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Section 102 Amendment for Consolidation of all Matla EMPs, IWULs and the inclusion of Phase 1 Stooping at Exxaro Matla Coal Mine

In terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) and the National Environmental Management Act, 1998 (Act No. 107 of 1998)

Version -Draft

July 2018

Exxaro Resources (Pty) Ltd

GCS Project Number: 13-0400 & 16-1208

DMR Reference Number: MP30/5/1/2/3/2/1/ (327) MR

Client Reference: Matla Stooping

POWERING POSSIBILITY

GCS (Pty) Ltd. **Reg No:** 2004/000765/07 Est. 1987
Offices: Durban **Johannesburg** Lusaka Ostrava Pretoria Windhoek
Directors: AC Johnstone (Managing) PF Labuschagne AWC Marais S Napier B Bredenkamp W Sherritt (Financial)
Non-Executive Director: B Wilson-Jones
www.gcs-sa.biz

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Report
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Exxaro Resources

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Title	**Section 102 Amendment for the inclusion of Phase 1 Stooping at Exxaro Matla Coal Mine**		
	Name	**Signature**	**Date**
Author	Riana Panaino		July 2018
Document Reviewer	Renee Janse van Rensburg		July 2018
Director			July 2018

LEGAL NOTICE

DISCLAIMER

Information contained in this report is based on data/information supplied to GCS Water and Environment (Pty) Ltd (GCS) by the client and other external sources (including previous site investigation data and external specialist studies). It has been assumed that the information provided to GCS is correct and as such the accuracy of the conclusions made are reliant on the accuracy and completeness of the data supplied. No responsibility is accepted by GCS for incomplete or inaccurate data supplied by the client and/or other external sources. Opinions expressed in this report apply to the site conditions and features that existed at the time of the start of the relevant investigations and the production of this application process, ESR and EIA/EMP reports.

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1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) was appointed by Exxaro Resources (Pty) Ltd to undertake the required processes for the consolidation of the existing Environmental management Plans (EMPs), Integrated Water use Licenses (IWULs) and Environmental Authorisations (EA) for inclusion of the Stooping Project in to the consolidation process.

The EA process and associated reports, including the Environmental Impact Assessment (EIA) Report, the Environmental Management Programme (EMP) Report, and all Specialist Assessments fulfil the requirements of the following legislation:

- Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) Section 102 Amendment - for including the Stooping Project area into the existing Matla Mine;
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) Section 32 Amendment (of GNR 982) for the inclusion of listed activities (as per GNR 983 and 984) as amended in 2017; and
- National Water Act, 1998 (Act No. 36 of 1998) (NWA) – Integrated Water Use Licence Application (IWULA) and Integrated Water and Waste Management Plan (IWWMP).

1.1 Background

Matla is an existing underground coal mining operation that began end 1973 and consisted of four complexes: Mine 1, Mine 2, Mine 3 and E'Tingweni. E'tingweni was mined completely, closed and rehabilitated. Mine 1 was closed, and a new Mine 1 Shaft is being constructed for further mining. The remainder of the shafts are still operational.

Matla has the following authorisations in place which will form part of the consolidation process:

- Environmental Management Plans:
  - Matla EMP – Existing operations: Mine 1, Mine 2 and Mine 3;
  - Matla Water Treatment Plant; and
  - Matla Mine 1 New Shaft.
- Integrated Water Use Licenses:
  - Matla EMP – Existing operations: Mine 1, Mine 2, Mine 3 and Crushing and Screening Plant;
  - Matla Water Treatment Plant;
  - Matla Mine 1 New Shaft; and
  - Matla River Diversion.

The Matla Management Team has decided to consolidate all environmental authorisations (EMPs and IWULs) in order to achieve the following:

- Better management of the various legal requirements set out in each authorisation,
- Improvement in the management of the costs associated with the implementation of the legal requirements; and
- To avoid duplications in compliance related matters and ensure all reporting requirements are met.

The consolidation and application for activities related to Stooping will be undertaken in accordance with the requirements of the MPRDA, the NEMA, and the NWA.

The proposed project is located within the following District and Local Municipalities (Figure 1.1):

- Nkangala District Municipality (DC31)
    - Emalahleni Local Municipality (MP312)
- Gert Sibande District Municipality (DC30)
    - Govan Mbeki Local Municipality (MP307)

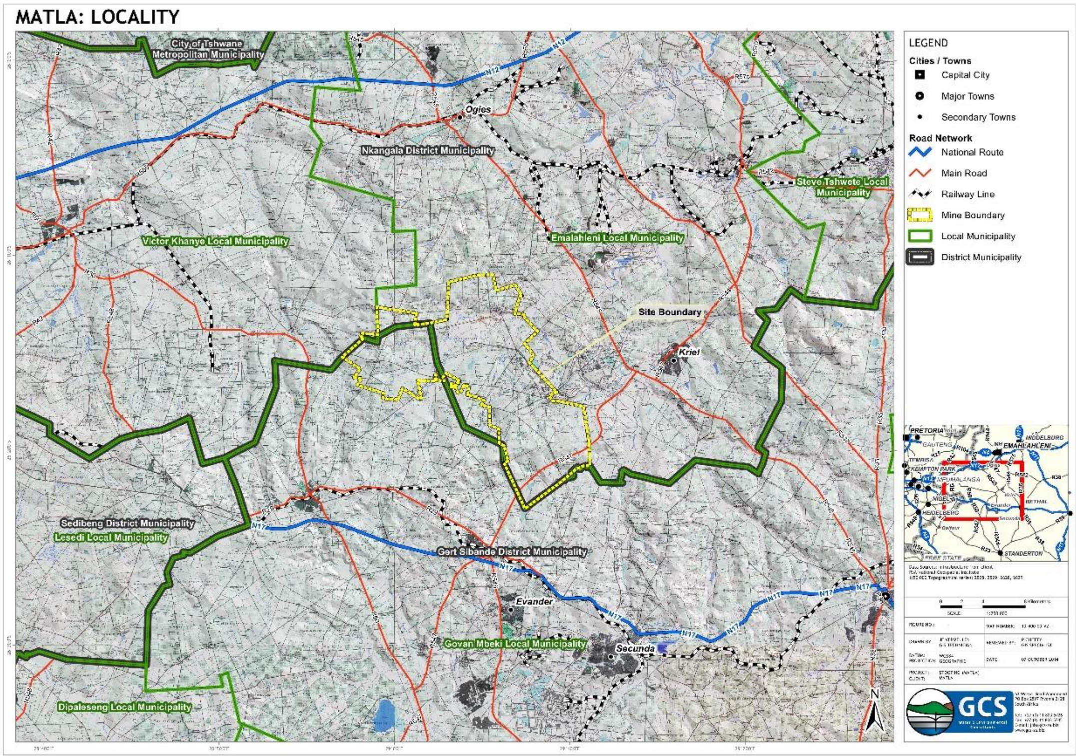

Figure 1.1. Location of Proposed Matla Phase 1 Stooping areas within the District and Local Municipalities

1.2 Project Summary

As mentioned before Matla currently consists of Mine 1, 2, and 3, of which various authorizations were obtained at various stages. The following infrastructure is associated with each of the Mines:

- Mine 1
    - Settling ponds;
    - Evaporation dams;
    - Plant;
    - Workshop;
    - Administration and other buildings;
    - Shaft complex (not in operation);
    - Stockpiles;
    - Waste Rock Dumps; and
    - Water Treatment Plant.
- Mine 2
    - Sewage treatment plant;
    - Evaporation dam;
    - Workshops; and
    - Shaft complex.
- Mine 3
    - Sewage treatment plant;
    - Settling dams;
    - Workshops;
    - Shaft complex; and
    - River diversion.

The following Mine licenses, EMPs and Environmental Authorisations were approved:

- Original Licence received 1994
- River Diversion
    - MDALA ref 17/2/1/1 (M) MP-07 of 9 August 2007
- Mine 1 New Shaft
    - DME ref MP30/5/1/2/3/2/1 (327) EM of 20 August 2009
- Water Treatment Plant
    - MDEDET ref 17/2/3 N-70 of 7 August 2012
    - DEA ref (Waste Licence) 12/9/11/L649/6 of 23 Sept 2013
    - DMR ref MP30/5/1/2//3/2/1 (327) EM of 2 October 2013

Current Integrated Water Use Licences in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) that are approved for Matla:

- Licence No. 24084303 of July 2007
    - River Diversion – Section 21(c) and (i)
- Licence No. 24084303 of 1 October 2010
    - Mines 1, 2 and 3 – Sections 21(a), (b), (f), (g) and (j)
- Licence No. 04/B11E/ABCFGIJ/2446 of 17 March 2014
    - Water Treatment Plant – Sections 21(a), (b), (c), (f), (g), (i) and (j)
- Licence No. 04/B11E/ACFGIJ/3734 of 16 July 2015
    - New Mine 1 Shaft – Sections 21 (a), (c), (f), (g), (i) and (j)

Due to the work intensity of having several authorisations and licences Matla decided to consolidate all existing authorisations and licences into one EMP document and one IWUL document. This would ensure that management actions that no longer apply will fall away, and the incorporation of improved management actions where applicable, as some of the EMPs and IWULs are now 10 years in existence. It would further simplify the process of meeting legal requirements for the mine as one entity as opposed to separate smaller entities in isolation.

