AMENDED DRAFT ENVIRONMENTAL IMPACT ASSESSMENT FOR THE DESIGN AND CONSTRUCTION OF ERLING ROAD BETWEEN K46 AND K56, AND THE K56 BETWEEN K46 AND MAIN ROAD

JUNE 2015

GAUT: 002/11-12/E0255

BOKAMOSO
LANDSCAPE ARCHITECTS &
ENVIRONMENTAL CONSULTANTS CC
P.O. BOX 11375
MAROELANA
0161
TEL: (012) 346 3810
Fax: 086 570 5659
Email: Lizelleg@mweb.co.za

TABLE OF CONTENTS

FIGURES

TABLES

ANNEXURES

Annexure M: Public Participation

Annexure M(i): Proof of Advertisement in Fourways Review

Annexure M(ii): Site Notice

Annexure M(ii): Notice / flyers distributed to I & AP's

Annexure M(iv): Focus Group Meeting

Annexure M(v): Invitation to Public Meeting

Annexure M(vi): Minutes of Public Meeting

Annexure M(vii): I&AP's List

Annexure M(viii): Correspondence form and to I&AP's

Annexure M(ix): Objections received from Envirokey Management Services cc

Annexure M(x): Copy of the document on the Movement of Horses and Horse Riders through Glenferness

Annexure M(xi): *correspondence from Dr. Böhme*

Annexure M(xii): Comments and Issues Register

Annexure N: Comments received form COJ

Annexure O: GDARD Scoping Approval

Annexure P: Social Impact Assessment

Annexure Q: Typical section through road that cuts across watercourse/wetland areas

Annexure R: Typical pedestrian/ equestrian linkage underneath the K56

Annexure S: Alignment Alternatives that were considered

LIST OF ABBREVIATIONS

BDA: Broadacres Drive Association

CBD: Central Business District

C-Plan: Conservation Plan

DEA: Department of Environmental Affairs

EAP: Environmental Assessment Practitioner

EIA: Environmental Impact Assessment

IEMA: Institute of Environmental Management and Assessment

EIAR: Environmental Impacts Assessment Report

DWA: Department of Water Affairs

EMP: Environmental Management Plan

GAPA: Gauteng Agricultural Potential Atlas

GDARD: Gauteng Department of Agriculture, Conservation and Environment

GDRT: Gauteng Department of Roads and Transport

GECKO: Greater Kyalami Conservancy

GKRC: Greater Kyalami Residents Council

GSDF: Gauteng Spatial Development Framework

GDS: Growth and Development Strategy

GTIA: Gauteng Transport Infrastructure Act

I&AP: Interested and affected party

IDP: Integrated Development Plan

JMOSS: Johannesburg Metropolitan Open Space System

MOU: Memorandum of Understanding

NSBA: National Spatial Biodiversity Assessment

NEMA: National Environmental Management Act

PoS: Plan of Study

RSDF: Regional Spatial Development Framework

SACLAP: The South African Council of the Landscape Architects Profession

SAHRA: South African Heritage Resources Agency

SR: Scoping Report

SDF: Spatial Development framework

TIA: Traffic Impact Assessment

UNCED: United Nations Conference on Environment and Development

GLOSSARY OF TERMS

Agricultural Hub: An area identified for agricultural use by GDARD according to the Draft Policy on the Protection of Agricultural Land (2006).

Alien species: A plant or animal species introduced from elsewhere: neither endemic nor indigenous.

Applicant: Any person who applies for an authorisation to undertake an activity or to cause such activity to be undertaken as contemplated in the National Environmental Management Act (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

Biodiversity: The variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are apart.

Conservation of Agricultural Resources Act (Act No. 43 of 1983): This Act provides for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

C-Plan: The GDARD C-Plan focuses on the mapping and management of biodiversity priority areas within Gauteng. The GIDS includes protected areas, irreplaceable and important sites due to the presence of Red Data species, endemic species and potential habitat for these species to occur. GIDS, 2007.

Ecology: The study of the inter relationships between organisms and their environments.

Environment: All physical, chemical and biological factors and conditions that influence an object and/or organism. Also defined as the surroundings within which humans exist and are made up of the land, water, atmosphere, plant and animal life (micro and macro), interrelationship between the factors and the physical or chemical conditions that influence human health and well-being.

Environmental Impact Assessment: Assessment of the effects of a development on the environment.

Environmental Management Plan: A legally binding working document, which stipulates environmental and socio-economic mitigation measures which must be implemented by several responsible parties throughout the duration of the proposed project.

GDARD Draft Ridges Policy, 2001: According to the GDARD Draft Ridges Policy no development should take place on slopes steeper than 8.8%.

GDARD Draft Red Data Species Policy, 2001: A draft policy to assist with the evaluation of development applications that affected Red Data plant species.

GDARD Requirements for Biodiversity Assessments Version 2 (June 2012): GDARD requirements for biodiversity assessments.

National Environmental Management Act (NEMA), 1998 (Act No 107 of 1998): NEMA provides for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith.

National Environmental Management: Air Quality Act (Act No. 39 of 2004): The purpose of the Act is "To reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development; to provide for national norms and standards regulating air quality monitoring, management and control by all spheres of government; for specific air quality measures; and for matters incident thereto".

National Environmental Management: Biodiversity Act, 2004 (Act No 10 of 2004): The purpose of the Biodiversity Act is to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA and the protection of species and ecosystems that warrant national protection. As part of its implementation strategy, the National Spatial Biodiversity Assessment was developed.

National Environmental Management: Protected Areas Act, 2003 (Act No 57 of 2003): The purpose of this Act is to provide the protection, conservation and management of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes.

National Heritage Resource Act, 1999 (Act No 25 of 1999): The National Heritage Resources Act legislates the necessity for cultural and heritage impact assessment in areas earmarked for development, which exceed 0.5 ha. The Act makes provision for the potential destruction to existing sites, pending the archaeologist's recommendations through permitting procedures. Permits are administered by the South African Heritage Resources Agency (SAHRA).

National Veld and Forest Fire Act, 1998 (Act No. 101, 1998): The purpose of this Act is to prevent and combat veld, forest and mountain fires throughout the Republic.

Furthermore the Act provides for a variety of institutions, methods and practices for achieving the prevention of fires.

National Road Traffic Act, 1996 (Act No. 93 of 1996): This Act provides for all road traffic matters which shall apply uniformly throughout the Republic and for matters connected therewith.

National Water Act, 1998 (Act No 36 of 1998): The purpose of this Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled.

Open Space: Areas free of building that provide ecological, socio-economic and place-making functions at all scales of the metropolitan area.

Study Area: Refers to the entire study area compassing the total area of the land parcels as indicated on the study area map.

Sustainable Development: Development that has integrated social, economic and environmental factors into planning, implementation and decision making, so as to ensure that it serves present and future generations.

Water Services Act, 1997 (Act No 108 of 1997): The purpose of this Act is to ensure the regulation of national standards and measures to conserve water.

1. INTRODUCTION, BACKGROUND AND WAY FORWARD

1.1 Introduction

The application is made for authorization of the **Design and Construction of Erling Road between Road K46 and Road K56 and Road K56 between Road K46 and Main Road, including all required access roads.** Road K56 is a planned east-west provincial road intended to provide vital east-west connectivity in the area and to distribute traffic to the future PWV9 and K46 (William Nicol Drive).

The Gauteng major road network is critically evaluated and adapted on a continuous basis, along with the latest land use and other developments. The route determination for the K56 between Road P126-1 and K111 was done by the PWV Consortium in 1976 ***(Report 393, attached as Annexure B)*** and the Basic Planning Report was done by Brian Colquhoun, Hugh O' Donnell and Partners in 1978 ***(Report 1018, attached as Annexure C).*** The K56 had been adopted as part of the Gauteng Strategic Road Network.[1] The purpose of this investigation is to evaluate this possible alignment of the involved section of the K56 for design and construction purposes.

The proposed road under consideration only represents a section of the larger K56 route. It stretches from William Nicol Drive (K46) in the west (km 21.0) to Main Road in the east (km 26.5) and is approximately **5,5km** in extent. The application also includes a section of **Erling Road** from William Nicol intersection up to intersection with K56. The involved section of the K56 and Erling Road falls within the area of jurisdiction of the City of Johannesburg Municipal area ***(refer to Figure 1: Locality Map and Figure 2: Aerial Map).***

Note: Enlarged copies of the figures inserted in between the text below are included in Annexure A of this report.

[1] *SEF Environmental Consultants supplied the Environmental Inputs for the Strategic Road review project. SEF assisted GDARD with the compilation of the C-Plan, which indicates the Gauteng ecological and agricultural sensitive areas/ irreplaceable sites. GDARD officials however indicated that they are aware of the Strategic Road Review Project, but the alignments of the provincial roads must however still undergo (where required) EIA applications.*

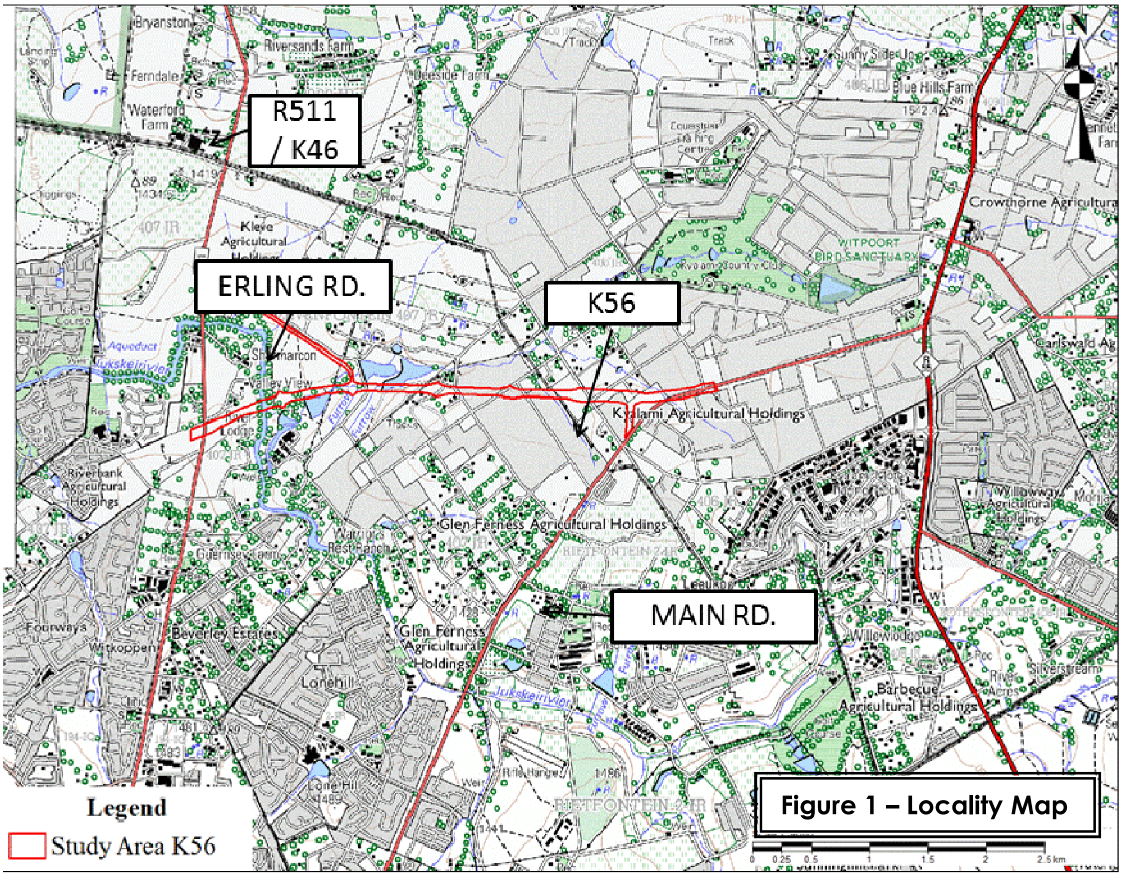


Figure 1 – Locality Map

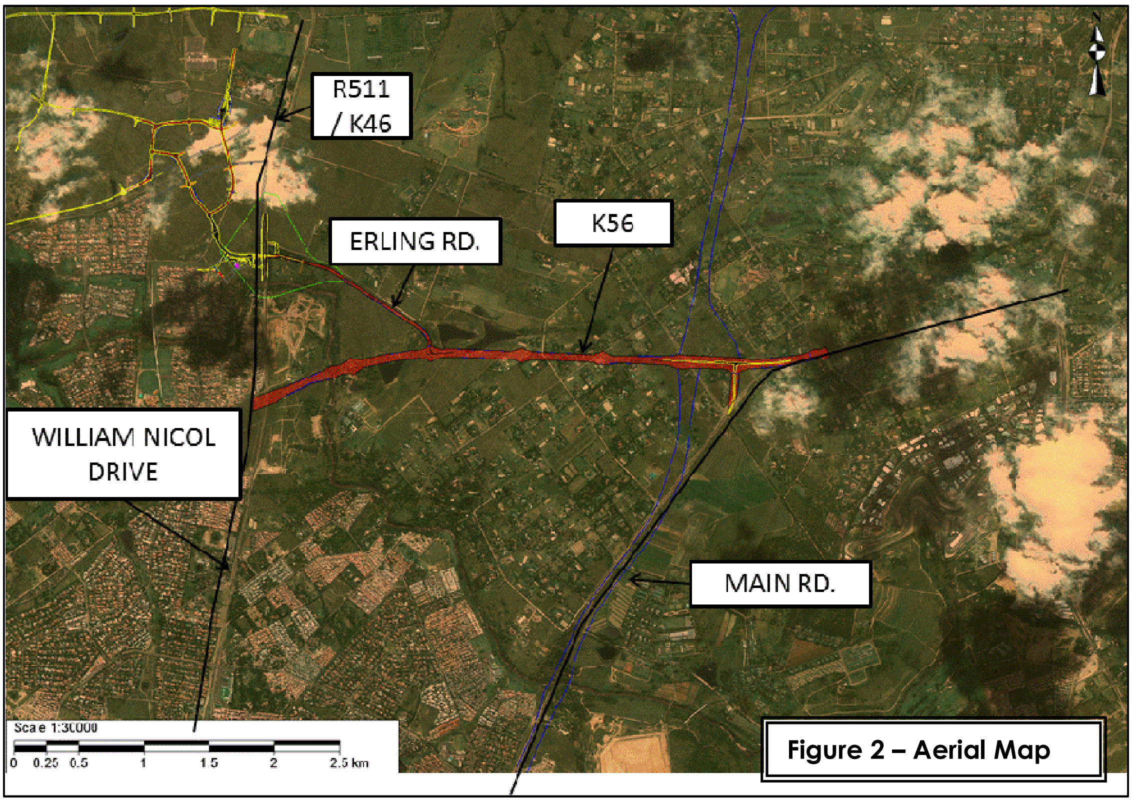


Figure 2 – Aerial Map

Note: Enlarged copies of the figures inserted in between the text below are included in Annexure A of this report.

The application is made in terms of Government Notices No. R544, No. R545 and No. R546 published in the Government Gazette no. 33306 of 02 August 2010 of the National Environment Management Act, 1998 (Act No. 107 of 1998) and the intention of the application is to fix this section of the alignment of the K56 for future land-use planning and road construction purposes.

According to the above mentioned Regulations and Notices, an Environmental Impact Assessment Process is required for the above-mentioned project, due to the following listed activity/ activities:

Table 1: Listed activities in terms of Notice No. R 544

Listing No. 1, R544, 18 June 2010	Activity 11	The construction of: (i) Canals; (ii) Channels; (iii) Bridges; (iv) Dams; (v) Weirs; (vi) Bulk storm water outlet structures; (vii) Marinas; (viii) Jetties exceeding 50 square metres in size; (ix) Slipways exceeding 50 square metres in size; (x) Building exceeding 50 square metres or more Where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line. ***Reason for inclusion:*** *The proposed road has four river crossings which would entail construction within a watercourse.*
Listing No. 1, R. 544, 18 June 2010	Activity 18	The Infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from (i) a watercourse; (ii) the sea; (iii) the seashore; (iv) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater-

		but excluding where such infilling, depositing, dredging, excavation, removal or moving (i) is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or (ii) occurs behind the development setback line ***Reason for inclusion:*** *To make provision for construction associated with river and wetland crossings.*
Listing No. 1, R.544, 18 June 2010	Activity 24	The transformation of land bigger than 1 000 square meters in size, to residential, retail, commercial, industrial or institutional use, where, at the time of the coming into effect of this schedule such land was zoned open space, conservation or had an equivalent zoning. ***Reason for inclusion:*** *To make provision for the transformation of land zoned as open space due to the construction of the road.*
Listing No. 1, R.544, 18 June 2010	Activity 39	The expansion of – (i) canals; (ii) channels; (iii) bridges; (iv) weirs; (v) bulk storm water outlet structures; (vi) marinas, within a watercourse or within 32 meters of a watercourse, measured from the edge of a watercourse, where such expansion will result in an increased development footprint but excluding where such expansion will occur behind the development setback line. ***Reason for inclusion:*** *To make provision for the expansion of existing bridges, bulk stormwater outlets etc. if required.*
Listing No. 1, R.544, 18 June 2010	Activity 47	The widening of a road by more than 6 meters, or the lengthening of a road by more than 1 kilometer – (i) where the existing reserve is wider than 13,5 meters; or (ii) where no reserve exists, where the existing road is wider than 8 meters, excluding widening or lengthening occurring inside urban areas. ***Reason for inclusion:*** *To make provision for the widening and lengthening of Main Road*

Table 2: Listed activities in terms of Notice No. R 545

Listing No. 2, R. 545, 18 June 2010	Activity 18	The route determination of roads and design of associated physical infrastructure, including roads that have not yet been built for which routes have been determined before 03 July 2006 and which have not been authorized by a competent authority in terms of the Environmental Impact Assessment Regulations, 2006 or 2009, made under section 24(5) of the Act and published in Government Notice No. 385 of 2006, - (i) It is a national road as defined in Section 40 of the South African National Roads Agency Limited and National Roads Act, 1998 (Act No. 7 of 1998); (ii) It is a road administered by a provincial authority; (iii) The road reserve is wider than 30 metres, or The road will cater for more than one lane of traffic in both directions. ***Reason for inclusion:*** *The proposed K56 is a provincial road.*

Table 3: Listed activities in terms of Notice No. R 546

Listing No. 3 R. 546, 18 June 2010	Activity 4	The construction of a road wider than 4 metres with a reserve less than 13.5 metres.	(b) In Gauteng: i. A protected area identified in terms of NEMPAA, excluding conservancies; ii. National Protected Area Expansion Strategy Focus area; iii. Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; iv. Sites identified in terms of the Ramsar Convention; iv. Sites identified as irreplaceable or important in the Gauteng Conservation plan; v. Areas larger than 2 hectares zoned for use as public open space; vi. Areas zoned for a conservation purpose. vii. Any declared protected area including Municipal or Provincial Nature Reserves as contemplated by the Environmental Conservation Act, 1989 (Act No. 73 of 1989) and the Nature Conservation Ordinance (Ordinance 12 of 1983); Any site identified as land with high agricultural potential located within the Agricultural Hubs or important

			Agricultural Sites identified in terms of the Gauteng Agricultural Potential Atlas, 2006. ***Reason for inclusion:*** *The proposed route traverses Irreplaceable Sites*
Listing No. 3, R. 546, 18 June 2010	Activity 13	The clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous	**d)In Gauteng** i. A protected area identified in terms a of NEMPAA, excluding conservancies; ii. National Protected Area Expansion Strategy Focus areas; iii. Any declared protected area including Municipal or Provincial Nature Reserves as contemplated by the Environment Conservation Act, 1989 (Act No. 73 of 1989), the Nature Conservation Ordinance (Ordinance 12 of 1983); (v) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; iv. Sites or areas identified in terms of an international convection; vi. Sites identified as irreplaceable or important in the Gauteng Conservation Plan. ***Reason for inclusion:*** *The proposed route traverses Irreplaceable Sites*
Listing No. 3, R. 546, 18 June 2010	Activity 19	The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre.	**(b) In Gauteng** i. A protected area identified in terms of NEMPAA, excluding conservancies; ii. National Protected Area Expansion Strategy Focus areas; iii. Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; iv. Sites or areas identified in terms of an International Convention; v. Any site identified as land with high agricultural potential located within the Agricultural Hubs or important Agricultural Potential Atlas, 2006; vi. All sites identified as irreplaceable or important in terms of the applicable Gauteng Conservation

			Plan; vii. Any declared protected area including Municipal or Provincial Nature Reserves as contemplated by the Environment Conservation Act, 1989 (Act No. 73 of 1989), the Nature Conservation Ordinance (Ordinance 12 of 1983) and the NEMPAA. ***Reason for inclusion:*** *The proposed route traverses Irreplaceable Sites*

Since the proposed development includes listed activities from No. R544, No. R545 and No. R546, an application for a full EIA process was lodged at the Gauteng Department of Agriculture and Rural Development (GDARD). The reference number ***Gaut: 002/11-12/E0255*** had been assigned to the application.

1.1 Background

The Environmental Impact Management Guideline document published by the Department of Environmental Affairs and Tourism, in April 1998, identified the activity of the planning and construction of a provincial road numbered and administered by a provincial authority as a potentially detrimental activity that needs to be investigated. In Regulation 1182, Schedule 1 (c) and (d) of the former EIA Regulations and in Part 4 of the National Environmental Management Act (Act 107 of 1998), the construction and upgrading of transportation routes were identified as specific listed activities, which required that the EIA process be followed. However, the fact that road planning consist of various planning phases (network planning phase, route determination phase, preliminary design phase and the detail design phase) made it difficult for authorities, applicants and environmental consultants to determine the specific EIA process (scoping/ EIA) required for each planning phase.

As a consequence, Gautrans (now the Gauteng Department of Roads and Transport (GDRT) and the Department of Agriculture, Conservation Environment and Land Affairs (GDARD) agreed (in a Memorandum of Understanding (MOU)) that an Environmental Scan be conducted for the Route Determination Stage, that a Scoping Report be conducted for the Preliminary Design Stage and that an EIA Report be compiled for the Detail Design Stage of each provincial road. Although the Scoping and EIA reports were a requirement of the former EIA Regulations, the environmental scan report required for the route determination phase of a road was not a requirement of the EIA process.

The environmental scan was however added to the road planning process to assist with the determination and identification of the most significant environmental issues and "fatal flaws" before entering into the costly preliminary and detailed design stages of roads. The MOU also required that a Road History Report, which supplies the history and background of the road applied for, be included as part of the specific road report submitted to the authorities for evaluation. The purpose of the road history report was to supply the planning history of a specific road to GDARD, because the network planning for the Gauteng Roads already commenced more than 30 years ago and all the roads on the network plan are at different planning stages and different levels of engineering[2] and environmental[3] reports have been compiled for the various roads.

The MOU as discussed above was however compiled when the former ECA EIA Regulations were still in place and not applicable anymore.

Since the ECA Regulations and the MoU came into effect, the EIA Regulations have already changed 3 times. The first set of new EIA Regulations that replaced the 1997 ECA EIA Regulations, was the NEMA EIA Regulations that came into effect on 3 July 2006. These Regulations were replaced by the 2010 Amended NEMA EIA Regulations, which came into effect on 2 August 2010. The 2010 NEMA EIA Regulations were replaced by the 2014 Amended NEMA EIA Regulations on 8 December 2014.

The EIA application for the involved section of the K56 was however submitted in terms of the 2010 NEMA EIA Regulations and in terms of the amended 2014 EIA Regulations such pending applications must be dispensed with in terms of the 2010 NEMA EIA Regulations.

[2] i.e. Route Determination reports/Basic Planning Reports/Detail Design Reports
[3] i.e. Environmental Evaluation Reports (prior to the EIA Process)/Environmental Scans/Scoping Reports/ EIA Reports

According to the relevant GDRT officials they are currently in the process of compiling a revised MoU between GDARD and GDRT. This MoU will take all the applicable legislation, policies, guidelines, the Strategic Road Review etc. into consideration but it will not be applicable to this application.

1.3 The Application

Bokamoso Landscape Architects and Environmental Consultants were appointed by **Gauteng Department of Roads and Transport (GDRT)** as independent consultants to prepare the applicable environmental reports and GDARD accepted the application that was submitted on 3 February 2012. The Reference Number issued by GDARD for the project is **Gaut: 002/11-12/E0257.**

GDARD approved the Plan of Study for Environmental Impact Assessment (EIA) and Scoping Report for EIA, which was submitted by Bokamoso Landscape Architects and Environmental Consultants and received by the Department on 9 December 2013. GDARD requested that the following information requirements be addressed in the EIAR:

1. In addition to three alternatives identified, additional alternative provided by stakeholder (Mr. Mackenzie) must be investigated further and be included in the EIA Report, as this alternative is environmental friendly.
2. It must be noted that any development, e.g. Bridge widening or construction that impacts on the wetland or the riparian zones would also require authorization through a Water Use License under Section 21 of the National Water Act. Alternatives must also be provided and assessed for the type of bridges to be constructed.
3. The proposed activity has a potential to cause ground and surface water pollution during construction phase. As such, a Geo-Hydrological Study must be undertaken by a suitably qualified person.

4. Wetland delineation must be undertaken according to "DWAF" 2005 A Practical Guideline Procedures for the identification and delineation of wetlands and riparian zones.
5. Wetland Rehabilitation Plan must be complied by a suitably qualified specialist as per the South African Council for Natural Scientific Professions Act of 2003 (Act 27 of 2003) and included in the Final EIA Report.
6. Comments from the Department of Water Affairs (DWA) must be attached in the final EIA Report.
7. A layout plan with overlaid sensitivities, delineated 30m buffer and all infrastructure and servitudes that will be associated with construction of the proposed road, must be provided on an A2 Map.
8. A comprehensive site specific storm water management plan indicating the management of all surface runoff generated as a result of the development activities while not negatively affecting the water body on site.
9. All specialist studies as indicated in the Plan of Study for EIA should adequately address issues of concern e.g. loss of biodiversity and must be submitted with the report for consideration.

2 ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP) - (In Line with Section 32 (2) (a) (i) & (ii)

The new Environmental Regulations require that relevant details of the Environmental Assessment Practitioner be included as part of the EIAR. In this regard, attached as ***Annexure D***, is a copy of the CV of the EAP for this project, Ms. Lizelle Gregory from Bokamoso Landscape Architects and Environmental Consultants. In summary details of the EAP are indicated below:

- **Name:** Lizelle Gregory
- **Company:** Bokamoso Landscape Architects and Environmental Consultants.
- **Qualifications:** Registered Landscape Architect and Environmental Consultant

(degree obtained at the University of Pretoria) with more than 18 years' experience in the following fields:

- Environmental Planning and Management;
- Compilation of Environmental Impact Assessment;
- Landscape Architecture; and
- Landscape Contracting

Ms. L. Gregory also lectured at the Technicon of South Africa and the University of Pretoria. She is a registered member of the South African Council of the Landscape Architects Profession (SACLAP), the International Association of Impact Assessments (IAIA) and the Institute of Environmental Management and Assessment (IEMA).

3 SCOPE OF WORK AND APPROACH TO THE STUDY

An application form for environmental authorisation of the relevant activity as well as an Environmental Scoping Report has been submitted to Gauteng Department of Agriculture, Conservation and Environment (GDARD). An investigative approach was followed and the relevant physical, social, economic and institutional environmental aspects were assessed. The scope of work includes the necessary investigations, to assess the suitability of the study area and the surrounding environment for the proposed activities. The scoping exercise identified the anticipated environmental aspects in an issues matrix and it also supplied a preliminary significance rating for the impacts identified. The scoping process also assessed the possible impacts of the proposed development on the surrounding environment (including the interested and affected parties).

This document represents the EIA for the proposed development. The EIA must be in line with Section 32 of the National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) and the Approved Plan of Study for EIA that was submitted as part of the Scoping Report.

The EIA takes into consideration the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity. A description of the property on which the activity is to be undertaken and the location of the activity on the property are described. A description of the proposed activity and any feasible and reasonable alternatives were identified. In addition, a description of the need and desirability of the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have, on the environment and community that may be affected by the activity are included.

An identification of all legislation and guidelines that Bokamoso is currently aware of is considered in the preparation of this EIA Report. Furthermore a description of environmental issues and potential impacts, including cumulative impacts, are identified and discussed. Information on the methodology that will be adopted in assessing the potential impacts is furthermore identified, including any specialist studies or specialised processes that were/ should be undertaken. The EIA Report eventually determines whether a proposed project should receive the "go-ahead" or whether the "no-go" option should be followed. If the EAP recommends that the project receive the "go-ahead", it will (in most cases) be possible to mitigate the issues identified to more acceptable levels. Reference is also made to the mitigation of identified impacts or for further studies that may be necessary to facilitate the design and construction of an environmentally acceptable facility.

Details of the Public Participation Process (in terms of Sub-Regulation 1) are also included. Sub-Regulation 1 requires that the following information be included as part of the Public Participation Section of the EIA report:

(i) The steps undertaken in accordance with the Plan of Study For EIA,

(ii) A list of persons, organisations and government organs that were registered as interested and affected parties;

(iii) A summary of comments received from, and a summary of issues raised by the interested and affected parties, the date of receipt of these comments and the response of the EAP to those comments;

(iv) Copies of any representations, objections and comments received from the registered interested and affected parties.

The mitigation measures and guidelines that are listed in the EIA Report are also summarised in a user-friendly document named an Environmental Management Plan (EMP) ***(refer to Annexure H).*** A Draft EMP is also a requirement of the EIA Process (Section 32 and 34 of the National Environmental Management Act (NEMA), 1998 (Act 107 of 1998)).

4. DESCRIPTION OF THE PROPOSED ACTIVITY

4.1. Name of Activity

The Design and Construction of Erling Road between Road K46 and Road K56 and Road K56 between Road K46 and Main Road, including all required access roads.

4.2. Particulars of Applicant

Applicant:	Gauteng Department of Road and Transport
Contact Person:	Eddy H. Sikaala
Physical Address:	Sage life Building 41 Simmonds Street Marshalltown 2107
Postal Address:	Private Bag X 83 Marshalltown

2107

Tel:	(011) 355 7037
Cell:	+27 83 647 6188
Fax:	(011) 355 7532/086 510 6798
Email:	Edwin.Sikaala@gauteng.gov.za

4.3 Background of Route

The original route determination for **Road K56** (between P126-1 and K111) was completed by the PWV Consortium in September 1976 (Report 393) ***(refer to Annexure B).*** More recently the Basic Planning Report for Road K56 (between PWV 3 and PWV 3) was done by Brian Colquhoun, Hugo O' Donnel and Partners (Report 1018) in 1978, and the Basic Planning Report for the K56 (between Roads K71 and K60) was done by De Leeuw, Cather and Associates (Report 1077) in October 1983 ***(refer to Annexure C).***

The proposed alignment of the K56 was included in the Gauteng Strategic Road Network Review, 2010 and is protected in terms of the Gauteng Transport Infrastructure Act, 2001 (Act 8 of 2001).

4.4 Particulars of Activity

4.4.1 Nature of Activity

The function of K-routes is two-fold, namely to serve through traffic i.e., traffic having neither an origin nor a destination in the area traversed by them, as well as to provide area access from the higher order freeway system to the surrounding land. Freeways (PWV-routes) are spaced at an 8 km to 12 km grid, while major arterials (K-routes) are spaced at approximately 1,8 km to 2,4 km intervals. Minor arterials and collector roads are again linked to the K-routes at 600m or larger intervals to complete the higher order road network.

The K56 is part of the second order mobility network planned for Gauteng Province and will play a supporting role to the future PWV5 and will supply linkage to the future PWV9. It would also provide local accessibility by means of well-spaced intersections with minor arterials and collector roads and in a few instances give direct access to minor tracts of land.

The proposed activity is the **Design and Construction of Erling Road between K46 and K56 and the K56 between K46 and Main Road, including all required access roads.**

4.4.2 Location of Activity

Refer to Figure 1 for Locality Map and Figure 2, Aerial Map

The involved section of the K56 lies in the quarter degree grid square 2528CC and stretches in a west-east direction from the K46 (William Nicol Drive) in Fourways to Main Road in Kyalami Agricultural Holdings. The route traverses Fourways X 2, Glen Ferness Agricultural Holdings and the Kyalami Agricultural Holdings.

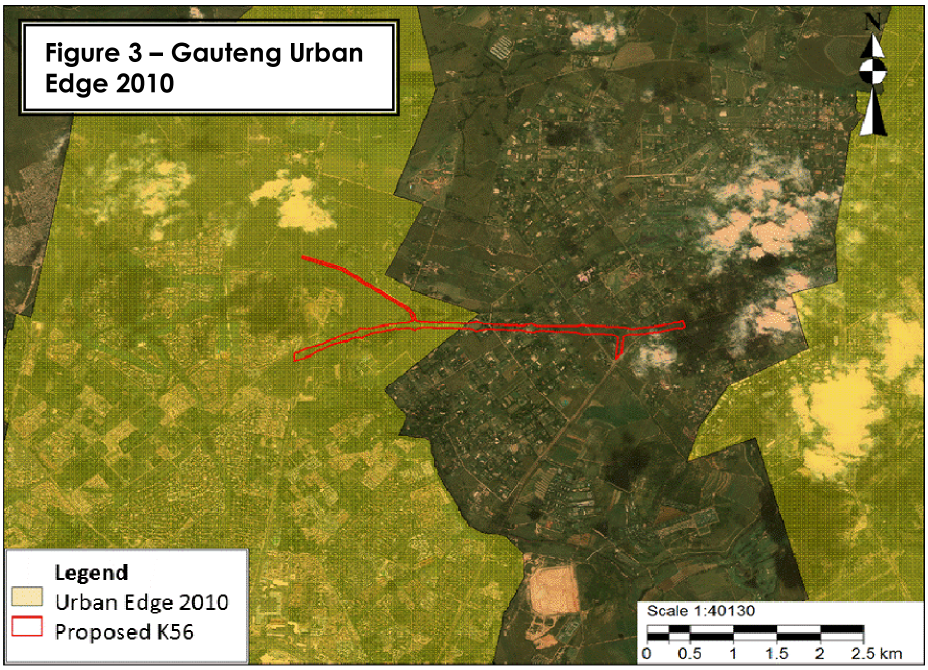


Figure 3 – Gauteng Urban Edge 2010

The western section of the proposed route falls within the Provincial Urban Edge while the eastern section falls outside the Provincial Urban Edge, as indicated on ***Figure 3.***

The alignment alternative, which is indicated on ***Figure 3*** is the alignment as published by GDRT. This alignment has been on the planning maps for the area since the 1070s and the recent Gauteng Road Review of 2010 also regarded this alignment as the preferred alignment for the route. This alignment also proved to be the preferred alignment and this report therefore focus on the environmental aspects associated with this alignment.

Some of the properties in the vicinity of Zinnia Road (the eastern portion of the road where it links up with Main Road) have already been expropriated for purpose of the PWV 9 / K56 interchange and such areas lies outside the "so-called" urban edge as illustrated on the GDARD database. ***Figure 19 below identifies the areas that were expropriated.***

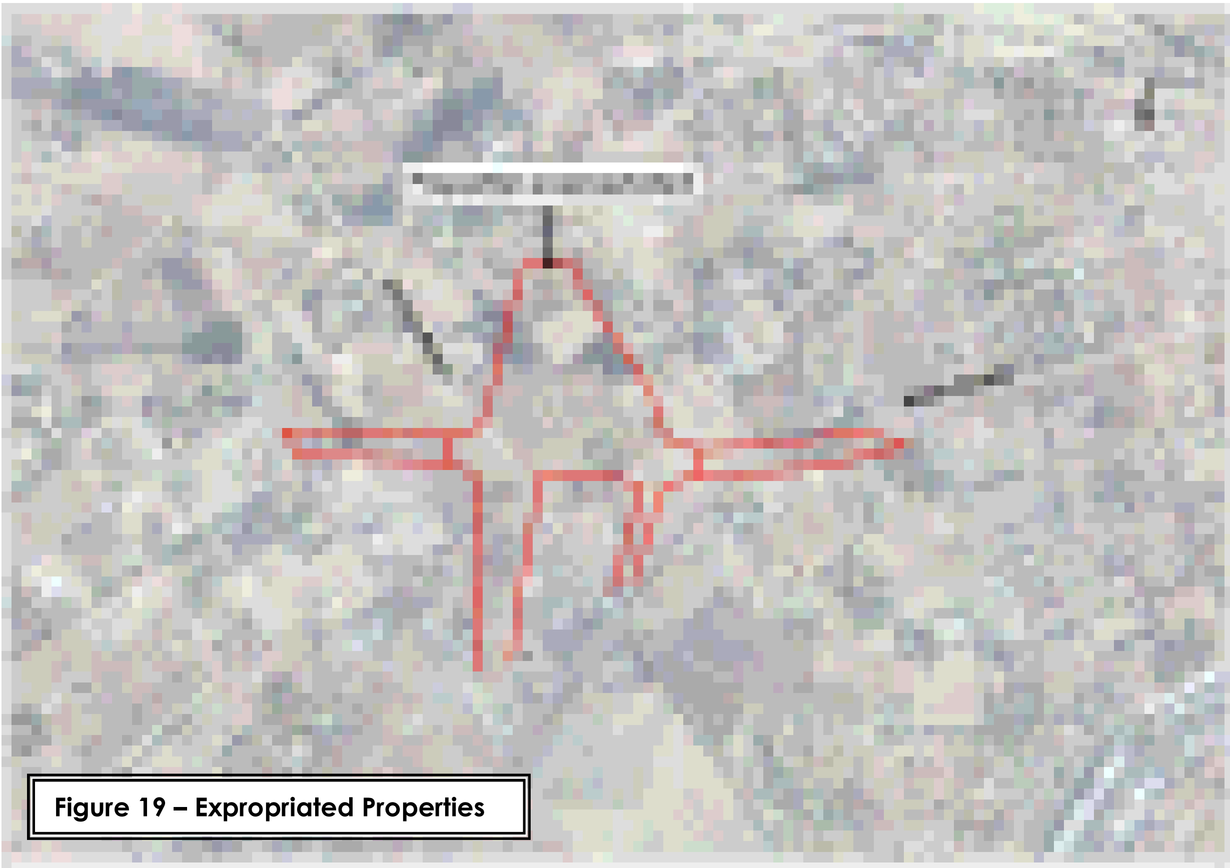


Figure 19 – Expropriated Properties

Take Note:

Even though GDARD compiled the above mentioned urban edge map and incorporated such map into their database, GDARD confirmed that they apparently decided **not to adapt** any urban edge in Gauteng Province.

The 2010 NEMA Regulations supply a definition for the "urban development boundary" and specifies that it must be adopted by the competent authority. According to GDARD they are the competent authority referred to in the 2010 NEMA EIA Regulations and they specifically decided not to adopt any urban edge. According to GDARD they will consider development inside and outside the local authority urban development boundaries and such applications will be considered on merits.

During the public participation meetings there were many debates regarding the legal status of the urban edge as supplied in the presentations, Spatial Development Frameworks and other development plans, but as already mentioned above, GDARD indicated that they will not adopt any urban edge.

The reason why the affected community regard the specific delineation of the urban edge as very important is due to the fact that they want to protect this unique and valuable equestrian area from fragmentation and urban densification. This multi-billion rand equestrian industry rely on this area for special equestrian events and there are also many horse training schools and stables in the area. The area also caters for international events and specialised horse veterinarian services are also found in this area. The area has a unique rural character and many of the horse riders (including young children) use their horses as transport through the area to various social facilities and to the events and training facilities. The area currently includes sub-standard rural roads and exclusive horse bridal paths in between many of the agricultural holdings and the equestrian community and other residents of the area regard this area as pedestrian and horse friendly and indicated that that will vehemently oppose any development (including roads) that threaten the co-existence of this valuable and unique international and national facility, which incorporates most of the agricultural holdings that surrounds the K56 study area. The current sub-standard state of the roads make it difficult for vehicles to speed through the area and this also assist with the safe pedestrian and equestrian movement through the area.

The schools in the area are also very concerned about the fragmentation that will be caused by the proposed road and apparently the schools in the area also offer horse training courses that often require that children ride on the roads of the affected agricultural holdings.

Apparently many of the residents of the area work in Johannesburg and in busy business areas of Gauteng, but they specifically chose to reside in this unique area, because of the tranquillity, rural character and the high quality equestrian facilities.

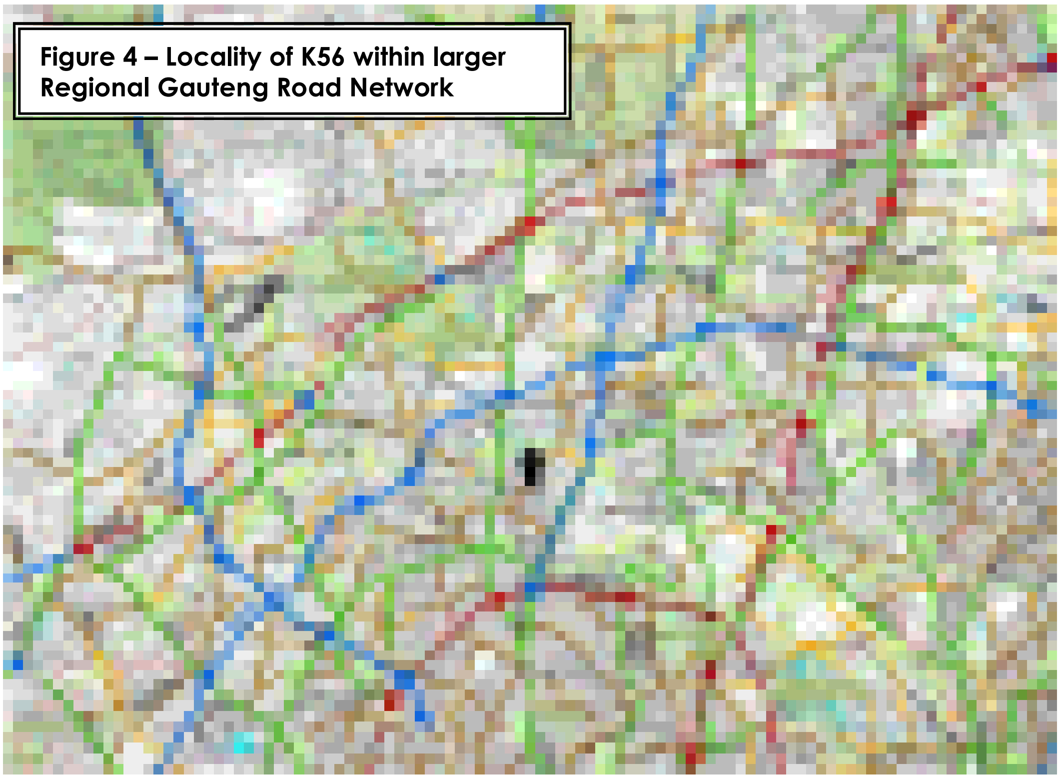
From discussions with many members of the community and during the various public participation meetings it became clear that the affected community will do anything possible to protect the area from development and they regard the construction of a road such as the proposed K56 as the first step of urban densification and rural fragmentation. Obviously one can understand their concerns and the important issues raised by the affected community cannot be ignored, even though the area is almost completely surrounded by urban development, including important road and services infrastructure.

The community even established a Conservancy in the area namely GECKO and the main purpose of this conservancy is to protect the existing ecological and socio-economic assets of the area. The members of this Conservancy are very active and they were of great assistance during the compilation of this report. According to the representatives of the equestrian community and GECKO they already went through an enormous amount of effort to protect the area, but government and developers ignore/ is unaware of the unique value of this area and still regards the area as suitable for urban densification in future planning projects.

According to the equestrian community the area is regarded as an “irreplaceable site” from a horse-lover and socio-economic point of view. This area does not only have high social value, but it also plays an irreplaceable economical role (including job creation to previously disadvantaged individuals) in the horse industry, which also incorporates many international role players.

4.4.3 Delineation of the study area

The section of the K56 investigated in this EIA Report is only a small section **(approximately 5,5km)** of a Provincial Route, which forms an important link in the larger Gauteng Road Network system ***(Refer to Figure 4 and Annexure E).***



Although the Gauteng New Infrastructure Act, 2001, requires that all listed roads be accommodated in the layouts of new developments, EIA authorisation in terms of the new NEMA regulations must still be obtained for the roads and if any "fatal flaws" / significant environmental issues along the listed alignment are identified the regulations provides for alignment alternatives and even for the "no-go" alternative. This variable makes it difficult to finalise development layouts around such roads or only small portions of a larger road.

There were cases in the past where GDARD considered and authorised only isolated sections of K-routes / Freeways to accommodate the layouts and planning of surrounding developments affected by such roads. Unfortunately, these isolated decisions compromised the option of investigating alternative alignments if significant environmental issues / "fatal flaws" were identified along other sections of the road not applied for as part of a specific development. Refer to ***Figure 5*** below for a conceptual illustration.

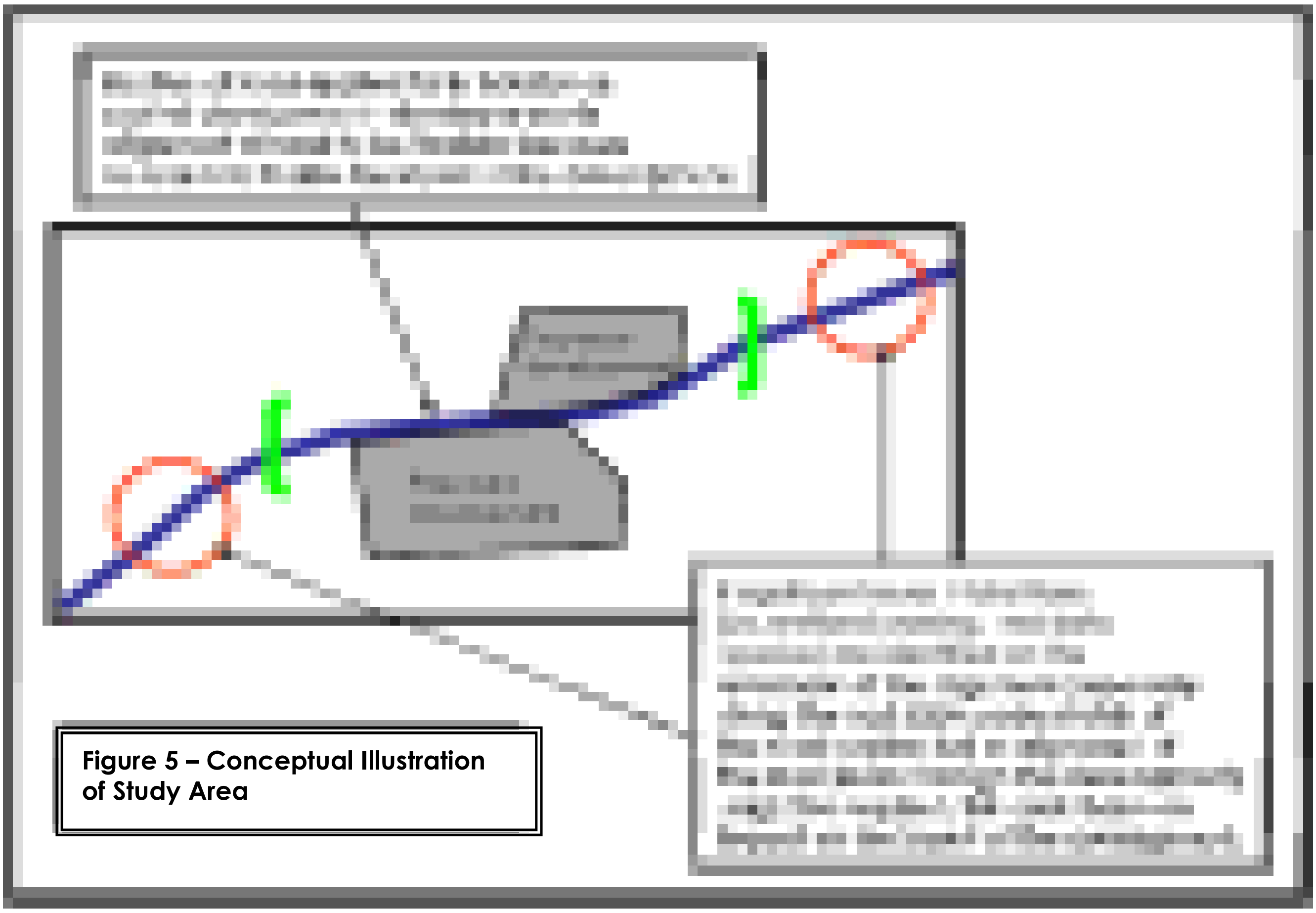
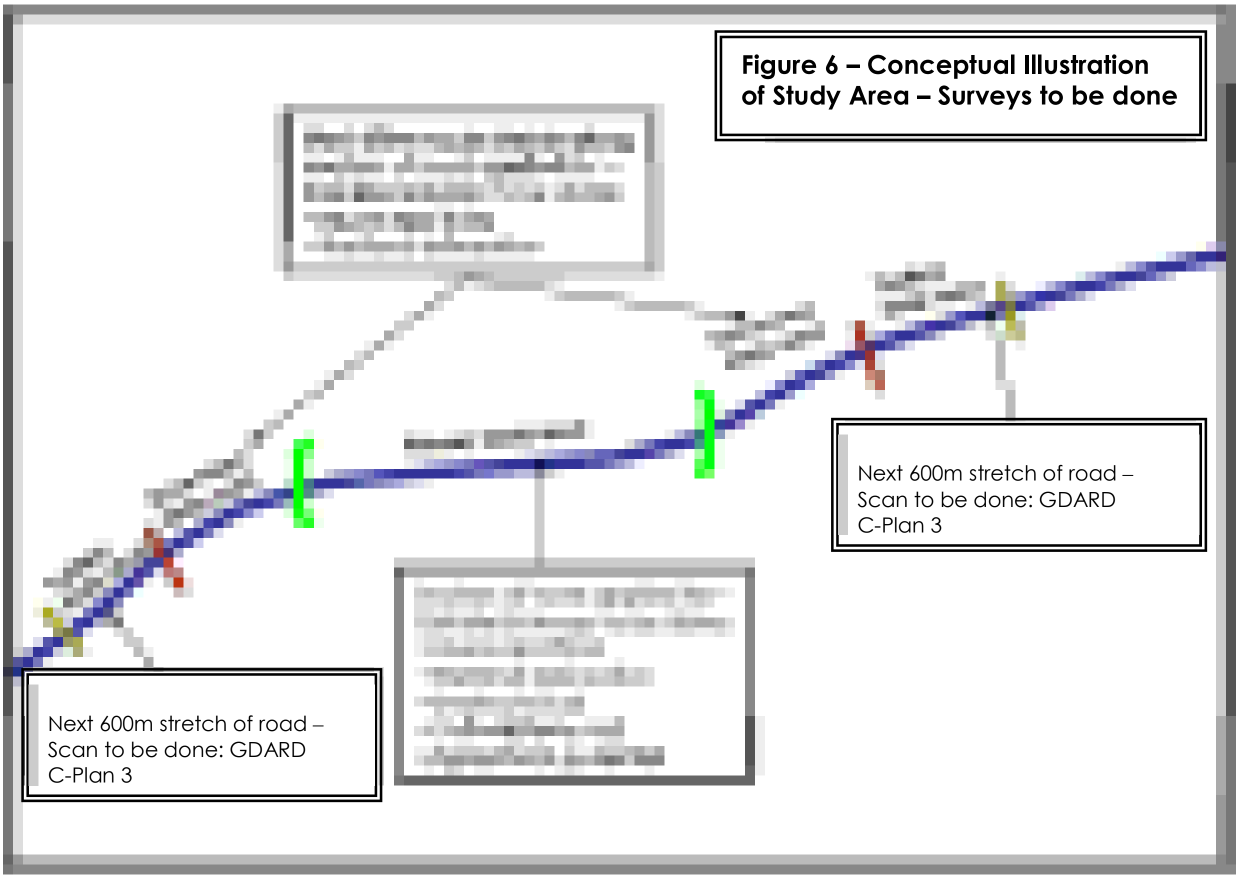


Figure 5 – Conceptual Illustration of Study Area

In order to prevent such cases, GDARD now requires that EAPs not only limit their environmental assessments to the portion of a road applied for, but that they also extend their investigations to incorporate a longer section of the road (to both sides of the involved portion of the road). This will allow for two options: (i) amendments in the alignment or (ii) to investigate a portion of road that can easily terminate into existing roads and act as an independent internal / local road if "fatal flaws" prevent the remainder of the route from happening. ***Refer to Figure 6 and 7*** for conceptual illustrations.



According to a traffic engineer an acceptable distance which would allow for an amendment in the alignment is 600m from a node (distance from one intersection to the next potential intersection). It is therefore recommended that detailed surveys also be done for the next 600m node extensions of the section of road applied for and that a scan (GDARD C-Plan) be done for the adjacent 600m extensions of the road in question.

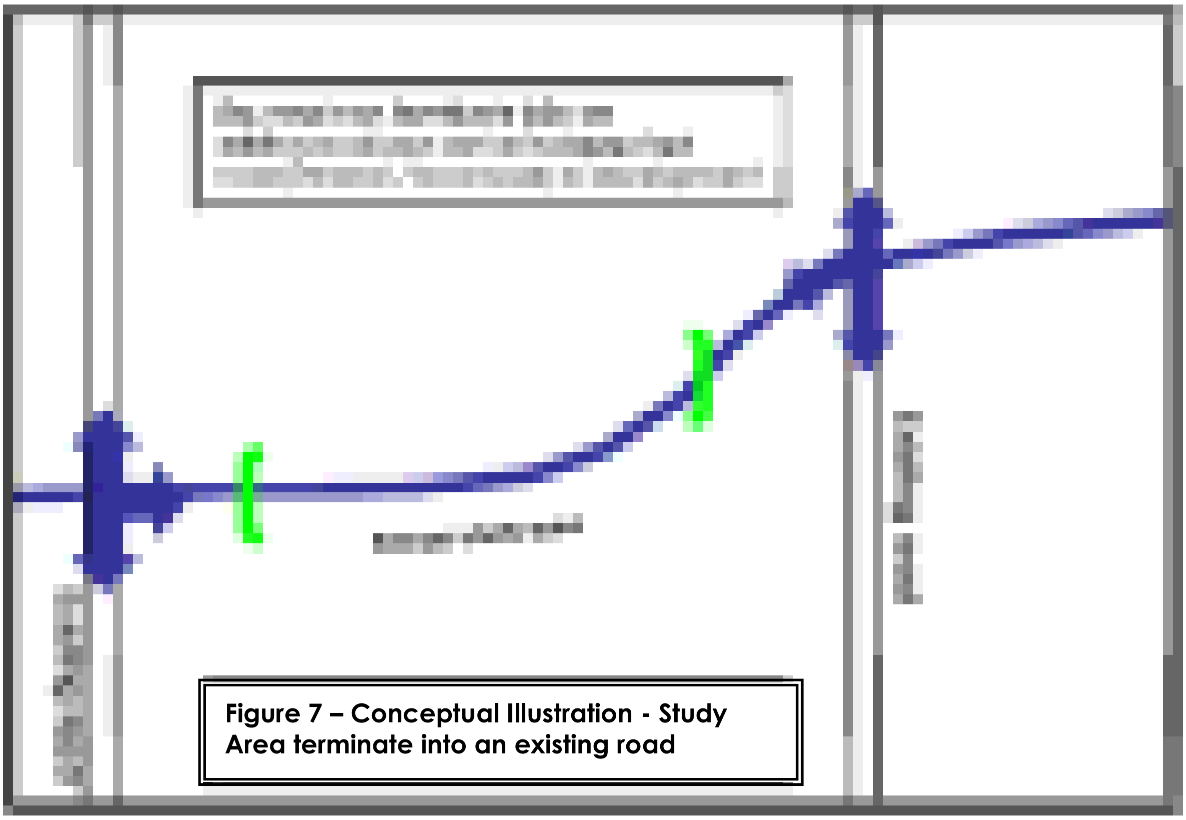


Figure 7 – Conceptual Illustration - Study Area terminate into an existing road

In the case of this application the EAPs investigated the 600m node extensions of the involved section of the K56 and identified **irreplaceable sites further to the west** of the involved section of the route that could result in a "fatal flaw" ***(Refer to Figure 8).***

It is however possible for the route to terminate into Road K46 (William Nicol Drive), should a fatal flaw be identified in the western extension of the route. It should also be noted that development had already taken place along the alignment of the K56 to the west of Road K46 and the alignment of the proposed K56 is clearly visible on the aerial photographs of the area.

The eastern extension of the route follows the alignment of an existing road (Main Road).

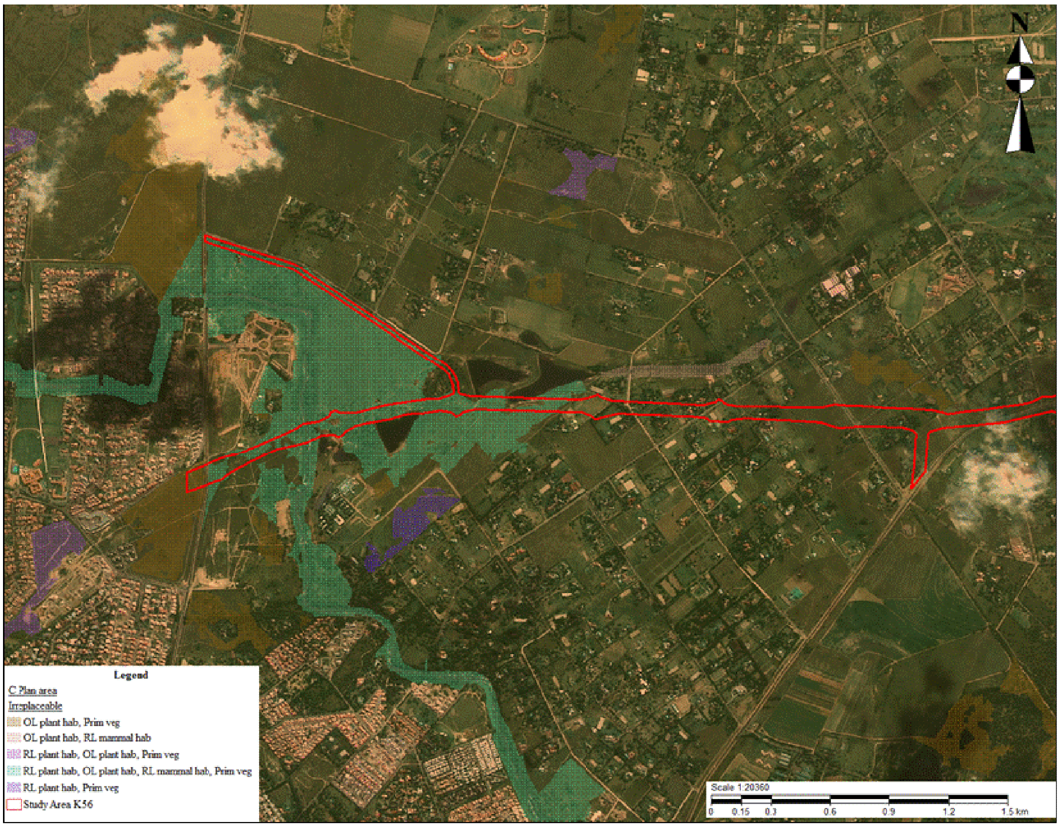


Figure 8 – Irreplaceable Sites Map

4.4.4 The role of route K56 in the Gauteng Road Network and the importance of the proposed road for the City of Johannesburg.

The road network in Gauteng is under increasing pressure due to a number of factors, including:

- The economic growth of the province which currently stand at almost double the national growth rate;
- Increased car ownership;
- Increased urbanization towards the major cities; and
- Increased job opportunities resulting in more people entering the business market thereby increasing their personal wealth through property and car ownership.

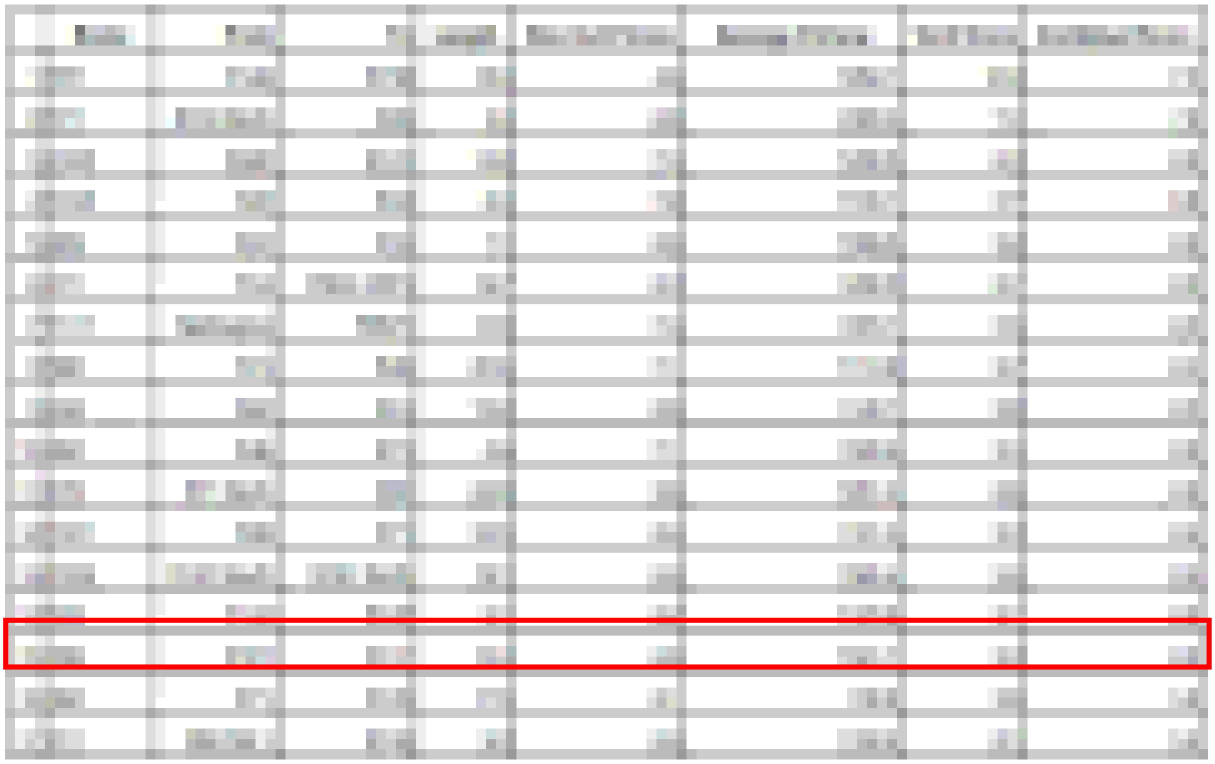
Refer to Figure 4 and Annexure E for locality of the proposed K56 within the larger Gauteng Road Network System

Amongst others this has resulted in increased demand for road capacity in general in Gauteng. The current system has over the last couple of years become notorious for the lack of capacity, with great congestion, huge delays, and severe safety concerns raised by various sectors, including the public, all spheres of government, and other institutions. Due to the lack of building new infrastructure to create a balanced road network or transport system the system has also resulted in increased pollution due to the congestion on the network.

The overall objectives of the Gautrans road network are to provide mobility and access in the Gauteng province. The K56 plays an important role in achieving these objectives. In a regional context, K56 provides east-west mobility through the greater Fourways area. It will provide linkages to the future PWV9 and K46 and play a supporting role to the future PWV5 some distance to the north.

The Strategic Road Network Review (2010) identified the K56 as a priority road (15 & 24).

Table 4: Prioritization of Class 2 Roads (Table 11: Strategic Road Network Review, 2010)



4.4.5 The Need For Route K56

Refer to Figure 9 for Surrounding Land Use Map

As mentioned the involved section of the K56 traverses an area that still reflects a rural character and which is regarded as a very important equestrian node, the only one of its kind in South-Africa.

In the past this area was situated outside the urban area, but over the years development pressure in the surrounding area triggered the need for urban densification. Road and service infrastructure were developed around this rural area and after 1994 government adopted a policy of intense urbanisation and optimum utilisation of services. The development of gentleman's estates and residential areas with very large stands were no longer promoted, especially in urban areas. This densification policy made residential properties in the urban areas more affordable and it also promoted increased rates and taxes, which generates funds for the upgrading of services and infrastructure.

The proposed K56 road which traverses this equestrian area is not regarded as an essential road by the affected community and they cannot understand why it is necessary to construct this road, especially if the road will be terminated at a meaningless point that halts the intended improved traffic circulation patterns. The affected community is furthermore of the opinion that the Steyn City Development is the main catalyst for this section of the road and they are of the opinion that this road would not have been required if the Steyn City Development never took place.

This matter was discussed with GDRT and it was confirmed that the road will be required even without the Steyn City Development. The Steyn City Development is however a large development, which will generate a significant amount of traffic in the area and GDRT therefore required that the Steyn City Developer assist with the application processes and construction involved with the section of the K56 that will be required to accommodate the additional traffic of Steyn City and the other new developments in the area. GDRT has limited funds and capacity and government departments often use developers to assist with the upgrading of roads and infrastructure, because the new developments and the surrounding area will benefit from such upgradings.

It was also confirmed that it will not be possible to construct the entire road at once. GDRT plan the construction and upgrading of provincial roads in phases and funds are allocated to priority areas. The phased approach is the only option, because government has limited funds and such funds must be applied to implement the priority road projects. The involved section of the K56 is regarded as a priority project ***(Refer to Table 4 above)***. The road will however be very expensive and it was therefore decided to ask for the assistance of a developer. This road application is therefore a joint venture between the Steyn City Developer and GDRT.

A reassessment of the major road network in the area (which has already been on the table since the 1970s) and its development potential has confirmed and emphasized the urgent need to strengthen the regional network.

The proposed road network link will divert traffic from existing road network links and thereby alleviate the severe congestion on the existing road network system. As already mentioned the K56 will supply a vital east–west link in the greater Fourways area and will supply a link to the future PWV9 and K46. It will play a supporting role to the future PWV5 some distance to the north. This road link will establish another element to facilitate a more balanced road network and is also part of the Local Authorities and Provincial Government's road network planning for the larger areas.

A number of new developments are proposed in the greater Fourways area, which is regarded as a priority development area: ***(Refer to Figure 9 for Surrounding Land Use Map)***

- Steyn City
- Helderfontein Development
- Riversands Industrial Park
- Northern Farms
- Maroun Square Shopping Centre
- Cradle City
- Riverside View X 29

A Roads Masterplan Report for **Steyn City Development** had been compiled by WSP Civil and Structural Engineers (Pty) Ltd in August 2011.

The results of the Roads Masterplan Report indicated that the potential developments in the greater Fourways area can potentially generate a significant amount of traffic when they are fully developed, in the order of 16 000 and 18 000 peak hour vehicle trips in the 2025 AM and PM peak hours respectively. According to the involved traffic engineers new road links and substantial upgrades of the existing network will be required in order to accommodate these trips at acceptable levels of service.

The new roadways required include the K56 between PWV9 and Cedar Road (2 lanes per direction, design speed limit of 80kph) and the Erling Street extension between William Nicol Drive and the K56 (single carriageway road with a single lane per direction and speed limit of 60kph). It also includes a new access interchange at Erling Street/William Nicol Drive which will provide the main access to Steyn City from the east.

The east-west linkage investigation has shown that east-west links are required throughout the study area. These will ultimately be provided by the East West Link Road through Northern Farms, the PWV9 and the K56.

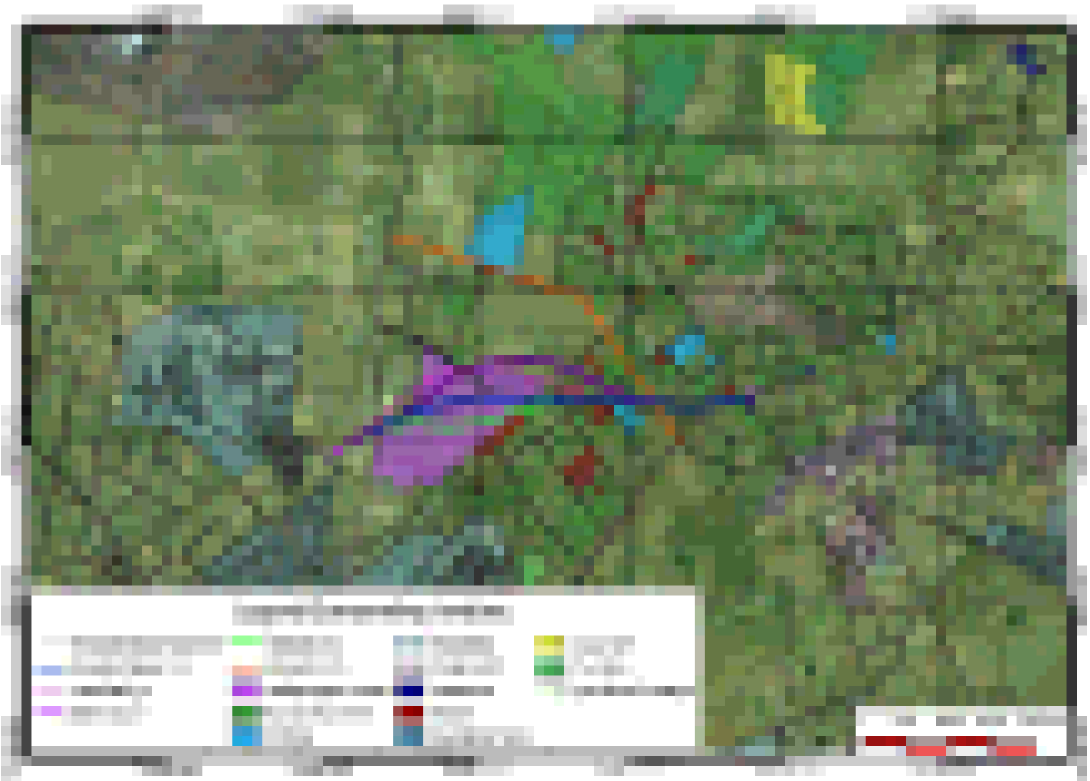


Figure 9 – Surrounding Land Use Map

4.4.6 *Intersecting roads and accesses*

The involved section of route K56 intersects with other important routes including the K46 (William Nicol), future K58 and PWV9. It also intersects with the Erling Street extension. The eastern section of the proposed route follows the alignment of the existing road P71-1 (Main Road).

4.4.7 End Points And Length

The section of the K56 to be constructed is proposed to be from the **K46 (William Nicol) (km 21.0)** in the west and **Main Road (R71) (km 26.5)** in the east.

The proposed section has a total length of approximately **5.5 km.**

4.4.8 Geometric design standards

(refer to the BP Report (Report 1018) attached as Annexure C)

Table 5: Design Standards

Design element	**Desirable**	**Applied**
Horizontal alignment:		
Design for super elevation	100km/h	100km/h
Minimum radius of curves	1000m	1000m
Canting: Maximum	0,06m/m	0,0032m/m
Design speed for canting	80km/k	80km/h
Vertical alignment		
Design speed	100km/h	100km/h
Stopping sight distance	155m	155m
Maximum gradient	6%	6%
Minimum gradient	0,5%	0,5%
Minimum vertical curve length	180m	180m
Minimum K values – crest	62	66
Minimum K values – sag	37	58

4.4.9 The Gautrans Network Planning and the Gautrans Road Planning Stages

- **Network Planning at 1:50 000 scale**

During the mid-seventies a grid network covering the traditional PWV area compiled by Gautrans was planned on a 1: 50 000 scale and maintained ever since. The grid network concept was based on a road hierarchy system comprising of a range of mobility and access routes.

- **Route Determination at 1: 10 000 scale**

During the Route Determination phase each route is investigated in more detail. Amongst others, the following aspects receive attention:

- The purpose of the route;
- Delineation of study area;
- Collection and interpretation of environmental information;
- Site visit;
- Literature Study;
- The description, analyses and interpretation of physical, biotic, socio-economic and environmental procedures; and
- Consultation with major landowners, local and other affected authorities.

- **Preliminary Design Phase - (Basic Planning)**

During this stage of planning, the issues addressed during the preceding stage are re-evaluated. Normally a long time period has passed between the above two stages and therefore revision is required.

The main purpose of Preliminary Design is to establish the road reserve and to conduct a cost framework. This phase includes also detail regarding bridge structures, culverts road fillings and road reserve boundaries. The commencement of this phase is normally dependant on either/ both the traffic demand and land use development pressure within the area.

- **Detail Design and Construction.**

During this phase all-physical, environmental and socio-economic issues are integrated with the road planning. Land will be expropriated and detailed design of the road will depend on the priority of the route and the available funding.

- **The Design Phase Of This Application**

The involved section of the K56 is currently at the Design and Construction stage.

5. ALTERNATIVES IDENTIFIED *[Regulation 29(b)]*

5.1 The "No-Go" Alternative

According to the GDARD C-Plan 3, 2011, the western section of the route traverses irreplaceable sites and is regarded as ecologically sensitive. ***Refer to Figure 8, Irreplaceable Sites map.*** However, this section of the proposed route is bordered by the Century Development to the south and Fourways X2 to the north, which also fall within irreplaceable sites.

The proposed alignment traverses the Jukskei River and tributaries as well as wetlands and could have a significant impact on the hydrology in the area, especially wetlands if the proposed road construction and operational phases are not well planned and managed.

The involved section of the K56 could have a significant socio-economic impact on Glenferness A. H. and Kyalami A.H. i.e. equestrian industry, dissection of properties, potential loss of jobs due to the fragmentation/ destruction of the equestrian node, safety and security, noise, lightning, sense of place etc.

There is however a proven need and demand for the proposed K56 in order to provide east-west mobility in the area and to provide linkages to other major roads i.e. K46 and future PWV9. This was once again confirmed in the Gauteng Strategic Road Network Review, 2010.

The "No-Go" alternative is not viable from a road planning point of view, however it could be supported from a socio-economic point of view.

The option of aligning the proposed road around the GECKO Conservancy and the equestrian node was also considered, but this option is not viable form a geometrical or road network planning point of view.

We also requested that the appointed civil engineers investigate a possible alignment that runs even more to the north than Alignment Alternative 1, because this was an attempt to avoid the hydrological and ecological impacts on the man-made dams that will be affected by the preferred alignment, but this option proved to be even more detrimental to the hydrological and ecological environments. The appointed wetland specialist confirmed that this proposed northern alignment (between the Alternative that follows Zinnia Road and Alternative 1) will cut across a wetland that is regarded as pristine. The wetland specialist confirmed that the wetlands around the dams are man-made wetlands at that they were more sensitive and if suitable mitigation measures are applied, the ecological and hydrological systems associated with such wetlands can accommodate the proposed road. ***Refer to Annexure S for more detail regarding the alignment alternatives that were considered.***

To follow now are tables that represent a preliminary comparison between the "No-Go" alternative and the development alternative.

Diagram 1: Environmental issues - "No-Go" Option

Issue	Short term	Medium term	Long Term	Impact
Geology and soils				Positive Neutral Negative
No development will not have a significant impact on the geology or hydrology of the study area, especially in the short term. Indirect impacts created by the edge effects of the surrounding developments (i.e. Century Development) could however, in the long term, lead to a decrease in vegetative coverage and even to exposed areas. Erosion, siltation and water pollution problems could then be caused. Changes in the surface drainage patterns could also occur.				
Hydrology				Positive Neutral Negative
No development will not have a significant impact on the geology or hydrology of the study area, especially in the short term. Indirect impacts created by the edge effects of the surrounding developments (i.e. Century Development) could however, in the long term, lead to a decrease in vegetative coverage and even to exposed areas. Erosion, siltation and water pollution problems could then be caused. Changes in the surface drainage patterns could also occur.				
Vegetation				Positive Neutral Negative
f no development takes place around the linear strip of land earmarked for the K56, the impacts on the fauna and flora and bio-diversity will not be significant. The Century Development is located adjacent to the linear strip of land earmarked for the western section of the K56, and the edge effect could, in the long term, have an impact on the ecological potential and bio-diversity of the vegetation of the western section of the study area.				
Fauna				Positive Neutral Negative
f no development takes place around the linear strip of land earmarked for the K56, the impacts on the fauna and flora and bio-diversity will not be significant. The Century Development is located adjacent to the linear strip of land earmarked for the western section of the K56, and the edge effect could, in the long term, have an impact on the ecological potential and bio-diversity of the vegetation of the western section of the study area.				
Social				Positive Neutral Negative

The No-Go alternative is not supported from a traffic point of view due to the need for an east-west link road in the larger Fourways area.	
Economic	Positive Neutral Negative
The No-Go alternative would have a neutral impact on the equine industry and social environment of the Kyalami and Glenferness A.H.	

***Note:** The "no-go" option is predominantly neutral in the short, medium term and long term; however it could turn negative in the long term.*

Diagram 2: Environmental issues of the proposed section of the K56

Issue	Short term	Medium term	Long Term	Impact
Geology and soils				Positive Neutral Negative
In the short term (the construction phase), the proposed K56 will have a negative impact on the geology and hydrology of the study area. It is, however possible to mitigate the impacts to acceptable levels. The impacts will be neutralised in the medium and long term.				
Hydrology				Positive Neutral Negative
Effective temporary and permanent storm water management and guidelines to reduce impacts on the water courses and wetlands will have to be implemented during all the development phases. Mitigation measures will be in place to insure that the hydrology of the area will reach a neutral level again.				
Vegetation				Positive Neutral Negative
The proposed K56 will have a negative impact on the sensitive vegetation and fauna and bio-diversity of the study area. The natural grassland vegetation will be permanently lost, but the proposed vegetative coverage of the road reserves could be natural vegetation that will create habitats for fauna species adaptable to the urban environment. In the long term the vegetative coverage will also prevent erosion, siltation and water pollution. It will also assist with softening of the road reserves and the screening of the road at strategic points.				
Fauna				Positive

	Neutral
	Negative
The proposed K56 will have a negative impact on the sensitive vegetation and fauna and bio-diversity of the study area. The natural grassland vegetation will be permanently lost, but the proposed vegetative coverage of the road reserves could be natural vegetation that will create habitats for fauna species adaptable to the urban environment. In the long term the vegetative coverage will also prevent erosion, siltation and water pollution. It will also assist with softening of the road reserves and the screening of the road at strategic points.	
Social	Positive
	Neutral
	Negative
The construction phase could cause some social impacts on the surrounding Glenferness and Kyalami A.H. and the equine industry i.e. safety, security, noise, interruption of services and access etc. The operational phase will also have a significant social and economic impact on the Kyalami and Glenferness A.h. and equine industry.	
Economic	Positive
	Neutral
	Negative
The road is however supported from a road point of view. In long term the larger region will benefit from the road. The construction of the road will also create some temporary job opportunities, but in long term the economic impact will reach a neutral level again.	

***Note:** It is anticipated that the proposed section of the K56 is predominantly negative in the short and medium term, but turns neutral and even positive in the long term.*

5.2 Alignment Alternatives

Also refer to Annexure S for more detail regarding the alignment alternatives that were considered.

Three alternative routes for the involved section of the K56 were investigated by the involved engineers during the Scoping Phase ***(Refer to Figures 10 and 11).***

- Alternative 1: to the north of the proposed K56 alignment
- Alternative 2: to the south of the proposed K56 alignment
- Alternative 3: along the alignment of Zinnia and Caracal from Main Road linking to

the K46 *(supplied by a member of the public, Mr. Mackenzie)* – ***Refer to Figure 11 below for the Alternative as proposed by members of the public***

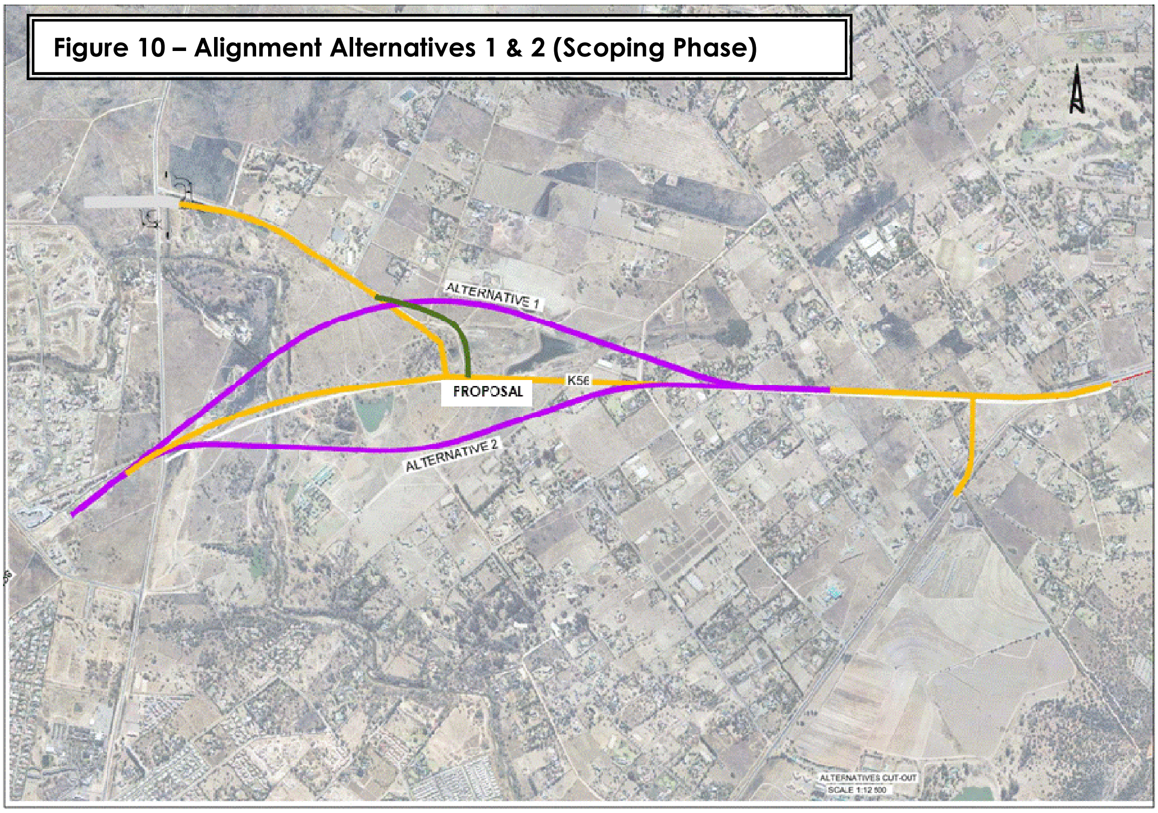


Figure 10 – Alignment Alternatives 1 & 2 (Scoping Phase)

During the EIA Phase an additional alternative, to the north of the proposed alignment and Alternative 1, was investigated. However, this alternative traverses a sensitive wetland area as well as a newly constructed house. In addition, this alignment is not supported from an engineering point of view. Another Alternative, Alternative 4, was proposed by the involved traffic engineers. ***Refer to Table 6 for comparison of the alternatives from a road planning point of view.***

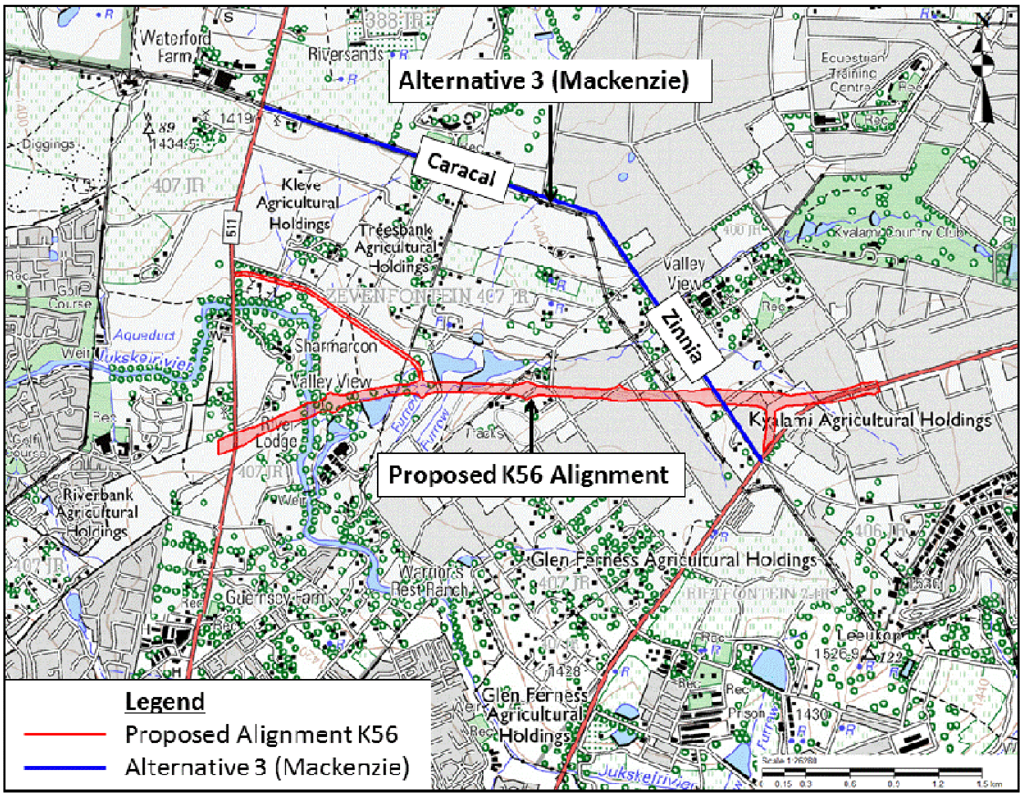


Figure 11 – Alignment Alternative 3 (EIA Phase)

6. THE DESCRIPTION OF THE BIOPHYSICAL AND SOCIO-ECONOMICAL ENVIRONMENTS OF THE WIDER CORRIDOR WHICH INCORPORATES ALL THE ALIGNMENT ALTERNATIVES– (In line with Section 32 (d)

Take Note: This Section however focusses on the preferred alignment. More detail regarding the alternatives that were considered is attached as Annexure S

6.1. The Physical Environment

This section briefly describes the biophysical and socio-economical environments. It also lists the anticipated adverse and beneficial impacts of the proposed road on the environment. Where possible, mitigation measures were supplied for the adverse impacts and the significance of the impacts listed was also indicated in specific impact tables. In some cases the impacts have already (during the planning phase) been addressed to such an extent that it was not regarded as necessary to carry the impacts over to the significance rating section of the report.

Although it was not necessary to mitigate the positive impacts listed in the impacts tables, the positive impacts identified in this section of the report will also automatically be carried over to the significance rating section of the report to indicate the specific benefits associated with the proposed development. This will also make it possible to compare the severity of the adverse impacts with the advantages of the beneficial impacts and to eventually make an informed decision regarding the proposed road.

The following section incorporates the most important information supplied by specialist studies and reports.

6.1.1. Geology and Soils

According to Dr J.H van der Waals a soil specialist the study area is underlay with granite and magmatite of the Halfway House Granite dome and as such well drained coarse sandy soils of variable to shallow depth are expected in the upper parts of the landscape and bleach sandy soils of variable depth,

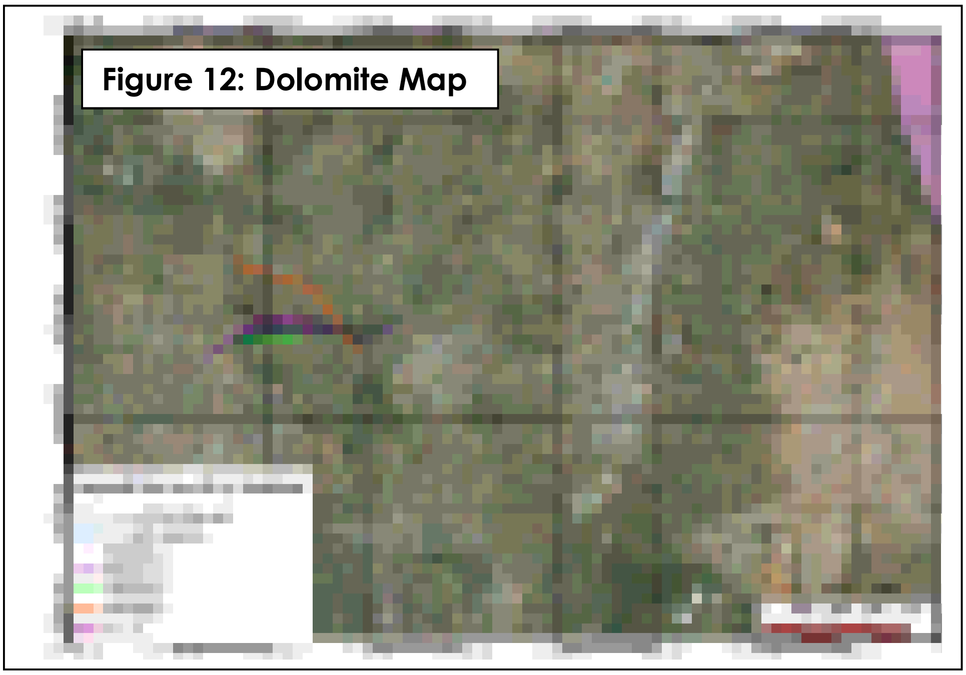


Figure 12: Dolomite Map

with occasional signs of water saturation, are expect in mid-slope to valley bottom positions.

The site is dominated by shallow to moderately deep sandy soils with deep soils occurring in the drainage features only. The soils are dominantly coarse sandy in texture. On the bulk of the site the soils are underlain by a hard plinthic layer that acts as aquaculture under natural conditions. The bulk water movement on the site occurs with 50cm of the soil surface on top of the ferricrete layer in the absence of human impacts. ***(Refer to Annexure Fi for the study of Dr J.H van der Waals)***

Table 7: Issues and Impacts – Geology and Soils

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities High ☻ Medium ☺ Low ◙ Positive Impact - Not Necessary To Mitigate ☼**
1)	Stability of road and structures due to collapsible and expansive soils **Legend**	-	☺
2)	Excavatability problems are foreseen and some blasting exercises may be required	-	☻
3)	Perched water table	-	☺
4)	Erosion	-	☺
5)	Stockpile areas for construction materials and topsoil	-	☺

6.1.1.a Discussion of issues identified, possible mitigation measures and significance of issue after mitigation – geology and soils

1) Stability of road and structures

Stability problems due to collapsible sands and expansive clays could occur.

Table 8: Significance of Issue1 (Stability of road and structures) After Mitigation

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P & C –** The precautionary measures and foundation design from the involved geotechnical engineers must be implemented to ensure the stability of structures and embankments. **P & C –** Collapsible material must pre-collapsed by impact rolling. More detailed investigations are required during the detail design phase. **P & C** – More detailed foundation investigations should be conducted during the detail design phase especially for structures such as bridges and culverts.	**M - ** To be included in EMP **M - ** To be included in EMP **M - ** To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

2) Excavatability problems are foreseen and some blasting exercises may be required

Excavatability problems are foreseen and some blasting may be required where deep road cuttings are required.

Table 9: Significance of Issue 2 (Excavatibility problems are foreseen and some blasting exercises may be required) After Mitigation

Mitigation Possibilities **High ☻ Medium ☺ Low ◘ Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**C** – Surrounding residents must be informed of blasting exercises at least one week in advance. **C** – Blasting operations should be carefully controlled and the necessary safety precautions must be implemented.	**M -** To be included in EMP **M -** To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

3) Perched Water Table

During the wet season a perched water table can develop on the granites, especially where elevated groundwater levels occur due to ferricrete.

Table 10: Significance of Issue 3 (Perched water table) After Mitigation

Mitigation Possibilities **High ☻ Medium ☺ Low ◘ Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**C** – Special attention must be given to subsurface drainage	**M -** To be included in EMP

	during the detail design of the proposed road. **P/C –** Precautionary measures to prevent seepage of groundwater into excavations should be implemented.	

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

4) Erosion

Unnecessary clearing of vegetation could lead to exposed soils prone to erosive conditions. Insufficient soil coverage after placing of topsoil, especially during construction where large surface areas are applicable could also cause erosion. To cause the loss of soil by erosion is an offence under the Soil Conservation Act (Act No 76 of 1969). The management of surface water run-off during construction is very important to prevent soils erosion on the site. If construction takes place during the rainy season, sufficient storm water management will be required to manage water runoff.

Table 11: Significance of Issue 4 (Erosion) After Mitigation

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P & C –** A storm water management plan must be compiled for the construction and operational phases of the proposed road. **P & C –** Cut-off drains should	**H - ** To be included in EMP **M -** To be included in EMP

	be excavated up- and down-hill of denuded areas to reduce run-off across these areas.	
	P & C – Large exposed areas during the construction phases should be limited. Where possible areas earmarked for construction during later phases should remain covered with vegetation coverage until the actual construction phase. This will prevent unnecessary erosion and siltation in these areas.	**M -** To be included in EMP
	P & C - Rehabilitate exposed areas immediately after construction in these areas is completed (not at the end of the project).	**L -** To be included in EMP
	P & C – Unnecessary clearing of flora resulting in exposed soil prone to erosive conditions should be avoided.	**L -** To be included in EMP
	P – Specifications for topsoil storage and replacement to ensure sufficient soil coverage as soon as possible after construction must be implemented.	**L -** To be included in EMP
	P & C – All embankments must be adequately compacted and planted with grass to stop any excessive soils erosion and scouring of the landscape.	**L -** To be included in EMP
	C – Storm water diversion measures are recommended to control peak flows during thunder storms.	**M -** To be included in EMP
	P & C – The eradication of alien vegetation should be followed up as soon as possible by replacement with indigenous vegetation to	**M -** To be included in EMP

	ensure quick and sufficient coverage of exposed areas.	

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

5) Stockpile areas for construction materials and topsoil

Designated areas for stockpiling of construction materials must be specified by the Environmental Control Officer in an area that is already disturbed. Stockpiling in the wrong areas might be detrimental to fauna and flora and will deplete the soil quality. Topsoil should be stockpiled as specified in the EMP to ensure that the soil quality doesn't deplete and that the grass seed remain in the soil for later rehabilitation of the disturbed areas.

In addition to the impact discussed in the paragraph above, rainwater falling onto stockpiles may become polluted with dust originating from aggregate and other construction material, such as bitumen from pre-mix stockpiles. Therefore stockpiles of topsoil should be correctly covered to prevent this as well as loss of topsoil by wind erosion.

The footprint of stockpile areas will be contaminated with the stored material and will require cleaning before rehabilitation.

Table 12: Significance of Issue 5 (Stockpile areas for construction materials and topsoil) After Mitigation

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**C** - Remove vegetation only in	**M** - To be included in EMP

	designated areas for construction.	**M** - To be included in EMP
	C - Rehabilitation works must be done immediately after the involved works are completed	**M** - To be included in EMP
	C -All compacted areas should be ripped prior to them being rehabilitated/landscaped;	**M**- To be included in EMP
	P/C - The top layer of all areas to be excavated must be stripped and stockpiled in areas where this material will not be damaged, removed or compacted. This stockpiled material should be used for the rehabilitation of the site and for landscaping purposes	**M**- To be included in EMP
	C - Strip topsoil at beginning of works and store in stockpiles no more than 1,5 m high in designated materials storage area.	**M**- To be included in EMP
	C – Stockpiles should be covered correctly	

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

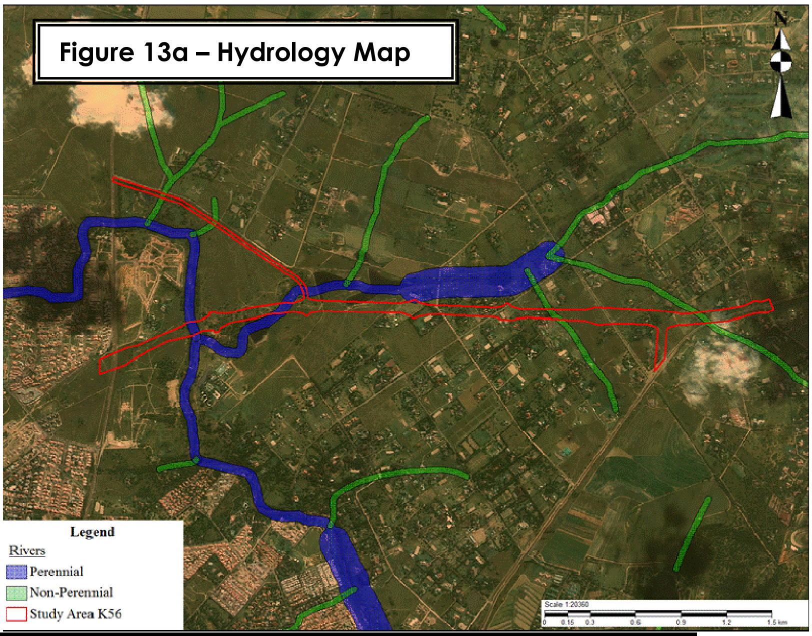


Figure 13a – Hydrology Map

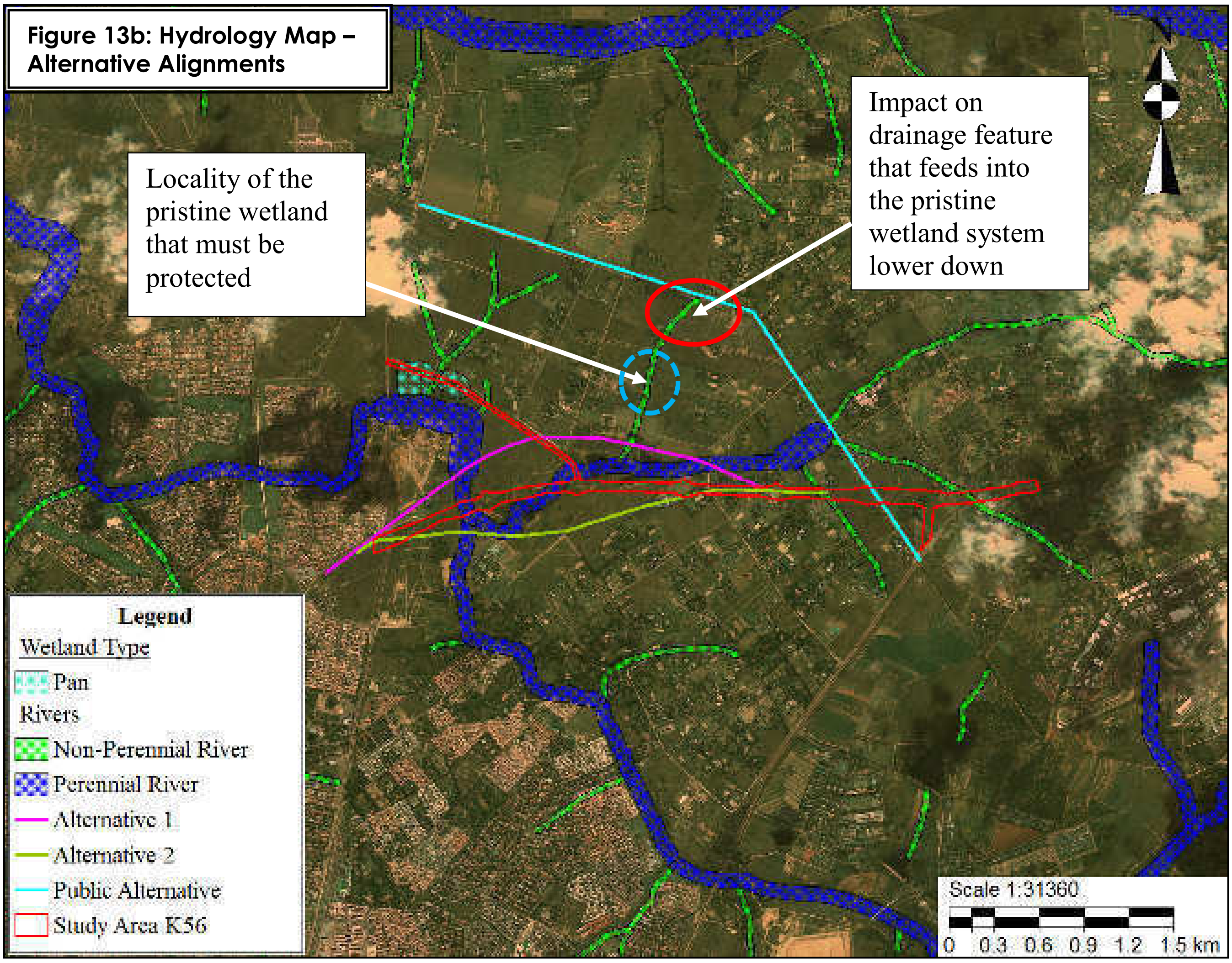
6.1.2 Hydrology

(Refer to Figure 13: Hydrology Map).

6.1.2.1 Surface Hydrology

The study area falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo catchment.

All three the route alThe route traverses an undulating terrain and slopes towards the Jukskei River. The proposed route and alternatives cross the Jukskei River and tributary as well as non- perennial rivers a number of times. ***Refer to Figure 13a, Hydrology Map.***



Take note that Alternative Alignments 1 and 2 will also have significant impacts on the hydrology. The Alternative alignment (supplied by the community) that follows Zinnia Road will have the lowest impact on the general hydrology, but it could have the largest impact on the long term sustainability of the pristine wetland, which is situated lower down within and along this drainage line*. **Refer to Annexure F1*** for wetland report compiled by Dr. Johan van der Waals. We requested that Dr. van der Waals investigate the possibility of moving Alignment Alternative 1 more to the north, but he rejected this proposal in order to protect this wetland area.

Dr. van der Waals did not regard the man-made dams and wetlands affected by the preferred alignment as pristine and he indicated that it will be possible to construct the road through this area. He however supplied mitigation guidelines that must be taken into consideration during the planning, construction and operational phases.

The proposal is to elevate the road across this area and some pedestrian and equestrian links will also be provided underneath the road to allow for safe movement through the area and to avoid conflict with the K56. Such pedestrian and equestrian movement corridors will also consider the hydrological mitigation measures as provided.

6.1.2.2 Floodlines

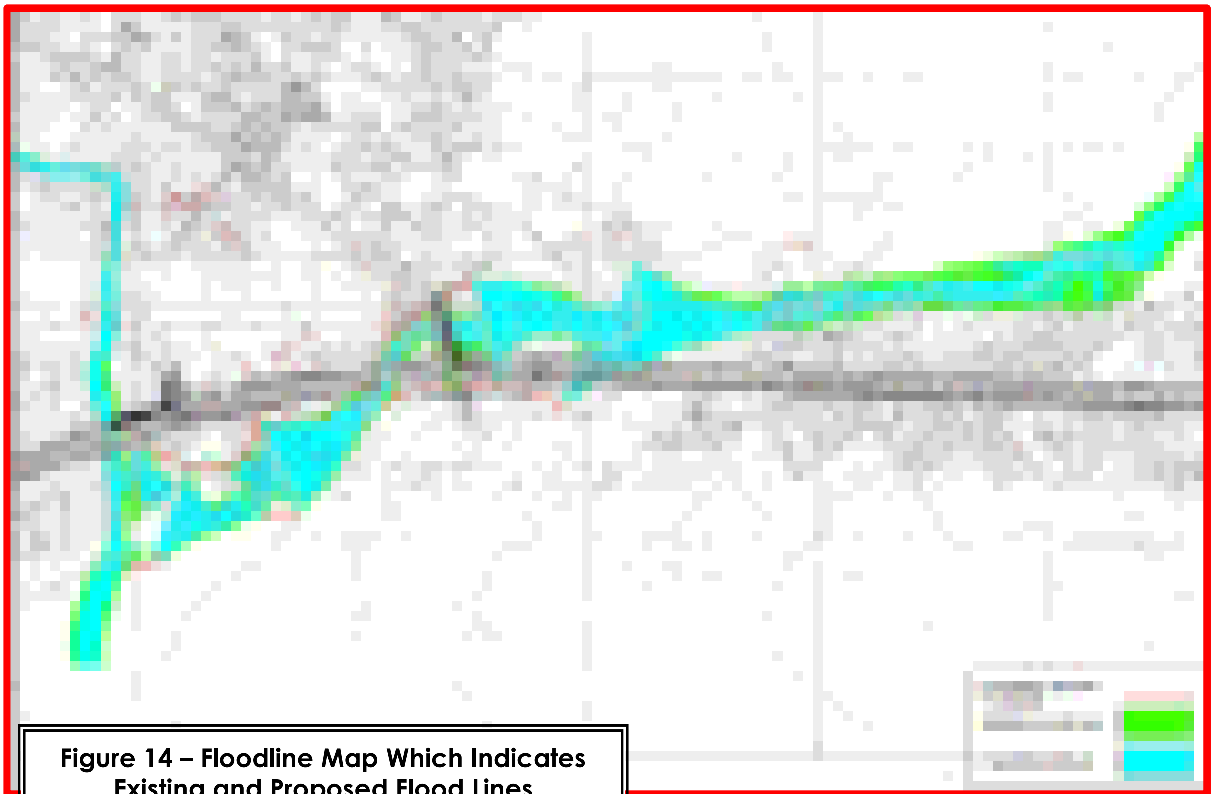


Figure 14 – Floodline Map Which Indicates Existing and Proposed Flood Lines

The involved section of the K56 crosses the Jukskei River, a tributary of the Jukskei River and two non-perennial rivers and is therefore influenced by a number of 1:100 year floodlines. ***(Refer to Figure 14 above, Floodline Map in Annexure A)***

6.1.2.3 Sub-Surface Hydrology

The permeability of the surface soil is expected to be high unless clays occur. Local seepage can be expected on the granites, especially where elevated groundwater levels occur due to ferricrete.

The Granite is strong water bearing on a relatively shallow depth. The involved engineers stated that all the properties adjacent to the route are dependent on boreholes for water provision. This must be taken into consideration during the detail design of the road.

Bokomoso appointed Dr M Levin to perform a desktop geohydrological study for the upgrade of the Erling Road traversing Treesbank/Glenferness Agricultural Holdings north of Fourways in Johannesburg. The objective of the study is to describe the baseline geohydrological conditions within the project area on a desktop level.

According to the published 1:50 000 geological map (2528CC Lyttleton), the project area are underlain by the Halfway House Granite Group from the Swazian Era consisting of Gneiss, Migmatite and Porphyritic Granodiorite. ***(Refer to Annexure F(v))***

According to Dr. Manie Levin the ground water rest levels is generally between 5 and 30m below surface. Due to the project area's close proximity to the Jukskei River, a shallow groundwater level (less than 10m below surface) can be expected. Shallow perched water levels can be expected during the rainy season. This is due to the presence of ferricrete in the mid-slope areas.

Based on aerial photo interpretation and the numerous numbers of smallholdings present within the project area, it can be assumed that boreholes are present and groundwater is used for irrigation purposes as a minimum. Groundwater being used for domestic purposes should not be excluded. This should however be verified by means of a hydrocensus.

Table 13: Issues and Impacts – Hydrology

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact/ Neutral - Not Necessary To Mitigate ☼**
6)	Siltation, erosion and water pollution could occur in the Jukskei River, tributaries and associated wetlands and systems lower down in the catchment area if a stormwater management plan is not implemented.	-	☺
7)	Groundwater pollution and contamination of the Jukskei River, tributaries and associated wetlands.	-	☺
8)	Increased storm water runoff from road into surrounding natural areas	-	☻
9)	Presence of boreholes along the route can have an impact on the stability of deep excavations	-	☺

6.1.2.2.c Discussion of issues identified, possible mitigation measures and significance of issue after mitigation - Hydrology

6) Siltation, erosion and water pollution could occur in the Jukskei River, tributaries and associated wetlands and systems lower down in the catchment area due to a lack of suitable storm water management measures during construction and operational phases.

If erosion, siltation and water pollution is not addressed, the sustainability of the wetlands and the open space systems lower down in the catchment area can be negatively impacted by the development.

More impermeable surfaces will lead to an increase in the speed, quantity and quality of the storm water and erosion could be caused at discharge points of storm water.

Table 14: Significance of Issue 6 (Siltation, erosion and water pollution) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/ C / O –** The storm water design for the proposed road must be designed to: - Reduce and/ or prevent siltation, erosion and water pollution. - Storm water runoff should not be concentrated as far as possible and sheet flow should be implemented. - The vegetation must be retained as far as possible, and rehabilitated if disturbed by construction activities to ensure that erosion and siltation do not take place.	**M -** To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

7) Groundwater pollution and contamination of Jukskei River and tributaries

Uncontrolled construction activities could cause run-off contaminated with silt or cement to reach the wetlands, streams and spring, leading to water contamination. Accidental spillages of diesel, oil or other hazardous substances could contaminate soil, leach into the groundwater or reach the water bodies through run-off.

The storm water management plan must be designed to:

- Reduce and/ or prevent siltation, erosion and water pollution; and
- Improve the surface and ground water quality of the study area and the lower lying areas within the catchment area.

Table 15: Significance of Issue 7 (Ground water pollution and contamination of Jukskei River and tributaries) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/C/O -** Compilation of a storm water management plan that will address storm water management during the construction and operational phases of the project. **P/C –** Bridges or other infrastructure to cross the rivers should be constructed first to allow the remainder of the work to be undertaken on grade and should preferably be constructed during the dry season.	**M - T**o be included in EMP **M - T**o be included in EMP

	P/C – Containment of run-off from construction areas should be implemented and the streams closed off from access by construction workers.	**M** - To be included in EMP
	P/C – Cut-off drains should be trenched between the streams and the construction activities and hay bales should be stacked along the trenches where possible to contain siltation.	**M** - To be included in EMP
	P/C/O – All spillages must be cleaned up and contaminated soil removed as hazardous waste.	**M** - To be included in EMP
	P/C/O – Affected soil must be treated with DRIZIT or similar product.	**M** - To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

8) Increased storm water run-off from the proposed road into surrounding natural areas.

At present the study area is covered with vegetation and surface drainage is taking place.

The proposed road will add a large amount of hard surfaces and will also lead to the compaction of soils. The soils layers will thus become less permeable, storm water will be canalised rather than evenly spread. The quantity and speed of the storm water will increase significantly and the quality of the surface water will deteriorate, because of the lack of vegetative coverage. Erosion and siltation will also become a problem.

In order to address this issue, it will be necessary to compile a storm water management plan/ system for the proposed development.

Table 16: Significance of Issue 8 (Increased storm water run-off from the proposed road into surrounding natural areas) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High** ☻ **Medium** ☺ **Low** ◙ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P -** Compilation of a storm water management plan that will address storm water management during the construction and operational phases of the project. **P/ C / O -** The storm water management plan must be designed to: • Reduce and/ or prevent siltation, erosion and water pollution. • Improve the surface and ground water quality of the study area and the lower lying areas within the catchment area; and • Ensure that no ponding of water and concentrated ingress of water take place.	**M - T**o be included in EMP and conditions of approval **M - T**o be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

9) Presence of boreholes along the route

The presence of boreholes along the route can have an impact on the stability of deep excavations.

