrocarbon pollutants	- Identify areas where the soil was impacted. - Control through management or remediation options. -Prevent by restricting spillage from construction vehicles; - Control by implementation of storm water management measures; - Remedy by treatment of contaminated soils.	During project	Rehabilitation standards/objectives
Surface water				
Pollution of surface water	Pollution of receiving water resource during the construction of the road. Pollution of receiving water from vehicles used during construction.	Control through management and monitoring		

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Sedimentation and siltation	Increased sediment transport into water resources	Control through management and monitoring		
Pollution of wetlands	Pollution of receiving wetlands during the construction of the road. Pollution of receiving wetlands from vehicles used during construction.	Control through management and monitoring		
Change in hydrological regime	Changes in the hydrological regime resulting from construction of access roads. Changes in the hydrological regime due to flow reduction	Control through management and monitoring		
Traffic Impact Study				
Closure and re-alignment of sections of district roads D684 and D1048	Minimal increase in travel distance, time and cost for road users			

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Closure and re-alignment of sections of district roads D684 and D1048	Drainage surface disturbance		During operational phase	
Closure of existing road sections	Disruption, rerouting, signage	Control through management and availability of required information	During construction phase	
Construction of new road sections	Delays, safety hazards	Control through application of applicable engineering standards	During construction phase	Safety standards/objectives
Construction of new road sections	Dust, noise, inconvenience	Control through adequate construction management	During construction phase	Construction standards
Long-term operations of new road sections	Increase in travel distance, time and cost for road users	Control through management, monitoring and maintenance	During operational phase	Mpumalanga provincial roads standards
Heritage Resources				
Construction of new road sections	Disturbance of graveyard	Control through management		

ACTIVITY *whether listed or not listed. (E.g. Excavations, blasting, stockpiles, discard dumps or dams, loading, hauling and transport, Water supply dams and boreholes, accommodation, offices, ablution, stores, workshops, processing plant, storm water control, berms, roads, pipelines, power lines, conveyors, etc.).*	**POTENTIAL IMPACT** *(e.g. dust, noise, drainage surface disturbance, fly rock, surface water contamination, groundwater contamination, air pollution etc.)*	**MITIGATION TYPE** *(modify, remedy, control, or stop) through* *(e.g. noise control measures, storm-water control, dust control, rehabilitation, design measures, blasting controls, avoidance, relocation, alternative activity etc.) E.g. Modify through alternative method. Control through noise control through management and monitoring Remedy through rehabilitation.*	**TIME PERIOD FOR IMPLEMENTATION** *Describe the time period when the measures in the environmental management programme must be implemented Measures must be implemented when required. With regard to Rehabilitation specifically this must take place at the earliest opportunity. With regard to Rehabilitation, therefore state either upon cessation of the individual activity or upon the cessation of mining, bulk sampling or alluvial diamond prospecting as the case may be.*	**COMPLIANCE WITH STANDARDS** *(A description of how each of the recommendations in 2.11.6 read with 2.12 and 2.15.2 herein will comply with any prescribed environmental management standards or practices that have been identified by Competent Authorities)*
Socio-economic				
Construction of new road sections	Possible short-term employment opportunities	Control through management		
Long-term operations of new road sections	Increased accessibility to the area	Control through management		
Long-term operations of new road sections	Minimal increase in travel distance, but reduced travel time and vehicle maintenance costs for road users	Control through management		
Long-term operations of new road sections	Safety of local road users	Control through management		

16.0 MECHANISMS FOR MONITORING COMPLIANCE WITH AND PERFORMANCE ASSESSMENT AGAINST THE ENVIRONMENTAL MANAGEMENT PROGRAMME AND REPORTING THEREON

The mechanisms for compliance monitoring with and performance assessment against the environmental management programme and reporting thereof, include:

- Monitoring of impact Management Actions;
- Monitoring and reporting frequency;
- Responsible persons;
- Time period for implementing impact management actions; and
- Mechanisms for monitoring compliance;

The impact of the development of the proposed route alternative Route F activities the various environmental aspects can be monitored by the following methods (Table 78).