In addition to the Consolidation of all previous approved Authorisations and Licences, Matla Coal proposes to stoop (or totally extract) pillars at the previously underground mined areas with the intent to reclaim the remaining coal reserves by using the conventional board and pillar mining method (drill and blast).

The proposed activities for phase 1 of Stooping will occur on all relevant farms and portions within the Matla Coal mining boundary owned by Eskom and Exxaro (**Figure 1.2**). The proposed project will exclude wetlands, rivers, registered servitudes, provincial and national roads, private properties and buildings or any other structure or sensitive natural stature protected in terms of national and/or international law.

The reclamation of the remaining coal reserves will utilise the existing current operations' infrastructure.

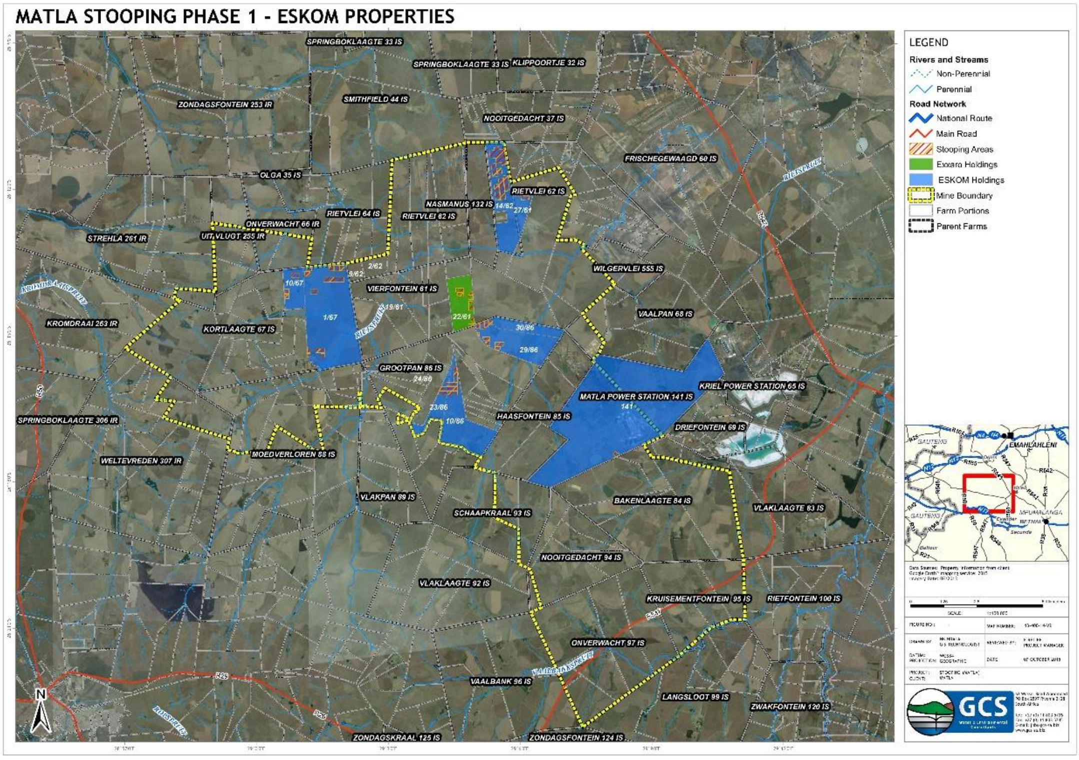

Figure 1.2. Stooping areas located within Exxaro and Eskom properties

The inclusion of the Stooping Project into the Matla Operations will trigger the listed activities in terms of NEMA as shown in Table 1.1 and Table 1.2 and will therefore require an environmental application for approval of the proposed activities before Stooping can commence.

Table 1.1: Listed activities triggered under GN R983 (as amended)

Activity No (s) (in terms of the relevant or notice):and date of the relevant notice:	Listed activity:	Description of project activity that triggers listed activity
National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2014		
GN R983, 4 December 2014, Activity 19	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse;	The underground Stooping will cause subsidence in close proximity to wetland areas

Table 1.2: Listed activities triggered under GN R984

Activity No (s) (in terms of the relevant or notice):and date of the relevant notice:	Listed activity:	Description of project activity that triggers listed activity
National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2010		
GN R984, 4 December 2014, Activity 6	The development of facilities or infrastructure for any process or activity which requires a permit or licence or an amended permit or licence in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent,…	Application for an IWUL for activities triggered in terms of Section 21 of the NWA
GN R984, 4 December 2014, Activity 15	The clearance of an area of 20 hectares or more of indigenous vegetation	Rehabilitation of goafing areas, where areas are stripped of vegetation and topsoil, shaped and then topsoiled and revegetated.
GN R984, 4 December 2014, Activity 17	Any activity including the operation of that activity which requires a mining right as contemplated in section 22 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), including- (a) associated infrastructure, structures and earthworks, directly related to the extraction of a mineral resource; or (b) the primary processing of a mineral resource including winning, extraction, classifying, concentrating, crushing, screening or washing;	Stooping is a method of mining and Matla Coal needs to amend their mining works programme to include stooping. A Section 102 application will then be required.

The inclusion of the Stooping Project into the Matla Operations will also trigger the listed activities in terms of Section 21 of the NWA as shown in Table 1.3, which will be included in the consolidation of the IWULs.

Table 1.3: NWA Listed Activities for IWULA & IWWMP related to Stooping

SECTION 21	DESCRIPTION	PROJECT DESCRIPTION
(c)	Impeding or diverting the flow of water in a	Mining and associated

SECTION 21	DESCRIPTION	PROJECT DESCRIPTION
	watercourse	activity near wetlands
(i)	Altering the bed, banks, course or characteristics of a watercourse;	Mining and associated activity near wetlands

1.3 Description of Activities that could Impact on the Environment

1.3.1 Activities previously authorized

Due to Matla being operational for a long period of time stretching beyond the implementation of the NEMA and its regulations, most of the earlier EMPs were authorized only under the MPRDA through the then Department of Minerals and Energy (DME). The NEMA EIA regulations came into effect in 2006 and repealed most of the Environmental conservation Act (ECA) which was previously used as a guideline for Environmental studies. The first EMP to include Listed Activities under the NEMA was the Mine 1 New Shaft EMP (under reference number MP 30/5/1/2/3/2/1(327) EM) and was authorized under the DME as the lead authority. Thus the first activities authorized was only post 2006, and are depicted in Table 1.4.

Table 1.4: Activities previously authorised

Activity Description	Regulation	Listed Activity
Licence MP 30/5/1/2/3/2/1(327) EM of 2009: Mine 1 New Shaft		
Construction of a coal transportation conveyor. Length: Approximately 4.2 km Capacity: Approximately 1 800 tons of coal per hour	GN R387 of 2006	Activity 1: The construction of facilities or infrastructure, including associated structures or infrastructure for: (j) the bulk transportation of dangerous goods using pipelines, funiculars or conveyors with a throughput capacity of 50 tons or 50 cubic metres or more per day.
Sewage treatment plant to be constructed on the proposed Matla 1 new access shaft site. Approximate daily discharge: 250m^3 (250 000 litres)	GN R387 of 2006	Activity 1: The construction of facilities or infrastructure, including associated structures or infrastructure, for: (p) the treatment of effluent, wastewater or sewage with an annual throughput capacity of 15 000 cubic metres or more
Fuel storage facility at the proposed Matla 1 new access shaft site: 10 000 litres Proposed lubrication storage facilities on the proposed Matla 1 new access shaft site: • Gear oil: 10 000 litres • Hydraulic lubricant: 10 000 litres • Diesel machinery oil: 10 000 litres	GN R386 of 2006	Activity 7: The above ground storage of a dangerous good, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres at any one location or site.

