APPENDIX A

Database of Potentially Interested and Affected Parties

Title	First Name/ Organisation	Last Name	Organisation/ Land Owner
Mr	Mavhungu	Nesindande	Land Owner
Mr	Erens	Gouws	Land Owner
Ms	Werda Louise	Gouws	Land Owner
Ms	Susara	Kloppers	Land Owner
Mr	Joseph	Strydom	Land Owner
Mr	Stefanus	Du Plessis	Land Owner
			Arum Lily Trading CC
		Schoeman	Plaatjie Game Farm
Mr	Nathaniel	Vos	Land Owner
Ms	Jean	Caddy	Messina Investments (Pty) Ltd (Petra Diamonds?)
Mr	Jacques	Cilliers	Messina Investments (Pty) Ltd (Petra Diamonds?)
Mr	Jan	Louw	Messina Investments (Pty) Ltd (Petra Diamonds?)
Mr	Martin	van Zyl	Messina Investments (Pty) Ltd (Petra Diamonds?)
Mr	Gerrit	Loef	Nari Danga Safaris
			National Government of the Republic of South Africa
			National Government of the Republic of South Africa
			National Government of the Republic of South Africa
			Musina Local Municipality
Mr		Africa	Department of Rural Development and Land Reform
			W N C L Boerdery
			W N C L Boerdery
Ms	Jacoba	Visser	Land Owner
Mr	Folkers	van Zyl	Assoprop Properties (Pty) Ltd
Mr	Hermanus	Schoeman	Hermanus Schoeman Familie Trust
Mr	Michiel	Roos	Land Owner
Mr	Jan	Roos	Land Owner
	Adrian Joubert Trust		Land Owner
	National Government of the Republic of South Africa		Land Owner
	Greater Messina Transitional Local Council		Land Owner
Mr	Hermanus	Schoeman	H Schoeman Investments
	Musina Local Municipality		Land Owner
	Musina Local Municipality		Land Owner
Ms	Namadzavho	Nesindande	Messina Gesondheids Komitee
	Provincial Government of Limpopo		Landowner
	Servitude		Landowner
	Vhembe District Municipality		Landowner
Ms	Bella	Tanzwani	Landowner
Mr	Clive	Neethling	Landowner
Ms	Diana	Neethling	Landowner
Ms	Cornelia	Carstens	Landowner
Mr	Cornelius	Kloppers	Landowner
Mr	Emmanuel	Munenge	Landowner
Mr	Pedzisai	Munenge	Landowner
Ms	Mary	van Rensburg	Landowner

Mr	Michael	Kanyongolo	Landowner
Ms	Nicolene	Adam	Landowner
Mr	Nicholaas	Joubert	Landowner
Ms	Charmaine	Diener	Central Africa Crushers (Pty) Ltd
Mr	Irral	Naude	Central Africa Crushers (Pty) Ltd
Mr	Jarques	Naude	Central Africa Crushers (Pty) Ltd
Ms	Tanya	Roos	Central Africa Crushers (Pty) Ltd
			De Beers Consolidated Mines (Pty) Ltd
Mr	Peter	Glendining	Pacific Eagle Properties 109 (Pty) Ltd
Mr	Jack	Paul	Pacific Eagle Properties 109 (Pty) Ltd
Ms	Reshma	Devdhara	VRV Investments
Mr	Vijay	Devdhara	VRV Investments
Mr	Ian	Cooper	Landowner
Mr	Balanganani	Tshilande	Landowner
Ms	Muhangwi	Tshilande	Landowner
Ms	Shonisani	Tshilande	Landowner
Ms	Alice	Mathew	The South African National Roads Agency
Ms	Ayanda	Ceba	Transnet
	National Government of the Republic of South Africa		Landowner
Mr	Isaac	Chalumbira	Matoppi Investments (Pty) Ltd
Mr	Hendrik	Erwee	Matoppi Investments (Pty) Ltd
Mr	Petrus	Lee	Matoppi Investments (Pty) Ltd
Mr	Jayasingh	Rana	Matoppi Investments (Pty) Ltd
Ms	Elsje	Henrico	Landowner
Mr	Jan	Knoetze	Landowner
Ms	Bertina	Genis	Klein Ranchero Boerdery
Ms	Bertina	Kiliam	Klein Ranchero Boerdery
Mr	Jacque	Kiliam	Klein Ranchero Boerdery
	National Government of the Republic of South Africa		Landowner
	Greater Messina Transitional Local Council/SANDF		Landowner
	Akoo Muhammed B-E		Landowner
Ms	Uzma	Gulzar	Landowner
Mr	Willem	Bezuidenhout	Landowner
Mr	Gavin	Parkin	East of Eden Trading 815
Mr	Rodney	Parkin	East of Eden Trading 815
Mr	Naik	Muhammad	Jan Africa Inv CC
Ms	Barbara	Visser	Pakama Steak Ranch (Pty) Ltd
Mr	Wessel	Visser	Pakama Steak Ranch (Pty) Ltd
Mr	Johann	Ellis	Riverport Trading 270 (Pty) Ltd
Mr	Eric	Libert	Riverport Trading 270 (Pty) Ltd
		Ragabush	Riverport Trading 270 (Pty) Ltd
Mr	Johann	Ellis	Eagle Creek Investments 154 (Pty) Ltd
Mr	Eric	Libert	Eagle Creek Investments 154 (Pty) Ltd
Ms	Serah	Chirwa	Vhembe District Colourstone Mining Primary Co-operative Limited

Ms	Florance	Makwarela	Vhembe District Colourstone Mining Primary Co-operative Limited
Ms	Mamsy	Maphosa	Vhembe District Colourstone Mining Primary Co-operative Limited
Mr	Jack	Moagi	Vhembe District Colourstone Mining Primary Co-operative Limited
Ms	Sosia	Munyai	Vhembe District Colourstone Mining Primary Co-operative Limited
Mr	Alwyn	Nel	Vhembe District Colourstone Mining Primary Co-operative Limited
	Tshimangadzo	Senama	Vhembe District Colourstone Mining Primary Co-operative Limited
Ms	Tshilidzi	Tshikhwama	Vhembe District Colourstone Mining Primary Co-operative Limited
	Musina Local Municipality		Landowner
	Greater Messina Transitional Local Council		Landowner
Mr	Jacobus	Venter	Landowner
Ms	Jennifer	Venter	Landowner
Mr	Petrus	Knoetze	Landowner
Mr	Quinton-Claud	Rodrigues	Landowner
Ms	Stacey-Anne	Rodrigues	Landowner
	Jack Smith Trust		Landowner
	Jack Smith Trust		Landowner
	De Beers Consolidated Mines (Pty) Ltd		Landowner
Mr	Anders	Skov	Maremani Nature Reserve (Pty) Ltd
Mr	Leif	Skov	Maremani Nature Reserve (Pty) Ltd
Mr	Mette	Skov	Maremani Nature Reserve (Pty) Ltd
	MARLYS FRANCES STORE		Landowner
Ms	Rosella	Gerner	Landowner
Mr	Thomas	Sinden	Limpopo Goue Sand
Mr	Helena	van Jaarsveld	Agri Limpopo
Mr	Willem	van Jaarsveld	Agri Limpopo
Mr	Nic	Opperman	Agri SA
Ms	Sarah	Venter	Baobab Researcher VBR Conservation Committee
Dr	Hanneline	Smit-Robinson	BirdLife South Africa
Kgosi	Thobejane	Setlamorago	Congress of Traditional Leaders in South Africa (Contralesa)
Mr	Makomma	Makhuruptje	Department of Cooperative Governance, human Settlements and Traditional Affairs
Mr	Aaron	Kharivhe	Department of Mineral Resources
Ms	Mapula	Sathekge	Department of Mineral Resources
Mr	Kolani	Thivhulawi	Department of Mineral Resources
	NZ	Rammela	Department of Public Works
	Nnyadzeni	Tshivhengwa	Department of Public Works
Mr	Michael	Buys	Department of Rural Development and Land Reform
Ms	Connie	Mathumo	Department of Rural Development and Land Reform
Ms	Lorraine	Mosebedi	Department of Rural Development and Land Reform
Ms	Fhumulani	Netshitomboni	Department of Rural Development and Land Reform
Mr	Julius	Mashapu	Department of Rural Development and Land Reform Limpopo

Ms	Fhumulani	Netshitomboni	Department of Rural Development and Land Reform Limpopo
Ms	RC	Mashaba	Department of Water and Sanitation
Ms	Marcia	Malapane	Department of Water and Sanitation
Ms	Bridget	Corrigan	Endangered Wildlife Trust
Mr	Quintus	Richter	Evelyn Game Ranch
Mrs	Mariette	Liefferink	Federation for a Sustainable Environment
Dr	Koos	Pretorius	Federation for a Sustainable Environment
Prof	Gaigher	Ian	Lajuma Environmental Research Centre
Mr	Thabe	Mogoboye	Lawyers for Human Rights Musina Office
Ms	NM	Mudau	LEDET
	TL	Moyane	LEDET
Ms	Mdluli	Connie	Lepelle Northern Water
Ms	Mpachoe	Motlalepula	Lepelle Northern Water
Mr	Mboweni	Reuben	Lepelle Northern Water
Mr	Schmal	Carel	Lepelle Water Board
Mr	NR	Sirwali	Limpopo Department of Health
Mr	Fritz	George	Makoppa Irrigation Board
Mr	Rieker	Botha	Maremani Nature Reserve (Pty) Ltd
Mr	Francois	van den Berg	Mokolo WUA
Pastor	MJ	Ramphabana	Musina Council of Churches
Mr	Phiri	Calvin	Musina Local Municipality
Ms	Chuene	Dinyake	Musina Local Municipality
	IA	Dzeton	Musina Local Municipality
Mr	Themba	Ncube	Musina Local Municipality
	Musina Tourism Information Centre		Musina Local Municipality
	Musina SAPS		Musina Local Municipality
Mr	Christo	Vorster	Nzelele Farmers Association
Mr	Chris	Basson	Realsearch Environmental Management and Development
Dr	Riddell	Eddie	South African National Parks (SANPARKS)
Mr	Dini	John	South African National Biodiveristy Institute
Dr	Thomas	Gyedu-Ababio	South African National Parks (SANPARKS)
Ms	Robin	Petersen	South African National Parks (SANPARKS)
Ms	Tracy-Lee	Petersen	South African National Parks (SANPARKS)
Mr	Andre	Spies	South African National Parks (SANPARKS)
Dr	Freek	Venter	South African National Parks (SANPARKS)
Mr	Jacques	Venter	South African National Parks (SANPARKS)
Mr	Chris	Maritz	Steenbokpan Development Consortium
Mr	Nic	Haarhof	TAU/TLU SA
Mr	MJ	Mahwasane	Vhembe District Municipality
Mr	Ratidzai	Madimutsa	Vhembe District Municipality (Technical manager for Mutale Local Muncipality)
Mr	Nomquphu	Wandile	Water Research Commission
Mr	Ben	Esterhuyse	Weipe Farmers Association
Mr	Perkins	Luke	Wildlife and Environment Society of South Africa (WESSA)

Ms	M	Rossaak	Wildlife and Environment Society of South Africa (WESSA)
Mr	Malcolm	Suttill	Wildlife and Environment Society of South Africa (WESSA)
Mr	Jaco	Engelbrecht	Wildlife Ranching Association of South Africa
			Limpopo Department of Public Works
Mr	Hunt	Arthur	Regional Advisory Environmental Forum
	E	Manganyi	Musina Local Municipality
Mr	Wilson	Dzebu	Musina Local Municipality
Pastor	NJ	Luvengo	PHC MCC Musina
Ms	Wilma		TAU/TLU SA (Limpopo)
Mr	Marius	Beijeman	Nari Danga Safaris
Mr	Jack	Klaff	Adjacent Landowner
Ms	Rika	Le Roux	Musina Local Municipality
Ms	Lientjie	Whelan	Adjacent Landowner
Mr	Mushaphi	Mukundi	Vhembe District Municipality
Mr	Themba	Ncube	Musina Local Municipality
Mr	Innocent	Ramoutla	Polokwane DMR
Mr	Nathi	Tshiwammbi	Musina Local Municipality
Mr	Chris	Madzibane	Musina Local Municipality
Mr	Johnson	Matshivha	Musina Local Municipality
Mr	Mpho	Mudau	Musina Local Municipality
Ms	Mphephu	Musiwalo	Musina Local Municipality
Mr	Phillimon	M	Musina Local Municipality
Ms	Evelyn	Shirilele	Musina Local Municipality
Mr	Taxi	Nare	Musina Local Municipality
Mr	Prince	Sakala	Musina Local Municipality
Mr	Nkele	Milanzi	Musina Local Municipality
Mr	Carlton	Netshivhulani	Musina Local Municipality
Mr	Tiyani	Morivate	Vhembe District Municipality
Ms	Nkhangwe	Dzivhani	Vhembe District Municipality
Mrs	Khanyisa	Mathonsi	Vhembe District Municipality
Mr	Nkhangwe	Makhavhu	Vhembe District Municipality
Ms	Thoko Nonhle	Mkhwanazi-Xaluva	CRL Rights Commmission
Prof	David Luka	Mosoma	CRL Rights Commmission
Mr	Edward	Mafadza	CRL Rights Commmission
Mr	Obed	Simone	CRL Rights Commmission
Adv	Mabedle Lawrence	Mushwana	South African Human Rights Commission (SAHRC)
Ms	Lindiwe	Khumalo	South African Human Rights Commission (SAHRC)
Ms	Gail	Smith	South African Human Rights Commission (SAHRC)
Ms	Lindiwe	Khumalo	South African Human Rights Commission (SAHRC)
Mr	David Douglas	van Rooyen	Cooperative Governance and Traditional Affairs
Mr	Ben	Ramile	Cooperative Governance and Traditional Affairs [Ministry of]
Mr	Lebohang	Tekane	Cooperative Governance and Traditional Affairs [Ministry of]
Mr	Mbulelo	Tshangana	Human Settlements [Department of]

Ms	Moipone	Ngoasheng	Human Settlements [Department of]
Ms	Malebona Precious	Matsoso	Health [Department of]
Ms	Tsakani	Ngobeni	Health [Department of]
Dr	Shadrack	Moephuli	Agricultural Research Council (ARC)
Mr	Benjamin	Mphahlele	Limpopo Economic Development Enterprise
Ms	Veliswa	Baduza	South African Heritage Resources Agency
Mr	Dumisani	Sibayi	South African Heritage Resources Agency
	Roelanda	Smit	Munati Lodge

APPENDIX B

Letter of Invitation and Registration, Comment and Reply Sheet

4 November 2016 Project No. 1655245

APPLICATION FOR A MINING RIGHT, ENVIRONMENTAL AUTHORISATION, A WASTE MANAGEMENT LICENCE AND AWATER USE LICENSE ON THE FARMS PLAATJIE, TRALEE, PAPENBRIL, UITENPAS, MESSINA, ANTONVILLA, HEREWARD AND VOGELENZANG, MUSINA LOCAL MUNICIPALITY (LIMPOPO PROVINCE).

- Availability of Draft Scoping Report for public review.

This letter serves to notify interested and affected parties about a proposed copper mining project near Musina in Limpopo Province. Smarty (SA) Resources Investment (Pty) Ltd (Smarty), South Africa, a company based in Johannesburg, have acquired prospecting rights for copper on eight farms near Musina. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated. The prospecting rights will expire in November 2016 and Smarty have applied for a mining right (MR), environmental authorisation (EA), a waste management licence (WML) and a water use licence (WUL), all of which must be obtained before mining may commence. The proposed project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure.

In terms of the MPRDA Smarty is required to undertake an EIA process and submit a Scoping Report, an EIA Report and an Environmental Management Programme (EMPr), which describes the environmental impacts of the proposed development and how they will be managed and mitigated. In particular, Chapter 6, section 79(4)(a) and (b) *(4)* of the MPRDA stipulates that, *if the designated agency accepts the application* (for an exploration right[1])*, the designated agency must, within 14 days from the date of acceptance, notify the applicant in writing—*

> *(a) to notify and consult with any affected party; and to submit an environmental management programme in terms of section 39 within a period of 120 days from the date of the notice.*

Smarty has appointed Golder Associates Africa (Pty) Ltd, an independent environmental and engineering company, to undertake the required EIA and public consultation process for this project.

The Draft Scoping Report contains:

- A description of the proposed mining activities;
- An overview of the EIA process, including public participation;
- A description of the existing environment in the proposed project area;
- The anticipated environmental issues and impacts which have been identified;
- The proposed scope of specialist studies planned for the Impact Assessment phase; and
- A list of interested and affected parties and their comments.

The Scoping Report will be available for public review and comment from Friday **04 November 2016 to Monday 05 December 2016** at the public places listed in the table below. The information can also be downloaded during that period from the following website: **http://www.golder.com/public**.

List of public places where the updated Scoping Report will be displayed:

Name of public place	Address	Contact number (tel)	Contact person
Musina Local Municipality	21 Irwin Street, Musina	015 534 6100	Phillimon (reception)
Musina Tourism Information Centre	National Road/ N1	015-534- 3500	Sylvester Mugwagwa
Golder Associates Africa	Magwa Cresent West, Maxwell Office Park, Midrand	011 254 4800	Taryn Smith

This Draft Scoping Report is being presented to stakeholders to provide them with more information and an opportunity to provide comment and/or raise issues of concern.

Your comment is important

We invite you to formally register as an interested and affected party (I&AP) and to participate in the EIA/EMPr process and/or to comment on the Draft Scoping Report in any of the following ways:

- Completing the enclosed Registration and Comment Sheet and submitting it to me at the Public Participation Office by the due date of **Monday 05 December 2016**. Also, please use the Registration and Comment Sheet to indicate your preferred method of notification and any direct business or other interest you may have in the approval or refusal of the application; and/or
- Providing your comments in writing to Golder Associates.

The due date for comment on the draft Scoping Report is **Monday 05 December 2016**. Comments received during the public review period will be acknowledged and recorded in the EIA Report/EMPr, which will be presented for public comment during 2017.

Please contact me should you have any questions, would like more information, to obtain a copy of the Draft Scoping Report; or would like to contribute comments. You can reach me at the following contact number and/or email address: (011) 254 4805 or email: pp@golder.co.za.

I look forward to your participation in the project and receiving your comments.

Sincerely,

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Tani Pietersen

Antoinette Pietersen
Senior Public Participation Practitioner

Attachments: Locality Map

APPLICATION FOR A MINING RIGHT, ENVIRONMENTAL AUTHORISATION, A WASTE MANAGEMENT LICENCE AND AWATER USE LICENSE ON THE FARMS PLAATJIE, TRALEE, PAPENBRIL, UITENPAS, MESSINA, ANTONVILLA, HEREWARD AND VOGELENZANG, MUSINA LOCAL MUNICIPALITY (LIMPOPO PROVINCE).

Golder Associates

Registration and Comment Sheet

November 2016 – December 2016

Your comments are an important contribution into this permitting process. We would like to interact directly with you and encourage you to register as a stakeholder so that we can keep you updated as this project moves forward and respond to any questions or concerns that you may wish to raise.

PERSONAL DETAILS			
Name	Surname	Title	Organisation / Department *(If applicable)*

CONTACT INFORMATION				
Cell Number	Land Line Contact Number		Fax Number	Preferred Language
		Office		
		Home		
Email	Postal Address			Postal code

LANDOWNERS	
If your property falls within the boundary of the exploration right application area, please tell us your farm name and erf/portion number	

WOULD YOU LIKE TO REGISTER AS AN INTERESTED AND AFFECTED PARTY?		
Please register me as an interested and affected party (I&AP) for this project so that I may receive further information and notifications as the project develops	YES	NO

Preferred Method of Communication *(Mark with an X)*	Post	Email	Fax
Alternate Method of Communication *(Mark with an X)*	Post	Email	Fax

PLEASE TURN OVER TO PROVIDE COMMENTS

In terms of GNR 543 (EIA Regulations) I disclose below any direct business, financial, personal or other interest that I may have in the approval or refusal of the application:	Date	
	Signature	

COMMENT(S)

You are welcome to use different pages should you so wish.

I have the following comments to make regarding this project and/or the public consultation process:

Please ask the following of my colleagues / friends to register as Interested and Affected Persons for this EIA process:

NAME	CONCTACT DETAILS

PLEASE RETURN THE REGISTRATION AND COMMENT SHEET TO:

Golder Associates Africa

PUBLIC PARTICIPATION OFFICE

Antoinette Pietersen/Taryn Smith

P.O. Box 6001, Halfway House, 1685

Tel: +27(011) 254 4805 / 4937

Fax:+27(0)86 582 1561

E-mail: ppofice@golder.co.za

Website : http://www.golder.com

THANK YOU

BACKGROUND INFORMATION DOCUMENT

September 2016

IRL (SA) RESOURCES INVESTMENTS (PTY) LTD

Regulatory Authorisation Processes for a proposed copper mine in Musina Local Municipality, Limpopo Province.

PURPOSE OF THIS DOCUMENT

To provide stakeholders with information on the application for a Mining Right, and associated licensing processes for the proposed Smarty (SA) Resources opencast copper mine and associated infrastructure near Musina.

Golder Associates

INTRODUCTION

Smarty (SA) Resources Investment (Pty) Ltd (Smarty), a company currently based in Johannesburg, South Africa, have acquired prospecting rights for copper on eight farms near Musina in Limpopo Province. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated. The prospecting rights will expire in November 2016 and Smarty have applied for a mining right (MR), environmental authorisation (EA), a waste management licence (WML) and a water use licence (WUL), all of which must be obtained before mining may commence.

Golder Associates Africa (Pty) Ltd, an independent environmental consulting company, is undertaking the EIA, SLP, MWP and associated authorisation processes for Smarty, which include environmental authorisation for specific activities listed in the EIA Regulations GN R.983, GN R.984 and GN R.985

PROJECT DESCRIPTION

Smarty (SA) Investment Holdings (Pty) Ltd (Smarty) acquired the prospecting rights listed in Table 1 and shown in outline on

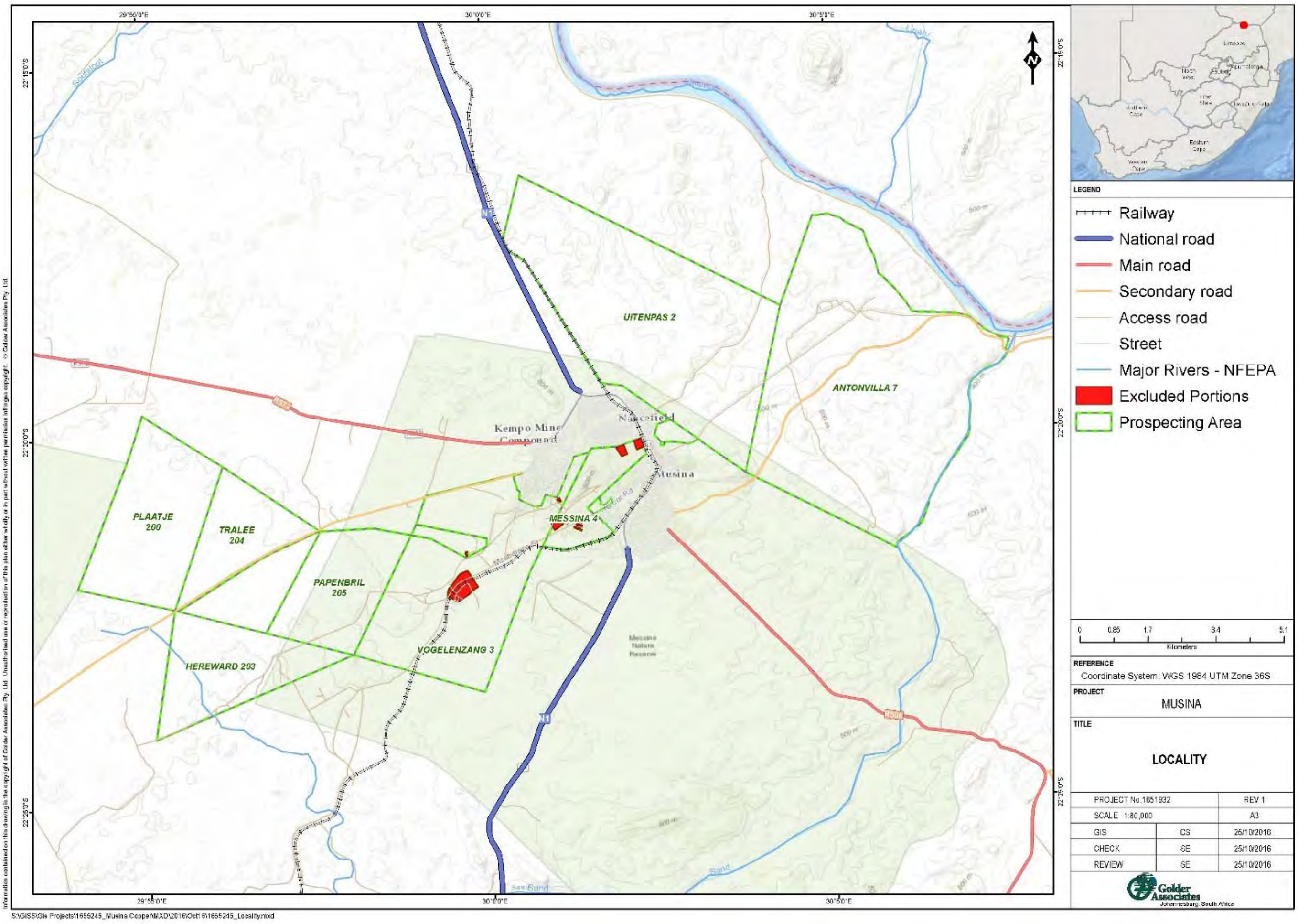

Figure 1. The proposed project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure.

Table 1: Details of area applied for

Farm	Prospecting Right	Surveyor General Codes	Area (hectare)	Listed Owner
Vogelenzang	1610PR	T0MT00000000000300000	1526.431727	Musina Local Municipality

3 MT	1610PR	T0MT00000000000300009	71.103752	Messina Investments Ltd
	1999PR	T0MT00000000000300010	0.112753	Jacobus Daniel Venter Jennifer Lynette Venter
	1999PR	T0MT00000000000300011	0.170743	Jacobus Daniel Venter
Messina 4 MT	1999PR	T0MT00000000000400000	278.592251	Musina Local Municipality
	1999PR	T0MT00000000000400030	11.740779	De Beers Consolidated Mines Ltd
	957PR	T0MT00000000000400040	39.983736	Central Africa Crushers CC
Tralee 204 MS	930PR	T0MS00000000020400002	518.144266	Nathaniel Vos
	958PR	T0MS00000000020400006	344.909899	Plaatjie Game Farm CC
Hereward 203 MS	1610PR	T0MS00000000020300000	750.333993	Nari Danga Safaris CC
Papenbril 205 MS	930PR	T0MS00000000020500000	677.261639	Nari Danga Safaris CC
Plaatje 200 MS	930PR	T0MS00000000020300000	993.829525	Plaatjie Game Farm CC
Uitenpas 2 MT	957PR	T0MT00000000000200000	2407.6431	H Schoeman Investments CC
Antonvilla 7 MT	1608PR	T0MT00000000000700001	3122.101182	Republiek van Suid-Afrika

The mining right being applied for is located in the Magisterial District of Musina in the Limpopo Province. See Figure 1. Sufficient resources were proven to support a conventional drill and blast, truck and shovel opencast mining operation at projected mining and production costs and copper prices for about 20 years. The mining operations will take place in two areas known as Molly Too and 67 Area. The locations of these two areas and the layout of the supporting infrastructure are shown schematically on Figure 2.

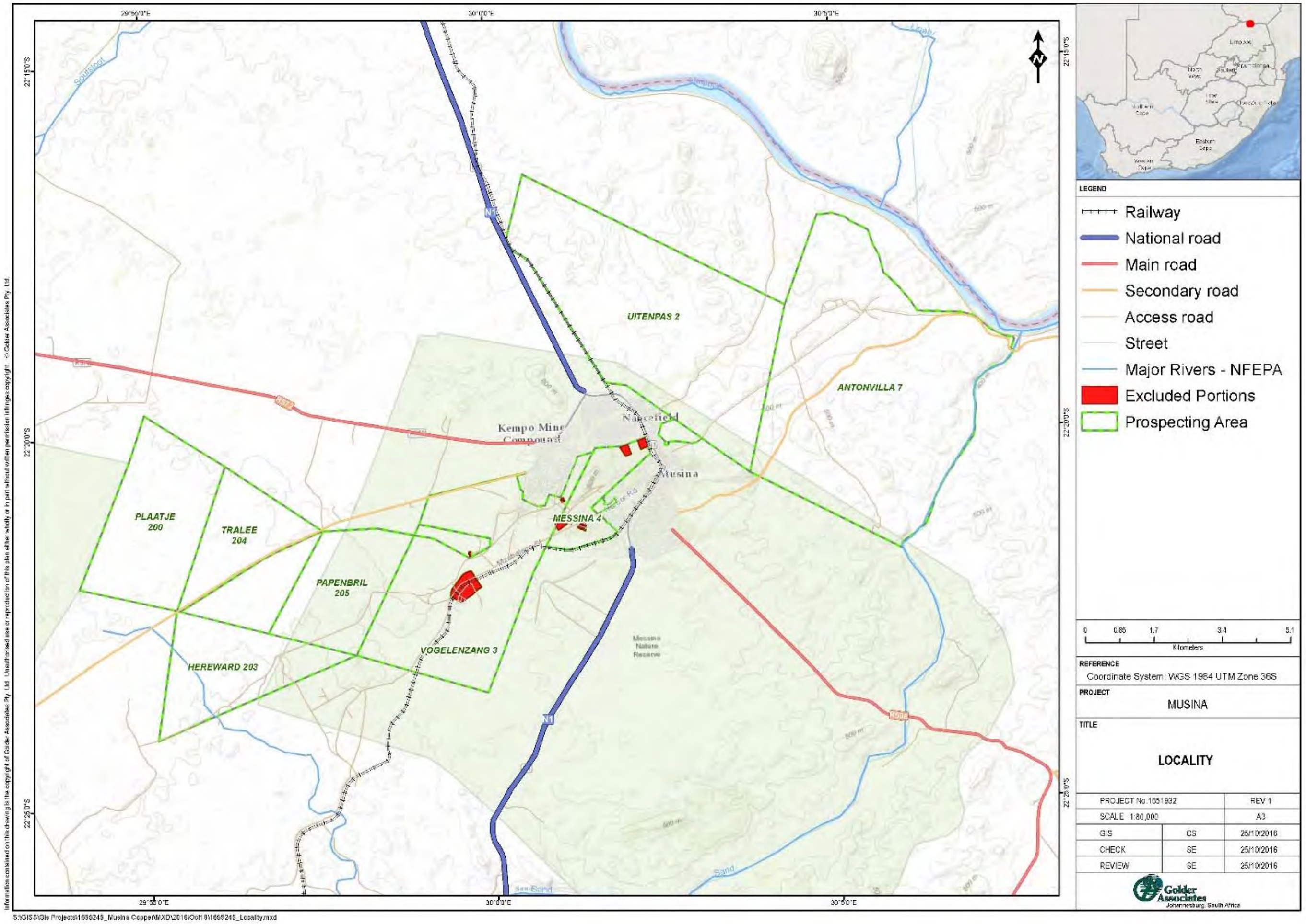

Figure 1: Locality map

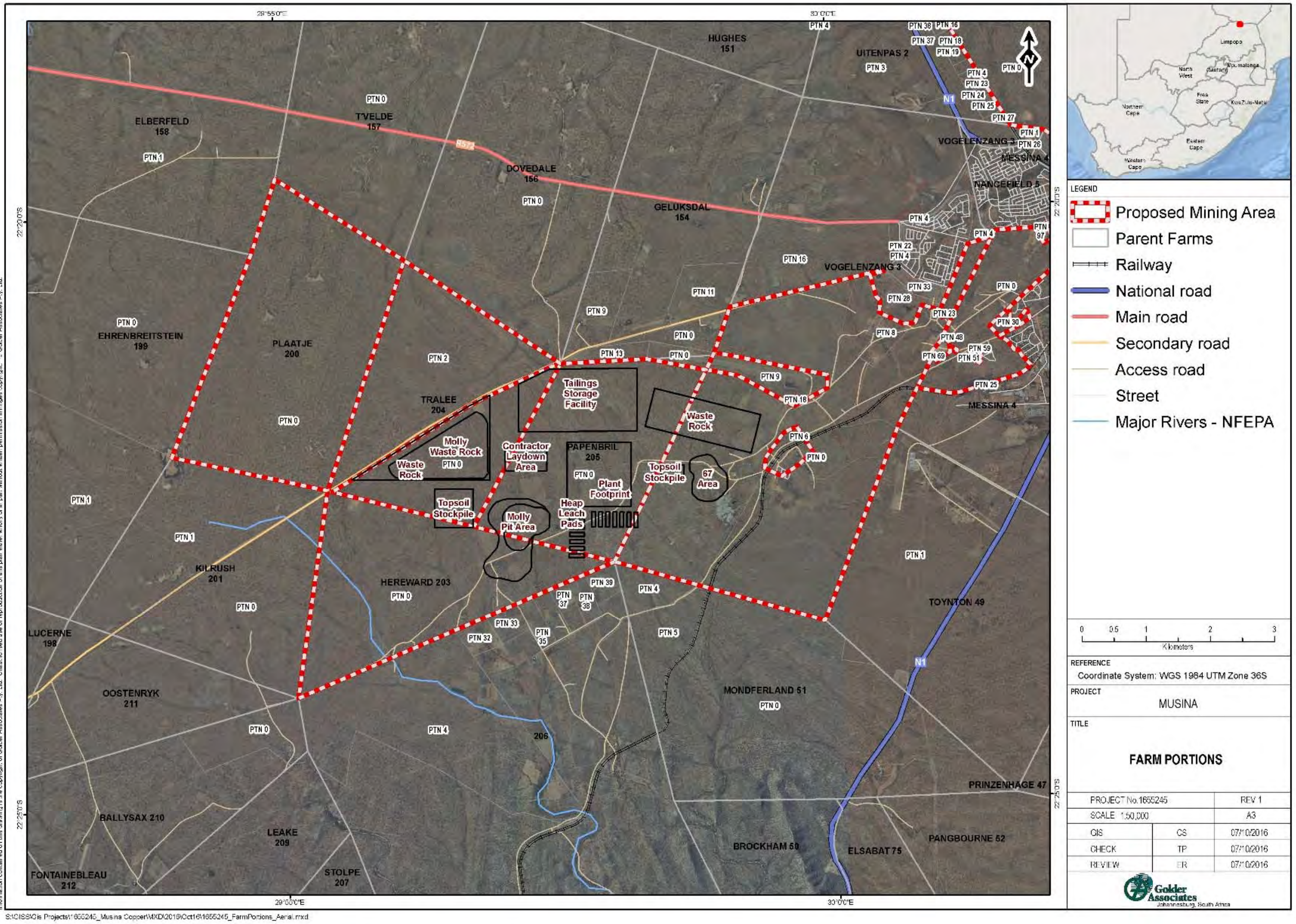

Figure 2: Schematic infrastructure layout

NEED AND DESIRABILITY OF PROPOSED ACTIVITIES

Copper occurs in metallic form nature, and was used in this form since about 8 000 BC. It was the first metal to be smelted from ore, ca. 5 000 BC, the first metal to be cast into a shape in a mold, ca. 4 000 BC and the first metal to be purposefully alloyed with another metal, (tin) to make bronze, ca. 3 500 BC.

Copper is indispensable to modern civilisation. It is the third-most consumed industrial metal in the world, after iron and aluminium. Its major applications are electrical wire (60%), roofing and plumbing (20%), and industrial machinery (15%). Copper paint has been used on boat hulls to control the growth of barnacles for more than two centuries. A small part of the copper supply is used to manufacture fungicides for agricultural use and nutritional supplements for humans.

Copper mining and smelting in the Musina area was undertaken several centuries ago by indigenous peoples. Their ancient smelting sites are still to be found on some high ridges in the area. Modern mining commenced in 1906 when the Messina Development Company started mining the copper ore at the Campbell, Harper, Artonvilla, Messina and Spence mines. When mining ceased in 1992, more than 40 million tons of ore had been mined and some 700 000 tons of copper metal had been produced (Mundalamo, H R; Ogola, J S;, June 2012). At peak production these mining operations provided employment for more than 4 000 people (Malunga, May 2006).

SMARTY's prospecting programme and subsequent feasibility studies have demonstrated that a viable mining operation can be established that would provide significant benefits to the local economy and approximately 54 employment opportunities (not including contractors) for at least 20 years. It is anticipated that the copper produced by the Musina copper project will be sold on international markets supported by the high demand created mostly by China as the leading global consumer of copper.

THE EIA PROCESS

Smarty is required to undertake an Environmental Impact Assessment **(**EIA) and submit a Scoping Report, an EIA Report and an Environmental Management Programme (EMPr), which describe the environmental impacts of the proposed development and how these will be managed and mitigated.

An EIA process consists of a number of phases (***see Figure below***). Each phase has a public participation component whereby any Interested and Affected Party (I&AP) has the opportunity to raise issues for clarification. These issues are documented in a Comment and Response Report (CRR) that accompanies the Scoping and EIA Reports to the authorities to demonstrate that stakeholders had the opportunity to contribute to the process.

POSSIBLE IMPACTS

A number of potential impacts, normally associated with opencast mining, have already been identified and will be studied in the Environmental Impact Assessment Phase. Such studies include the following:

Surface water and Groundwater	**Traffic**	**Air quality**	**Biodiversity**
Socio-economic	**Visual**	**Heritage**	**Soil and Land Capability**

AVAILABILITY OF DRAFT SCOPING REPORT

This background information letter serves to notify landowners and/or affected parties that the draft scoping report is available for public review and comment. In terms of the MPRDA Smarty is required to undertake an EIA process and submit a Scoping Report, an EIA Report and an Environmental Management Programme (EMPr), which describes the environmental impacts of the proposed development and how they will be managed and mitigated.

The Draft Scoping Report contains:

- A description of the proposed mining activities;
- An overview of the EIA process, including public participation;
- A description of the existing environment in the proposed project area;
- The anticipated environmental issues and impacts which have been identified;
- The proposed scope of specialist studies planned for the Impact Assessment phase; and
- A list of interested and affected parties and their comments.

The Draft Scoping Report will be available for public review and comment from **04 November 2016 to 05 December 2016** at the public places listed in the table. The report can also be downloaded during that period from the following website: **http://www.golder.com/public**.

List of public places where the Draft Scoping Report will be displayed:

Name of public place	Address	Contact number (tel)	Contact person
Musina Local Municipality	21 Irwin Street, Musina	015 534 6100	Phillimon (reception)
Musina Tourism Information Centre	National Road/ N1	015-534- 3500	Sylvester Mugwagwa
Golder Associates Africa	Magwa Cresent West, Maxwell Office Park, Midrand	011 254 4800	Taryn Smith

The Draft Scoping Report is being presented to stakeholders to provide them with more information and an opportunity to provide comment and/or raise issues of concern.

Your comment is important

We invite you to formally register as an interested and affected party (I&AP) and to participate in the EIA/EMPr process and/or to comment on the Draft Scoping Report in any of the following ways:

- completing the enclosed Registration and Comment Sheet and submitting it to me at the Public Participation Office by the due date of xxxxx 2016. Also, please use the Registration and Comment Sheet to indicate your preferred method of notification and any direct business or other interest you may have in the approval or refusal of the application; and/or
- providing your comments in writing to Golder Associates.

The due date for comment on the Draft Scoping Report is XXXX 2016. Comments received during the public review period will be acknowledged and recorded in the Draft EIA Report/EMPr, which will be presented for public comment during XXXX 2017.

Please contact me should you have any questions, would like more information, to obtain a copy of the Draft Scoping Report or would like to contribute comments. You can reach me at the following contact number and/or email address: tel (011) 254 4805 or email: pp@golder.co.za.

I look forward to your participation in the project and receiving your comments.

Sincerely,

GOLDER ASSOCIATES AFRICA (PTY) LTD.

APPENDIX C

Newspaper Advertisements

APPLICATION FOR A MINING RIGHT, ENVIRONMENTAL AUTHORISATION, A WASTE MANAGEMENT LICENCE AND A WATER USE LICENSE ON THE FARMS PLAATJIE, TRALEE, PAPENBRIL, UITENPAS, MESSINA, ANTONVILLA, HEREWARD AND VOGELENZANG, MUSINA LOCAL MUNICIPALITY (LIMPOPO PROVINCE).

Smarty (SA) Resources Investment (Pty) Ltd (Smarty), a company currently based in Johannesburg, South Africa, have acquired prospecting rights for copper on eight farms near Musina in Limpopo Province. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated. The prospecting rights will expire in November 2016 and Smarty have applied for a mining right (MR), environmental authorisation (EA), a waste management licence (WML) and a water use licence (WUL), all of which must be obtained before mining may commence.

The proposed project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure, located on portions of the farms Tralee, Papenbril, Hereward and Vogelenzang.

This advertisement serves to notify landowners and/or affected parties that, in terms of section 79 of the Mineral and Petroleum Resources Development Act, 28 of 2002 (MPRDA), Smarty is required to undertake an EIA process and submit a Scoping Report, an EIA Report and an Environmental Management Programme (EMPr), which describe the environmental impacts of the proposed development and how they will be managed and mitigated.

PUBLIC COMMENT INVITED

Stakeholders are invited to **register** as Interested and Affected Parties (I&APs) and to participate in the environmental authorisation processes by commenting on the Draft Scoping Report. The Draft Scoping Report will be available for public review and comment for a period of 30 (thirty) days from **Friday the 4th of November 2016 to the 5th December 2016**. The report will be available at the public places listed below and also on the following website: www.golder.com/public.

Name of Public Place	Contact Person	Contact Number
Musina Local Municipality	Phillimon (reception)	015-534-6100
Musina Tourism Information Centre	Sylvester	015-534-3500
Golder Associates Africa, Midrand	Mrs Antoinette Pietersen	011-254-4800

FOR MORE INFORMATION, PLEASE CONTACT:
Antoinette (Toni) Pietersen / Taryn Smith
Public Participation Office:
Golder Associates Africa (Pty) Ltd
PO Box 6001, Halfway House, 1685
Tel: (011) 254 4800; Fax: (011) 086 582 1561
E-mail: ppoffice@golder.co.za

Golder Associates

Date of advert: November 2016

APPENDIX D

Site Notice

APPLICATION FOR A MINING RIGHT, ENVIRONMENTAL AUTHORISATION, A WASTE MANAGEMENT LICENCE AND A WATER USE LICENSE ON THE FARMS PLAATJIE, TRALEE, PAPENBRIL, UITENPAS, MESSINA, ANTONVILLA, HEREWARD AND VOGELENZANG, MUSINA LOCAL MUNICIPALITY (LIMPOPO PROVINCE).

Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty), a company based in Johannesburg, South Africa, have acquired prospecting rights for copper on eight farms near Musina in Limpopo Province. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated. The prospecting rights will expire in November 2016 and Smarty have applied for a mining right (MR), environmental authorisation (EA), a waste management licence (WML) and a water use licence (WUL), all of which must be obtained before mining may commence.

The proposed project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure, located on portions of the farms Tralee, Papenbril, Hereward and Vogelenzang in the first stage.

This advertisement serves to notify landowners and/or affected parties that, in terms of section 79 of the Mineral and Petroleum Resources Development Act, 28 of 2002 (MPRDA), Smarty is required to undertake an EIA process and submit a Scoping Report, an EIA Report and an Environmental Management Programme (EMPr), which describe the environmental impacts of the proposed development and how they will be managed and mitigated.

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Stakeholders are invited to **register** as Interested and Affected Parties (I&APs) and to participate in the environmental authorisation processes by commenting on the Draft Scoping Report. The Draft Scoping Report will be available for public review and comment for a period of 30 (thirty) days from **Friday the 4th of November 2016 to the 5th December 2016.** The report will be available at the public places listed below and also on the following website: www.golder.com/public.

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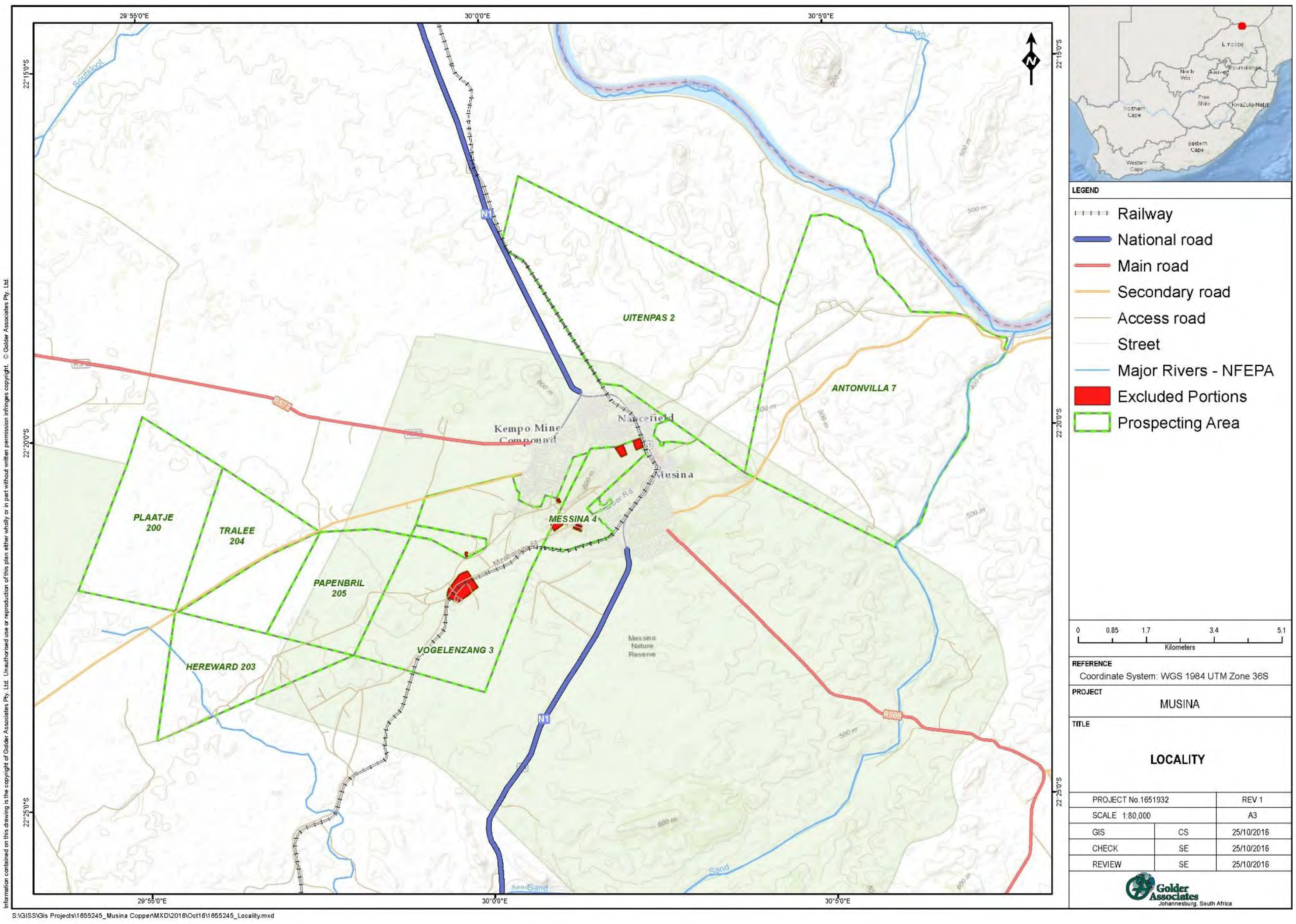
Golder Associates Africa, Midrand	Mrs Antoinette Pietersen	011-254-4800



Locality Map

FOR MORE INFORMATION, PLEASE CONTACT:

Antoinette (Toni) Pietersen / Taryn Smith
Public Participation Office:
Golder Associates Africa (Pty) Ltd
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Tel: (011) 254 4800; Fax: (011) 315-0317
E-mail: apietersen@golder.co.za / tasmith@golder.co.za

APPENDIX E

Specialist Studies

August 2016

SMARTY (SOUTH AFRICA) MINERALS INVESTMENT (PTY) LTD

Scoping Air Quality Study for the Proposed Smarty Musina Mine

Submitted to:
Smarty (South Africa) Minerals Investment (Pty) Ltd

REPORT

Report Number: 1655245-307330-3

Distribution:

1 x electronic copy Smarty (South Africa) Minerals Investment (Pty) Ltd
1 x electronic copy project folder
1 x electronic copy e-Library

Golder Associates

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Acronyms

%	Percentage
°C	Degrees Celsius
µg	Microgram
µg/m^2	Micrograms per square meter
AEL	Atmospheric emission license
AQIA	Air quality impact assessment
AQMP	Air quality management plan
CO	Carbon monoxide
DEA	Department of Environmental Affairs
DJF	December, January, February
E	East
ENE	East-north-east
ESE	East-south-east
ESIA	Environmental and Social Impact Assessment
g/s	Grams per second
Ha	Hectares
HP	High pressure
JJA	June, July, August
Km	Kilometre
km^2	Kilometre squared
LP	Low pressure
M	Meter
m/s	Meters per second
m^2	Meters square/square meters
MAM	March, April, May
Mamsl	Meters above mean sea level
Mg	Milligrams
mg/m^2/day	Milligrams per square meter per day
N	North
NAAQS	National Ambient Air Quality Standard
NE	North-east
NEM: AQA	National Environmental Management Act: Air Quality Act (Act no. 39 of 2004)
NNE	North-north-east
NNW	North-north-west
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides

Acronyms	
NW	North-west
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbons
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 µm
S	South
SE	South-east
SO_2	Sulphur dioxide
SON	September, October, November
SO_x	Sulphur oxides
SSE	South-south-east
SSW	South-south-west
SW	South-west
US EPA	United States Environmental Protection Agency
VOC	Volatile organic compound
W	West
WHO	World health organisation
WNW	West-north-west
WSW	West-south-west

1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd (Golder) was appointed by Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) to conduct an air quality impact assessment (AQIA) for the proposed copper mining and ore beneficiation project, near the town of Musina in Limpopo Province, South Africa.

Proposed project components include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possible electro-winning and/or solvent extraction, tailings disposal, as well as various supporting infrastructure.

The AQIA forms part of the larger Environmental and Social Impact Assessment (ESIA) process, which is aimed at obtaining the necessary rights and authorisations to undertake the proposed mining and beneficiation project.

This scoping report focuses on describing the baseline air quality characteristics of the area, based on a desktop review of available literature and datasets.

1.1 Project location

Seven farms comprise the mine lease area, hereafter collectively referred to as the study area. The study area covers approximately 10 719 ha, and extends on an east-west orientation with the town of Musina located at its centre (Figure 1). The east of the study area is bounded by the Limpopo River, which acts as the international border between South Africa and Zimbabwe.

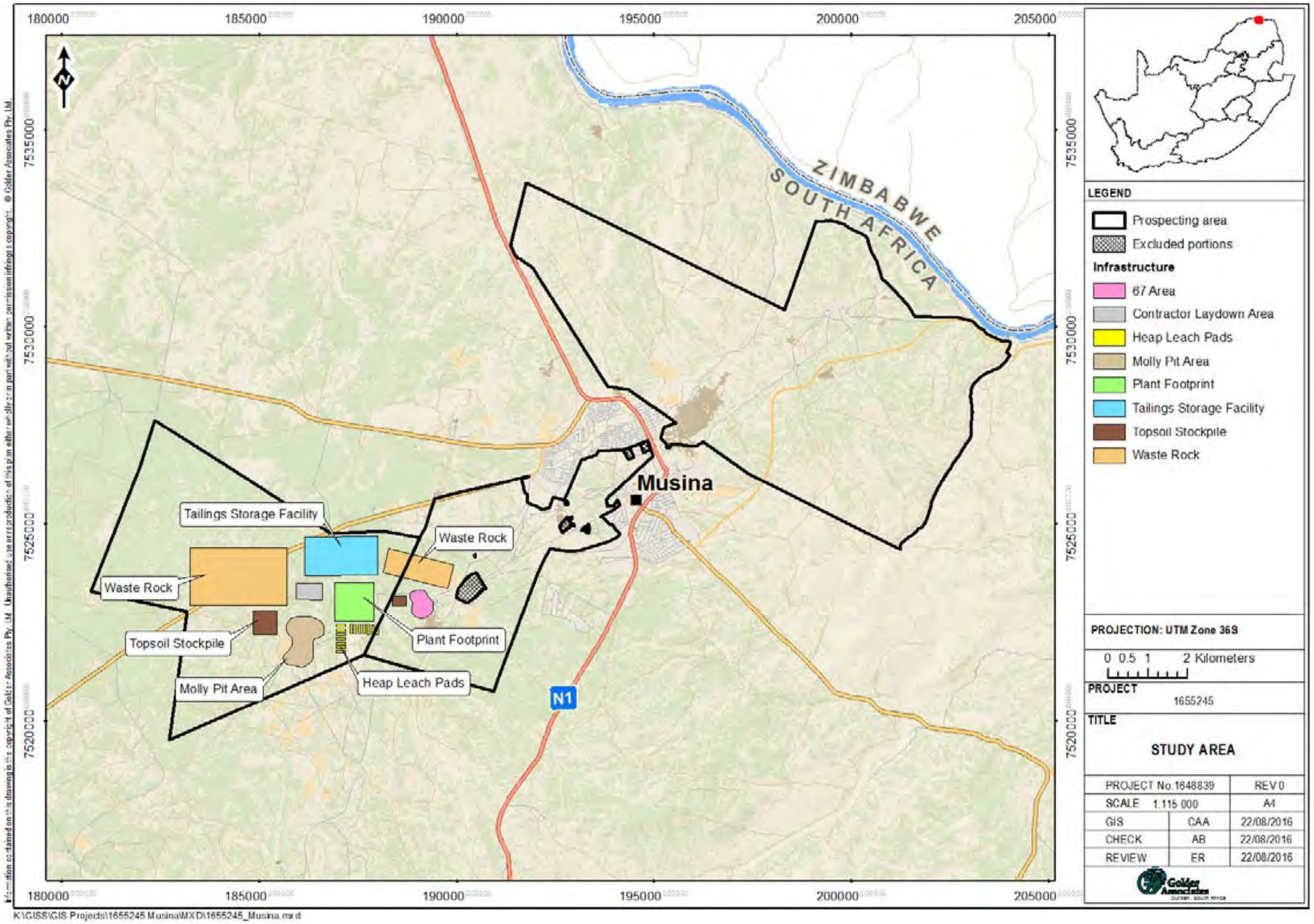

Figure 1: Project location

2.0 LEGISLATION, GUIDELINES AND STANDARDS

2.1 National Environmental Management: Air Quality Act (Act no. 39 of 2004) (NEM: AQA)

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

2.2 Listed activities

The NEM: AQA makes provision for the setting and formulation of national ambient air quality and emission standards. On a provincial and local level, these standards can be set more stringently if the need arises. The control and management of emissions relates to the listing of activities that are emission sources and the issuing of atmospheric emission licences (AELs). In terms of Section 21 of the NEM: AQA, a listed activity is an activity which 'results in atmospheric emissions that are regarded to have a significant detrimental effect on the environment, including human health'. The proposed Smarty copper mine is not considered a listed activity in terms of the NEM: AQA

2.3 National Ambient Air Quality Standards

The South African national ambient air quality standards (NAAQS) for common pollutants prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area (Table 1). If the standards are exceeded, the ambient air quality is defined as poor and potential adverse health impacts are likely to occur.

Table 1: South African Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Averaging Period	Limit Value (µg/m^3)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
SO_2 (a)	10 minute	500	191	526	Immediate
	1 hour	350	134	88	
	24 hours	125	48	4	
	1 year	50	19	0	
NO_2 (b)	1 hour	200	106	88	Immediate
	1 year	40	21	0	
PM_{10} (c)	24 hour	75	-	4	Immediate
	1 year	40	-	0	
$PM_{2.5}$ (d)	24 hours	40	-	4	Immediate
	24 hours	25	-	4	01/01/2030
	1 year	20	-	0	Immediate
	1 year	15	-	0	01/01/2030
O_3 (e)	8 hours (running)	120	61	11	Immediate
Lead (Pb) (f)	1 year	0.5	-	0	Immediate
CO (g)	1 hour	30,000	26,000	88	Immediate
	8 hour (calculated on 1 hourly averages)	10,000	8,700	11	

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
Benzene (C_6H_6) [h]	1 year	5	1.6	0	Immediate

a. *The reference method for the analysis of SO_2 shall be ISO 6767*
b. *The reference method for the analysis of NO_2 shall be ISO 7996*
c. *The reference method for the determination of the particulate matter fraction of suspended particulate matter shall be EN 12341*
d. *The reference method for the analysis of $PM_{2.5}$ shall be EN 14907*
e. *The reference method for the analysis of ozone shall be the UV photometric method as described in ISO 13964*
f. *The reference method for the analysis of lead shall be ISO 9855*
g. *The reference method for analysis of CO shall be ISO 4224*
h. *The reference methods for benzene sampling and analysis shall be either EPA compendium method TO-14 A or method TO-17*

On 1 November, 2013, the National Dust Control Regulations were promulgated under the NEM: AQA and published in the Government Gazette No. 36974. The dust fall standard defines acceptable dust fall rates in terms of the presence of residential areas (Table 2).

Table 2: Acceptable dust fall rates

Restriction areas	Dust fall rate (mg/m²/day over a 30 day average)	Permitted frequency of exceedance
Residential areas	Dust fall <600	Two per annum (not in sequential months)
Non-residential areas	600 < Dust fall <1 200	Two per annum (not in sequential months)

3.0 RECEIVING ENVIRONMENT

3.1 Land use and sensitive receptors determination

According to the National Land Cover Dataset (2013/14), land use within 50 km of the proposed Smarty mine infrastructure primarily comprises grassland, open bush and thicket (Figure 2).

Land use within 10 km of the proposed Smarty mine infrastructure primarily comprises (Figure 3):

- Grassland, open bush and thicket (97%);
- Urban built-up commercial, industrial and residential areas (±2%); and
- Cultivated land (±1%).

Numerous households are located within 10 km of the proposed Smarty mine infrastructure (Figure 3). While households are concentrated in the Musina town, numerous smallholdings and homesteads are present with 1 km of the proposed infrastructure in all directions.

Schools, old age homes are healthcare facilities within 10 km radius of the proposed Smarty mine infrastructure are listed in Table 3. The closest sensitive receptor is St. Martin de Porres Primary, located 2 km north east of the proposed Smarty mine infrastructure. No nursing/old age/retirement homes were identified within Musina.

Table 3: Sensitive receptors within 10 km of the proposed Smarty mine infrastructure

Receptor	Latitude	Longitude
Eric Louw High School	-22.35839	30.04660
Rixile/ Bonwa UDI Primary	-22.33112	30.03264
St. Martin de Porres Primary	-22.35540	30.00615

Receptor	Latitude	Longitude
Makushu Primary	-22.33135	30.03027
Laerskool Messina Primary	-22.35260	30.04524
Musina Secondary	-22.33042	30.02590
Doreen Bridge	-22.34580	30.04110
Madavhila Primary	-22.40430	30.03011
Nancefield Community Health Centre	-22.35533	30.02326
Messina Clinic and Emergency Services	-22.34616	30.04220
Messina Hospital	-22.34183	30.04302

3.2 Elevation

The topography in the vicinity of the prospecting area ranges from 400 m to 700 m above mean sea level (mamsl), sloping from west to east, towards the Limpopo River. Elevated terrain ridges 1 000 mamsl to 1 800 mamsl are located approximately 50 km south of the Smarty prospecting area, running in a south-westerly to north-easterly direction (Figure 5 and Figure 6).

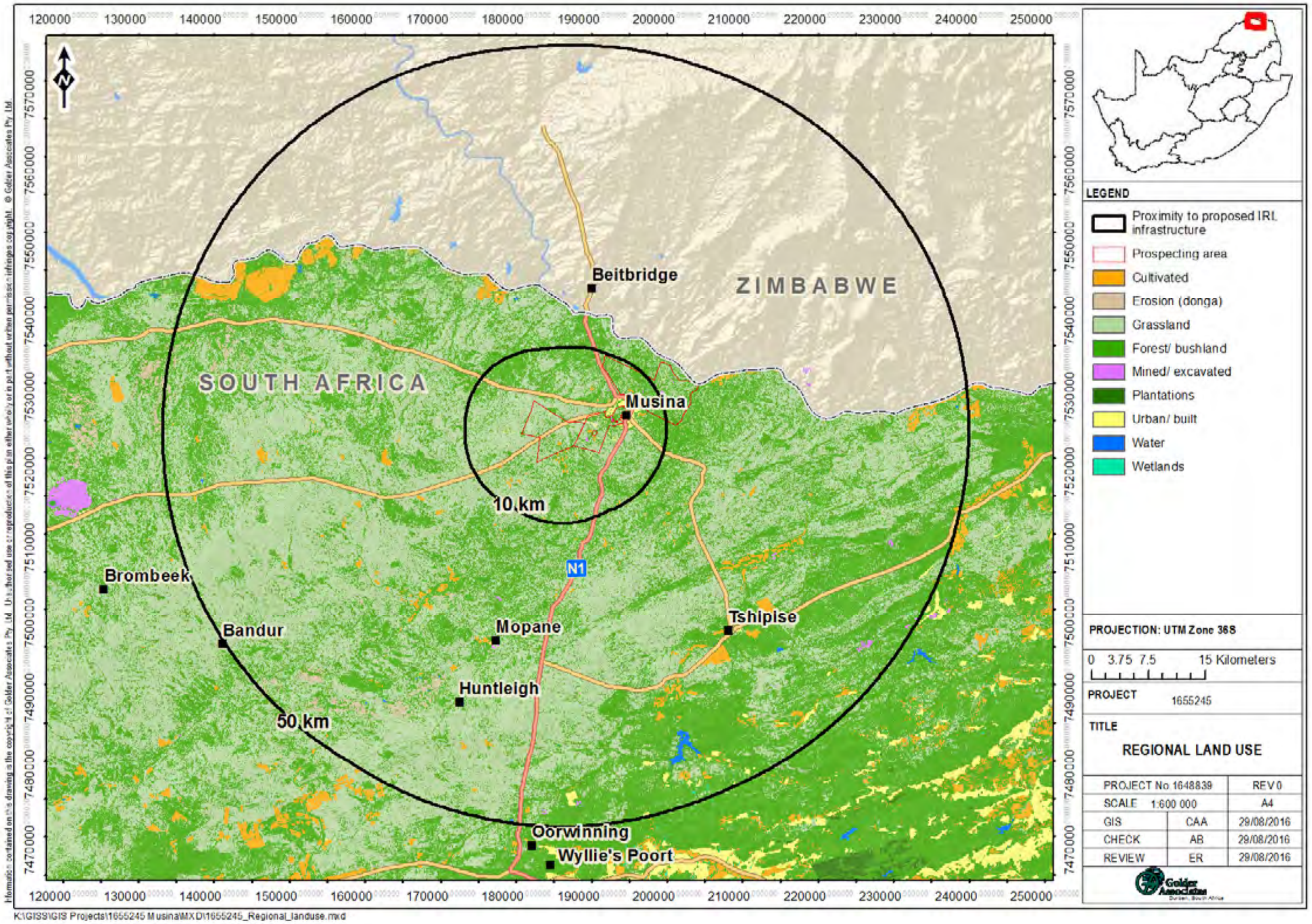

Figure 2: Land use and sensitive receptors within 50 km of the proposed Smarty mine infrastructure

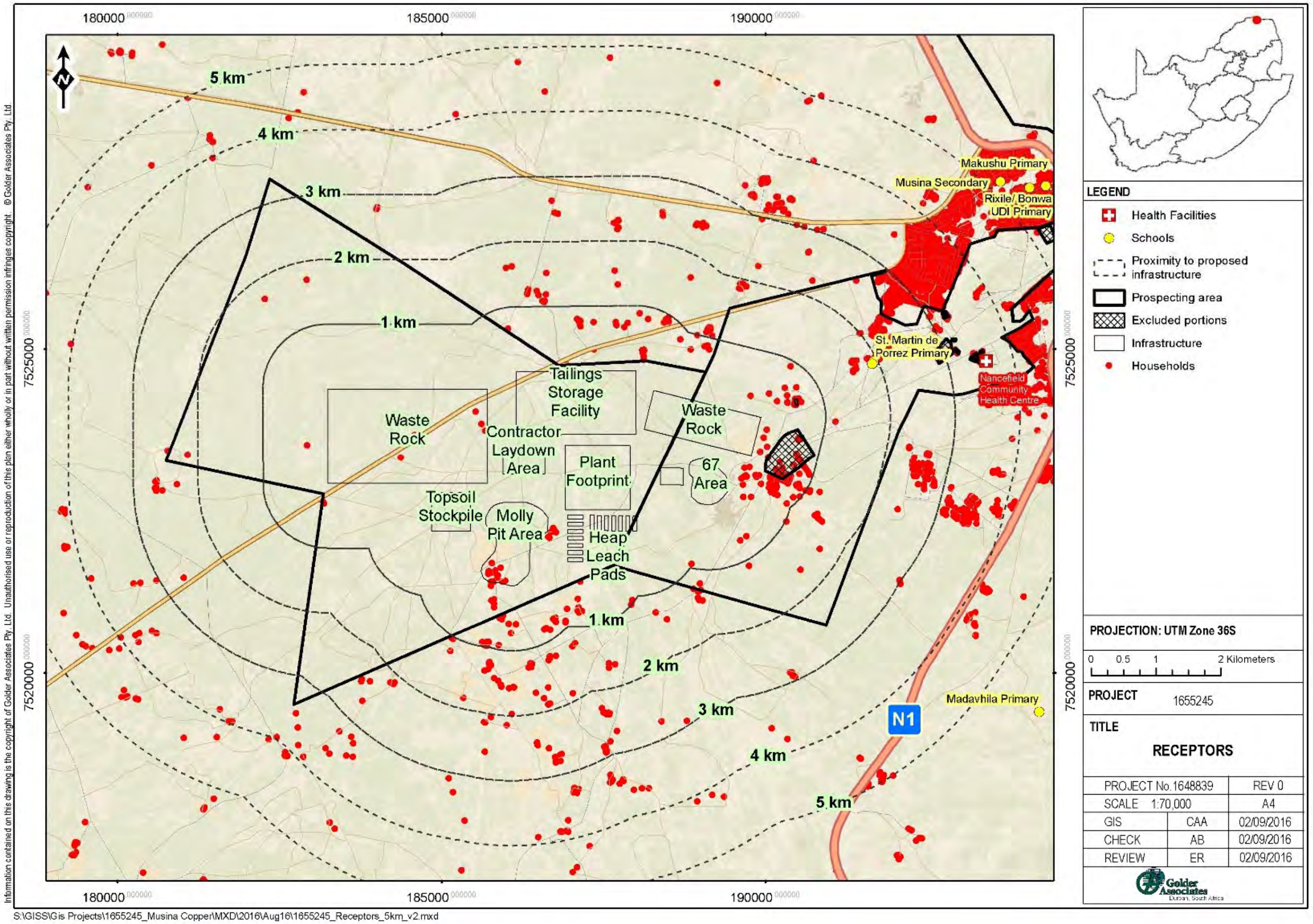

Figure 3: Land use and sensitive receptors within 10 km of the proposed Smarty mine infrastructure

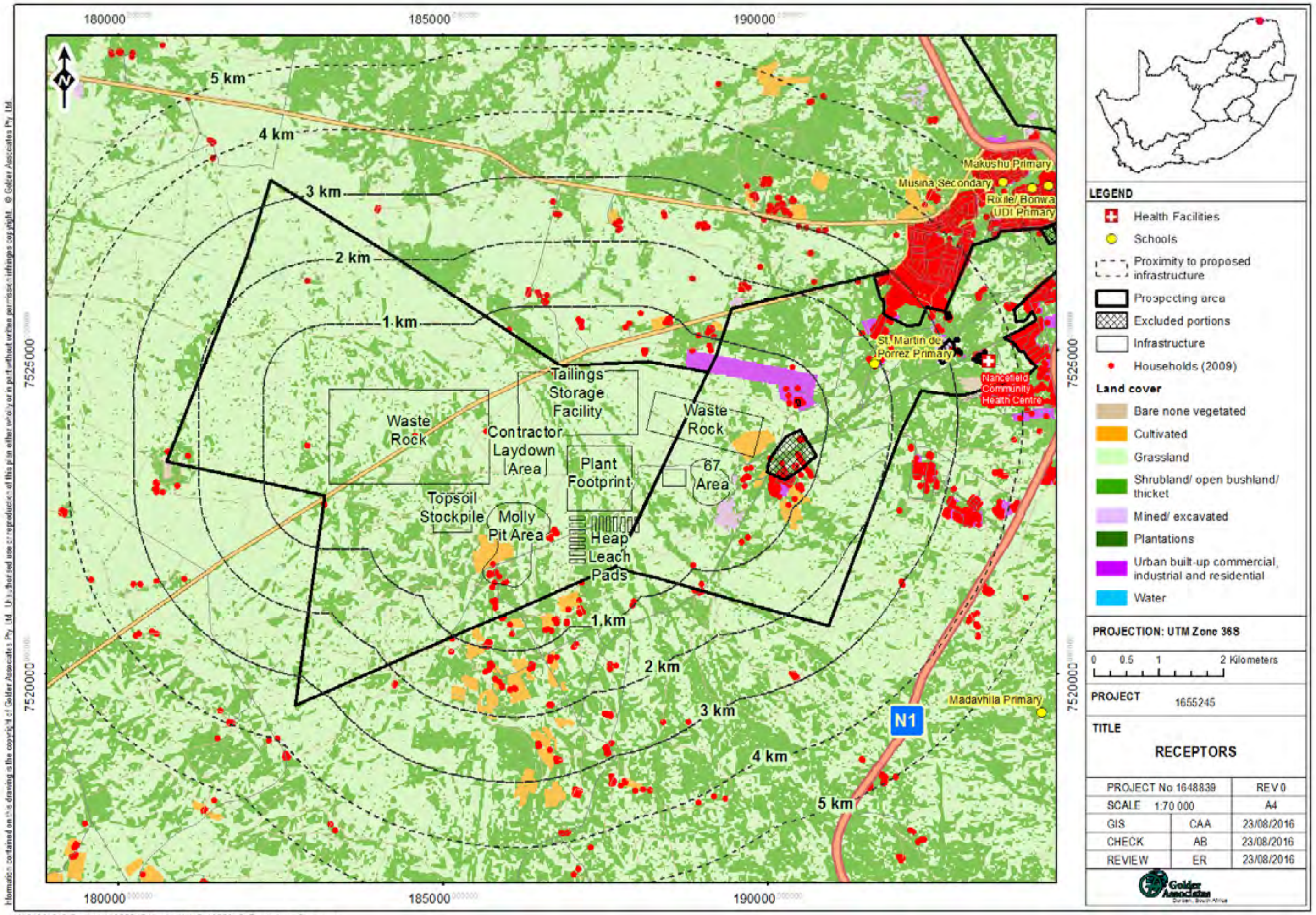

Figure 4: Land use and sensitive receptors within 5 km of the proposed Smarty mine infrastructure

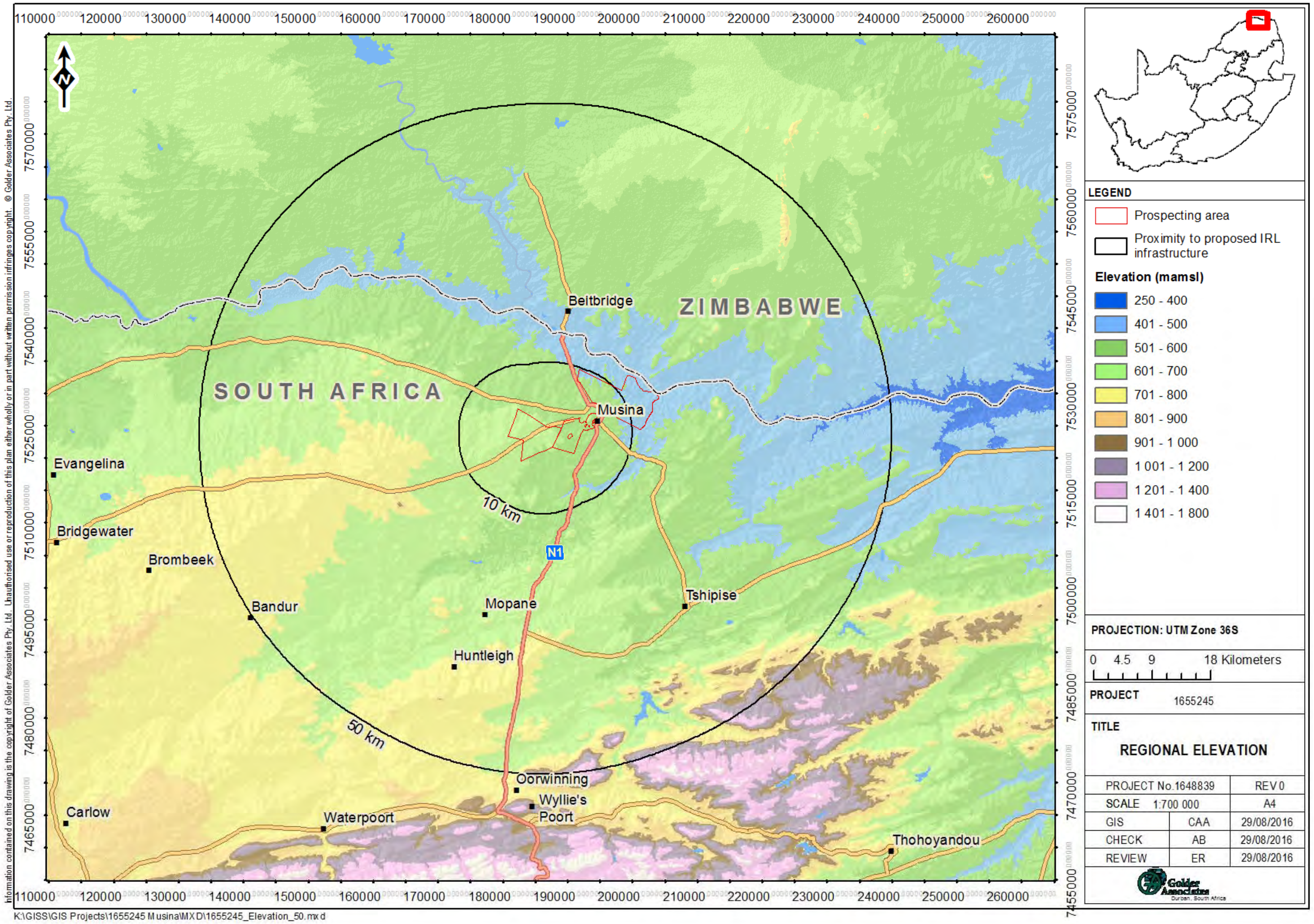

Figure 5: Elevation within 50 km of the Smarty prospecting area

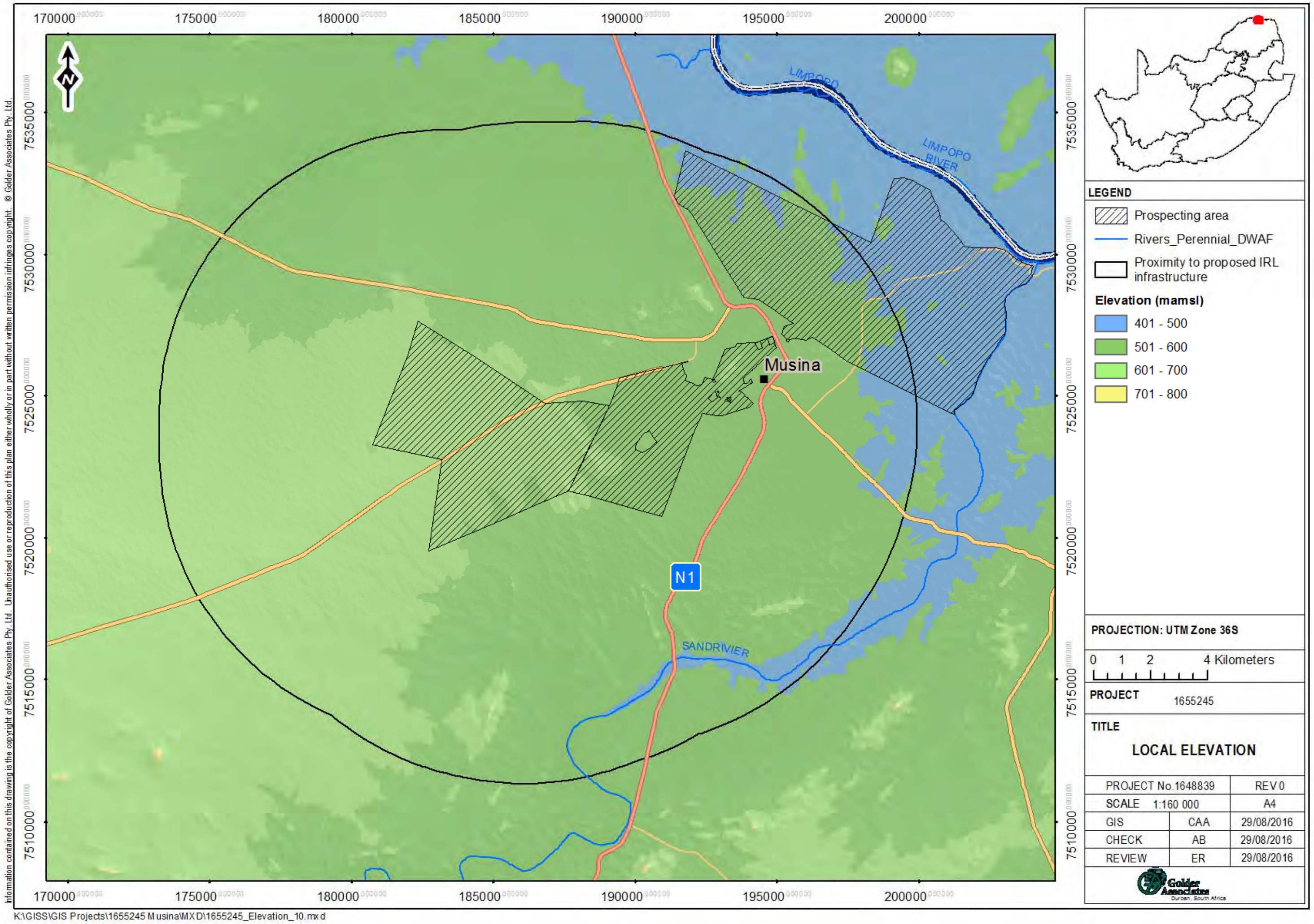

Figure 6: Elevation within 10 km of the Smarty prospecting area

3.3 Regional circulation

Musina is situated in the subtropical high-pressure belt. The mean circulation of the atmosphere over the subcontinent is anticyclonic throughout the year (except for near the surface) (Preston-Whyte and Tyson, 1997). The synoptic patterns affecting the typical weather experienced in the region owe their origins to the subtropical, tropical and temperate features of the general atmospheric circulation over Southern Africa.