Table 17: Significance of Issue 9 (Presence of boreholes along the route) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High** ☻ **Medium** ☺ **Low** ◘ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P –** The impact of boreholes along the route must be investigated during the detail design of the road	**M - T**o be included in EMP and conditions of approval

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

6.1.3 Wetlands

Scientific Aquatic Services (SAS) and Dr. Johan van der Waals were appointed by Bokamoso Landscape Architects and Environmental Consultants to conduct wetland delineations and PES determinations for the study area. ***Refer to Annexure F2, Wetland Delineation Reports.***

Results of Wetland Delineation Reports

The study area falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo drainage system. The specialists identified four wetland features within the study. The man-made dams within the drainage line caused severe modification of the wetlands around the dams and the wetlands are therefore no longer regarded as pristine. The wetland study conducted by SAS consisted of field surveys and some soils tests, whilst the wetland delineation and status determination of Dr. van der Waals specifically focused on the former impacts on the wetlands, the artificial modifiers and the larger hydrological system that will be affected. ***Figures 15 a and b below represents the wetland delineation maps compiled by the specialists.***

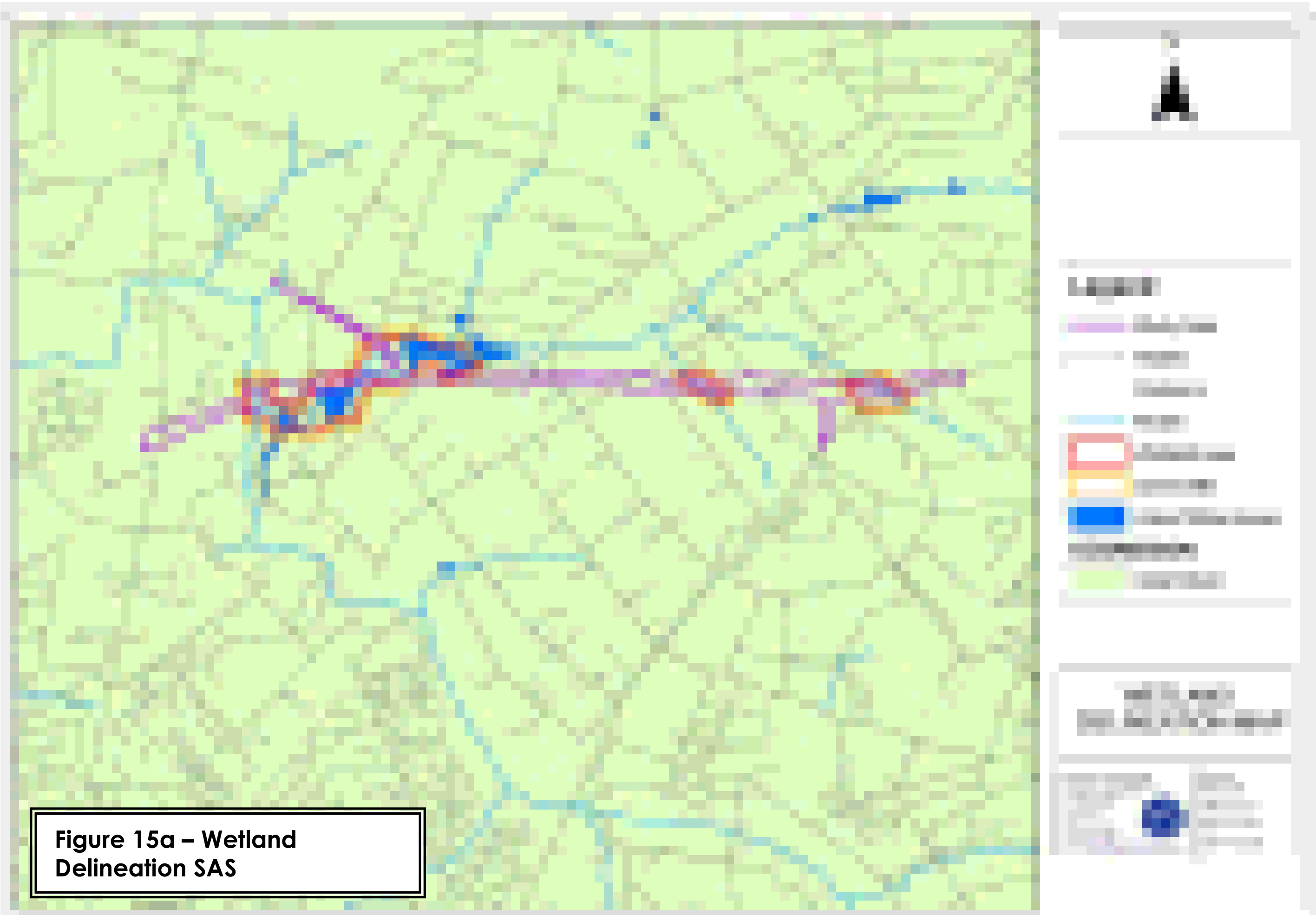


Figure 15a – Wetland Delineation SAS

Figure 15b – Wetland Delineation Dr. van der Waals

The survey results of the two wetland studies were very similar, but the recommendations supplied by such specialists were different. The SAS report regarded one of the wetlands as almost pristine, whilst the survey of Dr. van der Waals, which included more detailed soil analysis, proved that the affected wetlands were highly modified by the human intervention associated with the construction of the man-made dams. He took soil profiles of the area and also investigated the hydrological history of the larger area. Dr. van der Waals also conducted many wetland studies in the surrounding area and he also works in close association with Mr. Paul Fairall, a wetland rehabilitation specialist that also resides in the area affected by the proposed road.

Dr. van der Waals also considered the wetland report compiled by SAS and he enevtually confirmed that it will be possible to construct the preferred alignment across the hydrological features if the construction is well planned and managed.

It was suggested that Mr. Paul Fairall assist with the rehabilitation of the wetland and riparian areas that will be affected by the proposed road throughout the road planning and construction phases.

Findings:

After we perused both wetland reports, it was concluded that it will be possible to construct the proposed road across the affected wetland systems, but this will only be possible if strict mitigation measures that prevent siltation, water pollution and impacts on the functioning of the wetland and ecological systems are implemented from the outset.

As already mentioned in this report, Dr. van der Waals regarded the hydrological features affected by the proposed Alignments 1, 2 and the preferred alignment as artificial and highly modified. He regarded the implementation of the preferred alignment as possible and he made certain recommendations to restrict and prevent the potential impacts of the construction and operational phases.

He also investigated a possible alignment alternative to the north of Alignment Alternative 1 (between the Zinnia Road Alternative and Alternative 1) and he regarded this alternative as a no-go alternative, because it traversed a pristine wetland system. He confirmed that this wetland system will not be affected by the implementation of the preferred alternative, because the pristine wetland is situated within and along a drainage line that feeds into the dams.

If well planned and managed, the construction of the road can assist with the improvement of storm water management and water purification and the mitigation measures applied can even assist with the increase in bio-diversity and habitat creation and conservation.

It is important that wetland and riparian zone management and rehabilitation specialists such as Dr. van der Waals and Mr. Fairall be involved in the planning in this section of the road from the outset. Dr. van der Waals must also be consulted to assist with storm water management during the construction and operational phases.

6.1.4 Topography

The topography of this site and catchments is insulating with incised and often eroded stream channels especially in the lower reaches of the drainage features. The site has a south-south westerly aspect and is situated between 1380 and 1420 meters above sea level. The route traverses an undulating terrain and slopes towards the Jukskei River which crosses the western section of the involved section of the route as indicated on ***Figures 13a and b, Hydrology Maps.***

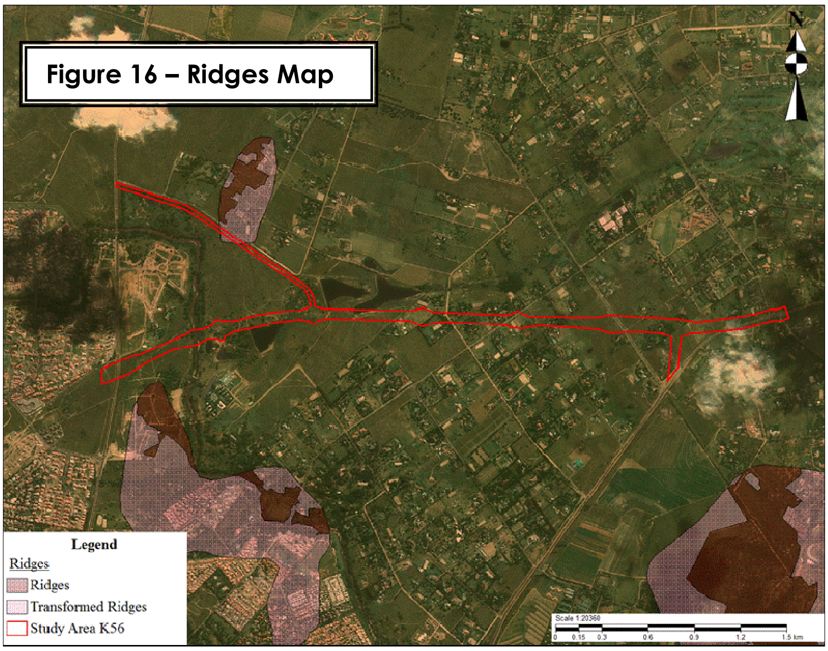


Figure 16 – Ridges Map

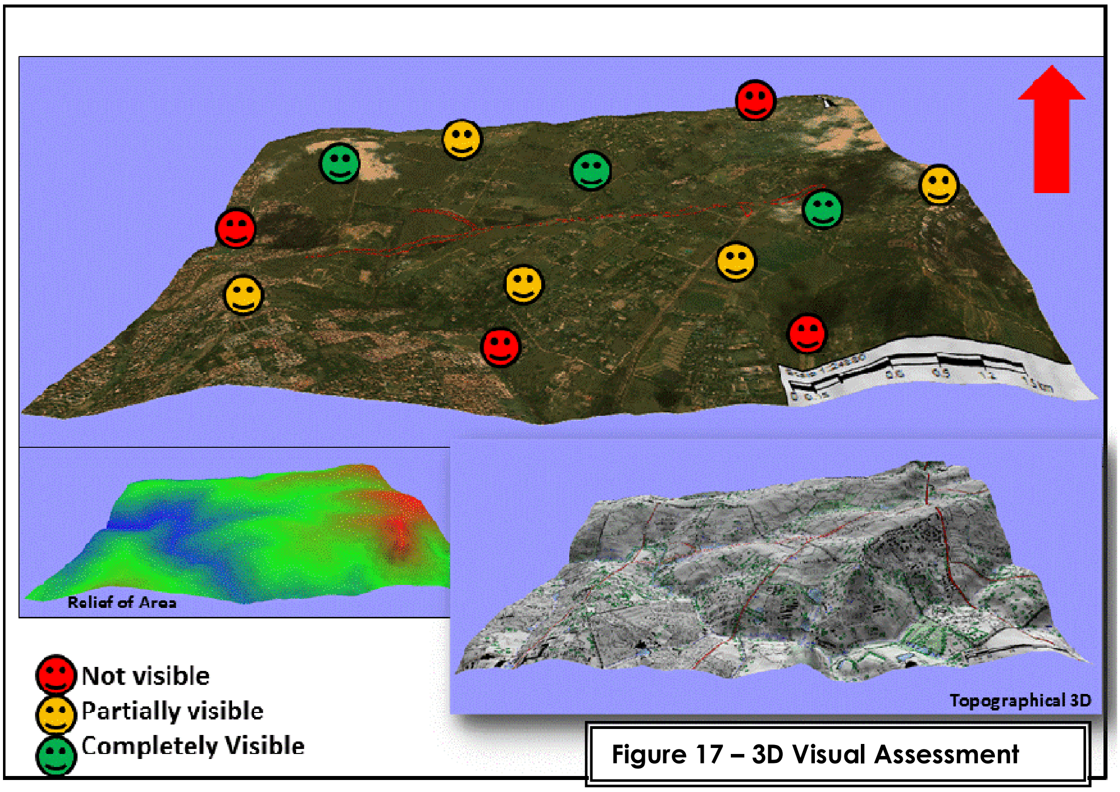


Figure 17 – 3D Visual Assessment

According to the GDARD C-Plan, 2011, the involved section of the K56 does not traverse any ridges, however the existing Erling Road traverses a small section of a transformed ridge ***(refer to Figure 16).***

Due to the topography the involved section of the K56 will be visible from the various view sheds that surround the study area. ***Refer to Figure 17, 3D Visual Assessment.***

Also take note that the proposed road will be slightly elevated at the watercourse crossings in order to allow for the free movement of water underneath such crossings (***refer to Annexure Q for conceptual treatment of road that cuts through wetland/ watercourse areas)***. There is also a possibility that the road will be elevated to allow for the pedestrian/ equestrian links that will connect the isolated southern corner of the equestrian node with the remainder of such node. According to the appointed engineers, the proposed linkage will either be established by means of an excavated sub-way underneath the road or the road will be elevated. ***Refer to Annexure R for a typical linkage as envisaged.*** The elevated section of the road across the watercourse/ dams will also be visible, especially from the properties to the south, but this section of the road traverses the Helderfontein Estate premises, which will eventually be developed and walled/fenced and the proposed development will act as visual screen. As mentioned, the proposed road across the watercourse will be designed to allow for free movement of water underneath the road. This will be established through the construction of the road on a "French drain type base". This base will also assist with the purification of water and the idea is to promote the establishment of attractive man-made wetlands around the road crossings. If well planned and managed, this will also enhance the "Sense of Place" and aesthetical qualities of the area.

Table 18: Issues and Impacts – Topography

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼**
10)	The proposed road will be visible from surrounding view-sheds.	-	☺

6.1.4.a Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

10) Due to the topography the proposed road will be visible from surrounding view-sheds.

Mitigation measures to restrict/ prevent the visual impacts of the road will have to be implemented.

Table 19: Significance of Issue 10 (the proposed road will be visible from surrounding view-sheds in the Flatter Areas around the Study Area) After Mitigation/ Addressing of the Issue

Mitigation Possibilities	Mitigation	Significance of Issue after

High ☻ **Medium** ☺ **Low** ◘ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/C/O -** Possible mitigation measures that could be considered are the establishment of dense vegetation at strategic points to screen-off the most visible sections of the roads / construction of berms adjacent to the road/ a combination of berms with vegetation.	**M –** To be incorporated as part of the EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed assessed in the Significance Rating Table*

6.1.5 Climate

The climate is typical of the Transvaal Highveld. The summers are mild to hot and the winters mild. It is a summer rainfall region with a mean annual precipitation of approximately 740mm. The Weinert N value is approximately 2.3, which indicates that chemical decomposition is the predominant form of weathering of rock.

The climatological data for the site was taken from the Johannesburg weather office.

Wind

Summer prevailing winds northwest, winter winds southeast.

Temperature °C

Average maximum 26.0 °C, minimum 13.63 °C in summer. Average winter temperature maximum 18.32 C, minimum 5.37°C.

Rain

Average annual rainfall of 740mm.

Table 20: Issues and Impacts – Climate

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼**
11)	Should the construction phase be scheduled for the summer months, frequent rain could cause very wet conditions, which makes road construction and environmental rehabilitation works extremely difficult.	-	☻
12)	If dry and windy conditions occur during the construction phase, dust pollution could become a problem.	-	☻

6.1.5.a Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

11) Should the construction phase be scheduled for the summer months, frequent rain could cause very wet conditions, which makes it extremely difficult to build in and to do rehabilitation works of disturbed areas.

These wet conditions often cause delays to building projects and the draining of water away from the construction works (in the case of high water tables) into the Jukskei River, tributary and associated wetlands, could (if not planned and managed correctly) have an impact on the water quality of these water bodies.

Table 21: Significance of Issue 11 (Should the construction phase be scheduled for the summer months, frequent rain could cause very wet conditions, which makes it extremely difficult to build in and to do rehabilitation works of disturbed areas) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P/C** – Construction workers and construction vehicles and machinery must stay out of the soggy areas during the wet periods. Barrier tape should be used to demarcate the areas that are drenched with water and it should only be removed when the appointed Environmental Control Officer (ECO)/ site supervisor/ project manager/ main contractor regard the conditions in the affected areas as favourable.	**M** - To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed assessed in the Significance Rating Table*

12) If dry and windy conditions occur during the construction phase, dust pollution could become a problem.

If dry and windy conditions occur during the construction phase, dust pollution could become a problem. During the summer months dust pollution could be carried over the properties to the south-east (i.e. Glenferness A.H. and Kyalami A.H., Helderfontein Estate

Development) and during the winter months dust could be carried over the properties to the north-west (i.e. Glenferness A.H., Kyalami A.H., Fourways X2) as well as the K46.

Sweeping of the construction site, clearing of builders' rubble and debris as well as the regular watering of the construction site (storage areas, roads etc.) must take place at least once a day.

Table 22: Significance of Issue 12 (Dust Pollution) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High** ☻ **Medium** ☺ **Low** ◙ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P/C –** Sweeping of the construction site, clearing of builders' rubble and debris as well as the regular watering of the construction site (storage areas, roads etc.) must take place at least once a day.	**L -** To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed assessed in the Significance Rating Table*

6.2 The Biological Environment

GDARD Biodiversity Information:

According to the information received from GDARD specialist biodiversity studies are required to investigate the following aspects:

- Plants, with specific reference to *Brachycorythis conica*, *Gnaphalium nelsonii* and *Trachyandra erythrorrhiza*.
- Vegetation.
- Wetlands.
- Rivers.

Refer to Annexure G for Biodiversity information received from GDARD.

Scientific Aquatic Services (SAS) was appointed to conduct a Floral, Faunal, Wetland and Aquatic Assessment for the involved section of the K56 *(refer to Annexure F(iii) for the reports).*

6.2.1 Vegetation

The study area falls within the Savanna Biome, the Bushveld Basin bioregion and Egoli Grassland Vegetation Type, which is considered to be an endangered vegetation type. Ecological functioning and the condition of the study area range from high within wetland areas to low within the transformed areas.

Four habitat units were identified during the assessment, namely the Wetland Habitat Unit, the Rocky Outcrop Habitat Unit, the Open Grassland Habitat Unit and the Transformed Habitat Unit. The Transformed Habitat Unit encompasses the majority of the study area, while the Wetland Habitat Unit occurs within the east, west and central portions of the study area. ***Refer to Figure A, in Annexure F3.***

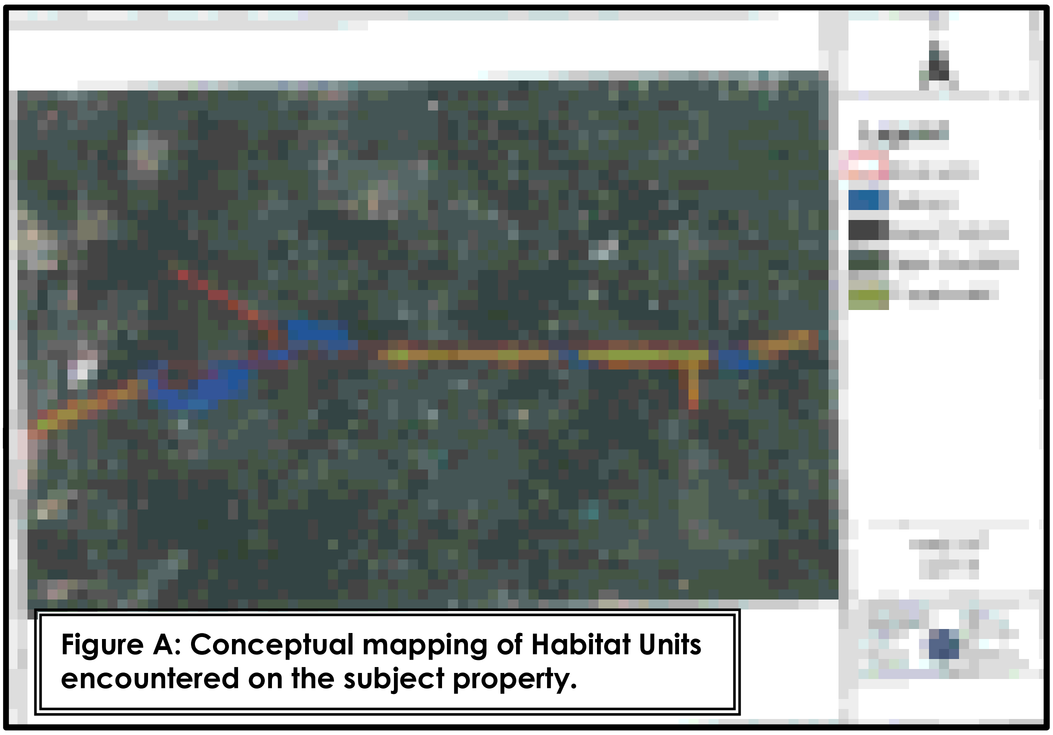


Figure A: Conceptual mapping of Habitat Units encountered on the subject property.

This habitat unit covers a relatively large portion of the study area and is present in the eastern, western and central portion of the proposed route and include a number of artificial impoundments. Several wetland and drainage features occur along the proposed route. Although the ecological integrity of some of these wetland features have been impacted by anthropogenic activities, in particular urban and residential development, as well as historic agricultural activities, the majority of the riparian and wetland areas have remained reasonably undisturbed and are in a largely natural state, apart from the dam areas. The wetland areas are considered to be of high ecological sensitivity and have high potential to support an increased diversity of faunal and floral species and are also important in terms of faunal migratory connectivity.

Moderate to high floral species diversity was observed in wetland and riparian areas. ***Refer to Table 1, Annexure F3*** for a list of the dominant species encountered within the wetland areas.

- **Habitat Unit 2: Rocky Outcrop Area**

The Rocky Outcrop Habitat Unit is located in the area of the proposed Erling Road link with the proposed alignment. This habitat unit consists mainly of rocky boulders which protrude from the wetlands in areas. The tree layer is dominated by very large specimens of *Combretum erythrophyllum*, *Searsia pyroides, Celtis africana, Euclea crispa, Olea europaea* subsp *africana* and *Diospyros lycioides* trees while the forb layer is dominated by *Cheilanthes virides* ferns.

A large portion of this habitat unit is located within the footprint of the proposed Erling Road link with the proposed route. Due to the high ecological functionality, unique habitat and intact habitat integrity of the rocky ridge areas, the conservation value of this habitat unit is considered to be **high.** The involved floral specialist recommended that the proposed route avoid the Rocky Outcrop Habitat Unit. It is further stated this habitat unit could also provide suitable habitat for Red Data Listed floral species, namely *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica.* Furthermore, the Rocky Outcrop Habitat Unit provides important habitat for faunal species that move through the area and unique habitat for a number of floral species. This Habitat Unit is therefore deemed to be **of high ecological sensitivity.**

Refer to Table 2, Annexure F3 for a list of the dominant species encountered in the Rocky Outcrop Habitat Unit.

- **Habitat Unit 3: Open Grassland**

The Open Grassland Habitat Unit covers part of the central portion of the proposed route not affected by current urban development.

This habitat unit consists of a well-developed grass layer, interspersed with clumps of indigenous tree specimens, dominated by *Combretum erythrophyllum*, *Ziziphus mucronata* and *Searsia pyroides*. The overall ecological functionality of these areas remains intact although a number of alien plant species are present within this habitat unit. *Babiana hypogea* var *hypogea*, as well as *Hypoxis hemerocallidae*, (the latter being IUCN listed as „Declining") have been encountered in this area and the overall forb layer is well-represented. The grass layer is dominated by *Heteropogon contortus, Themeda triandra, Hyparrhenia hirta* and *Melinis repens*, the latter two species being indicative of disturbance. A number of graminoid species encountered are representative of the expected vegetation type, Egoli Granite Grassland. The involved flora specialist stated that the ecological sensitivity is lowered due to the relatively high number of alien plant species present and disturbance in the form of trampling and informal roads. Dominant alien species include *Lantana camara, Schkuria pinnata, Tagetes minuta, Bidens pilosa, Stoebe vulgaris* and *Zinnia peruviana*.

Refer to Table 3, Annexure F3 for a list of the dominant species encountered in the Open Grassland.

- **Habitat Unit 4: Transformed Areas**

The Transformed Habitat Unit includes areas directly adjacent to the road reserves, that have been impacted or transformed by historic construction activities, as well as areas associated with urban development, including residential gardens. The majority of areas associated with this habitat unit are situated within the east of the study area. Although some indigenous plant species occur within this habitat unit, the majority of species are typical of urban habitats and include a number of invasive species.

No plant species of concern were encountered within this habitat unit, and it highly unlikely that any such specimens will occur, due to the lack of suitable habitat and high levels of transformation.

Refer to Table 4, Annexure F3 for a list of the dominant species encountered in the Transformed Areas.

Red Data Listed Species

No RDL or protected floral species were identified during the various assessments that were conducted. However, the involved flora specialist stated that the Rocky Outcrop and Wetland Habitat Units may provide suitable habitat to support such floral species.

Exotic and Invader Species

Levels of alien floral invasion were moderate to high within all habitat units identified, apart from within the Rocky Outcrop Habitat Unit, where alien invasive species are restricted to riparian edges.

Sensitivity Mapping

Wetland features, as well as the rocky outcrop area located centrally with respect to the proposed development route, are considered sensitive and were identified and delineated by SAS ***(refer to Wetland Delineation report, Annexure F2).*** This is mainly due to the higher diversity of faunal and floral species expected to occur within these areas and the potential of these areas to host RDL species, as well as the unique habitat the wetland and rocky outcrop areas provide for both faunal and floral species. It is therefore deemed important that these areas be excluded from the proposed alignment of the route.

The Open Grassland Habitat Unit is not deemed to be sensitive, as a result of high levels of alien plant species invasion, while the transformed areas are deemed to be of low sensitivity as a result of the high levels of transformation present. The Transformed Habitat Unit is not likely to support any RDL or sensitive faunal or floral species, while the Open Grassland and Wetland Habitat Units may hosts RDL floral species such as *Hypoxis hemerocallidae* (positively identified on site) and *Boophane distcha*. ***Refer to Figure B, Sensitivity Map.***

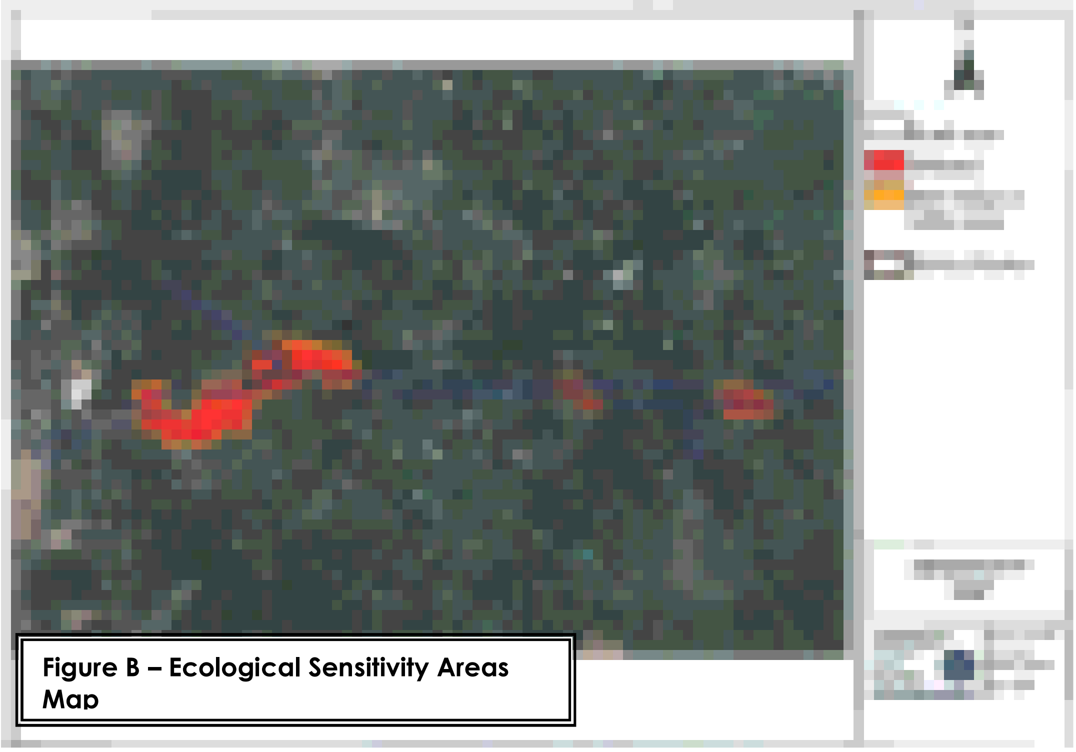


Figure B – Ecological Sensitivity Areas Map

CONCLUSIONS AND RECOMMENDATIONS BY SAS

The study area can be broadly divided into four habitat units. Each is considered different with regards to ecological condition and functioning. Only the Wetland and Rocky Outcrop Habitat Units can be considered of increased ecological importance. These areas have the highest potential of supporting a variety floral and faunal species when compared to the remainder of the subject property. One RDL floral species, namely *Hypoxis hemerocallidae* („Declining") was encountered during the assessment.

The following general conclusions were drawn on completion of the survey:

- The study area falls within the Savanna Biome, the Bushveld Basin bioregion and Egoli Grassland Vegetation Type, which is considered to be an endangered vegetation type;

- Four habitat units were identified along the proposed development route, namely the Wetland Habitat Unit, the Rocky Outcrop Habitat Unit, the Open Grassland Habitat Unit and the Transformed Habitat Unit. The Transformed Habitat Unit encompasses the majority of the study area, while the Wetland Habitat Unit occurs within the east, west and central portions of the subject property;
- The entire subject property has been subjected to a degree of vegetation transformation as a result of urban and residential development and historic agricultural activities. Alien invasive plant species are present in all habitat units;
- The Rocky Outcrop Habitat Unit has experienced a low degree of disturbance and is considered to be highly sensitive as a result of the unique habitat it provides for faunal and floral species. It also has the potential to host RDL plant species, such as *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica*;
- The Wetland Habitat Unit also has higher ecological sensitivity compared to the Open Grassland and Transformed Habitat Unit due to the potential habitat for faunal and floral species and the migratory connectivity for faunal species that these areas potentially provide;
- The Open Veld Habitat Unit is not considered to be ecologically sensitive, as a result of its isolated nature and the high numbers of alien plant species present;
- The Transformed Habitat unit is considered to be of low ecological sensitivity as a result of its impacted nature due to past development in the area;
- No RDL or protected floral species were identified during the assessment. However, the Rocky Outcrop and Wetland Habitat Units may provide suitable habitat to support such floral species;
- Levels of alien floral invasion were moderate to high within all habitat units identified, apart from within the Rocky Outcrop Habitat Unit, where alien invasive species are restricted to riparian edges;

After conclusion of this floral assessment, the following recommendations are provided:

Development and operational footprint

- A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities in order to aid in the conservation of ecology within and adjacent to the proposed development area. The Rocky Outcrop Habitat Unit should not be disturbed due to its unique ecology.
- *Hypoxis hemerocallidae*, *Babiana hypogea* var. *hypogea*, and *Boophane disticha* (if discovered on site), occurring within the development footprint should be rescued and relocated to suitable habitat in the vicinity of the study area.
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland and rocky outcrop areas. The boundaries of footprint areas are to be clearly defined.
- Large trees should be maintained where possible for the length of the proposed development route.
- Proper planning of infrastructure, which avoids unnecessary barriers in migratory corridors, should be conducted during the pre-construction phase.

Wetlands

- As much of the ecological functioning and migratory connectivity of the drainage features need to be maintained.
- No topsoil, waste rock or building material should be dumped into any existing wetland and rocky outcrop areas, as these areas are considered to be of higher ecological importance.
- It must be ensured that construction-related waste and effluent do not affect the wetland resources and associated buffer zones.

- Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in more sensitive wetland and rocky outcrop areas.
- All construction vehicles should remain on designated roads with no indiscriminate driving through wetlands/ riparian or rocky outcrop areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater and erosion management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the wetland areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
- Where the track has slope of less than 2%, berms every 50m should be installed.
- Where the track slopes between 2% and 10%, berms every 25m should be installed.
- Where the track slopes between 10%-15%, berms every 20m should be installed.
- Where the track has slope greater than 15%, berms every 10m should be installed.

Alien plant species

- Proliferation of alien and invasive species is expected within disturbed areas.
- These species should be eradicated and controlled to prevent their spread beyond the site boundary. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on rehabilitation in the future, has to be controlled.
- Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the

Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.

- All soils compacted as a result of construction activities and falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.

Fire

- All informal fires on the property should be prohibited, specifically during the construction phase of the proposed development.

Dust

- It is to be ensured that all temporary access roads and construction areas are regularly sprayed with water or treated with other dust suppression measures in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss into adjacent waterways.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting are to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.

- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.
- Any areas where earthworks have taken place, should be reseeded with indigenous vegetation to prevent erosion.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation.
- A suitably qualified wetland management and rehabilitation specialist must be appointed to assist with the road planning and construction phases. If possible such specialist must also be appointed to manage and monitor the ecological integrity, habitat creation, ecological systems etc. during the operational phase (on a on-going basis).

6.2.2 Fauna

SAS was appointed to conduct terrestrial, wetland and aquatic ecological assessment of the study area.

Two site visits were undertaken during March and April 2012 to determine the ecological status of the subject property to undertake a general faunal biodiversity assessment, with emphasis being placed on the potential occurrence of any threatened RDL faunal species which are highlighted for Gauteng Province (GDARD, 2004).

Mammals

Field sightings of Yellow Mongoose (Cynictis penicillata) and Angoni Vlei Rat (otomys angoniensis) were made during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property were Mole rat mounds (Genus; Cryptomys), Cape Clawless Otter (Aonyx capensis) droppings and small rondents that are associated with domestic and urban areas and domestic waste products. **No**

other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mammal species.

Avifauna

All bird species seen or heard during the time of the assessment were recorded. Surveys were conducted along the entire subject property and in the immediate surroundings.

Refer to Table2, in Annexure F3 for the list of bird species recorded during the field survey.

Reptiles

One non RDL reptile species was identified during the assessment of the rocky outcrop habitat unit, namely the Striped Skink (*Mabuya striata*), it is anticipated that other commonly occurring reptile species may reside within the subject property. **No RDL reptile species were encountered during the field assessment.**

Amphibians

No RDL amphibian species were found during the field assessment, only the Common platanna (Xenopus laevis) species was noted during the field assessment. The likelihood of this RDL species occurring in the subject property is considered significant due to the suitable wetland habitat conditions.

Invertebrates

The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property**.** **Refer to Table 6 in Annexure F3, for the general results from invertebrate collecting.**

Arachnids and Scorpions

None of the RDL species were encountered during the site survey.

The following general conclusions were made by SAS on completion of the survey:

In general there is good natural rocky outcrop and woodland habitat units along with good wetland units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. ***Refer to Figure A, Habitat Map.***

- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property. No GDARD and IUCN RDL threatened mammal species were found in the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit.
- No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may occur within the subject property. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck

(Oxyura maccoa) and African Finfoot *(Podica senegalensis*) and for feeding purposes by the African Marsh Harrier *(Circus ranivorus*), the Lesser Falcon *(Falco naumanni*) and the Lanner Falcon *(Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.

- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.
- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri)*. The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is

known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered significant.

- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.
- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the

migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

After the conclusion of this biodiversity assessment, it is the opinion of the ecologists that from an ecological viewpoint, the proposed development be permitted provided that the recommendations below are strictly adhered to:

- The defined areas of high sensitivity habitat (wetland and rocky out crop habitat unit) areas should remain undeveloped as public or private open space. A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning and construction phases of the proposed development activities to aid in the conservation of ecological processes within the subject property. It is highly recommended that the proposed intersection be moved away from the wetland and unique rocky habitat unit areas since this intersection development will have the largest impact on the ecology of all the development areas and is currently located within and adjacent to the most sensitive area along the entire proposed development route within the subject property.
- All footprint areas should remain as small as possible and should not encroach into the wetland and rocky outcrop habitat units. This can be achieved by fencing footprint areas to contain all activities within designated areas. However, all fencing material should be removed and disposed of in an appropriate manner when activities are completed. In addition fencing should be constructed in such a way as to still ensure free movement of smaller faunal taxa through the area.
- Proliferation of alien and invasive floral species is expected within disturbed areas such as next to the gravel road. These exotic flora species should be eradicated and controlled to prevent their spread beyond the site boundary as well as seed dispersal within the top layers of the soil within footprint areas that will have an impact, habitat and food availability as well as on rehabilitation in the future.

- In order to preserve faunal habitat, the recommended faunal management and mitigation plans as in the floral report (Section A) should be taken into consideration to prevent any loss of faunal habitat as well as any further establishment of alien flora.
- Construction vehicles should be restricted to travelling only on the existing road servitudes to limit the ecological footprint of the proposed development activities.
- Ensure that construction boundaries are clearly marked and no vehicles are to encroach upon the wetland and other sensitive habitat unit areas. If this is unavoidable, ensure that these areas are suitably rehabilitated with special mention of ensuring habitat connectivity and re-establishment of natural conditions as far as possible.
- Ensure that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected.
- Adequate sanitation facilities should be provided for labourers to avoid the informal usage of the veld.
- No fires should be lit whatsoever within designated sensitive areas during the construction phase of the development.
- Edge effects of project related activities in these areas including erosion and alien floral species establishment need to be strictly managed in these areas.
- Compare the positions of planned infrastructure to the areas of mapped sensitivity.
- No dumping of waste should take place within any area of the subject property. If any spills or waste deposits occur, they should be immediately cleaned up.
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the wetland areas.
- As much of the grassland is to be left undisturbed as possible to allow for the ongoing conservation of invertebrate species which may inhabit the proposed development site.
- As much vegetation growth, thus faunal habitat areas, as possible should be promoted within the proposed development area in order to protect soils and to reduce the percentage of the surface area which is paved. In this regard special

mention is made of the need to use indigenous vegetation species as the first choice during landscaping to ensure that there is adequate natural faunal habitat.

- If any threatened RDL faunal species are identified within the proposed development route and subject property during construction activities, the proponent and contractors should ensure effective relocation of individuals to suitable offset areas or within designated open space on the subject property.
- All rescue and relocation plans should be overseen by a suitably qualified specialist.
- Designated sensitive areas must be off-limits to construction personnel.
- No trapping or hunting of fauna is to take place. Access control must be implemented to ensure that no illegal trapping or poaching takes place.
- All soils compacted as a result of construction activities falling outside development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout the all phases of the development.
- Ensure that all disturbed and exposed areas are rehabilitated and covered with vegetation to prevent post-rehabilitation dust generation.
- Ensure that all hazardous storage containers comply with the relevant SABS standards to prevent leakage.
- Regularly inspect all construction vehicles for leaks.
- Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.
- Erosion management measures must be implemented to prevent soils from eroding into surface water resources.

Aquatic Survey

SAS was appointed to conduct an aquatic ecological assessment prior to the proposed construction of Road K56. ***Refer to Section E, Annexure F3.***

The purpose of the aquatic ecological assessment was to survey the general habitat integrity, habitat conditions for aquatic macro-invertebrates, aquatic macro-invertebrate community integrity and fish community integrity.

It was the objective of the study to provide detailed information to guide the development of the proposed K56 road upgrade in the vicinity of riparian areas to ensure that the ongoing functioning of the areas aquatic systems in conjunction with the wetlands is facilitated with specific mention of the following:

- To ensure that connectivity of the riparian areas is maintained between the areas upstream and downstream of the portions of the K56 Roadway designated for the upgrade;
- To ensure ongoing functioning of the riparian areas in the vicinity K56 Roadway;
- To ensure that the risks to the instream ecology are adequately understood and that suitable mitigatory measures are presented to minimise impacts on these resources.
- To ensure that no incision and canalisation of the riparian system takes place as a result of the K56 Roadway upgrade.

The following key findings are highlighted pertaining to the study:

Jukskei River (Site K1)

Biota specific Water quality

- General water quality can be considered to be fair, based on the results of the biota specific water quality analyses
- Limited amounts of dissolved salts present in the system although salt concentrations can be considered to be elevated form the natural conditions expected for the area. Limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is slightly alkaline however no impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.

- Dissolved oxygen concentration in the system is low and is likely to place significant stress on the aquatic community in the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the K1 site, it is evident that there are serious impacts on the habitat integrity of the area. The most significant instream impacts included water bed modification, water quality and channel modification. Moderate impact from solid waste disposal, as well as flow and water abstraction was noted. Overall, the site achieved a 33% score for instream habitat integrity ***(Refer to Appendix 3, Annexure F).***
- The most significant riparian zone impacts were alien encroachment followed by bank erosion and channel modification. Moderate level impacts observed were namely vegetation removal, water abstraction, flow modification and channel modification. The site achieved a 17% score for riparian integrity ***(Refer to Appendix 3, Annexure F).***
- The site obtained an overall IHIA rating of 25%, which indicates extensively modified (class E) conditions. The site, therefore, falls outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is considered inadequate for supporting a diverse aquatic macro-invertebrate community

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K1) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.

- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 29.
- The site, falls below the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

- No fish were captured during the assessment indicating that long term impacts on the system are likely. In this regard special mention is made of the water quality has a major effect on the fish assemblage as does migration barriers in the system which were observed upstream from site K1. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system with special mention of migratory connectivity.
- Thus according to the protocol of Kleynhans (1999) Present State Classes in terms of FAII scores, the fish community at this point is critically modified (Class F).

Tributary River (Site K2)

Biota specific Water quality

- The water quality for this tributary stream can be considered to be fair, with limited amounts of dissolved salts present in the system although some elevation of salt concentrations from the natural conditions is deemed likely. Fairly limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is 7.2 and considered relatively natural. No impact on the aquatic community due to altered pH conditions is deemed likely.

- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentrations are fair but some more sensitive taxa may be absent from the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the tributary river at site K2, which falls within the study area, it is evident that there are impacts on the habitat integrity of the area. The most significant instream impacts included flow modification due to the already existing upstream impoundments that are situated along this tributary system. Overall, the site achieved a 52% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impact was flow modification. Low level impacts observed were namely vegetation removal, water abstraction, bank erosion, water quality and channel modification. The site achieved a 37% score for riparian zone integrity (Appendix 3).
- The site obtained an overall IHIA rating of 45%, which indicates largely modified (class D) conditions. The tributary site K2, therefore, falls just outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the tributary river which flows into the Jukskei River has suffered a severe loss in integrity.

- At present, the site (K2) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.
- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 39 and ASPT of 3.5.
- The K2 site, falls outside the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

Two fish species, the Long bearded Barb (*Barbus unitaeniatus)* and the Mozambique Tilapia (*Oreochromis mossambicus*) were captured, identified and released during the assessment. The low diversity indicates that long term impacts on the system are likely. In this regard special mention is made of migration barriers (such as dams) in the system and the water quality levels. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system.

- The FAII data indicates that the fish community in this section of the tributary system has suffered a critical loss in integrity when compared to the expected score for a stream in this catchment with the habitat characteristics of the area.
- The absence of fish in the system is indicative of long term impacts on the system, with special mention of impacts on water flow modification and migration barriers.
- With only a low diversity and abundance of fish in the area, the fish community of the area is considered critically modified (Class F).

- Measures to improve water flow should be sought in order to allow fish species to re-establish in the system.
  It is important to ensure that no impacts on fish migration on the system occur as a result of the proposed development

Recommendations by SAS

- Measures to control seepage and sedimentation into the riparian areas especially during the construction phase on site should be considered to prevent further sedimentation from reaching the receiving surface water environment.
- Sediment analyses within the Jukskei River and associated stormwater systems should take place on a two yearly basis and compared to historical data.
- As much of the ecological functioning and natural connectivity of the riparian features drainage systems need to be maintained.
- All construction vehicles should remain on designated roads with no indiscriminate driving through riparian areas.
- No construction vehicles are to be allowed to cross through riparian areas.
- Where construction vehicles need to cross over riparian areas (natural rivers) a bridge should be constructed over the riparian areas in order to preserve the aquatic habitat integrity and connectivity.
- Vehicles are to be regularly serviced to ensure minimal hydrocarbon spillages occur.
- If there is a hydrocarbon spill, a clean-up plan should be implemented immediately.
- No topsoil, waste rock or building material should be dumped into any existing riparian area, as these areas are considered to be of higher ecological importance.
- It must be ensured that construction-related waste and effluent do not affect the aquatic resources and associated buffer zones.
- Edge effects of activities, including erosion and sedimentation, have to be strictly managed along the riparian areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater, erosion and sedimentation management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the riparian areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the riparian areas. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils and the riparian areas. In this regard special mention is made of the need to use indigenous vegetation species where rehabilitation planting is to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are

to be reinforced where necessary with reno mattresses and geotextiles.

- Any areas where earthworks have taken place should be reseeded with indigenous vegetation to prevent erosion and sedimentation.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation and sedimentation.

6.2.4 Species List for Helderfontein supplied by Jacqueline Wetselaar

A species list for Helderfontein (October 2012) was supplied by Jacqueline Wetselaar (M.Sc Zoology (Wits)) ***(please refer to Annexure I).***

The species list consists of 97 flora and fauna species and according to Ms. Wetselaar it can be noted from this list that it is not any particular species that makes this area valuable (although there are a few red data species in the list), but rather it's the eco-system itself that deserves conservation as Egoli Granite Grassland in its climax condition.

Ms. Wetselaar stated that this system is VERY SENSITIVE and intolerant to frequent impacts such as heavy grazing, ploughing, trampling and general domestic activities due to the granitically derived shallow nutrient poor soils. Road making would be a massive impact on this system. Degradation occurs easily resulting in a change from the climax (high species richness) vegetation to an anthropogenic *Hyparrhenia hirta* (low species richness) dominated vegetation type.

Furthermore, the bottomland areas and wetlands within the Egoli Granite Grassland provide suitable habitat for various sensitive fauna species such as the Grass Owl *Tyto capensis* (Red Listed), Marsh Sylph *Metisella meninx* (Vulnerable), and the Giant Bullfrog *Pyxicephalus adspersus* (Near Threatened).

In an area that has been largely overtaken by pastureland and gardens, where biodiversity has been significantly reduced, here we find a small (almost intact) section of primary Highveld vegetation. According to Ms. Wetselaar this is indeed a valuable treasure which needs to be conserved. ***Refer to Annexure J for an article by G.J. Bredenkamp, L.R.***

Brown and M.F. Pfab on the Conservation value of the Egoli Granite Grassland, and endemic grassland in Gauteng, South Africa

Table 23: Issues and Impacts – Flora and Fauna

	Issue/ Impact	Positive/ Negative / Neutral ±	Mitigation Possibilities High ☻ Medium ☺ Low ◙ Positive Impact - Not Necessary To Mitigate ☼
13)	Impact on natural grassland areas and sensitive vegetation	-	☺
14)	Impact on wetland features and aquatic systems	-	☺
15)	The eradication of weeds and exotic invaders	+	☼
16)	If the entire road alignment area is cleared at once, smaller birds, mammals and reptiles will not be afforded the chance to weather the disturbance in an undisturbed zone close to their natural territories.	-	☺
17)	Noise of construction machinery could have a negative impact on the fauna species during the construction phase.	-	☺
18)	During the construction and operational phase (if not managed correctly) fauna species could be disturbed, trapped, hunted or killed.	-	☻
19)	Loss of habitat can lead to the decrease of fauna numbers and species.	-	◙

6.2.2.a Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

13) Impact on sensitive natural grassland areas and sensitive rocky outcrop vegetation

A section of the proposed route runs through natural grassland areas and sensitive rocky outcrop vegetation.

Table 24: Significance of Issue 13 (Impact on natural grassland areas and sensitive rocky outcrop vegetation) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P –** - The route should preferably avoid the rocky outcrop habitat. - *Hypoxis hemerocallidae*, *Babiana hypogea* var. *hypogea*, and *Boophane disticha* (if discovered on site), occurring within the development footprint should be rescued and relocated to suitable habitat in the vicinity of the study area. - All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland and rocky outcrop areas. The boundaries of footprint areas are to be clearly defined. - Large trees should be maintained where possible for the length of the proposed development route. - Proper planning of infrastructure, which avoids unnecessary barriers in migratory corridors, should be conducted during the pre-construction phase. **P/C** –	**M** **-T**o be included in EMP **M** **-T**o be included in EMP

	- No topsoil, waste rock or building material should be dumped into the rocky outcrop areas. - Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in rocky outcrop areas. -All construction vehicles should remain on designated roads with no indiscriminate driving through rocky outcrop areas.	
	P/C/O – No plants not indigenous to the area or exotic plant species, especially lawn grasses and other ground-covering plants should be used as soil-binding agents along new road verges as they will drastically interfere with the nature of the area.	**M** **-T**o be included in EMP
	C – As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting are to be implemented.	**M** **-T**o be included in EMP
	C/O – Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.	**M** **-T**o be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

14) Impact on wetland features and aquatic systems

The proposed route traverses the Jukskei River and tributaries as well as wetlands and could have negative impacts on these systems if not carefully planned.

Table 25: Significance of Issue 14 (Impact on wetland features and aquatic systems) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/C/O –** As much of the ecological functioning and migratory connectivity of the drainage features need to be maintained.	**M -T**o be included in EMP
	C - No topsoil, waste rock or building material should be dumped into any existing wetland areas.	**M -T**o be included in EMP
	C - It must be ensured that construction-related waste and effluent do not affect the wetland resources and associated buffer zones.	**M -T**o be included in EMP
	P/C/O – Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in more sensitive wetland areas.	**M -T**o be included in EMP
	C - All construction vehicles should remain on designated roads with no indiscriminate	**M -T**o be included in EMP

	driving through wetlands/ riparian or rocky outcrop areas.	
	P/C/O – It must be ensured that flow connectivity along the riparian features is maintained.	**M -T**o be included in EMP
	C/O – Banks of disturbed drainage areas must be reprofiled.	**M -T**o be included in EMP
	C/O – Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.	**M -T**o be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

15) The proposed development will result in the eradication of exotic invaders and weeds.

Category 1 Declared weeds, Category 2 Declared invaders and Category 3 Declared invaders were recorded in the vicinity of the proposed route. All Category 1 weeds and other alien species must be eradicated on a continuous basis.

Table 26: Significance of Issue 15 (The eradication of invasive species) After Mitigation/ Addressing of the Issue

Mitigation Possibilities	Mitigation	Significance of Issue after mitigation
High ☻ **Medium** ☺ **Low** ◘ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal

		flaw **NP**
Positive Impact - Not Necessary To Mitigate ☼	**P/C/O** – Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.	**L -T**o be included in EMP
	C -All soils compacted as a result of construction activities and falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.	**L -T**o be included in EMP
	P/C/O – No plants not indigenous to the area or exotic plant species, especially lawn grasses and other ground-covering plants should be used as soil-binding agents along new road verges as they will drastically interfere with the nature of the area.	**L -T**o be included in EMP

Result: *Positive impact, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

16) If the entire road alignment area is cleared at once, smaller birds, mammals and reptiles will not be afforded the chance to weather the disturbance in an undisturbed zone close to their natural territories

Due to the length of the proposed road it is unlikely that the entire area to be constructed will be cleared as once.

Table 27: Significance of Issue 16 (If the entire road alignment area is cleared at once, smaller birds, mammals and reptiles will not be afforded the chance to weather the disturbance in an undisturbed zone close to their natural territories) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/C -** Where possible, work should be restricted to one area at a time.	**L -**To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

17) Noise of construction machinery could have a negative impact on the fauna species during the construction phase

If not managed correctly, noise pollution (i.e. by machinery without noise muffing devices) could have a negative impact on the fauna and birds in the area. This will however only be a short-term impact and it is expected that many of the birds will return to the area during the operational phase.

Table 28: Significance of Issue 17 (Noise of construction machinery could have a negative impact on the fauna species during the construction phase) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/ C -** Noise should be kept to a minimum and the construction of the road should be done in phases to allow faunal species to temporarily migrate into the conservation areas in the vicinity.	**L -T**o be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

18) During the construction phase (if not managed correctly) fauna species could be disturbed, trapped, hunted or killed.

There is always a risk that construction personnel may disturb, trap, hunt or kill fauna on the study area. This will have a detrimental impact on the local biodiversity and will decrease fauna numbers. The issue can be mitigated if this issue is included in conservation-orientated clauses that may be built into contracts of construction personnel and if council prosecutes offenders of these actions.

Caught animals should also be relocated to conservation areas in the vicinity.

Table 29: Significance of Issue 18 (During the construction and operational phase (if not managed correctly) fauna species could be disturbed, trapped, hunted or killed) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**C/O** - The integrity of remaining wildlife should be upheld, and no trapping or hunting by construction personnel should be allowed. Caught animals should be relocated to the conservation areas in the vicinity. Council shall prosecute offenders. Should hedgehogs be encountered during the construction phase of the proposed road, these should be relocated to natural grassland areas in the vicinity. **P** - Conservation-orientated clauses should be built into contracts for construction personnel complete with penalty clauses for non-compliance.	**L -T**o be included in EMP **M -T**o be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

19) Loss of habitat can lead to the decrease of fauna numbers and species

All mitigation measures for impacts on the indigenous flora of the area should be implemented in order to limit habitat loss and maintain and improve available habitat, in order to maintain and possibly increase numbers and species of indigenous fauna.

Table 30: Significance of Issue 19 (Loss of habitat can lead to the decrease of local fauna numbers and species) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Low ◙	**P/ C / O** – All mitigation measures for impacts on the indigenous flora of the area should be implemented in order to limit habitat loss as far as possible and maintain and improve available habitat, in order to maintain and possibly increase numbers and species of indigenous fauna.	**M** - In terms of local fauna population **L** - In terms of the global conservation status of fauna

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

7 DESCRIPTION OF THE SOCIAL ENVIRONMENT *[Regulation 29(c) (d)]*

7.1 Cultural and Historical

It terms of the legislation, it is necessary to identify and list the specific legislation and permit requirements, which potentially could be infringed upon by the proposed project. The necessity and possibilities for the implementation of mitigation measures should also be identified.

It should be noted that in terms of the South African Resources Act (Act 25 of 1999) Section 35(4) no person may, without a permit issued by the responsible heritage resources authority destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or material.

Also important is that Section 34(1) of this act 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.

A Phase 1 Heritage Impact Assessment was done by Leonie Marais-Botes/Archaetnos Archaeologists and Heritage Consultants ***(refer to Annexure F4).***

The objective of the Phase 1 Heritage Impact Assessment (HIA) was to gain an overall understanding of the heritage sensitivities of the area and indicate how they may be impacted on through development activities. The survey took place on 31 March 2014.

Findings of the HIA:

- **Pre-Colonial Heritage Sites**

There are no pre-colonial heritage sites evident in the study area. This can be attributed to previous farming and infra-structure development activities in the greater study area.

- **Historical Period Heritage Sites**

There are no historical period sites in the area earmarked for development.

- **Original Landscape**

Infrastructure and other development have altered the original landscape in most of the greater study area.

- **Intangible Heritage**

The intangible heritage of the greater study area can be found in the stories of past and present inhabitants.

Heritage Value weighed against Cultural Significance Categories

- **Spiritual value**

During the site visit/field work no indication of any spiritual activity was observed on/near the proposed site. Thus no sites of spiritual value will be impacted on by the proposed project.

- **Scientific value**

No sites of scientific value was observed on or near the site earmarked for development.

- **Historical value**

No historical value associated with the proposed site could be found in primary and secondary sources.

- **Aesthetic value**

No heritage item with exceptional aesthetic (architectural) value was identified in the study area.

- **Social value**

Social value is attributed to sites that are used by the community for recreation and formal and informal meetings regarding matters that are important to the community. These sites include parks, community halls, sport fields etc. Visually none of the above is evident in the study area.

Conclusion and Recommendations by involved Heritage Specialist

- There are no visible restrictions or negative impacts in terms of heritage associated with the site other than the structures older than 60 years. In terms of heritage this project can proceed.
- The proposed site does not contain any surface archaeological deposits due to the large scale alteration of the original landscape. The possibility of sub-surface findings always exists and should be taken into consideration in the Environmental Management Plan. If sub-surface archaeological material is discovered work must stop and a heritage practitioner preferably an archaeologist contacted to assess the find and make recommendations.
- The site does not contain marked graves, however the possibility of graves not visible to the human eye always exists and this should be taken into consideration in the Environmental Management Plan. It is important to note that all graves and cemeteries are of high significance and are protected by various laws. Legislation with regard to graves includes the National Heritage Resources Act (Act 25 of 1999) whenever graves are 60 years and older. Other legislation with regard to graves includes those when graves are exhumed and relocated, namely the Ordinance on Exhumations (no 12 of 1980) and the Human Tissues Act (Act 65 of 1983 as amended). If sub-surface graves are discovered work should stop and a professional preferably an archaeologist contacted to assess the age of the grave/graves and to advice on the way forward.

Comments from SAHRA

Refer to Annexure K

In correspondence from SAHRA, dated 16 May 2014, Andrew Salomon stated that the SAHRA Archaeology, Paleontology and Meteorites Unit have no objection to the construction of Road K56. If any new evidence or archaeological sites or artefacts, palaeontological fossils, graves or other heritage resources is found during development, SAHRA and an archaeologist and/or palaeontologist, depending on the nature of the finds, must be alerted immediately.

7.1.a Issues & Impact Identification – Cultural and Historical

Table 31: Issues and Impacts – Cultural and Historical

	Issue/ Impact	Positive/ Negative/ Neutral ±	Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼
20)	Structures of cultural and historical significance may be destroyed.	-	☻

7.1.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

20) Structures of cultural and historical significance may be destroyed.

As no sites, features or object of cultural significance were identified in the study area, there would be no impact resulting from the proposed alignment of the K56.

If any archaeological sites or graves are exposed during construction work, it should immediately be reported to a museum, preferably one at which an archaeologist is available, so that an investigation and evaluation of the finds can be made.

Table 32: Significance of Issue 20 (Structures of cultural and historical significance may be destroyed) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Positive ☼ Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P/ C / O** - It should be noted that in terms of the South African Resources Act (Act 25 of 1999) Section 35(4) no person may, without a permit issued by the responsible heritage resources authority destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or material **P/ C** - Also important is that Section 34(1) of this act 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	**L** – To be included in the EMP **L** – To be included in the EMP

	provincial heritage resources authority. **P/ C / O** - If any new evidence or archaeological sites or artefacts, palaeontological fossils, graves or other heritage resources is found during development, SAHRA and an archaeologist and/or palaeontologist, depending on the nature of the finds, must be alerted immediately.	 **L** – To be included in the EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

7.2 Agricultural Potential

According to GAPA 3 the involved section of route K56 traverses areas with **low agricultural potential soils** and does not falls within an Agricultural Hub, an area identified for agricultural use by GDARD according to the **Draft Policy on the Protection of Agricultural Land (2006).** ***Refer to Figure 18.***

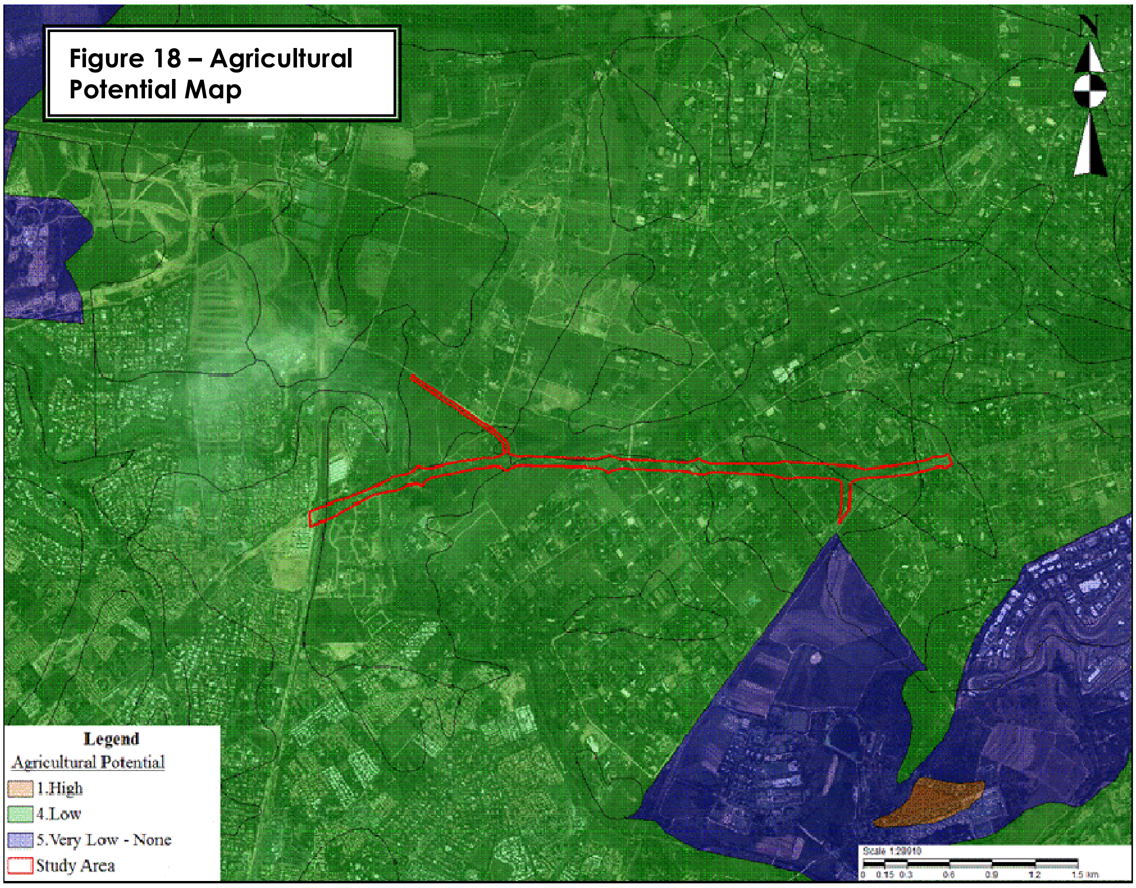


Figure 18 – Agricultural Potential Map

7.2.a Issues & Impact Identification – Agricultural Potential

Table 33: Issues and Impacts – Agricultural Potential

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities** High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼
21)	Loss of agricultural land	-	◘

7.2.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

21) Loss of agricultural land

According to GAPA 3 the involved section of route K56 traverses areas with **low agricultural potential soils** and does not falls within an Agricultural Hub, an area identified for agricultural use by GDARD according to the **Draft Policy on the Protection of Agricultural Land (2006).** The study area does not fall within an Agricultural Hub and the western section of the route is located within the Provincial Urban Edge.

The proposed route traverses agricultural holdings of which most are used for equestrian purposes.

Table 34: Significance of Issue 21 (Loss of agricultural land) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Positive ☼ Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/ C / O** – Some agricultural land will be loss due to the proposed road.	Not possible to mitigate, but not regarded as a fatal flaw. **NP**

Result: *The significance of this impact need to be determined/confirmed and assessed in the Significance Rating Table*

7.3 Institutional Environment *[Regulation 29(e)]*

7.3.1 On an International Level

Relevant International Conventions to which South Africa is party:

- **Convention relative to the Preservation of Fauna and Flora** in their natural state, 8 November 1993 (London);
- **Convention on Biological Diversity**, 1995
  (Provided and added stimulus for a re-examining and harmonization of its activities relating to biodiversity conservation. This convention also allows for the in-situ and ex-situ propagation of gene material); and
- **Agenda 21** adopted at the United Nations Conference on Environment and Development (UNCED) in 1992.
  (An action plan and blueprint for sustainable development).

7.3.2 On a National Level

National Environmental Management Act (NEMA), 1998 (Act No 107 of 1998)

In terms of the 2010 Amended NEMA EIA Regulations a Full EIA Process is required for the design and construction of the involved section of the K56 Road. Tables 1 and 2 of this reports lists the various activities that will be triggered by the proposed road development.

The NEMA Act itself furthermore provides for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith.

This Act formulates a set of general principles to serve as guidelines for land development and it is desirable that:

- The law develops a framework for integrating good environmental management into all development activities;
- The law should promote certainty with regard to decision-making by organs of state on matters affecting the environment;
- The law should establish principles guiding the exercise of functions affecting the environment;
- The law should ensure that organs of state maintain the principles guiding the exercise of functions affecting the environment;
- The law should establish procedures and institutions to facilitate and promote co-operative government and intergovernmental relations;
- The law should establish procedures and institutions to facilitate and promote public participation in environmental governance; and
- The law should be enforced by the State and that the law should facilitate the enforcement of environmental laws by civil society.

If the involved authorities do not take the principles of NEMA into consideration when evaluating an environmental report/ document, the involved authority can be held responsible for any damage to the environment (social, ecological and economical).

The proposed development is listed under the activities as regulated under NEMA.

Integrated Environmental Management

Integrated Environmental Management (IEM) is a philosophy, which prescribes a code of practice for ensuring that environmental considerations are fully integrated into all stages of the development process. This philosophy aims to achieve a desirable balance between conservation and development (Department of Environmental Affairs, 1992). The IEM guidelines intend endearing a pro-active approach to sourcing, collating and presenting information at a level that can be interpreted at all levels.

The National Water Act, 1998 (Act No 36 of 1998)

The purpose of this Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways that take into account, amongst other factors, the following:

- Meeting the basic human needs of present and future generations;
- Promoting equitable access to water;
- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Reducing and preventing pollution and degradation of water resources;
- Facilitating social and economic development; and
- Providing for the growing demand for water use.

In terms of the Section 21 of the National Water Act, the developer must obtain water use licenses if the following activities are taking place:

a) Taking water from a water resource;
b) Storing water;
c) Impeding or diverting the flow of water in a watercourse;
d) Engaging in a stream flow reduction activity contemplated in section 36;
e) Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
g) Disposing of waste in a manner which may detrimentally impact on a water resource;
h) Disposing in any manner of water which contains waste from or which has been heated in any industrial or power generation process;
i) Altering the bed, banks, course or characteristics of a water course;
j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
k) Using water for recreational purposes.

Section 21 water use licences will be required for any development which may take place within and/or impact any water resource and or floodlines. The National Water Act also required that the 1:50 and 1:100 year flood line be indicated on all the development drawings that are being submitted for approval.

The proposed route traverses the Jukskei River and tributary, non-perennial rivers as well as wetlands. Section 21 water use license applications would therefore be required.

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

This act replaced the Atmospheric Pollution Prevention Act (Act No. 45 of 1965), however Part 2 of the act is still applicable. Part 2 deals with the control of noxious or offensive gases and has relevance to the proposed road.

The purpose of the Act is "To reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development; to provide for national norms and standards regulating air quality monitoring, management and control by all spheres of government; for specific air quality measures; and for matters incident thereto".

Water Services Act, 1997 (Act No 108 of 1997)

The purpose of this Act is to ensure the regulation of national standards and measures to conserve water taking into account, amongst other factors, the following:

- Basic sanitation;
- Basic Water supply;
- Interruption in provision of water services;
- Quality of potable water;

- Control of objectionable substances;
- Disposal of grey water;
- Use of effluent; and
- Quantity and quality of industrial effluent discharged into a sewerage system.

Interruption in provision of water services during the construction phase of the involved section of the proposed K56 must be according to national standards.

Mitigation measures must be implemented to prevent contamination of groundwater due to the construction and operational phase of the road.

National Heritage Resource Act, 1999 (Act No 25 of 1999)

The National Heritage Resources Act legislates the necessity for cultural and heritage impact assessment in areas earmarked for development, which exceed 0.5 ha. The Act makes provision for the potential destruction to existing sites, pending the archaeologist's recommendations through permitting procedures. Permits are administered by the South African Heritage Resources Agency (SAHRA).

It is important to note that in terms of the National Heritage Resources Act, (Act No 25 of 1999) all historical sites and materials older than 50 years are protected. It is an offence to destroy, damage, alter or remove such objects from the original site, or excavate any such site(s) or material without a permit from the National Monuments Council. Gravesites are subject to the requirements of Act 28 of 1969.

National Environmental Management: Biodiversity Act, 2004 (Act No 10 of 2004)

The purpose of the Biodiversity Act is to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA and the protection of species and ecosystems that warrant national protection. As part of its implementation strategy, the National Spatial Biodiversity Assessment was developed.

According to the GDARD C-Plan 3, 2011, the involved section of the proposed K56 traverses irreplaceable sites. Specialist ecological assessment studies had been conducted for the study area.

National Spatial Biodiversity Assessment

The National Spatial Biodiversity Assessment (NSBA) classifies areas worthy of protection based on its biophysical characteristics, which are ranked according to priority levels.

According to the GDARD C-Plan 3, 2011, the involved section of the proposed K56 traverses irreplaceable sites. Specialist ecological assessment studies will be conducted for the study area. Specialist ecological assessment studies had been conducted for the study area.

National Environmental Management: Protected Areas Act, 2003 (Act No 57 of 2003)

The purpose of this Act is to provide the protection, conservation and management of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes.
According to the GDARD C-Plan 3, 2011, the involved section of the proposed K56 traverses irreplaceable sites. Specialist ecological assessment studies had been conducted for the study area. The status of GECKO in terms of this act must also be determined and addressed.

National Veld and Forest Fire Act, 1998 (Act No. 101, 1998)

The purpose of this Act is to prevent and combat veld, forest and mountain fires throughout the Republic. Furthermore the Act provides for a variety of institutions, methods and practices for achieving the prevention of fires.

Mitigation measures for the prevention of fires must be implemented.

Conservation of Agricultural Resources Act (Act No. 43 of 1983)

This Act provides for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith. The removal of Category 1 Declared Weeds is ***compulsory*** in terms of this Act.

Category 1 Declared weeds must be removed on a continuous basis, as will be indicated in the EMP.

According to GAPA 3 the involved section of the proposed K56 traverses low agricultural potential soils. In addition the study area does not fall within an agricultural hub identified by GDARD.

National Road Traffic Act, 1996 (Act No. 93 of 1996)

This Act provides for all road traffic matters which shall apply uniformly throughout the Republic and for matters connected therewith.

The design and construction of the involved section of the proposed K56 must comply with the National Road Traffic Act.

Mine Health and Safety Act, 1996 (Act 29 of 1996)

This Act introduced the concepts of risk assessment and occupational health and safety (OHS) management systems in the mining industry.

The alignment of the involved section of the proposed K56 must comply with the regulations of the Mine Health and Safety Act with regard to distance from mining operations.

7.3.3 On a Provincial Level

Planning Responsibilities of the Involved Local Authority

The prerogative to plan a development within its jurisdictional area has always constitutionally, in terms of the Local Government Transitional Act, 1993 and recently the Municipal Systems Act, 2000, vested in the local authority involved.

In order to ensure that the proposed developments comply with the standards and requirements of the involved local authority (City of Johannesburg), the relevant officials were involved in the planning of the project from the start.

Gauteng Spatial Development Framework (GSDF)

This document published by the Gauteng Department of Development Planning and Local Government provides a spatial development framework for the whole of the Gauteng Province, and focuses on growth and development on a broad level. This Document identifies several spatial development components, of which the following is relevant to the proposed development:

The GSDF also lists so-called interventions of which the following is applicable to the involved section of the proposed K56:

- Containing and Compacting the City: The infill of vacant land contributes towards the optimizing of municipal infrastructure
- Access and Mobility: The easy access development areas, as well as the densification of the city, also encourage the optimizing of municipal resources.

Gauteng Transport Infrastructure Act, 2001 (Act No 8, 2001)

The purpose of this Act is to consolidate the laws relating to roads and other types of transport infrastructure in Gauteng. It provides for the planning, design, development, construction, financing, management, control, maintenance, protection and rehabilitation of provincial roads, railway lines and other transport infrastructure in Gauteng.

According to this provincial act, the proposed alignments for all the Gautrans roads on the Gautrans Grid Road Network Map must be honoured by planners.

GDARD C-Plan 3, 2011

The environmental data contained in the C-Plan 3, 2011, was taken into consideration during the compilation of the scoping report. According to the C-Plan 3, 2011, the involved section of the proposed K56 traverses irreplaceable sites.

GDARD Draft Red Data Species Policy, 2001

According to the C-Plan 3, 2011, the involved section of the proposed K56 traverses irreplaceable sites. The occurrence of red data species must be confirmed during the EIA phase.

GDARD Draft Ridges Policy, 2001

According to the GDARD Draft Ridges Policy no development should take place on slopes steeper than 8.8%.

The involved section of the proposed K56 does not cut across any ridge according to C-Plan 3, 2011. However, Erling Road crosses a small section of a transformed ridge.

GDARD Biodiversity Requirements, March 2014

The GDARD Draft Biodiversity Requirements, March 2014, will be taken into consideration during the EIA phase of the development.

Environment Conservation Act, 1989 (Act No. 73 of 1989): Gauteng Noise Control Regulations

The involved section of the proposed K56 must comply with the Provincial Noise Control requirements as outlined in the Provincial Notice, 5479 of 1999: Gauteng Noise Control Regulations.

Draft Policy on the Protection of Agricultural Land (2006)

The study area does not lie within an Agricultural Hub that was identified by GDARD in 2006. The Draft Policy on the Protection of Agricultural Land (2006) is therefore not applicable to the proposed road.

7.3.4 On a Local Level

Planning responsibilities of the involved Local Authority

The prerogative to plan development within its jurisdictional area has always constitutionally, in terms of the Development Facilitation Act, 1995, the Local Government Transitional Act, 1993 and recently the Municipal Systems act, 2000 vested in the local authority involved.

In order to ensure that the proposed developments comply with the standards and requirements of the involved local authority, the relevant officials were involved in the planning of the project from the start.

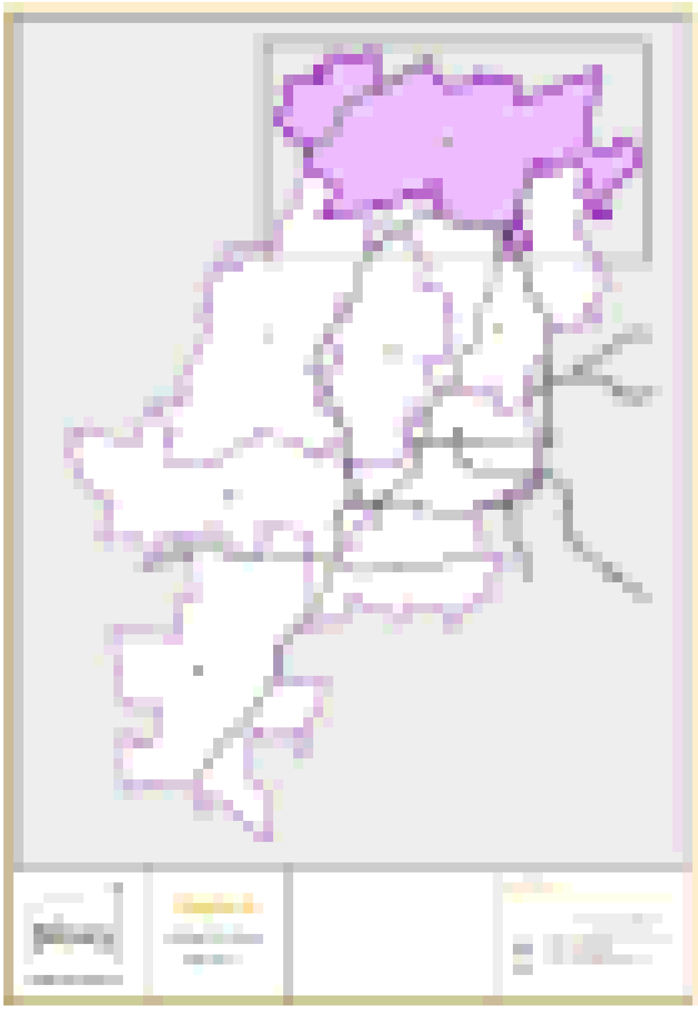
Municipal Systems Act - 2000)

This Act clearly establishes the Integrated Development Plan and Integrated Spatial Development Framework as guidelines to inform development and processes in this regard.

City of Johannesburg Regional Spatial Development Framework (RSDF), 2010/2011: Region A

The Regional Spatial Development Framework (RSDF), together with the Spatial Development Framework (SDF), represents the prevailing spatial planning policy within the City of Johannesburg. These spatial planning policy documents are prepared and adopted in terms of the Municipal Systems Act, Act 32 of 2000 as an integral component of the City's Integrated Development Plan (IDP).

This Regional Spatial Development Framework must be read in conjunction with the overarching Spatial Development Framework. The SDF provides a city wide perspective of challenges and interventions within the City and the RSDFs are primarily regional and local implementation tools that:



- Contextualise development trends and challenges within a regional context.
- Prescribe localised development objectives and guidelines (e.g. density, land use etc.).
- Provide a more detailed reflection of the SDF objectives, strategies and policies as they impact on local area planning.
- Reflect localised Precinct Plans and Development Frameworks adopted through official Council protocols.
- Capture the most updated information in terms of regional developmental trends, issues and community needs.
- Add substantive value to the budgeting and spatial development processes within the City by identifying local development interventions.

The study area falls within Administrative **Region A** of City of Johannesburg. Within the larger Gauteng metropolitan area, Region A is bordered by Mogale City Local Municipality to the west, City of Ekurhuleni to the east and City of Tshwane to the north. Within the City of Johannesburg administrative boundary, Region C and Region E form the southern boundaries of Region A.

The following sections of the RSDF are applicable to the proposed K56:

2.1.6 *Road Network*

The east-west linkages are less defined in comparison to the north-south linkages and heavy congestion occurs along the region's major routes due to large traffic volumes travelling through the region daily.

The existing infrastructure within the region is inadequate to cater for the increased developments at the desired densities which indicate that developments must be accompanied by road infrastructure upgrades.

3.1 DEVELOPMENT STRATEGIES

The SDF provides a comprehensive overview of the Spatial Development Strategies and the desired urban form for the City. Therefore this section should be read in conjunction with the SDF (2010/2011).

3.1.1. Growth Management Strategy

In addition to the SDF component, a Growth Management Strategy (GMS) was developed to compliment the seven other SDF strategies. The strategy is detailed in the Spatial Development Framework 2010/2011. The GMS prescribes where, and under what conditions, growth can be accommodated. The future growth of the City must ensure that population and economic growth is supported by complimentary services and infrastructure whilst also meeting spatial and socioeconomic objectives. The two key objectives of the strategy are to:

- *Determine priority areas for short-medium term investment and allocation of future development rights.*

- *Re-direct the respective capital investment programmes of the City's service providers to address the short-term hotspots and strategic priority areas.*

The GMS sets high, medium and low priority areas across the City and describes specific interventions:

Low Priority (i.e. no infrastructure upgrading / provision before 2020)

Peri Urban Areas

Localities beyond the extent of the Urban Development Boundary comprise the Peri-Urban Management Areas. There are no short or medium term obligations or plans to service these areas.

The study area falls within a peri-urban area.

3.1.2 Supporting an Efficient Movement System

The Movement Strategy is premised on the provision and maintenance of a highly accessible movement system and network that supports a range of modes (road, rail and non-motorised transport modes, public and private) and activities at various levels, intensity and scale. It specifically endorses the promotion of public transport as the means to increase accessibility of opportunities to all City users.

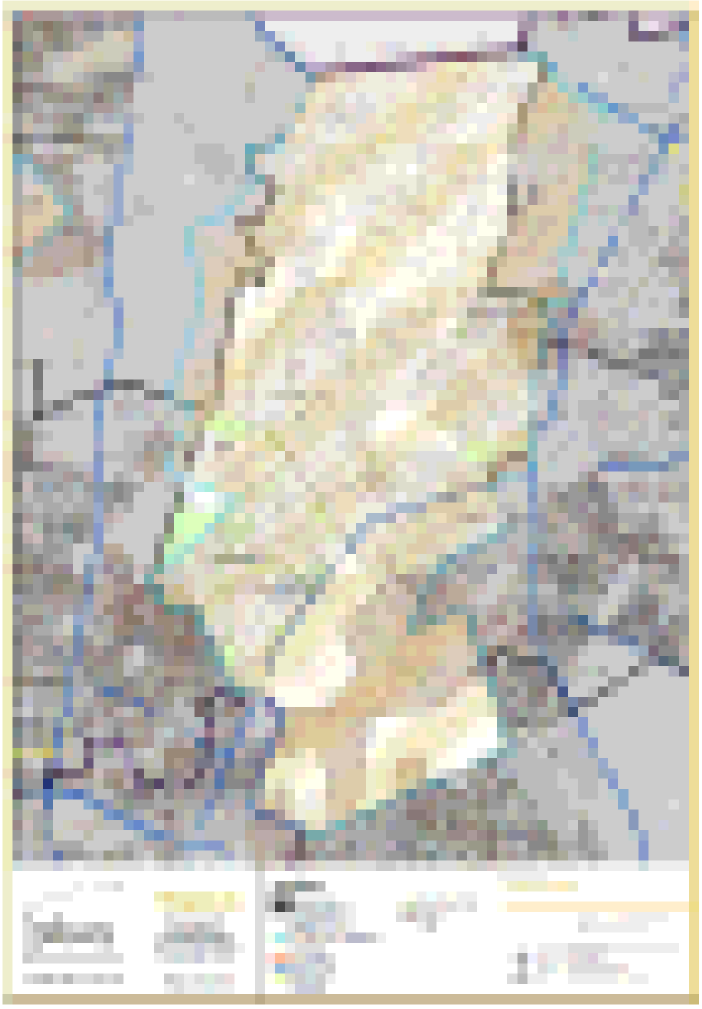
Road Network Hierarchy and Management Guidelines

In order to develop an appropriate and functional movement network for the City, a study was commissioned by the Johannesburg Roads Agency and Transportation Planning and Management Directorate, in 2004. The Transportation Department has recently updated this study (February 2010) in order to reflect the current status of the network as well as to align the classification of the City's roads with the official roads policy for planning and development of road infrastructure in South Africa; Road Infrastructure Strategic Framework for South Africa (RISFSA). The updated study focuses on the following elements:

1. Road Reclassification: according to the RISFSA classification scheme

2. A Proposed future Road Network based on 5 and 10 year scenarios which include:

- *·Priorities for implementation (upgrades and implementation of new roads)*
- *Land acquisition associated with the future road network*
- *Protection of road development corridors*
- *City's Freight Network*



Roads provide two types of services, namely the provision of traffic mobility and access.

Generally, major roads in Region A are overburdened and the construction of the following proposed major roads would in future enhance better mobility within the region:

***Proposed K46:** North-south route that will follow the alignment of William Nicol Drive, which currently forms the eastern boundary of the Diepsloot settlement.*

***Proposed K56:** East-west link that connects the Region to Ekurhuleni and Mogale City. The road will also connect several significant nodes in the Region.*

***Proposed K54/R562:** East-west route that will run through the centre of the Diepsloot settlement. This route is critical towards the effective functioning of the Diepsloot/Tanganani areas*

Proposed K27: *East-west route that ends at William Nicol Drive and is likely to have an impact on the expansion of Diepsloot.*

Proposed K33*: North South route that traverses the western parts of the Region along Kya Sands toward Lanseria*

Proposed PWV 5 & PWV 9: East west and north south routes respectively through the region.

4.1. Suburbs per sub area

In order to deal with the application of the region-wide goals, objectives and development strategies regarding movement, activity and the environment, it was necessary to divide Region A into 12 Sub Areas, based on the following criteria:

- *The area covered by community submissions.*
- *Homogeneity in residential density and character/requirements.*
- *Land use homogeneity.*
- *Natural/environmental features.*
- *Economic investment.*

The study area falls within **Sub-Area 8 *(refer to Plan 41 in Annexure L)*.**

SUB AREA 8 (WITPOORT PRECINCT)

Kyalami A.H., Glenferness A.H. and extensions, Knopieslaagte, **Kyalami A.H. and extensions, Leeuwkop Prison**, **Saddlebrook**

The entire sub area falls outside the Urban Development Boundary. It comprises mainly of environmentally sensitive areas, natural open spaces, agricultural holdings and farm *portions. **This means that no further township establishments can be supported on any even within Sub Area 8.***

*The entire sub area falls within the Greater Kyalami Conservancy (GEKCO) area. Development applications in this sub area are to be assessed in accordance with the **Witpoort Development Framework 2020 (2008)**, which should be read in conjunction with the **Growth Management Strategy (GMS)**, which identifies this area as a Peri Urban Management Area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.*

Future planned roads affect this sub area and as such any applications impacted by these future planned roads must be assessed on the merits of the application and impact of the roads to the proposed development.

DEVELOPMENT OBJECTIVE 1 ***Protect environmental qualities and amenities in the sub area***	
1.1 Support low densities and preserve the non-urban residential and agricultural related uses in areas outside the UDB.	*1.1.1 Development of land outside the UDB to be guided by Urban Development Boundary Strategy.* *1.1.2 Allow low residential density between 2units/ha as per the land use zone management table.* *1.1.3 Only support non-urban residential development and compatible hospitality uses e.g. guesthouses, conference and training facilities, nurseries, seed farming, hydroponics, estates, equestrian facilities outside the UDB* *1.1.4 Support institutional and community facilities development.*

Johannesburg Metropolitan Open Space System (JMOSS)

According to the JMOSS the proposed K56 traverses rivers, waterbodies/wetlands and existing open space (agriculture). ***Refer to Plan No. 13, RSDF.***

Witpoort Development Framework, 2020

The following sections of the Witpoort Development Framework are applicable to the proposed K56:

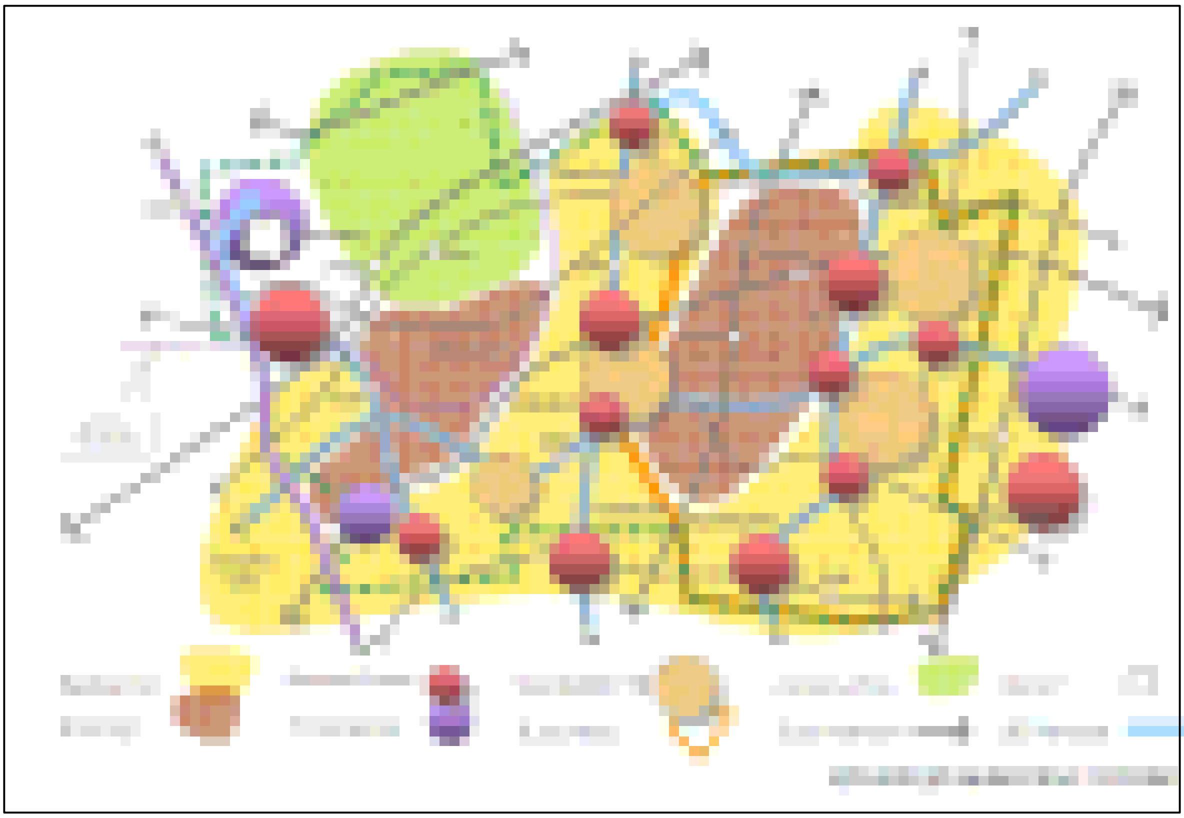
5.1.2. DEVELOPMENT CONCEPT

The aim of the Development Concept is to guide spatial development on a sub-regional level, based on the metropolitan spatial perspective set out above. In addition, as suggested by the development vision, the aim of the Development Concept should be to promote the development of a sustainable community within the Eastern Sub-Region. The Development Concept, which is illustrated by the Diagram below, guides spatial development within the Eastern Sub-Region through a set of nodes, corridors and infill areas. The Development Concept is made up of the following elements:

a. Transportation structure

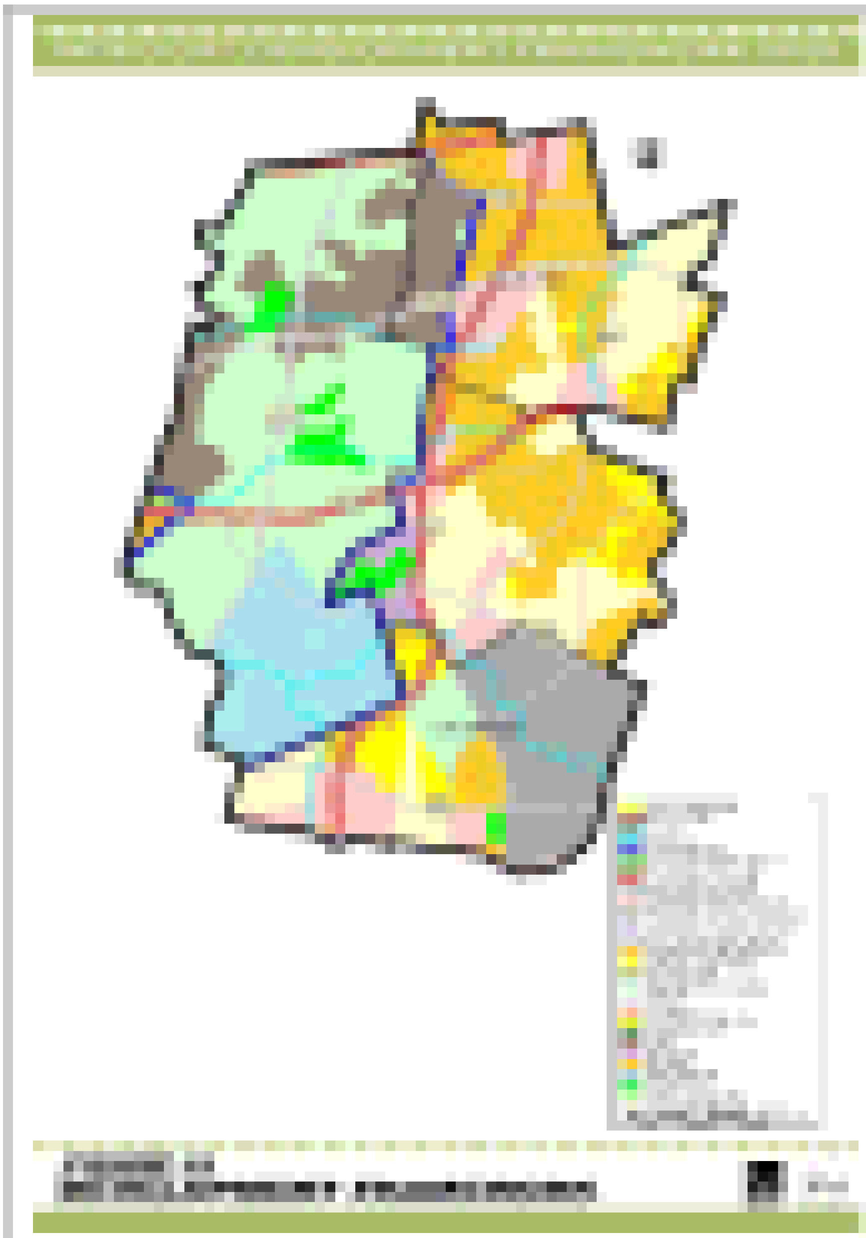
The K71 is currently the central road spine linking the Eastern Sub-Region to Woodmead and the rest of Johannesburg. Other significant roads include Lever Road, which runs parallel to the N1 freeway and links the residential areas along the Midrand strip, the K55 (Allandale Road) and the K60 (Witkoppen Road). ***Two roads in particular will improve***

***accessibility within the Eastern Sub-Region. The K73 will link Sunninghill to the Midrand strip and the K56 will link the Eastern Sub-Region westward to Cosmo City. The K71 and the K56 has the potential to link the Eastern Sub-Region to local and regional employment opportunities, social amenities and shopping destinations and should therefore be developed as public transportation spines.** Two freeway are planned that will link the Eastern Sub-Region regionally. The PWV9 will link the Eastern Sub-Region to the western parts of Tshwane and the PWV5 will link the Eastern Sub-Region to the northern parts of Ekurhuleni.*



b. Nodal structure

A number of mixed-use nodes can be developed within the Eastern Sub-Region along the spines mentioned above. **The K71 and the *K56* are proposed public transportation spines and are therefore ideally suited as access spines for the nodal structure**. It is also important to develop a hierarchy of node, which would provide different levels and a range of services within the Eastern Sub-Region. In addition to the existing Sunninghill regional mixed-use node, a regional mixed-use node would by suited on the intersection of the K71 and the planned PWV5 freeway. The freeway will provide regional and visual access, whereas the K71 will provide the necessary local and public transportation access.



c. Spatial structure

Currently, the Eastern Sub-Region is characterized by a number of fragmented settlements, mostly straddling the Midrand Strip. To achieve urban consolidation and create a spatial structure that would enable better land use and transportation integration, it is proposed that the existing settlements within the Eastern Sub-Region be consolidated through corridor development along the K71. This will require infill development along this corridor, with higher-density residential development being encouraged along the proposed public transportation spines and nodes within this corridor. The areas abutting the planned PWV9 freeway should preferably be left rural at this stage, until the PWV9 is constructed.

5.1.5. URBAN DEVELOPMENT BOUNDARY

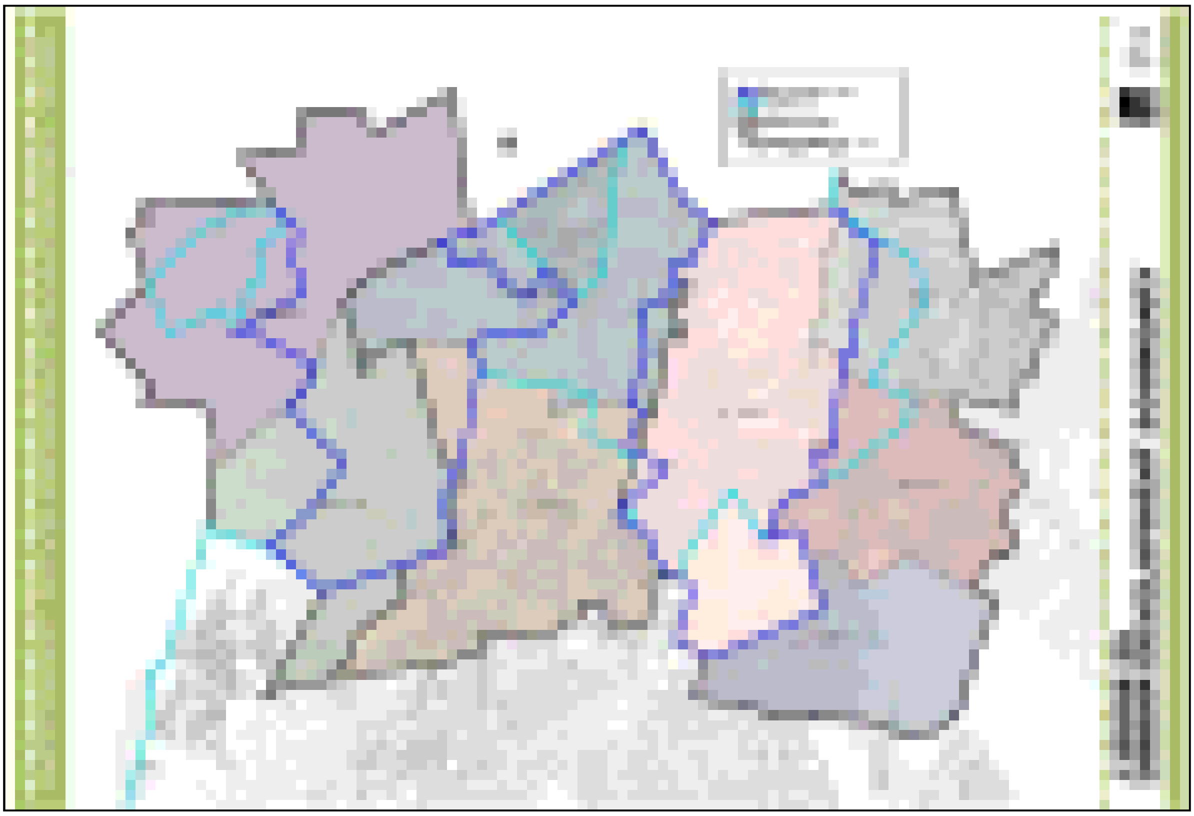
Demarcating an Urban Development Boundary has specific advantages, the primary being to prevent uncontrolled urban sprawl. Urban sprawl is undesirable since it increases pressures on the limited resource of local government, from public transport to water and sanitation infrastructure provision. Demarcating an Urban Development Boundary can also protect valuable agricultural land and ecologically sensitive areas from urban encroachment. But an Urban Development Boundary can also have drawbacks. For example, it can restrict the supply of land for urban development, which could inflate land prices within the boundary. Care should therefore be taken when demarcating an Urban Development Boundary. A balance should be reach between providing enough land for urban development and the need for sustainable and managed urban development.

*The latest Urban Development Boundary is the 2007 boundary, as depicted on **Figure 20.** Within the Eastern Sub-Region, this boundary includes the Leeukop Correctional Services area, Sunninghill, Mia's land and Kyalami, but excludes the western parts of the Blue Hills area. The result of the later is that the northern parts of the K71 is excluded and the potential of developing this road into a corridor. Reasons for excluding this part of the Blue Hills area may be due to problems experienced in connecting localized areas within the Blue Hills area to the bulks sewer network.*

*A new Urban Development Boundary is proposed by this study, which is illustrated on **Figure 20.** The proposed Urban Development Boundary was first and foremost demarcated according to the Land Use Budget estimates for settlement expansion up to the year 2020.*

In other words, the Urban Development Boundary does not allow the Eastern Sub-Region to sprawl beyond the spatial limits required by the population growth of the Eastern Sub-Region up to the year 2020. Other principles used to demarcate the Urban Development Boundary include the following:

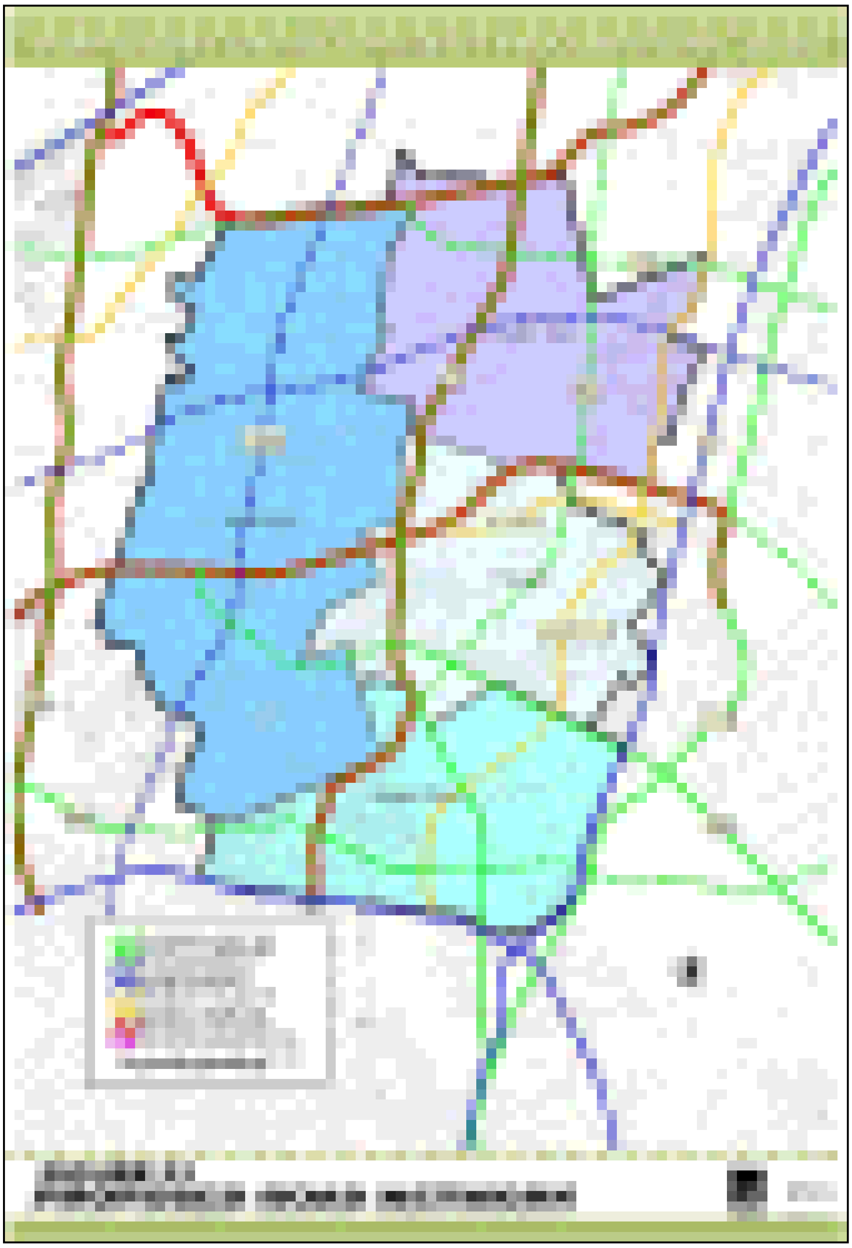
- *The containment of the urban sprawl and the promotion of infill and densification*
- *The creation of urban corridors along public transportation routes, such as the K71.*
- *The integration of existing and planned affordable housing projects (such as Olievenhoutbosch South) with other urban settlements*
- *The cost implications of establishing new infrastructure for new township developments in remote areas*
- *Taking into consideration unsafe geological conditions where and if applicable*
- *The conservation of environmentally sensitive areas*
- *The protection of high-potential agricultural land where and if applicable*



Compared to the 2007 Urban Development Boundary, the proposed Urban Development Boundary excludes the Leeukop Correctional Services site and rather concentrates this settlement growth potential along the K71, specifically in the Blue Hills area, to establish the K71 corridor. It was argued that the Leeukop site can rather be developed as part of the PWV9 corridor, which would first require the construction of the PWV freeway.

5.1.6.4. DENSIFICATION SPINES

A densification spine is a higher order road, typically used as a public transportation route, accommodating high-density residential development immediately adjacent to it. The following densification spines have been identified within the Eastern Sub-Region and should become the focus of high-density residential development:



- *K71 and K73 (west of K71): The K71 and part of the K73 is proposed as the primary public transportation (BRT) route through the Eastern Sub-Region and should therefore be* *densified in support of the BRT system.*

- ***K56**: **the K56 is a proposed east-west public transportation linkage, which will ultimately link Cosmo City to Midrand and the Midrand Gautrain Station.***

Infrastructure development often forms of backbone of urban development initiatives. The reason for this is the fact that infrastructure development provides the access, the capacity and the opportunities for urban development.

5.2.1. TRANSPORTATION

Developing the Eastern Sub-Region's transportation infrastructure is dealt with in terms of the road network and public transportation network. Whereas the road network primarily refers to provincial and metropolitan roads, transit facilities refer to public transportation routes and stations (bus and rail) that provide access to public transportation systems.

5.2.1.1. ROAD NETWORK DEVELOPMENT

An extensive freeway and distributor road network is planned for the Eastern Sub-Region (as was set out in the Status Quo section of this report), characterized by strong north-south and east-west linkages. However, compared to the planned network, the existing network is poorly developed. The reason for this is probably because the Eastern Sub-Region was mostly rural in nature until recently. However, this situation is rapidly changing as the area is urbanized. Consequently, urbanization is exerting pressure for the development of the planned road network or at least parts thereof. Planned freeway and distributor roads that are currently prioritized in terms of provincial planning and developer pressure as follows:

a. Freeway Construction

The PWV 9 will most probably be the next freeway to be built within Gauteng, primarily because it needs to serve as an alternative route to the N1 freeway between Johannesburg and Tshwane. Whether the entire route from Sandton to Soshanguve will be constructed is in question, because the section of the road north of the N14 freeway involves tunnelling, through 3 mountain ranges, which is costly. However, the stretch of the

PWV9 south of the N14, linking the Sandton to the N14 freeway is feasible and will allow commuter to access Johannesburg via the N14 and the PWV9. In addition to the PWV9, the section of the PWV5 stretching from Cosmo City to Midrand is also considered a priority, as this freeway will relieve pressure on the N1 freeway. Currently, the N1 is carrying all the east-west destined regional traffic within the northern reaches of Johannesburg, but was actually only intended as the bypass for national traffic. Both the PWV9 and the PWV5 are at detailed design level, the planning level before construction.

There is great concern amongst the residents of the Eastern Sub-Region, in particular the residents of the small holdings located along the planned alignment of the of the PWV9 freeway, on the impact that the freeway will have on the rural residential landscape of the Eastern Sub-Region. As a freeway, the purpose of the planned PWV9 is first and foremost mobility. In other words, the freeway aims to transport large volumes of traffic efficiently over large distances. This purpose impacts on the design of the freeway; usually involving grade separation and interchanges located at 3km intervals, which makes the freeway largely inaccessible from neigbouring properties. As a result, a freeway tends to cut or split communities, creating a buffer between communities, hence the concerns of the communities of the Eastern Sub-Region.

To address the above, it is suggested that the Eastern Sub-Region communities engage with the Provincial Roads Department (Gautrans) to research and considered alternative options for the design and/ or alignment of the PWV9 freeway. Mention was made in the stakeholder meetings that as an alternative, the PWV9 could be replaced by an enlarged K46 (William Nicol Drive) and K71 (Main Road) road design. The proposed BRT routes along these roads can assist in transporting the high commuter volumes. Another alternative would be to maintain the current alignment of the planned PWV9 freeway, but alter its design to negate its impact of the local landscape. For example, it can be developed as a pedestrian-crossable, accessible road, with additional lanes to allow the same traffic volumes and mobility that a typical freeway would be able to accommodate. The additional lanes could the separated to reduce the scale of the road's cross-section in a particular area.

b. Distributor Road Construction

*Two distributor roads in particular are a priority within the Eastern Sub-Region: the **K56**, the K60 and the K73. **The K56 will provide a needed east-west linkage, linking Cosmo City, as well as the northern reaches of Fourways and Kyalami, to Midrand. The development of this road is favoured by private developers as it will open up development within the central parts of the Eastern Sub-Region**. The K60 has partially been constructed in the Sunninghill and Fourways regions. The remaining section of this road between Sunninghill and Fourways needs to be completed. This will provide commuters access to alternative interchanges to the N1 freeway, thus better distributing access to the N1 freeway. Also, the section of the K73, linking Rivonia Road to the K71 (Main Road) needs to be constructed. This will enable the construction of a BRT route that will link to the current BRT route on Rivonia Road and stretches up along the K71 to Olievenhoutbosch. This K73 road link is considered a high priority.*

c. Collector Road Construction

Compared to the distributor road network, the collector road network is poorly conceived and developed. This creates a situation whereby the internal road network designed to serve small holdings is used to access employment and shopping areas within the region. To address this, it is proposed that Lever Road be extended southwards to link up with Maxwell Drive in Sunninghill. This will create a north-south collector road serving the strip development abutting the N1 freeway. This linkage will cross Mia's Land and will therefore have to be taken into account in the layout design of Mia's Land.

The City of Johannesburg 2040 Growth and Development Strategy

The City of Johannesburg developed its first Growth and Development Strategy (GDS) in 2006, as a long-term strategy – an articulation of Johannesburg's future development path. At the time, there were numerous strategies, including, amongst others: 'Joburg 2030', the Human Development Strategy (HDS), the Integrated Transport Plan and the City Safety Strategy. Each addressed a different angle of the city's development. The GDS provided the opportunity to consolidate all of these into a single cross-City strategy. It also served as the conceptual foundation for the five-year Integrated Development Plan (IDP).

The 2006 GDS specified the need for a five-yearly review of the long-term strategy, allowing for evaluation of progress against goals – and reframing of objectives and priorities as necessary – in the context of new challenges and opportunities. The period between 2006 and 2011 has seen significant socio-economic and political changes, both locally and in the global arena. A review of the 2006 GDS was therefore initiated with the new 2011-2016 term of office, resulting in a refined 'Joburg 2040 GDS' that sets its sights on a desired Johannesburg of the future – a Johannesburg in which all will aspire to live and work.

Joburg 2040 GDS is an aspirational strategy that defines the type of society the city aspires to achieve, by 2040. The strategy restates the City's resolve in confronting the past injustices created during Apartheid, working towards a democratic, non-racial, non-sexist and just City while simultaneously confronting present and future challenges as they emerge. Therefore, the 2040 GDS contains:

- A vision and mission – which serves as a mental picture of Joburg, the city, by 2040;
- Principles – the values held by the City, as first articulated in the 2006 GDS;
- Outcomes – what the City seeks to achieve by 2040;
- Long-term outputs – the deliverables through which the City plans to achieve the desired outcomes; and
- Indicators – the measures through which the City plans to assess progress against its desired outcomes.

Four major outcomes define the Joburg 2040 GDS:

Outcome 1: Improved quality of life and development-driven resilience for all

The City envisages a future that presents significantly improved human and social development realities, through targeted focus on poverty reduction, food security, development initiatives that enable self-sustainability, improved health and life expectancy, and real social inclusivity. By 2040, the City aims to achieve substantially *enhanced quality of life for all, with this outcome supported by the establishment of development-driven resilience.*

Outcome 2: Provide a resilient, liveable, sustainable urban environment – underpinned by infrastructure supportive of a low-carbon economy

The City plans to lead in the establishment of sustainable and eco-efficient infrastructure solutions (e.g. housing, eco-mobility, energy, water, waste, sanitation and information and communications technology), to create a landscape that is liveable, environmentally resilient, sustainable, and supportive of low-carbon economy initiatives.

Outcome 3: An inclusive, job-intensive, resilient and competitive economy that harnesses the potential of citizens

The City of Johannesburg will focus on supporting the creation an even more competitive, 'smart' and resilient city economy, when measured in relation to national, continent and global performance. The City will promote economic growth and sustainability through the meaningful mobilisation of all who work and live here, and through collaborating with others to build job-intensive long-term growth and prosperity, from which all can benefit.

Outcome 4: A high performing metropolitan government that pro-actively contributes to and builds a sustainable, socially inclusive, locally integrated and globally competitive Gauteng City Region

The City envisages a future where it will focus on driving a caring, responsive, efficient and progressive service delivery and developmental approach within the GCR and within its own metropolitan space, to enable both to reach their full potential as integrated and vibrant spaces.

The City of Joburg has made use of an extensive stakeholder engagement process in the form of the GDS outreach, to include and empower all its key stakeholders – ensuring that the vision of a Johannesburg in 2040 is jointly formulated, and is one in which all want to be a part. Responses were actively solicited, reviewed, analysed and refined for inclusion in the Joburg 2040 GDS.

The GDS emerges with four core outcomes envisaged for 2040 – to serve as guides for short and medium-term planning and implementation. Through the City's future focus on these outcomes, success in realising the Johannesburg of our dreams is envisaged.

The following section of the GDS 2040 is applicable to the proposed K56:

3.8.2 Urban Sprawl and Traffic Congestion

Congestion in the city has increased significantly over time, worsened by the predominance of private cars and private mini-bus taxis, with Johannesburg's sprawl contributing to this congestion (as noted above). The decentralisation of business from the city centre, to other locations such as Sandton and Midrand, has further compounded congestion around major business nodes, very often not designed for the current volumes. The movement of freight from rail to road has also had a major impact on our road system, both in terms of congestion and maintenance. In addition, Johannesburg's placement within the GCR means that there is a continual interface with other road networks and cities, with a constant flow of people and goods in and out of the city, as part of a daily commute.

The GCR's road network has to cope with an annual traffic increase rate of seven percent, with 1,8 million drivers and 2,8 million registered vehicles (Chakwizira 2007). This has seen an annual increase of traffic on the M1/N1 corridor of roughly seven percent, with this annual increase witnessed for the past ten years. The average travel time to work in the region has increased from 41,5 minutes in 1995, to 50 minutes in 2003 (i.e. a 17 percent increase over eight years). By 2040, it is anticipated that Johannesburg will have an extra 2,5 million inhabitants. The existing system, with its dominant mode of private vehicle use, is unsustainable. A larger population with more cars means more congestion – with negative effects for the quality of life of residents, let alone the impact on the environment and the sustainability of Johannesburg's infrastructure.

Regional Environmental Management Framework (EMF) for South Western Tshwane and North Western Johannesburg, Volume III: Draft Strategic Environmental Management Plan Compiled on behalf of GDARD by SEF, September 2009

The Regional Environmental Management Framework for South Western Tshwane and North Western Johannesburg, Volume III: Strategic Environmental Management Plan was Gazetted in 2013.

The following section of the Strategic Environmental Management Plan (EMF) is applicable to the proposed K56:

The involved section of the proposed K56 falls within GECKO Conservancy, which has been identified as a wetland rich environment and according to the EMF is identified as a medium development constraint zone.

The Management Guidelines in relation to Conservancies include the following:

- If listed activities in terms of the NEMA Regulations are considered, it must be subject to a full EIA and an Environmental Management Plan; and
- Infrastructure (roads, bridges, etc.) are supported activities.

The Management Guidelines in relation to Rivers and Wetlands include the following:

- All wetlands, drainage lines and rivers must be delineated within proposed developments;
- No development is allowed within wetlands or a protective buffer zone of 30m inside the urban edge and 50m outside the urban edge;
- Where road systems are upgraded, effective storm water measures must be included as a matter of priority. Roads must be constructed in such a way as to have a minimal impact on the flow of water through the wetland (e.g. by using a

bridge or box culverts in preference to pipes) (Kotze *et al*, 2002). Feed-off points should be incorporated into road networks at regular intervals (at least every 100m). Stormwater originating from these roads should also not be allowed to enter directly into wetland areas (Kotze *et al*, 2002);

- All wetlands that are linked to GECKO must be considered as important ecological corridors for the dispersal of sensitive faunal species;
- Enforce strict wetland sensitive pollution and stormwater control policies;
- Prioritise the rehabilitation of wetlands downstream of potential sources of pollution to assist the improvement of water quality provided by aquatic resources;
- Promote the establishment artificial wetlands as a compensatory measure for the loss of wetlands in order to maintain and restore ecosystem functioning and reduce pollution levels in the river ecosystems;
- Detailed description of individual wetlands, taking into consideration their connectivity, should be undertaken in a protection and management plan of the wetlands in the study area in order to identify specific conservation and rehabilitation priorities, including feeder zones and critical linkages;
- Where roads cross water courses, an underpass should provide for the movement of aquatic as well as terrestrial species through the inclusion of appropriate buffer zones within the underpass. The number and spacing of the underpasses should be determined by a specialist registered in accordance with the Natural Scientific Professions Act 2003 (Act No. 27 of 2003) in the field of ecology or zoology; and
- Where roads traverse a wetland, measures are required to ensure that the road has minimal effect on the flow of water through the wetland, e.g. using a high level clearspan bridge or wide box culverts as opposed to using piped structures.