Activity Description	Regulation	Listed Activity
• Road treat: 10 000 litres		
• Construction of a gravel service road next to the proposed conveyor structure Construction of tarred access roads on the Matla 1 new access shaft site	GN R386 of 2006	Activity 15: The construction of a road that is wider than 4 metres or that has a reserve wider than 6 metres, excluding roads that fall within the ambit of another listed activity or which are access roads of less than 30 metres long.
Licence (MDEDET) 17/2/3 N-70 of 2012: Water Treatment Plant		
Water Pipelines	GNR 544 of 18 June 2010	Activity 9: The construction of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of water, sewage or storm water - (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more, excluding where: a. such facilities or infrastructure are for bulk transportation of water, sewage or storm water or storm water drainage inside a road reserve; or b. where such construction will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse
Brine Ponds	GNR 544 of 18 June 2010	Activity 11: The construction of: (i) canals; (ii) channels; (iii) bridges; (iv) dams; (v) weirs; (vi) bulk storm water outlet structures;

Activity Description	Regulation	Listed Activity
		(vii) marinas; (viii) jetties exceeding 50 square metres in size; (ix) slipways exceeding 50 square metres in size; (x) buildings exceeding 50 square metres in size; or (xi) infrastructure or structures covering 50 square metres or more where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.
Brine Ponds	GNR 544 of 18 June 2010	Activity 12: The construction of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50000 cubic metres or more, unless such storage falls within the ambit of activity 19 of Notice 545 of 2010;
Possible acid or other chemical storage related to the treatment of the brine pond material.	GNR 544 of 18 June 2010	Activity 13: The construction of facilities or infrastructure for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 but not exceeding 500 cubic metres;
Construction of haul roads	GNR 544 of 18 June 2010	Activity 22: The construction of a road, outside urban areas, with a reserve wider than 13,5 meters or, where no reserve exists where the road is wider than 8 metres, or for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Notice 545 of 2010.
WTP and Brine Ponds	GNR 544 of 18 June 2010	Activity 23: The transformation of undeveloped, vacant or derelict land to –

Activity Description	Regulation	Listed Activity
		residential, retail, commercial, recreational, industrial or institutional use, inside an urban area, and where the total area to be transformed is 5 hectares or more, but less than 20 hectares, or residential, retail, commercial, recreational, industrial or institutional use, outside an urban area and where the total area to be transformed is bigger than 1 hectare but less than 20 hectares; - except where such transformation takes place for linear activities.
For NWA application	GNR 544 of 18 June 2010	Activity 28: The expansion of existing facilities for any process or activity where such expansion will result in the need for a new, or amendment of, an existing permit or license in terms of national or provincial legislation governing the release of emissions or pollution, excluding where the facility, process or activity is included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply.
Road	GNR 544 of 18 June 2010	Activity 47: The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre - where the existing reserve is wider than 13,5 meters; or where no reserve exists, where the existing road is wider than 8 metres – excluding widening or lengthening occurring inside urban areas.
Diesels storage and other dangerous good storage	GNR 545 of 18 June 2010	Activity 3: The construction of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres.

Activity Description	Regulation	Listed Activity
WULA related	GNR 545 of 18 June 2010	Activity 5: The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent and which is not identified in Notice No. 544 of 2010 or included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply.
Electricity generation	GNR 545 of 18 June 2010	Activity 8: The construction of facilities or infrastructure for the transmission and distribution of electricity with a capacity of 275 kilovolts or more, outside an urban area or industrial complex.
Pollution Control Dams – depends on the final design	GNR 545 of 18 June 2010	Activity 19: The construction of a dam, where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 hectares or more.
Depends if the road falls within a sensitive area	GNR 546 of 18 June 2010	Activity 4: The construction of a road wider than 4 metres with a reserve less than 13,5 metres (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and Western Cape: ii. Outside urban areas, in: (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;

Activity Description	Regulation	Listed Activity
Depends if the storage area falls within a sensitive area	GNR 546 of 18 June 2010	Activity 10: The construction of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres. (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and Western Cape: ii. Outside urban areas, in: (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;
	GNR 546 of 18 June 2010	Activity 13: The clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, except where such removal of vegetation is required for: the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), in which case the activity is regarded to be excluded from this list. the undertaking of a linear activity falling below the thresholds mentioned in Listing Notice 1 in terms of GN No 544 of 2010. (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and Western Cape: ii. Outside urban areas, in: (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;

Activity Description	Regulation	Listed Activity
	GNR 546 of 18 June 2010	Activity 19: The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre. (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and Western Cape: ii. Outside urban areas, in: (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;
Licence (DEA) 12/9/11/L649/6 of 2013: Water Treatment Plant		
Brine Ponds	General Notice 718, 3 July 2009	Category B Activity 1: The storage including the temporary storage of hazardous waste in lagoons.
Water treatment facility for the treatment of Process Water	General Notice 718, 3 July 2009	Category B Activity 3: The recovery of hazardous waste including the refining, utilisation or co-processing of waste at a facility with a capacity to process more than 500 kg of hazardous waste per day excluding recovery that takes place as an integral part of an internal manufacturing process within the same premises or unless the Minister has approved re-use guidelines for the specific waste stream.
Water treatment facility for the treatment of Process Water	General Notice 718, 3 July 2009	Category B Activity 5: The treatment of hazardous waste using any form of treatment regardless of the size or capacity of such a facility to treat such waste.

1.3.2 New activities requiring authorisation

The inclusion of the Stooping Project into the Matla Operations will entail the activities that could impact upon the receiving environment are anticipated for each phase of the project:

- Construction Phase:
  - No construction phase activities anticipated as this will be a continuation of mining activities within the current infrastructure.
- Operational Phase:
  - Underground Mining Of Coal – stooping/total extraction; and
  - Concurrent surface rehabilitation.
- Closure Phase:
  - Active Surface Rehabilitation
- Residual Impacts; and
- Cumulative Impacts

GCS wishes to advise the reader that this report should be read in conjunction with all specialist assessments that were developed for the Stooping Project. This includes the following reports:

- Hydrogeology Assessment;
- Hydrology Report;
- Soils, Land Use and Land Capability Assessment;
- Biodiversity Assessment including both Flora and Fauna Assessments;
- Wetland Assessment.
- Social Impact Assessment; and
- Archaeological Assessment.

1.4 Contact details

The applicant for the proposed project is Exxaro Matla Coal. The contact details for the applicant can be seen

Table 1.5: Contact Details - Applicant

ITEM	COMPANY CONTACT DETAILS
Company Name:	Exxaro Matla Coal
Company Representative:	Stephen Badenhorst
Telephone No.:	017 616 2255
Facsimile No.:	017 616 2205
E-mail Address:	Stephen.badenhorst@exxaro.com

ITEM	COMPANY CONTACT DETAILS
Postal Address:	Private Bag X 5006, Kriel, Mpumalanga

Table 1.6: Contact Details – EAP

ITEM	COMPANY CONTACT DETAILS
Company Name:	GCS Water and Environment (Pty) Ltd
Company Representative:	Ms Riana Panaino
Telephone No.:	+27 (0)11 803 5726
Facsimile No.:	+27 (0)11 803 5745
E-mail Address:	rianap@gcs-sa.biz
Postal Address:	PO Box 2597, Rivonia, 2128

1.5 Description of Land

In general, the land use of the study area is considered to be altered, with a significant portion of the area having been changed from its original grassland biome to commercial farmlands.

The lower lying areas associated with the wetlands and wet based soils are for the most part unchanged, albeit that cultivation and utilisation of areas within this zone for livestock grazing and crop production were noted. On balance, the remainder of the site has been developed to either intensive grazing of the natural veld grasses or to commercial crops and cultivated pastures.

Table 1.7 details the properties associated with the current Matla Mining Right. Matla is undergoing an exchange of land areas (as per Appendix G), which would then exclude certain portions from the Current Mining Right and include new portions in to the Section 102 amendment to the Mining Right (Table 1.7). Anglo will cede coal reserves on a portion of the Farm Vlaklaagte 83 IS, in exchange for Exxaro ceding coal reserves on a portion of the Farm Vierfontein 61 IS as depicted in Figure 1.3

Table 1.8 and Figure 1.4 gives the details of the farms on which the proposed stooping will be located.