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

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

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

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

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

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

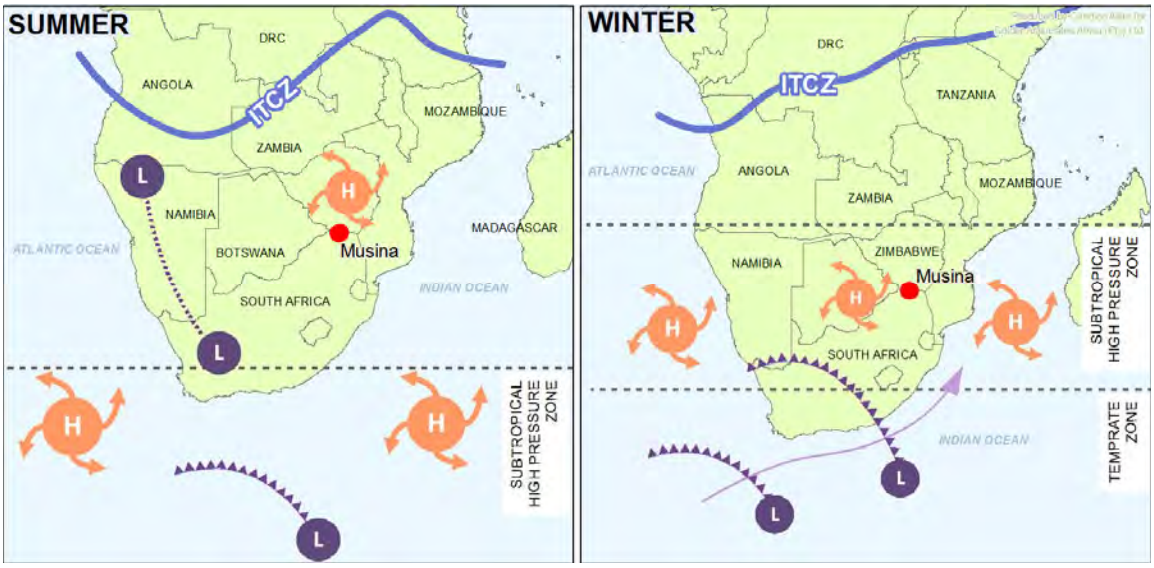

Figure 7: Seasonal circulation patterns affecting the regional climate

3.4 Boundary layer conditions

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

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

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

The mixed layer ranges in depth from a few metres during night times to the base of the lowest elevated inversion during unstable, daytime conditions.

Elevated inversions occur for a variety of reasons, however typically the lowest elevated inversion on the Highveld is located at a mean height above ground of 1 550 m during winter months with a 78% frequency of occurrence.

During summer, the mean subsidence inversion occurs at about 2 600 m with a 40% frequency. Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in Table 4.

Table 4: Atmospheric stability classes

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

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

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

3.5 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

Average summer temperatures in Musina range from 22°C to 34°C, while winter temperatures range from 9°C to 26°C (Table 5) (www.worldclimateguide.co.uk, accessed August 2016).

Table 5: Average temperature for Musina

	Jan	Feb	March	April	May	June	July	August	September	October	November	December	Year
Average maximum temperature (°C)	33	32	31	30	28	25	25	27	29	31	32	32	29.6
Average minimum temperature (°C)	21	21	19	16	12	8	8	10	14	17	19	20	15.4

(From: http://www.worldclimateguide.co.uk/climateguides/southafrica/messina.php, accessed August, 2016)

3.6 Precipitation

Precipitation reduces erosion potential by increasing the moisture content of erodible materials. This represents an effective mechanism for the removal of atmospheric pollutants and is therefore considered during air pollution studies. Rain-days are defined as days experiencing greater than 0.1 mm of rainfall.

Musina has a mean annual rainfall ranging from 300 mm to 400 mm. This figure varies considerably from year to year as a result of frequent dry spells. Rainfall occurs almost exclusively in the form of thundershowers during the summer months, with maximum rainfall occurring between November and January (Table 6) (www.worldclimateguide.co.uk, accessed August 2016).

Thunderstorms occur frequently during the summer months, between October and March, and are usually accompanied by lightning, heavy rain, strong winds and occasionally hail.

Table 6: Average rainfall for Musina

	Jan	Feb	March	April	May	June	July	August	September	October	November	December	Year
Average rainfall (mm)	61	65	42	26	12	4	1	2	15	33	55	56	372
Number of rain days	8	8	5	4	2	2	2	1	3	5	7	9	55

(From: http://www.worldclimateguide.co.uk/climateguides/southafrica/messina.php, accessed August, 2016)

3.7 Wind roses

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

Based on modelled MM5 meteorological data, winds at Musina are expected to originate predominantly from the east-north-east to east-south-east sector (Figure 8). Wind speeds are moderate, averaging 3 m/s with a low percentage (13%) of calm conditions (<1 m/s).

3.7.1 MM5 modelled meteorological data cross-check & confidence

A wind rose based on locally available measured data is provided for comparison to the MM5 modelled data in Figure 9. This wind rose was generated by Royal Haskoning DHV (2013) using local meteorological data obtained from the South African Weather Services station located in Mopane approximately 35 km south east of Musina for the monitoring period of 01 January 2008 to 31 December 2012.

In comparing the results of the MM5 wind rose to that of the Mopane wind rose, it is clear that, while there are minor variations, the outputs are consistent and display a dominance of wind direction from the easterly sector. A high confidence is thus placed in the MM5 modelled meteorological data.

Note: Similar consistencies are also observed in the diurnal and seasonal wind roses (Figure 10 and Figure 11).

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

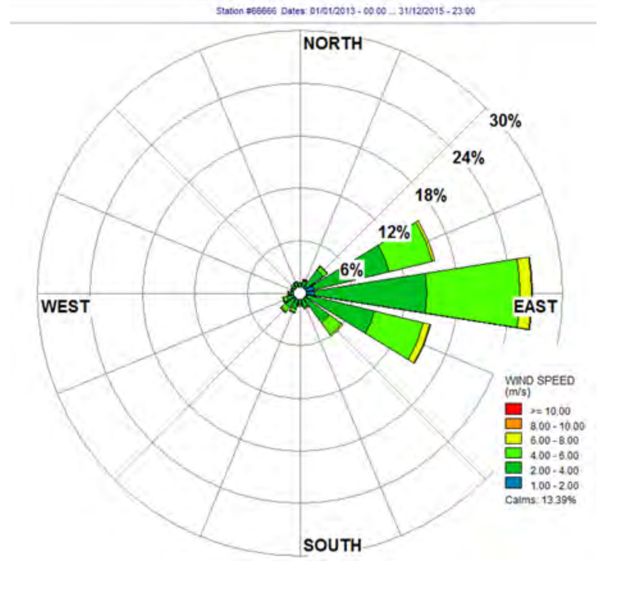

Figure 8: Modelled period wind rose for 2013 – 2015

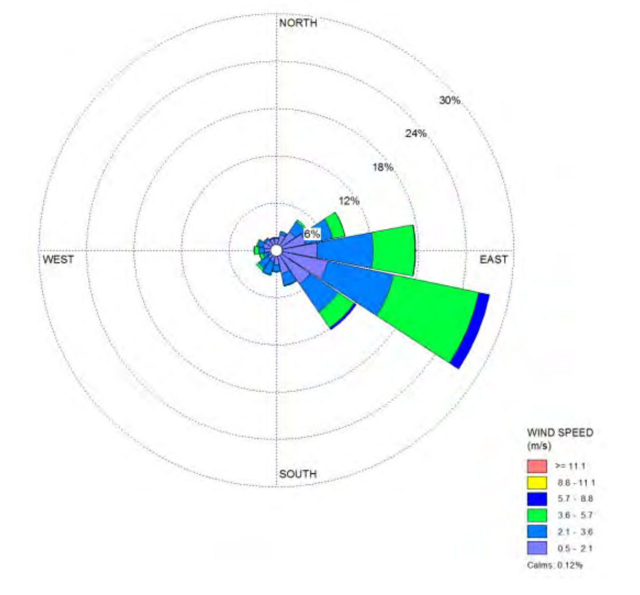

Figure 9: Measured period wind rose for Mopane 01/01/2008 – 31/12/2012 (source: RHDVH, 2013)

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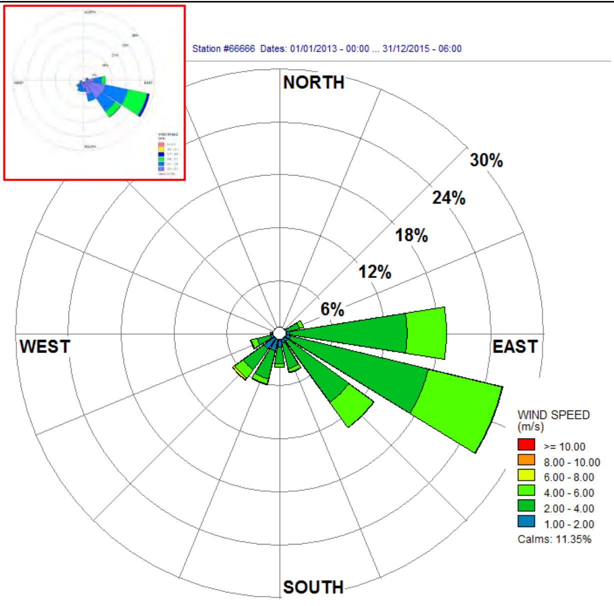
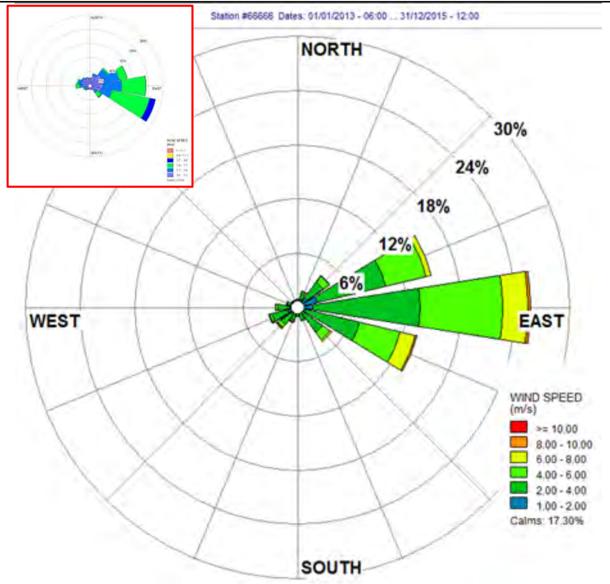


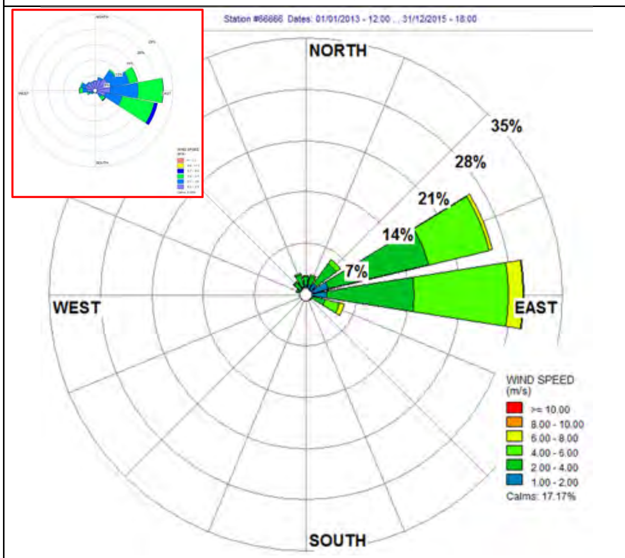
Early morning (00:00 – 06:00)

E to SE winds dominate



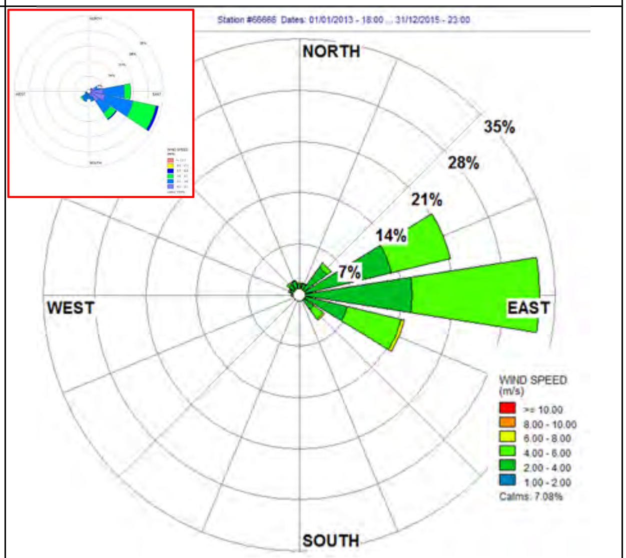
Morning (06:00 – 12:00)

ENE to ESE winds dominate



Afternoon (12:00 – 18:00)

ENE to E winds dominate



Evening (18:00 – 00:00)

ENE to ESE winds dominate

Figure 10: Modelled diurnal wind roses (2013-2015). Diurnal measured wind roses for Mopane from RHDVH, 2013 (01/01/2008 – 31/12/2012) are provided as overlay insets for comparison

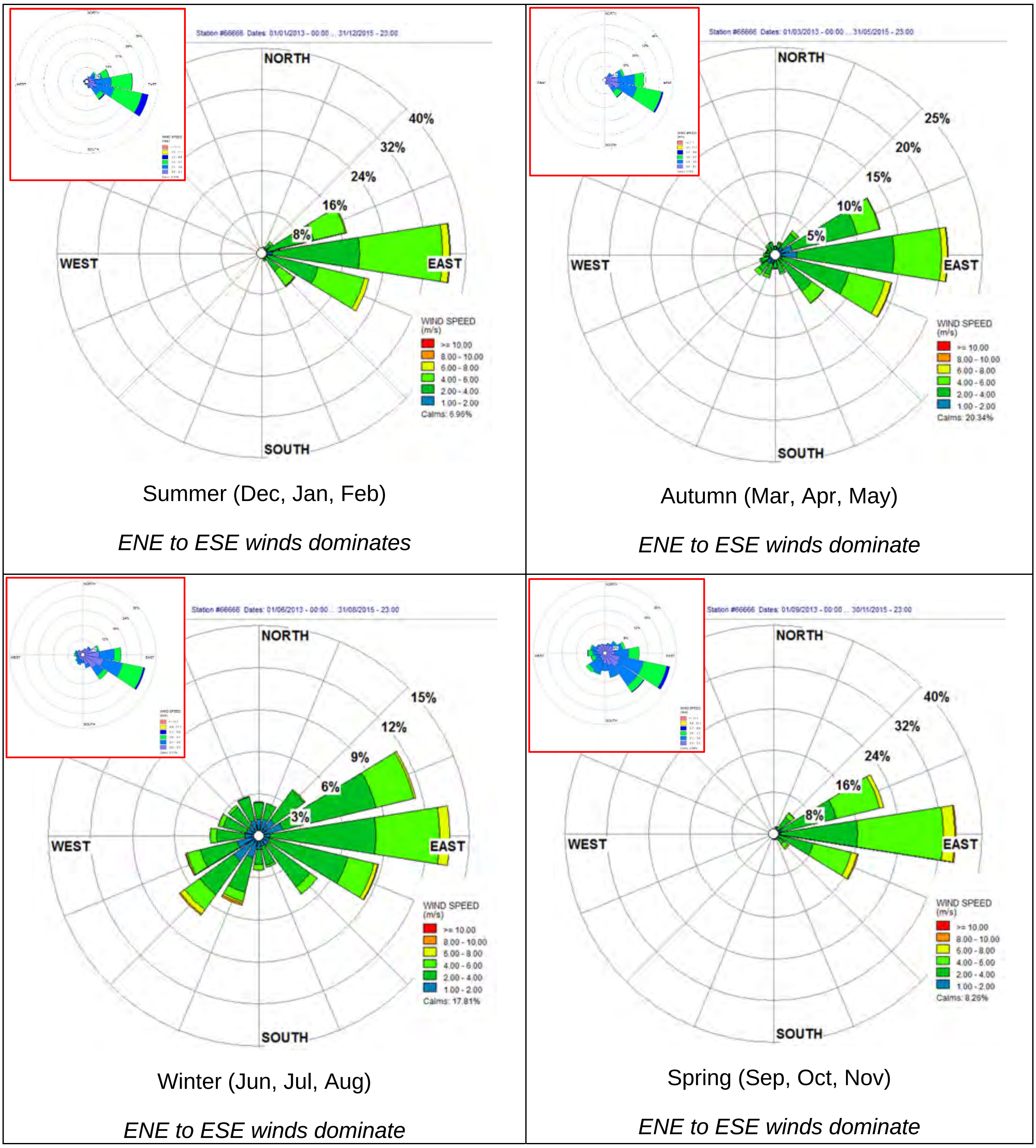


Figure 11: Modelled seasonal wind roses (2013 - 2015). Seasonal measured wind roses for Mopane from RHDVH, 2013 (01/01/2008 – 31/12/2012) are provided as overlay insets for comparison

4.0 BASELINE AMBIENT AIR QUALITY

Limited ambient monitored data exist for the Limpopo Province and for the Musina area in particular. Reliance was therefore placed on literature and typical emissions associated with primary emission sources identified in the area to characterise the baseline ambient air quality qualitatively. Based on the National Land Cover Dataset (2013/14), and Limpopo Provincial Air Quality Monitoring Plan (AQMP) (2013) primary emissions sources are likely to include agricultural activities, domestic fuel burning, veld fires and vehicles travelling on unpaved roads.

4.1 Agricultural activities

Agriculture is considered to be a significant contributor to particulate emissions, although tilling, harvesting and other activities associated with field preparation are seasonally based. Agricultural activities associated with the release of particulates and gases to the atmosphere include (DEA, 2012):

- Particulate emissions generated due to mechanical action of equipment used for tilling and harvesting operations;
- Particulate emissions generated due to wind erosion from exposed areas;
- Vehicle entrained dust on paved and unpaved road surfaces;
- Gaseous and particulate emissions due to fertilizer and chemical treatment; and
- Gaseous and particulate emissions due to agricultural land resource management practices such as burning of residue crops and vegetation.

4.2 Domestic fuel burning

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

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

4.3 Veld fires

Veld fires result in the incomplete combustion of natural plant matter with CO, methane and NO_2 being emitted during the process. During the combustion process, approximately 40% of the nitrogen in biomass is emitted as NO_2, 10% remains in the ashes and it is assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds. In comparison to the nitrogen emissions, only small amount of SO_2 and sulphate aerosols are emitted. With biomass burning, visible smoke plumes are typically generated. These plumes are created by the aerosol content of the emissions and are often visible for many kilometres from the actual source of origin.

The emissions from biomass burning are controlled by several factors, these include the following:

- The type of biomass material;
- The quantity of material available for combustion;
- The quality of the material available for combustion;
- The fire temperature; and
- Rate of fire progression through the biomass body.

4.4 Vehicles travelling on unpaved roads

Vehicle entrained dust emissions from paved and unpaved roads represent a potentially significant source of fugitive dust in the region. Particulate emissions from paved roads occur when loose and/or spilt material on the road surface becomes suspended as vehicles travel across the road surface and or when fine particulates are blown from the transported load. At industrial and construction sites the atmospheric loading is continually replenished by vehicular activities on unpaved surfaces and spillage of materials from vehicles.

Various field studies have shown that even paved roadways can be major sources of atmospheric particulate matter (USEPA, 1995).

The surface of an unpaved road is unprotected from both the weight of a vehicle as well as the wind turbulence generated by the vehicle. The wheels of vehicles pulverise the surface and thus loosen material from the road, generating fine dust particles. This loosened material can then be lifted from the road surface by turbulent air currents created as the vehicle is moving. The effect of this turbulent wake persists for some time after the vehicle has passed. The quantity of dust emissions from an unpaved road varies linearly with the volume of traffic.

4.5 Key pollutants and associated health effects

The potential health effects associated with exposure to elevated concentrations of the key pollutants identified in this baseline assessment are summarised in Table 7.

Table 7: Key pollutants and associated health effects

Pollutant	Description	Health effects
Carbon monoxide	One of the most common and widely distributed air pollutants (WHO, 2000). CO is an odourless, colourless and tasteless gas which has a low solubility in water.	■ Severe hypoxia; ■ Headaches, nausea & vomiting; ■ Muscular weakness & shortness of breath; and ■ Long term exposure can lead to Neurological deficits and damage
Nitrogen dioxide	Formed though the oxidation of nitric oxide in the atmosphere, it is a primary pollutant emitted from the combustion of stationary point sources and from motor vehicles. It is toxic by inhalation. However, as the compound is acrid and easily detectable by smell at low concentrations, inhalation exposure can generally be avoided.	■ Effects on pulmonary function, especially in asthmatics; and ■ Increase in airway allergic inflammatory reactions.
Particulate matter (TSP, PM_{10} and $PM_{2.5}$)	Can be classified by their aerodynamic properties into coarse particles, PM_{10} (particulate matter with an aerodynamic diameter of less than 10 µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm). The fine particles contain the secondarily formed aerosols such as combustion particles, sulphates, nitrates, and re-condensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dusts from roads and industries (Fenger, 2002).	■ Airway allergic inflammatory reactions & a wide range of respiratory problems; ■ Increase in medication usage related to asthma, nasal congestion and sinuses problems; and ■ Adverse effects on the cardiovascular system.
Sulphur dioxide (SO_2)	One of a group of highly reactive gasses known as "oxides of sulphur." Anthropogenic sources include; fossil fuel combustion (particularly coal burning power plants) industrial processes such as wood pulping, paper manufacture, petroleum and metal refining, metal smelting (particularly from sulphide containing ores, e.g. lead, silver and zinc ores) and vehicle tailpipe emissions.	■ Reduction in lung function; and ■ Respiratory symptoms (wheeze and cough).

Pollutant	Description	Health effects
Volatile organic compounds (benzene, toluene, ethyl benzene and xylene)	Organic compounds that easily vaporise at room temperature and are colourless. VOCs are released from vehicle exhaust gases either as unburned fuels or as combustion products, and are also emitted by the evaporation of solvents and motor fuels.	■ Adverse effects on the cardiovascular system and central nervous system; and ■ Long term exposure can lead to Neurological and cardiovascular system damage and Increased prevalence of carcinomas in the community.

5.0 IMPACT ASSESSMENT METHODOLOGY

The following tasks will be undertaken in the assessing the impact of the proposed Smarty copper mining operations on the ambient air quality:

- Establishing an inventory of emissions from the mining and ore processing activities;
- For identified sources, emission rates will be used where available; otherwise the USEPA AP-42 or NPI EET documents will be consulted to obtain emission rates for the identified sources;
- Developing concentration isopleths for atmospheric pollutants by dispersion modelling. The model proposed for this assessment is ICS-AERMOD, which is a regulatory approved steady-state plume model capable of simulating the fugitive emissions typically expected for the proposed activities. The dispersion meteorology will be generated using the AERMET pre-processor. Construction phase emissions will not be modelled, but a professional opinion will be provided;
- Dispersion modelling results and associated air quality impacts will be analysed and presented in an Air Quality Impact Assessment Report (AQIA); and
- Recommendations for mitigating/managing the impact of air emissions will be provided.

6.0 REFERENCES

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National Environmental Management: Air Quality Act (39/2004): List of activities which result in atmospheric emissions which may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage, GN33064, 31 March 2010.

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APPENDIX A

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August 2016

SMARTY (SOUTH AFRICA) MINERALS INVESTMENT (PTY) LTD

Preliminary Scoping Noise Study for the Proposed Smarty Musina Mine

Submitted to:
Smarty (South Africa) Minerals Investment (Pty) Ltd

REPORT

Report Number: 1655245-307331-4

Distribution:

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Golder Associates

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Acronyms

dB	Decibel
dB	A-weighted sound pressure level, expressed in decibels
ESIA	Environmental and Social Impact Assessment
Ha	Hectares
Hz	Hertz
L_{Aeq}	Equivalent continuous A-weighted sound pressure level, expressed in decibels
$L_{Req.D}$	Equivalent continuous rating level for day
$L_{Req.DN}$	Equivalent continuous rating level for day/ night
$L_{Req.N}$	Equivalent continuous rating level for night
$L_{Req.T}$	Equivalent continuous rating level
mamsl	meters above mean sea level
NIA	Noise impact assessment
SANS	South African National Standard

1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd. (Golder) was appointed by Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) to conduct a noise impact assessment (NIA) for the proposed copper mining and ore beneficiation project, near the town of Musina in Limpopo Province, South Africa.

Proposed project components include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possible electro-winning and/or solvent extraction, tailings disposal, as well as various supporting infrastructure.

The NIA forms part of the larger Environmental and Social Impact Assessment (ESIA) process, which is aimed at obtaining the necessary rights and authorisations to undertake the proposed mining and beneficiation project.

This scoping report focuses on describing the baseline noise characteristics of the area, based on a desktop review of available literature and datasets.

1.1 Project location

Seven farms comprise the mine lease area, hereafter collectively referred to as the study area. The study area covers approximately 10 719 ha, and extends on an east-west orientation with the town of Musina located at its centre (Figure 1). The east of the study area is bounded by the Limpopo River, which acts as the international border between South Africa and Zimbabwe.

2.0 NOISE TERMINOLOGY

Noise is defined as unwanted sound. The range of sound audible to humans is from 0 dB to 140 dB, from the threshold of audibility to the threshold of pain, respectively. The frequency response of the human ear is usually taken to cover the range from 20 Hz to 20,000 Hz. The human ear's response to sound is not equal across all frequencies; it is more sensitive in the mid-frequency range than in the low and high frequencies. In order to compensate for this in sound measurement equipment, a weighting (filter) is applied. The weighting which is most widely used and which correlates best with the human response to noise is the A-weighting. This is an internationally accepted standard for noise measurements to represent the human subjective response to sound.

For steady-state noise levels an increase or decrease of 1 dB(A) is not perceptible to most people under normal conditions, although this may be perceptible under laboratory conditions. An increase of 3 dB(A) is normally just perceptible under normal conditions. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/decrease of 10 dB(A) corresponds to a doubling or halving in the perceived loudness.

External noise levels are rarely steady, but rise and fall according to surrounding activities. In an attempt to produce a figure that relates this variable noise level to the subjective response a number of noise metrics may be used. The relevant noise parameter to this assessment is the L_{Aeq} level.

The L_{Aeq} level is the 'equivalent continuous A-weighted sound pressure level, expressed in decibels'. The L_{Aeq} is defined as:

- *"The value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time".*

It is a unit commonly used to describe construction noise and noise from industrial premises, and is the most suitable unit for the description of many other forms of environmental noise.

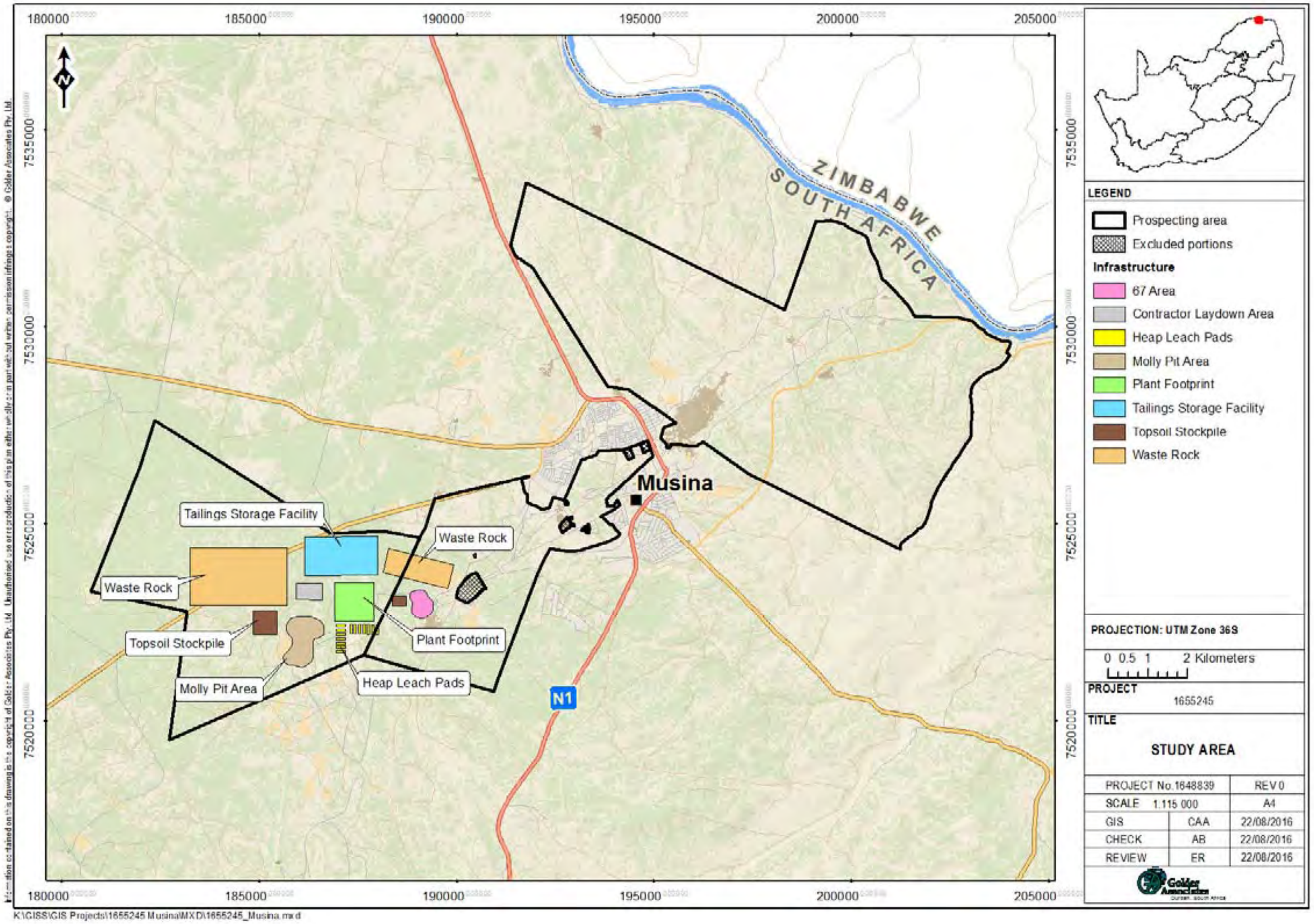

Figure 1: Project location

3.0 LEGISLATION, GUIDELINES AND STANDARDS

3.1 South African National Standard (SANS)

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

The SANS 10103 Code of Practice provides typical ambient noise rating levels ($L_{Req,T}$) in various districts. The outdoor ambient noise levels recommended for the districts are shown in Table 1 below.

It is probable that the noise is annoying or otherwise intrusive to the community or to a group of persons if the rating level of the ambient noise under investigation exceeds the applicable rating level of the residual noise (determined in the absence of the specific noise under investigation), or the typical rating level for the ambient noise for the applicable environment given in Table 1.

Table 1: Typical Rating Levels for Ambient Noise

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

Notes:

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

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

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

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

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

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

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

SANS 10103 provides criteria for evaluating the community or group response to a noise source. These are presented in Table 2.

Table 2: SANS 10103 Categories of community or group response

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

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

- $\Delta L_{Req,T} = L_{Req,T}$ of ambient noise under investigation minus $L_{Req,T}$ of the residual noise (determined in the absence of the Rated noise, i.e. the specific noise under investigation);
- $\Delta L_{Req,T} = L_{Req,T}$ of ambient noise under investigation minus the typical rating level for the applicable district as determined from Table 1 of SANS 10103:2008; or
- $\Delta L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in an area because of a proposed development under investigation.

4.0 EFFECTS OF NOISE

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

An increase in ambient noise levels of more than 3 dB(A) will be noticeable to most people, although such an increase is unlikely to cause disturbance to leisure activities or sleep. An increase of 10 dB(A), however, is likely to cause disturbance or require people to modify their behaviour to avoid that disturbance, depending on the absolute level of noise.

Typical sound levels (dB(A)) are shown in Figure 2 for reference.

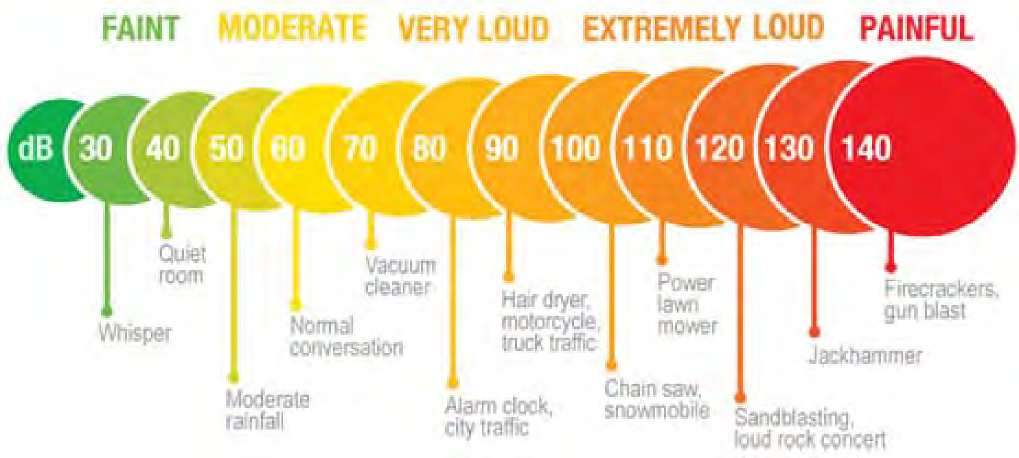

Figure 2: Typical sound levels (source: https://sites.google.com/site/laurenmcnanyspln/sound?mobile=true, July 2016)

5.0 RECEIVING ENVIRONMENT

5.1 Land use

According to the National Land Cover Dataset (2013/14), land use within 10 km of the proposed Smarty mine infrastructure primarily comprises (Figure 3):

- Grassland, open bush and thicket (97%);

- Urban built-up commercial, industrial and residential areas (±2%); and
- Cultivated land (±1%).

5.2 Sensitive receptors

Noise impacts are typically experienced at relatively close proximity to the emitting source. The noise sensitive receptors are considered by SANS 10328:2008 to include residential dwellings, institutional and culturally-important sites, such as schools, hospitals, nursing/old age/retirement homes and places of worship.

Numerous households are located within 10 km of the proposed Smarty mine infrastructure (Figure 3). While households are concentrated in the Musina town, numerous smallholdings and homesteads are present within 1 km of the proposed infrastructure in all directions.

Schools are healthcare facilities within 10 km of the proposed Smarty mine infrastructure are listed in Table 3. The closest sensitive receptor is St. Martin de Porres Primary, located 2 km north east of the proposed Smarty mine infrastructure.

Table 3: Sensitive receptors within 10 km of the proposed Smarty mine infrastructure

Receptor	Latitude	Longitude
Eric Louw High School	-22.35839	30.04660
Rixile/ Bonwa UDI Primary	-22.33112	30.03264
St. Martin de Porres Primary	-22.35540	30.00615
Makushu Primary	-22.33135	30.03027
Laerskool Messina Primary	-22.35260	30.04524
Musina Secondary	-22.33042	30.02590
Doreen Bridge	-22.34580	30.04110
Madavhila Primary	-22.40430	30.03011
Nancefield Community Health Centre	-22.35533	30.02326
Messina Clinic and Emergency Services	-22.34616	30.04220
Messina Hospital	-22.34183	30.04302

5.3 Elevation

The topography in the vicinity of the prospecting area ranges from 400 m to 700 m above mean sea level (mamsl), sloping from west to east, towards the Limpopo River (Figure 5).

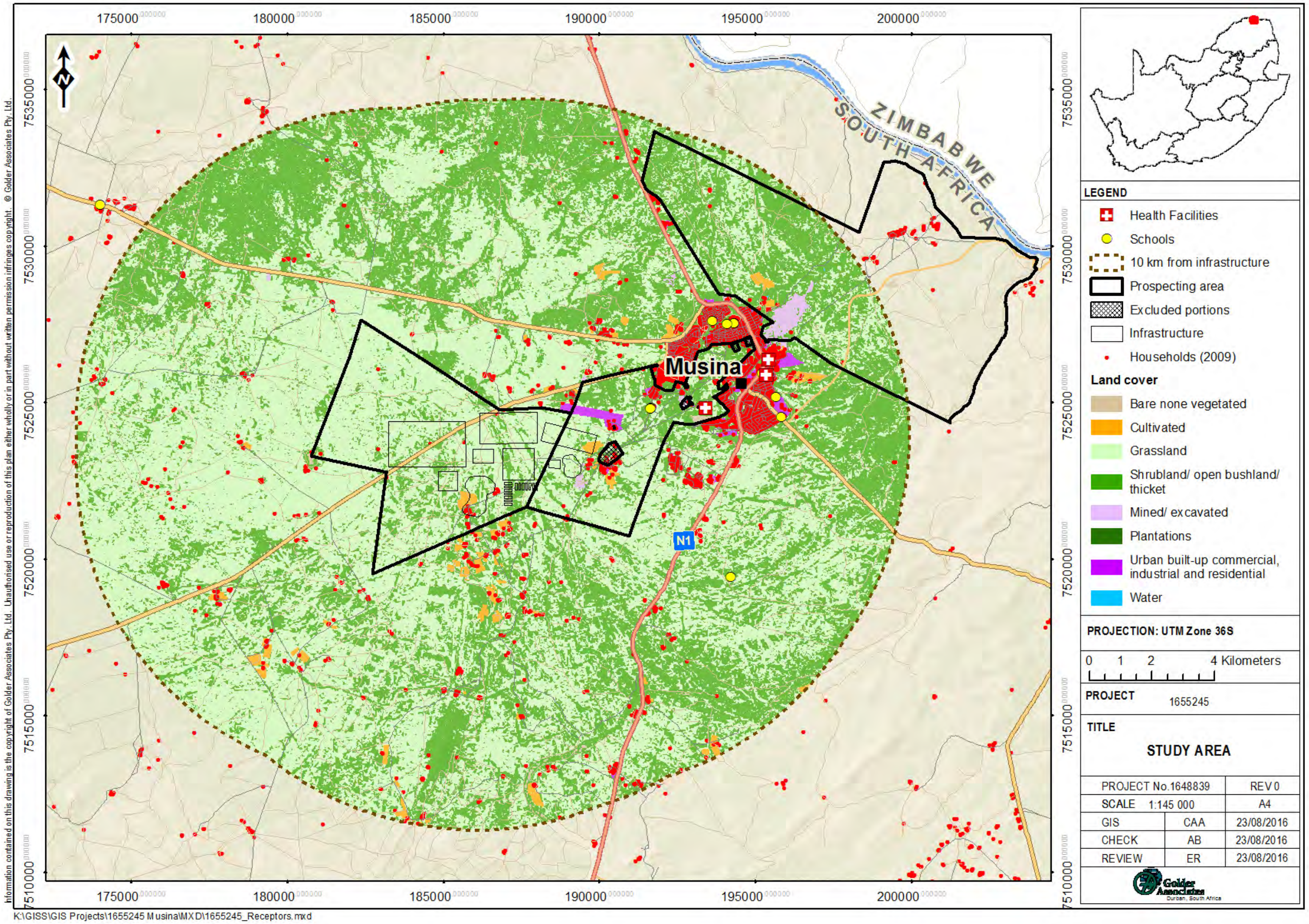

Figure 3: Land use and sensitive receptors in the vicinity of the proposed Smarty mine infrastructure

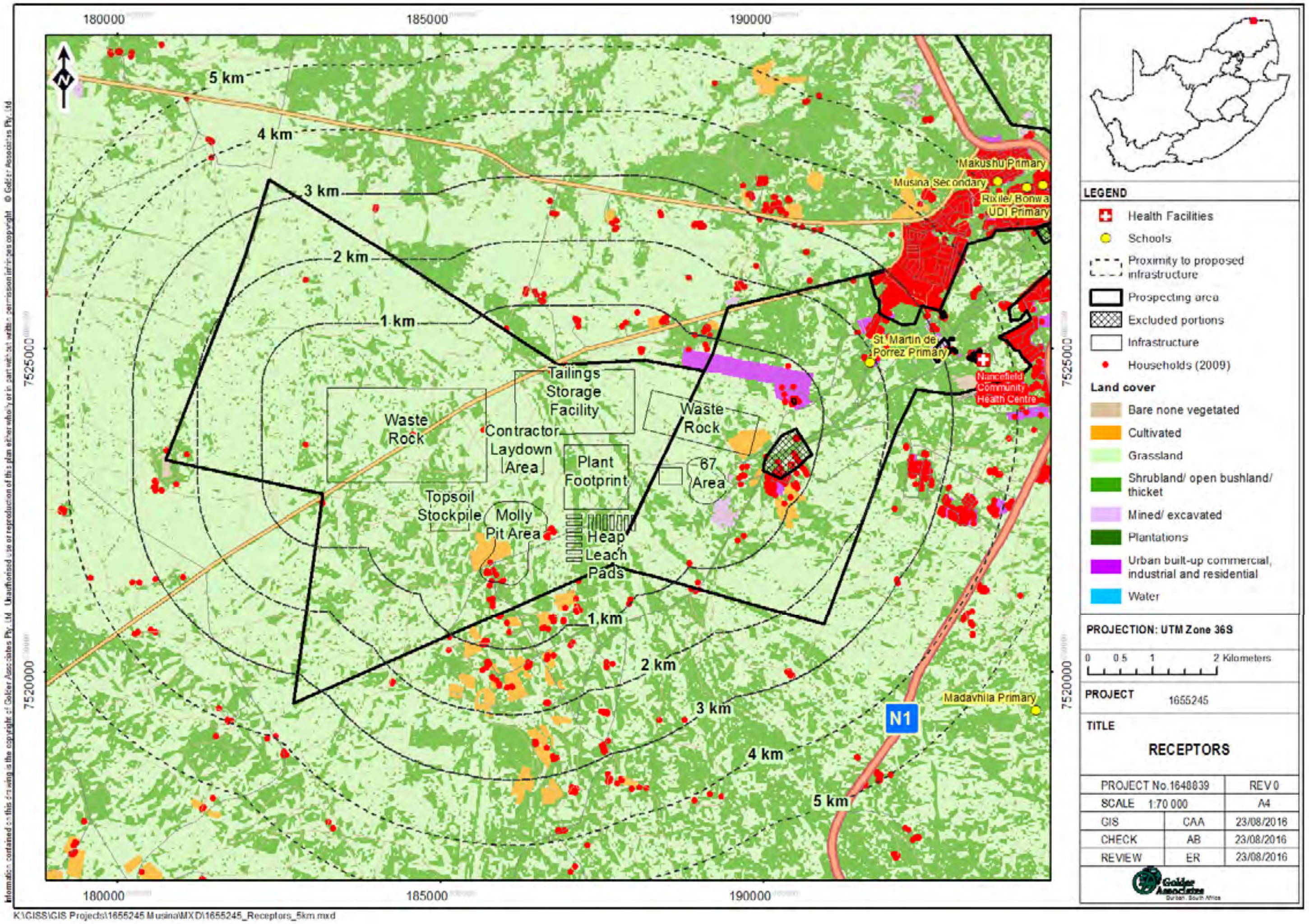

Figure 4: Land use and sensitive receptors within 5 km of the proposed Smarty mine infrastructure

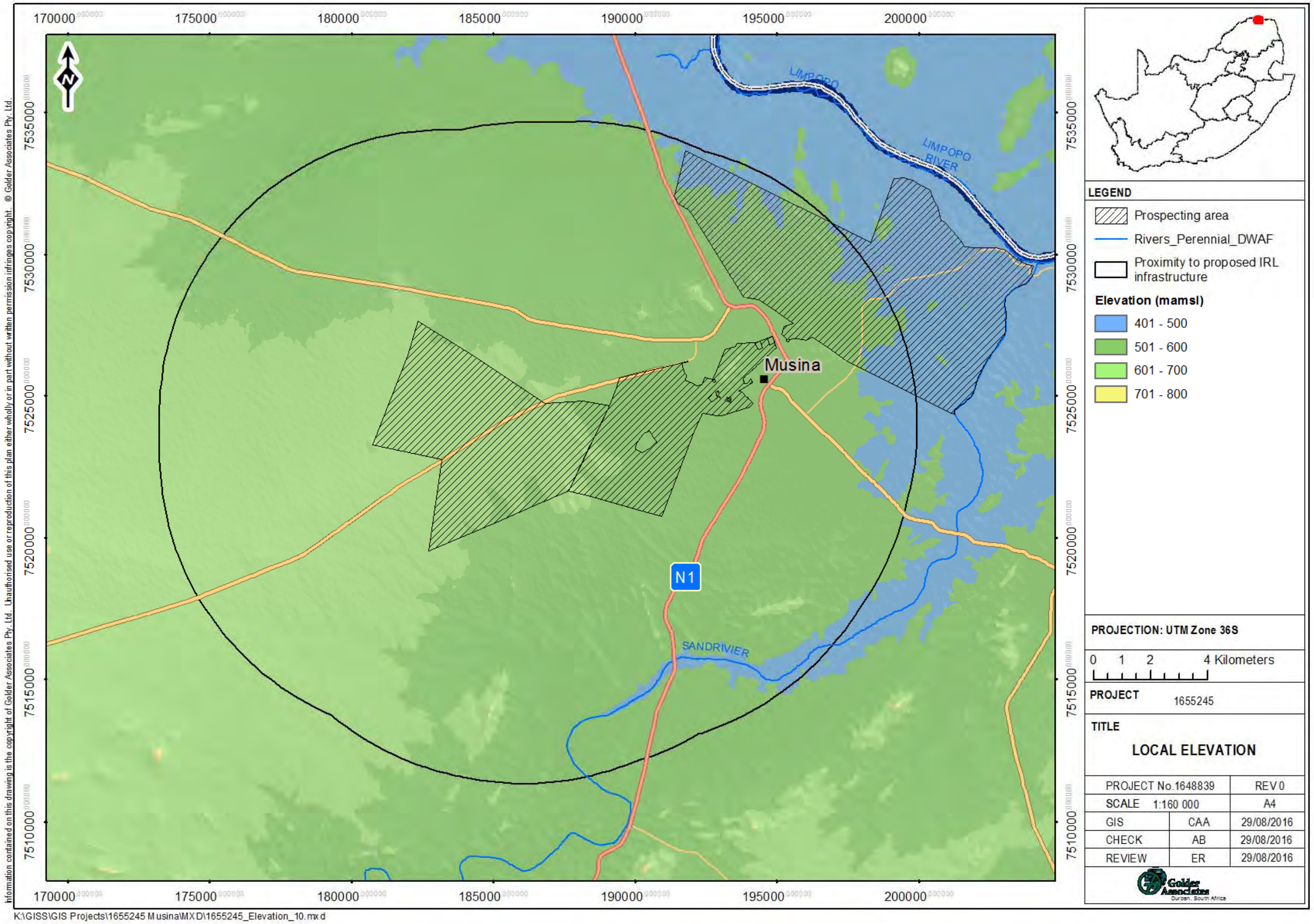

Figure 5: Elevation in the vicinity of the Smarty prospecting area

6.0 BASELINE NOISE AND VIBRATION CHARACTERISATION

Baseline noise monitoring could not be undertaken in support of the scoping phase as landowners refused to grant access to the area. Quantitative baseline monitoring will however be undertaken in support of the impact assessment, once the the landowners have agreed to allow Golder access. Due to the strict regulatory timeframes, reliance is placed on literature, land use and typical noise levels associated with primary noise sources identified in the area to qualitatively characterise the baseline ambient noise levels. These sources and their associated potentials for noise generation are detailed in Table 4 and Figure 6.

The prevailing ambient noise levels will vary because of the existing farming activities, roads (gravel and tarred) and distant N1 National Road. The levels of noise emissions and noise sources are a function of:

- The distance the receptors are from the existing roads and farming activities;
- The intervening topography and structures that may shield the receptors from the noise; and
- Meteorological conditions such as wind speed, temperature and the season.

Table 4: Existing noise sources identified in the vicinity of the proposed Smarty infrastructure

Noise source	Description
Rural environmental noise sources	Birds, animals and insects. These noise sources are particularly prevalent at night. The prevailing ambient noise levels will be higher during the summer periods when insects such as crickets and beetles increase the ambient noise level. Typical noise levels for rural environments are given in SANS 10103 as: ■ Day-night ($L_{R,dn}$) or "average" and daytime ($L_{Req,d}$) – 45 dB; and ■ Night time ($L_{Req,n}$) – 35 dB.
Residential (suburban)	Typical noise levels for residential/suburban environments with little traffic are given in SANS 10103 as: ■ Day-night ($L_{R,dn}$) or "average" and daytime ($L_{Req,d}$) – 50 dB; and ■ Night time ($L_{Req,n}$) – 40 dB.
Road traffic noise	■ The majority of roads within 10 km of the proposed Smarty infrastructure are gravel farm access roads; ■ The tarred R572 road runs through the proposed waste rock dump area. Traffic volumes on this road are anticipated to be low; and ■ The N1 National Road is located 5 km from the proposed Smarty infrastructure. Road traffic noise levels fluctuate over time. There are short-term changes over one or two seconds as an individual vehicles passes. Variations over a number of minutes due to the changing composition of the traffic (i.e. ratio of cars to trucks etc.). Daily oscillations due to peak and off-peak traffic flows. Road traffic noise is the combination of all sources of noise from a vehicle and includes propulsion (i.e. engine, exhaust, intake etc.), tyre/road (i.e. noise or road surface noise is that which is generated as the tyre rolls), and aerodynamic noise sources (turbulence around a vehicle as it passes through the air) (NZ Transport Agency, 2014).
Rail	Wayside noise is generated by the train's propulsion system, the auxiliary equipment such as compressors, motor generators, brakes, interaction of wheels and rails, speed and length of the train, and noise radiated by vibrating structures such as bridges.
Musina Aerodrome	The airfield is located approximately 600 m north of the proposed waste rock dump. Due to the perceived scale of this operation it is assumed that the aerodrome only hosts light aircraft and flights are infrequent. The aerodrome is therefore thought to be a minor source of noise in the area.

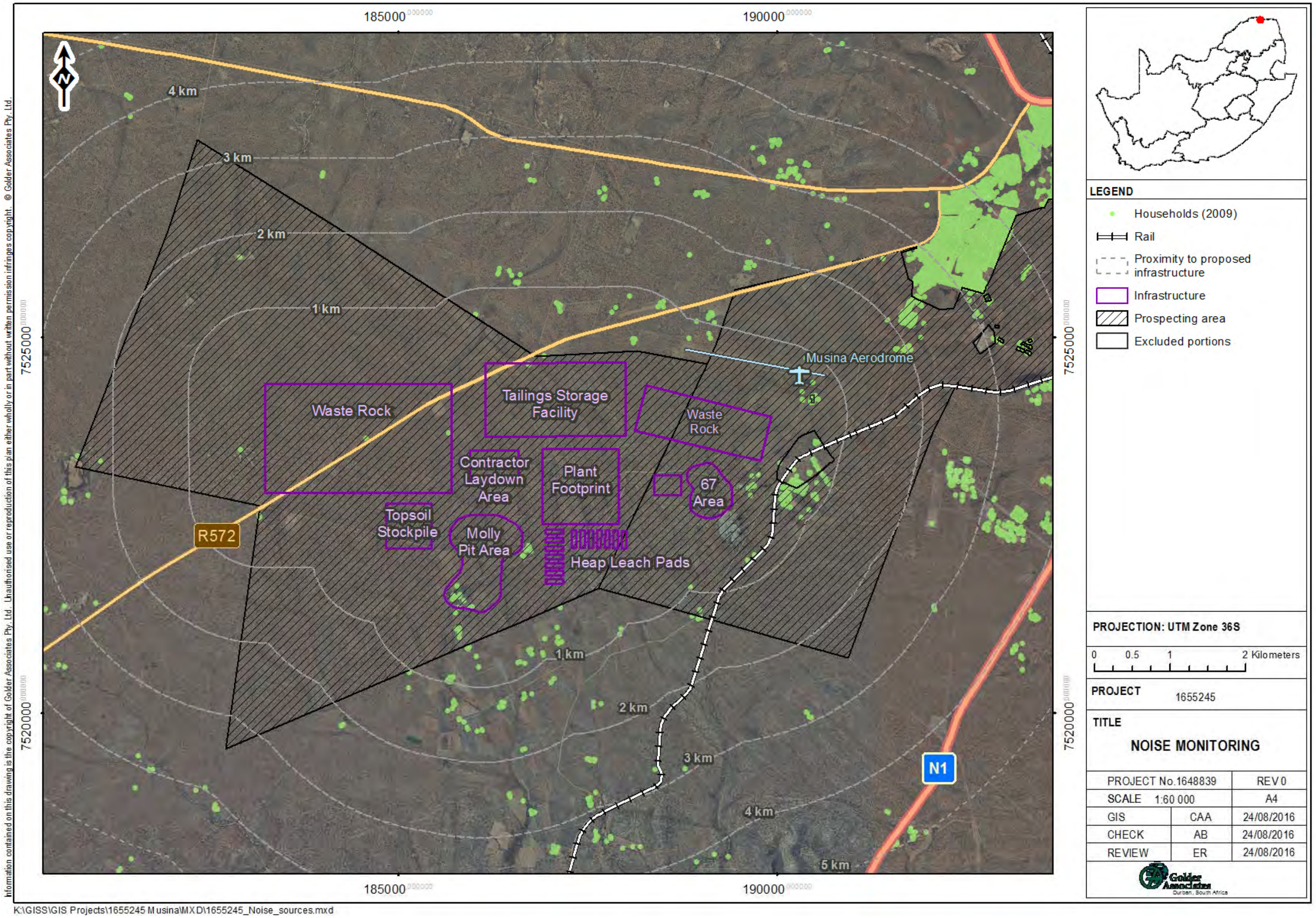

Figure 6: Noise sources identified in the vicinity of the proposed Smarty operations

7.0 ASSESSMENT METHODOLOGY

7.1 Quantitative baseline noise characterisation

In order to determine the noise impact and annoyance potential resulting from the proposed Smarty operations, baseline noise levels will be quantified by field survey.

7.1.1 Equipment

The Rion NL-52 Class 1 sound level meter will be used to undertake the noise survey (Table 5). The sound level meter will meet the accuracy requirements specified for a Class 1 instrument described in SANS 656 *Sound level meters*, SANS 658 *Integrating-averaging sound level meters* and SANS 61672-1 *Electroacoustic – Sound level meters – Part 1: Specifications*.

Table 5: Instrumentation

Instrument	Make/Model	Serial No.	Set up
Sound Level Meter	Rion NL-52	1043472	Frequency weighting – A Time weighting – Fast Tripod mounted
Calibrator	Rion NC-74	35246919	n/a

7.1.2 Monitoring locations

Monitoring will be undertaken at five locations. The proposed monitoring locations and their coordinates are provided in Table 6 and Figure 7. The closest school (NSR1) and residential dwellings at the prospecting area boundary (NSR2 to NSR5) were selected as monitoring points.

Table 6: Monitoring locations

Monitoring Point	Description	Latitude	Longitude	Receptor classification
NSR1	St. Martin de Porres Primary, located 1.9 km north-east of the proposed waste rock dump, within the prospecting area.	-22.355677	30.006294	Residential (suburban with little traffic)
NSR2	Residence 100 m north of the proposed tailings storage facility. Located at the boundary of the prospecting area.	-22.354645	29.960448	Rural
NSR3	Residence 530 m west of the proposed waste rock dump. Located at the boundary of the prospecting area.	-22.373087	29.923551	Rural
NSR4	Residence 570 m south of the proposed Molly Pit area. Located at the boundary of the prospecting area.	-22.38994	29.949483	Rural
NSR5	Residence 450 m south-east of the proposed waste rock dump. Located within the excluded area, at the boundary of the prospecting area.	-22.370644	29.991021	Residential (suburban with little traffic)

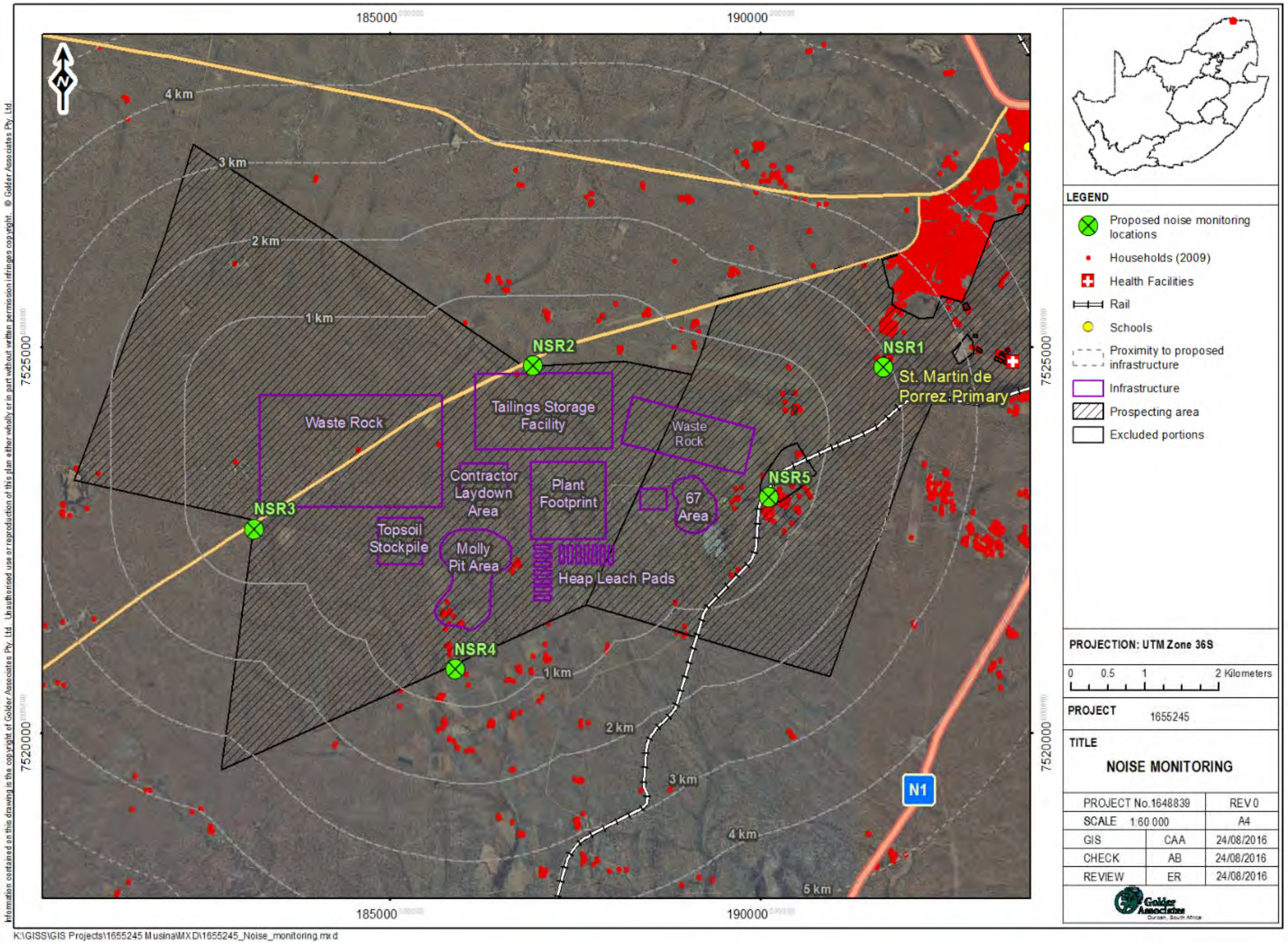

Figure 7: Proposed noise baseline monitoring locations

7.1.3 Monitoring duration

Once the landowners have granted access, monitoring will be undertaken for a duration of one hour at the preselected sites during both the daytime (06:00 to 22:00) and night time (22:00 to 06:00) periods, as defined in SANS 10103.

7.2 Impact assessment

The following tasks will be undertaken in the assessing the noise and vibration impacts associated with the proposed Smarty copper mining operations:

- Prediction of noise levels at sensitive receptors during the construction and operational phases of the mine;
- Evaluation of the predicted noise levels in the context of the baseline characterisation to identify any significant noise impacts arising from the mining activities;
- The noise impact will be assessed by constructing an acoustic model of the operations, using proprietary modelling software that conforms to international standard ISO 9613. The model will be developed based on local mapping data, project description and site plans provided by Smarty and will include static noise sources, as well as mobile and linear sources such as road traffic and conveyors. Topography will be assumed to be flat and smooth, representing the “worst-case” scenario in terms of noise attenuation;
- Predicted noise levels at receptor points will be evaluated by comparison with South African and international standards and guidelines. The dominant noise sources will be identified and recommendations provided for mitigation measures to control the noise at source and for on-going monitoring and compliance surveys as may be necessary;
- Providing guidelines for acceptable vibration levels in terms of damage to structures; and
- South African and international guidelines for the design and monitoring of blasts to remain within acceptable limits regarding noise generated by air blast, ground vibration levels and fly rock travel distance during the construction and operating (mining) phases will be discussed.

8.0 REFERENCES

1) NZ Transport Agency (2014) Guide to state highway road surface noise v1.0 ISBN 978-0-478-39453-5.

2) South African Standard - Code of practice, SABS 10328:2008, Methods for environmental nose impact assessments.

3) South African Standard - Code of practice, SANS 10103:2008, the measurement and rating of environmental noise with respect to annoyance and to speech communication.

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

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APPENDIX A

Document Limitations

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REPORT

September 2016

SMARTY (SOUTH AFRICA) MINERALS INVESTMENT (PTY) LTD

Scoping level Groundwater Investigation at Proposed Copper Mine at Musina

Submitted to:
Smarty (South Africa) Minerals Investment (Pty) Ltd

Report Number: 1655245-307525-5

Distribution:

1 x electronic copy Smarty (South Africa) Minerals Investment (Pty) Ltd
1 x electronic copy e-Library
1 x electronic copy project folder

Golder Associates

Executive Summary

Background

Golder Associates Africa (Pty) Ltd (Golder) conducted a preliminary, literature based groundwater scoping investigation for Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) for their proposed open cast copper mine close to Musina - Limpopo Province. The study will be completed once access to the land has been granted.

Smarty have acquired prospecting rights for copper on seven farms. In terms of the Mineral and Petroleum Resources Development (Act No. 28 of 2002) (MPRDA), a Mining Right Application (MRA) must be accompanied by a Mining Work Programme (MWP) and a Social and Labour Plan (SLP). Golder and Ukwazi Mining Solutions have been appointed to assist with the development of the MWP.

Golder understands that the groundwater specialist study is part of a Mining Right Application (MRA) for Smarty to support their environmental permitting process and that this investigation is limited to the scoping phase of the project.

Groundwater Study Objective

The main objective of the groundwater baseline study is to conduct a hydrogeological investigation based on available information as input into a scoping report that includes a gap analysis and scope of work required to support Smarty's environmental permitting process.

Scope of Work

The following scope of work was followed in order to meet the scoping objectives:

- Desk study of existing information;
- Gap analysis of existing groundwater information;
- Develop initial groundwater conceptual site model; and
- Compile groundwater scoping report.

Description of Investigation Area

Locality

The investigation area is located within the magisterial district of Musina of the Limpopo Province of South Africa. The investigation area comprises seven farms, located approximately 8 km south of the Limpopo River, forming the border line between South Africa and Zimbabwe and is ~ 2 km north and west of Musina (previously Messina).

Climate and Rainfall

The investigation area lies in the Limpopo Province of South Africa with a hot semi-arid climate. The mean annual rainfall for Musina and the investigation area is ~ 246 mm (Coffey 2016)

Topography

The investigation area forms part of the low plateau (or low-veld) of South Africa and is covered in typical low-veld vegetation, comprising woody thickets with scattered grass.

Groundwater Baseline

Desk study and Information Review

The following information and data was utilised during the desk study and groundwater baseline characterization:

- 1:250 000 geological map series;
- 1:2 500 000 Groundwater Resources map of RSA –Sheet 1 (WRC.DWAF 1995);
- 1:4 000 000 Groundwater Resources map of RSA – Sheet 2 (WRC.DWAF 1995);
- 1: 500 000 Hydrogeological Map Series of RSA (1996);
- Existing borehole information was obtained from the following database:
  - Department of Water Affairs (DWAF) National Groundwater Database (NGDB): The NGDB is a National groundwater database initiated and driven by DWAF. Groundwater information is captured from numerous government and private projects. This borehole information is available through data request to DWAF and some of the borehole information is online obtainable; and
  - Borehole information from Aquabase, Golder's groundwater database.
- Existing information and reports:
  - MSA (Group 2014). International Resources Limited (IRL), Musina Drilling Project Limpopo, South Africa, Technical Report, J2848 – July 2014;
  - Coffey (2016). Mineral Resource Evaluation of the Musina Copper Project;
  - Ukwazi (2016). Mine Design Criteria- Musina Copper Project; and
  - Smarty (2016). Musina Drilling Project Limpopo, South Africa, Technical Report.

Existing Groundwater Information

No existing groundwater reports were available; however, 175 existing boreholes were located from the Golder database (Aquabase) and the NGDB in the vicinity of the investigation area. The current status of these boreholes however needs to be verified. The available borehole information was used to gain an initial understanding of the groundwater regime.

Geology

The investigation area falls on two overlapping maps on the published 1:250 000 Geology map series, namely the 2 228 Alldays and 2 230 Messina series.

The investigation area is located within the central zone of the Limpopo mobile belt, an east-north-east trending belt of strongly deformed, largely granulite facies high grade metamorphic rocks which separates the ancient Kaapvaal and Zimbabwe cratons (Coffee 2016).

Hydrogeology

Igneous and metamorphic rocks are relatively impermeable and hence serve as poor aquifer systems. In order for groundwater to occur, there must be openings that have developed through fracturing faulting, or weathering of the formation.

Aquifer Classification and Borehole Yield

The hydrogeological map series published by DWAF (1996) was used to define the regional aquifer classification. The aquifer is classified as an intergranular and fractured aquifer system with borehole yields ranging from 0.04 to 11.36/s with an average yield of 3.0 l/s. The published hydrogeological maps (DWAF 1996) indicate the yield to be between 0.5 to 2.0 l/s.

Groundwater Vulnerability

Groundwater vulnerability at the investigation area is shown on the national groundwater vulnerability map as low to the east of the proposed mining area and medium to high in the central area.

Groundwater Levels and Flow Direction

The published hydrogeological maps (DWAF 1996) indicate the water level to be between 20 to 40 m below ground level (mbgl) with an average of ~22.54 mbgl.

With the only available data being the groundwater database, it is assumed that the groundwater contours will mimic the topography and regionally the flow will be towards the Sand and Limpopo Rivers.

Groundwater Conceptual Model

An initial groundwater conceptual model was derived using the 1:250 000 geology map series and available groundwater information.

Two potential aquifer zones are distinguished within the metamorphic formations (needs to be confirmed by drilling) namely:

- An upper weathered aquifer system; and
- A fractured underlying aquifer system, controlled by geological structures.

Groundwater Quality

The published hydrogeological maps series by DWAF (1996) were used to define the regional groundwater quality based on EC (Electrical Conductivity) values. The EC values for the investigation area are indicated to the west of proposed mining area as 0 to 70 mS/m (Class 0 water quality) and the remaining area as 70 to 1 000 mS/m (Class 1 to 4).

Aquifer Recharge

From the published hydrogeological maps (DWAF 1996) the average recharge for the study area is between 1 mm to 5 mm per annum.

Gap Analysis

The aim of the initial Gap analysis is to identify any gaps in the available groundwater information. The following groundwater information gaps were identified:

- No existing groundwater reports are available;
- No historic or recent groundwater quality data available;
- Existing borehole positions from the data base located on the investigation area need to be verified;
- There are no existing groundwater monitoring boreholes around the proposed mining area. An initial monitoring network needs to be installed to determine background water qualities; and
- There is no information available about hydraulic parameters such as Conductivity (k) and Transmissivity (T), which values would indicate the rate at which groundwater flows in the subsurface. These aquifer parameters can be highly variable in different formations and geological conditions (faults, dykes, sills, and weathering) that apply. These hydraulic parameters are essential to understand and update the conceptual model and form the basis for estimating potential contaminant migration rates. These values are derived from borehole testing results.

Conclusion

The following conclusions are drawn from the available groundwater data:

- The investigation area is located within the central zone of the Limpopo mobile belt, an east-north-east trending belt of strongly deformed, largely granulite facies high grade metamorphic rocks which separates the ancient Kaapvaal and Zimbabwe cratons;
- The published hydrogeological maps (DWAF 1996) indicate that the average borehole yield in the area is between 0.5 l/s and 2.0 l/s, with reported yields between 0.04 to 11.36/s;

- The average water levels are approximately ~22.54 mbgl;
- Two potential aquifer zones are distinguished within metamorphic formations (need to be confirmed by drilling) namely:
  - An upper weathered aquifer system; and
  - A fractured underlying aquifer system, controlled by geological structures.
- It is assumed that the groundwater contours will mimic the topography and regionally the groundwater flow will be towards the Sand and Limpopo Rivers.

Recommendations

Following the groundwater scoping investigation and gap analysis the following additional groundwater work needs to be undertaken:

- Site familiarization visit and hydrocensus within 2 km of the project footprint to:
  - Determine the status of existing boreholes;
  - Record borehole use and equipment;
  - Record GPS coordinates of boreholes;
  - Measure static water levels to confirm groundwater flow direction; and
  - Groundwater sampling to confirm background groundwater quality of existing groundwater users.
- Geophysical survey to optimize drilling targets for installation of monitoring boreholes around the proposed opencast mining area;
- Drilling of 5 new monitoring boreholes, which will provide:
  - Direct geological and hydrogeological control across the proposed mining right area as required;
  - Provide facilities to undertake aquifer testing and water sample collection; and
  - Serve as future monitoring points (initial groundwater monitoring network).
- Aquifer testing to determine hydraulic parameters and update the groundwater conceptual model;
- Groundwater sampling of newly drilled monitoring boreholes to determine baseline water quality;
- Update Initial groundwater conceptual model;
- Numerical groundwater flow and transport model to assess:
  - Impacts on the groundwater levels and yield of existing users, caused by the need to pump to maintain dry working conditions in the proposed mining activities;
  - Impacts on the groundwater quality at existing users;
  - Possible development of pollution plumes emanating from the mining activities; and
  - Transport model for pollution impact assessment and control.
- Reporting.

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TABLES

FIGURES

APPENDICES

1.0 BACKGROUND

Golder Associates Africa (PTY) Ltd (Golder) conducted a preliminary, literature based groundwater scoping investigation for Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) for their proposed open cast copper mine close to Musina - Limpopo Province. The study will be completed once access to the land has been granted.

Smarty have acquired prospecting rights for copper on seven farms (Figure 1). In terms of the Mineral and Petroleum Resources Development (Act No. 28 of 2002) (MPRDA), a Mining Right Application (MRA) must be accompanied by a Mining Work Programme (MWP) and a Social and Labour Plan (SLP). Golder and Ukwazi Mining Solutions have been appointed to assist with the development of the MWP.

Golder understands that the groundwater specialist study is part of a Mining Right Application (MRA) for Smarty to support their environmental permitting process and that this investigation is limited to the scoping phase of the project.

2.0 OBJECTIVES

The main objective of the groundwater baseline study is to conduct a hydrogeological investigation based on available information as input into a scoping report that includes a gap analysis and scope of work required to support Smarty's environmental permitting process.

The groundwater baseline study objective furthermore aims to:

- Characterise the prevailing groundwater situation;
- Define the water bearing strata in the area;
- Determine current groundwater level distribution and flow directions;
- Assess groundwater vulnerability;
- Determine baseline groundwater quality; and
- Develop an initial conceptual groundwater model.

3.0 SCOPE OF WORK

The following scope of work was followed in order to meet the scoping objectives:

- Desk study of existing information;
- Gap analysis of existing groundwater information;
- Develop initial groundwater conceptual site model; and
- Compile groundwater scoping report.

4.0 DESCRIPTION OF INVESTIGATION AREA

4.1 Locality

The investigation area is located within the magisterial district of Musina in the Limpopo Province of South Africa. The investigation area comprises seven farms as indicated on Figure 1, located approximately 8 km south of the Limpopo River, forming the border line between South Africa and Zimbabwe and is ~ 2 km north and west of Musina (previously Messina).

The investigation area falls mainly within the A71K quaternary catchment area and partly (Plaatje 200MS) within the A71L quaternary catchment area, as indicated on Figure 1.

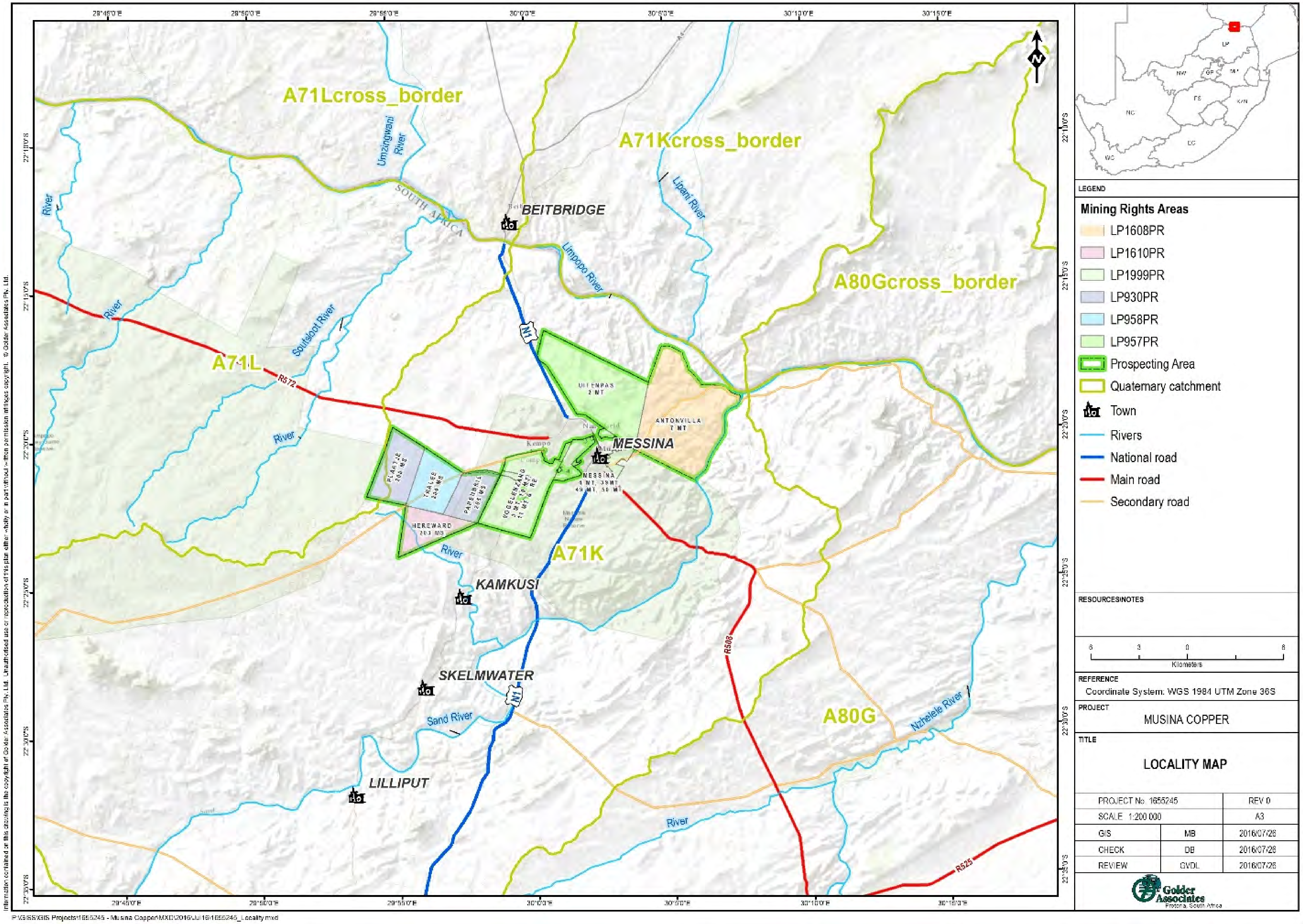

Figure 1: Locality map

4.2 Climate and Rainfall

The investigation area lies in the Limpopo Province of South Africa with a hot semi-arid climate. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Musina range from 23.9°C in July to 32.1°C in January. The region is the coldest during July when temperatures drop to 7.6°C on average during the night (Coffey 2016).

Clear skies and exceptionally low humidity at this time of the year enable temperatures to plunge close to freezing at night, although frost is fairly uncommon. Droughts frequently occur during the winter months, and infrequently during summers when very little rain falls and drought conditions prevail.

The mean annual rainfall for Musina and the investigation area is ~ 246 mm (Coffey 2016) which is concentrated during the summer months from October to April, when severe late-afternoon and evening thunderstorms are common. Winters are extremely dry, with little to no precipitation typically recorded in the driest months, from June to August (MSA 2014).

4.3 Topography

The investigation area forms part of the low plateau (or low-veld) of South Africa and is covered by typical low-veld vegetation, comprising woody thickets with scattered grass. The investigation area has elevations of between 660 meter above mean sea level (mamsl) and 700 mamsl, and the local topography comprises low-relief valley floors and shallow ridge crests (Smarty 2016).

5.0 GROUNDWATER BASELINE

5.1 Desk Study

The following information and data was utilised during the desk study and groundwater baseline characterization:

- 1:250 000 geological map series;
- 1:2 500 000 Groundwater Resources map of RSA –Sheet 1 (WRC.DWAF 1995);
- 1:4 000 000 Groundwater Resources map of RSA – Sheet 2 (WRC.DWAF 1995);
- 1: 500 000 Hydrogeological Map Series of RSA (1996);
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  - Ukwazi (2016). Mine Design Criteria- Musina Copper Project; and
  - Smarty (2016). Musina Drilling Project Limpopo, South Africa, Technical Report.

5.2 Existing Groundwater Information

No existing groundwater reports were available, however 175 existing boreholes were located from the Golder database (Aquabase) and the NGDB in the vicinity of the investigation area and summarised in Table 1. Plot positions (not labelled) are indicated on Figure 2. The current status of these boreholes however needs to be verified. The borehole information was used to gain an understanding of the groundwater regime.

The depths of the boreholes according to the database range between 5.71 to 125.66 m with an average depth of 38.5 m.

According to the database information, the water level for the area ranges between 0.1 and 41.02 mbgl (metres below ground level); whereas the average reported water level is 14.16 mbgl. The published hydrogeological maps (DWAF 1996) indicate the water level to be between 20 and 40 mbgl and the average ~22.54 mbgl (Figure 7).

The available borehole yield from the groundwater data base ranges from 0.04 to 11.36/s with an average yield of 3.0 l/s, whereas the published hydrogeological maps (DWAF 1996) indicate the yield to be between 0.5 to 2.0 l/s (Figure 5).