Land-Use and Land-Use Change Considerations with regards to infrastructure, services and roads

- All proposed service lines (e.g. roads, powerlines, sewer, water etc.) should be designed to avoid or minimise intrusion into sensitive area. These facilities should be routed through developed areas, where possible. If no other routing is feasible, the lines should follow previously existing roads, servitudes and disturbed areas, minimising habitat fragmentation.

- Where possible, roads within the study area should not be wider than existing designs to minimise habitat fragmentation and disruption of faunal movements. Roads must be located on disturbed areas to the extent possible.

The proposed construction of the K56 is in line with the future planning for the area.

7.3.a Issues & Impact Identification – Institutional

Table 35: Issues and Impacts – Institutional

	Issue/ Impact	Positive/ Negative/ Neutral ±	Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼
22)	The proposed construction of the K56 will be in line with the international, national, provincial and local legislation, planning frameworks, guidelines, policies etc.	+	☼

7.4 Qualitative Environment

7.4.1 Noise Impact

The involved section of the proposed K56 could have a significant noise impact on existing residents and equestrian activities of agricultural holdings traversed by the route. Mitigation measures should be implemented to reduce the noise levels to an acceptable level (50 dBa) in sub-urban areas.

7.4.1.a Issues & Impact Identification – Noise Impact

Table 36: Issues and Impacts – Noise Impact

	Issue/ Impact	Positive/ Negative/ Neutral ±	Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼
23)	Noise impact	-	◘

7.4.1.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

23) Noise Impact

The involved section of the proposed K56 could have a significant noise impact on existing residents and equestrian activities of agricultural holdings traversed by the route. Mitigation measures should be implemented to reduce the noise levels to an acceptable level (50 dBa) in sub-urban areas.

Table 37: Significance of Issue 23 (Noise Impact) After Mitigation/ Addressing of the Issue

Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact/ Neutral - Not	Mitigation Already achieved √ Must be implemented during	Significance of Issue after mitigation Positive ☼ Low/ eliminated L / E

Necessary To Mitigate ☼	planning phase, construction and/ or operational phase **P/ C / O**	Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Low ◙	**P/ C** – Mitigation measures must be implemented to reduce the noise levels to an acceptable level (50 dBa) in sub-urban areas. The mitigation measures can only be finalized once the vertical and horizontal alignments of the proposed road are fixed. **P/ C / O –** The layout designs of proposed new developments in the area must take the noise impact from the K56 into consideration and mitigation measures must be implemented if necessary i.e. strategic placement of vegetation, berms etc.	**M –** to be included in the EMP **M –** to be included in the EMP

Result: *Although the impact can be mitigated, the significance of this impact still need to be determined/confirmed and assessed in the Significance Rating Table*

7.4.2 Visual Environment

The following visual assessment criteria ***(see Table 38)*** have been used to determine the impact of the proposed development on the state of the environment – the significance is indicated by the respective colour coding for each of the impacts, being high, medium and low:

Table 38: Visual Impact Criteria

	IMPACT		
CRITERIA	**HIGH**	**MEDIUM**	**LOW**
Visibility	**A prominent place with an almost tangible theme or ambience**	A place with a loosely defined theme or ambience	A place having little or no ambience with which it can be associated
Visual quality	A very attractive setting with great variation and interest – no clutter	**A setting with some visual and aesthetic merit**	A setting with no or little aesthetic value
Compatibility with the surrounding landscape	Cannot accommodate proposed road without the development appearing totally out of place – not compatible with the existing theme	**Can accommodate the proposed road without it looking completely out of place**	The surrounding environment will ideally suit or match the proposed road
Character	**The site or surrounding area has a definite character/ sense of place**	The site or surrounding environment has some character	The site or surrounding environment exhibits little or no character/ sense of place
Visual Absorption Capacity	The ability of the landscape not to accept a proposed development because of a uniform texture, flat slope and limited vegetation cover	**The ability of the landscape to less easily accept visually a particular type of development because of less diverse landform, vegetation and texture**	The ability of the landscape to easily accept visually a particular type of development because of its diverse landform, vegetation and texture
View distance	If uninterrupted view distances to the site are > 5 km	**If uninterrupted view distances to the site are < 5 km but > 1 km**	If uninterrupted view distances to the site are > 500 m and < 1000 m
Critical Views	**Views of the site seen by people from sensitive view sheds i.e. farms, nature areas, hiking trails etc.**	Some views of the site from sensitive view sheds	Limited or partial views of the site from sensitive view sheds
Scale	A landscape with horizontal and vertical elements in high contrast to human scale	**A landscape with some horizontal and vertical elements in some contrast to human scale**	Where vertical variation is limited and most elements are related to the human and horizontal scale

From the visual assessment it is evident that the proposed road will be visible from the surrounding view sheds. It could have a visual impact on the surrounding environment and should be planned and designed correctly to minimise any impacts in the area.

7.4.2.a Issues & Impact Identification – Visual

Table 39: Issues and Impacts – Visual

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities High ☻ Medium ☺ Low ◙ Positive Impact - Not Necessary To Mitigate ☼**
24)	The proposed road will be visible from surrounding view-sheds.	-/+	☺

7.4.3. "Sense of Place"

The concept of "a Sense of Place" does not equate simply to the creation of picturesque landscapes or pretty buildings, but to recognise the importance of a sense of belonging. Embracing uniqueness as opposed to standardisation attains quality of place. In terms of the natural environment it requires the identification, a response to and the emphasis of the distinguishing features and characteristics of landscapes. Different natural landscapes suggest different responses. Accordingly, settlement design should respond to nature.

In terms of the human made environment, quality of place recognises that there are points where elements of settlement structure, particularly the movement system, come together to create places of high accessibility and these places are recognised in that they become the focus of public investment, aimed at making them attractive, user-friendly and comfortable to experience.

The landscape is usually experienced in a sensory, psychological and sequential sense, in order to provide a feel and image of place ("genius loci").

A landscape is an integrated set of expressions, which responds to different influences. Each has its unique spirit of place, or "genius loci". Each landscape has a distinct character, which makes an impression in the mind, an image that endures long after the eye has moved to other settings.

If planned correctly the proposed road could enhance the genius loci of the broader area by establishing infrastructure for the future development of the area.
Sense of Place is the subjective feeling a person gets about a place, by experiencing the place, visually, physically, socially and emotionally. The "Sense of Place" of a property/ area within the boundaries of a city, is one of the major contributors to the "Image of a City/ City Image".

City Image consists of two main components, namely ***place structure*** and ***sense of place***. Place structure refers to the arrangement of physical place making elements within a space, whereas sense of place refers to the spirit of a place. It could be defined as follows:

- ***Place Structure*** refers to the arrangement of physical place making elements within a unique structure that can be easily legible and remembered.
- The ***Sense of place*** is the subjective meanings attached to a certain area by individuals or groups and is closely linked to its history, culture, activities, ambience and the emotions the place creates.

The Kyalami/Glenferness agricultural holdings area has a unique "Sense of Place" and character mainly created by the equestrian activities in this rural area. The Jukskei River as well as the manmade dams and wetlands along the proposed route also contribute to the

Sense of Place of the area. The involved section of the proposed K56 could have a significant impact on the "Sense of Place" and tranquillity in this area.

However, today one aspect of South African city life (especially in Gauteng), that adds frustration must be traffic congestion. Most Public meetings for developments are dominated by discussions of traffic and roads. People want development but not more traffic, more roads to be built but not on their properties. In this regard the construction of the involved section of the K56 will enhance the "Sense of Place" of the area.

7.4.3.a Issues & Impact Identification – "Sense of Place"

Table 40: Issues and Impacts – "Sense of Place"

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities** **High ☻ Medium ☺** **Low ◘** **Positive Impact - Not Necessary To Mitigate ☼**
25)	If not planned and managed correctly the proposed road could have a negative impact on the "Sense of Place" of Glenferness and surrounding areas.	-	☻

6.4.3.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

25) If not planned and managed correctly the proposed road could have a negative impact on the "Sense of Place" of Glenferness and surrounding areas.

Table 41: Significance of Issue 25 (If not planned and managed correctly, the proposed road could have a negative impact on the "Sense of Place" of the study area and its surroundings) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P/C/O** - Landscaping guidelines should be provided for the linear strips of land adjacent to the proposed road.	**L/E –** To be included in the EMP

Result: *Although the impact can be mitigated, the significance of this impact still need to be determined/confirmed and assessed in the Significance Rating Table*

7.4.4 Services and Infrastructure

The involved section of route K56 intersects with other important routes including the K46 (William Nicol), future K58 and PWV9. It also intersects with the Erling Street extension. The eastern section of the proposed route follows the alignment of the existing road P71-1 (Main Road).

Furthermore, the road will traverse areas with existing services and infrastructure and the construction of the proposed road could cause damage to such services or it could require the relocation, upgrading or temporary disruptions of such services. The proposed alignments run underneath Eskom Powerlines and the impact of the proposed road on the high-voltage power lines must be determined.

Property accesses that will be affected by the proposed alignments must be identified and workable solutions for alternative accesses must be discussed with the relevant authorities, the land-owners etc.

7.4.4a Issues and impacts identification - services and infrastructure

Table 42: Issues and Impacts – Services and Infrastructure

	Issue/ Impact	Positive/ Negative/ Neutral ±	Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact - Not Necessary To Mitigate ☼
26)	Impact on existing infrastructure and services during the construction of the proposed road.	-	☺

7.4.4.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

26) The construction of roads often requires the relocation of services and/or temporary disruptions to existing services such as access roads, electricity, water, Telkom services, sewage etc.

Table 43: Significance of Issue 26 (Impact on existing infrastructure and services during the construction of the proposed road) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction and/ or operational phase **P/ C / O**	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
High ☻	**P** – Servitudes must be indicated on Engineering drawings. **P** – Services to be upgraded, removed, relocated, disrupted, re-aligned etc. and accesses to properties that will be affected must be indicated on the Engineering Drawings. **P** - Servitudes must be negotiated with land-owners and the involved local authority for the services upgrading, relocations etc. **P** – The Impact on Eskom Power Lines must be determined. A formal application must be submitted to Eskom Tx's before any construction work commences in the vicinity of Eskom Tx's services. **P/ C** – Determine areas where services will be upgraded and relocated well in advance. Discuss possible disruptions with affected parties to determine most convenient times for service disruptions and warn affected parties well in advance of dates that service disruptions will take place.	**M –** To be included in the EMP **M –** To be included in the EMP **M –** To be included in the EMP **M –** To be included in the EMP **M –** To be included in the EMP

	C - It is important to erect proper signs indicating the operations of heavy vehicles in the vicinity of dangerous crossings and access roads.	
	C – Construction vehicles must avoid peak hour traffic, i.e. between 7am and 9am and again between 4pm and 6pm on weekdays. Routes should be planned to avoid construction vehicles travelling through residential areas where possible.	**M –** To be included in the EMP
	C – It is important to erect warning signs on existing roads when impacted on by the construction of the K56 (i.e. construction of intersections/bridges).	**M –** To be included in the EMP
	C – Traffic on existing roads should be controlled during construction activities impacting on these roads (i.e. construction works at intersections, construction of bridges). At least one lane should be open for traffic or alternatively a detour route must be available at all times. A traffic points man should be appointed.	**M –** To be included in the EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed assessed in the Significance Rating Table*

7.4.5 Affected Properties

The following properties area affected by the involved section of the K56 (proposal):

- **Farm Zevenfontein 407-JR:**

The Remainder, Portions 156, 14, 5, 11, 202 and 8 of the Farm Zevenfontein 407-JR.

- **Kyalami Agricultural Holdings Area**

  Erven 91, 76, 75, 40, 42, 56, 74, 80, 81, 82, 83, 72 and 73, and Portion 1 Kyalami Agricultural Holdings.

- **Glenferness Agricultural Holdings**

  Erven 118, 116, 115, 114, 113, 110, 100, 99 and Portion 1, Glen Ferness Agricultural Holdings

- **Glenfox area**

  Erven 15, 17, 19, 20, 21, 22, 25 and 27 Glenfox

- **Road Reserves/Servitudes affected by the proposed K56 Road**

  Ash Road, Lynx Street, Chattan Road, Macgregor Road, Zinnia Road, Macinnes Road, Macgillivray Road, Salvia Road, Pine Road, Campoloni Road, Macintyre Road, Erling Road, William Nicol Drive (R511), Dunmaglass Road, Maple Road and Main Road (M71).

A section of K56 road reserve had already been secured (proclaimed). ***Refer to Figure 19 for an illustration of the properties which had already been expropriated.***

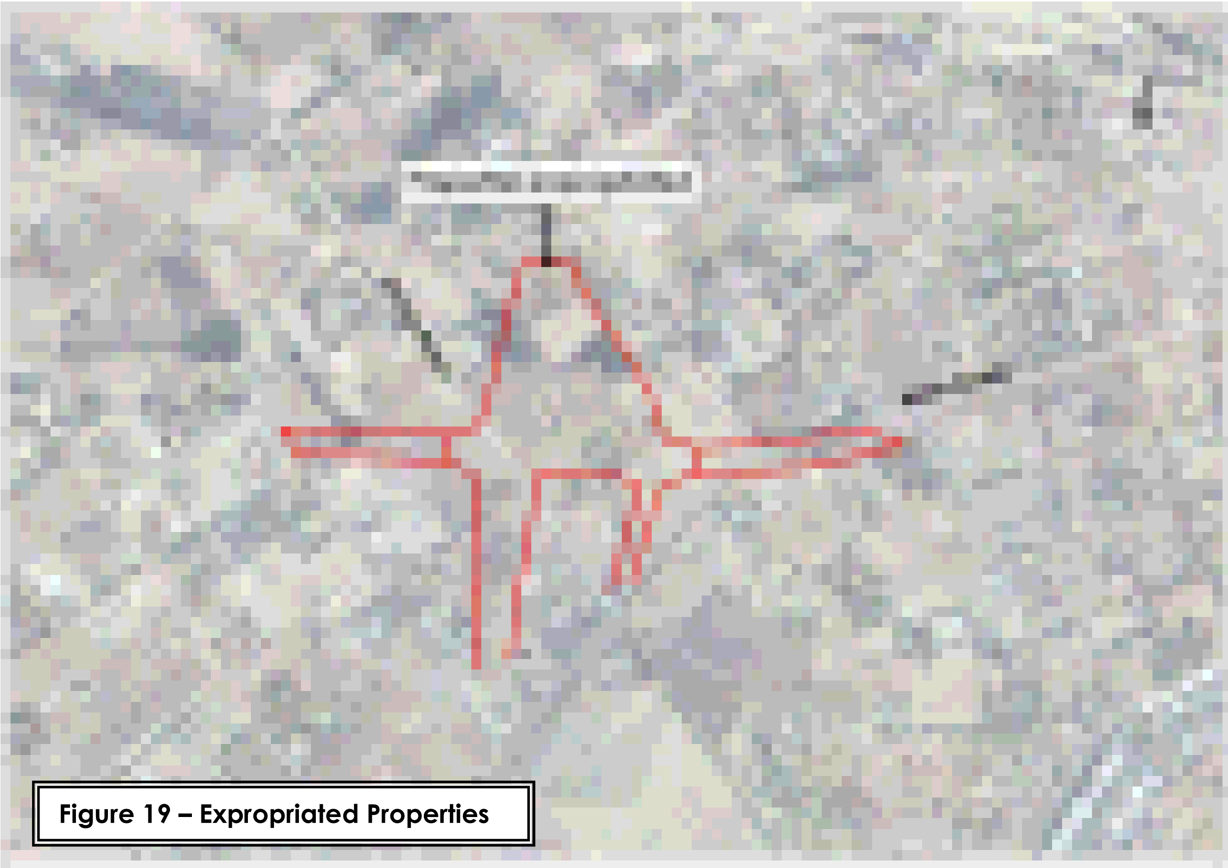


Figure 19 – Expropriated Properties

7.4.5.a Issues and Impacts – Affected Properties

Table 44: Issues and Impacts – Affected Properties

	Issue/ Impact	Positive/ Negative/ Neutral ±	Mitigation Possibilities High ☻ Medium ☺ Low ◘ Positive Impact/ Neutral - Not Necessary To Mitigate ☼

27)	Expropriation of properties	-	◘
28)	Impact on property values	-/+	◘/☼
29)	Access to local roads and properties	-	☺

7.4.5.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

27) Expropriation of properties

The construction of the involved section of the K56 will require the expropriation of a number of properties. Some of the properties within the K56 road reserve had already been expropriated as indicated on ***Figure 17.***

Table 45: Significance of Issue 27 (Expropriation of properties) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High** ☻ **Medium** ☺ **Low** ◘ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Low ◘	**P –** The expropriation of properties must be finalised prior to the construction of the road.	**M -** To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

28) Impact on property values

Although the proposed road could have negative impacts on the property values in the short and medium term, there is a possibility that the long-term impact of the K-Route will be positive.

Table 46: Significance of Issue 28 (Impact on property values) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◙** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Low ◙	**P –** The properties affected by the proposed alignment must be taken into consideration during the planning phases.	High **H**

Result: *This issue could be negative in the short term but could turn positive in the long term, the significance of the impact should be determined / confirmed and assessed in the Significance Rating Table*

29) Access to local roads and properties

The proposed road could have an impact on access to local roads and properties during the construction and operational phase.

Property accesses that will be affected by the proposed alignments must be identified and workable solutions for alternative accesses must be discussed with the relevant authorities, the land-owners etc.

Table 47: Significance of Issue 29 (Access to local roads and properties) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High** ☻ **Medium** ☺ **Low** ◙ **Positive Impact/ Neutral - Not Necessary To Mitigate** ☼	Mitigation Already achieved √ Must be implemented during **P**lanning phase, **C**onstruction and/ or **O**perational phase **P/ C / O** Mitigation	Significance of Issue after mitigation Low/ eliminated **L / E** Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P –** The design of the K56 must make provision for access to local roads and properties as well as future roads. **P/C –** Mitigation measures must be implemented to ensure access to local roads and properties. If access is restricted, alternative access/routes must be provided.	**M** - To be included in EMP **M** - To be included in EMP

Result: *Although issue can be mitigated, the significance of the impact should still be determined / confirmed and assessed in the Significance Rating Table*

7.4.6 Greater Kyalami Conservancy (GEKCO)

The involved section of the K56 traverses the Greater Kyalami Conservancy (GEKCO), which is a green lung of large and small agricultural holdings and open space tucked between Johannesburg and Pretoria ***(refer to Figure 20)***.

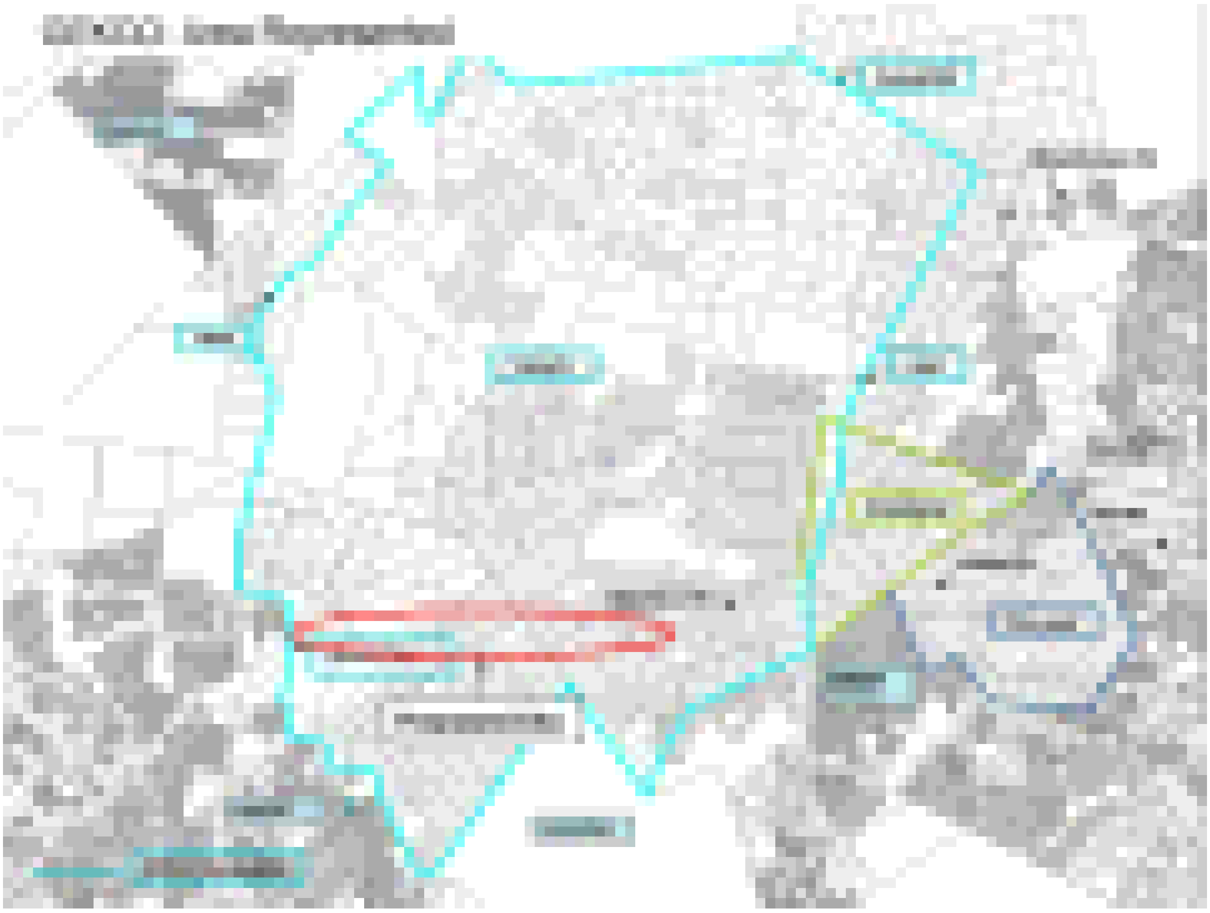


Figure 20 – Locality of K56 within GEKCO

Please note: the following information was obtained from GEKCO's website

Vision:

The members of the GEKCO Conservancy desire to protect and conserve nature and a relatively rural way of life in an area which sustains several endangered species, wetlands and ridges as well as one of the highest densities of horses in the Southern hemisphere and a thriving equine industry.

Residents and visitors to Kyalami know the magic of this place – where the call of the jackal can still be heard – where nature continues to enchant! Breathe deeply as you leave the stress of the city behind and discover Kyalami for yourself.

The GEKCO (Greater Kyalami) conservancy is located in the greater Kyalami area (north of Sandton and west of Midrand). The area is encompassed by the Kyalami Ridge to the South, the Braamfontein Spruit and R511 to the West, the R562 to the North and R55 to the East and includes the suburb of Carlswald.

The area has been subject to varying levels of disturbance and several alien plant species are present. However there are nevertheless many noteworthy examples of natural vegetation of the region: There is a major ridge to the south of the area and many hill slope seepage wetland regions; there are a number of water courses that run through the area and several dams are present.

The area is going through a process of rural urbanisation which many residents do not agree with. The conservancy is generally peri-urban with a strong equestrian presence. Development has and is threatening this lifestyle and one of the objectives is to try to slow this tide or at least educate it in ecologically sensitive and equine friendly development. There are still numerous fauna species in the area that are under threat: tortoises, terrapins, scrub hares, black-backed jackal, mongoose, the African Bullfrog etc. There are several red data plant species and over 240 bird species regularly seen in the area. The wetlands form an integral part of the area not only from an aesthetic point of view, but also as filters and sites of species richness and landscape heterogeneity.

Objectives:

The objectives represent those of the residents who appreciate the natural habitat within the region and would like to also preserve and conserve a relatively rural way of life. In order to achieve this goal, the following objectives have been identified:

- *Protect and conserve the remnant indigenous habitat and ecological processes, in an effort to maintain the ecological integrity of the conservancy by ensuring the appropriate protection, rehabilitation and management of:*
- *Remnant habitat, particularly that which supports populations of red data species.*
- *Wetlands and waterways in the region.*
- *Ridges in the region.*
- *Promote environmentally sensitive development and technologies in an effort to encourage sustainable development that is aimed at:*
  - *Improving resource efficiencies, including the use of water and electricity.*
  - *Improving waste avoidance, minimisation and recycling.*
  - *Reducing erosion and pollution through effective storm water management.*
- *Encouraging landscaping principles that reduce water use and utilise species indigenous to the vegetation types zones in which they occur.*
- *Protect the character and aesthetic quality of Kyalami, as a semi-rural environment that has been established around the equine industry by:*
- *Influencing property development so that it is sensitive to the character of the Kyalami region and respects the objectives of the conservancy.*
- *Developing the equine industry in a socially responsible and sustainable manner.*
- *Align with the principles of the Johannesburg Metropolitan Open Space System (JMOSS), the Johannesburg Spatial Development Framework and the Johannesburg development principle of a compact city with a mixture of housing densities and lower densities on the periphery.*
- *Raise awareness amongst residents and the public for the need to conserve the environmental resources and character of the region with the aim of:*
  - *Actively involving all residents and the public in the endeavours of the conservancy through conservation projects, educational processes and marketing.*
  - *Gaining recognition as a bone fide organisation for the aims of the conservancy from the public, business and government.*
  - *Affording residents the opportunity to appreciate the fauna and flora of the conservancy and the rural way of life that it characterises.*

7.4.6.a Issues & Impact Identification – GECKO

Table 48: Issues and Impacts – Impact on GECKO

	Issue/ Impact	**Positive/ Negative/ Neutral ±**	**Mitigation Possibilities** **High ☻ Medium ☺ Low ◘** **Positive Impact - Not Necessary To Mitigate ☼**
30)	Impact on GEKCO	-	◘

7.2.b Discussion of issues identified, possible mitigation measures and significance of issue after mitigation

30) Impact on GEKCO

The proposed route traverse GEKCO and could have an impact on the relatively rural way of life in an area which sustains several endangered species, wetlands and ridges as well as one of the highest densities of horses in the Southern hemisphere and a thriving equine industry.

Table 49: Significance of Issue 30 (Impact on GEKCO) After Mitigation/ Addressing of the Issue

Mitigation Possibilities **High ☻ Medium ☺ Low ◘** **Positive Impact/ Neutral - Not Necessary To Mitigate ☼**	Mitigation Already achieved √ Must be implemented during planning phase, construction	Significance of Issue after mitigation Positive ☼ Low/ eliminated **L / E**

	and/ or operational phase **P/ C / O**	Medium **M** High **H** Not possible to mitigate, but not regarded as a fatal flaw **NP**
Medium ☺	**P/ C / O** – The proposed route could have an impact on GEKCO and mitigation measures must be implemented to ensure the protection of the wetlands and sensitive fauna and flora species.	**H** – To be included in EMP

Result: *The significance of this impact need to be determined/confirmed and assessed in the Significance Rating Table*

7.4.7 Public Participation

(Refer to Annexure M for Public Participation)

Public Participation is a cornerstone of any environmental impact assessment. The principles of the National Environment Management Act, 1998 (Act No. 107 of 1998) govern many aspects of environmental impact assessments, including public participation. These include provision of sufficient and transparent information on an on-going basis to the stakeholders to allow them to comment and ensuring the participation of previously disadvantaged people, women and youth.

Effective public involvement is an essential component of many decision–making structures, and effective community involvement is the only way in which the power given to communities can be used efficiently. The public participation process is designed to provide sufficient and accessible information to interested and affected parties (I&APs) in an objective manner to assist them to:

- Raise issues of concern and suggestions for enhanced benefits.
- Verify that their issues have been captured.
- Verify that their issues have been considered by the technical investigations.
- Comment on the findings of the EIA.

In terms of the Guideline Document for Environmental Impact Assessment (EIA) Regulations promulgated in terms of the National Environmental Management Act (Act No.107 of 1998), stakeholders (I&APs) were notified of the Environmental Evaluation Process during the EIA Phase through:

1) An advertisement was placed in **Fourways Review** newspaper on **10 April 2014** ***(Annexure M (i)).***

2) A site notice that was erected (at prominent points on and around the study area) on **10 April 2014** ***(Annexure M (ii)).***

3) On **9 April 2014** public notices/ flyers were distributed to the councillor and neighbouring properties and estates/ developments that may be affected by the proposed section of the K56 ***(Annexure M (iii)).***

4) Focus Group Meetings was held on **8 May 2014 and 12 May 2014**. Refer to ***Annexure M (iv) for Minutes of Meetings.***

5) An EIA Public Meeting was held on **27 May 2014.** ***Refer to Annexure M(v) for Invitation to Meeting and Annexure M (vi) for Minutes of Meeting.***

6) The draft EIA Report will be available for review by I & APs, including CoJ and DWA for a period of 40 days. Comments received will be included in the Final EIA Report.

More than 1000 persons/organisations registered as I & APs ***(refer to Annexure M (vii) for a list of I&APs) and Annexure M (viii) for correspondence received from I & APs.***
GEKCO raised objections to the proposed construction of the K56 during both the Scoping and EIA Phases. ***Refer to Annexure M(viii) for a Petition submitted by GEKCO.***

An **objection t**o the proposed construction of Erling Road between K46 and K56 and the K56 between K46 and Main Road was received from Envirokey Management Services cc on behalf of the Greater Kyalami Conservancy (GECKO) and the Greater Kyalami Residents Council (GKRC) ***(refer to Annexure M (ix)).***

The key points for the objection are the following:

i. Environmental sensitivity of the receiving environment;
ii. Necessity for the road development
iii. Social impacts associated with the K56 road development
iv. Non-compliance with the Environmental Framework for the area.

A Document on the Movement of Horses and Horse Riders through Glenferness and the associated bridle paths compiled by Janine Turner, Margie Donde and Pierre Heffer for and on behalf of the Glenferness Equestrian Community, dated 24 March 2014, was submitted to Bokamoso. ***Refer to Annexure M(x) for a copy of the document.***

The document includes 3 attachments:

1. Attachments A – Z comprising of 2126 Petitions against the K56
2. Impact of Development on the Viability of the Equine Industry in the Greater Kyalami Area – Survey Results including 26 comments
3. Comment from South African Veterinary Association

Correspondence was received from Dr. Karen Böhme, an equine veterinarian practicing in the Kyalami Area. She stated that the reason for her practice being economically viable is that most of her clients are concentrated in the relatively small Kyalami area and that without the high density of horses in the Kyalami area her practice would no longer be economically viable and will have to close. There are seven other equine practices which would also be affected in this way. The impact that the destruction of Kyalami has on all these practices can be imagined and the ripple effect (loss of employment of staff contributing to unemployment problems and families ending up living below the breadline) will be massive since these people are highly skilled at what they do but completely unskilled at anything else. ***Refer to Annexure M(xi) for correspondence from Dr. Böhme.***

Please note: although the majority of affected parties are opposed to the proposed Road K56, some parties support the proposed road.

Comments received in support for K56 (Mr. Gillespie) *(refer to Annexure M(xii)*

- Mr. Gillespie, the major shareholder or director of all the companies / properties on the attached list attached as ***Annexure M (iii)*** stated that he is very much in favour of the much needed East/West road, the K56. All these properties are within close proximity of the K56. He stated that he would have said something at the second public meeting but there was an element there that would not let anyone speak in favour of the road. The guy who tried to speak in favour of the road was not given an uninterrupted opportunity to speak. According to Mr. Gillespie there were many other people in favour of the road.

- A Glenferness resident stated that the area is anything but a "quiet rural" area. She lives on a road that is already accommodating two schools and a large nursery with a lot of traffic. She is in support of the road ***(refer to Annexure G (xii))*.**

- **Need for the road**
  - Clearly this road has to be built, but it will only serve its purpose if it is built in its entirety. Anything less defeats its purpose.
  - It is understood that people object to the road traversing their area. The acid test has to be whether they purchased their properties after it was proclaimed and put onto the map in the 1970's. Anyone who purchased their properties after this date (and I suspect that this will be the overwhelming majority) did so with the full knowledge that this was a proposed road in their area. The fact that this road was on the books would have been factored into the price that they paid for their properties. To now come along after the fact and claim all manner of rights to the alignment of the road holds no water. A simple test would be to say to those who want the road realigned

onto someone else's property, this action will undoubtedly increase the value of their property, those benefiting from improved value must logically then pay the increase in value of their property to the owners of the property that would be affected by any realignment (I cannot see them accepting this, therefore how can they realistically expect those affected by any realignment to be any more accepting than they were). Those property owners who have owned the property prior to the proclamation of the roads must be treated as a special case as they do have a legitimate case for compensation for loss of value. However I suspect that they will be very few and far between.

- There is potentially a silver lining for property owners whose properties are affected by the road, that is the council typically looks favourably on applications for commercial rights along a corridor next to such roads to act as a buffer between busy roads and residential areas. This would undoubtedly increase the value of these properties as it has done with many of the properties along the Gautrain route.
- The only legitimate gripe residents may have that bought their properties after the proclamation of these roads could be over environment issues where rare and endangered species habitats could be destroyed. I hope that this points offer a more balanced perspective to what has clearly become an emotional issue.

- **Advantages of the route**
  - The additional bridge over the Jukskei River will relieve traffic on both existing bridges on Main and William Nicol/K46.
  - The present routing will be less disruptive to the horse/equestrian industry than going via Zinnia/Caracal roads. It is assumed that safe crossings of one or other design will be provided for anyway.
  - Knowing that all this will only happen in 4 or 5 years' time, this should give all concerned parties enough time to develop alternative habitats for bull-frogs and other species.

- The present routing also is shorter than going via Zinnia road.

Comments received from the Broadacres Drive Association (BDA) *(refer to Annexure M(xii))*

The BDA is a voluntary association of the residential estates and other entities that use Broadacres Drive to access the R511/William Nicol Highway. The members of the association represent over 2500 households, a school with 1 100 pupils, a shopping centre and an office park.

The BDA consulted with a traffic engineer and it was established that the proposed link road (Erling Road between K46 and K56 and the K56 between K46 and Main Road) will significantly reduce congestion on the R511/William Nicol Highway south of Erling Road. This will benefit the members of the association and reduce the commuting times endured by the large numbers of Diepsloot residents travelling south on R511/William Nicol Highway.

Refer to ***Table 50*** for a summary of Issues/Objections raised during the Scoping/EIA Phase:

Table 50 : Summary of Issues/Objections Raised							
Ecological Issues							
Scoping Phase – 1st Public Participation Process (emails)	**1st Scoping Public Meeting**	**2nd Scoping Public Meeting**	**Draft Scoping & Final Scoping - Review Process**	**2nd EIA Public Participation Process (emails)**	**Petition**	**Forum Meetings and Correspondence received from Janine Turner, Margie Donde and Pierre Heffer for and on behalf of the Glenferness Equestrian Community**	**No. of people raised issues**
Impacts on Hydrology (Jukskei River & perennial streams), Wetlands and sensitive ecosystems (1)	Impacts on Hydrology (Jukskei River & perennial streams), Wetlands and sensitive ecosystems (13)	Impacts on Hydrology (Jukskei River & perennial streams), Wetlands and sensitive ecosystems (2)	Hydrology (Jukskei River & perennial streams), Impacts on Wetlands and sensitive ecosystems (2)	Hydrology (Jukskei River & perennial streams), Impacts on Wetlands and sensitive ecosystems (1)	Hydrology (Jukskei River & perennial streams), Impacts on Wetlands and sensitive ecosystems (45)		(64)
Impact on African Bullfrog (1)	Impact on African Bullfrog (15)	Impact on African Bullfrog (1)	Impact on African Bullfrog (1)	Impact on African Bullfrog (1)	Impact on African Bullfrog (9)		(28)
Road crosses Irreplaceable conservation sites (1)	Road crosses Irreplaceable conservation sites (1)	Road crosses Irreplaceable conservation sites (1)	Road crosses Irreplaceable conservation sites (1)				(4)
	Impact on GEKCO Conservancy				Impact on GEKCO Conservancy	Impact on GEKCO Conservancy	
	Impact on						(1)

	butterflies - migration area of butterflies						
Loss of Largest Butterfly Farm in the world (1)	Loss of Largest Butterfly Farm in the world (1)						(2)
	Negative Impact on Fauna & Flora (8)	Negative Impact on Fauna & Flora (4)	Negative Impact on Fauna & Flora (1)		Negative Impact on Fauna & Flora (10)		(23)
	Negative impact on Wild Life (10)	Negative impact on Wild Life (2)		Negative impact on Wild Life (1)	Negative impact on Wild Life (79)		(92)
	Loss of Green belt (Green lung) (4)	Loss of Green belt (Green lung) (1)			Loss of Green belt (Green lung) (13)		(18)
	Affects the Rainfall pattern (1)						(1)
	Impact on Soil (1)	Impact on Soil (1)					(2)
	Loss of Red data species (1)	Loss of Red data species (2)	Loss of Red data species (1)				(4)
		Endangered grassland (Egoli Granite Grassland) (3)	Endangered grassland (Egoli Granite Grassland) (2)		Endangered grassland (Egoli Granite Grassland) (13)		(18)
			Environmental sensitivity of receiving environment (1)			Horses support biodiversity of the area (1)	
						Equine Industry in Greater Kyalami area located in rich	

						bio-diverse environment (1)	
Social and Economical Issues							
	1st Scoping Public Meeting	**2nd Scoping Public Meeting**	**Draft Scoping & Final Scoping - Review Process**	**2nd EIA Public Participation Process (emails and Public Meeting)**	**Petition**	**Forum Meetings and Correspondence received from Janine Turner, Margie Donde and Pierre Heffer for and on behalf of the Glenferness Equestrian Community**	**Scoping Phase – 1st Public Participation Process (emails)**
Qualitative Environment							
Noise Impact (1)	Noise Impact (5)	Noise Impact (1)			Noise Impact (2)		(9)
	Dust Pollution (2)						(2)
	Visual impact (1)						(1)
	Impact on tranquil and rural lifestyle/quality of life (3)				Impact on tranquil and rural lifestyle/quality of life (3)		(4)
	Impact on Sense of Place/ loss of ambience		Impact on Sense of Place			Impact on Sense of Place	
	Urban/Rural area (2)	Urban/Rural area (1)	Urban/Rural area (1)	Urban/Rural area (1)	Urban/Rural area (7)		(12)
	Increasing						(1)

	Lighting Levels (1)						
Equestrian Industry							
Negative impact on equestrian activities, associated facilities and events in the area (2)	Negative impact on equestrian activities, associated facilities and events in the area (10)	Negative impact on equestrian activities, associated facilities and events in the area (2)		Negative impact on equestrian activities, associated facilities and events in the area (4)	Negative impact on equestrian activities, associated facilities and events in the area (10))		(28)
	Negative impact on Equestrian Community (10)			Negative impact on Equestrian Community (1)	Negative impact on Equestrian Community (8)		(19)
			Socio Economic Impact Assessment to be conducted to assess impacts of proposed road on equine industry.				
	Lipizzaner Centre will have to move (1)				Lipizzaner Centre will have to move (2)		(3)
				Traditional Bridle paths (1)			(1)
	Glenferness will be cut off from the riding community in Kyalami and					Glenferness will be cut off from the riding community in Kyalami and	

	environs					environs	
	Destruction of Equestrian area of Glenferness						
	Vehicles with horse trailers must use major roads						
	The use of horses for the process of healing will be influenced						
						Proposed K56 will result in fragmentation of the equine area – the whole area will be lost. Where will they go?	
						Equine Industry in Greater Kyalami area ± R800M. Glenferness makes 25% - 30% of land mass and horse industry in this area	
						Glenferness will not exist as a riding community without easy access to the	

						rest of the Kyalami area.	
						Impact on large competitive stable yards i.e. Ascot Stables, Phaeton Park and Glenfox Stables.	
						Massive amount of movement of riders and horses in Glenferness AH. Every road in Glenferness used by horse riders.	
						Overpasses or underpasses will be dangerous and is not a viable alternative.	
						Socio-economic impact on thousands of informal workers skilled for the equestrian industry. Most of them (including their	

						families) work and live in Glenferness AH area.	
						Kyalami and Sunvalley and surrounds depend on Glenferness for viability and Glenferness depends on the interaction and accessibility of Kyalami and Sunvalley and environments	
						K56 is about destruction of community and reason why community came together in this area	
						Impact on veterinarians in equine industry.	
Services and Infrastructure							
Upgrade/widening/ maintenance of existing roads needed instead of new road (2)	Upgrade/widening/ maintenance of existing roads needed instead of new road (13)	Upgrade/widening/ maintenance of existing roads needed instead of new road (3)	Upgrade/widening/ maintenance of existing roads needed instead of new road (4)	Upgrade/widening/ maintenance of existing roads needed instead of new road (2)	Upgrade/widening/ maintenance of existing roads needed instead of new road(23)	Upgrade/widening/ maintenance of existing roads needed instead of new road	(47)

	Storm water management of proposed road		Storm water management of proposed road				(2)
	Inadequate capacity of sewerage and electricity for current load (1)						(1)
	Bridge needs to be built at great expense						
	Water & electricity on opposite sides of road						
	Roll of Eskom & where are their lines going?						
K56 – General							
	Size of proposed road and reserves						
	Access points along the road						
	Where is the East/west connection?						
			Alignment traverses existing residential homes (1)				
	Estimate usage of K56						

	Why only a section of K56 to be constructed?					Why EIA application for only a section of K56 to serve developer's needs?	
	Process timeline – when will construction commence?						
	Need for public transport.	Need for public transport.					
	Where is the funding for this road coming from?	Where is the funding for this road coming from?					
	Why are developers pushing for this road?						
	Alternatives i.e. Mackenzie Alternative		Alternatives, including Mackenzie alternative to be investigated			Mackenzie alternative supported by community	
	Who are the beneficiaries of this road?						
				Any upgrade of Zinnia Road is not supported			
	Will encourage further urban spreading						
	Need for the		Need for the				

	road – was a traffic impact study done?		road				
		Advantages of the route					
		K56 will bring more traffic to K46 and R55 which both need to be upgraded.					
		Need for access to the Kyalami area (1)					
		Status of PWV9 and PWV5					
			No Go Option to be considered				
Traffic congestions (2)	Traffic congestions (13)	Traffic congestions (7)	Traffic congestions (2)	Traffic congestions (2)	Traffic congestions (6)		(32)
Stop the K56 (1)	Stop the K56 (6)		Stop the K56 (1)	Stop the K56 (1)	Stop the K56 (49)		(58)
	Since the 80's the public never wanted these roads						
	K56 divides existing properties into two sections						
Greedy property developers (1)	Greedy property developers (2)				Greedy property developers (4)		(7)
	Impact on						(1)

	Churches (1)						
	Difficult to relocate (1)						(1)
	Ignore the people on the ground (1)						(1)
	Corruption & Bribery (1)						(1)
Benefit for Steyn City & Helderfontein (1)	Benefit for Steyn City & Helderfontein (1)	Benefit for Steyn City & Helderfontein (1)			Benefit for Steyn City & Helderfontein (1)		(4)
Safety (1)	Safety (4)	Safety (2)					(7)
			No-go option (1)				(1)
	Heritage (Graves on Helderfontein will be destroyed) (1)	Heritage (Graves on Helderfontein will be destroyed) (1)		Heritage (Graves on Helderfontein will be destroyed) (1)	Heritage (Graves on Helderfontein will be destroyed) (1)		(4)
		Agricultural (1)	Impact on existing farming activities	Agricultural (1)	Agricultural (1)		(3)
Economic Impact							
Job losses (2)	Job losses (13)	Job losses (1)	Job losses (3)	Job losses (1)	Job losses (18)	Job losses (6)	(44)
	Businesses close down (5)	Businesses close down (1)	Businesses close down (3)	Businesses close down (1)	Businesses close down (2)		(12)
Loss of Schools/impact on schools (2)	Loss of Schools/impact on schools (7)	Loss of Schools/impact on schools (1)			Loss of Schools/impact on schools (18)		(28)
	Funding (3)	Funding (2)	Funding (1)		Funding (1)		(7)
	What prices will properties expropriate? (1)						(1)
	Value of property /				Value of property (1)		(1)

	property devaluation (2)						
					Equestrian Economy (1)		(1)
Institutional Issues							
Scoping Phase – 1st Public Participation Process (emails)	**1st Scoping Public Meeting**	**2nd Scoping Public Meeting**	**Draft Scoping & Final Scoping - Review Process**	**2nd EIA Public Participation Process (emails)**	**Petition**	**Forum Meetings**	**No. of people raised issues**
Environmental Management Framework (1)						Proposed road not in line with Regional EMF compiled by SEF	(1)
	Gauteng Government is trying to discourage private transport into the CBD (1)						(1)
	K56 not in line with Johannesburg Growth & Development Strategy 2040 (1)	K56 not in line with Johannesburg Growth & Development Strategy 2040 (1)					(2)
	Municipality & Government complain about not having enough funds (1)						(1)
		The Gauteng Land Transport	The Gauteng Land Transport				(2)

		Framework (GLTF) (1)	Framework (GLTF) (1)				
			Non-compliance with the Environmental Framework (1)				(1)
			Conservation Plan (Version 3) as "Irreplaceable" (1)				(1)
			The City of Johannesburg's Biodiversity Strategy and Action Plan (BSAP) (1)				(1)
			Gauteng Spatial Development Framework 2011 (1)				(1)
			National List of Threatened Ecosystems (1)				(1)
					A new Framework is needed (1)		(1)

7.5 Social Impact Assessment

The scoping approval letter from GDRAD dated 24th of March 2014 request that a social impact assessment must be conducted on the proposed development. ***A social impact assessment is attached as Annexure P***.

From the Social Impact Assessment Report it is clear that there are significant impacts associated with the construction of new major roads if proper planning and mitigation is not practiced. On the other hand the study also recognizes the importance of road for economic and social development within the economy of a developing country. It is also clear that urban sprawl has led to the unsustainable growth of cities beyond the capacity to successfully implement a public transport system throughout the city. For this reason roads are still a considered an important necessity within a developing economy.

It is also expected that the local area will experience some form of economic growth particularly with regards to tourism within the area, however this will be dependent on the declaration of the GECKO area as a no-development zone for an indefinite time. **It is therefore recommended that the GECKO area be declared as a no/ controlled development zone so as to ensure that it remains protected and that it can continue to act as a 'green lung' and associated equestrian node within the City of Johannesburg.**

It is also suggested that the social impacts of other facilities constructed within the area, for example the church to which one I&AP refers to, are assessed as a means of determining whether it did meet the expectations of the EIA for that particular project. This will assist the proponent in identifying whether the perceived social impacts actually occurred and whether the development had a positive or negative impact on the social fiber within the area. This will also guide the proponent and specialists in identifying any other impacts that could result from the implementation of the road. Although the facilities are completely different

8. COMPARATIVE ASSESSMENT BETWEEN ALTERNATIVES 1, 2 AND 3

8.1 Anticipated impacts, including cumulative impacts

The impacts/ aspects (beneficial and adverse) of the proposed section of the K56 (Alternative 1, Alternative 2 and Alternative C "Proposal") on the receiving environment were identified. The above impacts, as well as the affected environmental characteristics, are indicated in **Tables 51 and 52** below.

Table 51: Comparative Assessment between impacts of proposed alignment and Alternatives 1, 2 & 3 for Road K56

Environmental Aspects	**Physical**				**Biological**		**Socio-Economical**									**Institutional**				**Total of Impacts**
Key to impacts: ☺ l– Lower positive ☺ m– Medium positive ☺ h– Higher positive ☹ l– Lower negative ☹ m–Medium negative ☹ h– Higher negative 😐 - Neutral	Geology and Soils	Hydrology	Topography	Climate	Fauna	Flora	Qualitative Environment Visual, Noise, Pollution, Security	Compatibility of Land-Use	Availability of municipal services	Upgrading of Municipal Services	Economical Impact Local Authority	Economical Impact I&AP's	Economical Impact Private Sector	Cultural and Historical	Impact on high agricultural potential land	In line with IDP	In line with SDF or other frameworks And open space plans	In line with policies and guidelines	In line with Acts and other legislation	
CONSTRUCTION PHASE **Preliminary Issues and Impacts**																				
Proposal	☹ h	☹ h	😐	☹ m	☹ h	☹ h	☹ h	☹ h	😐	😐	😐	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 4 ☹ h x 8 ☹ m x 3 😐 x 4
Alternative 1	☹ h	☹ m	😐	☹ m	☹ h	☹ h	☹ h	☹ h	😐	😐	😐	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 4 ☹ h x 7 ☹ m x 4 😐 x 4

Alternative 2	☹ h	☹ m	😐	☹ m	☹ h	☹ h	☹ h	☹ h	😐	😐	😐	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 4 ☹ h x 7 ☹ m x 4 😐 x 4
Alternative 3	☹ m	☹ l	😐	☹ m	☹ l	☹ m	☹ m	☺ m	😐	😐	😐	☹ l	☹ l	😐	😐	☺ h	☺ h	☺ h	☹ h	☺ h x 3 ☹ h x 1 ☹ m x 4 ☹ l x 4 😐 x 6

OPERATIONAL PHASE Preliminary Issues and Impacts																				
	Geology/ soils	Hydrology	Topography	Climate	Fauna	Flora	Qualitative Env	Compatibility of Land-Use	Municipal Serv	Upgrading of Mun Serv	Econ Impact LA	Econ Impact I & AP's	Econ Impact Priv Sector	Cult & Hist	Agric Potential	IDP	SDF, Open Space Plan	Policies/ Guidelines	Acts other legislation	
Proposal	☹ h	☹ h	😐	☹ l	☹ h	☹ h	☹ h	☹ h	😐	☺ h	☺ h	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 6 😐 x 2 ☹ h x 8 ☹ m x 2

																				☹ l x 1
Alternative 1	☹ h	☹ m	😐	☹ l	☹ h	☹ h	☹ h	☹ h	😐	☺ h	☺ h	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 6 😐 x 2 ☹ h x 7 ☹ m x 3 ☹ l x 1
Alternative 2	☹ h	☹ m	😐	☹ l	☹ h	☹ h	☹ h	☹ h	😐	☺ h	☺ h	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 6 😐 x 2 ☹ h x 5 ☹ m x 3 ☹ l x 1
Alternative 3	☹ h	☹ l	😐	☹ l	☹ m	☹ m	☹ l	☹ l	😐	☺ h	☺ h	☹ l	☹ h	😐	😐	☺ h	☺ h	☺ h	☹ h	☺ h x 5 😐 x 4 ☹ h x 3 ☹ m x 2 ☹ l x 5

Table 52: Comparative Assessment between impacts of Alternatives 1, 2 & 3 for Road K56

Environmental Aspects	Physical				Biological		Socio-Economical									Institutional				Total of Impacts
Key to impacts: ☺ l– Lower positive ☺ m– Medium positive ☺ h– Higher positive ☹ l– Lower negative ☹ m–Medium negative ☹ h– Higher negative 😐 - Neutral	Geology and Soils	Hydrology	Topography	Climate	Fauna	Flora	Qualitative Environment Visual, Noise, Pollution, Security	Compatibility of Land-Use	Availability of municipal services	Upgrading of Municipal Services	Economical Impact Local Authority	Economical Impact I&AP's	Economical Impact Private Sector	Cultural and Historical	Impact on high agricultural potential land	In line with IDP	In line with SDF or other frameworks And open space plans	In line with policies and guidelines	In line with Acts and other legislation	
CONSTRUCTION PHASE **Preliminary Issues and Impacts**																				
Proposal	☹ l	☹ h	😐	☹ l	☹ h	☹ h	☹ h	☹ h	😐	☺ h	😐	☹ h	☹ h	☹ m	☹ m	☺	☺	☺	☺	☺ h x 5 😐 x 3 ☹ l x 2 ☹ m x 2 ☹ h x 7
Alternative 1	☹ l	☹ m	😐	☹ l	☹ h	☹ h	☹ h	☹ h	😐	☺ h	😐	☹ h	☹ h	☹ m	☹ m	☺	☺	☺	☺	☺ h x 5 😐 x 3 ☹ l x 2 ☹ m x 3 ☹ h x 6

Alternative 2	☹ l	☹ m	😐	☹ l	☹ h	☹ h	☹ h	☹ h	😐	☺ h	😐	☹ h	☹ h	☹ m	☹ m	☺ h	☺ h	☺ h	☺ h	☺ h x 5 😐 x 3 ☹ l x 2 ☹ m x 3 ☹ h x 6
Alternative 3	☹ l	☹ l	😐	☹ l	☹ l	☹ l	☹ l	☹ l	😐	☺ h	😐	☺ m	☺ m	😐	😐	☺ h	☺ h	☺ h	☹ h	☺ h x 4 ☺ m x 5 😐 x 5 ☹ l x 7 ☹ h x 1
OPERATIONAL PHASE **Preliminary Issues and Impacts**																				
	Geology/ soils	**Hydrology**	**Topography**	**Climate**	**Fauna**	**Flora**	**Qualitative Env**	**Land-Use**	**Municipal Serv**	**Upgrading of Mun Serv**	**Econ Impact LA**	**Econ Impact I & AP's**	**Econ Impact Priv Sector**	**Cult & Hist**	**Agric Potential**	**IDP**	**SDF, Open Space Plan**	**Policies/ Guidelines**	**Acts other legislation**	
Proposal	☹ l	☹ m	😐	😐	☹ h	☹ h	☹ h	☹ h	😐	☺ h	😐	☹ h	☹ h	☹ l	☹ l	☺ h	☺ h	☺ h	☺ h	☺ h x 5 ☹ l x 3 ☹ m x 1 ☹ h x 6 😐 x 4
Alternative 1	☹	☹	😐	😐	☹	☹	☹	☹	😐	☺	😐	☹	☹	☹	☹	☺	☺	☺	☺	☺ h x 5

	l	l			h	h	h	h		h		h	h	l	l	h	h	h	h	☹ l x4 ☹ h x 6 😐 x 4
Alternative 2	☹ l	☹ l	😐	😐	☹ h	☹ h	☹ h	☹ h	😐	☺ h	😐	☹ h	☹ h	😐	☹ l	☺ h	☺ h	☺ h	☺ h	☺ h x 5 ☹ l x 3 ☹ h x 6 😐 x 5
Alternative 3	☹ l	☹ l	😐	😐	☹ l	☹ l	☹ l	☺ l	😐	☺ h	😐	☺ m	☺ m	😐	☹ l	☺ h	☺ h	☺ h	☹ h	☺ h x 4 ☺ m x 2 ☺ l x 1 ☹ l x 6 ☹ h x 1 😐 x 5

8.3 *Comparative Assessment between the Proposed Alignment (the published alignment),* Alternatives 1, 2 & 3 for Road K56

The Tables above represent a comparative assessments based on the issues identified in the EIA phase.

The comparative assessment assisted the EAP with the identification of the preferred alternative.

Due to the fact that many of the high impact issues identified in the above mentioned tables can be mitigated to more acceptable levels, the issues ratings before and after mitigation could differ considerably. In many cases, high impact issues (mostly related to the construction phase of a development) can be mitigated completely. The comparative assessment after mitigation (Refer to table above) will therefore give a more accurate indication of the preferred alternative for the project.

Table 53: Summary - Comparative Assessment between Alternatives 1, 2 & 3 before Mitigation

Environmental Aspects	Physical	Biological	Socio-Economic	Institutional
Proposal	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 8
	☹ l x 1 ☹ m x 1 ☹ h x 4	☹ l x 0 ☹ m x 0 ☹ h x 4	☹ l x 0 ☹ m x 4 ☹ h x 8	☹ l x 0 ☹ m x 0 ☹ h x 0
	😐 x 2	😐 x 0	😐 x 4	😐 x 0
Alternative 1	☺ l x 0 ☺ m x 0	☺ l x 0 ☺ m x 0	☺ l x 0 ☺ m x 0	☺ l x 0 ☺ m x 0

	☺ h x 0	☺ h x 4	☺ h x 2	☺ h x 8
	☹ l x 1 ☹ m x 3 ☹ h x 2	☹ l x 0 ☹ m x 4 ☹ h x 0	☹ l x 0 ☹ m x 4 ☹ h x 8	☹ l x 0 ☹ m x 0 ☹ h x 0
	😐 x 2	😐 x 0	😐 x 4	😐 x 0
Alternative 2	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 8
	☹ l x 1 ☹ m x 3 ☹ h x 2	☹ l x 0 ☹ m x 0 ☹ h x 4	☹ l x 0 ☹ m x 4 ☹ h x 8	☹ l x 0 ☹ m x 0 ☹ h x 0
	😐 x 2	😐 x 0	😐 x 4	😐 x 0
Alternative 3	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 1 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 4
	☹ l x 3 ☹ m x 3 ☹ h x 0	☹ l x 1 ☹ m x 3 ☹ h x 0	☹ l x 5 ☹ m x 1 ☹ h x 1	☹ l x 0 ☹ m 0 1 ☹ h x 4
	😐 x 2	😐 x 0	😐 x 8	😐 x 0

Table 54: Summary - Comparative Assessment between the Proposed Alternative (the published alignment), Alternatives 1, 2 & 3 after Mitigation

Aspects	Physical	Biological	Socio-Economic	Institutional

Proposal	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 8
	☹ l x 3 ☹ m x 1 ☹ h x 1	☹ l x 0 ☹ m x 0 ☹ h x 8	☹ l x 2 ☹ m x 2 ☹ h x 8	☹ l x 0 ☹ m x 0 ☹ h x 0
	😐 x 3	😐 x 0	😐 x 4	😐 x 0
Alternative 1	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 8
	☹ l x 4 ☹ m x 1 ☹ h x 0	☹ l x 0 ☹ m x 0 ☹ h x 4	☹ l x 2 ☹ m x 2 ☹ h x 8	☹ l x 0 ☹ m x 0 ☹ h x 0
	😐 x 3	😐 x 0	😐 x 4	😐 x 0
Alternative 2	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 0 ☺ m x 0 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 8
	☹ l x 4 ☹ m x 1 ☹ h x 0	☹ l x 0 ☹ m x 0 ☹ h x 4	☹ l x 1 ☹ m x 2 ☹ h x 8	☹ l x 0 ☹ m x 0 ☹ h x 0
	😐 x 3	😐 x 0	😐 x 5	😐 x 0
Alternative 3	☺ l x 0 ☺ m x 0 ☺ h x 0	☺ l x 4 ☺ m x 0 ☺ h x 0	☺ l x 1 ☺ m x 4 ☺ h x 2	☺ l x 0 ☺ m x 0 ☺ h x 4
	☹ l x 5 ☹ m x 0 ☹ h x 0	☹ l x 0 ☹ m x 0 ☹ h x 0	☹ l x 4 ☹ m x 0 ☹ h x 0	☹ l x 0 ☹ m x 0 ☹ h x 4
	😐 x 3	😐 x 0	😐 x 7	😐 x 0

Discussion Of Impacts Associated With Each Alternative Identified:

The Proposal/Preferred Alternative (This Also Represents the Published Alignment for the Route and Is In Line With the Strategic Road Review)

This alignment, which has already been on all the GDRT planning maps since the 1970s is regarded as the preferred alternative from a social and institutional point of view. The affected parties have been aware of the alignment, which has been published in terms of the Gauteng Road Infrastructure Act, for many years and sections of this published alignment have already been expropriated and proclaimed.

Development already took place around the road reverse from Broadacres Road in the west up to the Jukskei River, which is traversed by the road at approximately Km 1, 2. From approximately Km 1, 2 to approximately Km 2, 5 the proposed road cuts through the Helderfontein Estate Property. On this property the road runs between man-made dams and across some man-made and natural wetland areas. The natural wetland areas have also been severely transformed by human intervention. From approximately Km 2, 5 to Km 3, 8 it traverses diagonally across agricultural holdings in the north-eastern section of the Glenferness Agricultural Holdings and from approximately km 3, 9 to Km 5, 0 it traverses diagonally across holdings that are situated in the south-western corner of the Kyalami Agricultural holdings. The interchange between the Proposed PWV9 Freeway and the K56 is located at approximately km 3,9 (at Zinnia Road) and as already mentioned in this report, many of the agricultural holdings adjacent to this interchange have already been expropriated and the land-owners already received remuneration for the land affected. The remainder of the alignment follows the alignment of the existing MacGregor Road.

The main negative issues associated with the Proposed Alignment were the following:

- Impacts on the wetland systems;
- The fragmentation of the equestrian node and conflicts between the horse riding activities and the traffic, especially where the K56 is crossed;

- The removal of the linkage between the stables and equestrian agricultural holdings to the south of the K56 and the grounds of the Gauteng Horse Society where all the equestrian events take place. Many children and adult horse riders ride on their horses to the grounds and at present they have no dangerous roads to cross;

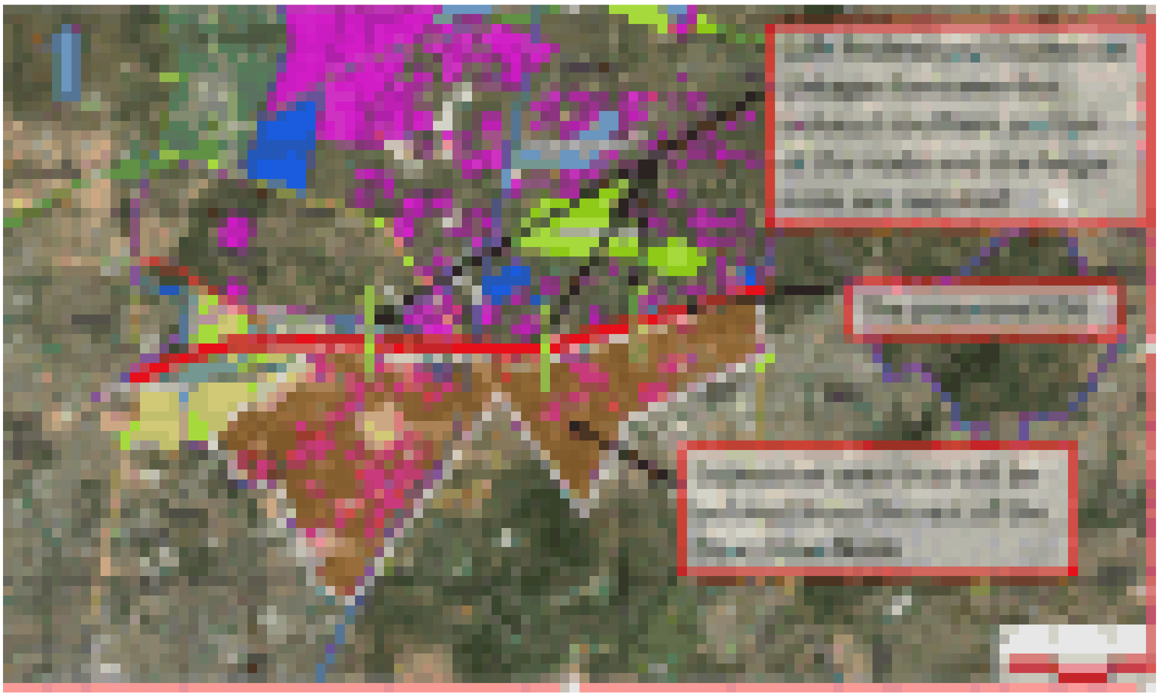


Figure 22 – Pedestrian linkages required to connect isolated southern part with the larger node to the north

- The fragmentation of the GECKO Conservancy;
- Impacts on sensitive eco-systems;
- Impacts of the proposed alignment of the school in the Glenferness Agricultural Holdings;
- Impacts of the proposed road on the existing man-made dams;
- The most expensive alternative to construct, because equestrian linkages will be provided and the detail design must take the hydrological aspects into consideration (many culvert and bridge structures will be required).

The main advantages of this alignment:

- The affected I&APs have already been aware of the road for many years;
- A large section of the road (to the east and west) have specifically been reserved for the proposed road;
- The wetland and man-made dams affected by the proposed road alignment are not pristine and if well planned and managed it will be possible to construct a road through these hydrological features. The geo-hydrological and hydrological reports confirmed this;
- The road is the preferred alignment from a geometrical point of view;
- It will be possible to create aesthetical pleasing linkages between the agricultural holdings to the south and the horse society grounds. Such linkages will be accommodated in the area that accommodates the dams;

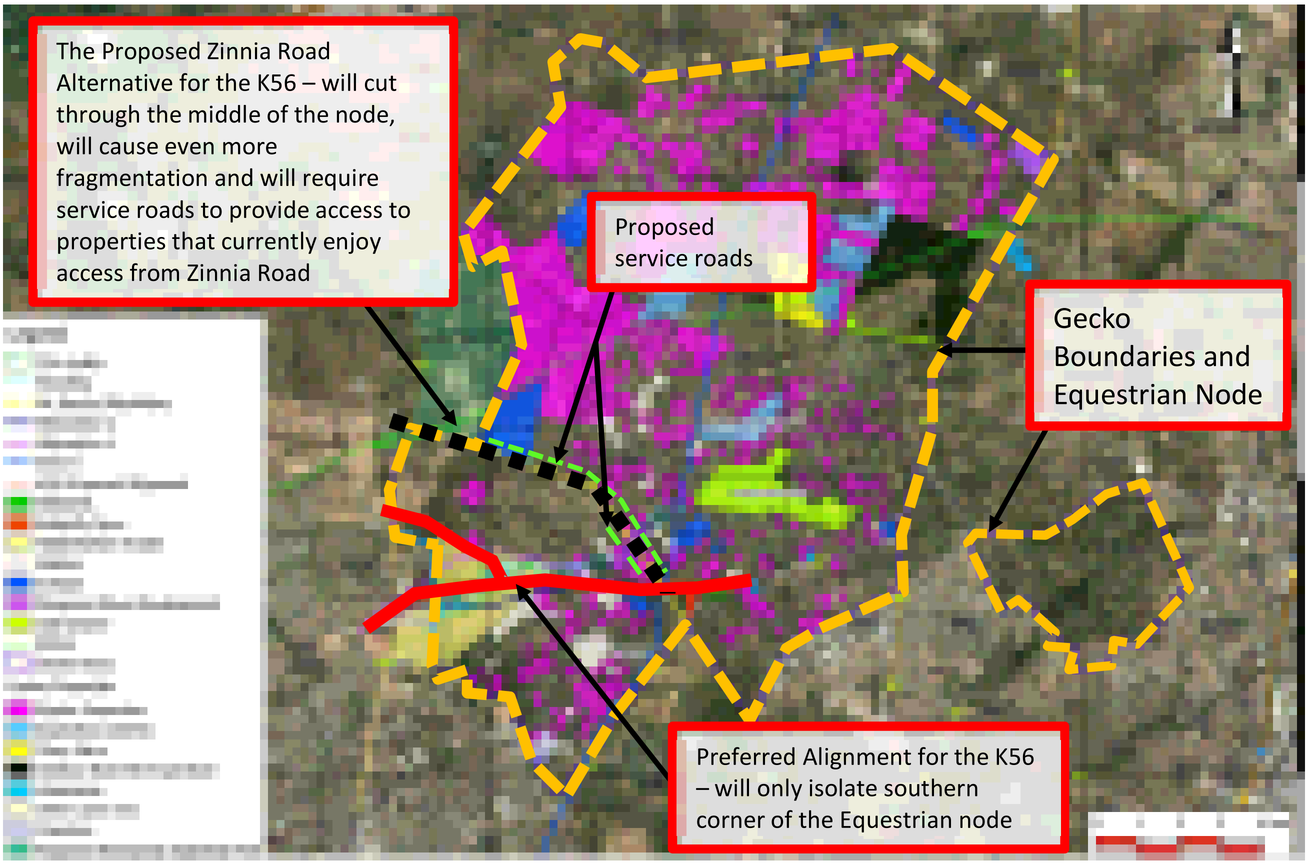


Figure 23 – Preferred Alignment versus Zinnia Road Alignment/ Alternative 3

- The appointed wetland specialist regarded the proposed construction of a road on this alignment as more acceptable than alternative 1, which traverses almost pristine wetlands.

Alternative 1:

During one of the public participation meetings, some of the I&APs recommended that the road be moved to the north, because this alignment will avoid the dams and wetlands and it will only affect one land-owner (a developer). The developer must still finalise his development layouts and concepts and it was suggested that the developer amend his development layout and accommodate the proposed road in his development.

The developer agreed with this suggestion and appointed WSP engineers to investigate alignment alternatives to the north of the dams across his property. The engineers eventually proposed two possible alignments for Alternative 1, but both alignments eventually proved to be problematic. Apart from the fact that the alignments traversed a very sensitive wetland system, it also affected a possible school in the vicinity of the dam.

The main reason why this alignment was discarded is due to the fact that the wetland specialist regarded the original alignment as the most suitable from a hydrological and ecological point of view. Also take note that the proposed development will be fenced and according to the developer he did not plan to allow for equestrian linkages to the Gauteng Horse Society.

We however discussed the possibility of accommodating equestrian links through the development property is the K56 is constructed on the original alignment (the preferred alignment) and the developer indicated that he is willing to consider this option.

The main negative issues associated with the Proposed Alignment were the following:

- Regards as a no-go alternative from a hydrological and ecological point of view;
- Will have a significant impact on the planned school to the north of the dams, especially with regards to the planned accesses;
- The fragmentation of the equestrian node and conflicts between the horse riding activities and the traffic, especially where the K56 is crossed;
- The removal of the linkage between the stables and equestrian agricultural holdings to the south of the K56 and the grounds of the Gauteng Horse Society where all the equestrian events take place. Many children and adult horse riders ride on their horses to the grounds and at present they have no dangerous roads to cross;
- The fragmentation of the GECKO Conservancy;

The main advantages of this alignment:

- Less property owners will be affected;
- The proposed road will be further away from the Glenferness Agricultural Holdings.

Alternative 2:

This alternative runs to the south of the dams and it cuts through many of the properties of the Glenferness Agricultural Holdings. This alignment is regarded as unfair, because the affected land-owners were not aware of the proposed road. The fragmentation and noise impacts of this alignment will be significantly higher and it will not only isolate the Glenferness Agricultural Holdings from the horse events areas, but it will also cause the fragmentation of the specific community.

The main advantages associated with this alignment:

- Alternatives 2 and 3 will have the lowest ecological impacts.

Alternative 3 (The alternative as provided by the community):

This alignment entails an alignment that follow the alignment of existing roads, namely Zinnia Road and Caracal Road. This alignment originates in the north-east and runs in a south-eastern direction to eventually link up with the alignment of the proposed K56 on Macgregor Road. This option was discussed with GDRT and according to the relevant officials and engineers this alignment is totally unacceptable from a geometrical and network planning point of view. The spacings between the main roads are also compromised and the "strive-line" of the proposed alignment deviates from the original line.

This road furthermore cuts through the middle of the equestrian node and even if this road follows an existing road, the function, size and access spacing requirements of this road will be upgraded to K-Route standards, which means that services road will most probably be required to provide accesses. The provision of services roads will increase the costs of the road. Accesses on provincial roads are only allowed at 600m intervals. We are therefore of the opinion that the fragmentation and other social impacts caused by this alignment will be higher that the social impacts of the original alignment (the proposal) and Alternative 1.

Another aspect to take into consideration is the fact that this alignment will be developed at ground level and it will thus not be possible to incorporate safe equestrian linkages underneath the road. In the case of the preferred alternative, the road will be elevated at certain points and this creates an in deal opportunity for the creation of equestrian links with attractive landscaped features in the vicinity of the dams.

The main advantages associated with this alignment:

This alignment will have the lowest ecological and hydrological impacts.

The significant assessment below only considered the Preferred Alternative.

9. SIGNIFICANCE ASSESSMENT

9.1 Description of Significance Assessment Methodology

The significance of Environmental Impacts was assessed in accordance with the following method:

Significance is the product of probability and severity. Probability describes the likelihood of the impact actually occurring, and is rated as follows:

- ❑ Improbable - Low possibility of impact to occur either because of design or historic experience.
  Rating = 2

- ❑ Probable - Distinct possibility that impact will occur.
  Rating = 3

- ❑ Highly probable - Most likely that impact will occur.
  Rating = 4

- ❑ Definite - Impact will occur, in the case of adverse impacts regardless of any prevention measures.
  Rating = 5

The ***severity factor*** is calculated from the factors given to "intensity" and "duration". Intensity and duration factors are awarded to each impact, as described below.

The ***Intensity factor*** is awarded to each impact according to the following method:

- Low intensity - natural and man made functions not affected – Factor 1
- Medium intensity - environment affected but natural and man made functions and processes continue - Factor 2
- High intensity - environment affected to the extent that natural or man made functions are altered to the extent that it will temporarily or permanently cease or become disfunctional - Factor 4

Duration is assessed and a factor awarded in accordance with the following:

- Short term - <1 to 5 years - Factor 2
- Medium term - 5 to 15 years - Factor 3
- Long term - impact will only cease after the operational life of the activity, either because of natural process or by human intervention - factor 4.
- Permanent - mitigation, either by natural process or by human intervention,

will not occur in such a way or in such a time span that the impact can be considered transient – Factor 4.

The ***severity rating*** is obtained from calculating a severity factor, and comparing the severity factor to the rating in the table below. For example:

The Severity factor = Intensity factor X Duration factor
= 2 x 3
= 6

A ***Severity factor*** of six (6) equals a Severity Rating of Medium severity (Rating 3) as per table below:

TABLE 55: SEVERITY RATINGS

RATING	FACTOR
Low Severity (Rating 2)	Calculated values 2 to 4
Medium Severity (Rating 3)	Calculated values 5 to 8
High Severity (Rating 4)	Calculated values 9 to 12
Very High severity (Rating 5)	Calculated values 13 to 16
Severity factors below 3 indicate no impact	

A Significance Rating is calculated by multiplying the Severity Rating with the Probability Rating.

The ***significance rating*** should influence the development project as described below:

- ❑ Low significance (calculated Significance Rating 4 to 6)
  - Positive impact and negative impacts of low significance should have no influence on the proposed development project.

- ❑ Medium significance (calculated Significance Rating >6 to 15)

- Positive impact:
  Should weigh towards a decision to continue
- Negative impact:
  Should be mitigated to a level where the impact would be of medium significance before project can be approved.

❑ High significance (calculated Significance Rating 16 and more)

- Positive impact:
  Should weigh towards a decision to continue, should be enhanced in final design.

- Negative impact:
  Should weigh towards a decision to terminate proposal, or mitigation should be performed to reduce significance to at least medium significance rating.

In correspondence received from GDARD some officials were of the opinion that the significance methodology used by Bokamoso applies a simple mathematical formula to environmental aspects with significantly different sensitivity values, which might or might not give an inaccurate final significance value.

The significance methodology used by Bokamoso was prescribed to environmental consultants in courses in impact assessments. No methodology can be accurate to a numerical value where the environment is concerned, because it cannot be measured. Numerical values are only an indication of the significance or severance of impacts. If we do not agree with the outcome of the assessment, we will adjust the numerical value to reflect a more realistic significance. The methodology only acts as an aid to the environmental consultant and the consultant need to use his/her experience in the field together with the methods in order to reach a realistic significance of impacts. Bokamoso, in particular Ms. Lizelle Gregory, has extensive experience in the field of impact assessments.

9.2 Significance Assessment of Anticipated Impacts of the Preferred Alternative

Impacts indicated under each section of the environment were each assessed according to the above methodology. ***Table 56*** below contains the results of the significance assessment.

TABLE 56: RESULT OF SIGNIFICANCE ASSESSMENT OF IMPACTS IDENTIFIED TO BE ASSOCIATED WITH THE PROPOSED ROAD K56 (AFTER MITIGATION)

Impact	Probability Rating	Severity Rating		Severity Factor	Severity Rating	Significance Rating
		Intensity	Duration			
CONSTRUCTION PHASE						
Beneficial Impacts						
15. The eradication of weeds and exotic invaders	5	4	3	12	4	**20 High**
Adverse Impacts						
2. Stability of structures	3	4	4	16	5	15 Medium
3. Perched water table	3	4	4	16	5	15 Medium
4. Erosion	3	4	4	16	5	15 Medium
5. Stockpile areas for construction materials and topsoil	3	4	4	16	5	15 Medium
6. Siltation, erosion and Water pollution	4	4	4	16	5	**20 High**
7. Groundwater Pollution	3	4	4	16	5	15 Medium
8. Increased storm water runoff from road into surrounding natural areas	3	4	4	16	5	15 Medium

9. Presence of boreholes along the route	4	4	4	16	5	**20 High**
10. Due to the topography only sections of the proposed K56 will be visible from view sheds in the flatter areas around the study area.	4	2	4	8	3	12 Medium
11. Should the construction phase be scheduled for the summer months, frequent rain could cause very wet conditions, which makes road construction and environmental rehabilitation works extremely difficult.	2	2	4	8	3	6 Low
12. If dry and windy conditions occur during the construction phase, dust pollution could become a problem. Although this impact will only be a short term impact, mitigation will be necessary during the construction phase.	2	2	4	8	3	6 Low
13. Impact on natural grassland areas	3	4	4	16	5	15 Medium
14. Impact on wetland features and aquatic systems	3	4	4	16	5	15 Medium
16. If the entire road alignment area is cleared at once, smaller birds, mammals and reptiles will not be afforded the chance to weather the disturbance in an undisturbed zone close to their natural territories.	2	4	2	8	3	6 Low
17. Noise of construction machinery could have a negative impact on the fauna species during the construction phase.	2	4	2	8	3	6 Low
18. During the construction and operational phase (if not managed correctly) fauna species could be disturbed, trapped, hunted or killed.	3	4	4	16	5	15 Medium

19. Loss of habitat can lead to the decrease of fauna numbers and species.	3	4	4	16	5	15 Medium
20. Structures of cultural and historical significance may be destroyed.	2	4	4	16	4	8 Medium
21. Loss of agricultural land	3	2	4	8	3	9 Medium
26. Impact on existing infrastructure and services (i.e. electricity, water, damage to Telkom cables) during the construction of the proposed road.	3	4	4	16	5	15 Medium
27. Expropriation of properties	5	4	4	16	5	**25 High**
29. Access to local roads and properties	3	4	4	16	5	15 Medium
30. Impact on GECKO	3	4	4	16	5	15 Medium
OPERATION PHASE						
Beneficial Impacts						
22. The proposed construction of the K56 will be in line with the international, national, provincial and local legislation, planning frameworks, guidelines, policies etc.	5	4	4	16	5	**25 High**
Adverse Impacts						
2. Stability of structures	3	4	4	16	5	15 Medium
6. Siltation, erosion and water pollution could occur if a stormwater management plan is not implemented.	4	4	4	16	5	**20 High**
7. Possible ground water pollution.	3	4	4	16	5	15 Medium
14. Impact on wetland adjacent to the study area	4	4	4	16	5	**20 High**
10. Due to the topography only sections of the proposed K56 will be visible	4	2	4	8	3	12 Medium

from view sheds in the flatter areas around the study area.						
25. If not planned and managed correctly (i.e. though the holistic planning of the entire development area) the proposed road could have a negative impact on the "Sense of Place" to be created in this developing area.	2	2	4	8	3	6 Low
37. Expropriation of properties	5	4	4	16	5	**25 High**
23. Noise impact	5	2	4	8	3	15 Medium
28. Impact on property values	3	4	4	16	5	15 Medium
29. Access to local roads and properties	5	2	4	8	3	15 Medium
30. Impact on GECKO	5	4	4	16	5	**25 High**

9.3 Discussion of Significance Assessment

Two beneficial impacts associated with the proposed road are anticipated and both which a high significance rating. The Environmental Management Plan ***(Refer to Annexure H)*** contains measures to achieve maximum gain from the above beneficial impacts. This indicates that the proposed development should contribute to an improvement in the quality of life of the people residing in the broader area and the quality of the physical environment. 36

Of the thirty-six anticipated adverse impacts associated with the construction and operational phases of the proposed road nine of the anticipated impacts have a high significance rating, twenty two impacts have a medium significance rating and five have a low significance rating.

Measures that are recommended in this report and the Environmental Management Plan could mitigate the medium and high-anticipated adverse impacts to an acceptable level.

No "fatal flaw" adverse impacts, or adverse impacts that cannot be adequately mitigated, are anticipated to be associated with the proposed construction of the involved section of K56

10 CONCLUSION

The purpose of the EIA (Environmental Impact Assessment) process was to investigate the Biophysical and Socio-economic environments further by means of specialist studies to identify further issues/impacts of the proposed K56 on these environments. Further, to provide mitigation measures for adverse impacts and to assess the significance of these impacts over the short and long term.

As environmental consultants Bokamoso feel satisfied that all site sensitivities were taken into consideration when the alignment was finalised and it is recommended that the proposed/original alignment be accepted as the alignment for the road.

The most significant environmental issues that were identified are the following ***(refer to Figure 21, Sensitivity Map):***

- **Geotechnical:** The route is underlain by granites and comprehensive blasting will be required. Collapsible materials and expansive materials. A perched water table can develop and slight seepage may be present during the wet season.
- **Hydrology:** The proposed alignment traverses the Jukskei River and tributaries as well as wetlands.
- **Fauna and flora:** Possible red data flora and fauna species: According to GDARD C-Plan 3, 2011 the proposed alignment traverses irreplaceable sites. The proposed alignment traverses Egoli Granite grasslands. Wildlife corridors affected by the proposed route
- **Cultural:** Possible cultural/historic artefacts or graves affected by the proposed alignment.

- **Noise Impact:** The proposed alignment of the K56 could have noise impacts on surrounding residents.
- **Visual Impact:** The proposed alignments could have visual impacts on the surrounding view sheds during the construction and operational phases and mitigation measures should be implemented.
- **Air pollution:** The increase in traffic through the area will result in an increase in air pollution from vehicles.
- **Sense of Place:** The proposed alignment of the K56 will have a significant impact on the Sense of Place and tranquillity of Glenferness A.H. and Kyalami A.H.
- **Impact on GEKCO:** The proposed alignment of the K56 traverses the GEKCO and could have a significant ecological, social and economy impact on the conservancy.
- **Socio-Economic impact on equine industry:** The proposed alignment of the K56 will have a significant impact on the equine industry i.e. job losses, safety of horse riders, Lipizzaner Centre, Gauteng Horse Society, equestrian events, dissection of large rural residential area which houses a large equestrian community and industry, etc
- **Fragmentation of the equestrian node:** According to the affected communities the proposed road will lead to the fragmentation of the equestrian node. Some stables and other horse facilities are situated to the south of the proposed road and this road will not only isolate these facilities from the larger node, but it will also create dangerous horse and vehicular conflict situations. The community proposed that the road rather follow the alignment of the existing Zinnia Road, but this alternative will cause even more fragmentation, because it cuts through the middle of the equestrian node. The preferred alignment only isolates the most southern section of the node. If the road follow the alignment of Zinnia road the width of the road infrastructure will not only be limited to the K56 on Zinnia Road. K-Routes only allow for local accesses at 600m intervals and this means that it will also be necessary to implement services roads parallel to the K56 (on the Zinnia alignment) to provide alternative access to properties adjacent to the road.

- **Loss of schools:** Two schools (a Pre-School and Cedarwood Remedial School) are affected by the proposed alignment of the K56 which could result in the closure of these schools.
- **Safety and crime:** The proposed road could result in an increase in safety and crime in the area both during the construction and operational phases.
- **Property devaluation:** The proposed alignment of the K56 could have a negative impact on property values, especially those properties dissected by the route.
- **Expropriation of properties:** A large number of properties need to be expropriated.
- **Increase in traffic:** The involved section of the K56 will result in an increase in traffic at both ends of the road.
- **Impact on existing roads and developments:** The proposed alignment of the K56 will have an impact on existing roads and developments in the area.
- **Need for the K56:** There is a proven need for the K56 to supply east-west linkage in the area.

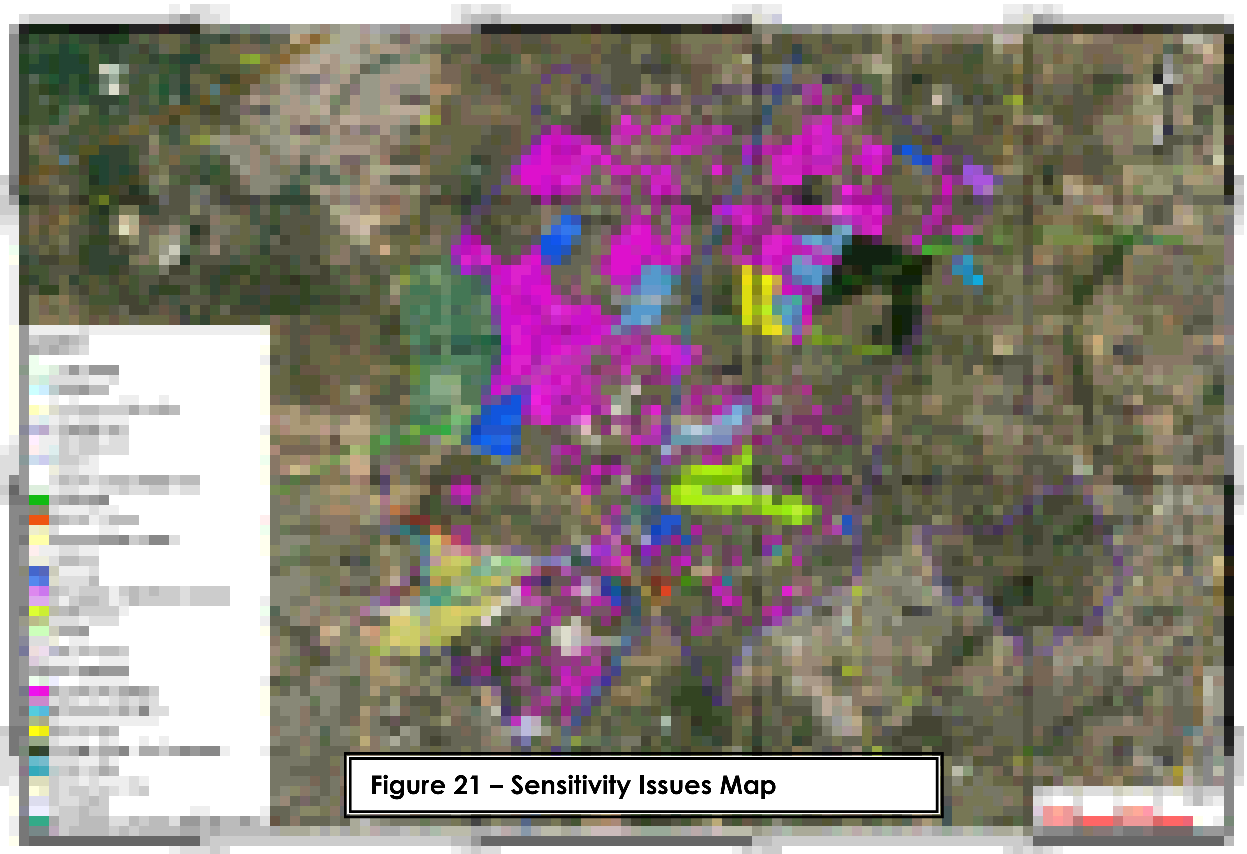


Figure 21 – Sensitivity Issues Map

11. PROPOSED COMPROMISE/ GIVE AND TAKE SCENARIO TO CONSIDER ON AN URGENT BASIS

The affected community were very co-operative throughout the entire public participation and EIA process and most of the issues raised by the community are valid and cannot be ignored.

The affected community have been trying to protect their area from development for many years and it seems that their desperate efforts to protect this valuable and unique equestrian node are fruitless and one must have empathy for this situation. The community already spent significant amounts of their own money on the compilation of conservation and management plans in an effort to protect the area, but yet urban planning around this node without formally recognising the value of this node.

Even though this equestrian node is not unique and completely irreplaceable from an ecological point of view, it is regarded as irreplaceable from a socio-economic point of view. After 1994 government adopted a planning approach with promotes sustainable development and development can only be sustainable if all environments (ecological, social, economical and institutional) are equally addressed.

If this equestrian node is destroyed by on-going urban development and densification within this node, it will be almost impossible to replace this very valuable socio-economic asset that is the only one of its kind in South-Africa and that is also regarded as very important from an international point of view. If this equestrian node, which covers hundreds of hectares is to be relocated to an area outside the urban environment, the ecological impacts on such "greenfields" area will be enormous. The economical impacts of the re-establishment of the existing events, stabling, specialised veterinary services etc. will also be devastating.

It has been proved that the provincial and national road networks in and around the area, including the involved section of the K56 road will be needed to address the traffic requirements on a regional and local scale. Development must take place and infrastructure must be upgraded on a continuous basis to support and accommodate development.

It was furthermore confirmed by the appointed engineers that it will not be possible from a road network and geometrical point of view to re-align the proposed road around the GECKO area.

The affected community is however concerned about the construction of the proposed road through the southern portion of the equestrian node an GECKO, because it will stimulate more development around the road and it will cause the fragmentation of the area and it will isolate some of the equestrian facilities (including important equestrian related businesses) to the south of the proposed road from the rest of the node.

It was therefore decided to suggest that GDARD, GDRT, the planning sections of the City of Johannesburg Metropolitan Municipality and the affected community consider the following compromise/ give and take scenario:

Proposed compromise of the community:

- That the proposed road be allowed on the alignment as published (the preferred alignment), because portions of land have already been expropriated for the road and urban development to the east and west of the alignment already accommodated the published road;
- As mentioned, the alignment has already been on the planning maps for many years and the people in the area have been aware of the road for many years. It will be unfair to re-align the road at this late stage, because the newly affected parties were not aware of any road that will cut through their properties;

Proposed compromise to be considered by government:

- That the access road to the equestrian facilities be improved as part of the K56 road project, even if this is implemented at a later stage by GDRT/ the local authority. Apparently it is difficult to reach the premises of the Gauteng Horse Society and the community made certain proposals regarding the improvement of the accessibility of these facilities that can be considered during the upgrading of the K56;

- That safe and attractive pedestrian and equestrian links be provided where possible to link the area to the south of the proposed road to the larger node.
- The GDARD, GDRT and the City of Johannesburg acknowledge the importance of this node in all their future planning documents and that this area be identified and protected an irreplaceable socio-economic node; and
- The various authorities must acknowledge the valuable socio-economical function of this node and must assist with the on-going protection and maintenance of this node and any future development within this node must take the equestrian facilities
- The only development that should take place within this area should be the upgrading of the existing municipal services and infrastructure and residential and other land-uses that are not in conflict with the existing functioning of the equestrian node.

12. RECOMMENDATIONS

It is believed that the impacts identified have not been of such a nature that short and long term mitigation cannot occur and therefore it is recommended that the **Route Determination and Preliminary Design Phases** of the proposed/preferred road be approved subject to:

1) The implementation of the mitigation measures contained in the Environmental Management Plan ***(Annexure H)*** to achieve maximum advantage from beneficial impacts, and sufficient mitigation of adverse impacts;
2) The finalization of the expropriation of properties during the detail design phase of the road;

3) Safe and attractive equestrian and pedestrian linkages be provided underneath the k56 (the K56 road must either be raised or the link must be provided by way of an underpass) in the areas as indicated on ***Figure 24*** below;

Figure 24 – Proposed Areas for Pedestrian/ Equestrian Linkages

4) The finalization of the access / interchanges during the detail design phase of the road;
5) The finalization of culvert/bridge details during the detail design phase of the road;
6) The road planning (including construction and operational phase storm water management measures) across the wetland areas and hydrological features must be done in conjunction with a suitably qualified wetland management and rehabilitation specialist;
7) The specialist must issue a document in support of the planning across the wetland areas and such document must be forwarded to GDARD and DWS for record keeping purposes. The project team must conduct all planning and construction works in line with the guidelines and conditions as supplied by such specialist;

8) A detailed geotechnical study and the comments from the Council for Geosciences during the detail design phase of the road;
9) The development area to the north of the preferred alignment (between the dams and Zinnia Road) has already been fenced and it will be necessary to discuss the proposed equestrian links through this fenced area with the developer. The developer attended the public meetings and is aware of the proposed road and the issued associated with the proposed road. The fenced development will however also benefit from the proposed linkage. Confirmation of discussions and of the proposed linkage routes are required prior to the implementation of the road;
10) The submission of the Storm Water Management Plan to the Local Authority for approval.

Annexure A

ENLARGEMENTS OF FIGURES

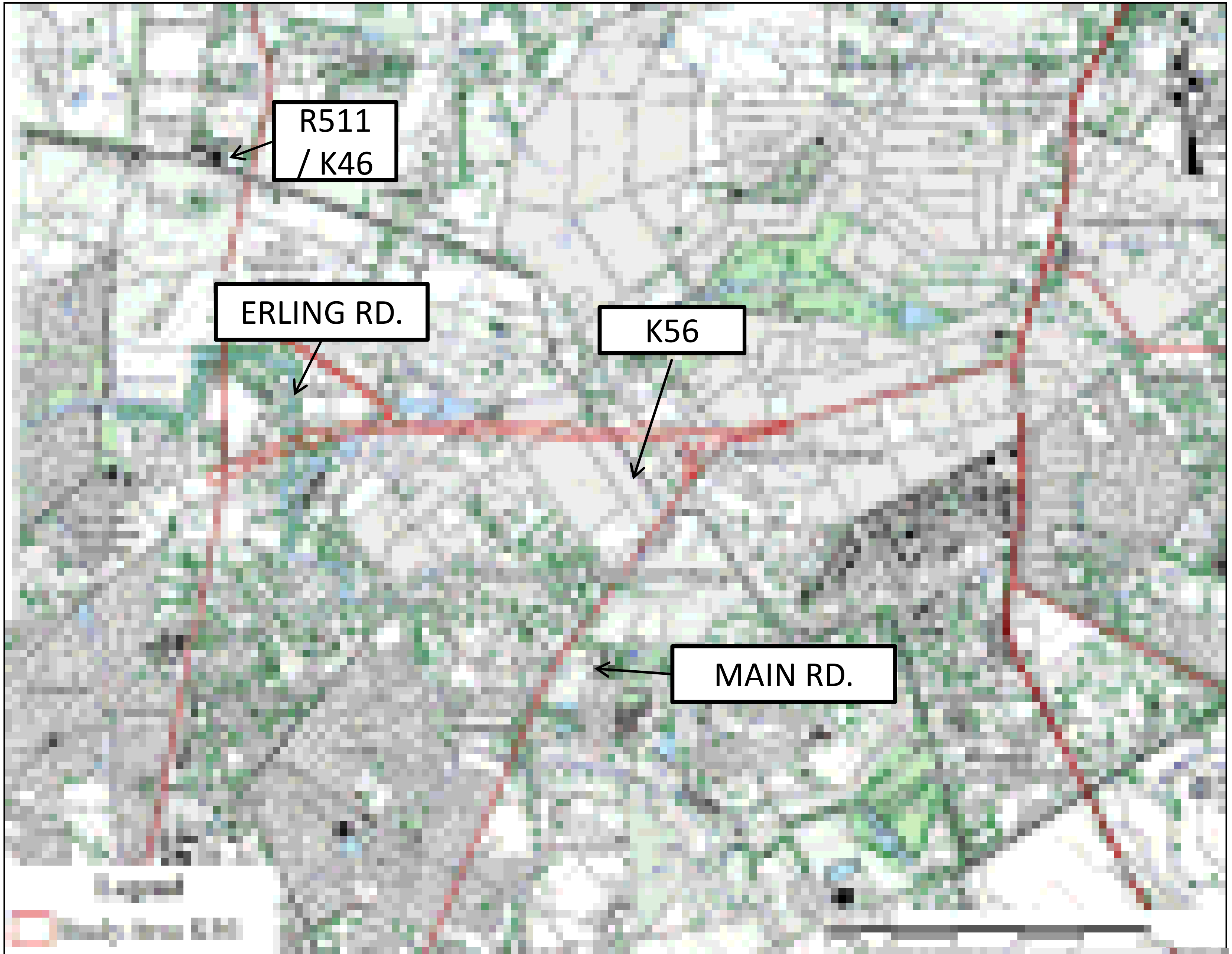


Fig 1: Locality Map

Erling road between K46 and K56 and the K56 between K46 and Main Road

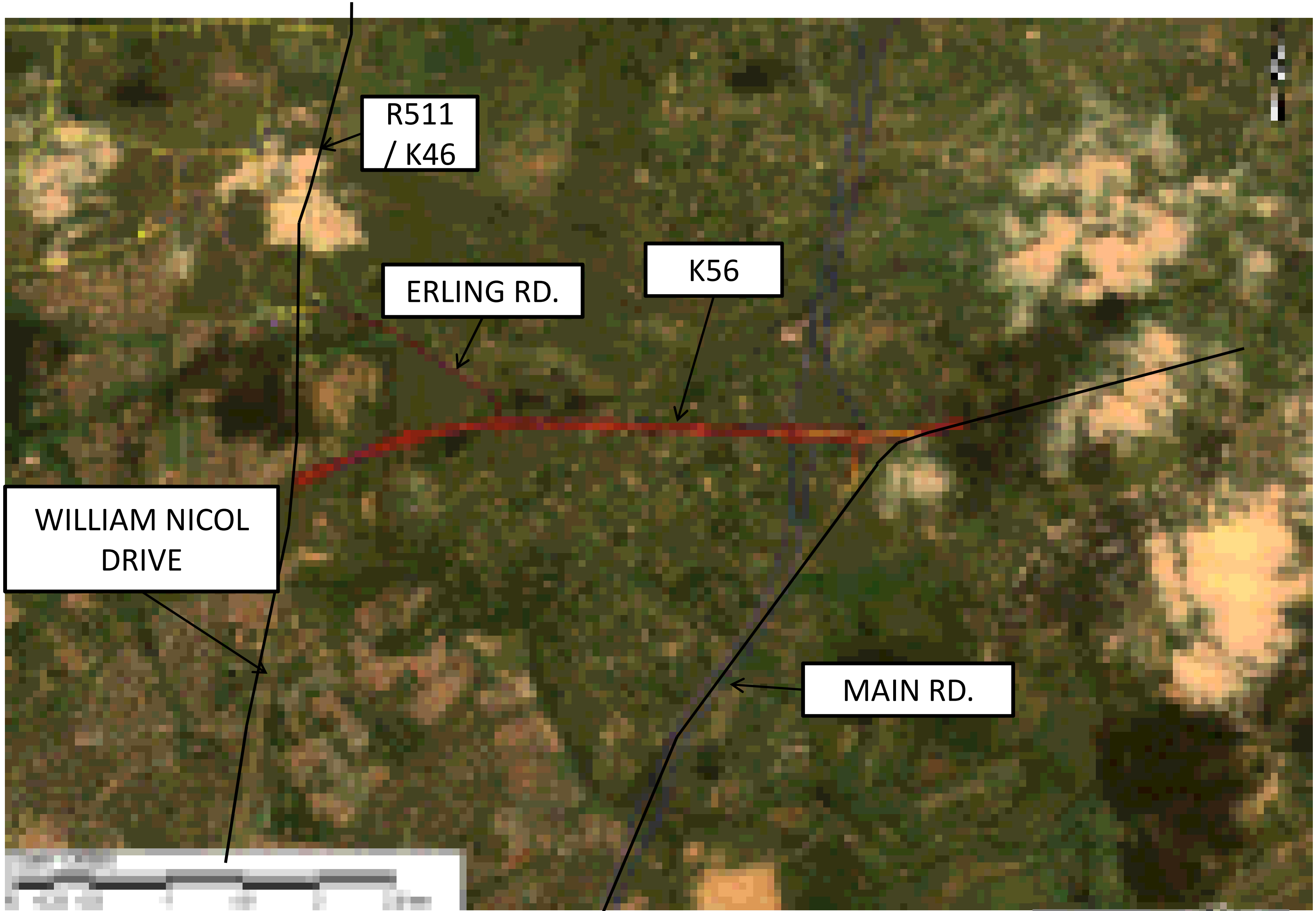


Fig 2: Aerial Map

Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 3: Gauteng Urban Edge

Erling road between K46 and K56 and the K56 between K46 and Main Road

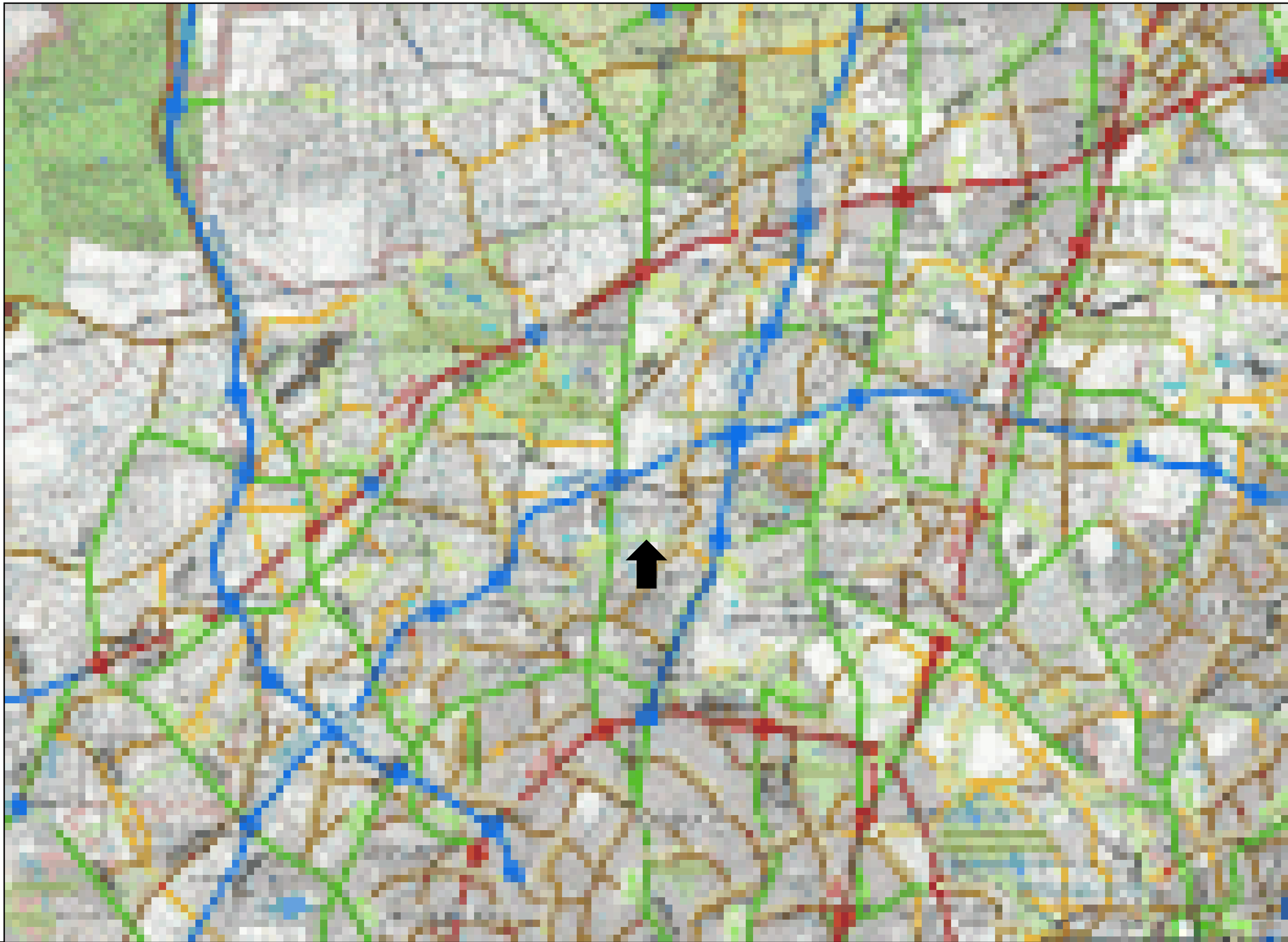


Fig 4: Locality of K56 within larger Gauteng Road Network

Erling road between K46 and K56 and the K56 between K46 and Main Road

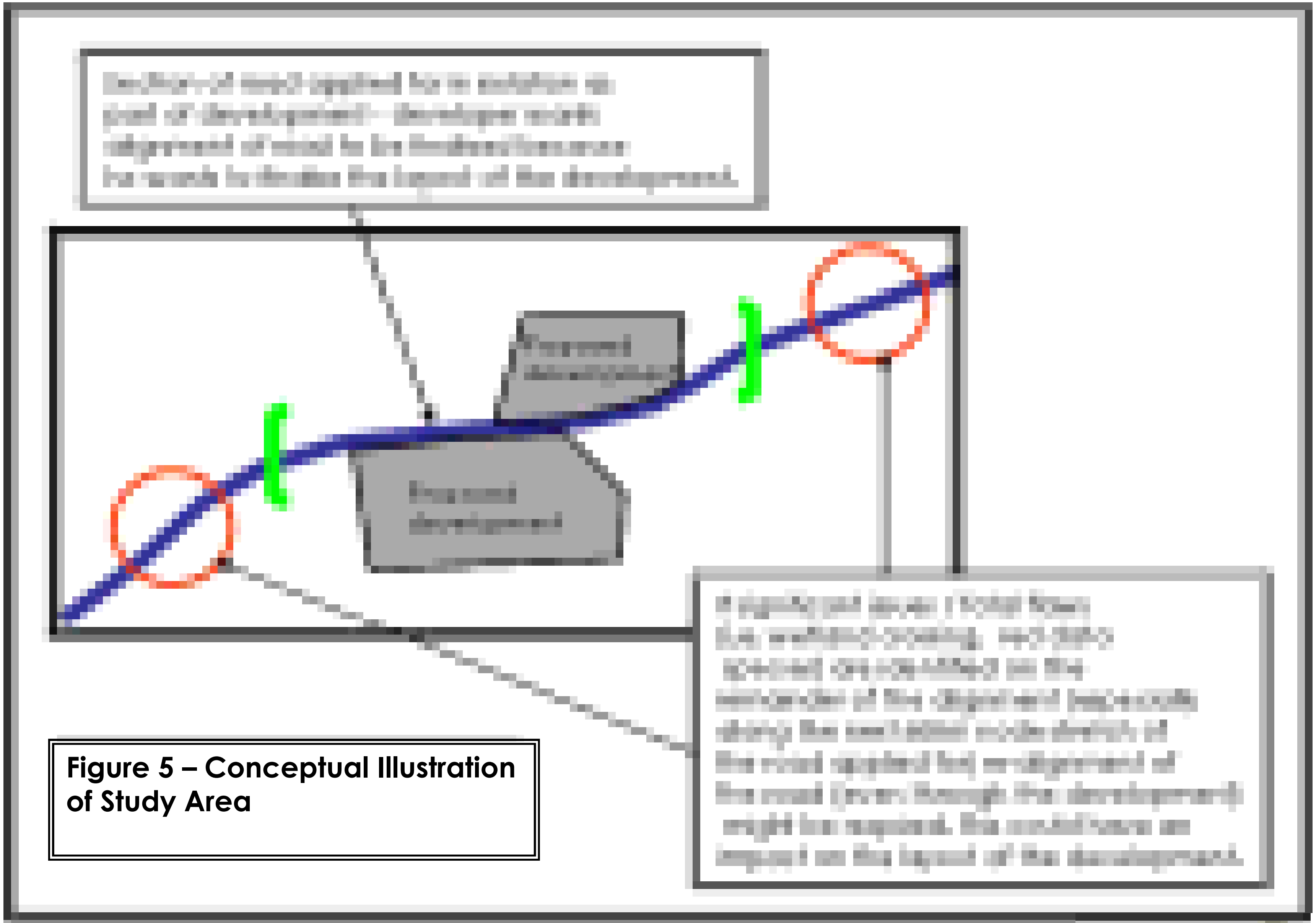


Figure 5 – Conceptual Illustration of Study Area

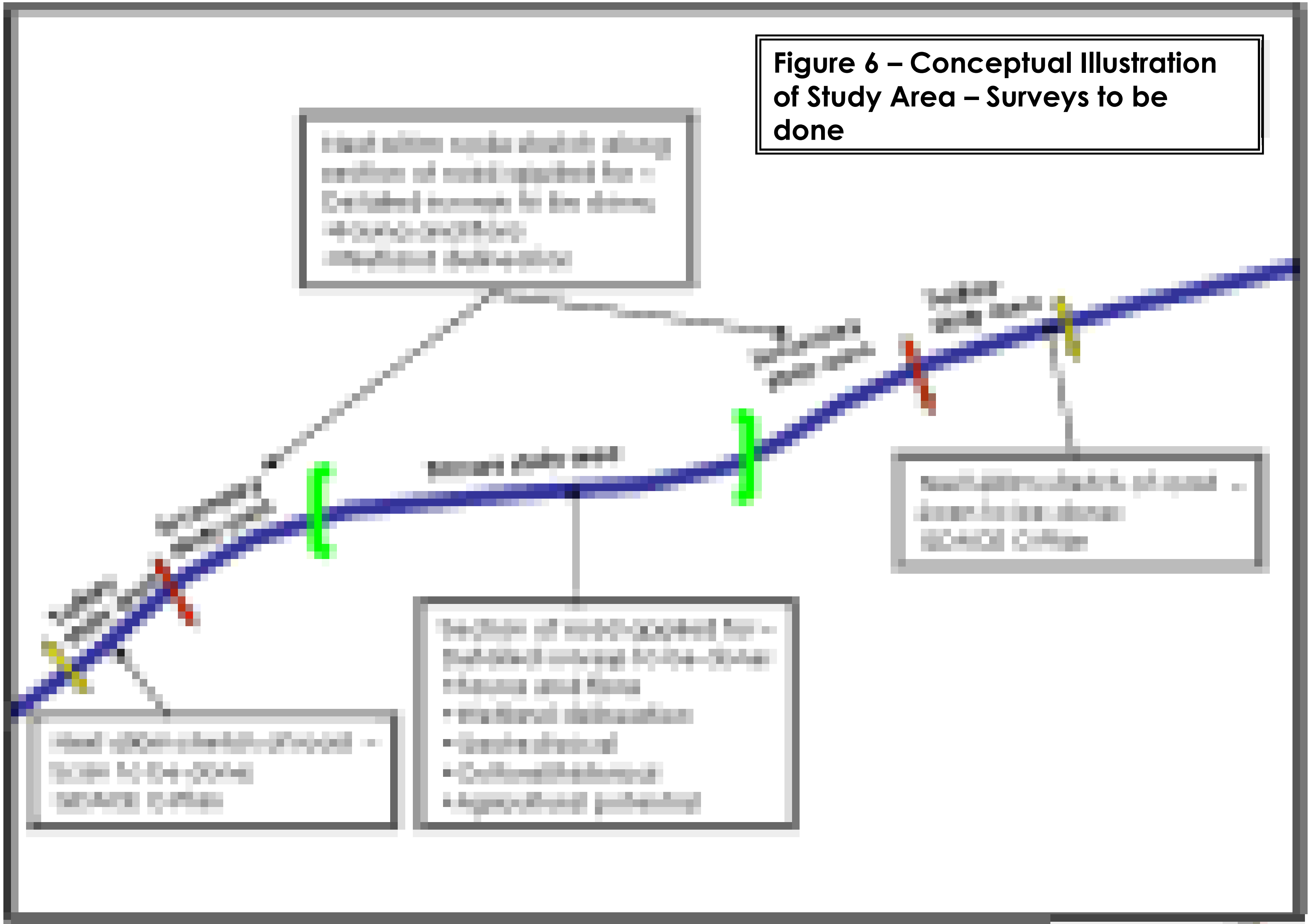


Figure 6 – Conceptual Illustration of Study Area – Surveys to be done

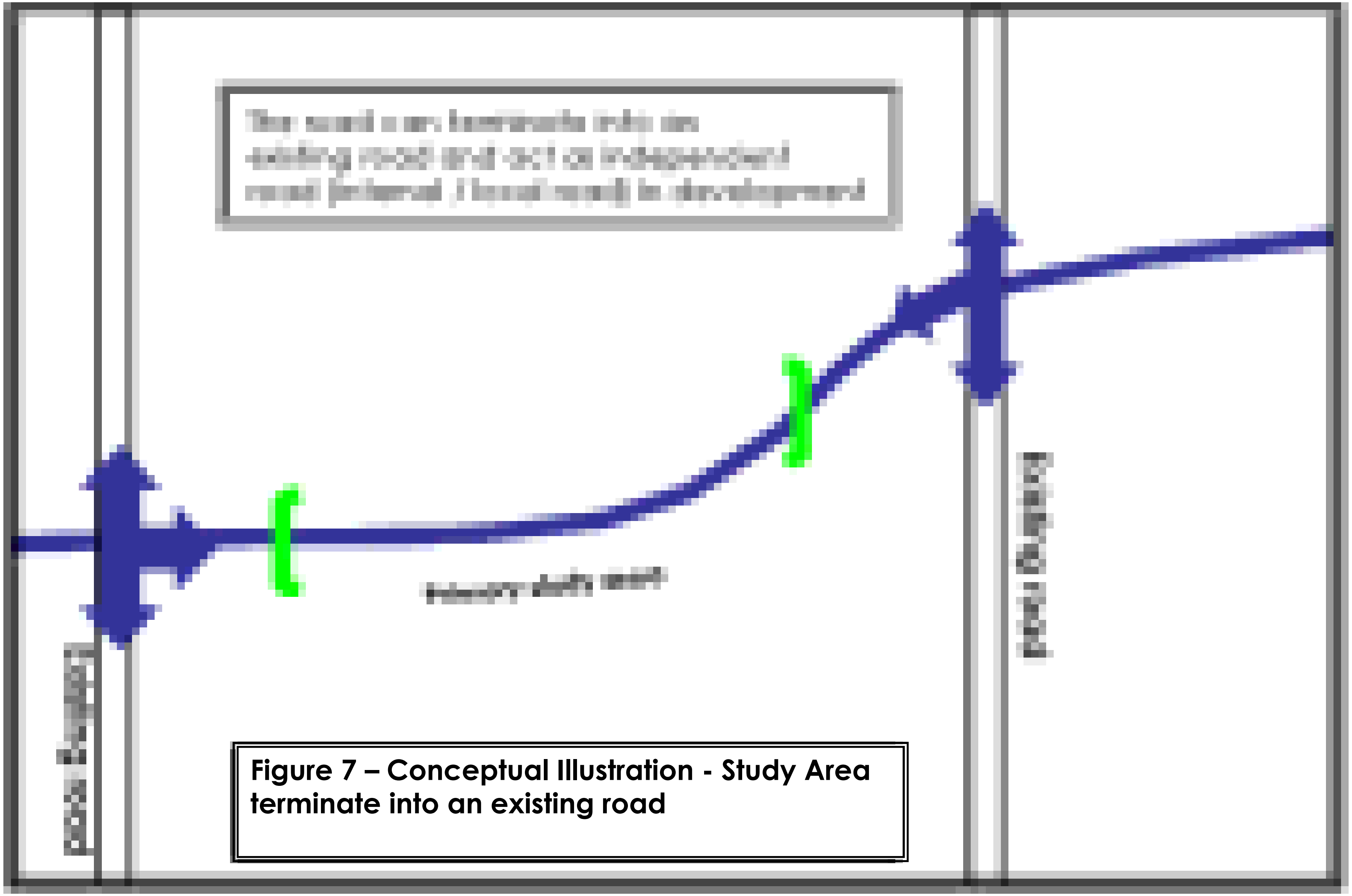
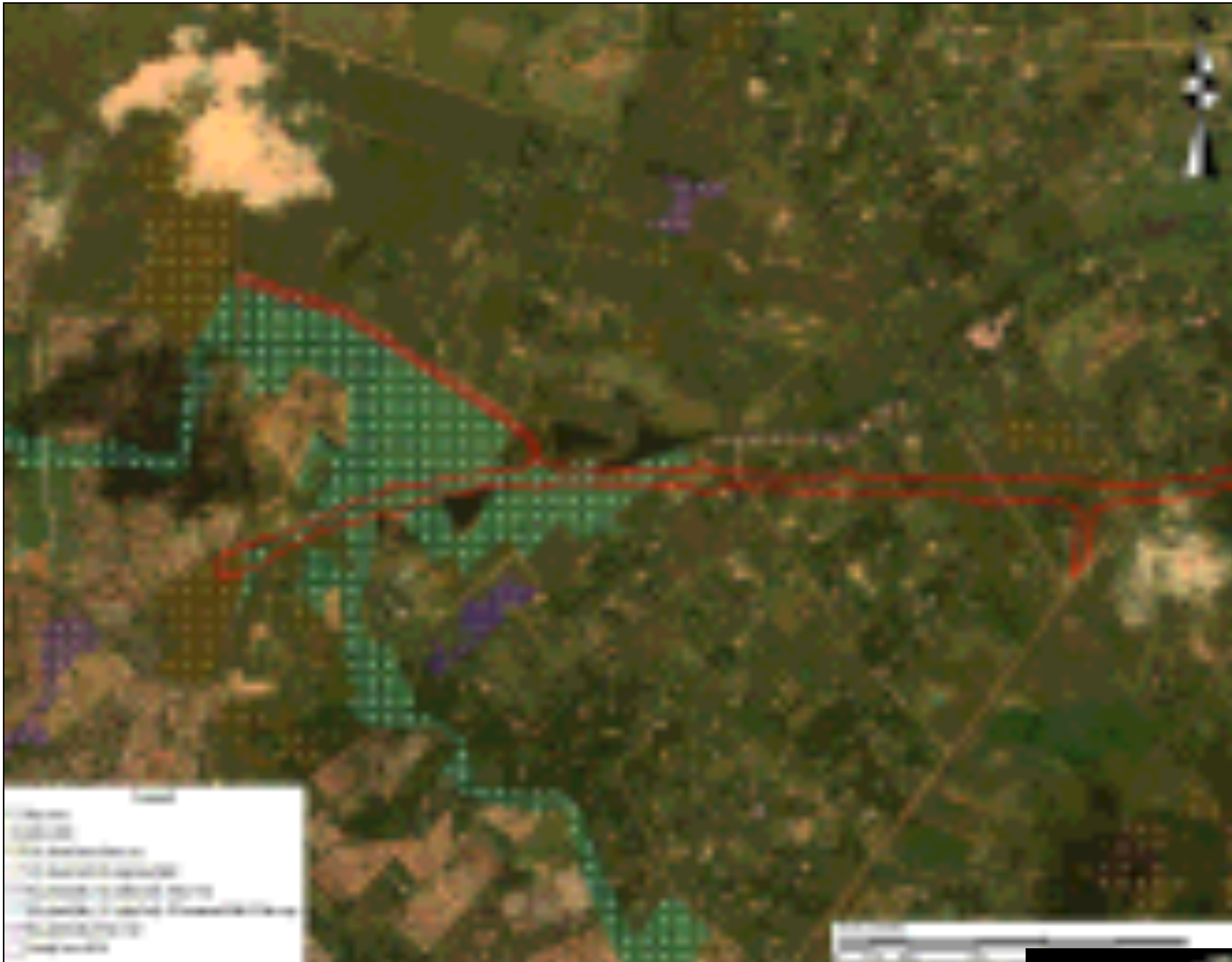