Table 78: Mechanisms for monitoring compliance

Source Activity	**Impacts Requiring Monitoring Programmes**	**Functional Requirements for Monitoring**	**Roles and Responsibilities** *(For the execution of the monitoring programmes)*	**Monitoring and Reporting Frequency and Time Periods for Implementing Impact Management Actions**
Surface preparation for construction of road.	**Soil Contamination** - Sampling of soils for analysis	All areas where oil and diesel spillages may have occurred Minimum - three samples per affected area.	Soil Analysis of Hydrocarbons, Trace and semi-metals if spillages are reported.	Environmental team to monitor – and appoint appropriate consultant for soil sampling when required.
Road usage	**Soil contamination** - Visual inspection of open land along Route for signs of illegal waste disposal and signs of hydrocarbon spillages.	Entire length of Route	None required if no visible signs of illegal waste disposal is noted. *If* illegal dumping of waste is reported, conduct appropriate Waste Assessment and Classification to guide waste disposal.	Environmental team to monitor – and appoint appropriate waste consultant when required.
Surface preparation for construction of road.	**Soil Contamination** - Sampling of soils for analysis	All areas where oil and diesel spillages may have occurred Minimum - three samples per affected area.	Soil Analysis of Hydrocarbons, Trace and semi-metals if spillages are reported.	Environmental team to monitor – and appoint appropriate consultant for soil sampling when required.
Construction of Route F (including land clearing, materials transfer, grading etc.)	Dust and fine particulate emissions	Dust buckets erected at proposed locations 1 and 2 (Figure 78)	Mafube Environmental/ SHE officer	Buckets should be exposed for a period of approximately 30 days. Monthly reports should be generated to monitor compliance.

Source Activity	Impacts Requiring Monitoring Programmes	Functional Requirements for Monitoring	Roles and Responsibilities *(For the execution of the monitoring programmes)*	Monitoring and Reporting Frequency and Time Periods for Implementing Impact Management Actions
Operation (use) of Route F	Dust and fine particulate emissions	Dust buckets erected at proposed locations 1 and 2 (Figure 78)	Mafube Environmental/ SHE officer	Buckets should be exposed for a period of approximately 30 days. Monthly reports should be generated to monitor compliance.
Vegetation clearing and earth works during construction.	Dust generation	Measure dust fallout adjacent to the proposed road to inform dust suppression frequency.	Mafube Environmental Team	As per recommendations in air quality monitoring programme
Vegetation clearing and earth works during construction.	Establishment of alien invasive plant species	Measure the success of the alien species control actions and monitor further encroachment.	Mafube Environmental Team	As per recommendations in AIS control and eradication plan
Vegetation clearance during construction Presence of the road in the landscape during operation.	Loss and disturbance of wetland habitat Interruption of wetland hydrology Soil erosion	Conduct wetland site audit during construction to ensure that recommended wetland crossing designs are in place Annual monitoring of PES and EIS at wetland crossings to be conducted following construction	Wetland specialist	Audit during construction Annual monitoring post-construction for at least 3 years
Construction of Route F (including land clearing, materials transfer, grading etc.)	Noise	A complaints log should be maintained and noise compliance monitoring should be undertaken at receptor locations, should receptors raise concerns regarding construction noise	Mafube Environmental/ SHE officer	Monitoring should be performed on an *ad hoc* basis as required
Operation (use) of Route F	Noise	A complaints log should be maintained and noise compliance monitoring should be undertaken at receptor locations, should receptors raise concerns regarding Route F noise contributions	Mafube Environmental/ SHE officer	Monitoring should be performed on an *ad hoc* basis as required

17.0 IMPLEMENTATION OF THE EMPR

A number of activities must take place before commencement of construction. Certain of these activities are not directly related to physical work on site, but are presented below, as they should be addressed before commencement of, or during the early phases of construction.

17.1 Responsibility for EMPr implementation

- Responsibility for implementation of the EMPr will rest with the Mine Manager at Mafube LifeX Nooitgedacht operations. The Mine Manager will appoint a Safety, Health, Environmental and Quality (SHEQ) Manager, who will be based on site. The SHEQ Manager will ensure that all environmental activities delegated to contractors operating on the road realignment construction site are implemented. Similarly the SHEQ Manager will ensure that all conditions of the EMPr are implemented. It will furthermore be the responsibility of the SHEQ Manager to resolve any conflicts that may arise between Mafube LifeX and contracting parties regarding implementation of the EMPr. (Such responsibilities are captured by the legal appointment of the SHEQ Manager);
- Mafube LifeX will ensure that the responsibility for implementing and adhering to the conditions of the EMPr forms part of the conditions of appointment of all contractors;
- Mafube LifeX will ensure that all contracting companies tendering for work receive a copy of this EMPr and understand their responsibility to operate within the framework of the measures defined in this EMPr. When adjudicating tenders, Mafube LifeX will ensure that contractors have made appropriate allowance for management of environmental matters;
- Mafube LifeX will ensure that, upon appointment, all contracting companies operating on the site receive a copy of this EMPr and understand their responsibility to operate within the framework of the measures defined in this EMPr;
- Mafube LifeX will ensure that contractor SHE induction includes environmental and social issues and awareness training (“Environmental Awareness Plan”, see section 18.0 of this report) to build capacity of Mafube LifeX personnel and contract staff regarding management of the environment;
- The SHE Manager will brief contractors about no development/no go areas. These will include:
  - No access to neighbouring properties without prior approval; and
  - No access to fenced-off sensitive areas.
- Mafube LifeX to appoint a responsible person to audit the implementation of, and adherence to, this EMPr. This party will be an independent environmental practitioner; and
- The SHEQ Manager will bring to the attention of the Mine Manager any major environmental incident or breach of the conditions of the EMPr, within 24 hours of occurrence of such event. If the environmental incident constitutes a breach of any permit or licence condition, the Mine Manager will notify the controlling authority within 48 hours of such an incident.