The existing groundwater use is reported as primarily for domestic purposes, agriculture and watering of livestock.

Table 1: Existing borehole information

Site ID	Latitude	Longitude	Site Name	Depth (m)	Use	Water Level (mbgl)	Reported Yield (l/s)	Field EC mS/m
2229BB00001	-22.186582	29.870032	RIVER	5.71	Agriculture and domestic	-	-	-
2229BB00002	-22.186622	29.868782	RIVER	-	Agriculture and irrigation	-	-	-
2229BB00003	-22.183932	29.867062	RIVER	-	Domestic all purpose	-	-	-
2229BB00004	-22.186922	29.871352	RIVER	11.91	Domestic all purpose	4.61	-	-
2229BB00005	-22.184052	29.868532	RIVER	50	Agriculture and irrigation	-	-	-
2229BB00006	-22.190432	29.873332	RIVER	-	Agriculture and irrigation	-	-	-
2229BB00007	-22.190282	29.868522	RIVER	-	Agriculture and irrigation	-	-	-
2229BB00008	-22.188752	29.873292	RIVER	-	Agriculture and domestic	-	-	-
2229BB00012	-22.244718	29.884993	NEW BRUNSWICK	-	Agriculture and domestic	-	-	-
2229BB00013	-22.243878	29.886663	NEW BRUNSWICK	-	Domestic all purpose	-	-	-
2229BB00014	-22.245268	29.874172	NEW BRUNSWICK	-	Agriculture and domestic	-	-	-
2229BB00015	-22.244718	29.889163	NEW BRUNSWICK	-	Agriculture and domestic	-	-	-
2229BB00016	-22.195661	29.885263	STRATAN	28.04	Agriculture and irrigation	-	11.36	-
2229BB00017	-22.195541	29.882483	STRATAN	15.27	Agriculture and irrigation	5.85	-	-
2229BB00018	-22.195312	29.880422	STRATAN	-	Agriculture and irrigation	-	-	-
2229BB00019	-22.196561	29.879192	STRATAN	-	Agriculture and irrigation	-	-	-
2229BB00020	-22.195781	29.886543	STRATAN	37.8	Agriculture and irrigation	-	5.68	-
2229BB00021	-22.197471	29.878682	STRATAN	-	Agriculture and irrigation	-	-	-
2229BB00022	-22.196361	29.886113	STRATAN	52.79	Agriculture and irrigation	-	-	-
2229BB00023	-22.195851	29.879402	STRATAN	58.88	Agriculture and irrigation	-	-	-
2229BB00024	-22.194692	29.880732	STRATAN	33.81	Agriculture and irrigation	-	-	-
2229BB00030	-22.178593	29.860342	ISLET	-	Domestic all purpose	--	-	-
2229BB00031	-22.21359	29.934455	THOR	-	Agriculture and stock watering	-	1.11	263
2229BB00032	-22.22356	29.898593	FREYA	-	Agriculture and stock watering	-	-	-
2229BB00033	-22.231569	29.928524	WODIN	-	Agriculture and stock watering	-	0.65	118
2229BB00035	-22.21747	29.881912	STRATAN	-	Agriculture and stock watering	-	-	-
2229BB00036	-22.243288	29.888543	NEW BRUNSWICK	-	Domestic all purpose	-	-	-
2229BB00037	-22.243318	29.882052	NEW BRUNSWICK	-	Agriculture and stock watering	-	-	-
2229BB00038	-22.243748	29.874072	NEW BRUNSWICK	-	Domestic all purpose	-	-	-
2229BB00039	-22.243458	29.883242	NEW BRUNSWICK	-	Domestic all purpose	-	-	-
2229BB00040	-22.195691	29.885933	STRATAN	71.82	Agriculture and irrigation	6.49	-	-
2229BB00041	-22.195641	29.885543	STRATAN	30.08	Agriculture and irrigation	6.56	-	-
2229BB00046	-22.230559	29.928294	WODIN	11.57	Agriculture and stock watering	-	-	-
2229BB00047	-22.230719	29.928794	WODIN	32.77	Agriculture and stock watering	12.45	-	-
2229BB00048	-22.231169	29.927874	WODIN	-	Agriculture and stock watering	-	-	-
2229BB00049	-22.244898	29.889403	MACUVILLE	-	Domestic all purpose	-	-	-
2229BB00050	-22.21416	29.907634	THOR	44.84	Agriculture and stock watering	26.88	-	-
2229BB00051	-22.21964	29.905673	THOR	-	Agriculture and stock watering	-	-	-
2229BB00052	-22.21777	29.909284	THOR	-	Agriculture and stock watering	-	-	-
2229BB00053	-22.244508	29.909564	THOR	60.12	Agriculture and stock watering	11.92	-	-
2229BB00054	-22.243268	29.909584	THOR	-	Agriculture and stock watering	-	-	-
2229BB00063	-22.229419	29.971366	TEMPELHOF	27.87	Agriculture and stock watering	8.58	-	-
2229BB00064	-22.231259	29.967686	TEMPELHOF	39.64	Agriculture and stock watering	-	0.13	-
2229BB00072	-22.185682	29.870042	RIVER	-	Domestic all purpose	-	-	-
2229BB00073	-22.188402	29.869152	RIVER	-	-	-	-	-
2229BB00074	-22.196871	29.867692	RIVER	-	Domestic all purpose	-	-	210
2229BB00075	-22.21942	29.864512	RIVER	-	Agriculture and stock watering	-	0.54	150.8
2229BB00086	-22.229999	29.928884	THOR	110	-	-	0.76	
2229BD00001	-22.270076	29.889273	MACUVILLE	-	Domestic all purpose	-	-	770
2229BD00002	-22.266466	29.887533	MACUVILLE	-	Agriculture and domestic	-	-	-
2229BD00003	-22.265287	29.888533	MACUVILLE	36.32	Agriculture and domestic	-	-	-
2229BD00004	-22.251937	29.888053	MACUVILLE	-	Agriculture and domestic	-	-	-
2229BD00005	-22.253047	29.937225	WODIN	-	Nature conservation	-	-	-
2229BD00006	-22.273666	29.857341	BOLTON	40.07	Agriculture and stock watering	7.16	-	-
2229BD00007	-22.285415	29.969886	MUNNICHSHAUSEN	62.01	Agriculture and stock watering	37.65	-	-
2229BD00008	-22.281695	29.959566	MUNNICHSHAUSEN	88.75	Agriculture and stock watering	21.21	-	-
2229BD00009	-22.280656	29.956826	MUNNICHSHAUSEN	26.25	Agriculture and stock watering	21.75	-	-
2229BD00010	-22.274696	29.941555	MUNNICHSHAUSEN	49.59	Agriculture and stock watering	18.15	-	-
2229BD00011	-22.275416	29.940985	MUNNICHSHAUSEN	-	Agriculture and stock watering	-	-	141
2229BD00012	-22.251858	29.916704	BOSTON	-	Agriculture and stock watering	-	-	-

Site ID	Latitude	Longitude	Site Name	Depth (m)	Use	Water Level (mbgl)	Reported Yield (l/s)	Field EC mS/m
2229BD00013	-22.277586	29.915214	BOSTON	-	Agriculture and stock watering	-	-	-
2229BD00016	-22.268466	29.885863	MACUVILLE	-	Agriculture and domestic	-	-	-
2229BD00019	-22.271786	29.855861	BOLTON	-	Agriculture and stock watering	-	-	-
2229BD00021	-22.370429	29.82652	BERG-EN-DAL	-	Agriculture and stock watering	-	-	-
2229BD00022	-22.368319	29.82678	BERG-EN-DAL	14.31	-	13.16	-	-
2229BD00023	-22.369439	29.82461	BERG-EN-DAL	13.21	-	-	-	-
2229BD00024	-22.372579	29.83831	BERG-EN-DAL	11.38	-	-	-	-
2229BD00025	-22.371649	29.84041	BERG-EN DAL	-	Agriculture and domestic	-	-	-
2229BD00027	-22.370379	29.83979	BERG-EN-DAL	51.71	-	0.1	-	-
2229BD00028	-22.338301	29.853021	BERG-EN-DAL	-	Agriculture and stock watering	-	-	715
2229BD00029	-22.343231	29.843181	BERG-EN-DAL	-	Domestic all purpose	-	-	-
2229BD00043	-22.381938	29.8204	ROSENTAWICH	-	Agriculture and domestic	-	-	-
2229BD00044	-22.382158	29.82164	ROSENTAWICH	-	Domestic all purpose	-	-	-
2229BD00045	-22.308453	29.851291	EVELYN	-	Agriculture and stock watering	-	-	-
2229BD00046	-22.307813	29.848971	EVELYN	10.04	-	8.58	-	-
2229BD00047	-22.316863	29.83448	EVELYN	-	Agriculture and stock watering		-	-
2229BD00048	-22.316823	29.83464	EVELYN	63.71	-	22.59	-	-
2229BD00054	-22.417256	29.861911	FONTAINEBLEAU	-	Agriculture and stock watering	-	0.59	153
2229BD00067	-22.351271	29.981377	TOVEY	-	Agriculture and stock watering	-	-	
2229BD00068	-22.351321	29.981407	TOVEY	-	Domestic all purpose	-	-	213
2229BD00069	-22.351951	29.975506	TOVEY	62.74	-	41.02	-	-
2229BD00070	-22.350501	29.978057	TOVEY	36.48	-	-	-	-
2229BD00071	-22.35293	29.981457	TOVEY	28.69	-	-	-	-
2229BD00085	-22.395607	29.83611	LUCERNE	-	Agriculture and stock watering	-	-	158.6
2229BD00086	-22.400137	29.847721	LUCERNE	-	Agriculture and stock watering	-	-	164.3
2229BD00087	-22.404727	29.853111	LUCERNE	-	Domestic all purpose	-	-	143.6
2229BD00088	-22.403777	29.854041	LUCERNE	-	Domestic all purpose	-	-	-
2229BD00089	-22.402707	29.856501	LUCERNE	-	Domestic all purpose	-	-	-
2229BD00090	-22.405447	29.857021	LUCERNE	19.94	-	-	-	-
2229BD00103	-22.344781	29.891883	EHRENBREITSTEIN	-	Domestic all purpose	-	-	-
2229BD00104	-22.337151	29.902753	EHRENBREITSTEIN	-	Agriculture and stock watering	-	-	-
2229BD00105	-22.342561	29.879562	EHRENBREITSTEIN	-	Domestic all purpose	-	-	226
2229BD00106	-22.342341	29.879782	EHRENBREITSTEIN	44.48	-	15.97		-
2229BD00107	-22.324782	29.907723	ELBERFELD	-	Domestic all purpose	-	-	-
2229BD00108	-22.321523	29.883352	ELBERFELD	-	Domestic all purpose	-	-	-
2229BD00109	-22.321343	29.870502	ELBERFELD	34.05	-	9.78	-	-
2229BD00110	-22.320343	29.870642	ELBERFELD	125.68	-	9.65	-	-
2229BD00111	-22.322842	29.868942	ELBERFELD	61.24	-	6.66	-	-
2230AA00005	-22.371929	30.033607	MESSINA	82.31	-	-	0.21	-
2230AC00012	-22.421056	30.129651	DOVER	-	Agriculture and domestic	-	-	-
2230AC00017	-22.435065	30.056038	BUSH	16.5	Agriculture and domestic	-	-	-
2230AC00018	-22.435075	30.056038	BUSH	-	-	-	-	-
2230AC00019	-22.435065	30.056048	BUSH	-	Agriculture and domestic	-	-	-
2230AC00020	-22.435085	30.056038	BUSH	-	Agriculture and domestic	-	-	-
2230AC00021	-22.435065	30.056058	BUSH	-	-	-	-	-
2230AC00022	-22.435095	30.056038	BUSH	12.0	-	-	-	-
2230AC00023	-22.435065	30.056068	BUSH	12.84	Agriculture and domestic	-	-	-
2230AC00034	-22.406787	30.126821	MAGDALA	-	Agriculture and stock watering	-	-	-
2230AC00035	-22.277356	30.076849	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00036	-22.276766	30.076539	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00037	-22.272716	30.071559	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00038	-22.268477	30.068179	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00039	-22.266337	30.066439	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00040	-22.263647	30.063708	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00041	-22.261717	30.061558	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00042	-22.258237	30.053718	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00043	-22.258247	30.053718	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00044	-22.258237	30.053728	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00045	-22.257557	30.048418	MARYLAND GROEP NOMMER 7	-	Domestic all purpose	-	-	-

Site ID	Latitude	Longitude	Site Name	Depth (m)	Use	Water Level (mbgl)	Reported Yield (l/s)	Field EC mS/m
2230AC00046	-22.257467	30.045808	MARYLAND GROEP NOMMER 7	-	Domestic all purpose	-	-	-
2230AC00047	-22.257607	30.042608	MARYLAND GROEP NOMMER 7	-	Domestic all purpose	-	-	-
2230AC00048	-22.257607	30.042618	MARYLAND GROEP NOMMER 7	-	Domestic all purpose	-	-	-
2230AC00049	-22.257717	30.036157	MARYLAND GROEP NOMMER 7	-	Domestic all purpose	-	-	-
2230AC00050	-22.256127	30.027697	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00051	-22.256137	30.027697	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00052	-22.256127	30.027707	MARYLAND	-	Domestic all purpose	-	-	-
2230AC00053	-22.256147	30.027697	MARYLAND; DIKKIDYK	-	Domestic all purpose	-	-	-
2230AC00054	-22.293295	30.050138	MARYLAND	-	Agriculture and stock watering	-	-	-
2230AC00055	-22.271856	30.047748	MARYLAND	-	Agriculture and stock watering	-	-	-
2230AC00056	-22.280966	30.047738	MARYLAND	-	Agriculture and stock watering	-	-	-
2230AC00057	-22.282746	30.09023	ANTONVILLA	-	Domestic all purpose	-	-	-
2230AC00058	-22.285585	30.0968	ANTONVILLA GROEP NOMMER 9	-	Domestic all purpose	-	-	-
2230AC00059	-22.285595	30.0968	ANTONVILLA GROEP NOMMER 9	-	Domestic all purpose	-	-	-
2230AC00060	-22.285585	30.09681	ANTONVILLA GROEP NOMMER 9	-	Domestic all purpose	-	-	-
2230AC00061	-22.285605	30.0968	ANTONVILLA GROEP NOMMER 9	-	Domestic all purpose	-	-	-
2230AC00062	-22.293205	30.106	ANTONVILLA	-	Domestic all purpose	-	-	-
2230AC00063	-22.293205	30.10601	ANTONVILLA	-	Domestic all purpose	-	-	-
2230AC00064	-22.293185	30.106	ANTONVILLA	-	Domestic all purpose	-	-	-
2230AC00073	-22.36749	30.059438	SINGELELE	60.77	Domestic all purpose	-	0.1	-
2230AC00074	-22.36609	30.059158	SINGELELE	19.6	-	-	-	-
2230AC00075	-22.36665	30.059438	SINGELELE	20	-	-	-	-
2230AC00076	-22.36693	30.059438	SINGELELE	47.85	-	-	0.2	-
2230AC00077	-22.35693	30.049718	SINGELELE	22.22	-	-	1.26	-
2230AC00078	-22.35776	30.049718	SINGELELE	18.3	Domestic all purpose	-	7.5	-
2230AC00079	-22.35638	30.052498	SINGELELE	18.3	Domestic all purpose	-	6.93	130
2230AC00080	-22.35638	30.053888	SINGELELE	15.24	Domestic all purpose	-	6.93	-
2230AC00145	-22.314153	30.121941	ANTONVILLA	21.94	-	4.85	0.5	160
2230AC00146	-22.314153	30.121951	ANTONVILLA	26.96	-	6.85	5.04	200
2230AC00147	-22.312494	30.122171	ANTONVILLA	29.29	-	7.31		110
2230AC00148	-22.314153	30.121941	ANTONVILLA	26.5	-	8.16	5.04	300
2230AC00149	-22.314153	30.121931	ANTONVILLA	33.55	-	6.41	10.1	310
2230AC00150	-22.369149	30.047217	BERKENRODE	81	Domestic all purpose	15.57	6.5	128
2230AC00151	-22.370819	30.038327	MESSINA	82	-	19.97	-	125
2230AC00152	-22.370829	30.038337	MESSINA	59	-	-	0.37	128
2230AC00153	-22.370539	30.034437	MESSINA	42.78	-	24.31	0.6	-
2230AC00154	-22.36748	30.058878	SINGELELE	33.29	Domestic all purpose	18.77	0.1	-
2230AC00155	-22.36749	30.052778	BERKENRODE	33.11	-	15.37	1.7	-
2230AC00156	-22.368869	30.052768	BERKENRODE	66	-	15.58	1.3	128
2230AC00157	-22.371089	30.025826	MESSINA	42.54	-	23.94	1.21	152
2230AC00158	-22.371929	30.025826	MESSINA	42.78	-	23.86	-	142
2230AC00159	-22.370259	30.025266	MESSINA	66.5	-	23.91	2.5	150
2230AC00160	-22.36054	30.09555	SINGELELE	16.85	-	7.67	-	225
2230AC00161	-22.374159	30.085829	BERKENRODE	39.62	Agriculture and stock watering	-	10.08	-
2230AC00162	-22.36554	30.043047	MESSINA	18.3	Domestic all purpose	-	10.08	160
2230AC00163	-22.36471	30.043037	MESSINA	24.2	-	9.6	-	-
2230AC00164	-22.3661	30.042217	MESSINA	15.15	-	8.05	-	-
2230AC00165	-22.36388	30.045547	MESSINA	11.54	-	-	-	-
2230AC00166	-22.36332	30.027497	MESSINA	30.5	Domestic all purpose	-	2.52	153
2230AC00167	-22.370269	30.034987	MESSINA	45.93	-	23.09	-	-
2230AC00184	-22.411926	30.048047	PRINZENHAGE	20.24	-	5.04	-	-
2230AC00185	-22.384428	30.058048	STOCKFORD	39.25	-	9.51	0.04	-
2230AC00186	-22.384148	30.006656	TOYNTON	30.5	Domestic all purpose	-	1.01	-
2230AC00187	-22.378599	30.008046	TOYNTON	45.72	Domestic all purpose	-	1.3	-

Site ID	Latitude	Longitude	Site Name	Depth (m)	Use	Water Level (mbgl)	Reported Yield (l/s)	Field EC mS/m
2230AC00188	-22.381379	30.012216	TOYNTON	36.57	Domestic all purpose	-	0.6	-
2230AC00190	-22.35665	30.037217	MESSINA	30	-	-	-	-
Minimum				5.71		0.1	0.04	110.00
Maximum				125.68		41.02	11.36	770.00
Average				38.50		14.16	3.07	211.29

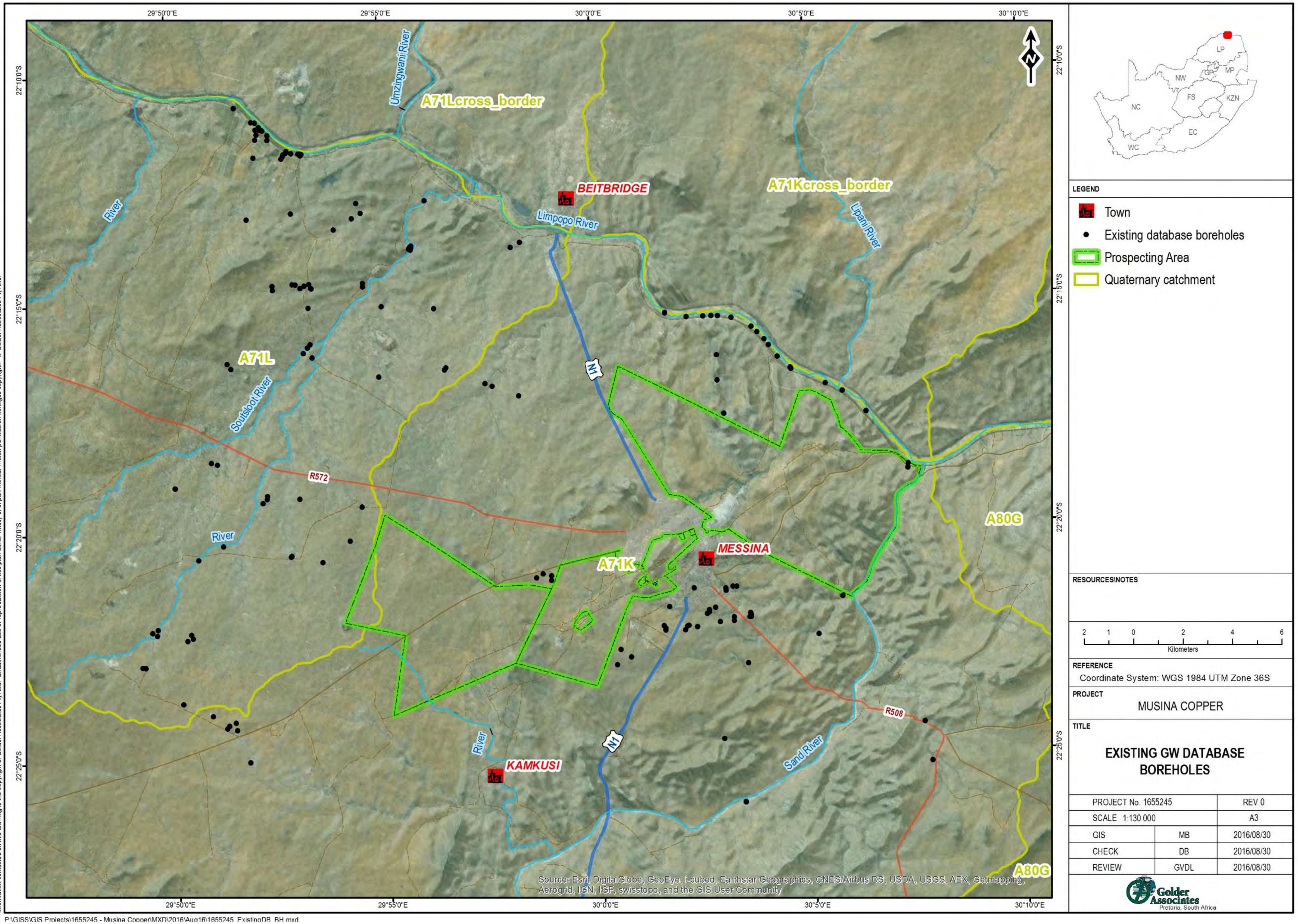

Figure 2: Existing groundwater data base boreholes

5.3 Geology

5.3.1 Regional Geology

Regionally (Figure 3), the area of investigation is underlain by the Central Zone of the Limpopo belt which extends from Botswana to Mozambique, along the Limpopo Province-Zimbabwe border.

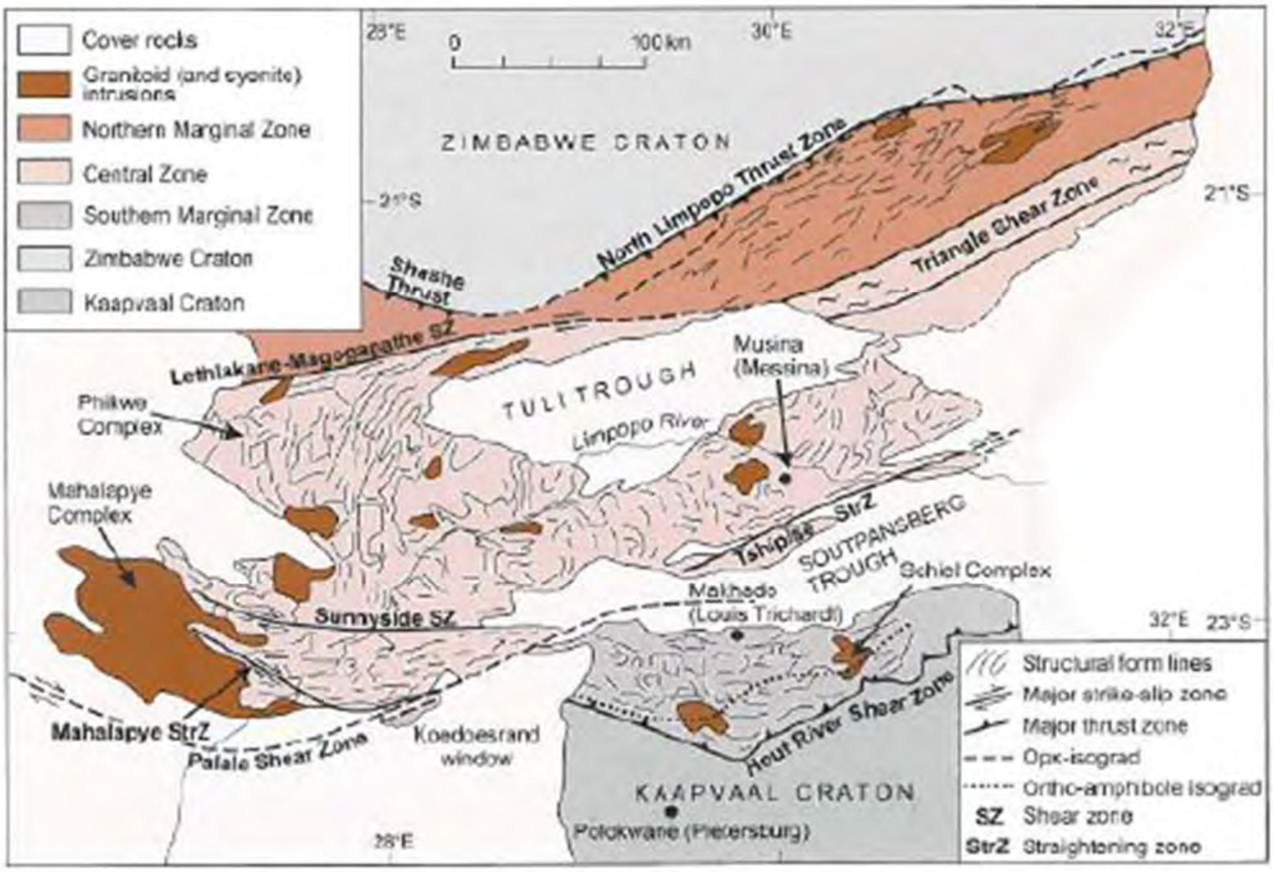

Figure 3: Regional Geology (Limpopo Belt; Kramer's et al., 2006)

The Limpopo Belt is an east-northeast trending belt of strongly deformed, largely granulite facies metamorphic rocks which separates the Kaapvaal and Zimbabwe cratons. The Central Zone is one of three main domains within the Limpopo Belt and is bordered by prominent shear zones with the Northern Marginal Zone to the north and the Southern Marginal Zone to the south. The Central Zone contains a multiplicity of rock types and, owing to the structural complexity and prevailing high-grade metamorphism, stratigraphic relationships between rock types can, in most places, not be readily defined (MSA 2014).

The dominant rock type association is that of high-grade metasediments with interlayered quartzofeldspathic gneisses and mafic rocks. The metasediments forming part of the Beit Bridge complex can be divided into three lithostratigraphic groups, the Mount Dowe Group (3.3 to 3.15 Ga.); the Malala Drift Group (3.3 to 3.15 Ga.) and the Gumbu Group (2.0 to 2.2 Ga.). The Messina Suite (3.15Ga.), Alldays Gneiss (2.56 to 2.68 Ga.) and the Bulai Gneiss (2.56 to 2.68 Ga.) are intrusive within the Beit Bridge complex. The Sand River gneiss (a banded tonalitic gneiss of 3.2 to 3.4 Ga.) is interpreted as depositional basement to the supracrustal rocks of the Beit Bridge Complex (Kramer's *et al.,* 2006).

The Central Zone does not show uniform structural grain, with both east-west and north-south striking structures, with the north-south structures dominating the central part of the Central Zone (Kramer's *et al.,* 2006). Within this part, a number of fold-like structures are seen, with apparent fold closures on their northern side mostly defined by distinct rock units trending east-west over a short distance. These features are referred to cross-folds (Kramer's *et al.,* 2006).

Second order folding observed in the Musina area is a result of the Dowe Tokwe wrench fault which caused the development of second order drag folds. Faulting over the Central Zone includes east-northeast and north-east striking normal and wrench faults (Jacobsen *et al.,* 1976).

During Karoo times, the belt underwent a period of renewed activity in the form of normal faulting and magmatism. The marginal zones of the belt were the sites of sedimentation and later intense volcanism and rifting, whereas the Central Zone (the Messina block) remained as a comparatively stable unit (Cox *et al.,* 1965) Figure 3 (MSA 2014).

5.3.2 Local Geology

The investigation area falls on two overlapping maps on the published 1:250 000 Geology map series, namely the 2 228 Alldays and 2 230 Messina series. (Figure 4 - different formation colours used on the two map series).

The investigation area is located within the central zone of the Limpopo mobile belt, an east-north-east trending belt of strongly deformed, largely granulite facies high grade metamorphic rocks which separates the ancient Kaapvaal and Zimbabwe cratons (Figure 3), and a belt formed between >3.0 to 2.04 Ga ago (Coffee 2016).

The area of investigation focusses on a small copper deposit located at the intersection zone of the Messina and Dowe Tokwe faults. This deposit forms part of the historically mined Messina copper deposits within the Musina district Figure 6-3. The majority of these copper deposits are associated with the linear north-easterly fracture reverse fault line called the Messina fault. The propagation of the Messina line of fractures also extends south of the Dowe Tokwe wrench fault zone. As a result, the hydrothermal copper mineralization has accessed preferred host lithologies via major Messina northeast trending fractures on the south and north sides of the Tokwe fault zone at the Molly Too shaft location (MSA 2014).

The country rocks surrounding the Messina copper deposits consist of metasediments and quartzofeldspathic gneisses which fall within the Mount Dowe Group and the Malala Suite respectively of the Beit Bridge Complex. The Messina Suite (meta-anorthosites and leucograbbros) intruded as locally conformable layers within the Beit Bridge Complex rocks. The structural and lithological complexity of the gneisses can be ascribed to the multiple folding and subsequent recrystallization under metamorphic conditions (MSA 2014).

The Dowe Tokwe wrench fault and Messina line of fractures were reactivated during late Waterberg and late Karoo times. The Dowe Tokwe fault zone is a steep mylonite zone from 2 m to over 40 m in width, along which younger mafic dykes intruded (MSA 2014).

The lithologies surrounding the Molly Too mine shaft comprise interbanded units of quartzites, hornblende gneisses, biotite garnet gneisses, leucogneisses (granulites), amphibolites and banded ironstones. These units have a general northeast - southwest strike and dip roughly 40 to 50 degrees to the west south-west (MSA 2014).

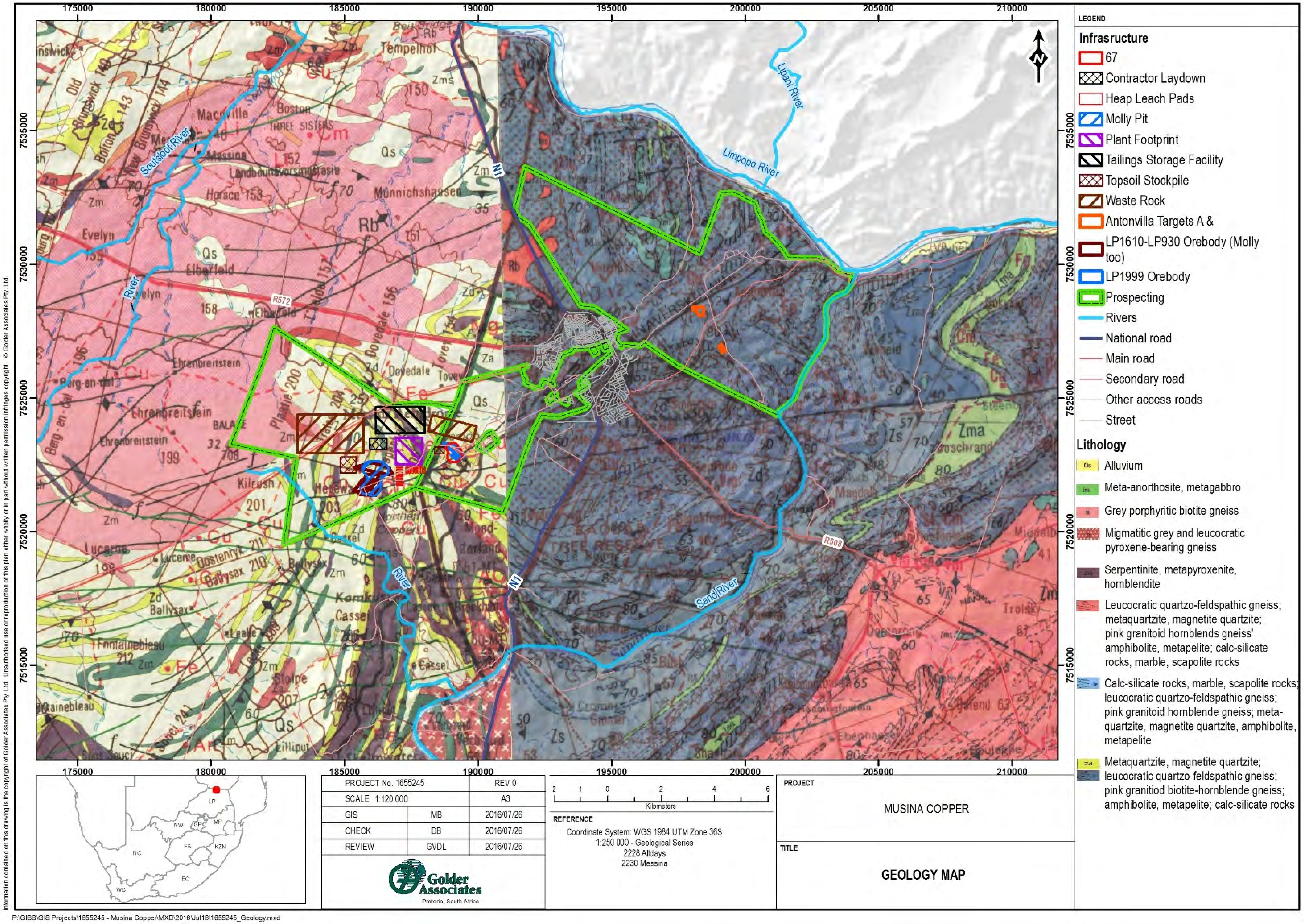

Figure 4: 1:250 000 Geology. Note: Different formation colours used on two map series

5.3.2.1 Copper Deposits

The copper deposits in the Messina area occur in a more or less linear configuration in close association with the NE-striking Messina fault, which itself parallels' the main trend of the Limpopo mobile belt. The deposits are of three morphological types, breccia columns, tabular veinlike bodies and inclined elliptical replacement bodies, which are normally controlled by SW striking sub faults and/or fissures associated with the NE-striking Messina faults (Coffey 2016).

The Breccia Columns (developed at the Messina, Spence and Campbell mines)

The breccia columns are known over a vertical extent of 1 250 m, and are not exposed on surface; they are circular to polygonal in plan outline as a result of joint controls. Peripheral micro breccia grades downwards and inwards to macro breccia. Downward displacement of country rock marker zones indicates a maximum 1 - 3% volume increase, while observed interfragmental fill constitutes 15 - 25%. Hydrothermal alteration of wallrock gneiss mantles the breccia columns and does not extend to surface; it is comprised of distinct zones, the outermost characterized by sericitized gneiss, grading to an albitite, and finally to zoisite-quartz rock around the immediate brecciated contacts, and within the pipes.

The interfragmental fill consists largely of quartz and sulphides, and grades downwards to albite + sulphides in the West Lode pipe. Sulphide mineral distribution is zoned, pyrite dominating in the apex of the pipes, grading downwards to chalcopyrite-bornite and then bornite-chalcocite at deeper levels. The nature of the fragmentation precludes normal stoping collapse mechanisms for brecciation and suggests a single implosive event. Chemical reaction induced shrinkage of fragments probably created the bulk of the interfragmental volume (Coffey 2016).

Breccia-pipe (developed at the Messina, Spence and Campbell mines)

The breccia-pipe mineralized bodies apparently formed by collapse following solution of quartz-rich silicate host rocks. This conclusion is supported by the angular to sub angular nature of the breccia fragments they contain, the bedded nature of tabular fragments in some parts of the pipes and the fact that downward movement of breccia fragments of distinctive lithology can be demonstrated. The settling of breccia fragments with respect to their source is minimal in the upper levels of the pipes, but tends to increase in magnitude progressively downward. The spaces between the breccia fragments have been subsequently infilled with quartz and lesser copper sulfides.

The volume relations between breccia fragments and later quartz infilling suggest that at least 20% of the original volume of country rock now occupied by breccia must have been removed in each case by passage of hydrothermal solutions. Some of the breccia pipes do not reach surface and appear to have been propagated upward by collapse of wall rock with the major part of the solution of country rock taking place toward their base. Some secondary brecciation of large collapse fragments is associated with quartz deposition and appears to be the result of chemical brecciation (Coffey 2016).

Replacement Bodies (mostly developed at the Antonvilla and the Harper mines)

During the earliest stages of hydrothermal activity large-scale dissolution of quartz occurred, accompanied or closely followed by strong albitization of the adjacent country rocks. Subsequent to this, deposition of copper sulphides occurred, together within filling of quartz in the voids between the breccia fragments in the breccia-pipe orebodies. In the replacement orebodies copper sulfide deposition occurred largely as a replacement of mafic minerals in mafic metamorphic units, and in these orebodies quartz deposition is more or less restricted to the vug stage.

The alteration mineral assemblages that appear to be most closely associated with the main metallization stage are albite, clinozoisite, epidote and chlorite, developed in that order. During vug-stage deposition, quartz was the major phase to form, and in a number of instances was followed by deposition of calcite. Larger quartz crystals in many cases exhibit a well-defined zoning and some contain occluded epidote crystals toward their outer extremities. In some instances a dusting of specularite coats the later growth zones of outer surfaces of the crystals (Coffey 2016).

5.4 Hydrogeology

Igneous and metamorphic rocks are relatively impermeable and hence serve as poor aquifer systems. In order for groundwater to occur, there must be openings that developed through fracturing, faulting, or weathering of the formation.

Geological structures normally enhance the groundwater potential by increasing the permeability and transmissivity of the host rock. The fractured fault zones of the Messina and Dowe Tokwe faults in the study area are possible areas of increased groundwater potential. These two geological structures are sub-vertical (Coffee 2106).

However, the permeability of these fault zones will need to be investigated and confirmed.

Two distinct aquifer types are typically distinguished within metamorphic formations:

- Upper weathered aquifer system; and
- Fractured underlying aquifer system.

5.4.1 Aquifer Classification and Borehole Yield

The published hydrogeological map series by DWAF (1996) was used to define the regional aquifer classification (Figure 5). The aquifer is classified as an intergranular and fractured aquifer system and the average borehole yield in the area is between 0.5 l/s and 2.0 l/s.

The reported borehole yield on the groundwater database is reported as 0.04 to 11.36 l/s with an average yield of 3.0 l/s.

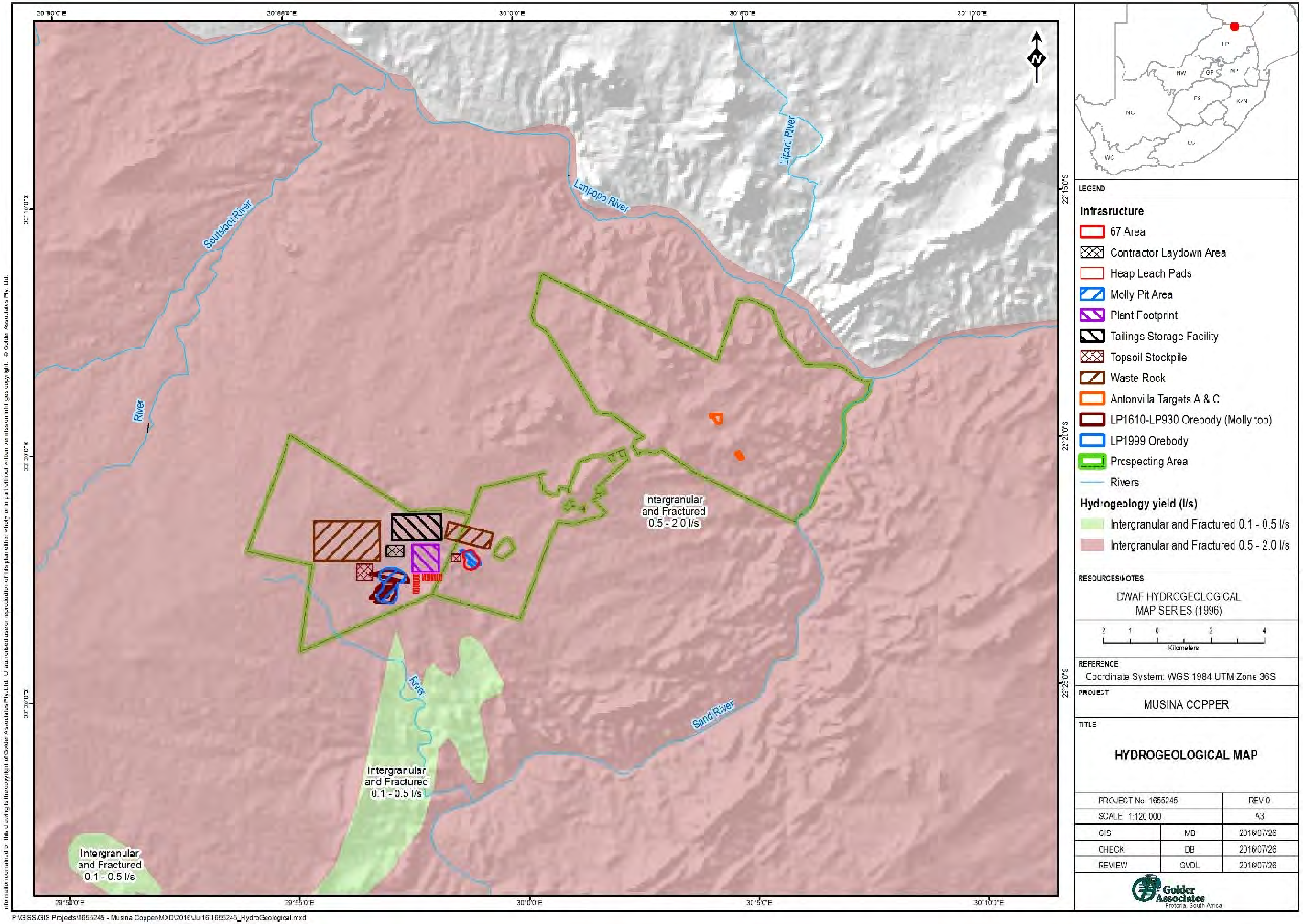

Figure 5: Aquifer classification and average borehole yield

5.4.2 Groundwater Vulnerability

Groundwater vulnerability gives an indication of how susceptible an aquifer is to contamination. Aquifer vulnerability is used to represent the intrinsic characteristics that determine the sensitivity of various parts of an aquifer to being adversely affected by an imposed contaminant load.

A national scale groundwater vulnerability map of South Africa was prepared by the WRC (Water Research Commission), using the DRASTIC methodology that includes the following components:

- **D**epth to groundwater;
- **R**echarge due to rainfall;
- **A**quifer media;
- **S**oil media;
- **T**opography;
- **I**mpact of the vadose zone; and
- Hydraulic **C**onductivity.

Groundwater vulnerability was classified into six classes ranging from very low to very high.

Groundwater vulnerability at the investigation area is shown on the national groundwater vulnerability map as low to the east of the proposed mining area and medium to high in the central area (Figure 6).

5.4.3 Groundwater Levels and Flow directions

The published hydrogeological maps (DWAF 1996) indicate the water level to be between 20 to 40 m below ground level (mbgl) and the average ~22.54 mbgl (Figure 7).

With the only available groundwater level data being the groundwater database, it is assumed that the groundwater contours will mimic the topography and regionally the flow will be towards the Sand and Limpopo Rivers. Groundwater levels need to be confirmed.

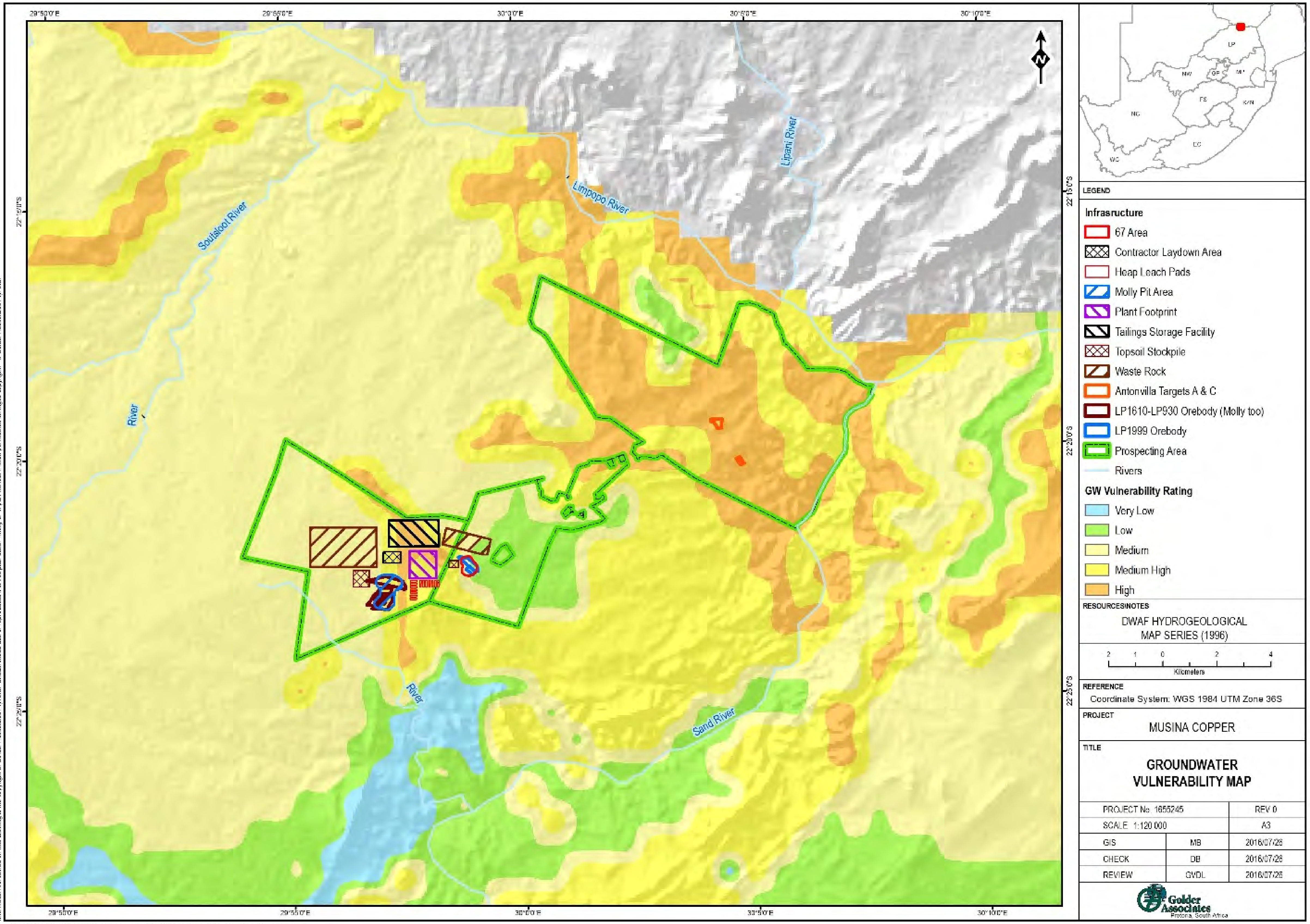

Figure 6: Groundwater vulnerability map

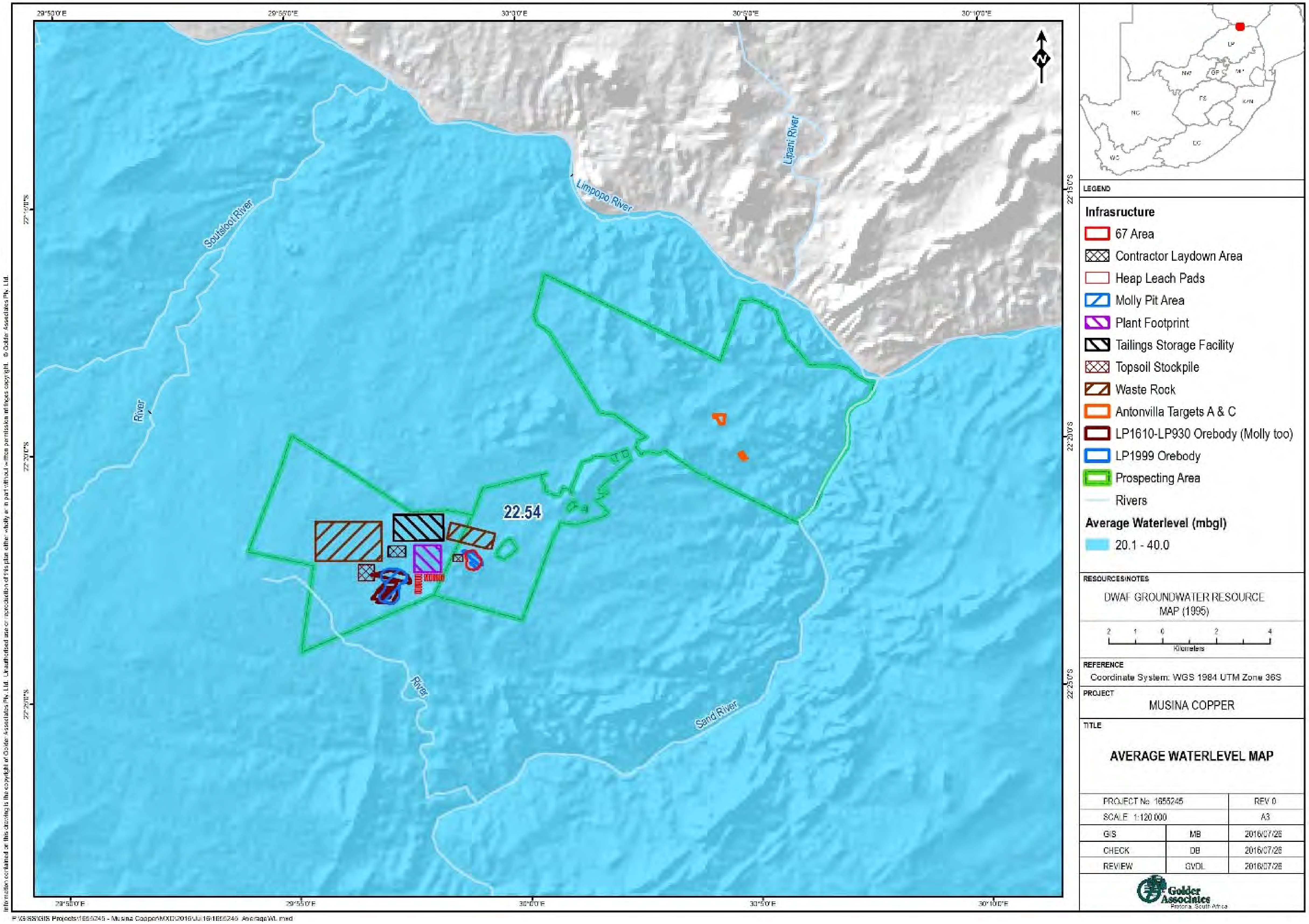

Figure 7: Average ground water level (DWAF 1996)

5.5 Groundwater Conceptual Model

A groundwater conceptual model is an interpretation of the characteristics and dynamics of an aquifer system which is based on an examination of all available hydrogeological data for a modelled area. This includes the external configuration of the system, location and rates of recharge and discharge, location and hydraulic characteristics of natural boundaries, and the directions of groundwater flow throughout the aquifer system.

An initial groundwater conceptual model was developed, using the 1:250 000 geology map series and available groundwater information (Figure 8).

The conceptual model forms the basis for the understanding of the groundwater occurrence and flow mechanisms in the area of investigation, and is used as a basis for future numerical groundwater modelling.

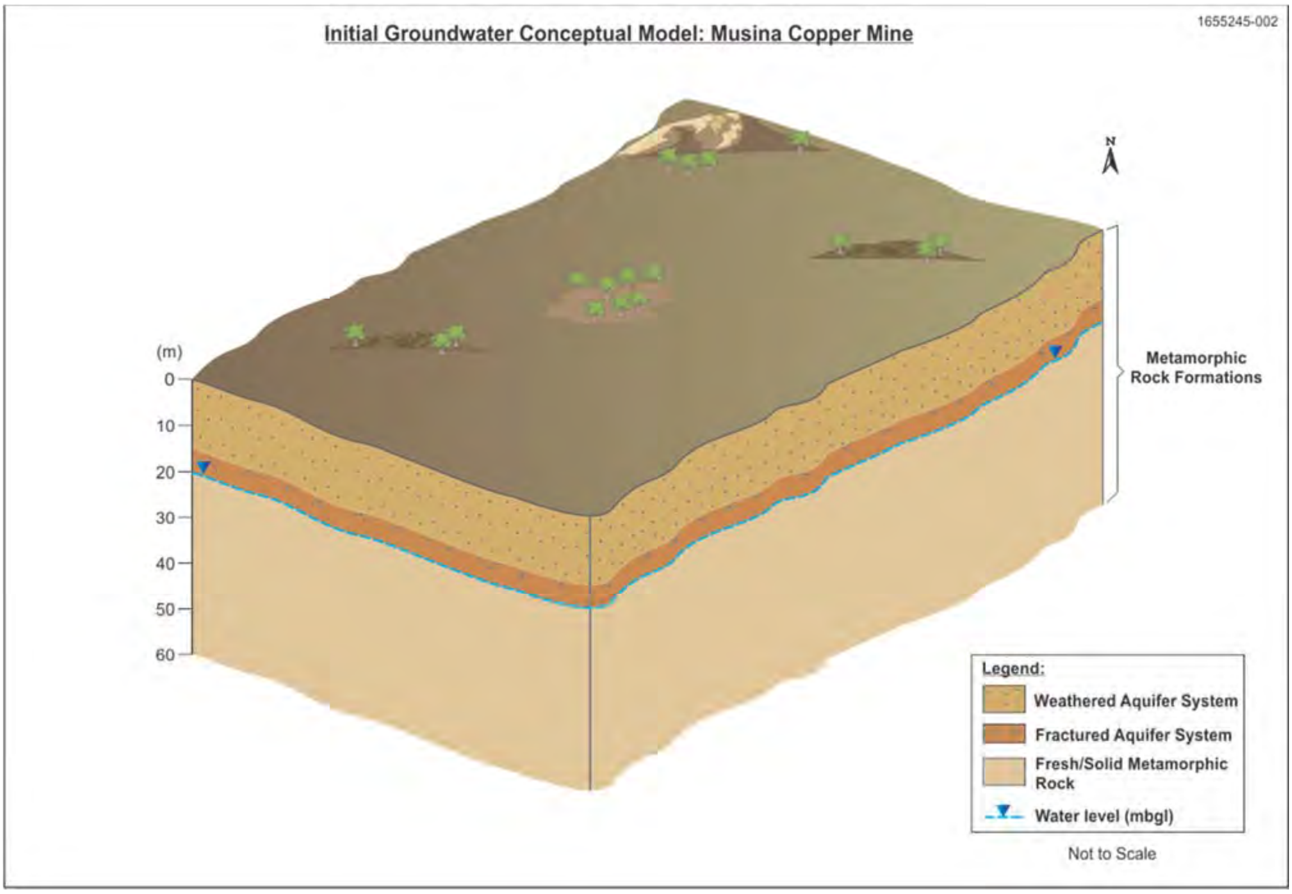

Figure 8: Initial groundwater conceptual model

5.5.1 Aquifer zones

Two potential aquifer zones are distinguished within metamorphic formations (needs to be confirmed by drilling) namely:

- An upper weathered aquifer system; and
- A fractured underlying aquifer system, controlled by geological structures.

5.6 Groundwater Quality

5.6.1 Regional Groundwater Quality

No existing groundwater quality information is available, however 29 field measured EC Values were recorded on the groundwater data base and range from 110 to 770 mS/m with an average of 211 mS/m (Class 2).

The published hydrogeological maps series by DWAF (1996) was used to define the regional groundwater quality based on EC (Electrical Conductivity) values (Figure 9). The EC values for the investigation area are indicated to the west of proposed mining area as 0 to 70 mS/m (Class 0 water quality) and the remaining area as between 70 to 1 000 mS/m (Class 1 to 4). The corresponding water quality classes (DWAF 1996) as per EC values are:

- EC = <70 mS/m = Class 0;
- EC = 70 – 150 mS/m = Class 1;
- EC = 150 – 370 mS/m = Class 2;
- EC = 370 – 520 mS/m = Class 3; and
- EC = >520 mS/m = Class 4

5.7 Aquifer Recharge

5.7.1 Regional Aquifer Recharge

The published hydrogeological maps (DWAF 1996) show the average recharge for the study area as between 1 to 5 mm per annum (Figure 10).

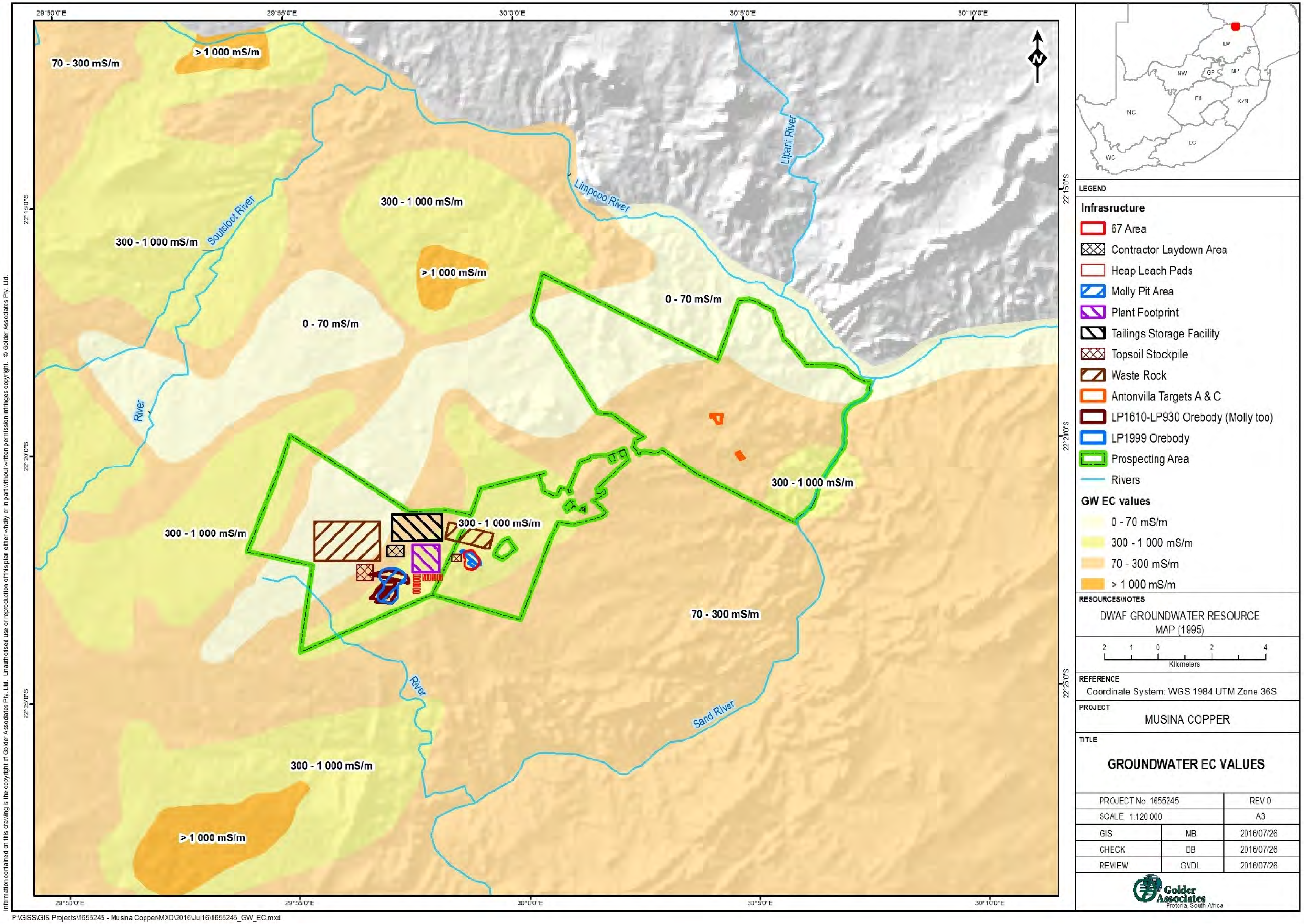

Figure 9: Groundwater quality, EC Values – DWAF (1996)

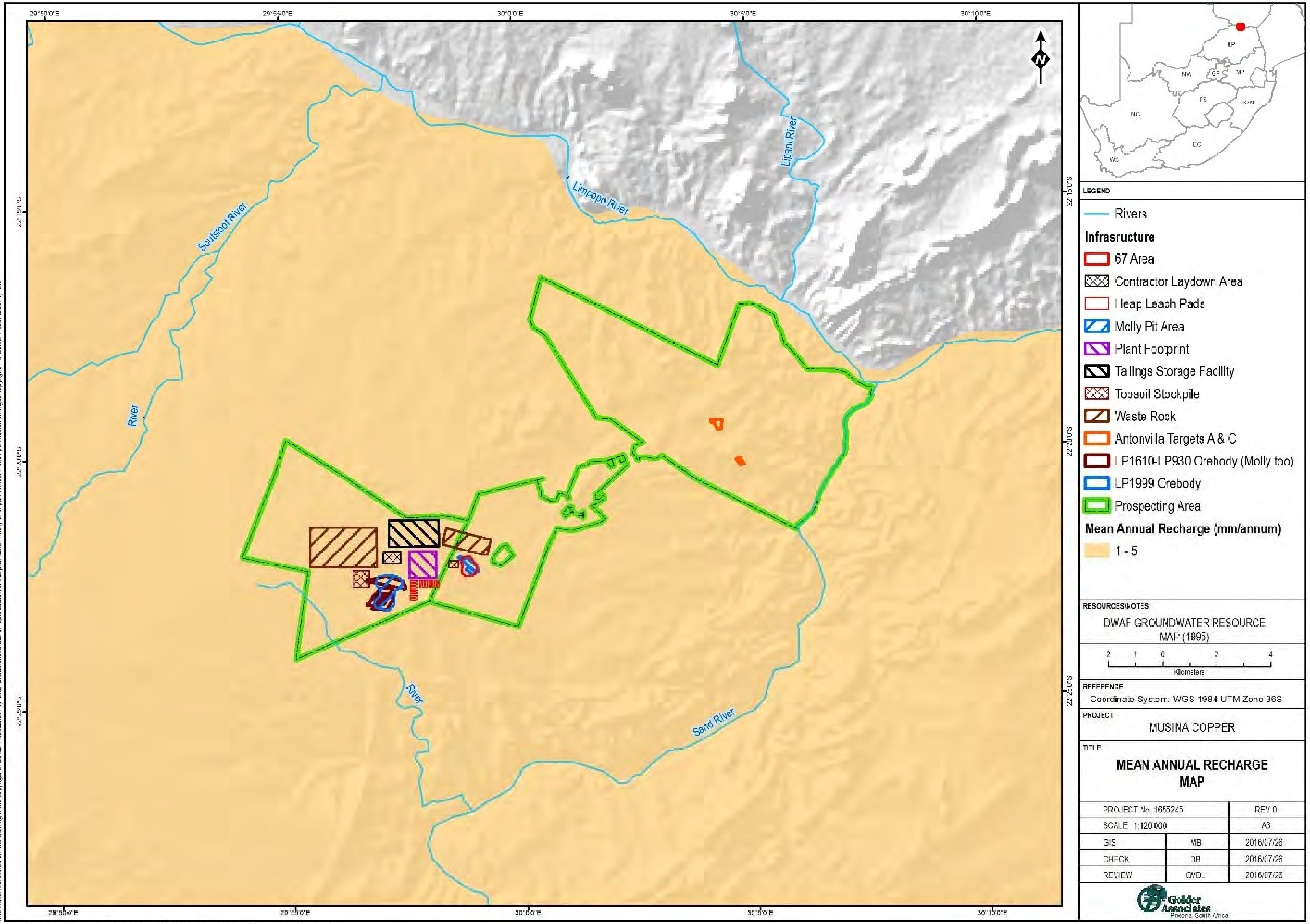

Figure 10: Groundwater mean annual recharge (Vegter 1996)

5.8 Gap Analysis

The aim of the initial gap analysis is to identify any gaps in the available groundwater information. The following groundwater information gaps were identified:

- No existing groundwater reports are available;
- No historical or recent groundwater quality data available;
- Existing borehole positions from the database located on the investigation area need to be verified;
- There are no existing groundwater monitoring boreholes around the proposed mining area. A initial monitoring network needs to be installed to determine background water qualities; and
- There is no available information about hydraulic parameters such as Conductivity (k) and Transmissivity (T), which values would indicate the rate at which groundwater flows in the subsurface. These aquifer parameters can be highly variable in different formations and geological conditions (faults, dykes, sills, and weathering) that apply. These hydraulic parameters are essential to understand and update the conceptual model and form the basis for estimating potential contaminant migration rates. These are calculated from borehole testing results.

6.0 CONCLUSIONS

The following conclusions are drawn from the available groundwater data:

- The investigation area is located within the central zone of the Limpopo mobile belt, an east-north-east trending belt of strongly deformed, largely granulite facies high grade metamorphic rocks which separates the ancient Kaapvaal and Zimbabwe cratons;
- The published hydrogeological maps (DWAF 1996) indicate that the average borehole yield in the area is between 0.5 l/s and 2.0 l/s, with reported yields between 0.04 to 11.36/s;
- The average water levels are approximately ~22.54 mbgl;
- Two potential aquifer zones are distinguished within metamorphic formations (need to be confirmed by drilling) namely:
  - An upper weathered aquifer system; and
  - A fractured underlying aquifer system, controlled by geological structures.
- It is assumed that the groundwater contours will mimic the topography and regionally the groundwater flow will be towards the Sand and Limpopo Rivers.

7.0 RECOMMENDATIONS

Following the groundwater scoping investigation and gap analysis the following additional groundwater work should be undertaken:

- Site familiarization visit and hydrocencus within 2 km of the project footprint to:
  - Determine the status of existing boreholes;
  - Record borehole use and equipment;
  - Record GPS coordinates of boreholes;
  - Measure static water levels to confirm groundwater flow directions; and
  - Groundwater sampling to confirm background groundwater quality of existing groundwater users.

- Geophysical survey to optimize drilling targets for installation of monitoring boreholes around the proposed opencast mining area;
- Drilling of 5 new monitoring boreholes, which will provide:
  - Direct geological and hydrogeological control across the proposed mining right area as required;
  - Provide facilities to undertake aquifer testing and water sample collection; and
  - Serve as future monitoring points (initial groundwater monitoring network).
- Aquifer testing to determine hydraulic parameters and update groundwater conceptual model;
- Groundwater sampling of newly drilled monitoring boreholes to determine baseline water quality;
- Update Initial groundwater conceptual model;
- Numerical groundwater flow and transport model to assess:
  - Impacts on the groundwater levels and yield of existing users, caused by the need to pump to maintain dry working conditions in the proposed mining activities;
  - Impacts on the groundwater quality at existing users;
  - Possible development of pollution plumes emanating from the mining activities; and
  - Develop transport model for pollution impact assessment and control.
- Reporting.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

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APPENDIX A

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Golder Associates

August 2016

SMARTY (SOUTH AFRICA) MINERALS INVESTMENT (PTY) LTD

Scoping Terrestrial Ecology Study for the Proposed Smarty Musina Mine

Submitted to:
Smarty (South Africa) Minerals Investment (Pty) Ltd

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Distribution:

1 x electronic copy Smarty (South Africa) Minerals Investment (Pty) Ltd
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REPORT

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1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd (Golder) was appointed by Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) to conduct a terrestrial ecological assessment of the farms associated with a proposed copper mining and ore beneficiation project, near the town of Musina in Limpopo Province, South Africa.

Proposed project components include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possible electro-winning and/or solvent extraction, tailings disposal, as well as miscellaneous supporting infrastructure.

The terrestrial ecological assessment forms part of the larger Environmental and Social Impact Assessment (ESIA) process, which is aimed at obtaining the necessary rights and authorisations to undertake the proposed mining and beneficiation project. This preliminary scoping report focuses on describing the baseline terrestrial flora and fauna characteristics of the area, based on a desktop review of available literature and datasets, because access to the relevant farms to undertake field work has not been obtained from the landowners. The field work will be undertaken and the preliminary report will be updated after access has been obtained.

1.1 Location of Study Area and Landscape Context

Seven farms comprise the area over which Smarty holds prospecting rights and has applied for a mining right, hereafter collectively referred to as the study area. The study area covers approximately 10 719 ha, and extends on an east-west orientation with the town of Musina located at its centre – see Figure 1. The east of the study area is bounded by the Limpopo River, which acts as the international border between South Africa and Zimbabwe. Beitbridge Border Post is located about 6 km north of the study area.

Apart from urban and commercial infrastructure associated with the town Musina and a few small sites of development or disturbance, much of the study area, as well as the surrounding land, comprises natural habitat. Figure 2 shows an aerial image of the study area.

2.0 TERMS OF REFERENCE

The study aimed to develop a baseline ecological characterisation of the study area. Specific objectives of the study were to:

- Present a description of the study area’s flora and fauna characteristics;
- Identify species (Red List and protected species) and sites of conservation importance occurring in the study area; and
- Identify key ecological processes that occur or potentially occur in the study area and surrounding landscape.

2.1 Legislative Framework

The following national and provincial legislation was consulted during the study:

- National Environmental Management Act (Act No. 107 of 1998) (NEMA);
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA);
- Environment Conservation Act (ECA) (Act No. 73 of 1989);
- Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983);
- National Forests Act (Act No. 84 of 1998); and
- Limpopo Environmental Management Act (Act No. 7 of 2003).

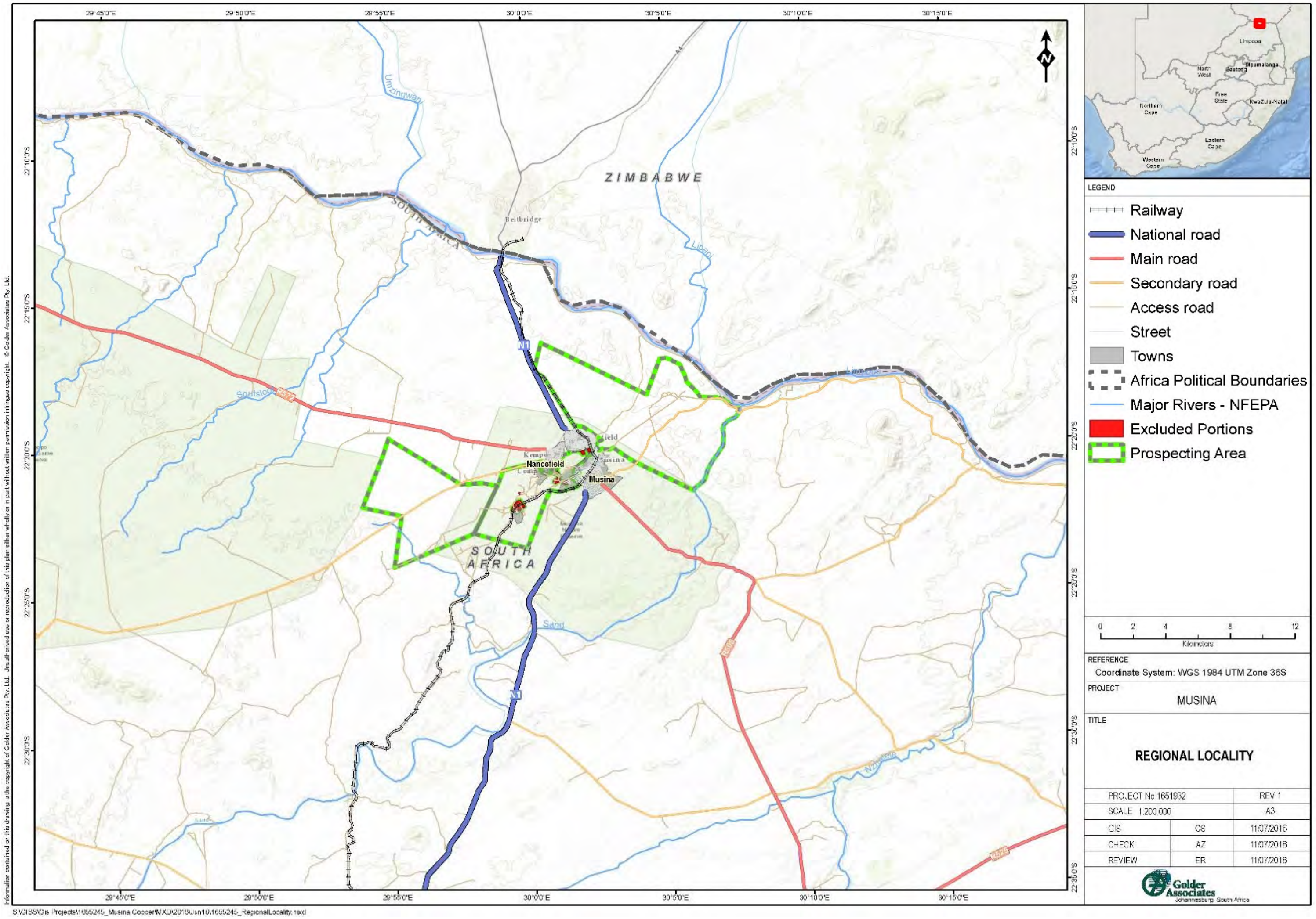

Figure 1: Regional location of the study area

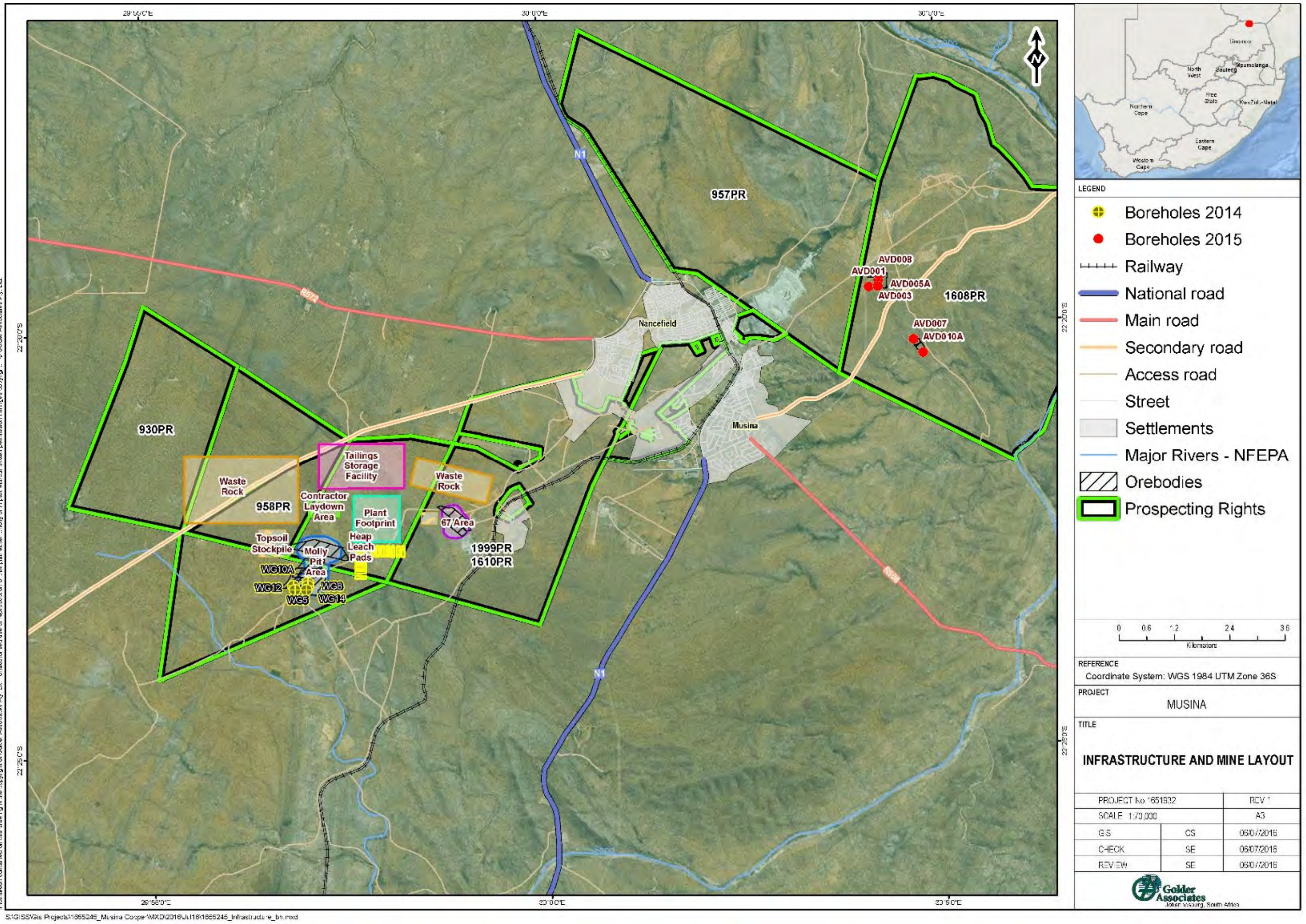

Figure 2: Aerial image of the study area and surrounding landscape

3.0 METHODOLOGY

3.1 Literature Review Component

3.1.1 Vegetation Types and Flora Species

- A general habitat description relevant to the study area was obtained from Scholes & Walker (1993) and Mucina & Rutherford (2006);
- The formal conservation context of the region at a national and provincial level was established, based on the National List of Threatened Ecosystems (*sensu* NEMBA, 2011) and the Limpopo Conservation Plan V2 (2013); and
- Potential flora species likely to occur in the study area were based on existing records for the 2229BD and 2330AC Quarter Degree Square (QDS), as presented by South African National Biodiversity Institute's (SANBI) Plants of South Africa (POSA 2009) database.

For full references for the cited literature and databases, refer to section 7.0.

3.1.2 Fauna Characterisation

Mammals

A list of expected mammal species was compiled by consulting Stuart & Stuart (2007) and the Animal Demograpghic Unit's MammalMAP (ADU - Virtual Museum 2015).

Birds

A list of expected bird species was compiled based on the South African Bird Atlas Project 2 (SABAP 2) list of birds previously recorded in the relevant Pentads. The presence of nearby Important Bird Areas (IBA) was also determined based on BirdLife South Africa (2016).