Table 1.7: Matla Mining Right Properties

Farm name	Farm portion	Farm name	Farm portion
BAKENLAAGTE	84	MOEDVERLOREN	24/88
BAKENLAAGTE	1/84	MOEDVERLOREN	25/88
BAKENLAAGTE	2/84	MOEDVERLOREN	26/88
BAKENLAAGTE	3/84	MOEDVERLOREN	27/88
BAKENLAAGTE	5/84	MOEDVERLOREN	28/88
GROOTPAN	2/86	NASMANUS	132

Farm name	Farm portion	Farm name	Farm portion
GROOTPAN	3/86	NASMANUS	1/132
GROOTPAN	5/86	NOOITGEDACHT	1/94
GROOTPAN	6/86	NOOITGEDACHT	2/94
GROOTPAN	7/86	NOOITGEDACHT	4/94
GROOTPAN	10/86	NOOITGEDACHT	6/94
GROOTPAN	12/86	ONVERWACHT	97
GROOTPAN	13/86	ONVERWACHT	2/66
GROOTPAN	14/86	ONVERWACHT	1/97
GROOTPAN	15/86	ONVERWACHT	2/97
GROOTPAN	19/86	ONVERWACHT	3/97
GROOTPAN	20/86	ONVERWACHT	4/97
GROOTPAN	21/86	ONVERWACHT	5/97
GROOTPAN	23/86	RIETVLEI	2/62
GROOTPAN	24/86	RIETVLEI	3/62
GROOTPAN	25/86	RIETVLEI	4/62
GROOTPAN	26/86	RIETVLEI	6/62
GROOTPAN	29/86	RIETVLEI	7/62
GROOTPAN	30/86	RIETVLEI	8/62
GROOTPAN	31/86	RIETVLEI	9/62
GROOTPAN	32/86	RIETVLEI	11/62
HAASFONTEIN	1/85	RIETVLEI	12/62
HAASFONTEIN	4/85	RIETVLEI	14/62
HAASFONTEIN	5/85	RIETVLEI	15/62
HAASFONTEIN	6/85	SCHAAPKRAAL	2/93
KORTLAAGTE	67	SCHAAPKRAAL	3/93
KORTLAAGTE	1/67	STREHLA	10/261
KORTLAAGTE	2/67	UITVLUGT	1/255
KORTLAAGTE	3/67	UITVLUGT	2/255
KORTLAAGTE	4/67	VAALPAN	68
KORTLAAGTE	5/67	VIERFONTEIN	5/61
KORTLAAGTE	6/67	VIERFONTEIN	10/61
KORTLAAGTE	7/67	VIERFONTEIN	11/61
KORTLAAGTE	8/67	VIERFONTEIN	17/61
KORTLAAGTE	9/67	VIERFONTEIN	18/61
KORTLAAGTE	10/67	VIERFONTEIN	19/61
KRUISEMENTFONTEIN	1/95	VIERFONTEIN	20/61
KRUISEMENTFONTEIN	2/95	VIERFONTEIN	21/61
MATLA POWER STATION	141	VIERFONTEIN	22/61
MOEDVERLOREN	1/88	VIERFONTEIN	23/61
MOEDVERLOREN	2/88	VIERFONTEIN	26/61
MOEDVERLOREN	3/88	VIERFONTEIN	27/61
MOEDVERLOREN	4/88	VIERFONTEIN	28/61
MOEDVERLOREN	5/88	VIERFONTEIN	52/61
MOEDVERLOREN	14/88	VIERFONTEIN	53/61
MOEDVERLOREN	15/88	VLAKPAN	7/89
MOEDVERLOREN	20/88	VLAKPAN	8/89
MOEDVERLOREN	21/88	VLAKPAN	9/89
MOEDVERLOREN	22/88	WELTEVREDEN	10/307
MOEDVERLOREN	23/88	WELTEVREDEN	6/307

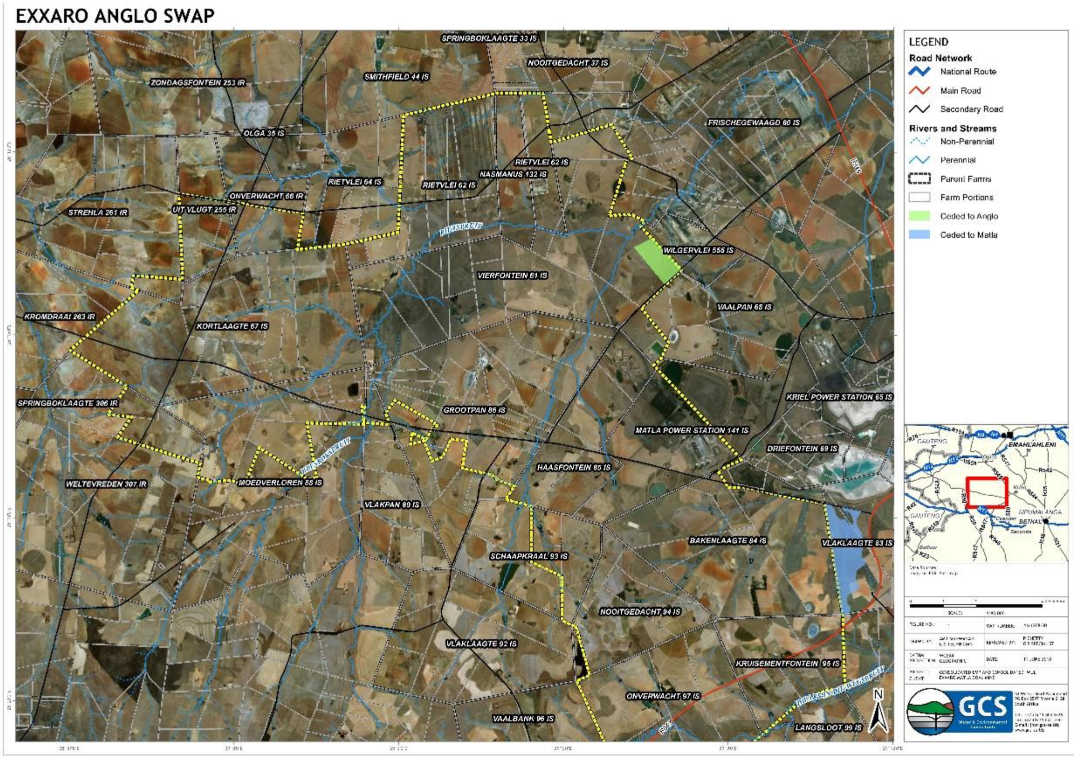

Figure 1.3: Property exchange with Anglo

Table 1.8: Eskom and Exxaro owned properties within the Mining Right area associated with the Phase 1 Stooping activities.

Farm Name	No.	Ptn	Property Owner	Farm Portion SG Codes	Area (Ha)	Title deed no
Block B						
Kortlaagte	67 IS	1	Eskom Holdings SOC LTD	T0IS00000000006700001	46.5876	T1007/2012
Kortlaagte	67 IS	10	Eskom Holdings SOC LTD	T0IS00000000006700010	11.59176	T1007/2012
Block C						
Rietvlei	62 IS	9	Eskom Holdings SOC LTD	T0IS00000000006200009	44.68588	T109068/2007
Rietvlei	62 IS	2	Eskom Holdings SOC LTD	T0IS00000000006200002	70.77356	T109068/2007
Block D						
Rietvlei	62 IS	14	Eskom Holdings SOC LTD	T0IS00000000006200014	293.8029	T54978/1987
Vierfontein	61 IS	27	Eskom Holdings SOC LTD	T0IS00000000006100027	79.92335	T54978/1987
Block F						
KortlaagtE	67 IS	1	Eskom Holdings SOC LTD	T0IS00000000006700001	46.5876	T1007/2012
Block G						
Vierfontein	61 IS	22	Exxaro Coal Mpumalanga PTY LTD	T0IS00000000006100022	19.20741	T1736/2003
Block H						
Vierfontein	61 IS	22	Exxaro Coal Mpumalanga PTY LTD	T0IS00000000006100022	19.20741	T1736/2003
Grootpan	86 IS	24	Eskom Holdings SOC LTD	T0IS00000000008600024	22.84575	T16868/2014
Grootpan	86 IS	23	Eskom Holdings SOC LTD	T0IS00000000008600023	10.17588	T16868/2014

Farm Name	No.	Ptn	Property Owner	Farm Portion SG Codes	Area (Ha)	Title deed no
Grootpan	86 IS	10	Eskom Holdings SOC LTD	T0IS00000000008600010	24.91222	T16868/2014
Grootpan	86 IS	29	Eskom Holdings SOC LTD	T0IS00000000008600029	26.251	T16869/2014
Grootpan	86 IS	30	Eskom Holdings SOC LTD	T0IS00000000008600030	1.25578	T16869/2014
Block I						
Matla power station	141 IS	0	Eskom Holdings SOC LTD	T0IS00000000014100000	2.869387	T18624/1979