Figure 7 – Conceptual Illustration - Study Area terminate into an existing road



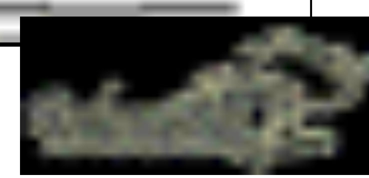


Fig 8: Irreplaceable Sites Map (GDARD C-Plan 3)

Erling road between K46 and K56 and the K56 between K46 and Main Road

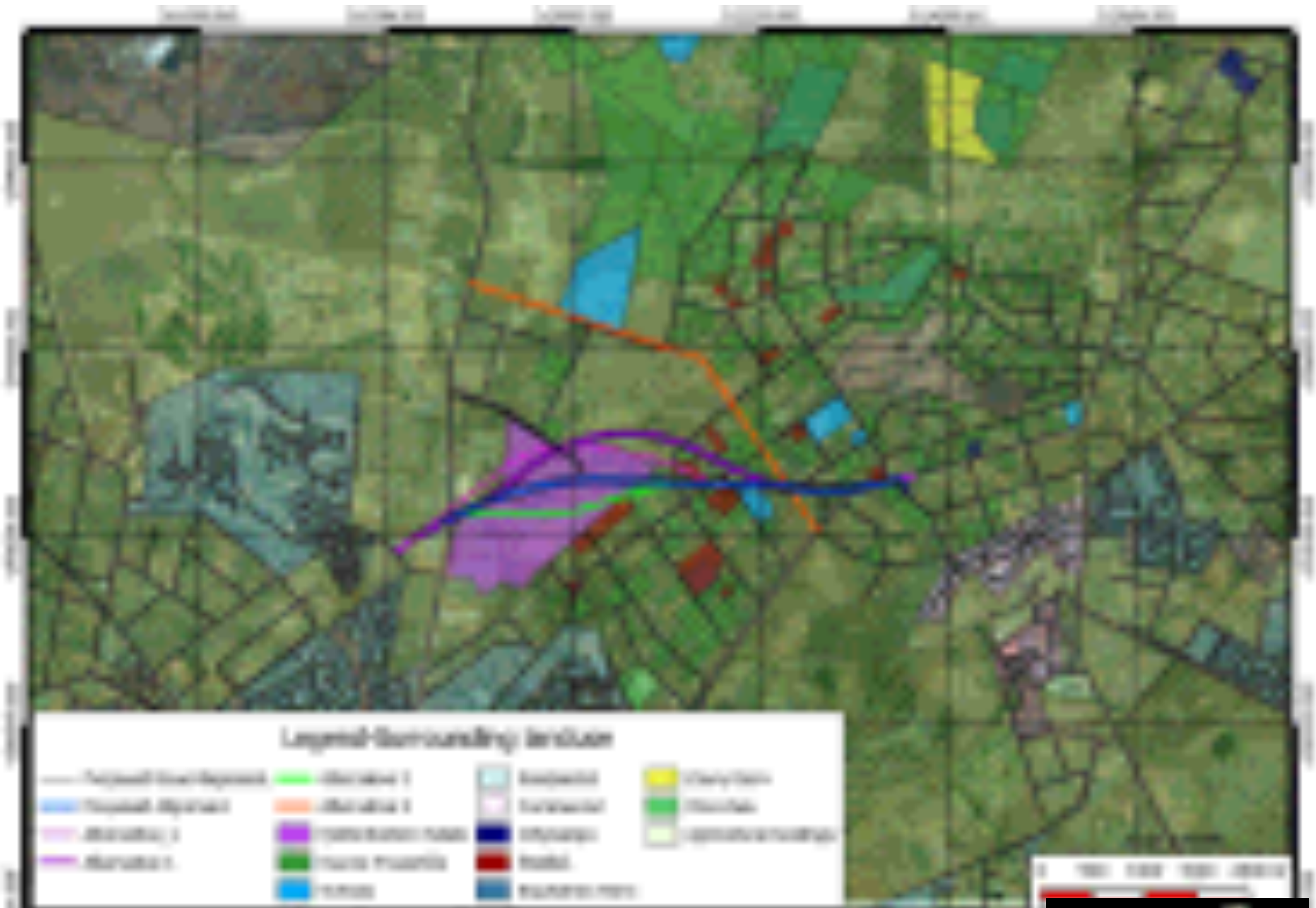


Fig 9: Surrounding land Uses

Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 10: Alignment Alternatives

Erling road between K46 and K56 and the K56 between K46 and Main Road

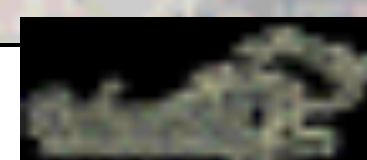


Fig 11: MacKenzie Altrernative

Erling road between K46 and K56 and the K56 between K46 and Main Road

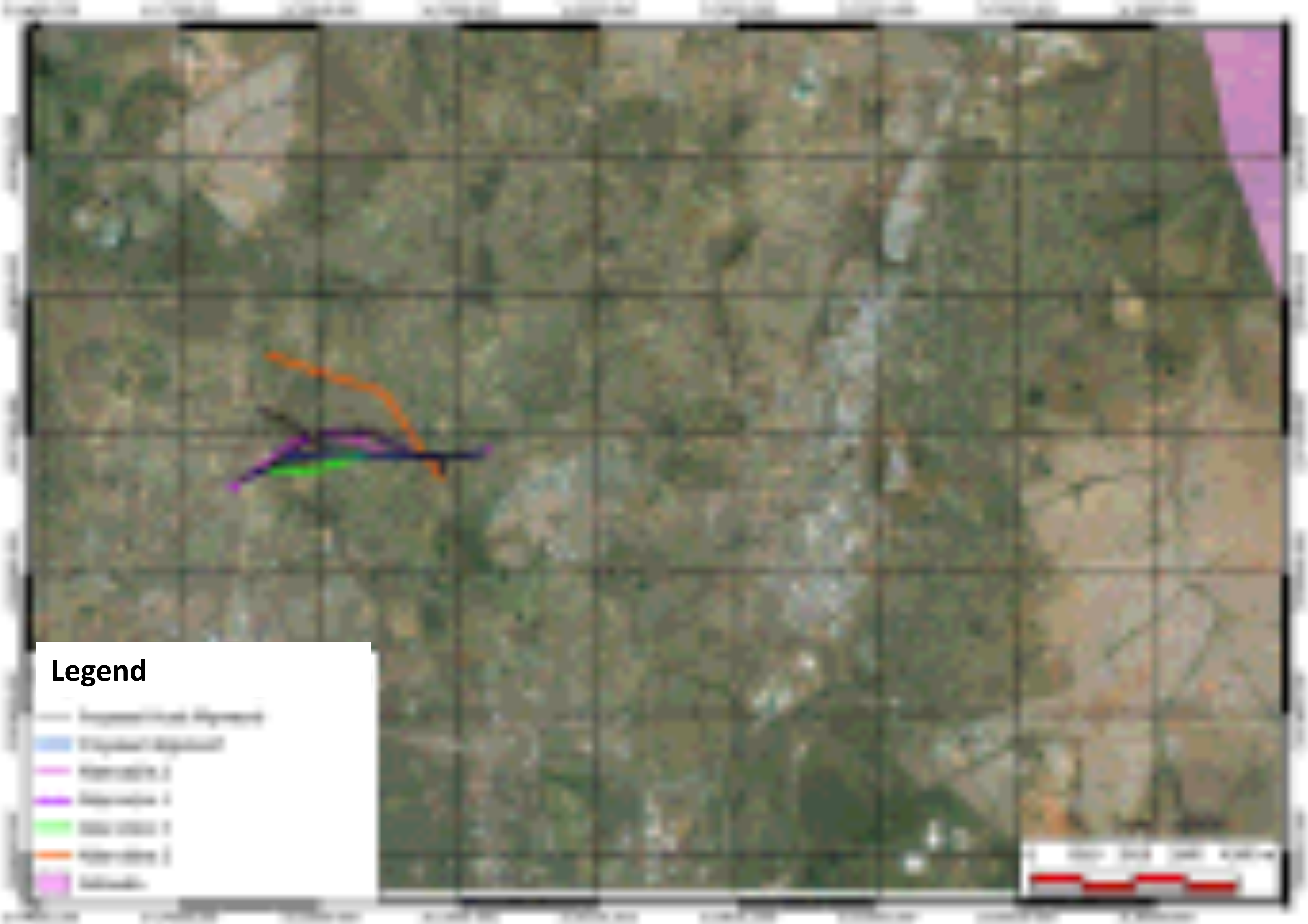


Fig 12: Dolomite Map

Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 13: Hydrology Map

Erling road between K46 and K56 and the K56 between K46 and Main Road

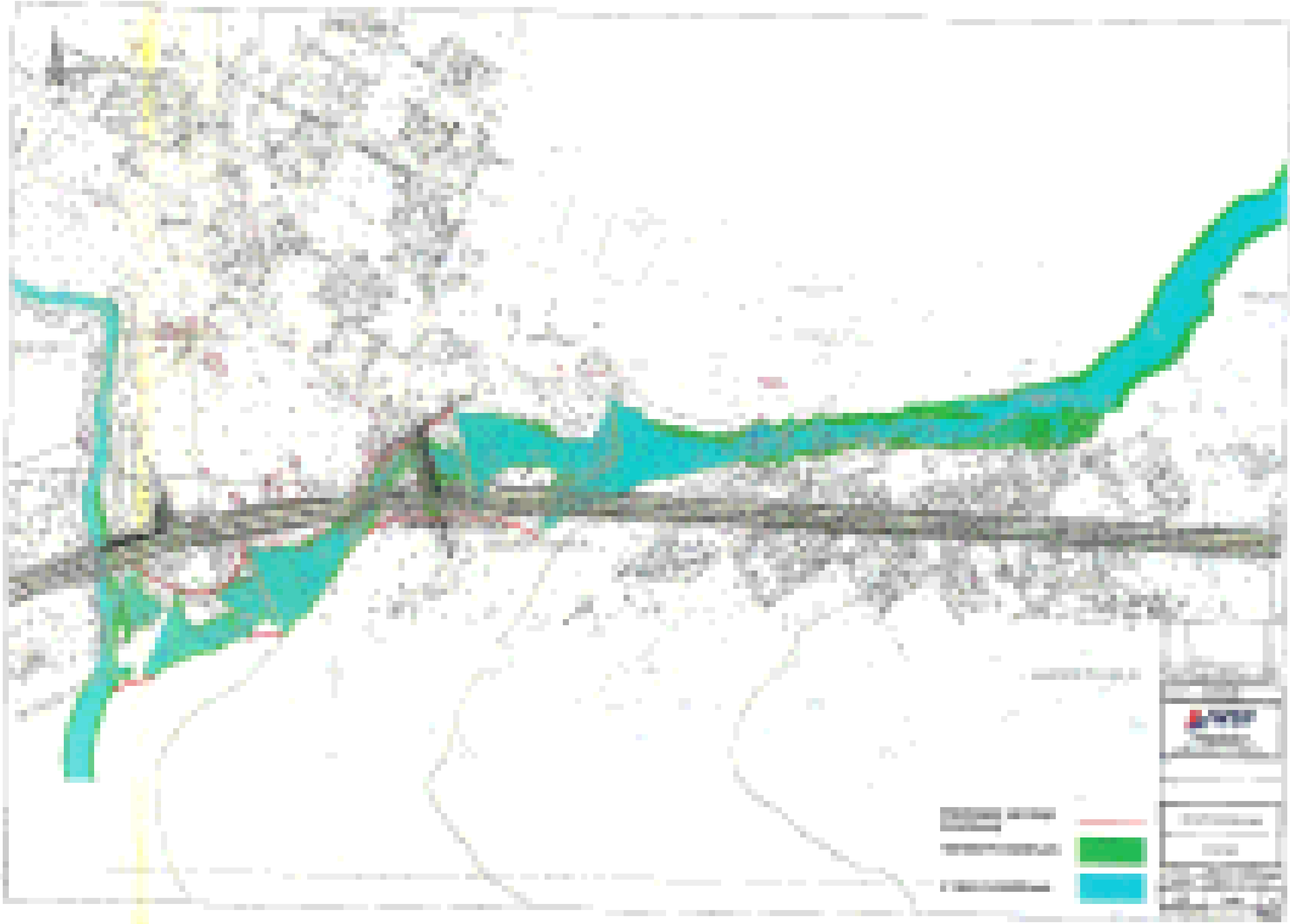


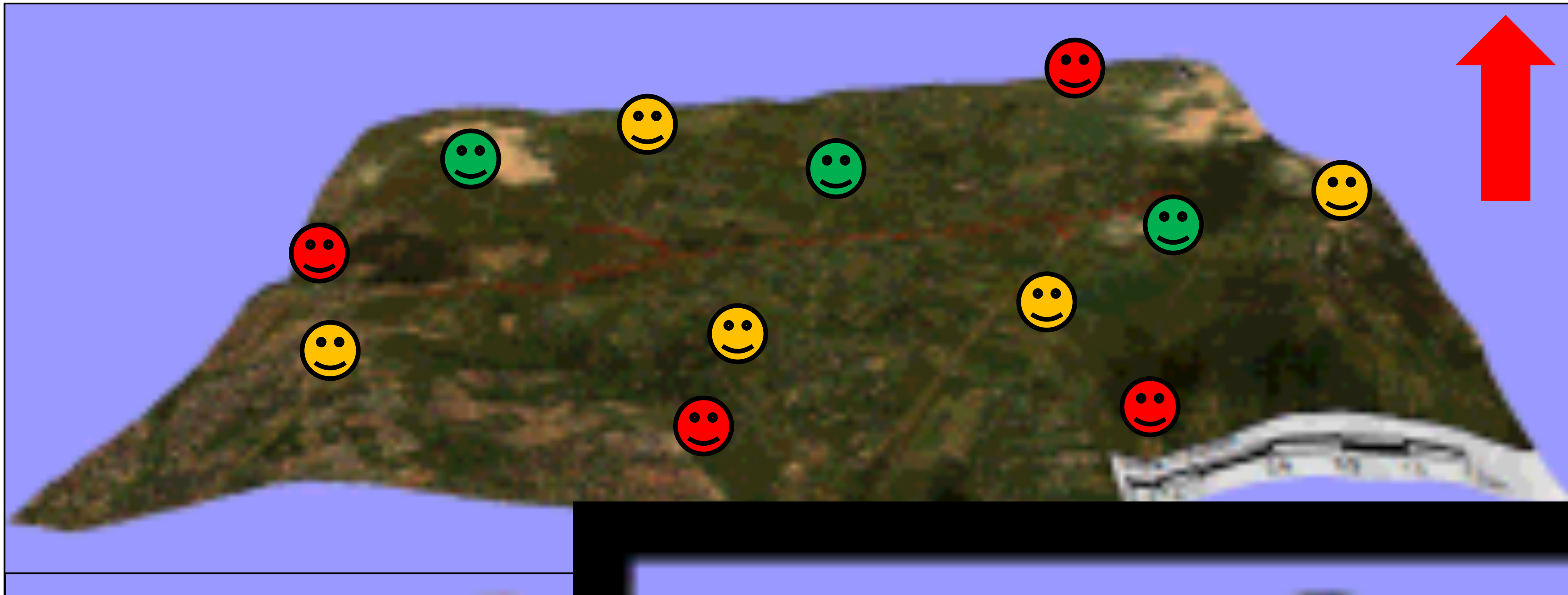
Fig 15: Wetland Delineation Map

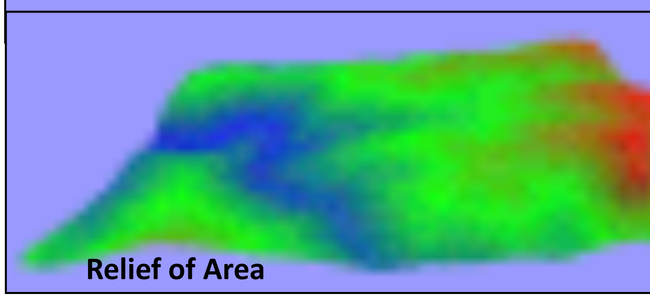
Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 16: Ridges Map

GDARD C-Plan 3

Erling road between K46 and K56 and the K56 between K46 and Main Road





Not visible
Partially visible
Completely Visible

Fig 17: Preliminary Visual Assessment

Erling road between K46 and K56 and the K56 between K46 and Main Road

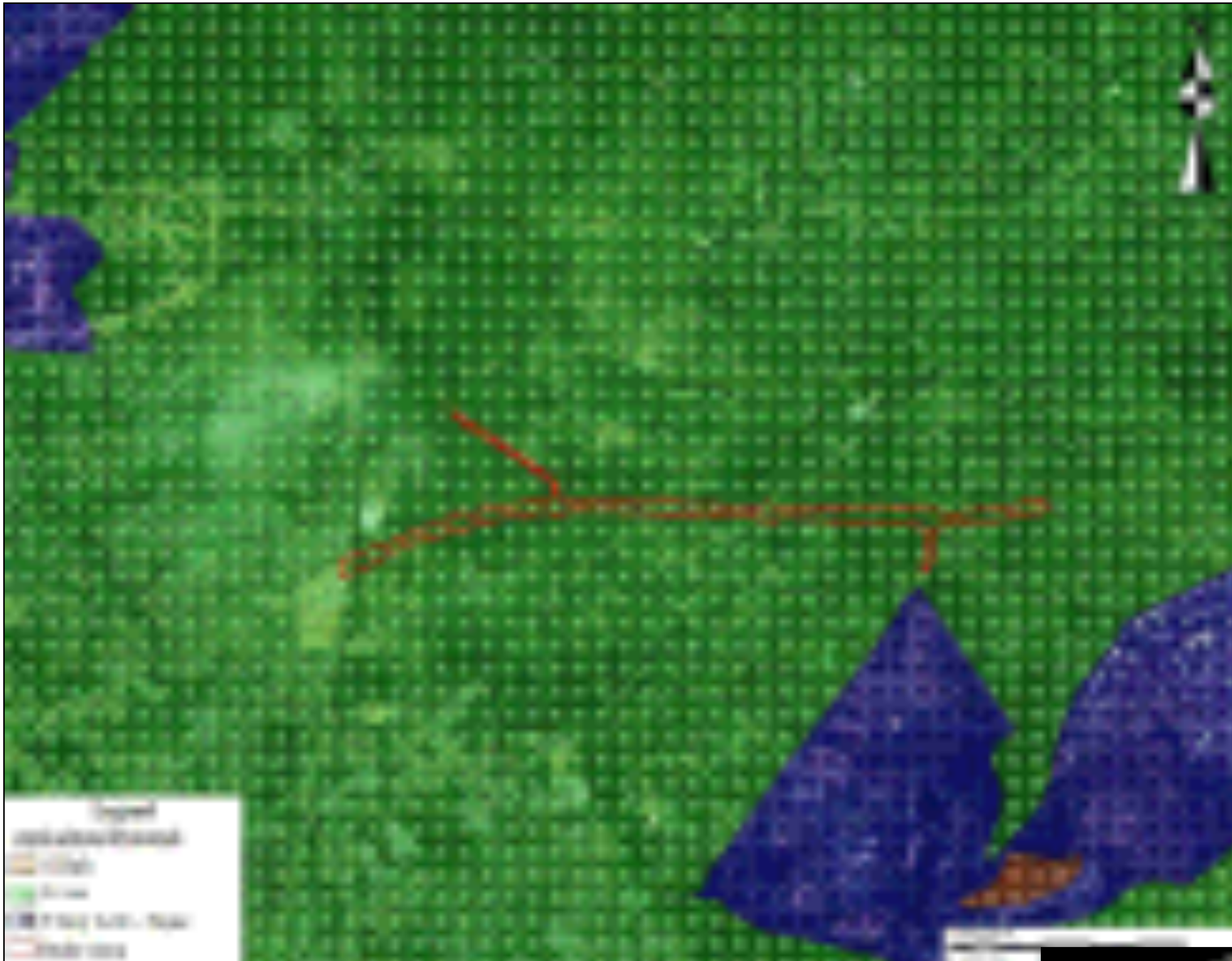


Fig 18 : Agricultural Potential Map (GAPA 3)

Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 19: Properties Expropriated

Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 20: GECKO Locality Map

Erling road between K46 and K56 and the K56 between K46 and Main Road

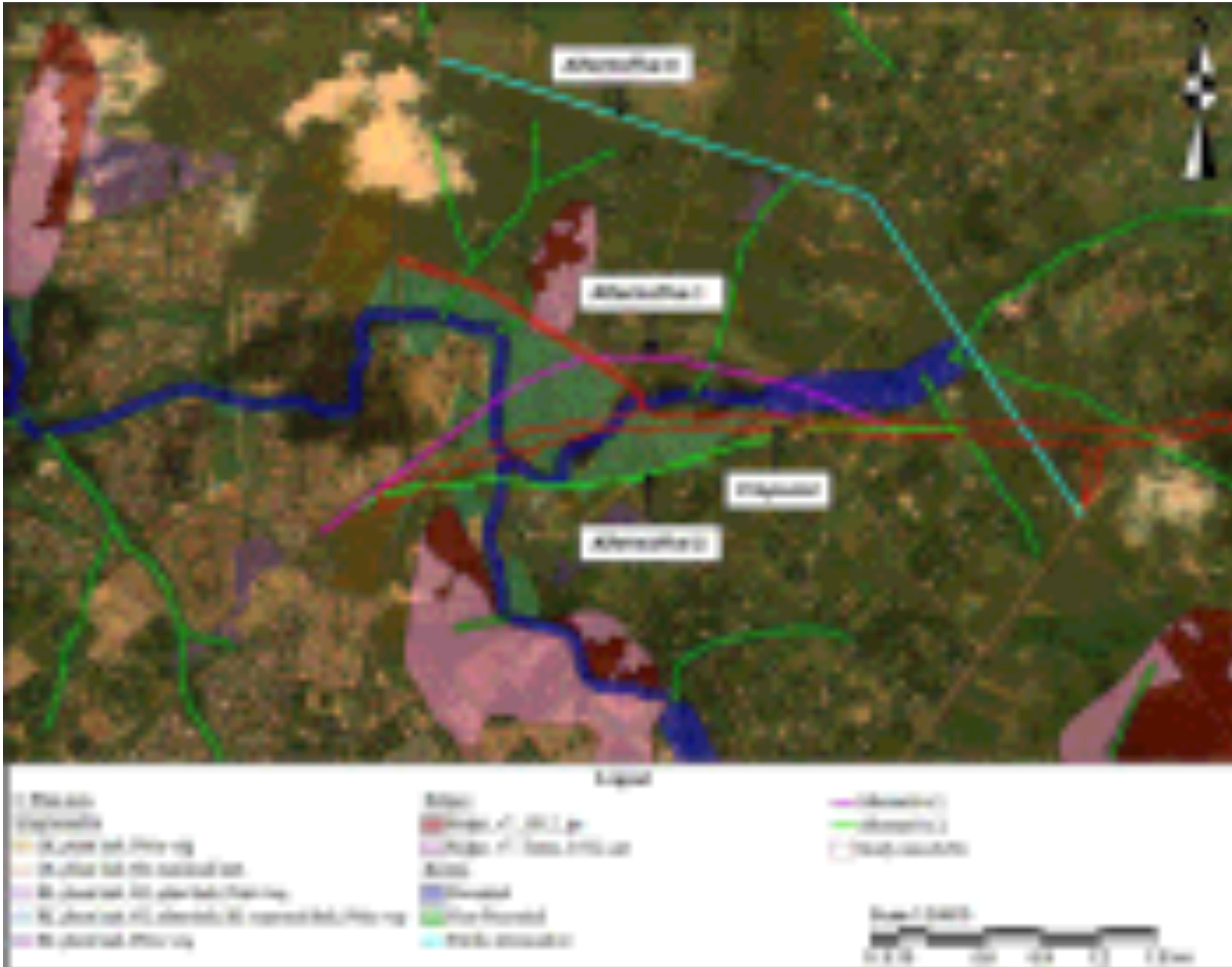


Fig 21: Preliminary Sensitive Issues Map

Erling road between K46 and K56 and the K56 between K46 and Main Road

Annexure B

REPORT 393

PRETORIA-WITWATERSRAND-VEREENIGING

HOOFPADNETWERK ONDERSOEK

ROETEBEPALING VIR PAD K56

1976 : 08 : 08.

Transvaalse Provinsiale Administrasie Paaie-departement

TRANSVAALSE PROVINSIALE ADMINISTRASIE

PAAIEDEPARTEMENT

KOSTEBEREKENINGSVERSLAG

VIR

ROETE [illegible]

DIREKTEUR VAN PAAIE

TRANSVAAL

[illegible]

[illegible]

1. [illegible]
   - 1.1 [illegible]
   - 1.2 [illegible]
   - 1.3 [illegible]
   - 1.4 [illegible]
2. [illegible]
   - 2.1 [illegible]
   - 2.2 [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
   - 5.1 [illegible]
   - 5.2 [illegible]
   - 5.3 [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]
10. [illegible]

[illegible]

[illegible] [illegible]

[illegible] [illegible]

[illegible] [illegible]

[illegible]

1. [illegible]

1.1 [illegible]

[illegible]

1.2 [illegible]

[illegible]

1.3 [illegible]

1.3.1 [illegible]

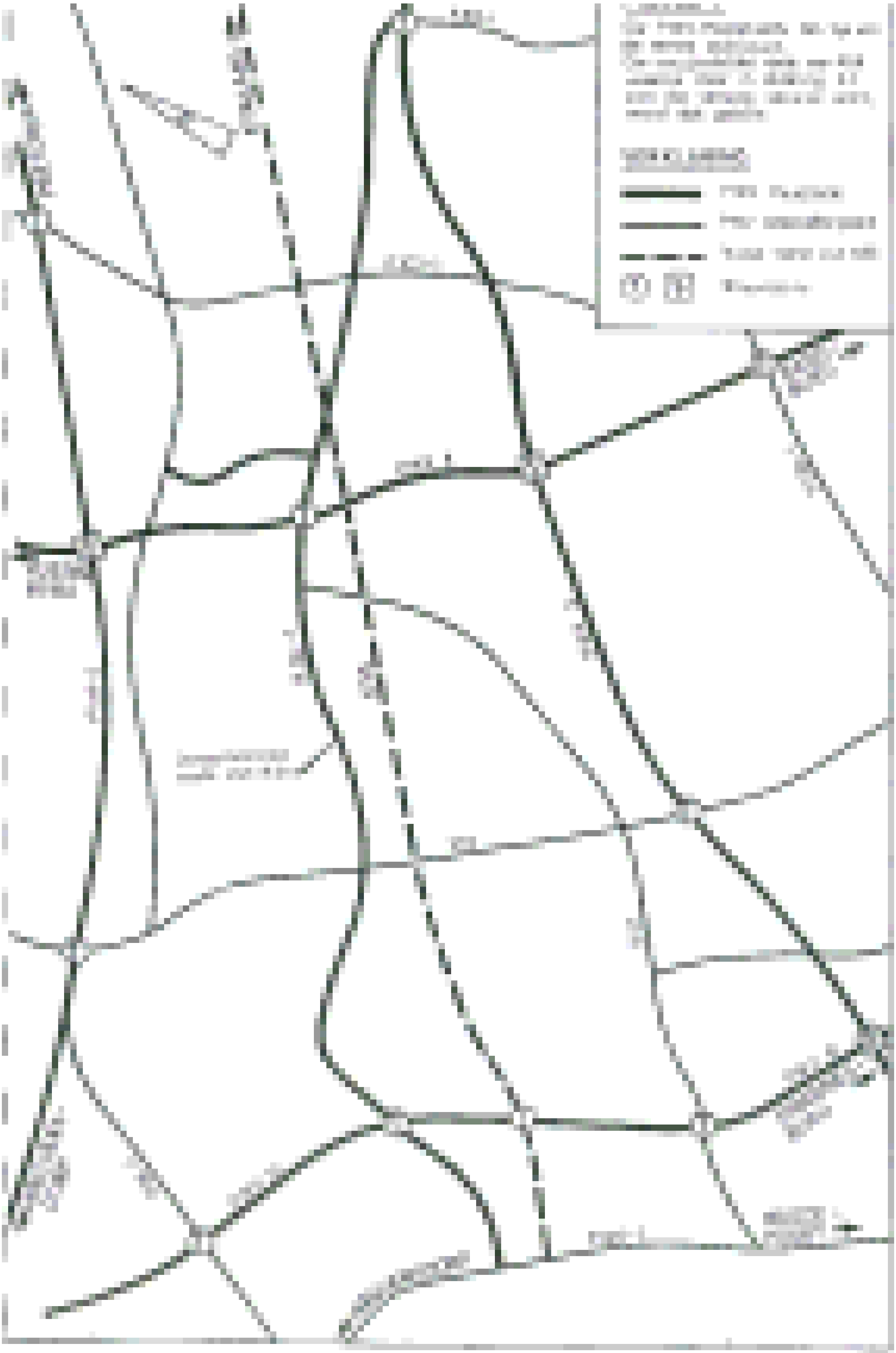
[illegible]

1.3.2 [illegible]

[illegible]

1.3.3 [illegible]

[illegible]



[illegible] [illegible]

[illegible]

1.4 [illegible]

[illegible]

2. [illegible]

2.1 [illegible]

[illegible]

2.2 [illegible]

2.2.1 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(a) [illegible]

(b) [illegible]

(c) [illegible]

[illegible] [illegible]

[illegible]

[illegible]

3. [illegible]

3.1 [illegible]

[illegible]

3.2 [illegible]

[illegible]

4. [illegible]

[illegible]

5. [illegible]

5.1 [illegible]

[illegible]

[illegible] [illegible]

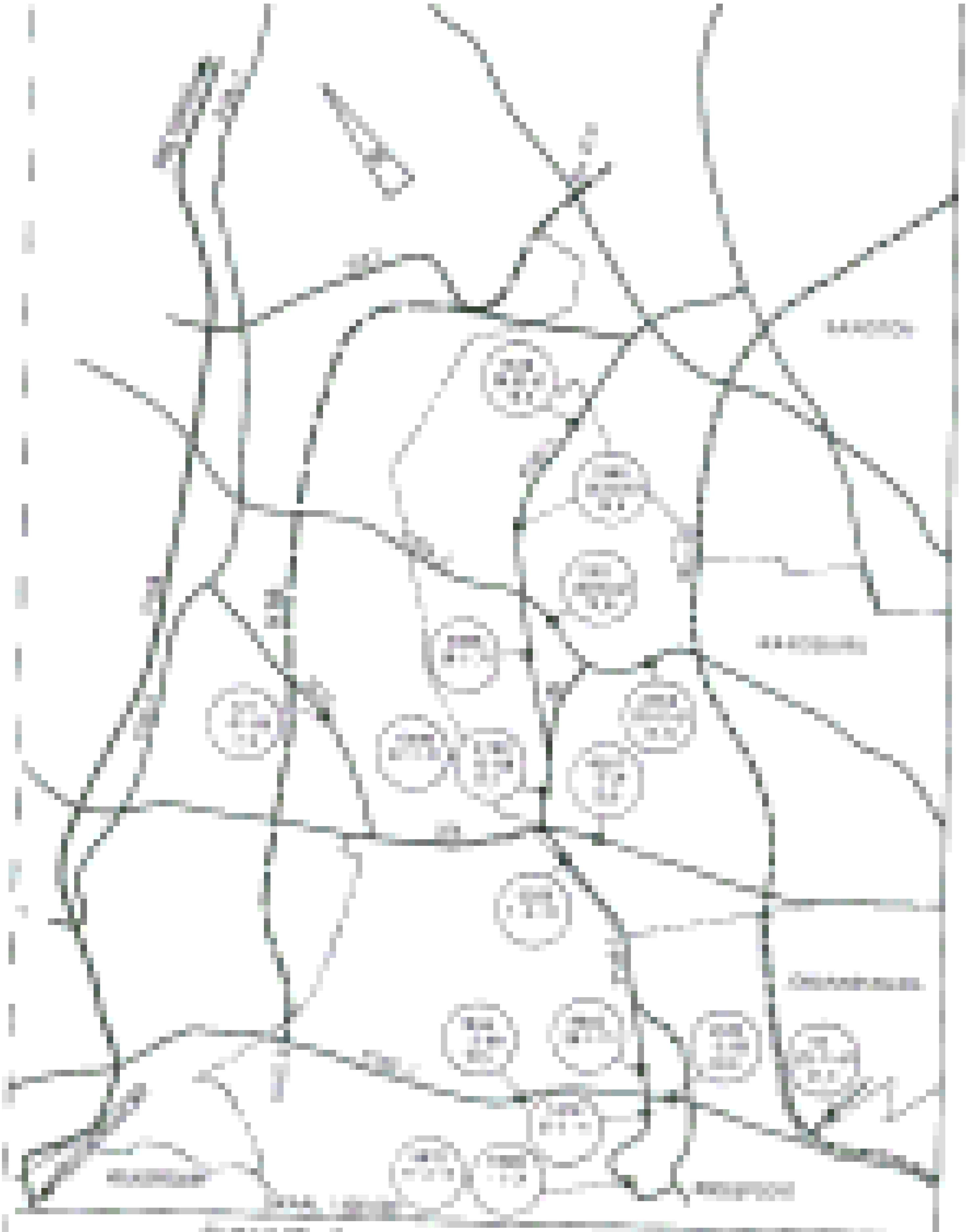
[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible] [illegible]

[illegible]



[illegible]

6. [illegible]

[illegible]

[illegible]

7. [illegible]

[illegible]

7.1 [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

9. [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]		
(a) [illegible]	[illegible] km/h	[illegible] km/h
(b) [illegible]	[illegible] m	[illegible] m
(c) [illegible]	[illegible] m	[illegible] m
[illegible]		
(a) [illegible]	[illegible] km/h	[illegible] km/h
(b) [illegible]	[illegible]	[illegible]
(c) [illegible]	[illegible]	[illegible]
(d) [illegible]	[illegible] m	[illegible] m
(e) [illegible] [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

10. [illegible]

[illegible]

[illegible]

Annexure C

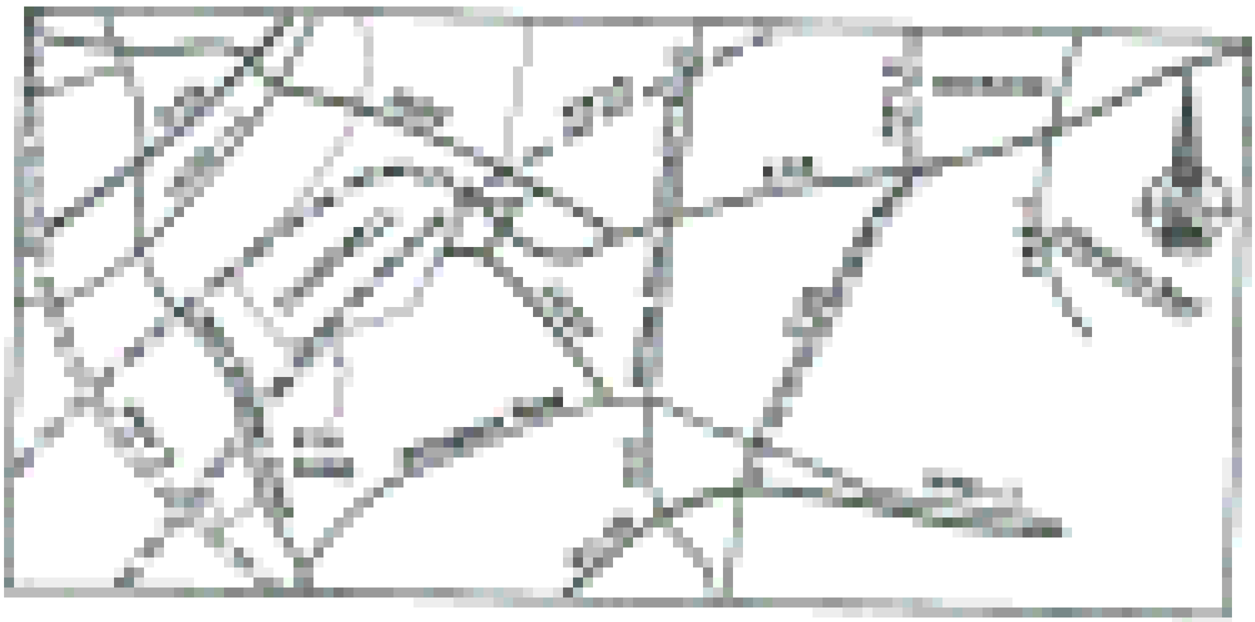
REPORT 1018

1018A

PUBLIC TRANSPORT AND ROADS

ADDENDUM TO
REPORT NO. 1018

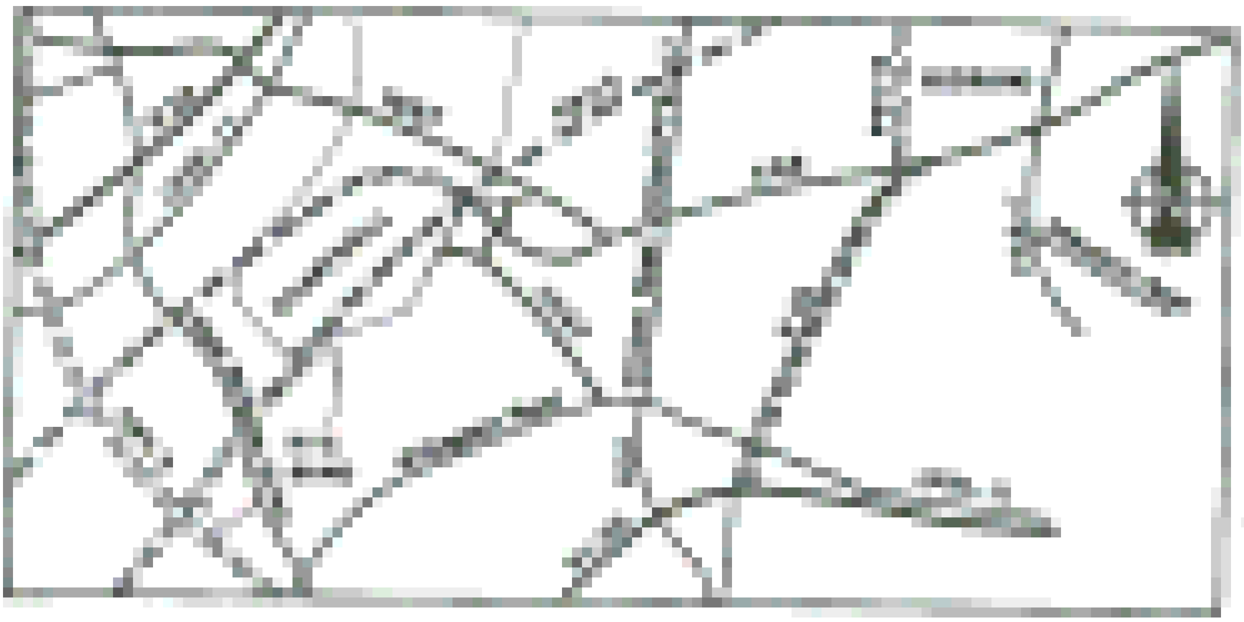
REVISION OF BASIC PLANNING TO [illegible]
TO ACCOMMODATE
THE PRESENT AND FUTURE STATUS OF ROAD [illegible]



PUBLIC TRANSPORT AND ROADS

ADDENDUM TO
REPORT NO. [illegible]

REVISION OF BASIC PLANNING TO [illegible]
TO ACCOMMODATE
THE PRESENT AND FUTURE STATUS OF ROAD [illegible]



AUGUST [illegible]

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

REVISION OF BASIC PLANNING NEEDED TO ACCOMMODATE THE PRESENT AND FUTURE STATUS OF ROAD [illegible]

PART 1: INTRODUCTION

1. TERMS OF REFERENCE

In their letter ref. [illegible] dated [illegible] 1996 the Deputy Director General : Roads commissioned [illegible] Specialists to undertake the revision and amendments to the Basic Planning of portions of [illegible] between km [illegible] and [illegible], where necessary, to accommodate possible realignment of Road [illegible].

These terms of reference were expanded upon at a meeting between officials of the Department and [illegible], with the following items [illegible] for consideration:

i) Ascertain whether the [illegible] radius curve on this section of [illegible] can be increased to [illegible] radius.
ii) Consider access from other roads to the area to [illegible].
iii) Examine Basic Planning of [illegible] to see suggest interchange with regard to Road [illegible] ([illegible] shall not be modified).
iv) The Department/Regional office [illegible] be consulted and [illegible] prior to the commencement.
v) Access from Road [illegible] to [illegible] must be finalised.

2. OVERVIEW

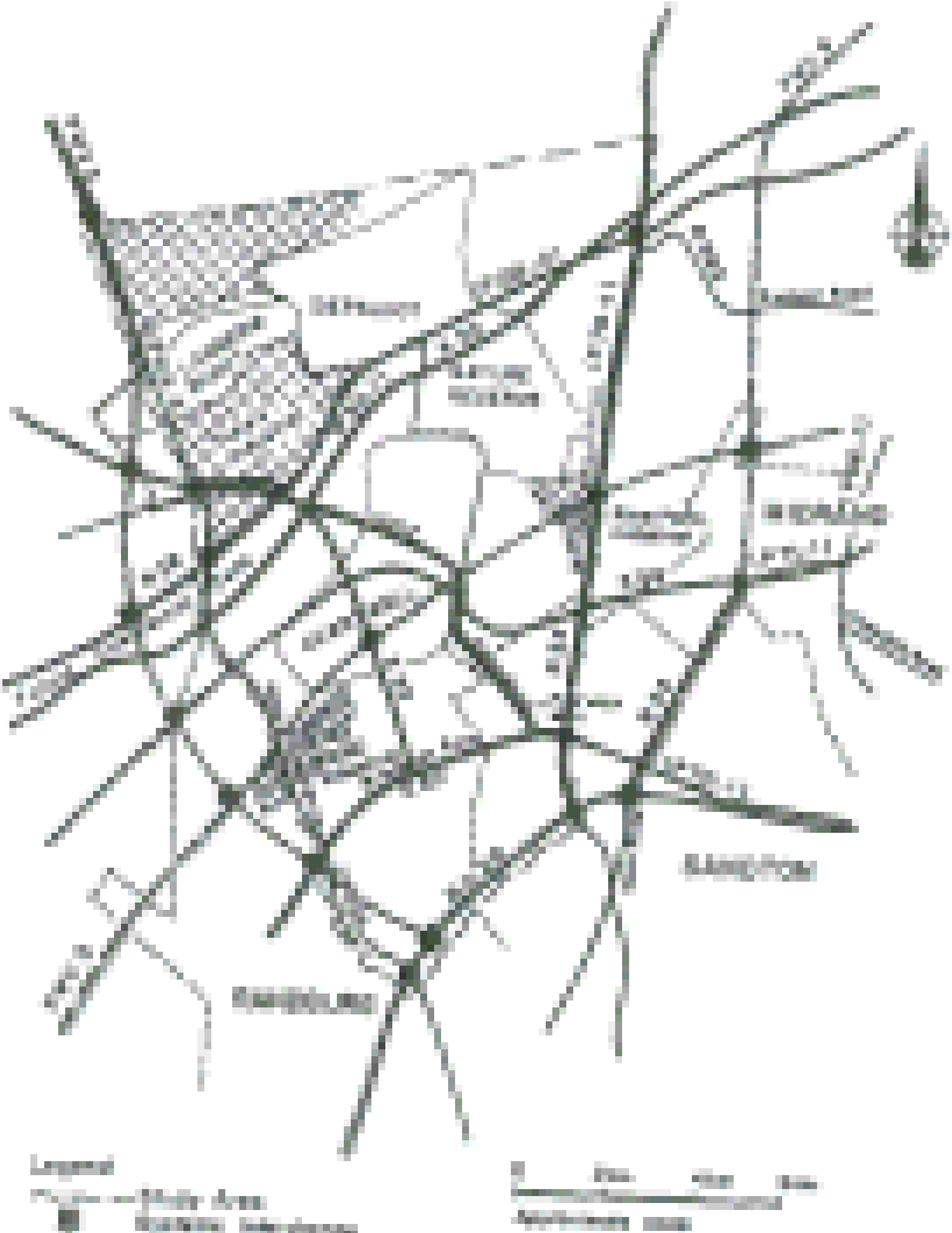
The PWV network was planned and designed some twenty years ago when legislation [illegible] and placed strict controls on the settlement of [illegible] groups. Conditions have changed in the interim and are now characterised by rapid urbanisation, new legislation and dwindling funding. Thus it has become necessary to review portions of the network in the light of these changed conditions.

According to previous planning Road [illegible], north of the [illegible] Krugersdorp Freeway ([illegible]) was due to traverse the [illegible]. South of the Krugersdorp freeway, the [illegible] was planned to run [illegible] to [illegible] with the [illegible] Road [illegible] (See Figure 1).

Secondly there has been a considerable amount of development in the study area with an attendant rise in the use of Road 1027. The question now arises as to whether the existing road infrastructure, and particularly Road 1027, should be upgraded and what effect this will have on the status of the other planned PWV routes/links. Any upgrading action of the Road 1027 will significantly affect the design of access [illegible] to the proposed [illegible].

The first part of this report, therefore, is a network analysis to ascertain the status that should be given to Road 1027.

The second part of the report contains the [illegible] that are required to the Route Planning of 1027 to accommodate the [illegible] status of Road 1027.



Legend
- Study Area
- Systems Interchange
- Access Interchange
- Existing Road
- Future Open Freeway
- Future Closed Freeway
- Municipal Boundary

STUDY AREA SHOWING EXISTING
AND FUTURE ROAD NETWORK
IN RELATION TO EXISTING [illegible]

FIGURE 1

PART II: LAND USE, TRAFFIC GENERATION AND NETWORK ANALYSIS

1. INTRODUCTION

In this part of the report we carry out analysis to [illegible] the optimum network for the study area and to [illegible] on Road 1027.

2. METHODOLOGY

In the light of the uncertainty surrounding land use planning in the area, it was decided:

i. To assign a [illegible] period to existing land use applications in the area served by Road 1027 and [illegible] this development [illegible] to predict the number of additional trips generated by these new developments that will be assigned to Road 1027 within the [illegible] year horizon. From this information, the [illegible] requirements for the Road 1027 would be apparent. Design volumes were calculated on the morning peak hour traffic [illegible]. It was assumed that the evening peak hour volumes would be the reverse of these.

ii. To liaise with all the relevant town planning bodies involved in the area and to obtain comments as far as possible on likely development scenarios for the area using a 10 year horizon.

The ultimate status of Road 1027 within the context of the PWV network and in particular with regard to K96, will then be assessed.

The study area includes the area [illegible] by PWV [illegible] in the [illegible] Road [illegible] to the [illegible] and [illegible] in the [illegible] and the [illegible] in the south. Refer to Figure 1.

The study reference [illegible] of Figure 1 is included on the [illegible] page of this report in Appendix [illegible].

3 THE ROAD HIERARCHY

[illegible]

[illegible]

TABLE 1: FUNCTIONAL HIERARCHY OF ROADS IN STUDY AREA

FUNCTIONAL HIERARCHY	ROAD	EXISTING or FUTURE
CLASS 1: Metropolitan/Regional Distributor [illegible]	[illegible] [illegible] [illegible] [illegible] [illegible]	Future Future Future Existing Existing
CLASS 2: Primary Arterials [illegible]	[illegible] [illegible] [illegible] [illegible] [illegible] [illegible]	Existing Existing Existing Future Existing Future
CLASS 3: Secondary Arterials [illegible]	[illegible]	Existing

3.3 The Road Network

[illegible]

[illegible]

[illegible]

4. THE 5 YEAR HORIZON

4.1 Land Use Applications in the Area

The study area as described above falls within the jurisdiction of [illegible]:

i. The Greater Johannesburg Transitional Metropolitan Council : [illegible] Administration

ii. The Greater Johannesburg Transitional Metropolitan Council : Sandton Administration

iii. The Gauteng Provincial Administration

The nature and size of all pending land use applications within the study area were obtained in order to [illegible] the applicable trip generation rates, as contained in the Department of Transport [illegible] South African Trip Generation Rates [illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

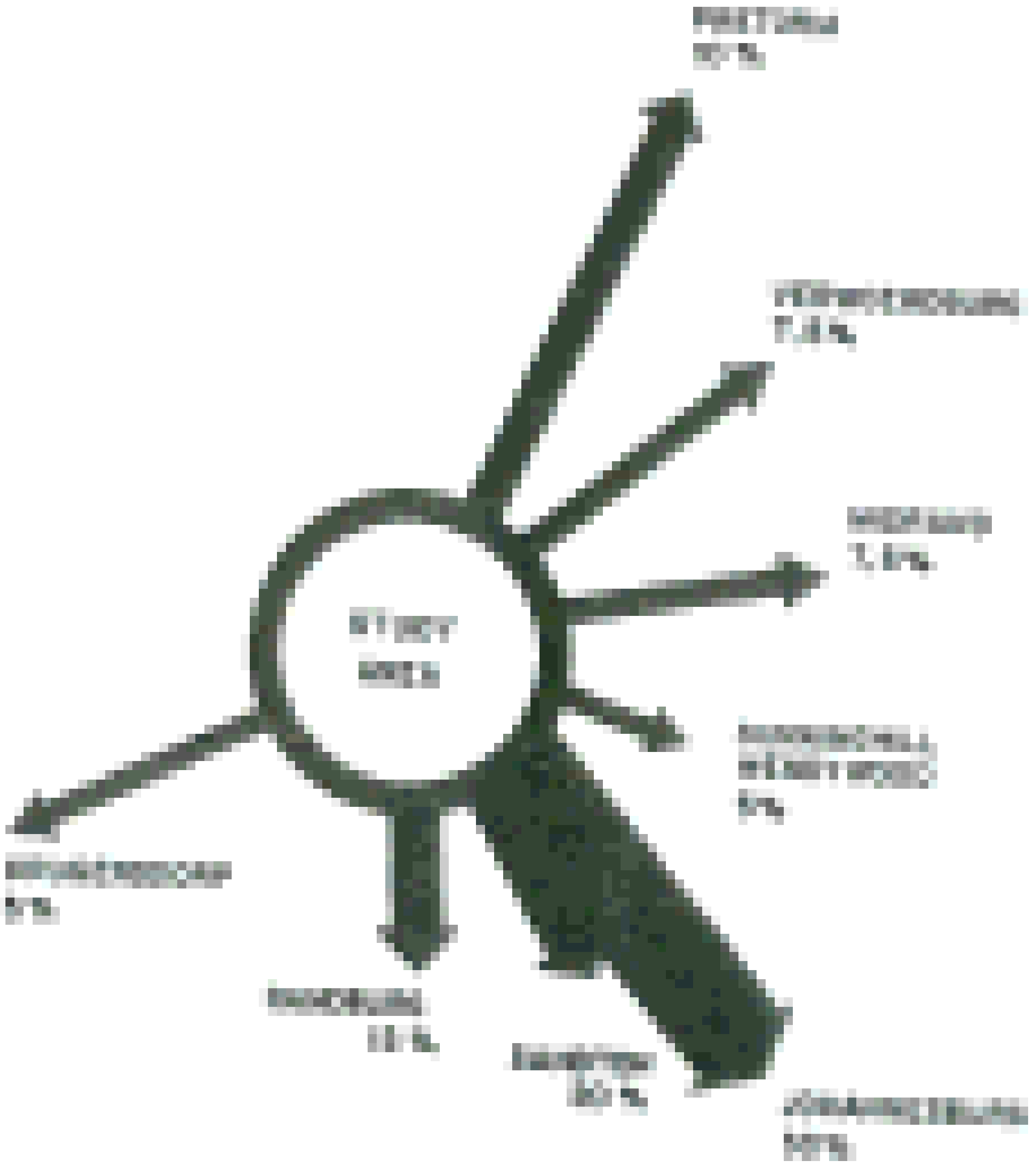
i. [illegible]

ii. [illegible]

[illegible]

ZONING

FIGURE 5



EXISTING DESIRE LINES

FIGURE 3

4.3 Existing Traffic Volumes

[illegible]

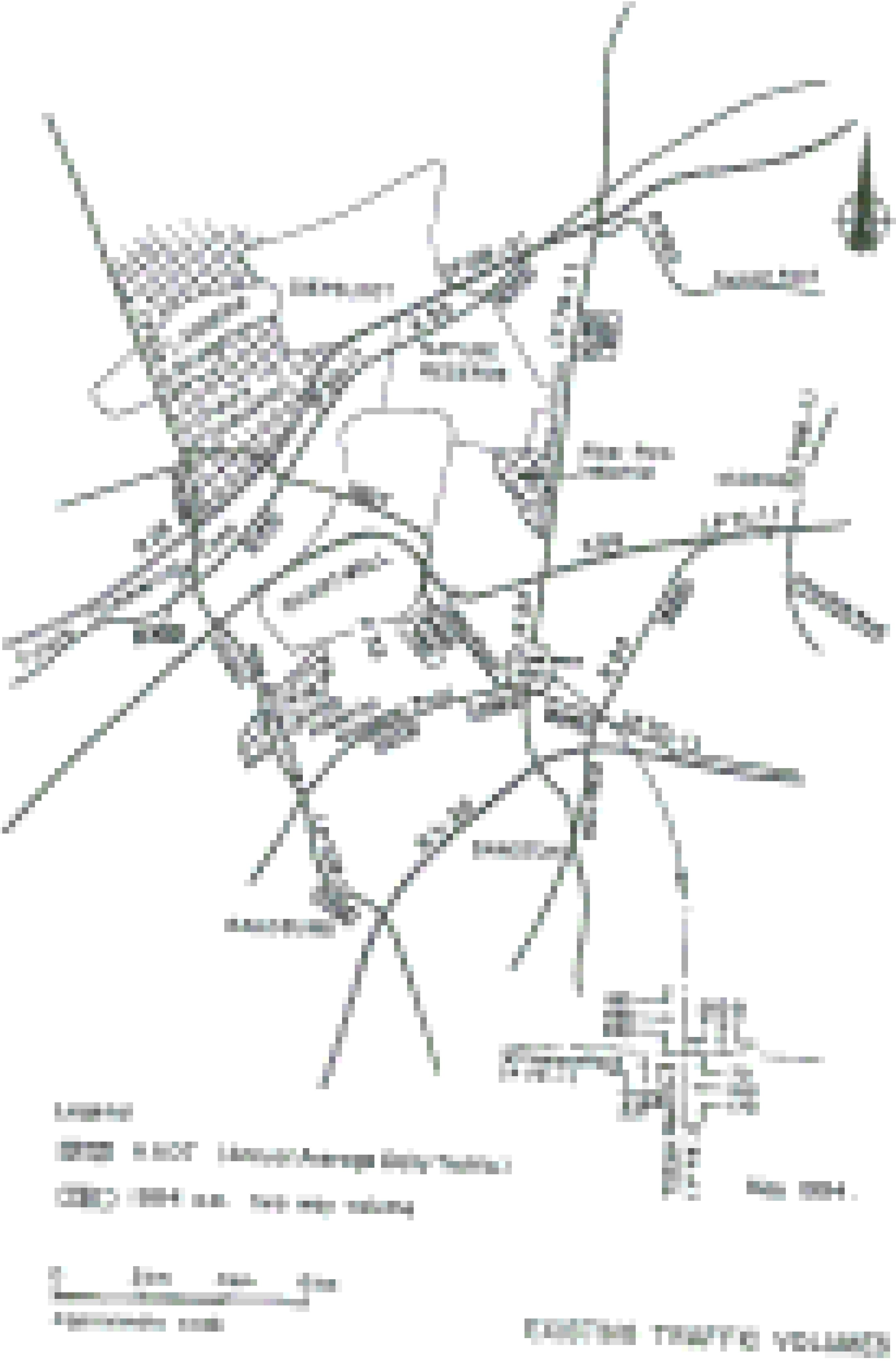
4.4 Trip Generation

[illegible]

TABLE 2: TRIP GENERATION RATES

LAND USE	TRIP GENERATION RATE	DIRECTIONAL SPLIT
Residential		
High Density	[illegible]	[illegible]
Low Density	[illegible]	[illegible]
Industrial	[illegible]	[illegible]
Office	[illegible]	[illegible]
Business	[illegible]	[illegible]
Hotel	[illegible]	[illegible]

[illegible]



EXISTING TRAFFIC VOLUMES

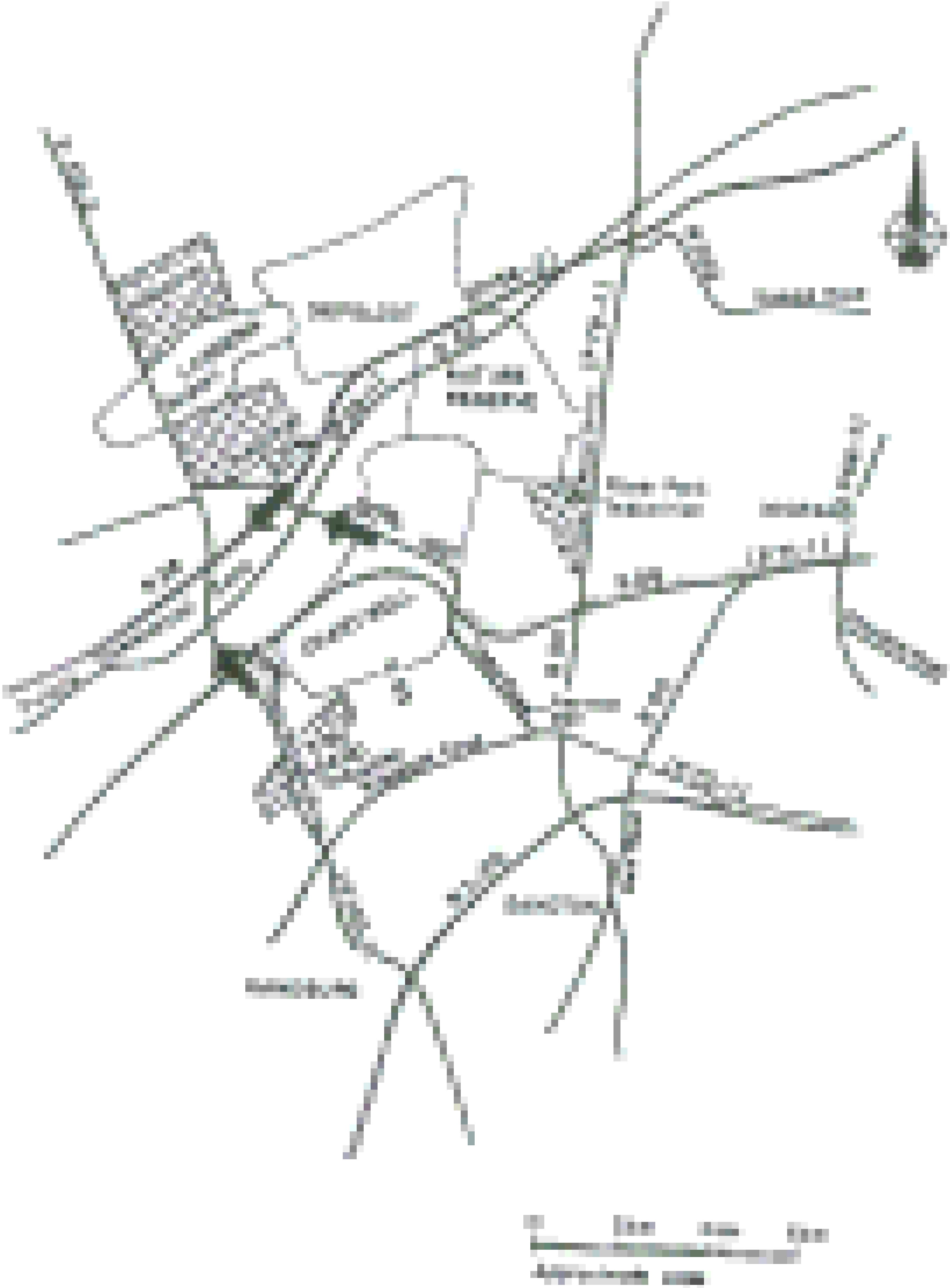
FIGURE 4

[illegible]

[illegible]

ZONE	TRIPS IN	TRIPS OUT	TOTAL TRIPS
1 [illegible]	[illegible]	[illegible]	[illegible]
2 [illegible]	[illegible]	[illegible]	[illegible]
3 [illegible]	[illegible]	[illegible]	[illegible]
4 [illegible]	[illegible]	[illegible]	[illegible]
5 [illegible]	[illegible]	[illegible]	[illegible]
6 [illegible]	[illegible]	[illegible]	[illegible]
7 [illegible]	[illegible]	[illegible]	[illegible]
8 [illegible]	[illegible]	[illegible]	[illegible]
9 [illegible]	[illegible]	[illegible]	[illegible]
10 [illegible]	[illegible]	[illegible]	[illegible]
11 [illegible]	[illegible]	[illegible]	[illegible]
12 [illegible]	[illegible]	[illegible]	[illegible]
13 [illegible]	[illegible]	[illegible]	[illegible]

[illegible]



ESTIMATED DIRECTIONS OF
APPROACH TO CANBERRA

FIGURE 5

4.3 Expected Traffic Volumes within 3 Years

The AADT on Road 3027 is at present [illegible]. During the peak hour it carries 750 vehicles (2-way total). The results of this analysis indicate that should all the pending rezoning applications materialise within the next few years, the Road 3027 could carry an additional 2000 vehicles in the morning peak hour with an fairly even split between the two directions.

As stated previously, it is assumed that the afternoon peak hour will be the reverse of the morning peak hour. It must be borne in mind that a limitation of this study is that only external directed and internally directed traffic volumes were considered. It is believed that this assumption underestimates traffic volumes as it will not include the shopping trips which will occur [illegible] during the afternoon peak hour. However, it is considered that this refinement is unnecessary for this study.

Assuming a capacity of 1800 vehicles per hour for a two-lane road, it is clear that Road 3027, as presently constructed, will not have the capacity to carry the generated traffic should all the pending applications materialise within 3 years. Thus consideration must be given to either reducing the traffic load on Road 3027, or to improving and upgrading this road.

The proposed K56 and PWV9 will not take over the basic function of Road 3027 [illegible] a Class 3 link between [illegible] and [illegible] Road, and should strategy as discussed in chapter 5 not be adopted, it is clear that Road 3027 will require upgrading to a 4 lane facility as a forerunner to development within the study area.

5. THE 10 YEAR HORIZON

5.1 Possible Future Development: An Overview

From discussions with planners from the Provincial Roads Department, it was established that the development tendency in the PWV region is noticeable. However the [illegible]

[illegible] the PWV/[illegible] [illegible] to [illegible] employment opportunities in the [illegible] direction i.e. Rosslyn and the future Bronkhorstspruit [illegible] industrial area.

There is a growing trend within the entire PWV region to identify land suitable for mass housing schemes. It is the considered opinion of both provincial and [illegible] planning officials that [illegible] development in the study area will have to be dramatically revised [illegible] although land within the study area is available and within a [illegible] from the centre of Johannesburg, the location is generally planned in less than ideal [illegible] for the following reasons:

i. The study area is relatively far from established places of possible employment.
ii. There are no well-established mass transportation routes.
iii. The area is relatively [illegible] [illegible] and [illegible] of the [illegible] income groups.

Therefore, if high density housing schemes are to be established in the area as it is [illegible] it is essential that a work-creating facility such as the PWVW be built, together with [illegible] in order to create sufficient employment opportunities.

5.2 **The Chartwell Structure Plan and the [illegible] Structure Plan**

The Chartwell Structure Plan and the [illegible] Structure Plan [illegible] within the [illegible] of the study area. Refer to Map [illegible], Appendix C, Land Use Proposals.

These plans are considered to be out of date as additional industrial and high density housing areas are already being planned [illegible] high density housing development at [illegible] City, [illegible] of Chartwell, [illegible] [illegible] [illegible] [illegible] and [illegible].

We are aware of changes in zoning [illegible] but we are not aware of any further [illegible] high density housing. This we consider to be [illegible].

[illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] **Road Network Scenarios**

The road most likely to substantiate within a 20-year horizon will be the PWV3. The eastern link of K76 (east of the intersection with Road 1027) will thus be a necessity, as it will provide access to the PWV3 and ultimately to possible employment in the industrial areas ([illegible] and [illegible]) ([illegible] particular importance to high density housing areas), as well as River Park.

It is, therefore, suggested that the eastern link of the K76 be built with, or soon before, PWV3 to open up the study area for development. The implementation of this section has to be planned. (Refer to Figure [illegible].)

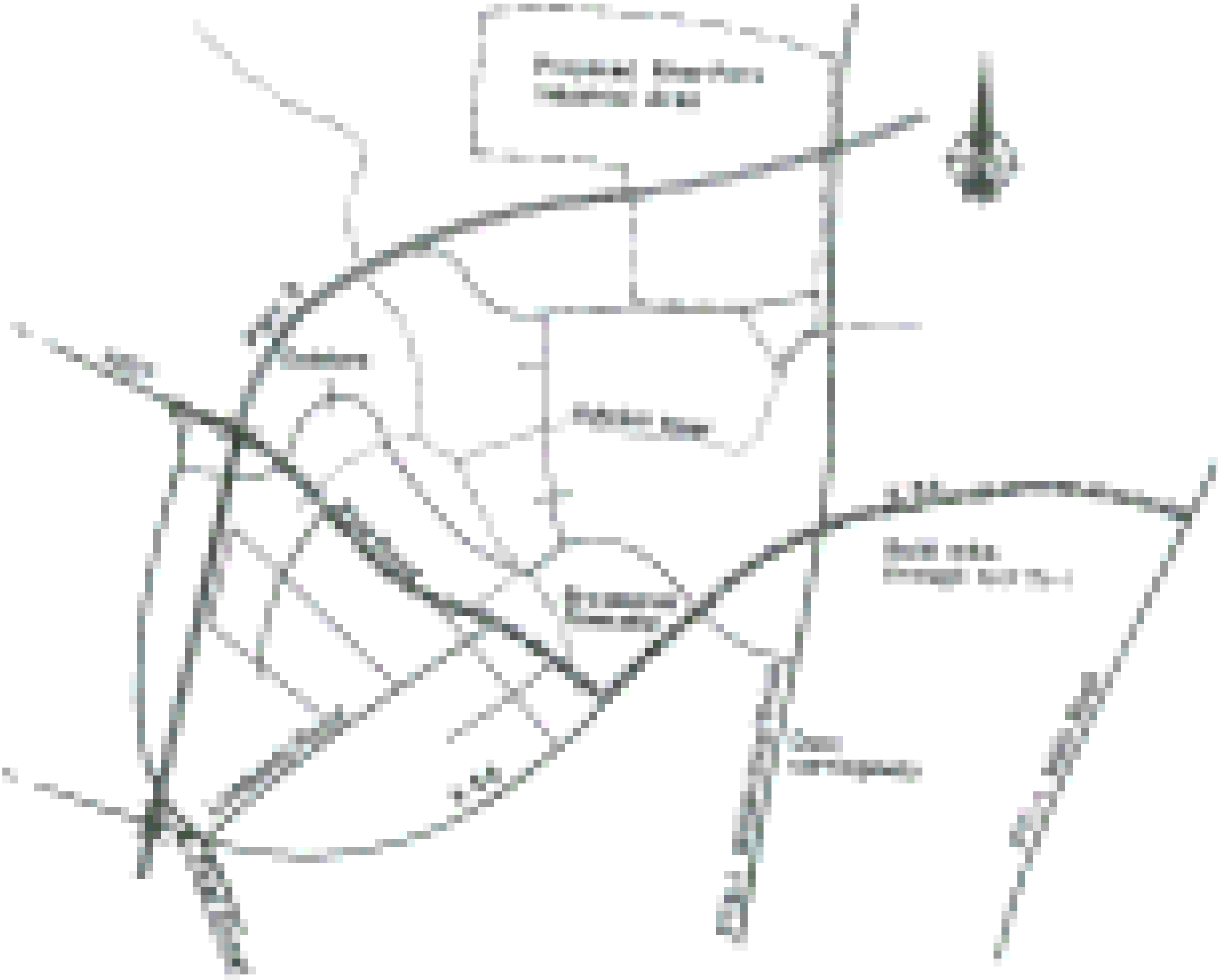
Several scenarios capable of providing satisfactory road networks were examined. The one considered to be superior to all those examined was:

SCENARIO I:

To retain the present planning of K56 and Road 1027 whereby the northern section of Road 1027 continues in a straight line into Blue Bank, passing just south of [illegible] to join the K56 just west of the [illegible] Entrance (Refer to Figure [illegible]). The K56 is to be built from this intersection eastwards across William Nicol to [illegible]. William Nicol will then require upgrading to a 4-lane facility at least as far as the K56 crossing, but preferably as far as the entrance to the proposed River Park Industrial Township. The existing section of Road 1027 (Cedar Road) south of the K56 will be downgraded to feed into the local street road system as well as provide access to [illegible]. There will be no access to PWV3. The southern portion of Road 1027 will be re-aligned, as provided for in the current basic planning of PWV3, to cross over the PWV3 by an overpass, with no access to PWV3. Further assessment will be provided to the southern portion of Road 1027. (Refer to Figure [illegible].)

SCENARIO II:

The present alignment of Road 1027 will be retained. Road 1027 will be upgraded to a four-lane facility and an interchange with K56 will be provided. There will be no direct access to PWV3 at this point. The section north of K56 will have to be upgraded and improved particularly in the vicinity of the Dainfern access.



RECOMMENDED FUTURE
ROAD NETWORK
SCENARIO

FIGURE 6

[illegible] CONCLUSIONS

The current function of Road 1027 is that of a Class 3 secondary distributor linking the Lanseria area with William Nicol Drive (PWV-5) [illegible]. It also functions in a lesser capacity as a collector road for residential areas [illegible] Chartwell, [illegible], Fourways and Witkoppen.

It is proposed to separate these two functions, as in SCENARIO 1, [illegible] of the road network with through traffic being routed as it should be, onto the higher class road and local residential traffic remaining on the collector road.

SCENARIO 1 as described in subheading 5.1 will maintain the integrity of the road network. The traffic from Lanseria is taken straight along [illegible] Road, instead of having to negotiate the sharp bend in the [illegible] and then link up with the R28 just west of the "Broadacres" Township (See Figure 4). R28 must then be built through to William Nicol Drive (PWV-5) to continue the link to the south. The traffic load on William Nicol Drive (PWV-5) will then require that a 4-lane facility be provided at least up to the intersection with R28 and preferably further north to the River Park entrance. R28 should be taken even further eastwards to link up with Main Road (P71-1) which is the future alignment of PWV-5, as access to this facility will be essential to open up the area for development.

The portion of Road 1027 south of PWV-5 will then function as a lower class collector road for the residential areas surrounding it and will not require upgrading as the through traffic will have been routed onto the [illegible] Road link to the R28. This scenario favours Road 1027 as a two-lane road.

SCENARIO 2 as described in subheading 5.2 will require that the southern residential part of Road 1027 be upgraded to a 4-lane facility. William Nicol Drive (PWV-5) will also have to be upgraded to a 4-lane facility in order to accommodate the industrial development of River Park.

Further, it is considered that Road [illegible] is a minor road, which essentially duplicates the function of [illegible] and thus is undesirable.

It is therefore felt that it would be wrong to [illegible] Road [illegible] as this is not expected to [illegible] and would [illegible] a possible [illegible] of the [illegible] available.

SCENARIO 1 represents an investment in [illegible] and a partial implementation of the [illegible] planned road network. This will facilitate development in the area and is not a duplication of existing facilities. The expenditure can thus be fully justified.

7. RECOMMENDATIONS

It is, therefore, recommended that SCENARIO 1 as shown in figure 4 be adopted for implementation for the following reasons:

i. It [illegible] the [illegible] integrity of the road network by separating the through traffic between [illegible] and [illegible] from the purely residential traffic in the area.

ii. It improves the horizontal alignment by realigning the [illegible] road in the vicinity of the [illegible] to [illegible] the higher class road.

iii. It is a partial implementation of the [illegible] planned [illegible] network, not a duplication of an existing facility. This will improve the accessibility of the area and open it up for development.

iv. It utilises funding for investment in the future planned road network and not for upgrading an existing facility which, in future, will become insignificant once the [illegible] network is implemented in this area.

PART [illegible] [illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

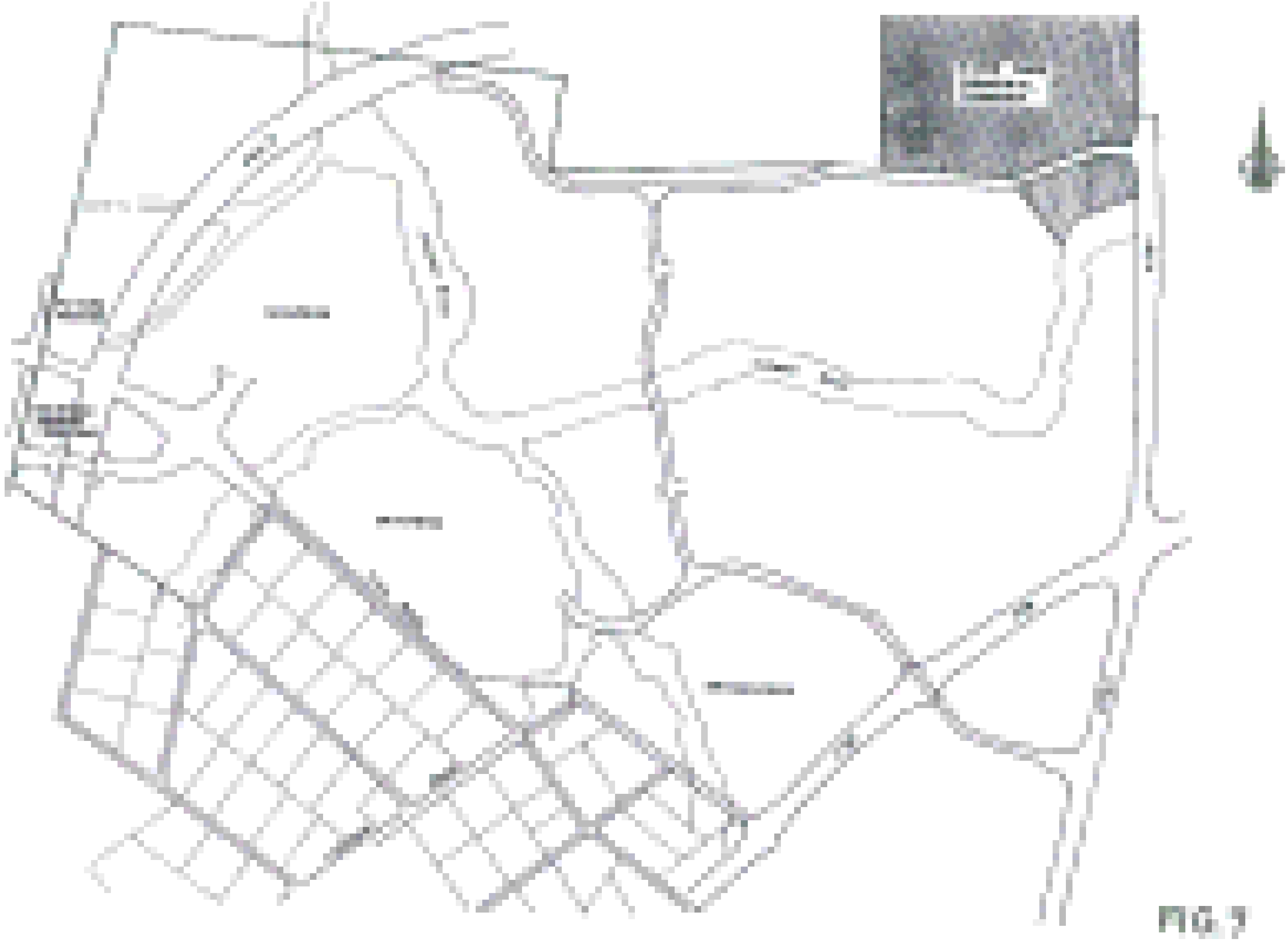


FIG. 7

3. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

4. [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(i) [illegible]

(ii) [illegible]

The possibility of increasing the radius of Curve 1 was investigated. This is not possible without incurring very expensive land acquisition and compensation costs due to high density housing adjacent to the existing road [illegible].

The possibility of adjusting the vertical alignment was also investigated and decided against as this would involve major [illegible].

After [illegible] it was [illegible] that it is not practical at this stage to change the design of [illegible] in this area.

It is thus apparent that access to [illegible] is only available [illegible] between [illegible].

4.[illegible] [illegible]

4.1.1 [illegible]

[illegible] application for access to Service Road by [illegible] developer of Portion 24 of [illegible] [illegible] to [illegible]. The present access road [illegible] Road is [illegible].

A new service road has now been designed across Portion 24 and Portion 43 to give access from [illegible] Road. The [illegible] of this service road [illegible] Service Road [illegible] to the landowner in exchange for the new servitude [illegible].

These proposals have been discussed with [illegible], the town planners for the development of Portion 24. They consider the proposals [illegible] development and [illegible].

The [illegible] Christian Fellowship, the owners of Portion 43, have considered the proposal for Service Road [illegible] acceptable to their congregation.

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

- Design Speed [illegible]
- Maximum Grade [illegible]
- Minimum Grade [illegible]
- Stopping Sight Distance [illegible]
- Minimum length of Vertical Curve [illegible]
- Minimum Radius [illegible]
- Minimum K-value [illegible]
- Minimum K-value [illegible]

[illegible]

- [illegible] [illegible]
  [illegible]
- [illegible] [illegible]
- [illegible]

[illegible]

[illegible]

1. Modifying the current planning by bringing Road 3327 into Valley Road at an intersection angle of [illegible] (see Fig. [illegible]).
2. Modifying the current planning by bringing Road 3327 into Valley Road at an intersection angle of [illegible] (see Fig. [illegible]).

In discussion both of these proposals were rejected as undesirable in connection with Road 3327, as both envisage Road 3327 as a very minor road.

Consequently other more dramatic changes to the current planning were considered, namely:

1. To align Road 3327 along [illegible] to the [illegible] alignment. This alignment incorporates a [illegible] radius curve into Valley Road. This radius is acceptable, as the speed on Road 3327 will be restricted to [illegible] km/h. Sight distance in excess of [illegible] is obtainable. Service Road [illegible], therefore, be configured and extended to give access to [illegible] on Valley Road.

These proposals are shown in Fig. [illegible]. They are geometrically acceptable and are in accordance with present standards. However, there are objections from both traffic and financial aspects. The deviation of Road 3327 [illegible] increases travel time and distance, giving bad travel direction for traffic entering [illegible] from Road 3327 [illegible]. The biggest objection to the route is, however, cost. It is estimated that, at today's construction costs, the cost would be in the order of [illegible].

Both the Roads Dept. officials and members could find no justification for this large expenditure.

2. A further investigation into the provision of a partial, or fully, diamond interchange over the [illegible] at [illegible]. This is shown in Fig. [illegible]. At this point [illegible] is in a cut of [illegible], which will reduce construction costs. However, as these would still be in the order of [illegible] even a partial diamond interchange based on [illegible] was rejected.

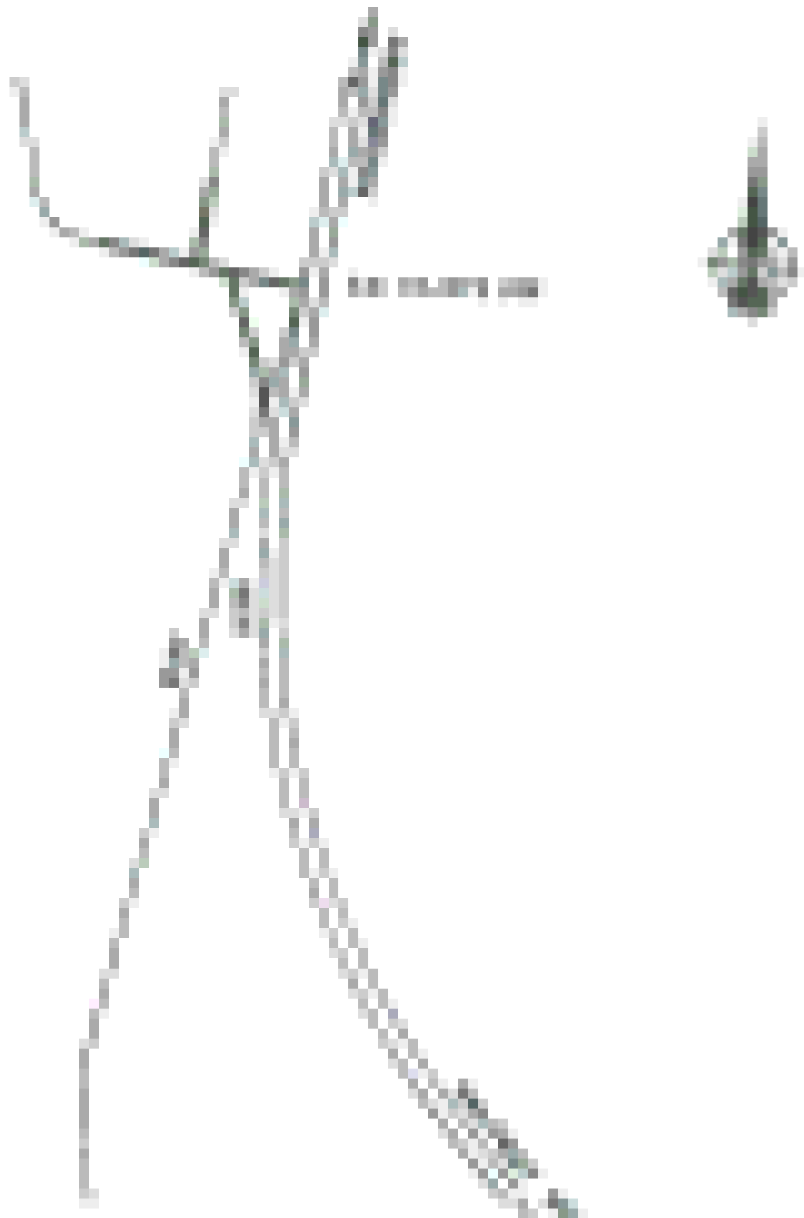


FIG. 8

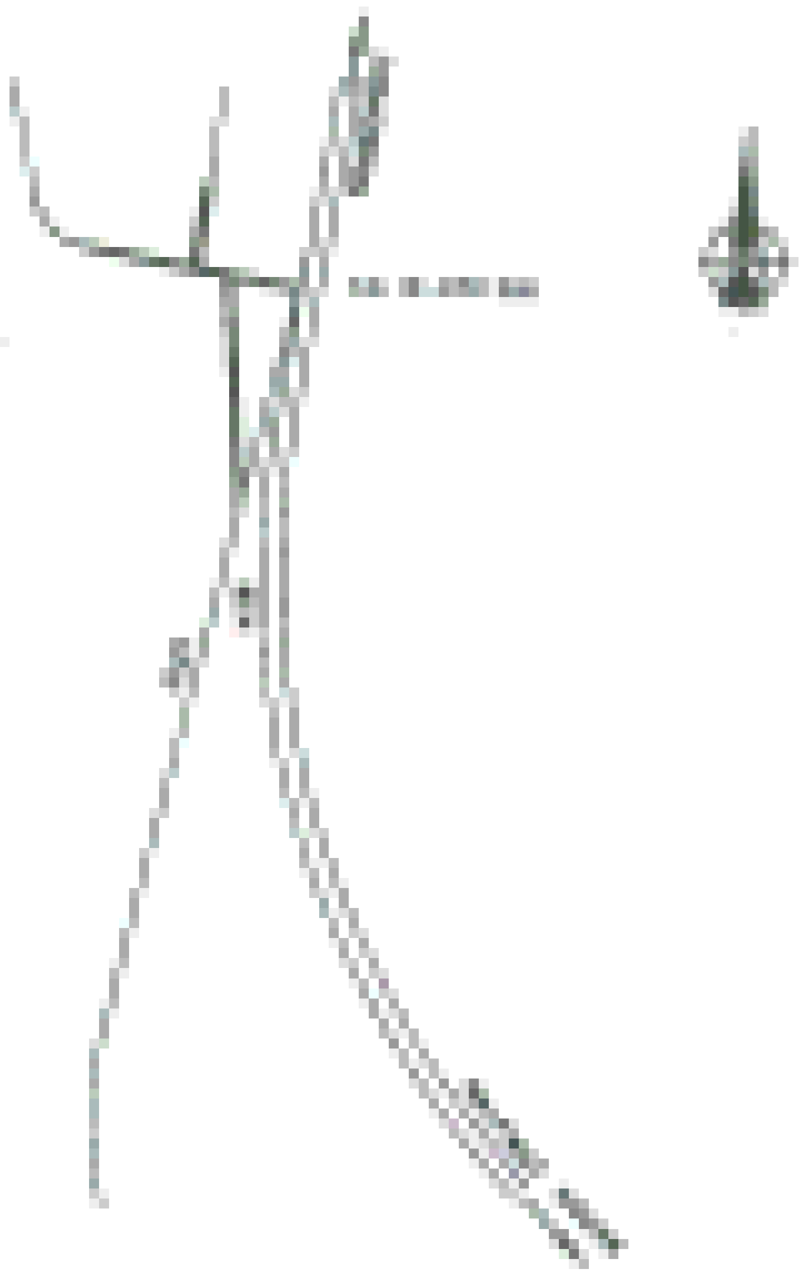


FIG.9

FIG. 10

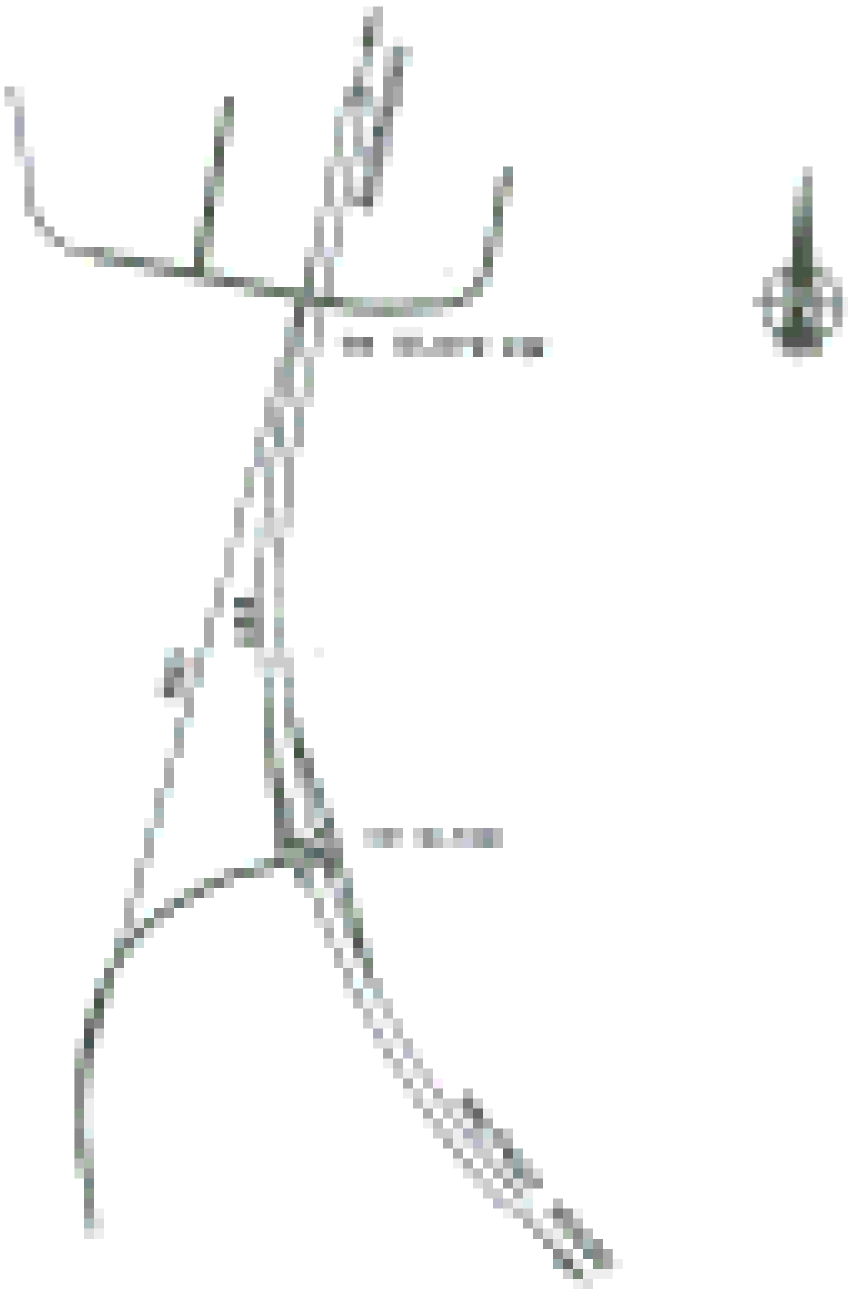


FIG. 11

5. One [illegible] solution [illegible] developed was to bring Road 1027 to intersect with R56 at km. [illegible].

Road 1027 can be realigned to deviate from the existing alignment on a curve of radius [illegible] and a gradient of [illegible] for the first [illegible], thereafter descending to the R56 on a gradient of [illegible], with the final [illegible] to the intersection with [illegible] on a grade of [illegible].

At the intersection the realigned Road 1027 would [illegible]. See fig. [illegible].

All the geometric design elements of the realigned Road 1027 are acceptable. However, the design elements of the intersection are outside the guidelines specified by the Department with respect to [illegible] of the major road and the K value of the vertical curve at the intersection with R56.

In assessing the acceptability of this solution the following issues were taken into account:

i) The primary function of the criteria specified by the Department is to ensure the safety and comfort of the road user and really to protect them from making poor decisions when operating on the road facility. The road facility is designed for various operating conditions, one of those primary conditions being to provide adequate and safe sight distances so that an operator can make the necessary judgements to avoid a conflict in normal circumstances.

That means basically that an operator [illegible] sight distance to be aware of an unusual happening and then give him sufficient reaction and operating time to take evasive action. The [illegible] of which would be the stopping of the vehicle in a controlled manner.

ii) It is considered that the traffic stream in these circumstances should be considered namely:

(a) traffic from the south [illegible] R56 to the intersection [illegible]

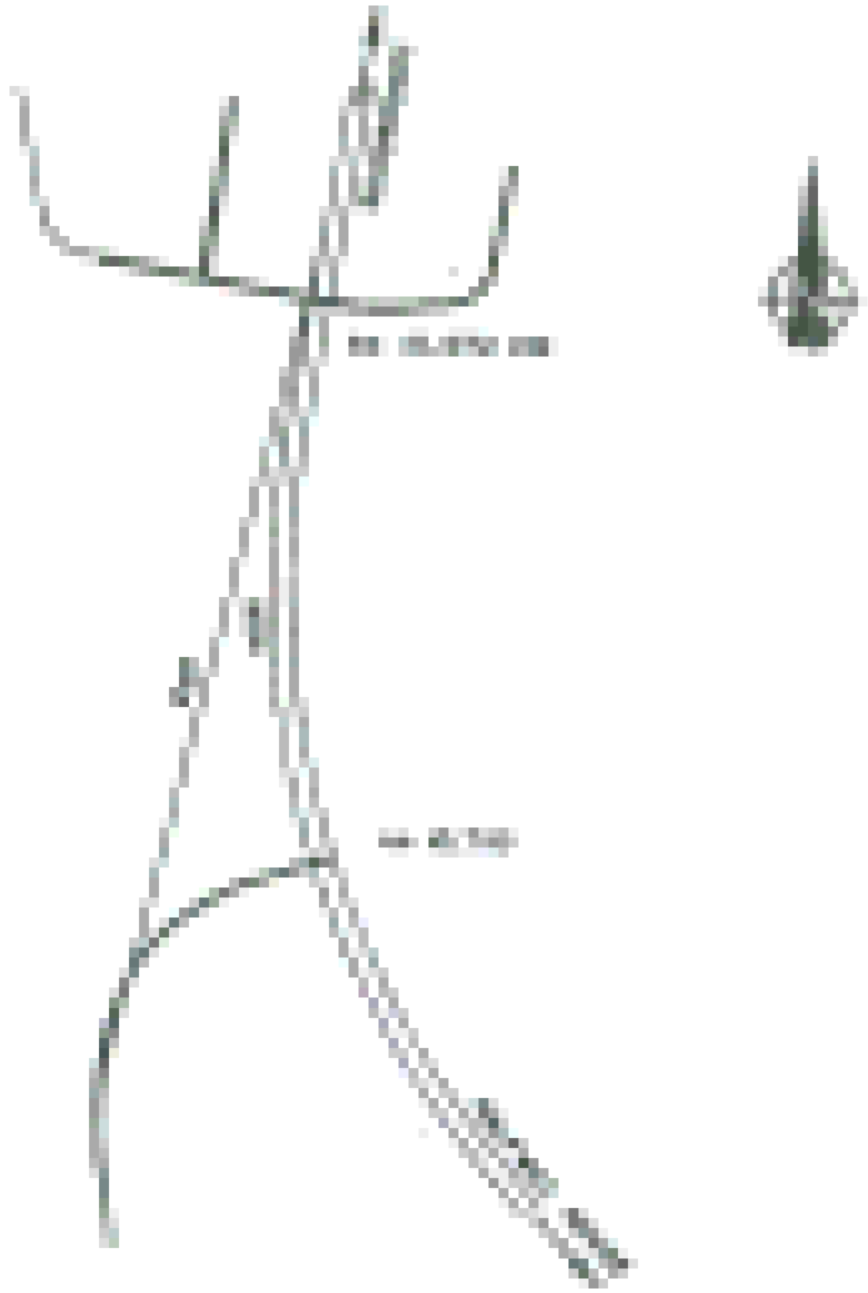


FIG. 12

(ii) traffic from Road 1027 weaving for [illegible] with (left) turn into R[illegible].

In both these operations there is no crossing of the travel lanes of R24 and thus bare of [illegible] signs and other [illegible] or [illegible] will suffice to take the traffic from on to R24. Sight distance is not a dominant factor as traffic lanes and enter the freeway [illegible] and travelling at the operating speed on the freeway.

The other two circumstances are more problematical:

(iii) traffic travelling from the south on R24 wishing to enter Road 1027 (right-turn off R24);

(iv) traffic from Road 1027 wishing to travel south on R24 (right-turn onto R24).

In the third instance of traffic from the south wishing to turn into Road 1027, the traffic can be taken off R24 [illegible] with a filter taper or a right-decelerating lane. At the time of detailed design traffic [illegible] whether any stacking distance is required [illegible]. The turning traffic will then be stationary at the time of wishing to turn into Road 1027. The turning lane is located in the middle of a curve of [illegible] with a K value of [illegible].

The safe stopping sight distance for vehicles travelling at [illegible] design speed [illegible] measured from an eye height of 1,05m to an object height of 0,15m. However, when one considers an eye height of 1,05 and an object height of 1,3, the sight distance over the vertical curve is [illegible]. The [illegible] minimum sight distance is [illegible]. However, [illegible] a vehicle travelling in the opposite direction [illegible] vehicle when it is [illegible] away. It is generally accepted that [illegible] seconds reaction time is required by the stopped motorist in deciding whether it will be safe to [illegible]. Further, it is generally accepted that a gap acceptance time of [illegible] seconds is required by the stopped motorist. During this time the approaching

[illegible]

[illegible]

Finally, it is anticipated that at the time of construction of [illegible] and the diversion of Road 2027 to the intersection, suitable warrants for signalisation of the intersection will exist.

With signalisation the intersection will definitely meet all current road traffic safety and traffic operation conditions.

This solution is very definitely suitable and consequently full geometric road design was undertaken.

4.2.[illegible] Developments by [illegible] Holdings

Discussions with all affected landowners were initiated in late December 199[illegible] and January 199[illegible].

Despite several meetings with the Town Planners and Traffic Engineers appointed by [illegible] access to Holding [illegible], no solution was obtained until early April 199[illegible], when we were advised that [illegible] Holdings were planning the development of Holdings [illegible]. At this time [illegible] Road 2027 [illegible] traffic figures in terms of [illegible] from their development.

[illegible] Road 1027 [illegible] Portion 35 [illegible]

[illegible] Road 1027 [illegible]

[illegible] CONCLUSIONS AND RECOMMENDATIONS

[illegible] Road 1027 [illegible]

[illegible]

[illegible]

[illegible] Road 1027 [illegible]

[illegible] Road 1027 [illegible]

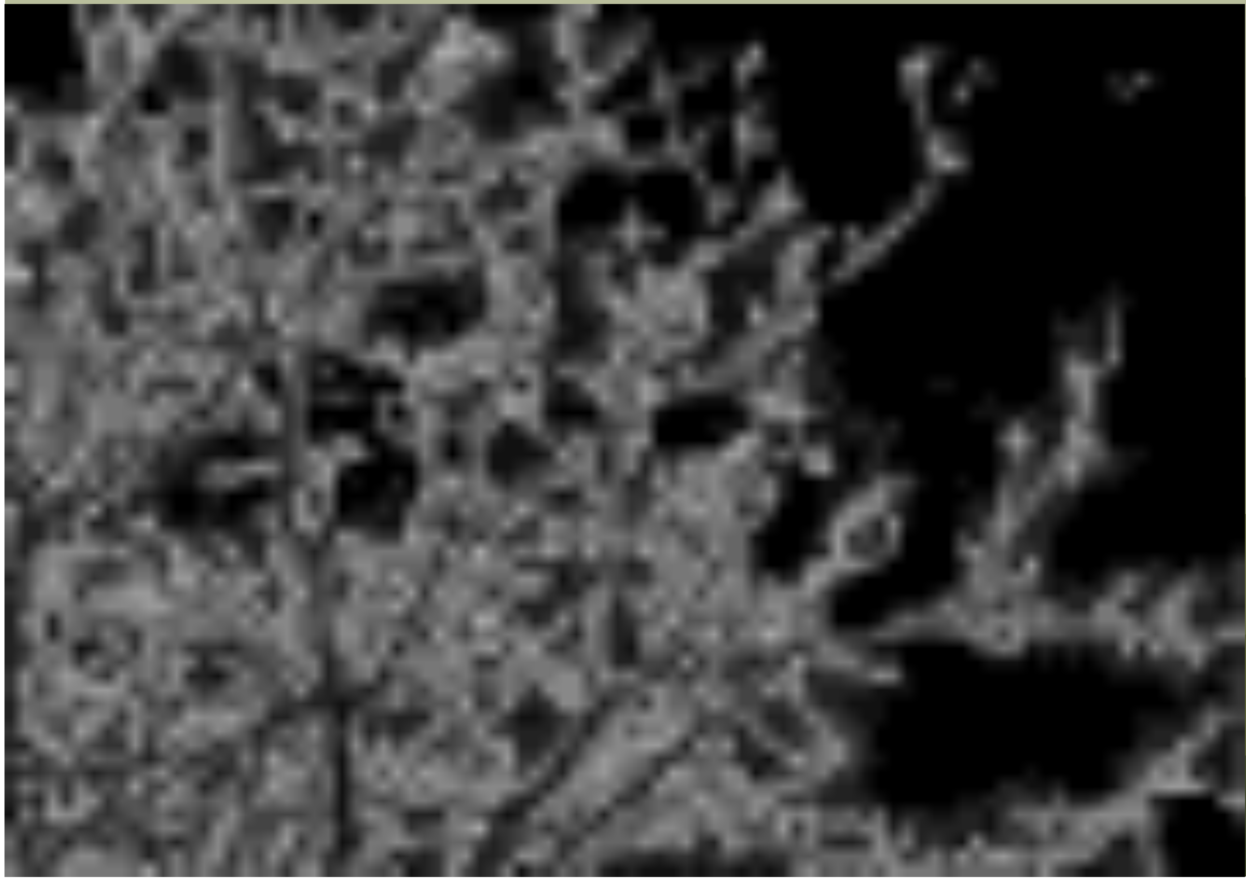
Annexure D

COPY OF CV OF LIZELLE GREGORY FROM BOKAMOSO LANDSCAPE ARCHITECTS AND ENVIRONMENTAL CONSULTANTS

Bokamoso

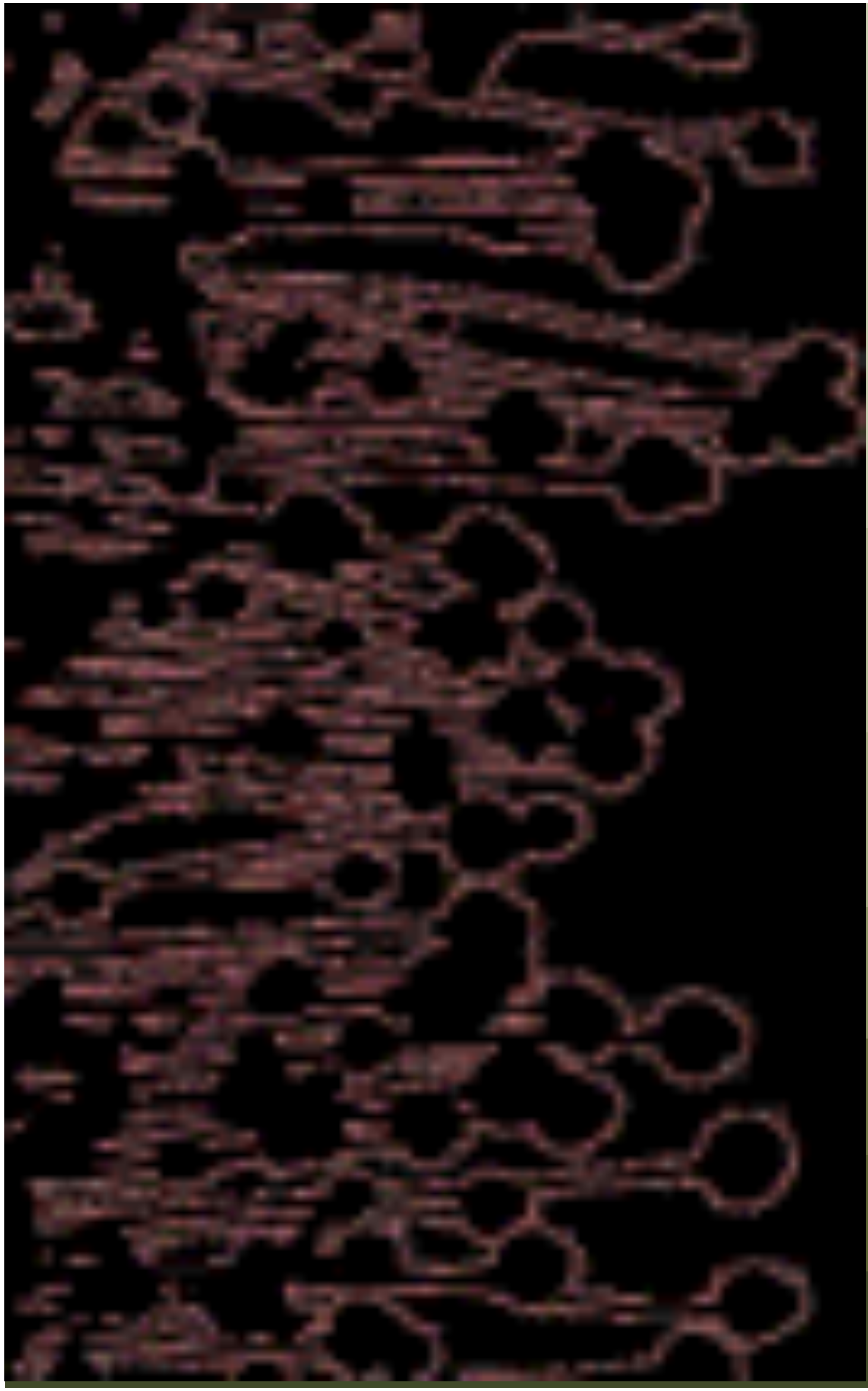
Bokamoso specialises in the fields of Landscape Architecture and all aspects of Environmental Management and Planning. Bokamoso was founded in 1992 and has shown growth by continually meeting the needs of our clients. Our area of expertise stretches throughout the whole of South Africa. Our projects reflect the competence of our well compiled team. The diversity of our members enables us to tend to a variety of needs. Our integrated approach establishes a basis for outstanding quality. We are well known to clients in the private, commercial as well as governmental sector.

At Bokamoso we stand on a firm basis of environmental investigation in order to find unique solutions to the requirements of our clients and add value to their operations.



01 Executive Summary

011 Company Overview



02 Vision, Mission & Values

Vision:

At Bokamoso we strive to find the best planning solutions by taking into account the functions of a healthy ecosystem. Man and nature should be in balance with each other.

Mission:

We design according to our ethical responsibility, take responsibility for successful completion of projects and constitute a landscape that contributes to a sustainable environment. We add value to the operations of our clients and build long term relationships that are mutually beneficial.

Values:

Integrity

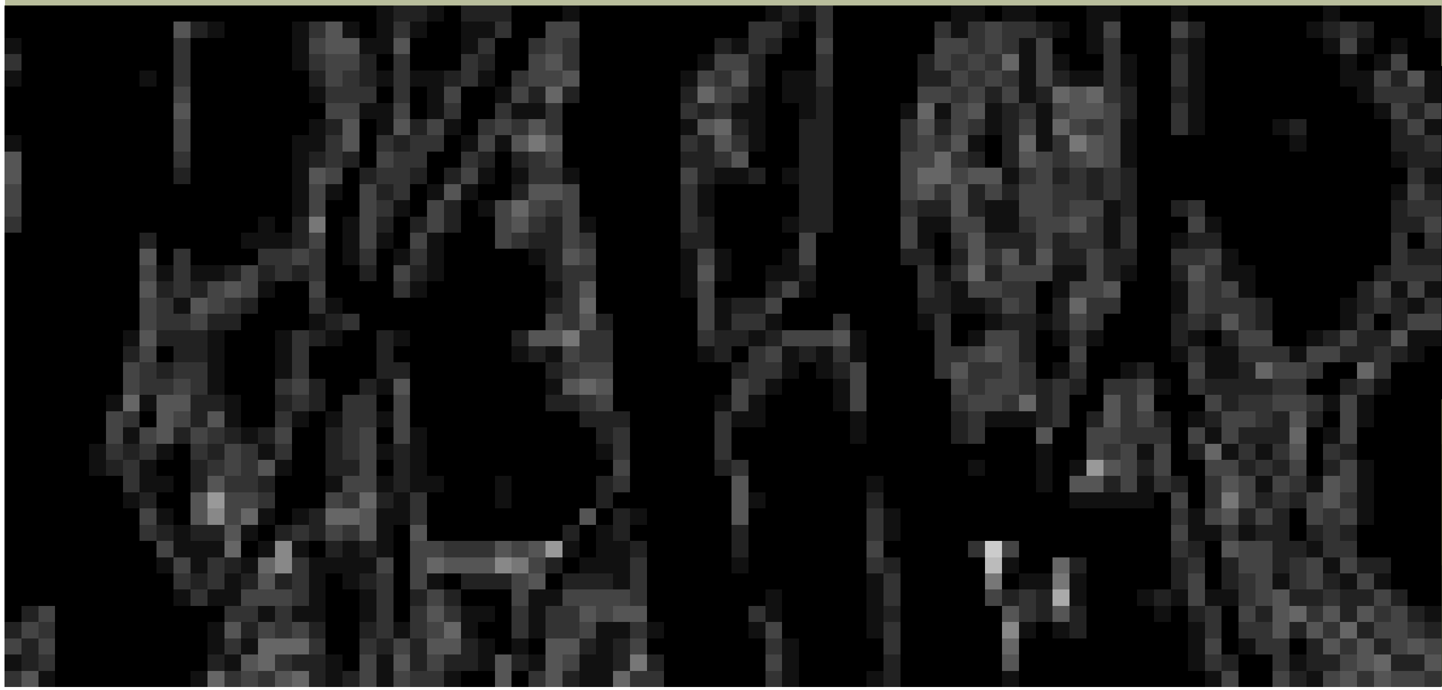
Respect

Bokamoso stands on the basis of fairness. This include respect within our multicultural team and equal opportunities in terms of gender, nationality and race.