Herpetofauna (reptiles and amphibians)

Expected reptile and amphibian species lists were compiled by consulting Branch (1994) and Bates*, et al*. (2014) for reptiles, and Minter, *et al.* (2004) and Du Preez & Carruthers (2009) for amphibians. Data were also sourced from the ADU - Virtual Museum's (2015) ReptileMAP and FrogMAP.

Arthropoda

Data on arthropods of conservation importance potentially occuring in the study area were obtained from Henning *et al*. (2009) for butterflies and the ADU - Virtual Museum's (2015) SpiderMAP and ScorpionMAP.

For full references for the cited literature and databases, refer to section 7.0.

3.1.3 Flora and Fauna of Conservation Importance

The Red List and protected status of species occurring or potential occurring in the study area was based on the following sources:

- International Union for the Conservation of Nature (IUCN) Red List of Threatened Species – Regional/National Statuses, as per:
  - Red List of South African Plants Version (SANBI 2015);
  - Red Data Book of Mammals of South Africa (Friedmann & Daly 2004);
  - Regional Red List for Birds of South Africa, Lesotho and Swaziland (BirdLife South Africa 2015);
  - Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland (Bates *et al*. 2014);
  - Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland (Minter *et al*. 2004);

- National Environmental Management: Biodiversity Act (NEMBA) (Act No. 10 of 2004) - Threatened or Protected Species List (Notice 389 of 2013) (NEMBA ToPS List 2013);
- National Forests Act (Act No. 84 of 1998) – List of Protected Tree Species; and
- Limpopo Environmental Management Act (Act No. 7 of 2003), specifically Schedule 2 and 3 concerning Specially Protected and Protected Animals respectively, and Schedule 11 and 12 concerning Specially Protected and Protected Plants respectively.

4.0 LIMITATIONS OF STUDY

This report is based on a desktop review of available ecological literature and datasets, as well as relevant conservation plans and guidelines. The report does not include any field data and will be updated and expanded after completion of the field programme, which will include wet and dry season flora and fauna surveys.

5.0 BASELINE ECOLOGICAL CHARACTERISATION

5.1 General Physical Environment

The study area is located in the Musina Mopane Bushveld and Limpopo Ridge Bushveld vegetation types of the savanna biome (Mucina & Rutherford 2006). (Figure 3).

5.1.1 Savanna Biome

The savanna biome is the largest biome in South Africa, covering approximately 35% of the country's land surface (Scholes & Walker 1993). Savannas are characterised by a dominant grass layer, over-topped by a discontinuous yet distinct woody plant component. Primary determinants of savanna composition, structure and functioning include fire, a distinct seasonal climate, substrate type, as well as browsing and grazing by large herbivores (Scholes & Walker 1993).

Compositionally, Africa's savannas are distinguished as either fine-leafed savannas or broad-leafed savannas. The distribution of these forms is based primarily on soil fertility (Scholes & Walker 1993). Fine-leafed savannas typically occur on nutrient rich soils and are dominated by microphyllous woody species of the *Mimosaceae* family (most commonly *Acacia* species). These savannas have a productive and diverse herbaceous layer that is dominated by grasses and can support large populations of mammalian herbivores (Scholes & Walker 1993).

Conversely, broad-leafed savannas usually occur on nutrient poor soils and are dominated by macrophyllous woody species from the *Combretaceae* family (common genera: *Combretum* & *Terminalia*). Compared to fine-leafed savannas, broad-leafed savannas are less productive and support a lower herbivore biomass (Scholes & Walker 1993).

5.1.2 Musina Mopane Bushveld

Musina Mopane Bushveld is characterised by undulating to very irregular plains, with scattered hills. The western extent of the vegetation type is dominated by open woodland to moderately closed shrubland, with *Colophospermum mopane* prevalent on clayey valley bottoms and *Combretum apiculatum* on the hill sides. In the east, vegetation is characterised by moderately closed to open shrubveld dominated by *Colophospermum mopane* and *Terminalia prunioides.* The herbaceous layer is generally well developed, except in areas of dense *Colophospermum mopane* cover (Mucina & Rutherford 2006).

Important Plant Taxa

Based on Mucina & Rutherford's (2006) classification of South Africa's vegetation types, important plant taxa are those species that have a high abundance, a frequent occurrence (not being particularly abundant) or are prominent in the landscape within a particular vegetation type.

They note the following species as important taxa in Musina Mopane Bushveld:

- **Trees**: Acacia nigrescens, Adansonia digitata, Sclerocarya birrea, Colophospermum mopane, Combretum apiculatum, Acacia senegal var. leiorhachis, A. tortilis, Boscia albitrunca, B. foetida, Commiphora glandulosa, C. tenuipetiolata, C. viminea, Sterculia rogersii, Terminalia prunioides, T. sericea, Ximenia americana, Grewia flava, Gardenia volkensii and Grewia bicolor;
- **Shrubs**: Acalypha indica, Aptosimum lineare, Barleria senensis, Dicoma tomentosa, Felicia clavipilosa, Gossypium herbaceum, Hermannia glanduligera, Neuracanthus africanus, Pechuel-loeschea leubnitziae, Ptycholobium contortum and Seddera suffruticosa;
- **Graminiodes:** Schmidtia pappophoroides, Aristida adscensionis, A. congesta, Bothriochloa insculpta, Brachiaria deflexa, Cenchrus ciliaris, Digitaria eriantha, Enneapogon cenchroides, Eragrostis lehmanniana, E. pallens, Fingerhuthia africana, Heteropogon contortus, Sporobolus nitens, Stipagrostis hirtigluma, S. uniplumis, Tetrapogon tenellus and Urochloa mosambicensis; and
- **Herbs**: Acrotome inflata, Becium filamentosum, Harpagophytum procumbens, Heliotropium steudneri, Hermbstaedtia odorata, Oxygonum delagoense and Stapelia gettliffei.

5.1.3 Limpopo Ridge Bushveld

Like Musina Mopane Bushveld, Limpopo Ridge Bushveld is characterised by irregular plains with ridges and hills. Vegetation structure consists of moderately open savanna, with a poorly developed herbaceous layer. *Kirkia acuminata* typically dominates hilltops, while large *Adansonia digitata* trees defined areas of calcareous gravel (Mucina & Rutherford 2006).

Important Plant Taxa

The following species are important taxa in Limpopo Ridge Bushveld (*sensu* Mucina & Rutherford 2006):

- **Trees**: Acacia nigrescens, Adansonia digitata, Sclerocarya birrea, Colophospermum mopane, Combretum apiculatum, Combretum imberbe, Acacia senegal var. leiorhachis, A. tortilis, Boscia albitrunca, Commiphora glandulosa, C. tenuipetiolata, C. mollis, Kirkia acuminata, Ficus abutilifolia, F. tettensis, Sterculia rogersii, Terminalia prunioides and Ximenia Americana;
- **Shrubs**: Catophractes alexandri, Cissus cornifolia, Commiphora pyracanthoides, Gardenia resiniflua, Grewia bicolor, G. villosa, Hibiscus calyphyllus, H. micranthus, Barleria affinis, Blepharis diversispina, Neuracanthus africanus, Plinthus rehmannii and Ptycholobium contortum;
- **Graminiodes:** Schmidtia pappophoroides, Aristida adscensionis, A. stipitata, Digitaria eriantha, Enneapogon cenchroides and Stipagrostis uniplumis;
- **Herbs**: Tavaresia barklyi; and
- **Endemic Taxa**: Pavonia dentata and Cleome oxyphylla.

5.1.4 Limpopo Conservation Plan (2013)

The provincial coverage of Musina Mopane Bushveld and Limpopo Ridge Bushveld are approximately 880 218 ha and 278 375 ha, respectively. About 2.2% of the former and 19% of the later are formally protected (Limpopo Conservation Plan V2 2013). Despite the relatively low level of formal protection, both vegetation types are listed as Least Threatened at a national (NEMBA Threatened Ecosystems 2011) and provincial (Limpopo Conservation Plan V2 2013) level.

The Limpopo Conservation Plan V2 (2013) recognises parcels of land in the eastern portion of the study area as Critical Biodiversity Areas (CBA) 1 and CBA 2, with remaining portions either uncategorised or considered Ecological Support Areas (ESA) – see Figure 4. Much of the western portion of the study area is unclassified, with the balance mostly categorised as Ecological Support Areas and a small land portion as Critical Biodiversity Area 1 (Figure 4).

Critical Biodiversity Areas are sites that are required to meet biodiversity conservation targets; CBA 1 are considered ‘irreplaceable sites’, while CBA 2 are ‘best design selected sites’ to meet biodiversity targets. As the name implies, ESA have been selected to support CBA’s by maintain ecological processes (Limpopo Conservation Plan V2 2013).

5.1.5 Protected Areas

Two protected areas are situated in the vicinity of the study area:

- Musina Nature Reserve – located immediately south of the study area and Musina town; and
- Maremani Nature Reserve - located to the north of the study area.

The Soutpansberg Important Bird Area (IBA) is situated approximately 30 km south of the study area. This IBA encompasses the Soutpansberg mountain range, which is characterised by a diverse range of habitats including high-altitude grassland and Afromontane forest (BirdLife South Africa 2016). Triggers of IBA status include the presence of over 100 pairs of breeding Cape Vulture (*Gyps coprotheres*), as well as other threatened species, such as Crowned Eagle (*Stephanoaetus coronatus*), Black Stork (*Ciconia nigra*) and Orange Ground Thrush (*Zoothera gurneyi*) (BirdLife South Africa 2016).

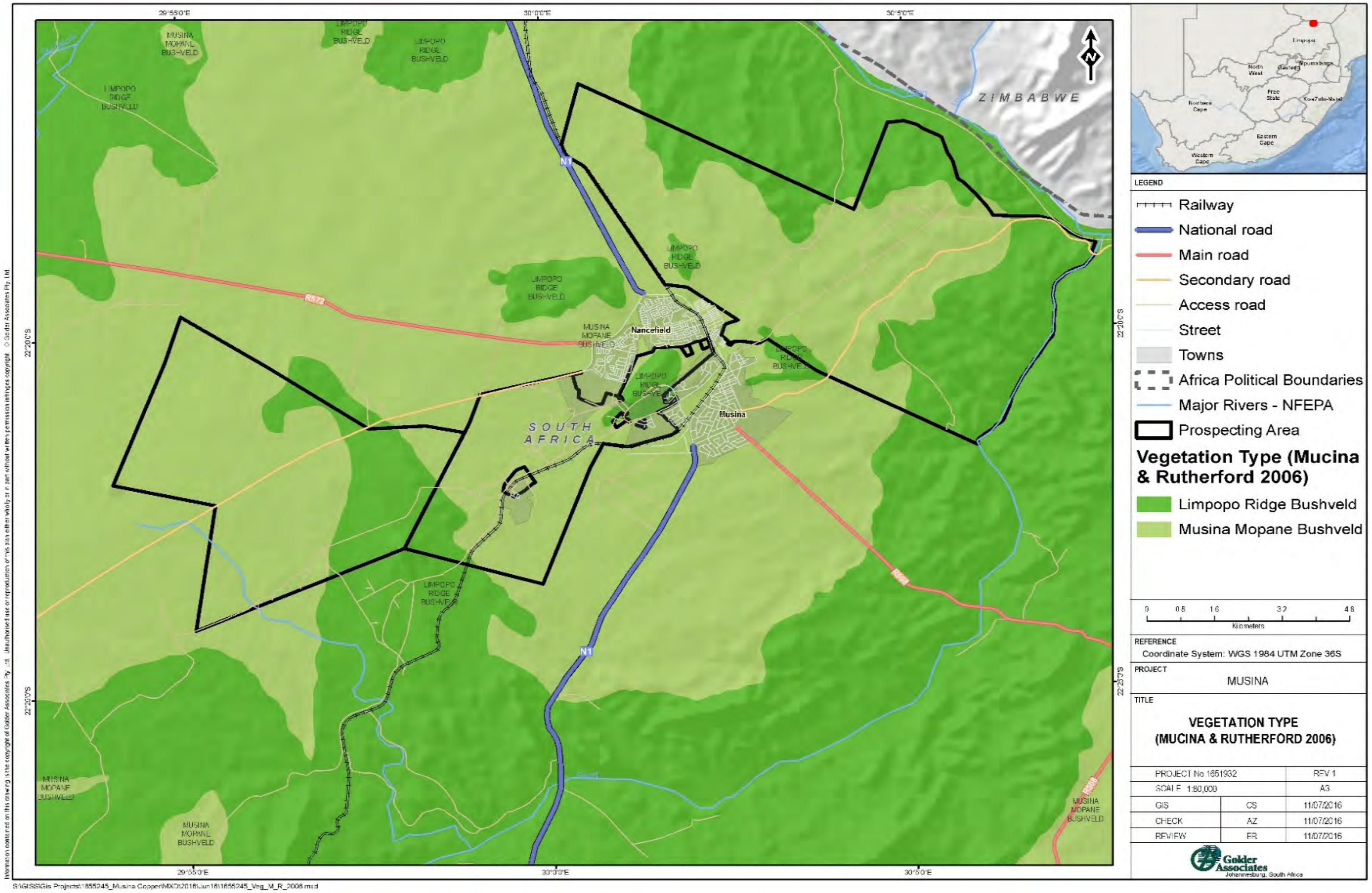

Figure 3: Vegetation types of the region, as per Mucina & Rutherford (2006)

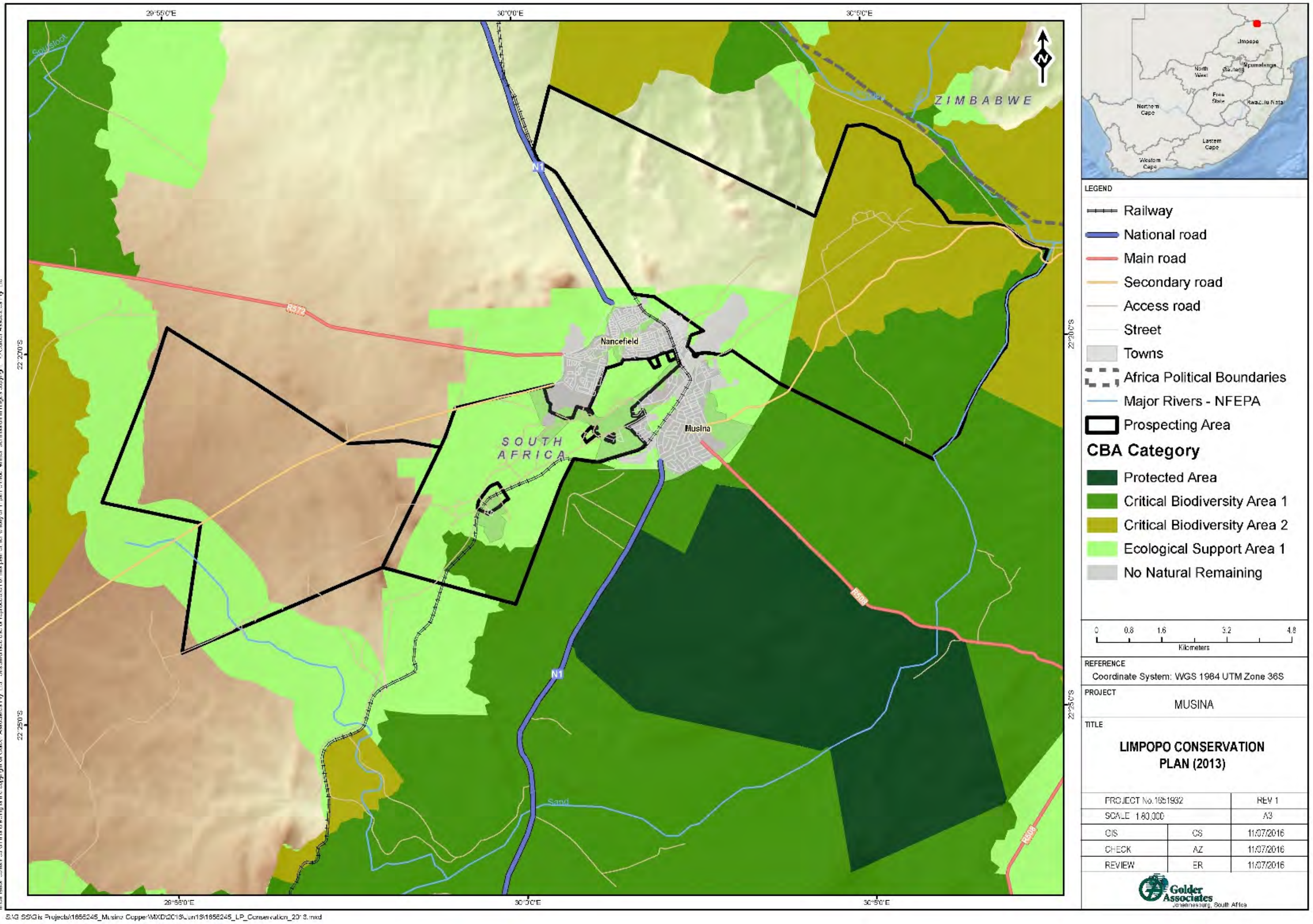

Figure 4: Study area in relation to the Limpopo Conservation Plan V2 (2013)

5.2 Land Cover Characteristics of Study Area

A study of aerial imagery indicates that outside the large residential/commercial areas of Musina and small localised sites of development and disturbance associated with mining and agriculture, virtually the entire study area is covered by indigenous vegetation. This is supported by Geoterra Image (2014) land cover data, which designates the area as 'natural land' – see Figure 5. This pattern is similarly reflected in the surrounding landscape.

Prominent natural landscape features in the study area include:

- The **Limpopo River** abuts the north-east corner of the study area. The Limpopo is the major river system in the region, draining much of the northern interior of South Africa and southern Zimbabwe. The banks of the river adjacent to the study area are characterised by well-developed riparian woodland;
- The smaller **Sand River** flows along the eastern boundary of the study area, and its confluence with the Limpopo River marks the most western point of the area. Vegetation along the river embankments is less well-developed than that along the Limpopo. The Sand River bisects the Musina Nature Reserve; and
- Numerous other smaller drainage features characterise the study area – with most likely to be ephemeral. Of note is a small river emanating in Musina town, which flows through the centre of the eastern portion of the study area. Aerial imagery indicates that tailings material from an existing mine appears to be entering the river in the study area. This river is characterised by a well-vegetated riparian corridor.

5.3 Plant Species of Conservation Importance

The South African National Biodiversity Institutes (SANBI) POSA lists 151 flora species for the 2229BD and 2230AC QDS (see APPENDIX A). This undoubtedly only represents only a small fraction of the total number of flora species present in the region.

Of species contained in the POSA database, only the Vulnerable *Orbea woodii* is on the regional IUCN Red List (SANBI 2015). The flowering plant *Dicliptera cliffordii* has been recorded in Musina Nature Reserve (Nature Conservation Coporation 2013). This species is listed as Rare (SANBI 2015) and may potentially occur in the study area.

Several protected trees, as listed under the National Forests Act (1998), may also potentially occur in the study area. These include *Adansonia digitata, Afzelia quanzensis, Boscia albitrunca, Combretum imberbe, Philenoptera violacea, Sclerocarya birrea* and *Spirostachys africana.*

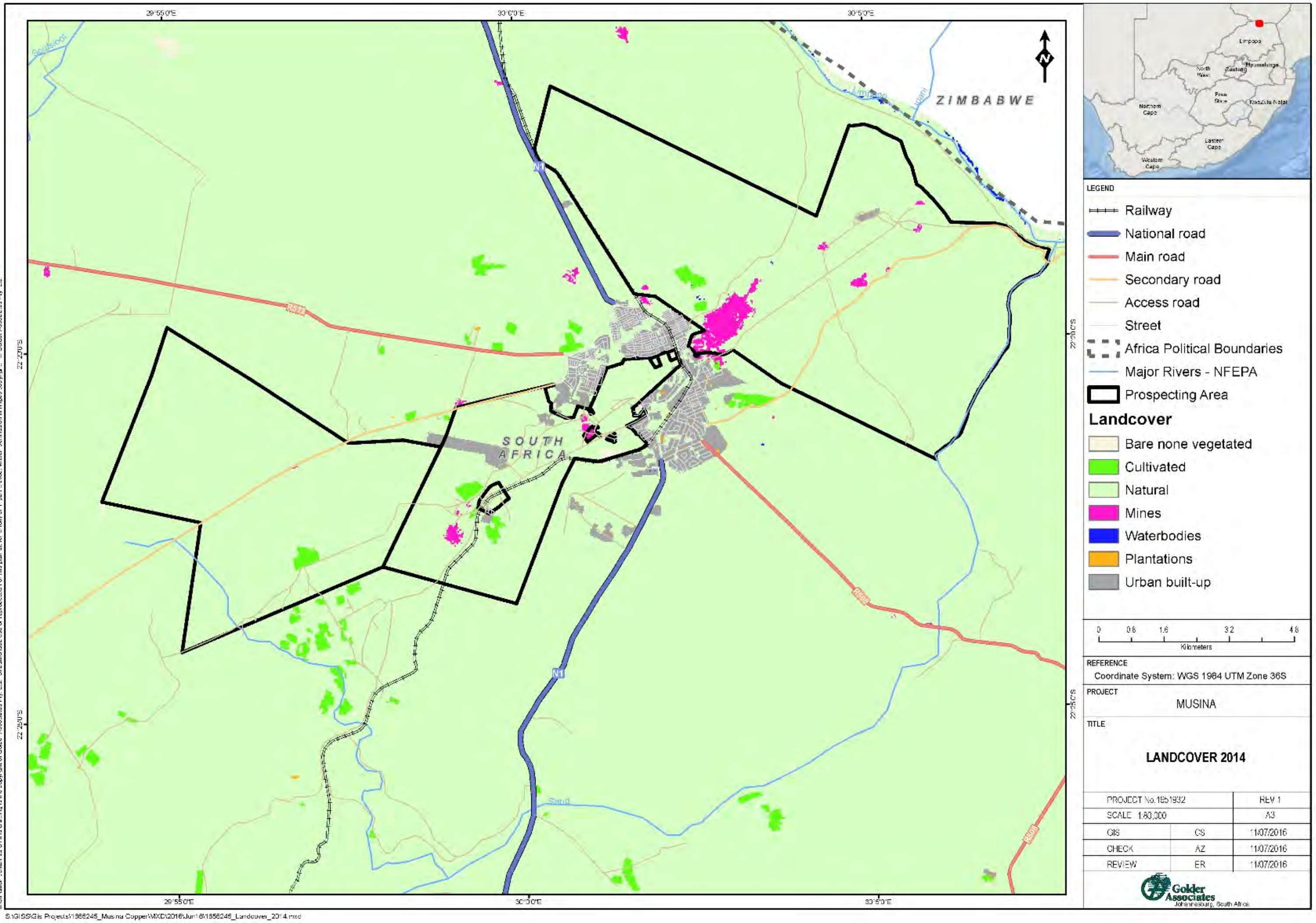

Figure 5: Land cover classes characterising the study area and surrounding landscape

5.4 Fauna

5.4.1 Mammals

The broader northern Limpopo region comprises large tracts of undisturbed natural bushveld habitat, with many farms dedicated to game ranching. It is thus expected that the study area and surrounding landscape will have a rich mammal community - the region's original small to medium-sized mammal assemblages probably remain intact, and it is likely that many large mammals, particularly those not dependent on formal conservation operations, such as Kudu (*Tragelaphus strepsiceros*), may also be present and indeed fairly abundant.

The distribution maps presented in Stuart & Stuart (2007) indicate that, based on historic extent of occurrence[1] (EOO), about 114 mammals potentially occur in the study area – the list of potential mammals (shown in APPENDIX B) includes both conservation dependent[2] and conservation independent[3] species, several of which are of conservation importance - see Table 1.

Table 1: Mammals of conservation importance potentially occurring in the study area.

Common Name	Scientific Name	Conservation Status			Conservation Dependent
		IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	
Blue Wildebeest[2]	*Connochaetes taurinus*	-	Protected	-	Yes
Tsessebe[2]	*Damaliscus lunatus*	Endangered	Endangered	-	Yes
Roan Antelope[2]	*Hippotragus equinus*	Vulnerable	Protected	Specially Protected	Yes
Sable Antelope[2]	*Hippotragus niger*	Vulnerable	Protected	Protected	Yes
Klipspringer	*Oreotragus oreotragus*	-	Protected	Protected	No
Steenbok	*Raphicerus campestris*	-	-	Protected	No
Sharpe's Grysbok	*Raphicerus sharpei*	Near Threatened	Protected	Specially Protected	No
Nyala[2]	*Tragelaphus angasii*	-	Protected	-	Yes/No
Bushbuck[2]	*Tragelaphus scriptus*	-	Protected	-	No
Wild Dog[2]	*Lycaon pictus*	Endangered	Endangered	Specially Protected	Yes/No
Samango Monkey	*Cercopithecus albogularis*	Vulnerable	Vulnerable	Protected	No

[1] Geographical area bounded by the outermost known /projected species' record (Thorn *et al.* 2011).

[2] Species that are generally confined to formal nature reserves and protected areas, or that are actively bred on game farms. Typically includes large ungulates and predators- the presence of conservation dependent species will be determined upon discussions with the land owners.

[3] Species that are free-range, i.e. not confined or dependant on formal nature reserves and protected areas.

Common Name	Scientific Name	Conservation Status			Conservation Dependent
		IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	
South African Hedgehog	*Atelerix frontalis*	Near Threatened	Protected	Protected	No
Cheetah	*Acinonyx jubatus*	Vulnerable	Vulnerable	Protected	Yes/No
Black-footed Cat	*Felis nigripes*	-	Protected	Specially Protected	No
Serval	*Leptailurus serval*	Near Threatened	Protected	Protected	No
Leopard	*Panthera pardus*	-	Protected	Protected	No
Selous's Mongoose	*Paracynictis selousi*	Data Deficient	-	Protected	No
Thick-tailed Galago	*Otolemur crassicaudatus*	-	-	Protected	No
Lesser Bushbaby	*Galago moholi*	-	-	Protected	No
Giraffe	*Giraffa camelopardalis*	-	Protected	Protected	
Hippopotamus	*Hippopotamus amohibius*	-	-	Protected	No
Spotted Hyaena	*Crocuta crocuta*	Near Threatened	Protected	Protected	Yes
Brown Hyaena	*Parahyaena brunnea*	Near Threatened	Protected	Protected	No
Jameson's Red Rock Rabbit	*Pronolagus randensis*	-	-	Protected	No
Ground Pangolin	*Manis temminckii*	Vulnerable	Vulnerable	Specially Protected	No
Water Rat	*Dasymys incomtus*	Near Threatened	-		No
Cape Clawless Otter	*Aonyx capensis*	-	Protected	Protected	No
Honey Badger	*Mellivora capensis*	Near Threatened	-	Protected	No
Aardvark	*Orycteropus afer*	-	Protected	Specially Protected	No
Yellow-spotted Rock Dassie	*Heterohyrax brucei*	-	-	Protected	No

Common Name	Scientific Name	Conservation Status			Conservation Dependent
		IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	
Aardwolf	*Proteles cristatus*	-	-	Protected	No
Darling's Horseshoe Bat	*Rhinolophus darlingi*	Near Threatened	-	-	No
Hildebrandt's Horseshoe Bat	*Rhinolophus hildebrandtii*	Near Threatened	-	-	No
Lesser Wooly Bat	*Kerivoula lanosa*	Near Threatened	-	-	No
Rusty Pipistrelle	*Pipistrellus rusticus*	Near Threatened	-	-	No
African Civet	*Civettictis civetta*	-	-	Protected	No

5.4.2 Birds

The study area encompasses a rich diversity of potential bird habitat, including open and closed bushveld, mountainous terrain and riparian woodland and reedbeds. The SABAP2 lists 287 birds for the pentads in which the study area is located (refer to APPENDIX C for the full list). Documented birds include a range of species typical of arid bushveld. Areas of riparian habitat occurring along the Limpopo and Sand Rivers are particularly important bird habitat, providing large nesting trees for species such as raptors.

Eighteen species of conservation importance are potentially present. These are listed in Table 2, and include one Critically Endangered, seven Endangered, four Vulnerable and five Near Threatened species, as per the IUCN – Regional List (2016). Several species are further recognised on the NEMBA TOPS List (2013) and the Limpopo Environmental Management Act (2003) list of Specially Protected species[4].

Table 2: Bird species of conservation importance potentially occurring in the study area

Common Name	Scientific Name	Conservation Status		
		IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
Bateleur	*Terathopius ecaudatus*	Endangered	Vulnerable	Specially Protected
Kori Bustard	*Ardeotis kori*	Near Threatened	Protected	Specially Protected
Martial Eagle	*Polemaetus bellicosus*	Endangered	Vulnerable	Specially Protected
Tawny Eagle	*Aquila rapax*	Endangered	Vulnerable	-
Verreaux's Eagle	*Aquila verreauxii*	Vulnerable	-	-

[4] All birds, except those listed as Specially Protected or as common game birds, are considered Protected according to the Limpopo Environmental Management Act (2003).

Common Name	Scientific Name	Conservation Status		
		IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
Lanner Falcon	*Falco biarmicus*	Vulnerable	-	-
Ground-hornbill	*Bucorvus leadbeateri*	Endangered	Vulnerable	Specially Protected
Crested Guineafowl	*Guttera edouardi*	-	-	Specially Protected
Pallid Harrier	*Circus macrourus*	Near Threatened	-	-
Greater Painted-snipe	*Rostratula benghalensis*	Near Threatened	-	-
European Roller	*Coracias garrulus*	Near Threatened	-	-
Secretarybird	*Sagittarius serpentarius*	Vulnerable	-	-
Abdim's Stork	*Ciconia abdimii*	Near Threatened	-	-
Black Stork	*Ciconia nigra*	Vulnerable	-	-
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	Endangered	-	Specially Protected
Yellow-billed Stork	*Mycteria ibis*	Endangered	-	-
Cape Vulture	*Gyps coprotheres*	Endangered	Vulnerable	Specially Protected
White-backed Vulture	*Gyps africanus*	Critically Endangered	Protected	-

5.4.3 Herpetofauna

A combination of relatively high summer rainfall, coupled with warm temperatures and high humidity promote a high degree of reptile and amphibian diversity in southern Africa's savannas (du Preez & Carruthers 2009; Alexander & Marais 2010). Indeed, the distribution maps presented in Bates *et al*. (2014) indicate that 122 reptile species have been recorded in the region. Of these, 17 are of conservation importance and may potentially occur in the study area (Table 3). These include three Vulnerable and five Near Threatened species, as per the IUCN regional statuses (Bates *et al*. 2014), as well as several other species listed under either the NEMBA ToPS List (2013) or the Limpopo Environmental Management Act (2003). The region also supports numerous endemic reptile taxa, with 19 regarded as Endemic and nine as Near Endemic – see APPENDIX D.

Thirty two amphibians potentially occur in the study area (Minter *et al*. 2004; du Preez & Carruthers 2009) (APPENDIX D). The Near Threatened Giant Bullfrog (*Pyxicephalus adspersus*) is the only amphibian of conservation importance potentially present. Two records of Giant Bullfrog exist for the far Limpopo Province– one far east and the other far west of the study area (Minter *et al*. 2004). Considering the paucity of records for the region, it is considered unlikely that Giant Bullfrog are present.

Table 3: Reptiles of conservation importance potentially occurring in the study area.

Common Name	Scientific Name	Conservation Status		
		IUCN – Regional Status (2014)	**NEMBA TOPS List (2013)**	**Limpopo Protected Species (2003)**
Soutpansberg Worm Lizard	*Chirindia langi occidentalis*	Vulnerable	-	-
Coppery Grass Lizard	*Chammaesaura aenea*	Near Threatened	-	-
Large-scaled Grass Lizard	*Chammaesaura macropholis*	Near Threatened	Protected	-
Nile Crocodile	*Crocodylus niloticus*	Vulnerable	Vulnerable	Specially Protected
Muller's Velvet Gecko	*Homopholis mulleri*	Vulnerable	-	-
Transvaal Gecko	*Pachydactylus affinis*	-	Protected	-
Cape Gecko	*Pachydactylus capensis*	-	Protected	-
Speckled Gecko	*Pachydactylus punctatus*	-	Protected	-
Tiger Gecko	*Pachydactylus tigrinus*	-	Protected	-
Van Son's Gecko	*Pachydactylus vansoni*	-	Protected	-
Soutpansberg Rock Lizard	*Vhembelacerta rupicola*	Near Threatened	-	-
Black File Snake	*Gonionotophis nyassae*	-	-	Protected
Spotted Rock Snake	*Lamprophis guttatus*	-	Protected	-
South African Python	*Python natalensis*	-	Protected	Protected
Richard's Legless Skink	*Acontias richardi*	Near Threatened	-	-
White-bellied Dwarf Burrowing Skink	*Scelotes limpopoensis albiventris*	Near Threatened	-	-
Horned Adder	*Bitis caudalis*	-	Protected	-

5.4.4 Arthropods

Henning *et al*. (2009) lists nine Red List butterflies for Limpopo Province. Apart from *Telchinia induna salmontana,* which is found in the Soutpansberg Mountains, these butterflies are mostly confined to the Wolkberg area, which is located about 170 km south of the study area (Henning *et al*. 2009).

SpiderMAP records indicate that *Idiothele nigrofulva* has been recorded in the 2230AC QDS. This species is a member of the baboon spider family (Family Theraphosidae), which is considered to be of conservation value. Other members of the Theraphosidae that may present in the study area are listed in Table 4.

Members of the genus *Opistophthalmus* – the burrowing scorpions (Family Scorpionidae) may also be present in the study area. These are also considered to be of conservation value.

Table 4: Arthropods of conservation value potentially occurring in the study area

Family	Genus
Theraphosidae	*Augacephalus*
	Brachionopus
	Ceratogyrus
	Idiothele
Scorpionidae	*Opistophthalmus glabrifrons*
	Opistophthalmus wahlbergii

Source: (Leeming 2003; Dippenaar-Schoeman 2014)

6.0 DISCUSSION AND CONCLUSIONS

The majority of the study area comprises natural, undeveloped habitat that forms part of a broader ecosystem network – with large adjacent areas managed as formal nature reserves. Musina Mopane Bushveld and Limpopo Ridge Bushveld characterise the region's vegetation (Mucina & Rutherford 2006).

Considering the availability and connectivity of natural habitat, prevailing land management practices and the reasonably high degree of habitat heterogeneity across the landscape, it is expected that the study area has a rich fauna assemblage. Literature suggests that two Red List plant species are potentially present, and it is likely that several species of protected trees are fairly abundant on-site. In addition, a number of fauna species that potentially occur on-site are of conservation importance at both a national and provincial level.

Habitat in the study area is of conservation importance. Hansen & DeFries (2007) note that because the spatial domain of many ecological processes operate at broad scales, land use changes in a portion of an ecosystem can cause a rescaling of the ecosystem as a whole, and result in changes in overall functioning and biodiversity. Proposed mining activities in the study area thus may have ecological impacts that extend beyond the project boundary, and that could affect ecological integrity and processes negatively at broader scales.

It is therefore recommended that a field programme consisting of both flora and fauna sampling be undertaken as part of the environmental impact assessment process. The field programme should be undertaken during the wet season survey and should aim to:

- Provide a characterisation of on-site fauna and flora communities;
- Identify species of conservation importance occurring on-site, as well as those having a high probability of occurrence; and
- Characterise habitats and sites of particular sensitivity and/or conservation value, and identify ecosystem processes of importance.

The findings of the field programme should then be used to identify and assess potential negative ecological impacts arising from the proposed mining project, and develop a suite of germane management and mitigation measures for inclusion in the project's environmental management programme.

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APPENDIX A

Plants Listed for the 2229BD & 2330AC QDS by SANBI's POSA Database

Family	Species Name
ACANTHACEAE	*Barleria elegans*
ACANTHACEAE	*Barleria lancifolia* subsp. *lancifolia*
ACANTHACEAE	*Megalochlamys revoluta* subsp. *cognata*
ACANTHACEAE	*Thunbergia atriplicifolia*
AGAPANTHACEAE	*Agapanthus inapertus* subsp. *inapertus*
AMARANTHACEAE	*Achyranthes aspera* var. *sicula*
AMARANTHACEAE	*Amaranthus praetermissus*
AMARANTHACEAE	*Hermbstaedtia fleckii*
AMARANTHACEAE	*Hermbstaedtia odorata* var. *odorata*
AMARANTHACEAE	*Kyphocarpa angustifolia*
APOCYNACEAE	*Adenium multiflorum*
APOCYNACEAE	*Orbea woodii*
APONOGETONACEAE	*Aponogeton stuhlmannii*
ASPARAGACEAE	*Asparagus cooperi*
ASPARAGACEAE	*Asparagus suaveolens*
ASPHODELACEAE	*Aloe chabaudii* var. *chabaudii*
ASTERACEAE	*Ageratum conyzoides*
ASTERACEAE	*Aspilia mossambicensis*
ASTERACEAE	*Blumea dregeanoides*
ASTERACEAE	*Cotula anthemoides*
ASTERACEAE	*Denekia capensis*
ASTERACEAE	*Dicoma arenaria*
ASTERACEAE	*Felicia mossamedensis*
ASTERACEAE	*Helichrysum umbraculigerum.*
ASTERACEAE	*Laggera crispata*
ASTERACEAE	*Litogyne gariepina*
ASTERACEAE	*Pechuel-Loeschea leubnitziae*
ASTERACEAE	*Pluchea bojeri*
ASTERACEAE	*Schistostephium heptalobum*
ASTERACEAE	*Senecio latifolius*
ASTERACEAE	*Senecio pterophorus*
ASTERACEAE	*Sphaeranthus peduncularis* subsp. *peduncularis*
BORAGINACEAE	*Heliotropium ciliatum*
BORAGINACEAE	*Heliotropium lineare*
BORAGINACEAE	*Heliotropium ovalifolium*
BORAGINACEAE	*Heliotropium zeylanicum*
BORAGINACEAE	*Trichodesma physaloides*
BORAGINACEAE	*Trichodesma zeylanicum*
BRYACEAE	*Rhodobryum roseum*
CAPPARACEAE	*Cleome monophylla*

Family	Species Name
CAPPARACEAE	*Maerua angolensis* subsp. *angolensis*
CAPPARACEAE	*Maerua juncea* subsp. *crustata*
CELASTRACEAE	*Catha edulis*
COMBRETACEAE	*Combretum microphyllum*
COMBRETACEAE	*Terminalia prunioides*
CONVOLVULACEAE	*Ipomoea magnusiana*
CUCURBITACEAE	*Cucumis zeyheri*
CYPERACEAE	*Cyperus austro-africanus*
CYPERACEAE	*Cyperus sexangularis*
CYPERACEAE	*Schoenoplectus senegalensis*
DIOSCOREACEAE	*Dioscorea quartiniana*
EUPHORBIACEAE	*Euphorbia inaequilatera* var. *inaequilatera*
EUPHORBIACEAE	*Euphorbia neopolycnemoides*
EUPHORBIACEAE	*Euphorbia tirucalli*
EUPHORBIACEAE	*Euphorbia transvaalensis*
EUPHORBIACEAE	*Jatropha schlechteri* subsp. *setifera*
FABACEAE	*Acacia nigrescens*
FABACEAE	*Acacia tortilis* subsp. *spirocarpa* var. *spirocarpa*
FABACEAE	*Bolusanthus speciosus*
FABACEAE	*Colophospermum mopane*
FABACEAE	*Desmodium setigerum*
FABACEAE	*Eriosema angustifolium*
FABACEAE	*Indigofera heterotricha*
FABACEAE	*Indigofera holubii*
FABACEAE	*Indigofera ingrata*
FABACEAE	*Indigofera trita* subsp. *scabra*
FABACEAE	*Indigofera trita* subsp. *subulata*
FABACEAE	*Indigofera vicioides* var. *rogersii*
FABACEAE	*Philenoptera violacea*
FABACEAE	*Rhynchosia caribaea*
FABACEAE	*Rhynchosia totta* var. *totta*
FABACEAE	*Schotia brachypetala*
FABACEAE	*Tephrosia longipes* subsp. *longipes* var. *longipes*
FABRONIACEAE	*Fabronia pilifera*
FABRONIACEAE	*Fabronia rehmannii*
FISSIDENTACEAE	*Fissidens rufescens*
GENTIANACEAE	*Sebaea filiformis*
GERANIACEAE	*Monsonia glauca*
GISEKIACEAE	*Gisekia africana* var. *africana*
HYACINTHACEAE	*Dipcadi glaucum*

Family	Species Name
IRIDACEAE	*Crocosmia aurea* subsp. *aurea*
LAMIACEAE	*Leonotis nepetifolia*
LESKEACEAE	*Pseudoleskea leskeoides*
LESKEACEAE	*Pseudoleskeopsis claviramea*
LOBELIACEAE	*Lobelia erinus*
LOPHIOCARPACEAE	*Corbichonia decumbens*
LYTHRACEAE	*Nesaea schinzii*
MALVACEAE	*Abutilon angulatum* var. *angulatum*
MALVACEAE	*Abutilon mauritianum*
MALVACEAE	*Abutilon ramosum*
MALVACEAE	*Abutilon rehmannii*
MALVACEAE	*Hermannia modesta*
MALVACEAE	*Hibiscus cannabinus*
MALVACEAE	*Hibiscus coddii* subsp. *barnardii*
MALVACEAE	*Melhania forbesii*
MALVACEAE	*Sida rhombifolia* subsp. *rhombifolia*
MALVACEAE	*Sterculia rogersii*
MALVACEAE	*Waltheria indica*
MARSILEACEAE	*Marsilea ephippiocarpa*
MELIACEAE	*Entandrophragma caudatum*
MELIACEAE	*Melia azedarach*
MENISPERMACEAE	*Cocculus hirsutus*
MOLLUGINACEAE	*Limeum sulcatum* var. *sulcatum*
MORACEAE	*Ficus capreifolia*
MORACEAE	*Ficus ingens*
NYCTAGINACEAE	*Boerhavia coccinea* var. *coccinea*
NYCTAGINACEAE	*Commicarpus pentandrus*
NYMPHAEACEAE	*Nymphaea nouchali* var. *caerulea*
OCHNACEAE	*Ochna inermis*
OROBANCHACEAE	*Alectra orobanchoides*
PASSIFLORACEAE	*Basananthe pedata*
PEDALIACEAE	*Pterodiscus ngamicus*
PHYLLANTHACEAE	*Bridelia mollis*
PHYLLANTHACEAE	*Phyllanthus reticulatus* var. *reticulatus*
PHYLLANTHACEAE	*Pseudolachnostylis maprouneifolia* var. *maprouneifolia*
POACEAE	*Andropogon chinensis*
POACEAE	*Cenchrus ciliaris*
POACEAE	*Chloris roxburghiana*
POACEAE	*Danthoniopsis dinteri*
POACEAE	*Imperata cylindrica*

Family	Species Name
POACEAE	*Melinis repens* subsp. *grandiflora*
POACEAE	*Panicum infestum*
POACEAE	*Pogonarthria squarrosa*
POACEAE	*Sporobolus acinifolius*
POACEAE	*Urochloa stolonifera*
POLYGONACEAE	*Persicaria lapathifolia*
POLYGONACEAE	*Polygonum aviculare*
POTTIACEAE	*Trichostomum brachydontium*
PTERIDACEAE	*Actiniopteris radiata*
PTERIDACEAE	*Adiantum poiretii*
PTERIDACEAE	*Pteris catoptera* var. *catoptera*
PTERIDACEAE	*Pteris cretica*
RACOPILACEAE	*Racopilum capense*
RUBIACEAE	*Breonadia salicina*
RUBIACEAE	*Canthium armatum*
RUBIACEAE	*Gardenia resiniflua* subsp. *resiniflua*
RUBIACEAE	*Gardenia ternifolia* subsp. *jovis-tonantis* var. *goetzei*
RUBIACEAE	*Sericanthe andongensis* subsp. *andongensis* var. *andongensis*
SCROPHULARIACEAE	*Aptosimum lineare* var. *lineare*
SCROPHULARIACEAE	*Jamesbrittenia micrantha*
SINOPTERIDACEAE	*Cheilanthes hirta* var. *hirta*
SINOPTERIDACEAE	*Cheilanthes viridis* var. *viridis*
SOLANACEAE	*Solanum nigrum*
SOLANACEAE	*Solanum tettense* var. *renschii*
STRYCHNACEAE	*Strychnos spinosa* subsp. *spinosa*
THELYPTERIDACEAE	*Christella gueinziana*
THELYPTERIDACEAE	*Thelypteris confluens*
TURNERACEAE	*Tricliceras glanduliferum*
TURNERACEAE	*Tricliceras longepedunculatum* var. *longepedunculatum*
VISCACEAE	*Viscum rotundifolium*
VITACEAE	*Cissus cornifolia*
Source: POSA (2009)	

APPENDIX B

Mammals Potentially Occurring in the Study Area

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
Bathyerigidae	*Cryptomys hottentotus*	Common Mole-rat	-	-	-
Bovidae	***Aepyceros melampus***	**Impala**	**-**	**-**	-
	Connochaetes taurinus	**Blue Wildebeest**	**-**	**Protected**	-
	Damaliscus lunatus	**Tsessebe**	**Endangered**	**Endangered**	-
	Hippotragus equinus	**Roan Antelope**	**Vulnerable**	**Protected**	**Specially Protected**
	Hippotragus niger	**Sable Antelope**	**Vulnerable**	**Protected**	**Protected**
	Kobus ellipsiprymnus	**Waterbuck**	**-**	**-**	**-**
	Oreotragus oreotragus	Klipspringer	-	Protected	Protected
	Raphicerus campestris	Steenbok	-	-	Protected
	Raphicerus sharpei	Sharpe’s Grysbok	Near Threatened	Protected	Specially Protected
	Sylvicapra grimmia	Common Duiker	-	-	-
	Tragelaphus angasii	Nyala	-	Protected	-
	Tragelaphus oryx	**Eland**	**-**		-
	Tragelaphus scriptus	Bushbuck	-	Protected	-
	Tragelaphus strepsiceros	Kudu	-	-	-
	Damaliscus lunatus	**Tsessebe**	**-**	**-**	**Protected**
Canidae	*Canis mesomelas*	Black-backed Jackal	-	-	-
	Lycaon pictus	Wild Dog	Endangered	Endangered	Specially Protected

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
Cercopithecidae	*Papio cynocephalus ursinus*	Chacma Baboon	-	-	-
	Cercopithecus albogularis	Samango Monkey	Vulnerable	Vulnerable	Protected
	Cercopithecus pygerythrus	Vervet Monkey	-	-	-
Emballonuridae	*Taphozous mauritianus*	Mauritian Tomb Bat	-	-	-
Erinaceidae	*Atelerix frontalis*	South African Hedgehog	Near Threatened	Protected	Protected
Equidae	***Equus quagga***	**Plains Zebra**	**-**	**-**	**-**
Felidae	*Acinonyx jubatus*	Cheetah	Vulnerable	Vulnerable	Protected
	Caracal caracal	Caracal	-	-	-
	Felis nigripes	Black-footed Cat	-	Protected	Specially Protected
	Felis sylvestris	African wild Cat	-	-	-
	Leptailurus serval	Serval	Near Threatened	Protected	Protected
	Panthera pardus	Leopard	-	Protected	Protected
Herpestidae	*Atilax paludinosus*	Water Mongoose	-	-	-
	Galerella sanguinea	Slender Mongoose	-	-	-
	Helogale parvula	Dwarf Mongoose	-	-	-
	Ichneumia albicauda	White-tailed Mongoose	-	-	-
	Mungos mungo	Banded Mongoose	-	-	-
	Paracynictis selousi	Selous's Mongoose	Data Deficient	-	Protected
Galagidae	*Otolemur crassicaudatus*	Thick-tailed Galago	-	-	Protected
	Galago moholi	Lesser Bushbaby	-	-	Protected

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
Giraffidae	***Giraffa camelopardalis***	**Giraffe**	**-**	**Protected**	**Protected**
Hippopotamidae	*Hippopotamus amohibius*	Hippopotamus	-	-	Protected
Hipposideridae	*Hipposideros caffer*	Sundevall's leaf-nosed Bat	Data Deficient	-	-
Hyaenidae	*Crocuta crocuta*	Spotted Hyaena	Near Threatened	Protected	Protected
	Parahyaena brunnea	Brown Hyaena	Near Threatened	Protected	Protected
Hystricidae	*Hystrix africaeaustralis*	Porcupine	-	-	-
Leporidae	*Lepus saxatilis*	Scrub Hare	-	-	-
	Pronolagus randensis	Jameson's Red Rock Rabbit	-	-	Protected
Macroscelididae	*Elephantulus brachyrhynchus*	Peter's Sort-snouted Sengi	-	-	-
	Elephantulus myurus	Eastern Rock Sengi	-	-	-
Mandiae	*Manis temminckii*	Ground Pangolin	Vulnerable	Vulnerable	Specially Protected
Molossidae	*Chaerephon pumila*	Little Free-tailed Bat	-	-	-
	Mops condulurus	Angola Free-tailed Bat	-	-	-
	Mops midas	Midas Free-tailed Bat	-	-	-
	Sauromys petrophilus	Flat-headed Free-tailed Bat	-	-	-
	Tadarida aegyptiaca	Egyptian Free-tailed Bat	-	-	-
Muridae	*Acomys spinosissimus*	Spiny Mouse	-	-	-
	Aethomys chrysophilus	Red Veld Rat	-	-	-

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
	Dasymys incomtus	Water Rat	Near Threatened	-	-
	Dendromus melanotis	Grey Climbing Mouse	-	-	-
	Dendromus mystacalis	Chestnut Climbing Mouse	-	-	-
	Gerbillurus paeba	Hairy-footed Gerbil	-	-	-
	Lemniscomys rosalia	Single-striped Grass Mouse	Data Deficient	-	-
	Mastomys sp.	Multimammate Mouse	-	-	-
	Micaelamys namaquensis	Namaqua Rock Mouse	-	-	-
	Mus minutoides	Pygmy Mouse	-	-	-
	Mus musculus	House Mouse	-	-	-
	Mus neavei	Neave's Pygmy Mouse	Data Deficient	-	-
	Otomys angoniensis	Angoni Vlei Rat	-	-	-
	Rattus rattus	House Rat	-	-	-
	Rhabdomys pumilio	Striped Mouse	-	-	-
	Saccostomus campestris	Pouched Mouse	-	-	-
	Steatomys pratensis	Fat Mouse	-	-	-
	Tatera leucogaster	Bushveld Gerbil	Data Deficient	-	-
	Thallomys paedulcus	Acacia Rat	-	-	-
Mustelidae	*Aonyx capensis*	Cape Clawless Otter	-	Protected	Protected
	Ictonyx striatus	Striped Polecat	Data Deficient	-	-

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
	Mellivora capensis	Honey Badger	Near Threatened	-	Protected
	Poecilogale albinucha	African Striped Weasel	Data Deficient	-	-
Myoxidae	*Graphiurus kelleni*	Lesser Savanna Dormouse	-	-	-
	Graphiurus murinus	Woodland Dormouse	-	-	-
	Graphiurus platyops	Rock Dormouse	Data Deficient	-	-
Nycteridae	*Nycteris thebaica*	Eqyptian Slit-faced Bat	-	-	-
Orycteropodidae	*Orycteropus afer*	Aardvark	-	Protected	Specially Protected
Pedetidae	*Pedetes capensis*	Springhare	-	-	-
Procaviidae	*Procavia capensis*	Rock Hyrax	-	-	-
	Heterohyrax brucei	Yellow-spotted Rock Dassie	-	-	Protected
Protelidae	*Proteles cristatus*	Aardwolf	-	-	Protected
Pteropodidae	*Epomophorus gambianus*	Gambian Epauletted Fruit-bat	Data Deficient	-	-
	Rousettus aegyptiacus	Egyptian Fruit-bat	-	-	-
Rhinolophidae	*Rhinolophus darlingi*	Darling's Horseshoe Bat	Near Threatened	-	-
	Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat	Near Threatened	-	-
	Rhinolophus simulator	Bushveld Horseshoe Bat	-	-	-
Sciuridae	*Paraxerus cepapi*	Tree Squirrel	-	-	-
Soricidae	*Crocidura cyanea*	Reddish-grey Musk Shrew	Data Deficient	-	-
	Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	-	-

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
	Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	-	-
	Crocidura mariquensis	Swamp Musk Shrew	Data Deficient	-	-
	Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	-	-
	Myosorex cafer	Dark-footed Forest Shrew	Data Deficient	-	-
	Suncus lixus	Greater Dwarf Shrew	Data Deficient	-	-
Thryonomyidae	*Thryonomys swinderianus*	Greater Cane-rat	-	-	-
Suidae	*Potamochoerus africanus*	Warthog	-	-	-
	Potamochoerus procus	Bush Pig	-	-	-
Vespertilionidae	*Eptesicus hottentotus*	Long-tailed Serotine Bat	-	-	-
	Neoromicia capensis	Cape Serotine Bat	-	-	-
	Neoromicia nanus	Banana Bat	-	-	-
	Neoromicia zuluensis	Aloe Serotine Bat	-	-	-
	Nycticeinops schlieffenii	Schlieffen's Bat	-	-	-
	Pipistrellus rueppelli	Ruppell's Pipistrelle	-	-	-
	Pipistrellus rusticus	Rusty Pipistrelle	Near Threatened	-	-
	Scotophilus dinganii	Yellow House Bat	-	-	-
	Scotophilus viridis	Lesser Yellow House Bat	-	-	-
Viverridae	*Civettictis civetta*	African Civet	-	-	Protected

Family	Scientific Name	Common Name	Conservation Status		
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)
	Genetta genetta	Small-spotted Genet	-	-	-
	Genetta maculata	Common Large-spotted Genet	-	-	-

Species listed in **bold** text are those that are typically conservation dependent.

Source: Distributions = Stuart & Stuart (2007);Conservation Status = Friedmann & Daly (2004), NEMBA ToPS List (2013) & Limpopo Environmental Management Act (2003)

APPENDIX C

Birds Recorded in the Region as per SABAP2

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Apalis, Bar-throated	*Apalis thoracica*	-	-	-
Apalis, Yellow-breasted	*Apalis flavida*	-	-	-
Babbler, Arrow-marked	*Turdoides jardineii*	-	-	-
Babbler, Southern Pied	*Turdoides bicolor*	-	-	-
Barbet, Acacia Pied	*Tricholaema leucomelas*	-	-	-
Barbet, Black-collared	*Lybius torquatus*	-	-	-
Barbet, Crested	*Trachyphonus vaillantii*	-	-	-
Bateleur, Bateleur	*Terathopius ecaudatus*	Endangered	Vulnerable	Specially Protected
Batis, Chinspot	*Batis molitor*	-	-	-
Bee-eater, European	*Merops apiaster*	-	-	-
Bee-eater, Little	*Merops pusillus*	-	-	-
Bee-eater, Southern Carmine	*Merops nubicoides*	-	-	-
Bee-eater, White-fronted	*Merops bullockoides*	-	-	-
Bittern, Dwarf	*Ixobrychus sturmii*	-	-	-
Boubou, Tropical	*Laniarius aethiopicus*	-	-	-
Brownbul, Terrestrial	*Phyllastrephus terrestris*	-	-	-
Brubru, Brubru	*Nilaus afer*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Buffalo-weaver, Red-billed	*Bubalornis niger*	-	-	-
Bulbul, Dark-capped	*Pycnonotus tricolor*	-	-	-
Bunting, Cinnamon-breasted	*Emberiza tahapisi*	-	-	-
Bunting, Golden-breasted	*Emberiza flaviventris*	-	-	-
Bunting, Lark-like	*Emberiza impetuani*	-	-	-
Bush-shrike, Grey-headed	*Malaconotus blanchoti*	-	-	-
Bush-shrike, Orange-breasted	*Telophorus sulfureopectus*	-	-	-
Bustard, Kori	*Ardeotis kori*	Near Threatened	Protected	Specially Protected
Buttonquail, Kurrichane	*Turnix sylvaticus*	-	-	-
Buzzard, Augur	*Buteo augur*	-	-	-
Camaroptera, Green-backed	*Camaroptera brachyura*	-	-	-
Camaroptera, Grey-backed	*Camaroptera brevicaudata*	-	-	-
Canary, Black-throated	*Crithagra atrogularis*	-	-	-
Canary, Yellow-fronted	*Crithagra mozambicus*	-	-	-
Chat, Familiar	*Cercomela familiaris*	-	-	-
Cisticola, Desert	*Cisticola aridulus*	-	-	-
Cisticola, Rattling	*Cisticola chiniana*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Cisticola, Red-faced	*Cisticola erythrops*	-	-	-
Cisticola, Zitting	*Cisticola juncidis*	-	-	-
Cormorant, Reed	*Phalacrocorax africanus*	-	-	-
Cormorant, White-breasted	*Phalacrocorax carbo*	-	-	-
Coucal, Burchell's	*Centropus burchellii*	-	-	-
Coucal, White-browed	*Centropus superciliosus*	-	-	-
Courser, Bronze-winged	*Rhinoptilus chalcopterus*	-	-	-
Courser, Temminck's	*Cursorius temminckii*	-	-	-
Crombec, Long-billed	*Sylvietta rufescens*	-	-	-
Crow, Pied	*Corvus albus*	-	-	-
Cuckoo, African	*Cuculus gularis*	-	-	-
Cuckoo, Black	*Cuculus clamosus*	-	-	-
Cuckoo, Diderick	*Chrysococcyx caprius*	-	-	-
Cuckoo, Jacobin	*Clamator jacobinus*	-	-	-
Cuckoo, Klaas's	*Chrysococcyx klaas*	-	-	-
Cuckoo, Levaillant's	*Clamator levaillantii*	-	-	-
Cuckoo, Red-chested	*Cuculus solitarius*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Cuckoo-shrike, Black	*Campephaga flava*	-	-	-
Cuckoo-shrike, White-breasted	*Coracina pectoralis*	-	-	-
Darter, African	*Anhinga rufa*	-	-	-
Dove, Laughing	*Streptopelia senegalensis*	-	-	-
Dove, Namaqua	*Oena capensis*	-	-	-
Dove, Red-eyed	*Streptopelia semitorquata*	-	-	-
Dove, Rock	*Columba livia*	-	-	-
Drongo, Fork-tailed	*Dicrurus adsimilis*	-	-	-
Duck, African Black	*Anas sparsa*	-	-	-
Duck, Comb	*Sarkidiornis melanotos*	-	-	-
Duck, White-faced	*Dendrocygna viduata*	-	-	-
Eagle, Booted	*Aquila pennatus*	-	-	-
Eagle, Lesser Spotted	*Aquila pomarina*	-	-	-
Eagle, Martial	*Polemaetus bellicosus*	Endangered	Vulnerable	Specially Protected
Eagle, Tawny	*Aquila rapax*	Endangered	Vulnerable	-
Eagle, Verreaux's	*Aquila verreauxii*	Vulnerable	-	-
Eagle, Wahlberg's	*Aquila wahlbergi*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Eagle-owl, Spotted	*Bubo africanus*	-	-	-
Egret, Cattle	*Bubulcus ibis*	-	-	-
Egret, Yellow-billed	*Egretta intermedia*	-	-	-
Eremomela, Burnt-necked	*Eremomela usticollis*	-	-	-
Eremomela, Yellow-bellied	*Eremomela icteropygialis*	-	-	-
Falcon, Amur	*Falco amurensis*	-	-	-
Falcon, Lanner	*Falco biarmicus*	Vulnerable	-	-
Finch, Cut-throat	*Amadina fasciata*	-	-	-
Finch, Red-headed	*Amadina erythrocephala*	-	-	-
Finch, Scaly-feathered	*Sporopipes squamifrons*	-	-	-
Firefinch, Jameson's	*Lagonosticta rhodopareia*	-	-	-
Firefinch, Red-billed	*Lagonosticta senegala*	-	-	-
Fiscal, Common (Southern)	*Lanius collaris*	-	-	-
Fish-eagle, African	*Haliaeetus vocifer*	-	-	-
Flycatcher, Ashy	*Muscicapa caerulescens*	-	-	-
Flycatcher, Marico	*Bradornis mariquensis*	-	-	-
Flycatcher, Pale	*Bradornis pallidus*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Flycatcher, Southern Black	*Melaenornis pammelaina*	-	-	-
Flycatcher, Spotted	*Muscicapa striata*	-	-	-
Francolin, Coqui	*Peliperdix coqui*	-	-	-
Francolin, Crested	*Dendroperdix sephaena*	-	-	-
Go-away-bird, Grey	*Corythaixoides concolor*	-	-	-
Goose, Egyptian	*Alopochen aegyptiacus*	-	-	-
Goshawk, Dark Chanting	*Melierax metabates*	-	-	-
Goshawk, Gabar	*Melierax gabar*	-	-	-
Goshawk, Southern Pale Chanting	*Melierax canorus*	-	-	-
Grebe, Little	*Tachybaptus ruficollis*	-	-	-
Greenbul, Yellow-bellied	*Chlorocichla flaviventris*	-	-	-
Green-pigeon, African	*Treron calvus*	-	-	-
Greenshank, Common	*Tringa nebularia*	-	-	-
Ground-hornbill, Southern	*Bucorvus leadbeateri*	Endangered	Vulnerable	Specially Protected
Guineafowl, Crested	*Guttera edouardi*	-	-	Specially Protected
Guineafowl, Helmeted	*Numida meleagris*	-	-	-
Hamerkop, Hamerkop	*Scopus umbretta*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Harrier, Pallid	*Circus macrourus*	Near Threatened	-	-
Harrier-Hawk, African	*Polyboroides typus*	-	-	-
Hawk-eagle, African	*Aquila spilogaster*	-	-	-
Helmet-shrike, Retz's	*Prionops retzii*	-	-	-
Helmet-shrike, White-crested	*Prionops plumatus*	-	-	-
Heron, Black-headed	*Ardea melanocephala*	-	-	-
Heron, Green-backed	*Butorides striata*	-	-	-
Heron, Grey	*Ardea cinerea*	-	-	-
Heron, Squacco	*Ardeola ralloides*	-	-	-
Hobby, African	*Falco cuvierii*	-	-	-
Hobby, Eurasian	*Falco subbuteo*	-	-	-
Honeyguide, Greater	*Indicator indicator*	-	-	-
Honeyguide, Lesser	*Indicator minor*	-	-	-
Hoopoe, African	*Upupa africana*	-	-	-
Hornbill, African Grey	*Tockus nasutus*	-	-	-
Hornbill, Damara	*Tockus damarensis*	-	-	-
Hornbill, Hybrid Damara/Red-billed	*Tockus damarensis/erythrorhynchus*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Hornbill, Red-billed	*Tockus erythrorhynchus*	-	-	-
Hornbill, Southern Yellow-billed	*Tockus leucomelas*	-	-	-
House-martin, Common	*Delichon urbicum*	-	-	-
Ibis, Hadeda	*Bostrychia hagedash*	-	-	-
Indigobird, Village	*Vidua chalybeata*	-	-	-
Kestrel, Lesser	*Falco naumanni*	-	-	-
Kestrel, Rock	*Falco rupicolus*	-	-	-
Kingfisher, Brown-hooded	*Halcyon albiventris*	-	-	-
Kingfisher, Giant	*Megaceryle maximus*	-	-	-
Kingfisher, Pied	*Ceryle rudis*	-	-	-
Kingfisher, Striped	*Halcyon chelicuti*	-	-	-
Kingfisher, Woodland	*Halcyon senegalensis*	-	-	-
Kite, Black	*Milvus migrans*	-	-	-
Kite, Black-shouldered	*Elanus caeruleus*	-	-	-
Kite, Yellow-billed	*Milvus aegyptius*	-	-	-
Korhaan, Red-crested	*Lophotis ruficrista*	-	-	-
Lapwing, Blacksmith	*Vanellus armatus*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Lapwing, Crowned	*Vanellus coronatus*	-	-	-
Lapwing, Senegal	*Vanellus lugubris*	-	-	-
Lapwing, White-crowned	*Vanellus albiceps*	-	-	-
Lark, Dusky	*Pinarocorys nigricans*	-	-	-
Lark, Fawn-coloured	*Calendulauda africanoides*	-	-	-
Lark, Flappet	*Mirafra rufocinnamomea*	-	-	-
Lark, Monotonous	*Mirafra passerina*	-	-	-
Lark, Rufous-naped	*Mirafra africana*	-	-	-
Lark, Sabota	*Calendulauda sabota*	-	-	-
Mannikin, Bronze	*Spermestes cucullatus*	-	-	-
Martin, Brown-throated	*Riparia paludicola*	-	-	-
Masked-weaver, Lesser	*Ploceus intermedius*	-	-	-
Masked-weaver, Southern	*Ploceus velatus*	-	-	-
Moorhen, Lesser	*Gallinula angulata*	-	-	-
Mousebird, Red-faced	*Urocolius indicus*	-	-	-
Mousebird, Speckled	*Colius striatus*	-	-	-
Myna, Common	*Acridotheres tristis*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Neddicky, Neddicky	*Cisticola fulvicapilla*	-	-	-
Night-Heron, Black-crowned	*Nycticorax nycticorax*	-	-	-
Nightjar, European	*Caprimulgus europaeus*	-	-	-
Nightjar, Fiery-necked	*Caprimulgus pectoralis*	-	-	-
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*	-	-	-
Nightjar, Square-tailed	*Caprimulgus fossii*	-	-	-
Oriole, African Golden	*Oriolus auratus*	-	-	-
Oriole, Black-headed	*Oriolus larvatus*	-	-	-
Oriole, Eurasian Golden	*Oriolus oriolus*	-	-	-
Osprey, Osprey	*Pandion haliaetus*	-	-	-
Ostrich, Common	*Struthio camelus*	-	-	-
Owl, Barn	*Tyto alba*	-	-	-
Owlet, Pearl-spotted	*Glaucidium perlatum*	-	-	-
Oxpecker, Red-billed	*Buphagus erythrorhynchus*	-	-	-
Painted-snipe, Greater	*Rostratula benghalensis*	Near Threatened	-	-
Palm-swift, African	*Cypsiurus parvus*	-	-	-
Paradise-flycatcher, African	*Terpsiphone viridis*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Paradise-whydah, Long-tailed	*Vidua paradisaea*	-	-	-
Parrot, Brown-headed	*Poicephalus cryptoxanthus*	-	-	-
Parrot, Meyer's	*Poicephalus meyeri*	-	-	-
Penduline-tit, Cape	*Anthoscopus minutus*	-	-	-
Petronia, Yellow-throated	*Petronia superciliaris*	-	-	-
Pigeon, Speckled	*Columba guinea*	-	-	-
Pipit, African	*Anthus cinnamomeus*	-	-	-
Pipit, Buffy	*Anthus vaalensis*	-	-	-
Pipit, Bushveld	*Anthus caffer*	-	-	-
Pipit, Plain-backed	*Anthus leucophrys*	-	-	-
Plover, Common Ringed	*Charadrius hiaticula*	-	-	-
Plover, Kittlitz's	*Charadrius pecuarius*	-	-	-
Plover, Three-banded	*Charadrius tricollaris*	-	-	-
Plover, White-fronted	*Charadrius marginatus*	-	-	-
Prinia, Black-chested	*Prinia flavicans*	-	-	-
Prinia, Tawny-flanked	*Prinia subflava*	-	-	-
Puffback, Black-backed	*Dryoscopus cubla*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Pytilia, Green-winged	*Pytilia melba*	-	-	-
Quelea, Red-billed	*Quelea quelea*	-	-	-
Robin-chat, White-browed	*Cossypha heuglini*	-	-	-
Robin-chat, White-throated	*Cossypha humeralis*	-	-	-
Roller, Broad-billed	*Eurystomus glaucurus*	-	-	-
Roller, European	*Coracias garrulus*	Near Threatened	-	-
Roller, Lilac-breasted	*Coracias caudatus*	-	-	-
Roller, Purple	*Coracias naevius*	-	-	-
Roller, Racket-tailed	*Coracias spatulatus*	-	-	-
Ruff, Ruff	*Philomachus pugnax*	-	-	-
Rush-warbler, Little	*Bradypterus baboecala*	-	-	-
Sandgrouse, Double-banded	*Pterocles bicinctus*	-	-	-
Sandpiper, Common	*Actitis hypoleucos*	-	-	-
Sandpiper, Marsh	*Tringa stagnatilis*	-	-	-
Sandpiper, Wood	*Tringa glareola*	-	-	-
Scimitarbill, Common	*Rhinopomastus cyanomelas*	-	-	-
Scops-owl, African	*Otus senegalensis*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Scops-owl, Southern White-faced	*Ptilopsus granti*	-	-	-
Scrub-robin, Bearded	*Cercotrichas quadrivirgata*	-	-	-
Scrub-robin, Kalahari	*Cercotrichas paena*	-	-	-
Scrub-robin, White-browed	*Cercotrichas leucophrys*	-	-	-
Secretarybird, Secretarybird	*Sagittarius serpentarius*	Vulnerable	-	-
Seedeater, Streaky-headed	*Crithagra gularis*	-	-	-
Shikra, Shikra	*Accipiter badius*	-	-	-
Shrike, Crimson-breasted	*Laniarius atrococcineus*	-	-	-
Shrike, Lesser Grey	*Lanius minor*	-	-	-
Shrike, Magpie	*Corvinella melanoleuca*	-	-	-
Shrike, Red-backed	*Lanius collurio*	-	-	-
Shrike, Southern White-crowned	*Eurocephalus anguitimens*	-	-	-
Snake-eagle, Black-chested	*Circaetus pectoralis*	-	-	-
Snake-eagle, Brown	*Circaetus cinereus*	-	-	-
Sparrow, Cape	*Passer melanurus*	-	-	-
Sparrow, House	*Passer domesticus*	-	-	-
Sparrow, Northern Grey-headed	*Passer griseus*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Sparrow, Southern Grey-headed	*Passer diffusus*	-	-	-
Sparrowhawk, Black	*Accipiter melanoleucus*	-	-	-
Sparrowhawk, Little	*Accipiter minullus*	-	-	-
Sparrow-weaver, White-browed	*Plocepasser mahali*	-	-	-
Spurfowl, Natal	*Pternistis natalensis*	-	-	-
Spurfowl, Swainson's	*Pternistis swainsonii*	-	-	-
Starling, Cape Glossy	*Lamprotornis nitens*	-	-	-
Starling, Greater Blue-eared	*Lamprotornis chalybaeus*	-	-	-
Starling, Meves's	*Lamprotornis mevesii*	-	-	-
Starling, Red-winged	*Onychognathus morio*	-	-	-
Starling, Violet-backed	*Cinnyricinclus leucogaster*	-	-	-
Stilt, Black-winged	*Himantopus himantopus*	-	-	-
Stonechat, African	*Saxicola torquatus*	-	-	-
Stork, Abdim's	*Ciconia abdimii*	Near Threatened	-	-
Stork, Black	*Ciconia nigra*	Vulnerable	-	-
Stork, Marabou	*Leptoptilos crumeniferus*		-	-
Stork, Saddle-billed	*Ephippiorhynchus senegalensis*	Endangered	-	Specially Protected

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Stork, White	*Ciconia ciconia*	-	-	-
Stork, Yellow-billed	*Mycteria ibis*	Endangered	-	-
Sunbird, Amethyst	*Chalcomitra amethystina*	-	-	-
Sunbird, Marico	*Cinnyris mariquensis*	-	-	-
Sunbird, Scarlet-chested	*Chalcomitra senegalensis*	-	-	-
Sunbird, White-bellied	*Cinnyris talatala*	-	-	-
Swallow, Barn	*Hirundo rustica*	-	-	-
Swallow, Grey-rumped	*Pseudhirundo griseopyga*	-	-	-
Swallow, Lesser Striped	*Hirundo abyssinica*	-	-	-
Swallow, Red-breasted	*Hirundo semirufa*	-	-	-
Swallow, Wire-tailed	*Hirundo smithii*	-	-	-
Swift, African Black	*Apus barbatus*	-	-	-
Swift, Alpine	*Tachymarptis melba*	-	-	-
Swift, Horus	*Apus horus*	-	-	-
Swift, Little	*Apus affinis*	-	-	-
Swift, White-rumped	*Apus caffer*	-	-	-
Tchagra, Black-crowned	*Tchagra senegalus*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Tchagra, Brown-crowned	*Tchagra australis*	-	-	-
Tern, White-winged	*Chlidonias leucopterus*	-	-	-
Thick-knee, Spotted	*Burhinus capensis*	-	-	-
Thrush, Groundscraper	*Psophocichla litsipsirupa*	-	-	-
Thrush, Kurrichane	*Turdus libonyanus*	-	-	-
Tinkerbird, Yellow-fronted	*Pogoniulus chrysoconus*	-	-	-
Tit, Southern Black	*Parus niger*	-	-	-
Tit-flycatcher, Grey	*Myioparus plumbeus*	-	-	-
Turaco, Purple-crested	*Gallirex porphyreolophus*	-	-	-
Turtle-dove, Cape	*Streptopelia capicola*	-	-	-
Vulture, Cape	*Gyps coprotheres*	Endangered	Vulnerable	Specially Protected
Vulture, White-backed	*Gyps africanus*	Critically Endangered	Protected	-
Wagtail, African Pied	*Motacilla aguimp*	-	-	-
Warbler, Garden	*Sylvia borin*	-	-	-
Warbler, Icterine	*Hippolais icterina*	-	-	-
Warbler, Willow	*Phylloscopus trochilus*	-	-	-
Waxbill, Black-faced	*Estrilda erythronotos*	-	-	-

Common Name	Scientific Name	IUCN – Regional Status (2016)	NEMBA TOPS List (2013)	Limpopo Protected Species* (2003)
Waxbill, Blue	*Uraeginthus angolensis*	-	-	-
Waxbill, Common	*Estrilda astrild*	-	-	-
Waxbill, Violet-eared	*Granatina granatina*	-	-	-
Weaver, Golden	*Ploceus xanthops*	-	-	-
Weaver, Red-headed	*Anaplectes rubriceps*	-	-	-
Weaver, Spectacled	*Ploceus ocularis*	-	-	-
Weaver, Village	*Ploceus cucullatus*	-	-	-
Whydah, Pin-tailed	*Vidua macroura*	-	-	-
Whydah, Shaft-tailed	*Vidua regia*	-	-	-
Wood-dove, Emerald-spotted	*Turtur chalcospilos*	-	-	-
Wood-hoopoe, Green	*Phoeniculus purpureus*	-	-	-
Woodpecker, Bearded	*Dendropicos namaquus*	-	-	-
Woodpecker, Cardinal	*Dendropicos fuscescens*	-	-	-
Woodpecker, Golden-tailed	*Campethera abingoni*	-	-	-
Wren-warbler, Barred	*Calamonastes fasciolatus*	-	-	-

*All birds, except those listed as Specially Protected or as game birds, are Protected in Limpopo Province.