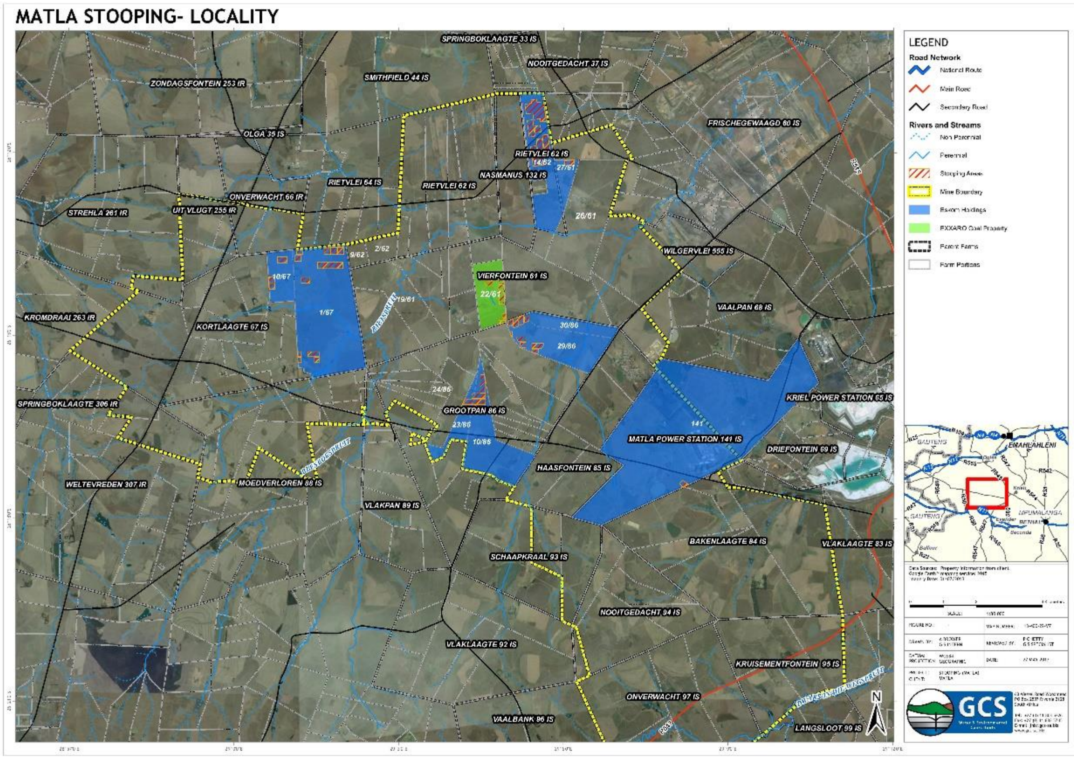

Figure 1.4. Farm Portions associated with stooping

2 LEGISLATIVE BACKGROUND

2.1 Environmental Regulations

For most of its history, the mining industry in South Africa has not been subjected to comprehensive environmental regulation. However, in recent years, this has changed significantly and the industry is now required to comply with a multifaceted network of mining and environmental legislation. There are no shortages of policy and legal frameworks to ensure "responsible" mining in South Africa. The Minerals and Mining Policy for South Africa, 1998 affirmed that the State, as custodian of the nation's natural resources will support mining development while maintaining and enhancing environmental awareness of the mining industry in accordance with national environmental policy, norms and standards.

To this end, 10 principles on sustainable mining were adopted. These include the adoption of the precautionary approach as well as the polluter pays principle; assertion that a consistent standard of environmental impact management would be adopted, irrespective of the scale of mining concerned; encouraging the mining industry to reduce problems of pollution by promoting a culture of waste minimisation through re-cycling, and re-use of waste products; and ensuring the effective implementation of environmental management measures and monitoring of occurrences of pollution, amongst others.

For the purposes of this application, authorization in terms of the National Environmental Management Act, Act No.107 of 1998 (hereinafter referred to as "NEMA"), the Minerals and Petroleum Resources Development Act, Act No. 28 of 2002 (hereinafter referred to as the "MPRDA"), and the National Water Act, Act No. 36 of 1998 (hereinafter referred to as the "NWA") is applied for.

2.1.1 The Constitution

The Constitution reigns supreme and the advancement of human rights is one of the foundations of South Africa's democracy. Furthermore, the Bill of Rights plays a central role in the democratic regime because it embodies a set of fundamental values which should be promoted at all times. One of the fundamental values is contained in Section 24 and is, arguably, the cornerstone for environmental governance in South Africa which includes the mining industry. Section 24(a) proclaims the right of everyone "to an environment that is not harmful to their health or well-being".

Mining companies are thus duty-bound to constitutional, legislative, and other measures to prevent pollution and ecological degradation, promote conservation and to develop in a sustainable manner.

Two particular judgments deserve consideration in that they contain a comprehensive analysis of the nature and content of the environmental right within the sustainability context. Firstly, the court in BP Southern Africa (Pty) Ltd v MEC for Agriculture, Conservation and Land Affairs 2004 5 SA 124 (WLD) confirmed that environmental interests should be balanced with justifiable economic and social development well beyond the interests of the present living generation.

The court justified the latter with Section 24(b), since this Section requires the environment to be protected for the benefit of present and future generations. The court confirmed the importance of sustainable development and predicted that it will "…play a major role in determining important environmental disputes in the future".

Within this context, the mining industry (and the accompanied social and economic development it should bring with it) is constitutionally bound to uphold the environmental right. The court in Fuel Retailers Association of Southern Africa v Director General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province 2007 6 SA 4 (CC) attempted to balance these social, environmental and economic concerns by recognising the importance of economic and social development for the well-being of human beings. However, the court emphasised that development and the environment are inexorably linked and development cannot exist upon a weakening environmental base. Consequently, the promotion of development requires the protection of the environment.

The constitutional environmental right elevates the importance of environmental protection and conservation, and emphasises the significance that South Africans attach to a sound and healthy environment. In addition, the environmental right applies horizontally and this implies that the mining industry has to exercise a duty of care if liability, on the basis of the constitutional environmental right, is to be avoided. The constitutional environmental right is given effect to by means of detailed statutory provisions ranging from framework to sectoral legislation which relate to mining.

2.1.2 Environmental principles

Section 2(1) (c) of NEMA provides that:

"The principles set out in this section apply throughout the Republic to the actions of all organs of state that may significantly affect the environment and… serve as guidelines by reference to which any organ of state must exercise any function when taking any decision in terms of this Act or any statutory provision concerning the protection of the environment…"

Any decision taken in respect of the proposed application for environmental authorization should take into account the principles as set out in Section 2 of NEMA.

GCS acknowledge that these principles serve as guiding principles because they are binding, enforceable and justiciable. By adhering to these principles, GCS promotes a cautious approach when advising on the activities, processes and daily operations of the Matla mining operation and advocates compliance with environmental regulatory measures.

The principles contained in Section 2 of NEMA are the corner stone of environmental governance and liability in South Africa and is based on the foundation of sustainable development. These principles all apply directly to mines by virtue of Section 37(1) of the MPRDA which provides that regard must be had to the NEMA principles by stipulating that the principles set out in Section 2 of NEMA:

"a) apply to all prospecting and mining operations, as the case may be, and any matter or activity relating to such operation; and
b) serve as a guideline for the interpretation, administration and implementation of the environmental requirements of this Act."

Section 37(2) of the MPRDA further provides that:
"Any prospecting or mining operation must be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors into the planning and implementation of prospecting and mining projects in order to ensure that exploitation of mineral resources serves present and future generations."
(Own emphasis)
By virtue of Section 37(1) of the MPRDA, these principles apply to the mining sector and therefore the mining industry must adopt a risk-averse and cautious approach; prevent negative impacts or effects of their activities on the health and well-being of people and the environment; and pay for all their pollution since they remain liable for the effects of their policies, projects, programmes, products, processes, services or activities throughout their life cycles.

When a competent authority takes a decision in terms of NEMA or any other law concerned with environmental protection, the principles must serve as guidelines. More specifically, the principles should guide the interpretation and implementation of the liability regime of NEMA and any other law concerned with environmental protection including mining related legislation. The following principles are particularly important and are discussed herewith.

2.1.2.1 Polluter pays principle

The polluter pays principle (PPP) is reflected in the provision that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.

In essence, the PPP means that “polluters and users of natural resources (should) bear the full environmental and social costs of their activities”. The PPP can also be described as an economic principle that requires the polluter (the mining industry in this instance) to be held liable to compensate or pay for pollution prevention, minimisation and remediation.

Therefore, the crux of the principle is to impose economic obligations when environmental damage is caused by a polluter and this is achieved by setting minimum rules on liability for environmental damage.