17.2 Responsibility of contractors

- Each contracting company will receive a copy of the EMPr at time of tender. Each contractor must familiarise himself with the required environmental management measures and ensure that contracting prices allow for environmental costs;
- Appointed contractors must keep their copies of the EMPr on site. It is the responsibility of the contractors to ensure that all their staff are aware of the measures applicable to their area of work; and
- It is the responsibility of the contractors to bring to the attention of the Mafube LifeX SHE Manager any environmental incident or breach of the conditions of the EMPr, within 24 hours of occurrence of such event through the company’s Incident Reporting System.

18.0 ENVIRONMENTAL AWARENESS PLAN

As stipulated above, environmental conditions will be included in all operational contracts, thereby making contractors aware of the potential environmental risks associated with the project and the necessity of implementing good environmental and housekeeping practices. The following principles and training will apply to the Environmental Awareness Plan training and the Environmental Management System (EMS) training:

- All personnel, including contactors will, at a minimum, undergo general safety, health, environmental and quality (SHEQ) induction and environmental management system (EMS) training;
- The Safety, Health, Environmental and Quality (SHEQ) Manager will identify the SHEQ training requirements for the personnel and contractors. The training requirements will be recorded in a training needs matrix indicating particular training that must be undertaken by identified personnel and contractors. The training matrix will be administered by Mafube LifeX's Human Resources Department (HRD); and
- Development of the Training Programme, which will include:
  - Job-specific training – training for personnel performing tasks which could cause potentially significant environmental impacts;
  - Assessment of extent to which personnel are equipped to manage environmental impacts;
  - Basic environmental training;
  - EMS training;
  - Comprehensive training – on emergency response, spill management, etc.;
  - Specialised skills;
  - Training verification and record keeping; and
  - Periodic re-assessment of training needs, with specific reference to new developments, newly identified issues and impacts and associated mitigation measures.

18.1 General Awareness Training

- The HRD Manager, together with the SHEQ Manager, will be responsible for the development of, or facilitating the development of, the required general SHEQ induction and awareness training. A general environmental awareness training module will be developed and integrated into the general induction programme. The general awareness training must include the Environmental Policy, a description of the environmental impacts and aspects and the importance of conformance to requirements, general responsibilities of Mafube LifeX personnel and contractors with regard to the environmental requirements and a review of the emergency procedures and corrective actions; and
- A Training Practitioner or the Environmental Control Officer (ECO) or nominated representative will conduct the general awareness training. The training presenter will keep a record of the details of all persons attending general awareness training. Such attendance registers shall indicate the names of attendants and their organisations, the date and the type of training received.

18.2 Specific Environmental Training

- Specific environmental training will be in line with the requirements identified in the training matrix; and
- Personnel whose work tasks can impact on the environment will be made aware of the requirements of appropriate procedures/work instructions. The SHE Manager will communicate training requirements to responsible supervisors to ensure that personnel and contractors are trained accordingly.

18.3 Training Evaluation and Re-training

- Effectiveness of the environmental training will be reflected by the degree of conformance to EMPr requirements, the results of internal audits and the general environmental performance achieved;
- Incidents and non-conformances will be assessed through an internal incident investigation and reporting system, to determine the root cause, including the possible lack of awareness/training;
- Should it be evident that re-training is required, the SHEQ Manager will inform the Heads of Departments of the need and take the appropriate actions;
- General awareness training of all personnel shall be repeated annually; and
- The re-induction shall take into consideration changes made in the EMPr, changes in legislation, the current level of environmental performance and areas of improvement.

18.4 Emergency Procedures

The following emergency procedures are relevant to the project:

- The SHE Manager shall define emergency reporting procedures for the project;
- All personnel shall be made aware of emergency reporting procedures and their responsibilities;
- Any spills will be cleaned up immediately in accordance with relevant legislation; and
- Telephone numbers of emergency services, including the local firefighting service, shall be conspicuously displayed.

19.0 UNDERTAKING

The EAP herewith confirms

a) the correctness of the information provided in the reports [X]

   i) the inclusion of comments and inputs from stakeholders and I&APs; [X]

   ii) the inclusion of inputs and recommendations from the specialist reports where relevant; and [X]

   iii) the acceptability of the project in relation to the finding of the assessment and level of mitigation proposed; [X]

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