Source: SABAP2

APPENDIX D

Herpetofauna potentially occurring in the study area

Reptiles

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
Agamidae	*Acanthocercus atricollis atricollis*	Southern Tree Agama	-	-	-	-
	Agama aculeata distanti	Eastern Ground Agama	-	-	-	Endemic
	Agama armata	Northern Ground Agama	-	-	-	-
	Agama atra	Southern Rock Agama	-	-	-	Near Endemic
Aphisbaenidae	*Chirindia langi occidentalis*	Soutpanberg Worm Lizard	Vulnerable	-	-	Endemic
	Monopeltis infuscata	Dusky Worm Lizard	-	-	-	-
	Monopeltis sphenorhynchus	Slender Work Lizard	-	-	-	-
	Zygaspis quadrifrons	Kalahari Dwarf Worm Lizard	-	-	-	-
Chamaeleonidae	*Bradypodion transvaalensis*	Northern Dwarf Chameleon	-	-	-	Endemic
	Chamaeleo dilepis	Flap-neck Chameleon	-	-	-	-
Colubridae	*Crotaphopeltis hotamboeia*	Red-lipped Snake	-	-	-	-
	Dasypeltis inornata	Southern Brown Egg-eater	-	-	-	Endemic
	Dasypeltis scabra	Rhombic Egg-eater	-	-	-	-
	Dispholidus typus	Boomslang	-	-	-	-

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Philothamnus hoplogaster	Green Water Snake	-	-	-	-
	Philothamnus natalensis natalensis	Eastern Natal Green Snake	-	-	-	-
	Philothamnus natalensis occidentalis	Western Natal Green Snake	-	-	-	Endemic
	Philothamnus semivariegatus	Spotted Bush Snake	-	-	-	-
	Telescopus semiannulatus semiannulatus	Eastern Tiger Snake	-	-	-	-
	Thelotornis capensis capensis	Southern Twig Snake	-	-	-	-
Cordylidae	*Chammaesaura aenea*	Coppery Grass Lizard	Near Threatened	-	-	Endemic
	Chammaesaura anguina anguina	Cape Grass Lizard	-	-	-	Endemic
	Chammaesaura macropholis	Large-scaled Grass Lizard	Near Threatened	Protected	-	Endemic
	Cordylus jonesii	Jone’s Girdled Lizard	-	-	-	-
	Cordylus vittifer	Common Girdled Lizard	-	-	-	Near Endemic
	Platysaurus relictus	Soutpansberg Flat Lizard	-	-	-	Endemic

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Platysaurus intermedius rhodesianus	Zimbabwe Flat Lizard	-	-	-	-
	Smaug warren depressus	Flat Dragon Lizard	-	-	-	Endemic
Crocodylidae	*Crocodylus niloticus*	Nile Crocodile	Vulnerable	Vulnerable	Specially Protected	-
Elapidae	*Aspidelaps scutatus intermedius*	Intermediate Shield Cobra	-	-	-	-
	Dendroaspis polylepis	Black Mamba	-	-	-	-
	Elapsoidea boulengeri	Boulenger's Garter Snake	-	-	-	-
	Elapsoidea sundevallii	Sundevall's Garter Snake	-	-	-	-
	Naja annulifera	Snouted Cobra	-	-	-	-
	Naja mossambica	Mozambique Spitting Cobra	-	-	-	-
Gekkonidae	*Afroedura transvaalica*	Zimbabwe Flat Gecko	-	-	-	-
	Chondrodactylus turneri	Turner's Gecko	-	-	-	-
	Hemidactylus mabouia	Common Tropical House Gecko	-	-	-	-
	Homopholis mulleri	Muller's Velvet Gecko	Vulnerable	-	-	Endemic
	Homopholis wahbergii	Wahlberg's Velvet Gecko	-	-	-	-

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Lygodactylus capensis capensis	Common Dwarf Gecko	-	-	-	-
	Pachydactylus affinis	Transvaal Gecko	-	Protected	-	Endemic
	Pachydactylus capensis	Cape Gecko	-	Protected	-	-
	Pachydactylus punctatus	Speckled Gecko	-	Protected	-	-
	Pachydactylus tigrinus	Tiger Gecko	-	Protected	-	-
	Pachydactylus vansoni	Van Son's Gecko	-	Protected	-	Near Endemic
	Ptenopus garrulus garrulus	Spotted Barking Gecko	-	-	-	-
Gerrhosauridae	*Broadleysaurus major*	Rough-scaled Plated Lizard	-	-	-	-
	Gerrhosaurus flavigulari	Yellow-throated Plated Lizard	-	-	-	-
	Gerrhosaurus intermedius	Eastern Black-lined Plated Lizard	-	-	-	-
	Matobosaurus validus	Common Giant Plated Lizard	-	-	-	
Lacertidae	*Heliobolus lugubris*	Bushveld Lizard	-	-	-	-
	Meroles squamulosus	Savanna Lizard	-	-	-	-
	Nucras holubi	Holub's Sandveld	-	-	-	-
	Nucras intertexta	Spotted Sandveld Lizard	-	-	-	-

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Nucras ornata	Ornate Sandveld Lizard	-	-	-	-
	Pedioplanis lineoocellata lineoocellata	Spotted Sand Snake	-	-	-	-
	Vhembelacerta rupicola	Soutpansberg Rock Lizard	Near Threatened	-	-	Endemic
Lamprophiidae	*Amblyodipas microphthalma nigra*	Soutpansberg Purple-glossed Snake	-	-	-	Endemic
	Amblyodipas polylepis polylepis	Common Purple-glossed Snake	-	-	-	-
	Aparallactus capensis	Cape centipede-eater	-	-	-	-
	Atractaspis bibronii	Bibron's Stiletto Snake	-	-	-	-
	Boaedon capensis	Common House Snake	-	-	-	-
	Duberria lutrix lutrix	South African Slug Eater	-	-	-	Endemic
	Gonionotophis nyassae	Black File Snake	-	-	Protected	-
	Hemirhagerrhis nototaenia	Eastern Bark Snake	-	-	-	-
	Homoroselaps lacteus	Spotted Harlequin Snake	-	-	-	Endemic
	Lamprophis guttatus	Spotted Rock Snake	-	Protected	-	Near Endemic
	Lycodonomorphus inornatus	Live Ground Snake	-	-	-	Endemic

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Lycodonomorphus rufulus	Brown Water Snake	-	-	-	-
	Lycophidion capense	Cape Wolf Snake	-	-	-	-
	Lycophidion variegatum	Variegatum Wolf Snake	-	-	-	-
	Prosymna bivittata	Two-striped Shovel-snout	-	-	-	-
	Prosymna lineata	Lined Shovel-snout	-	-	-	-
	Prosymna stuhlmannii	East African Shovel-snout	-	-	-	-
	Psammophis angolensis	Dwarf Sand Snake	-	-	-	-
	Psammophis brevirostris	Short-snouted Grass Snake	-	-	-	-
	Psammophis crucifer	Montane Grass Snake	-	-	-	Near Endemic
	Psammophis jallae	Jalla's Sand Snake	-	-	-	-
	Psammophis mossambicus	Olive Grass Snake	-	-	-	-
	Psammophis subtaeniatus	Western Yellow-bellied Sand Snake	-	-	-	-
	Psammophylas tritaeniatus	Striped Grass Snake	-	-	-	-
	Pseudaspis cana	Mole Snake	-	-	-	-
	Rhamphiophis rostratus	Rufous Beaked Snake	-	-	-	-

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Xenocalamus bicolor lineatus	Striped Quill-snouted Snake	-	-	-	-
	Xenocalamus transvaalensis	Speckled Quill-snouted Snake	-	-	-	Near Endemic
Pelomedusidae	*Pelusois sinuatus*	Serrated Hinged Terrapin	-	-	-	-
Pythonidae	*Python natalensis*	South African Python	-	Protected	Protected	-
Scincidae	*Acontias cregoi*	Cregoi's Legless Skink	-	-	-	Near Endemic
	Acontias kgalagadi subtaeniatus	Stripe-bellied Legless Skink	-	-	-	-
	Acontias occidentalis	Savanna Legless Skink	-	-	-	-
	Acontias plumbeus	Giant Legless Skink	-	-	-	-
	Acontias richardi	Richard's Legless Skink	Near Threatened	-	-	Endemic
	Afroablepharus maculicollis	Spotted-neck Snake-eyed Skink	-	-	-	-
	Afroablepharus wahlbergii	Wahlberg's Snake-eyed Skink	-	-	-	-
	Mochlus sundevallii sundevallii	Sundevall's Writhing Skink	-	-	-	-
	Scelotes limpopoensis albiventris	White-bellied Dwarf Burrowing Skink	Near Threatened	-	-	Endemic

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Scelotes limpopoensis limpopoensis	Dwarf Burrowing Skink	-	-	-	-
	Trachylepis capensis capensis	Cape Skink	-	-	-	-
	Trachylepis depress	Eastern Sand Skink	-	-	-	-
	Trachylepis margaritifer	Rainbow Skink	-	-	-	-
	Trachylepis punctatissima	Montane Rock Skink	-	-	-	-
	Trachylepis punctulata	Speckled Sand Skink	-	-	-	-
	Trachylepis striata	Striped Skink	-	-	-	-
	Trachylepis varia	Variable Skink	-	-	-	-
Testudinidae	*Kinixys spekii*	Speke's Hinged-back Tortoise	-	-	-	-
	Psammobates oculifer	Serrated tent Tortoise			-	-
	Stigmochelys pardalis	Leopard Tortoise	-	-	-	-
Typhlopidae	*Afrotyphlops bibronii*	Bibron's Blind Snake	-	-	-	Near Endemic
	Megatyphlops mucruso	Zambezi Giant Blind Snake	-	-	-	-
	Megatyphlops schlegelii	Schlegel's Giant Blind Snake	-	-	-	-

Family	Scientific Name	Common Name	Conservation Status			
			IUCN – Regional Status (2014)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	Endemic Status
	Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	-	-	-	-
Leptotyphlopidae	*Leptotyphlops distanti*	Distant's Thread Snake	-	-	-	Near Endemic
	Leptotyphlops incognitus	Incognito Thread Snake	-	-	-	-
	Leptotyphlops scutifrons	Peter's Thread Snake	-	-	-	-
	Myriopholis longicauda	Long-tailed Thread Snake	-	-	-	-
Varanidae	*Varanus albigularis albigularis*	Rock Monitor	-	-	-	-
	Varanus niloticus	Water Monitor	-	-	-	-
Viperidae	*Bitis arietans arietans*	Puff Adder	-	-	-	-
	Bitis caudalis	Horned Adder	-	Protected	-	-
	Causus defilippii	Snouted Night Adder	-	-	-	-
	Causus rhombeatus	Rhombic Night Adder	-	-	-	-

Source: Distribution = Bates et al. (2014); Conservation Status = Bates et al. (2014), NEMBA ToPS List (2013) & Limpopo Environmental Management Act (2003)

Amphibians

Family	Scientific Name	Common Name	Conservation Status			Recorded in Study Area
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	
Arthroleptidae	*Leptopelis mossambicus*	Brown-backed Tree Frog	-	-	-	
Breviceptidae	*Breviceps adspersus*	Bushveld Rain Frog	-	-	-	
Bufonidae	*Amietophrynus gutturalis*	Guttural Toad	-	-	-	
	Amietophrynus maculatus	Flat-backed Toad	-	-	-	
	Amietophrynus rangeri	Raucous Toad	-	-	-	
	Amietophrynus garmani	Eastern olive Toad	-	-	-	
	Potntonophrynus fenoulheti	Northern Pygmy Toad	-	-	-	
	Schismaderma carens	Red Toad	-	-	-	
Hemisotidae	*Hemisus guineensis*	Guinea Shovel-nosed Frog	-	-	-	
	Hemisus marmoratus	Mottled Shovel-nosed Frog	-	-	-	
Hyperoliidae	*Hyperolius marmoratus*	Painted Reed Frog	-	-	-	
	Kassina maculata	Red-legged Kassina	-	-	-	
	Kassina senegalensis	Bubbling Kassina	-	-	-	
	Phrynomantis bifasciatus	Banded Rubber Frog	-	-	-	
Phrynobatrachidae	*Phrynobatrachus mabiensis*	Dwarf Puddle Frog	-	-	-	

Family	Scientific Name	Common Name	Conservation Status			Recorded in Study Area
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	
	Phrynobatrachus natalensis	Snoring Puddle Frog	-	-	-	
Pipidae	*Xenopus laevis*	Common Platanna	-	-	-	
	Xenopus muelleri	Muller's Platanna	-	-	-	
Ptychadenidae	*Ptychadena anchietae*	Plan Grass Frog	-	-	-	
	Ptychadena mossambica	Broad-banded Grass Frog	-	-	-	
Pyxicephalidae	*Amietia angolensis*	Common River Frog	-	-	-	
	Cacosternum boettgeri	Common Caco	-	-	-	
	Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	-	Protected	
	Pyxicephalus edulis	African Bullfrog	-	-	-	
	Strongylopus bonaespei	Banded Stream Frog	-	-	-	
	Strongylopus fasciatus	Striped Stream Frog	-	-	-	
	Strongylopus grayii	Clicking Stream Frog	-	-	-	
	Tomopterna cryptotis	Tremolo Sand Frog	-	-	-	
	Tomopterna krugerensis	Knocking Sand Frog	-	-	-	
	Tomopterna marmorata	Russet-backed Sand Frog	-	-	-	
	Tomopterna natalensis	Natal Sand Frog	-	-	-	

Family	Scientific Name	Common Name	Conservation Status			Recorded in Study Area
			IUCN – Regional Status (2004)	NEMBA TOPS List (2013)	Limpopo Protected Species (2003)	
Rhacophoridae	*Chiromanis xerampelina*	Southern Foam Nest Frog	-	-	-	

Source: Distributions = du Preez & Carruthers (2009); Conservation Status = Minter et al. (2004), NEMBA ToPS List (2013) and Limpopo Environmental Management Act (2003)

APPENDIX E

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September 2016

SMARTY (SOUTH AFRICA) MINERALS INVESTMENT (PTY) LTD

Surface Water Baseline and Impact Assessment for Musina Copper Mine

Submitted to:
Smarty (South Africa) Minerals Investment (Pty) Ltd
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Chislehurston
Sandton
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REPORT

Report Number: 1655245-308183-7

Distribution:

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Golder Associates

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1.0 INTRODUCTION

Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) have acquired prospecting rights for copper on seven farms close to Musina in Limpopo Province. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated and Smarty have requested an assessment to undertake the necessary environmental permitting process. Golder Associates Africa (Golder) have been appointed to aid in the process of the application of an Environmental and Water Use License Application (WULA) for the proposed copper mine.

The project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure.

This report considers the surface water aspects of the proposed site and provides considerations for the proposed infrastructure such they conform to Section 19 of the National Water Act (Act No. 36 of 1998) (NWA).

2.0 SCOPE OF WORK

The scope for this baseline assessment was as follows:

- Compiled a map showing the catchment areas, mining and infrastructural areas and the major surface water drainage lines;
- Assessed the available daily rainfall data collected and check for integrity. The rainfall data was patched to produce a daily rainfall record for use in surface water modelling;
- Rainfall statistics such as monthly averages, number of rain days per month, distribution of annual totals and the 2, 5, 10, 20, 50, 100 and 200 year recurrence interval 24 hour storm depths were determined;
- The available climate data was collected and reviewed to produce monthly potential evaporation and temperature statistics based on regional and local climatic data;
- The surface water resources classification in the study area were mapped and described;
- The available flow records were collected from the Department of Water and Sanitation's (DWS) database. The available data was analysed to characterise the flow regimes in the local streams;
- The impact assessment was done by exploring and predicting the effects of the proposed mining project on the pre-project baseline conditions described in the scoping report and acceptable conditions as defined by the standards, guidelines and good practice. Cognisance of Regulation 704 under the National Water Act (Act No. 36 of 1998) (NWA) was taken and recommendations are provided for achieving compliance with the requirements and regulation. Accordingly the study will encompass the following:
  - Determining the quantity and quality of runoff from the proposed mining areas for rainfall events with 50 year recurrence intervals to properly size and design storm water control measures;
  - Delineating clean and dirty areas on the project area from the mining and infrastructure layout plans;
  - A stormwater model (PCSWMM) was set up and applied to determine the layout and sizes of the conveyance structures required for the clean and dirty water collection systems and pollution control dam(s) to meet the requirements of Regulation 704 of the NWA. A water balance schematic is to be completed and will be developed with the plant designers, mine planners, infrastructure engineers and TSF designers.
- The 50 year and 100 year flood lines were determined for streams that could be impacted by the proposed project. The flood lines were calculated using the HEC-RAS programme. The resulting flood lines were plotted on a map;
- A water quality monitoring programme will be set up for the drainages that could be impacted on by the proposed mining; and

- A specialist report describing the surface water situation will be produced.

3.0 REGIONAL DESCRIPTION

The proposed copper mine site is located within the A71K Quaternary catchment in the Limpopo province. The site infrastructure will be located approximately 5 km west of the town of Musina and the N1 national road. There is a tributary that runs through the proposed prospecting rights area. This tributary flows in a South Easterly direction for approximately 14 km and until joins the Sand River. The Sand River flows in a North Easterly direction where it meets the Limpopo River. A number of non-perennial rivers exist on the proposed copper mine site.

4.0 WATER RESOURCE CLASSIFICATION

Classification of water resources aims to ensure that a balance is reached between the need to protect and sustain water resources on the one hand and the need to develop and use its resource on the other. The Water Resource Classification System (Department of Water and Forestry, 2007) places the following principles at the forefront of implementation:

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

The Resource Classification System is used to classify each quaternary catchment in South Africa in either a Class I, II or III, defined as:

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

Water Resource Classification is currently being undertaken in the Limpopo water management area but has not been finalised and has been identified in a detailed gap analysis by the Department of Water and Sanitation.

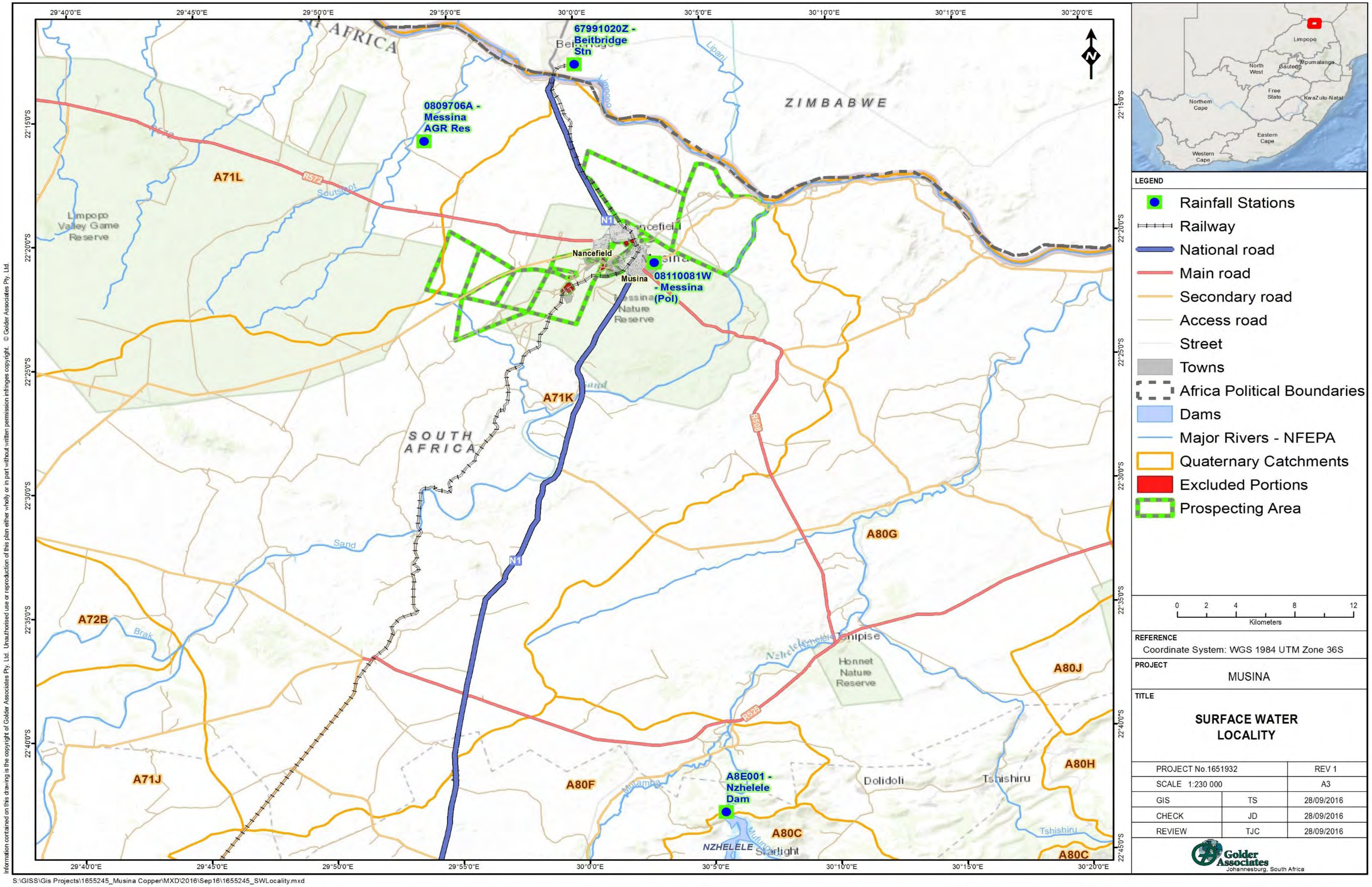


Figure 1: Locality and climate stations map for the proposed Musina site

5.0 ASSESSMENT OF CLIMATE DATA

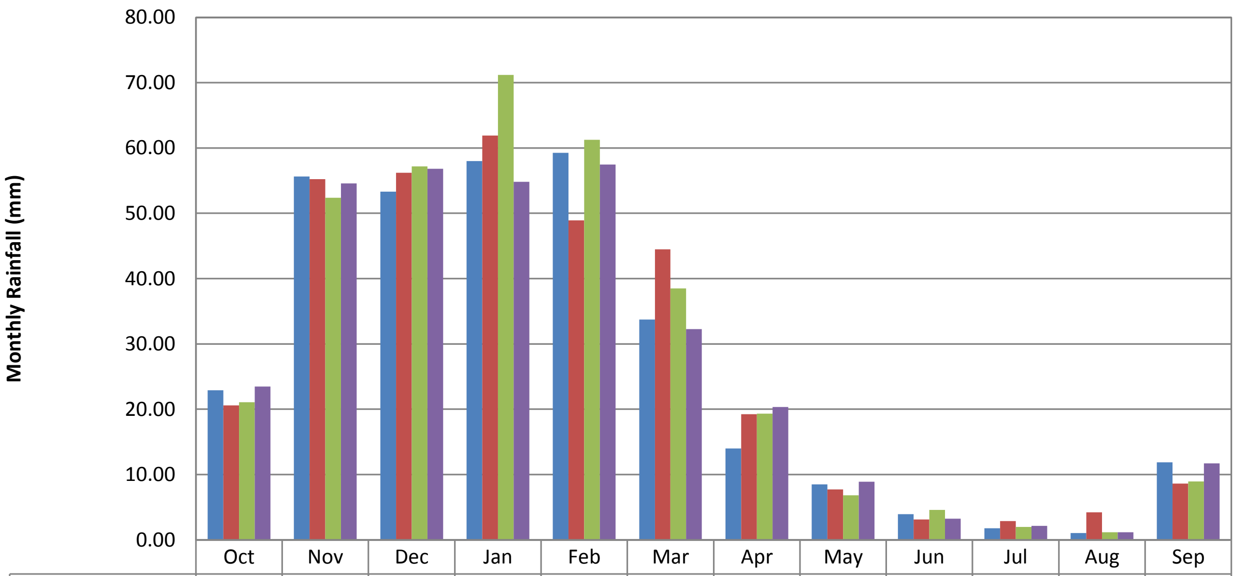
Climate data is essential in forecasting and predicting future risks on site and is divided into three main groups for analysis, these are: rainfall, temperature and evaporation. Climate data in the area around the project site was sourced from the Daily Rainfall extraction utility (Kunz, 2004) and the DWS website (Department of Water Affairs, 2008). The climate stations are presented in Table 1. It was acknowledged that an additional DWS climate station (A7E001) was available in the town of Musina, but it has been inactive since 1965 which will not provide a good representation of the current climate in the region. The A7E001 station has been omitted from the study.

Table 1: Rainfall Stations

Station	Name	Altitude (masl)	From	To	No of Years	MAP(mm)
0810081 W	Messina (Pol)	535	1965	2009	44 (1% patched)	324
A8E001	Nairobi @ Nzhelele Dam	779	1971	2016	45 (1% patched)	333
0809706 A	Messina AGR Res.	520	1933	2000	67 (26% patched)	344
67791020 Z	Beit Bridge Station	451	1959	1999	40 (1% patched)	327

5.1 Rainfall

Figure 2 shows the monthly rainfall distribution for the four rainfall stations in the region for the duration of the rainfall record period.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Messina (Pol)	22.90	55.64	53.32	58.01	59.28	33.75	13.98	8.49	3.94	1.77	1.05	11.88
Nairobi	20.58	55.23	56.19	61.93	48.92	44.47	19.25	7.72	3.12	2.88	4.24	8.63
Messina AGR Res	21.06	52.39	57.20	71.20	61.25	38.50	19.32	6.82	4.57	1.97	1.17	8.96
Beit Bridge	23.48	54.59	56.80	54.81	57.46	32.26	20.34	8.90	3.23	2.16	1.15	11.72

Figure 2: Monthly rainfall distribution for rainfall stations in the surrounding area

Figure 3 illustrates the cumulative plots of rainfall for the four rainfall stations in the region. This is done to check for any irregularities and anomalies that may have occurred during the rainfall record. Changes in slope and long flat periods are indicative of irregularities and need to be investigated. The monthly cumulative plots do not highlight any anomalies in the data. The 0810081 W station (Messina (Pol)) was chosen as the station used in the study for the following reasons:

- Messina (Pol)'s rainfall record is of a long duration;
- The station Messina (Pol) is the closest climate station to the site and is at a similar altitude as the site;
- The patched data applied to the Messina (Pol) records is minimal, thus providing a reliable set of data; and
- The Messina (Pol) station's MAP falls within a suitable range of other stations in the region.

It was that noted that the Messina (Pol) station had experienced a large storm during the 1999 hydrological year, which was also experienced at the Nairobi and Messina AGR Res stations.

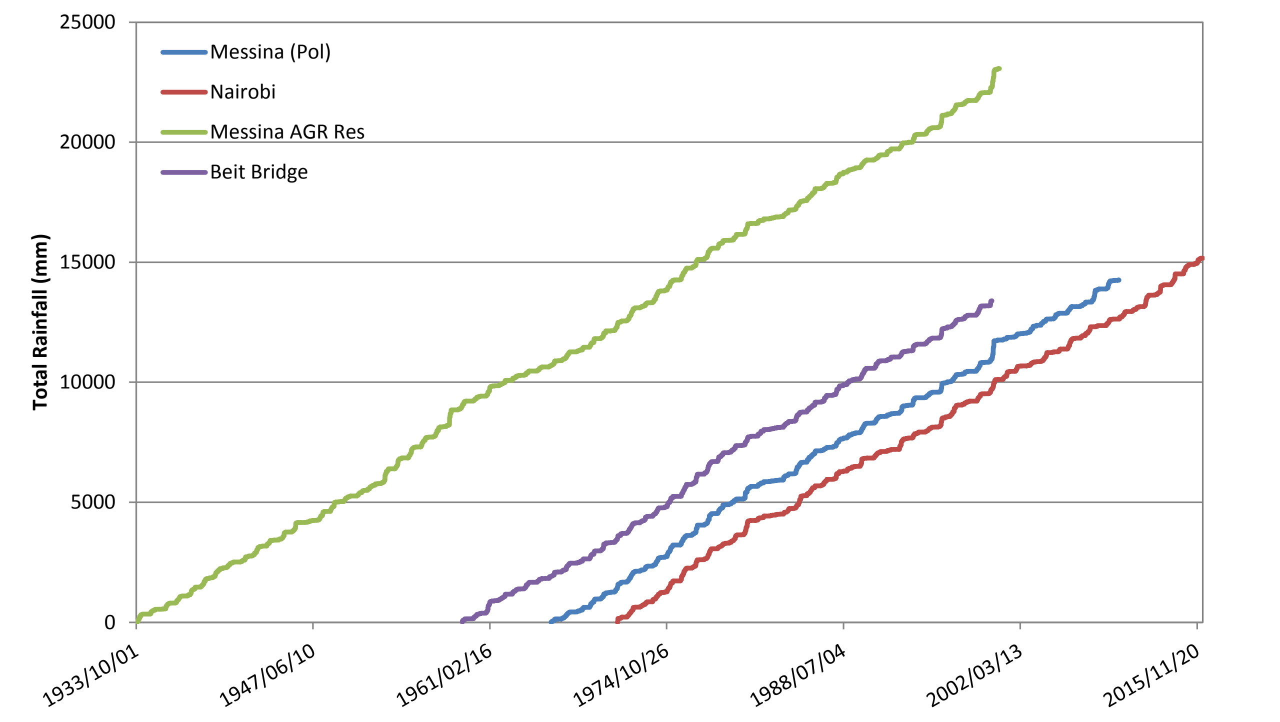


Figure 3: Cumulative rainfall for the rainfall stations in the Musina area

Figure 4 shows the daily rainfall for the 0810081 W (Messina (pol)) station. The plot and MAP recorded is indicative of a low rainfall area.

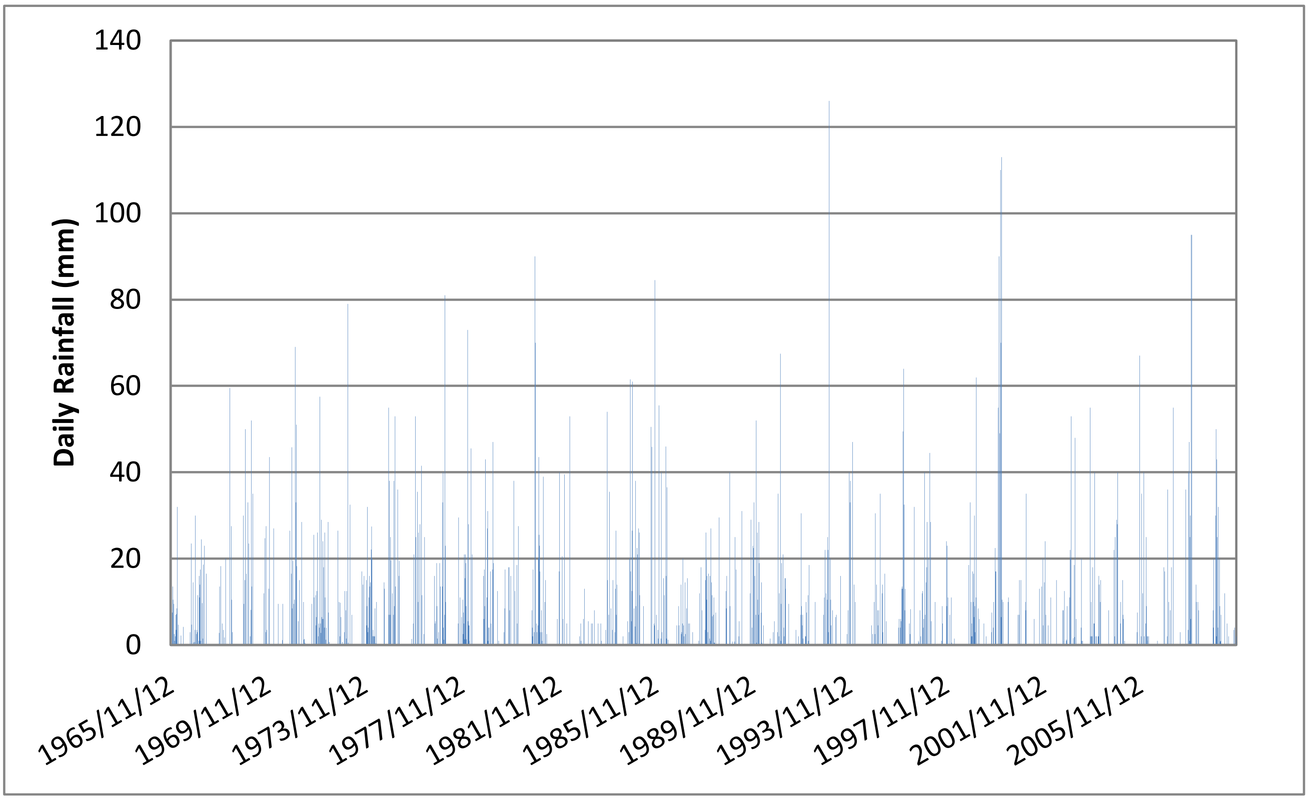


Figure 4: Daily rainfall for the Messina (Pol) station

The boxplot of the monthly rainfall of the Messina (Pol) station shown in Figure 5. A boxplot shows the variations of observed monthly rainfall totals in a five number summary. This includes the 1st percentile, 25th percentile, 50th percentile, 75th percentile and 99th percentile, of the observed monthly rainfall records. The higher rainfall occurs between November and February while very little rain falls between March and October.

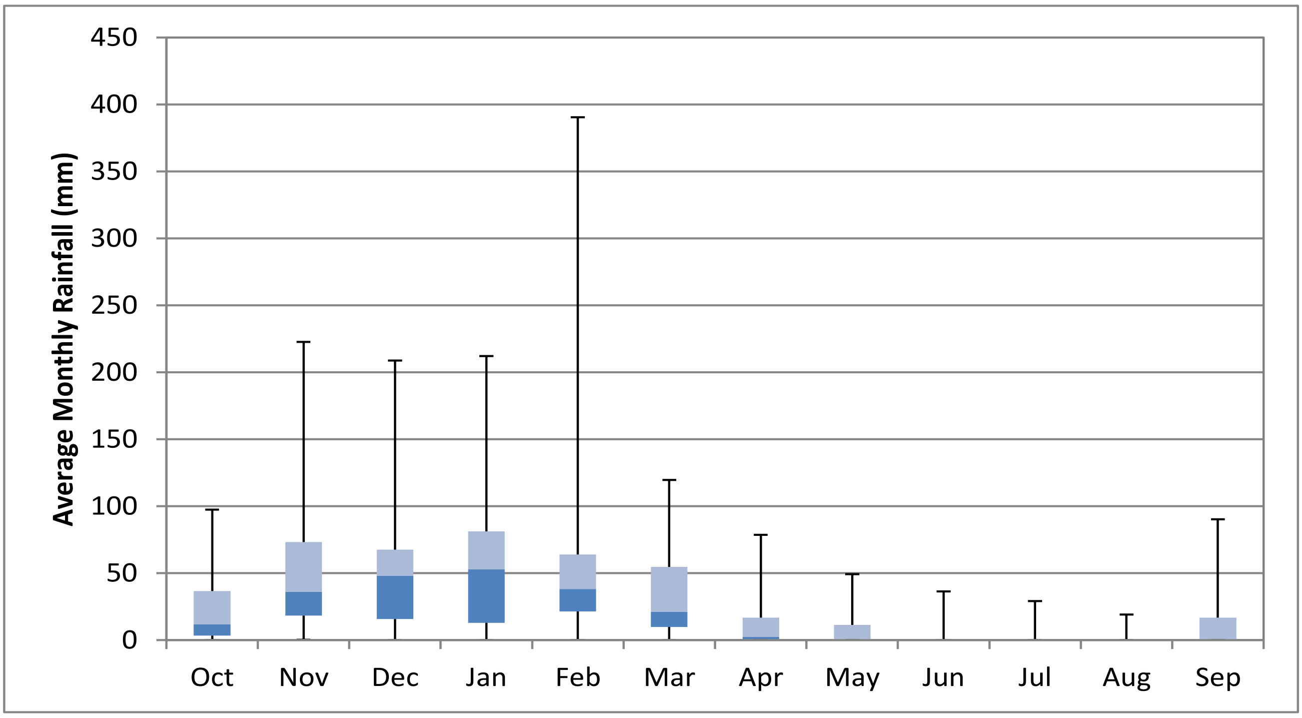


Figure 5: Monthly box plot averages for the Messina (Pol) station

Figure 6 shows the annual rainfall for each year compared to the MAP of the combined rainfall record.

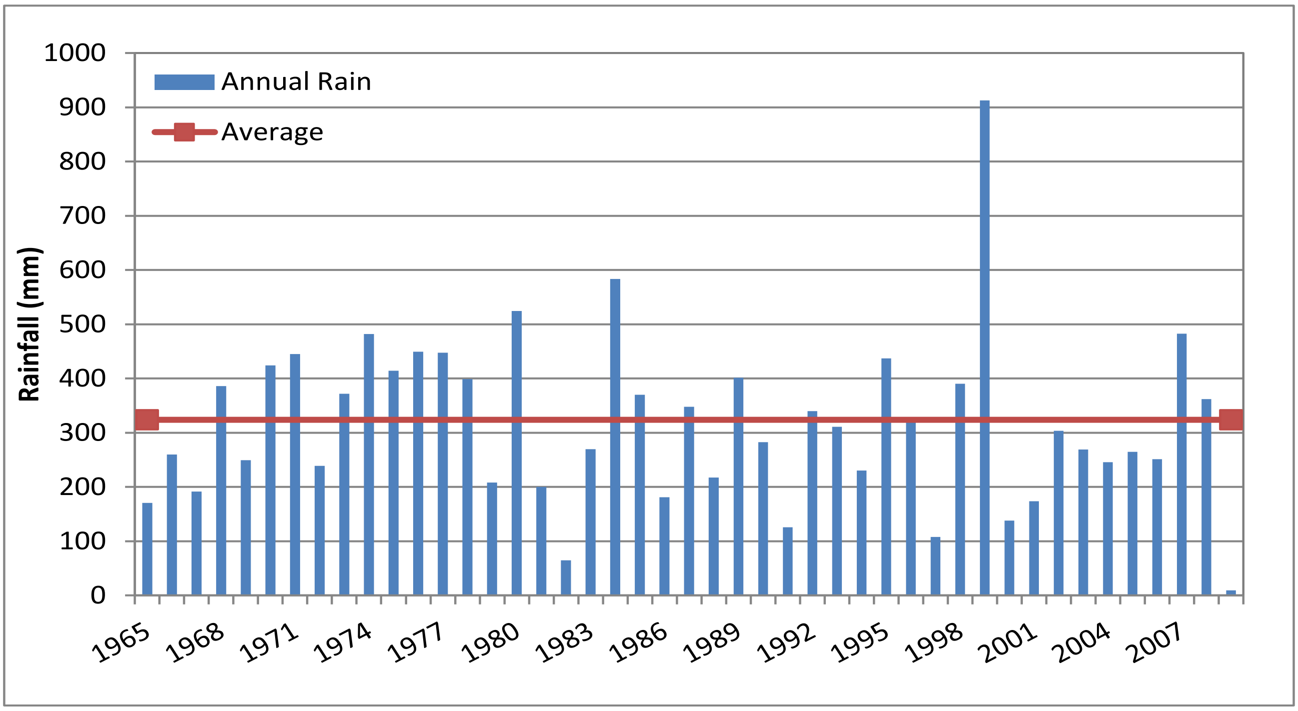


Figure 6: Annual rainfall for the Messina (Pol) station

The highest rainfall was in the 1999 hydrological year with 913 mm of rain in that year. This indicates an unusually wet year for the region. The average Mean Annual Precipitation (MAP) for the 0810081 W weather station is 324 mm.

The 5, 50 and 95 percentiles of the annual rainfall totals for the rainfall station are presented in Table 2. Figure 7 shows the cumulative distribution function of the annual rainfall totals measured at the Messina (Pol) station.

Table 2: 5, 50, and 95 percentiles of the annual rainfall totals

Station Number	Station name	5th percentile	50th percentile	95th percentile
0810081 W	Messina (Pol)	127	311	520

Table 2 indicates the following occurrences at Messina (Pol), based on the data collected at the station:

- 95% of sample observations indicate that the station will experience an annual rainfall of 127 mm or more;
- 50% of sample observations indicate that the station will experience an annual rainfall of 311 mm or more; and
- 5% of sample observations indicate that the station will experience an annual rainfall of 520 mm or more.

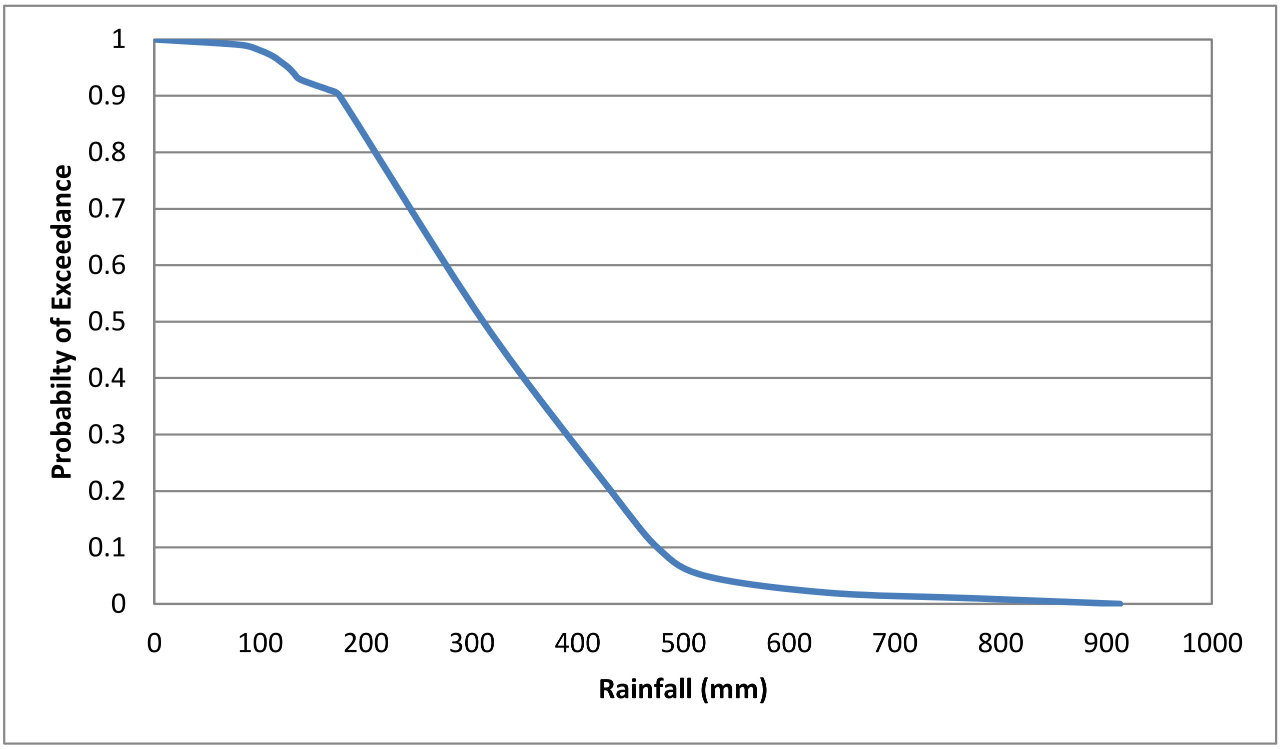


Figure 7: Probability of exceedance for the Messina (Pol) station

At the 0810081 W station, 37 events measured between 50 mm/day and 100mm/day. Four events measured over 100 mm/day in the rainfall record. Table 3 presents the five daily rainfall events measured at the 0810081 W station with the highest rainfall depths. Four out of the five Maximum Recorded Daily Rainfalls occurred in February 2000. This data corresponds to the high annual rainfall of 913 mm seen in Figure 6 for the 1999 hydrological year (October 1999 to September 2000).

Table 3: High Rainfall Events

Maximum Recorded Daily Rainfall (mm)	Date of Maximum Rainfall
126	1993/01/09
113	2000/02/23
110	2000/02/04
100	2000/02/05
92.5	2000/02/24

In order to determine the likely magnitude of storm events, a statistical approach, using the Reg Flood program (Alexander, van Aswegen, & Hansford, 2003) was applied to the available recorded daily rainfall depths. The maximum 24 hour rainfall depth for each year was analysed. The 24-Hour rainfall depths for the 1 in 2, 1 in 5, 1 in 10, 1 in 50, 1 in 100 and 1 in 200 year recurrence intervals were determined and are provided in Table 4. APPENDIX A describes the methodology of determining the storm depths for the different recurrence intervals.

Table 4: 24 Hour Rainfall Depths for Different Recurrence Intervals (mm/day)

Recurrence Interval (years)	1 in 2	1 in 5	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200
24 Hour Rainfall Depth (mm)	49	69	85	99	117	130	144

5.2 Temperature

Temperature data was sourced for the Polokwane area to represent the site area at Musina (World Weather Online, 2016). Temperature data is shown graphically in Figure 8. High average summer temperatures in the months of September to March range between 28^0 C and 30^0 C with high average winter temperatures in the months April to August ranging between 22^0 C and 26^0 C. Low average summer temperatures range between 11^0 C and 17^0 C with low average winter temperatures ranging between 5^0 C and 12^0 C.

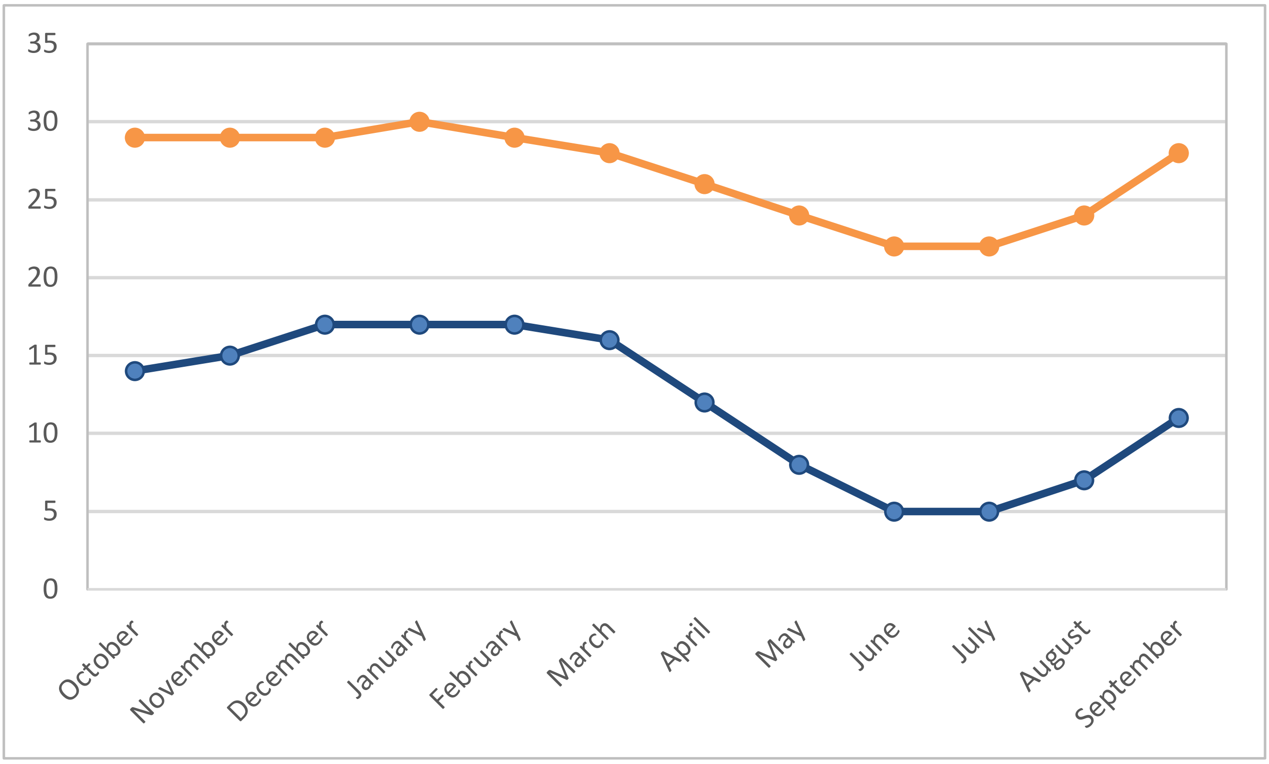


Figure 8: Average Temperature (ºC) Graph for Polokwane

5.3 Evaporation

DWS climate station A8E001 (Nairobi) was used as the source of evaporation data. The mean annual S-pan evaporation depth measured is 2248 mm/annum. Figure 9 summarises the average monthly evaporation values for the station A8E001. The monthly evaporation boxplot is shown plotted in Figure 10. These figures correlate with the seasonal changes expected. Higher average evaporation depths are seen with higher average temperatures.

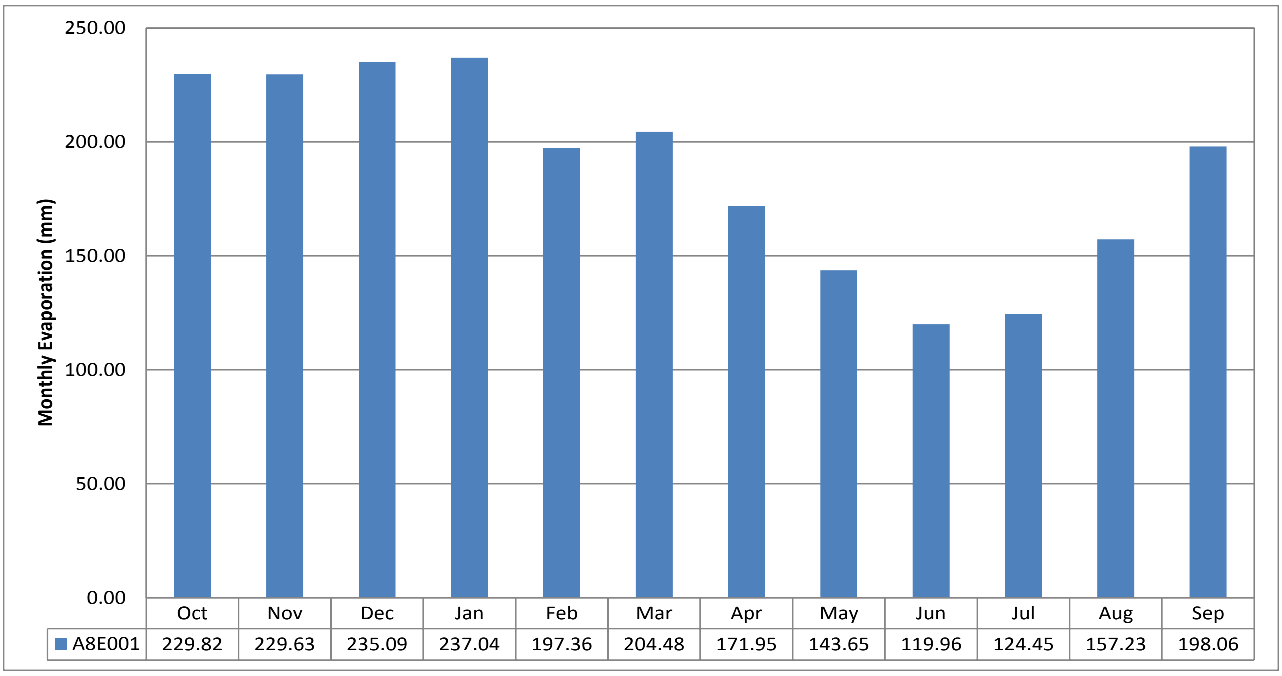


Figure 9: Mean monthly evaporation values for station A8E001

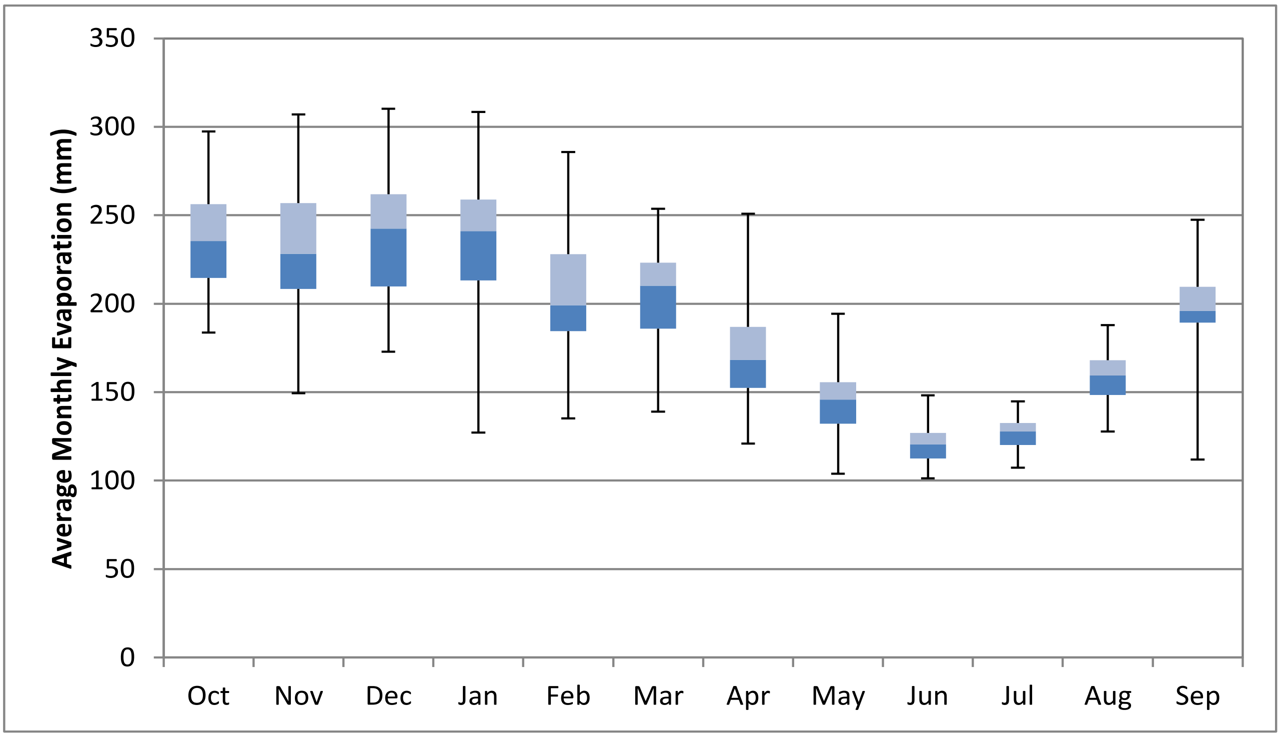


Figure 10: Boxplot of evaporation values for A8E001 station

6.0 WATER QUALITY AND FLOW MONITORING

6.1 Water quality and flow programme

The importance of a monitoring programme is to provide a baseline data set to describe the baseline quality profile against future potential impacts from mine activity. If there are large variations in constituent values during the operation of the mine, it will be possible to assess the reason for the change and implement the necessary mitigation measures. A monitoring programme is also important when the monitoring site is a point of discharge to the environment from the mine. This allows the mine to determine the impacts that the discharge could have on the downstream users and to implement mitigation measures.

The streams in the area are non-perennial and with the recent drought, the area is particularly dry, probably with no surface water flows in the local streams. One round of field monitoring during the rainy season will be undertaken once there is flow in these streams. The following field monitoring programme will be undertaken:

- Local and downstream water users will be identified and recorded; and
- The cross-sections of monitoring sites will be surveyed, flow will be measured and water samples will be collected at 5 sampling sites for water quality analysis to determine the baseline for current water quality and flow.

6.2 DWS Flow monitoring

The DWS maintains river flow monitoring data in the area. Three flow monitoring stations were identified: A7H004, A7H008 and A7H009. The locations of the flow stations are shown in Figure 11.

A7H004 and A7H008 are located upstream of the site and measure flow in the Limpopo River at the Beit bridge station. The A7H004 and A7H008 stations are linked in the continuation of the time series data at Beit Bridge. A7H009 is a flow measuring station located south of the site and measures flow in the Sand River. The data at the A7H009 station was limited.

Table 5 describes the characteristics of the flow stations. Figure 12 presents the average monthly flow measured at each station. There is only measurable flow in the summer months for the Sand River. The estimated size of the study area is 50km^2. The presence of site infrastructure will reduce the area contributing to the Sand River and Limpopo River which will result in a lower flow in the rivers.

Table 5: Flow Stations around the proposed Musina Site

Station Name	Station	Date from	Date to	Catchment Area (km^2)	River	Location relative to site
Limpopo River @ Beit Bridge	A7H004	1954	1991	201 000	Limpopo	Upstream
Limpopo River @ Beit Bridge	A7H008	1991	2015	202 985	Limpopo	Upstream
Sand River @ Beit Bridge	A7H009	1993	1999	12 873	Sand	Upstream

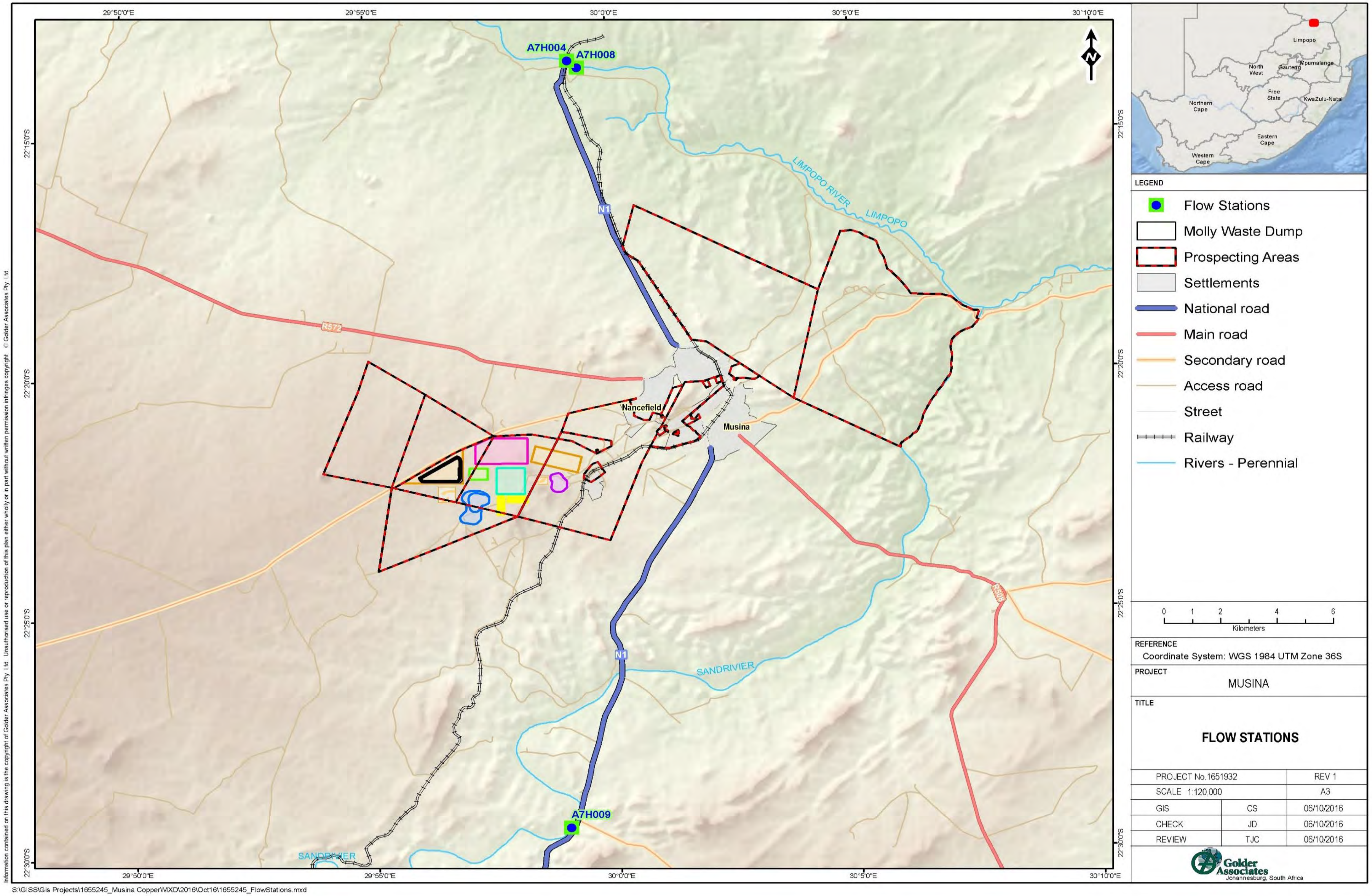
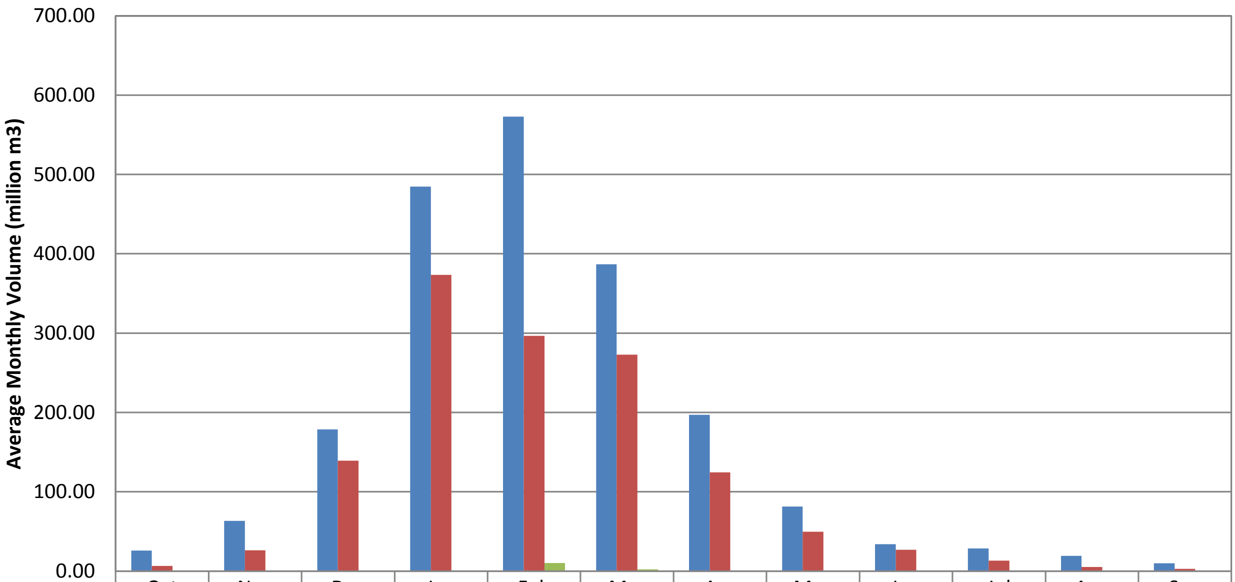


Figure 11: Flow monitoring station locations



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A7H004	25.80	63.24	178.62	484.59	572.78	386.76	197.15	81.42	34.07	28.48	19.18	9.92
A7H008	6.37	26.19	139.27	373.54	296.45	272.73	124.36	49.73	27.02	13.12	5.25	2.89
A7H009	0.00	0.00	0.00	0.09	10.06	2.05	0.00	0.00	0.00	0.00	0.00	0.00

Figure 12: Average Monthly flow for A7H004, A7H008, and A7H009

Figure 13, Figure 14, and Figure 15 represent the monthly boxplot graphs of flow stations A7H004, A7H008 and A7H009 respectively. The monthly boxplots show the variations of observed monthly flow records in a five number summary. This includes the minimum, 25th percentile, 50th percentile, 75th percentile, and 99th percentile observed monthly flow volumes. Higher flow occurs between December and April and low flow between May and November. No flow data is available for the tributaries surrounding the site.

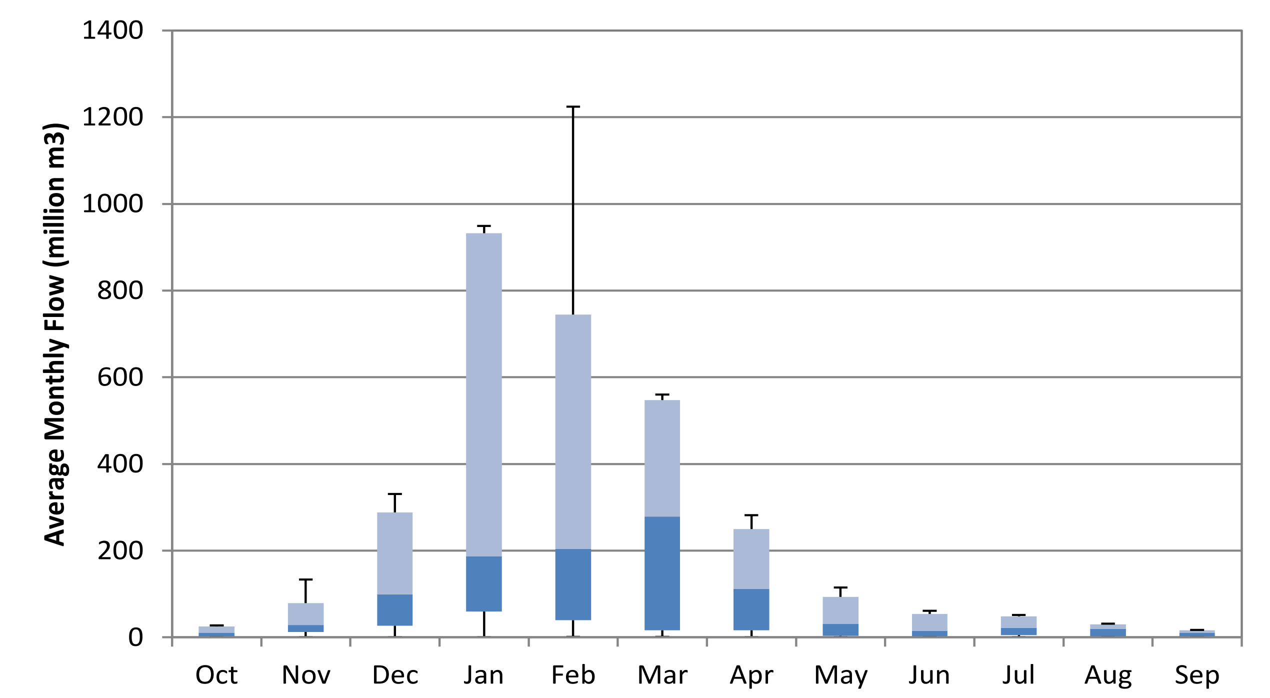


Figure 13: Boxplot for flow monitoring station A7H004.

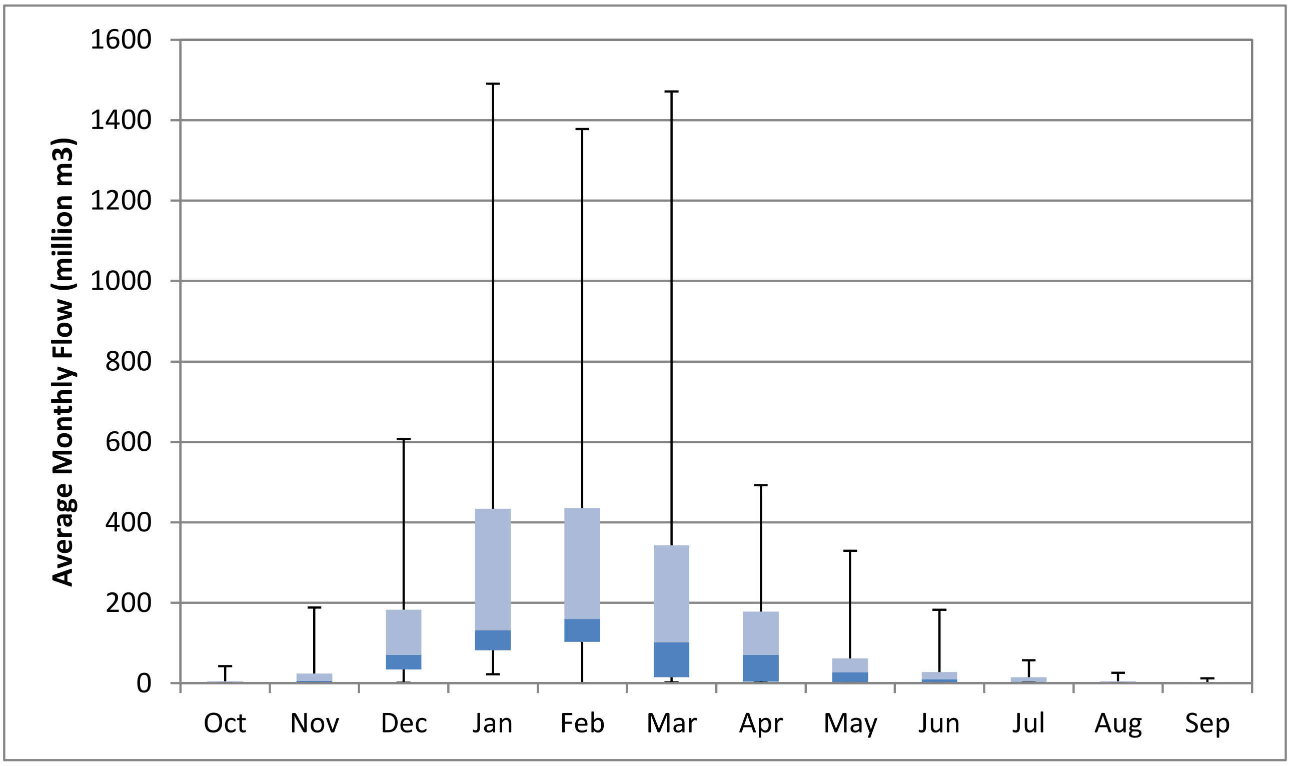


Figure 14: Boxplot for flow monitoring station A7H008

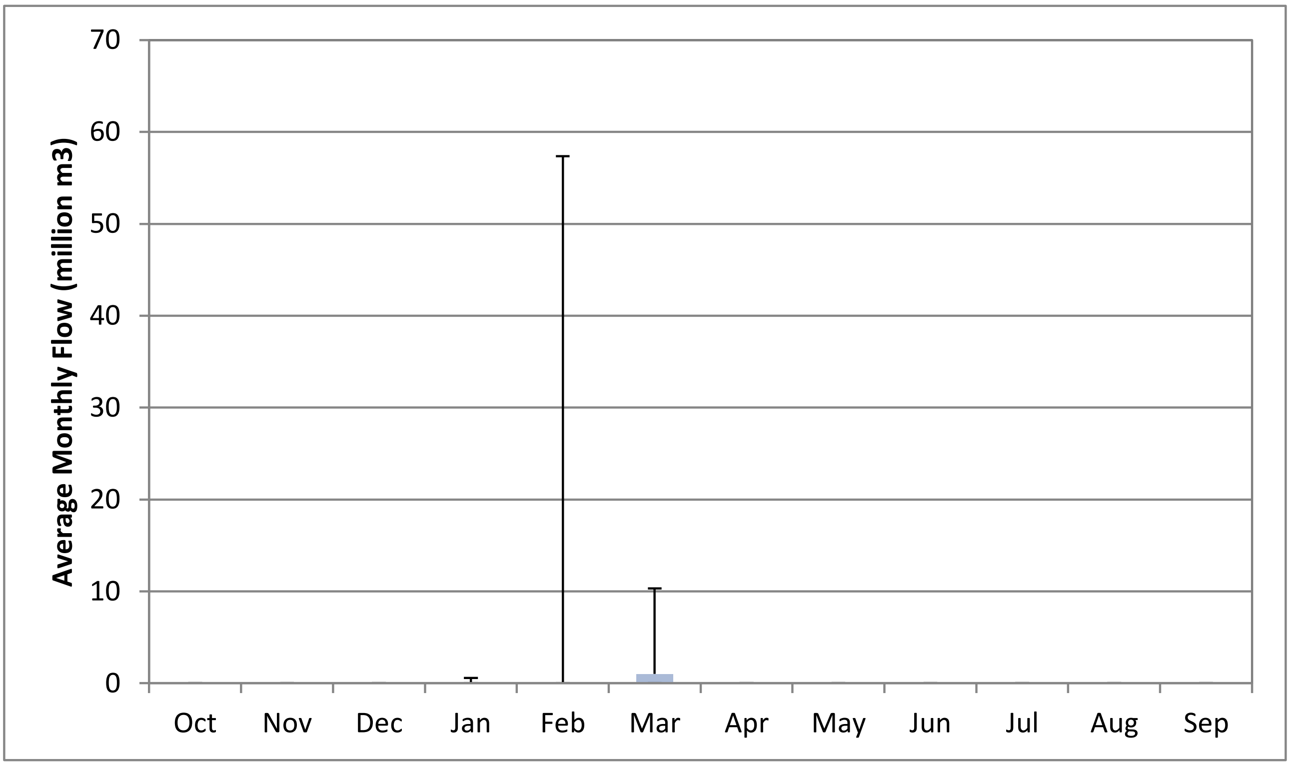


Figure 15: Boxplot for flow monitoring station A7H009

7.0 IMPACT ASSESSMENT

7.1 Potential surface water impacts

The potential surface water impacts from the project, both direct and indirect, are summarised in Table 6. In summary, these potential impacts contribute to overall surface water impacts and include:

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

The site consists of various infrastructure including: Two mining pits, two waste rock sites, leach pads, a tailings facility and a plant area. A number of non-perennial tributaries flow in the proposed Musina project area and could impact the water quality by creating a polluted water flow to the tributaries. The detailed impact assessment is outlined in Section 7.1.2.

Table 6: Summary of potential surface water impacts

Major aspect	Key Environmental Issues / Potential Impacts
Changes in surface water catchment areas	■ Disruption and reduction in land due to the presence of infrastructure created by the mine.
Changes in surface water quality	■ Poor quality runoff from mining and associated activities; and ■ Possible fuel and lubricants spillage from equipment and other chemical spills.
Change in surface water runoff	■ Increased in flood peaks due to vegetation and soil removal therefore decreasing infiltration into soil; and ■ Runoff impact due to mining activities during operation and rehabilitation.
Erosion	■ Erosion on site and surrounding areas may be increased due to site clearance of vegetation and veld.

7.1.1 Impact assessment methodology

The significance of identified impacts was determined using the approach outlined below as recommended by the Department of Environmental Affairs and Tourism (Department of Environmental Affairs and Tourism, 2009). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Table 7: Impact assessment factors

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

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

Table 8: Impact assessment scoring methodology

Magnitude	**Duration**
10- Very high/ unknown	5- Permanent (>10 years)
8- High	4- Long term (7-10 years, impact ceases after site closure has been obtained)
6- Moderate	3- Medium-term (3 months- 7 years, impact ceases after the operational life of the activity)

Magnitude	Duration
4- Low	2- Short-term (0-3 months, impact ceases after the construction phase)
2- Minor	1- Immediate
Scale	**Probability**
5- International	5- Definite/Unknown
4- National	4- Highly Probable
3- Regional	3- Medium Probability
2- Local	2- Low Probability
1- Site Only	1- Improbable
0- None	0- None

Significance Points = (Magnitude + Duration + Scale) x Probability

Table 9: Significance of impact based on point allocation

Points	Significance	Description
SP>60	High environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30-60	Moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP<30	Low environmental significance	Impacts with little real effect and which will not have an influence on, or require modification of, the project design.
+	Positive impact	An impact that is likely to result in positive consequences/effects.

For the methodology outlined above, the following definitions were used:

- Magnitude is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely-recognised standards are to be used as a measure of the level of impact;
- Scale/Geographic extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international;
- Duration refers to the length of time over which an environmental impact may occur: i.e. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent; and
- Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

7.1.2 Surface water impacts

Table 10 sets out the detailed potential surface water impacts during construction, operation and decommissioning.

Table 10: Impact assessment during construction, operation and rehabilitation

Aspect	Potential Impact	Magnitude	Duration	Scale	Probability	Impact	Notes
CONSTRUCTION PHASE							
Water quality impacts due to runoff	■ Spillage of fuels, lubricants and other chemicals; and ■ Construction equipment and vehicles will be a likely source of pollution as a non-point source.	4	2	2	3	**24 - low**	It is expected that without mitigation a **low** negative impact can be expected. Mitigation will include: ■ Storing chemicals and/or fuel in bunded areas; ■ Clean-up of spills as soon as they occur; and ■ Implementation of a stormwater management plan as construction occurs.
Erosion of the watercourse	Erosion on site and surrounding areas will be increased due to site clearance of vegetation and veld over the pit areas for the construction of new infrastructure.	4	2	3	4	**36 - moderate**	Removal of vegetation on site will likely cause water erosion and thus a **medium** impact rating can be expected
OPERATIONAL PHASE							
Changes in surface water quality	Poor quality runoff from spillages of PCDs.	4	4	2	3	**30 - moderate**	This will be mitigated by a proper stormwater management system which will separate the clean and dirty water as per Regulation 704. Mitigation would reduce the impact to **low.**
Decreased catchment area	■ Disruption and reduction in catchment area due to mining of pits; and ■ Decrease in runoff due to reduction of catchment area.	2	3	1	5	**30 - moderate**	It is expected that without mitigation the impact may be **moderate**. Implementation of a well-designed stormwater management plan will keep the clean water away from the mine area to allow the maximum water to enter the environment. Mitigation will reduce the impact to **low**.
Erosion of the watercourse	Erosion on site and surrounding areas may increase due to mining of the pits.	2	4	1	4	**28 - low**	The low flow dynamics at the site will unlikely cause any surface water erosion and thus a **low** impact rating can be expected.
Acid Rock Drainage	Rocks containing sulphur-bearing minerals are excavated and react with water and oxygen to form sulfuric acid.	3	3	2	4	**32 - moderate**	Appropriate treatment of mine impacted water that cannot be reused on the mine to mitigate the effects of Acid Rock Drainage will reduce the impact to **low**.
REHABILITATION PHASE							
Decommissioning of local infrastructure	Decommissioning may leave large barren areas that may increase erosion, which might increase the amount of suspended solids in downstream surface water reducing water quality.	4	1	2	3	**21 - low**	The topography of the area should be, where possible, returned to pre-construction state.

8.0 FLOODLINE DETERMINATION

8.1 Methodology used to determine flood lines

The 1:50 and 1:100 year flood lines were determined to assess the flood risk to the Musina mine infrastructure. The water surface elevations were calculated using the HEC-RAS model, for the 50 year and 100 year flood peaks. The floodlines were determined for the streams in the vicinity of the mine were. The following method was used for the determination of the floodlines:

- The catchment areas of the streams and tributaries located within and nearby the mine area were delineated based on the available contour information;
- A flood peak analysis was undertaken to determine the 50 year and 100 year recurrence interval flood peaks for the watercourses within the mining boundary using the Rational Method as described in the SANRAL Drainage Manual (South African National Roads Agency Limited, 2006);
- Cross-sections of the water courses were derived based on available contour data;
- The flood peaks cross sections for the study area were used as inputs to the HEC-RAS backwater programme to determine the surface water elevations for the 1:50 year and 1:100 year flood peaks; and
- The floodlines were plotted on available mapping.

The watercourse cross-sections were based on available topographical information. The extent and locations of the cross-sections along the modelled streams and tributaries is shown in Figure 16

8.2 Limitations and assumptions

The following limitations and assumptions have been made in this specialist study:

- No stream flow and site specific rainfall data against which the runoff calculations might be calibrated were available. The runoff volumes were therefore calculated theoretically;
- The model is based on the 5m contour data made available. The floodlines presented in this report can only be considered indicative. It is recommended the floodlines be revised once a detailed survey is conducted with at least 1m contours;
- In order to generate conservative results, no river obstruction structures (bridges, conduits etc.) were taken into account during the floodline analysis. It was assumed that the streams and tributaries flow freely; and
- Since there is very limited flow data available to estimate the roughness coefficients, the Manning's 'n' coefficients were estimated by comparing the vegetation and nature of the channel surfaces to published data (Webber, 1971), therefore slightly conservative estimations were adopted.

8.3 Sub-catchments

The total drainage area of the mining region was divided into several sub-catchments based on the topography of the area and the river reaches where floodlines were required. The sub-catchment boundaries are shown in Figure 17. The sub-catchments of the streams and tributaries were used in the calculation of the flood peaks for the floodlines.

8.4 Flood peak calculations

Flood peaks were estimated for each delineated sub-catchment using the Rational Method as described in the SANRAL Drainage Manual (South African National Roads Agency Limited, 2006). The rational method was applied to the development area sub-catchments. The rational method considers the entire drainage area as a single unit and estimates the peak discharge at the most downstream point of that area.

The sub-catchment characteristics are shown in Table 11 and the calculated flood peaks for the 1:50 year and the 1:100 year are shown in Table 12. The predicted floodlines for the region are graphically presented in Figure 18. The HEC-RAS output file is given in APPENDIX B.

Table 11: Sub-catchment characteristics used in the flood estimation

Catchment	Area (km^2)	River Length (m)	10-85 Slope (m/m)	Time of concentration (h)
1	3.50	2.72	0.04	0.49
2	1.77	2.96	0.01	0.65
3	2.78	3.13	0.01	0.93
4	2.02	1.64	0.01	0.49
5	3.60	3.09	0.01	0.82
6	4.88	2.80	0.01	0.85
7	1.01	1.05	0.006	0.49

Table 12: Computed flood peak flows for the water courses

Sub Catchments	Flood peak for the 1:50 year flood (m^3/s)	Flood peak for the 1:100 year flood (m^3/s)
1	17.9	26.3
2	7.4	10.9
3	9.4	13.9
4	10.4	15.4
5	13.1	19.5
6	17.4	25.6
7	5.1	7.5

8.5 Recommendations

The analysis shows that the infrastructure will lie within the calculated 50 year and 100 year floodlines and is presented in Figure 18. The affected tributaries are non-perennial, and the site infrastructure is to be situated in the head waters of the tributaries. The design of the proposed mine site should take the affected streams into consideration. An exemption to Regulation 704 may be required or a river diversion may be necessary such that the mine site complies with Regulation 704.