2.1.2.2 Precautionary principle

The precautionary principle provides guidance during development or when anything occurs which might harm the environment and where there is scientific uncertainty.
NEMA stipulates and requires “a risk averse and cautious approach” to be applied and that decision-makers should take “into account the limits of current knowledge about the consequences of decisions and actions”. This approach is also acknowledged in the White Paper on a Minerals and Mining Policy for South Africa in that:

“…during decision-making a risk averse and cautious approach that recognises the limits of current environmental management expertise will be adopted and where there is uncertainty, action is required to limit the risk.”

The precautionary principle requires the mining industry to take adequate precautionary measures to safeguard against contamination, pollution or degradation of the environment and where there is uncertainty, the action taken should be to limit the risk to the environment.

2.1.2.3 Preventive principle

The preventive principle is reflected in the concept that the disturbance of ecosystems and loss of biological diversity are to be "…avoided, or…minimised and remedied."

Furthermore, the principle prescribes that the disturbance of the landscape and the nation's cultural heritage is to be avoided, and where it cannot be altogether avoided, must be minimised and remedied. Any negative impacts on the environment and on people's environmental rights should also be anticipated and prevented, and where they cannot be altogether prevented they should minimised and remedied.

The principle aims to minimise environmental damage by requiring that action be taken at an early stage of the process, and if possible, before such damage actually occurs. Broadly stated, it prohibits any activity which causes or may cause damage to the environment in violation of the duty of care established under environmental law. The preventive principle bestows on the mining industry an obligation to take steps to avoid causing certain types of damage to the environment, including the environment beyond their own territory or property.

2.1.2.4 Cradle-to-grave

A cradle-to-grave stewardship perspective indicates the adoption of a comprehensive ecological view of the impacts of a process on the environment, commencing with research, development and design through the extraction and use of raw materials, production and processing, storage, distribution and use, to the final disposal of the product and the waste generated as a by-product.

The integrated consideration of all the environmental impacts forms part of this cycle. The "cradle-to-grave" principle advocates liability as a result of, or caused by, policies, programmes, projects, products, processes, services and activities.

Given the general purpose of NEMA, together with the other sustainability principles, this legal liability may include to rectify, remedy or compensate for environmental damage or degradation. The principle also recognises that environmental impacts, pollution or degradation may be associated with the entire life cycle of a mine, that is, from the identification, exploration phase through project planning, implementation, operations and post-operational closure, decommissioning and rehabilitation. Thus, the mining industry will remain liable for the damage or degradation caused by its activities throughout the life cycle of the mining operations until decommissioning and rehabilitation.

2.1.3 The National Environmental Management Act

As stated above, NEMA provides for a comprehensive array of principles which cumulatively aim to create among others, corporate socially responsible behaviour by establishing legal liability for environmental damage as well as damage to human health and well-being.

Apart from these principles, NEMA also contains mechanisms, procedures and structures to facilitate pollution prevention, minimisation and remediation.

Chapter 7 of NEMA contains essential provisions dealing with liability for environmental damage in South Africa and two key elements form part thereof; namely: pollution prevention and remediation.

A duty of care is contained in Section 28, which encompasses the main liability provision which applies retrospectively and therefore also to historical pollution. Section 28(1) applies to all forms of pollution, including mining pollution, and is formulated generally by providing a duty of care to avoid, minimise and/or remedy pollution or environmental degradation.

In terms of this subsection, the duty imposes liability on an almost non-exhaustive category of persons, because it refers to "every person".

Section 28(2) goes even further and imposes the duty on a range of people including owners or people in control of land or premises and people who have the right to use the land or premises on which, or in which, an activity or process is, or was, performed or undertaken, or any other situation exists which causes, or is likely to cause, significant pollution or degradation to the environment.

The duty of care imposes strict liability since Section 28(1) requires reasonable persons to take reasonable measures. Subsection (3) provides an indicative range of measures that can be considered as “reasonable measures” and these may include measures to investigate, assess and evaluate the impact on the environment; inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation, contain or prevent the movement of pollutants or the causing of degradation, eliminate any source of the pollution or degradation and to remedy the effects of the pollution or degradation.

One can identify from the wording an obligation to prevent and minimise pollution or degradation and this indicates that remediation is clearly part of South African law. Where a mine fails to take reasonable measures to prevent or minimise pollution, it can be directed to do so by the relevant authority and if it does not comply with the directive, measures will be taken by government on its behalf, but at the mine's expense.

Under Section 34(7), liability is specifically extended to the director of the mining company concerned in his or her personal capacity, in other words, the director is personally liable.

Furthermore, Section 43 provides that if directors failed to take all reasonable steps to prevent the offence being committed, and monetary advantage was gained, they may be personally liable for damages or compensation, have to pay a fine, or have to comply with remedial measures determined by the Court, and may even have to pay the State's investigative costs. The latter was confirmed in Minister of Water Affairs and Forestry v Stilfontein Gold Mining Co Ltd and Others 2006 5 SA 333 (W) where the court held, in a telling statement that:

"To permit mining companies and their directors to flout environmental obligations is contrary to the Constitution, the Mineral Petroleum Development Act and to the National Environmental Management Act. Unless courts are prepared to assist the State by providing suitable mechanisms for the enforcement of statutory obligations an impression will be created that mining companies [and their directors] are free to exploit the mineral resources of the country for profit over the lifetime of the mine, thereafter they may simply walk away from their environmental obligations. This simply cannot be permitted in a constitutional democracy which recognises the right of all of its citizens to be protected from the effects of pollution and degradation."

2.1.4 The Mineral and Petroleum Resources Development Act

Section 43(1) of the MPRDA and Section 24R of NEMA provides key insight into how the MPRDA approaches liability. In terms of this section, mining companies remain liable for, inter alia, any pollution and ecological degradation until the Minister has issued a closure certificate.

Granting of permission to mine or prospect, among others, is conditional on an environmental management programme and plan being submitted and accepted by the relevant government authority. Section 43 is one of the most important provisions as it deals with the responsibility for any environmental liability, pollution or ecological degradation until the issue of the closure certificate. It is important to note that environmental liability will not necessarily cease or fall away by the issuing of a closure certificate. In addition to the broader liability provisions above, Section 45 provides that the relevant authority may direct a mine to undertake remedial measures where:

"...any prospecting, mining, reconnaissance or production operations cause or results in ecological degradation, pollution or environmental damage which may be harmful to the health or well-being of anyone and requires urgent remedial measures."

Where the mine fails to take these measures, the relevant authority will act on its behalf and then recover costs incurred from the mine. If the mine fails to compensate the authority, the latter is empowered to seize and sell the mine's property to recover the costs. The mine will thus remain financially liable for the rehabilitation, even if it chooses to ignore the government directive.

2.1.5 The National Water Act

One of the main and ever-continuing concerns in South Africa is the sustainability of water management, and the costs associated with the prevention and remediation of pollution in a country with an average rainfall far below international standards.

The NWA is one of the government's answers to some of these challenges and functions as sectoral legislation within the framework of NEMA.

Section 19 of the NWA mirrors the provision of Section 28 of NEMA and addresses the prevention and remediation of the effects of pollution. The NWA provides a wide duty of care in that:
"(1) an owner of land, a person in control of land or a person who occupies or uses the land on which-
(a) any activity or process is or was performed or undertaken; or
(b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring."

The words "likely to cause pollution" broadens the scope of the duty, which enables an activity, or situation that is land-based, to trigger the application of the duty. The "reasonable measures" are not prescribed, but may include measures intended to:

"cease, modify or control any act or process causing the pollution; comply with any prescribed waste standard or management practice; contain or prevent the movement of pollutants; eliminate any source of pollution; remedy the effects of pollution; and remedy the effects of any disturbance to the bed and banks of a watercourse."

The NWA, furthermore, provides for water use authorisations which a mine will have to apply for, before commencing with its primary activity of mining. Various conditions may be attached to these licenses and a breach thereof will result in criminal and civil liability. The conditions attached to water use authorisations will function alongside the additional protective measures, duty of care and statutory liability provisions provided by the NWA and other legislation to regulate a whole array of water issues.

The detrimental impact of mining on water resources is further regulated by the NWA in a comprehensive set of regulations titled: “Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources”. In terms of these regulations:

“No person in control of a mine or [mining] activity may place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation.”

Regulation 7 provides for a whole array of provisions which specifically aim to protect water resources from mining.