We have a wide variety of projects to tend to, from complicated reports to landscape installation. This wide range of projects enables us to combine a variety of professionals and skilled employees in our team.

Bokamoso further aids in the development of proficiency within the working environment. Each project, whether in need of skilled or unskilled tasks has its own variety of facets to bring to the table.

We are currently in the process of receiving our BEE scorecard. We support transformation in all areas of our company dynamics.



03 Human Resources

031 Employment Equity

Lizelle Gregory (100% interest)

Lizelle Gregory obtained a degree in Landscape Architecture from the University of Pretoria in 1992 and passed her board exam in 1995.
Her professional practice number is PrLArch 97078.

Ms. Gregory has been a member of both the Institute for Landscape Architecture in South Africa (ILASA) and South African Council for the Landscape Architecture Profession (SACLAP), since 1995.

Although the existing Environmental Legislation doesn't yet stipulate the academic requirements of an Environmental Assessment Practitioner (EAP), it is recommended that the Environmental Consultant be registered at the International Association of Impact Assessments (IAIA). Ms. Gregory has been registered as a member of IAIA in 2007.

Ms. Gregory attended and passed an International Environmental Auditing course in 2008.
She is a registered member of the International Environmental Management and Assessment Council (IEMA).

She has lectured at the Tshwane University of Technology (TUT) and the University of Pretoria (UP). The lecturing included fields of Landscape Architecture and Environmental Managemen

Ms. Gregory has more than 20 years experience in the compilation of Environmen
Reports:
Environmental Management Plans (EMP);
Strategic Environmental Assessments;
All stages of Environmental input ;
EIA under ECA and the new and amended NEMA regulations and various other
reports and documents.

Ms. Gregory has compiled and submitted more than 600 Impact Assessments within the last 5-6 years. Furthermore, Ms. L. Gregory is also familiar with all the GDARD/Provincial Environmental policies and guidelines. She assisted and supplied GAUTRANS/former PWV Consortium with Environmental input and reports regarding road network plans, road determinations, preliminary and detailed designs for the past 12 years.

Consulting

Anè Agenbacht

Introduction to Sustainable Environmental Management—An overview of Principles, Tools,& Issues (Potch 2006)
Leadership Training School (Lewende Woord 2010)
BA Environmental Management (UNISA 2011)
PGCE Education (Unisa 2013) - CUM LAUDE
Project Manager
More than 10 years experience in the compilation of various environmental reports

Mary-Lee Van Zyl

Msc. Plant Science (UP)
BSc (Hons) Plant Science (UP)
BSc Ecology (UP)
2years 7months working experience in the Environmental field
Specialises in ECO works, Basic Assessments, EIA's, and Flora Reports
Compilation of various Environmental Reports

Dashentha Naidoo

BA Honours Degree in Environmental Management (UNISA) - CUM LAUDE
Bachelor Social Science in Geography & Environmental Management (UKZN)
More than 4 years experience in WUL Application& Integrated Enviro
within water resource management.
Senior Environmental Practitioner & Water Use Licences Consu
Specialises in Water Use License & Compilation of various Env

Ben Bhukwana

BSc Landscape Architecture (UP)
More than 5 years experience in the field of Landscape Archite
Construction, and Implementation).
Specialises in Landscape Design, ECO, Rehabilitation Plans and
Compilation Basic Assessment Reports
Compilation of Tender documents

Anton Nel

B-Tech Landscape Technology (TUT)
N Dip Landscape Technology (TUT)
Hazardous Waste Management Short Course
2 years experience in ECO.
Specialises in Basic Assessment Reports.

Juanita de Beer

Diploma Events Management and Marketing (Damelin)
Specializes in Public relations and Public Participation Processes (3 years experience)

Alfred Thomas

CIW Foundation& Internet Marketing (IT Academy)
12 years experience in GIS and IT in general.
GIS Operator and Multimedia Specialist.

Bianca Reyneke

Applying SHE Principles and Procedures (NOSA)
Intro to SAMTRAC Course (NOSA)
SHEQ Coordinator and compilation of environmental rep
Specialises in compiling various environmental reports

Elsa Viviers — **Interior Decorating (Centurion College)**
(Accounting/ Receptionist) and Secretary to Lizelle Gregory

Loura du Toit — **N. Dip. Professional Teacher (Heidelberg Teachers Training College)**
Librarian and PA to Project Manager

Merriam Mogalaki — Administration Assistant with in-house training in bookkeeping

Landscape Contracting

Elias Maloka — Site manager overseeing landscape installations.
Irrigation design and implementation.
Landscape maintenance
18 years experience in landscape contracting works.

The contracting section compromises of six permanently employed black male workers. In man
of up to 12 workers, depending on the quantity of work.

01

l Management Services

c Assessment Reports
& Scoping Reports
ronmental Management Plans
ronmental Scans
egic Environmental Assessments
for Mines
ronmental Input and Evaluation of
ial Development Frameworks
e of Environmental Reports
pilation of Environmental Legislation
a Policy Documents
ronmental Auditing and Monitoring
ronmental Control Officer (ECO)
al Impact assessments
ialist Assistance with Environmental
slation Issues and Appeals
lopment Process Management
r Use License applications to DWA
e License Application

04 Services

041 Consulting Services

02 Landscape Architecture

- Master Planning
- Sketch Plans
- Planting Plans
- Working Drawings
- Furniture Design
- Detail Design
- Landscape Development Frameworks
- Landscape Development Plans (LDP)
- Contract and Tender Documentation
- Landscape Rehabilitation Works

03 Landscape Contracting

Implementation of Plans for:

- Office Parks
- Commercial/ Retail / Recreational Development
- Residential Complexes
- Private Residential Gardens
- Implementation of irrigation systems

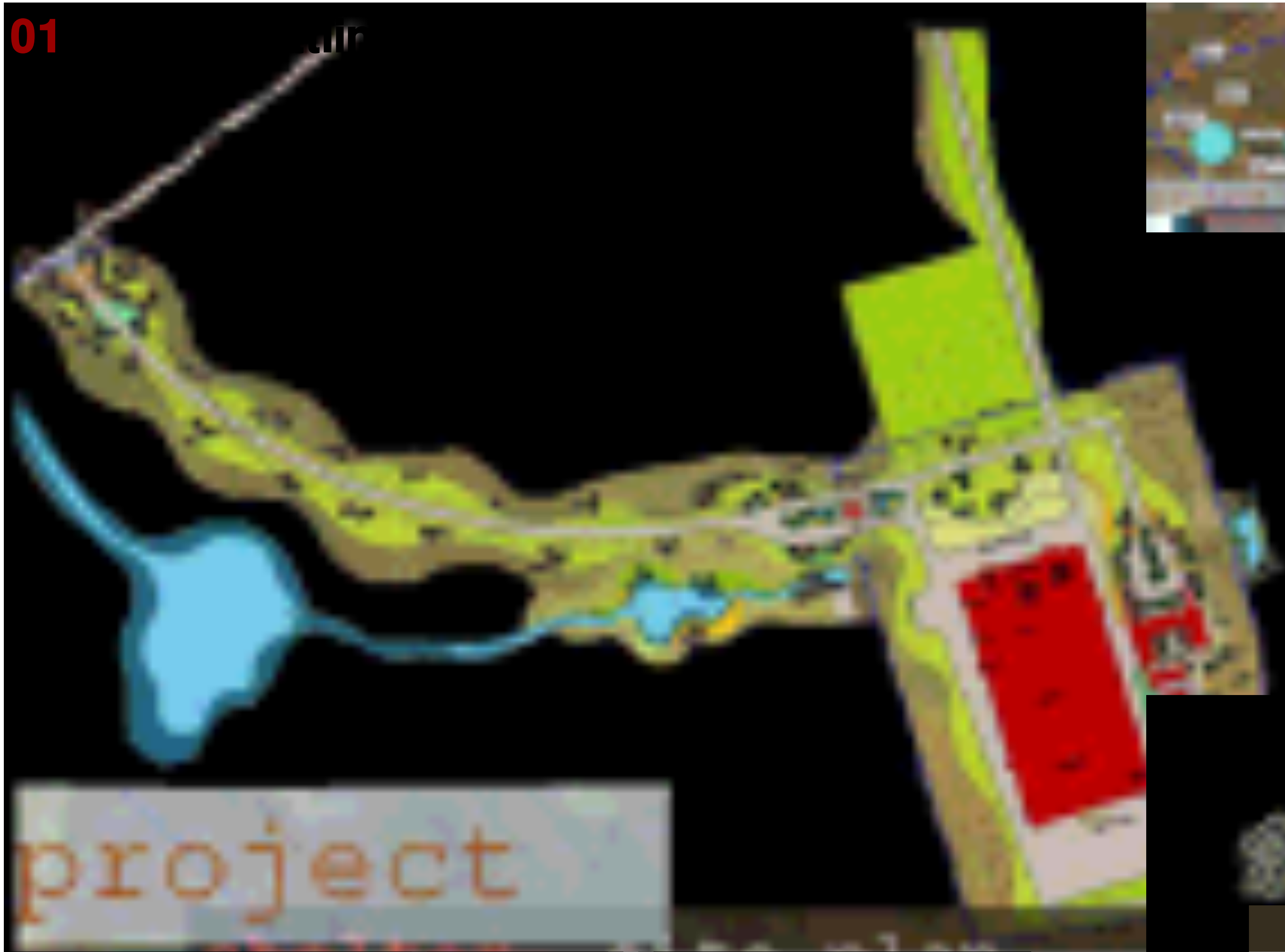
042

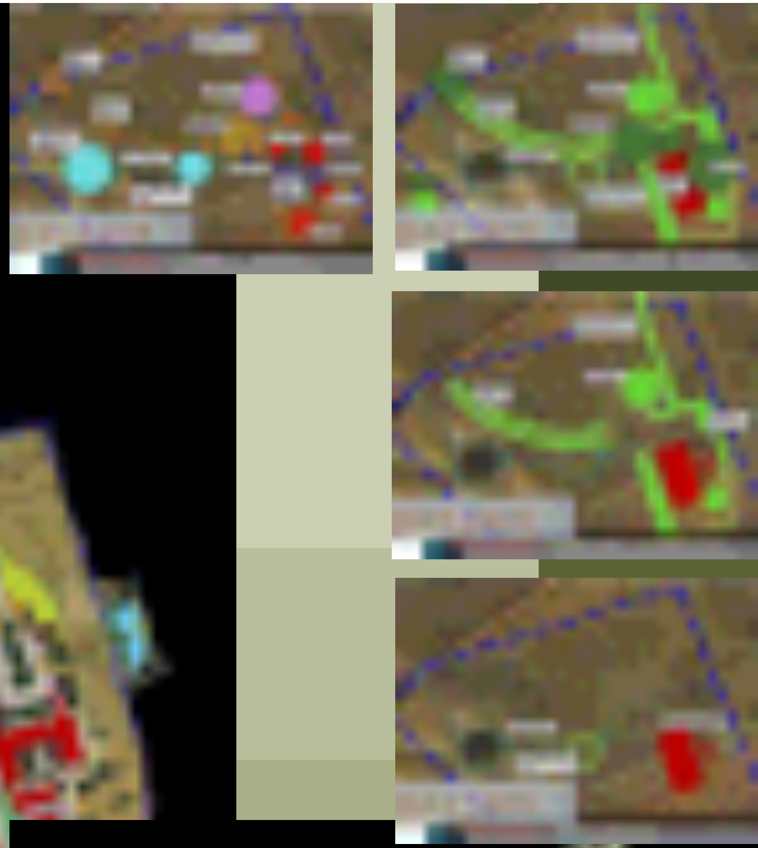
04 Services

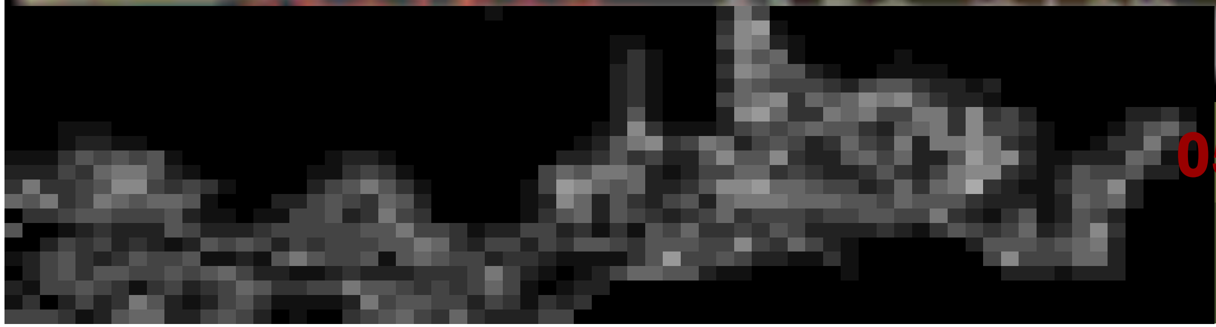
g Services


LIMPOPO
NORTH WEST
FREE STATE
KWAZULU-
NATAL
CAPE
EASTERN CAPE

01



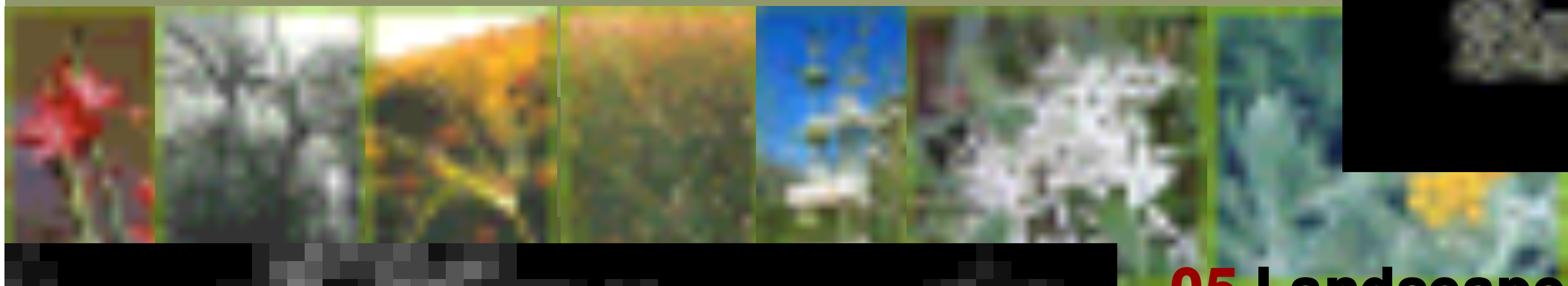


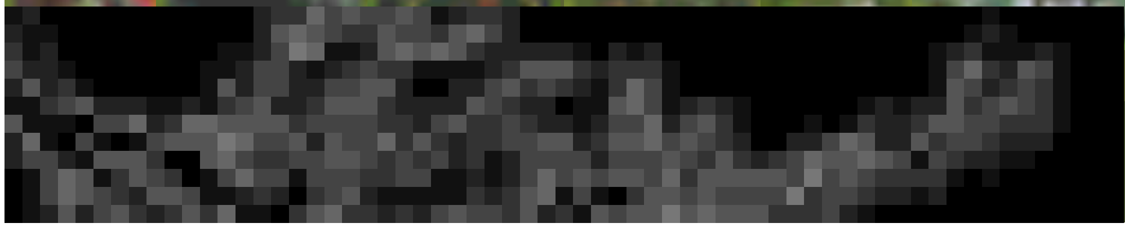


05 Landscape Projects– Current

051 Commercial

01 Valpre Bottling Plant, Heidelberg

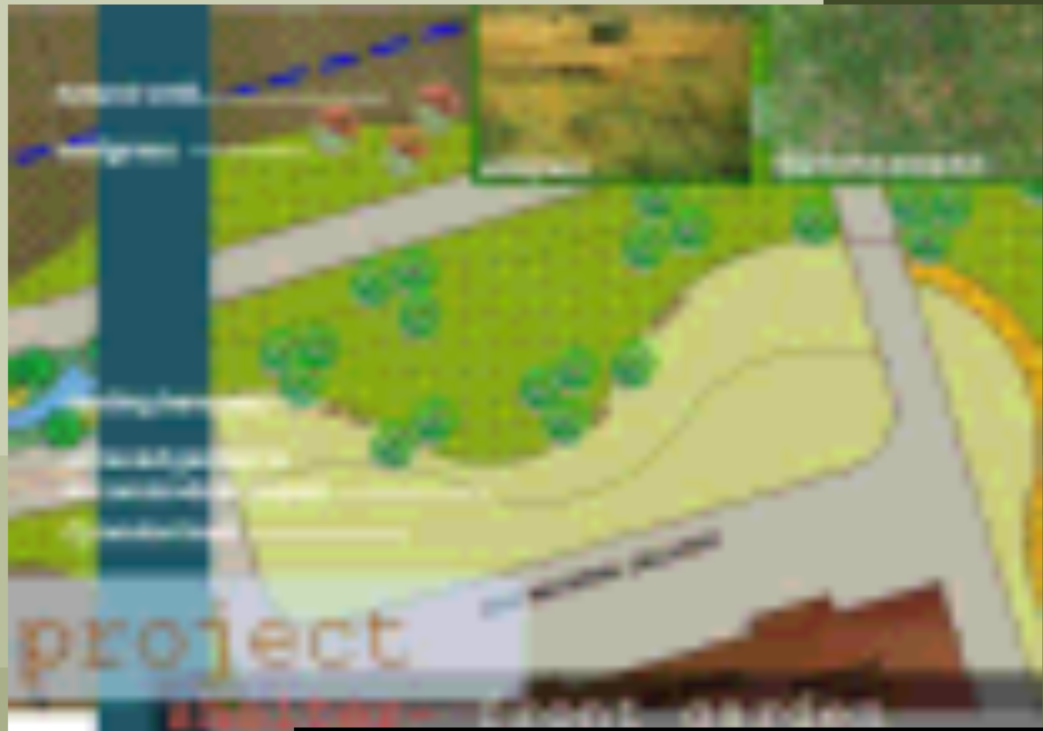


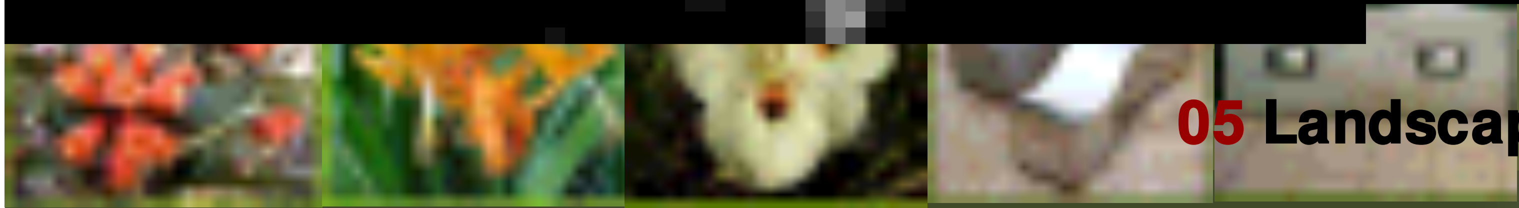


05 Landscape Projects– Current

051 Commercial

01 Valpre Bottling Plant, Heidelberg

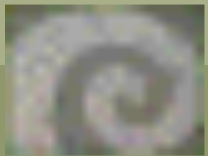


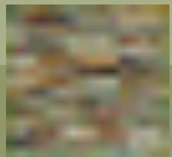


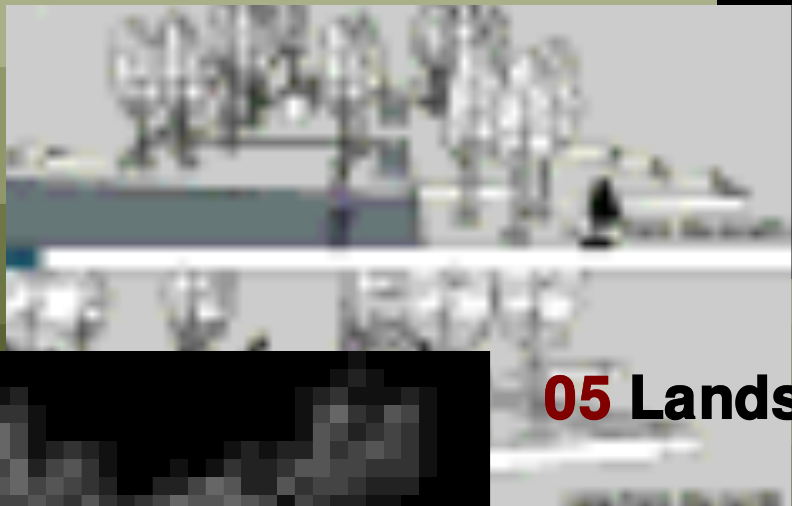
05 Landscape Projects– Current

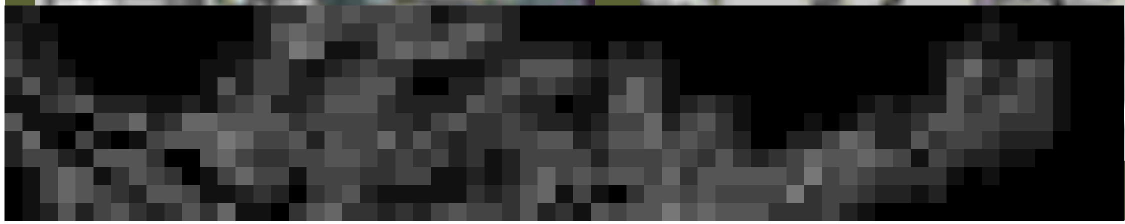
051 Commercial

01 Valpre Bottling Plant, Heidelberg





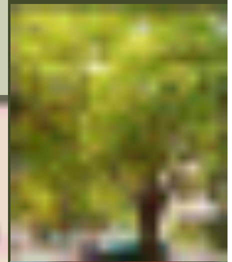


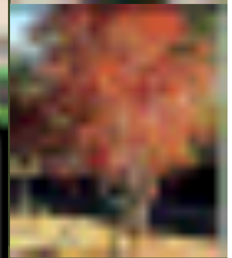


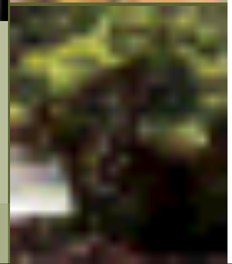
05 Landscape Projects– Current

051 Commercial

02 Melodie Waters, Hartebeespoortdam







Spatial Planning

Streetscape

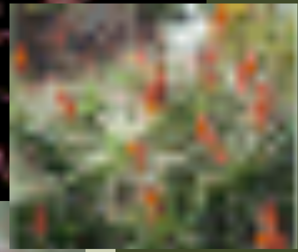
Indigenous

05 Landscape Projects – Current

052 Commercial/Recreational

02 Melodie waters, Hartebeestpoortdam

Development Framework



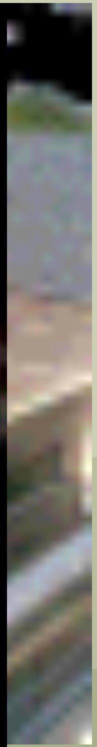
Rehabilitation

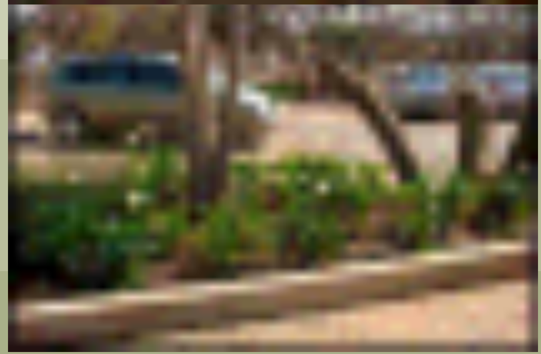
Area Layout

05 Landscape Projects– Current

052 Commercial/Recreational

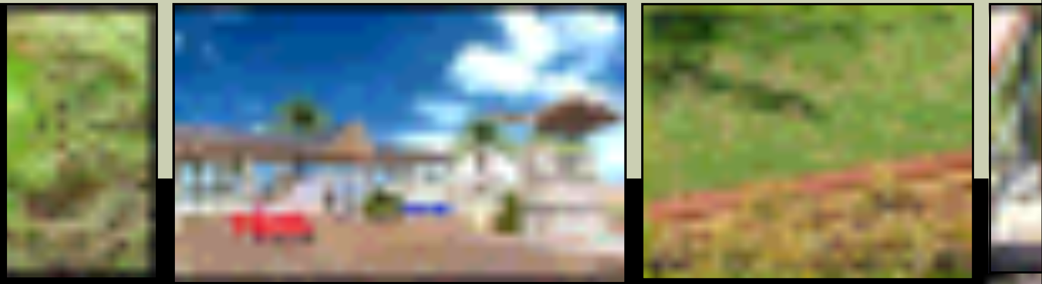
03 Grain Building, Pretoria





04 Ismail Dawson offices, Pretoria

05 Celtic Manor, Pretoria



05

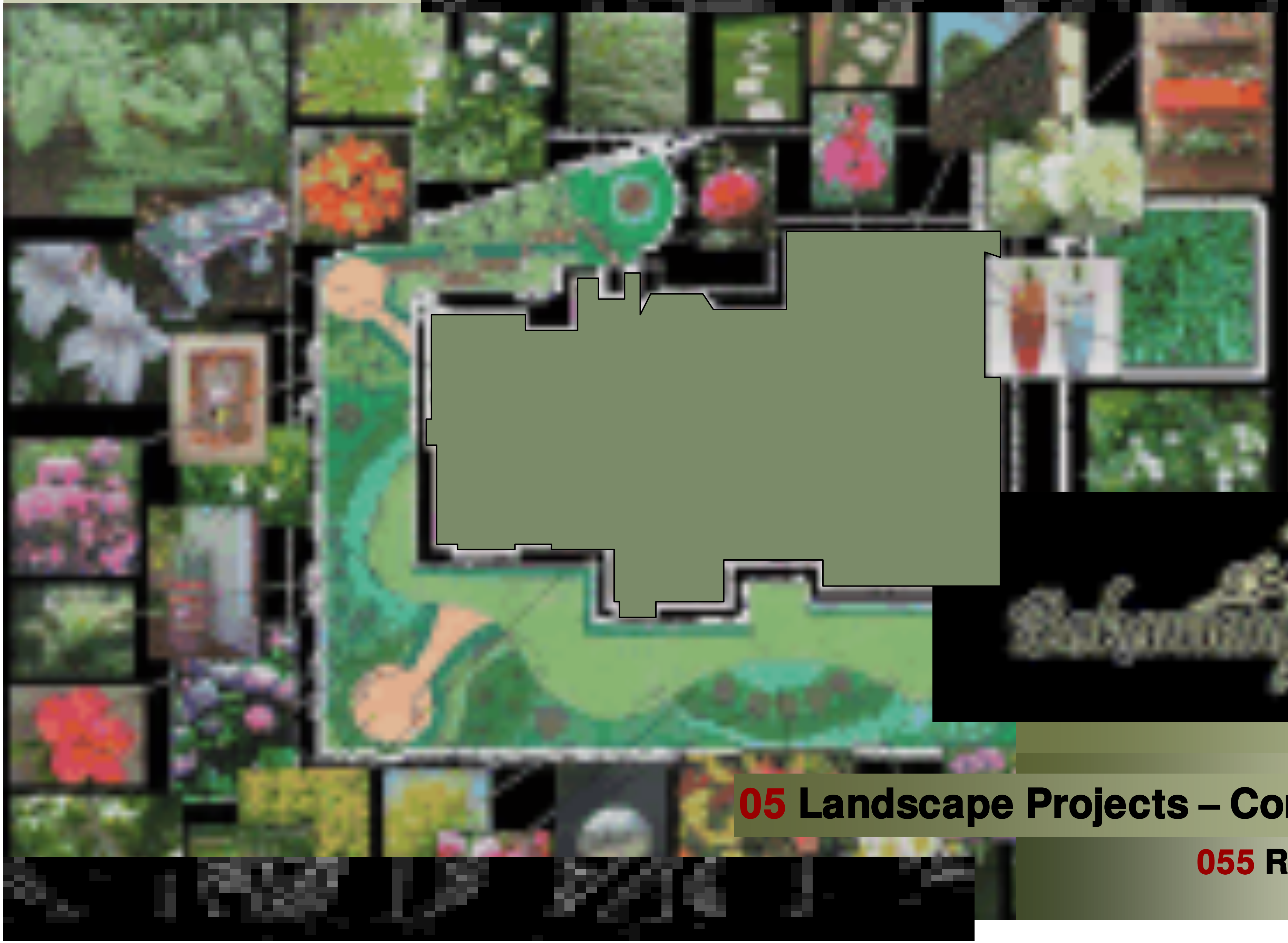
054

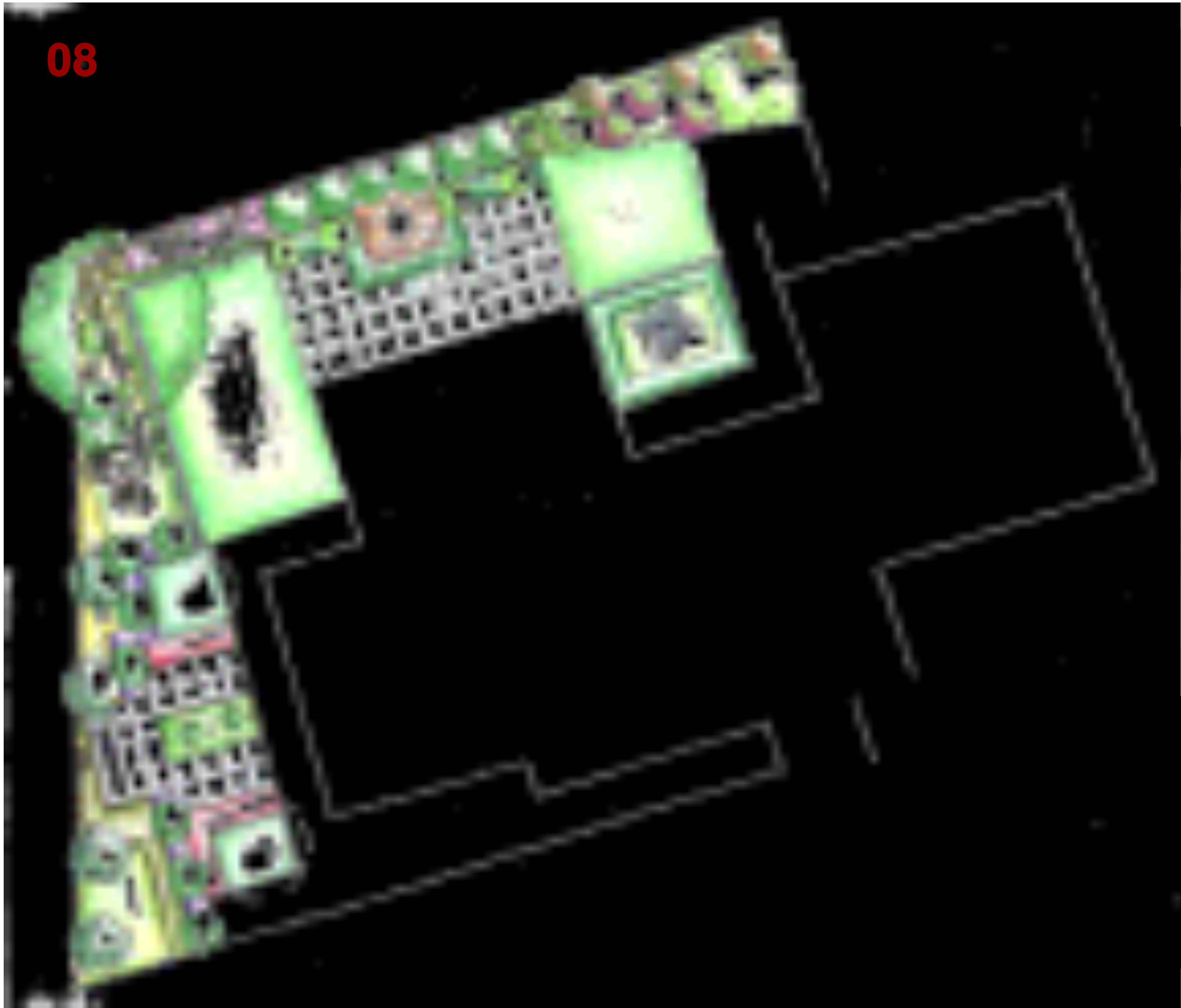
pleted

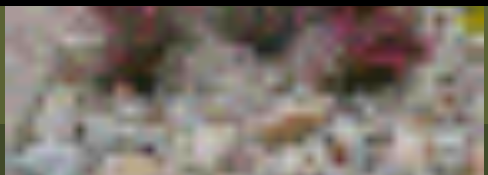
opment

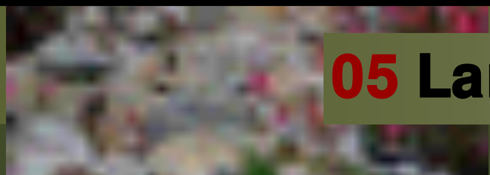
06 The Wilds, Pretoria

07 The Wilds, Pretoria





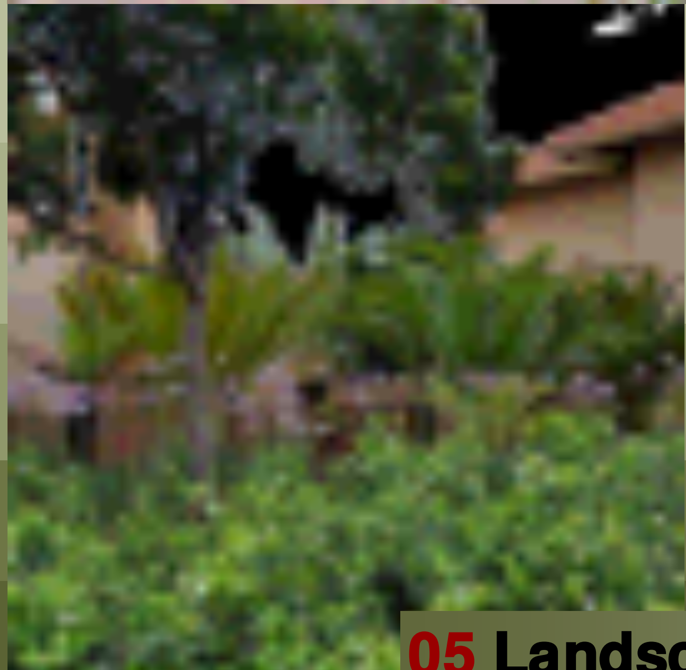




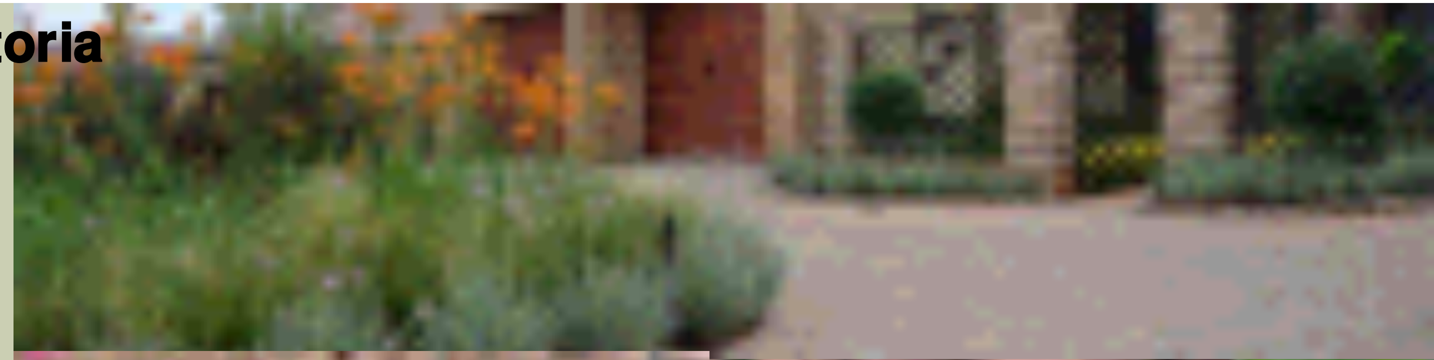
05 Landscape Projects – Completed

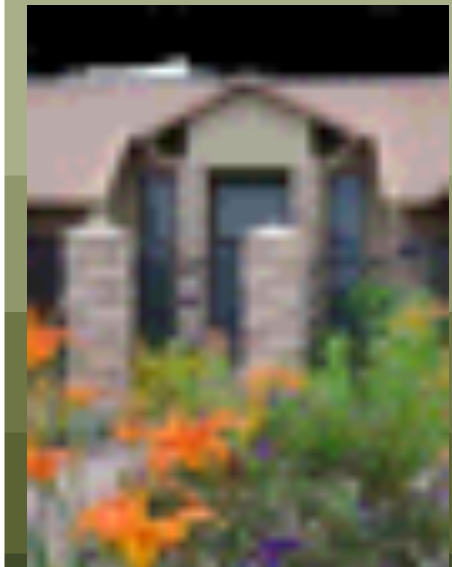
055 Residential

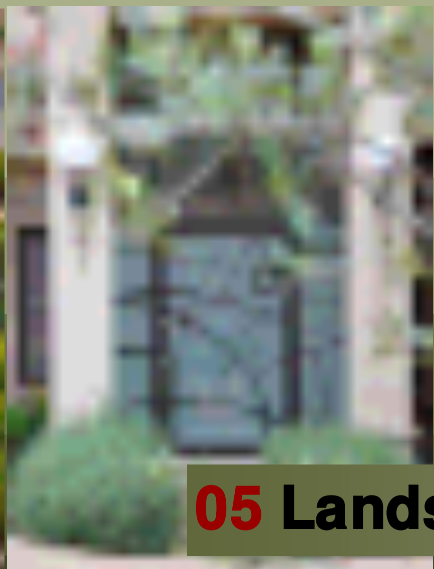
09 The Wilds, Pretoria



010 The Wilds, Pretoria







05 Landscape Projects – Completed

055 Residential

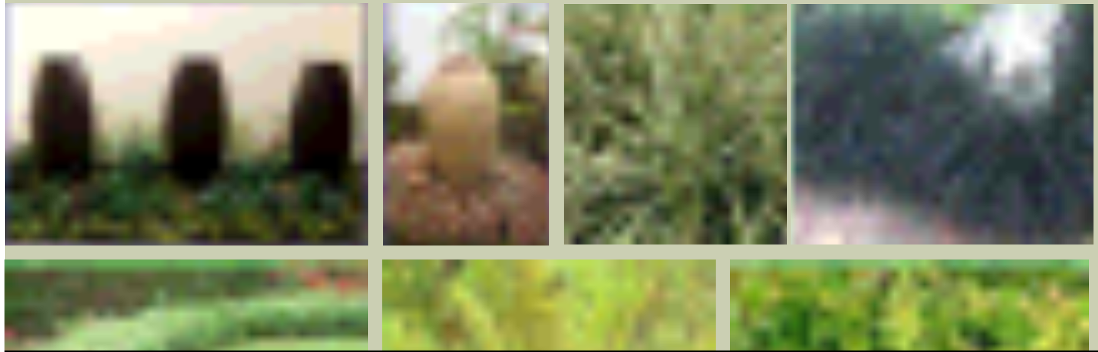
011 Governor of Reserve Bank's Residence, Pretoria

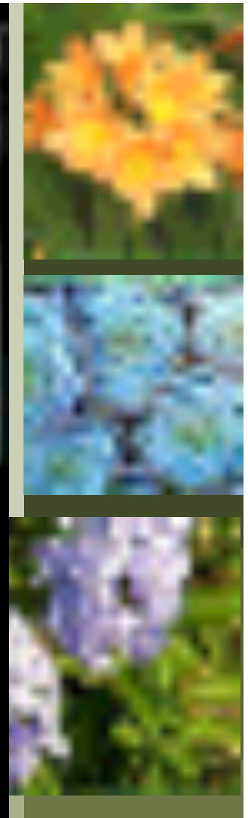
Plant Palette

Option 1

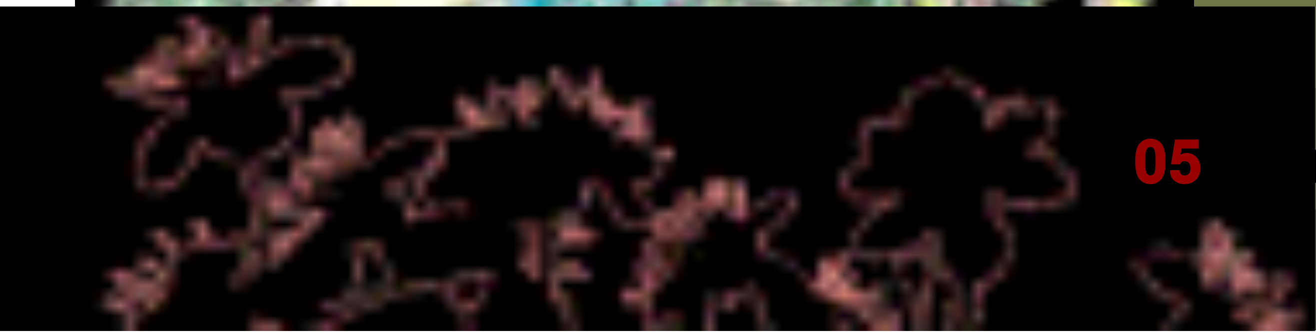
Option 2

012 House Ismail, Pretoria

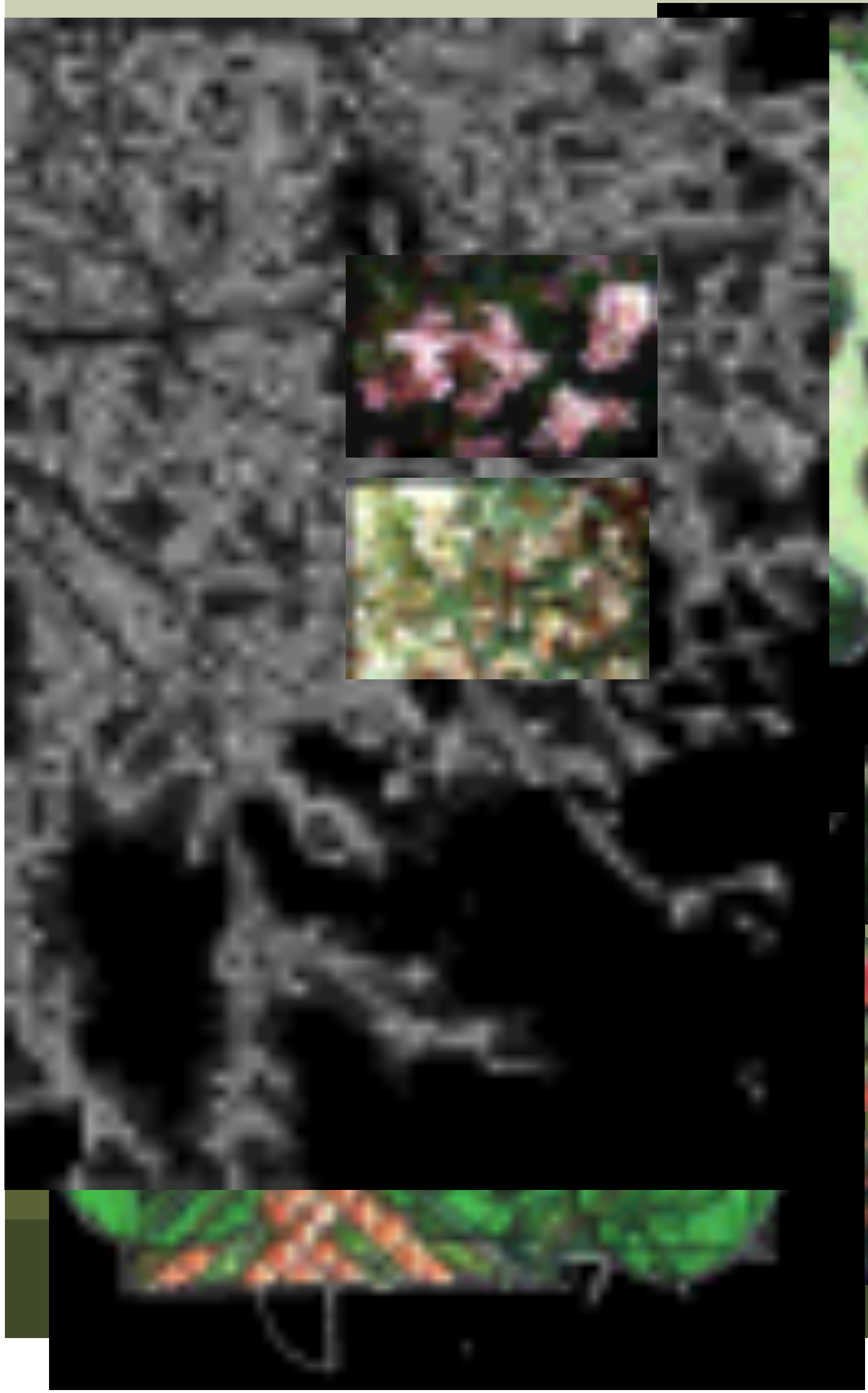


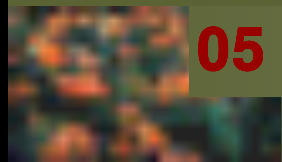


Back Gard

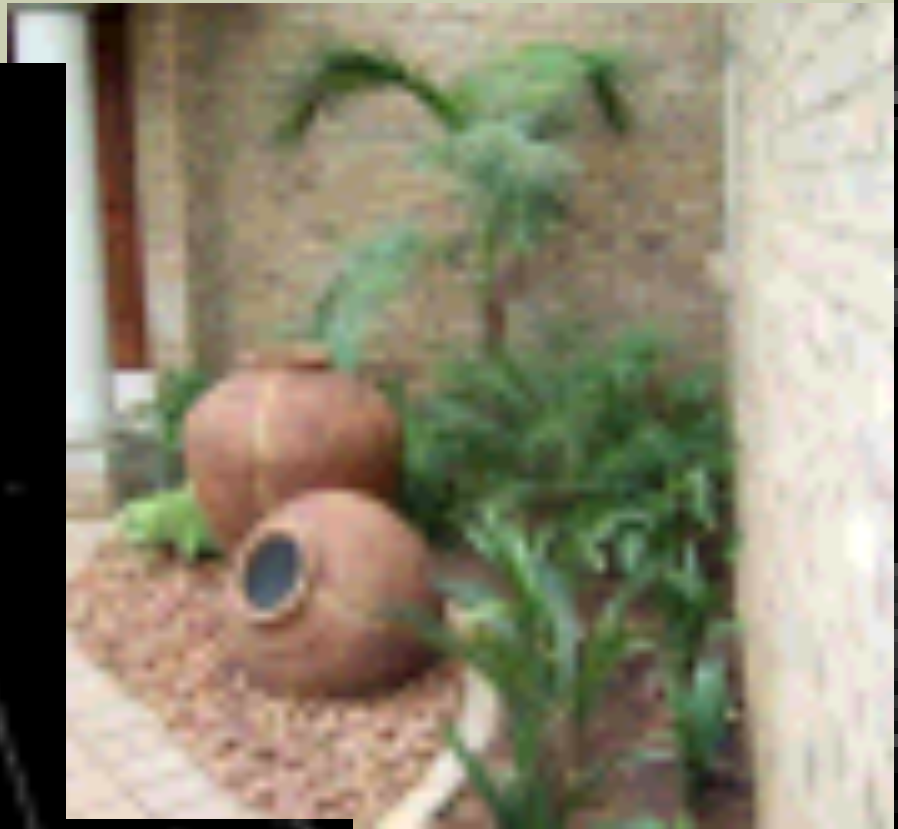


013 Forest Garden, Pretoria





015 Forest Garden, Pretoria



05 Landscape Projects - Completed

055 Residential

01 Safari Garden Expo

Received a Silver Certificate at the Safari Garden

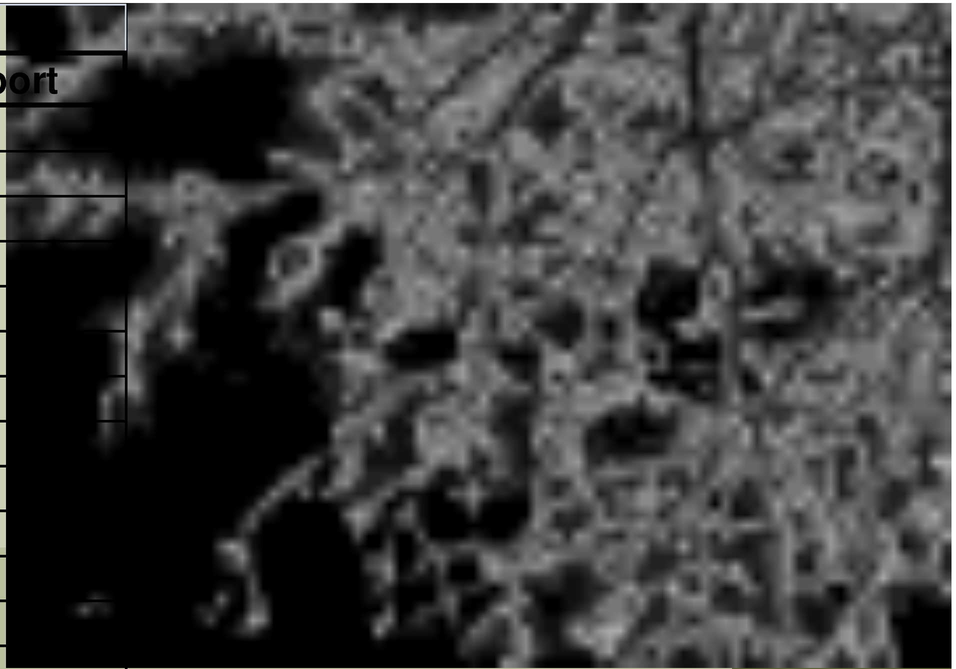
02 UNISA Sunnyside Campus, Pretoria

Best Commercial Paving Plan in Gauteng, 1997

07 Current Environmental Projects

071 EIA, Scoping& Opinion

Project Name	Status	Project
Environmental Impact Assessment(EIA) and Scoping Report		
Junction 21	ROD	EIA
5 O'clock site access	In Progress	EIA
Bokamoso X 1	In Progress	Scoping & EIA
Doornvallei Phase 6 & 7	In Progress	EIA
Engen Interchange	In Progress	Scoping & EIA
Erasmia X15	In Progress	EIA
Franschkloof	In Progress	EIA
K113	Amendment of ROD	EIA
K220 East	ROD	EIA
K220 West	ROD	EIA
K54 ROD conditions	In Progress	EIA
Knopjeslaagte 95/Peachtree	ROD	EIA
Knopjeslaagte portion 20 & 21	ROD	EIA
Lillieslief/Nooitgedacht	In Progress	EIA
Mooiplaats 70 (Sutherland)	In Progress	EIA
Naauwpoort 1 - 12/Valley View	In Progress	EIA
PeachTree X5	In Progress	EIA
Strydfontein 60	In Progress	EIA
Thabe Motswere	In Progress	Scoping & EIA
Vlakplaats	In Progress	EIA
Waterval Valley	In Progress	EIA
Environmental Opinion		
Doornkloof 68 (Ross)	In Progress	Opinion
Monavoni X 53	In Progress	BA & Opinion
Mooikloof (USN)	In Progress	Opinion
Norwood Mall/Sandspruit	In Progress	Opinion
Riversong X 9	In Progress	Opinion
Sud Chemie	In Progress	Opinion
USN Benjoh Fishing Resort	In Progress	Opinion

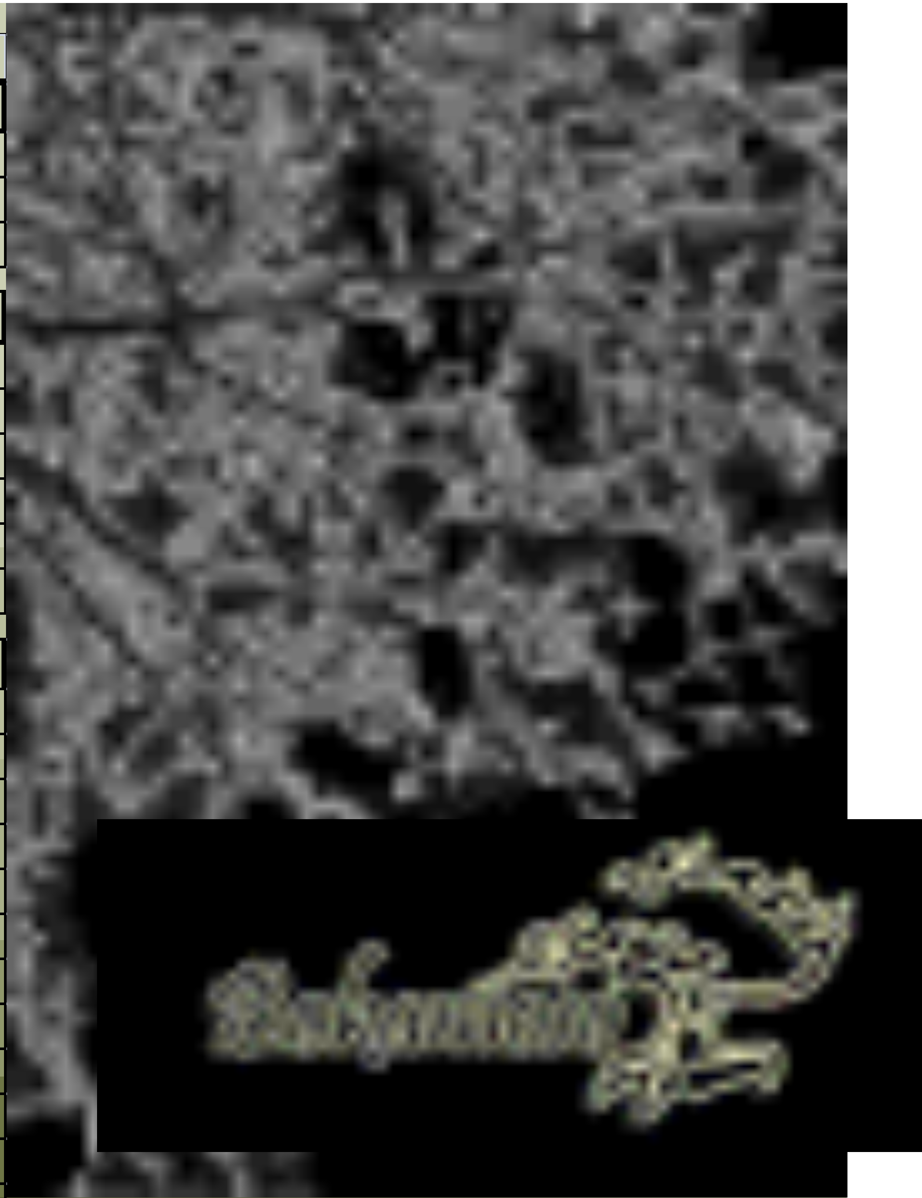


The adjacent list host the status of our current projects. Only a selected amount of projects are

Project Name	Status	Project
Basic Assessment(BA)		
Annlin X 138	In Progress	BA
Clubview X 29	ROD	BA
Darrenwood Dam	In Progress	BA
Durley Holding 90 & 91	In Progress	BA
Elim	In Progress	BA
Fochville X 3	In Progress	BA
Hartebeeshoek 251	In Progress	BA
Klerksdorp (Matlosana Mall)	In Progress	BA
Monavoni External Services	ROD	BA
Monavoni X 45	Amendment of ROD	BA
Montana X 146	In Progress	BA
Rooihuiskraal X29	In Progress	BA
Thorntree Mall	In Progress	BA
Environmental control officer (ECO)		
Grace Point Church	In Progress	ECO
R 81	In Progress	ECO
Highveld X 61	In Progress	ECO
Mall of the North	In Progress	ECO
Olievenhoutbosch Road	In Progress	ECO
Orchards 39	In Progress	ECO
Pierre van Ryneveld Reservoir	In Progress	ECO
Project Shelter	In Progress	ECO
S24 G		
Wonderboom	In Progress	S24 G
Mogwasi Guest houses	Completed	S24 G

07 Current Environmental Projects

072 BA, ECO & S24 G



07 Current Environmental Projects

073 Objection, DFA & WULA

Project Name	Status	Project
Objection		
Colesberg WWTW	In Progress	Objection
Nigel Steelmill	Completed	Objection
Chantilly Waters	Completed	Objection
Development facilitation Act- Input (DFA)		
Burgersfort	In Progress	DFA & BA
Doornpoort Filling Station	In Progress	DFA & EIA & Scoping
Eastwood Junction	In Progress	DFA
Ingersol Road (Erf 78, 81 - 83)	In Progress	DFA
Roos Senekal	In Progress	DFA & EIA & Scoping
Thaba Meetse 1	In Progress	DFA & EIA & Scoping
Water Use License Act (WULA)		
Britstown Bulk Water Supply	In Progress	WULA
Celery Road / Green Channel	In Progress	WULA
Clayville X 46	In Progress	WULA
Dindingwe Lodge	In Progress	WULA
Doornpoort Filling Station	In Progress	WULA+DFA+EIA+SC
Eco Park Dam	In Progress	WULA
Groote Drift Potch	In Progress	WULA
Jozini Shopping Centre	In Progress	WULA+BA
K60	Completed	WULA
Maloto Roads	In Progress	WULA
Kwazele Sewage Works	In Progress	WULA
Monavoni External Services	In Progress	WULA+BA
Nyathi Eco Estate	In Progress	WULA
Prairie Giants X 3	In Progress	WULA
Waveside Water Bottling Plant	Completed	WULA

Project Name	Status	Project
Environmental Management Plan(EMP)		
Heidelberg X 12	ROD	EMP
Monavoni Shopping Centre	Completed	EMP
Forest Hill Development	Completed	EMP
Weltevreden Farm 105KQ	Completed	EMP+EIA
Raslouw Holding 93	Completed	EMP+BA
Durley Development	Completed	EMP+BA
Rooihuiskraal North X 28	Completed	EMP
Rehabilitation Plan		
Norwood Mall/Sandspruit	In Progress	Rehabilitation
Project Shelter Heidelberg	In Progress	Rehabilitation
Sagewood Attenuation Pond	ROD	Rehabilitation
Velmore Hotel	Completed	Rehabilitation
Grace Point Church	Completed	Rehabilitation
Mmamelodi Pipeline	Completed	Rehabilitation
Visual Impact Assessment		
Swatzkop Industrial Developme	Completed	Assessment +DFA
Erasmia	Completed	Assessment
Signage Application		
Menlyn Advertising	Completed	Signage
The Villa Mall	Completed	Signage+EMP+BA

07 Current Env

074 EMP, Rehabilitation , Waste Manageme

- Billion Property Group
- Cavaleros Developments
- Centro Developers
- Chaimberlains
- Chieftain
- Century Property Group
- Coca Cola
- Elmado Property Development
- Flanagan & Gerard
- Gautrans
- Hartland Property Group
- Moolman Group
- MTN
- M&T Development
- Old Mutual
- Property Investment Company
- Petroland Developments
- RSD Construction
- SAND
- Stephan Parsons
- Twin City Developments
- Urban Construction
- USN

08 Indicative Clients

obe Illustrator CS3

obe Photoshop CS3

obe InDesign CS3

oCAD

ogle SketchUP

s

rosoft Office Word

rosoft Office Excel

rosoft Office Publisher

rosoft Office Power Point

09 Tools

Qualifications And Experience In The Field Of Environmental Planning And Management (Lizelle Gregory (Member Bokamoso)):

Qualifications:

-Qualified as ***Landscape Architect*** *at UP 1991;*
-Qualified as ***Professional Landscape Architect in 1997****;*
-A Registered Member at The ***South African Council for the Landscape Architect Profession (SACLAP)*** *with Practise Number:* ***PrLArch97078****;*
- A Registered Member at the ***International Association for Impact Assessment Practitioners (IAIA)****;*
- Qualified as an ***Environmental Auditor in July 2008*** *and also became a Member of the International Environmental Management Association (IEMAS) in 2008.*

Working Experience:

-Worked part time at Eco-Consult – 1988-1990;
-Worked part time at ***Plan Associates as Landscape Architect in training*** *– 1990-1991;*
-Worked as Landscape Architect at ***Environmental Design Partnership (EDP)*** *from 1992 - 1994*
-Practised under ***Lizelle Gregory Landscape Architects*** *from 1994 until 1999;*
*-****Lectured*** *at Part-Time at* ***UP*** *(1999) – Landscape Architecture and* ***TUT*** *(1998- 1999)- Environmental Planning and Plant Material Studies;*
-Worked as ***part time Landscape Architect and Environmental Consultant at Plan Associates*** *and* ***managed their environmental division for more that 10 years*** *– 1993 – 2008 (assisted the* ***PWV Consortium*** *with various road planning matters which amongst others included environmental Scans, EIA's, Scoping reports etc.)*
-Renamed business as ***Bokamoso in 2000*** *and is the only member of Bokamoso Landscape Architects and Environmental Consultants CC;*
*-****More than 20 years experience in the compilation of Environmental Reports,*** *which amongst others included the compilation of various* ***DFA Regulation 31 Scoping Reports****, EIA's for EIA applications in terms of the applicable environmental legislation, Environmental Management Plans, Inputs for Spatial Development Frameworks, DP's, EMF's etc. Also included EIA Application on and adjacent to mining land and slimes dams (i.e. Brahm Fisherville, Doornkop)*

Qualifications And Experience In The Field Of Landscape Architecture (Lizelle Gregory (Member Bokamoso)):

Landscape Architecture:

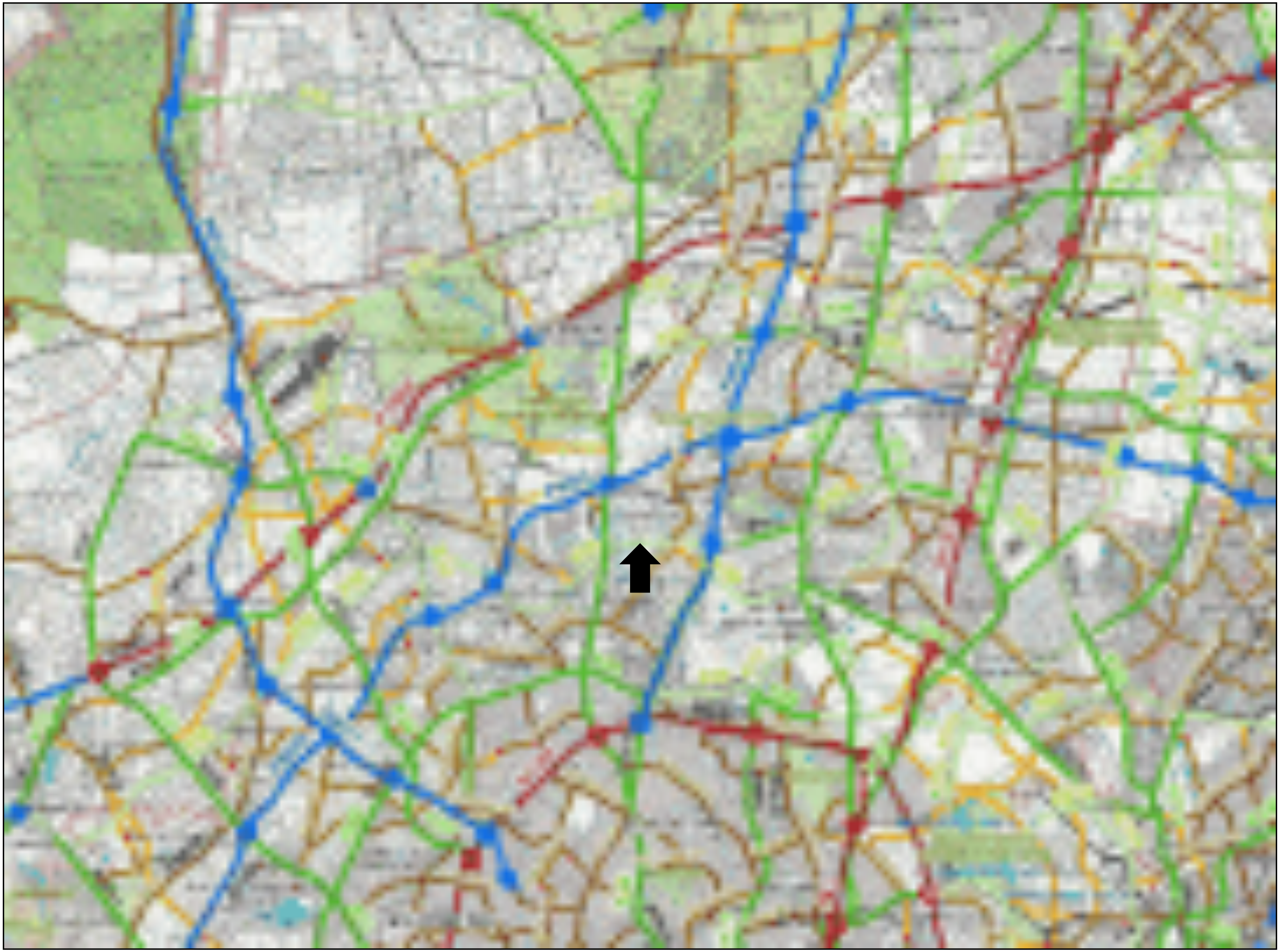
-Compiled landscape and rehabilitation plans for more than 22 years.

The most significant landscaping projects are as follows:
-Designed the Gardens of the Witbank Technicon (a branch of TUT). Also supervised the implementation of the campus gardens (2004);
-Lizelle Gregory was the Landscape Architect responsible for the paving and landscape design at the UNISA Sunnyside Campus and received a Corobrick Golden Award for the paving design at the campus (1998-2004);
-Bokamoso assisted with the design and implementation of a park for the City of Johannesburg in Tembisa (2010);
-The design and implementation of the landscape gardens (indigenous garden) at the new Coca-Cola Valpre Plant (2012-2013);
-Responsible for the rehabilitation and landscaping of Juksei River area at the Norwood Shopping Mall (johannesburg) (2012-2013);
-Designed and implemented a garden of more than 3,5ha in Randburg (Mc Arthurpark). Bokamoso also seeded the lawn for the project (more than 2,5 ha of lawn successfully seeded) (1999);
-Bokamoso designed and implemented more than 800 townhouse complex gardens and submitted more than 500 Landscape Development Plans to CTMM for approval (1995 – 2013);
-Assisted with Landscape Designs and the Masterplan at Eco-Park (M&T Developments) (2005-2011);
-Bokamoso designed and implemented an indigenous garden at an office park adjacent to the Bronberg. In this garden it was also necessary to establish a special garden for the Juliana Golden Mole. During a recent site visit it was established that the moles are thriving in this garden. Special sandy soils had to be imported and special indigenous plants had to be established in the natural section of the garden.

-Lizelle Gregory also owns her own landscape contracting business**. For the past 20 years she trained more than 40 PDI jobless people (sourced from a church in Mamelodi)** to become landscape contracting workers. All the workers are (on a continuous basis) placed out to work at nurserys and other associated industries;
-Over the past 20 years the Bokamoso team compiled more than 800 landscape development plans and also implemented most of the gardens. Bokamoso also designed and implemented the irrigation for the gardens (in cases where irrigation was required). Lizelle regarded it as important to also obtain practical experience in the field of landscape implementation.

Annexure E

GAUTENG ROAD NETWORK SYSTEM



Annexure F

SPECIALIST REPORTS

Annexure F(i)

WETLAND AND STORMWATER ASSESSMENT

REPORT

WETLAND AND STORM WATER ASSESSMENT (SITE, CATCHMENT AND RECONNAISSANCE SOIL SURVEY):

HOLDING 32 OF THE FARM GLENFERNES AGRICULTURAL HOLDINGS, KYALAMI, GAUTENG PROVINCE

31st January, 2014

Compiled by:
J.H. van der Waals
(PhD Soil Science, Pr.Sci.Nat)
Member of:
Soil Science Society of South Africa (SSSSA)

Accredited member of:
South African Soil Surveyors Organisation (SASSO)

Registered with:
The South African Council for Natural Scientific Professions
Registration number: 400106/08

Declaration

I, Johan Hilgard van der Waals, declare that I –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

TABLE OF CONTENTS

WETLAND ASSESSMENT (SITE, CATCHMENT AND RECONNAISSANCE SOIL SURVEY): HOLDING 32 OF THE FARM GLENFERNES AGRICULTURAL HOLDINGS, KYALAMI, GAUTENG PROVINCE

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Terra Soil Science was requested by Ms Denise Moyse to provide detailed input regarding a compliance related matter pertaining to the construction of dam the property – Holding 32 of the Farm Glenvernes Agricultural Holdings, Kyalami in the Gauteng Province.

1.2 PROBLEM STATEMENT

Following on increased storm water impacts since 2006 on Holding 32, Ms Moyse conducted excavation and water retention activities on the said property in an attempt to manage the storm water as well as limit damage to her property.

The increased storm water runoff and runoff intensity (spikes in water volume) is a grave cause for concern and negative storm water related impacts have been experienced on the said plot as well as upstream and downstream. In this regard my colleague Mr Paul Fairall has conducted several interventions regarding storm water management in the catchment in the past decade. The situation is worsening as the prevalence of hard surfaces increases. There are many cases of increased surface sealing (roads and construction of buildings and paved-up areas) within the catchment. These developments increase the spikes in volume of water flow through the catchment and leads to significant degradation of the drainage features and wetlands.

1.3 HISTORY OF THE PROBLEM

The history of the problem and Ms Moyse's engagement with several local and municipal authorities is contained in other relevant documentation. For the sake of brevity these will not be addressed here but it is imperative that this report be read and considered with all the relevant correspondence.

It is important to note that storm water is released into the lower parts of the landscape (i.e. existing drainage lines) and that there is no consideration given to the impacts of the altered hydrological regime on the soils in the drainage features and wetlands. This problem is not unique to this site but is a striking feature of all the urban drainage features on the Halfway House Granite Dome (HHGD).

1.4 ATTEMPTS AT ADDRESSING THE BROADER PROBLEM

I have conducted several (40 +) detailed soil and wetland surveys in the HHGD area (Midrand and surrounding areas) and have attempted to provide guidance on the understanding of wetlands and soils in the area. In this regard I have been involved in several problematic wetland delineation projects that include the Pan African Parliament development site on the farm Randjesfontein south of the Development Bank of South Africa.

In order to provide guidance on the understanding of the wetland and erosion problems in the HHGD area I was approached in 2009/10 on several occasions by personnel from the then Gauteng Department of Agriculture, Conservation and Environment (GDACE) as well as City of Joburg (COJ) to provide a guideline/document that could be used for the understanding and management of the problems discussed above. The generation of a guideline is not a rapid nor easy exercise and should ideally be an iterative approach through regular interaction with and input from stakeholders. The request above culminated in a draft document that was presented, at an open presentation, to all interested parties at the Endangered Wildlife Trust (EWT) offices in Modderfontein on the 14th of May 2012. The presentation was well attended by personnel from COJ as well as a range of consultants (mainly landscape architects). The Gauteng Department of Agriculture and Rural Development (GDARD), who requested the document/guideline in the first place, was very conspicuous in their absence.

Attempts have been made by myself to secure funding for the further development of and proper publication of the draft guidelines, specifically from the Water Research Commission at the end of 2012 (at the request of one of their representatives!). The proposal was in the end not accepted as it was termed "not critical research". Given the frequent insistence for my input on wetland delineation in the HHGD area, the need for a consistent storm water and wetland management guideline, is imperative.

1.5 CURRENT STATUS OF THE PROBLEM

The current situation is untenable as land owners are being subjected to highly altered storm water peaks with consequent damage to property and wetlands (through erosion and siltation). In addition, the land owners have a duty of care according to the National Environmental Management Act (NEMA) and have one remedy only in the form of a costly and cumbersome environmental authorisation process that often seems very foreign as officials do not know how to approach the problem. The implication is that certain land owners are subjected to criminal prosecution if they attempt to remedy a problem that is the making of a complex combination of actions by several different government departments (national, provincial and local) and developers (both authorised and unauthorised) as well as natural fluxes.

1.6 AIM OF THIS REPORT

The aim of this report is to provide a perspective of the broader problems and challenges faced on the HHGD as well as a focused assessment of the problems and challenges experienced on Holding 32.

1.7 METHODOLOGY

The report was generated through:

1. The collection and presentation of baseline land type and topographic data for the site;
2. The thorough consideration of the statutory context of wetlands and the process of wetland delineation;
3. The identification of water related landscape parameters (conceptual and real) for the site;
4. Aerial photograph interpretation of the site;
5. Assessment of historical impacts and changes on the site through the accessing of various historical aerial photographs and topographic maps;
6. Focused soil and site survey in terms of soil properties as well as drainage feature properties; and
7. Presentation of the findings of the various components of the investigation.

2. SITE LOCALITY AND DESCRIPTION

2.1 SURVEY AREA BOUNDARY

The site lies between 25° 59’ 04’’ and 25° 59’ 12’’ south and 28° 02’ 22’’ and 28° 02’ 41’’ east about 3 km north west of the Kyalami race track the north of Johannesburg (**Figure 1**).

2.2 LAND TYPE DATA

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

Figure 1 Locality of the survey site

Holding 32 falls into the **Bb2** land type (Land Type Survey Staff, 1972 - 2006) with F**igure 2** providing the land type distribution for the site. The catchment of the drainage feature on the site falls into the Bb1 land type as well. The **Bb1** and **Bb2** land types are restricted to the Halfway House Granite Dome with the typical bleached sandy soils (details provided later in the report).

Figure 2 Land type map of the Glen Fernes site

2.3 TOPOGRAPHY

The topography of the site and catchment is undulating with incised and often eroded stream channels especially in the lower reaches of drainage features. The contour map for the site is provided in **Figure 3**. From the contour data a digital elevation model (DEM) (**Figure 4**), topographic wetness index (TWI) (**Figure 5**) and SAGA wetness index (SWI) (**Figure 6**) were generated for the site.

Figure 3 Contours of the survey area superimposed on an aerial photograph

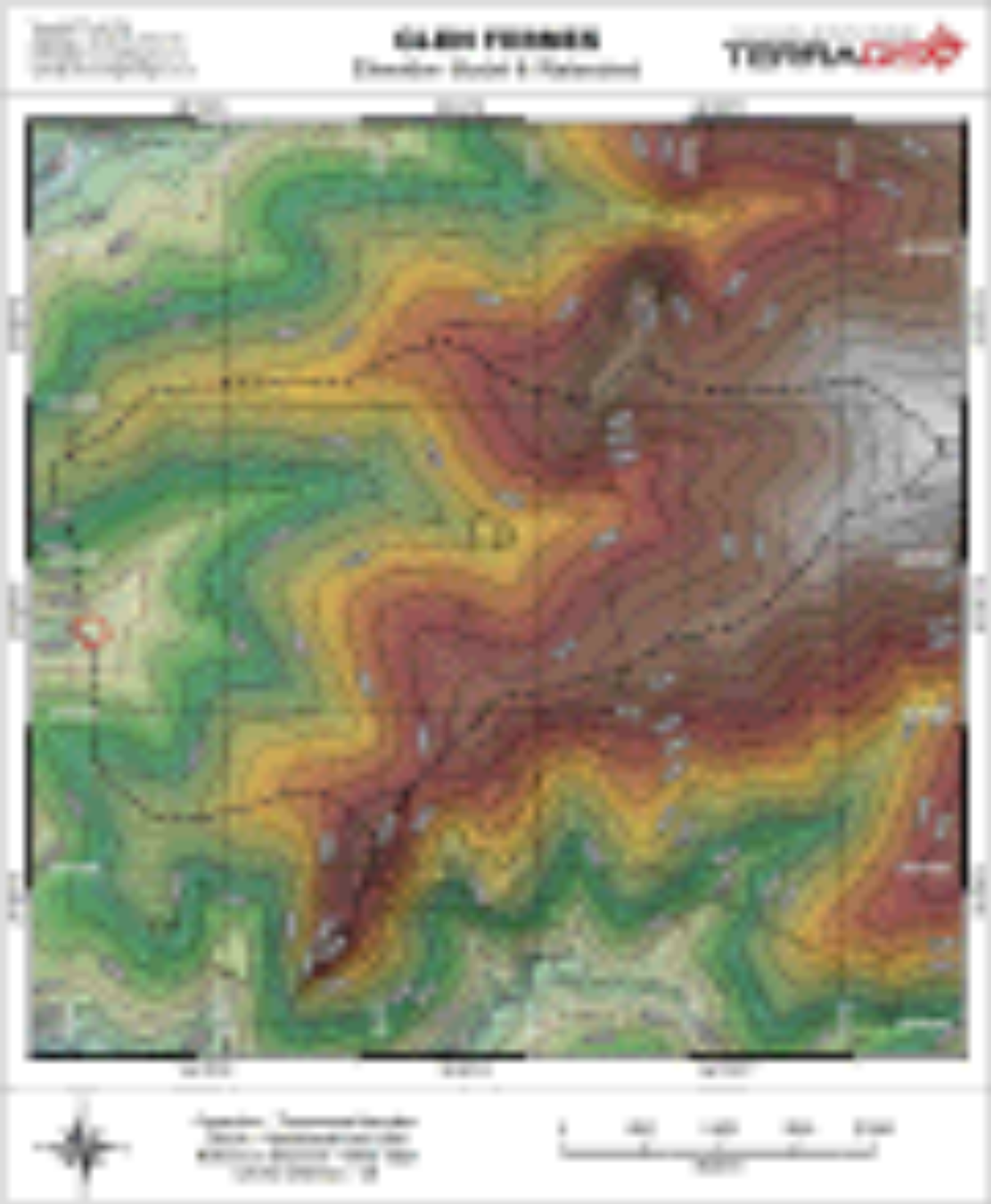


Figure 4 DEM of the survey site

The TWI provides a very accurate indication of water flow paths and areas of water accumulation. This is a function of the topography of the site. The difference between the TWI and the SWI is provided by a quote from Boehner et. al. (2002) “The 'SAGA Wetness Index' is, as the name says, similar to the 'Topographic Wetness Index' (TWI), but it is based on a modified catchment area calculation ('Modified Catchment Area'), which does not think of the flow as very thin film. As result it predicts for cells situated in valley floors with a small vertical distance to a channel a more realistic, higher potential soil moisture compared to the standard TWI calculation.”

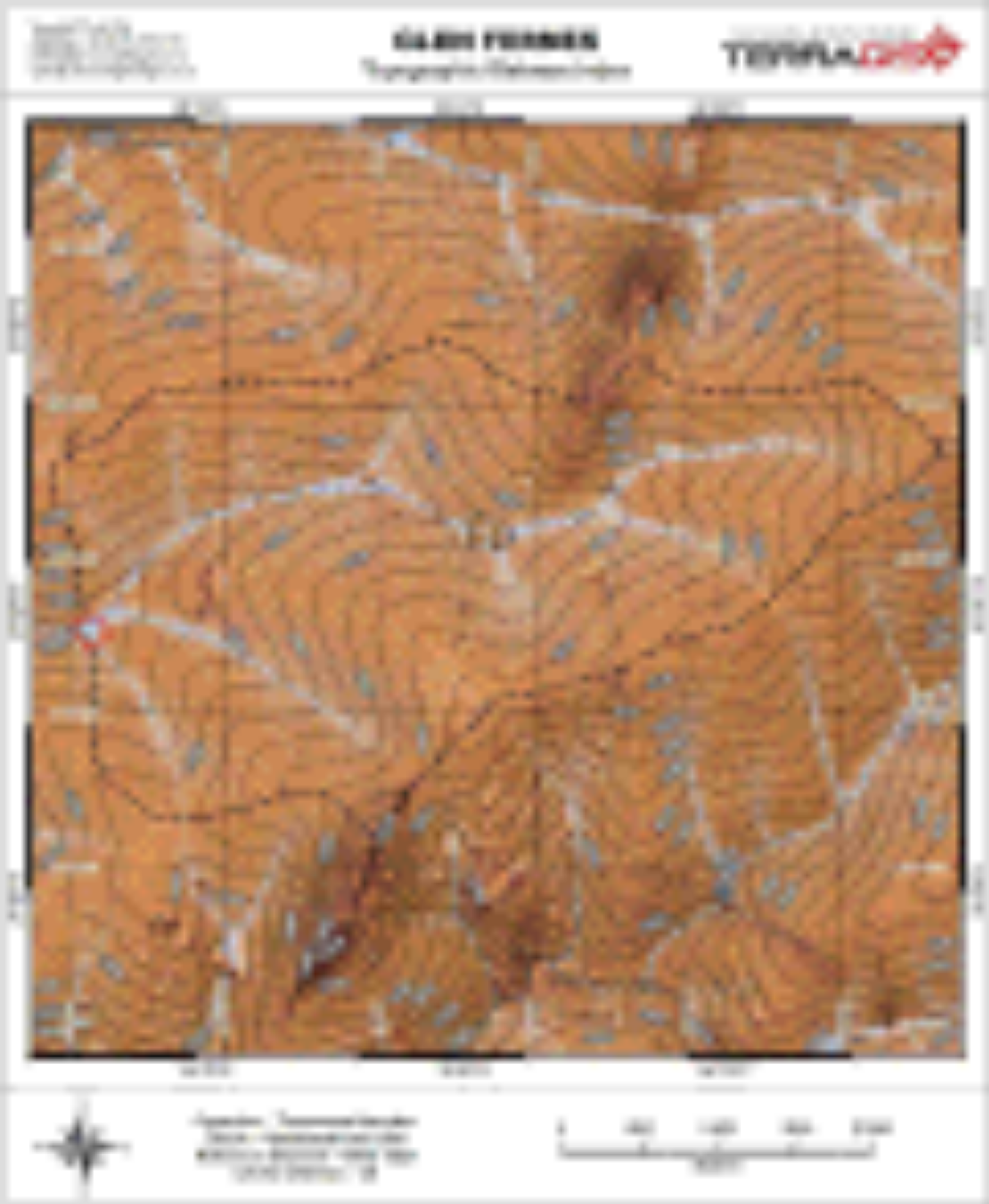


Figure 5 Topographic wetness index (TWI) of the survey site

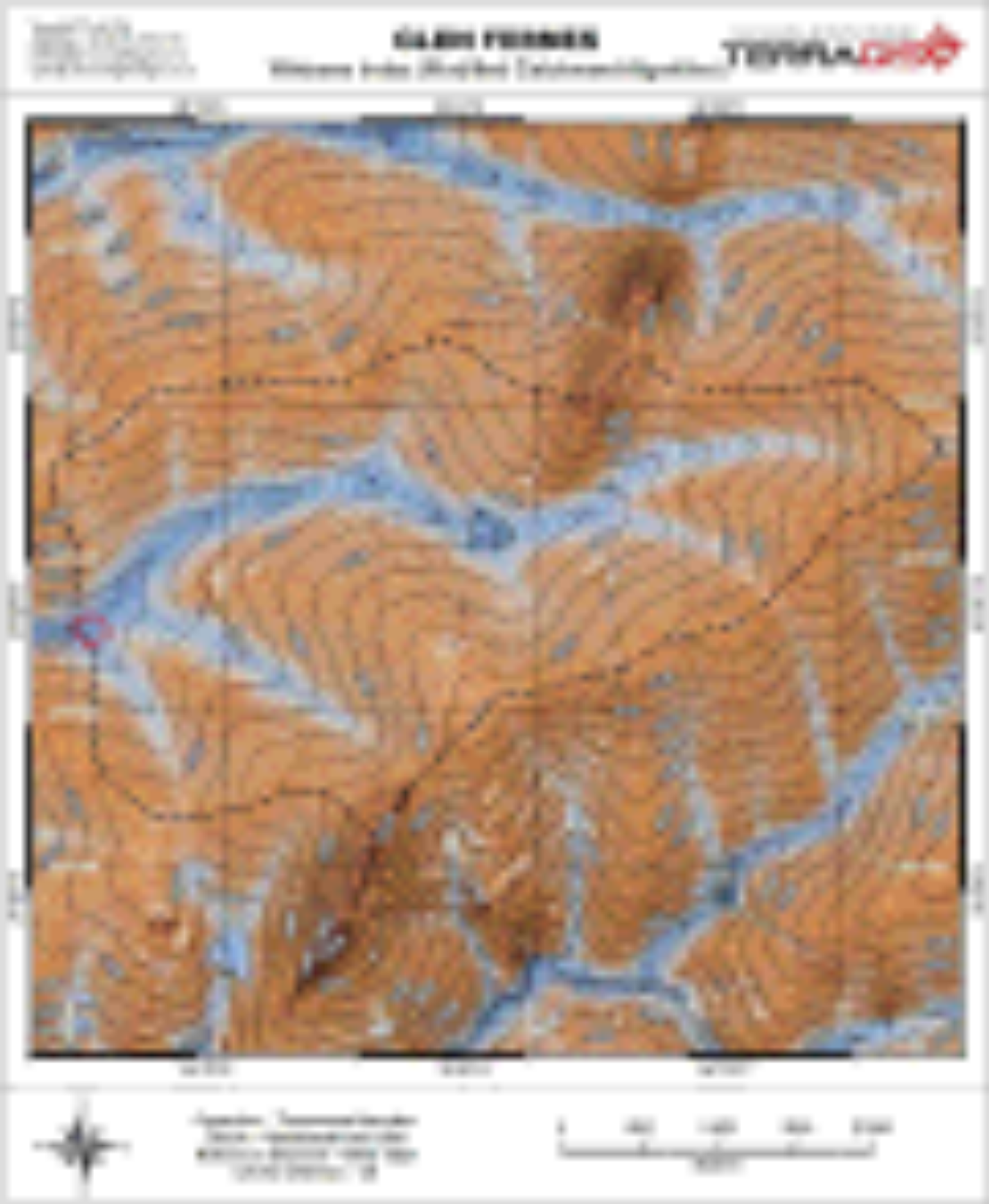


Figure 6 SAGA wetness index for the survey site

2.4. AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise was conducted through the use of Google Earth images and historical aerial photographs of the site. This data was used to obtain an indication of the extent of road and residential infrastructure development in the catchment (**Figure 7**).

Figure 7 Extent of development in the catchment area

3. PROBLEM STATEMENT

The Halfway House Granite Dome (HHGD) is particularly problematic regarding the expression of morphological signs of wetness in soils as well as erodibility of soils in hydrologically altered environments. This investigation will address the causes and results of such erosion through a dedicated assessment and elucidation of pedohydrological processes experienced in the catchment and on the site.

4. WETLANDS: STATUTORY CONTEXT

4.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

4.2 THE WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "…manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- Terrain Unit Indicator. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.
- Soil Form Indicator. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- Soil Wetness Indicator. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of

mottles are the two main criteria for the identification of soils that are periodically or permanently wet.

- Vegetation Indicator. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands. The applicability of these guidelines in the context of the survey site will be discussed in further detail later in the report.

Due to numerous problems with the delineation of wetlands there are a plethora of courses being presented to teach wetland practitioners and laymen the required techniques. Most of the courses and practitioners focus on ecological or vegetation characteristics of landscapes and soil characteristics are often interpreted incorrectly due to a lacking soil science background of these practitioners. As such this author regularly presents, in conjunction with a colleague (Prof. Cornie van Huysteen) from the University of the Free Sate, a course on the aspects related to soil classification and wetland delineation.

4.3 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES.

The following are specific quotes from the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999).

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

From Appendix W1 (Ecoregional Typing for Wetland Ecosystems)

Artificial modifiers are explained namely:
“Many wetlands are man-made, while others have been modified from a natural state to some degree by the activities of humans. Since the nature of these alterations often greatly influences the character of such habitats, the inclusion of modifying terms to accommodate human influence is important. In addition, many human modifications, such as dam walls and drainage ditches, are visible in aerial photographs and can be easily mapped. The following Artificial Modifiers are defined and can be used singly or in combination wherever they apply to wetlands:
Farmed: the soil surface has been physically altered for crop production, but hydrophytes will become reestablished if farming is discontinued
Artificial: substrates placed by humans, using either natural materials such as dredge spoils or synthetic materials such as concrete. Jetties and breakwaters are examples of Non-vegetated Artificial habitats
Excavated: habitat lies within an excavated basin or channel
Diked/Impounded: created or modified by an artificial barrier which obstructs the inflow or outflow of water
Partially Drained: the water level has been artificially lowered, usually by means of ditches, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes.“

4.4 CHALLENGES REGARDING WETLAND DELINEATION ON THE HALFWAY HOUSE GRANITE DOME

Disclaimer: The following section represents a discussion that I use as standard in describing the challenges regarding wetland delineation and management in the Halfway House Granite Dome (HHGD) area. This implies that the section is verbatim the same as in other reports provided to clients and the authorities. Copyright is strictly reserved.

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena).

4.4.1 Pedogenesis

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941(:

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

4.4.2 WATER MOVEMENT IN THE SOIL PROFILE

In a specific soil profile, water can move upwards (through capillary movement), horizontally (owing to matric suction) and downwards under the influence of gravity.

The following needs to be highlighted in order to discuss water movement in soil:

- Capillary rise refers to the process where water rises from a deeper lying section of the soil profile to the soil surface or to a section closer to the soil surface. Soil pores can be regarded as miniature tubes. Water rises into these tubes owing to the adhesion (adsorption) of water molecules onto solid mineral surfaces and the surface tension of water.

  The height of the rise is inversely proportional to the radius of the soil pore and the density of the liquid (water). It is also directly proportional to the liquid's surface tension and the degree of its adhesive attraction. In a soil-water system the following simplified equation can be used to calculate this rise:

  $$\text{Height} = 0.15/\text{radius}$$

  Usually the eventual height of rise is greater in fine textured soil, but the rate of flow may be slower (Brady and Weil, 1999; Hillel, 1983).

- Matric potential or suction refers to the attraction of water to solid surfaces. Matric potential is operational in unsaturated soil above the water table while pressure potential refers to water in saturated soil or below the water table. Matric potential is always expressed as a negative value and pressure potential as a positive value.

  Matric potential influences soil moisture retention and soil water movement. Differences in the matric potential of adjoining zones of a soil results in the movement of water from the moist zone (high state of energy) to the dry zone (low state of energy) or from large pores to small pores.

  The maximum amount of water that a soil profile can hold before leaching occurs is called the field capacity of the soil. At a point of water saturation, a soil exhibits an energy state of

0 J.kg^{-1}. Field capacity usually falls within a range of -15 to -30 J.kg^{-1} with fine textured soils storing larger amounts of water (Brady and Weil, 1999; Hillel, 1983).

- Gravity acts on water in the soil profile in the same way as it acts on any other body; it attracts towards earth's centre. The gravitational potential of soil water can be expressed as:

  Gravitational potential = Gravity x Height

  Following heavy rainfall, gravity plays an important part in the removal of excess water from the upper horizons of the soil profile and recharging groundwater sources below.

  Excess water, or water subject to leaching, is the amount of water that falls between soil saturation (0 J.kg^{-1}) or oversaturation (> 0 J.kg^{-1}), in the case of heavy rainfall resulting in a pressure potential, and field capacity (-15 to -30 J.kg^{-1}). This amount of water differs according to soil type, structure and texture (Brady and Weil, 1999; Hillel, 1983).

- Under some conditions, at least part of the soil profile may be saturated with water, resulting in so-called saturated flow of water. The lower portions of poorly drained soils are often saturated, as are well-drained soils above stratified (layers differing in soil texture) or impermeable layers after rainfall.

  The quantity of water that flows through a saturated column of soil can be calculated using Darcy's law:

  $$Q = Ksat.A.\Delta P/L$$

  Where Q represents the quantity of water per unit time, Ksat is the saturated hydraulic conductivity, A is the cross sectional area of the column through which the water flows, ΔP is the hydrostatic pressure difference from the top to the bottom of the column, and L is the length of the column.

  Saturated flow of water does not only occur downwards, but also horizontally and upwards. Horizontal and upward flows are not quite as rapid as downward flow. The latter is aided by gravity (Brady and Weil, 1999; Hillel, 1983).

- Mostly, water movement in soil is ascribed to the unsaturated flow of water. This is a much more complex scenario than water flow under saturated conditions. Under unsaturated conditions only the fine micropores are filled with water whereas the macropores are filled with air. The water content, and the force with which water molecules are held by soil surfaces, can also vary considerably. The latter makes it difficult to assess the rate and direction of water flow. The driving force behind unsaturated water flow is matric potential. Water movement will be from a moist to a drier zone (Brady and Weil, 1999; Hillel, 1983).

The following processes influence the amount of water to be leached from a soil profile:

- Infiltration is the process by which water enters the soil pores and becomes soil water. The rate at which water can enter the soil is termed infiltration tempo and is calculated as follows:

  $$I = Q/A.t$$

Where I represents infiltration tempo (m.s^{-1}), Q is the volume quantity of infiltrating water (m^3), A is the area of the soil surface exposed to infiltration (m^2), and t is time (s).

If the soil is quite dry when exposed to water, the macropores will be open to conduct water into the soil profile. Soils that exhibit a high 2:1 clay content (swelling-shrinking clays) will exhibit a high rate of infiltration initially. However, as infiltration proceeds, the macropores will become saturated and cracks, caused by dried out 2:1 clay, will swell and close, thus leading to a decline in infiltration (Brady and Weil, 1999; Hillel, 1983).

- Percolation is the process by which water moves downward in the soil profile. Saturated and unsaturated water flow is involved in the process of percolation, while the rate of percolation is determined by the hydraulic conductivity of the soil.

  During a rain storm, especially the down pouring of heavy rain, water movement near the soil surface mainly occurs in the form of saturated flow in response to gravity. A sharp boundary, referred to as the wetting front, usually appears between the wet soil and the underlying dry soil. At the wetting front, water is moving into the underlying soil in response to both matric and gravitational potential. During light rain, water movement at the soil surface may be ascribed to unsaturated flow (Brady and Weil, 1999; Hillel, 1983).

  The fact that water percolates through the soil profile by unsaturated flow has certain ramifications when an abrupt change in soil texture occurs (Brady and Weil, 1999; Hillel, 1983). A layer of course sand, underlying a fine textured soil, will impede downward movement of water. The macropores of the coarse textured sand offer less attraction to the water molecules than the macropores of the fine textured soil. When the unsaturated wetting front reaches the coarse sand, the matric potential is lower in the sand than in the overlying material. Water always moves from a higher to a lower state of energy. The water can, therefore, not move into the coarse textured sand. Eventually, the downward moving water will accumulate above the sand layer and nearly saturate the fine textured soil. Once this occurs, the water will be held so loosely that gravitational forces will be able to drag the water into the sand layer (Brady and Weil, 1999; Hillel, 1983).

  A coarse layer of sand in an otherwise fine textured soil profile will also inhibit the rise of water by capillary movement (Brady and Weil, 1999; Hillel, 1983).

Field observations and laboratory based analysis can aid in assessing the soil-water relations of an area. The South African soil classification system (Soil Classification Working Group, 1991.) comments on certain field observable characteristics that shed light on water movement in soil. The more important of these are:

- Soil horizons that show clear signs of leaching such as the E-horizon – an horizon where predominantly lateral water movement has led to the mobilisation and transport of sesquioxide minerals and the removal of clay material;
- Soil horizons that show clear signs of a fluctuating water table where Fe and Mn mottles, amongst other characteristics, indicate alternating conditions of reduction and oxidation (soft plinthic B-horizon);

- Soil horizons where grey colouration (Fe reduction and redox depletion), in an otherwise yellowish or reddish matrix, indicate saturated (or close to saturated) water flow for at least three months of the year (Unconsolidated/Unspecified material with signs of wetness);
- Soil horizons that are uniform in colouration and indicative of well-drained and aerated (oxidising) conditions (e.g. yellow brown apedal B-horizon).

4.4.2 Water Movement in the Landscape

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape there are a number of factors determining the paths along which this water moves. **Figure 8** provides a simplified schematic representation of an idealised landscape (in "profile curvature". The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile.

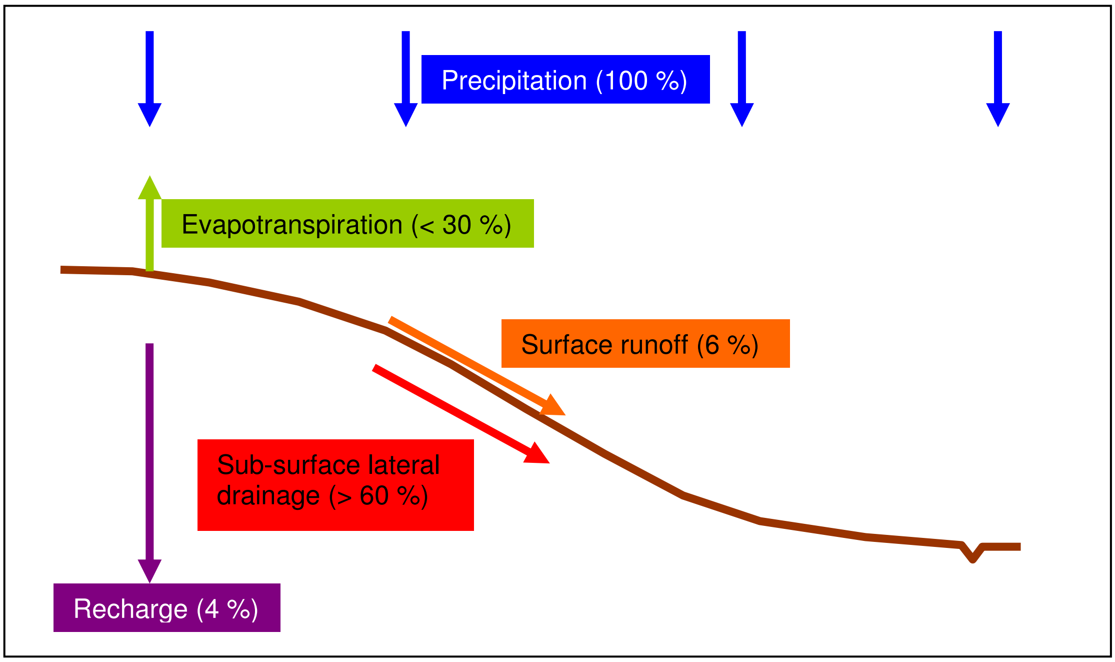


Figure 8 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

Flow paths through soil and geological strata, referred to as "interflow" or "hillslope water", are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as "redox morphology". In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 9** provides a schematic representation of the different flow regimes that are usually encountered. The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

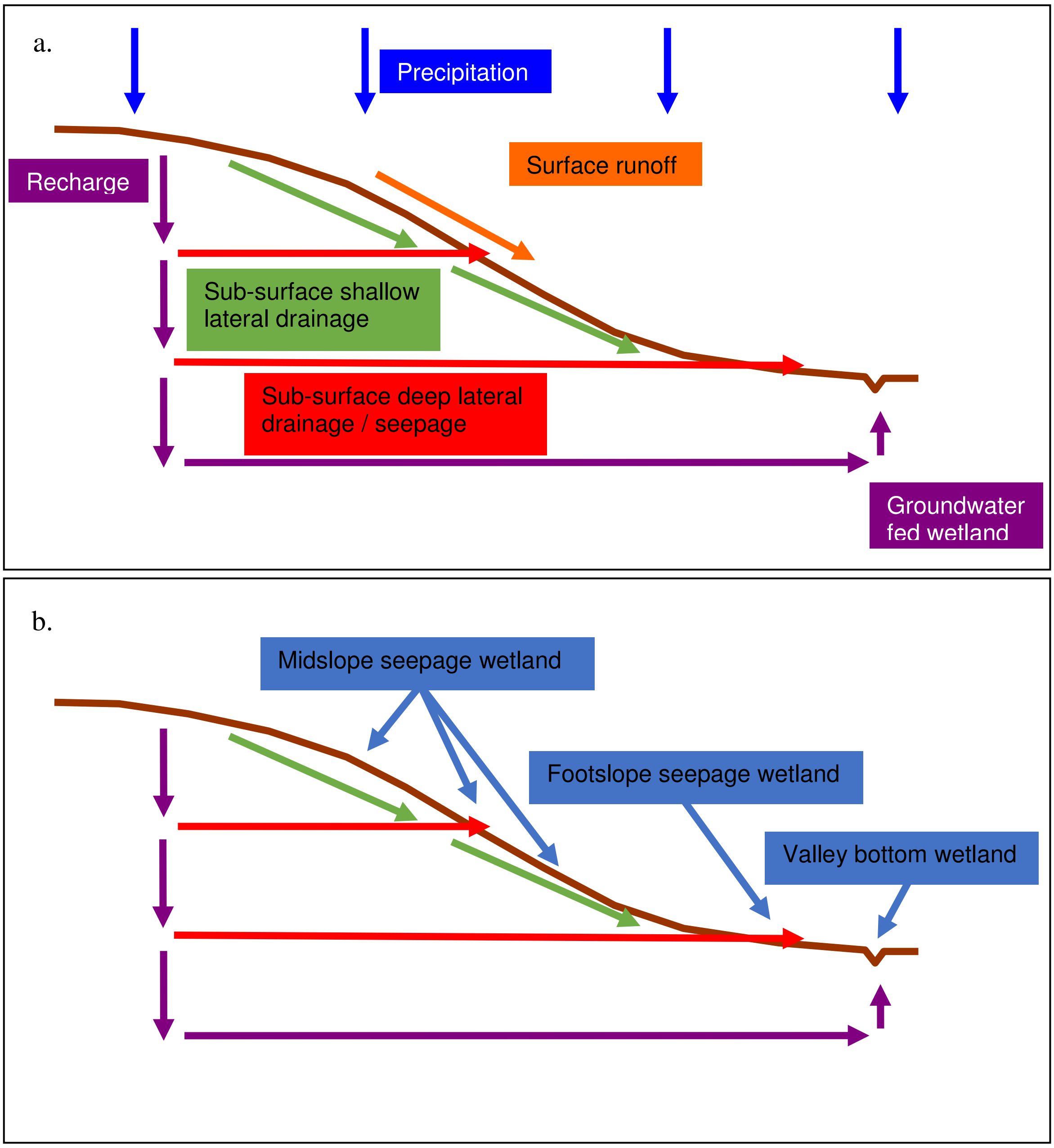


Figure 9 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 10** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

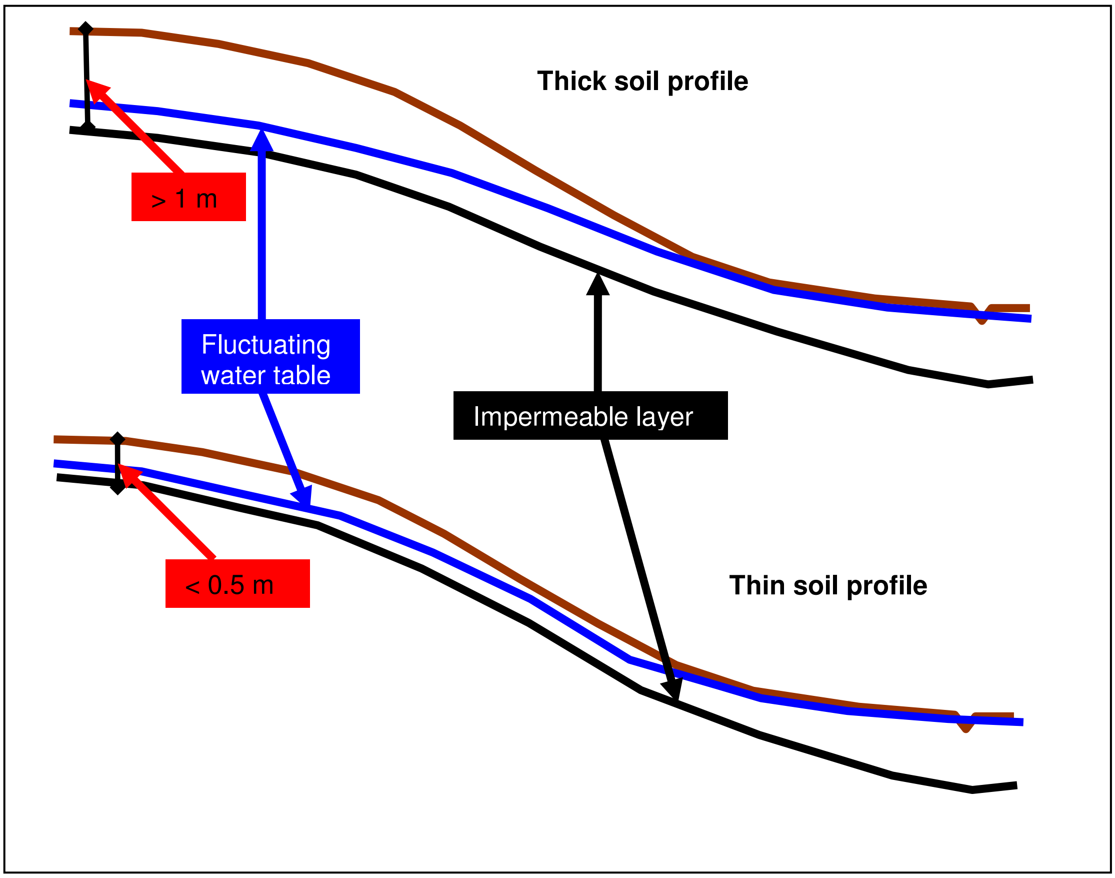


Figure 10 The difference in water flow between a dominantly thick and dominantly thin soil profile.

4.4.3 The Catena Concept

Here it is important to take note of the “catena” concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 11** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

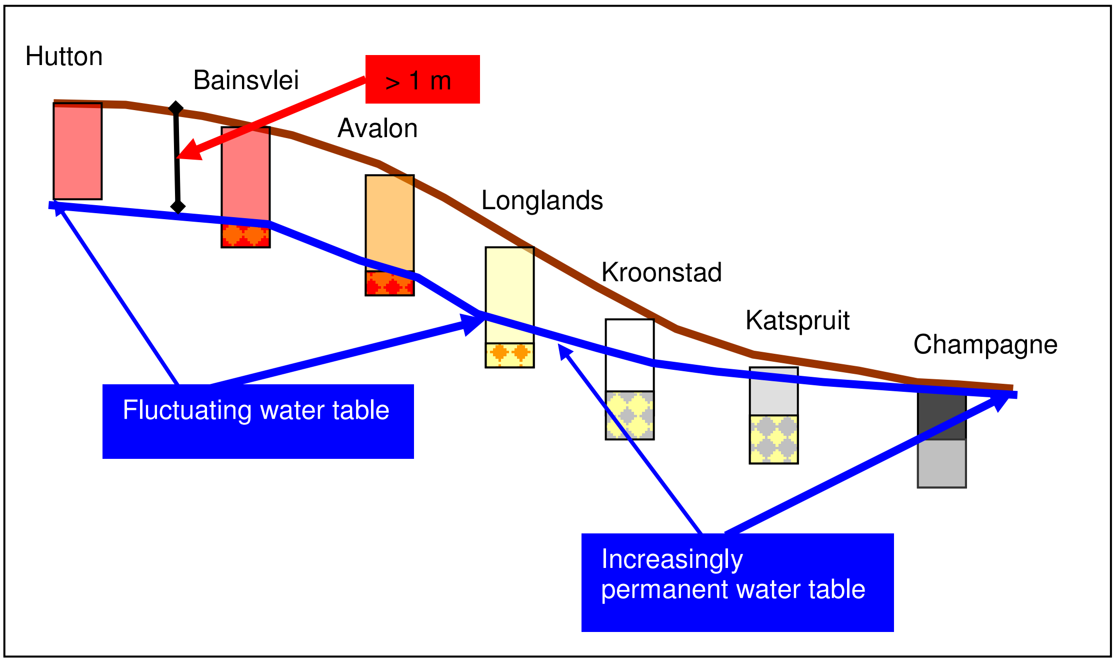


Figure 11 Idealised catena on a quartz rich parent material.

4.4.4 The Halfway House Granite Dome Catena

The Halfway House Granite Catena is a well-studied example of a quartz dominated Bb catena. As a result of the elucidation of the wetland delineation parameters and challenges in the specialist testimony in the matter between The State versus 1. Stefan Frylinck and 2. Mpofu Environmental Solutions CC (Case Number 14/1740/2010) it will be discussed in further detail here.

The typical catena that forms on the Halfway House granite differs from the idealised one discussed above in that the landscape is an old stable one, often with extensive subsoil ferricrete (or hard plinthic) layers where perched water tables occur. The parent material is relatively hard and the ferricrete layer is especially resistant to weathering. The quartz rich parent materials have a very low Fe content/"reserve", and together with the age of the material leads to the dominance of bleached sandy soils. The implication is that the whole catena is dominated by bleached sandy soils with a distinct and shallow zone of water fluctuation. This zone is often comprised of a high frequency of Fe/Mn concretions and sometimes exhibits feint mottles. In lower lying areas the soils tend to be deeper due to colluvial accumulation of sandy soil material but then exhibit more distinct signs of wetness (and pedogenesis). **Figure 12** provides a schematic representation of the catena.

The essence of this catena is that the soils are predominantly less than 50 cm thick and as such have a fluctuating water table (mimicking rainfall events) within 50 cm of the soil surface. One of the main criteria used during wetland delineation exercises as stipulated by the guidelines (DWAF, 2005) is the presence of mottles within 50 cm of the soil surface (temporary and seasonal wetland zones). Even from a theoretical point of view the guidelines cannot be applied to the above described catena as soils at the crest of the landscape would already qualify as temporary wetland zone soils (upon request many such examples can be supplied). The practical implication of this statement as well as practical examples will be discussed in the next section.

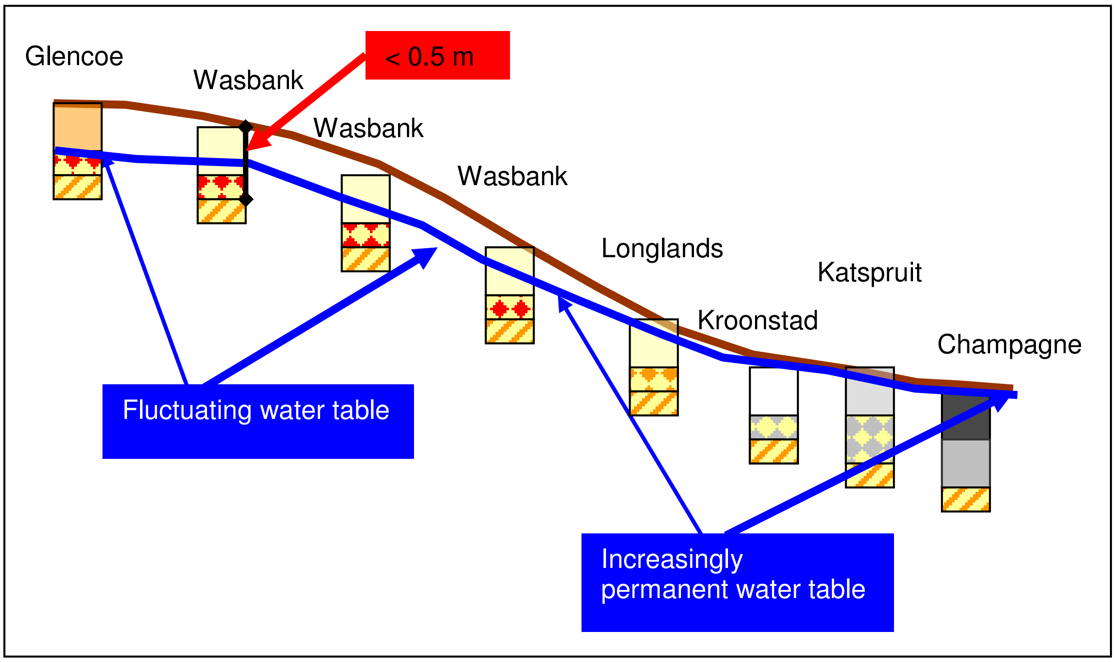


Figure 12 Schematic representation of a Halfway House Granite catena.