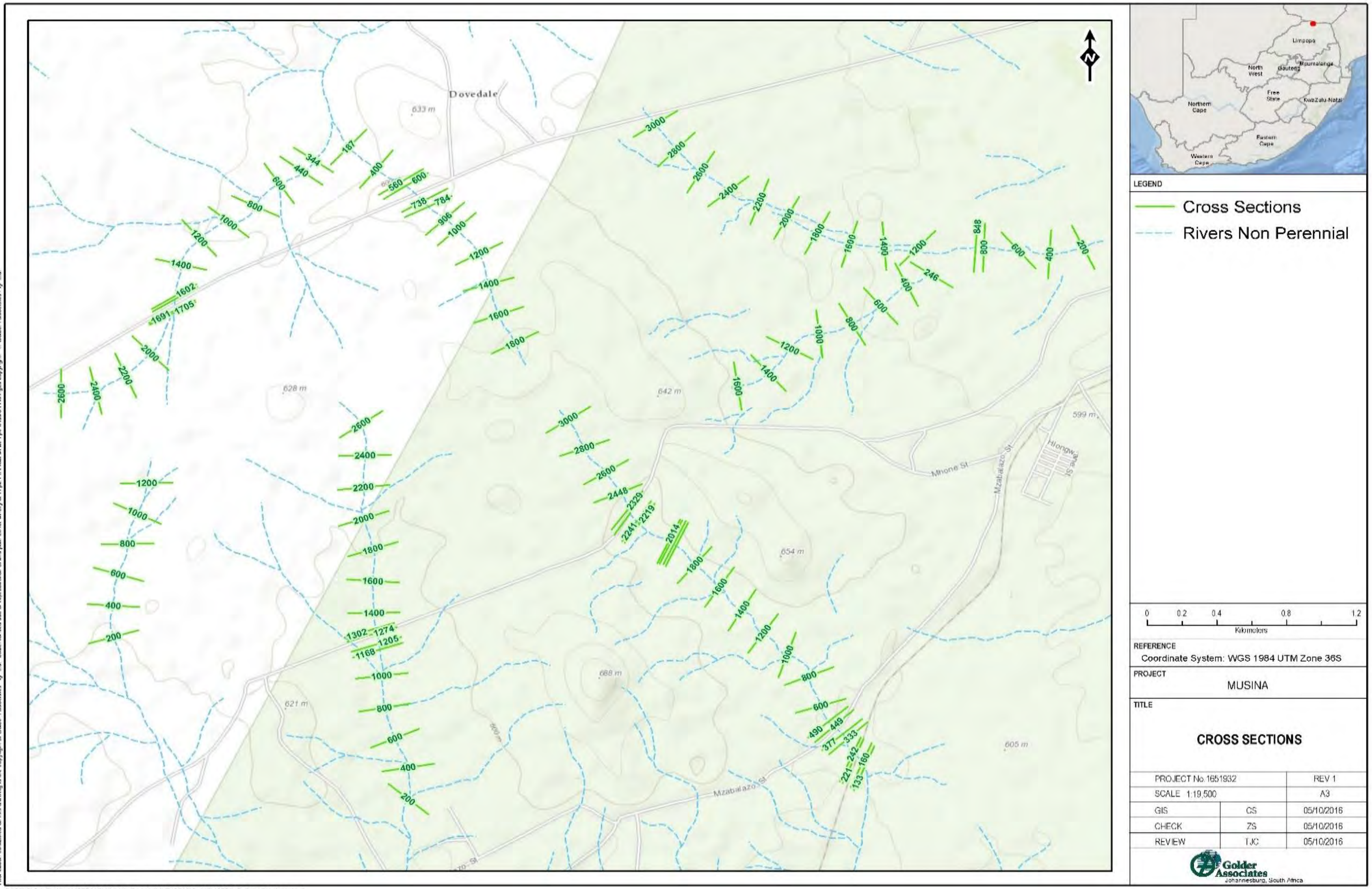


Figure 16: The extent and location of the cross-sections along the modelled streams and tributaries

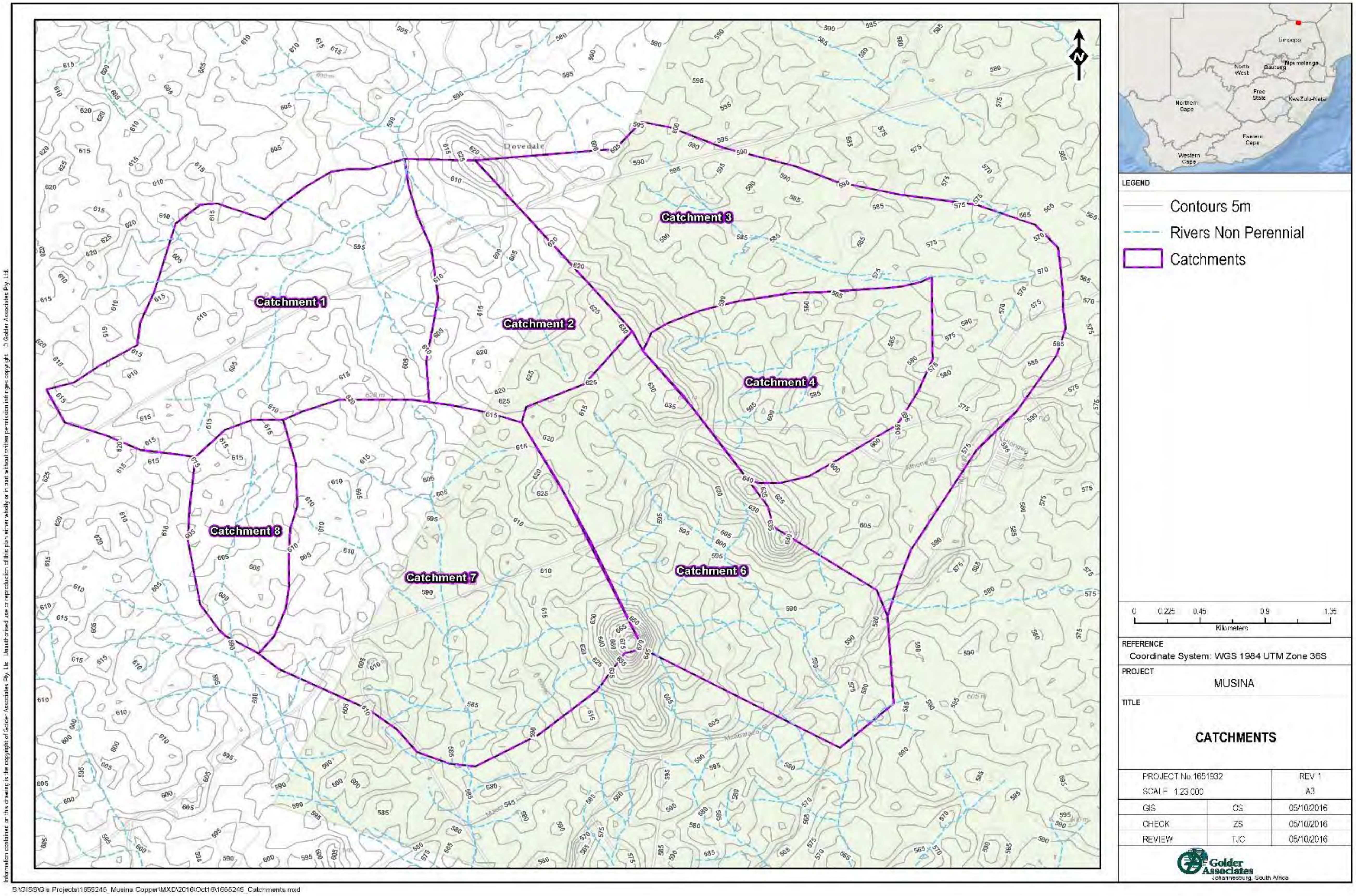


Figure 17: Discretization of Musina sub-catchments

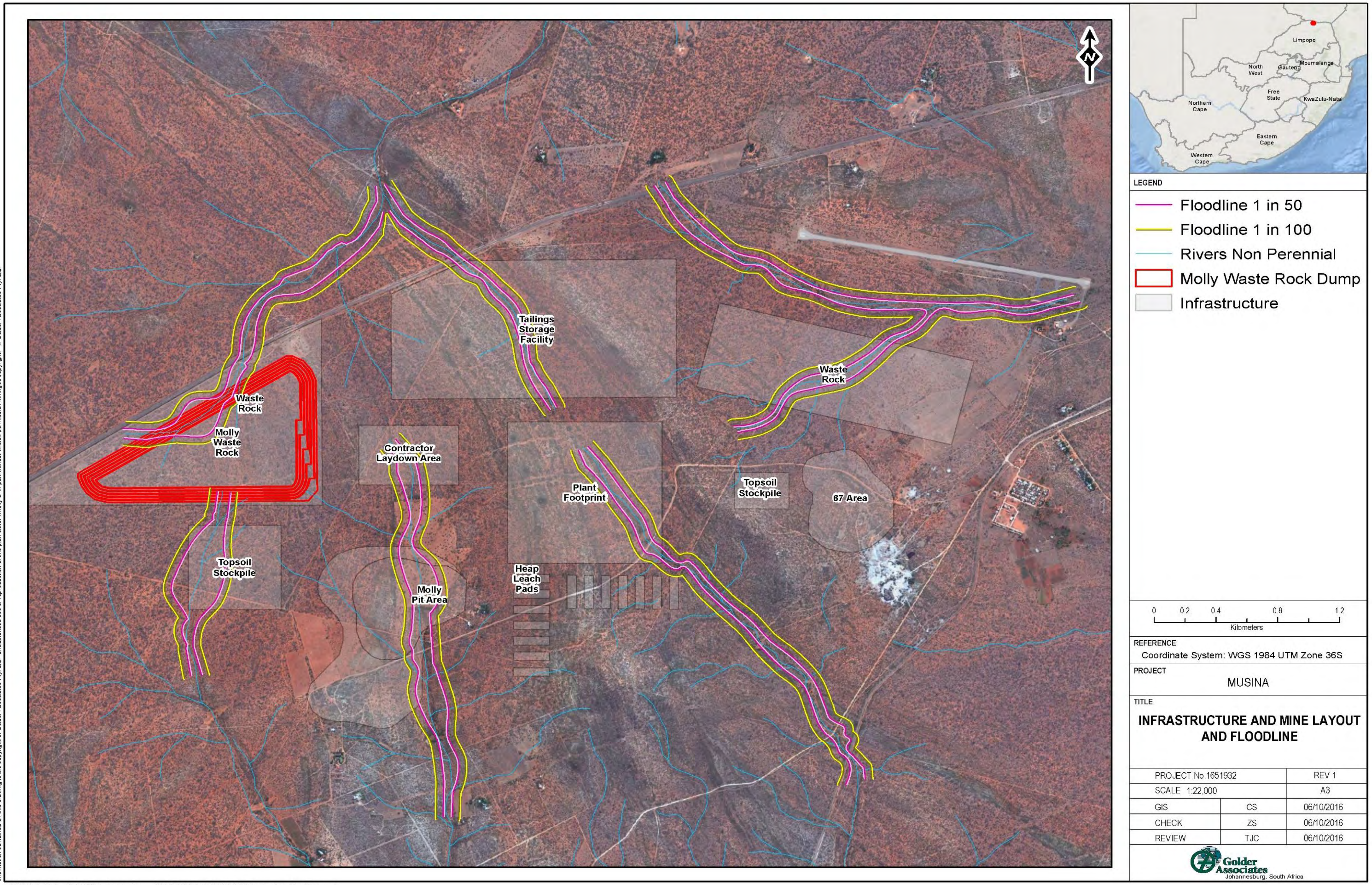


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Figure 18: The 1 in 50 and 1 in 100 recurrence interval floodline for Musina

9.0 STORMWATER MANAGEMENT

The Musina facility requires a stormwater management plan (SWMP) to mitigate flows around key infrastructure and to prevent clean stormwater interacting with potentially polluted runoff water. Regulation 704 was used to set up the design criteria for sizing stormwater management infrastructure for the Musina site. Regulation 704 states that: "*every person in control of an activity must design, construct, maintain and operate any dirty water system at the activity so that it is not likely to spill into any clean water system more than once in 50 years*" This section will describe a conceptual storm water management plan such that the Musina site complies with Regulation 704.

9.1 Modelling the stormwater diversion channels

The PCSWMM model was used as the flood analysis model. PCSWMM is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity. A model was set up for the site and the scenario described in 9.3 was modelled to size the stormwater diversion implementation.

9.2 Site and sub-catchment overview

The catchment area for the Musina Site was discretised into sub-catchments based on the topography of the area. The sub-divided catchments for the mine infrastructure and the proposed stockpile locations are shown in Figure 19. Each sub-catchment and the model parameters are described in more detail in this report. The Manning's 'n' coefficient used in the model for the impervious areas was taken as 0.016 and the coefficient for the pervious areas was taken as 0.15. The sub-catchments' soil texture was classified as sandy loam, which indicates a capillary suction of 110.1 mm and a hydraulic conductivity of 21.8 mm/h. The sub-catchment areas and slopes together with the total runoff volume and the flood peaks for the 1:50 year 24 hour storm event will be presented in the sections below.

9.3 Proposed stormwater methodology

Stormwater is only diverted if required so that the natural flow is not impeded unnecessarily. The proposed infrastructure that will generate polluted runoff was identified as the follows:

- Molly Waste Rock;
- Eastern Waste Rock;
- Plant Area;
- Topsoil Stockpiles; and
- 67 Area.

The Topsoil stockpiles are considered to be a potential source of contamination due to the expected higher total suspended solids in the runoff. These will be diverted through silt traps accordingly before diverted back into the environment. The plant area, leach pads and tailings facilities were assumed to have their own stormwater management systems and have not been accounted for in this stormwater management system. The activities to occur at 67 Area were unclear, and the runoff generated here would be classified as polluted. The stormwater runoff being generated from the surrounding catchments is considered clean. Stormwater runoff will be collected, contained and diverted around key points.

9.3.1 Channel characteristics

All diversion channels have been sized to convey the 50 year return period flood peak. The South African SCS 24-hour Type 2 rainfall distribution was associated with the rainfall on the sub-catchments (Schmidt & Schulze, 1987). The dimensions of the channels, the channel slope and the maximum velocity are listed per area on site. The freeboard standards used were: for flow less than 10 m^3/s a 0.3 m freeboard was added to the flow depth while for flows above 10 m^3/s a freeboard of 0.6 m was added. The channels were assumed to be earth-lined channels with a roughness co-efficient of 0.03.

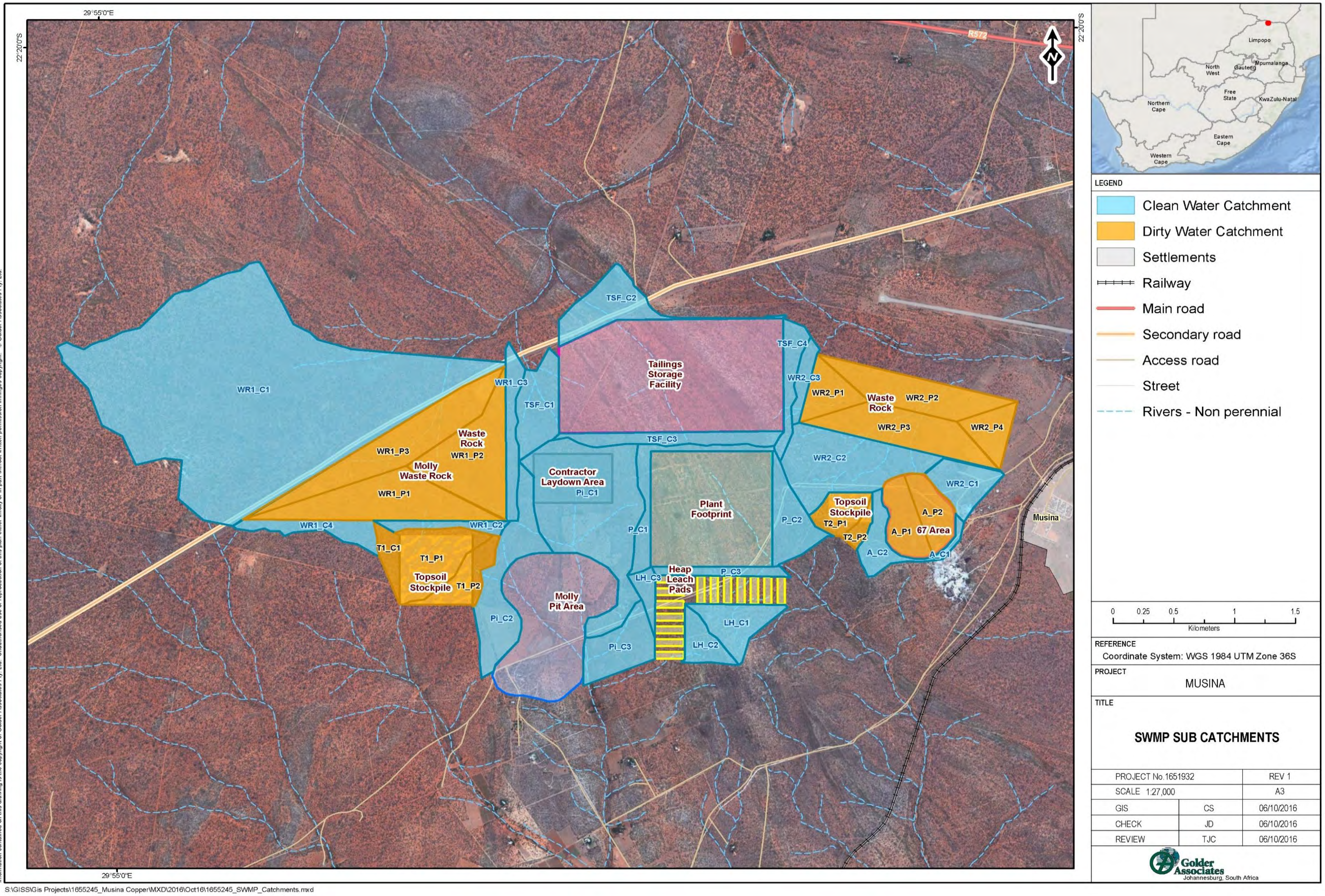

Figure 19: Delineated catchment area for the Musina Site

9.3.2 Molly Waste Rock and Topsoil Stockpile

The clean and dirty catchment areas and layout of stormwater conduits for the Molly Waste Rock and Topsoil Stockpile are presented in Figure 20.

Runoff generated from the Molly Waste Rock sub-catchment is considered polluted due the presence of sulphide-bearing materials and is diverted accordingly into a storage facility, WR1_PCD, at the lowest point at the Waste Rock area. Runoff generated around the Waste Rock area is considered clean, and diverted by a separate channel away from the Waste Rock area and into the environment.

Runoff generated from the topsoil stockpile is considered as polluted, this is due to the runoff containing high suspended solids eroded from the topsoil stockpile. Polluted runoff generated is diverted through a silt trap to remove suspended solids before released back to a tributary. There is a small clean catchment area (T1_C1) that feeds into the T1_1 channel. The total runoff volume from the clean catchment was small and was also diverted through the silt trap. The sub-catchment characteristics for the surrounding regions are presented in Table 13 and channel dimensions and properties for the diversion channels are provided in Table 14.

Table 13: Catchment areas, slopes and computed runoff volumes and flood peaks for the 50 year 24-hour storm

Name	Area (ha)	Slope (%)	Runoff Volume (ML)	Peak Runoff (m^3/s)
WR1_C1	383	0.5	9.4	2.28
WR1_C2	8	0.2	0.3	0.07
WR1_C3	15	1.2	0.8	0.21
WR1_C4	16	1.1	0.9	0.25
T1_C1	8	3.2	1.3	0.55
T1_P1	31	1.2	2.8	0.86
T1_P2	16	0.2	0.7	0.19

Table 14: Dimensions of the diversion channels to convey the 50 year 24-hour return flood peak at Molly Waste Rock

Name	Cross-Section	Depth (m)	Bottom Width (m)	Side Slope (m/m)	Max. Flow (m^3/s)	Max. Velocity (m/s)
WR1_1	Trapezoidal	1	1	1:1.5	1.34	1.53
WR1_2	Trapezoidal	1	1.5	1:1.5	2.11	1.17
WR1_3	Trapezoidal	1	1.5	1:1.5	1.38	0.80
WR1_4	Trapezoidal	1	1	1:1.5	2.04	1.86
WR1_5	Trapezoidal	1	1	1:1.5	0.19	0.75
WR1_6	Trapezoidal	1	1	1:1.5	2.19	2.18
WR1_7	Trapezoidal	1	1	1:1.5	1.81	1.76
T1_1	Trapezoidal	1	1.5	1:1.5	1.39	0.98
T1_2	Trapezoidal	1	0.5	1:1.5	0.20	0.49

9.3.2.1 PCD and silt trap characteristics

A pollution control dam (PCD) is proposed to contain the dirty water and a silt trap to remove silt from runoff from the Topsoil Stockpile area seen in Figure 20. The expected inflow rate and total volume for the waste rock PCD and the silt trap are given in Table 15.

Table 15: Characteristics of PCD to store polluted water from the 50 year 24-hour storm and silt trap

Name	Max. Total Inflow (m^3/s)	Total inflow (ML)
WR1_PCD	2.9	16.0
T1_SiltTrap	1.6	4.8

9.3.1 Tailings Storage Facility

Figure 21 shows the layout of the stormwater management plan for the Tailings Storage Facility (TSF). The runoff from the TSF was excluded from the stormwater management planning. The TSF stormwater management plan will follow the TSF operational plan manual to manage its own stormwater management system. Runoff from surrounding sub-catchments are diverted by channels around the TSF and released back into the environment. The characteristics for the TSF sub-catchments are presented in Table 16 and channel dimensions for the associated diversion channels are provided in Table 17.

Table 16: Catchment areas, slopes and computed runoff volumes and flood peaks for the 50 year 24-hour storm for the Tailings storage facility

Name	Area (ha)	Slope (%)	Runoff Volume (ML)	Peak Runoff (m^3/s)
TSF_C1	25	2.0	2.1	0.6
TSF_C2	27	6.7	3.8	1.5
TSF_C3	19	4.3	4.6	3.8
TSF_C4	14	2.8	1.1	0.3

Table 17: Dimensions of the diversion channels to convey the 50 year 24-hour return flood peak at Molly Waste Rock

Name	Cross-Section	Depth (m)	Bottom Width (m)	Side Slope (m/m)	Max. Flow (m^3/s)	Max. Velocity (m/s)
TSF_1	Trapezoidal	1	1	1:1.5	1.19	1.10
TSF_2	Trapezoidal	1	1	1:1.5	1.26	1.64
TSF_3	Trapezoidal	1	1	1:1.5	0.34	1.52
TSF_4	Trapezoidal	1	1.5	1:1.5	2.64	1.71
TSF_5	Trapezoidal	1	1.5	1:1.5	1.39	0.89
TSF_6	Trapezoidal	1	1.5	1:1.5	1.39	2.32

9.3.1 Plant, Molly Pit, Leach Pads and Contractor Yard

The layout of the stormwater management plan for the Plant, Molly Pit, Leach Pads and Contractor Yard is shown in Figure 22. Stormwater runoff generated from the Plant's surrounding sub-catchments are considered clean. Runoff originating from the Plant's Eastern sub-catchment is collected and diverted away from the plant area and released into a tributary via channel P_2. Runoff generated from the Plant's western sub-catchments is collected and diverted to the leach pad stormwater management system where it is released into a tributary from channel LH_3.

Runoff generated by the southern clean catchments of the leach pads will be collected and diverted and released into a tributary from channels LH_1 and LH_5.

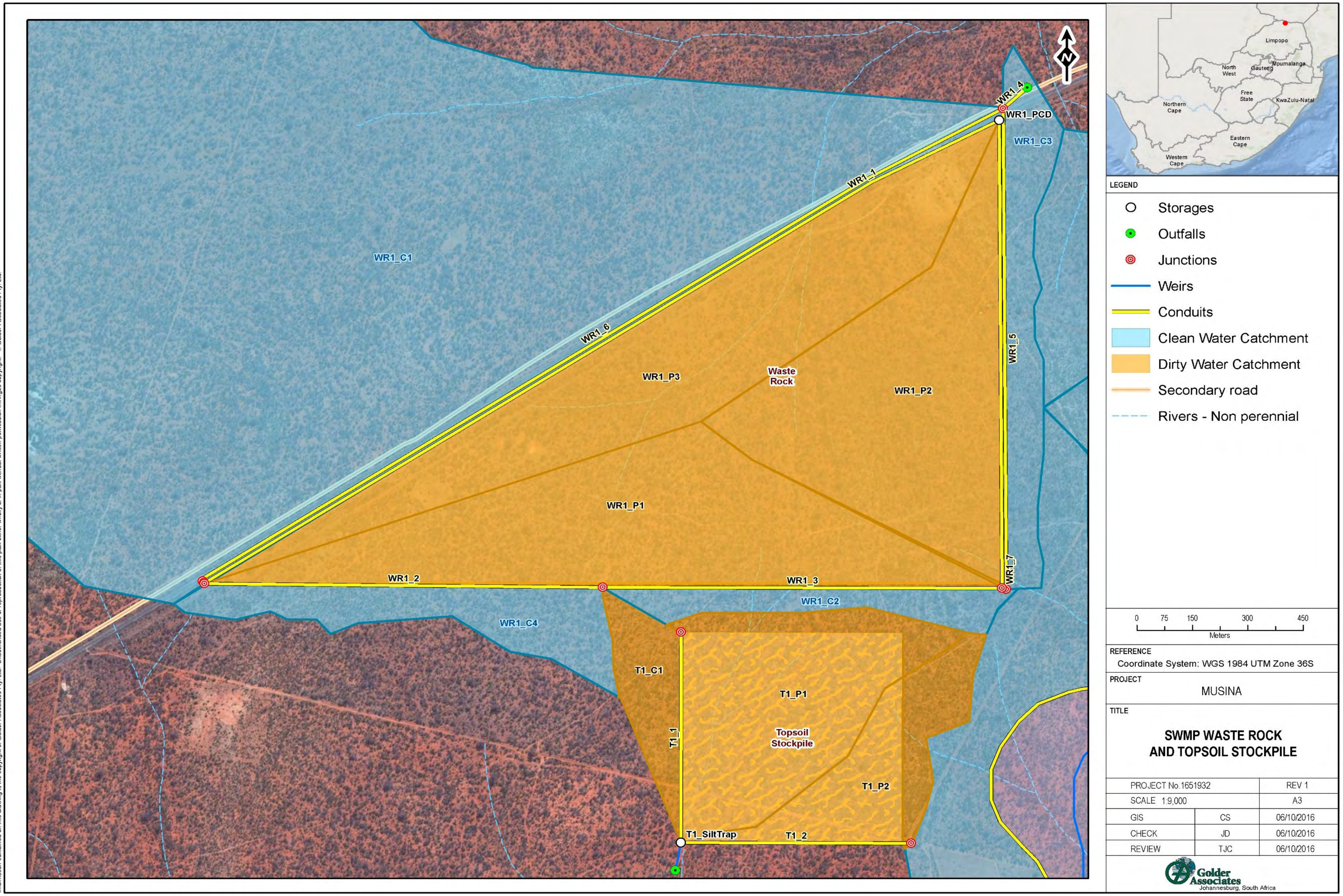

Figure 20: Western Waste Rock site and Topsoil Stockpile storm water management plan

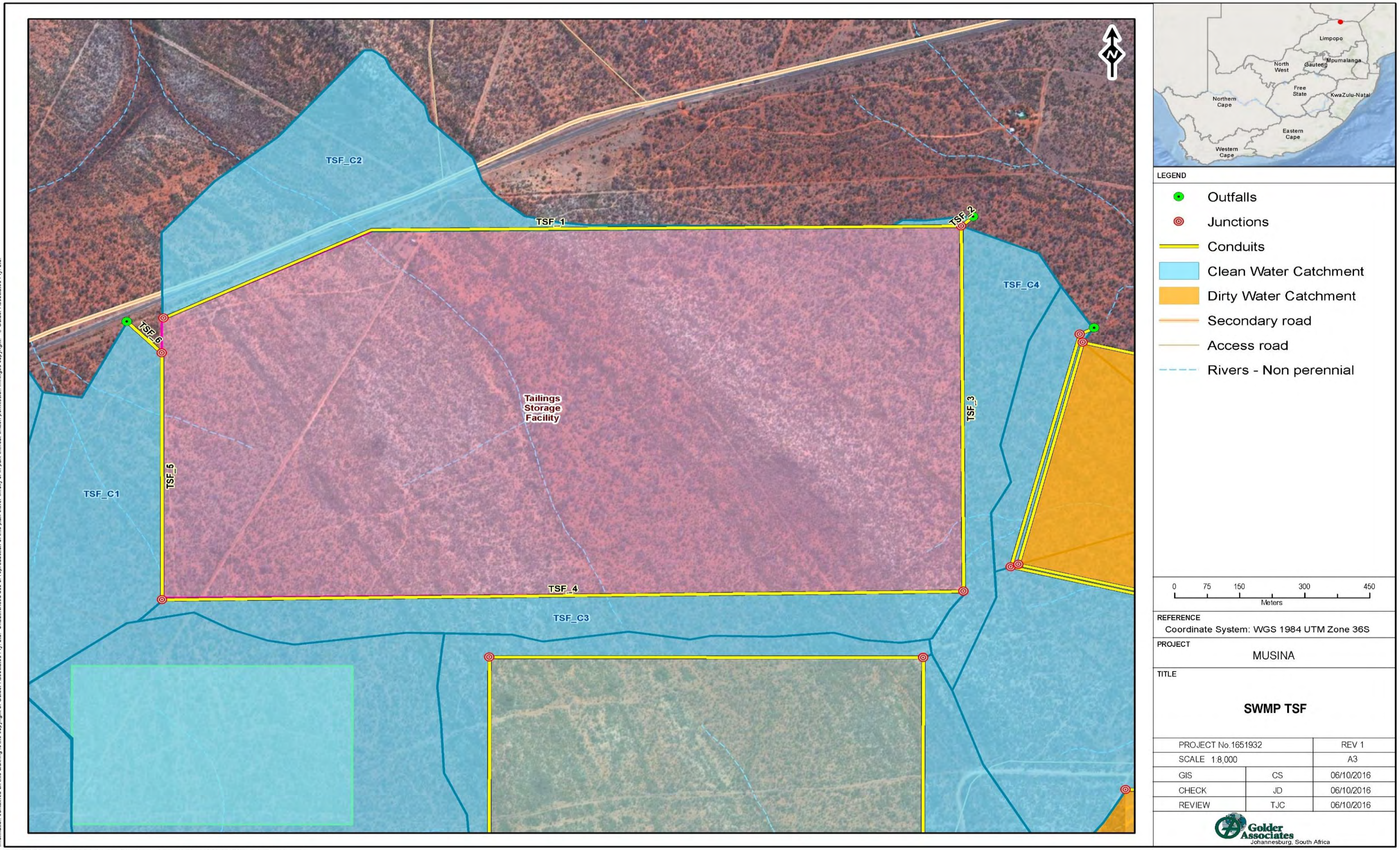

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Figure 21: Tailings storage stormwater management plan

Sub-catchments that contribute to the runoff at the contractor yard is considered clean and the runoff reports to the drainage system created for the pit. Runoff collected at the pit is discharged back into tributaries located at channels Pi_2 and Pi_4.

Runoff from the Plant area, Leach Pads and the Pit was excluded from this stormwater management plan. Runoff from these regions will be contained by its own operational stormwater management procedures set out by the Plant, Leach Pads and Pit operational manuals respectively. The characteristics for the Plant, Molly Pit, Leach Pads and Contractor yard sub-catchments are presented in Table 18 and the associated channel dimensions used to divert runoff are described in

Table 18: Catchment areas, slopes and computed runoff volumes and flood peaks for the 50 year 24-hour storm at the Plant, Pits, Leach Pads and Contractor Yard

Name	Area (ha)	Slope (%)	Runoff Volume (ML)	Peak Runoff (m^3/s)
LH_C1	20	14.9	3.6	1.89
LH_C2	12	13.2	2.0	0.95
LH_C3	6	1.5	0.9	0.37
P_C1	18	1.0	2.2	0.86
P_C2	22	4.0	2.4	0.84
P_C3	9	2.7	2.7	1.66
Pi_C1	95	2.6	9.5	2.92
Pi_C2	41	1.2	3.4	1.02
Pi_C3	24	1.0	2.4	0.76

Table 19: Dimensions of the diversion channels to convey the 50 year 24-hour return flood peak at the Plant, Pits, Leach Pads and Contractor Yard

Name	Cross-Section	Depth (m)	Bottom Width (m)	Side Slope	Max. Flow (m^3/s)	Max. Velocity (m/s)
LH_1	Trapezoidal	1	1.5	1:1.5	0.17	0.43
LH_2	Trapezoidal	2	1.5	1:1.5	1.37	1.84
LH_3	Trapezoidal	2	1.5	1:1.5	1.22	1.60
LH_4	Trapezoidal	1	1	1:1.5	0.96	1.09
LH_5	Trapezoidal	1	1	1:1.5	0.92	1.45
LH_6	Trapezoidal	1	1	1:1.5	1.84	2.28
LH_7	Trapezoidal	1	1	1:1.5	1.78	2.28
P_1	Trapezoidal	1	1	1:1.5	0.83	2.26
P_2	Trapezoidal	1	1	1:1.5	0.80	1.72
P_3	Trapezoidal	1.5	1	1:1.5	0.87	1.97
P_4	Trapezoidal	1.5	1	1:1.5	0.67	1.50
P_5	Trapezoidal	1.5	1	1:1.5	0.66	1.51
Pi_1	Trapezoidal	1	1	1:1.5	0.92	0.71
Pi_2	Trapezoidal	1	1	1:1.5	0.81	1.19
Pi_3	Trapezoidal	1.5	1.5	1:1.5	2.12	1.32

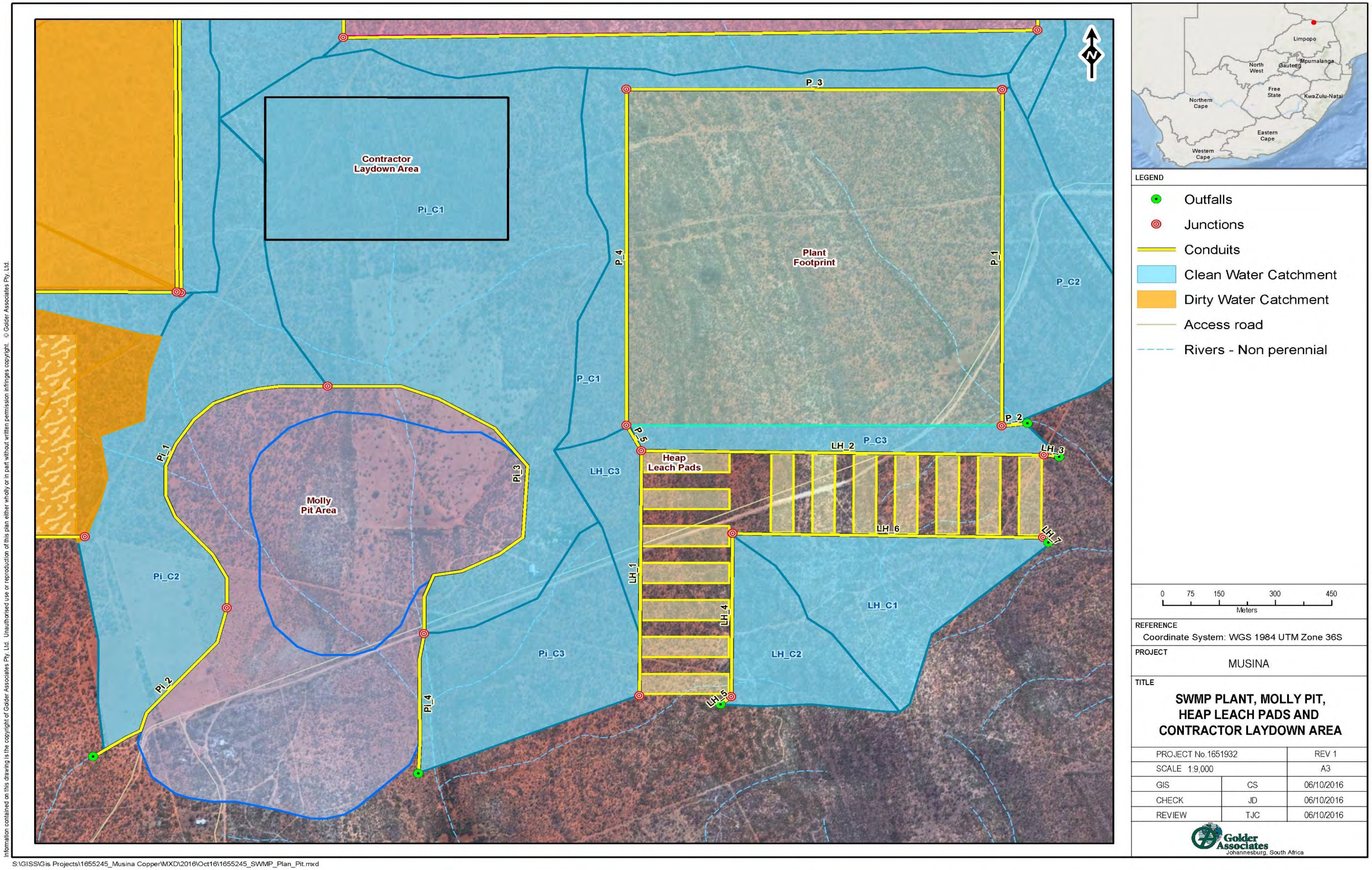

Figure 22: Plant, Molly Pit, Leach Pads and Contractor yard stormwater management plan

9.3.2 Eastern Waste Rock, 67 Area and Eastern Topsoil stockpile

Figure 23 shows the stormwater management system for the Eastern Waste Rock, 67 Area and Topsoil stockpile where clean and potentially polluted sub-catchments are delineated.

Runoff generated from the Eastern Waste Rock is considered polluted and is diverted through channels WR2_3 and WR2_4 into a storage facility at the lowest point around the Waste Rock area. Runoff generated around the Waste Rock area is considered clean, and diverted by a separate channel away from the Waste Rock area and discharged into tributaries by channels WR2_6 and WR2_9.

The runoff generated from 67 Area is considered to be potentially polluted as it is currently uncertain what activities will form part of 67 Area. Dirty run off is diverted and collected in a PCD by channels A_8 and A_10. Clean runoff is collected and diverted to the Eastern Waste Rock stormwater management system by channel A_3.

Runoff generated from the Topsoil Stockpile area is considered to be potentially polluted due to the expected high concentration of suspended solids in the runoff. This runoff is collected and diverted through a silt trap to settle the expected suspended solids before linking with the stormwater management system prepared for Area 67. The sub-catchment characteristics for 67 Area, Eastern Waste Rock and Topsoil stockpile are presented in Table 20 and the associated dimensions and properties for channels are described in Table 21.

Table 20: Catchment areas, slopes and computed runoff volumes and flood peaks for the 50 year 24-hour storm at the Eastern Waste Rock, 67 Area and Eastern Topsoil Stockpile

Name	Area (ha)	Slope (%)	Runoff Volume (ML)	Peak Runoff (m^3/s)
A_C1	2	4.6	0.4	0.2
A_C2	13	7.5	1.9	0.8
A_P1	19	1.6	3.7	1.3
A_P2	16	0.3	2.7	0.8
T2_P1	13	10.3	2.5	1.3
T2_P2	4	12.2	0.9	0.6
WR2_C1	18	0.1	0.9	0.2
WR2_C2	55	4.1	5.1	1.6
WR2_C3	7	2.3	0.8	0.3
WR2_P1	16	0.5	1.3	0.4
WR2_P2	36	0.5	1.3	0.3
WR2_P3	39	0.5	1.4	0.3
WR2_P4	14	0.5	1.2	0.4

Table 21: Dimensions of the diversion channels to convey the 50 year 24-hour return flood peak at the Eastern Waste Rock, 67 Area and Eastern Topsoil stockpile

Channel Name	Cross-Section	Depth (m)	Bottom Width (m)	Slope (m/m)	Max. Flow (m^3/s)	Max. Velocity (m/s)
A_1	Trapezoidal	1	1	1:1.5	0.16	0.92
A_2	Trapezoidal	1	1	1:1.5	0.15	0.68
A_3	Trapezoidal	1	1	1:1.5	2.09	2.23
A_4	Trapezoidal	1	1	1:1.5	0.76	1.67
A_5	Trapezoidal	1	1	1:1.5	0.66	0.57
A_6	Trapezoidal	1	1	1:1.5	1.96	1.79

Channel Name	Cross-Section	Depth (m)	Bottom Width (m)	Slope (m/m)	Max. Flow (m^3/s)	Max. Velocity (m/s)
A_7	Trapezoidal	1	1	1:1.5	0.68	1.47
A_8	Trapezoidal	1	1	1:1.5	0.55	1.52
A_9	Trapezoidal	1	1	1:1.5	1.07	1.71
A_10	Trapezoidal	1	1	1:1.5	0.57	0.72
T_1	Trapezoidal	1	1	1:1.5	1.35	2.35
T_2	Trapezoidal	1	1	1:1.5	0.57	2.24
WR2_1	Trapezoidal	1	1	1:1.5	0.39	1.64
WR2_2	Trapezoidal	1	1	1:1.5	0.58	1.01
WR2_3	Trapezoidal	1	1	1:1.5	0.49	0.65
WR2_4	Trapezoidal	1	1	1:1.5	0.27	1.19
WR2_5	Trapezoidal	1	1	1:1.5	0.26	1.47
WR2_6	Trapezoidal	1	1	1:1.5	0.25	1.34
WR2_7	Trapezoidal	1	1	1:1.5	1.65	2.27
WR2_8	Trapezoidal	1.5	1	1:1.5	3.67	2.12
WR2_9	Trapezoidal	1.5	1	1:1.5	3.66	1.97

9.3.2.1 PCD and silt trap characteristics

PCDs are proposed to contain the dirty water and the silt trap to remove silt as shown in Figure 23. The expected inflow rates and total volumes for both PCDs and the silt trap are shown in Table 22.

Table 22: Characteristics of PCDs to store polluted water from the 50 year 24-hour storm and Silt Trap

Name	Max. total inflow (m^3/s)	Total Inflow (ML)
A_PCD	1.1	6.3
WR2_PCD	0.7	5.0
T2_SiltTrap	1.9	3.3

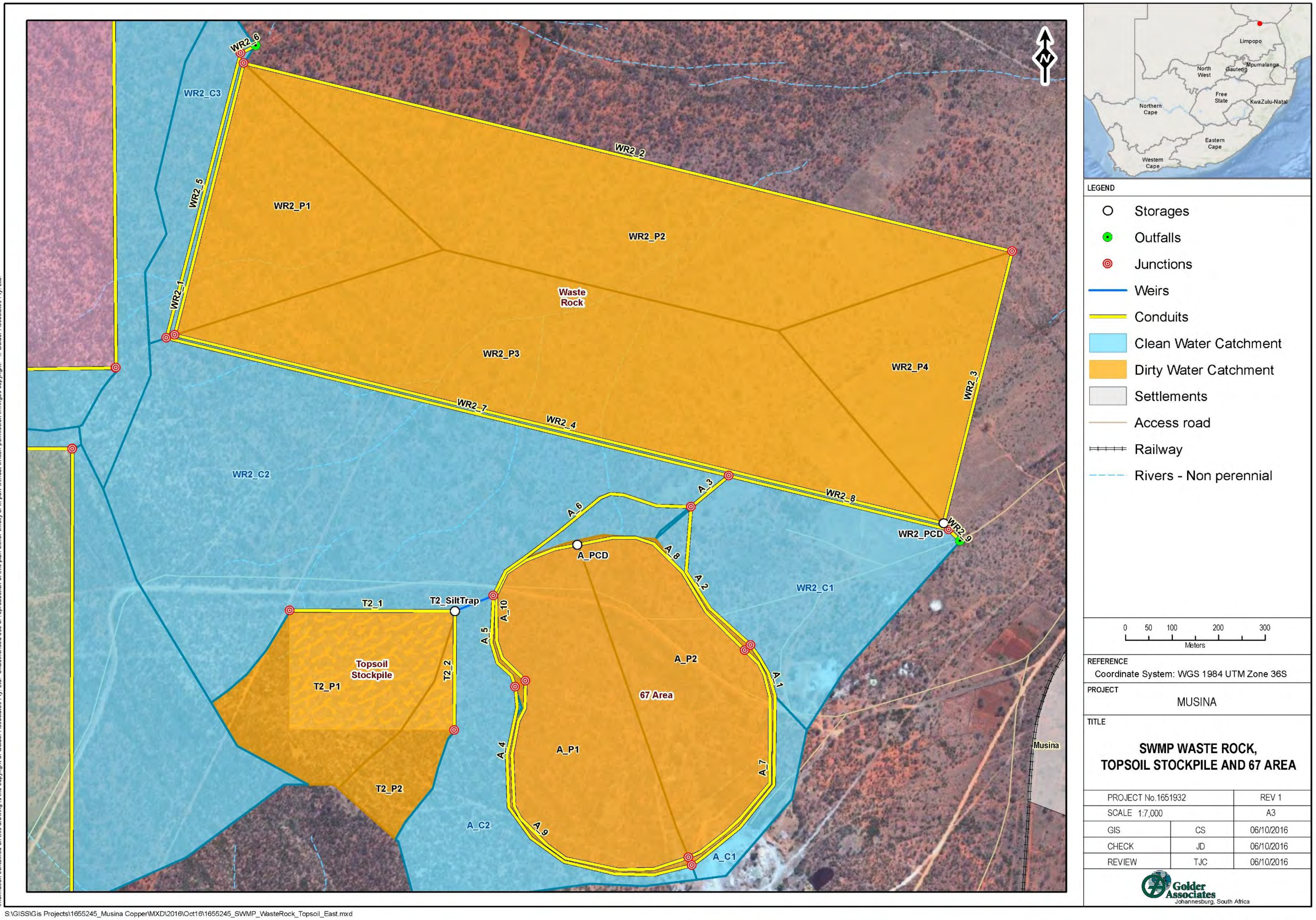

Figure 23: Eastern Waste Rock and topsoil stockpile stormwater management plan

9.3.3 Erosion control

The DWS stipulates that necessary works must be constructed to regulate the velocities of stormwater discharge to prevent erosion. The outlets of stormwater channels are points of erosion potential. To prevent scour at stormwater outlets, protect the outlet structure and minimize the potential for downstream erosion, a flow transition structure is needed to absorb the initial impact of flow and reduce the speed of flow to a non-erosive velocity. It is recommended that at each outlet where runoff is released, that a form of water flow transition is put in place to prevent scouring.

The flow velocities associated with the 50-year storm are considered to be at the upper end of acceptability for channel LH_2 but no excessive erosion is foreseen. Channels should be kept free of woody vegetation and should be inspected for erosion damage periodically such that corrective measures can be taken, should high erosion damage occur.

10.0 CONCLUSION

- A map has been compiled indicating catchment areas, mining and infrastructural areas and the major surface water drainage lines;
- The MAP for the region was found to be 324 mm while the MAE was seen to be 2 248 mm;
- The 1:50 year and 1:100 year flood peaks and floodlines have been determined for the tributaries located near the Musina site using the available survey data. The analysis shows that the infrastructure will lie within the calculated 50 year and 100 year floodlines and recommendations were provided;
- A conceptual impact assessment of the proposed site was undertaken and mitigation measures for each potentially harmful event proposed during the construction, operation and rehabilitation phases;
- The water resource classification for the area was assessed and found to be inconclusive as classification of area is still in progress;
- A water quality programme will created once a site visit has been conducted, where water quality and flows will be measured;
- Flow records were sourced and described for major perennial rivers around the mine site area at Limpopo River and Sand River, but there is currently no data available for tributaries in the region.
- A conceptual stormwater management plan for the pits was established to mitigate many of the surface water impacts that could potentially arise from the mining of the pit other infrastructure; and
- Once the site is established it is recommended that process water streams going to and from the pit be monitored on a regular basis to have an understanding of the flow rates. This will allow optimisation of the water circuits and will help with water conservation and demand management (WCDM);
- A static site water balance and site salt balance will be created and presented after a site visit has been conducted.

11.0 REFERENCES

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APPENDIX A

24 HOUR STORM RAINFALL DEPTHS STATISTICAL ANALYSIS

Table A1 shows the data used in the Reg Flood program (Alexander, et al., 2003) to produce the 24 hour rainfall depths for the 1 in 2, 1 in 10, 1 in 20, 1 in 50, 1 in 100 and 1 in 200 recurrence intervals at the 0810081 W station.

Table A1: Daily recorded maximum's for every year for D7E001

Year	Daily Maximum
1965	32
1966	30
1967	59.5
1968	52
1969	43.5
1970	69
1971	57.5
1972	79
1973	32
1974	55
1975	53
1976	81
1977	73
1978	47
1979	38
1980	90
1981	53
1982	13
1983	54
1984	61.5
1985	84.5
1986	20
1987	29.5
1988	40
1989	52
1990	67.5
1991	30.5
1992	126
1993	47
1994	35
1995	64
1996	44.5
1997	24
1998	62
1999	113

Year	Daily Maximum
2000	35
2001	24
2002	53
2003	55
2004	40
2005	67
2006	55
2007	95
2008	50
2009	4

In order to determine the likely magnitude of storm events, a statistical approach, using the Reg Flood program (Alexander, van Aswegen, & Hansford, 2003), was applied to the available recorded daily rainfall depths. The maximum 24 hour rainfall depth for each year was analysed. This method statistically analyses the maximum daily rainfall depths for each year to determine the different recurrence interval daily rainfall depths. The best fit is the Extreme Value Type 1 distribution for 0810081 W. Figure A1 shows Extreme Value Type 1 graph for the 0810081 W station.

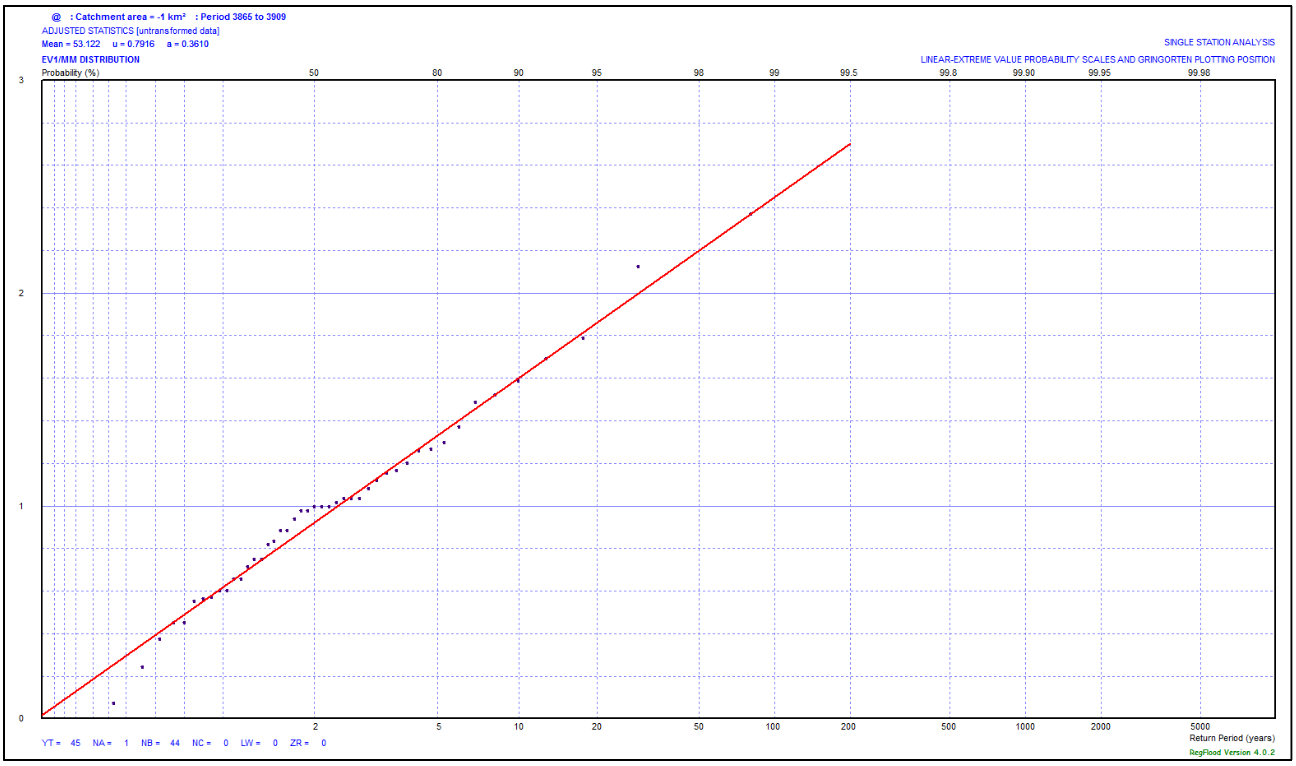

Figure A1: Extreme Value Type 1 curve for 0810081 W

APPENDIX B

HEC-RAS Outputs

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_WR2_2	Trib4	1600	1 in 50	10.43	595.45	595.71	595.65	595.77	0.008965	1.05	9.98	41.51	0.68
River_WR2_2	Trib4	1600	1 in 100	15.47	595.45	595.78	595.71	595.86	0.00842	1.18	13.11	43.35	0.69
River_WR2_2	Trib4	1400	1 in 50	10.43	593.41	593.73	593.68	593.81	0.010818	1.21	8.62	33.18	0.76
River_WR2_2	Trib4	1400	1 in 100	15.47	593.41	593.81	593.76	593.9	0.011489	1.39	11.09	36.08	0.8
River_WR2_2	Trib4	1200	1 in 50	10.43	590.55	590.74	590.74	590.83	0.021814	1.28	8.13	48.46	1
River_WR2_2	Trib4	1200	1 in 100	15.47	590.55	590.8	590.8	590.9	0.020458	1.43	10.81	52.14	1
River_WR2_2	Trib4	1000	1 in 50	10.43	586.26	586.42	586.4	586.48	0.016281	1.07	9.79	61.88	0.86
River_WR2_2	Trib4	1000	1 in 100	15.47	586.26	586.47	586.45	586.54	0.015383	1.22	12.66	62.41	0.87
River_WR2_2	Trib4	800	1 in 50	10.43	583.3	583.47	583.45	583.52	0.013589	0.98	10.67	67.06	0.78
River_WR2_2	Trib4	800	1 in 100	15.47	583.3	583.51	583.48	583.58	0.014337	1.15	13.43	68.77	0.83
River_WR2_2	Trib4	600	1 in 50	10.43	579.74	579.86	579.86	579.92	0.024832	1.06	9.83	85.98	1
River_WR2_2	Trib4	600	1 in 100	15.47	579.74	579.9	579.9	579.97	0.023338	1.2	12.87	89.1	1.01
River_WR2_2	Trib4	400	1 in 50	10.43	575.4	575.67	575.54	575.69	0.002413	0.57	18.26	70.23	0.36
River_WR2_2	Trib4	400	1 in 100	15.47	575.4	575.74	575.58	575.76	0.002555	0.68	22.9	71.5	0.38
River_WR2_2	Trib4	245.71	1 in 50	10.43	574.61	574.75	574.75	574.82	0.023308	1.15	9.08	67.11	1
River_WR2_2	Trib4	245.71	1 in 100	15.47	574.61	574.79	574.79	574.88	0.021471	1.3	11.93	69.19	1

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_WR2_1	Trib3	3000	1 in 50	9.38	594.1	594.3	594.3	594.39	0.02025	1.26	7.42	42.81	0.97
River_WR2_1	Trib3	3000	1 in 100	13.91	594.1	594.36	594.36	594.46	0.019243	1.41	9.84	46.22	0.98
River_WR2_1	Trib3	2800	1 in 50	9.38	590.1	590.42	590.24	590.43	0.001372	0.48	19.5	63.59	0.28
River_WR2_1	Trib3	2800	1 in 100	13.91	590.1	590.5	590.28	590.51	0.001389	0.56	24.75	64.52	0.29
River_WR2_1	Trib3	2600	1 in 50	9.38	589.23	589.64	589.63	589.73	0.020013	1.39	6.72	33.16	0.99
River_WR2_1	Trib3	2600	1 in 100	13.91	589.23	589.7	589.7	589.82	0.019232	1.52	9.17	38.73	0.99
River_WR2_1	Trib3	2400	1 in 50	9.38	585.1	585.23	585.23	585.3	0.024615	1.14	8.25	64.59	1.02
River_WR2_1	Trib3	2400	1 in 100	13.91	585.1	585.27	585.27	585.36	0.024988	1.33	10.48	65.77	1.06
River_WR2_1	Trib3	2200	1 in 50	9.38	583.1	583.43	583.29	583.45	0.002816	0.61	15.33	59.77	0.39
River_WR2_1	Trib3	2200	1 in 100	13.91	583.1	583.49	583.34	583.51	0.003247	0.74	18.84	61.72	0.43
River_WR2_1	Trib3	2000	1 in 50	9.38	582.1	582.21	582.21	582.25	0.019722	0.92	10.23	93.59	0.89
River_WR2_1	Trib3	2000	1 in 100	13.91	582.1	582.25		582.3	0.014668	0.98	14.24	94.97	0.81
River_WR2_1	Trib3	1800	1 in 50	9.38	581.1	581.48	581.28	581.49	0.001499	0.52	17.91	54.95	0.29
River_WR2_1	Trib3	1800	1 in 100	13.91	581.1	581.57	581.32	581.58	0.001579	0.61	22.89	58.43	0.31
River_WR2_1	Trib3	1600	1 in 50	9.38	580.51	580.66	580.66	580.72	0.021804	1.13	8.28	59.48	0.97
River_WR2_1	Trib3	1600	1 in 100	13.91	580.51	580.7	580.7	580.79	0.022495	1.32	10.52	61.44	1.02

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_WR2_1	Trib3	1400	1 in 50	9.38	576.13	576.4	576.25	576.41	0.001554	0.45	21.05	84.57	0.29
River_WR2_1	Trib3	1400	1 in 100	13.91	576.13	576.47	576.28	576.48	0.001576	0.52	26.91	87.52	0.3
River_WR2_1	Trib3	1200	1 in 50	9.38	575.39	575.56	575.56	575.63	0.022752	1.18	7.94	55.37	1
River_WR2_1	Trib3	1200	1 in 100	13.91	575.39	575.6	575.6	575.69	0.020818	1.31	10.65	59.71	0.99
River_WR2_1	Trib3	848	1 in 50	9.38	571.88	572.35	572.22	572.38	0.003487	0.74	12.64	43.36	0.44
River_WR2_1	Trib3	848	1 in 100	13.91	571.88	572.43	572.28	572.47	0.003631	0.86	16.08	45.14	0.46
River_WR2_1	Trib3	800	1 in 50	9.38	571.53	572.36		572.36	0.000073	0.2	46.39	61.68	0.07
River_WR2_1	Trib3	800	1 in 100	13.91	571.53	572.44		572.44	0.000119	0.27	51.24	62.78	0.1
River_WR2_1	Trib3	600	1 in 50	9.38	572.14	572.25	572.25	572.31	0.025992	1.05	8.97	82.91	1.02
River_WR2_1	Trib3	600	1 in 100	13.91	572.14	572.28	572.28	572.36	0.025448	1.21	11.48	83.71	1.05
River_WR2_1	Trib3	400	1 in 50	9.38	570.57	570.9	570.71	570.91	0.001367	0.48	19.6	64.31	0.28
River_WR2_1	Trib3	400	1 in 100	13.91	570.57	570.97	570.76	570.99	0.001477	0.57	24.59	66.46	0.3
River_WR2_1	Trib3	200	1 in 50	9.38	569.99	570.12	570.12	570.19	0.024063	1.11	8.42	66.87	1
River_WR2_1	Trib3	200	1 in 100	13.91	569.99	570.16	570.16	570.24	0.022009	1.25	11.09	68.9	1
River_WR	Trib1	2600	1 in 50	17.87	609.37	609.76	609.6	609.8	0.003336	0.85	21.03	56.9	0.45
River_WR	Trib1	2600	1 in 100	26.3	609.37	609.86	609.67	609.91	0.003469	0.99	26.52	58.57	0.47

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_WR	Trib1	2400	1 in 50	17.87	608.11	608.34	608.34	608.45	0.019966	1.46	12.24	56.25	1
River_WR	Trib1	2400	1 in 100	26.3	608.11	608.41	608.41	608.54	0.018379	1.64	16.02	58.05	1
River_WR	Trib1	2200	1 in 50	17.87	605.1	606.84	605.31	606.84	0.000002	0.05	371.36	266.58	0.01
River_WR	Trib1	2200	1 in 100	26.3	605.1	606.93	605.35	606.93	0.000003	0.07	396.29	270.76	0.02
River_WR	Trib1	2000	1 in 50	17.87	606.5	606.73	606.73	606.83	0.020275	1.42	12.61	61.33	1
River_WR	Trib1	2000	1 in 100	26.3	606.5	606.79	606.79	606.92	0.019112	1.59	16.51	64.43	1.01
River_WR	Trib1	1705.09	1 in 50	17.87	603.05	603.95	603.22	603.95	0.000057	0.21	83.63	106.64	0.08
River_WR	Trib1	1705.09	1 in 100	26.3	603.05	604.05	603.27	604.05	0.000084	0.28	94.91	109.73	0.1
River_WR	Trib1	1691.37	1 in 50	17.87	603.14	603.94		603.95	0.000137	0.27	67.26	119.94	0.11
River_WR	Trib1	1691.37	1 in 100	26.3	603.14	604.05		604.05	0.000183	0.33	80.14	129.03	0.13
River_WR	Trib1	1620.62	1 in 50	17.87	603.05	603.94		603.94	0.000093	0.23	76.24	122.05	0.09
River_WR	Trib1	1620.62	1 in 100	26.3	603.05	604.04		604.04	0.000131	0.3	88.94	130.23	0.11
River_WR	Trib1	1601.59	1 in 50	17.87	603.45	603.92		603.93	0.000858	0.48	37.12	107.23	0.26
River_WR	Trib1	1601.59	1 in 100	26.3	603.45	604.02		604.04	0.000898	0.55	48.16	119.05	0.27
River_WR	Trib1	1400	1 in 50	17.87	603.12	603.34	603.34	603.44	0.020855	1.4	12.74	64.3	1.01
River_WR	Trib1	1400	1 in 100	26.3	603.12	603.41	603.41	603.53	0.019205	1.56	16.87	68.29	1

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_WR	Trib1	1200	1 in 50	17.87	599.23	599.6	599.49	599.65	0.006078	1.04	17.2	53.99	0.59
River_WR	Trib1	1200	1 in 100	26.3	599.23	599.68	599.56	599.75	0.006606	1.22	21.63	57.04	0.63
River_WR	Trib1	1000	1 in 50	17.87	597.28	597.45	597.45	597.53	0.022869	1.28	13.92	85.89	1.02
River_WR	Trib1	1000	1 in 100	26.3	597.28	597.5	597.5	597.6	0.02016	1.43	18.38	87.69	1
River_WR	Trib1	800	1 in 50	17.87	595.96	597.02	596.15	597.02	0.000052	0.19	95.55	110.66	0.06
River_WR	Trib1	800	1 in 100	26.3	595.96	597.12	596.2	597.12	0.000081	0.25	107.22	132.16	0.08
River_WR	Trib1	600	1 in 50	17.87	596.4	596.98		596.99	0.001154	0.46	38.65	120.43	0.26
River_WR	Trib1	600	1 in 100	26.3	596.4	597.06		597.08	0.001196	0.54	49.71	141.63	0.27
River_WR	Trib1	439.99	1 in 50	17.87	596.08	596.56	596.47	596.6	0.00732	0.94	19.02	79.83	0.61
River_WR	Trib1	439.99	1 in 100	26.3	596.08	596.63	596.54	596.69	0.007285	1.03	25.48	92.5	0.63
River_WR	Trib1	343.88	1 in 50	17.87	594.93	595.4	595.4	595.52	0.019328	1.51	11.83	50.49	1
River_WR	Trib1	343.88	1 in 100	26.3	594.93	595.48	595.48	595.61	0.018803	1.65	15.99	58.74	1.01
River_TSF	Trib2	1800	1 in 50	7.4	617.23	617.45	617.45	617.51	0.025329	1.05	7.07	64.12	1.01
River_TSF	Trib2	1800	1 in 100	10.94	617.23	617.5	617.5	617.55	0.019225	1.04	10.52	78.2	0.91
River_TSF	Trib2	1600	1 in 50	7.4	609.25	609.45	609.49	609.58	0.070555	1.62	4.57	46.32	1.65
River_TSF	Trib2	1600	1 in 100	10.94	609.25	609.46	609.53	609.7	0.119571	2.18	5.03	48.59	2.16

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_TSF	Trib2	1400	1 in 50	7.4	607.82	608.19	608.09	608.21	0.00489	0.65	11.46	62.4	0.48
River_TSF	Trib2	1400	1 in 100	10.94	607.82	608.25	608.14	608.28	0.004572	0.69	15.77	73.19	0.48
River_TSF	Trib2	1200	1 in 50	7.4	606.66	607.13	607.03	607.16	0.005638	0.82	9.05	38.49	0.54
River_TSF	Trib2	1200	1 in 100	10.94	606.66	607.2	607.09	607.24	0.005883	0.92	11.95	44.22	0.56
River_TSF	Trib2	1000	1 in 50	7.4	604.8	605.06	605.06	605.12	0.023602	1.12	6.61	51.35	1
River_TSF	Trib2	1000	1 in 100	10.94	604.8	605.1	605.1	605.18	0.022433	1.21	9.04	60.03	1
River_TSF	Trib2	905.79	1 in 50	7.4	600.72	602.34	601.04	602.34	0.000009	0.09	86.14	85.11	0.03
River_TSF	Trib2	905.79	1 in 100	10.94	600.72	602.42	601.1	602.43	0.000016	0.12	93.08	87.99	0.04
River_TSF	Trib2	783.56	1 in 50	7.4	597.85	602.34		602.34	0	0.02	492.19	167.51	0
River_TSF	Trib2	783.56	1 in 100	10.94	597.85	602.42		602.42	0	0.02	505.71	169.48	0
River_TSF	Trib2	737.99	1 in 50	7.4	597.58	602.34		602.34	0	0.01	557.04	172.39	0
River_TSF	Trib2	737.99	1 in 100	10.94	597.58	602.42		602.42	0	0.02	570.94	173.93	0
River_TSF	Trib2	600	1 in 50	7.4	599.64	602.34		602.34	0	0.03	289.57	144.47	0.01
River_TSF	Trib2	600	1 in 100	10.94	599.64	602.42		602.42	0	0.04	301.2	145.6	0.01
River_TSF	Trib2	560.02	1 in 50	7.4	600.56	602.34		602.34	0.000001	0.05	163.04	129.29	0.01
River_TSF	Trib2	560.02	1 in 100	10.94	600.56	602.42		602.42	0.000003	0.06	173.58	133.55	0.02

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_TSF	Trib2	400	1 in 50	7.4	601.95	602.34		602.34	0.000241	0.22	33.99	98.86	0.12
River_TSF	Trib2	400	1 in 100	10.94	601.95	602.42		602.42	0.000279	0.26	41.94	103.66	0.13
River_TSF	Trib2	187.22	1 in 50	7.4	601.97	602.11	602.11	602.17	0.025683	1.06	6.96	62.23	1.01
River_TSF	Trib2	187.22	1 in 100	10.94	601.97	602.15	602.15	602.22	0.022918	1.18	9.31	65.77	1
River_TS	Trib7	1200	1 in 50	5.06	606.87	606.99	606.99	607.04	0.026035	1.03	4.91	46.49	1.01
River_TS	Trib7	1200	1 in 100	7.51	606.87	607.04	607.04	607.09	0.016546	1.01	7.42	51.37	0.85
River_TS	Trib7	1000	1 in 50	5.06	605.67	607	605.74	607	0.000001	0.03	155.05	184.2	0.01
River_TS	Trib7	1000	1 in 100	7.51	605.67	607.04	605.76	607.04	0.000002	0.05	161.7	190.9	0.01
River_TS	Trib7	800	1 in 50	5.06	603.78	607		607	0	0.02	311.9	300	0
River_TS	Trib7	800	1 in 100	7.51	603.78	607.04		607.04	0	0.03	322.52	300	0.01
River_TS	Trib7	600	1 in 50	5.06	605.2	607		607	0.000001	0.03	176.88	299.76	0.01
River_TS	Trib7	600	1 in 100	7.51	605.2	607.03		607.04	0.000002	0.05	187.46	300	0.01
River_TS	Trib7	400	1 in 50	5.06	606.83	606.94	606.94	606.99	0.042736	1.04	4.87	65.99	1.22
River_TS	Trib7	400	1 in 100	7.51	606.83	606.97	606.97	607.03	0.031211	1.07	7.03	72.2	1.09
River_TS	Trib7	200	1 in 50	5.06	599.95	600.05	600.05	600.1	0.028386	1	5.05	53.18	1.04
River_TS	Trib7	200	1 in 100	7.51	599.95	600.06	600.08	600.15	0.038125	1.28	5.88	53.68	1.23

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_Plant	Trib5	3000	1 in 50	13.13	613.13	613.25	613.25	613.3	0.02549	1.07	12.26	107.87	1.01
River_Plant	Trib5	3000	1 in 100	19.47	613.13	613.28	613.28	613.36	0.022645	1.21	16.15	108.77	1
River_Plant	Trib5	2800	1 in 50	13.13	610.29	610.59	610.52	610.62	0.006557	0.77	17.12	89.71	0.56
River_Plant	Trib5	2800	1 in 100	19.47	610.29	610.64	610.56	610.68	0.006692	0.87	22.42	99.03	0.58
River_Plant	Trib5	2600	1 in 50	13.13	608.13	608.31	608.31	608.38	0.023478	1.13	11.61	88.53	1
River_Plant	Trib5	2600	1 in 100	19.47	608.13	608.35	608.35	608.43	0.022508	1.28	15.16	92.38	1.01
River_Plant	Trib5	2448.4	1 in 50	13.13	603.47	603.58	603.61	603.68	0.042768	1.34	9.79	90.59	1.3
River_Plant	Trib5	2448.4	1 in 100	19.47	603.47	603.61	603.64	603.74	0.045243	1.58	12.31	92.8	1.39
River_Plant	Trib5	2329.36	1 in 50	13.13	598.56	598.65	598.69	598.75	0.040076	1.36	9.68	105.77	1.43
River_Plant	Trib5	2329.36	1 in 100	19.47	598.56	598.68	598.71	598.8	0.038092	1.55	12.53	107.41	1.45
River_Plant	Trib5	2303.38	1 in 50	13.13	597.37	597.46	597.49	597.57	0.05191	1.47	8.95	105.39	1.61
River_Plant	Trib5	2303.38	1 in 100	19.47	597.37	597.48	597.52	597.63	0.054018	1.73	11.26	106.74	1.7
River_Plant	Trib5	2241.01	1 in 50	13.13	594.4	596.64	594.71	596.64	0.000004	0.09	145.78	95.71	0.02
River_Plant	Trib5	2241.01	1 in 100	19.47	594.4	596.76	594.78	596.77	0.000007	0.12	158.27	99.02	0.03
River_Plant	Trib5	2218.82	1 in 50	13.13	593.18	596.64		596.64	0.000001	0.05	253.14	86.49	0.01
River_Plant	Trib5	2218.82	1 in 100	19.47	593.18	596.76		596.77	0.000001	0.07	264.32	87.47	0.01

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_Plant	Trib5	2013.6	1 in 50	13.13	595	596.63		596.64	0.000027	0.19	69	59.11	0.06
River_Plant	Trib5	2013.6	1 in 100	19.47	595	596.76		596.76	0.000043	0.25	76.64	61.47	0.07
River_Plant	Trib5	2000	1 in 50	13.13	594.62	596.63		596.64	0.000007	0.13	101.93	56.96	0.03
River_Plant	Trib5	2000	1 in 100	19.47	594.62	596.76		596.76	0.000012	0.18	109.21	57.73	0.04
River_Plant	Trib5	1978.63	1 in 50	13.13	595.45	596.63		596.64	0.000035	0.21	63.54	59.36	0.06
River_Plant	Trib5	1978.63	1 in 100	19.47	595.45	596.76		596.76	0.000055	0.27	71.07	60.38	0.08
River_Plant	Trib5	1962.25	1 in 50	13.13	595.4	596.63		596.63	0.000026	0.19	70.96	62.45	0.06
River_Plant	Trib5	1962.25	1 in 100	19.47	595.4	596.76		596.76	0.000041	0.25	78.87	63.22	0.07
River_Plant	Trib5	1800	1 in 50	13.13	596.21	596.48	596.48	596.61	0.019031	1.59	8.24	31.99	1
River_Plant	Trib5	1800	1 in 100	19.47	596.21	596.56	596.56	596.72	0.017417	1.8	10.8	32.59	1
River_Plant	Trib5	1600	1 in 50	13.13	592.7	593.16	593	593.21	0.004073	1.01	12.94	31.12	0.5
River_Plant	Trib5	1600	1 in 100	19.47	592.7	593.27	593.08	593.34	0.004345	1.19	16.38	32.55	0.54
River_Plant	Trib5	1400	1 in 50	13.13	591.33	591.55	591.55	591.66	0.020151	1.43	9.19	43.92	1
River_Plant	Trib5	1400	1 in 100	19.47	591.33	591.62	591.62	591.75	0.018701	1.62	12.03	45.06	1
River_Plant	Trib5	1200	1 in 50	13.13	587.98	588.31	588.19	588.35	0.004706	0.87	15.13	51.37	0.51
River_Plant	Trib5	1200	1 in 100	19.47	587.98	588.4	588.26	588.45	0.004526	0.98	19.85	54.43	0.52

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_Plant	Trib5	1000	1 in 50	13.13	586.67	586.97		587.04	0.009787	1.12	11.75	47.28	0.72
River_Plant	Trib5	1000	1 in 100	19.47	586.67	587.04		587.13	0.010372	1.29	15.1	51.14	0.76
River_Plant	Trib5	800	1 in 50	13.13	585.12	585.44		585.47	0.006315	0.87	15.17	64.44	0.57
River_Plant	Trib5	800	1 in 100	19.47	585.12	585.51	585.41	585.56	0.006019	0.97	20.15	70.02	0.58
River_Plant	Trib5	600	1 in 50	13.13	583.2	583.42	583.41	583.51	0.017514	1.33	9.91	47.72	0.93
River_Plant	Trib5	600	1 in 100	19.47	583.2	583.47	583.47	583.59	0.018517	1.57	12.43	48.62	0.99
River_Plant	Trib5	490.08	1 in 50	13.13	581.1	581.32	581.32	581.42	0.020717	1.4	9.41	47.57	1
River_Plant	Trib5	490.08	1 in 100	19.47	581.1	581.39	581.39	581.51	0.01937	1.56	12.47	50.66	1.01
River_Plant	Trib5	448.7	1 in 50	13.13	580.2	580.39	580.4	580.49	0.024616	1.39	9.46	54.96	1.07
River_Plant	Trib5	448.7	1 in 100	19.47	580.2	580.43	580.46	580.57	0.027107	1.65	11.83	57.19	1.16
River_Plant	Trib5	376.86	1 in 50	13.13	576.74	577.71	577.02	577.72	0.000217	0.33	39.46	56.14	0.13
River_Plant	Trib5	376.86	1 in 100	19.47	576.74	577.81	577.1	577.82	0.000326	0.43	45.27	59.36	0.16
River_Plant	Trib5	332.97	1 in 50	13.13	576.8	577.7		577.71	0.000197	0.3	43.3	65.75	0.12
River_Plant	Trib5	332.97	1 in 100	19.47	576.8	577.8		577.81	0.000292	0.39	49.84	69.57	0.15
River_Plant	Trib5	242.25	1 in 50	13.13	575.47	577.7		577.71	0.000009	0.14	95.34	60.33	0.03
River_Plant	Trib5	242.25	1 in 100	19.47	575.47	577.8		577.8	0.000017	0.19	101.22	61.85	0.05

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_Plant	Trib5	221.11	1 in 50	13.13	575.7	577.7		577.71	0.000005	0.08	169.68	139.15	0.02
River_Plant	Trib5	221.11	1 in 100	19.47	575.7	577.8		577.8	0.000008	0.1	183.39	144.27	0.03
River_Plant	Trib5	159.85	1 in 50	13.13	576.76	577.7		577.7	0.000124	0.22	59	111.73	0.1
River_Plant	Trib5	159.85	1 in 100	19.47	576.76	577.8		577.8	0.000171	0.28	70.06	121.33	0.12
River_Plant	Trib5	132.53	1 in 50	13.13	577.83	577.57	577.57	577.68	0.020206		9.16	43.31	0
River_Plant	Trib5	132.53	1 in 100	19.47	577.83	577.65	577.65	577.77	0.018667		12.81	60.81	0
River_MPA	Trib6	2600	1 in 50	17.4	607.26	607.61	607.61	607.7	0.021718	1.32	13.16	74.76	1.01
River_MPA	Trib6	2600	1 in 100	25.61	607.26	607.67	607.67	607.77	0.020852	1.43	17.85	87.08	1.01
River_MPA	Trib6	2400	1 in 50	17.4	603.82	604.06	604	604.09	0.006588	0.76	22.82	121	0.56
River_MPA	Trib6	2400	1 in 100	25.61	603.82	604.11	604.04	604.15	0.006815	0.88	28.96	126.22	0.59
River_MPA	Trib6	2200	1 in 50	17.4	601.6	601.8	601.8	601.89	0.021612	1.31	13.3	76.51	1
River_MPA	Trib6	2200	1 in 100	25.61	601.6	601.86	601.86	601.96	0.020162	1.45	17.63	82.31	1
River_MPA	Trib6	2000	1 in 50	17.4	597.01	598.1	597.29	598.1	0.000128	0.27	64.54	84.84	0.1
River_MPA	Trib6	2000	1 in 100	25.61	597.01	598.18	597.36	598.18	0.000213	0.36	71.1	88.41	0.13
River_MPA	Trib6	1800	1 in 50	17.4	597.41	598.08		598.08	0.000078	0.18	95.64	197.27	0.08
River_MPA	Trib6	1800	1 in 100	25.61	597.41	598.15		598.15	0.000115	0.24	108.92	204.09	0.1

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_MPA	Trib6	1600	1 in 50	17.4	597.83	597.98	597.98	598.03	0.018829	0.99	17.52	173.09	1
River_MPA	Trib6	1600	1 in 100	25.61	597.83	598.01	598.01	598.07	0.017711	1.1	23.3	189.02	1
River_MPA	Trib6	1400	1 in 50	17.4	591.62	591.79	591.84	591.98	0.056212	1.94	8.95	58.19	1.58
River_MPA	Trib6	1400	1 in 100	25.61	591.62	591.83	591.9	592.09	0.057548	2.25	11.36	60.2	1.66
River_MPA	Trib6	1301.79	1 in 50	17.4	590.35	590.67	590.62	590.75	0.00779	1.24	14.07	51.63	0.76
River_MPA	Trib6	1301.79	1 in 100	25.61	590.35	590.78	590.7	590.86	0.00641	1.31	19.54	56.8	0.71
River_MPA	Trib6	1274.25	1 in 50	17.4	589.97	590.7		590.71	0.000236	0.36	48.28	81.64	0.15
River_MPA	Trib6	1274.25	1 in 100	25.61	589.97	590.81		590.82	0.000318	0.45	56.8	86.02	0.18
River_MPA	Trib6	1204.72	1 in 50	17.4	590.16	590.68		590.69	0.000393	0.4	43.3	91.2	0.19
River_MPA	Trib6	1204.72	1 in 100	25.61	590.16	590.78		590.79	0.000478	0.49	52.12	94.16	0.21
River_MPA	Trib6	1167.85	1 in 50	17.4	590.29	590.53	590.53	590.64	0.014962	1.44	12.12	57.95	1
River_MPA	Trib6	1167.85	1 in 100	25.61	590.29	590.6	590.6	590.73	0.01379	1.59	16.11	62.21	1
River_MPA	Trib6	1000	1 in 50	17.4	588.09	588.98	588.36	588.99	0.000248	0.35	50.08	73.84	0.13
River_MPA	Trib6	1000	1 in 100	25.61	588.09	589.11	588.43	589.12	0.000323	0.43	59.9	78.79	0.16
River_MPA	Trib6	800	1 in 50	17.4	588.33	588.84		588.87	0.002801	0.73	23.75	70.42	0.4
River_MPA	Trib6	800	1 in 100	25.61	588.33	588.94		588.97	0.002898	0.83	30.92	78.24	0.42

River	Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
River_MPA	Trib6	600	1 in 50	17.4	587.67	587.96		588	0.007468	0.95	18.32	76.83	0.62
River_MPA	Trib6	600	1 in 100	25.61	587.67	588.03		588.09	0.007447	1.07	23.88	83.27	0.64
River_MPA	Trib6	400	1 in 50	17.4	585.9	586.07		586.12	0.012198	0.94	18.45	112.96	0.74
River_MPA	Trib6	400	1 in 100	25.61	585.9	586.11		586.18	0.012832	1.11	23.16	116.04	0.79
River_MPA	Trib6	200	1 in 50	17.4	582.68	582.88	582.88	582.97	0.020867	1.35	12.85	68.41	1
River_MPA	Trib6	200	1 in 100	25.61	582.68	582.94	582.94	583.06	0.019319	1.52	16.81	70.8	1

APPENDIX C

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October 2016

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Table of Abbreviations

DWS	Department of Water and Sanitation
GVA	Gross Value Added
HDI	Historically Disadvantaged Individuals
IDC	Industrial Development Corporation
LED	Local Economic Development
LSDI	Lubombo Spatial Development Initiative
MLM	Musina Local Municipality
RWS	Regional Water System
SADC	Southern African Development Community
SEZ	Special Economic Zone
SMME	Small, Medium and Micro Enterprise
VDM	Vhembe District Municipality
VIP	Ventilation Improved Pit
WMA	Water Management Areas
WSA	Water Service Authority
GDP	Gross Domestic Product

1.0 INTRODUCTION

Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty), a subsidiary of IRL (SA) Resources Investment (Pty) Ltd (IRL), with offices in Sandton, South Africa, have acquired prospecting rights for copper on seven farms near Musina in Limpopo Province. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated. The prospecting rights will expire in November 2016 and Smarty have applied for a mining right (MR), environmental authorisation (EA), a waste management licence (WML) and a water use licence (WUL), all of which must be obtained before mining may commence.