These provisions state that every person in control of a mine or mining activity must take all reasonable measures to, inter alia: prevent water containing waste or any substance which causes or is likely to cause pollution from entering any water resource; design, modify, locate, construct and maintain all water systems including residue deposits, to prevent the pollution of any water resource through the operation or use thereof; cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings, opencast workings, other workings or subterranean caverns; prevent the erosion or leaching of materials from any residue deposit or stockpile from any area; and ensure that water used in any process at a mine or activity is recycled as far as practicable.

These provisions specifically relate to the protection of water resources and they clearly set out further additional liabilities for mines as far as their water resource protection activities are concerned.

2.2 Environmental process

The environmental processes involved with the project will be undertaken in three (3) parallel processes namely the NEMA process for all the associated listed activities and the MPRDA process to develop a consolidated EIA/EMP for the DMR, and the NWA process regarding the consolidation of existing IWULs and water uses that will be associated with the proposed stooping project. The NEMA and MPRDA processes will be an integrated process and only one EMP will be compiled and submitted to the DMR.

The following documents will be compiled and submitted to the indicated competent authorities:

- Section 102 EMP in terms of the MPRDA to include all new activities into the consolidated EMP (including the Financial Provision) as well as the Listed activities in terms of NEMA;
    - In terms of the One Environment System (As of 08 December 2014) all Mining related activities are approved as part of the MPRDA process. The Minister of Mineral Resources will, as of 08 December 2014, issue environmental authorisations in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), for mining and related activities. The Minister of Environmental Affairs will be the appeal authority for these authorisations.
- Consolidated IWULA and Integrated Waste and Water Management Plan (IWWMP) under NWA: Department of Water and Sanitation (DWS).

The various environmental authorisation processes being followed for this project are described in the sections which follow hereunder.

2.2.1 The ONE-Environmental System

On the 8th of December 2014 the various departments that regulate mining activates introduced a system that would improve competitiveness of the South African mining sector. This system was ultimately created to represent government's commitment to improve and enhance the way of doing business in the mining sector.

Furthermore this system will streamline the South African licencing process for mining, environmental authorisations and water use. The competent authority will now be the DMR, while the DEA will remain the appeal authority.

2.2.2 The process in terms of MPRDA

Mines and mining related activities are regulated by the MPRDA, therefore in terms of Section 102 of the MPRDA, Exxaro requires authorisation for the proposed activities and the consolidation of the EMPs in the form of an amendment application, which must be approved by the DMR in Mpumalanga.

The MPRDA process will address the project as a whole including all activities regarding the Expansion area.

The application to amend the EMP requires the compilation and submission of a consolidated EMP. This report is compiled in compliance with Regulation 51 of GN R527, dated 23 April 2004 (published in terms of Section 107(1) of the MPRDA) (hereinafter referred to as the "MPRDA Regulations") as well as the Guidelines, and takes into consideration all aspects included in these documents.

The EIA/EMP will contain the following:

- An assessment of the environment likely to be affected by the proposed operations;
- An assessment of the nature, extent, duration, probability and significance of the identified potential environmental, social and cultural impacts of the proposed operation, including cumulative impacts;
- A comparative assessment of the potential operation, as well as a comparison of other potential land uses for those sites;
- Identification of appropriate mitigatory measures for each significant potential impact of the proposed operation;
- Description of the stakeholder engagement process undertaken during the course of the assessment, issues that were raised and questions asked by I&APs and authorities, and how these issues and questions were addressed;
- Identification of gaps in knowledge, report on the adequacy of predictive methods, underlying assumptions and uncertainties encountered in compiling the required information;
- Description of the arrangements for monitoring and management of environmental impacts;
- A description of the environmental objectives and specific goals for the management of the identified environmental and socio-economic impacts during all phases of the development(construction, operation, decommissioning and post-closure);
- A description of the appropriate technical and management options chosen for each environmental, socio-economic, cultural and historical impact for all project phases;
- Action plans to achieve the specific goals set out, as well as timeframes for the implementation of mitigatory measures;
- Procedures for environmental related emergencies and remediation;
- Planned monitoring and environmental management programme performance assessment;
- An environmental awareness plan; and

- An undertaking by the applicant to comply with the provisions of the MPRDA and regulations thereto.

2.2.3 The process in terms of NEMA

Section 24(1) of NEMA requires that the potential consequences of or impacts on the environment of listed activities must be considered, investigated, assessed and reported on to the competent authority. Where environmental impact assessment has been identified as the instrument to be utilised in achieving the aforementioned, an application for environmental authorisation needs to be obtained. The identified activities are listed under GNR R982, R983, R984 and R985 of the NEMA Regulations of 04 December 2014.

The listed activities (Table 1.1 and Table 1.2) which are triggered by the proposed mining operation are contained in Listing Notice 1 and 2 (GN R983, GN 984). Activities contained in Listing Notice 1 require a Basic Assessment (BA) process to be followed and activities in Listings 2 require a Scoping and EIA process be followed.

The DMR is regarded as the competent authority for all mining related activities and as such an amendment to the approved EMP will be developed for the proposed expansion and submitted to DMR (Emalahleni) for assessment and authorisation as per discussions with DMR on 20 December 2016.

2.2.4 The process in terms of NWA

In addition to the MPRDA authorisation, activities which have the potential to impact on a water resource require a water use licence (WUL) issued by the Department of Water and Sanitation (DWS), under the NWA. Section 21 of the NWA identifies certain water uses which have to be authorised. A consolidated Water Use Licence Application (WULA) and an accompanying Integrated Waste Water Management Plan (IWWMP) must be submitted to the DWS and will include the following new activities for stooping, dust suppression and stockpiles:

- Section 21(c): Impeding or diverting the flow of water in a watercourse; and
- Section 21 (i): Removing, discharging or disposing of water found underground.
- Section 21 (g): disposing of waste in a manner which may detrimentally impact on a water resource.

The IWWMP is used as a management tool by Exxaro to manage water emanating from their operations, using best practices in the interest of protecting the water resources which may be affected.

A WUL may be issued for a maximum period of 40 years with a specified review period. The WUL also prescribes a set of conditions to protect water resources, and gauge the impact of the water use. These have to be strictly adhered to for as long as the water use continues. This may extend beyond the life of the mining operation, as Matla will be responsible for impacts caused by the mining operations after decommissioning and closure.

Furthermore, Section 27 of the NWA specifies that the following factors, regarding water use authorization, must be taken into consideration:

- The efficient and beneficial use of water in the public interest;
- The socio-economic impact of the decision whether or not to issue a license;
- Alignment with the catchment management strategy;
- The impact of the water use and possible resource directed measures; and
- Investments made by the applicant in respect of the water use in question.

Section 27 considerations will be included in the WULA and IWWMP. This will assist Matla in ensuring that the water uses applied for, are undertaken in a manner that does not negatively impact on the public, water resources, or downstream water users or compromise any of the country's international obligations with regards to shared water resources.

2.3 Environmental Assessment Practitioner

In terms of Section 17 of the NEMA, the applicant has to appoint Environmental Assessment Practitioners (EAPs) before applying for an environmental authorisation of any activity listed in terms of GNR 983, 984 and 985.

For this purpose Exxaro has appointed GCS Water and Environment (Pty) Ltd t/a GCS (Pty) Ltd (GCS) to undertake the necessary environmental assessments and to ensure that all legislative requirements are adhered to as part of the environmental authorisation processes.

GCS provides a professional, independent consulting service in the fields of water, environmental, engineering and earth sciences. The GCS team consists of highly trained staff that has extensive experience in the fields of hydrogeology, hydrology, earth sciences, engineering geology, engineering and environmental sciences.

GCS have considerable experience in Southern Africa and undertake investigations for environmental assessments. The environmental scientists carry out all aspects of environmental assessments and management programmes.

GCS was founded in 1987 and the broad GCS client base ranges from individuals, engineers, municipalities and mines, to Independent States and Governments. GCS is an independent practice, which is wholly owned by the partners of the company.

GCS is an independent environmental consulting firm and has undertaken the Environmental Impact Assessment (EIA)/Environmental Management Programme (EMP) Report development. GCS is also responsible for the Public Participation Process (PPP) pertaining to the proposed operation. The EAP is independent and has no vested interest in the outcome of the environmental authorization applications. Refer to Table 2.1 for the EAPs involved.

Table 2.1: EAP

EAP	Qualification	Position	Experience
Renee Janse van Rensburg	MA: Environmental Management	Environmental Project Manager	>10 years
Riana Panaino	BSc Hons: Biodiversity and Conservation	Environmental Consultant	10 years

3 PROJECT DESCRIPTION

3.1 Background to the Existing Authorisations

3.1.1 1994 Mining Licence

A old order mining licence was awarded to Matla Coal Limited, for the mining of Coal.