4.4.5 Convex Versus Concave Landscapes in the Halfway House Granite Catena

An additional factor of variation in all landscapes is the shape of the landscape along contours (referred to a "plan curvature"). Landscapes can be either concave or convex, or flat. The main difference between these landscapes lies in the fact that a convex landscape is essentially a watershed with water flowing in diverging directions with a subsequent occurrence of "dryer" soil conditions. In a concave landscape water flows in converging directions and soils often exhibit the wetter conditions of "signs of wetness" such as grey colours, organic matter and subsurface clay accumulation. **Figure 13** presents the difference between these landscapes in terms of typical soil forms encountered on the Halfway House granites. In the convex landscape the subsurface flow of water removes clays and other weathering products (including Fe) in such a way that the midslope position soils exhibit an increasing degree of bleaching and relative accumulation of quartz (E-horizons). In the concave landscapes clays and weathering products are transported through the soils into a zone of accumulation where soils start exhibiting properties of clay and Fe accumulation. In addition, coarse sandy soils in convex environments tend to be thinner due to the removal of sand particles through erosion and soils in concave environments tend to be thicker due to colluvial accumulation of material transported from upslope positions. Similar patterns are observed for other geological areas with the variation being consistent with the soil variation in the catena.

Often these concave and convex topographical environments occur in close proximity or in one topographical sequence of soils. This is often found where a convex upslope area changes into a concave environment as a drainage depression is reached (**Figure 14**). The processes in this landscape are the same as those described for the convex and concave landscapes above.

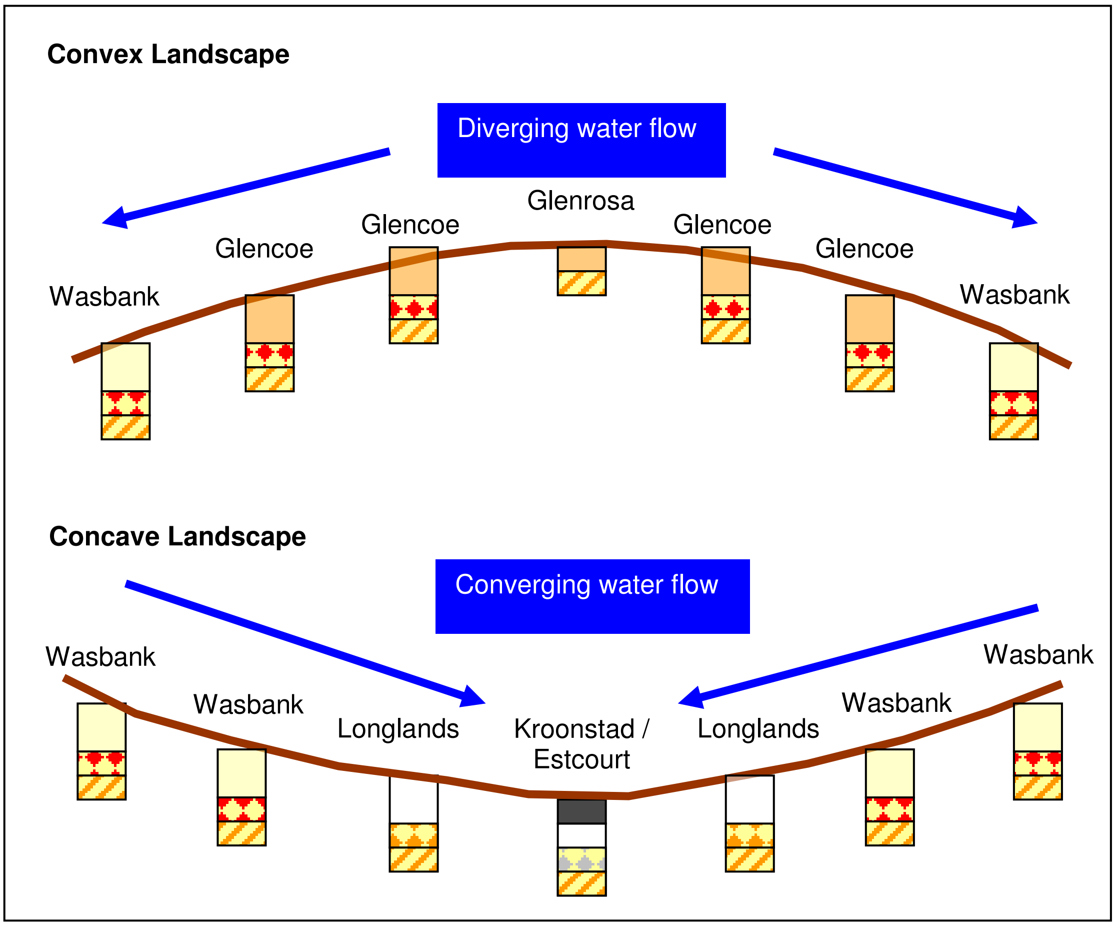


Figure 13 Schematic representation of the soils in convex and concave landscapes in the Halfway House Granite catena.

4.4.6 Implications for Wetland Delineation and Application of the Guidelines

When the 50 cm criterion is used to delineate wetlands in the HHGD environment, the soils in convex positions often "qualify" as temporary wetland soils due to their relatively thin profile and the presence of concretions (often weathering to yield "mottles") within this zone. In conjunction with a low Fe content in the soils and subsequent bleached colours (as defined for E-horizons) in the matrix a very large proportion of the landscape "qualifies" as temporary wetland zones. On the other hand, the soils in the concave environments, especially in the centre of the drainage depression, tend to be thicker and the 50 cm criterion sometimes does not flag these soils as being wetland soils due to the depth of the signs of wetness (mottles) often occurring only at depths greater than 80 cm. Invariably these areas are always included in wetland delineations due to the terrain unit indicator flagging it as a wetland area and drainage feature.

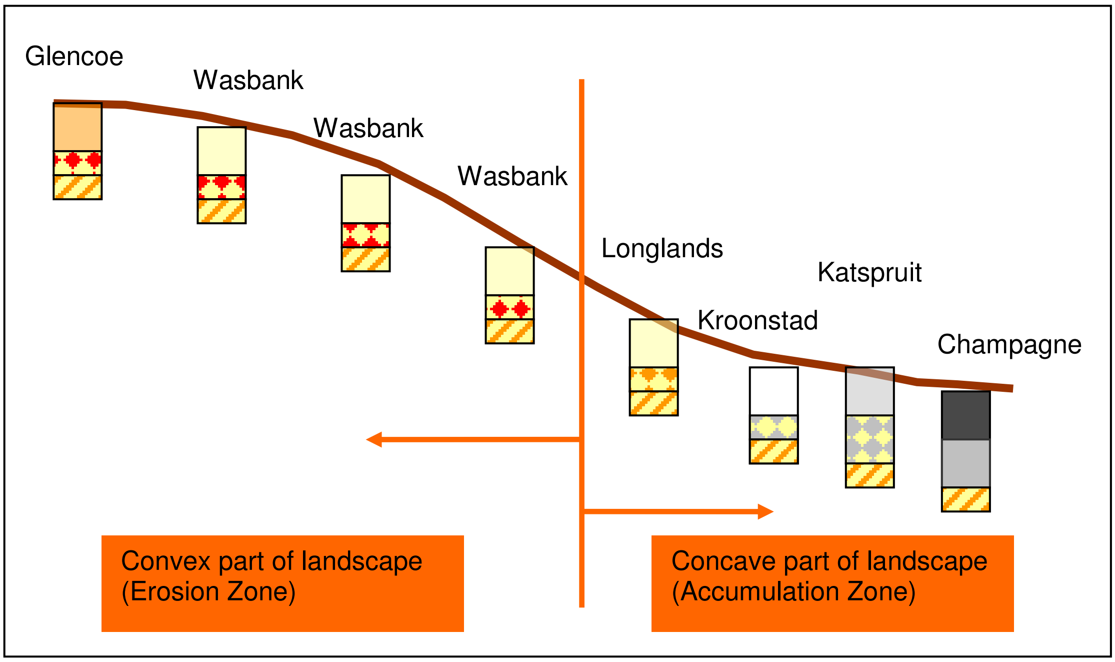


Figure 14 Schematic representation of the soils in a combined convex and concave landscape in the Halfway House Granite catena.

The strict application of the wetland delineation guidelines in the Halfway House Granite area often leads to the identification of 70 % or more of a landscape as being part of a wetland. For this reason a more pragmatic approach is often followed in that the 50 cm criterion is not applied religiously. Rather, distinctly wet horizons and zones of clay accumulation within drainage depressions are identified as distinct wetland soils. The areas surrounding these are assigned to extensive seepage areas that are difficult to delineate and on which it is difficult to assign a realistic buffer area. The probable best practice is to assign a large buffer zone in which subsurface water flow is encouraged and conserved to lead to a steady but slow recharge of the wetland area, especially following rainfall events. In the case where development is to take place within this large buffer area it is preferred that a "functional buffer" approach be followed. This implies that development can take place within the buffer area but then only within strict guidelines regarding storm water management and mitigation as well as erosion prevention in order to minimise sediment transport into stream and drainage channels and depressions.

4.4.7 Implications for Wetland Delineation and Application of the Guidelines

When the 50 cm criterion is used to delineate wetlands in the Halfway House granite environment (as well as other quartz dominated environments), the soils in convex positions often "qualify" as temporary wetland soils due to their relatively thin profile and the presence of concretions (often weathering to yield "mottles") within this zone. In conjunction with a low Fe content in the soils and subsequent bleached colours (as defined for E-horizons) in the matrix a very large proportion of the landscape "qualifies" as temporary wetland zones. On the other hand, the soils in the concave environments, especially in the centre of the drainage depression, tend to be thicker and the 50 cm criterion sometimes does not flag these soils as being wetland soils due to the depth of the signs of wetness (mottles) often occurring only at depths greater than 80 cm. Invariably these areas are always included in wetland delineations due to the terrain unit indicator flagging it as a wetland area and drainage feature.

The strict application of the wetland delineation guidelines in the Halfway House granite area (and other similar areas) often leads to the identification of 70 % or more of a landscape as being part of a wetland. For this reason a more pragmatic approach is often followed in that the 50 cm criterion is not applied religiously. Rather, distinctly wet horizons and zones of clay accumulation within drainage depressions are identified as distinct wetland soils. The areas surrounding these are assigned to extensive seepage areas that are difficult to delineate and on which it is difficult to assign a realistic buffer area. The probable best practice is to assign a large buffer zone in which subsurface water flow is encouraged and conserved to lead to a steady but slow recharge of the wetland area, especially following rainfall events.

4.4.8 Implications for Wetland Conservation in Urban Environments

Whether an area is designated a wetland or not loses some of its relevance once drastic influences on landscape hydrology are considered. If wetlands are merely the expression of water in a landscape due to proximity to the land surface (viz. the 50 cm mottle criterion in the delineation guidelines) it follows that potentially large proportions of the water moving in the landscape could fall outside of this sphere – as discussed in detail above. **Figures 15** and **16** provide schematic representations (as contrasted with **Figure 9**) of water dynamics in urban environments with distinct excavations and surface sealing activities respectively.

Through the excavation of pits (**Figure 15**) for the construction of foundations for infrastructure or basements for buildings the shallow lateral flow paths in the landscape are severed. As discussed above these flow paths can account for up to 60 % of the volume of water entering the landscape in the form of precipitation. These severed flow paths often lead to the ponding of water upslope from the structure with a subsequent damp problem developing in buildings. Euphemistically we have coined the term “wet basement syndrome” (WBS) to describe the type of problem experienced extensively on the HHGD. A different impact is experienced once the surface of the land is sealed through paving (roads and parking areas) and the construction of buildings (in this case the roof provides the seal) (**Figure 16**). In this case the recharge of water into the soil and weathered rock experienced naturally is altered to an accumulation and concentration of water on the surface with a subsequent rapid flowing downslope. The current approach is to channel this water into storm water structures and to release it in the nearest low lying position in the landscape. These positions invariable correlate with drainage features and the result is accelerated erosion of such features due to a drastically altered peak flow regime.

The result of the above changes in landscape hydrology is the drastic alteration of flow dynamics and water volume spikes through wetlands. This leads to wetlands that become wetter and that experience vastly increased erosion pressures. The next section provides a perspective on the erodibility of the soils of the HHGD. It is important to note the correlation between increasing wetness, perching of water and erodibility.

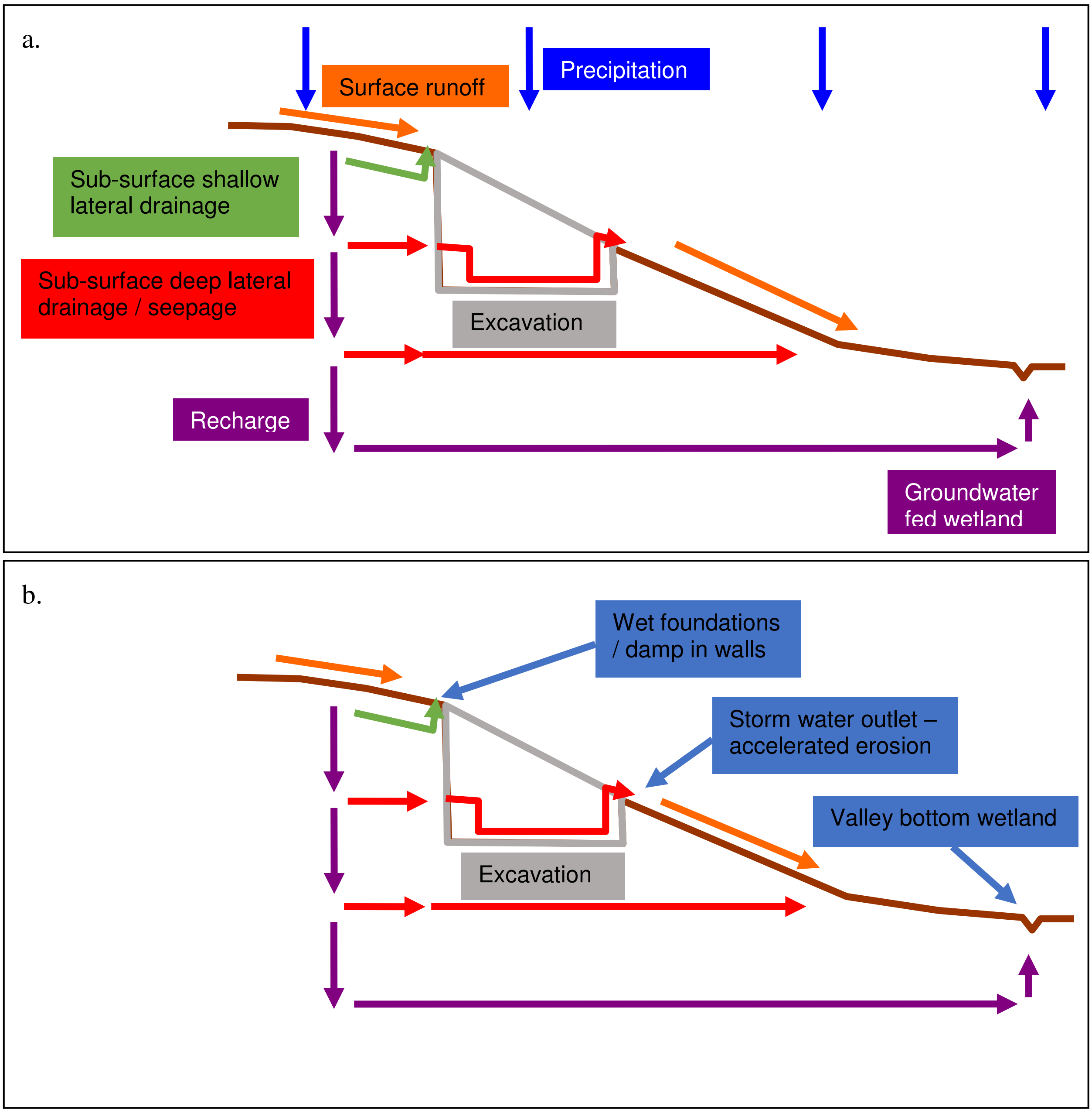


Figure 15 Different flow paths of water through a landscape with an excavated foundation (a) and typical wetland types associated with the altered water regime (b)

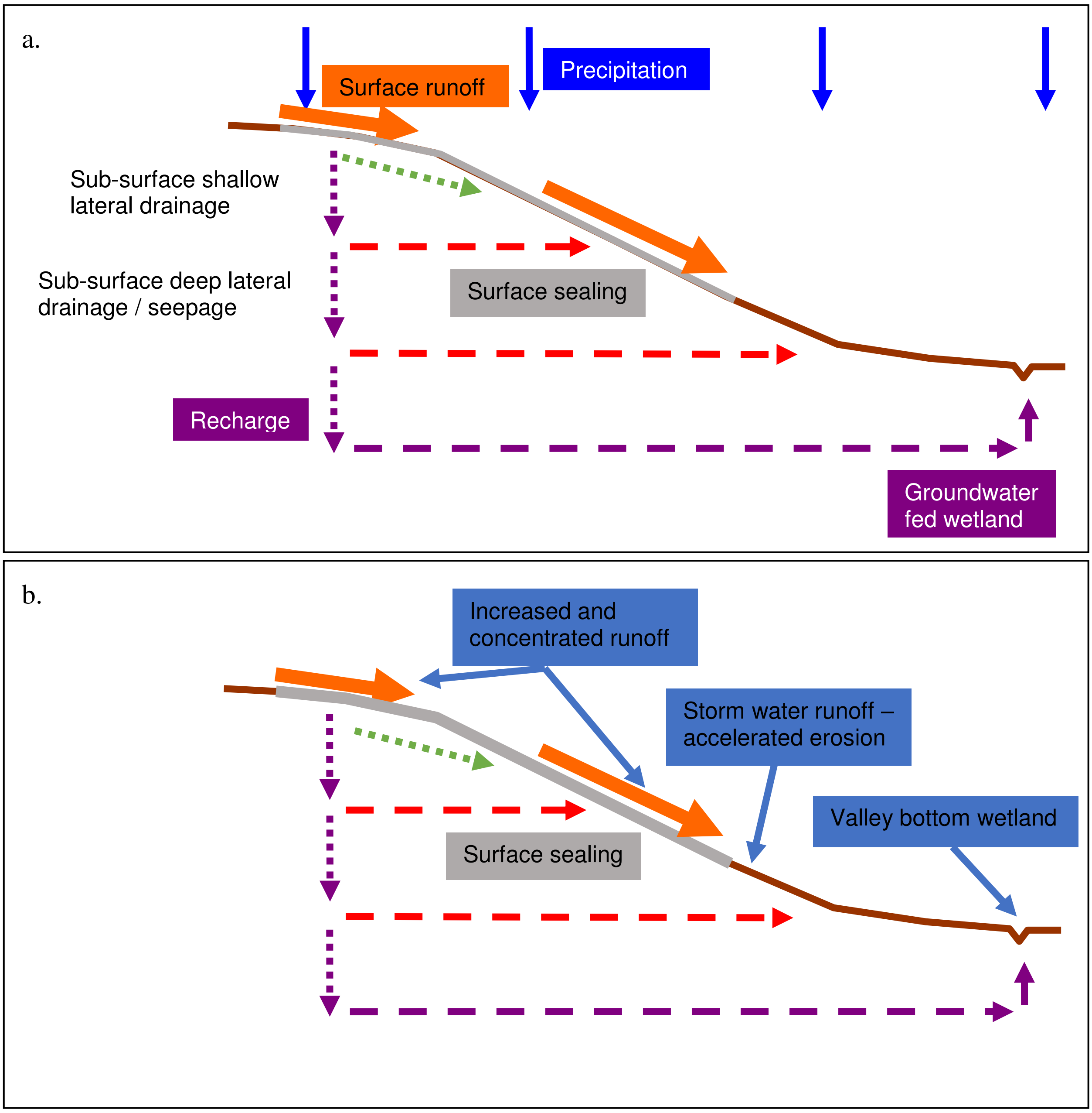


Figure 16 Different flow paths of water through a landscape with surface sealing (buildings and paving) (a) and typical wetland types associated with the altered water regime (b)

4.4.9 Soil Erosion on the Halfway House Granite Dome

Infiltration of water into a soil profile and the percolation rate of water in the soil are dependent on a number of factors with the dominant one being the soil's texture (**Table 1**). Permeability and the percolation of water through the soil profile are governed by the least permeable layer in the soil profile. The implication of this is that soil horizons that overlie horizons of low permeability (i.e. hard rock, hard plinthite, G-horizon) are likely to become saturated with water relatively quickly - particularly if the soil profile is shallow and a large amount of water is added. Another impermeable layer is one that is saturated with water and such a layer acts the same way as the ones mentioned earlier. In cases where internal drainage is hampered by an impermeable layer such as hard rock (the Dresden or Wasbank soil forms) evaporation and lateral water movement are the only processes that will drain the soil profile of water.

Infiltration of water into a soil profile is dependent on the factors leading to the downward movement of water. In cases where impermeable layers exist water will infiltrate into the profile until it is saturated. Once this point is reached water infiltration will cease and surface runoff will become the dominant water flow mechanism. A similar situation will develop if a soil has a slow infiltration rate of water due to fine texture, hardened or compacted layers and low hydraulic conductivity. When these soils are subjected to large volumes and rates of rainfall the rate of infiltration will be exceeded and excess water will flow downslope on the soil surface.

Table 1 Infiltration/permeability rates for soil textural classes (Wischmeier, Johnson & Cross 1971)

Texture class	Texture	Permeability Rate (mm/hour)	Permeability Class
Coarse	Gravel, coarse sand Sand, loamy sand	>508 152 – 508	Very rapid Rapid
Moderately coarse	Coarse sandy loam Sandy loam Fine sandy loam	51 - 152	Moderately rapid
Medium	Very fine sandy loam Loam Silt loam Silt	15 – 51	Moderate
Moderately fine	Clay loam Sandy clay loam Silty clay loam	5.1 – 15.2	Moderately slow
Fine	Sandy clay Silty clay Clay (>60%)	1.5 – 5.1	Slow
Very fine	Clay (>60%) Clay pan	< 1.5	Very slow

The texture, permeability and presence of impeding layers are some of the main determinants of soil erosion. Wischmeier, Johnson and Cross (1971) compiled a soil erodibilty nomograph from soil analytical data (**Figure 17**). The nomograph uses the following parameters that are regarded as having a major effect on soil erodibility:

- The mass percentage of the fraction between 0.1 and 0.002 mm (very fine sand plus silt) of the topsoil.
- The mass percentage of the fraction between 0.1 and 2.0 mm diameter of the topsoil.
- Organic matter content of the topsoil. This "content" is obtained by multiplying the organic carbon content (in g/100 g soil – Walkley Black method) by a factor of 1.724.
- A numerical index of soil structure.
- A numerical index of the soil permeability of the soil profile. The least permeable horizon is regarded as horizon that governs permeability.

Box 1 describes the procedure to use the nomograph.

As part of a different study 45 soil samples were collected from 19 points on the HHGD. The samples were described in terms of soil form and analysed with respect to texture (6 fractions) and organic carbon content of the A-horizons (data not presented here but available upon request). The erodibility index and maximum stable slope were calculated for each horizon (according to the method discussed above) in both an unsaturated and saturated soil matrix (data not presented here but available upon request).

The erosion risk is based on the product of the slope (in percentage) and the K-value of erodibility (determined from the Wischmeier, Johnson and Cross (1971) nomograph). <u>This product should not exceed a value of 2.0 in which case soil erosion becomes a major concern</u>. The K-value allows for a "hard" rainfall event but is actually based on scheduled irrigation that allows for infiltration and percolation rates and so-called "normal" rainfall intensity. Soil erosion potential increases with an increase in the very fine sand plus silt fraction, a decrease in the organic matter content, an increase in the structure index and a decrease in permeability. Water quality is assumed not to be a problem for the purposes of the erosion hazard calculations.

Box 1: Using the nomograph by Wischmeier, Johnson and Cross (1971)
In examining the analysis of appropriate surface samples, enter on the left of the graph and plot the percentage of silt (0.002 to 0.1 mm), then of sand (0.10 to 2 mm), then of organic matter, structure and permeability in the direction indicated by the arrows. Interpolate between the drawn curves if necessary. The broken arrowed line indicates the procedure for a sample having 65% silt + very fine sand, 5% sand, 2.8% organic matter, 2 of structure and 4 of permeability. Erodibility factor K = 0,31.

<u>Note</u>: The erodibility factor increase due to saturation was also calculated. These results indicated an increase in erodibiity of a factor predominantly between 3 and 4 for saturated soil conditions.

4.4.10 Detailed Soil Characteristics – Summarising Conclusions

The following general conclusions can be made regarding the soil characteristics of the HHGD (and the catchment):

1. The site (and catchment) is dominated by shallow to moderately deep sandy soils with deep soils occurring in the drainage features only ;
2. The soils are dominantly coarse sandy in texture;

3. On the bulk of the site the soils are underlain by a hard plinthic layer (ferricrete) that acts as an aquaclude under natural conditions;
4. The bulk of the water movement on the site occurs within 50 cm of the soil surface on top of the ferricrete layer in the absence of human impacts;
5. Wetland delineation is a challenging exercise on the HHGD; and
6. The soils of the HHGD, as those of the site, are highly erodible, especially when saturated with water.

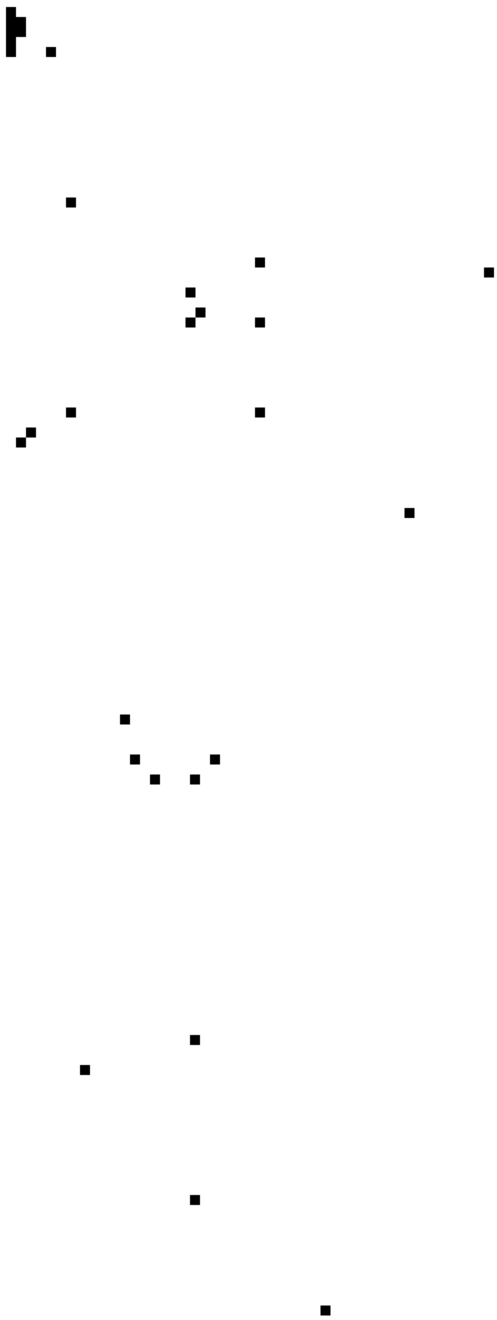


Figure 17 The nomograph by Wischmeier, Johnson and Cross (1971) that allows a quick assessment of the K factor of soil erodibility

5. SITE SURVEY RESULTS AND DISCUSSION

5.1 PRESENCE OF WETLAND / STATUS

Holding 32 is situated on a valley bottom wetland system that forms part of a larger drainage feature (**Figure 18**). The soils on the site are considered to be wetland soils with distinct signs of wetness (morphological). From the soils and historic aerial photographs it can be concluded with a large degree of confidence that the site constitutes a seasonal wetland (through seasonal saturation of soils) with associated temporary wetlands on the fringes. There are no signs in the soils or from the aerial photographs that the site has any section that qualifies (naturally) as a permanent wetland.

Figure 18 Image of the catchment indicating the position of roads and Holding 32 superimposed on the drainage features

5.2 ARTIFICIAL MODIFIERS ON SITE AND IMMEDIATE CATCHMENT

From recent Google Earth images (various dates) a rough wetland delineation was conducted. **Figure 19** provides an indication of the approximate original wetland area. This delineation exercise was based on the interpretation of the image alone as there has been significant human influence in the wetland area (evident in **Figure 19**) with a subsequent drastic alteration in soils, vegetation and hydrological regime. The following drastic impacts (all indicated by coloured arrows) have been identified:

1. Warehousing(?) buildings (red arrows)
2. Dams (several) (blue arrows)
3. Roads (yellow arrows)
4. Residential/small holder dwellings (red arrows)
5. Alien invasive tree species (green arrows)
6. Trenches and other flow alterations (**Figure 20** – red arrows)

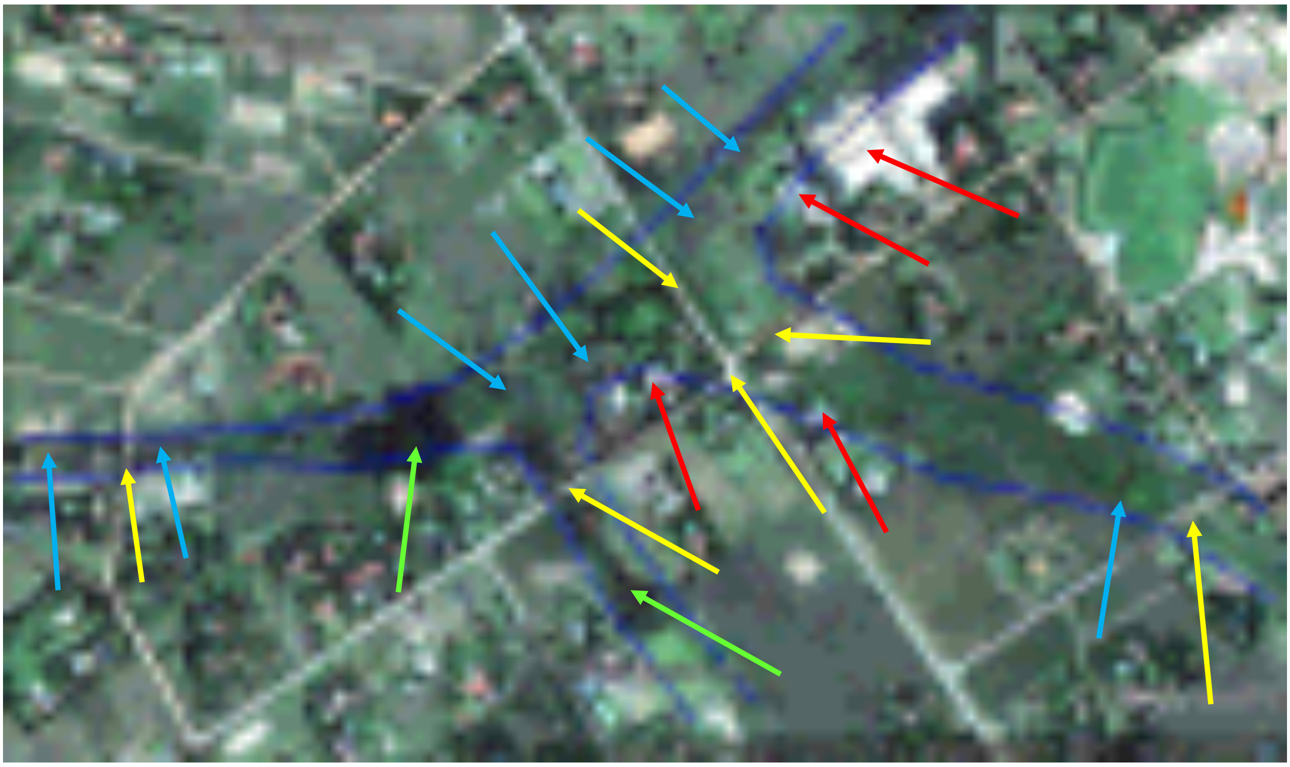


Figure 19 Approximate original wetland area with human impacts indicated by coloured arrows

Figure 20 Area surrounding (and including) Holding 32 with indicated flow alterations in the form of trenches and erosion

5.3 STORM WATER INFRASTRUCTURE AND IMPACTS

Storm water from one drainage depression (flowing north-west) is channelled and concentrated onto the site through a culvert under Mc Innes road (**Figures 21** to **24**). On the site itself an old trench channelled the water past the residential buildings (**Figures 25** and **26**). The trench is also evident on an old Google Earth image from 2004 (**Figure 27**). In the same image other trenches are evident. These trenches appear to have been used for diverting and channelling storm water around the site already in 2004. The other source of storm water on the site is from the main depression that has been dammed upstream in several places. **Figure 28** indicates the dam to the east of Zinnia Road one hour after a storm event on the 31st of January 2014. The water remaining one hour after the storm event is evident in **Figures 29** and **30**. This water accumulates from runoff along Rena Road (**Figure 31**) and the drainage line running from the east (**Figure 32**). All this water runs onto the property immediately upslope from Holding 32 and then joins up with the drainage feature discussed above on Holding 32.

A distinct head-cut erosion gulley is found on the site as well as the downslope property (amongst the poplar trees) (**Figures 33** and **34**). This is an indication of a drastic change in hydrological regime on the site in the form of increased water flow peaks and volumes.

The drainage feature downslope crosses Macintyre Road where a large volume of storm water was evident on the 31st of January (**Figure 35**). In the same figure distinct sedimentation (eroded material and road grit) of the lowest part on the road and drainage feature is evident due to poor road grading practices. The material was thick enough after the storm event to trap a vehicle (**Figure 35**). **Figures 36** to **38** indicate the volume of storm water below Macintyre road in dams and structures.

Figure 21 Culvert under Mc Innes road

Figure 22 Culvert under Mc Innes road receiving water from the road itself (1 hour after a storm event on the 31st of January 2014)

Figure 23 Culvert under Mc Innes road receiving water from the drainage line and surrounding properties (1 hour after a storm event on the 31st of January 2014)

Figure 24 Culvert under Mc Innes road releasing water into the trench on Holding 32 (1 hour after a storm event on the 31st of January 2014)

Figure 25 Trench for storm water on the site

Figure 26 Trench for storm water on the site


Figure 27 Existing trenches on site (red arrows)


Figure 28 Dam to the east of Zinnia Road overflowing one hour after a storm event on the 31st of January 2014

Figure 29 Storm water still present in Zinnia Road one hour after a storm event on the 31st of January 2014

Figure 30 Storm water still present in Zinnia Road one hour after a storm event on the 31st of January 2014

Figure 31 Storm water running down Rena Road one hour after a storm event on the 31st of January 2014

Figure 32 Storm water running onto and under Zinnia Road still present in Zinnia Road from the drainage line running to the east (one hour after a storm event on the 31st of January 2014)


Figure 33 Erosion gulley at the downslope side of the site


Figure 34 Erosion gulley at the downslope side of the site

Figure 35 Sedimentation (on road verge) and storm water on Macintyre road following on a storm event on the 31st of January 2014

Figure 36 Storm water inflow into a dam on Macintyre road following on a storm event on the 31st of January 2014

Figure 37 Storm water outflow

Figure 35 Storm water outflow

5.4 Newly Constructed Dam

The newly "constructed" dam is situated in the centre of the site and the existing dam upslope is immediately north-east of the new dam (**Figure 36**). The new dam holds water and has a stabilising structure for overflow (**Figure 37** to **39**).

Figure 36 New dam on the site with the existing dam immediately north-east

Figure 37 New dam on the site

Figure 38 New dam on the site

Figure 39 New dam on the site with stabilised overflow

5.5 STORM WATER VOLUMES (CONCEPTUAL)

The volume of water flowing through the landscape is a function of the landscape characteristics, soil (and especially soil surface) properties as well as rainfall intensity and spread. The catchment of the drainage feature running through Holding 32 is 1110 ha. If it is assumed that a rainfall event generates the equivalent of 2 mm runoff on the entire catchment the volume of water flowing through Holding 32 will be (1110 ha X 10000 m^2 per hectare X 0.002 m =) 22200 m^3 (cubic meters). If it is assumed that it takes one hour for the water to drain through and average flow rate is (22200 m^3 / 3600 s =) **6.2 m^3** per second for the hour. If the runoff doubles due to paving and roads with the other parameters remaining the same the flow rate will increase to **12.4 m^3** for the hour. In practice it is found that the spike is higher at the peak of the rainfall event and immediately after and it tapers off systematically. It can therefore be assumed with certainty that the site (Holding 32) will be subjected to significant storm water flows that is exacerbated by the construction of roads and paved/sealed area.

5.6 SOIL EROSION PRESSURES

The first characteristic of Holding 32 is the fact that it lies at the "outflow" of a relatively large catchment area (1110 ha) (**Figure 18**). The soils in the survey area follow the trends and distribution as explained under sections **4.4.4** and **4.4.5** and will therefore not be discussed in further detail here. The essence of the matter is that the soils on the site would have been stable under natural conditions with the hydrological characteristics of the catchment. The road network currently established on the catchment area is also indicated in **Figure 18**. As explained under section **4.4.8** the roads (and other surface sealing developments) in the catchment act as preferential flow paths for water through the impeding of infiltration as well as channelling to the lowest points. The volume of water flowing through the landscape (surface) is now not subject to the infiltration characteristics of the soils any more but rather to the design and alignment of the roads and storm water inlets (if present). A distinct spike in flow following rainfall events is therefore experienced throughout the network and these spikes are especially distinct in areas where the water is released to natural depressions and drainage features. The alteration in water volume and flow leads to a drastically altered water energy regime where it enters the natural environment. In these positions as well as other areas where the water concentrates distinct and severe erosion pressures are exerted on the natural soil material (see section **4.4.9**). The resultant effect of the alteration in the hydrology of the landscape is therefore experienced as more pronounced flooding as well as accelerated flows of water. Both of these are instrumental in leading to a higher prevalence of water saturation in soil with associated accelerated soil erosion.

Although current bylaws and legislation allow for the disposal of storm water into the lowest parts of the landscape it appears that there is a glaring omission in the statutory tools to account for and manage the impacts on drainage features and erodible soil environments. However, if the intention of the statutory environment is to account for such impacts then the omission lies with the relevant authorities tasked to implement such management practices. Holding 32 is a very clear example of a situation where the relevant authorities have not accepted due responsibility for managing the results of increasing water flow pressures on private land owners. Holding 32 is also an example of a plethora of such cases on the HHGD where wetlands are impacted negatively through poorly planned storm water attenuation.

5.7 CURRENT STORM WATER MANAGEMENT LIMITATIONS

The management of storm water in the catchment is a problem as there is a lack of adequate attenuation capacity. Even though many dams are located in the drainage features these cannot a act as attenuation structures as most of them are full to capacity. In large rainfall events these dams cannot contain more water and therefore release water downstream. The newly constructed dam on the site suffers the same limitation.

6. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn from the investigation:

1. Holding 32 is situated in a drainage depression that has a catchment area of 1110 ha.
2. Holding 32 is situated in an area that can be described as a seasonal wetland. The determination of the wetland boundary is difficult due to a large range of human activities in the past (artificial modifiers).
3. The catchment area is characterised by increasing human influence in the form of roads and paved/sealed areas. Consequently there is a distinct increase in runoff rates following on rainfall events.
4. Holding 32 has a new dam that was constructed as an attempt at dealing with storm water running through the site.

The following recommendations are made:

1. The authorities should engage with Ms Moyse regarding the dam and the storm water flows through Holding 32. The terms of engagement should focus on the increased storm water release onto the site by specific road and storm water infrastructure surrounding the site.
2. An additional motivation for the engagement should be the settling of the prosecution as I am not convinced that the authorities have a sound case, especially considering the extent of engagement that Ms Moyse has already had with the authorities.
3. The dam on the site is not adequate for the management of storm water. Ideally the dam should have a low water level and with several outflows designed to release water at differential rates. The dam design should be conducted by a suitably qualified engineer.
4. It is recommended that the other dams in the catchment be adapted to act as storm water management structures, even if it is only to a limited degree so as to not compromise the status of such dams.
5. Due to the benefit of a properly designed storm water attenuation structure on the site it is recommended that the cost for such development be carried by the entities charged with storm water management in the area.
6. The dam wall and sections should be vegetated to ensure stability of side slopes and areas as well as to minimise sediment generation.

REFERENCES

Boehner, J., Koethe, R. Conrad, O., Gross, J., Ringeler, A., Selige, T. 2002: Soil Regionalisation by Means of Terrain Analysis and Process Parameterisation. In: Micheli, E., Nachtergaele, F., Montanarella, L. [Ed.]: Soil Classification 2001. European Soil Bureau, Research Report No. 7, EUR 20398 EN, Luxembourg. pp.213-222.

Brady, N.C. and Weil, R.P. 1999. *The Nature and Properties of Soils*. Twelfth edition. Upper Saddle River, New Jersey: Prentice Hall.

Department of Water Affairs and Forestry (DWAF). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Hillel, D. 1982. Introduction to soil physics. Acedemic Press, INC. Harcourt Brace Javonovich, Publishers.

Jenny, H. 1941. Factors of soil formation. New York, NY, USA: McGraw-Hill Book Company, p 281

Land Type Survey Staff. (1972 – 2006). *Land Types of South Africa: Digital map (1:250 000 scale) and soil inventory databases*. ARC-Institute for Soil, Climate and Water, Pretoria.

MacVicar, C.N. et al. 1977. *Soil Classification. A binomial system for South Africa.* Sci. Bull. 390. Dep. Agric. Tech. Serv., Repub. S. Afr., Pretoria.

Soil Classification Working Group. 1991. Soil Classification. A taxonomic system for South Africa. *Mem. Agric. Nat. Resour. S.Afr.* No.15. Pretoria.

Wischmeier, W.H., C.B. Johnson and B.V. Cross. 1971. A Soil Erodibility Nomograph for Farm Land and Construction Sites. J. Soil Water Conserv. 26: 189 – 193.

Annexure F(ii)

WETLAND DELINEATION
REPORT

REPORT

WETLAND DELINEATION AND MANAGEMENT REPORT:

PORTION 155 OF THE FARM ZEVENFONTEIN 407-JR, GAUTENG PROVINCE

21st May, 2014

Compiled by:
J.H. van der Waals
(PhD Soil Science, Pr.Sci.Nat.)
Member of:
Soil Science Society of South Africa (SSSSA)

Accredited member of:
South African Soil Surveyors Organisation (SASSO)

Registered with:
The South African Council for Natural Scientific Professions
Registration number: 400106/08

Declaration

I, Johan Hilgard van der Waals, declare that:

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing
  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

TABLE OF CONTENTS

WETLAND DELINEATION AND MANAGEMENT REPORT: PORTION 155 OF THE FARM ZEVENFONTEIN 407-JR, GAUTENG PROVINCE

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Terra Soil Science (TSS) was appointed by World of Coaching Properties (Pty) Ltd to conduct a soil based wetland delineation of Portion 155 of the Farm Zevenfontein 407-JR in the Gauteng Province. The purpose of the wetland delineation exercise is to determine the extent of the wetlands in a highly disturbed area as well as to propose mitigation and management measures for the rehabilitation of the site.

Soil development is a slow process and therefore soil characteristics can be used to accurately describe and delineate wetlands that have been present for thousands of years. A proper understanding of soil forming factors and soil classification is required however to be able to interpret specific site soil data and to delineate wetlands and describe wetland functioning. A detailed description of these processes is provided in the report.

1.2 AIM OF THIS REPORT

The aim of this report is to provide a wetland delineation result for Portion 155 within the context of the broader problems and challenges faced on the Halfway House Granite Dome (HHGD) in terms of wetland impacts of current and future land uses.

1.3 DISCLAIMER

This report was generated under the regulations of NEMA (National Environmental Management Act) that guides the appointment of specialists. The essence of the regulations are 1) independence, 2) specialisation and 3) duty to the regulator. The independent specialist has, in accordance with the regulations, a duty to the competent authority to disclose all matters related to the specific investigation should he be requested to do such (refer to declaration above).

It is accepted that this report can be submitted for peer review (as the regulations also allow for such). However, the intention of this report is not to function as one of several attempts by applicants to obtain favourable delineation outcomes. Rather, the report is aimed at addressing specific site conditions in the context of current legislation, guidelines and best practice with the ultimate aim of ensuring the conservation and adequate management of the water resource on the specific site.

Due to the specific legal liabilities wetland specialists face when conducting wetland delineations and assessments this author reserves the right to, in the event that this report becomes part of a delineation comparison exercise between specialists, submit the report to the competent authorities, without entering into protracted correspondence with the client, as an independent report.

1.4 METHODOLOGY

The report was generated through:

1. The collection and presentation of baseline land type and topographic data for the site;
2. The thorough consideration of the statutory context of wetlands and the process of wetland delineation;
3. The identification of water related landscape parameters (conceptual and real) for the site;
4. Aerial photograph interpretation of the site;
5. Assessment of historical impacts and changes on the site through the accessing of various historical aerial photographs and topographic maps;
6. Focused soil and site survey in terms of soil properties as well as drainage feature properties; and
7. Presentation of the findings of the various components of the investigation.

2. SITE LOCALITY AND DESCRIPTION

2.1 SURVEY AREA BOUNDARY

The site lies between 25° 58' 48'' and 25° 59' 08'' south and 28° 01' 39'' and 28° 02' 18'' east in Glenferness in the Gauteng Province (**Figure 1**).

2.2 GEOLOGY AND SOILS

The underlying material is granite and migmatite of the Halfway House Granite Dome and as such well drained coarse sandy soils of variable to shallow depth are expected in the upper parts of the landscape and bleached sandy soils of variable depth, with occasional signs of water saturation, are expected in mid-slope to valley bottom positions. Midslope wetlands often exhibit deeper but poorly drained soils.

2.3 LAND TYPE DATA

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

Figure 1 Locality of the survey site

Land Parcel 3 falls into the **Bb1** land type (Land Type Survey Staff, 1972 - 2006) with F**igure 2** providing the land type distribution for the site. The catchment of the drainage feature on the site falls into the Bb1 land type as well. The **Bb1** and **Bb2** land types are restricted to the Halfway House Granite Dome with the typical bleached sandy soils (details provided later in the report).

Figure 2 Land type map of the survey site and surrounding area

2.3 TOPOGRAPHY

The topography of the site and catchment is undulating with incised and often eroded stream channels especially in the lower reaches of drainage features. The contour map for the site is provided in **Figure 3**. From the contour data a digital elevation model (DEM) (**Figure 4**) was generated.

Figure 3 Contours of the survey area superimposed on an aerial photograph

The site (**Figure 2**) has a south-south westerly aspect and is situated between 1380 and 1420 meters above mean sea level. On all sides the site is bordered by low key developments and agricultural activities. A distinct drainage depression starts above the site and runs in a southerly direction to a stream on the site sometimes erroneously referred to the Moddersspruit.

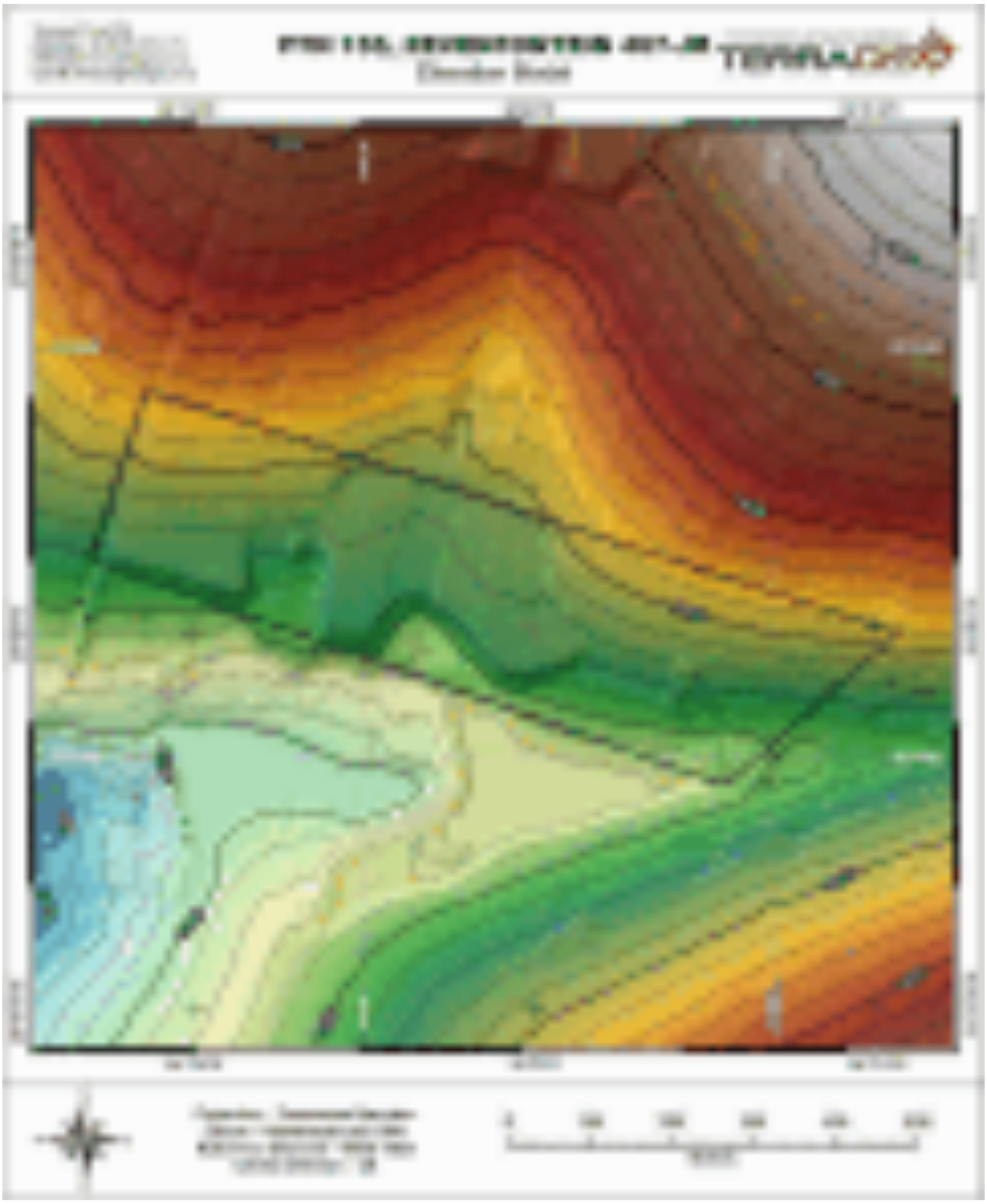


Figure 4 DEM of the survey site

3. PROBLEM STATEMENT

The Halfway House Granite Dome (HHGD) is particularly problematic regarding the expression of morphological signs of wetness in soils as well as erodibility of soils in hydrologically altered environments. This investigation will focus on the delineation of the wetland features based on soil hydromorphy and landscape hydrology as well as address the causes and results of erosion through a dedicated assessment and elucidation of pedohydrological processes experienced in the catchment and on the site.

4. WETLANDS: STATUTORY CONTEXT

4.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

4.2 WATERCOURSE DEFINITION

"Catchment" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"…, in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;"

"Watercourse" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"*(a)* a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette*, declare to be a water course,
and a reference to a watercourse includes, where relevant, its bed and banks;"

4.3 THE WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "…manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- Terrain Unit Indicator. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.
- Soil Form Indicator. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- Soil Wetness Indicator. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of mottles are the two main criteria for the identification of soils that are periodically or permanently wet.
- Vegetation Indicator. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands. The applicability of these guidelines in the context of the survey site will be discussed in further detail later in the report.

Due to numerous problems with the delineation of wetlands there are a plethora of courses being presented to teach wetland practitioners and laymen the required techniques. Most of the courses and practitioners focus on ecological or vegetation characteristics of landscapes and soil characteristics are often interpreted incorrectly due to a lacking soil science background of these practitioners. As such this author regularly presents, in conjunction with a colleague (Prof. Cornie van Huysteen) from the University of the Free Sate, a course on the aspects related to soil classification and wetland delineation.

4.4 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES.

The following are specific quotes from the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999).

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

From Appendix W1 (Ecoregional Typing for Wetland Ecosystems)

Artificial modifiers are explained namely:
"Many wetlands are man-made, while others have been modified from a natural state to some degree by the activities of humans. Since the nature of these alterations often greatly influences the character of such habitats, the inclusion of modifying terms to accommodate human influence is important. In addition, many human modifications, such as dam walls and drainage ditches, are visible in aerial photographs and can be easily mapped. The following Artificial Modifiers are defined and can be used singly or in combination wherever they apply to wetlands:
Farmed: the soil surface has been physically altered for crop production, but hydrophytes will become reestablished if farming is discontinued
Artificial: substrates placed by humans, using either natural materials such as dredge spoils or synthetic materials such as concrete. Jetties and breakwaters are examples of Non-vegetated Artificial habitats
Excavated: habitat lies within an excavated basin or channel
Diked/Impounded: created or modified by an artificial barrier which obstructs the inflow or outflow of water
Partially Drained: the water level has been artificially lowered, usually by means of ditches, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes."

4.5 CHALLENGES REGARDING WETLAND DELINEATION ON THE HALFWAY HOUSE GRANITE DOME

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena).

4.5.1 Pedogenesis

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941(:

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

4.5.2 Water Movement in the Soil Profile

In a specific soil profile, water can move upwards (through capillary movement), horizontally (owing to matric suction) and downwards under the influence of gravity.

The following needs to be highlighted in order to discuss water movement in soil:

- Capillary rise refers to the process where water rises from a deeper lying section of the soil profile to the soil surface or to a section closer to the soil surface. Soil pores can be regarded as miniature tubes. Water rises into these tubes owing to the adhesion (adsorption) of water molecules onto solid mineral surfaces and the surface tension of water.

  The height of the rise is inversely proportional to the radius of the soil pore and the density of the liquid (water). It is also directly proportional to the liquid's surface tension and the degree of its adhesive attraction. In a soil-water system the following simplified equation can be used to calculate this rise:

  $$\text{Height} = 0.15/\text{radius}$$

  Usually the eventual height of rise is greater in fine textured soil, but the rate of flow may be slower (Brady and Weil, 1999; Hillel, 1983).

- Matric potential or suction refers to the attraction of water to solid surfaces. Matric potential is operational in unsaturated soil above the water table while pressure potential refers to water in saturated soil or below the water table. Matric potential is always expressed as a negative value and pressure potential as a positive value.

  Matric potential influences soil moisture retention and soil water movement. Differences in the matric potential of adjoining zones of a soil results in the movement of water from the moist zone (high state of energy) to the dry zone (low state of energy) or from large pores to small pores.

  The maximum amount of water that a soil profile can hold before leaching occurs is called the field capacity of the soil. At a point of water saturation, a soil exhibits an energy state of 0 $J.kg^{-1}$. Field capacity usually falls within a range of -15 to -30 $J.kg^{-1}$ with fine textured soils storing larger amounts of water (Brady and Weil, 1999; Hillel, 1983).

- Gravity acts on water in the soil profile in the same way as it acts on any other body; it attracts towards earth's centre. The gravitational potential of soil water can be expressed as:

  $$\text{Gravitational potential} = \text{Gravity} \times \text{Height}$$

  Following heavy rainfall, gravity plays an important part in the removal of excess water from the upper horizons of the soil profile and recharging groundwater sources below.

  Excess water, or water subject to leaching, is the amount of water that falls between soil saturation (0 $J.kg^{-1}$) or oversaturation (> 0 $J.kg^{-1}$), in the case of heavy rainfall resulting in a pressure potential, and field capacity (-15 to -30 $J.kg^{-1}$). This amount of water differs according to soil type, structure and texture (Brady and Weil, 1999; Hillel, 1983).

- Under some conditions, at least part of the soil profile may be saturated with water, resulting in so-called saturated flow of water. The lower portions of poorly drained soils are often saturated, as are well-drained soils above stratified (layers differing in soil texture) or impermeable layers after rainfall.

  The quantity of water that flows through a saturated column of soil can be calculated using Darcy's law:

  $$Q = Ksat.A.\Delta P/L$$

  Where Q represents the quantity of water per unit time, Ksat is the saturated hydraulic conductivity, A is the cross sectional area of the column through which the water flows, ΔP is the hydrostatic pressure difference from the top to the bottom of the column, and L is the length of the column.

  Saturated flow of water does not only occur downwards, but also horizontally and upwards. Horizontal and upward flows are not quite as rapid as downward flow. The latter is aided by gravity (Brady and Weil, 1999; Hillel, 1983).

- Mostly, water movement in soil is ascribed to the unsaturated flow of water. This is a much more complex scenario than water flow under saturated conditions. Under unsaturated conditions only the fine micropores are filled with water whereas the macropores are filled with air. The water content, and the force with which water molecules are held by soil surfaces, can also vary considerably. The latter makes it difficult to assess the rate and direction of water flow. The driving force behind unsaturated water flow is matric potential. Water movement will be from a moist to a drier zone (Brady and Weil, 1999; Hillel, 1983).

The following processes influence the amount of water to be leached from a soil profile:

- Infiltration is the process by which water enters the soil pores and becomes soil water. The rate at which water can enter the soil is termed infiltration tempo and is calculated as follows:

  $$I = Q/A.t$$

  Where I represents infiltration tempo ($m.s^{-1}$), Q is the volume quantity of infiltrating water (m^3), A is the area of the soil surface exposed to infiltration (m^2), and t is time (s).

  If the soil is quite dry when exposed to water, the macropores will be open to conduct water into the soil profile. Soils that exhibit a high 2:1 clay content (swelling-shrinking clays) will exhibit a high rate of infiltration initially. However, as infiltration proceeds, the macropores will become saturated and cracks, caused by dried out 2:1 clay, will swell and close, thus leading to a decline in infiltration (Brady and Weil, 1999; Hillel, 1983).

- Percolation is the process by which water moves downward in the soil profile. Saturated and unsaturated water flow is involved in the process of percolation, while the rate of percolation is determined by the hydraulic conductivity of the soil.

  During a rain storm, especially the down pouring of heavy rain, water movement near the soil surface mainly occurs in the form of saturated flow in response to gravity. A sharp boundary, referred to as the wetting front, usually appears between the wet soil and the underlying dry soil. At the wetting front, water is moving into the underlying soil in response to both matric and gravitational potential. During light rain, water movement at the soil surface may be ascribed to unsaturated flow (Brady and Weil, 1999; Hillel, 1983).

  The fact that water percolates through the soil profile by unsaturated flow has certain ramifications when an abrupt change in soil texture occurs (Brady and Weil, 1999; Hillel, 1983). A layer of course sand, underlying a fine textured soil, will impede downward movement of water. The macropores of the coarse textured sand offer less attraction to the water molecules than the macropores of the fine textured soil. When the unsaturated wetting front reaches the coarse sand, the matric potential is lower in the sand than in the overlying material. Water always moves from a higher to a lower state of energy. The water can, therefore, not move into the coarse textured sand. Eventually, the downward moving water will accumulate above the sand layer and nearly saturate the fine textured soil. Once this occurs, the water will be held so loosely that gravitational forces will be able to drag the water into the sand layer (Brady and Weil, 1999; Hillel, 1983).

  A coarse layer of sand in an otherwise fine textured soil profile will also inhibit the rise of water by capillary movement (Brady and Weil, 1999; Hillel, 1983).

Field observations and laboratory based analysis can aid in assessing the soil-water relations of an area. The South African soil classification system (Soil Classification Working Group, 1991.) comments on certain field observable characteristics that shed light on water movement in soil. The more important of these are:

- Soil horizons that show clear signs of leaching such as the E-horizon – an horizon where predominantly lateral water movement has led to the mobilisation and transport of sesquioxide minerals and the removal of clay material;
- Soil horizons that show clear signs of a fluctuating water table where Fe and Mn mottles, amongst other characteristics, indicate alternating conditions of reduction and oxidation (soft plinthic B-horizon);
- Soil horizons where grey colouration (Fe reduction and redox depletion), in an otherwise yellowish or reddish matrix, indicate saturated (or close to saturated) water flow for at least three months of the year (Unconsolidated/Unspecified material with signs of wetness);
- Soil horizons that are uniform in colouration and indicative of well-drained and aerated (oxidising) conditions (e.g. yellow brown apedal B-horizon).

4.5.3 Water Movement in the Landscape

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape there are a number of factors determining the paths along which this water moves. **Figure 5** provides a simplified schematic representation of an idealised landscape (in "profile curvature". The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile.

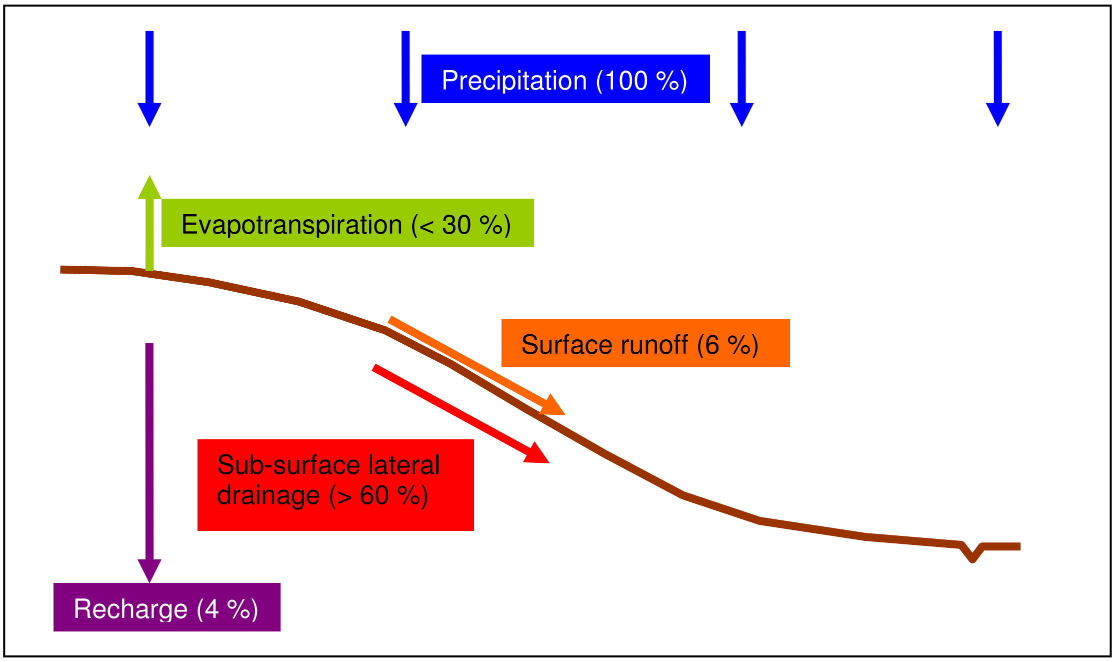


Figure 5 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

Flow paths through soil and geological strata, referred to as “interflow” or “hillslope water”, are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as “redox morphology”. In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 6** provides a schematic representation of the different flow regimes that are usually encountered. The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

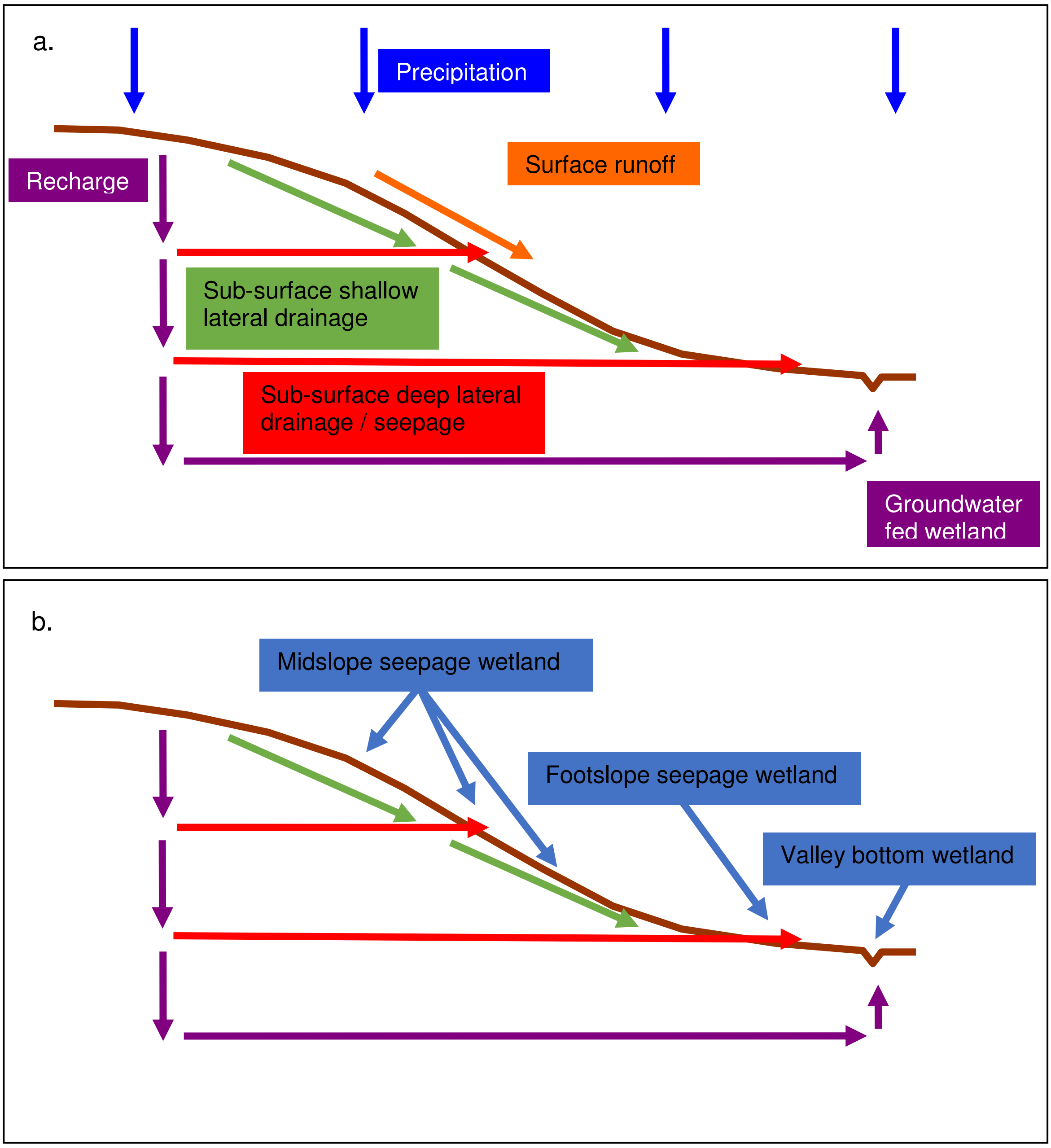


Figure 6 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 7** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

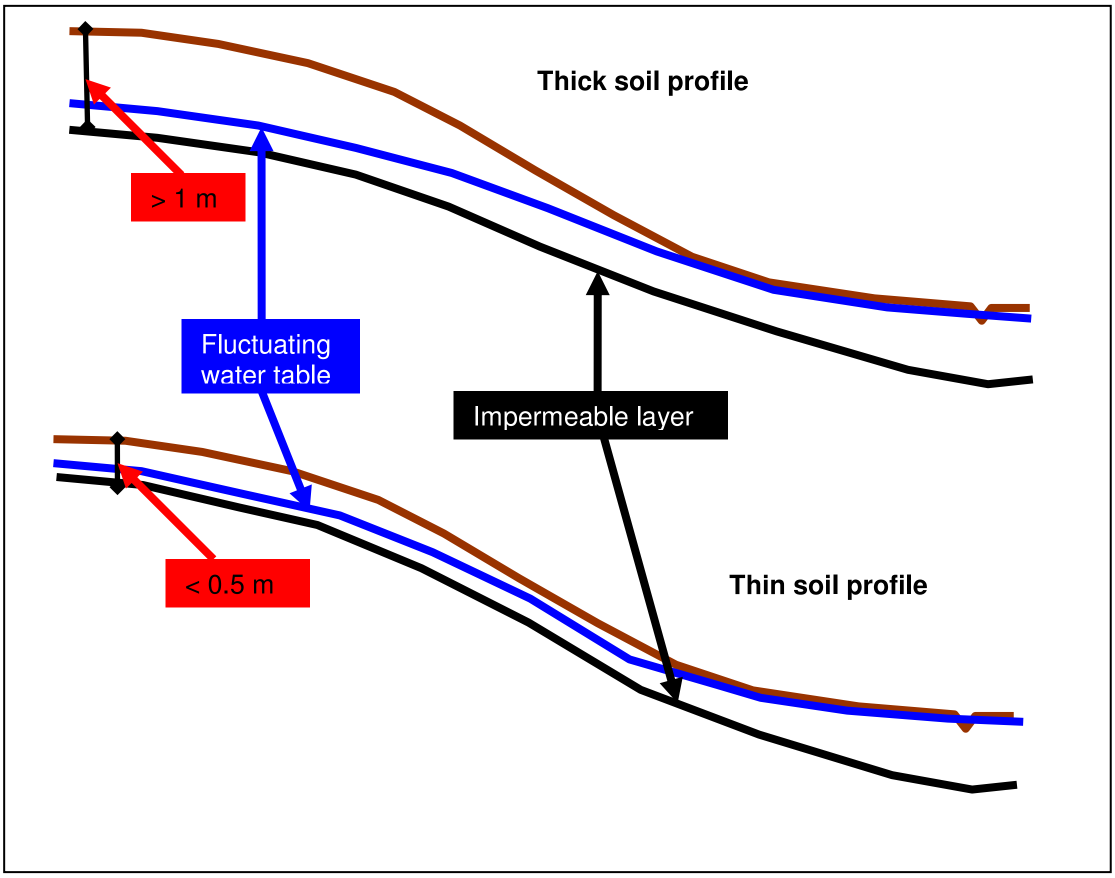


Figure 7 The difference in water flow between a dominantly thick and dominantly thin soil profile.

4.5.4 The Catena Concept

Here it is important to take note of the "catena" concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 8** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

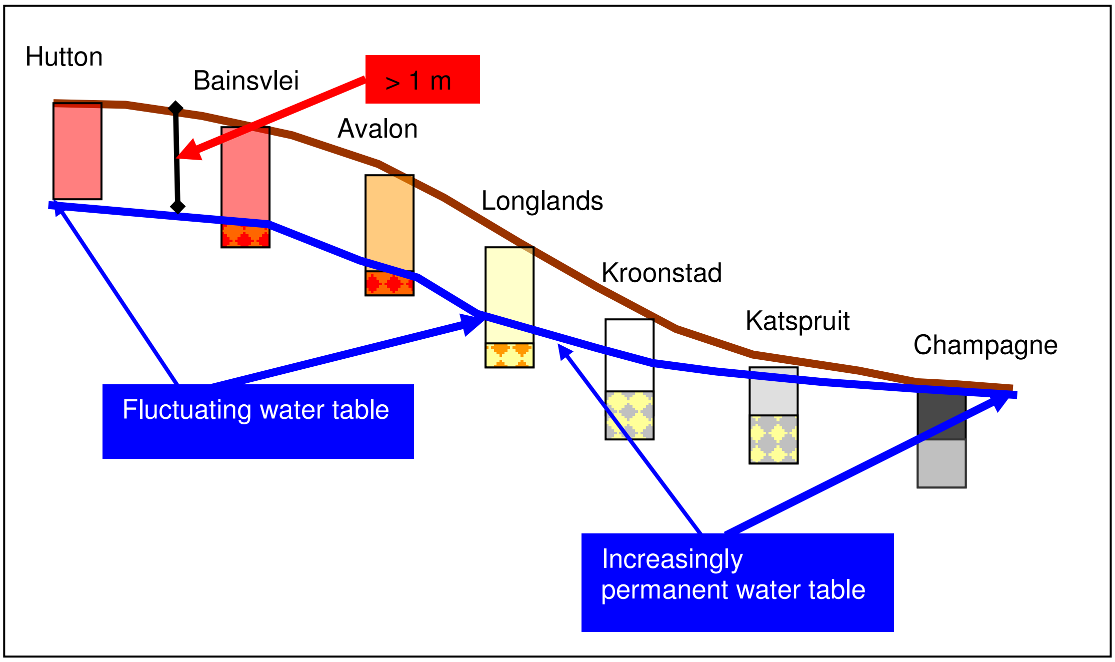


Figure 8 Idealised catena on a quartz rich parent material.

4.5.5 The Halfway House Granite Dome Catena

The Halfway House Granite Catena is a well-studied example of a quartz dominated Bb catena. As a result of the elucidation of the wetland delineation parameters and challenges in the specialist testimony in the matter between The State versus 1. Stefan Frylinck and 2. Mpofu Environmental Solutions CC (Case Number 14/1740/2010) it will be discussed in further detail here.

The typical catena that forms on the Halfway House granite differs from the idealised one discussed above in that the landscape is an old stable one, often with extensive subsoil ferricrete (or hard plinthic) layers where perched water tables occur. The parent material is relatively hard and the ferricrete layer is especially resistant to weathering. The quartz rich parent materials have a very low Fe content/"reserve", and together with the age of the material leads to the dominance of bleached sandy soils. The implication is that the whole catena is dominated by bleached sandy soils with a distinct and shallow zone of water fluctuation. This zone is often comprised of a high frequency of Fe/Mn concretions and sometimes exhibits feint mottles. In lower lying areas the soils tend to be deeper due to colluvial accumulation of sandy soil material but then exhibit more distinct signs of wetness (and pedogenesis). **Figure 9** provides a schematic representation of the catena.

The essence of this catena is that the soils are predominantly less than 50 cm thick and as such have a fluctuating water table (mimicking rainfall events) within 50 cm of the soil surface. One of the main criteria used during wetland delineation exercises as stipulated by the guidelines (DWAF, 2005) is the presence of mottles within 50 cm of the soil surface (temporary and seasonal wetland zones). Even from a theoretical point of view the guidelines cannot be applied to the above described catena as soils at the crest of the landscape would already qualify as temporary wetland zone soils (upon request many such examples can be supplied). The practical implication of this statement as well as practical examples will be discussed in the next section.

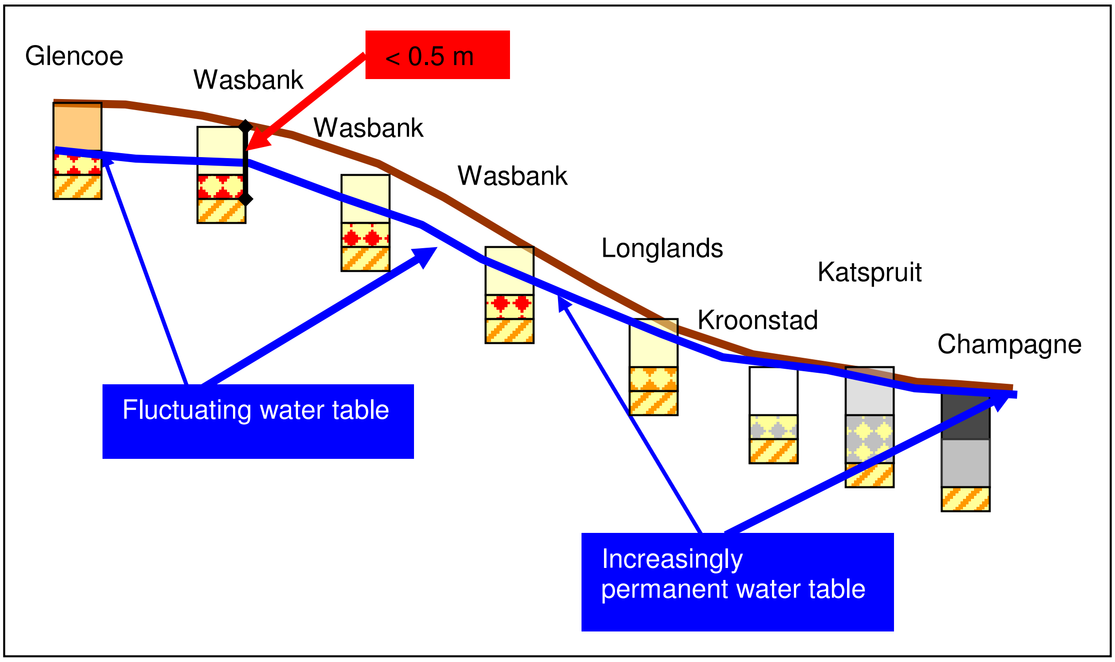


Figure 9 Schematic representation of a Halfway House Granite catena.

4.5.6 Convex Versus Concave Landscapes in the Halfway House Granite Catena

An additional factor of variation in all landscapes is the shape of the landscape along contours (referred to a "plan curvature"). Landscapes can be either concave or convex, or flat. The main difference between these landscapes lies in the fact that a convex landscape is essentially a watershed with water flowing in diverging directions with a subsequent occurrence of "dryer" soil conditions. In a concave landscape water flows in converging directions and soils often exhibit the wetter conditions of "signs of wetness" such as grey colours, organic matter and subsurface clay accumulation. **Figure 10** presents the difference between these landscapes in terms of typical soil forms encountered on the Halfway House granites. In the convex landscape the subsurface flow of water removes clays and other weathering products (including Fe) in such a way that the midslope position soils exhibit an increasing degree of bleaching and relative accumulation of quartz (E-horizons). In the concave landscapes clays and weathering products are transported through the soils into a zone of accumulation where soils start exhibiting properties of clay and Fe accumulation. In addition, coarse sandy soils in convex environments tend to be thinner due to the removal of sand particles through erosion and soils in concave environments tend to be thicker due to colluvial accumulation of material transported from upslope positions. Similar patterns are observed for other geological areas with the variation being consistent with the soil variation in the catena.

Often these concave and convex topographical environments occur in close proximity or in one topographical sequence of soils. This is often found where a convex upslope area changes into a concave environment as a drainage depression is reached (**Figure 11**). The processes in this landscape are the same as those described for the convex and concave landscapes above.

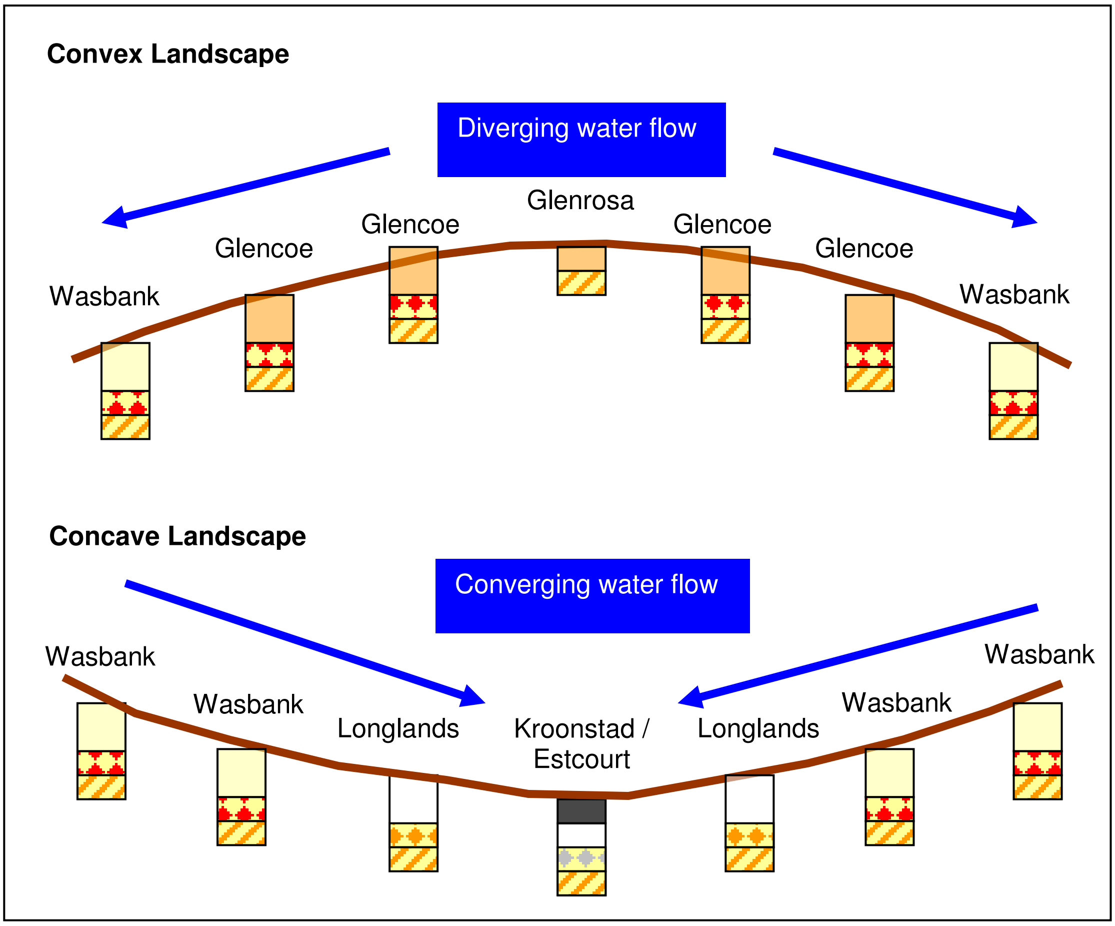


Figure 10 Schematic representation of the soils in convex and concave landscapes in the Halfway House Granite catena.

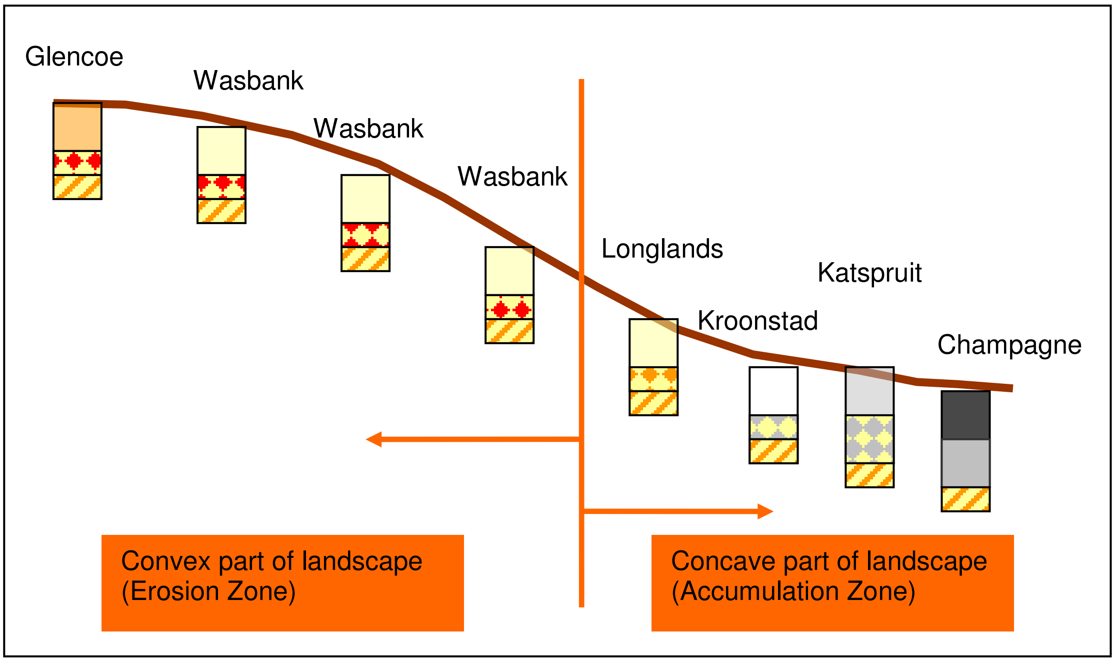


Figure 11 Schematic representation of the soils in a combined convex and concave landscape in the Halfway House Granite catena.

4.5.7 Implications for Wetland Delineation and Application of the Guidelines

When the 50 cm criterion is used to delineate wetlands in the HHGD environment, the soils in convex positions often “qualify” as temporary wetland soils due to their relatively thin profile and the presence of concretions (often weathering to yield “mottles”) within this zone. In conjunction with a low Fe content in the soils and subsequent bleached colours (as defined for E-horizons) in the matrix a very large proportion of the landscape “qualifies” as temporary wetland zones. On the other hand, the soils in the concave environments, especially in the centre of the drainage depression, tend to be thicker and the 50 cm criterion sometimes does not flag these soils as being wetland soils due to the depth of the signs of wetness (mottles) often occurring only at depths greater than 80 cm. Invariably these areas are always included in wetland delineations due to the terrain unit indicator flagging it as a wetland area and drainage feature.

The strict application of the wetland delineation guidelines in the Halfway House Granite area often leads to the identification of 70 % or more of a landscape as being part of a wetland. For this reason a more pragmatic approach is often followed in that the 50 cm criterion is not applied religiously. Rather, distinctly wet horizons and zones of clay accumulation within drainage depressions are identified as distinct wetland soils. The areas surrounding these are assigned to extensive seepage areas that are difficult to delineate and on which it is difficult to assign a realistic buffer area. The probable best practice is to assign a large buffer zone in which subsurface water flow is encouraged and conserved to lead to a steady but slow recharge of the wetland area, especially following rainfall events. In the case where development is to take place within this large buffer area it is preferred that a “functional buffer” approach be followed. This implies that development can take place within the buffer area but then only within strict guidelines regarding storm water management and mitigation as well as erosion prevention in order to minimise sediment transport into stream and drainage channels and depressions.

4.5.8 Implications for Wetland Conservation in Urban Environments

Whether an area is designated a wetland or not loses some of its relevance once drastic influences on landscape hydrology are considered. If wetlands are merely the expression of water in a landscape due to proximity to the land surface (viz. the 50 cm mottle criterion in the delineation guidelines) it follows that potentially large proportions of the water moving in the landscape could fall outside of this sphere – as discussed in detail above. **Figures 12** and **13** provide schematic representations (as contrasted with **Figure 6**) of water dynamics in urban environments with distinct excavations and surface sealing activities respectively.

Through the excavation of pits (**Figure 12**) for the construction of foundations for infrastructure or basements for buildings the shallow lateral flow paths in the landscape are severed. As discussed above these flow paths can account for up to 60 % of the volume of water entering the landscape in the form of precipitation. These severed flow paths often lead to the ponding of water upslope from the structure with a subsequent damp problem developing in buildings. Euphemistically we have coined the term “wet basement syndrome” (WBS) to describe the type of problem experienced extensively on the HHGD. A different impact is experienced once the surface of the land is sealed through paving (roads and parking areas) and the construction of buildings (in this case the roof provides the seal) (**Figure 13**). In this case the recharge of water into the soil and weathered rock experienced naturally is altered to an accumulation and concentration of water on the surface with a subsequent rapid flowing downslope. The current approach is to channel this water into storm water structures and to release it in the nearest low lying position in the landscape. These positions invariable correlate with drainage features and the result is accelerated erosion of such features due to a drastically altered peak flow regime.

The result of the above changes in landscape hydrology is the drastic alteration of flow dynamics and water volume spikes through wetlands. This leads to wetlands that become wetter and that experience vastly increased erosion pressures. The next section provides a perspective on the erodibility of the soils of the HHGD. It is important to note the correlation between increasing wetness, perching of water and erodibility.

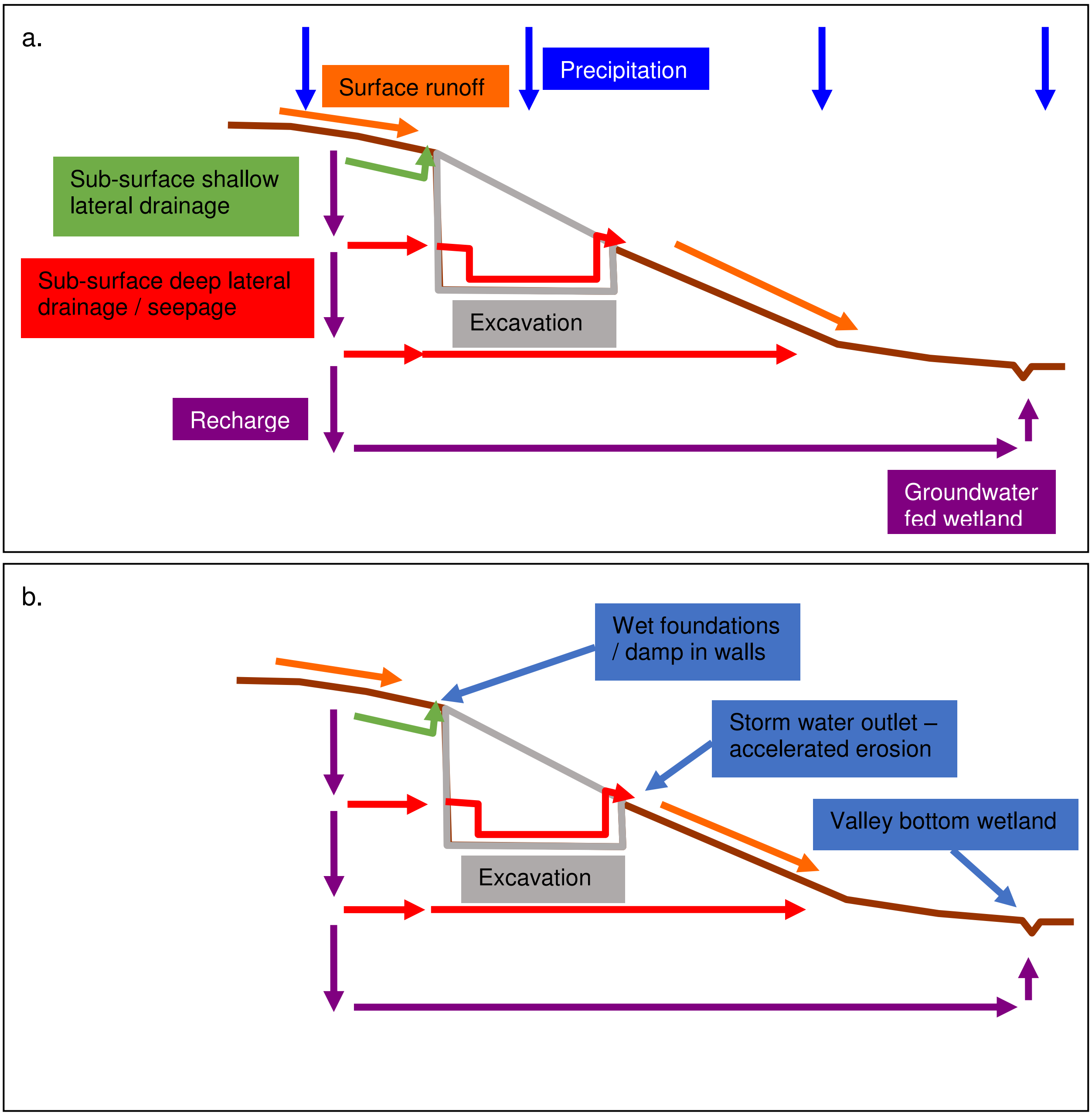


Figure 12 Different flow paths of water through a landscape with an excavated foundation (a) and typical wetland types associated with the altered water regime (b)

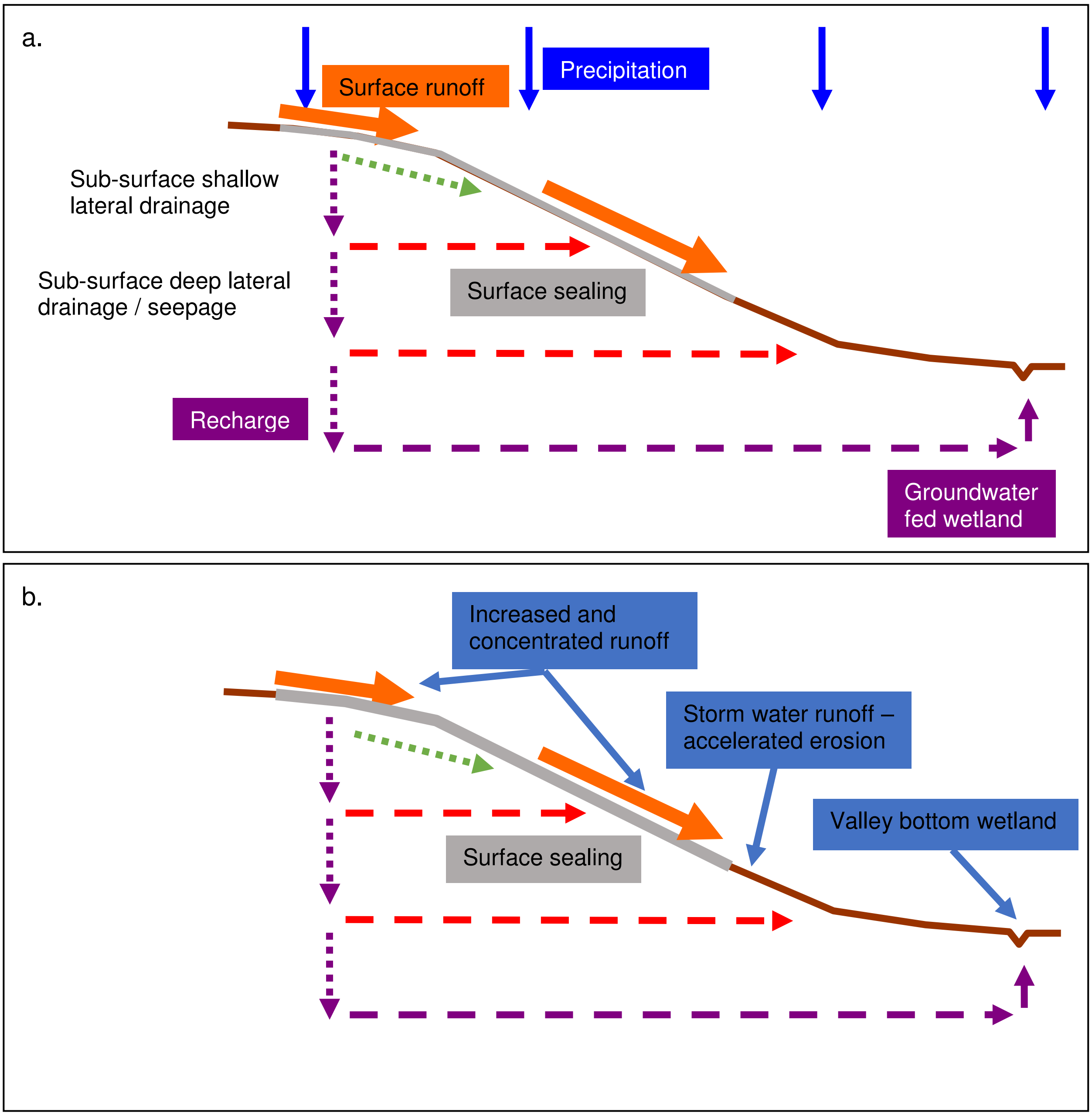


Figure 13 Different flow paths of water through a landscape with surface sealing (buildings and paving) (a) and typical wetland types associated with the altered water regime (b)

4.5.9 Soil Erosion on the Halfway House Granite Dome

Infiltration of water into a soil profile and the percolation rate of water in the soil are dependent on a number of factors with the dominant one being the soil's texture (**Table 1**). Permeability and the percolation of water through the soil profile are governed by the least permeable layer in the soil profile. The implication of this is that soil horizons that overlie horizons of low permeability (i.e. hard rock, hard plinthite, G-horizon) are likely to become saturated with water relatively quickly - particularly if the soil profile is shallow and a large amount of water is added. Another impermeable layer is one that is saturated with water and such a layer acts the same way as the ones mentioned earlier. In cases where internal drainage is hampered by an impermeable layer such as hard rock (the Dresden or Wasbank soil forms) evaporation and lateral water movement are the only processes that will drain the soil profile of water.

Infiltration of water into a soil profile is dependent on the factors leading to the downward movement of water. In cases where impermeable layers exist water will infiltrate into the profile until it is saturated. Once this point is reached water infiltration will cease and surface runoff will become the dominant water flow mechanism. A similar situation will develop if a soil has a slow infiltration rate of water due to fine texture, hardened or compacted layers and low hydraulic conductivity. When these soils are subjected to large volumes and rates of rainfall the rate of infiltration will be exceeded and excess water will flow downslope on the soil surface.

Table 1 Infiltration/permeability rates for soil textural classes (Wischmeier, Johnson & Cross 1971)

Texture class	Texture	Permeability Rate (mm/hour)	Permeability Class
Coarse	Gravel, coarse sand Sand, loamy sand	>508 152 – 508	Very rapid Rapid
Moderately coarse	Coarse sandy loam Sandy loam Fine sandy loam	51 - 152	Moderately rapid
Medium	Very fine sandy loam Loam Silt loam Silt	15 – 51	Moderate
Moderately fine	Clay loam Sandy clay loam Silty clay loam	5.1 – 15.2	Moderately slow
Fine	Sandy clay Silty clay Clay (>60%)	1.5 – 5.1	Slow
Very fine	Clay (>60%) Clay pan	< 1.5	Very slow

The texture, permeability and presence of impeding layers are some of the main determinants of soil erosion. Wischmeier, Johnson and Cross (1971) compiled a soil erodibilty nomograph from soil analytical data (**Figure 14**). The nomograph uses the following parameters that are regarded as having a major effect on soil erodibility:

- The mass percentage of the fraction between 0.1 and 0.002 mm (very fine sand plus silt) of the topsoil.
- The mass percentage of the fraction between 0.1 and 2.0 mm diameter of the topsoil.
- Organic matter content of the topsoil. This "content" is obtained by multiplying the organic carbon content (in g/100 g soil – Walkley Black method) by a factor of 1.724.
- A numerical index of soil structure.
- A numerical index of the soil permeability of the soil profile. The least permeable horizon is regarded as horizon that governs permeability.

Box 1 describes the procedure to use the nomograph.

As part of a different study 45 soil samples were collected from 19 points on the HHGD. The samples were described in terms of soil form and analysed with respect to texture (6 fractions) and organic carbon content of the A-horizons (data not presented here but available upon request). The erodibility index and maximum stable slope were calculated for each horizon (according to the method discussed above) in both an unsaturated and saturated soil matrix (data not presented here but available upon request).

The erosion risk is based on the product of the slope (in percentage) and the K-value of erodibility (determined from the Wischmeier, Johnson and Cross (1971) nomograph). <u>This product should not exceed a value of 2.0 in which case soil erosion becomes a major concern</u>. The K-value allows for a "hard" rainfall event but is actually based on scheduled irrigation that allows for infiltration and percolation rates and so-called "normal" rainfall intensity. Soil erosion potential increases with an increase in the very fine sand plus silt fraction, a decrease in the organic matter content, an increase in the structure index and a decrease in permeability. Water quality is assumed not to be a problem for the purposes of the erosion hazard calculations.

Box 1: Using the nomograph by Wischmeier, Johnson and Cross (1971)
In examining the analysis of appropriate surface samples, enter on the left of the graph and plot the percentage of silt (0.002 to 0.1 mm), then of sand (0.10 to 2 mm), then of organic matter, structure and permeability in the direction indicated by the arrows. Interpolate between the drawn curves if necessary. The broken arrowed line indicates the procedure for a sample having 65% silt + very fine sand, 5% sand, 2.8% organic matter, 2 of structure and 4 of permeability. Erodibility factor K = 0,31.

<u>Note</u>: The erodibility factor increase due to saturation was also calculated. These results indicated an increase in erodibiity of a factor predominantly between 3 and 4 for saturated soil conditions.

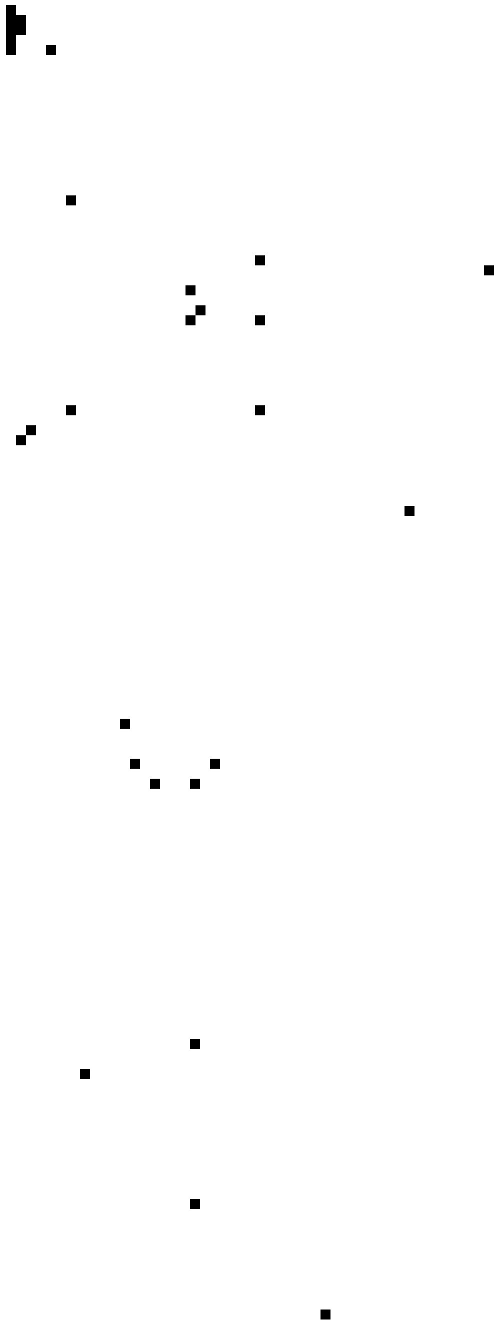


Figure 14 The nomograph by Wischmeier, Johnson and Cross (1971) that allows a quick assessment of the K factor of soil erodibility

4.5.10 Detailed Soil Characteristics – Summarising Conclusions

The following general conclusions can be made regarding the soil characteristics of the HHGD (and the catchment):

1. The site (and catchment) is dominated by shallow to moderately deep sandy soils with deep soils occurring in the drainage features only ;
2. The soils are dominantly coarse sandy in texture;

3. On the bulk of the site the soils are underlain by a hard plinthic layer (ferricrete) that acts as an aquaclude under natural conditions;
4. The bulk of the water movement on the site occurs within 50 cm of the soil surface on top of the ferricrete layer in the absence of human impacts;
5. Wetland delineation is a challenging exercise on the HHGD; and
6. The soils of the HHGD, as those of the site, are highly erodible, especially when saturated with water.

5. METHOD OF WETLAND INVESTIGATION AND DELINEATION

The wetlands on the site were investigated and assessed on the basis of the wetland indicators as described in the wetland delineation guidelines (DWAF, 2005). The initial site assessment and survey was conducted during February 2011 and the subsequent assessment and survey was conducted during January 2014.

5.1. AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise was conducted through the use of Google Earth images and historical aerial photographs of the site. This data was used to obtain an indication of the extent of the wetlands on the site as well as infrastructure development on the site and in the catchment.

5.2 TERRAIN UNIT INDICATOR

Detailed contours of the site (filtered to 2 m intervals for the purpose of map production) were used to provide an indication of drainage depressions and drainage lines. From this data the terrain unit indicator was deduced. Due to historical impacts on the site different sources of contour data had to be used.

5.3 SOIL FORM AND SOIL WETNESS INDICATORS

Due to the filling-in of part of the wetland on the site the usefulness of soil parameters for delineation was very limited. The impacts on the soils are very distinct though and soil characteristics could therefore be used to provide a good indication of the historical impacts on the grounds of a forensic approach. In areas where soil impacts are limited the standard approach in terms of identification of soil form and soil wetness indicators was used.

5.4 VEGETATION INDICATOR

Due to the extent of the historical impacts a dedicated vegetation survey for the purpose of wetland delineation was not conducted. Vegetation parameters were noted and these are addressed in the report where relevant.

6. SITE SURVEY RESULTS AND DISCUSSION

6.1 AERIAL PHOTOGRAPH INTERPRETATION

The historical changes on the site are indicated in Figures 15 to 20 by historical aerial photographs and Google Earth images with the entire wetland boundary superimposed on them.

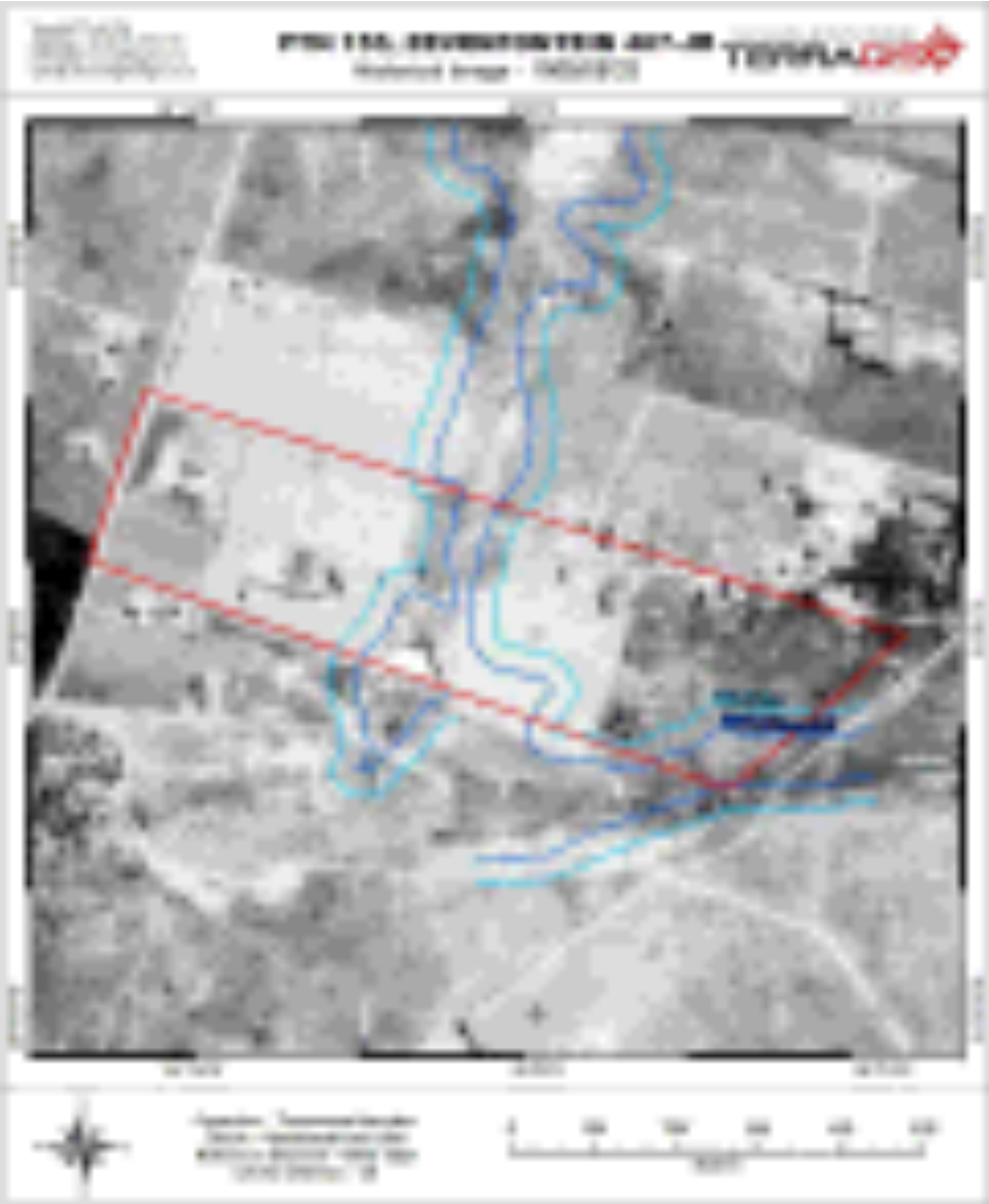


Figure 15 Aerial photograph (1968/08/25) with the superimposed wetland boundary

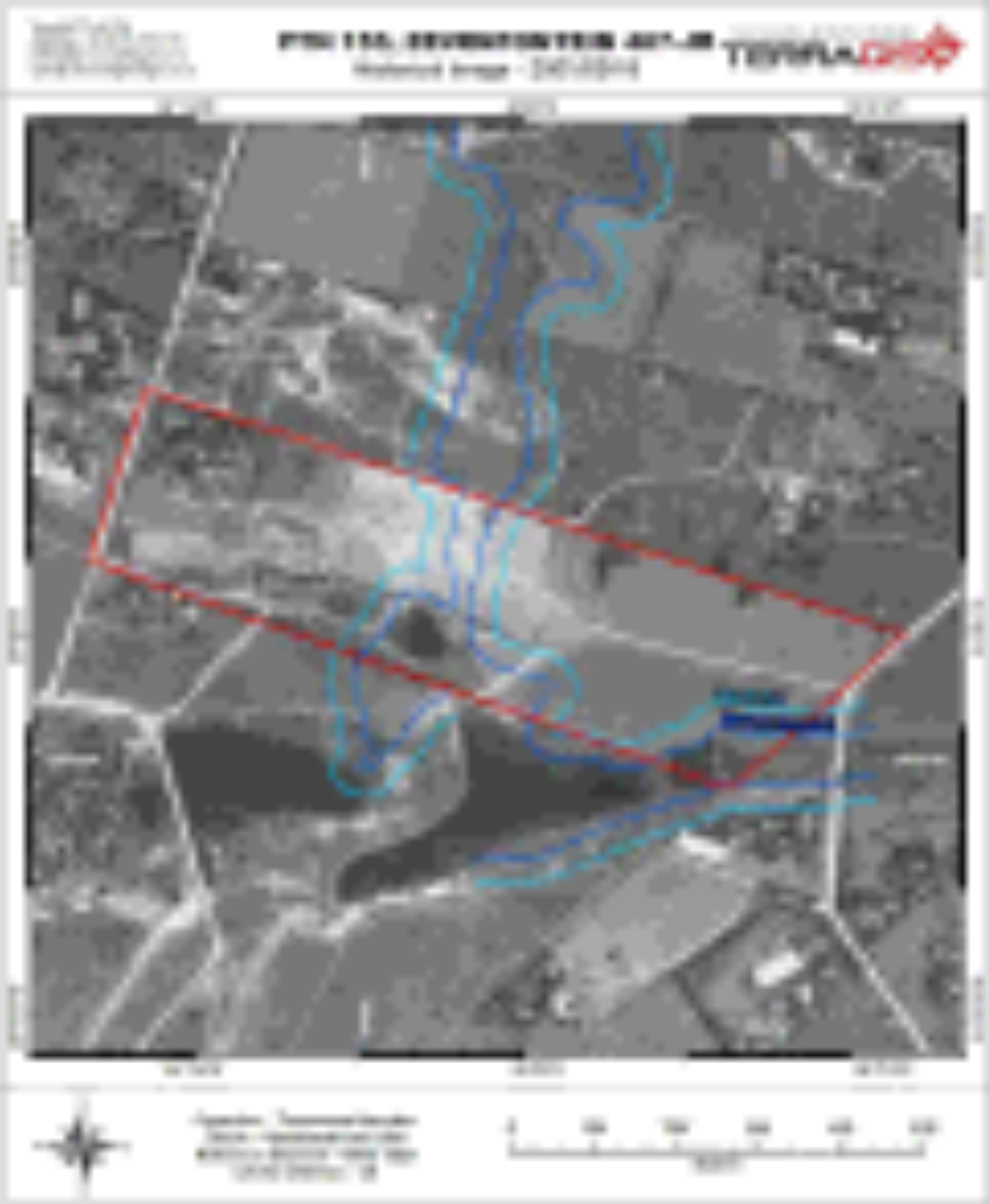


Figure 16 Aerial photograph (2001/05/18) with the superimposed wetland boundary

Figure 17 Aerial photograph (2004/04/18) with the superimposed wetland boundary

Figure 18 Aerial photograph (2006/08/10) with the superimposed wetland boundary

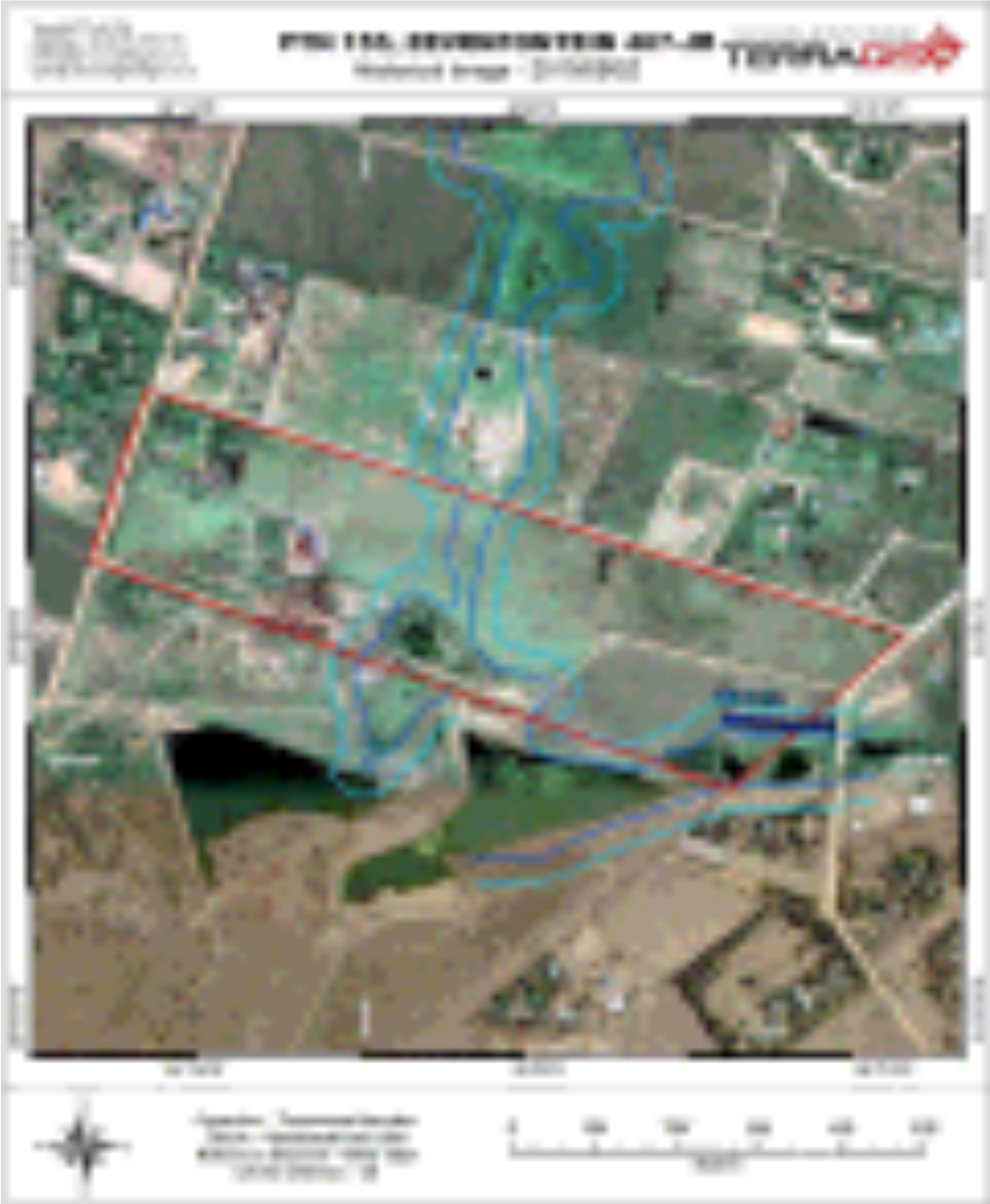


Figure 19 Aerial photograph (2010/09/02) with the superimposed wetland boundary

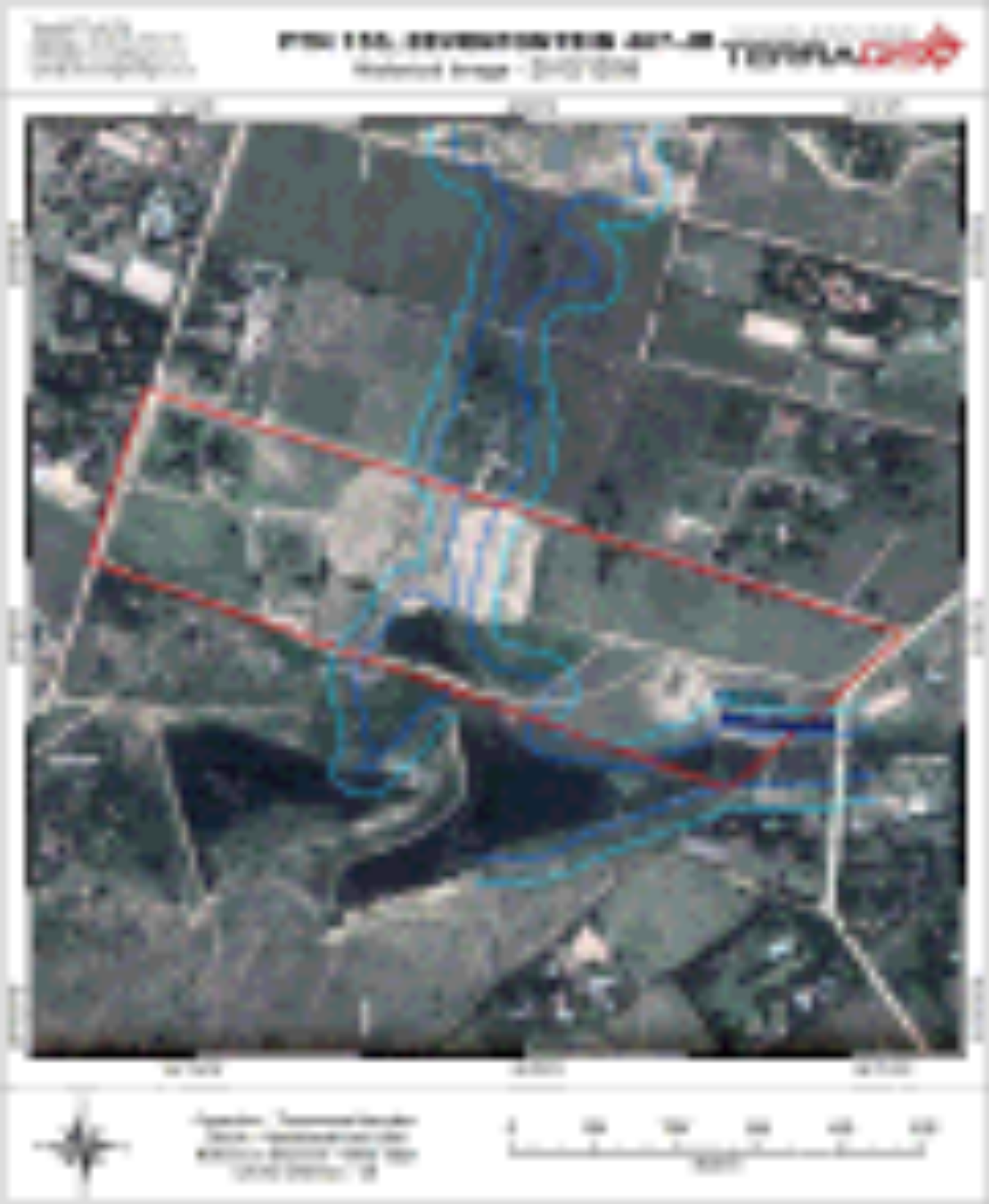


Figure 20 Aerial photograph (2012/12/09) with the superimposed wetland boundary

6.2 TERRAIN UNIT INDICATOR

From the current contour data for the site (**Figure 20**) a topographic wetness index (TWI was generated (Figure 21). From extensive experience on the HHGD it is evident that the TWI provides a very accurate indication of water flow paths and areas of water accumulation that are often correlated with wetlands. This is a function of the topography of the site and ties in with the dominant water flow regime in the soils and the landscape (refer to previous section where the concept of these flows was elucidated). Areas in blue indicate concentration of water in flow paths with lighter shades of blue indicating areas of regular water flows in the soils and on the surface of the wetland / terrestrial zone interface. The head waters (or recharge zone) of the drainage feature is situated at the crest of the landscape to the north.