Golder Associates Africa (Pty) Ltd, an independent environmental consulting company, is conducting the EIA, SLP, MWP and associated authorisation processes for Smarty. These include applications for a mining right, a water use licence and environmental authorisation for specific activities listed in the EIA Regulations GN R.983, GN R.984 and GN R.985. As part of the EIA study, a Social Impact Assessment (SIA) is required as a specialist study. This document discusses the scoping phase of the SIA which describes the baseline of the project area and potential impacts arising from the activities.

2.0 THE EXISTING SOCIAL ENVIRONMENT

This social baseline report is a broad description of the current social environment at a regional and local level in the study area. The project area spans Wards 2, 3, 4, 5 and 6 in the Musina Local Municipality (MLM) within the Vhembe District Municipality (VDM) in Limpopo Province. For this project, the local and district municipalities and the provincial level have been termed the regional study area.

2.1 Overview of the Regional Area

2.1.1 Overview of Limpopo Province

Limpopo is South Africa's northern most province, lying within the curve of the Limpopo River. It is a region with contrasting topographical features, consisting of bushveld country to mountainous, indigenous forests and patchworks of farmland.

The province borders the countries of Botswana to the west, Zimbabwe to the north and Mozambique to the east. Limpopo is the gateway to the rest of Africa, with its shared borders making it favourably situated for economic cooperation with other parts of southern Africa.

Industry

Limpopo is rich in mineral deposits and the mining sector contributes more than a fifth of the provincial economy. The province is a typical developing area, exporting primary products and importing manufactured goods and services.

Agriculture[1]

The bushveld is cattle country, where extensive ranching operations are often supplemented by controlled hunting. About 80% of South Africa's hunting industry is found in Limpopo. Limpopo, known as the "garden of South Africa" produces the majority of South Africa's mangoes, papayas, avocados and tomatoes. The province also produces tea, citrus, bananas and litchis in abundance. Sunflower, cotton, maize and peanuts are cultivated in the Bela-Bela and Modimole areas. Modimole is also known for its table-grape crops. Tropical fruit, such as bananas, litchis, pineapples, mangoes and pawpaws, as well as a variety of nuts, are grown in the Tzaneen and Makhado areas. Tzaneen is also at the centre of extensive tea and coffee plantations. Extensive forestry plantations are also found in the region, including hardwood which is used for furniture manufacture. In addition to commercial agriculture, subsistence farming is the mainstay of a large section of the rural population.

[1] SOURCE http://www.southafrica.info/about/geography/limpopo.htm#.U-4JvsWSw4I#ixzz3AT0Rt0Ph (accessed 01/07/2016)

2.1.2 Overview of the Vhembe District Municipality[2]

The Vhembe District Municipality (VDM) consists of four local municipalities namely: Makhado, Musina, Thulamela and Mutale. It is located in the northern part of the Limpopo Province and covers an area of approximately 2 140 700 ha. It shares borders with Zimbabwe in the north, Mozambique through Kruger National Park in the east and Botswana in the north-west. The Limpopo River valley forms the border between the district and its international neighbours.

It covers a geographical area that is predominantly rural with the majority of settlements being clustered east of the N1 in Thulamela and Mutale. Only major settlements in Makhado are located west of the N1. Although the district is strategically located on the N1 corridor, it mainly serves as throughway for trade traffic to and from countries to the north with very little direct spin-offs accruing to the local economy (apart from the relatively limited shopping in Musina and at Beit Bridge).

The VDM is home to many sacred places of the vhaVenda people including Lake Fundudzi and Phiphidi Waterfalls. Unique attractions such as Tshiungani Caves and Musina Nature Reserve, home to “The Big Tree” which is the largest baobab tree in South Africa, are located within the VDM.

2.1.3 Overview of the Musina Local Municipality

Musina Local Municipality (MLM) is situated in the far northern part of the VDM. Its northern border forms part of the international border between South Africa, Botswana and Zimbabwe. It is bounded by Makhado Local Municipality to the south and Mutale Local Municipality to the east. MLM is also bounded in the south-west by the Local Municipality of Blouberg which falls within the Capricorn District Municipality. It covers an area of approximately 7 578 km^2. MLM is positioned 460 km from Tshwane and 24 km from the South African border with Zimbabwe. It is recognised as a gateway city to the rest of Africa by Zimbabwe, Botswana and other states in the SADC Region (Musina LM IDP, 2016/2017-2021).

2.2 Description of the Local Area

This section aims to present a description of the existing social environment at a municipal and ward level in comparison to the provincial data. Aspects of population demographics, infrastructure and services as well as economic profiles are discussed.

2.2.1 Population Demographics

The population demographic description of the regional and local area is an indicator used to assess social norms and power structure impacts on the lives and opportunities available to different groups such as men and women. The male population for the regional study area is a fraction higher at 34 504 (50.5%) than the female population which totals 33 855 (49.5%) as indicated in the Stats SA 2011 census. The gender distribution across the local Wards also indicates a slightly higher male population, except Ward 3 which recorded a higher female population (52.3%). A possible reason for the higher percentage of males in the region could be the presence of job opportunities in the area which attract male workers from other areas of the country.

The total number of households is recorded as being 20 042 in 2011 which is a 57.8% increase on the 2001 total of 11 577. The total population recorded in 2001 and 2011 showed a similar trend with the total population growing from 39 310 in 2001 to 68 359 in the 2011. It was noted in the Stats SA 2011 census that a large proportion of the population is within the 15 to 34 year age group, at 45% (Musina LM IDP, 2016/2017-2021).

The Stats SA 2011 census recorded that Ward 1 has the highest number of tribal or traditional households at 1 140 and Ward 2 has the highest number of farm households at 4 284. Ward 3 has the highest number of urban households at 3 513 followed by Ward 6 at 2 678, Ward 5 at 2 579 and Ward 4 at 1 668 (Musina LM IDP, 2016/2017-2021).

[2] SOURCE http://www.vhembe.gov.za/ (accessed 01/07/2016)

Table 1: Population profile

	Black	Coloured	Indian	White	Other	Male%	Female %	Total
Limpopo Province	96.7%	0.3%	0.3%	2.6%	0.2%	46.7%	53.3%	5 404 605
Vhembe DM	98.2%	0.1%	0.4%	1.1%	0.1%	45.7%	54.3%	1 294 671
Musina LM	94.0%	0.3%	0.5%	4.8%	0.3%	50.5%	49.5%	68 359
Ward 2	94.6%	0.1%	0.1%	5.1%	0.1%	52.0%	48.0%	16 747
Ward 3	99.7%	0.1%	0.0%	0.0%	0.1%	47.7%	52.3%	12 758
Ward 4	96.1%	0.3%	0.5%	2.9%	0.3%	52.0%	48.0%	5 098
Ward 5	99.0%	0.1%	0.1%	0.0%	0.8%	50.3%	49.7%	10 461
Ward 6	74.8%	1.4%	2.7%	20.2%	0.9%	50.1%	49.9%	9 929

** Stats SA, 2011*

Levels of Education

Understanding the education status of a specified geographic area gives an indication of the level of education the local population has attained. Table 2 reflects that 43.1% of the local population has some secondary education while 21.7% has completed secondary education. On average, 6.3% of the local population have completed higher education.

Table 2: Average education levels

	No schooling	Some primary	Completed primary	Some secondary	Completed secondary	Higher
Limpopo Province	17.3%	11.6%	4.4%	35.7%	22.7%	8.3%
Vhembe DM	17.8%	11.2%	4.6%	35.5%	21.9%	9.0%
Musina LM	11.3%	9.6%	7.9%	43.1%	21.7%	6.3%
Ward 2	11.8%	10.2%	13.6%	49.2%	11.9%	3.3%
Ward 3	7.6%	6.3%	3.8%	41.9%	31.4%	9.0%
Ward 4	6.7%	7.8%	3.3%	41.0%	30.7%	10.4%
Ward 5	10.8%	7.6%	5.8%	45.9%	26.1%	3.8%
Ward 6	8.6%	5.9%	3.2%	33.8%	34.5%	14.1%

** Stats SA, 2011*

In 2015, 26 535 learners in the VDM wrote the Grade 12 exams, with 19 809 students passing. This 74.7% pass rate is 6.5% lower than the 2014 figure of 81.1%[3].

There are nine secondary schools with 4 607 pupils, 29 primary schools with 9 791 number of pupils and four combined schools with 1 023 number of pupils in the MLM. There is no schools for learners with special needs in the MLM. Generally, there is an educational facility within a 30-minute walking distance from 90% of the population; the majority of these educational facilities are primary school facilities and are more easily accessible than secondary schools. Secondary schools also do not have sufficient maths and science teachers, which limits the students' future career options. These are further limited by the lack of technical high schools in the area. In VDM, the high levels of illiteracy is a challenge for local people who want to enter the skilled and semi-skilled employment market (Musina LM IDP, 2016/2017-2021).

[3] http://www.edu.limpopo.gov.za/index.php?option=com_phocadownload&view=category&id=6:mec-speech (accessed 04/07/2016)

2.2.2 Health

Health and HIV/AIDS Prevalence

The National Development Plan 2030 vision is to implement a district-based approach that will assist in ensuring quality healthcare for all the people in the community. The development plan will focus on improved management, better training of health professionals, better patient information systems and improved maternal and infant health care.

The scourge of HIV/AIDS is one of four epidemics affecting South Africa; the others being injury, both accidental and non-accidental, infectious diseases such as TB and pneumonia and growing lifestyle diseases, such as diabetes and obesity. South Africa has the highest prevalence of HIV/AIDS compared to any other country in the world with 5.6 million people living with HIV, and 270 000 HIV-related deaths recorded in 2011 (HSRC, 2014).

Table 3 below summarises the HIV prevalence in Limpopo from 2010 to 2012. More than half of the districts in Limpopo recorded increasing HIV rates from 2010 to 2012. Although VDM recorded the lowest HIV prevalence rates in the district in 2010 and a 2.4% decrease from 2010 to 2011, it has unfortunately recorded a 3.1% increase from 2011 to 2012.

Table 3: Estimated HIV prevalence (%) among antenatal clinic attendees – Limpopo Province

District	2010	2011	2012
Capricorn	23.7%	25.3%	22.4%
Mopani	24.9%	25.2%	25%
Sekhukhune	20.2%	18.9%	23%
Vhembe	17%	14.6%	17.7%
Waterberg	26.1%	30.3%	27.3%
LP Province	21.9%	22.1%	22.3%

**2012 National Antenatal Sentinel HIV and Herpes Simplex Type-2 Prevalence Survey in South Africa*

Table 4 summarises the number of antenatal women living with HIV from 2010 to 2012. The age group with the highest (31.9%) antenatal HIV prevalence are women in the age bracket of 30 to 34 years. Women under the age of 24 have the lowest (7.7%) antenatal HIV prevalence.

Table 4: HIV prevalence among antenatal women by age group, Limpopo, 2010 to 2012

Age Group	Population of Antenatal Women Living with HIV					
	2010		2011		2012	
	Number	%	Number	%	Number	%
<15 Year(s)	13	7.7	14	7.1	12	8.3
15 - 19 Year(s)	618	7.1	675	7.4	669	7.3
15 - 24 Year(s)	1520	14.2	1753	13.6	1678	12.3
20 - 24 Year(s)	902	19.1	1078	17.5	1009	15.6
25 - 29 Year(s)	726	28.7	877	27.4	780	29.9
30 - 34 Year(s)	452	31.9	571	33.5	595	34.0
35 - 39 Year(s)	245	29.4	335	33.7	367	30.8
40 - 44 Year(s)	100	24.0	96	22.9	119	26.1
45 - 49 Year(s)	4	25.0	19	15.8	14	42.9
>49 Year(s)	1	100	-	-	-	-

**Quantec Data, 2010*

Medical Facilities

Medical facilities within the local study area include:

- Local clinics:
  - Messina LA LHC Clinic;
  - Masisi EMS Clinic;
  - Messina West Mobile Health services;
  - Messina East Mobile Health services; and
  - Nancefield Community Health Centre.
- Public Hospitals:
  - Donald Fraser Hospital;
  - Louis Trichardt Hospital;
  - Malamulele Hospital;
  - Elim Hospital;
  - Tshilidzini Hospital;
  - Silaom Hospital; and
  - Messina Hospital.

The upgrading of the Messina Hospital has been identified as a priority area. The existing hospital lacks the capacity and resources to cater for the community it is meant to serve. There is a need for clinics to be built at Tanda, Tshikhudini, Domboni, Malale and Mopani. These facilities are required to provide adequate services for the population as it has grown exponentially since the establishment of the original clinic (Musina LM IDP, 2016/2017-2021).

Other challenges faced in the district include a lack of basic amenities such as shade at clinic visiting points, a shortage of medicine, a lack of dedicated primary healthcare pharmacists and assistant pharmacists, an influx of migrants from neighbouring countries, malaria, rabies, poor roads and communication networks in some of the clinics as the major challenges in the provision of health and social development services in the district (Vhembe DM 2015/16 IDP Review).

Although there has been an overall decline in the total number of reported malaria cases in Limpopo, from 9 487 in 2000 to 4 215 in 2010, of the three endemic provinces this province has become the largest contributor to malaria incidence and deaths. Malaria has serious economic impacts in Africa, slowing economic growth and development and perpetuating the cycle of poverty. Delays in malaria diagnosis and initiating appropriate therapy are key contributors to preventable malaria deaths. Given the proximity of the study area to borders with countries that have high malaria transmission burdens and poor malaria control, the potential exists for importation of insecticide resistant mosquitoes and drug resistant parasites that can cause local outbreaks. The successes of cross-border initiatives such as the Lubombo Spatial Development Initiative (LSDI) in Kwa-Zulu Natal have demonstrated that this challenge is not insurmountable. [4]

Levels of Employment

The regional and local employment rates provide an indication of the state of the economy. It also assists in understanding the economic growth of the area.

[4] http://www.samj.org.za/index.php/samj/article/view/7441/5461 (accessed 08/07/2016)

The unemployed population spends limited money; therefore their contribution to the local economy is limited. The unemployment rate measures the percentage of employable people in the country's workforce who are over the age of 16 and who have either lost their livelihoods or have unsuccessfully sought jobs previously and are still seeking employment.

The VDM has an employment rate of 25%, 16% of the population are unemployed and 51% are "other or inactive" which includes, children, pensioners, disabled persons or people seeking other work who are not actively seeking employment opportunities. MLM has an employment rate of 54%, with an unemployment rate of 12% and 30% falling within the other or inactive category. Ward 2 has the highest employment rate with 69% of the local population being employed. 8% are unemployed and 21% fall within the other or inactive category. Employment in Ward 2, which is the most densely populated Ward, is created predominantly through commercial farming. Regional and local employment trends are reflected below in Figure 1.

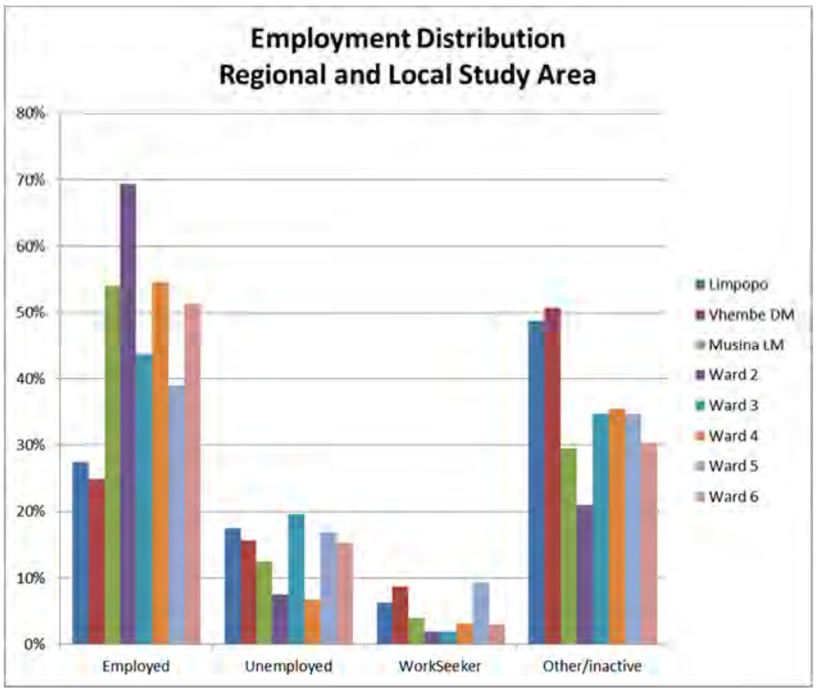

Figure 1: Employment Distribution in the Regional and Local Study Area

Household Income

Household income breakdown is crucial in determining the effects of household income and changes in employment levels, while also providing an indication of future demand and potential economic growth. Understanding this breakdown assists communities and local authorities tasked with development initiatives to better plan for anticipated growth (Thurston Regional Planning Council, 2012).

The regional household income shows a similar trend across the province and district municipality. In the VDM 25% of households earn within a range of R 9 601 – R 19 600 per annum and 21% within the R 19 601 - R 38 200 per annum range. 12% earn no income and 8% earn within the R 38 201 – R76 400 bracket. The regional trends are reflected below in Figure 2.

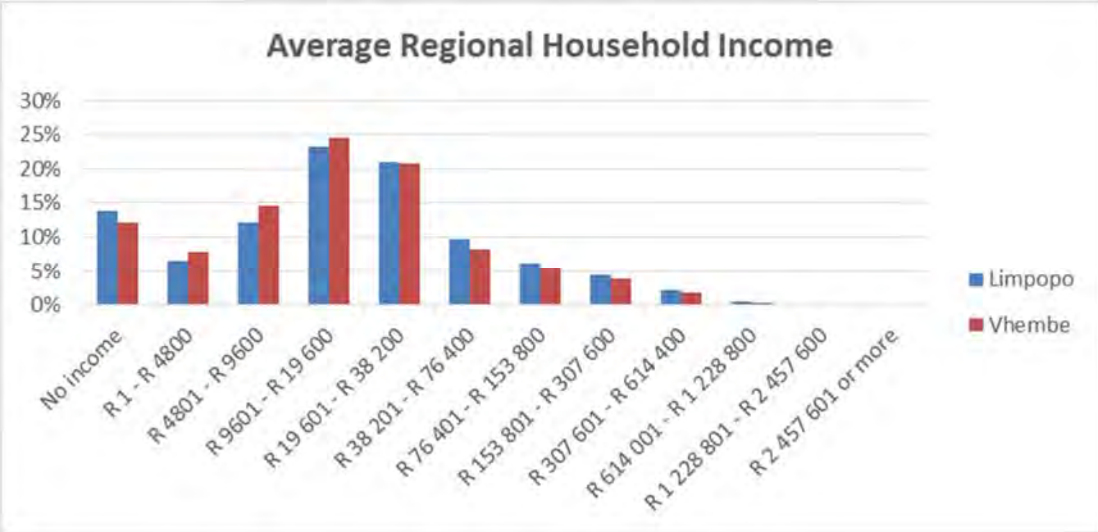

Figure 2: Average Regional Household Income

Figure 3 depicts that income breakdown for the MLM and the five Wards in question. The local household income breakdown shows a similar trend across the MLM and five Wards with the exception of Ward 2, which has a higher rate of rate of employment. 28% of the MLM population and 39% of the Ward 2 population feature in the R 9601 - R 19 600 per annum income range respectively. 20% are in the R 19 601 - R 38 200 income range and 11% in the R 4801 - R 9600 income range.

The average annual national household income according to the IES 2010/2011[5] was R 119, 542. It is apparent that both district and municipal household income ranges are below the average national household income.

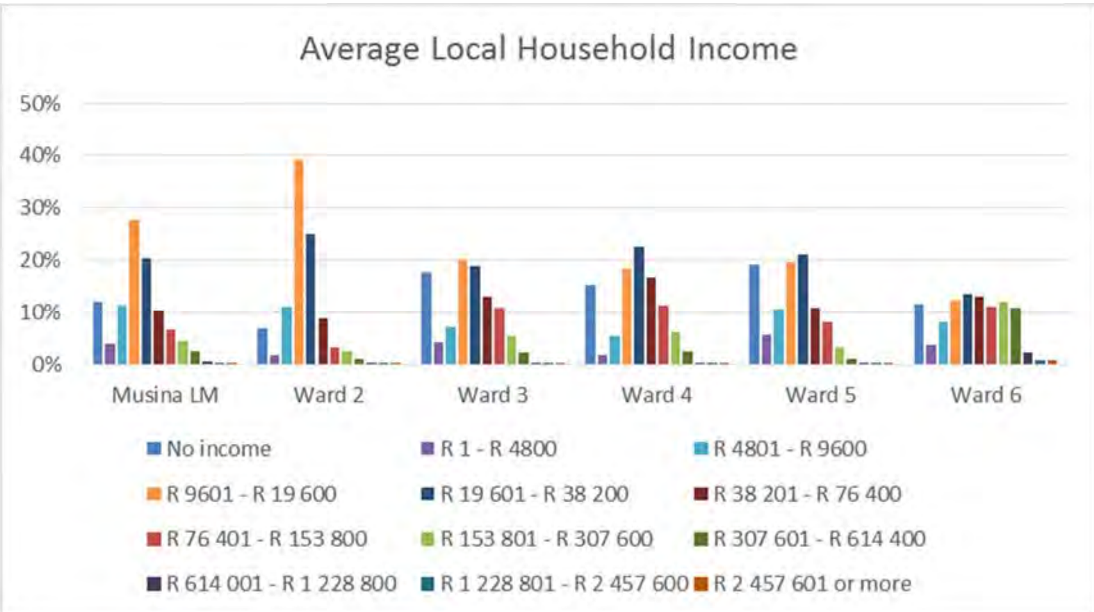

Figure 3: Average Local Household Income

[5] Income and Expenditure survey (IES) 2010-2011, South African Statistics.

2.2.3 Infrastructure

The infrastructure conditions for roads, water, sanitation, energy and housing conditions for the relevant municipal and ward areas are discussed in this section.

Roads

The roads within the VDM are well connected to national, provincial and district roads. The N1, R37, R71, R81, R510/R572 and R521/R523 all form part of the primary route network in the area (Musina LM IDP, 2016/2017-2021). The following corridors link nodes in the district (Vhembe DM 2015/16 IDP Review):

- N1 National Road from Polokwane to Beitbridge;
- R522 from Vivo to Makhado;
- R523 from Vivo via Waterpoort to Masekwapoort;
- R521 from Vivo to Pont Drift Border;
- R572 from Musina to Pont drift;
- R524 from the Makhado central business district to Punda Maria and Mozambique;
- R529 from Basani, Malamulele, Giyani to Moiketsi;
- R81 from Road R524 to Giyani;
- R525 from Mopani the N1 Road to Pafuri Gate; and
- R578 from Kruger National Park, Malamulele, Vuwani, Giyani via Elim to the N1 National Road, Thohoyandou, Masisi, Tshikondeni and Phafuri gate.

Along with the absence of a direct route between Limpopo Province and the North-West Province, increased traffic volumes associated with increased economic activity and a lack of road maintenance have contributed to a rapid deterioration in road conditions. Regional access roads are surfaced with gravel and are mostly in a state of disrepair. These roads, which are most commonly used by buses and taxis, also require maintenance regarding stormwater management, lighting and parking. Streets within local villages are generally in a poor condition but can only be upgraded once the major roads have been attended to. Musina municipality maintains 413 km of surfaced and 650.9 km of unsurfaced roads. Frequent equipment breakdowns, shortage of proper equipment and ageing personnel are cited as major challenges in the local municipality. The backlog in gravel roads that need to be tarred is 20 km and the backlog in tar roads that need to be upgraded or resurfaced is 25 km (Musina LM IDP, 2016/2017-2021).

Of the 3 940 km of provincial road in the VDM only 37% is tarred or paved. The total length of gravel roads in the district is 2 469 km. Roads that are surfaced, however, are not always in good condition. Delays in undertaking necessary road maintenance are usually attributed to a lack of funds, resources, equipment or capacity. Poor road conditions have a detrimental effect on the community in terms of accessibility to educational facilities, healthcare facilities and places of employment. Various road building and resurfacing projects are currently underway and it is hoped that this will improve accessibility and mobility within the community (Vhembe DM 2015/16 IDP Review).

The proposed project site has smaller farm access roads which are untarred. There is a tarred district road along the northern boundary of portions 16 and 28 of the Vogelenzang 33 MT farm that splits through the Tralee 204 MS and Kilrush 201 MS farms. Proposed mine development will be hindered by this existing road on the Tralee 204 MS farm.

Rail

There is a rail line which runs from Johannesburg, passing through the MLM with stops in Musina and Mokopane.

The railroad intersects Portion 6 of the Vogelenzang 33 MT farm, which is currently owned by the Musina Local Municipality, and the Messina 44 MT farm. It is Smarty's intention to limit their operations to the western side of the railroad.

Bulk Water Infrastructure

Bulk water supply is flagged as a major challenge in the Musina LM IDP, 2016/2017-2021. VDM is a Water Services Authority (WSA) and Provider. The district purchases bulk raw water from the Department of Water and Sanitation which it then processes for reticulation. The goal of VDM WSA is to supply every household with an adequate and reliable water supply and to manage the water supply services in an affordable, equitable and sustainable manner (Musina LM IDP, 2016/2017-2021).

The VDM is to a large extent dependent on grants and subsidies to augment its operating income with little income received from bulk water sale. It is currently in the process of developing a revenue enhancement strategy to ensure local municipalities are correctly billed for bulk water consumed (Vhembe DM 2015/16 IDP Review).

Housing

Housing in the regional area is predominantly residential houses and farm houses (86%) which represent a formal housing base in regional and local towns. The local ward areas have predominantly residential houses and farm houses (54% - 90%) (SA Census Stats, 2011) as reflected in Figure 4 below. The Musina Municipality have future plans for additional residential developments as part of their economic goals. Expansion of residential areas and other economic growth sectors may impact on the project.

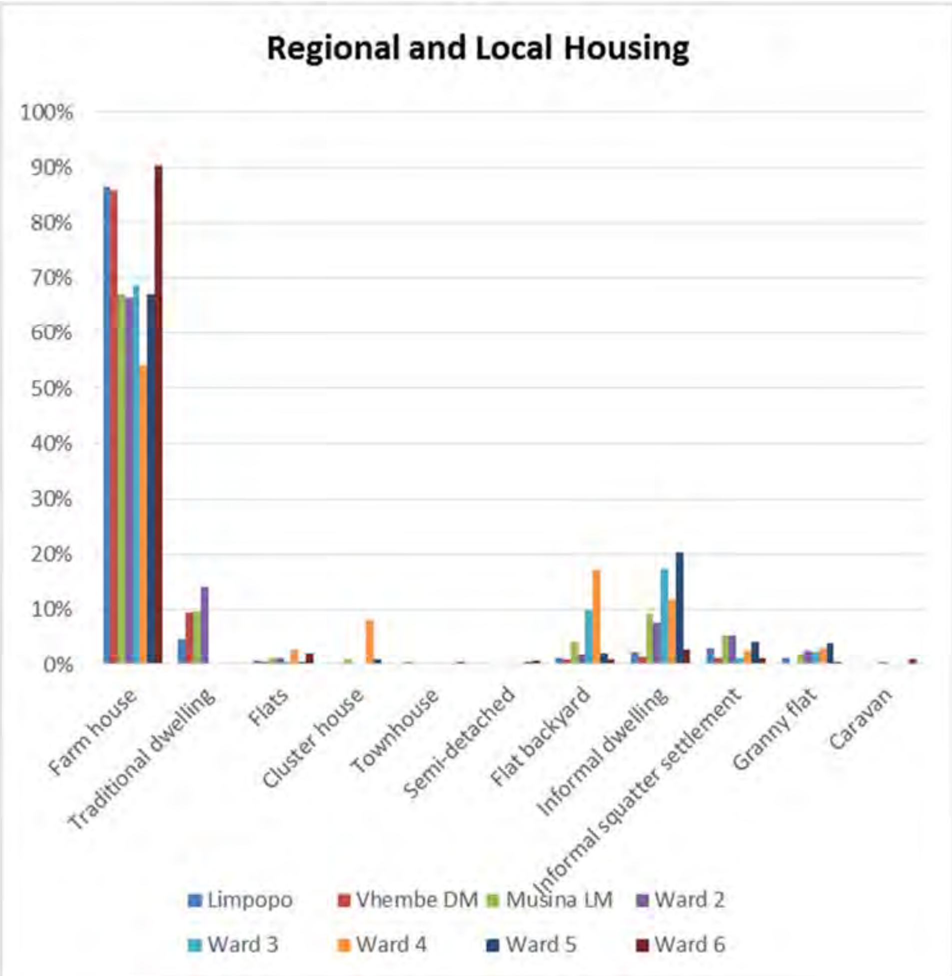

Figure 4: Housing Summary

Water and Sanitation

The province's water resources are obtained from four Water Management Areas (WMAs), namely the Limpopo, Olifants, Luvuvhu-Letaba and Crocodile West Marico WMAs. In terms of water resources, Nandoni and Vondo Regional Water System (RWS) fall within the Luvuvhu/Letaba water catchment area which spans across the Vhembe and Mopani District Municipalities. The sources of water in the Vhembe district are from 12 dams, three weirs and approximately 38 000 boreholes. These sources include the Nandoni, Nzhelele, Damani, Tshakhuma, Mutshedzi, Vondo, Capesthorne, Cross, Nwanedi, Lupepe, Middle Letaba and Albasini dams and the Mutale, Khalavha, and Magoloni weirs. Water sources in the area do not adequately meet the needs of the surrounding communities as some dams have no allocation for domestic use. In addition, boreholes do not always yield water in sufficient quantities or of a good enough quality to supply the needs of local communities (Musina LM IDP, 2016/2017-2021).

As seen in Figure 5, regional/local water schemes operated by municipalities are the largest suppliers of water in the province and the district municipality. In the MLM, water is supplied almost exclusively by the regional/local water scheme with the exception of Ward 2, which derives its water supply predominantly from boreholes (Stats SA, Census 2011).

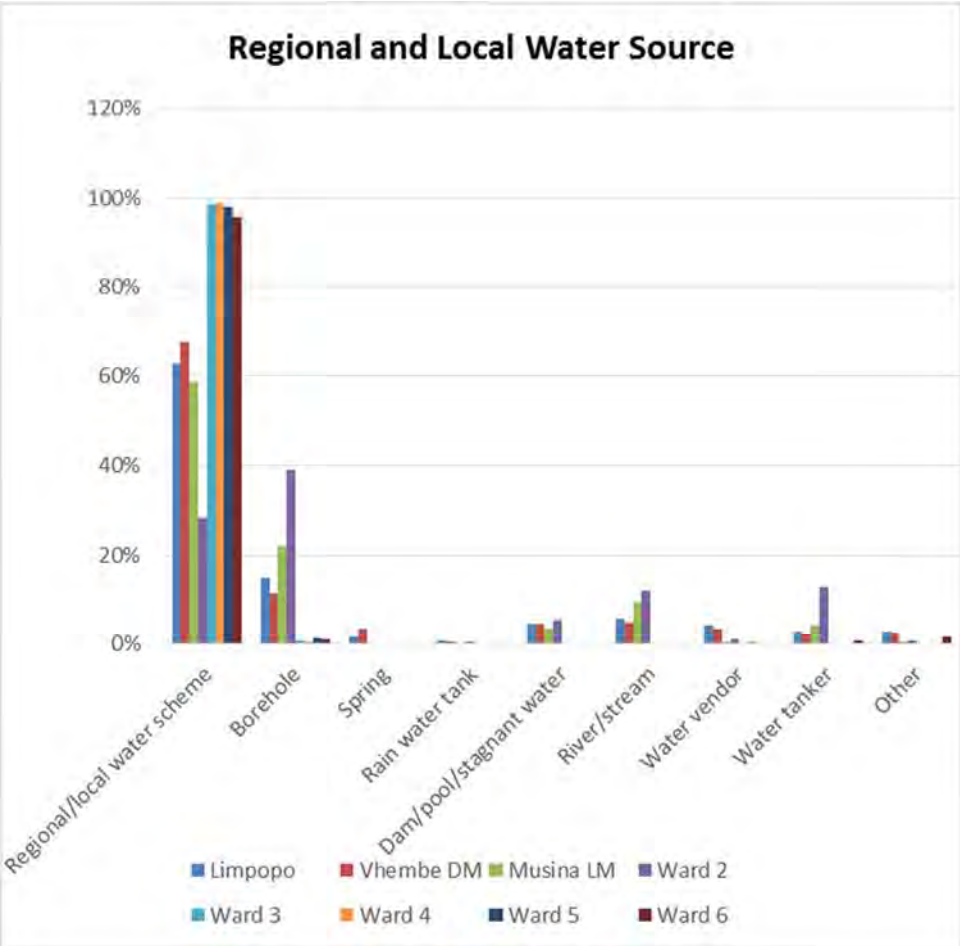

Figure 5: Sources of Water

The VDM has been criticised for its unsatisfactory performance in regard to provision of adequate sanitation services in the district. Problems identified during a recent DWS Audit cite institutional problems as being the main reason for its consistent unsatisfactory performance. Other challenges faced by the VDM include an inadequate and ageing infrastructure, vandalism, theft, understaffing and poor maintenance of the sewerage system. At the same DWS Audit, MLM was commended for its continued good performance.

MLM has two sewerage treatment plants, at Nancefield and Musina respectively. The following was noted in regard to the management of sanitation in the MLM (Musina LM IDP, 2016/2017-2021):

- The municipality does not have a bucket system in its area of operations;
- In the urban areas, 8 108 households are connected to a waterborne sewer system or onsite septic tank systems. 2 811 of these households benefit from free basic sanitation; and
- In the rural villages of Madimbo, Malale, Tshikhudini, Domboni and Tanda, 1 856 households have Ventilation Improved Pit (VIP) toilets thus receiving free basic sanitation. The backlog on VIP toilets is 510 households.

Poor sanitation is of serious concern as it leads to water-borne diseases such as cholera and diarrhoea. Although great progress has been made in the provision of adequate sanitation services within Wards 3, 4, 5 and 6, much still needs to be done to ensure that this basic right becomes a reality for the remaining 13% of households who have no access to sanitation services (see Figure 6).

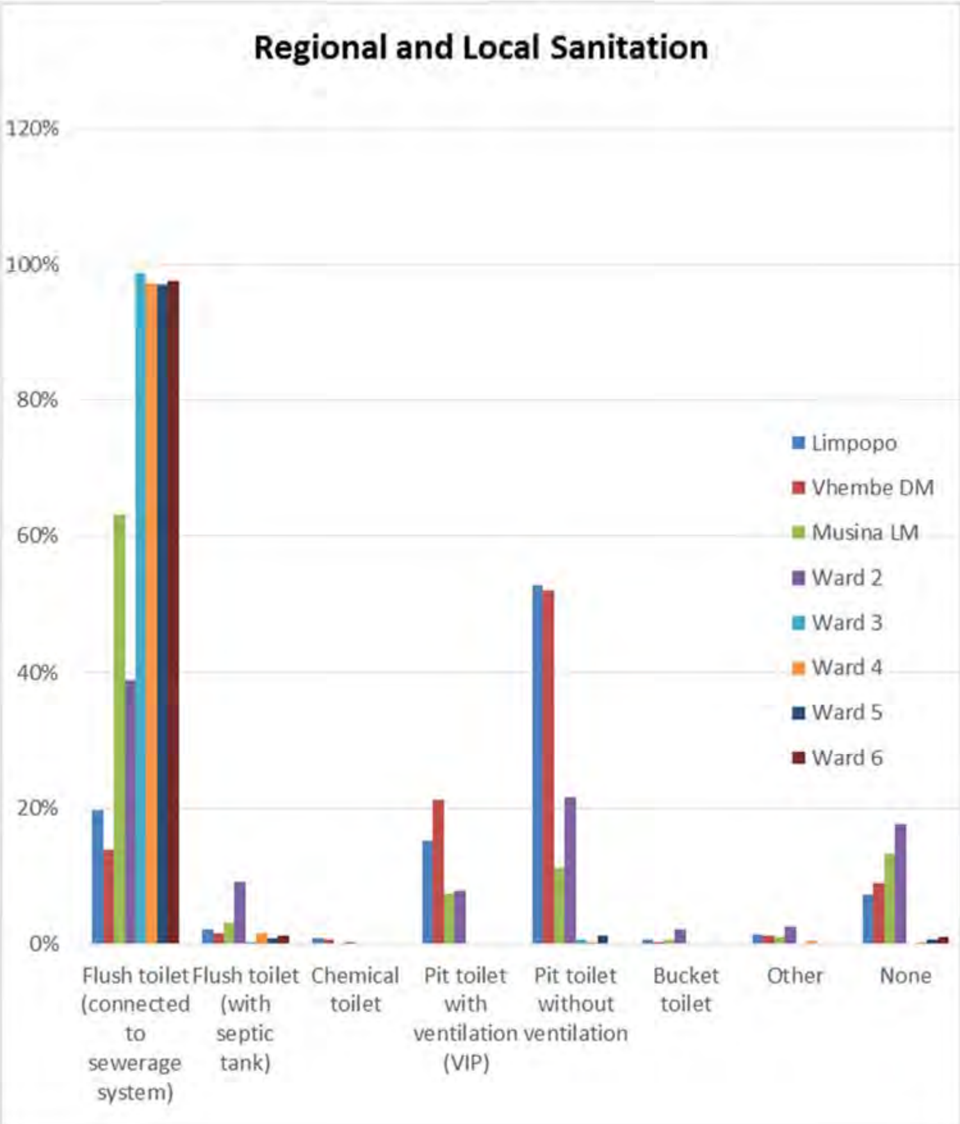

Figure 6: Sanitation

Energy Sources

There are 12 substations in the district, namely Sanari, Makonde, Malamulele, Tshikweta, Leeudraai, Paradise, Flurian, Pontdrif, Musina and Nesengani. The backlog is currently 9 x 132/22 KV that will need to be built at Singo, Mashau, Mamaila, Mageva, Mbahe, Jilongo, Mandala, Tshilamba, and Lambani. Challenges faced by the district include energy supply and interruption, lack of capacity to supply the demand, insufficient capacity of the power station to supply all areas in the district, cable theft, illegal connections, poor project management and slow rate of construction (Musina LM IDP, 2016/2017-2021).

Musina local municipality is a licence holder in the urban area of Musina and Nancefield while Eskom is the licence holder in the rural villages and farming areas. There is no backlog on electricity in municipal urban areas. There is however a 1 013 household backlog on electricity supply in the rural villages. Electricity is supplied to within the urban and rural regions as follows (Musina LM IDP, 2016/2017-2021):

- 10 051 households in urban areas have metered (conventional and pre-paid) electrical connections;
- 2 811 indigent households receive free basic electricity; and
- 523 households in rural villages receive free basic electricity.

The regional and local study area relies predominantly on electricity as an energy source for lighting, cooking and heating within a household as seen below in Figure 7.

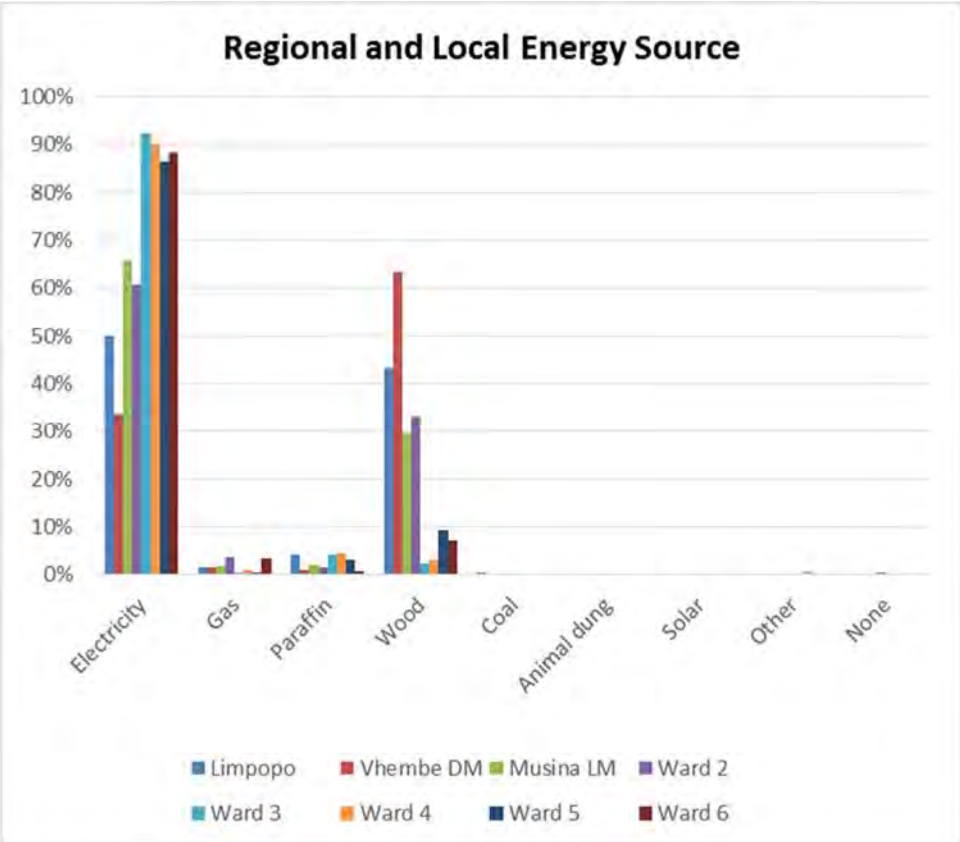

Figure 7: Regional and Local Energy Sources

Green Economy

Green economy is defined as a system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities.

Through funding made available by the Industrial Development Corporation (IDC) the district together with University of Venda, Eskom and other key role players are supporting bio-energy projects and generation of solar power in the district with particular focus on the Musina region. In addition, an assessment done on biogas usage in the district shows that there is potential for using it as an alternative source of energy (Vhembe DM 2015/16 IDP Review).

2.2.4 Economic Activities

The economy in the VDM is dominated by three active sectors which include mining, agriculture and tourism. Commodities such as copper, coal, corundum, diamond, dolomite, feldspar, garnet, graphite, iron, kieselguhr, limestone, magnesite, marble, phosphates and talc are mined in the region. The VDM makes an intermediate contribution towards the provincial agriculture sector (11.1% in 1980 and 18.6% in 1994). The most important agricultural commodities are nuts (about 50% of provincial production) and subtropical fruit (26% of provincial production). Well known tourist attractions include Dongolo Trans-National Park, Soutpansberg Conservation, Baobab Nature Reserve, Kruger National Park, Langjan Nature Reserve and Happy Rest Nature Reserve (Vhembe DM 2015/16 IDP Review).

MLM has been identified as a provincial growth point with significant potential to accelerate the industrialisation process in the province. This is evidenced by the commitment from Limpopo Premier Stanley Mathabatha of R 38.8 billion towards the establishment of a South African Energy Metallurgical Base Project in the Musina Special Economic Zone (SEZ). The region has seen further significant investment in other key areas of the local economy such as retail, agricultural production through mechanisation programmes, construction and property development (Musina LM IDP, 2016/2017-2021).

The main contributors to the economy of the MLM are agriculture, forestry and fishing (35%), mining (30%), transport and communication (15%), manufacturing (11%), finance and business services (9%), wholesale and retail trade, catering and accommodation (6%), community, social and personal services (6%), government services (5%) and construction (5%). The unemployment rate stands at 25% with the highest percentage among the youth aged between 15 to 19 years. MLM contributes 11% of GDP of the VDM (Musina LM IDP, 2016/2017-2021).

MLM boasts a variety of popular tourist destinations. These include Mapungubwe National Park and World Heritage Site; Honnet Nature Reserve; Limpopo River; the old Messina Copper Mine; Messina Nature Reserve; Poppalin Ranch; Ratho Crocodile Farm; Venetia Limpopo Nature Reserve; Beit Bridge; De Beers Diamond Mine; De Beers Game Farm; Nwanedi-Luphephe Resort and Aventura Tshipise Resort. Some initiatives aimed at boosting tourism in the region are currently in progress.

The regional Gross Value Added (GVA) contribution for 2010 is depicted in Table 5. In the VDM, General Government is listed as the main industry at 26% whereas in the MLM, Mining and Quarrying at 34% is the main industry. Finance, insurance, real estate and business services contribute 20% and 15% in the VDM and MLM respectively.

Table 5: GVA (2010)

Industry	Limpopo Province	Vhembe DM	Musina LM
Agriculture, forestry and fishing	3%	3%	8%
Mining and quarrying	23%	9%	34%
Manufacturing	4%	4%	4%
Electricity, gas and water	3%	2%	1%
Construction	2%	3%	2%
Wholesale and retail trade, catering and accommodation	12%	17%	12%
Transport, storage and communication	10%	10%	12%
Finance, insurance, real estate and business services	19%	20%	15%

Industry	Limpopo Province	Vhembe DM	Musina LM
Community, social and personal services	5%	6%	2%
General government	19%	26%	10%

**Quantec Data, 2010*

Local Economic Development (LED) is the process by which public, business and non-governmental sector partners work collectively to create better conditions for economic growth and employment generation. LED is based on local initiatives, driven by local stakeholders and it involves identifying and using primarily local resources, ideas and skills in an integrated way to stimulate economic growth and development in the region (Vhembe DM 2015/16 IDP Review).

2.3 Community Development Planning

2.3.1 Vhembe District Municipality

The Vhembe LED Strategy notes that the district's economic growth potential is in agriculture, tourism and mining. Through its Supply Chain Policy, the VDM endeavours to encourage procurement from local business, thereby driving economic transformation among Historically Disadvantaged Individuals (HDIs) (Vhembe DM 2015/16 IDP Review).

Vhembe district has developed enterprise, tourism, agriculture and forestry strategies for smooth prioritisation and proper planning in the relevant fields. Feasibility studies have been undertaken on the following projects (Vhembe DM 2015/16 IDP Review):

- Footsteps of the Ancestors;
- Poultry abattoirs;
- Development of a fish farm;
- Preservation of dried fruit/vegetables;
- Goats milk dairy products;
- Mutale goat farming; and
- Beneficiation of forestry products.

The areas for potential development within the VDM that were identified within the Vhembe DM 2015/16 IDP are in the mining, agriculture and tourism sectors. The major needs in the area are jobs and employment opportunities. Through the development of small and medium enterprises, more indirect employment opportunities would be available.

2.3.1.1 SMME Development

The district undertook a strategic evaluation of the potential of SMMEs with the goal of identifying trends and specific gaps. Various types of businesses distributed among different sectors within the four local municipalities in in the VDM were identified along with an uneven distribution of enterprises across different sectors. Retail was identified as the largest single contributor in each local municipality as well as in the district as a whole. The majority of retail enterprises consist of one employee or family businesses and hence there is minimal contribution to employment opportunities and income generation (Vhembe DM 2015/16 IDP Review).

2.3.1.2 Local Economic Development Challenges for the District Municipality

Challenges faced by SMMEs in the district include (Vhembe DM 2015/16 IDP Review):

- The negative effect of a lack of contracts with producers;

- An unskilled workforce;
- Poor infrastructure;
- Lack of access to finance;
- Lack of suitable space;
- Lack of business management skills and market research;
- Food insecurity;
- Transfer of indigenous skills; and
- Lack of information about available opportunities.

2.3.2 Musina Local Municipality

Through a detailed analysis and consultations with various relevant local stakeholders and role players, a list of high-priority focus areas were identified that require immediate attention in the MLM (Musina LM IDP, 2016/2017-2021). These priority focus areas are set out below in Table 6.

Table 6: High priority focus areas

Sector	Potential Development
Manufacturing and SMME Support	■ Establishment of a Manufacturing Incubator in Musina town; ■ Undertake a poster campaign to entice business start-ups on projects that have been identified in the LED Strategy; ■ Investigate potential and promote opportunities for development of retail, industrial, storage, distribution and wholesale enterprises and a transportation hub; ■ Establish a local Business Support Centre in Nancefield; ■ Create rural community support cooperatives in Madimbo, Malale and Domboni, Tshikhudini and Tanda; and ■ Provide land claims support.
Agriculture	■ Undertake expansion of aquaculture production and extension of aquaculture value chain linkages; and ■ Establish a vegetable processing plant in Musina town.
Tourism	■ Develop maps and brochures of local tourism facilities and attractions; ■ Improve and increase road signage to villages, major attractions and facilities; ■ Establish arts and crafts, jewellery and ornament incubators; ■ Exhibition and workshop stalls and curio shop linked to tourism information centre in Musina town; ■ Train tour guides and tour operators to facilitate and coordinate awareness campaign with SANPARKS and LEDET; ■ Promote game farming by developing a database of all farms in MLM; and ■ Promote birding, hiking and sport.
Mining	■ Establish database of available land for mining development and encourage commencement of mining activities with existing mineral rights holders; ■ Investigation/prospecting to identify untapped resources; ■ Promotion of mineral deposits to potential investors; ■ Skills development and training; ■ Local mineral processing and beneficiation activities; ■ Small-scale mining operations; ■ Magnesite production and beneficiation through the production of heat resistant bricks for the steel industry; ■ Production of moulds for glass manufacturing; ■ Producing fire retardant construction materials from vermiculite;

Sector	Potential Development
	■ Plastics production; ■ Facilitate financial and funding support for small-scale mining activities; ■ Providing skills training for higher level skills needs; ■ Sub-contracting cleaning and transport services; ■ Supplying manufactured inputs to mines; ■ Linkages with tourism sector for guided tours; ■ Expand current brick manufacturing facilities; and ■ Produce concrete.

Local Economic Development Challenges for the Local Municipality

Key constraints to growth in the MLM local economy include (Musina LM IDP, 2016/2017-2021):

Agriculture

- Agricultural activities take up large portions of land in the municipality, with more than half of the employed population being employed in this sector;
- A lack of resources to ensure proper transport of perishable goods;
- A lack of production facilities;
- A lack of start-up capital;
- No marketing;
- No access to producers for emerging farmers;
- Distance to market;
- Consistency of supply of raw materials;
- Competition from imports;
- An ageing population within the agri-industry; and
- Access for tourists to agricultural attractions.

Mining

- Mining and quarrying is currently a declining sector within the MLM with only two active mines, namely Venetia and Vele Mine. There is however a plethora of closed and derelict mines throughout the municipality that in some cases constitute an environmental problem;
- Lack of both mining skills and more advanced engineering skills;
- Inconsistent electricity provision;
- Cost and supply of water services;
- Lack of capital for efficient production;
- Inaccessibility and poor road infrastructure;
- High transport costs;
- Distance to markets;
- Depletion of resources due to inefficient extraction; and
- Quality, consistency and cost of locally manufactured products.

Tourism

Security in the MLM requires attention. In particular, the regions of Songozwi, Nwanedi, Mapungubwe and Pafuri require urgent attention. The main factors that negatively affect tourist safety in the district are insufficient registered tourist guides, lack of available and suitably trained security personnel and vandalism of fences around the area of Nwanedi. Poor road conditions, poaching, racism and tribalism at Makuleke game farm are also noted as contributing factors to poor safety and security in the area.

3.0 ENVIRONMENTAL ISSUES AND POTENTIAL IMPACTS

3.1 Employment

Key Issues

Key employment issues may include:

- The availability of skilled labour in the project area;
- Creation of employment opportunities during the construction phase;
- Employment opportunities are not always supplied to local people;
- Loss of farm labour to mining operations; and
- Growing pressure on alternative housing should people migrate to the project area.

Potential Impacts

Potential impacts could include:

- Increased employment opportunities;
- Likelihood and impact of the influx of non-local workers;
- Potential increase in crime; and
- Potential loss of land to mining and residential areas.

3.2 Economic

Key Issues

Key economic issues include:

- The economic value of mining versus the benefits of preserving the area in terms of biodiversity, water quality and agriculture i.e.:
  - The ecological and economic value of the agricultural land vs. that of the proposed mining activities and associated broader impacts of mining; and
  - The ecological and economic value of biodiversity in the project area vs. the cost associated with the cumulative impacts of mining on the ecosystems.
- The loss of tourism to the area based on the change of land use from game farming and hunting to mining;
- The economic benefits of having a mining operation in the local municipality:
  - Potential employment opportunities through direct and indirect avenues;
  - Community investment initiative which assist the municipality in their development goals;
  - Creation of new businesses to support the mining industry as vendors or suppliers; and
  - Increased municipal income through rates and taxes.

Potential Impacts

Economic impacts could include:

- Increased revenue to the proponent from extraction, processing and sale of copper;
- The economic costs of loss of biodiversity, tourism, and decreased downstream water quality (ecosystem goods and services); and
- Community investment spend by the proponent to improve development of the Musina community.

3.3 Land Use

Key Issues

The current land uses within the proposed mining area and surrounds are a combination of private game farms, agricultural farms, tourist lodges and private residential areas. The proponent is currently in the process of land acquisition negotiations for the land earmarked for the mine. The following issues have been raised in terms of the change in land use to mining:

- Loss of tourism to the area;
- Disturbance of the peaceful environment;
- Intrusion of environmental aspects like air pollution and contamination of water sources (groundwater) which impact on communities; and
- Development conflicts as the Musina Municipality have earmarked certain areas within the prospecting rights area as developmental zones. The government's Special Economic Zones conflict with the prospecting rights boundaries, especially the approved development of the Eco-Park Zone, which is planned for development on the north eastern side of Musina Town.

Potential Impacts

- Rehabilitation of the land is an integral part of the closure activities and the likelihood of returning the land to its current grazing and crop production levels will be assessed. This potential impact will be assessed by ecological and soil specialist studies;
- Crops and produce belonging to adjacent landowners may be at risk of contamination due to increased levels of dust and reduced water quality and availability;
- Disturbance of wildlife by blasting and mining activities; and
- Potential impacts relating to groundwater and air.

4.0 REFERENCES

1) Musina Local Municipality Integrated Development Plan, 2016/2017-2021.

2) Vhembe District Municipality Integrated Development Plan Review2015/16.

3) Statistics South Africa Census 2011.

4) http://www.southafrica.info/about/geography/limpopo.htm#.U-4JvsWSw4I#ixzz3AT0Rt0Ph (accessed 01/07/2016).

5) http://www.vhembe.gov.za/(accessed 01/07/2016).

7) http://www.samj.org.za/index.php/samj/article/view/7441/5461 (accessed 08/07/2016).

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APPENDIX A

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Golder Associates

Draft

MUSINA COPPER MINE

TRAFFIC IMPACT STATEMENT

REPORT 2016-049-01

AUGUST 2016

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Traffic Impact Assessment Information Sheet

Local authority : Musina Local Municipality (Vhembe District Municipality)

Property description : Various Portions of Farms in Musina

Development type : Mining Operations

Authors of the report:

	Reviewed by	Compiled by
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Qualifications	M. Eng. (Transportation)	B Tech. (Transportation)
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Musina Copper Mine

TRAFFIC IMPACT STATEMENT (TISm)

Figures

Figures	**Description**

Annexures

Annexure	**Description**

1 INTRODUCTION

1.1 Background

EDS Engineering Design Services (Pty) Ltd was appointed by Golder Associates (Pty) Ltd to undertake a Traffic Impact Assessment (TIA) for the proposed mining development on various farms in Musina, Limpopo Province. This TIA has been undertaken in support of the proposed mining rights application.

It is envisaged to establish an opencast copper mine in Musina, expected to produce approximately 20 000 tonnes of copper cathode per annum. Copper cathodes will either be exported or sold to a facility such as Palabora Copper that can process it into wire bar. Sulphide concentrates may be sold too, or toll refined by a facility with a smelter, such as Palabora Copper or any number of facilities overseas. The sulphide concentrates may also be pressure oxidised, leached and recovered as cathodes.

This traffic study investigates and reports on the following;

- ✓ Assessment of existing and required roads infrastructure for copper haulage
- ✓ Anticipated trip generation, assignment and distribution
- ✓ Need to implement road and/or intersections improvements required to mitigate the anticipated traffic impact

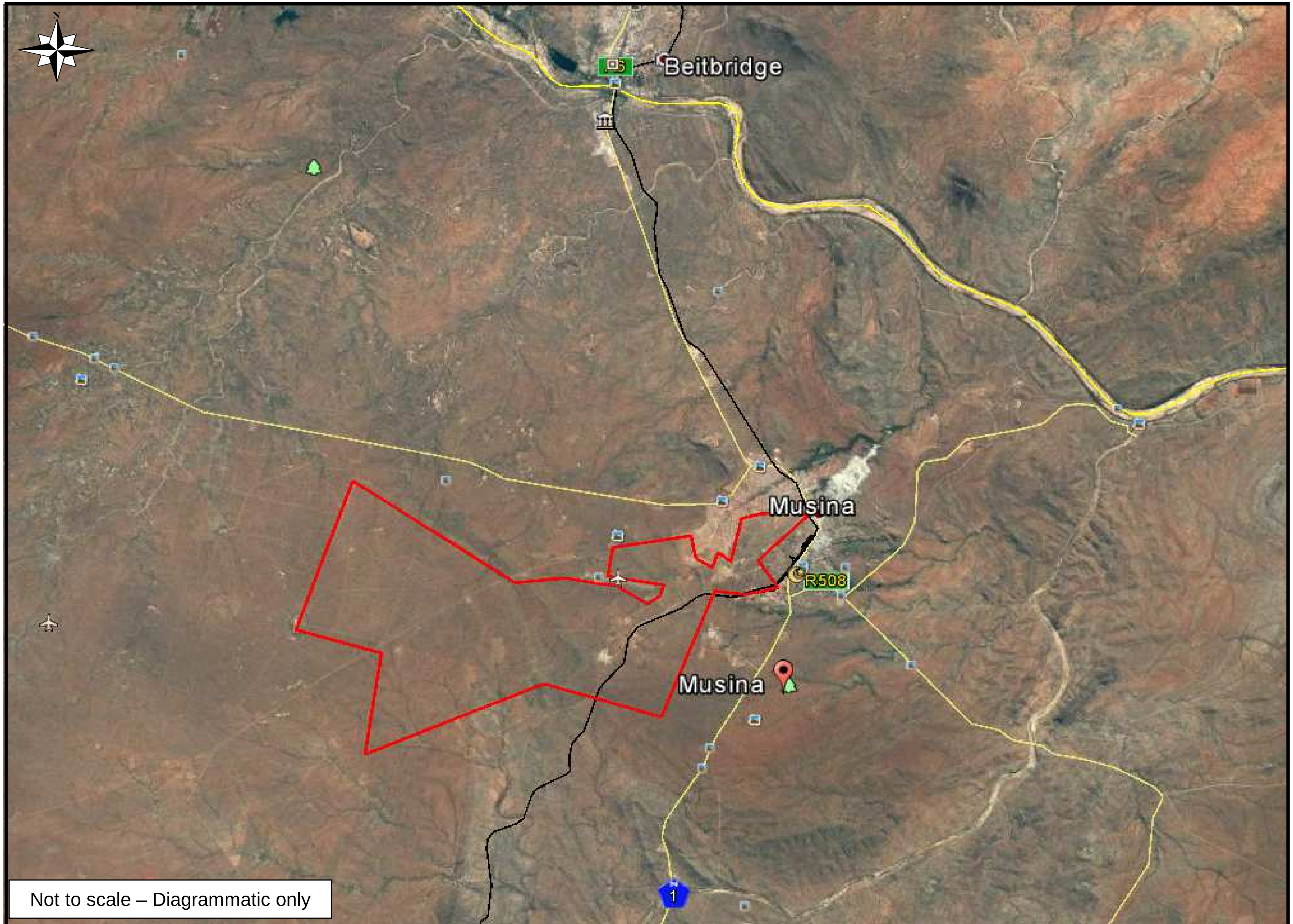
Comments are also made in respect of the non-motorised & public transport in this study.

This TIA has been undertaken in accordance with the requirements and guidelines as set out in the *TMH 16 Volume 2 (South African Traffic Impact and Site Impact Assessment Standards and Requirements Manual), COTO, Version 1 dated August 2012.*

1.2 Site Location

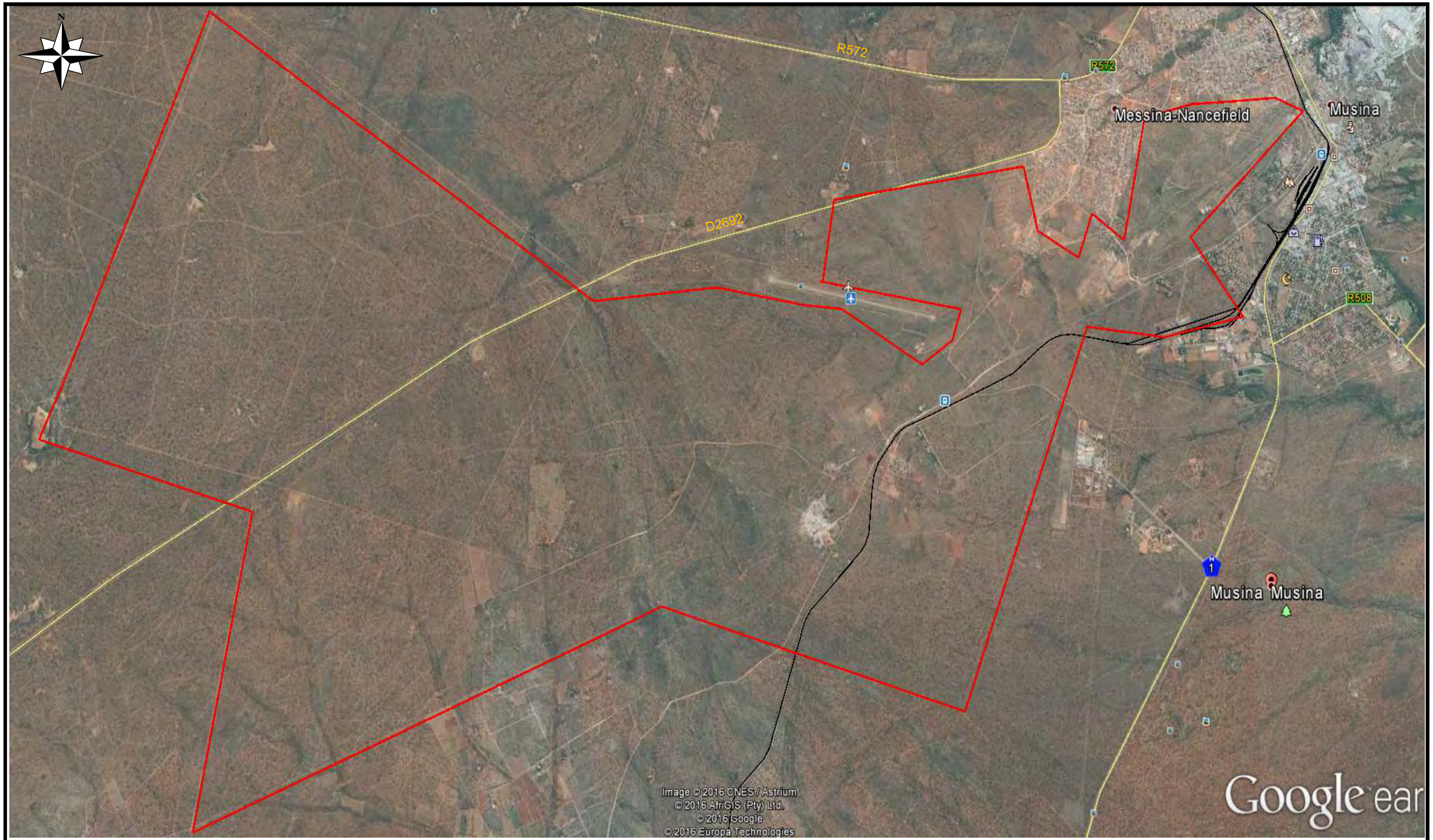
The site is located on the western periphery of Musina town, and it covers a large land area within the jurisdiction of Musina Local Municipality (Vhembe District Municipality).

Figure 1.1 shows the regional context of the site location relative to Musina Town and surrounding areas and **Figure 1.2** shows the site location in the local context.



MUSINA COPPER MINE
Locality Plan – Regional Context

Figure 1.1



Not to scale – Diagrammatic only

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Locality Plan – Local Context

Figure 1.2

1.3 Methodology

The study methodology included:

- Client liaison / meeting to gain understanding of the operation of the plant.
- Site visit to observe current travel patterns and gain understanding of the area, access routes and existing issues on surrounding roads (if any).
- Traffic counts at the key intersections within the study area.
- Identification of the haulage route for mineral concentrate.
- Consideration of any known latent development in the area.
- Consultation with the roads authority to find out if there are any other latent developments in the area.
- Trip generation estimations, distribution and assignment
- Consider relevant roads authority road network planning where applicable
- Site accessibility investigation (high level).
- Consideration of the road planning for the area.
- Consideration of the appropriate horizon year for the analysis (with and without project traffic).
- Consideration of mine workers and public transport requirements, as well as facilities required (such as lay byes and bus turning facilities and pedestrian pathways).
- Preparation of conceptual layouts of intersection upgrade requirements (if any).
- Technical reporting and capturing of all the findings, conclusions and recommendations.

2 PROPOSED DEVELOPMENT

2.1 Proposed Development

It is envisaged to establish copper mining operations on various farms in Musina. The mine is estimated to produce up to approximately 20 000 tonnes of copper cathode per annum.

The project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure.

The mine will employ contractors for mining and processing operations. They will work under the supervision of a small dedicated management team. The site will be accessible from Harper Road.

2.2 Envisaged Mining Operation

Trip generation expected from the proposed mine is dependent on the envisaged operations of the mine. The following information, inter alia, describes how the proposed mine will operate and it is regarded as the key basis of estimating development trip generation;

- A total number of personnel is estimated at between 500 and 600 employees
- Management will comprise approximately 54 employees
- The balance of 546 employees will be labour
- The mine will be operated 24 hours a day in three shifts, 6 days a week
- Copper cathode will be transported using typical 35 tonne road trucks during daylight or by rail.
- Total of 50 truck trips per hour may be expected (at most)
- Mining personnel will commute using buses and/or taxis and private vehicles

2.3 Latent Development

Accounted for in this study is Vele Colliery, a proposed mining development situated approximately 48 kilometres northwest of Musina Town, 7 kilometres from the most western boundary of Mapungubwe National Park and 35 kilometres from Mapungubwe Hill (to the west), within Vhembe Magisterial District, in Limpopo Province.

TIA for this development was undertaken by ITS Engineers in May 2011.

3 ROAD NETWORK PLANNING

The road network planning in the area entails the new realignment of the existing N1 Route past Musina (Musina Ring Road).

Appended in **Annexure A** is the planned realignment of the N1 Route, which is already under construction. It has therefore been assumed for the purpose of this study that the Musina Ring Road Project will be completed by the time the development traffic will realise.

It can be seen that the new N1 alignment will comprise two interchanges in the vicinity of the site, one to the north (Nancefield) and other one to the south (Musina) of the site boundary.

It is expected that the implementation of the Musina Ring Road would generally benefit the town of Musina and the surrounding areas. The benefits may include but not be limited to the following;

- ✓ Improved accessibility (N1 to/from surrounding land)
- ✓ Improved road network permeability
- ✓ Better balanced road network
- ✓ Potential for land development
- ✓ Reduction of traffic pressure on the N1 through Musina CBD (option to bypass CBD)
- ✓ Better functioning of the N1 as a Class 1 Route
- ✓ etc.

Important to also note in the planning is that other sections of the existing Harper Road alignment will change slightly - new Railway and Harper Road overpass.

Construction of the N1 Musina Ring Road commenced in April this year (2016) and it is anticipated to be completed by the end of 2018.

4 PRODUCT TRANSPORTATION ROUTE

It is envisaged that copper cathodes will either be *exported* or *sold to a facility such as Palabora Copper.*

It is therefore expected that this product will be transported by road or railway to Palabora Copper in Phalaborwa. The site will be accessible from Harper Road.

<u>Road transport: -</u> The trucks would depart the site from Harper Road, then travel in the north-east direction via existing roads (Unnamed Road, D2692, R572) and join onto the new N1 Route, at the new interchange (Nancefield) - leading to Palabora. **Figure 4.1** illustrates the transportation route described above.

<u>Railway transport: -</u> The trucks would depart the site from Harper Road and continue traveling towards the east along Harper Road then turn right into Musina Railway Station, for further transportation by rail.

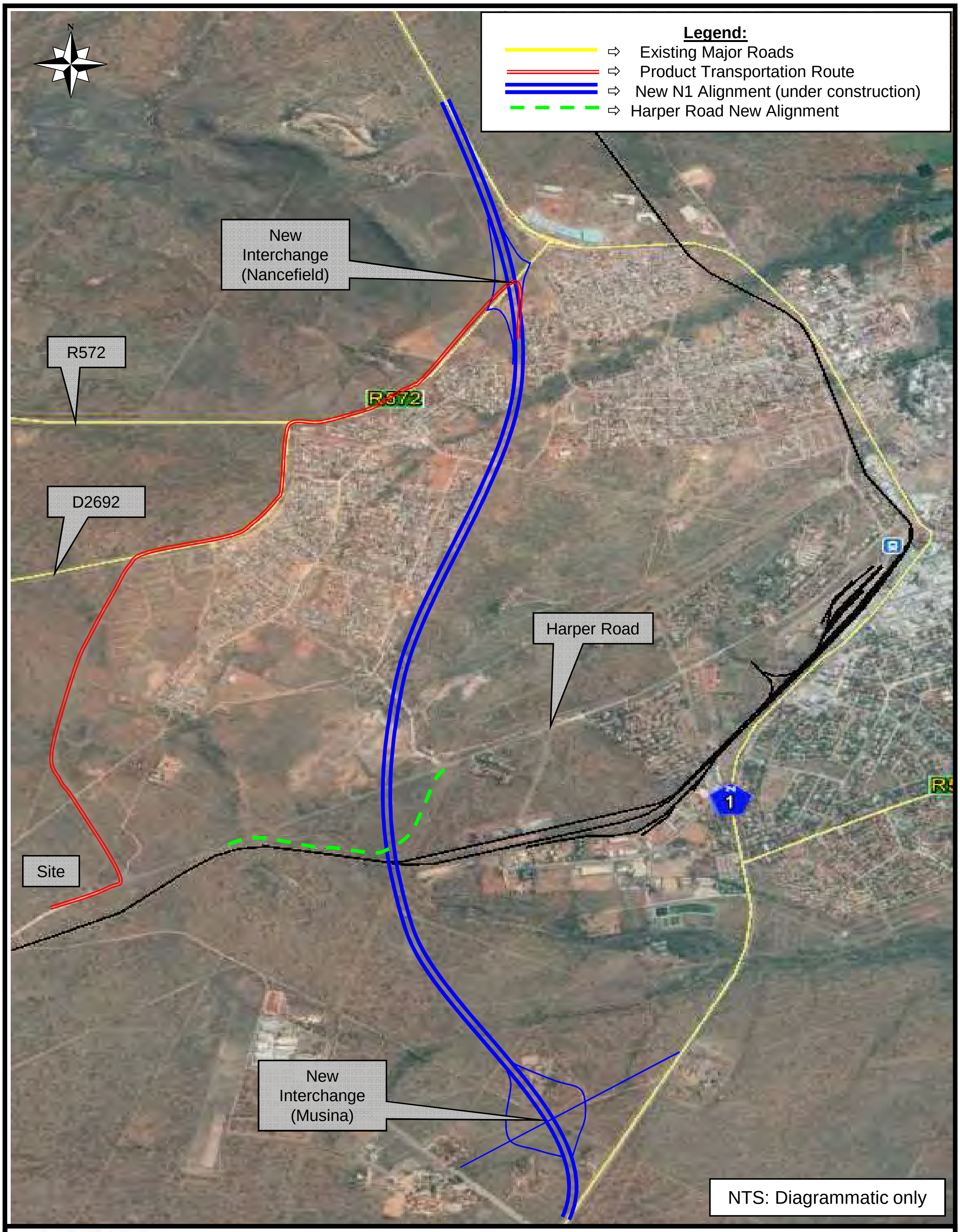

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Illustration of the Product Transportation Route

Figure 4.1

5 DATA COLLECTION

5.1 Traffic Counts

Manual traffic counts were conducted on Thursday 21st July 2016, between 06:00am to 18:00pm. The counts were undertaken at the following key intersections within the study area;

- ✓ D2692 / Unnamed Road Intersection
- ✓ Harper Road / Unnamed Road Intersection
- ✓ R572 (D1483) / D2692 Intersection

Locations of the intersections counted are shown in **Figure 5.1**.

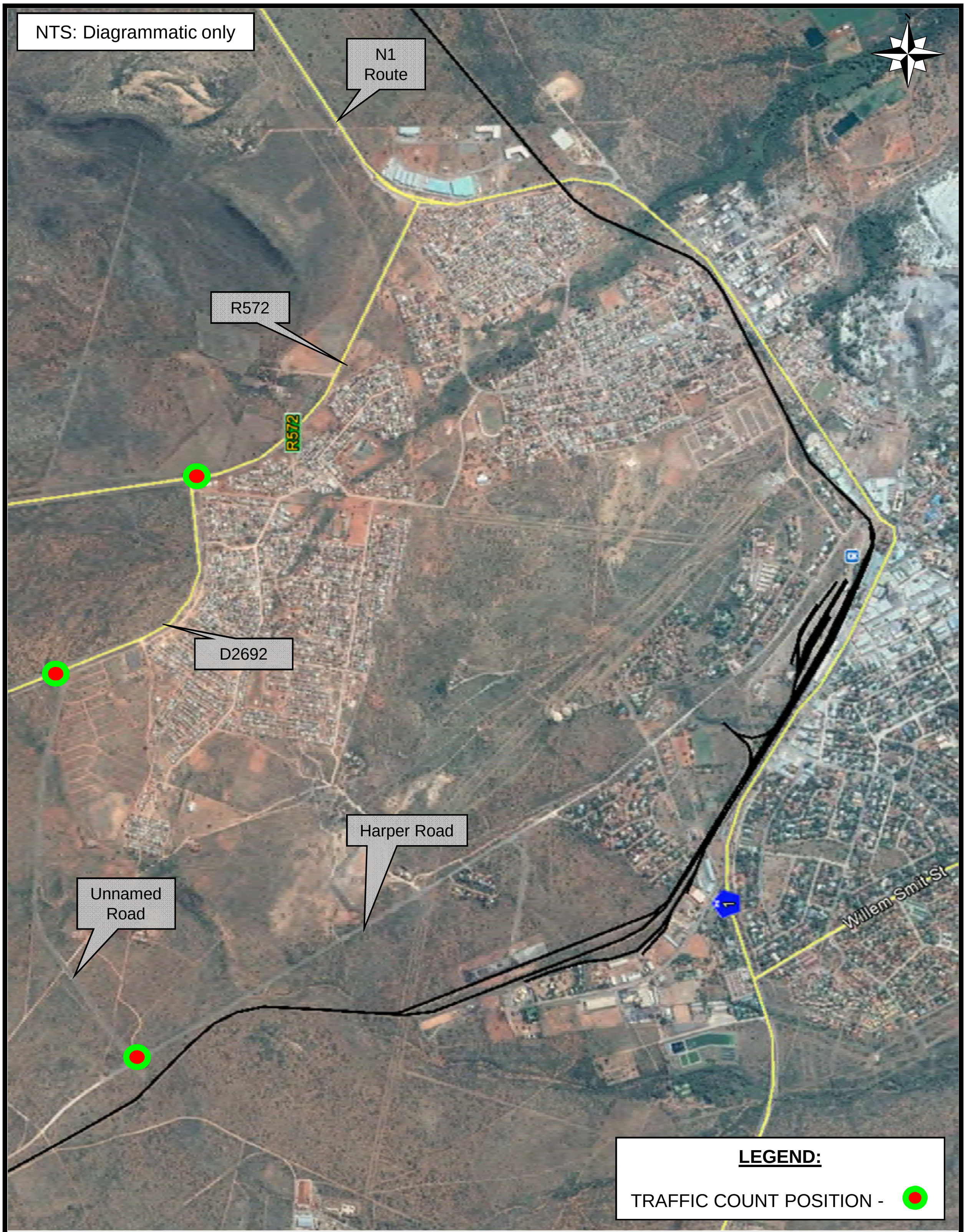
From the traffic counts undertaken, the busiest hour (peak hour) for each critical weekday peak hour period was found to be as follows:

- Morning peak 06:30 – 07:30
- Afternoon peak 15:45 – 16:45

The existing weekday AM and PM peak hour traffic volumes at the counted intersections are summarised in **Figure 5.2.**

5.2 Intersections Geometry

The existing intersections` geometric layouts have been used for base case analysis in this study.