From the Google Earth imagery of the site and the superimposed contours (**Figure 21**) as well as the TWI (**Figure 22**) it is clear that a hillslope seepage wetland without a channel occurs above the site. This structure is interrupted by a section that has been filled in and levelled – indicating almost level contours. Evidence of this is visible in two map figures that were obtained for the site indicating 1) an original channelled and V-shaped drainage feature culminating in a small dam (**Figure 23**) and 2) an area with almost level topography with an immediate sharp drop towards the same dam (**Figure 24**). Although these contours indicate the presence of a drainage channel it is calculated that this channel has been filled with material to a depth of almost 12 m at its thickest point. This aspect has serious implications for water management on site and will be discussed in more detail further in the report. The drainage feature to the south of the site still persists but has been impacted by the gradually increasing dam structures since the first aerial photograph provided in **Figure 15**.

Figure 21 Google Earth image with 2 m contours indicating a drainage depression and stream edge on the site.

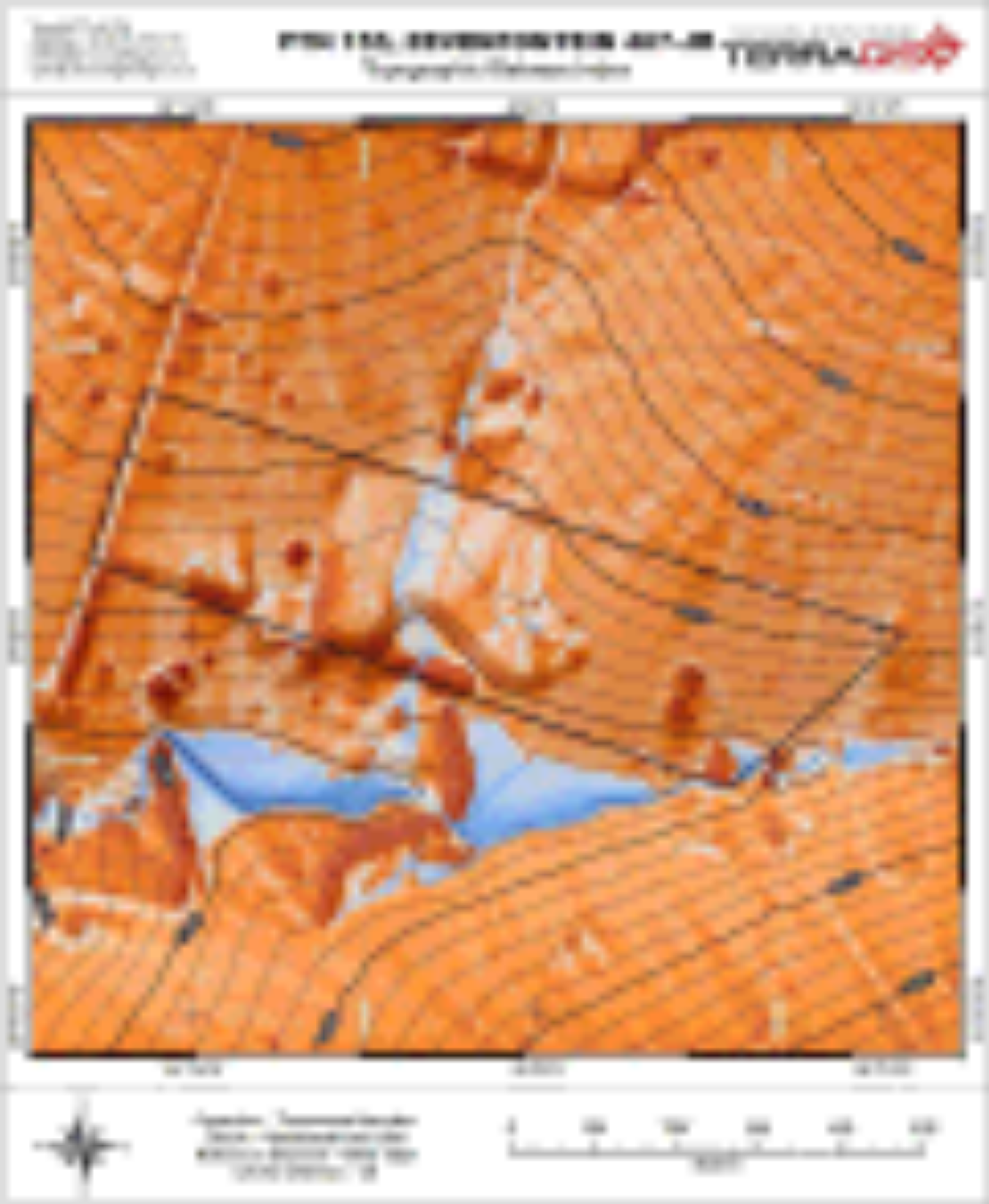


Figure 22 Topographic wetness index (TWI) for the survey site

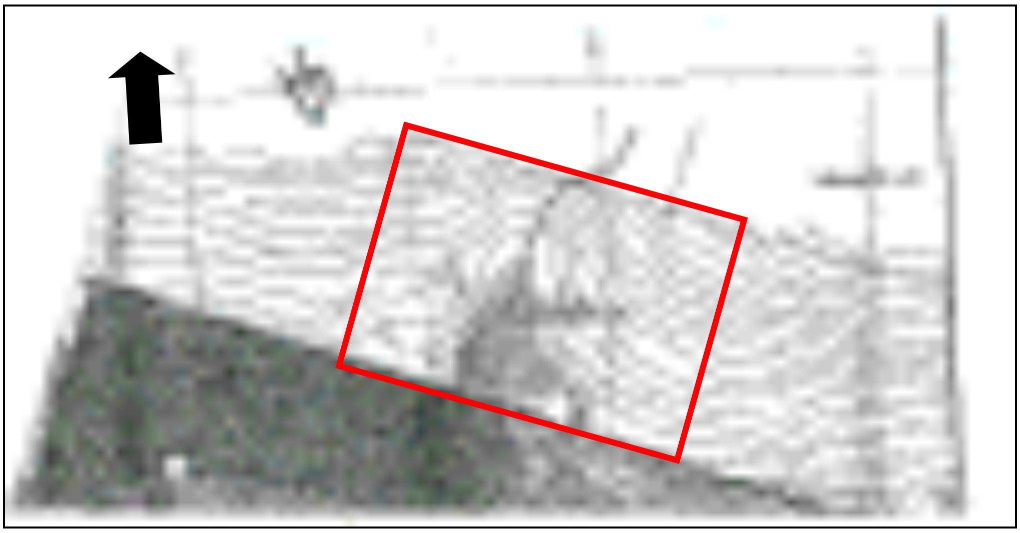


Figure 23 Historical map figure indicating original contours on the site (red box)

Figure 24 Recent map figure indicating new contours on the site (red box)

6.3 Soil Form and Soil Wetness Indicators

6.3.1 Filled-in Area

The soil form and wetness indicator could not be used in the area that had been filled-in as these soil materials are foreign to the site. From a profile pit that was dug at the northern boundary of the site (**Figures 25** and **26**) it was clear that the soil material had been brought in from other areas as fill material. The evidence of this is the colour, texture, structure and stratification of the material as well as the fact that it shows distinct signs of mixing (**Figures 27** and **28**). The introduced soil has numerous mottles and these are considered to be inherited from the original soil. The conclusion is therefore that this site has been impacted drastically and that the original wetland has all but been destroyed. It does still constitute a drainage depression though. The proposed management approaches for this part of the site will be provided later in the report.

Figure 25 Northern boundary of the site with water running off from the upslope site to the north.

Figure 26 Profile pit on the northern boundary of the site (filled-in area) with signs of ponding water.

Figure 27 Profile pit with layers of foreign soil material.

Figure 28 Some A-horizon soil formed in the filled-in area overlying soil material of mixed origin.

6.3.2 Valley Bottom Area

The valley bottom area is characterised by a number of dams and impoundments that show significant signs of soil disturbance. From west to east these impacts include erosion of the channel and old banks, failing and repair of dam walls, sedimentation and significant sediment runoff from the dirt road making up the one boundary. On the western edge a brick structure was erected in the past that has the aim of preventing erosion of the one dam wall (**Figure 29**). This area is highly problematic as the one "foot" of an Eskom pylon has already been impacted through the ensuing erosion (**Figure 29**). This aspect requires urgent attention from Eskom for the sake of the integrity of the pylon. **Figures 30** to **33** provide further evidence of the eroded nature of the drainage channel. **Figures 34** to **43** provide an indication of the degree of sedimentation and alien vegetation invasion of the impoundments on the site. In **Figures 44** and **45** the presence of an Eskom pylon within the wetland area / drainage channel is clearly visible as is the sediment in close proximity. In **Figures 46** and **47** the source of the sediment is clearly visible as the dirt roads leading into the drainage channel / wetland.

Figure 29 Eroded channel with distinct impacts on an Eskom pylon.

Figure 30 Eroded channel with newly constructed structures to prevent further erosion.

Figure 31 Eroded channel with bricks and rubble visible in the exposed profile indicating historical impacts.

Figure 32 Eroded channel with bricks and rubble visible in the exposed profile indicating historical impacts.

Figure 33 Eroded channel.

Figure 34 Impoundment with alien vegetation and distinct sedimentation.

Figure 35 Impoundment with alien vegetation and distinct sedimentation.

Figure 36 Impoundment with alien vegetation and distinct sedimentation.

Figure 37 Impoundment with alien vegetation and distinct sedimentation.

Figure 38 Impoundment with alien vegetation and distinct sedimentation.

Figure 39 Sediment accumulated in the impoundment.

Figure 40 Sediment accumulated in the impoundment.

Figure 41 Sediment accumulated in the impoundment.

Figure 42 Sediment accumulated in the impoundment.

Figure 43 Sediment accumulated in the impoundment.

Figure 44 Eskom pylon within the wetland/drainage channel.

Figure 45 Eskom pylon within the wetland/drainage channel with sediment in the foreground.

Figure 46 Erosion on the dirt road boundary of the site. This is the main source of the sediment in the impoundments.

Figure 47 Erosion on the dirt road boundary of the site. This is the main source of the sediment in the impoundments.

7. WETLAND DELINEATION

Based on the results of the delineation exercise (terrain unit indicator, soil form indicator, soil wetness indicator and vegetation indicator), the wetland was delineated as provided in **Figure 20**. The delineation and provision of the buffer will not lead to a pristine wetland. A number of aspects need to be addressed in order to stabilise the structures in the wetland / drainage channel (including the Eskom pylons!) and to prevent further erosion and sedimentation. In addition, the filled-in area has too large a volume of material for removal. This area should be channelled and stabilised (either on the surface or through a pipe running underground) to link the upslope wetland and the valley bottom wetland. Such a structure will have to be designed by a suitably qualified engineer. All these activities will have to take place within the delineated wetland and buffer zone.

8. MANAGEMENT REQUIREMENTS AND MITIGATION OF STORM WATER

The wetlands of the HHGD are stable against erosion under natural conditions where landscape runoff characteristics have not been altered by humans. As indicated earlier in the report, the HHGD soils are highly susceptible to erosion and as such even slight changes in storm water runoff intensity will cause increased erosion pressures on wetlands. **Important**: Opposite to the general notion that wetlands perform flood attenuation functions the HHGD wetlands cannot perform such as they are not stable against degradation once the runoff intensity increases.

It is therefore imperative that the wetland (and other open soil areas on the site) be protected against increased erosion pressures through the implementation of the following:

1. Adequate storm water mitigation throughout the construction site (from start to completion) to prevent large pulses in storm water.
2. Sediment containment structures throughout the site to prevent sediment runoff and accumulation in the wetland area.

The storm water runoff from soils in the area under natural conditions will be barely perceivable as the soils act as a sponge with a gradual release of the water once it leaches out of the landscape through lateral seepage on the impervious subsoil layers. Only in events of exceptional rainfall will the overland flow increase to significant volumes. Once development and construction start on soils of the HHGD the infiltration characteristics of the soils change drastically with a consequent drastic change in runoff characteristics. Runoff changes lead to a distinct spike in the hydrograph as elucidated through modelling and calculations. These spikes are the main drivers of accelerated degradation of water courses in the area. Please refer to sections 4.4.7, 4.4.8 and 4.4.9 for an explanation of the implications of the above in terms of the wetland delineation guidelines, urban developments and soil erosion in the HHGD area.

It is not the purpose of this document to provide detailed designs for mitigation measures as these should be generated by a suitably qualified engineer in conjunction with a suitably qualified wetland soil specialist. There are a few general pointers though that should be adhered to namely:

1. Subsurface lateral flow of water leads to the interception of such water once foundations are sunk into the soils and weathered rock / hard plinthite. Adequate drainage structures should be constructed to prevent damp problems in structures arising within the soil profiles and landscape start filling with water once rainfall increased during summer months. This aspect is already a major problem in large developments of housing such as Cosmo City.
2. In many areas it has been found that the water moving downslope in the fractured rock is under positive pressure (due to gravity) with a consequent squirting out from severed preferential flow structures. This implies that in some areas water ingress into foundations and basements can occur from below (leading to the expression of a "wet basement syndrome" as mentioned under section 4.4.8). Structures constructed in areas with such risks should have additional water removal mechanisms implemented at the structure / ground interface. These can include dedicated containment and drainage features. Where cut and fill operations take place with a consequent large volume of "overburden" material over the soil a specific capillary break layer with associated drainage should suffice.
3. Surface sealing of the landscape through roads, parking areas, roof covered areas and general soil compaction leads to accelerated and increased surface water runoff. In order to mitigate the potential large volumes over a large area numerous small containment structures with choked outflows should be constructed throughout a site. The fewer these structures are the larger other structures have to be to contain the said water. As a minimum requirement these structures should be adequate and enough to contain the standard storm water runoff from a site before it reaches the wetland /drainage feature area.
4. Several soft engineering approaches exist for the successful mitigation of storm water. If these are incorporated into the design and layout of development sites impacts on the wetlands and drainage features of the HHGD can be successfully mitigated.
5. In terms of both the NWA (National Water Act) and NEMA (National Environmental Management Act) land owners have a duty to protect water resources, water courses and wetlands. In addition, CARA (Conservation of Agricultural Resources Act) and the municipal bylaws address storm water aspects that are of importance to land owners and managers. Insufficient attention to storm water related impacts during the design phase of a development can lead to administrative and criminal liabilities for the developer / land owner post development.
6. Important: In the absence of adequate management of storm water, wetland impacts in terms of erosion will be inevitable therefore exposing the relevant entities involved with the development to unacceptable punitive administrative action or even criminal prosecution.

9. ARTIFICIAL MODIFIERS ON SITE AND IMMEDIATE CATCHMENT

For the purpose of establishing a baseline in terms of current site conditions (pre development) the following artificial modifiers of the wetland systems on the site are listed (as described in previous sections):

1. Historical infilling of the drainage depression by previous land owners/users;

2. Large scale erosion of the watercourse to the south of the site;
3. Large scale sedimentation in sections of the watercourse and dams within the drainage depression; and
4. .Historical construction activities of roads through the watercourse as well as Eskom electricity pylons within the water course.

10. CONCLUSIONS AND RECOMMENDATIONS

A wetland delineation exercise was conducted for Portion 155 of the farm Zevenfontein 407-JR in the Gauteng Province. Two main wetland features were identified namely a drainage depression fed by a hillslope seepage wetland upslope and a drainage depression / stream channel. Both of these wetlands have been impacted significantly. The first has been filled-in with soil material to a near level state and the second has been eroded and been the subject of the construction of a number of impoundments with its associated sedimentation and channel erosion. Although the delineation is provided in **Figure 20** (with a 30 m buffer) it is critical that the both the sites be managed intensively with respect to channelling of water, stabilisation of slopes and impoundment walls as well as sediment minimisation and removal.

Specific recommendations are:
1. Removal of sediment from the drainage depression and impoundments.
2. Removal of alien vegetation from the drainage depression and impoundments.
3. Attenuation of water on the site and prevention/management of erosion.
4. Channelling of the upslope wetland through the filled-in area.
5. Rehabilitation of the site and constructed impoundments through the establishment of indigenous wetland vegetation.
6. Management of the site into the future to prevent establishment of alien vegetation and erosion of mitigation structures.

REFERENCES

Boehner, J., Koethe, R. Conrad, O., Gross, J., Ringeler, A., Selige, T. 2002: Soil Regionalisation by Means of Terrain Analysis and Process Parameterisation. In: Micheli, E., Nachtergaele, F., Montanarella, L. [Ed.]: Soil Classification 2001. European Soil Bureau, Research Report No. 7, EUR 20398 EN, Luxembourg. pp.213-222.

Brady, N.C. and Weil, R.P. 1999. *The Nature and Properties of Soils*. Twelfth edition. Upper Saddle River, New Jersey: Prentice Hall.

Department of Water Affairs and Forestry (DWAF). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Hillel, D. 1982. Introduction to soil physics. Acedemic Press, INC. Harcourt Brace Javonovich, Publishers.

Jenny, H. 1941. Factors of soil formation. New York, NY, USA: McGraw-Hill Book Company, p 281

Land Type Survey Staff. (1972 – 2006). *Land Types of South Africa: Digital map (1:250 000 scale) and soil inventory databases*. ARC-Institute for Soil, Climate and Water, Pretoria.

MacVicar, C.N. et al. 1977. *Soil Classification. A binomial system for South Africa.* Sci. Bull. 390. Dep. Agric. Tech. Serv., Repub. S. Afr., Pretoria.

Soil Classification Working Group. 1991. Soil Classification. A taxonomic system for South Africa. *Mem. Agric. Nat. Resour. S.Afr.* No.15. Pretoria.

Wischmeier, W.H., C.B. Johnson and B.V. Cross. 1971. A Soil Erodibility Nomograph for Farm Land and Construction Sites. J. Soil Water Conserv. 26: 189 – 193.

Annexure F(iii)

FAUNA AND FLORA REPORTS

FAUNAL, FLORAL, WETLAND AND AQUATIC ASSESSMENT FOR THE PROPOSED K56 ROAD DEVELOPMENT, DAINFERN, GAUTENG.

Prepared for

Bokamoso Environmental Consultants

July 2012

Section A: Executive Summary

Prepared by:	**Scientific Aquatic Services**
Report author	**S. van Staden (Pr. Sci. Nat)**
	K. King (Pr.Sci. Nat)
	M. Hanekom
Report Reference:	**SAS 212023**
Date:	**July 2012**

Scientific Aquatic Services CC
CC Reg No 2003/078943/23
Vat Reg. No. 4020235273
91 Geldenhuis Rd
Malvern East, Ext 1
Tel: 011 616 7893
Fax: 011 615 6240/086 724 3132
E-mail: admin@sasenvironmental.co.za

Declaration

This report has been prepared according to the requirements of Section 33 (2) of the Environmental Impact Assessments EIA Regulations, 2010 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

Project Manager:

Stephen van Staden *Pr Sci Nat* (Ecological Sciences) 400134/05
BSc. Hons (Aquatic Health) (RAU);
M.Sc. Environmental Management Rau.

Field of expertise:
Wetland, aquatic and terrestrial ecology.

____________________ Date: 18/05/2012
Stephen van Staden

EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal and wetland assessment on the proposed development of the K56 road (Section A: Figures 1 & 2), hereafter referred to as the subject property. The total length of the proposed road development is approximately 7km. The proposed K56 is situated to the northwest of Midrand, in the vicinity of Dainfern, in the Gauteng Province.

This report, after consideration and the description of the ecological integrity of the subject property, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and potential mining proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed road development project. Only the subject property, including a 200m area surrounding the property, was assessed during the field visit. The surrounding area was, however, also considered as part of the desktop assessment.

The section below serves to summarise the findings of the terrestrial, wetland and aquatic assessments.

FLORAL ASSESSMENT

- The study area falls within the Savanna Biome, the Bushveld Basin bioregion and Egoli Grassland Vegetation Type, which is considered to be an endangered vegetation type;
- Four habitat units were identified along the proposed development route, namely the Wetland Habitat Unit, the Rocky Outcrop Habitat Unit, the Open Grassland Habitat Unit and the Transformed Habitat Unit. The Transformed Habitat Unit encompasses the majority of the study area, while the Wetland Habitat Unit occurs within the east, west and central portions of the subject property;
- The entire subject property has been subjected to a degree of vegetation transformation as a result of urban and residential development and historic agricultural activities. Alien invasive plant species are present in all habitat units;
- The Rocky Outcrop Habitat Unit has experienced a low degree of disturbance and is considered to be highly sensitive as a result of the unique habitat it provides for faunal and floral species. It also has the potential to host RDL plant species, such as *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica*;
- The Wetland Habitat Unit also has higher ecological sensitivity compared to the Open Grassland and Transformed Habitat Unit due to the potential habitat for faunal and floral species and the migratory connectivity for faunal species that these areas potentially provide;
- The Open Veld Habitat Unit is not considered to be ecologically sensitive, as a result of its isolated nature and the high numbers of alien plant species present. One RDL floral species, namely *Hypoxis hemerocallidae* ('Declining') was encountered in this Habitat Unit during the assessment and it is likely that *Boophane disticha* may also occur in this area;
- The Transformed Habitat unit is considered to be of low ecological sensitivity as a result of its impacted nature due to past development in the area;
- No RDL or protected floral species were identified during the assessment. However, the Rocky Outcrop and Wetland Habitat Units may provide suitable habitat to support such floral species;
- Levels of alien floral invasion were moderate to high within all habitat units identified, apart from within the Rocky Outcrop Habitat Unit, where alien invasive species are restricted to riparian edges;
- The VIS (Vegetation Index Score) for each Habitat Unit was calculated as follows:

Habitat unit	Score	Class	Motivation
Wetland/ Riparian	14	**C – Moderately modified**	Moderately impacted by past anthropogenic activities. Moderate levels of alien plant species invasion.
Rocky Outcrop	20	**B – Largely natural with few modifications**	Few disturbances present. Some alien invasive species present in the vicinity of wetlands
Open Grassland	15	**C – Moderately modified**	Disturbances present in the form of alien plant species, trampling and the proximity of informal roads.
Transformed	5	**E – Loss of natural habitat extensive**	Transformation levels high as a result of development and roads construction. High number of alien and landscaping plant species present.

FAUNAL ASSESSMENT

The period of investigation was undertaken during early winter/late summer and it must be noted that some faunal species may not have been identified due to natural behavioural patterns that vary from season to season. In this regard special mention is made of species which become inactive or which enter life cycle stages which are inactive

- In general there are good natural rocky ridge and woodland habitat units along with good wetland habitat units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. The ecological integrity of the rocky ridge and wetland areas are still largely intact, and as such the rocky ridge and wetland areas are considered to be of high ecological sensitivity.
- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). No GDARD and IUCN RDL threatened mammal species were observed on the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit. No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may move through the area from time to time. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck (*Oxyura maccoa*) and African Finfoot (*Podica senegalensis*) and for feeding purposes by the African Marsh Harrier (*Circus ranivorus*), the Lesser Falcon (*Falco naumanni*) and the Lanner Falcon (*Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.
- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae*

natalensis) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.

- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).* The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered highly significant.
- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.
- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

<u>WETLAND ASSESSMENT</u>

The following general conclusions were drawn on completion of the survey:

- The subject property falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo catchment.
- Two wetland features were identified within the study area at the time of the assessment.
- Wetland feature 1 can be described as a Riverine system, Upper perennial, Aquatic bed wetland feature. Wetland 2 can be described as a Riverine system, Lower Perennial, Aquatic bed wetland feature.
- The wetland features comprised of a wide diversity of wetland flora within the riparian zone including both wetland grassy layer species as well as trees associated with riparian zones.
- The wetland 1 PES falls within class B – largely natural with few modifications. This is due to the fact that the surrounding urban development has not significantly impacted the wetland.

The wetland 2 PES falls within class D – largely modified - as the riparian wetland is affected by scour and sand deposition.

- Therefore, the EMC class deemed appropriate to maintain current ecology as well as functionality in wetland 1 is class B (Largely natural with few modifications) and in wetland 2 is class D (Largely modified).
- A 32m buffer in terms of the GDARD Minimum Requirements for Biodiversity Assessments (2009) is shown for areas which fall within the Urban Edge. The subject property falls within the Urban Edge and in terms of the above regulations, a 32m buffer is prescribed.
- It is recommended that the proposed activities do not encroach into wetland feature 1 and the associated buffer The proposed activities can be considered favourably, from a wetland conservation point of view within wetland 2 as long as the recommended mitigation measures are adhered to and that the relevant environmental authorisation is obtained.

After conclusion of this wetland assessment, it is the opinion of the specialists that the proposed project should not be considered favourably as the construction of a road through wetland 1 will destroy this largely unmodified wetland. Construction can however be considered favourably in order to cross wetland systems 2, 3 and 4 if the mitigation measures, as presented in this report are strictly adhered to.

AQAUTIC ASSESSMENT

Jukskei River (Site K1)
Biota specific Water quality

- General water quality can be considered to be fair, based on the results of the biota specific water quality analyses
- Limited amounts of dissolved salts present in the system although salt concentrations can be considered to be elevated form the natural conditions expected for the area. Limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is slightly alkaline however no impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentration in the system is low and is likely to place significant stress on the aquatic community in the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the K1 site, it is evident that there are serious impacts on the habitat integrity of the area. The most significant instream impacts included water bed modification, water quality and channel modification. Moderate impact from solid waste disposal, as well as flow and water abstraction was noted. Overall, the site achieved a 33% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impacts were alien encroachment followed by bank erosion and channel modification. Moderate level impacts observed were namely vegetation removal, water abstraction, flow modification and channel modification. The site achieved a 17% score for riparian integrity (Appendix 3).
- The site obtained an overall IHIA rating of 25%, which indicates extensively modified (class E) conditions. The site, therefore, falls outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is considered inadequate for supporting a diverse aquatic macro-invertebrate community

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K1) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.

- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 29.
- The site, falls below the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

- No fish were captured during the assessment indicating that long term impacts on the system are likely. In this regard special mention is made of the water quality has a major effect on the fish assemblage as does migration barriers in the system which were observed upstream from site K1. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system with special mention of migratory connectivity.
- Thus according to the protocol of Kleynhans (1999) Present State Classes in terms of FAII scores, the fish community at this point is critically modified (Class F).

Tributary River (Site K2)
Biota specific Water quality

- The water quality for this tributary stream can be considered to be fair, with limited amounts of dissolved salts present in the system although some elevation of salt concentrations from the natural conditions is deemed likely. Fairly limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is 7.2 and considered relatively natural. No impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentrations are fair but some more sensitive taxa may be absent from the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the tributary river at site K2, which falls within the study area, it is evident that there are impacts on the habitat integrity of the area. The most significant instream impacts included flow modification due to the already existing upstream impoundments that are situated along this tributary system. Overall, the site achieved a 52% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impact was flow modification. Low level impacts observed were namely vegetation removal, water abstraction, bank erosion, water quality and channel modification. The site achieved a 37% score for riparian zone integrity (Appendix 3).
- The site obtained an overall IHIA rating of 45%, which indicates largely modified (class D) conditions. The tributary site K2, therefore, falls just outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the tributary river which flows into the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K2) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.

- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 39 and ASPT of 3.5.
- The K2 site, falls outside the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

Two fish species, the Long bearded Barb (*Barbus unitaeniatus)* and the Mozambique Tilapia (*Oreochromis mossambicus*) were captured, identified and released during the assessment. The low diversity indicates that long term impacts on the system are likely. In this regard special mention is made of migration barriers (such as dams) in the system and the water quality levels. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system.

- The FAII data indicates that the fish community in this section of the tributary system has suffered a critical loss in integrity when compared to the expected score for a stream in this catchment with the habitat characteristics of the area.
- The absence of fish in the system is indicative of long term impacts on the system, with special mention of impacts on water flow modification and migration barriers.
- With only a low diversity and abundance of fish in the area, the fish community of the area is considered critically modified (Class F).
- Measures to improve water flow should be sought in order to allow fish species to re-establish in the system.
  It is important to ensure that no impacts on fish migration on the system occur as a result of the proposed development.

Upon completion of the survey and consideration of findings, the following recommendations are made with respect to the proposed development:

Development and operational footprint

- A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities in order to aid in the conservation of ecology within and adjacent to the proposed development area. The Rocky Outcrop Habitat Unit should not be disturbed due to its unique ecology.
- *Hypoxis hemerocallidae*, *Babiana hypogea* var. *hypogea*, and *Boophane disticha* (if discovered on site), occurring within the development footprint should be rescued and relocated to suitable habitat in the vicinity of the study area.
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland and rocky outcrop areas. The boundaries of footprint areas are to be clearly defined.
- Large trees should be maintained where possible for the length of the proposed development route.
- Proper planning of infrastructure, which avoids unnecessary barriers in migratory corridors, should be conducted during the pre-construction phase.

Wetlands

- As much of the ecological functioning and migratory connectivity of the drainage features need to be maintained.
- No topsoil, waste rock or building material should be dumped into any existing wetland and rocky outcrop areas, as these areas are considered to be of higher ecological importance.

- It must be ensured that construction-related waste and effluent do not affect the wetland resources and associated buffer zones.
- Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in more sensitive wetland and rocky outcrop areas.
- All construction vehicles should remain on designated roads with no indiscriminate driving through wetlands/ riparian or rocky outcrop areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater and erosion management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the wetland areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Alien plant species

- Proliferation of alien and invasive species is expected within disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the site boundary. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on rehabilitation in the future, has to be controlled.
- Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.
- All soils compacted as a result of construction activities and falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.

Fire

- All informal fires on the property should be prohibited, specifically during the construction phase of the proposed development.

Dust

- It is to be ensured that all temporary access roads and construction areas are regularly sprayed with water or treated with other dust suppression measures in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss into adjacent waterways.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting are to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.

- Any areas where earthworks have taken place, should be reseeded with indigenous vegetation to prevent erosion.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation.

ECOLOGICAL SENSITIVITY

Wetland features, as well as the rocky outcrop area located centrally with respect to the proposed development route, are considered sensitive and were identified and delineated (refer to associated Wetland and Aquatic Ecology reports). This is mainly due to the higher diversity of faunal and floral species expected to occur within these areas and the potential of these areas to host RDL species, as well as the unique habitat the wetland and rocky outcrop areas provide for both faunal and floral species. It is therefore deemed important that these areas be excluded form the proposed development.

The Open Grassland Habitat Unit is not deemed to be sensitive, as a result of high levels of alien plant species invasion. The transformed areas are deemed to be of low sensitivity as a result of the high levels of transformation present. These areas are not likely to support any RDL or sensitive faunal or floral species.

TABLE OF CONTENTS

List of Figures

List of Tables

Glossary of Terms & Acronyms

Alien vegetation – Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.

Biome – A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.

Bush encroachment – A state where undesirable woody elements gain dominance within grassland, leading to depletion of the grass component. Typically due to disturbances and transformations as a consequence of veldt mismanagement (overgrazing, incorrect burning, etc.).

Decrease grass – Grass abundant in veldt in good condition, which decreases when veldt is under- or over-utilized.

°*C* – Degrees Celsius.

Endangered – Organisms in danger of extinction if causal factors continue to operate.

Endemic species – Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.

Exotic vegetation – Vegetation species that originate from outside of the borders of the biome - usually international in origin.

Ex situ conservation – Where a plant (or community) cannot be allowed to remain in its original habitat and is removed and cultivated to allow for its ongoing survival.

Extrinsic – Factors that have their origin outside of the system.

GDACE – Gauteng Department of Agriculture, Conservation and Environment

ha – Hectares.

Indigenous vegetation – Vegetation occurring naturally within a defined area.

Increaser 1 grass – Grass species that increase in density when veld is under-utilized.

Increaser 2 grass – Grass species that increase in density in over-utilized, trampled or disturbed veld.

Increaser 3 grass – Grass species that increase in density in over and under-utilized veld.

In situ conservation – Where a plant (or community) is allowed to remain in its natural habitat with an allocated buffer zone to allow for its ongoing survival.

Karoid vegetation – A shrub-type vegetation that dominates in grasslands that have seen historical disturbances. Mainly due to over-grazing and mismanaged burning regimes. The shrubby vegetation eventually becomes dominant and out-competes the grassy layer.

m – Metres.

mm – Millimetres.

MAMSL – Metres above mean sea level.

MAP – Mean annual precipitation.

MAPE – Mean annual potential for evaporation.

MASMS – Mean annual soil moisture stress.

MAT – Mean annual temperature.

Orange Listed – Species that are not Red Data Listed, but are under threat and at risk of becoming RDL in the near future. Usually allocated to species with conservation status of *Near Threatened (NT), Least Concern (LC), Rare* and *Data Deficient (DD)*.

PES – Present Ecological State.

POC – Probability of occurrence.

PRECIS – Pretoria Computer Information Systems.

Pioneer species – A plant species that is stimulated to grow after a disturbance has taken place. This is the first step in natural veld succession after a disturbance has taken place.

QDS – Quarter degree square (1:50,000 topographical mapping references).

Rare – Organisms with small populations at present.

RDL (Red Data listed) species – Organisms that fall into the *Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU)* categories of ecological status.

RDSIS – Red Data Sensitivity Index Score.

SANBI – South African National Biodiversity Institute.

Veld retrogression – The ongoing and worsening ecological integrity state of a veld.

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal, wetland and aquatic assessment on the proposed development of the K56 road (Section A: Figures 1 & 2), hereafter referred to as the subject property. The total length of the proposed road development is approximately 7km. The proposed K56 is situated to the northwest of Midrand, in the vicinity of Dainfern, in the Gauteng Province.

This report, after consideration and the description of the ecological integrity of the subject property, must guide the developer, Environmental Assessment Practitioner (EAP) and regulatory authorities, by means of the presentation of results and recommendations, as to the ecological viability of the proposed road development route. Only the subject property, including its immediate surroundings, was assessed during the field visits. The surrounding properties were, however, also considered as part of the desktop assessment.

Figure 1: Aerial photograph depicting the location of the subject property.

Figure 2: Subject property depicted on a 1:50 000 map in relation to its surrounding area.

1.2 Scope

Specific outcomes in terms of this report are as follow:

Terrestrial Assessment (Fauna and Flora):

- Red Data Listed (RDL) species assessment, including potential for species to occur on the subject property and the implementation of a Red Data Sensitivity Index Score (RDSIS) for the study area;
- provide faunal and floral inventories of species as encountered on site;
- determine and describe habitats, communities and ecological state of the study area and
- describe the spatial significance of the subject property with regards to surrounding natural areas.

Aquatic and Wetland Assessment:

- define the Present Ecological State (PES) of each wetland system within the study area;
- determine the functioning of each system and the environmental and socio-cultural services that the system provide;
- advocate a Recommended Ecological Category (REC) for each wetland feature;
- delineate all wetlands or riparian zones occurring within the assessment site and
- determine the environmental impacts of the proposed mining activity on the wetland areas within the proposed subject property.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The subject property is surrounded by properties of which agricultural and residential development are the dominant land use, leaving the surrounding areas largely transformed. Therefore, the ecological assessment was confined to the subject property and only included the ecological assessment of surrounding properties where relevant. The surrounding area was however considered as part of the desktop assessment of the area.
- Due to the nature and habits of most faunal taxa it is unlikely that all species would have been observed during a site assessment of limited duration. Therefore, site observations are compared with literature studies where necessary.
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked. A more accurate assessment would require that assessments take place in all seasons of the year however by undertaking assessments in the spring period it is deemed likely that most faunal and floral communities would have been adequately assessed and/or considered.

- Sampling by its nature, means that not all individuals are assessed and identified. Some species and taxa on the subject property may therefore been missed during the assessment.
- The wetland delineation as presented in this report is regarded as a best estimate of the wetland boundary based on the site conditions present at the time of assessment.
- Wetlands and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative and obligate wetland species. Within this transition zone some variation of opinion on the wetland boundary may occur, however if the DWAF 2005 method is followed, all assessors should get largely similar results.

2 METHODOLOGY

2.1 General Methodology

In order to accurately determine the Present Ecological State (PES) of the study area and capture comprehensive data with respect to faunal and floral taxa the following methodology was used:

- Maps, aerial photographs and digital satellite images were consulted prior to the field assessment in order to determine broad habitats, vegetation types and potentially sensitive sites. An initial visual on-site assessment of the subject property was made in order to confirm the assumptions made during consultation of the maps.
- Literature review with respect to habitats, vegetation types and species distribution was conducted.
- Relevant data bases considered during the assessment of the study area included SANBI [Threatened species programme (TSP) and PRECIS] and the SANBI Biodiversity GIS database (BGIS).
- Specific methodologies for the assessment of faunal, floral, wetland and aquatic ecological assemblages will be presented in the relevant sections along with the methodologies for assessing the integrity and function of wetland systems.

3 ECOLOGICAL DESCRIPTION OF THE PROPERTY

4 FLORAL DESCRIPTION

4.1 Biome and bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford 1997). This assessment site falls within the Grassland Biome (Figure 3). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. This assessment site is situated within the Mesic Highveld Grassland Bioregion (Musina & Rutherford, 2006) (Figure 4).

Figure 3: Biome associated with the subject property.

Figure 4: Bioregions associated with the study area (Mucina & Rutherford, 2006).

4.2 Vegetation type and Landscape Characteristics

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area (Figure 3), it is evident that the subject property falls within the Egoli Granite Grassland vegetation type (Musina & Rutherford, 2006).

Figure 5: Vegetation types associated with the subject property (Mucina & Rutherford, 2006).

4.3 Distribution

The distribution of Egoli Highveld Grassland is limited to Gauteng Province, and occurs within the Johannesburg Dome, extending in the region between northern Johannesburg (in the south), and from near Lanseria Airport and Centurion (south of Pretoria) to the north, westwards to about Muldersdrif and eastwards to Tembisa (Musina & Rutherford, 2006).

4.4 Climate

Egoli Granite Grassland falls within a strongly-seasonal summer-rainfall region, with very dry winters. The mean annual precipitation (MAP) is 620-800mm (overall average of 682mm) (Table below). The variation of the MAP is from 24-27% across the unit, showing the variation and unreliability of the rainfall. Incidences of frost are frequent within the vegetation type, being higher in the southern than in the northern areas (Mucina & Rutherford, 2006).

Average climatic values shows the region to have an average precipitation value of 682mm. The MASMS value for the region is 75%. These values, when compared to the MAT and MAPE averages of 16.0°C and 2,194mm, respectively, show the region to be a relatively water-stressed area. Conservation of surface (and ground) water resources is therefore imperative to biodiversity conservation within the region.

Table 1: General climatic information for Egoli Granite Grassland (Mucina & Rutherford, 2006).

Bioregion	Vegetation types	Altitude (m)	MAP* (mm)	MAT* (°C)	MAPE* (mm)	MASMS* (%)
Mesic Highveld Grassland	Egoli Granite Grassland	1,280-1,660	682	16.0	2,194	75

***MAP – Mean annual precipitation; MAT – Mean annual temperature; MAPE – Mean annual potential evaporation; MASMS – Mean annual soil moisture stress (% of days when evaporative demand was more than double the soil moisture supply).**

4.5 Geology and soils

The geology of Egoli Granite Grassland is dominated by Archaean Granite and Gneiss of the Halfway House granites at the core of the Johannesburg Dome, supporting leached, shallow, coarsely-grained and sandy soil poor in nutrients of the Glenrosa form. Small areas are built by ultramafics (DEAT, 2001; Mucina & Rutherford, 2006). The lithology for the area is also dominated by Iron, Jaspilite, Syenite, Hornblende Granite, Foskorite, Gabro, Potassic Granite and Dionite (ENPAT, 2001).

4.6 Conservation

This vegetation type is formally classified as an Endangered vegetation type that has only approximately 3% (provincial conservation target is 24%) of it conserved in statutory reserves (Diepsloot and Melville Koppies Nature Reserve). Other conserved areas include the Walter Sisulu National Botanical Gardens. More than two thirds of the vegetation unit has already undergone transformation mostly due to urbanisation, cultivation or by road construction. Current rates of transformation threaten most of the remaining unconserved areas. There is no serious alien infestation in this unit, although species such as *Eucalyptus grandis*, *Eucalyptus camaldulensis* and *Eucalyptus sideroxylon*, as well as exotic *Acacia* species, are commonly found. Erosion is moderate and very low.

4.7 Important Taxa of Egoli Granite Grassland

The proposed development site falls within the Grassland Biome and Mesic Highveld Grassland Bioregion of Gauteng. It is represented by one vegetation unit, namely Egoli Granite Grassland, which is an Endangered vegetation type. It occurs on moderately to strongly undulating plains and low hills supporting tall, usually *Hyparrhenia hirta*-dominated grasslands, with some woody species on rocky outcrops or rock sheets. The rocky habitat show a high diversity of woody species, which occur in the form of scattered shrub groups or solitary small trees. The dominant and typical floral species of Egoli Granite Grassland are presented in the table below.

Table 2: Dominant and typical floristic species of Egoli Granite Grassland (Mucina & Rutherford, 2006).

Grass species	Forb species	Tree/Shrub Species
Aristida canescens (d)	*Acalypha angustata*	*Vangueria infausta*
Aristida congesta (d)	*Acalypha peduncularis*	*Rhus pyroides*
Cynodon dactylon (d)	*Becium obovatum*	*Anthospermum hispidulum*
Digitaria monodactyla (d)	*Berkheya insignis*	*Anthospermum rigidum*
Eragrostis capensis (d)	*Crabbea hirsute*	subsp. *pumilum*
Eragrostis chloromelas (d)	*Cyanotis speciosa*	*Helichrysum kraussii*
Eragrostis curvula (d)	*Dicoma anomala*	*Ziziphus zeyheriana*
Eragrostis racemosa (d)	*Gnidia capitata*	*Lopholaena coriifolia*
Heteropogon contortus (d)	*Helichrysum rugulosum*	
Hyparrhenia hirta (d)	*Justicia anagalloides*	
Melinis repens subsp. *repens* (d)	*Kohautia amatymbica*	
Monocymbium ceresiiforme (d)	*Nidorella hottentotica*	
Setaria sphacelata (d)	*Pentanisia prunelloides* subsp. *latifolia*	
Themeda triandra (d)	*Pseudognaphalium luteo-album*	
Tristachya leucothrix (d)	*Senecio venosus*	
Andropogon eucomus (c)		
Aristida aequiglumis (c)	Geophytic herbs:	
Aristida diffusa (c)	*Cheilanthes deltoidea*	
Aristida scabrivalvis subsp.	*Cheilanthes hirta*	

Grass species	Forb species	Tree/Shrub Species
borumensis (c) *Bewsia biflora* (c) *Brachiaria serrata* (c) *Bulbostylis burchelli* (c) *Cymbopogon caesius* (c) *Digitaria tricholaeoides* (c) *Diheteropogon amplectens* (c) *Eragrostis gummiflua* (c) *Eragrostis sclerantha* (c) *Panicum natalense* (c) *Schizachyrium sanguineum* (c) *Setaria nigrirostris* (c) *Tristachya rehmannii* (c) *Urelytrum agropyroides* (c)		

***(d) – Dominant species for the vegetation type; (c) – Common species for the vegetation type.**

5 GENERAL IMPORTANCE OF SUBJECT PROPERTY

5.1 Importance According to Gauteng Conservation Plan

The Gauteng Urban Edge (2010) indicates the western portion of the proposed route alignment to fall within the Gauteng Urban Edge (Figure 6), while the remainder of the route development falls outside the urban edge. Where possible, development within the province should be contained within the Gauteng Urban Edge in order to prevent urban sprawl and to encourage and enforce a compact urban form.

According to the Gauteng C-Plan (Version 2), which focuses on the mapping and management of biodiversity priority areas within Gauteng, indicates the western portion of the proposed development route as being an 'Important Site' (Figure 8). The C-Plan includes protected areas, irreplaceable and important sites due to the presence of Red Data species, endemic species and potential habitat for these species to occur. An 'Important Site' refers to a site designated as important in meeting targets set for the conservation of biodiversity, the significance of which is subject to ground truthing. The site is important to protect in some way, but not essential and can be replaced by a similar site, but a trade-off in the efficiency of the conservation plan may be the result.

All wetland and associated wetland buffer areas are considered to be ecologically protected (Figure 7) and should be excluded from development where possible. No protected areas, apart from the wetland buffer areas, or irreplaceable sites were indicated by the C-Plan.

Figure 9 indicates that ridges are present in the north and east of the study area. The ridge area bordering the proposed route alignment in the east is considered to be transformed, but the ridge in the north of the study area is not considered to be transformed. According to the Gauteng Ridges Policy ridges play an important role in conservation of faunal and floral species and development should be limited in these areas.

Figure 6: Urban edge indicated by the GDACE C-Plan.

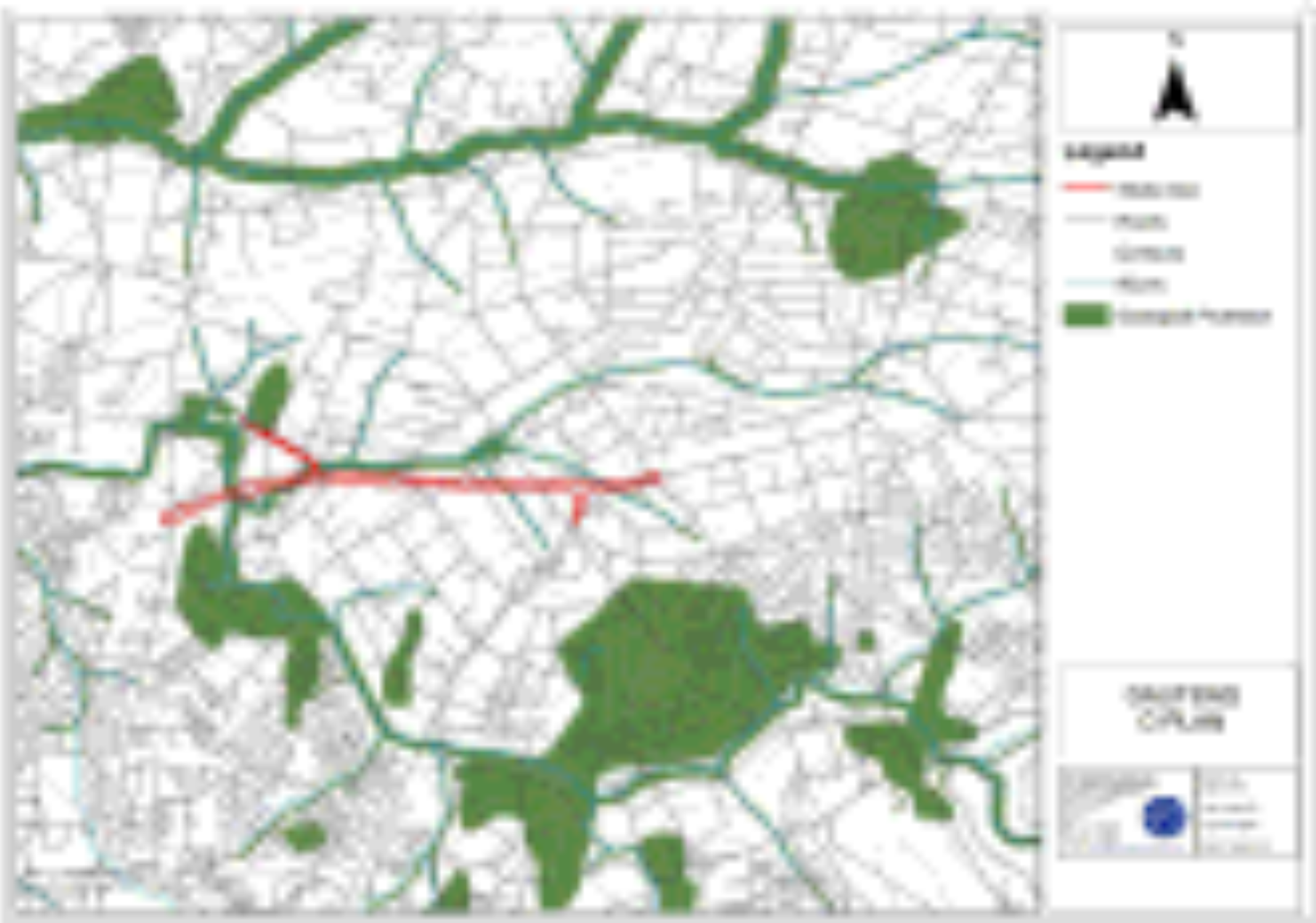


Figure 7: Areas of ecological protection indicated by the GDACE C-Plan

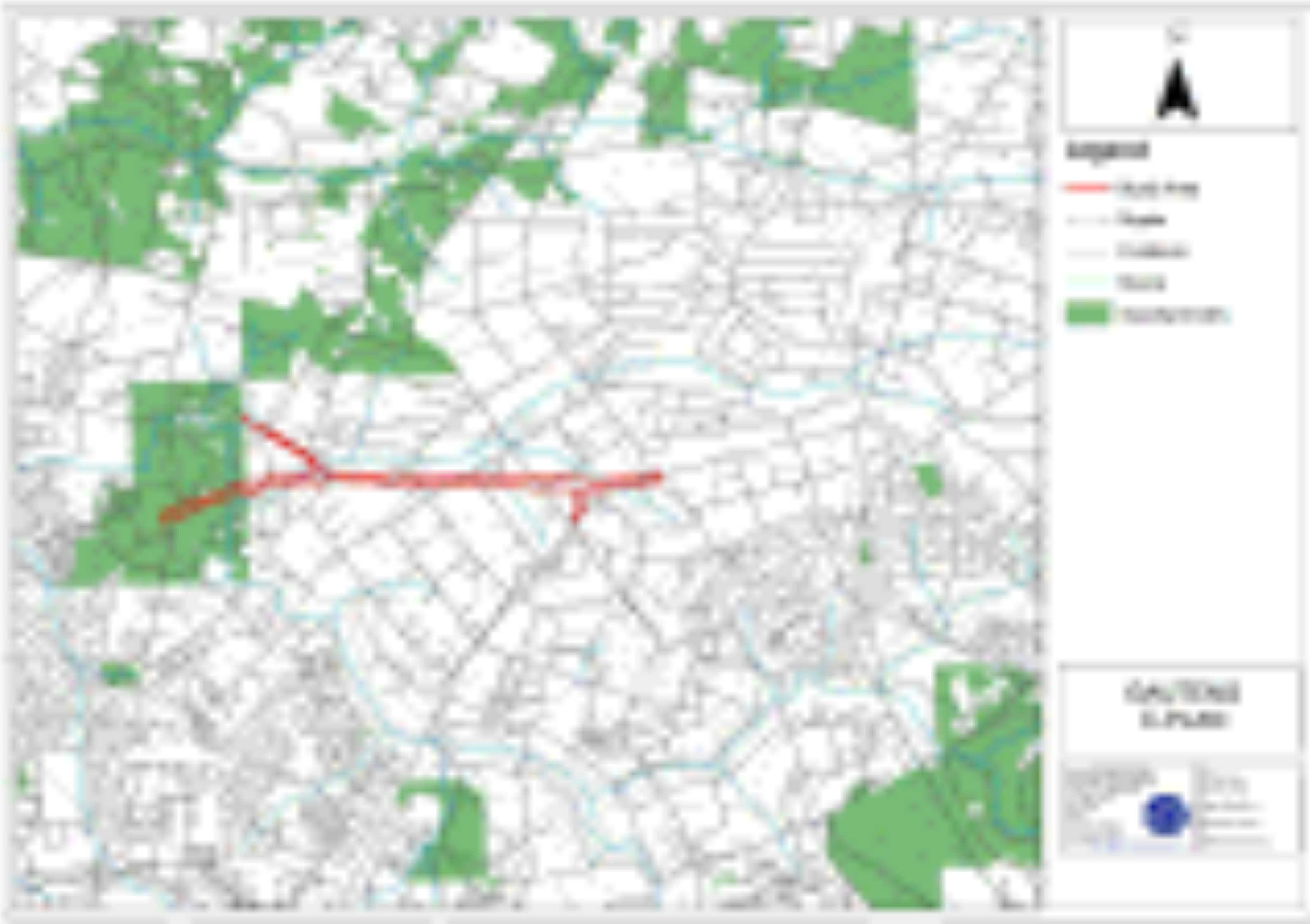


Figure 8: Important sites indicated by the GDACE C-Plan.

Figure 9: Ridge areas indicated by the GDACE C-Plan

6 AQUATIC ECOLOGICAL CHARACTERISTICS OF THE STUDY AREA

6.1 Ecoregions

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the study area is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

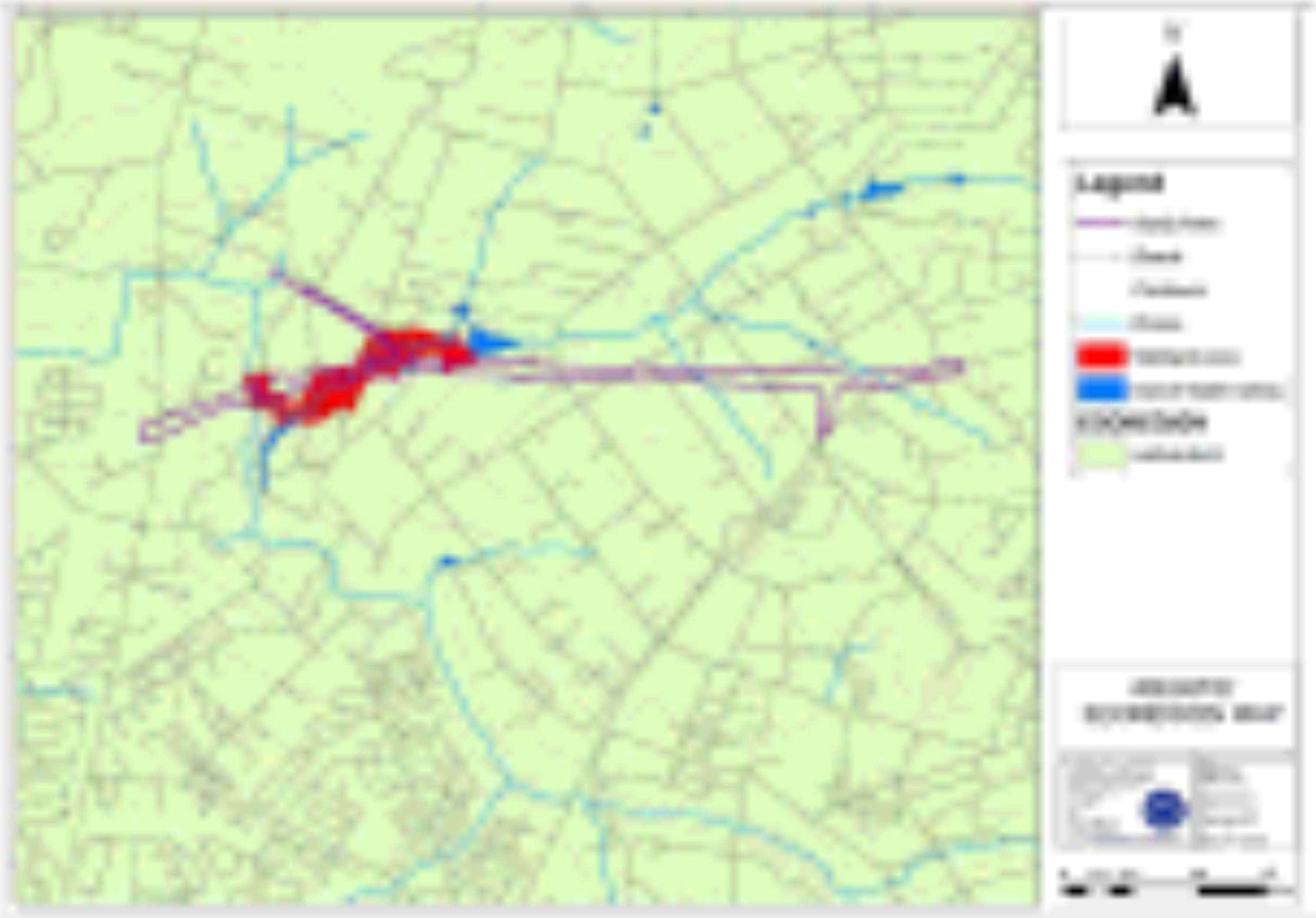


Figure 10: Aquatic Ecoregions associated with the subject property

6.2 Ecostatus

Water resources are generally classified according to the degree of modification or level of impairment. The classes, used by the South African River Health Program (RHP), are presented in the table below and will be used as the basis of classification of the systems in this desktop study, as well as future field studies.

Table 3: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems, prior to assessment or as part of a desktop assessment.

This database was searched for the four catchments of concern in order to define the EIS, PEMC and DEMC. The results of the assessment are summarised in the table below.

Table 4: Location of the catchment with co-ordinates and descriptions of the site in relation to surrounding features

Catchment	Resource	EIS	DEMC	PESC	PESC with rules as for desktop WBM
A21C	Jukskei River	Moderate	C: Moderately sensitive system	Class C	Class D: Largely Modified

The points below summarise the impacts on the aquatic resources in the A21C quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been moderately affected by bed modification.
- A moderate impact on the flow regime of the system has occurred due to larger floods and a Mean Annual Runoff (MAR) which is 17% larger than natural.
- A low impact from introduction of fish species to the system has occurred with special mention of *GAFF and CCAR*.

- Impacts as a result of inundation are low, inundation which does occur occurs as a result of weirs.
- Riparian zones and stream bank conditions have been moderately impacted due to the effects of exotics.
- High impacts on water quality are noted.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in the A21C quaternary catchment (Kleynhans 1999):

- The riverine system in this catchment has a high diversity of habitat types, including wetlands, cascades, riffles and pools.
- The site has a moderate importance in terms of conservation with the Ebenezer reserve nearby.
- Biota in this system has a moderate sensitivity to flow requirements with special mention of the invertebrate community as well as the fish species *Amphilius uranosccopus* and *Barbus eutaenia*.
- This area has a moderate importance in terms of migration of aquatic species.
- This area is considered to have a very high importance in terms of rare and endangered species, however, in terms of endemic species conservation the area is considered important with special mention of *Amphilius uranosccopus* and *Barbus eutaenia*.
- This area is important in terms of providing refuge areas for aquatic taxa.
- The ecology of this area is considered to have a moderate sensitivity to changes in water quality with special mention of concerns over altered temperature regimes and dissolved oxygen concentrations.
- The ecology of the area is sensitive to changes in flows with special mention of the need to have perennial rapids present with good water quality.
- The system has a high diversity of fish species and it is suspected that the aquatic macro-invertebrate community was more diverse in the past

7 SURROUNDING PROPERTIES/LAND USES

The greater area surrounding the subject property is located within a district primarily utilised for agricultural activities. The proposed road development meanders through agricultural and residential areas where varying levels of transformation were encountered.

8 SENSITIVITY MAPPING

All the ecological features of the study area were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). A geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed development (See figure below).

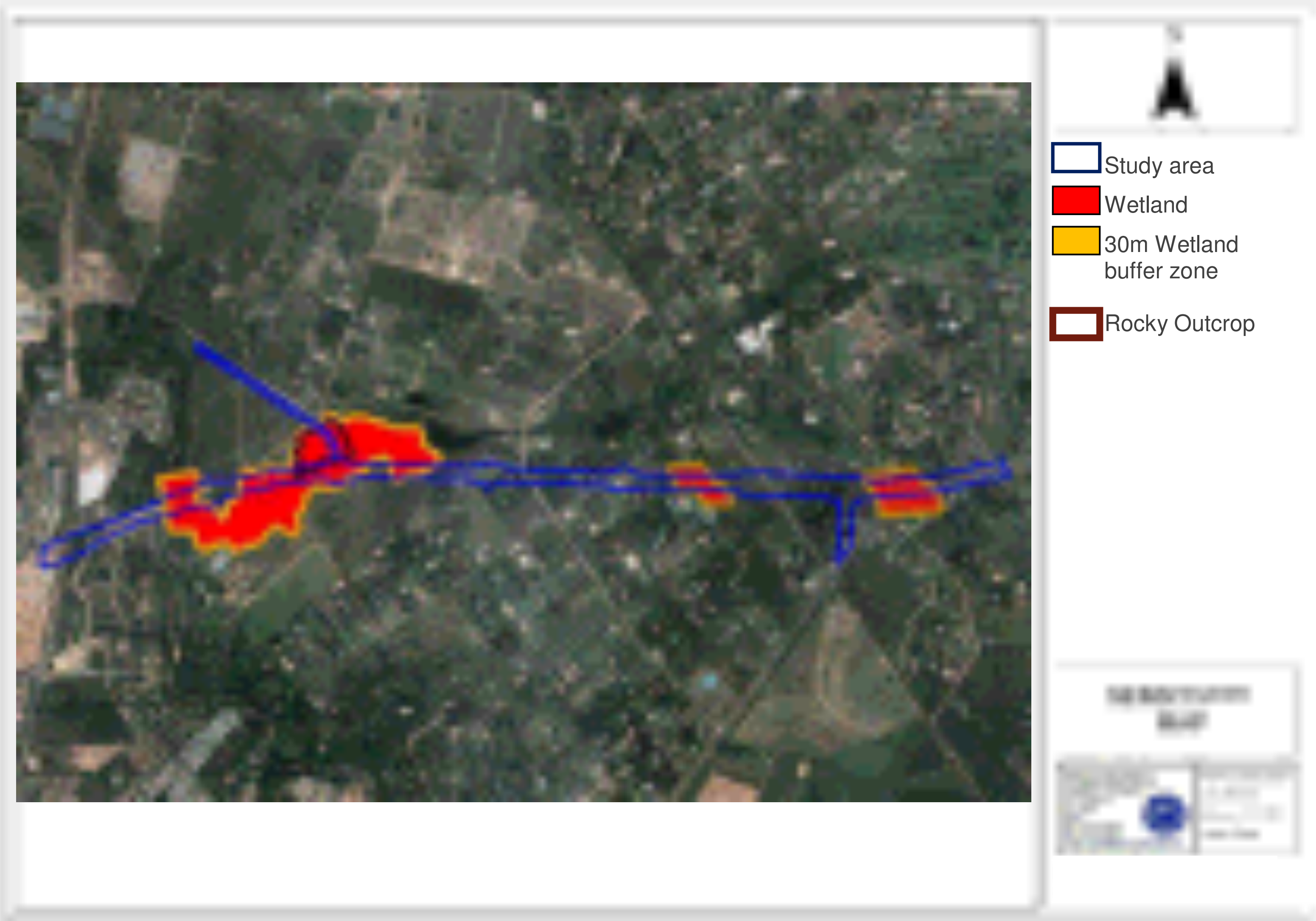


Figure 11: Sensitive areas of the subject property.

9 STRUCTURE OF THE REPORT

Section A of this report served to provide an introduction to the subject property, the general approach to the study as well as the method of impact assessment. Section A also presents the results of general desktop information reviewed as part of the study including the information generated by the relevant authorities as well as the context of the site in relation to the surrounding anthropogenic activities and ecological character. The section also indicates that the requirements for mitigation, monitoring and rehabilitation are addressed in each section.

Section B addresses all the issues pertaining to the assessment of the floral ecology of the subject property.

Section C addresses all the issues pertaining to the assessment of the floral ecology of the subject property.

Section D addresses all the issues pertaining to the assessment of the wetland ecology of the subject property.

Section E addresses all the issues pertaining to the assessment of the aquatic ecology of the subject property.

10 REFERENCES

Acocks, J. P. H. 1988 Third Edition. *Veld Types of South Africa.* Memoirs of the Botanical Survey of South Africa No. 57, Botanical Research Institute, RSA

Low, A.B. & Rebelo, A.G. (Eds) 1998. *Vegetation of South Africa, Lesotho and Swaziland.* Department of Environmental Affairs and Tourism, Pretoria, RSA.

Mucina, L. & Rutherford, M.C. (Eds). 2006. *The Vegetation of South Africa, Lesotho and Swaziland.* Strelitzia 19. South African National Biodiversity Institute, Pretoria, RSA.

Rutherford, M.C. & Westfall, R. H. 1994. *Biomes of Southern Africa: An objective categorization.* National Botanical Institute, Pretoria, RSA.

The South African National Biodiversity Institute (SANBI) is thanked for the use of data from the National Herbarium, Pretoria (PRE) **Computerised Information System (PRECIS)**

The South African National Biodiversity Institute - Biodiversity GIS (BGIS) *[online].* URL: http://bgis.sanbi.org.

FAUNAL, FLORAL, WETLAND AND AQUATIC ASSESSMENT FOR THE PROPOSED K56 ROAD DEVELOPMENT, DAINFERN, GAUTENG.

Prepared for

Bokamoso Environmental Consultants

July 2012

Section B: Floral Assessment

Prepared by:	**Scientific Aquatic Services**
Report author	**S. van Staden (Pr. Sci. Nat)**
Report Reference:	**SAS 212023**
Date:	**July 2012**

Scientific Aquatic Services CC
CC Reg No 2003/078943/23
Vat Reg. No. 4020235273
91 Geldenhuis Road
Malvern East Ext 1
2007
Tel: 011 616 7893
Fax: 011 615 6240/086 724 3132
E-mail: admin@sasenvironmental.co.za

TABLE OF CONTENTS

List of Figures

List of Tables

1. INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal, wetland and aquatic assessment on the proposed development of the K56 road (Section A: Figures 1 & 2), hereafter referred to as the subject property. The total length of the proposed road development is approximately 7km. The proposed K56 is situated to the northwest of Midrand, in the vicinity of Dainfern, in the Gauteng Province.

This report, after consideration and the description of the ecological integrity of the subject property, must guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, by means of the presentation of results and recommendations, as to the ecological viability of the proposed road development route. Only the subject property, including its immediate surroundings, was assessed during the field visits. The surrounding properties were, however, also considered as part of the desktop assessment.

2. GENERAL SITE SURVEY

Two site visits were undertaken during April 2012 to determine the ecological status of the proposed development site and the surrounding area. A reconnaissance 'walkabout' was initially undertaken in order to determine the general habitat types found throughout the subject property and, following this, specific study sites were chosen that were representative of the habitats found within the area. Special emphasis was placed on areas that may potentially support RDL species. Sites were investigated on foot to identify the occurrence of the dominant plant communities, species and habitat diversities.

3. FLORAL ASSESSMENT METHODOLOGY

3.1 Red and Orange Data Listed Flora

Prior to the field visit, a record of Red Data List plant species and their habitat requirements was acquired from SANBI for the quarter degree grid 2528CC (Appendix B). Throughout the floral assessment, specific attention was paid to the identification of any of these RDL species as well as the identification of suitable habitat that could potentially sustain these species.

The probability of occurrence (POC) for each floral species of concern (2528CC) was determined using the following calculations wherein the habitat requirements and habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Literature availability

	No Literature available					Literature available
Site score						
Score	0	1	2	3	4	5

Habitat availability

	No Habitat available					Habitat available
Site score						
Score	0	1	2	3	4	5

Habitat disturbance

	0	Very Low	Low	Moderately	High	Very High
Site score						
Score	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

3.2 Habitat Units

The overall vegetation survey was conducted by first identifying different habitat units and then analysing the floral species composition. Vegetation analyses were conducted within areas that were perceived to best represent the various plant communities. Species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the Egoli Granite Grassland vegetation type, which serves to provide an accurate indication of the ecological integrity and conservational value of each habitat unit.

3.3 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the present ecological state (PES) concerning the subject property in question. The information gathered during these assessments also significantly contributes to sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined habitat unit is assessed using separate data sheets (Appendix B) and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC)+((SIxPVC)+(RIS))]

Where:

1. **EVC** is extent of vegetation cover;
2. **SI** is structural intactness;
3. **PVC** is percentage cover of indigenous species and
4. **RIS** is recruitment of indigenous species.

Each of these contributing factors is individually calculated as discussed below. All scores and tables indicated in blue are used in the final score calculation for each contributing factor.

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover:

Vegetation cover % Site score	0%	1-5%	6-25%	26-50%	51-75%	76-100%
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score Site score	0	Very Low	Low	Moderately	High	Very High
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped								
Scattered								
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
RIS	0	1	2	3	4	5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	A	Unmodified, natural
18 to 22	B	Largely natural with few modifications.
14 to 18	C	Moderately modified
10 to 14	D	Largely modified
5 to 10	E	The loss of natural habitat extensive
<5	F	Modified completely

4. RESULTS OF FLORAL INVESTIGATION

4.1 Ecological condition and functioning

Ecological functioning and the condition of the study area range from high within wetland areas to low within the transformed areas. The subject property can be divided into four habitat units namely the Wetland Habitat Unit, occurring in the east and west of the subject property, the Rocky Outcrop Habitat Unit, occurring in the west of the subject property, and the Open Grassland and Transformed Habitat Units occurring throughout the remainder of the subject property (Figure 1).

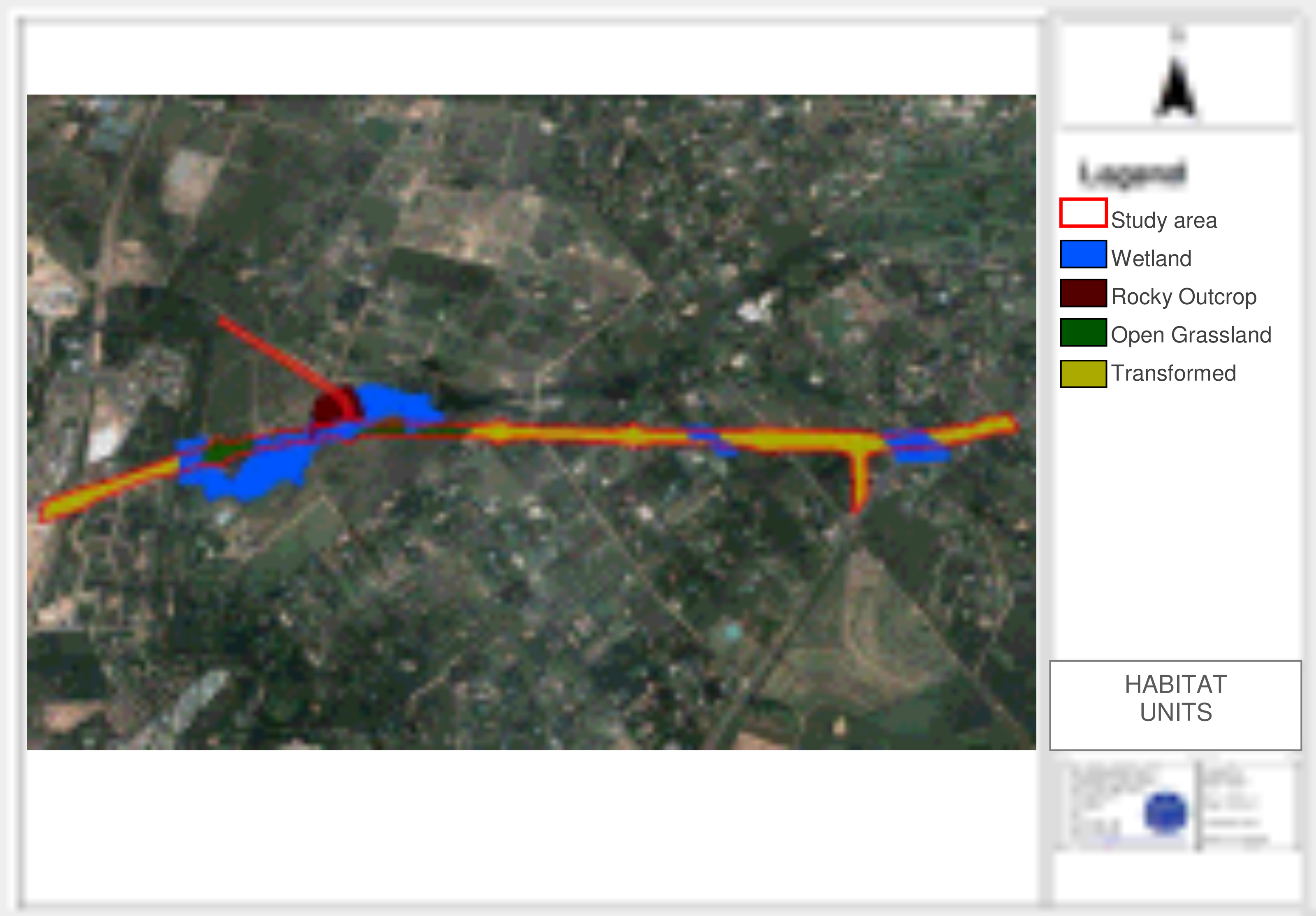


Figure 1: Conceptual mapping of Habitat Units encountered on the subject property.

4.2 Habitat descriptions

4.2.1 Habitat Unit 1: Wetland and Riparian Areas

The Wetland Habitat Unit covers a relatively large portion of the subject property. It is present in the eastern, western and central portion of the proposed development route and includes a number of artificial impoundments.

Figure 2: Wetland features encountered within the assessment site.

Several wetland and drainage features were encountered along the proposed development route. Although anthropogenic activities, in particular urban and residential development, as well as historic agricultural activities, have impacted the ecological integrity of some of these wetland features, the majority of the riparian and wetland areas have remained reasonably undisturbed and are in a largely natural state, apart from the dam areas. These areas are considered to be of high ecological sensitivity and have high potential to support an increased diversity of faunal and floral species. The wetland areas are also important in terms of faunal migratory connectivity.

Moderate to high floral species diversity was observed in wetland and riparian areas. The dominant species encountered within the wetland areas are represented in the table below.

Table 1: Dominant species encountered in the Wetland Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Aristida junciformis	*Buchnera reducta*	*Diospyros lycioides*
*Conyza podocephala**	*Persicaria lapathifolia**	*Ligustrum japonicum**
Cynodon dactylon	*Senna didimobotrya**	*Searsia lancea*
*Cyperus esculentus**	*Solanum mauritiuanum**	*Combretum erythrophyllum*
Cyperus ruprestis	*Verbena bonariensis**	*Searsia pyroides*
Eragrostis gummiflua		
Hyparrhenia hirta		
Imperata cylindrica		
Kylinga alba		
Panicum schinzii		
*Pennisetum clandestinum**		
Phragmites australis		
Schoenoplectus corymbosus		
Setaria megaphylla		
Sporobolus africanus		
Themeda triandra		
Typha capensis		

Section C of this report illustrates representative sections of the wetland and riparian zones. Overall fair to excellent levels of ecological functioning were observed, and as such these areas are deemed ecologically valuable. Please refer to the aquatic and wetland reports for further details on the ecological importance and functioning of the wetland and instream features.

4.2.2 Habitat Unit 2: Rocky Outcrop Areas

The Rocky Outcrop Habitat Unit is located in the west of the subject property. This habitat unit consists mainly of rocky boulders which protrude from the wetlands in areas. The tree layer is dominated by very large specimens of *Combretum erythrophyllum*, with *Searsia pyroides, Celtis africana, Euclea crispa, Olea europaea* subsp *africana* and *Diospyros lycioides* trees also identified. The forb layer is dominated by *Cheilanthes virides* ferns.

Figure 3: The Rocky Outcrop Habitat Unit encountered within the assessment site.

A large portion of this habitat unit is located within the footprint of the proposed development route, Due to the high ecological functionality, unique habitat and intact habitat integrity of the rocky ridge areas, the conservation value of this habitat unit is considered to be high and the Rocky Outcrop Habitat Unit should be excluded from the development activity. This habitat unit could also provide suitable habitat for Red Data Listed floral species, namely *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica.* Furthermore, the Rocky Outcrop Habitat Unit provides important habitat for faunal species that move through the area and unique habitat for a number of floral species. This Habitat Unit is therefore deemed to be of high ecological sensitivity.

The dominant species encountered within the wetland areas are represented in the table below.

Table 2: Dominant species encountered in the Rocky Outcrop Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Asparagus laricinus *Opuntia ficus-indica* *Searsia lancea* *Searsia pyroides* *Viscum rotundifolium*	*Cheilanthes viridis* *Nidorella hottentotica* *Pellaea calomelanos var calomelanos* *Salvia tiliifolia**	*Celtis africana* *Combretum erythrophyllum* *Dichapetalum cymosum* *Euclea crispa* *Olea europaea subsp. africana* *Ximenia americana* *Ziziphus mucronata* *Diospyros lycioides*

Overall high levels of ecological functioning were observed within the Rocky Outcrop Habitat Unit, and as such this area is deemed ecologically valuable.

4.2.3 Habitat Unit 3: Open Grassland

The Open Grassland Habitat Unit covers part of the central portion of the proposed development route not affected by current urban development. The figure below represent typical open grassland habitat encountered in the study area.

Figure 4: The Open Grassland Habitat Unit encountered within the assessment site.

This habitat unit consists of a well-developed grass layer, interspersed with clumps of indigenous tree specimens, dominated by *Combretum erythrophyllum*, *Ziziphus mucronata* and *Searsia pyroides*. A number of alien plant species are present within this habitat unit, but the overall ecological functionality of these areas remains intact. *Babiana hypogea* var *hypogea*, as well as *Hypoxis hemerocallidae*, (the latter being IUCN listed as 'Declining') have been encountered in this area and the overall forb layer is well-represented. The grass layer is dominated by *Heteropogon contortus, Themeda triandra, Hyparrhenia hirta* and *Melinis repens*, the latter two species being indicative of disturbance. A number of graminoid species encountered are representative of the expected vegetation type, Egoli Granite Grassland. The relatively high number of alien plant species present, and disturbance in the form of trampling and informal roads, however lowers the ecological sensitivity thereof. Dominant alien species include *Lantana camara, Schkuria pinnata, Tagetes minuta, Bidens pilosa, Stoebe vulgaris* and *Zinnia peruviana*.

The dominant species encountered within the Open Grassland Habitat Unit are represented in the table below.

Table 3: Dominant species encountered in the Open Grassland Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Andropogon eucomus	*Aloe zebrina*	*Combretum erythrophyllum*
Aristida junciformis	*Aruijia sericifera**	*Melia azederach*
Chloris virgata	*Babiana hypogea* var *hypogea*	*Searsia pyroides*
Cynodon dactylon	*Bidens pilosa**	*Tipuana tipu**
Eragrostis curvula	*Chamaecrista mimosoides*	*Ziziphus mucronata*
Eragrostis gummiflua	*Commelina africana*	
Harpochloa falx	*Convolvulus sagittatus*	
Heteropogon contortus	*Felicia muricata*	
Hyparrhenia hirta	*Helichrysum nudifolium*	
Melinis repens	*Helichrysum rugulosum*	
Panicum schinzii	*Hypochaeris radicata**	
Perotis patens	*Hypoxis hemerocallidae*	
Pogonarthria squarrosa	*Lantana camara**	
Setaria megaphylla	*Ledebouria revoluta*	
Sporobolus africanus	*Leonotis dysophylla*	
Themeda triandra	*Monsonia angustifolia*	
	Nidorella anomala	
	Polygala hottentotta	
	*Schkuhria pinnata**	
	Senecio inaequidens	
	*Stoebe vulgaris**	
	Striga elegans	
	*Tagetes minuta**	
	Turbina oblongata	
	*Verbena bonariensis**	
	*Verbena tenuisecta**	
	Vernonia poskeana	
	Wahlenbergia caledonica	
	Walafrida densiflora	
	*Zinnia peruviana**	

4.2.4 Habitat Unit 4: Transformed Areas

The Transformed Habitat Unit includes areas directly adjacent to the road reserves, that have been impacted or transformed by historic construction activities, as well as areas associated with urban development, including residential gardens. The majority of areas associated with this habitat unit are situated within the east of the subject property. Although some indigenous plant species occur within this habitat unit, the majority of species are typical of urban habitats and include a number of invasive species.

Figure 5: The Transformed Habitat Unit encountered within the assessment site

In terms of tree and shrub species, this habitat unit (Figure 5) consists mainly of landscaping specimens within residential properties located along the proposed development route. Dominant tree species include *Melia azedarach* and *Tipuana tipu.*

The forb layer within the Transformed Habitat Unit consists of typical roadside weeds and landscaping specimens/ garden ornamentals, such as *Agapanthus praecox*, *Dietes grandoflora* and *Tulbaghia violacea*. Grasses in this habitat unit comprise largely of *Pennisetum clandestinum* lawns and other grasses indicative of disturbance including *Melinis repens* and *Cynodon nlemfluensis*.

No plant species of concern were encountered within this habitat unit, and it highly unlikely that any such specimens will occur, due to the lack of suitable habitat and high levels of transformation.

The dominant species encountered within the Transformed Habitat Unit are presented in the table below:

Table 4: Dominant species encountered in the Transformed Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Chloris gayana	*Agapnthus praecox*	*Acacia karroo*
Cynodon nlemfluensis	*Bidens pilosa**	*Acacia sueberiana* var *woodii*
Cyperus ruprestis	*Dietes grandfilora*	*Combretum erythrophyllum*
Eragrostis pseudosclerantha	*Gomphrena celosioides**	*Eucalyptus* sp.
Melinis repens	*Ipomoea purpurea**	*Euphorbia* sp
Panicum maximum	*Lantana camara**	*Melia azedarach**
*Pennisetum clandestinum**	*Leonotis leonurus*	*Morus alba*
Themeda triandra	*Richardia brasiliensis**	*Olea europaea* subsp *africana*
	Ricinus communis	*Opuntia ficus-indica**
	*Schkuhria pinnata**	*Pinus pinaster*
	*Tagetes minuta**	*Quercus robusta**
	Tulbaghia violacea	*Searisa lancea*
	Wahlenbergia caledonica	*Tipuana tipu**
	*Xanthium strumarium**	

The ecological functionality and habitat integrity of the Transformed Habitat Unit is regarded as being limited. The high diversity of alien plant species, high levels of vegetation transformation and deviation from the expected vegetation type, adds to this habitat unit having a low ecological sensitivity and little conservation value from an ecological perspective.

5. FLORAL ASSESSMENT

5.1 RDL Floral Status Assessments

An assessment considering the presence of any RDL plant species, as well as suitable habitat to support any such species, was undertaken. The complete PRECIS (Pretoria Computer Information Systems) red data plant list for the grid reference (2528CC) was enquired from SANBI (South African National Biodiversity Institute).

Table 5: IUCN Red Data List Categories – Version 3.1 as supplied by SANBI.

Category	Definition
EX	Extinct
EW	Extinct in the wild
CR	Critically endangered
EN	Endangered
VU	Vulnerable
NT	Near threatened
LC	Least concern
DD	Data deficient
NE	Not evaluated

Table 6: PRECIS red data plant list for the QDS 2528CC (Raimondo *et al.*, 2009; SANBI, www.sanbi.org).

Family	Species	Threat status	Growth forms
ACANTHACEAE	*Dicliptera magaliesbergensis K.Balkwill*	VU	Herb, shrub
AMARYLLIDACEAE	*Boophone disticha (L.f.) Herb.*	Declining	Geophyte, succulent
AQUIFOLIACEAE	*Ilex mitis (L.) Radlk. var. mitis*	Declining	Shrub, tree
ASTERACEAE	*Callilepis leptophylla Harv.*	Declining	Herb
CAPPARACEAE	*Cleome conrathii Burtt Davy*	NT	Herb
FABACEAE	*Melolobium subspicatum Conrath*	VU	Dwarf shrub
HYACINTHACEAE	*Bowiea volubilis Harv. ex Hook.f. subsp. volubilis*	VU	Climber, geophyte, succulent
HYACINTHACEAE	*Drimia sanguinea (Schinz) Jessop*	NT	Geophyte
HYPOXIDACEAE	*Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.*	Declining	Geophyte
MESEMBRYANTHEMACEAE	*Lithops lesliei (N.E.Br.) N.E.Br. subsp. lesliei*	NT	Succulent
ORCHIDACEAE	*Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.*	EN	Geophyte, herb
ORCHIDACEAE	*Habenaria barbertoni Kraenzl. & Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria kraenzliniana Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria mossii (G.Will.) J.C.Manning*	EN	Geophyte, herb
ORCHIDACEAE	*Holothrix randii Rendle*	NT	Geophyte, herb
SCROPHULARIACEAE	*Freylinia tropica S.Moore*	Rare	Shrub

Table 7: POC for floral species of concern (Raimondo *et al.* 2009).

Species	Habitat	POC	Motivation
Dicliptera magaliesbergensis K.Balkwill	Forest, Savanna, Riverine forest and bush	60%	Suitable habitat is available for this species within the Rocky Outcrop Habitat Unit
Boophone disticha (L.f.)	Dry grassland and rocky areas	80%	Suitable habitat is available for this species, particularly within the Open Grassland Habitat Unit
Ilex mitis (L.) Radlk. var. *mitis*	Along rivers and streams in forest and thickets, sometimes in the open. Found from sea level to inland mountain slopes	60%	Suitable habitat is available for this species within the Rocky Outcrop or Wetland Habitat Units
Callilepis leptophylla Harv.	Grassland or open woodland, often on rocky outcrops or rocky hill slopes	54%	Limited habitat is available for this species, as the Open Grassland Habitat Unit is considered too disturbed to host these species
Cleome conrathii Burtt Davy	Stony quartzite slopes, usually in red sandy soil, grassland or deciduous woodland, all aspects	54%	Limited habitat is available for this species, as the Open Grassland Habitat Unit is considered too disturbed to host these species.
Melolobium subspicatum Conrath	Grassland	40%	Limited undisturbed habitat is available for this species.
Bowiea volubilis Harv. ex Hook.f. subsp. volubilis	Low and medium altitudes, usually along mountain ranges and in thick vegetated river valleys, often in bushclumps and under bolder screes. Often found in open woodland and on steep rocky hills	47%	If present, this species will occur within the Rocky Outcrop or Wetland Habitat Units
Drimia sanguinea (Schinz) Jessop	Open veld and scrubby woodland in a variety of soil types	40%	Limited habitat is available for this species, as the Open Grassland Habitat Unit is considered too disturbed to host these species.
Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.	Occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant	100%	This species has been encountered within the subject property, in the Open Grassland Habitat Unit.
Lithops lesliei (N.E.Br.) N.E.Br. subsp. lesliei	Primarily in arid grasslands, usually in rocky places, growing under the protection of forbs and grasses	33%	No suitable soils and no arid grasslands are available for this species
Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.	Short, open grassland and wooded grassland, on sandy gravel overlying dolomite, sometimes also on quartzite, 1 000-1 705 m	33%	No suitable soils are available for this species

Habenaria barbertoni Kraenzl. & Schltr.	Rocky hillsides, in bushveld in association with acacias, 1000-1500 m	47%	Limited habitat is available for this species.
Habenaria kraenzliniana Schltr	Stony, grassy hillsides, 1000-1400 m	54%	Limited habitat is available for this species. No grassy hillside habitat available.
Habenaria mossii (G.Will.) J.C.Manning	Open grassland on dolomite or in black, sandy soil	40%	Limited habitat is available for this species within the Open Grassland Habitat Unit.
Holothrix randii Rendle	Grassy slopes and rock ledges, usually southern aspects	33%	Limited habitat is available for this species.
Freylinia tropica S.Moore	Riverbanks and stream sides, 1800 m	73%	If present, this species will occur within the Rocky Outcrop or Wetland Habitat Units

From the above assessment, it is evident that two species have a POC of more than 80%, namely *Boophone disticha* and *Hypoxis hemerocallidae*. Of these species, *Hypoxis hemerocallidae* has been positively identified on the subject property and *Boophane disticha* is considered highly likely to occur with the Open Grassland Habitat Unit as well as within less disturbed portions of the Wetland Habitat Unit. Other floral species of concern that are considered to have a high probability of occurring in the subject property, particularly within the Rocky Outcrop Habitat Unit, include *Freylinia tropica*, *Ilex mitis* and *Dicliptera magaliesbergensis*, although none of these species were encountered. They were however specifically searched for where suitable habitat was present.

5.2 Vegetation Index Score

The information gathered during the assessment of the subject property was used to determine the Vegetation Index Score (VIS) - see Appendix B for calculations. Due to variation between the different habitat units within each site, all habitat units were assessed separately. The table below lists the results of each habitat unit.

Table 8: Scoring for the Vegetation Index Score

Vegetation Index Score	Assessment Class	Description
22 to 25	A	Unmodified, natural
18 to 22	B	Largely natural with few modifications.
14 to 18	C	Moderately modified
10 to 14	D	Largely modified
5 to 10	E	The loss of natural habitat extensive
<5	F	Modified completely

Table 9: Vegetation Index Score

Habitat unit	Score	Class	Motivation
Wetland/ Riparian	14	**C – Moderately modified**	Moderately impacted by past anthropogenic activities. Moderate levels of alien plant species invasion.
Rocky Outcrop	20	**B – Largely natural with few modifications**	Few disturbances present. Some alien invasive species present in the vicinity of wetlands
Open Grassland	15	**C – Moderately modified**	Disturbances present in the form of alien plant species, trampling and the proximity of informal roads.
Transformed	5	**E – Loss of natural habitat extensive**	Transformation levels high as a result of development and roads construction. High number of alien and landscaping plant species present.

From the Vegetation Index Score result outlined in Table 9, it is evident that the Rocky Outcrop Habitat Unit falls within Class B (Largely natural with few modifications), while the Wetland/ Riparian and Open Grassland Habitat Unit fall within Class C (Moderately Modified). The Transformed Habitat Unit received a low VIS of 5, and falls within Class 5 (Loss of natural habitat extensive).

5.3 Exotic and Invader Species

Alien invaders are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin, but as these exotic plant species have very limited natural "check" mechanisms within the natural environment, they are often the most opportunistic and aggressively-growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process, however, takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- a decline in species diversity;
- local extinction of indigenous species;
- ecological imbalance;
- decreased productivity of grazing pastures; and
- increased agricultural input costs.

As a result of current and historical disturbance from human settlement, agriculture, roads and overgrazing, alien invasive species are well represented, particularly within the Transformed, Open Grassland and Wetland Habitat Units. During construction and rehabilitation, it is thus especially important that alien floral management takes place to prevent further establishment. The table below indicates the dominant alien species encountered during the assessment.

Table 10: Dominant exotic vegetation species identified during the general area assessment.

Species	English name	Type or Origin	Category*
		Trees/ shrubs	
Ligustrum japonicum	Privet	China	1
Melia azedarach	Syringa	India	3
Opuntia ficus-indica	Prickly pear	South America	1
Solanum mauritiuanum	Bugweed	South America	1
Tipuana tipu	Tipu tree	Bolivia and Brazil	3
		Forbs	
Aruijia sericifera	Mothcatcher	Peru	1
Bidens pilosa	Common blackjack	South America	N/A
Conyza bonariensis	Flax leaved fleabane	America	N/A
Cyperus esculentus	Yellow nutsedge	Uncertain	M/A
Datura stramonium	Common thornapple	North America	1
Gomphrena celosioides	Globe amaranth	South America	N/A
Hypochaeris radicata	Hairy wild lettuce	Europe	N/A
Ipomoea purpurea	Morning glory	Tropical America	3
Lantana camara	Lantana	Tropical America	1
Pennisetum clandestinum	Kikuyu	East Africa	N/A
Richardia brasiliensis	Mexican richardia	South America	N/A
Salvia tiliifolia	Linderleaf sage	Uncertain	1
Schkuhria pinnata	Dwarf marigold	South America	N/A
Stoebe vulgaris	Bankrupt bush	Indigenous	N/A
Tagetes minuta	Tall khakiweed	South America	N/A
Verbena bonariensis	Purple top	South America	N/A
Verbena tenuisecta	Fine-leaved verbena	South America	N/A
Xanthium strumarium	Large cocklebur	South America	1
Zinnia peruviana	Redstar zinnia	South America	N/A

***Category 1** – Declared weeds. Prohibited plants, which must be controlled or eradicated.
***Category 2** – Declared invader plants with a value. “Invaders” with certain useful qualities (i.e. commercial). Only allowed in controlled, demarcated areas.
***Category 3** – Mostly ornamental plants. Alien plants presently growing in, or having escaped from, areas such as gardens, but are proven invaders. No further planting or trade in propagative material is allowed (Bromilow, 2001).

5.4 Medicinal plants

Medicinal plant species are not necessarily indigenous species, with many of them being regarded as alien invasive weeds. The majority of the medicinal plant species are located are not restricted the Wetland, Open Grassland and Rocky Outcrop Habitat Units..

Table 11: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, et al., 1997; van Wyk and Gericke, 2000; van Wyk and Wink, 2004; van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Datura stramonium	Thornapple	Leaves and rarely the green fruit.	Generally as asthma treatment and pain reduction.
Conyza bonariensis	Flax leaved fleabane	Herb	Astringent, diarrhoea, diuretic, colds, insect repellent.
Helichrysum nudifolium	Hottentot's tea	Leaves and twigs mainly used, sometimes roots.	General remedy – coughs, colds, fever, infections, headaches, menstrual pain and wound dressing.
Hypoxis hemerocallidae	African potato/ Star flower	Tuberous rootstock	Used as an emetic to treat dizziness, bladder disorders and insanity.
Ziziphus mucronata	Buffalo thorn	Roots, Leaves and Bark	Treatment of boils and wounds; allegedly sedative.

6. SENSITIVITY MAPPING

NOTE: Please refer to associated shapefiles for localities and extents of sensitive areas.

Wetland features, as well as the rocky outcrop area located centrally with respect to the proposed development route, are considered sensitive and were identified and delineated (refer to Wetland Ecology report – Section D). This is mainly due to the higher diversity of faunal and floral species expected to occur within these areas and the potential of these areas to host RDL species, as well as the unique habitat the wetland and rocky outcrop areas provide for both faunal and floral species. It is therefore deemed important that these areas be excluded from the proposed development.

The Open Grassland Habitat Unit is not deemed to be sensitive, as a result of high levels of alien plant species invasion, while the transformed areas are deemed to be of low sensitivity as a result of the high levels of transformation present. The Transformed Habitat Unit is not likely to support any RDL or sensitive faunal or floral species, while the Open Grassland and Wetland Habitat Units may hosts RDL floral species such as *Hypoxis hemerocallidae* (positively identified on site) and *Boophane distcha*.

Figure 11 (Section A) indicates the position of the ecologically sensitive wetland and rocky outcrop areas.

7. CONCLUSIONS AND RECOMMENDATIONS

The study area can be broadly divided into four habitat units. Each is considered different with regards to ecological condition and functioning. Only the Wetland and Rocky Outcrop Habitat Units can be considered of increased ecological importance. These areas have the highest potential of supporting a variety floral and faunal species when compared to the remainder of the subject property. One RDL floral species, namely *Hypoxis hemerocallidae* ('Declining') was encountered during the assessment.

The following general conclusions were drawn on completion of the survey:

- The study area falls within the Savanna Biome, the Bushveld Basin bioregion and Egoli Grassland Vegetation Type, which is considered to be an endangered vegetation type;
- Four habitat units were identified along the proposed development route, namely the Wetland Habitat Unit, the Rocky Outcrop Habitat Unit, the Open Grassland Habitat Unit and the Transformed Habitat Unit. The Transformed Habitat Unit encompasses the majority of the study area, while the Wetland Habitat Unit occurs within the east, west and central portions of the subject property;
- The entire subject property has been subjected to a degree of vegetation transformation as a result of urban and residential development and historic agricultural activities. Alien invasive plant species are present in all habitat units;
- The Rocky Outcrop Habitat Unit has experienced a low degree of disturbance and is considered to be highly sensitive as a result of the unique habitat it provides for faunal and floral species. It also has the potential to host RDL plant species, such as *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica*;
- The Wetland Habitat Unit also has higher ecological sensitivity compared to the Open Grassland and Transformed Habitat Unit due to the potential habitat for faunal and floral species and the migratory connectivity for faunal species that these areas potentially provide;
- The Open Veld Habitat Unit is not considered to be ecologically sensitive, as a result of its isolated nature and the high numbers of alien plant species present;
- The Transformed Habitat unit is considered to be of low ecological sensitivity as a result of its impacted nature due to past development in the area;
- No RDL or protected floral species were identified during the assessment. However, the Rocky Outcrop and Wetland Habitat Units may provide suitable habitat to support such floral species;

- Levels of alien floral invasion were moderate to high within all habitat units identified, apart from within the Rocky Outcrop Habitat Unit, where alien invasive species are restricted to riparian edges;
- The VIS (Vegetation Index Score) for each Habitat Unit was calculated as follows:

Habitat unit	Score	Class	Motivation
Wetland/ Riparian	14	**C – Moderately modified**	Moderately impacted by past anthropogenic activities. Moderate levels of alien plant species invasion.
Rocky Outcrop	20	**B – Largely natural with few modifications**	Few disturbances present. Some alien invasive species present in the vicinity of wetlands
Open Grassland	15	**C – Moderately modified**	Disturbances present in the form of alien plant species, trampling and the proximity of informal roads.
Transformed	5	**E – Loss of natural habitat extensive**	Transformation levels high as a result of development and roads construction. High number of alien and landscaping plant species present.

After conclusion of this floral assessment, the following recommendations are provided:

Development and operational footprint

- A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities in order to aid in the conservation of ecology within and adjacent to the proposed development area. The Rocky Outcrop Habitat Unit should not be disturbed due to its unique ecology.
- *Hypoxis hemerocallidae*, *Babiana hypogea* var. *hypogea*, and *Boophane disticha* (if discovered on site), occurring within the development footprint should be rescued and relocated to suitable habitat in the vicinity of the study area.
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland and rocky outcrop areas. The boundaries of footprint areas are to be clearly defined.
- Large trees should be maintained where possible for the length of the proposed development route.
- Proper planning of infrastructure, which avoids unnecessary barriers in migratory corridors, should be conducted during the pre-construction phase.

Wetlands

- As much of the ecological functioning and migratory connectivity of the drainage features need to be maintained.
- No topsoil, waste rock or building material should be dumped into any existing wetland and rocky outcrop areas, as these areas are considered to be of higher ecological importance.
- It must be ensured that construction-related waste and effluent do not affect the wetland resources and associated buffer zones.
- Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in more sensitive wetland and rocky outcrop areas.
- All construction vehicles should remain on designated roads with no indiscriminate driving through wetlands/ riparian or rocky outcrop areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater and erosion management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the wetland areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Alien plant species

- Proliferation of alien and invasive species is expected within disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the site boundary. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on rehabilitation in the future, has to be controlled.

- Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.
- All soils compacted as a result of construction activities and falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.

Fire

- All informal fires on the property should be prohibited, specifically during the construction phase of the proposed development.

Dust

- It is to be ensured that all temporary access roads and construction areas are regularly sprayed with water or treated with other dust suppression measures in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss into adjacent waterways.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting are to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.
- Any areas where earthworks have taken place, should be reseeded with indigenous vegetation to prevent erosion.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation.

8. REFERENCES

Acocks, J. P. H. 1988 Third Edition. *Veld Types of South Africa.* Memoirs of the Botanical Survey of South Africa No. 57, Botanical Research Institute, RSA

Bromilow, C. 2001. Revised Edition, First Impression. *Problem Plants of South Africa.* Briza Publications, Pretoria, RSA.

Germishuizen, G & Clarke, B. 2003. First Edition, First Impression. *Illustrated guide to the Wildflowers of Northern South Africa.* Briza Publications, Pretoria, RSA.

Henderson, L. 2001. *Alien Weeds and Invasive Plants*. Agricultural Research Council, RSA.

Henderson, L & Musil, K. J. 1987. *Plant Invaders of the Transvaal.* Department of Agriculture and Water Supply, Bulletin 412, RSA.

Low, A.B. & Rebelo, A.G. (Eds) 1998. *Vegetation of South Africa, Lesotho and Swaziland.* Department of Environmental Affairs and Tourism, Pretoria, RSA.

Manning, J. 2003. *Photographic Guide to the Wild Flowers of South Africa.* Briza Publications, Pretoria, RSA.

Mucina, L. & Rutherford, M.C. (Eds). 2006. *The Vegetation of South Africa, Lesotho and Swaziland.* Strelitzia 19. South African National Biodiversity Institute, Pretoria, RSA.

Pfab, M. F. & Victor, J. E. 2002. *Threatened Plants of Gauteng.* SA Journal of Botany, Volume 68, Number 3 (pages 370 – 375). NISC (Pty) Ltd, RSA.

Pooley, E. 2005. First Edition, Second Impression. *A Field Guide to Wild Flowers of Kwazulu-Natal and the Eastern Region.* The Flora Publications Trust, Durban, RSA.

Rutherford, M.C. & Westfall, R. H. 1994. *Biomes of Southern Africa: An objective categorization.* National Botanical Institute, Pretoria, RSA.

Tainton, N.M. (Ed) 1999. *Veld Management in South Africa.* University of Natal Press, Pietermaritzburg, RSA.

Van Oudtshoorn, F. 2004. Second Edition, Third Print. *Guide to Grasses of South Africa.* Briza Publications, Pretoria, RSA.

Van Wyk, B & Gericke, N. 2000. First Edition. *People's plants; A guide to useful plants of Southern Africa*. Briza Publications, Pretoria, RSA.

Van Wyk, B., & Malan, S. 1998 Second Impression. *Field Guide to the Wild Flowers of the Highveld.* Struik Publishers, Cape Town, RSA.

Van Wyk, B & Smith, G. 2005. Second Edition, Second Impression. *Guide to the Aloes of South Africa.* Briza Publications, Pretoria, RSA.

Van Wyk, B & Van Wyk, P. 1997. *Field Guide to Trees of Southern Africa.* Struik Publishers, Cape Town, RSA.

Van Wyk, B., Van Oudtshoorn, B. & Gericke, N. 2005. First Edition, Fourth Impression. *Medicinal Plants of South Africa.* Briza Publications, Pretoria, RSA.

Venter, F & Venter, J. 2002 Second Edition. *Making the most of Indigenous Trees.* Briza Publications, Pretoria, RSA.

APPENDIX A

Table 12: Expected floral species list for the QDS *2528CC* supplied by SANBI Precis Database.