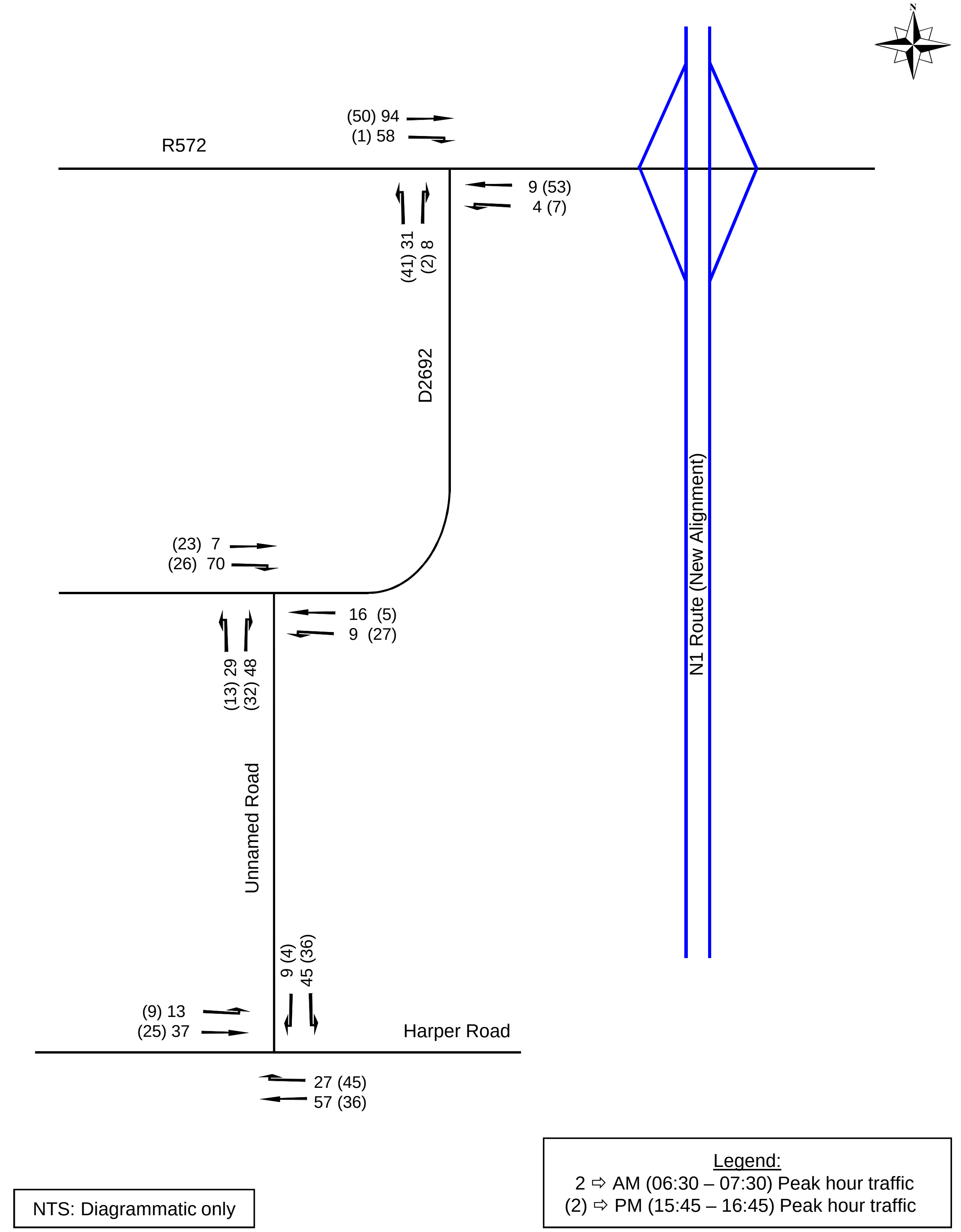


e•d•s
Structural, Civil & Transportation Engineers

MUSINA COPPER MINE

Intersections Considered

Figure 5.1



MUSINA COPPER MINE **Figure 5.2**

Existing 2016 Background Peak Hour Traffic Flows

6 TRIP GENERATION

6.1 General

The *South African Trip Generation Rate Manual* issued by the Department Of Transport, as well as the *TMH17* issued by the Committee of Transport Officials (COTO) do not make provision for mining types of developments in terms of trip generation rates.

It was therefore considered appropriate to rather determine the expected trip generation estimations from first principles, based on the envisaged operation of the proposed mine.

6.2 Development Trip Generation

Understanding of the envisaged mining operation plays a significant role in trip generation estimation of the proposed development. This information together with the following appropriate assumptions has been translated into expected development peak hourly trips;

- Approximately 90% of management staff would commute by own / company vehicles (see **Table 6.1**) – occupancy of 1 person per vehicle assumed.
- Approximately 10% of management staff would commute by staff transport (usually bus or minibus taxi) - see **Table 6.1**.
- 100% of labour would commute by staff / public transport (Bus / Minibus Taxi)
- Capacity of the staff transport (bus / minibus taxi) is estimated at 14 seated passengers (14 seater) – 100% vehicle occupancy assumed.
- Number of vehicles expected per shift is estimated at 29 (see **Table 6.1**)
- Total of 50 truck trips per hour may be expected (at most)
- Split percentage of inbound and outbound would be 50/50

Table 6.1: Conversion of personnel to number of vehicular trips

<table>
<tr><th colspan="2">Personnel</th><th colspan="4">Mode of Transport & Number of People</th><th rowspan="3">Total Vehicles Expected</th><th rowspan="3">No. of Vehicles Per Shift</th></tr>
<tr><th rowspan="2">Category</th><th rowspan="2">No. of People</th><th colspan="2">Light Vehicles</th><th colspan="2">Bus / Minibus Taxi</th></tr>
<tr><th>People</th><th>Vehicles</th><th>People</th><th>Vehicles</th></tr>
<tr><td>Management staff</td><td>54</td><td>48</td><td>48</td><td>6</td><td>1</td><td>49</td><td>16</td></tr>
<tr><td>Labour</td><td>546</td><td>0</td><td>0</td><td>546</td><td>39</td><td>39</td><td>13</td></tr>
<tr><td>Total</td><td>600</td><td colspan="4">-</td><td>88</td><td>29</td></tr>
</table>

Using the parameters and assumptions made above, it is expected that the proposed mining operations would generate a total (in plus out) of 79 trips (at the most) during the respective weekday AM and PM peak periods.

Table 6.2 summarises the expected development trip generation.

Table 6.2: Summary of estimated development trip generation

Type of vehicles (per working shift)	Split %		AM peak			PM peak		
	In	Out	In	Out	Total	In	Out	Total
Staff vehicles (Office)	50	50	8	8	16	8	8	16
Labour transport (Bus /Taxi)	50	50	6	7	13	7	6	13
Copper hauling trucks	50	50	25	25	50	25	25	50
Total			***39***	***40***	***79***	***40***	***39***	***79***

Note: It has been assumed for the worst case analysis, for the purpose of this study that change of shifts will occur during the critical weekday peak periods.

6.3 Development Trip Distribution & Assignment

Assumptions on the expected trip distribution and assignment were based on the type of the development proposed, anticipated origin and destination of trips (haulage route) as well as the existing traffic volumes and patterns in the area.

Figure 6.1 depicts summary of the expected development trip distribution and assignment.

The *South African Traffic Impact and Site Traffic Assessment Manual (TMH 16 – Version 1.0 Volume 1 Dated August 2012)* indicates the type / level of traffic impact assessment required based on the trip generation threshold indicated in **Table 6.3** below.

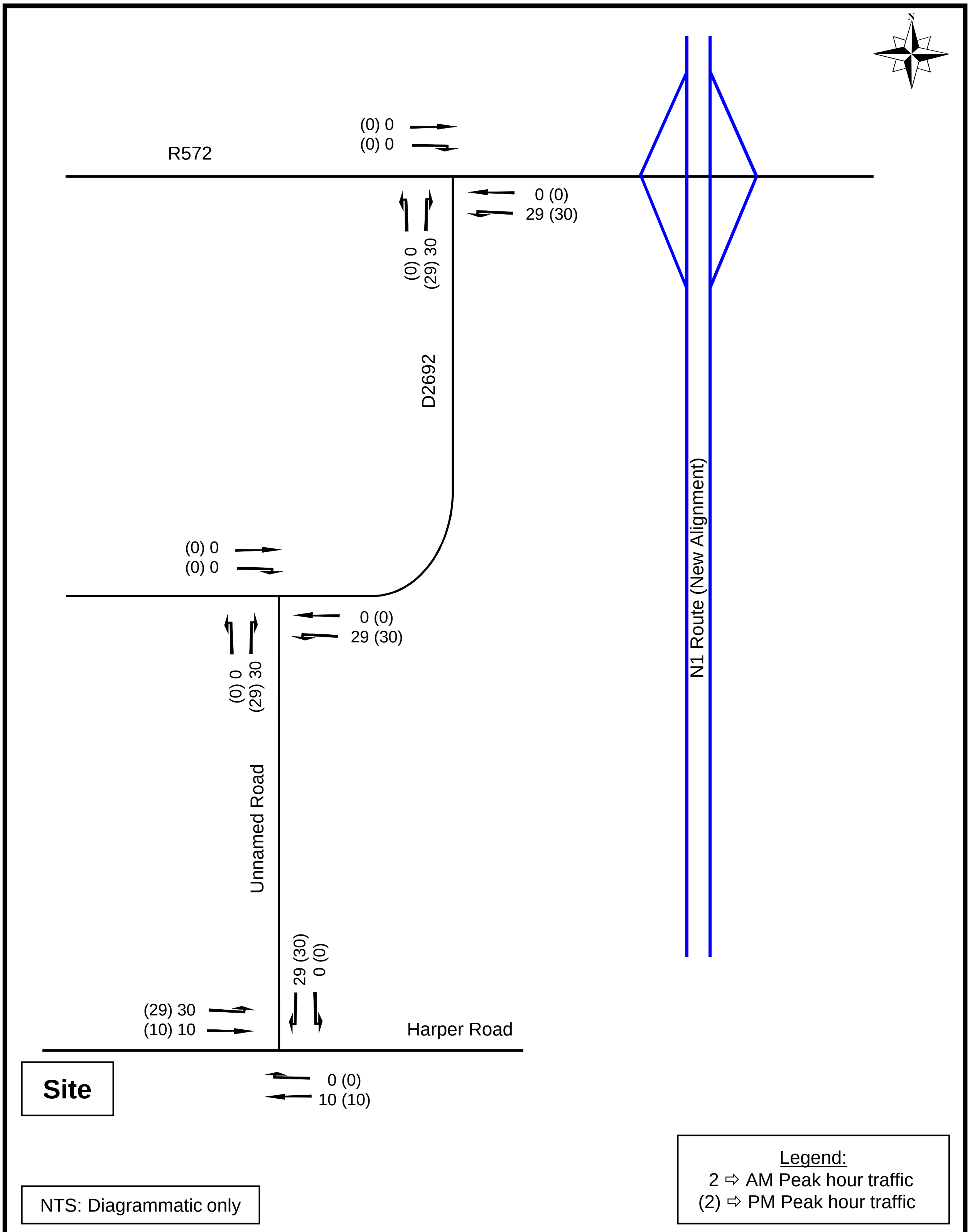
Table 6.3: Warrants for Traffic Impact Assessments (TMH16 Volume 1)

Threshold Value	Study Required
Less than 50 trips	Access Study*
More than 50 trips but less than 150 trips	Traffic Impact Statement
More than 150 trips	Traffic Impact Study

Note: * - At discretion of relative authority.

6.4 Latent Trip Generation

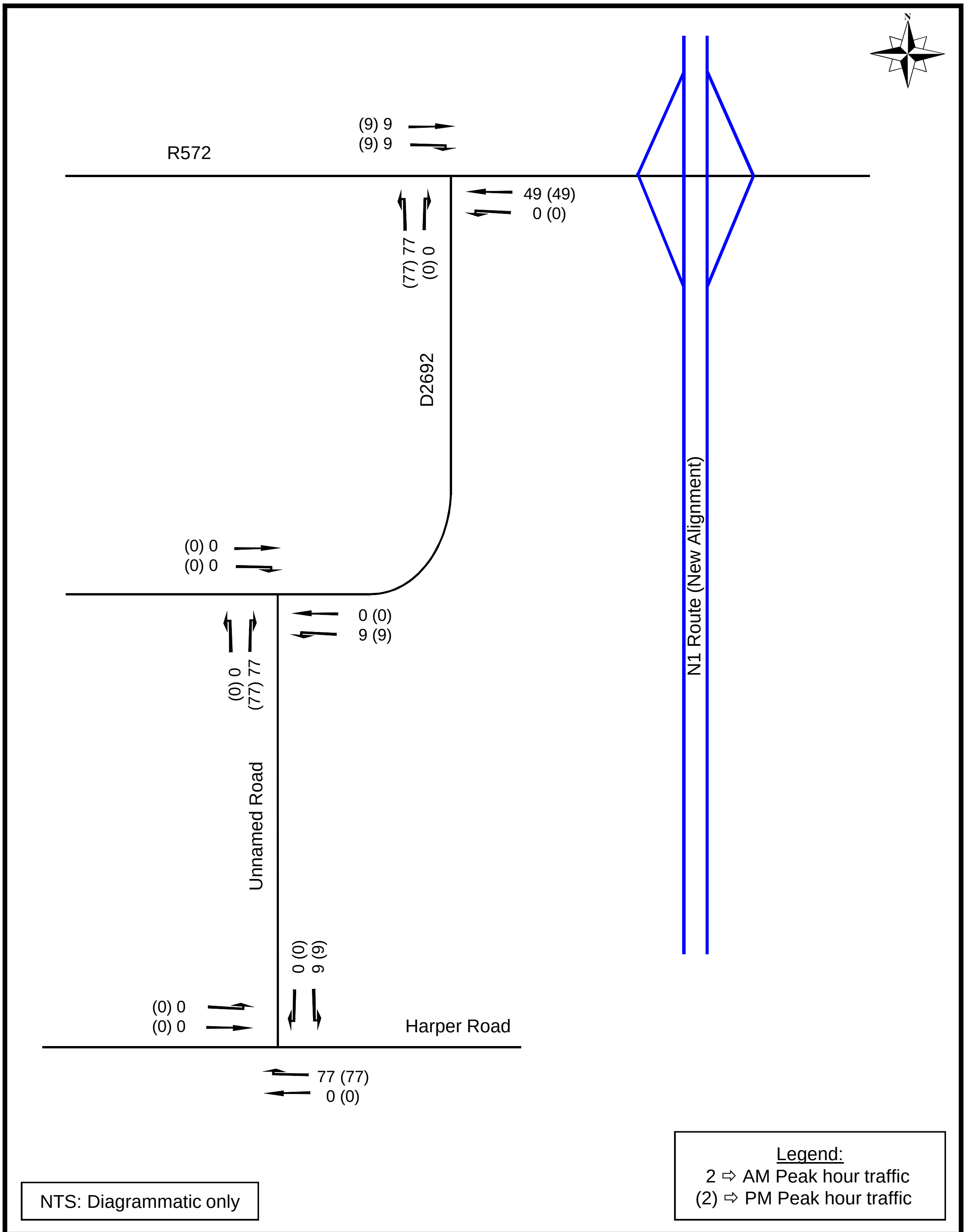
Figure 6.2 depicts summary of the estimated latent trip distribution and assignment.



MUSINA COPPER MINE

Development Peak Hour Trip Distribution & Assignment

Figure 6.1



MUSINA COPPER MINE

Latent Peak Hour Trip Distribution & Assignment

Figure 6.2

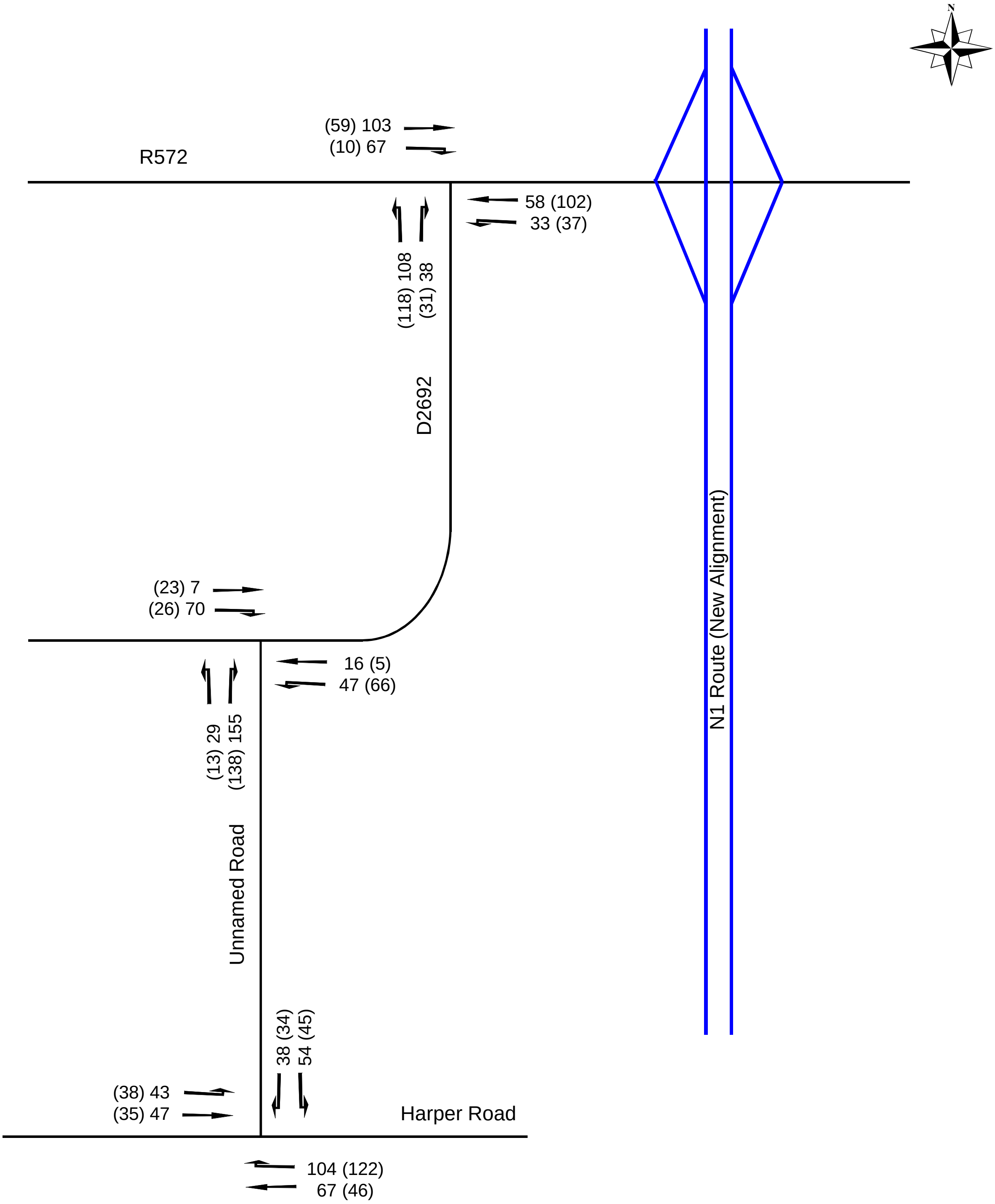
7 TRAFFIC DEMAND

7.1 Total Background Traffic Demand

The total background traffic demand refers to the summation of the 2016 background traffic flows and the estimated latent trips.

7.2 Analysis Traffic Demand

Analysis traffic demand for the purpose of this study is the total future traffic demand; which is the summation of the 2016 background traffic flows, the estimated latent trips as well as the estimated development trips (see **Figure 7.1**).



NTS: Diagrammatic only

Legend:
2 ⇨ AM Peak hour traffic
(2) ⇨ PM Peak hour traffic

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Existing 2016 Peak Hour Traffic Flows Plus Latent & Development

Figure 7.1

8 DEFINITIONS RELEVANT TO CAPACITY ANALYSIS

The following definitions from the 2000 Highway Capacity Manual are used in this report. A revised LOS method for vehicles was introduced in HCM 2010 (TRB 2010). It offers an important variation on the Delay (HCM 2000) method in using both the average control delay and the v/c (demand volume / capacity) ratio, or degree of saturation for LOS determination.

Capacity
The maximum hourly rate at which vehicles can reasonably be expected to traverse a lane or roadway during a given period under prevailing traffic and control conditions.

Volume
The hourly rate of vehicle arrivals at an intersection.

Volume to capacity ratio (v/c)
Is the ratio of volume to capacity

Level of service
Level of service is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption and lost travel time. The levels of service for signalised and unsignalised intersections as defined in the Highway Capacity Manual are tabulated in **Table 8.1** below.

Table 8.1: Delay & v/c (HCM 2010) definitions for LOS Based on delay and v/c ratio

Level of Service for **v/c≤1.0**	Rating	Average delay per vehicle in seconds (d)			Level of Service for **v/c>1.0**
		Signals	"SIDRA Roundabout LOS" option	Priority Control *(HCM2010 default for roundabouts)*	All Intersection Types
A	Excellent	d ≤ 10	d ≤ 10	d ≤ 10	**F**
B	Very Good	10 < d ≤ 20	10 < d ≤ 20	10 < d ≤ 15	**F**
C	Good	20 < d ≤ 35	20 < d ≤ 35	15 < d ≤ 25	**F**
D	Acceptable	35 < d ≤ **55**	35 < d ≤ **50**	25 < d ≤ **35**	**F**
E	Poor	**55** < d ≤ 80	**50** < d ≤ 70	**35** < d ≤ 50	**F**
F	Very Poor	80 < d	70 < d	50 < d	**F**

Note: V/c (demand volume / capacity) ratio or degree of saturation: v/c > 1.0 represents oversaturated conditions.

An intersection is deemed to be operating acceptably at levels of service A to D. If an intersection operates at a level of service E or F or has a volume to capacity ratio higher than 0.95 the intersection is considered to be operating at capacity.

9 TRAFFIC IMPACT & CAPACITY ANALYSIS

9.1 Capacity Analysis

The traffic impact expected from the proposed development at the key intersections within the study area was determined using **Sidra Intersection 7**, a traffic engineering software package.

The weekday AM and PM peak hours are considered the most critical peaks. Capacity analysis at the identified key intersections was undertaken for the following scenarios;

- *Scenario 1:* Existing 2016 background peak hour traffic flows (without development) – as per **Figure 5.1.**
- *Scenario 2:* Existing 2016 background traffic with latent and development trips – as per **Figure 7.1.**

The key scenarios analysed would indicate intersections which might already have existing capacity problems where applicable, as well as upgrades that would be required to accommodate the future traffic demand.

Detailed results of Sidra Intersection Capacity Analysis are appended in **Annexure B.**

9.2 Road and/or Intersections Improvements

Given the type and extent of the development proposed, the expected peak trip generations and capacity analyses, none of the analysed intersections require upgrading to accommodate the expected development traffic impact.

The expected traffic impact at each intersection may be briefly described as follows;

- ✓ *D2692 / Unnamed Road Intersection:* - The intersection currently operates acceptably during the peak periods, and it has ample spare capacity to accommodate both the latent as well as the subject development traffic impact.

  The existing intersection geometry is shown schematically in **Figure 9.1.**

- ✓ *Harper Road / Unnamed Road Intersection:* - The intersection currently operates acceptably during the peak periods, and it has ample spare capacity to accommodate both the latent as well as the subject development traffic impact.

  The existing intersection geometry is shown schematically in **Figure 9.2.**

- ✓ *R572 (D1483) / D2692 Intersection:* - The intersection currently operates acceptably during the peak periods, and it has ample spare capacity to accommodate both the latent as well as the subject development traffic impact.

  The existing intersection geometry is shown schematically in **Figure 9.3.**

Figure 9.1: Geometry - D2692 / Unnamed Road Intersection

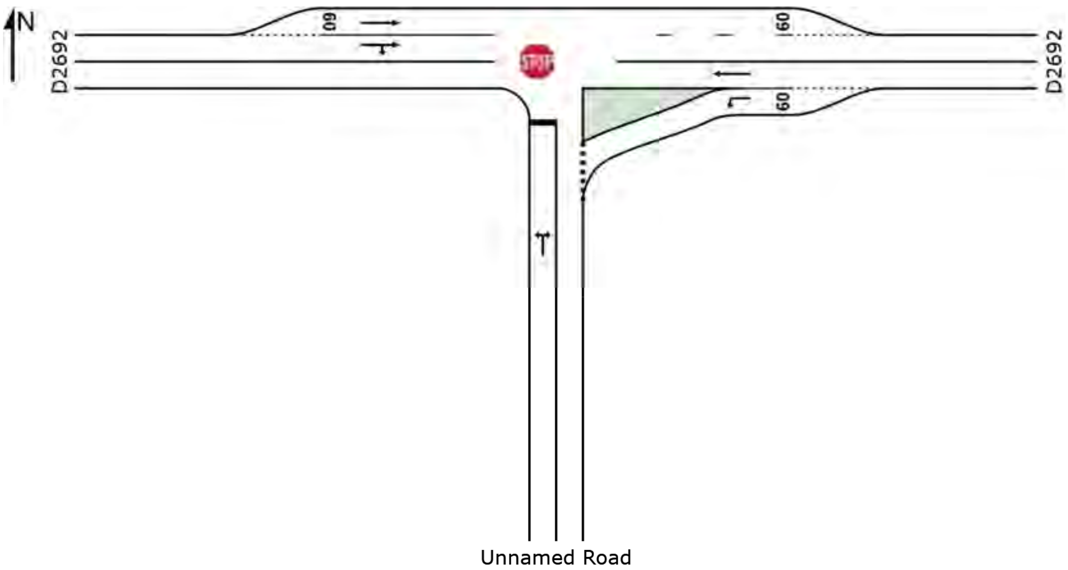
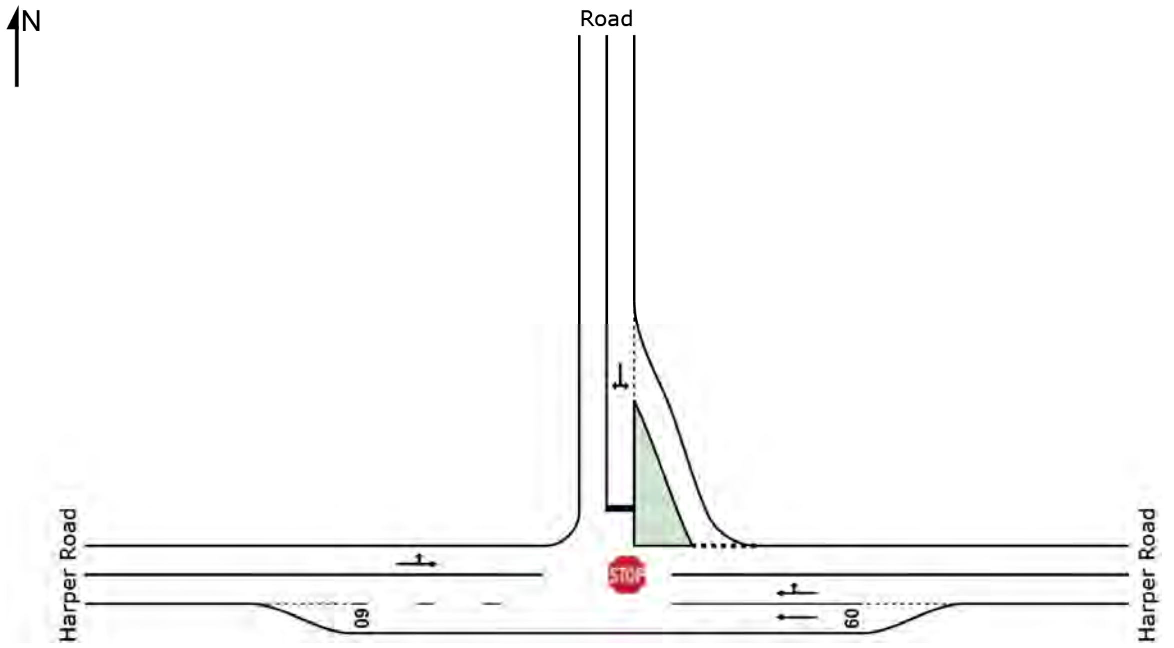
Existing Intersection Geometry (Stop Control)

Upgrades NOT Required

Figure 9.2: Geometry - Harper Road / Unnamed Road Intersection

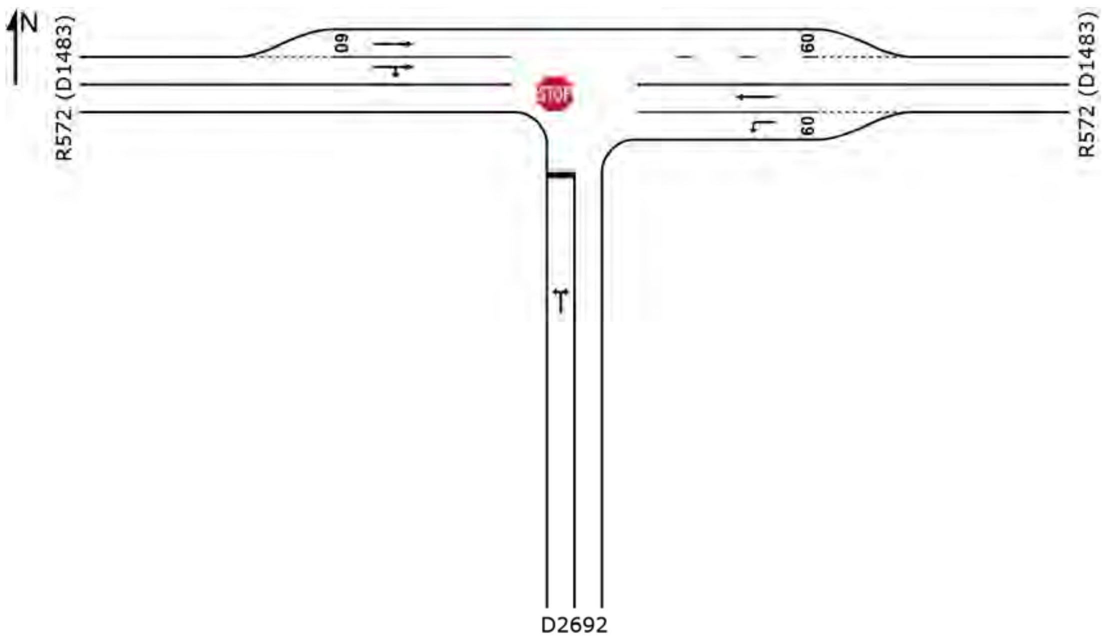
Existing Intersection Geometry (Stop Control)



Upgrades NOT Required

Figure 9.3: Geometry - R572 (D1483) / D2692 Intersection

Existing Intersection Geometry (Stop Control)



Upgrades NOT Required

10 NON-MOTORISED & PUBLIC TRANSPORT

Given that the proposed mining operation would create job opportunities, it is important to note that this would stimulate demand for public transport. The expectation is that some of the mine workers would make use of the public transport service for commuting purposes.

It is further expected that public transport in the form of bus or minibus taxis could be provided by the mine, to serve the commuting needs of the labour and some staff personnel. Possibility also exists for some or a group of workers to arrange staff transport themselves.

Given the close proximity of the site to the residential areas in Musina, it is expected that public transport operators such as taxis, could consider it an opportunity to target the mining workers and serve them with the necessary transportation needs.

It is therefore concluded that the non-motorised and public transportation needs expected from the proposed mining development would be met, by provision of public transport service (readily available in Musina, provided by the employer or both).

11 CONCLUSIONS AND RECOMMENDATIONS

It is concluded from the investigations that;

- This TIA was undertaken in support of the proposed mining rights application for the proposed mining development on various farms in Musina, Limpopo Province.
- This is an opencast copper mine proposed in Musina and is expected to produce approximately 20 000 tonnes of copper cathode per annum.
- The product (copper cathodes) will either be exported or sold to a facility such as Palabora Copper that can process it into wire bar.
- This traffic study investigates and reports on the following;
  - Assessment of existing and required roads infrastructure for copper haulage
  - Anticipated trip generation, assignment and distribution
  - Need to implement road and/or intersections improvements required to mitigate the anticipated traffic impact
- This study was conducted in terms of the requirements of the *TMH 16 Volume 2 (South African Traffic Impact and Site Impact Assessment Standards and Requirements Manual)*, COTO, Version 1 dated August 2012.
- Manual traffic surveys were undertaken at the key intersections within the study area.
- The proposed mining development is estimated to generate a total (inbound plus outbound) at most 79 peak hour trips during the critical weekday AM and PM peaks.
- The site will be accessible from Harper Road.
- The Musina Ring Road, currently under construction, has been assumed to be in place when the development trips will realise.
- Latent development to be known as Vele Colliery has been accounted for in this study.
- The key intersections analysed have ample spare capacity to accommodate the expected development trips.

It is recommended that:

- The proposed mining establishment be supported from traffic and transportation engineering perspectives and therefore be approved by the affected roads authorities.

12 REFERENCES

1. Committee of Transport Officials (COTO) - *TMH16 Vol. 1 South African Traffic Impact and Site Impact Assessment Manual*, August 2012.
2. Committee of Transport Officials (COTO) - *TMH16 Vol. 2 South African Traffic Impact and Site Impact Assessment Standards and Requirements Manual*, August 2012.
3. Committee of Transport Officials (COTO) - *TMH17 South Africa Trip Data Manual*, September 2012.

Annexure A

Musina Ring Road Planning

MUSINA
MUSINA RING ROAD
BEIT BRIDGE
MAIN ROAD
PONTDRIFT
HARPER
TOYNTON
LOUIS TRICHARDT

Annexure B

Outputs of the SIDRA 7 Intersection Capacity Analyses at the following

- ✓ D2692 / Unnamed Road Intersection
- ✓ Harper Road / Unnamed Road Intersection
- ✓ R572 (D1483) / D2692 Intersection

MOVEMENT SUMMARY

Site: vvv [Existing 2016 AM Peak Hour]

D2692 / Unnamed Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total (veh/h)	Demand Flows HV (%)	Deg. Satn (v/c)	Average Delay (sec)	Level of Service	95% Back of Queue Vehicles (veh)	95% Back of Queue Distance (m)	Prop. Queued	Effective Stop Rate (per veh)	Average Speed (km/h)
South: Unnamed Road											
1	L2	31	2,0	0,085	8,2	LOS A	0,3	2,4	0,10	0,94	51,5
3	R2	51	2,0	0,085	8,7	LOS A	0,3	2,4	0,10	0,94	51,3
Approach		81	2,0	0,085	8,5	LOS A	0,3	2,4	0,10	0,94	51,4
East: D2692											
4	L2	9	2,0	0,006	5,8	LOS A	0,0	0,2	0,16	0,51	53,7
5	T1	17	2,0	0,009	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		26	2,0	0,009	2,1	LOS A	0,0	0,2	0,06	0,18	57,5
West: D2692											
11	T1	7	2,0	0,004	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
12	R2	74	2,0	0,040	5,5	LOS A	0,0	0,0	0,00	0,60	53,1
Approach		81	2,0	0,040	5,0	NA	0,0	0,0	0,00	0,54	53,7
All Vehicles		188	2,0	0,085	6,1	NA	0,3	2,4	0,05	0,67	53,2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: vvv [Existing 2016 PM Peak Hour]

D2692 / Unnamed Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total (veh/h)	Demand Flows HV (%)	Deg. Satn (v/c)	Average Delay (sec)	Level of Service	95% Back of Queue Vehicles (veh)	95% Back of Queue Distance (m)	Prop. Queued	Effective Stop Rate (per veh)	Average Speed (km/h)
South: Unnamed Road											
1	L2	14	2,0	0,049	8,1	LOS A	0,2	1,3	0,05	0,97	51,5
3	R2	34	2,0	0,049	8,5	LOS A	0,2	1,3	0,05	0,97	51,4
Approach		47	2,0	0,049	8,4	LOS A	0,2	1,3	0,05	0,97	51,4
East: D2692											
4	L2	28	2,0	0,018	5,7	LOS A	0,1	0,5	0,09	0,52	53,9
5	T1	5	2,0	0,003	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		34	2,0	0,018	4,8	LOS A	0,1	0,5	0,07	0,44	54,8
West: D2692											
11	T1	24	2,0	0,020	0,0	LOS A	0,0	0,0	0,00	0,19	58,3
12	R2	27	2,0	0,020	5,5	LOS A	0,0	0,0	0,00	0,44	54,3
Approach		52	2,0	0,020	2,9	NA	0,0	0,0	0,00	0,32	56,1
All Vehicles		133	2,0	0,049	5,3	NA	0,2	1,3	0,04	0,58	54,0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: vvv [Existing 2016 AM Peak Hour + Latent & Development]

D2692 / Unnamed Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Unnamed Road											
1	L2	31	2,0	0,220	8,2	LOS A	1,0	7,0	0,18	0,92	51,3
3	R2	163	2,0	0,220	9,1	LOS A	1,0	7,0	0,18	0,92	51,2
Approach		194	2,0	0,220	8,9	LOS A	1,0	7,0	0,18	0,92	51,2
East: D2692											
4	L2	49	2,0	0,032	5,8	LOS A	0,1	0,9	0,16	0,52	53,6
5	T1	17	2,0	0,009	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		66	2,0	0,032	4,4	LOS A	0,1	0,9	0,12	0,38	55,1
West: D2692											
11	T1	7	2,0	0,004	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
12	R2	74	2,0	0,040	5,5	LOS A	0,0	0,0	0,00	0,60	53,1
Approach		81	2,0	0,040	5,0	NA	0,0	0,0	0,00	0,54	53,7
All Vehicles		341	2,0	0,220	7,1	NA	1,0	7,0	0,12	0,73	52,5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: vvv [Existing 2016 PM Peak Hour + Latent & Development]

D2692 / Unnamed Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Unnamed Road											
1	L2	14	2,0	0,177	8,1	LOS A	0,8	5,5	0,12	0,94	51,4
3	R2	145	2,0	0,177	8,7	LOS A	0,8	5,5	0,12	0,94	51,3
Approach		159	2,0	0,177	8,7	LOS A	0,8	5,5	0,12	0,94	51,3
East: D2692											
4	L2	69	2,0	0,044	5,7	LOS A	0,2	1,3	0,09	0,52	53,9
5	T1	5	2,0	0,003	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		75	2,0	0,044	5,3	LOS A	0,2	1,3	0,08	0,48	54,3
West: D2692											
11	T1	24	2,0	0,020	0,0	LOS A	0,0	0,0	0,00	0,19	58,3
12	R2	27	2,0	0,020	5,5	LOS A	0,0	0,0	0,00	0,44	54,3
Approach		52	2,0	0,020	2,9	NA	0,0	0,0	0,00	0,32	56,1
All Vehicles		285	2,0	0,177	6,8	NA	0,8	5,5	0,09	0,71	52,9

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: vvv [Existing 2016 AM Peak Hour]

Harper Road / Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: Harper Road											
5	T1	60	2,0	0,034	0,0	LOS A	0,0	0,0	0,00	0,16	58,6
6	R2	28	2,0	0,034	5,5	LOS A	0,0	0,0	0,00	0,26	55,6
Approach		88	2,0	0,034	1,8	NA	0,0	0,0	0,00	0,20	57,6
North: Road											
7	L2	47	2,0	0,041	5,7	LOS A	0,2	1,2	0,11	0,53	53,8
9	R2	9	2,0	0,041	6,3	LOS A	0,2	1,2	0,11	0,53	52,7
Approach		57	2,0	0,041	5,8	LOS A	0,2	1,2	0,11	0,53	53,6
West: Harper Road											
10	L2	14	2,0	0,027	5,6	LOS A	0,0	0,0	0,00	0,15	56,9
11	T1	39	2,0	0,027	0,0	LOS A	0,0	0,0	0,00	0,15	58,6
Approach		53	2,0	0,027	1,4	NA	0,0	0,0	0,00	0,15	58,2
All Vehicles		198	2,0	0,041	2,8	NA	0,2	1,2	0,03	0,28	56,5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: vvv [Existing 2016 PM Peak Hour]

Harper Road / Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: Harper Road											
5	T1	38	2,0	0,034	0,0	LOS A	0,0	0,0	0,00	0,19	58,4
6	R2	47	2,0	0,034	5,5	LOS A	0,0	0,0	0,00	0,46	54,1
Approach		85	2,0	0,034	3,0	NA	0,0	0,0	0,00	0,34	55,9
North: Road											
7	L2	38	2,0	0,028	5,7	LOS A	0,1	0,8	0,08	0,53	53,9
9	R2	4	2,0	0,028	6,2	LOS A	0,1	0,8	0,08	0,53	52,8
Approach		42	2,0	0,028	5,7	LOS A	0,1	0,8	0,08	0,53	53,8
West: Harper Road											
10	L2	9	2,0	0,019	5,6	LOS A	0,0	0,0	0,00	0,16	56,9
11	T1	26	2,0	0,019	0,0	LOS A	0,0	0,0	0,00	0,16	58,6
Approach		36	2,0	0,019	1,5	NA	0,0	0,0	0,00	0,16	58,1
All Vehicles		163	2,0	0,034	3,4	NA	0,1	0,8	0,02	0,35	55,8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: vvv [Existing 2016 AM Peak Hour Plus Latent & Development Trips]

Harper Road / Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: Harper Road											
5	T1	84	2,0	0,083	0,0	LOS A	0,0	0,0	0,00	0,17	58,5
6	R2	126	2,0	0,083	5,5	LOS A	0,0	0,0	0,00	0,49	53,9
Approach		211	2,0	0,083	3,3	NA	0,0	0,0	0,00	0,36	55,6
North: Road											
7	L2	74	2,0	0,061	5,8	LOS A	0,2	1,7	0,15	0,53	53,7
9	R2	9	2,0	0,061	7,5	LOS A	0,2	1,7	0,15	0,53	52,5
Approach		83	2,0	0,061	6,0	LOS A	0,2	1,7	0,15	0,53	53,6
West: Harper Road											
10	L2	14	2,0	0,040	5,6	LOS A	0,0	0,0	0,00	0,10	57,4
11	T1	64	2,0	0,040	0,0	LOS A	0,0	0,0	0,00	0,10	59,0
Approach		78	2,0	0,040	1,0	NA	0,0	0,0	0,00	0,10	58,7
All Vehicles		372	2,0	0,083	3,4	NA	0,2	1,7	0,03	0,35	55,8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: vvv [Existing 2016 PM Peak Hour Plus Latent & Development Trips]

Harper Road / Road Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: Harper Road											
5	T1	63	2,0	0,083	0,0	LOS A	0,0	0,0	0,00	0,07	59,3
6	R2	145	2,0	0,083	5,5	LOS A	0,0	0,0	0,00	0,57	53,3
Approach		208	2,0	0,083	3,8	NA	0,0	0,0	0,00	0,42	55,0
North: Road											
7	L2	64	2,0	0,047	5,8	LOS A	0,2	1,3	0,12	0,52	53,8
9	R2	4	2,0	0,047	7,4	LOS A	0,2	1,3	0,12	0,52	52,6
Approach		68	2,0	0,047	5,9	LOS A	0,2	1,3	0,12	0,52	53,7
West: Harper Road											
10	L2	9	2,0	0,031	5,6	LOS A	0,0	0,0	0,00	0,09	57,5
11	T1	51	2,0	0,031	0,0	LOS A	0,0	0,0	0,00	0,09	59,1
Approach		60	2,0	0,031	0,9	NA	0,0	0,0	0,00	0,09	58,9
All Vehicles		337	2,0	0,083	3,7	NA	0,2	1,3	0,03	0,38	55,4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: vvv [Existing 2016 AM Peak Hour]

R572 (D1483) / D2692 Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: D2692											
1	L2	33	2,0	0,038	8,1	LOS A	0,1	1,0	0,04	0,98	51,5
3	R2	8	2,0	0,038	9,3	LOS A	0,1	1,0	0,04	0,98	51,4
Approach		41	2,0	0,038	8,4	LOS A	0,1	1,0	0,04	0,98	51,5
East: R572 (D1483)											
4	L2	4	2,0	0,002	5,6	LOS A	0,0	0,0	0,00	0,58	53,5
5	T1	9	2,0	0,005	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		14	2,0	0,005	1,7	NA	0,0	0,0	0,00	0,18	57,8
West: R572 (D1483)											
11	T1	99	2,0	0,062	0,0	LOS A	0,0	0,0	0,00	0,18	58,4
12	R2	61	2,0	0,062	5,5	LOS A	0,0	0,0	0,00	0,31	55,2
Approach		160	2,0	0,062	2,1	NA	0,0	0,0	0,00	0,23	57,2
All Vehicles		215	2,0	0,062	3,3	NA	0,1	1,0	0,01	0,37	56,0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: vvv [Existing 2016 PM Peak Hour]

R572 (D1483) / D2692 Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: D2692											
1	L2	43	2,0	0,041	8,4	LOS A	0,1	1,1	0,15	0,91	51,7
3	R2	2	2,0	0,041	8,8	LOS A	0,1	1,1	0,15	0,91	51,5
Approach		45	2,0	0,041	8,4	LOS A	0,1	1,1	0,15	0,91	51,7
East: R572 (D1483)											
4	L2	7	2,0	0,004	5,6	LOS A	0,0	0,0	0,00	0,58	53,5
5	T1	56	2,0	0,029	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		63	2,0	0,029	0,7	NA	0,0	0,0	0,00	0,07	59,2
West: R572 (D1483)											
11	T1	53	2,0	0,021	0,0	LOS A	0,0	0,0	0,00	0,01	59,9
12	R2	1	2,0	0,021	5,5	LOS A	0,0	0,0	0,00	0,02	57,6
Approach		54	2,0	0,021	0,1	NA	0,0	0,0	0,00	0,01	59,8
All Vehicles		162	2,0	0,041	2,6	NA	0,1	1,1	0,04	0,28	57,1

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: vvv [Existing 2016 AM Peak Hour + Latent & Development Trips]

R572 (D1483) / D2692 Intersection
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: D2692											
1	L2	114	2,0	0,159	8,4	LOS A	0,6	4,6	0,18	0,91	51,3
3	R2	40	2,0	0,159	10,4	LOS B	0,6	4,6	0,18	0,91	51,2
Approach		154	2,0	0,159	8,9	LOS A	0,6	4,6	0,18	0,91	51,3
East: R572 (D1483)											
4	L2	35	2,0	0,019	5,6	LOS A	0,0	0,0	0,00	0,58	53,5
5	T1	61	2,0	0,031	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		96	2,0	0,031	2,0	NA	0,0	0,0	0,00	0,21	57,5
West: R572 (D1483)											
11	T1	108	2,0	0,070	0,0	LOS A	0,0	0,0	0,00	0,18	58,4
12	R2	71	2,0	0,070	5,5	LOS A	0,0	0,0	0,00	0,32	55,2
Approach		179	2,0	0,070	2,2	NA	0,0	0,0	0,00	0,24	57,1
All Vehicles		428	2,0	0,159	4,6	NA	0,6	4,6	0,07	0,47	54,9

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
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Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
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Mov ID	ODMov	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: D2692											
1	L2	124	2,0	0,160	8,7	LOS A	0,6	4,6	0,26	0,89	51,5
3	R2	33	2,0	0,160	9,8	LOS A	0,6	4,6	0,26	0,89	51,3
Approach		157	2,0	0,160	8,9	LOS A	0,6	4,6	0,26	0,89	51,4
East: R572 (D1483)											
4	L2	39	2,0	0,021	5,6	LOS A	0,0	0,0	0,00	0,58	53,5
5	T1	107	2,0	0,055	0,0	LOS A	0,0	0,0	0,00	0,00	60,0
Approach		146	2,0	0,055	1,5	NA	0,0	0,0	0,00	0,15	58,1
West: R572 (D1483)											
11	T1	62	2,0	0,028	0,0	LOS A	0,0	0,0	0,00	0,08	59,3
12	R2	11	2,0	0,028	5,5	LOS A	0,0	0,0	0,00	0,12	56,7
Approach		73	2,0	0,028	0,8	NA	0,0	0,0	0,00	0,09	58,9
All Vehicles		376	2,0	0,160	4,5	NA	0,6	4,6	0,11	0,45	55,3

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Prepared for:

Etienne Roux

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A Scoping Heritage Study for the Proposed Musina Copper Project Near Musina in the Limpopo Province

Prepared by:

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August 2016

CONTENTS

1 INTRODUCTION

This preliminary Scoping Heritage study is one of a series of specialist study reports which are compiled in support of an Environmental Impact Assessment study which is being done by Golder Associates Africa (Pty) Ltd (Golder) for the proposed Musina Copper Project near the town of Musina in the Limpopo Province.

The preliminary study is based on literature sources and the author's experience in the Musina area only, as access to the relevant farms to undertake field work has not been obtained from the landowners. The field work will be undertaken and the preliminary study will be updated after access is granted.

Smarty (South Africa) Minerals Investment (Pty) Ltd Ltd (Smarty) has acquired prospecting rights for copper on seven farms close to Musina in Limpopo Province. Sufficient ore reserves to support a copper mine and ore beneficiation plant have been demonstrated and Smarty have appointed Golder Associates Africa (Pty) Ltd (Golder) to undertake the necessary environmental permitting process. In terms of the Mineral and Petroleum Resources Development (Act 28 of 2002) (MPRDA), a mining right application (MRA) must be accompanied by a Mining Work Programme (MWP) and a Social and Labour Plan (SLP). Golder Associates Africa (Pty) Ltd (Golder) and Ukwazi Mining Solutions have been appointed to assist with the development of the MWP.

The proposed Musina Copper Project may have a negative influence on any of the types and ranges of heritage resources which are listed in Section 3 of the National Heritage Resources Act (No 25 of 1999) (Box 1). Consequently, a Phase I Heritage Impact Assessment (HIA) study has to be conducted as required by Section 38 of the National Heritage Resources Act (No 25 of 1999). The aims of the Phase I HIA study are as follows:

- To establish whether any of the types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999) (Box 1) do occur in the Project Area and, if so, to determine the nature and the extent of these remains.

- To establish whether any of the types and ranges of heritage resources which have been identified in the Project Area will be affected by Musina Copper's operations and, if so, to establish appropriate mitigation and management measures for these heritage resources.

Archaeological surveys and heritage studies have indicated that the Limpopo Province is rich in archaeological remains and in heritage resources.

Most of the types and ranges of heritage resources which are outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999) do occur across the Limpopo Province (see Box 1, next page).

Box 1: Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999).

The National Heritage Resources Act (Act 25 of 1999, Section 3) outlines the following types and ranges of heritage resources that qualify as part of the national estate:

a. Places, buildings structures and equipment of cultural significance;
b. Places to which oral traditions are attached or which are associated with living heritage;
c. Historical settlements and townscapes;
d. Landscapes and natural features of cultural significance;
e. Geological sites of scientific or cultural importance;
f. Archaeological and palaeontological sites;
g. Graves and burial grounds including-
    i. Ancestral graves;
    ii. Royal graves and graves of traditional leaders;
    iii. Graves of victims of conflict;
    iv. Graves of individuals designated by the Minister by notice in the Gazette;
    v. Historical graves and cemeteries; and
    vi. Other human remains which are not covered in terms of the Human Tissue Act (Act 65 of 1983);
h. Sites of significance relating to the history of slavery in South Africa;
i. Moveable objects, including -
    i. Objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects, material, meteorites and rare geological specimens;
    ii. Objects to which oral traditions are attached or which are associated with living heritage;
    iii. Ethnographic art and objects;
    iv. Military objects;
    v. Objects of decorative or fine art;
    vi. Objects of scientific or technological interest; and
    vii. Books, records, documents, photographs, positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act (Act 43 of 1996).

The National Heritage Resources Act (Act 25 of 1999, Sec 3) also distinguishes nine criteria for a place and/or object to qualify as 'part of the national estate if they have cultural significance or other special value …'. These criteria are the following:

a. Its importance in the community, or pattern of South Africa's history;
b. Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
c. Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
d. Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
e. Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
f. Its importance in demonstrating a high degree of creative or technical achievement at a particular period;
g. Its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
h. Its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and/or
i. Its significance relating to the history of slavery in South Africa.

2 DETAILS OF THE SPECIALIST

Profession: Archaeologist, Museologist (Museum Scientist), Lecturer, Heritage Guide Trainer and Heritage Consultant

Qualifications:

BA (Archaeology, Anthropology and Psychology) (UP, 1976)

BA (Hons) Archaeology (distinction) (UP, 1979)

MA Archaeology (distinction) (UP, 1985)

D Phil Archaeology (UP, 1989)

Post Graduate Diploma in Museology (Museum Sciences) (UP, 1981)

Work experience:

Museum curator and archaeologist for the Rustenburg and Phalaborwa Town Councils (1980-1984)

Head of the Department of Archaeology, National Cultural History Museum in Pretoria (1988-1989)

Lecturer and Senior lecturer Department of Anthropology and Archaeology, University of Pretoria (1990-2003)

Independent Archaeologist and Heritage Consultant (2003-date)

Accreditation: Member of the Association for Southern African Professional Archaeologists. (ASAPA)

Summary: Julius Pistorius is a qualified archaeologist and heritage specialist with extensive experience as a university lecturer, museum scientist, researcher and heritage consultant. His research focussed on the Late Iron Age Tswana and Lowveld-Sotho (particularly the Bamalatji of Phalaborwa). He has published a book on early Tswana settlement in the North-West Province and has completed an unpublished manuscript on the rise of Bamalatji metal working spheres in Phalaborwa during the last 1 200 years. He has excavated more than twenty LIA settlements in North-West and twelve IA settlements in the Lowveld and has mapped hundreds of stone walled sites in the North-West. He has written a guide for Eskom's field personnel on heritage management. He has published twenty scientific papers in academic journals and several popular articles on archaeology and heritage matters. He collaborated with environmental companies in compiling State of the Environment Reports for Ekhurhuleni and Hartebeespoort, and heritage management plans for the Magaliesberg and Waterberg. Since acting as an independent consultant he has done approximately 800 large to small heritage impact assessment reports. He has a long-standing working relationship with Eskom, Rio Tinto (PMC), Rio Tinto (EXP), Impala Platinum, Angloplats (Rustenburg), Lonmin, Sasol, PMC, Foskor, Kudu and Kelgran Granite, Bafokeng Royal Resources, Pilanesberg Platinum Mine, etc. as well as with several environmental companies.

3 DECLARATION OF INDEPENDENCE

I, Julius CC Pistorius, declare that:

•I act as the independent environmental practitioner 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 environmental impact assessments, including knowledge of the National Heritage Resources Act (No 25 of 1999) and any guidelines that have relevance to the proposed activity;

•I will comply with the Act, regulations and all other applicable legislation;

•I will take into account, to the extent possible, the matters listed in regulation **8** of the regulations when preparing the application and any report relating to the application;

•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;

•I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;

•I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;

•I will keep a register of all interested and affected parties that participated in a public participation process; and

•I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not

•all the particulars furnished by me in this form are true and correct;

•will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; 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.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010.

____
Signature of the environmental practitioner:

Private Consultant

____
Name of company:

5 August 2016

____
Date:

4 LEGAL FRAMEWORK

South Africa’s heritage resources (’national estate’) are protected by international, national and regional legislation which provides regulations, policies and guidelines for the protection, management, promotion and utilization of heritage resources. South Africa’s ‘national estate’ includes a wide range of various types of heritage resources as outlined in Section 3 of the National Heritage Resources Act (NHRA, Act No 25 of 1999) (see Table 1).

According to the NHRA heritage resources are categorised using a three-tier system, namely Grade I (national), Grade II (provincial) and Grade III (local) heritage resources.

At the provincial level, heritage legislation is implemented by Provincial Heritage Resources Agencies (PHRAs) which apply the National Heritage Resources Act together with provincial government guidelines and strategic frameworks. Metropolitan or Municipal (local) policy regarding the protection of cultural heritage resources is also linked to national acts and is implemented by the South African Heritage Resources Agency (SAHRA) and the Provincial Heritage Resources Agencies.

At a national level heritage resources are dealt with by the National Heritage Council Act (Act No 11 of 1999) and the National Heritage Resources Act (Act No 25 of 1999).

4.1 Legislation relevant to heritage resources

The identification, evaluation and assessment of heritage resources in South Africa are regulated by the following legislation:

- National Environmental Management Act (NEMA) Act 107 of 1998
- National Heritage Resources Act (NHRA) Act 25 of 1999
- Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Development Facilitation Act (DFA) Act 67 of 1995

4.2 The National Heritage Resources Act (NHRA)

According to the NHRA (Act No 25 of 1999) the ‘national estate’ comprises the following (see Table 1):

a. Archaeological artefacts, structures and sites older than 100 years
b. Ethnographic art objects (e.g. prehistoric rock art) and ethnography
c. Objects of decorative and visual arts
d. Military objects, structures and sites older than 75 years
e. Historical objects, structures and sites older than 60 years
f. Proclaimed heritage sites
g. Graveyards, burial grounds and graves older than 60 years
h. Meteorites and fossils
i. Objects, structures and sites of scientific or technological value.

Elaborating on the above, the ‘national estate’ also includes (Table 1):

1. Places, buildings, structures and equipment of cultural significance
2. Places to which oral traditions are attached or which are associated with living heritage
3. Historical settlements and townscapes
4. Landscapes and features of cultural significance
5. Geological sites of scientific or cultural importance
6. Archaeological and paleontological sites of importance
7. Sites of significance relating to the history of slavery
8. Movable objects (e.g. archaeological, paleontological, meteorites, geological specimens, military and ethnographic objects, books etc.)

4.3 Heritage Impact Assessment studies

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

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

4.4 Regulations with regard to heritage resources

The regulations outlined below are applicable to the types and ranges of heritage resources which are the most common in the region where the heritage study was conducted, namely:

4.4.1 Buildings and structures

According to Section 34(1) of the NHRA (Act No 25 of 1999) no person may alter (demolish) any structure or part thereof which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

A structure means any building, works, device or any other facility made by people and which is fixed to land and which includes fixtures, fittings and equipment associated with such structures.

Alter means any action which affects the structure, appearance or physical properties of a place or object, whether by way of structural or any other works such as painting, plastering, decorating, etc..

4.4.2 Graves and burial grounds

Graves and burial grounds are divided into the following:

a. ancestral graves
b. royal graves and graves of traditional leaders
c. graves of victims of conflict
d. graves designated by the Minister
e. historical graves and cemeteries
f. human remains

In terms of Section 36(3) of the NHRA (Act No 25 of 1999) no person, without a permit issued by the relevant heritage resources authority, may:

a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
b) destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation, or any equipment which assists in the detection or recovery of metals.

Unidentified graves are handled as if they are older than 60 years until proven otherwise.

Human remains that are less than 60 years old are subject to provisions of the Human Tissue Act (Act 65 of 1983) and to local regulations. Exhumation of graves must conform to the standards set out in the Ordinance on Excavations (Ordinance no. 12 of 1980) (replacing the old Transvaal Ordinance no. 7 of 1925).

Permission must also be gained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and local police. Furthermore, permission must also be gained from the various landowners (i.e. where the graves are located and where they are to be relocated) before exhumation can take place. Human remains can only be handled by a registered undertaker or an institution declared under the Human Tissues Act (Act 65 of 1983 as amended).

4.4.3 Archaeology, palaeontology and meteorites

Section 35(4) of the NHRA (Act No 25 of 1999) deals with archaeology, palaeontology and meteorites and states that no person without a permit issued by the responsible heritage resources authority (national or provincial) may:

- destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or paleontological site or any meteorite;
- destroy, damage, excavate, remove from its original position, collect or own any archaeological or paleontological material or object or any meteorite;
- trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or paleontological material or object, or any meteorite; or bring onto or use at an archaeological or paleontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and paleontological material or objects, or use such equipment for the recovery of meteorites.
- alter or demolish any structure or part of a structure which is older than 60 years.

Heritage resources may only be disturbed or moved by an archaeologist after being issued with a permit received from the South African Heritage Resources Agency (SAHRA). In order to demolish heritage resources the developer has to acquire a destruction permit from SAHRA.

5 THE PROJECT AREA

5.1 Location

The Musina Copper Project is located on several farms to the west, south-west and north-east of the town of Musina in the Limpopo Province. The focus of this heritage impact assessment study is confined to the farms Vogelenzang 3 MT,portions 9, 10, 11 and RE, Papenbril 205 MS and Hereward 203 MS. The project falls within the Musina Local Municipality which is located within the Vhembe District Council in the Limpopo Province (Figure 1) (Messina 2230 and Kamkusi 2230AA 1: 50 000 topographical maps; 2230 Messina 1:250 000 map and Google imagery).

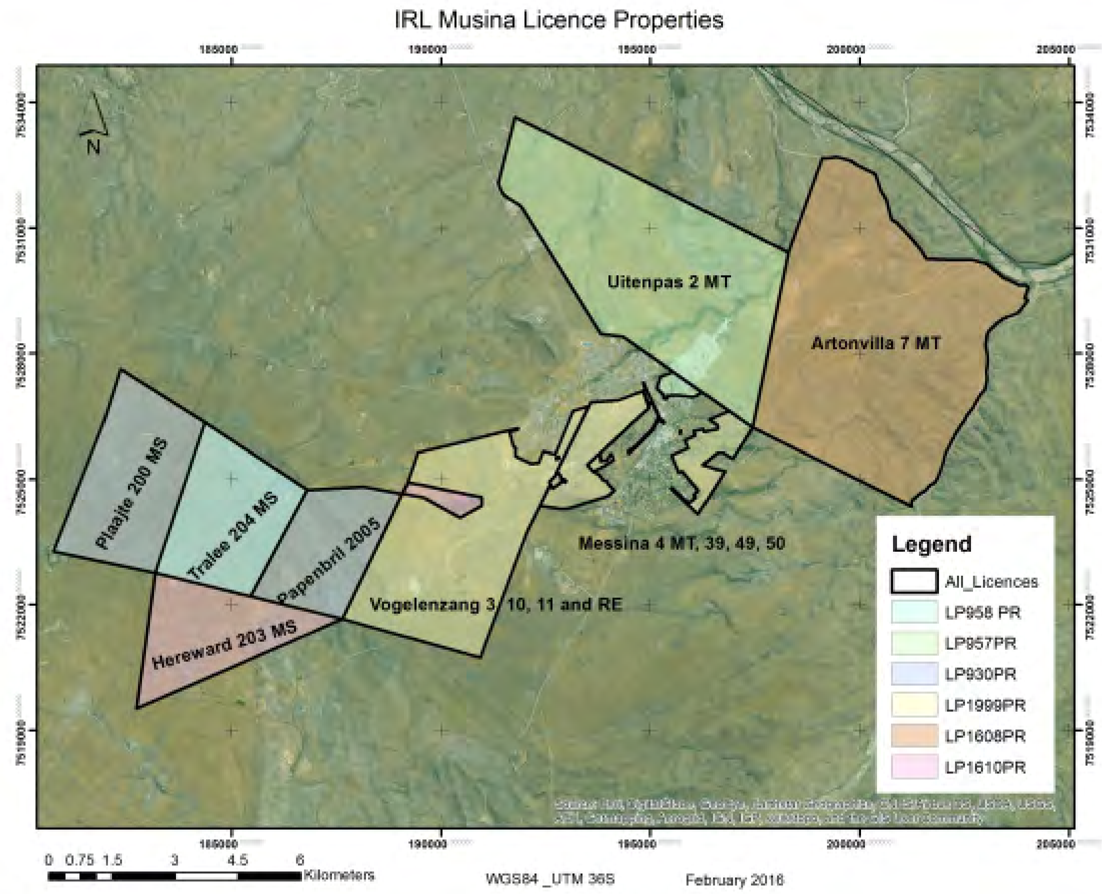

Figure 1- The Musina Copper Project in the Musina Local Municipality in the Vhembe District Council in the Limpopo Province. The Heritage Impact Assessment study will focus on the farms Papenbril 205MS, Hereward 203MS and Vogelzang 3MS, portions 9, 10, 11 and RE (above).

The Project Area is located approximately 50 km to the east of the Mapungubwe World Heritage site and is situated directly to the north of the Musina Nature Reserve and the Boabab Tree Reserve. Copper mines and older abandoned copper shafts such as Molly Too Mine and Campbell Mine occur on farms such as Vogelenzang 3 MS and Hereward 203 MS (Figure 1).

5.2 The heritage character of the Project Area hierso

The Musina Copper Project falls within a regional cultural landscape which houses a wide range of heritage resources as has been outlined by earlier archaeological and heritage studies, a few of which are listed in this report (see 'Part 8, Bibliography relating to earlier heritage studies').

According to these studies, the most common types and ranges of heritage resources in close proximity to the proposed Project Area are the following:

- Settlements dating from the Stone Age.
- Settlements dating from the Iron Age or the last two thousand years.
- Historical farmsteads with houses older than sixty years are not uncommon and also occur within the town of Musina itself.
- Graveyards and graves, many of an informal nature, which are scattered across the wider Project Area.
- The pre-historical copper mining remains of Musina, which have been observed and reported by geologists during the first half of the twentieth century. These remains have not been archaeologically investigated and large parts were destroyed in order to make way for contemporary copper mining activities.

The cultural and historical context of the Musina Copper Project is broadly outlined in Part 6 of the report, 'Contextualising the Project Area'

5.3 The nature of the Musina Copper Project

Smarty (South Africa) Minerals Investment (Pty) Ltd (Smarty) has acquired prospecting rights for copper on seven farms close to Musina in Limpopo Province. Copper will be mined on the farms Papenbril 205,MS, Hereward 203,MS and Vogelenzang 3 MT.

The project components will include an opencast mine, an ore beneficiation plant comprising crushing, screening, flotation and/or heap leaching, possibly electro-winning and/or solvent extraction, tailings disposal and supporting infrastructure.

6 CONTEXTUALISING THE PROJECT AREA

A brief overview of pre-historical and historical information below contextualises the project area. This description, in conjunction with earlier heritage surveys which were done in the general area, illuminates possible types and ranges of heritage resources that may occur in the project area.

6.1 The Stone Age (hunter gatherers)

Stone Age sites are marked by stone artefacts that are found scattered on the surface of the earth or as parts of deposits in caves and rock shelters. The Stone Age is divided into the Early Stone Age (ESA) (covers the period from 2.5 million years ago to 250 000 years ago), the Middle Stone Age (MSA) (refers to the period from 250 000 years ago to 22 000 years ago) and the Late Stone Age (LSA) (the period from 22 000 years ago to 200 years ago). The LSA is also associated with rock paintings and engravings which were done by the San, Khoi Khoi and in more recent times by Iron Age farmers (Inskeep 1978).

In and near the project area

Surveys, although limited, have recorded scattered finds of Stone Age sites whilst rock paintings sites are limited to rocky outcrops such as those in the Limpopo Valley in the Mapungubwe cultural landscape. In the Soutpansberg mountain range further to the south, numerous rock art sites have been recorded over the years (Eastwood & Cnoops 1999).

Stone Age hunters occupied the area from the Acheulian period judging from Acheulian hand axes which were recorded in the Mapungubwe cultural landscape to the west of Musina (Roodt 2009) and near the Soutpansberg, eighty kilometres further to the south-west (Matodzi, Matenga, & Pikirayi. 2013).

It can be expected that MSA sites, which are quite common over large parts of South Africa, will exist in or near the Project Area. LIA sites also have been recorded by the University of Pretoria in the Mapungubwe cultural landscape.

6.2 The Iron Age (earliest farmers)

Hunter-gatherers were followed by the first agro-pastoralists who lived in semi-permanent villages and who practised metal working during the last two millennia, the so-called Iron Age. The Iron Age is usually divided into the Early Iron Age (EIA) (covers the 1^{st} millennium AD) and the Later Iron Age (LIA) (covers the first 880 years of the 2^{nd} millennium AD).

Whilst the EIA is marked by small scattered sites with (elaborately) decorated pottery and in many instances with iron smelting, LIA sites may occur in clusters covering large tracts of land constituting cultural landscapes. These sites are mostly marked by stone walls and (undecorated) pottery. Metal working during the LIA occurs when this activity has attained specialised status. Historical links between LIA complexes and communities close to the sites can usually be pointed out. (This provides opportunities for oral traditions, cultural landscapes and aspects of living [tangible and intangible] heritage to be investigated as well).

EIA sites are limited to the northern and eastern parts of the country whilst LIA farmers' settlements cover a large part of South Africa – except the far western low-summer rainfall region and the southern extreme of the country.

In and near the project area

Early Iron Age farming sites have been recorded to the north of the Soutpansberg, but little is known about these early farming communities. An EIA site known as Klein Afrika, which dated from AD300 and one of the earliest dated IA sites in South Africa, used to exist on the farm Marius 732MS near the Soutpansberg. This site has since been destroyed by agricultural activities (Pistorius 2008).

Precursor settlements to the Mapungubwe chiefdom (AD900 to AD1200), which arose *prior* to the second millennium AD in the Limpopo Valley, include Schroda, Skutwater and K2. Mapungubwe sat at the top of a hierarchy of more or less contemporary settlements which were more or less similar with regard to their spatial layout and plans. These settlements also include Little Muck and Mmamagma Hill, respectively located ten and forty kilometres to the west of Mapungubwe and Mapela, eighty-five kilometres to the north-west of Mapungubwe (Hall 1987).

Mapungubwe, which flourished during AD900-AD1200, represents the first complex socio-political community in Southern Africa. At this flat-topped sandstone hill farmer-herders established a royal kinship which dominated the Limpopo Valley and which was characterised by an intricate and experienced gold working industry which contributed to it being part of an Indian Ocean trade network (Hall 1987; Huffman 1996).

The vast outstretched bushveld between the Soutpansberg and the Limpopo Valley also served as home for many of today's contemporary Bantu speaking communities who have Sotho-Tswana, Venda and Lemba ancestors (Hammond Tooke 1993).

6.3 Pre-historic copper working

Books and writings by early European travellers and more specifically prospectors, geologists and mine inspectors very often refer to 'ancient workings' or 'pre-European mines' in the interior of South Africa. Enough information on the topic was already available in 1920 for Percy Wagner to compile a map which outlined pre-European iron, tin, copper and gold mines and the workings of these early smelters in the interior of South Africa (Friede 1980).

Pre-historic copper working activities in and around Musina were first described by Trevor who remarked that these remains were extensive and that they occur in an almost continuous line stretching for more than 29km from Musina in a south-westerly direction. 'In this area there are at least five or six very large groups of ancient workings. That at the Messina Mine which was so successfully opened is, the writer thinks, the largest but the others are not very much smaller' (Trevor 1912:270).

All the workings had been filled up and appear as cup-like hollows varying in shape and extending for about one mile in length and sometimes running along three parallel lines. Approximately one hundred and twenty of these mines occurred, all of which were centred on a lens of copper glance (chalcocite) or bornite. It was estimated that several tens of thousands of tons of copper were mined from these workings (Trevor 1912).

The technology that was used to mine copper probably did not differ much from mining technological practises that were found in most pre-historic South African mines and also did not change fundamentally for nearly a millennium. The general methods of mining mainly comprised of the following:

> ‘Generally surface outcrops were cleared first, and then trenches were dug. Pits were carried down to depths from 4m to 15m. The lodes or reefs were followed in trenches or underground drives, sometimes branching off into short tunnels. In the larger copper and tin mines, vertical and inclined shafts were sunk to considerable depths, but not deeper than 25m when water, bad ventilation, or transportation difficulties stopped further work’ (Friede 1985:163). The technology of the Musina copper miners was recorded in detail by Van Warmelo (1940).

The copper mining industry in Musina was founded by the Musina and Thsope people who came from the Phalaborwa region where a large ancient copper working industry existed, probably contemporary with that in Musina. According to radio carbon dating, mining and copper working in Phalaborwa may have continued, although perhaps intermittently, over a period of more than a thousand years, from AD700 to AD1850 (Van der Merwe & Scully 1971; Pistorius 1989). No dates are available for the Musina copper mines or smelting activities. Trevor (1912) suggests that the Musina copper workings proceeded on a small scale at various intervals for longer than a thousand years.

According to G. H. Stanley it was possible that the Musina copper was smelted at settlements on the slopes of neighbouring hills. ‘There is no sign of the smelting floors above surface now, but at a depth of six inches or so layers of ash, cinders, slag, etc. with fragments of twyers made of a mixture of clay and quartz, are to be found in several places. … I did not find anything which could be identified as part of a crucible, and as the twyer noses were covered with slag stained with copper oxide and containing beads of copper, it would appear that smelting was performed in some sort of hearth ’ (Trevor 1912:371).

It is said that the Musina miners maintained a monopoly on copper working and that they became wealthy and proud, but also unpopular with their neighbours and, after a severe mine accident in which several mine workers were killed, the industry came to an end (Van Warmelo 1940).

6.4 Historical period

The two Voortrekker parties of Hans van Rensburg and Louis Trichardt reached the southern slopes of the Soutpansberg in 1836. As the two parties had quarrelled along the way, the Van Rensburg party moved eastwards in search of a route to Lourenço Marques (now Maputo) in Mocambique.

Whites moved into the Musina area first as hunters, traders and missionaries, with settlers following closely on their heels. The Musina area has a long history of ivory hunting during the eighteenth century, while prehistoric and historic mines occur across the Musina region, e.g. on the farms Jooste and Dorothy (Murimbika 2006).

From 1898 the Musina area with the rest of the Soutpansberg was placed under direct control of the ZAR following the defeat of the Venda kingdom. From 1917 most of the farms in the area have been in the hands of commercial family farmers. Today the area is predominantly occupied by Sotho-Tswana and Venda speaking communities (Loubser 1991).

The copper deposits in the Musina area were investigated in 1903 by Colonel John P Grenfell, who then set about to establish the Messina (Transvaal) Development Company Limited in 1904 to exploit the copper deposits. Most of the deposits were revealed by investigating the ancient workings, although many new sources were also identified. Mining commenced in 1906 and continued until the closure of the mine in 1991. In 1950 control of the mine moved from London to South Africa. The plant was modernised and ore production reached a peak of 1.7Mt per annum in the early nineteen seventies (Wilson & Anhaeusser 1998).

The town of Messina (renamed Musina in 2002) was founded in 1904 on the farm Berkenrode as a result of the exploitation of the copper deposits. It was proclaimed as town in 1957 (Hammerbeck & Schoeman 1976:143; Raper 2004:238).

7 THE PHASE I HERITAGE SURVEY

The Phase I Heritage Impact Assessment study for the Musina Copper Project entails the following:

7.1 Desktop study

Review of literature relating to the pre-historical and the historical unfolding of the Musina area.

Heritage studies which were done for developers near the Project Area provide information with regard to the general heritage characteristics of the larger Project Area as already outlined in this report.

The desktop study also involves consulting heritage data banks maintained at institutions such as the Limpopo Provincial Heritage Resources Agency in Polokwane, the Archaeological Data Recording Centre at the National Flagship Institute (Museum

Africa) in Pretoria and the national heritage resources register at the South African Heritage Resources Agency (SAHRIS) in Cape Town.

7.2 Fieldwork and research

The Project Area will be surveyed with a vehicle and by means of pedestrian surveys as soon as access to the land is obtained from the landowners. A track log will be registered with a mounted GPS instrument.

All coordinates for heritage resources will be recorded with a Garmin Etrex hand set Global Positioning System (instrument) with an accuracy of < 15m.

7.3 Baseline description

A baseline description will be compiled by means of a synthesis of the evidence derived from the desktop study (heritage data bases and literature research for contextual evidence) with the fieldwork evidence (GPS recording, describing, photographing and evaluating heritage resources encountered in the field).

7.4 Proposed activity description

It is assumed that certain project activities resulting from the Musina Copper Project may have a bearing (impact) on heritage resources. If such activities exist they will be described and assessment in terms of their possible influence on any heritage resources that may occur in the Project Area.

7.5 The heritage impact assessment

The significance of heritage resources in the Project Area is indicated by means of stipulations derived from the NHRA (Act No 25 of 1999) as well as criteria derived from the historical and cultural context of the heritage resources that may be impacted by the Musina Copper Project.

The significance of potential heritage impacts will be determined using a generic ranking scale which is used in most environmental and heritage impact assessment studies and which is based on various criteria (see Part 8.1, ‘The significance of potential impacts on the heritage resources’).

7.6 Heritage management measures

Recommendations for the mitigation and management of heritage resources which may be affected by the Musina Copper Project will be provided. These heritage management measures are based on guidelines derived from the National Heritage Resources Act (Act No 25 of 1999), from guidelines provided by the South African Heritage Resources Authority (SAHRA) and recommendations put forward by the Association for Southern African Professional Archaeologists (ASAPA)..

7.7 Heritage monitoring plan

Heritage monitoring measures are based on principles associated with best practise and guidelines and are derived from practical experience with regard to the monitoring of heritage resources. Guidelines for best practise are formulated by SAHRA and ASAPA and are recommended to and applied by heritage researchers and consultants.

8 THE SIGNIFICANCE, POSSIBLE IMPACT ON AND MITIGATION OF THE HERITAGE RESOURCES

8.1 The significance of potential impacts on the heritage resources

The significance of any potential impacts on the heritage resources will be determined using a generic ranking scale which is used in most environmental and heritage impact assessment studies and which is based on the following:

- Occurrence
  - Probability of occurrence (how likely is it that the impact may/will occur?), and
  - Duration of occurrence (how long may/will it last?)
- Severity
  - Magnitude (severity) of impact (will the impact be of high, moderate or low severity?), and

- Scale/extent of impact (will the impact affect the national, regional or local environment, or only that of the site?)

Each of these factors has been assessed for each potential impact using the following ranking scales:

Probability: 5 – Definite/don't know 4 – Highly probable 3 – Medium probability 2 – Low probability 1 – Improbable 0 – None	Duration: 5 – Permanent 4 - Long-term (ceases with the operational life) 3 - Medium-term (5-15 years) 2 - Short-term (0-5 years) 1 – Immediate
Scale: 5 – International 4 – National 3 – Regional 2 – Local 1 – Site only 0 – None	Magnitude: 10 - Very high/don't know 8 – High 6 – Moderate 4 – Low 2 – Minor

The significance of each potential impact was assessed using the following formula:

Significance Points (SP) = (Magnitude + Duration + Scale) x Probability

The maximum value is 100 Significance Points (SP). Potential impacts are rated as very high, high, moderate, low or very low significance on the following basis:

- More than 80 significance points indicates VERY HIGH environmental significance.
- Between 60 and 80 significance points indicates HIGH environmental significance.
- Between 40 and 60 significance points indicates MODERATE environmental significance.

- Between 20 and 40 significance points indicates LOW environmental significance.
- Less than 20 significance points indicates VERY LOW environmental significance.

8.2 Mitigating the impact on the heritage resources

Mitigation and management measures will be recommended for those types and ranges of heritage resources which may exist and which may be affected by the proposed Musina Copper Project.

9 CONCLUSION AND RECOMMENDATION

It is clear from the cultural historical context of the Project Area that the Musina region is rich in heritage remains. These heritage resources include a wide range and various types which are all outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999). From a heritage point of view this implies that a Phase I Heritage Impact Assessment (HIA) study, the aims and methodology of which have been outlined in this report, has to be conducted, as is required by Section 38 of the National Heritage Resources Act (No. 25 of 1999), for the proposed Musina Copper Project.

The Phase I HIA study will identify all possible types and ranges of heritage resources in the Project Area and will determine the significance of these remains. The HIA study will also determine the significance of the impact on these heritage resources according to criteria and guidelines which have been outlined in this report. Lastly, the HIA study will recommend mitigation and management measures for those heritage resources which may be impacted by the proposed Musina Copper Project.

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APPENDIX F

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