Family	Species	Threat status	Growth forms
ACANTHACEAE	*Barleria macrostegia Nees*	LC	Herb
ACANTHACEAE	*Blepharis innocua C.B.Clarke*	LC	Herb
ACANTHACEAE	*Blepharis squarrosa (Nees) T.Anderson*	LC	Dwarf shrub, herb
ACANTHACEAE	*Chaetacanthus costatus Nees*	LC	Dwarf shrub, herb
ACANTHACEAE	*Chaetacanthus setiger (Pers.) Lindl.*	LC	Dwarf shrub, herb, shrub
ACANTHACEAE	*Crabbea angustifolia Nees*	LC	Herb
ACANTHACEAE	*Crabbea hirsuta Harv.*	LC	Herb
ACANTHACEAE	*Crabbea ovalifolia Ficalho & Hiern*	LC	Herb
ACANTHACEAE	*Dicliptera magaliesbergensis K.Balkwill*	VU	Herb, shrub
ACANTHACEAE	*Justicia anagalloides (Nees) T.Anderson*	LC	Herb
ACANTHACEAE	*Justicia flava (Vahl) Vahl*	LC	Dwarf shrub, herb
ACANTHACEAE	*Ruellia cordata Thunb.*	LC	Dwarf shrub, herb
ACANTHACEAE	*Sclerochiton harveyanus Nees*	LC	Shrub
ACANTHACEAE	*Thunbergia atriplicifolia E.Mey. ex Nees*	LC	Dwarf shrub, herb
ACANTHACEAE	*Thunbergia neglecta Sond.*	LC	Herb, scrambler
ACHARIACEAE	*Kiggelaria africana L.*	LC	Shrub, tree
ALLIACEAE	*Nothoscordum borbonicum Kunth*	NE	Geophyte
ALLIACEAE	*Tulbaghia acutiloba Harv.*	LC	Herb
ALLIACEAE	*Tulbaghia leucantha Baker*	LC	Herb
ALLIACEAE	*Tulbaghia pretoriensis Vosa & Condy*	DDT	Herb
AMARANTHACEAE	*Achyranthes aspera L. var. aspera*	NE	Herb
AMARANTHACEAE	*Achyranthes aspera L. var. sicula L.*	NE	Herb
AMARANTHACEAE	*Aerva leucura Moq.*	LC	Herb
AMARANTHACEAE	*Amaranthus deflexus L.*	NE	Herb
AMARANTHACEAE	*Amaranthus hybridus L. subsp. hybridus var. erythrostachys Moq.*	NE	Herb
AMARANTHACEAE	*Amaranthus hybridus L. subsp. hybridus var. hybridus*	NE	Herb
AMARANTHACEAE	*Cyathula uncinulata (Schrad.) Schinz*	LC	Climber, herb
AMARANTHACEAE	*Gomphrena celosioides Mart.*	NE	Herb
AMARANTHACEAE	*Guilleminea densa (Willd. ex Roem. & Schult.) Moq.*	NE	Herb
AMARANTHACEAE	*Pupalia lappacea (L.) A.Juss. var. lappacea*	LC	Herb
AMARYLLIDACEAE	*Boophone disticha (L.f.) Herb.*	Declining	Geophyte, succulent
AMARYLLIDACEAE	*Crinum graminicola I.Verd.*	LC	Geophyte
AMARYLLIDACEAE	*Cyrtanthus contractus N.E.Br.*	LC	Geophyte
AMARYLLIDACEAE	*Nerine gaberonensis Bremek. & Oberm.*	LC	Geophyte
AMARYLLIDACEAE	*Nerine rehmannii (Baker) L.Bolus*	LC	Geophyte
AMARYLLIDACEAE	*Scadoxus puniceus (L.) Friis & Nordal*	LC	Geophyte, herb
ANACARDIACEAE	*Lannea edulis (Sond.) Engl. var. edulis*	LC	Dwarf shrub
ANACARDIACEAE	*Searsia discolor (E.Mey. ex Sond.) Moffett*	LC	Dwarf shrub, shrub
ANACARDIACEAE	*Searsia leptodictya (Diels) T.S.Yi, A.J.Mill. & J.Wen forma leptodictya*	NE	Shrub, tree
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. gracilis*	LC	Shrub, tree

Family	Species	Threat status	Growth forms
	(Engl.) Moffett		
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. integrifolia (Engl.) Moffett*	LC	Shrub, tree
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. pyroides*	LC	
ANACARDIACEAE	*Searsia rigida (Mill.) F.A.Barkley var. rigida*	LC	Shrub
ANACARDIACEAE	*Searsia zeyheri (Sond.) Moffett*	LC	Shrub
ANEMIACEAE	*Mohria vestita Baker*	LC	Geophyte, herb, lithophyte
ANTHERICACEAE	*Chlorophytum bowkeri Baker*	LC	Herb
ANTHERICACEAE	*Chlorophytum cooperi (Baker) Nordal*	LC	Herb
ANTHERICACEAE	*Chlorophytum fasciculatum (Baker) Kativu*	LC	Herb
ANTHERICACEAE	*Chlorophytum trichophlebium (Baker) Nordal*	LC	Herb
APIACEAE	*Afrosciadium magalismontanum (Sond.) P.J.D.Winter*	LC	Herb
APIACEAE	*Heteromorpha arborescens (Spreng.) Cham. & Schltdl. var. abyssinica (Hochst. ex A.Rich.) H.Wolff*	LC	Shrub, tree
APIACEAE	*Pastinaca sativa L.*	NE	Herb
APOCYNACEAE	*Acokanthera oppositifolia (Lam.) Codd*	LC	Shrub, tree
APOCYNACEAE	*Ancylobotrys capensis (Oliv.) Pichon*	LC	Climber, shrub
APOCYNACEAE	*Araujia sericifera Brot.*	NE	Climber
APOCYNACEAE	*Asclepias adscendens (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias albens (E.Mey.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias aurea (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias brevipes (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias densiflora N.E.Br.*	LC	Herb
APOCYNACEAE	*Asclepias eminens (Harv.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias fallax (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias gibba (E.Mey.) Schltr. var. media N.E.Br.*	LC	Herb
APOCYNACEAE	*Asclepias stellifera Schltr.*	LC	Herb
APOCYNACEAE	*Aspidoglossum lamellatum (Schltr.) Kupicha*	LC	Herb, succulent
APOCYNACEAE	*Brachystelma barberae Harv. ex Hook.f.*	LC	Geophyte, succulent
APOCYNACEAE	*Brachystelma circinatum E.Mey.*	LC	Geophyte, succulent
APOCYNACEAE	*Brachystelma foetidum Schltr.*	LC	Geophyte, succulent
APOCYNACEAE	*Carissa bispinosa (L.) Desf. ex Brenan*	LC	Shrub
APOCYNACEAE	*Ceropegia rendallii N.E.Br.*	LC	Climber, succulent
APOCYNACEAE	*Cryptolepis oblongifolia (Meisn.) Schltr.*	LC	Scrambler, shrub
APOCYNACEAE	*Cynanchum virens (E.Mey.) D.Dietr.*	LC	Climber
APOCYNACEAE	*Gomphocarpus fruticosus (L.) Aiton f. subsp. decipiens (N.E.Br.) Goyder & Nicholas*	LC	Herb, shrub
APOCYNACEAE	*Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus*	NE	Herb, shrub
APOCYNACEAE	*Gomphocarpus glaucophyllus Schltr.*	LC	Herb
APOCYNACEAE	*Huernia loeseneriana Schltr.*	LC	Succulent
APOCYNACEAE	*Orbea lutea (N.E.Br.) Bruyns subsp. lutea*	LC	Succulent
APOCYNACEAE	*Orthanthera jasminiflora (Decne.) Schinz*	LC	Creeper
APOCYNACEAE	*Pachycarpus schinzianus (Schltr.) N.E.Br.*	LC	Herb, succulent

Family	Species	Threat status	Growth forms
APOCYNACEAE	*Parapodium costatum E.Mey.*	LC	Herb, succulent
APOCYNACEAE	*Pentarrhinum insipidum E.Mey.*	LC	Climber
APOCYNACEAE	*Raphionacme hirsuta (E.Mey.) R.A.Dyer*	LC	Geophyte, herb, succulent
APOCYNACEAE	*Raphionacme velutina Schltr.*	LC	Geophyte, herb, succulent
APOCYNACEAE	*Riocreuxia burchellii K.Schum.*	LC	Climber
APOCYNACEAE	*Stapelia gigantea N.E.Br.*	LC	Succulent
APOCYNACEAE	*Xysmalobium brownianum S.Moore*	LC	Herb, succulent
APOCYNACEAE	*Xysmalobium undulatum (L.) Aiton f. var. undulatum*	LC	Herb, succulent
AQUIFOLIACEAE	*Ilex mitis (L.) Radlk. var. mitis*	Declining	Shrub, tree
ARACEAE	*Zantedeschia albomaculata (Hook.) Baill. subsp. albomaculata*	LC	Geophyte, herb
ARACEAE	*Zantedeschia albomaculata (Hook.) Baill. subsp. macrocarpa (Engl.) Letty*	LC	Geophyte, herb
ARALIACEAE	*Cussonia paniculata Eckl. & Zeyh. subsp. sinuata (Reyneke & Kok) De Winter*	LC	Succulent, tree
ASPARAGACEAE	*Asparagus cooperi Baker*	LC	Dwarf shrub, shrub
ASPARAGACEAE	*Asparagus flavicaulis (Oberm.) Fellingham & N.L.Mey. subsp. flavicaulis*	LC	Shrub
ASPARAGACEAE	*Asparagus laricinus Burch.*	LC	Shrub
ASPARAGACEAE	*Asparagus setaceus (Kunth) Jessop*	LC	Shrub
ASPARAGACEAE	*Asparagus suaveolens Burch.*	LC	Shrub
ASPARAGACEAE	*Asparagus virgatus Baker*	LC	Shrub
ASPHODELACEAE	*Aloe greatheadii Schönland var. davyana (Schönland) Glen & D.S.Hardy*	LC	Herb, succulent
ASPHODELACEAE	*Aloe zebrina Baker*	LC	Herb, succulent
ASPHODELACEAE	*Bulbine capitata Poelln.*	LC	Geophyte, herb, succulent
ASPHODELACEAE	*Kniphofia ensifolia Baker subsp. ensifolia*	LC	Herb
ASPHODELACEAE	*Kniphofia porphyrantha Baker*	LC	Herb
ASPHODELACEAE	*Trachyandra asperata Kunth var. asperata*	LC	Geophyte, succulent
ASPHODELACEAE	*Trachyandra asperata Kunth var. basutoensis (Poelln.) Oberm.*	LC	Geophyte, succulent
ASPHODELACEAE	*Trachyandra saltii (Baker) Oberm. var. saltii*	LC	Geophyte, succulent
ASPLENIACEAE	*Asplenium aethiopicum (Burm.f.) Bech.*	LC	Epiphyte, geophyte, herb, lithophyte
ASPLENIACEAE	*Asplenium capense (Kunze) Bir, Fraser-Jenk. & Lovis*		
ASPLENIACEAE	*Asplenium varians Wall. ex Hook. & Grev. subsp. fimbriatum (Kunze) Schelpe*	LC	Geophyte, herb, lithophyte
ASTERACEAE	*Acanthospermum glabratum (DC.) Wild*	NE	Herb
ASTERACEAE	*Achillea millefolium L.*	NE	Herb
ASTERACEAE	*Adenostemma caffrum DC. var. caffrum*	LC	Herb, hydrophyte
ASTERACEAE	*Artemisia afra Jacq. ex Willd. var. afra*	LC	Herb, shrub
ASTERACEAE	*Aster bakerianus Burtt Davy ex C.A.Sm.*	LC	Herb
ASTERACEAE	*Aster harveyanus Kuntze*	LC	Herb
ASTERACEAE	*Aster peglerae Bolus*	LC	Herb
ASTERACEAE	*Athrixia elata Sond.*	LC	Dwarf shrub
ASTERACEAE	*Berkheya radula (Harv.) De Wild.*	LC	Herb
ASTERACEAE	*Berkheya zeyheri Oliv. & Hiern subsp. zeyheri*	LC	Herb

Family	Species	Threat status	Growth forms
ASTERACEAE	*Callilepis laureola DC.*	LC	Herb
ASTERACEAE	*Callilepis leptophylla Harv.*	Declining	Herb
ASTERACEAE	*Campuloclinium macrocephalum (Less.) DC.*	NE	Herb
ASTERACEAE	*Cineraria parvifolia Burtt Davy*	LC	Herb
ASTERACEAE	*Cirsium vulgare (Savi) Ten.*	NE	Herb
ASTERACEAE	*Conyza aegyptiaca (L.) Aiton*	LC	Herb
ASTERACEAE	*Conyza pinnata (L.f.) Kuntze*	LC	Herb
ASTERACEAE	*Conyza podocephala DC.*	LC	Herb
ASTERACEAE	*Conyza scabrida DC.*	LC	Shrub
ASTERACEAE	*Conyza ulmifolia (Burm.f.) Kuntze*	LC	Herb
ASTERACEAE	*Crassocephalum x picridifolium (DC.) S.Moore*	NE	Herb
ASTERACEAE	*Crepis hypochaeridea (DC.) Thell.*	NE	Herb
ASTERACEAE	*Dicoma anomala Sond. subsp. gerrardii (Harv. ex F.C.Wilson) S.Ortíz & Rodr.Oubiña*	LC	Herb
ASTERACEAE	*Euryops chrysanthemoides (DC.) B.Nord.*	LC	Shrub
ASTERACEAE	*Felicia muricata (Thunb.) Nees subsp. muricata*	LC	Shrub
ASTERACEAE	*Flaveria bidentis (L.) Kuntze*	NE	Herb
ASTERACEAE	*Galinsoga parviflora Cav.*	NE	Herb
ASTERACEAE	*Gamochaeta coarctata (Willd.) Kerguélen*	NE	Herb
ASTERACEAE	*Gamochaeta subfalcata (Cabrera) Cabrera*	NE	Herb
ASTERACEAE	*Gazania krebsiana Less. subsp. serrulata (DC.) Roessler*	LC	Herb
ASTERACEAE	*Geigeria burkei Harv. subsp. burkei var. burkei*	LC	Herb
ASTERACEAE	*Geigeria burkei Harv. subsp. burkei var. intermedia (S.Moore) Merxm.*	LC	Herb
ASTERACEAE	*Gerbera ambigua (Cass.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Gerbera piloselloides (L.) Cass.*	LC	Herb
ASTERACEAE	*Gerbera viridifolia (DC.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Haplocarpha scaposa Harv.*	LC	Herb
ASTERACEAE	*Helichrysum acutatum DC.*	LC	Herb
ASTERACEAE	*Helichrysum argyrosphaerum DC.*	LC	Herb
ASTERACEAE	*Helichrysum aureonitens Sch.Bip.*	LC	Herb
ASTERACEAE	*Helichrysum caespititium (DC.) Harv.*	LC	Herb
ASTERACEAE	*Helichrysum chionosphaerum DC.*	LC	Herb
ASTERACEAE	*Helichrysum difficile Hilliard*	LC	Herb
ASTERACEAE	*Helichrysum harveyanum Wild*	LC	Herb
ASTERACEAE	*Helichrysum mixtum (Kuntze) Moeser var. mixtum*	LC	Herb
ASTERACEAE	*Helichrysum nudifolium (L.) Less. var. nudifolium*	LC	Herb
ASTERACEAE	*Helichrysum oreophilum Klatt*	LC	Herb
ASTERACEAE	*Helichrysum rugulosum Less.*	LC	Herb
ASTERACEAE	*Helichrysum setosum Harv.*	LC	Herb, shrub
ASTERACEAE	*Hilliardiella aristata (DC.) H.Rob.*		Herb
ASTERACEAE	*Hilliardiella hirsuta (DC.) H.Rob.*		Herb

Family	Species	Threat status	Growth forms
ASTERACEAE	*Hypochaeris radicata L.*	NE	Herb
ASTERACEAE	*Lactuca inermis Forssk.*	LC	Herb
ASTERACEAE	*Litogyne gariepina (DC.) Anderb.*	LC	Dwarf shrub, herb
ASTERACEAE	*Macledium zeyheri (Sond.) S.Ortíz subsp. zeyheri*	LC	Herb
ASTERACEAE	*Nidorella anomala Steetz*	LC	Herb
ASTERACEAE	*Nidorella hottentotica DC.*	LC	Herb
ASTERACEAE	*Nolletia rarifolia (Turcz.) Steetz*	LC	Suffrutex
ASTERACEAE	*Osteospermum muricatum E.Mey. ex DC. subsp. muricatum*	LC	Herb
ASTERACEAE	*Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt*	NE	Herb
ASTERACEAE	*Pseudognaphalium oligandrum (DC.) Hilliard & B.L.Burtt*	LC	Herb
ASTERACEAE	*Pulicaria scabra (Thunb.) Druce*	LC	Herb
ASTERACEAE	*Schistostephium heptalobum (DC.) Oliv. & Hiern*	LC	Shrub
ASTERACEAE	*Schkuhria pinnata (Lam.) Kuntze ex Thell.*	NE	Herb
ASTERACEAE	*Senecio affinis DC.*	LC	Herb
ASTERACEAE	*Senecio coronatus (Thunb.) Harv.*	LC	Herb
ASTERACEAE	*Senecio erubescens Aiton var. crepidifolius DC.*	LC	Herb
ASTERACEAE	*Senecio erubescens Aiton var. erubescens*	LC	Herb
ASTERACEAE	*Senecio glanduloso-pilosus Volkens & Muschl.*	LC	Herb
ASTERACEAE	*Senecio gregatus Hilliard*	LC	Herb
ASTERACEAE	*Senecio inaequidens DC.*	LC	Herb
ASTERACEAE	*Senecio inornatus DC.*	LC	Herb
ASTERACEAE	*Senecio laevigatus Thunb. var. integrifolius Harv.*	LC	Herb
ASTERACEAE	*Senecio lydenburgensis Hutch. & Burtt Davy*	LC	Herb
ASTERACEAE	*Senecio oxyriifolius DC. subsp. oxyriifolius*	LC	Herb, succulent
ASTERACEAE	*Senecio pentactinus Klatt*	LC	Herb, shrub
ASTERACEAE	*Senecio ruwenzoriensis S.Moore*	LC	Herb, succulent
ASTERACEAE	*Senecio serratuloides DC.*	LC	Herb
ASTERACEAE	*Senecio venosus Harv.*	LC	Herb
ASTERACEAE	*Sonchus nanus Sond. ex Harv.*	LC	Herb
ASTERACEAE	*Sonchus oleraceus L.*	NE	Herb
ASTERACEAE	*Sonchus wilmsii R.E.Fr.*	LC	Herb
ASTERACEAE	*Tagetes erecta L.*	NE	Herb
ASTERACEAE	*Tithonia rotundifolia (Mill.) S.F.Blake*	NE	Herb
ASTERACEAE	*Tolpis capensis (L.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Tripteris aghillana DC. var. aghillana*	LC	Herb, succulent
ASTERACEAE	*Vernonia galpinii Klatt*	LC	Herb
ASTERACEAE	*Vernonia staehelinoides Harv.*	LC	Shrub, suffrutex
ASTERACEAE	*Xanthium spinosum L.*	NE	Herb
ASTERACEAE	*Zinnia peruviana (L.) L.*	NE	Herb
AYTONIACEAE	*Plagiochasma rupestre (J.R.& G.Forst.)*		Bryophyte

Family	Species	Threat status	Growth forms
	Steph. var. rupestre		
BEGONIACEAE	*Begonia sutherlandii Hook.f. subsp. sutherlandii*	LC	Herb, succulent
BIGNONIACEAE	*Macfadyena unguis-cati (L.) A.H.Gentry*	NE	Climber
BORAGINACEAE	*Buglossoides arvensis (L.) I.M.Johnst.*	NE	Herb
BORAGINACEAE	*Cynoglossum hispidum Thunb.*	LC	Herb
BORAGINACEAE	*Cynoglossum lanceolatum Forssk.*	LC	Herb
BORAGINACEAE	*Ehretia rigida (Thunb.) Druce subsp. rigida*	LC	Shrub, tree
BORAGINACEAE	*Lithospermum cinereum A.DC.*	LC	Herb
BRASSICACEAE	*Capsella bursa-pastoris (L.) Medik.*	NE	Herb
BRASSICACEAE	*Lepidium africanum (Burm.f.) DC. subsp. africanum*	LC	Herb
BRASSICACEAE	*Lepidium bonariense L.*	NE	Herb
BRASSICACEAE	*Lepidium transvaalense Marais*	LC	Herb
BRASSICACEAE	*Rorippa nudiuscula Thell.*	LC	Herb
BRASSICACEAE	*Sisymbrium orientale L.*	NE	Herb
BRYACEAE	*Bryum argenteum Hedw.*		Bryophyte
BUDDLEJACEAE	*Buddleja saligna Willd.*	LC	Shrub, tree
BUDDLEJACEAE	*Gomphostigma virgatum (L.f.) Baill.*	LC	Dwarf shrub, herb, shrub
BUDDLEJACEAE	*Nuxia congesta R.Br. ex Fresen.*	LC	Shrub, tree
CAMPANULACEAE	*Wahlenbergia androsacea A.DC.*	LC	Herb
CAMPANULACEAE	*Wahlenbergia banksiana A.DC.*	LC	Herb
CAMPANULACEAE	*Wahlenbergia denticulata (Burch.) A.DC. var. transvaalensis (Adamson) W.G.Welman*	LC	Herb
CAMPANULACEAE	*Wahlenbergia krebsii Cham. subsp. krebsii*	LC	Herb
CAMPANULACEAE	*Wahlenbergia undulata (L.f.) A.DC.*	LC	Herb
CAPPARACEAE	*Cleome conrathii Burtt Davy*	NT	Herb
CAPPARACEAE	*Cleome monophylla L.*	LC	Herb
CAPPARACEAE	*Maerua cafra (DC.) Pax*	LC	Shrub, tree
CARYOPHYLLACEAE	*Agrostemma githago L. subsp. githago*	NE	Herb
CARYOPHYLLACEAE	*Corrigiola litoralis L. subsp. litoralis var. litoralis*	LC	Herb
CARYOPHYLLACEAE	*Dianthus mooiensis F.N.Williams subsp. mooiensis var. mooiensis*	NE	Herb
CARYOPHYLLACEAE	*Paronychia brasiliana DC. var. pubescens Chaudhri*	NE	Herb
CARYOPHYLLACEAE	*Pollichia campestris Aiton*	LC	Herb
CARYOPHYLLACEAE	*Silene burchellii Otth var. angustifolia Sond.*	NE	Herb
CARYOPHYLLACEAE	*Silene undulata Aiton*	LC	Herb
CELASTRACEAE	*Gymnosporia buxifolia (L.) Szyszyl.*	LC	Shrub, tree
CELASTRACEAE	*Gymnosporia maranguensis (Loes.) Loes.*	LC	Shrub, tree
CELASTRACEAE	*Salacia rehmannii Schinz*	LC	Dwarf shrub
CELTIDACEAE	*Celtis africana Burm.f.*	LC	Shrub, tree
CHENOPODIACEAE	*Chenopodium album L.*	NE	Herb
CHENOPODIACEAE	*Chenopodium ambrosioides L.*	NE	Herb
CHENOPODIACEAE	*Chenopodium carinatum R.Br.*	NE	Herb
CHENOPODIACEAE	*Chenopodium schraderianum Roem. & Schult.*	NE	Herb

Family	Species	Threat status	Growth forms
CHRYSOBALANACEAE	*Parinari capensis Harv. subsp. capensis*	LC	Dwarf shrub
CLADONIACEAE	*Cladonia glauca Flörke*		Lichen
COMBRETACEAE	*Combretum erythrophyllum (Burch.) Sond.*	LC	Shrub, tree
COMBRETACEAE	*Combretum molle R.Br. ex G.Don*	LC	Tree
COMBRETACEAE	*Combretum zeyheri Sond.*	LC	Shrub, tree
COMMELINACEAE	*Commelina africana L. var. barberae (C.B.Clarke) C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina africana L. var. lancispatha C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina livingstonii C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina modesta Oberm.*	LC	Herb
COMMELINACEAE	*Cyanotis speciosa (L.f.) Hassk.*	LC	Herb, succulent
CONVOLVULACEAE	*Convolvulus farinosus L.*	LC	Climber, herb
CONVOLVULACEAE	*Convolvulus ocellatus Hook.f. var. ocellatus*	LC	Herb
CONVOLVULACEAE	*Convolvulus sagittatus Thunb.*	LC	Herb
CONVOLVULACEAE	*Convolvulus thunbergii Roem. & Schult.*	LC	Herb
CONVOLVULACEAE	*Cuscuta campestris Yunck.*	NE	Herb, parasite
CONVOLVULACEAE	*Evolvulus alsinoides (L.) L.*	LC	Herb
CONVOLVULACEAE	*Ipomoea adenioides Schinz var. adenioides*	LC	Dwarf shrub, shrub
CONVOLVULACEAE	*Ipomoea bathycolpos Hallier f.*	LC	Herb
CONVOLVULACEAE	*Ipomoea bolusiana Schinz*	LC	Dwarf shrub, herb, succulent
CONVOLVULACEAE	*Ipomoea crassipes Hook. var. crassipes*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea oblongata E.Mey. ex Choisy*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea obscura (L.) Ker Gawl. var. obscura*	LC	Herb
CONVOLVULACEAE	*Ipomoea ommanneyi Rendle*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea papilio Hallier f.*	LC	Herb
CONVOLVULACEAE	*Ipomoea purpurea (L.) Roth*	NE	Climber, herb
CONVOLVULACEAE	*Ipomoea simplex Thunb.*	LC	Herb, succulent
CONVOLVULACEAE	*Merremia verecunda Rendle*	LC	Herb
CONVOLVULACEAE	*Xenostegia tridentata (L.) D.F.Austin & Staples subsp. angustifolia (Jacq.) Lejoly & Lisowski*	LC	Herb
CRASSULACEAE	*Cotyledon orbiculata L. var. oblonga (Haw.) DC.*	LC	Dwarf shrub, succulent
CRASSULACEAE	*Crassula alba Forssk. var. alba*	LC	Herb, succulent
CRASSULACEAE	*Crassula capitella Thunb. subsp. nodulosa (Schönland) Toelken*	LC	Herb, succulent
CRASSULACEAE	*Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. transvaalensis (Kuntze) Toelken*	LC	Herb, succulent
CRASSULACEAE	*Crassula natans Thunb. var. natans*	LC	Hydrophyte, succulent
CRASSULACEAE	*Crassula pellucida L. subsp. alsinoides (Hook.f.) Toelken*	LC	Herb, scrambler, succulent
CRASSULACEAE	*Crassula setulosa Harv. var. setulosa forma setulosa*	NE	Herb, succulent
CUCURBITACEAE	*Coccinia adoensis (A.Rich.) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Coccinia rehmannii Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Coccinia sessilifolia (Sond.) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Cucumis hirsutus Sond.*	LC	Herb, succulent

Family	Species	Threat status	Growth forms
CUCURBITACEAE	*Cucumis metuliferus E.Mey. ex Naudin*	LC	Climber, herb
CUCURBITACEAE	*Cucumis myriocarpus Naudin subsp. myriocarpus*	LC	Herb
CUCURBITACEAE	*Cucumis zeyheri Sond.*	LC	Herb
CUCURBITACEAE	*Kedrostis africana (L.) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Kedrostis hirtella (Naudin) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Trochomeria macrocarpa (Sond.) Hook.f. subsp. macrocarpa*	LC	Climber, herb, succulent
CUCURBITACEAE	*Zehneria marlothii (Cogn.) R.& A.Fern.*	LC	Climber
CUCURBITACEAE	*Zehneria parvifolia (Cogn.) J.H.Ross*	LC	Climber
CUCURBITACEAE	*Zehneria scabra (L.f.) Sond. subsp. scabra*	LC	Climber, herb
CYPERACEAE	*Abildgaardia ovata (Burm.f.) Kral*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis densa (Wall.) Hand.-Mazz. subsp. afromontana (Lye) R.W.Haines*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis oritrephes (Ridl.) C.B.Clarke*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Carex acutiformis Ehrh.*	NE	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Carex glomerabilis Krecz.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cladium mariscus (L.) Pohl subsp. jamaicense (Crantz) Kük.*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus albostriatus Schrad.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus congestus Vahl*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus denudatus L.f. var. denudatus*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus difformis L.*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Cyperus eragrostis Lam.*	NE	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus esculentus L. var. esculentus*	LC	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	*Cyperus fastigiatus Rottb.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus haematocephalus C.B.Clarke*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Cyperus latifolius Poir.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus leptocladus Kunth*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus longus L. var. tenuiflorus (Rottb.) Boeck.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus margaritaceus Vahl var. margaritaceus*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus obtusiflorus Vahl var. flavissimus (Schrad.) Boeck.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus obtusiflorus Vahl var. obtusiflorus*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus procerus Rottb.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus rupestris Kunth var. rupestris*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus semitrifidus Schrad.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus sexangularis Nees*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus sphaerospermus Schrad.*	LC	Cyperoid, herb, mesophyte

Family	Species	Threat status	Growth forms
CYPERACEAE	*Cyperus usitatus Burch.*	LC	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	*Eleocharis dregeana Steud.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Fimbristylis complanata (Retz.) Link*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Fuirena pubescens (Poir.) Kunth var. pubescens*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Isolepis cernua (Vahl) Roem. & Schult. var. cernua*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Isolepis costata Hochst. ex A.Rich.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Isolepis fluitans (L.) R.Br. var. fluitans*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Kyllinga alata Nees*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Kyllinga alba Nees*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Kyllinga erecta Schumach. var. erecta*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Kyllinga melanosperma Nees*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Mariscus uitenhagensis Steud.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Pycreus macranthus (Boeck.) C.B.Clarke*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Pycreus nitidus (Lam.) J.Raynal*	LC	Cyperoid, helophyte, herb, sudd hydrophyte
CYPERACEAE	*Schoenoplectus brachyceras (Hochst. ex A.Rich.) Lye*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J.Raynal*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus leucanthus (Boeck.) J.Raynal*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Schoenoplectus muricinux (C.B.Clarke) J.Raynal*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus muriculatus (Kük.) Browning*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus pulchellus (Kunth) J.Raynal*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoxiphium lehmannii (Nees) Steud.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Scirpoides burkei (C.B.Clarke) Goetgh., Muasya & D.A.Simpson*	LC	Cyperoid, herb, mesophyte
DICHAPETALACEAE	*Dichapetalum cymosum (Hook.) Engl.*	LC	Dwarf shrub
DIOSCOREACEAE	*Dioscorea retusa Mast.*	LC	Climber, geophyte, succulent
DIPSACACEAE	*Cephalaria zeyheriana Szabó*	LC	Herb
DIPSACACEAE	*Scabiosa columbaria L.*	LC	Herb
DRYOPTERIDACEAE	*Dryopteris athamantica (Kunze) Kuntze*	LC	Geophyte, herb, lithophyte
EBENACEAE	*Diospyros austro-africana De Winter var. microphylla (Burch.) De Winter*	LC	Shrub
EBENACEAE	*Diospyros lycioides Desf. subsp. guerkei (Kuntze) De Winter*	LC	Shrub, tree
EBENACEAE	*Diospyros lycioides Desf. subsp. lycioides*	LC	Shrub
EBENACEAE	*Diospyros whyteana (Hiern) F.White*	LC	Shrub, tree
EBENACEAE	*Euclea crispa (Thunb.) Gürke subsp. crispa*	LC	Shrub, tree
ELATINACEAE	*Bergia decumbens Planch. ex Harv.*	LC	Dwarf shrub
EQUISETACEAE	*Equisetum ramosissimum Desf. subsp. ramosissimum*	LC	Herb, hydrophyte
ERIOSPERMACEAE	*Eriospermum cooperi Baker var. cooperi*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum flagelliforme (Baker)*	LC	Geophyte

Family	Species	Threat status	Growth forms
	J.C.Manning		
ERIOSPERMACEAE	*Eriospermum porphyrium Archibald*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum porphyrovalve Baker*	LC	Geophyte
EUPHORBIACEAE	*Acalypha angustata Sond.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha caperonioides Baill. var. caperonioides*	DDT	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha peduncularis E.Mey. ex Meisn.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha villicaulis Hochst.*	LC	Dwarf shrub, herb, shrub
EUPHORBIACEAE	*Euphorbia clavarioides Boiss. var. truncata (N.E.Br.) A.C.White, R.A.Dyer & B.Sloane*	LC	Dwarf shrub, shrub, succulent
EUPHORBIACEAE	*Euphorbia heterophylla L.*	NE	Herb
EUPHORBIACEAE	*Euphorbia peplus L.*	NE	Herb
EUPHORBIACEAE	*Euphorbia pseudotuberosa Pax*	LC	Dwarf shrub, succulent
EUPHORBIACEAE	*Euphorbia schinzii Pax*	LC	Dwarf shrub, shrub, succulent
EUPHORBIACEAE	*Euphorbia striata Thunb. var. striata*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Jatropha lagarinthoides Sond.*	LC	Dwarf shrub, herb, succulent
EUPHORBIACEAE	*Tragia minor Sond.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Tragia rupestris Sond.*	LC	Climber, dwarf shrub, herb, shrub
EXORMOTHECACEAE	*Exormotheca holstii Steph.*		Bryophyte
FABACEAE	*Acacia cyclops A.Cunn. ex G.Don*	NE	Shrub, tree
FABACEAE	*Acacia galpinii Burtt Davy*	LC	Tree
FABACEAE	*Acacia karroo Hayne*	LC	Shrub, tree
FABACEAE	*Acacia podalyriifolia A.Cunn. ex G.Don*	NE	Shrub, tree
FABACEAE	*Acacia robusta Burch. subsp. robusta*	LC	Tree
FABACEAE	*Argyrolobium pauciflorum Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Astragalus atropilosulus (Hochst.) Bunge subsp. burkeanus (Harv.) J.B.Gillett var. burkeanus*	LC	Herb
FABACEAE	*Bolusanthus speciosus (Bolus) Harms*	LC	Tree
FABACEAE	*Calpurnia aurea (Aiton) Benth. subsp. aurea*	LC	Shrub, tree
FABACEAE	*Chamaecrista biensis (Steyaert) Lock*	LC	Herb
FABACEAE	*Chamaecrista capensis (Thunb.) E.Mey. var. capensis*	LC	Herb
FABACEAE	*Chamaecrista comosa E.Mey. var. capricornia (Steyaert) Lock*	LC	Herb
FABACEAE	*Chamaecrista mimosoides (L.) Greene*	LC	Herb
FABACEAE	*Crotalaria agatiflora Schweinf. subsp. agatiflora*	NE	Herb, shrub
FABACEAE	*Crotalaria brachycarpa (Benth.) Burtt Davy ex I.Verd.*	LC	Herb
FABACEAE	*Crotalaria capensis Jacq.*	LC	Shrub, tree
FABACEAE	*Crotalaria eremicola Baker f. subsp. eremicola*	LC	Herb
FABACEAE	*Crotalaria sphaerocarpa Perr. ex DC. subsp. sphaerocarpa*	LC	Herb
FABACEAE	*Dichilus strictus E.Mey.*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var.*	LC	Shrub, tree

Family	Species	Threat status	Growth forms
	africana		
FABACEAE	*Dipogon lignosus (L.) Verdc.*	LC	Climber, herb
FABACEAE	*Dolichos angustifolius Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Dolichos trilobus L. subsp. transvaalicus Verdc.*	LC	Climber, herb
FABACEAE	*Elephantorrhiza elephantina (Burch.) Skeels*	LC	Dwarf shrub, shrub, suffrutex
FABACEAE	*Eriosema burkei Benth. ex Harv. var. burkei*	LC	Herb
FABACEAE	*Eriosema cordatum E.Mey.*	LC	Herb
FABACEAE	*Eriosema squarrosum (Thunb.) Walp.*	LC	Herb
FABACEAE	*Erythrina caffra Thunb.*	LC	Tree
FABACEAE	*Erythrina lysistemon Hutch.*	LC	Tree
FABACEAE	*Erythrina zeyheri Harv.*	LC	Dwarf shrub, shrub, succulent
FABACEAE	*Indigastrum burkeanum (Benth. ex Harv.) Schrire*	LC	Herb
FABACEAE	*Indigofera confusa Prain & Baker f.*	LC	Herb
FABACEAE	*Indigofera filipes Benth. ex Harv.*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Indigofera hedyantha Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Indigofera heterotricha DC.*	LC	Dwarf shrub, herb
FABACEAE	*Indigofera hilaris Eckl. & Zeyh. var. hilaris*	LC	Herb
FABACEAE	*Indigofera melanadenia Benth. ex Harv.*	LC	Herb, shrub
FABACEAE	*Indigofera oxalidea Welw. ex Baker*	LC	Herb
FABACEAE	*Indigofera zeyheri Spreng. ex Eckl. & Zeyh.*	LC	Dwarf shrub, herb
FABACEAE	*Lablab purpureus (L.) Sweet subsp. uncinatus Verdc.*	LC	Climber, herb
FABACEAE	*Lessertia stricta L.Bolus*	LC	Herb
FABACEAE	*Lotononis bainesii Baker*	LC	Climber, creeper, herb
FABACEAE	*Lotononis calycina (E.Mey.) Benth.*	LC	Herb
FABACEAE	*Lotononis eriantha Benth.*	LC	Herb
FABACEAE	*Lotononis foliosa Bolus*	LC	Herb
FABACEAE	*Lotononis laxa Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Lotononis listii Polhill*	LC	Creeper, herb
FABACEAE	*Lotononis mucronata Conrath*	LC	Herb
FABACEAE	*Lotononis wilmsii Dummer*	LC	Herb
FABACEAE	*Lotus discolor E.Mey. subsp. discolor*	LC	Herb
FABACEAE	*Medicago laciniata (L.) Mill. var. laciniata*	NE	Herb
FABACEAE	*Medicago lupulina L.*	NE	Herb
FABACEAE	*Melilotus officinalis (L.) Pall.*	NE	Herb
FABACEAE	*Melolobium subspicatum Conrath*	VU	Dwarf shrub
FABACEAE	*Mundulea sericea (Willd.) A.Chev. subsp. sericea*	LC	Shrub, tree
FABACEAE	*Neonotonia wightii (Wight. ex Arn.) J.A.Lackey*	LC	Climber
FABACEAE	*Neorautanenia ficifolia (Benth. ex Harv.) C.A.Sm.*	LC	Climber, herb, succulent
FABACEAE	*Otholobium polyphyllum (Eckl. & Zeyh.) C.H.Stirt.*	LC	Dwarf shrub

Family	Species	Threat status	Growth forms
FABACEAE	*Pearsonia bracteata (Benth.) Polhill*	LC	Herb
FABACEAE	*Pearsonia cajanifolia (Harv.) Polhill subsp. cajanifolia*	LC	Herb, shrub
FABACEAE	*Pearsonia sessilifolia (Harv.) Dummer subsp. sessilifolia*	LC	Dwarf shrub, herb
FABACEAE	*Peltophorum africanum Sond.*	LC	Tree
FABACEAE	*Rhynchosia adenodes Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Rhynchosia caribaea (Jacq.) DC.*	LC	Climber, herb
FABACEAE	*Rhynchosia crassifolia Benth. ex Harv.*	LC	Climber, herb
FABACEAE	*Rhynchosia monophylla Schltr.*	LC	Herb
FABACEAE	*Rhynchosia nervosa Benth. ex Harv. var. nervosa*	LC	Herb
FABACEAE	*Rhynchosia nitens Benth. ex Harv.*	LC	Shrub
FABACEAE	*Rhynchosia pentheri Schltr. ex Zahlbr. var. pentheri*	LC	Herb
FABACEAE	*Rhynchosia totta (Thunb.) DC. var. totta*	LC	Climber, herb
FABACEAE	*Rhynchosia venulosa (Hiern) K.Schum.*	LC	Climber, herb
FABACEAE	*Robinia pseudoacacia L.*	NE	Shrub, tree
FABACEAE	*Sesbania punicea (Cav.) Benth.*	NE	Shrub, tree
FABACEAE	*Sphenostylis angustifolia Sond.*	LC	Dwarf shrub, herb
FABACEAE	*Stylosanthes fruticosa (Retz.) Alston*	LC	Dwarf shrub, herb
FABACEAE	*Tephrosia capensis (Jacq.) Pers. var. capensis*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia elongata E.Mey. var. elongata*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia longipes Meisn. subsp. longipes var. longipes*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia lupinifolia DC.*	LC	Herb
FABACEAE	*Tephrosia multijuga R.G.N.Young*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia reptans Baker var. reptans*	LC	Herb, shrub
FABACEAE	*Tephrosia retusa Burtt Davy*	LC	Herb
FABACEAE	*Tephrosia semiglabra Sond.*	LC	Herb
FABACEAE	*Trifolium africanum Ser. var. lydenburgense J.B.Gillett*	LC	Herb
FABACEAE	*Trifolium hybridum L. var. hybridum*	NE	Herb
FABACEAE	*Trifolium pratense L. var. pratense*	NE	Herb
FABACEAE	*Trigonella foenum-graecum L.*	NE	Herb
FABACEAE	*Tylosema esculentum (Burch.) A.Schreib.*	LC	Shrub, succulent
FABACEAE	*Vicia sativa L. subsp. sativa*	NE	Climber, herb
FABACEAE	*Vigna schlechteri Harms*		Climber, herb
FABACEAE	*Vigna unguiculata (L.) Walp. subsp. stenophylla (Harv.) Maréchal, Mascherpa & Stainier*	LC	Climber, herb
FABACEAE	*Vigna vexillata (L.) A.Rich. var. vexillata*	LC	Climber, herb
FABACEAE	*Zornia capensis Pers. subsp. capensis*	LC	Herb
FABACEAE	*Zornia linearis E.Mey.*	LC	Herb
FABACEAE	*Zornia milneana Mohlenbr.*	LC	Herb
FABRONIACEAE	*Fabronia pilifera Hornsch.*		Bryophyte, epiphyte
FISSIDENTACEAE	*Fissidens bryoides Hedw.*		Bryophyte

Family	Species	Threat status	Growth forms
FUNARIACEAE	*Funaria hygrometrica Hedw.*		Bryophyte
GENTIANACEAE	*Chironia palustris Burch. subsp. palustris*	LC	Herb
GENTIANACEAE	*Chironia palustris Burch. subsp. transvaalensis (Gilg) I.Verd.*	LC	Herb
GENTIANACEAE	*Chironia purpurascens (E.Mey.) Benth. & Hook.f. subsp. humilis (Gilg) I.Verd.*	LC	Herb
GENTIANACEAE	*Sebaea grandis (E.Mey.) Steud.*	LC	Herb
GENTIANACEAE	*Sebaea junodii Schinz*	LC	Herb
GERANIACEAE	*Erodium cicutarium (L.) L'Hér.*	NE	Herb
GERANIACEAE	*Monsonia angustifolia E.Mey. ex A.Rich.*	LC	Herb
GERANIACEAE	*Monsonia burkeana Planch. ex Harv.*	LC	Herb
GERANIACEAE	*Monsonia luederitziana Focke & Schinz*	LC	Herb
GERANIACEAE	*Pelargonium luridum (Andrews) Sweet*	LC	Geophyte, succulent
GISEKIACEAE	*Gisekia africana (Lour.) Kuntze var. africana*	LC	Herb
GREYIACEAE	*Greyia sutherlandii Hook. & Harv.*	LC	Shrub, tree
HALORAGACEAE	*Myriophyllum aquaticum (Vell.) Verdc.*	NE	Herb, hydrophyte
HYACINTHACEAE	*Albuca baurii Baker*		Geophyte
HYACINTHACEAE	*Albuca fastigiata Dryand. var. fastigiata*	LC	Geophyte
HYACINTHACEAE	*Bowiea volubilis Harv. ex Hook.f. subsp. volubilis*	VU	Climber, geophyte, succulent
HYACINTHACEAE	*Dipcadi marlothii Engl.*	LC	Geophyte
HYACINTHACEAE	*Dipcadi viride (L.) Moench*	LC	Geophyte
HYACINTHACEAE	*Drimia calcarata (Baker) Stedje*	LC	Geophyte
HYACINTHACEAE	*Drimia depressa (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Drimia elata Jacq.*	DDT	Geophyte
HYACINTHACEAE	*Drimia multisetosa (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Drimia sanguinea (Schinz) Jessop*	NT	Geophyte
HYACINTHACEAE	*Eucomis autumnalis (Mill.) Chitt. subsp. clavata (Baker) Reyneke*	NE	Geophyte
HYACINTHACEAE	*Ledebouria cooperi (Hook.f.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria inquinata (C.A.Sm.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria leptophylla (Baker) S.Venter*		
HYACINTHACEAE	*Ledebouria luteola Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria ovatifolia (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria revoluta (L.f.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ornithogalum tenuifolium F.Delaroche subsp. tenuifolium*	LC	Geophyte
HYACINTHACEAE	*Schizocarphus nervosus (Burch.) Van der Merwe*	LC	Geophyte
HYDROCHARITACEAE	*Lagarosiphon muscoides Harv.*	LC	Herb, hydrophyte
HYDROCHARITACEAE	*Ottelia ulvifolia (Planch.) Walp.*	LC	Herb, hydrophyte
HYPERICACEAE	*Hypericum aethiopicum Thunb. subsp. sonderi (Bredell) N.Robson*	LC	Herb
HYPERICACEAE	*Hypericum lalandii Choisy*	LC	Herb
HYPOXIDACEAE	*Hypoxis argentea Harv. ex Baker var. argentea*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis argentea Harv. ex Baker var. sericea Baker*	LC	Geophyte

Family	Species	Threat status	Growth forms
HYPOXIDACEAE	*Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.*	Declining	Geophyte
HYPOXIDACEAE	*Hypoxis interjecta Nel*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis iridifolia Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis multiceps Buchinger ex Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis rigidula Baker var. pilosissima Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis rigidula Baker var. rigidula*	LC	Geophyte, herb
IRIDACEAE	*Babiana bainesii Baker*	LC	Geophyte, herb
IRIDACEAE	*Freesia grandiflora (Baker) Klatt*	LC	Geophyte, herb
IRIDACEAE	*Freesia laxa (Thunb.) Goldblatt & J.C.Manning subsp. laxa*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus antholyzoides Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus crassifolius Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus elliotii Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus papilio Hook.f.*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus permeabilis D.Delaroche subsp. edulis (Burch. ex Ker Gawl.) Oberm.*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus pretoriensis Kuntze*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus woodii Baker*	LC	Geophyte, herb
IRIDACEAE	*Hesperantha longicollis Baker*	LC	Geophyte, herb
IRIDACEAE	*Moraea pallida (Baker) Goldblatt*	LC	Geophyte, herb
IRIDACEAE	*Moraea stricta Baker*	LC	Geophyte, herb
IRIDACEAE	*Tritonia nelsonii Baker*	LC	Geophyte, herb
JUNCACEAE	*Juncus exsertus Buchenau*	LC	Helophyte, herb
JUNCACEAE	*Juncus oxycarpus E.Mey. ex Kunth*	LC	Helophyte, herb
JUNCACEAE	*Juncus punctorius L.f.*	LC	Helophyte, herb
LAMIACEAE	*Leucas martinicensis (Jacq.) R.Br.*	LC	Herb
LAMIACEAE	*Mentha longifolia (L.) Huds. subsp. polyadena (Briq.) Briq.*	LC	Herb
LAMIACEAE	*Ocimum obovatum E.Mey. ex Benth. subsp. obovatum var. obovatum*	LC	Herb
LAMIACEAE	*Plectranthus cylindraceus Hochst. ex Benth.*	LC	Herb, succulent
LAMIACEAE	*Plectranthus neochilus Schltr.*	LC	Herb, succulent
LAMIACEAE	*Pycnostachys reticulata (E.Mey.) Benth.*	LC	Herb
LAMIACEAE	*Rotheca hirsuta (Hochst.) R.Fern.*	LC	Herb
LAMIACEAE	*Rotheca louwalbertsii (P.P.J.Herman) P.P.J.Herman & Retief*	LC	Herb
LAMIACEAE	*Salvia coccinea Etl.*	NE	Herb
LAMIACEAE	*Salvia runcinata L.f.*	LC	Herb
LAMIACEAE	*Salvia tiliifolia Vahl*	NE	Herb
LAMIACEAE	*Stachys caffra E.Mey. ex Benth.*	LC	Shrub
LAMIACEAE	*Stachys natalensis Hochst. var. galpinii (Briq.) Codd*	LC	Herb
LAMIACEAE	*Teucrium trifidum Retz.*	LC	Herb
LEMNACEAE	*Spirodela punctata (G.Mey.) C.H.Thomps.*	LC	Herb, hydrophyte, pleustophyte
LENTIBULARIACEAE	*Utricularia stellaris L.f.*	LC	Carnivore, herb, pleustophyte

Family	Species	Threat status	Growth forms
LINACEAE	*Linum thunbergii Eckl. & Zeyh.*	LC	Herb
LOBELIACEAE	*Lobelia erinus L.*	LC	Herb
LOBELIACEAE	*Monopsis decipiens (Sond.) Thulin*	LC	Herb
LYTHRACEAE	*Galpinia transvaalica N.E.Br.*	LC	Shrub, tree
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. galphimiifolius (A.Juss.) P.D.de Villiers & D.J.Botha*	LC	Climber, shrub
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. pruriens*	LC	Climber, shrub
MALPIGHIACEAE	*Triaspis hypericoides (DC.) Burch. subsp. nelsonii (Oliv.) Immelman*	LC	Climber, shrub
MALVACEAE	*Anoda cristata (L.) Schltdl.*	NE	Dwarf shrub, herb
MALVACEAE	*Corchorus asplenifolius Burch.*	LC	Herb
MALVACEAE	*Corchorus confusus Wild*	LC	Herb
MALVACEAE	*Dombeya rotundifolia (Hochst.) Planch. var. rotundifolia*	LC	Shrub, tree
MALVACEAE	*Grewia flava DC.*	LC	Shrub
MALVACEAE	*Grewia occidentalis L. var. occidentalis*	LC	Shrub, tree
MALVACEAE	*Hermannia boraginiflora Hook.*	LC	Dwarf shrub
MALVACEAE	*Hermannia burkei Burtt Davy*	LC	Climber, herb
MALVACEAE	*Hermannia cordata (E.Mey. ex E.Phillips) De Winter*	LC	Herb
MALVACEAE	*Hermannia depressa N.E.Br.*	LC	Herb
MALVACEAE	*Hermannia grandistipula (Buchinger ex Hochst.) K.Schum.*	LC	Herb
MALVACEAE	*Hermannia lancifolia Szyszyl.*	LC	Herb
MALVACEAE	*Hibiscus aethiopicus L. var. ovatus Harv.*	LC	Herb
MALVACEAE	*Hibiscus calyphyllus Cav.*	LC	Dwarf shrub, herb
MALVACEAE	*Hibiscus microcarpus Garcke*	LC	Herb
MALVACEAE	*Hibiscus pedunculatus L.f.*	LC	Herb
MALVACEAE	*Hibiscus trionum L.*	NE	Herb
MALVACEAE	*Malva parviflora L. var. parviflora*	NE	Herb
MALVACEAE	*Malvastrum coromandelianum (L.) Garcke*	NE	Dwarf shrub
MALVACEAE	*Modiola caroliniana (L.) G.Don*	NE	Herb
MALVACEAE	*Pavonia burchellii (DC.) R.A.Dyer*	LC	Dwarf shrub
MALVACEAE	*Sida chrysantha Ulbr.*	LC	Dwarf shrub
MALVACEAE	*Sida cordifolia L. subsp. cordifolia*	LC	Dwarf shrub
MALVACEAE	*Sida dregei Burtt Davy*	LC	Dwarf shrub, herb
MALVACEAE	*Sida rhombifolia L. subsp. rhombifolia*	LC	Dwarf shrub, herb, shrub
MALVACEAE	*Sida ternata L.f.*	LC	Herb
MALVACEAE	*Triumfetta rhomboidea Jacq. var. rhomboidea*	LC	Herb, shrub
MALVACEAE	*Triumfetta sonderi Ficalho & Hiern*	LC	Dwarf shrub
MALVACEAE	*Waltheria indica L.*	LC	Herb
MARCHANTIACEAE	*Marchantia debilis K.I.Goebel*		Bryophyte
MELASTOMATACEAE	*Antherotoma debilis (Sond.) Jacq.-Fél.*	LC	Herb
MENISPERMACEAE	*Antizoma angustifolia (Burch.) Miers ex Harv.*	LC	Climber
MENISPERMACEAE	*Cissampelos torulosa E.Mey. ex Harv.*	LC	Climber

Family	Species	Threat status	Growth forms
MESEMBRYANTHEMACEAE	*Aptenia cordifolia (L.f.) Schwantes*	LC	Succulent
MESEMBRYANTHEMACEAE	*Lithops lesliei (N.E.Br.) N.E.Br. subsp. lesliei*	NT	Succulent
MOLLUGINACEAE	*Limeum viscosum (J.Gay) Fenzl subsp. transvaalense Friedrich*	LC	Herb
MOLLUGINACEAE	*Mollugo cerviana (L.) Ser. ex DC. var. cerviana*	LC	Herb
MOLLUGINACEAE	*Psammotropha mucronata (Thunb.) Fenzl var. foliosa Adamson*	LC	Herb
MOLLUGINACEAE	*Psammotropha myriantha Sond.*	LC	Herb
MORACEAE	*Ficus ingens (Miq.) Miq.*	LC	Tree
MORACEAE	*Ficus salicifolia Vahl*	LC	Tree
MYRTACEAE	*Syzygium cordatum Hochst. ex C.Krauss subsp. cordatum*	LC	Shrub, tree
NYMPHAEACEAE	*Nymphaea nouchali Burm.f. var. caerulea (Savigny) Verdc.*	LC	Epihydate, herb, hydrophyte
OCHNACEAE	*Ochna pulchra Hook.f.*	LC	Shrub, tree
OLEACEAE	*Ligustrum japonicum Thunb.*	NE	Shrub
OLEACEAE	*Ligustrum sinense Lour.*	NE	Shrub, tree
OLEACEAE	*Menodora africana Hook.*	LC	Dwarf shrub, herb
OLEACEAE	*Olea europaea L. subsp. africana (Mill.) P.S.Green*	LC	Shrub, tree
OLINIACEAE	*Olinia emarginata Burtt Davy*	LC	Tree
ONAGRACEAE	*Epilobium hirsutum L.*	LC	Herb
ONAGRACEAE	*Epilobium tetragonum L. subsp. tetragonum*	LC	Herb
ONAGRACEAE	*Oenothera rosea L'Hér. ex Aiton*	NE	Herb
ONAGRACEAE	*Oenothera tetraptera Cav.*	NE	Herb
OPHIOGLOSSACEAE	*Ophioglossum polyphyllum A.Braun*	LC	Geophyte, herb
ORCHIDACEAE	*Bonatea antennifera Rolfe*	LC	
ORCHIDACEAE	*Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.*	EN	Geophyte, herb
ORCHIDACEAE	*Brachycorythis ovata Lindl. subsp. ovata*	LC	Geophyte, herb
ORCHIDACEAE	*Brachycorythis pubescens Harv.*	LC	Geophyte, herb
ORCHIDACEAE	*Brachycorythis tenuior Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Disperis micrantha Lindl.*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia clitellifera (Rchb.f.) Bolus*	LC	Geophyte, herb, succulent
ORCHIDACEAE	*Eulophia hians Spreng. var. hians*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia hians Spreng. var. nutans (Sond.) S.Thomas*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia leontoglossa Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia ovalis Lindl. var. bainesii (Rolfe) P.J.Cribb & la Croix*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia ovalis Lindl. var. ovalis*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia tuberculata Bolus*	LC	Geophyte, herb, succulent
ORCHIDACEAE	*Eulophia welwitschii (Rchb.f.) Rolfe*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria barbertoni Kraenzl. & Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria dregeana Lindl.*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria epipactidea Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria falcicornis (Burch. ex Lindl.) Bolus subsp. caffra (Schltr.) J.C.Manning*	LC	Geophyte, herb

Family	Species	Threat status	Growth forms
ORCHIDACEAE	*Habenaria kraenzliniana Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria mossii (G.Will.) J.C.Manning*	EN	Geophyte, herb
ORCHIDACEAE	*Habenaria nyikana Rchb.f. subsp. nyikana*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria schimperiana Hochst. ex A.Rich.*	LC	Geophyte, herb
ORCHIDACEAE	*Holothrix randii Rendle*	NT	Geophyte, herb
ORCHIDACEAE	*Satyrium hallackii Bolus subsp. ocellatum (Bolus) A.V.Hall*	LC	Geophyte, herb
OROBANCHACEAE	*Alectra orobanchoides Benth.*	LC	
OROBANCHACEAE	*Alectra sessiliflora (Vahl) Kuntze var. sessiliflora*	LC	Herb, parasite
OROBANCHACEAE	*Cycnium adonense E.Mey. ex Benth.*	LC	Herb, parasite
OROBANCHACEAE	*Cycnium tubulosum (L.f.) Engl. subsp. tubulosum*	LC	Herb
OROBANCHACEAE	*Graderia subintegra Mast.*	LC	Herb, parasite, suffrutex
OROBANCHACEAE	*Striga asiatica (L.) Kuntze*	LC	Herb, parasite
OROBANCHACEAE	*Striga bilabiata (Thunb.) Kuntze subsp. bilabiata*	LC	Herb, parasite
OROBANCHACEAE	*Striga elegans Benth.*	LC	Herb, parasite
OXALIDACEAE	*Oxalis obliquifolia Steud. ex A.Rich.*	LC	Geophyte
PAPAVERACEAE	*Papaver aculeatum Thunb.*	LC	Herb
PASSIFLORACEAE	*Adenia digitata (Harv.) Engl.*	LC	Climber, dwarf shrub, shrub, succulent
PASSIFLORACEAE	*Passiflora coerulea L.*	NE	Climber
PEDALIACEAE	*Harpagophytum zeyheri Decne. subsp. zeyheri*	LC	Herb
PHYLLANTHACEAE	*Phyllanthus incurvus Thunb.*	LC	Dwarf shrub, herb
PHYLLANTHACEAE	*Phyllanthus parvulus Sond. var. parvulus*	LC	Dwarf shrub, herb
PHYTOLACCACEAE	*Phytolacca octandra L.*	NE	Herb, succulent
PITTOSPORACEAE	*Pittosporum viridiflorum Sims*	LC	Shrub, tree
PLANTAGINACEAE	*Plantago lanceolata L.*	LC	Herb
PLANTAGINACEAE	*Plantago longissima Decne.*	LC	Herb
PLANTAGINACEAE	*Plantago major L.*	NE	Herb
POACEAE	*Agrostis eriantha Hack. var. eriantha*	LC	Graminoid
POACEAE	*Agrostis eriantha Hack. var. planifolia Gooss. & Papendorf*	DDT	Graminoid
POACEAE	*Agrostis lachnantha Nees var. lachnantha*	LC	Graminoid
POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. eckloniana (Nees) Gibbs Russ.*	LC	Graminoid
POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. semialata*	LC	Graminoid
POACEAE	*Andropogon appendiculatus Nees*	LC	Graminoid
POACEAE	*Andropogon chinensis (Nees) Merr.*	LC	Graminoid
POACEAE	*Andropogon schirensis Hochst. ex A.Rich.*	LC	Graminoid
POACEAE	*Anthephora pubescens Nees*	LC	Graminoid
POACEAE	*Aristida adscensionis L.*	LC	Graminoid
POACEAE	*Aristida canescens Henrard subsp. canescens*	LC	Graminoid
POACEAE	*Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter*	LC	Graminoid

Family	Species	Threat status	Growth forms
POACEAE	*Aristida congesta Roem. & Schult. subsp. congesta*	LC	Graminoid
POACEAE	*Aristida diffusa Trin. subsp. burkei (Stapf) Melderis*	LC	Graminoid
POACEAE	*Aristida scabrivalvis Hack. subsp. scabrivalvis*	LC	Graminoid
POACEAE	*Aristida stipitata Hack. subsp. graciliflora (Pilg.) Melderis*	LC	Graminoid
POACEAE	*Aristida transvaalensis Henrard*	LC	Graminoid
POACEAE	*Arundinella nepalensis Trin.*	LC	Graminoid
POACEAE	*Bewsia biflora (Hack.) Gooss.*	LC	Graminoid
POACEAE	*Brachiaria brizantha (A.Rich.) Stapf*	LC	Graminoid
POACEAE	*Brachiaria eruciformis (Sm.) Griseb.*	LC	Graminoid
POACEAE	*Brachiaria serrata (Thunb.) Stapf*	LC	Graminoid
POACEAE	*Bromus catharticus Vahl*	NE	Graminoid
POACEAE	*Bromus leptoclados Nees*	LC	Graminoid
POACEAE	*Calamagrostis epigejos (L.) Roth var. capensis Stapf*	LC	Graminoid
POACEAE	*Cenchrus ciliaris L.*	LC	Graminoid
POACEAE	*Chloris pycnothrix Trin.*	LC	Graminoid
POACEAE	*Chloris virgata Sw.*	LC	Graminoid
POACEAE	*Cymbopogon pospischilii (K.Schum.) C.E.Hubb.*	NE	Graminoid
POACEAE	*Cynodon dactylon (L.) Pers.*	LC	Graminoid
POACEAE	*Dichanthium aristatum (Poir.) C.E.Hubb.*	NE	Graminoid
POACEAE	*Digitaria argyrograpta (Nees) Stapf*	LC	Graminoid
POACEAE	*Digitaria debilis (Desf.) Willd.*	LC	Graminoid
POACEAE	*Digitaria diagonalis (Nees) Stapf var. diagonalis*	LC	Graminoid
POACEAE	*Digitaria didactyla Willd.*	NE	Graminoid
POACEAE	*Digitaria eriantha Steud.*	LC	Graminoid
POACEAE	*Digitaria eylesii C.E.Hubb.*	LC	Graminoid
POACEAE	*Digitaria monodactyla (Nees) Stapf*	LC	Graminoid
POACEAE	*Digitaria ternata (A.Rich.) Stapf*	LC	Graminoid
POACEAE	*Digitaria tricholaenoides Stapf*	LC	Graminoid
POACEAE	*Diheteropogon amplectens (Nees) Clayton var. amplectens*	LC	Graminoid
POACEAE	*Ehrharta erecta Lam. var. erecta*	LC	Graminoid
POACEAE	*Elionurus muticus (Spreng.) Kunth*	LC	Graminoid
POACEAE	*Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.*	LC	Graminoid
POACEAE	*Enneapogon scoparius Stapf*	LC	Graminoid
POACEAE	*Eragrostis capensis (Thunb.) Trin.*	LC	Graminoid
POACEAE	*Eragrostis chloromelas Steud.*	LC	Graminoid
POACEAE	*Eragrostis cilianensis (All.) Vignolo ex Janch.*	LC	Graminoid
POACEAE	*Eragrostis curvula (Schrad.) Nees*	LC	Graminoid
POACEAE	*Eragrostis gummiflua Nees*	LC	Graminoid
POACEAE	*Eragrostis heteromera Stapf*	LC	Graminoid
POACEAE	*Eragrostis inamoena K.Schum.*	LC	Graminoid

Family	Species	Threat status	Growth forms
POACEAE	*Eragrostis patentipilosa Hack.*	LC	Graminoid
POACEAE	*Eragrostis plana Nees*	LC	Graminoid
POACEAE	*Eragrostis planiculmis Nees*	LC	Graminoid
POACEAE	*Eragrostis racemosa (Thunb.) Steud.*	LC	Graminoid
POACEAE	*Eustachys paspaloides (Vahl) Lanza & Mattei*	LC	Graminoid
POACEAE	*Festuca arundinacea Schreb.*	NE	Graminoid
POACEAE	*Harpochloa falx (L.f.) Kuntze*	LC	Graminoid
POACEAE	*Helictotrichon turgidulum (Stapf) Schweick.*	LC	Graminoid
POACEAE	*Hemarthria altissima (Poir.) Stapf & C.E.Hubb.*	LC	Graminoid
POACEAE	*Heteropogon contortus (L.) Roem. & Schult.*	LC	Graminoid
POACEAE	*Hyparrhenia anamesa Clayton*	LC	Graminoid
POACEAE	*Hyparrhenia cymbaria (L.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia dregeana (Nees) Stapf ex Stent*	LC	Graminoid
POACEAE	*Hyparrhenia filipendula (Hochst.) Stapf var. pilosa (Hochst.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia hirta (L.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia quarrei Robyns*	LC	Graminoid
POACEAE	*Hyparrhenia tamba (Steud.) Stapf*	LC	Graminoid
POACEAE	*Imperata cylindrica (L.) Raeusch.*	LC	Graminoid
POACEAE	*Koeleria capensis (Steud.) Nees*	LC	Graminoid
POACEAE	*Leersia hexandra Sw.*	LC	Graminoid
POACEAE	*Lolium multiflorum Lam.*	NE	Graminoid
POACEAE	*Lolium temulentum L.*	NE	Graminoid
POACEAE	*Loudetia flavida (Stapf) C.E.Hubb.*	LC	Graminoid
POACEAE	*Loudetia simplex (Nees) C.E.Hubb.*	LC	Graminoid
POACEAE	*Melinis nerviglumis (Franch.) Zizka*	LC	Graminoid
POACEAE	*Melinis repens (Willd.) Zizka subsp. repens*	LC	Graminoid
POACEAE	*Microchloa caffra Nees*	LC	Graminoid
POACEAE	*Microchloa kunthii Desv.*	LC	Graminoid
POACEAE	*Monocymbium ceresiiforme (Nees) Stapf*	LC	Graminoid
POACEAE	*Panicum maximum Jacq.*	LC	Graminoid
POACEAE	*Panicum miliaceum L.*	NE	Graminoid
POACEAE	*Panicum natalense Hochst.*	LC	Graminoid
POACEAE	*Panicum repentellum Napper*	LC	Graminoid
POACEAE	*Panicum schinzii Hack.*	LC	Graminoid
POACEAE	*Panicum stapfianum Fourc.*	LC	Graminoid
POACEAE	*Paspalum dilatatum Poir.*	NE	Graminoid
POACEAE	*Paspalum distichum L.*	LC	Graminoid
POACEAE	*Paspalum notatum Flüggé*	NE	Graminoid
POACEAE	*Paspalum scrobiculatum L.*	LC	Graminoid
POACEAE	*Pennisetum thunbergii Kunth*	LC	Graminoid
POACEAE	*Pennisetum villosum R.Br. ex Fresen.*	NE	Graminoid
POACEAE	*Poa annua L.*	NE	Graminoid
POACEAE	*Poa pratensis L.*	NE	Graminoid

Family	Species	Threat status	Growth forms
POACEAE	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Graminoid
POACEAE	*Sacciolepis typhura (Stapf) Stapf*	LC	Graminoid
POACEAE	*Schizachyrium sanguineum (Retz.) Alston*	LC	Graminoid
POACEAE	*Setaria lindenbergiana (Nees) Stapf*	LC	Graminoid
POACEAE	*Setaria megaphylla (Steud.) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Setaria nigrirostris (Nees) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Setaria plicatilis (Hochst.) Hack. ex Engl.*	LC	Graminoid
POACEAE	*Setaria pumila (Poir.) Roem. & Schult.*	LC	Graminoid
POACEAE	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. sphacelata*	LC	Graminoid
POACEAE	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. torta (Stapf) Clayton*	LC	Graminoid
POACEAE	*Sorghum bicolor (L.) Moench subsp. arundinaceum (Desv.) de Wet & Harlan*	LC	Graminoid
POACEAE	*Sorghum halepense (L.) Pers.*	NE	Graminoid
POACEAE	*Sorghum versicolor Andersson*	LC	Graminoid
POACEAE	*Sporobolus africanus (Poir.) Robyns & Tournay*	LC	Graminoid
POACEAE	*Sporobolus discosporus Nees*	LC	Graminoid
POACEAE	*Sporobolus fimbriatus (Trin.) Nees*	LC	Graminoid
POACEAE	*Sporobolus natalensis (Steud.) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Sporobolus nitens Stent*	LC	Graminoid
POACEAE	*Sporobolus stapfianus Gand.*	LC	Graminoid
POACEAE	*Stipagrostis uniplumis (Licht.) De Winter var. neesii (Trin. & Rupr.) De Winter*	LC	Graminoid
POACEAE	*Stipagrostis zeyheri (Nees) De Winter subsp. sericans (Hack.) De Winter*	LC	Graminoid
POACEAE	*Themeda triandra Forssk.*	LC	Graminoid
POACEAE	*Trachypogon spicatus (L.f.) Kuntze*	LC	Graminoid
POACEAE	*Tragus berteronianus Schult.*	LC	Graminoid
POACEAE	*Tripogon minimus (A.Rich.) Steud.*	LC	Graminoid
POACEAE	*Triraphis andropogonoides (Steud.) E.Phillips*	LC	Graminoid
POACEAE	*Tristachya biseriata Stapf*	LC	Graminoid
POACEAE	*Tristachya rehmannii Hack.*	LC	Graminoid
POACEAE	*Urelytrum agropyroides (Hack.) Hack.*	LC	Graminoid
POACEAE	*Urochloa brachyura (Hack.) Stapf*	LC	Graminoid
POACEAE	*Urochloa mosambicensis (Hack.) Dandy*	LC	Graminoid
POACEAE	*Urochloa panicoides P.Beauv.*	NE	Graminoid
POLYGALACEAE	*Polygala amatymbica Eckl. & Zeyh.*	LC	Herb
POLYGALACEAE	*Polygala gracilenta Burtt Davy*	LC	Herb
POLYGALACEAE	*Polygala hottentotta C.Presl*	LC	Dwarf shrub, herb
POLYGALACEAE	*Polygala houtboshiana Chodat*	LC	Herb
POLYGALACEAE	*Polygala krumanina Burch. ex Ficalho & Hiern*	LC	Shrub
POLYGALACEAE	*Polygala myrtifolia L. var. myrtifolia*	LC	Shrub
POLYGALACEAE	*Polygala rehmannii Chodat*	LC	Herb

Family	Species	Threat status	Growth forms
POLYGALACEAE	*Polygala transvaalensis Chodat subsp. transvaalensis*	LC	Herb
POLYGALACEAE	*Polygala uncinata E.Mey. ex Meisn.*	LC	Dwarf shrub, herb
POLYGONACEAE	*Persicaria attenuata (R.Br.) Soják subsp. africana K.L.Wilson*	LC	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria decipiens (R.Br.) K.L.Wilson*	LC	Helophyte, herb
POLYGONACEAE	*Persicaria lapathifolia (L.) Gray*	NE	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria limbata (Meisn.) H.Hara*	NE	Helophyte, herb
POLYGONACEAE	*Rumex acetosella L. subsp. angiocarpus (Murb.) Murb.*	NE	Herb
POLYGONACEAE	*Rumex conglomeratus Murb.*	LC	Herb
POLYGONACEAE	*Rumex crispus L.*	NE	Herb
POLYGONACEAE	*Rumex lanceolatus Thunb.*	LC	Herb
POLYGONACEAE	*Rumex sagittatus Thunb.*	LC	Climber, herb
POLYGONACEAE	*Rumex woodii N.E.Br.*	LC	Herb
POLYPODIACEAE	*Pleopeltis macrocarpa (Bory ex Willd.) Kaulf.*	LC	Epiphyte, herb, lithophyte
PORTULACACEAE	*Talinum caffrum (Thunb.) Eckl. & Zeyh.*	LC	Dwarf shrub, herb, succulent
POTAMOGETONACEAE	*Potamogeton pusillus L.*	LC	Herb, hydrophyte
PRIMULACEAE	*Anagallis pumila Sw.*	NE	Herb
PROTEACEAE	*Protea caffra Meisn. subsp. caffra*	LC	Shrub, tree
PROTEACEAE	*Protea welwitschii Engl.*	LC	Dwarf shrub, shrub
PTERIDACEAE	*Adiantum capillus-veneris L.*	LC	Geophyte, herb, lithophyte
PTERIDACEAE	*Pteris cretica L.*	LC	Geophyte, herb, lithophyte
RANUNCULACEAE	*Clematis brachiata Thunb.*	LC	Climber
RANUNCULACEAE	*Ranunculus multifidus Forssk.*	NE	Herb
RHAMNACEAE	*Berchemia zeyheri (Sond.) Grubov*	LC	Tree
RHAMNACEAE	*Helinus integrifolius (Lam.) Kuntze*	LC	Climber, shrub
RHAMNACEAE	*Rhamnus prinoides L'Hér.*	LC	Shrub, tree
RHAMNACEAE	*Ziziphus mucronata Willd. subsp. mucronata*	LC	Shrub, tree
RHAMNACEAE	*Ziziphus zeyheriana Sond.*	LC	Dwarf shrub
RICCIACEAE	*Riccia atropurpurea Sim*		Bryophyte
RICCIACEAE	*Riccia congoana Steph.*		Bryophyte
RICCIACEAE	*Riccia okahandjana S.W.Arnell*		Bryophyte
RICCIACEAE	*Riccia volkii S.W.Arnell*		Bryophyte
ROSACEAE	*Agrimonia procera Wallr.*	LC	Herb
ROSACEAE	*Duchesnea indica (Andrews) Focke*	NE	Herb
RUBIACEAE	*Anthospermum rigidum Eckl. & Zeyh. subsp. rigidum*	LC	Dwarf shrub
RUBIACEAE	*Galium capense Thunb. subsp. capense*	LC	Herb
RUBIACEAE	*Galopina circaeoides Thunb.*	LC	Herb
RUBIACEAE	*Kohautia amatymbica Eckl. & Zeyh.*	LC	Herb
RUBIACEAE	*Kohautia caespitosa Schnizl. subsp. brachyloba (Sond.) D.Mantell*	LC	Herb
RUBIACEAE	*Kohautia virgata (Willd.) Bremek.*	LC	Herb
RUBIACEAE	*Oldenlandia herbacea (L.) Roxb. var. herbacea*	LC	Herb

Family	Species	Threat status	Growth forms
RUBIACEAE	*Pachystigma pygmaeum (Schltr.) Robyns*	LC	Dwarf shrub
RUBIACEAE	*Pavetta gardeniifolia A.Rich. var. gardeniifolia*	LC	Shrub, tree
RUBIACEAE	*Pentanisia angustifolia (Hochst.) Hochst.*	LC	Herb
RUBIACEAE	*Pentanisia prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp. subsp. prunelloides*	LC	Herb
RUBIACEAE	*Pygmaeothamnus zeyheri (Sond.) Robyns var. zeyheri*	LC	Dwarf shrub
RUBIACEAE	*Richardia brasiliensis Gomes*	NE	Herb
RUBIACEAE	*Richardia scabra L.*	NE	Herb
RUBIACEAE	*Rothmannia capensis Thunb.*	LC	Tree
RUBIACEAE	*Vangueria infausta Burch. subsp. infausta*	LC	Tree
RUBIACEAE	*Vangueria parvifolia Sond.*		Tree
RUTACEAE	*Zanthoxylum capense (Thunb.) Harv.*	LC	Shrub, tree
SALICACEAE	*Dovyalis zeyheri (Sond.) Warb.*	LC	Shrub, tree
SALICACEAE	*Salix babylonica L. var. babylonica*	NE	Tree
SALICACEAE	*Salix mucronata Thunb. subsp. woodii (Seemen) Immelman*	LC	Tree
SALICACEAE	*Scolopia zeyheri (Nees) Harv.*	LC	Shrub, tree
SANTALACEAE	*Thesium costatum A.W.Hill var. juniperinum A.W.Hill*	LC	Herb, parasite
SANTALACEAE	*Thesium magalismontanum Sond.*	LC	Herb, parasite, shrub
SANTALACEAE	*Thesium spartioides A.W.Hill*	LC	Herb, parasite
SANTALACEAE	*Thesium transvaalense Schltr.*	LC	Dwarf shrub, herb, parasite
SANTALACEAE	*Thesium utile A.W.Hill*	LC	Herb, parasite
SAPINDACEAE	*Pappea capensis Eckl. & Zeyh.*	LC	Shrub, tree
SAPOTACEAE	*Englerophytum magalismontanum (Sond.) T.D.Penn.*	LC	Shrub, tree
SCROPHULARIACEAE	*Aptosimum indivisum Burch. ex Benth.*	LC	Dwarf shrub
SCROPHULARIACEAE	*Craterostigma plantagineum Hochst.*	LC	Herb, succulent
SCROPHULARIACEAE	*Freylinia tropica S.Moore*	Rare	Shrub
SCROPHULARIACEAE	*Halleria lucida L.*	LC	Shrub, tree
SCROPHULARIACEAE	*Jamesbrittenia burkeana (Benth.) Hilliard*	LC	Shrub, suffrutex
SCROPHULARIACEAE	*Melanospermum foliosum (Benth.) Hilliard*	LC	Herb
SCROPHULARIACEAE	*Mimulus gracilis R.Br.*	LC	Helophyte, herb, hydrophyte
SCROPHULARIACEAE	*Nemesia fruticans (Thunb.) Benth.*	LC	Dwarf shrub, suffrutex
SCROPHULARIACEAE	*Selago canescens L.f.*	LC	Dwarf shrub
SEMATOPHYLLACEAE	*Sematophyllum brachycarpum (Hampe) Broth.*		Bryophyte, epiphyte
SEMATOPHYLLACEAE	*Sematophyllum subpinnatum (Brid.) E.Britton*		Bryophyte, epiphyte
SINOPTERIDACEAE	*Cheilanthes dolomiticola (Schelpe) Schelpe & N.C.Anthony*	LC	Herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes hirta Sw. var. hirta*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes involuta (Sw.) Schelpe & N.C.Anthony var. obscura (N.C.Anthony) N.C.Anthony*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes pentagona Schelpe & N.C.Anthony*	LC	Herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes viridis (Forssk.) Sw. var. glauca (Sim) Schelpe & N.C.Anthony*	LC	Geophyte, herb, lithophyte

Family	Species	Threat status	Growth forms
SINOPTERIDACEAE	*Cheilanthes viridis (Forssk.) Sw. var. viridis*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Doryopteris concolor (Langsd. & Fisch.) Kuhn*	LC	Geophyte, herb
SINOPTERIDACEAE	*Pellaea calomelanos (Sw.) Link var. calomelanos*	LC	Geophyte, herb, lithophyte
SOLANACEAE	*Physalis viscosa L.*	NE	Herb
SOLANACEAE	*Solanum lichtensteinii Willd.*	LC	Dwarf shrub, shrub
SOLANACEAE	*Solanum nigrum L.*	NE	Herb
SOLANACEAE	*Solanum panduriforme E.Mey.*	LC	Dwarf shrub, herb, shrub
SOLANACEAE	*Solanum pseudocapsicum L.*	NE	Shrub
SOLANACEAE	*Solanum sisymbriifolium Lam.*	NE	Herb, shrub
SOLANACEAE	*Withania somnifera (L.) Dunal*	LC	Dwarf shrub, herb, shrub
STRYCHNACEAE	*Strychnos pungens Soler.*	LC	Shrub, tree
TELOSCHISTACEAE	*Caloplaca subunicolor (Nyl.) Zahlbr.*		Lichen
THELYPTERIDACEAE	*Thelypteris confluens (Thunb.) C.V.Morton*	LC	Geophyte, herb, hydrophyte
THYMELAEACEAE	*Gnidia caffra (Meisn.) Gilg*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia capitata L.f.*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia kraussiana Meisn. var. kraussiana*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia sericocephala (Meisn.) Gilg ex Engl.*	LC	Dwarf shrub, shrub
TYPHACEAE	*Typha capensis (Rohrb.) N.E.Br.*	LC	Herb, hydrophyte, hyperhydate
ULMACEAE	*Ulmus parvifolia Jacq.*	NE	Tree
ULMACEAE	*Ulmus procera Salisb.*	NE	Tree
VALERIANACEAE	*Valeriana capensis Thunb. var. capensis*	LC	Herb
VELLOZIACEAE	*Xerophyta retinervis Baker*	LC	Herb
VERBENACEAE	*Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum*	LC	Herb
VERBENACEAE	*Lantana camara L.*	NE	Shrub
VERBENACEAE	*Lantana rugosa Thunb.*	LC	Shrub
VERBENACEAE	*Lippia javanica (Burm.f.) Spreng.*	LC	Shrub
VERBENACEAE	*Lippia wilmsii H.Pearson*	LC	Shrub
VERBENACEAE	*Priva cordifolia (L.f.) Druce var. abyssinica (Jaub. & Spach) Moldenke*	LC	Herb
VERBENACEAE	*Priva meyeri Jaub. & Spach var. meyeri*	LC	Herb
VERBENACEAE	*Verbena bonariensis L.*	NE	Herb
VERBENACEAE	*Verbena brasiliensis Vell.*	NE	Herb
VISCACEAE	*Viscum rotundifolium L.f.*	LC	Parasite, shrub, succulent
VISCACEAE	*Viscum verrucosum Harv.*	LC	Parasite, shrub, succulent
VITACEAE	*Rhoicissus tridentata (L.f.) Wild & R.B.Drumm. subsp. tridentata*	NE	Shrub
XYRIDACEAE	*Xyris obscura N.E.Br.*	LC	Helophyte, herb, hydrophyte
ZYGOPHYLLACEAE	*Tribulus terrestris L.*	LC	Herb

APPENDIX B

Vegetation Index Score

Vegetation Index Score – Wetland Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score						X
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								X
Clumped	X			X			X	
Scattered		X	X		X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %					X	
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

4. *RIS*

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
				X		
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] =14

Vegetation Index Score – Rocky Outcrop Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score				X		
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score		X				
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped	X	X	X	X			X	X
Scattered					X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
						X
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS)] = 20

Vegetation Index Score – Open Grassland Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score						X
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous							X	X
Clumped	X	X	X	X				
Scattered					X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %				X		
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

4. *RIS*

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
					X	
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 15

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score – Transformed Habitat Unit

1. EVC=[[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score						X
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								X
Clumped		X		X	X		X	
Scattered	X		X			X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %						X
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

4. *RIS*

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
			X			
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

ECOLOGICAL AND WETLAND ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF THE K56 ROAD, IN NORTHERN JOHANNESBURG, GAUTENG.

Prepared for

Bokomaso Landscape Architects and Environmental Consultants

July 2012

Section C: Faunal Assessment

Prepared by:	**Scientific Aquatic Services**
Report author	**S. van Staden (Pr. Sci. Nat)**
	M Hanekom
Report Reference:	**SAS 212023**
Date:	**July 2012**

Scientific Aquatic Services CC
CC Reg No 2003/078943/23
Vat Reg. No. 4020235273
91 Geldenhuis Road
Malvern East Ext 1
2007
Tel: 011 616 7893
Fax: 011 615 6240/086 724 3132
E-mail: admin@sasenvironmental.co.za

EXECUTIVE SUMMARY

- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). No GDARD and IUCN RDL threatened mammal species were observed on the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit. No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may move through the area from time to time. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck (*Oxyura maccoa*) and African Finfoot (*Podica senegalensis*) and for feeding purposes by the African Marsh Harrier (*Circus ranivorus*), the Lesser Falcon (*Falco naumanni*) and the Lanner Falcon (*Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.
- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.

- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).* The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered highly significant.
- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.

- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

TABLE OF CONTENTS

List of Figures

List of Tables

Glossary of Terms & Acronyms

Alien vegetation – Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.

Biome – A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.

Bush encroachment – A state where undesirable woody elements gain dominance within grassland, leading to depletion of the grass component. Typically due to disturbances and transformations as a consequence of veldt mismanagement (overgrazing, incorrect burning, etc.).

Decrease grass – Grass abundant in veldt in good condition, which decreases when veldt is under- or over-utilized.

°*C* – Degrees Celsius.

Endangered – Organisms in danger of extinction if causal factors continue to operate.

Endemic species – Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.

Exotic vegetation – Vegetation species that originate from outside of the borders of the biome - usually international in origin.

Ex situ conservation – Where a plant (or community) cannot be allowed to remain in its original habitat and is removed and cultivated to allow for its ongoing survival.

Extrinsic – Factors that have their origin outside of the system.

GDACE – Gauteng Department of Agriculture, Conservation and Environment

ha – Hectares.

Indigenous vegetation – Vegetation occurring naturally within a defined area.

Increaser 1 grass – Grass species that increase in density when veld is under-utilized.

Increaser 2 grass – Grass species that increase in density in over-utilized, trampled or disturbed veld.

Increaser 3 grass – Grass species that increase in density in over and under-utilized veld.

In situ conservation – Where a plant (or community) is allowed to remain in its natural habitat with an allocated buffer zone to allow for its ongoing survival.

Karoid vegetation – A shrub-type vegetation that dominates in grasslands that have seen historical disturbances. Mainly due to over-grazing and mismanaged burning regimes. The shrubby vegetation eventually becomes dominant and out-competes the grassy layer.

m – Metres.

mm – Millimetres.

MAMSL – Metres above mean sea level.

MAP – Mean annual precipitation.

MAPE – Mean annual potential for evaporation.

MASMS – Mean annual soil moisture stress.

MAT – Mean annual temperature.

Orange Listed – Species that are not Red Data Listed, but are under threat and at risk of becoming RDL in the near future. Usually allocated to species with conservation status of *Near Threatened (NT), Least Concern (LC), Rare* and *Data Deficient (DD)*.

PES – Present Ecological State.

POC – Probability of occurrence.

PRECIS – Pretoria Computer Information Systems.

Pioneer species – A plant species that is stimulated to grow after a disturbance has taken place. This is the first step in natural veld succession after a disturbance has taken place.

QDS – Quarter degree square (1:50,000 topographical mapping references).

Rare – Organisms with small populations at present.

RDL (Red Data listed) species – Organisms that fall into the *Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU)* categories of ecological status.

RDSIS – Red Data Sensitivity Index Score.

SANBI – South African National Biodiversity Institute.

Veld retrogression – The ongoing and worsening ecological integrity state of a veld.

1. INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct terrestrial, wetland and aquatic ecological assessment on the route of the proposed development of the K56 road (Figure 1). The total length of the proposed road portion is approximately 7km and is situated to the northwest of Fourways on the Helderfontien estate grounds between Kyalami and Dainfern, Gauteng.

1.2 Desktop Study

Initially a desktop study was undertaken to gather background information regarding the site and its surrounding areas. All relevant authorities were consulted regarding conservational species lists, as well as all the latest available literature utilised to gain a thorough understanding of the area and its surrounding habitats. This information and further literature reviews were then used to determine the potential biodiversity lists for the proposed development site and surrounding areas. This information incorporated (amongst others) data on vegetation types, habitat suitability and biodiversity potential coupled to this information.

Two site visits were undertaken to determine the ecological status of the proposed development sites and the surrounding area (see Section A for site maps). A reconnaissance ‘drive around’ followed then by a thorough ‘walk through’ were undertaken to determine the general habitat types found throughout the study area and, following this, specific study sites or habitat regions were chosen that were representative of the habitats found within the area. Special emphasis was placed on potential areas that may support RDL faunal species. Sites were investigated on foot to identify the occurrence of the *dominant* communities, species and habitat diversities. The presence of any faunal inhabitants of the study area was also assessed through direct visual observation or identifying them through calls, tracks, scats and burrows, with emphasis being placed on determining if any RDL faunal species occur within the study area.

1.3 Scope

Specific outcomes in terms of this report are as follow:

Ecological Assessment:

- Red data species assessment, including potential for species to occur on the subject property and the application of the Red Data Sensitivity Index for the study area in order to define the importance of the subject property for the conservation of Red Data Listed Fauna;
- provide faunal inventories of species as encountered on site;
- determine and describe habitats, communities and ecological state of the study area; and
- describe the spatial significance of the subject property with regards to surrounding natural areas.

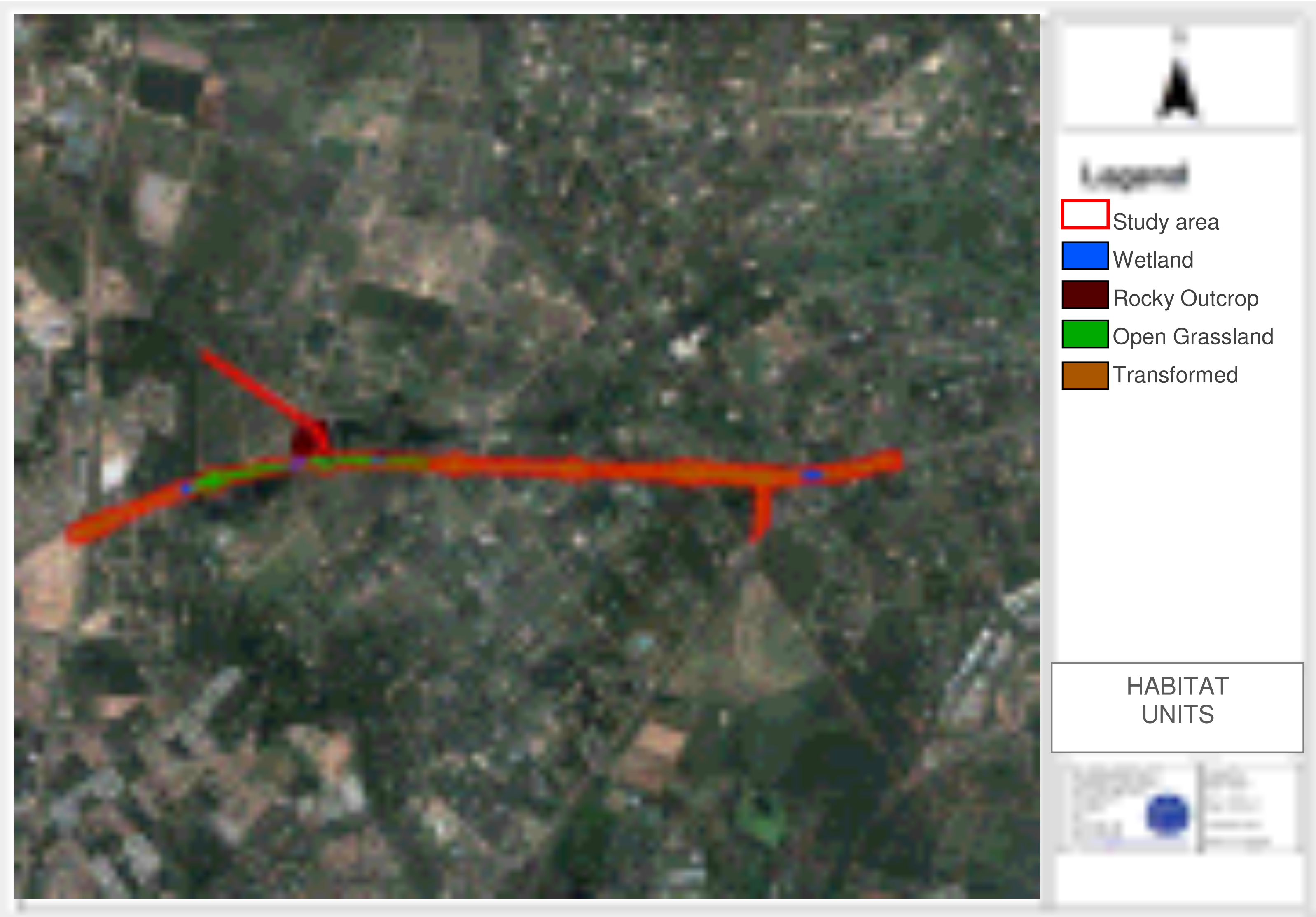


Figure 1: Subject property depicted on a digital Satellite Image.

2. METHODOLOGY

The faunal categories covered are: Mammals, Avifauna, Reptiles, Amphibians, Invertebrates, Spiders and Scorpions. It must be noted that studies undertaken on invertebrates were undertaken as a general survey although thorough searching and trapping techniques to capture both flying and ground dwelling taxa was undertaken.

Mammals

Small mammals are unlikely to be directly observed in the field because of their nocturnal/crepuscular and cryptic nature. A simple and effective solution to this problem is to use Sherman traps. A Sherman trap is a small aluminium box with a spring-loaded door. Once the animal is inside the trap, it steps on a small plate that causes the door to snap shut, thereby capturing the individual. Trapping took place within relatively undisturbed small mammal habitat identified throughout the study area. In the event of capturing a small mammal during the night, the animal would be photographed and then set free unharmed early the following morning. Traps were baited with a universal mixture of oats, peanut butter and syrup

Figure 2: Pictures of Sherman trap and bait.

Larger faunal species were recorded during the subject property assessment with the use of visual identification, spoor, call, dung and positively identification. It is important to note that due to the nature and habits of fauna, varied stages of life cycles, adverse weather or seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. In addition the levels of anthropogenic activity in the study area and surrounding area may determine whether species will be observed.

Birds

The Roberts (Roberts Multimedia Birds of Southern Africa) list for the quarter degree square (Appendix 1) was used to correlate with the recent field survey database of birds identified in the subject property. Recent field surveys where undertaken using a pair of Vespa 7x50 binoculars and bird call identification practices were utilised during the site visit.

Reptiles

Reptiles were physically identified whilst the field surveys were in progress in the area. Rocks were overturned and inspected. Abandoned termitaria were also inspected for reptiles dwelling within them.

Amphibians

Amphibians have been identified wherever encountered during the ongoing field surveys in the area. Amphibian species were recorded during the study area assessment with the use of direct visual identification along with other identification aids such as call identification. Amphibian species flourish in and around wetland and riparian areas. It is in these areas that specific attention was placed in searching for amphibian species. However, it is unlikely that all amphibian species will have been recorded during the site assessment, due to their cryptic nature and habits, varied stages of life cycles, weather conditions at the time of assessment or seasonal and temporal fluctuations along with other external factors.

Invertebrates as well as Arachnids and Scorpions

A list of visually identified and observed invertebrate species was compiled during the field surveys. Sweep nets were used to capture and identify invertebrate species. Insects were placed inside an emergence box enabling easy identification. An emergence box is a black plastic box which holds all invertebrate species captured. The box is sealed with a lid thus making the box dark. At one side of the box there is a hole there sunlight filters into the box. At this hole there is a transparent plastic container which contains 30% ethanol concentrate. The captured insects seek out the sunlight and are captured in the plastic container. This method ensures diverse and allows for comprehensive invertebrate collection.

Figure 3: Picture of emergence box. Spiders and Scorpions

Specific and most suitable habitat areas were searched. Rocks were over turned and searched for visual identification of Arachnids and Scorpions. Specific attention was aimed at searching for Mygalomorphae arachnids (Trapdoor and Baboon spiders) in the study area.

It is important to note that due to the nature and habits of fauna, varied stages of life cycles, adverse weather or seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. In addition the levels of anthropogenic activity in the study area and surrounding area may further influence whether species will be observed.

2.1 *Faunal Red Data Sensitivity Index Score (RDSIS)*

Given the restrictions of field assessments to identify all the faunal species that possibly occur on a particular property, the Red Data Sensitivity Index Score (RDSIS) has been developed to provide an indication of the potential red data faunal species that could reside in the area, while simultaneously providing a quantitative measure of the subject property's' value in terms of conserving faunal diversity. The RDSIS is based on the principles that when the knowledge of the specie's historical distribution is combined with a field assessment that identifies the degree to which the property supports a species habitat and food requirements, inferences can be made about the chances of that particular specie residing on the property. Repeating this procedure for all the potential red data faunal species of the area and collating this information then provides a sensitivity measure of the property that has been investigated. The detailed methodology to determine the RDSIS of the property is presented below:

<u>Probability of Occurrence (POC)</u>: Known distribution range (D), habitat suitability of the site (H) and availability of food sources (F) on site were determined for each of the species. Each of these variables is expressed a percentage (where 100% is a perfect score). The average of these scores provided a Probability of Occurrence (POC) score for each species. The POC value was categorised as follows:

- **0-20% = Low;**
- **21-40% = Low to Medium;**
- **41-60% = Medium;**
- **60-80% = Medium to High; and**
- **81-100% = High**

POC = (D+H+F)/3

<u>Total Species Score (TSS)</u>: Species with POC of more than 60% (High-medium) were considered when applying the RDSIS. A weighting factor was assigned to the different IUCN categories providing species with a higher conservation status, a higher score. This weighting factor was then multiplied with the POC to calculate the total species score (TSS) for each species. The weighting as assigned to the various categories is as follows:

- **Data Deficient = 0.2;**
- **Rare = 0.5;**
- **Near Threatened = 0.7;**
- **Vulnerable = 1.2;**
- **Endangered = 1.7; and**
- **Critically Endangered = 2.0.**

TSS = (IUCN weighting*POC) where POC > 60%

<u>Average Total Species (Ave TSS) and Threatened Taxa Score (Ave TT)</u>: The average of all TSS potentially occurring on the site is calculated. The average of all the Threatened taxa (TT) (*Near threatened*, *Vulnerable*, *Endangered* and *Critically Endangered)* TSS scores are also calculated. The average of these two scores (Ave

TSS and Ave TT) was then calculated in order to add more weight to threatened taxa with POC higher than 60%.

Ave = Ave TSS [TSS/No of Spp] + Ave TT [TT TSS/No of Spp]/2

Red Data Sensitivity Index Score (RDSIS): The average score obtained above and the sum of the percentage of species with a POC of 60% or higher of the total number of Red Data Listed species listed for the area was then calculated. The average of these two scores, expressed as a percentage, gives the RDSIS for the area investigated.

RDSIS = Ave + [Spp with POC>60%/Total no Of Spp*100]/2

RDSIS interpretation:

Table 1: RDSIS value interpretation with regards to RDL mammal importance on the subject property.

RDSIS Score	RDL mammal importance
0-20%	**Low**
21-40%	**Low-Medium**
41-60%	**Medium**
60-80%	**High-Medium**
81-100%	**High**

3. RESULTS OF FAUNAL INVESTIGATION

3.1 Surrounding properties/land uses and general habitat visual orientation

The greater area surrounding the subject property and proposed development route is located within a district primarily utilised for residential and recreational activities.

General faunal habitat visual indications	
 **Good natural rocky habitat areas within the subject property**	 **Good natural woodland vegetation providing good faunal habitat for foraging and shelter purposes**

Figure 4: Representative views of natural rocky and woodland habitat within the subject property.

General faunal habitat visual indications	
 **Dam, stream and wetland areas which provide habitat areas within the subject property**	 **Grassland vegetation providing good faunal habitat for foraging and habituation purposes**

Figure 5: Representative views of aquatic and grassland habitat within the subject property.

Subject area current usages (Recreational)	
	
Horse (Equu*s sp*) trails on subject property	**Mountain bike trails along dirt road network**

Figure 6: Evidential representative views of other land uses within the subject property.

In general there is good natural rocky outcrop and woodland habitat units along with good wetland units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. There habitat unit areas are visually displayed in Section A, Sensitivity Mapping.

The faunal assessment included field observations (visual identification, spoor, call or dung) in conjunction with an extensive literature referencing. This is done due to the fact that many faunal species are nocturnal and many species are shy and avoid human contact. Climatic conditions during the assessment were suitable to enable observations to occur. Mention must be made however that many faunal species possess migratory behaviour traits due to many uncontrollable variables such as habitat availability, food availability and water quality. These factors and the changing of the seasons play a significant role in the faunal species that may occur at any given time within the subject property. In addition the levels of anthropogenic activity in the subject property and surrounding area may determine whether species will be observed. A detailed discussion of the different faunal taxa follows in the sections below.

3.2 Mammals

A list of the updated Mammal Red Data list of Gauteng February 2011 according to GDARD threatened mammal species (GDARD SoER, 2004) is in Appendix 1 (personal communication with Lihle Dumalisile from GDARD).

Field sightings of Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were made during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property were Mole rat mounds (Genus; *Cryptomys*), Cape Clawless Otter (*Aonyx capensis*) droppings and small rodents that are associated with domestic and urban areas and domestic waste products. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). These natural areas, especially the rocky outcrop and wetland areas are deemed to provide good intact habitat for many mammal species. The rocky outcrop and wetland areas were also the habitat units where nearly all evidence of the mammal species were encountered.

Baited Sherman traps were utilised to capture small mammals which may inhabit the subject property. Traps were placed in areas where suitable small mammal habitat was observed. One small mammal species was successfully trapped during the exercise, the Angoni Vlei Rat (*Otomys angoniensis*). The presence of raptors such as the Black-Shouldered Kite (*Elanus caeruleus*), Barn Owl (*Tyto alba*) and the Lanner Falcon (*Falco biarmicus*) as identified (See 3.2, Birds) indicates that a small mammal population is likely to be present in the vicinity of the subject property.

No GDARD and IUCN RDL threatened mammal species were found in the subject property. It is unlikely that these GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit. Thus it is advised that a specific specialist bat survey study be conducted within the good rocky habitat unit to confirm whether or not there are RDL bats present within the subject property and the good natural rocky outcrop habitat unit.

Mammal sightings	
 Common Molerat (*Crytomys hottentotus*)	 Angoni Vlei Rat (*Otomys angoniensis*)

Figure 7: Evidential representative views of common molerat and Angoni vlei rat within the subject property.

Mammal sightings	
 Horse (*Equus sp*)	 Striped mouse (*Rhabdomys pumilio*)

Figure 8: Evidential representative views of horse and striped mouse within the subject property.

Mammal sightings	
 Yellow Mongoose (*Cynitis penicillata*)	 Cape Clawless Otter (*Aonyx capensis*)

Figure 9: Evidential representative views of yellow mongoose and Cape clawless otter within the subject property.

3.3 Avifauna

The species of conservational interest to Gauteng, as noted by GDARD (2004), are presented in Appendix 2a. No GDARD RDL listed bird species were noted during the site assessment.

All bird species seen or heard during the time of the assessment were recorded. Surveys were conducted along the entire subject property and in the immediate surroundings.

The table below lists all the bird species identified during the assessment. The complete list of bird species expected for the QDS 2528CC (Roberts Multimedia Birds of Southern Africa) is included in Appendix 2b.

Table 2: Bird species recorded during the field survey.

Common Name	Scientific Name
Common Fiscal Shrike	*Lanius collaris*
Egyptian goose	*Alopochen aegyptiacus*
Cape Turtle Dove	*Streptopelia capicola*
Laughing dove	*Stigmatopelia senegalensis*
Dark Capped Bulbul	*Pycnonotus tricolor*
Sacred ibis	*Threskiornis aethiopicus*
Hadeda ibis	*Bostrychia hagedash*
Black Shouldered Kite	*Elanus caeruleus*
Reed Cormorant	*Phalacrocorax africanus*
African Black Duck	*Anas sparsa*
Black headed heron	*Ardea melanocephala*
White faced Duck	*Dendrocygna viduata*
Pied Kingfisher	*Ceryle rudis*
Malachite kingfisher	*Alcedo Cristata*
African Grey Hornbill	*Tockus nasutus*
Green (Redbilled) Wood Hoopoe	*Phoeniculus purpureus*
Grey Go Away Bird (Lourie)	*Corythaixoides concolor*
Little Sparrowhawk	*Accipiter minullus*
Swainson's Spurfowl (Francolin)	*Pternistes swainsonii*
Sabota Lark	*Calendulauda sabota*
Southern Masked Weaver	*Ploceus velatus*
Red-knobbed coot	*Fulicia cristata*
Blacksmith Plover	*Vanellus armatus*

Common Name	Scientific Name
Barn Owl	*Tyto alba*
Crowned Plover	*Vanellus coronatus*
Spotted dikkop	*Burhinus capensis*
Indian myna	*Acridotheres tristis*

However since birds are mobile there is a good chance that some threatened RDL bird species which occur in the GDARD RDL bird list may occur within the subject property. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck (*Oxyura maccoa*) and African Finfoot (*Podica senegalensis*) and for feeding purposes by the African Marsh Harrier (*Circus ranivorus*), the Lesser Falcon (*Falco naumanni*) and the Lanner Falcon (*Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.

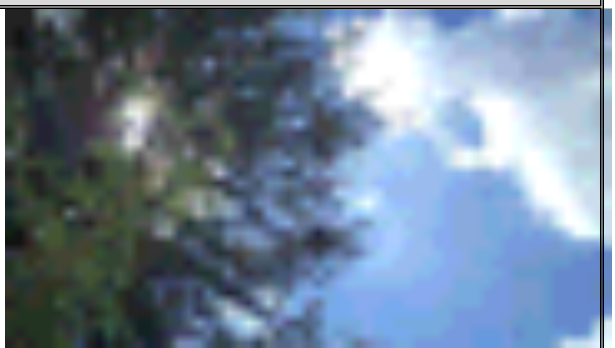
Table 3: Gauteng (GDARD) Bird species RDL avifauna species with a POC of more than 60%

Common name	Scientific name	GDARD status	POC
African Marsh Harrier	*Circus ranivorus*	VU	63
Lesser Kestrel	*Falco naumanni*	VU	65
Lanner Falcon	*Falco biarmicus*	NT	69
Maccoa duck	*Oxyura maccoa*	NT	61
African Finfoot	*Podica senegalensis*	VU	61

VU = Vulnerable, NT = Near threatened

Avifauna sightings

Barn Owl (*Tyto alba*) dropping



Southern masked weaver *(Ploceus velatus)* nests

Figure 10: Evidential representation of Barn owl and weavers within the subject property.

3.4 Reptiles

Threatened reptile species of concern in Gauteng, as noted by GDARD (2004), are presented in Appendix 3.

One non RDL reptile species was identified during the assessment of the rocky outcrop habitat unit, namely the Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*). Apart from the Striped Skink (*Mabuya striata*), it is anticipated that other commonly occurring reptile species may reside within the subject property, which include the Spotted Sandveld Lizard (*Nucras intertexta)* and Rough-scaled Plated Lizard (*Gerrhosaurus major*) along with several common snake species, such as the Highveld Garter Snake (*Elapsoidea sundevalli*) and Transvaal worm snake (*Leptotyphlops distanti*) that may be found in the subject property.

No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.

Thus it is recommended that the rocky outcrop area as well as the wetland areas be kept undisturbed to conserve and protect possible habitats for reptile species.

Table 4: Reptile RDL species list that has a high POC to be found within the subject property.

Common Name	Scientific Name	GDARD Status	POC
Blunt-tailed worm lizard	*Dalophia pistillum*	DD	61
Striped harlequin Snake	*Homoroselaps dorsalis*	R	63
Southern African Rock Python	*Python sebae natalensis*	VU	65

VU = Vulnerable, DD = Data Deficient; R = Rare

Reptile sightings

Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*)

Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*)

Figure 11: Evidential representative views of Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*) within the subject property.

3.5 Amphibians

Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).*

The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs

(*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered significant.

Table 5: Amphibian RDL species list that has a high POC which may be associated to the subject property.

Common Name	Scientific Name	GDARD Status	POC
Giant Bullfrog	Pyxicephalus adspersus	NT	69

NT = Near Threatened

3.6 Invertebrates

The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. As such, the invertebrate assessment will not be an indication of the complete invertebrate diversity potential of the subject property and surrounding area. A presentation of the encountered families in the Insecta class that were observed during the assessment is listed in the table below.

Threatened invertebrate species list for Gauteng is in Appendix 5 GDARD (2004). No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.

Table 6: General results from invertebrate collecting during the assessment of the subject property

Insects	Comments
Order: Lepidoptera (Butterflies & Moths)	These are all commonly occurring species typical of the locality and habitat
Family: Nymphalidae	
Subfamily: Danainae *Danaus chrysippus aegyptius* (African monarch)	Visual observations
Subfamily: Nimphalinae *Junonia hierta* (Yellow pansy) *Byblia ilythia* (Spotted joker)	Visual observations
Family: Pieridae *Eurema hecabe* (Common grass Yellow) *Beleonis creona* (African Common White) *Leptotes pirithous* (Common Blue)	Visual observations
Family: Hepialidae *Eudalaca exul* (Brown swift moths)	Visual observations
Family: Geometridae *Rhodometra sacrarial* (Vestal moths)	Visual observations
Family: Saturniidae *Bunaea alcinoe* (Emperor moth)	Visual observations
Family: Sphingidae *Pseudoclanis postica* (Mulberry Hawk moths)	Visual observations
Order: Orthoptera (Grasshoppers, Crickets & Locusts)	These are all commonly occurring species typical of the locality and habitat
Family: Anostostomatidae *Onosandrus* sp	Visual observations and sweep net
Family: Gryllidae *Gryllus bimaculatus* (Common garden cricket)	Visual observations
Family: Tettigoniidae *Phaneroptera* sp (Leaf katydids)	Visual observations
Family: Acrididae *Oedaleus* sp (Yellow wings) *Cyrtacanthacris aeruginosa* (Green tree locust)	Visual observations and sweep net
Order: Hymenoptera & Isoptera (Ants, Bees, Termites &Wasps)	These are all commonly occurring species typical of the locality and habitat
Family: Apidae *Apis mellifera scutellata* (African honey bee)	Visual observations
Family: Vespidae *Vespula germanica* (Hornet wasps)	Visual observations
Family: Termitidae *Trinervitermes trinervoides* (Snouted Harvester) Odontotermes latericus (Harvester Termites)	Visual observations
Order: Coleoptera (Beetles)	These are all commonly occurring species typical of the locality and habitat

Family: Meloidae *Decapotoma lunata* (Lunate blister beetle)	Visual observations
Family: Coccinellidae *Hippodamia variegata* (Spotted amber ladybird)	Visual observations and sweep net
Family: Carabidae *Tefflus* sp (Peaceful giant ground beetle)	Visual observations
Order: Phasmatodea (Stick insects)	These are all commonly occurring species typical of the locality and habitat
Family: Heteronemiidae *Maransis* rufolineatus (Grass stick insect)	Visual observations and sweep net
Order: Mantodea (Mantids)	These are all commonly occurring species typical of the locality and habitat
Family: Mantidae *Sphodromantis lineola* (African Praying mantis)	Visual observations and sweep net
Order: Odonata (Damselflies, Dragonflies, Skimmers)	These are all commonly occurring species typical of the locality and habitat
Family: Libellulidae *Trithemis arteriosa* (Red veined Dropwing)	Visual observations

Invertebrate sightings

African monarch (*Danaus chrysippus aegyptius*)

African Praying mantis (*Sphodromantis lineola*)

Figure 12: Evidential representative views of the African monarch butterfly and an African Praying mantis within the subject property.

3.7 Arachnids and Scorpions

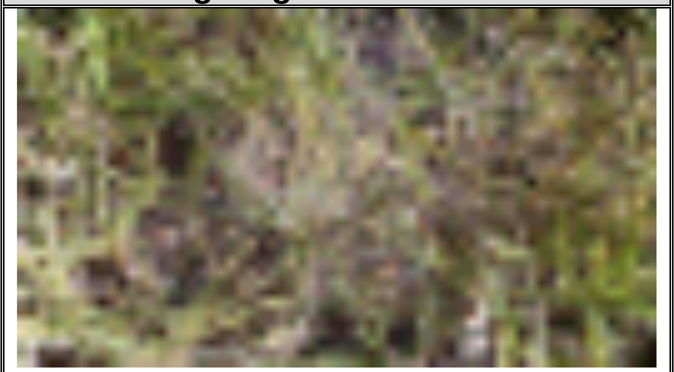
Gauteng Province Threatened, Rare and of conservation concern Spiders and Scorpions (GDARD SoER, 2004) are listed in Appendix 5.

No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey.

Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.

Non RDL Funnel web spider (*Angelena* sp) individuals were encountered during the site survey. These species are considered common and not threatened

Arachnid sightings



Funnel web spider (*Angelena* sp)

Figure 13: Evidential representative views of a Funnel web spider within the subject property.

4. FAUNAL RED DATA SPECIES ASSESSMENT

No threatened RDL faunal species were identified during the site surveys which are included in the Gauteng Province State of the Environment Reports. Nine threatened RDL species did however indicate to have a 60% or greater probability of being found on the subject property are presented in the table below. These species have a high probability of utilising the subject property as a migration corridor and an area to forage and maybe breed in if the conditions are favourable.

Table 7: Threatened faunal species with a 60% or greater Probability of Occurrence (POC) on the subject property.

Common Name	Scientific Name	IUCN	GDARD Status	POC
Lanner Falcon	*Falco biarmicus*	LC	NT	69
Lesser Kestrel	*Falco naumanni*	LC	VU	65
African Marsh Harrier	Circus ranivorus	LC	VU	63
African Finfoot	Podica senegalensis	LC	VU	61
Maccoa duck	*Oxyura maccoa*	NT	NT	61
Blunt-tailed worm lizard	*Dalophia pistillum*	Na	DD	61
Striped harlequin Snake	*Homoroselaps dorsalis*	NT	R	63
Southern African Rock Python	*Python sebae natalensis*	Na	VU	65
Giant Bullfrog	Pyxicephalus adspersus	LC	NT	69

Na = not assessed by the IUCN, LC = Least Concerned, R = Rare, DD = Data Deficient, NT = Near Threatened and VU = Vulnerable.

The species presented in the table above were then used to calculate the RDSIS for the site, the results of which are presented in the following table.

Table 8: Red Data Sensitivity Index Score calculated for the subject property.

Red Data Sensitivity Index Score	
Average Total Species Score	**54**
Average Threatened Taxa Score	**63**
Average (Ave TSS + Ave TT/2)	**59**
% Species greater than 60% POC	**10%**
RDSIS of Site	**34%**

The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

5. SENSITIVITY MAPPING

All the ecological features of the subject properties were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed development with regards to all sensitive areas. Sensitivity maps are displayed in Section A attached with this report.

6. CONCLUSIONS AND RECOMMENDATIONS

Two site visits were undertaken during March and April 2012 to determine the ecological status of the subject property to undertake a general faunal biodiversity assessment, with emphasis being placed on the potential occurrence of any threatened RDL faunal species which are highlighted for Gauteng Province (GDARD, 2004).

The following general conclusions were drawn on completion of the survey:

FAUNAL ASSESSMENT CONCLUSIONS

In general there is good natural rocky outcrop and woodland habitat units along with good wetland units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. There habitat unit areas are visually displayed in Section A, Sensitivity Mapping.

- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). No GDARD and IUCN RDL threatened mammal species were found in the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit.
- No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may occur within the subject property. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck *(Oxyura maccoa*) and African Finfoot *(Podica senegalensis*) and for feeding purposes by the

African Marsh Harrier *(Circus ranivorus*), the Lesser Falcon *(Falco naumanni*) and the Lanner Falcon *(Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.

- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.
- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).* The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are

active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered significant.

- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.
- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

After the conclusion of this biodiversity assessment, it is the opinion of the ecologists that from an ecological viewpoint, the proposed development be permitted provided that the recommendations below are strictly adhered to:

- The defined areas of high sensitivity habitat (wetland and rocky out crop habitat unit) areas should remain undeveloped as public or private open space. A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning and construction phases of the proposed development activities to aid in the conservation of ecological processes within the subject property. It is highly recommended that the proposed inter Section Ae moved away from the wetland and unique rocky habitat unit areas since this intersection development will have the largest impact on the ecology of all the development areas and is currently located within and adjacent to the most sensitive area along the entire proposed development route within the subject property.

- All footprint areas should remain as small as possible and should not encroach into the wetland and rocky outcrop habitat units. This can be achieved by fencing footprint areas to contain all activities within designated areas. However, all fencing material should be removed and disposed of in an appropriate manner when activities are completed. In addition fencing should be constructed in such a way as to still ensure free movement of smaller faunal taxa through the area.
- Proliferation of alien and invasive floral species is expected within disturbed areas such as next to the gravel road. These exotic flora species should be eradicated and controlled to prevent their spread beyond the site boundary as well as seed dispersal within the top layers of the soil within footprint areas that will have an impact, habitat and food availability as well as on rehabilitation in the future.
- In order to preserve faunal habitat, the recommended faunal management and mitigation plans as in the floral report (Section A) should be taken into consideration to prevent any loss of faunal habitat as well as any further establishment of alien flora.
- Construction vehicles should be restricted to travelling only on the existing road servitudes to limit the ecological footprint of the proposed development activities.
- Ensure that construction boundaries are clearly marked and no vehicles are to encroach upon the wetland and other sensitive habitat unit areas. If this is unavoidable, ensure that these areas are suitably rehabilitated with special mention of ensuring habitat connectivity and re-establishment of natural conditions as far as possible.
- Ensure that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected.
- Planning of gravel roads that will be utilised during the pre-construction and construction phases should consider the site sensitivity plan. If possible roads should be constructed a distance from the wetland areas and not directly adjacent to these areas. Mainly to prevent any impact on the proposed open space areas due to dust

generation, erosion and sedimentation from gravel roads situated next to these areas considered of increased ecological sensitivity.

- Adequate sanitation facilities should be provided for labourers to avoid the informal usage of the veld.
- No fires should be lit whatsoever within designated sensitive areas during the construction phase of the development.
- Edge effects of project related activities in these areas including erosion and alien floral species establishment need to be strictly managed in these areas.
- Compare the positions of planned infrastructure to the areas of mapped sensitivity.
- No dumping of waste should take place within any area of the subject property. If any spills or waste deposits occur, they should be immediately cleaned up.
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the wetland areas.
- As much of the grassland is to be left undisturbed as possible to allow for the ongoing conservation of invertebrate species which may inhabit the proposed development site.
- As much vegetation growth, thus faunal habitat areas, as possible should be promoted within the proposed development area in order to protect soils and to reduce the percentage of the surface area which is paved. In this regard special mention is made of the need to use indigenous vegetation species as the first choice during landscaping to ensure that there is adequate natural faunal habitat.
- If any threatened RDL faunal species are identified within the proposed development route and subject property during construction activities, the proponent and contractors should ensure effective relocation of individuals to suitable offset areas or within designated open space on the subject property.
- All rescue and relocation plans should be overseen by a suitably qualified specialist.
- Designated sensitive areas must be off-limits to construction personnel.
- No trapping or hunting of fauna is to take place. Access control must be implemented to ensure that no illegal trapping or poaching takes place.
- All soils compacted as a result of construction activities falling outside development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout the all phases of the development.
- Ensure that all disturbed and exposed areas are rehabilitated and covered with vegetation to prevent post-rehabilitation dust generation.

- Ensure that all hazardous storage containers comply with the relevant SABS standards to prevent leakage.
- Regularly inspect all construction vehicles for leaks.
- Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.
- Erosion management measures must be implemented to prevent soils from eroding into surface water resources.