3.1.2 Original EMP – 1997

The original EMP was compiled for underground Bord and Pillar, Long- and Shortwall mining of approximately 9,45 million tonnes R.O.M. per annum. At the time of the compilation of this EMP Matla has already been in operation for over twenty (20) years.

The Mine consists of a crushing and screening plant, workshops offices and shaft complexes. Processing is limited to the crushing and screening of the run of mine coal to produce a sized product. Oversized coal material removed from the run of mine product is stockpiled, crushed and sent to the strategic stockpile area. Matla has recently included an air jig plant as an addition to their beneficiation process in order to conserve water on site. This does not change the process, it simply makes the plant more water efficient.

The waste material, consisting of sandstone and carbonaceous shale, were dumped in heaps on the dump. An additional berm wall had been constructed +300m from the dump on the western side in order to divert all polluted run-off resulting from the dump into two big pollution control dams. These dams were designed by civil engineers and they have clay linings up to the sandstone layer.

At No 1 Mine, all raw sewage is pumped directly to Matla Power Station for treatment. At No's 2 and 3 Mines all the domestic waste water is piped to the individual sewage plants consisting of, activated sludge type with an aeration ditch, clarifier and drying beds with chemical dosage of chlorine chips and feri-chloride. Water from the workshops flow via oil separators into the settling pond. Treated sewerage is then pumped to the Spruit

The solid domestic waste was dumped on the rock dump. This was however not the long term management plan for the Mine's domestic waste. A contractor has been appointed and all domestic waste is sent to Middelburg domestic waste site and hazardous waste is sent to Holfontein landfill.

At Mine 1 polluted surface run-off water is channeled into settling dams via oil separators. The overflow of these dams flow into an evaporation dam. Negligible underground water is pumped to surface. At Mine 2 excess underground water is pumped into a large evaporation dam. Emergency facilities exists by means of a farmers pan. Cut-off drains around the shaft complex divert the clean run-off water directly into the spruit. Excess underground water is pumped into proposed settling ponds at Mine 3.

3.1.3 EMP Amendment – 2006

Matla Coal applied for authorisation to extract coal from the No. 5 seam horizon at E'Tingweni Mine, using conventional board and pillar mining (drill and blast). This coal was produced for use in both the local and export markets. Construction of the box cut at E'Tingweni Mine for auger mining was initiated during August 2000. The box cut was completed and experimental auger mining was undertaken in the area. The pre-feasibility phase had shown positive results and resulted in the need for Matla Coal to amend its EMPR in order to start mining the No. 5 seam.

Construction of an access shaft, a crushing and screening plant, stockpiles and 2 new settling dams were planned at E'Tingweni Mine. Recycling of mine water at Mine 2 was proposed, as was the construction of a river diversion at Mine 3.

Matla Coal further applied to extend the total extraction currently being undertaken at Mine 3, towards the north central area, which necessitated a river diversion. A rock dump was constructed at Mine 1 in order to cater for the additional waste rock produced at both Mine 2 and Mine 3. The mining method of total extraction was extended to allow the mining of a new block in the north-west corner of the No. 2 seam.

Matla Mine 1 is an underground bord and pillar mine, which mines the 4 seam. Matla Mine 2 utilises both bord and pillar and total extraction coal mining methods to mine the 2 seam. Total extraction of a wall in the north-east area was underway, but bord and pillar mining is utilised in that area if required. A wall in the north-west area is also mined using a combination of both methods. Matla Mine 3 previously utilised bord and pillar method coal mining to mine the 4 seam.

3.1.4 EMP for Mine 1 New Shaft – 2009

Matla Coal applied for authorisation for a new shaft for Mine 1 to access the coal reserves that are located within the approved mining right area. A proposed new overland conveyor system would deliver the coal to the infrastructure at the Matla Coal Plant.

Infrastructure associated with the project included the following:

- An incline shaft to provide employees access to the underground workings and to convey coal to the surface
- A vertical ventilation shaft
- Office complex with change house and parking
- A helicopter landing pad
- Workshops and consumable store
- Sewage treatment plant
- Wash bay
- Storm water management structures
- Pollution control structures
- Potable water pipeline from Matla Power Station
- Potable water reservoir and pump house
- Electricity supply from the Matla Power Station
- Electrical substation
- Access roads
- Three additional vertical ventilation shafts that will be developed approximately 3 km south-west of the Matla 1 new access shaft site
- Coal silos
- Crusher and screening plant
- Overland conveyor

This Environmental Management Programme (EMP) amendment was undertaken to meet the requirements of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (hereafter referred to as the MPRDA), which replaced the Minerals Act. The Environmental Impact Assessment (EIA) process for mining as laid out in the MPRDA was followed during the compilation of the 2009 EMP Amendment.

3.1.5 EMP for the Water Treatment Plant (WTP) – 2012

During 2011 – 2012 Mala coal applied for authorisation for the construction of a Water Treatment Plant (WTP). Initially a site selection study was conducted with regards to the most preferred option for location of the water treatment plant and brine ponds in terms of engineering and cost effectiveness by Digby Wells and Associates in December 2010. The assessment was conducted for seven (7) proposed sites. Site 7 was selected as the most ideal option for the location of the water treatment plant and non-discharge brine disposal ponds followed by two alternative sites, namely Sites 1 and 2. The three (3) sites that ranked favourable for the establishment of the proposed development were investigated by specialists at a desktop level.

During a meeting held at the Exxaro head office on 27 July 2011, the Exxaro project team stated that underground flood events occurred at Matla Colliery. During this meeting it was decided by the project team to go ahead with the establishment of the water treatment plant on Site 7. The urgency of establishment of the WTP was highlighted by the Exxaro team, due to the potential risks to Health and Safety aspects of the employees of the colliery, should another flood event occur. For this reason, the outcomes of the Site Selection Study for the three preferred options were not taken into consideration as part of the decision making process in selecting Site 7.

The initial Environmental authorisations were approved in June 2012, where after an amendment to the initial EMP was submitted and approved in October 2013.

3.2 Application for the inclusion of Stooping

This Section describes the proposed mining method, and associated activities for the proposed extension of mining.

Matla proposes to stoop (or totally extract) pillars at the previously underground mined areas with the intent to reclaim the remaining coal reserves by using the conventional board and pillar mining method (drill and blast).

The reclamation of the remaining coal reserves will utilise the existing current operations' infrastructure.

3.2.1 Mining process

Stooping of pillars or retreat mining is a term used to reference the final phase of an underground mining technique known as room and pillar mining. This involves excavating a room or chamber while leaving behind pillars of material for support. This excavation is carried out in a pattern advancing away from the entrance of a mine. Once a deposit has been exhausted using this method, the pillars that were left behind initially are removed, or 'pulled', retreating back towards the mine's entrance. After the pillars are removed, the roof (or back) is allowed to collapse behind the mining area (Figure 3.1).

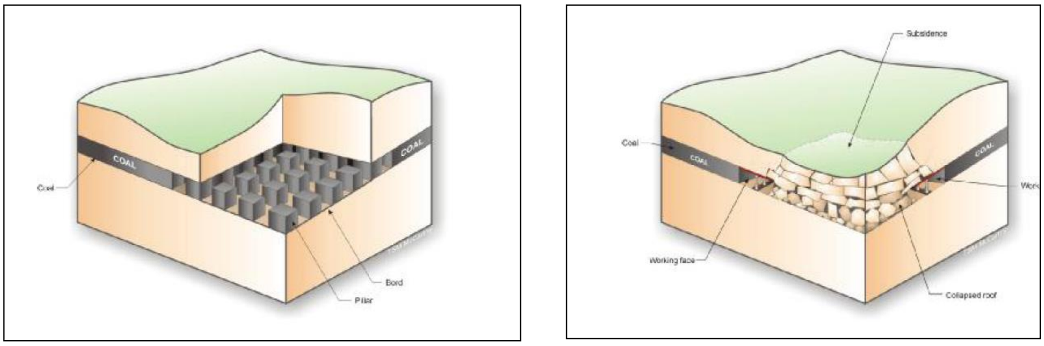

Figure 3.1 Stooping illustrated

Pillar removal must occur in a very precise order in order to reduce the risks to workers, due to the high stresses placed on the remaining pillars by the abutment stresses of the caving ground.

3.3 Water flow for Matla

3.3.1 Process Flow Diagrams

To setup an average water balance model, a PFD was created for each mine and scenario (current and 10-year future) to create insight into all water-linked flows within the Matla Coal Mine operations. All PFDs have been confirmed by Exxaro. The PFDs for the current mine water balances are shown in Figure 3.2 to Figure 3.4 and for the future mine water balance scenarios.

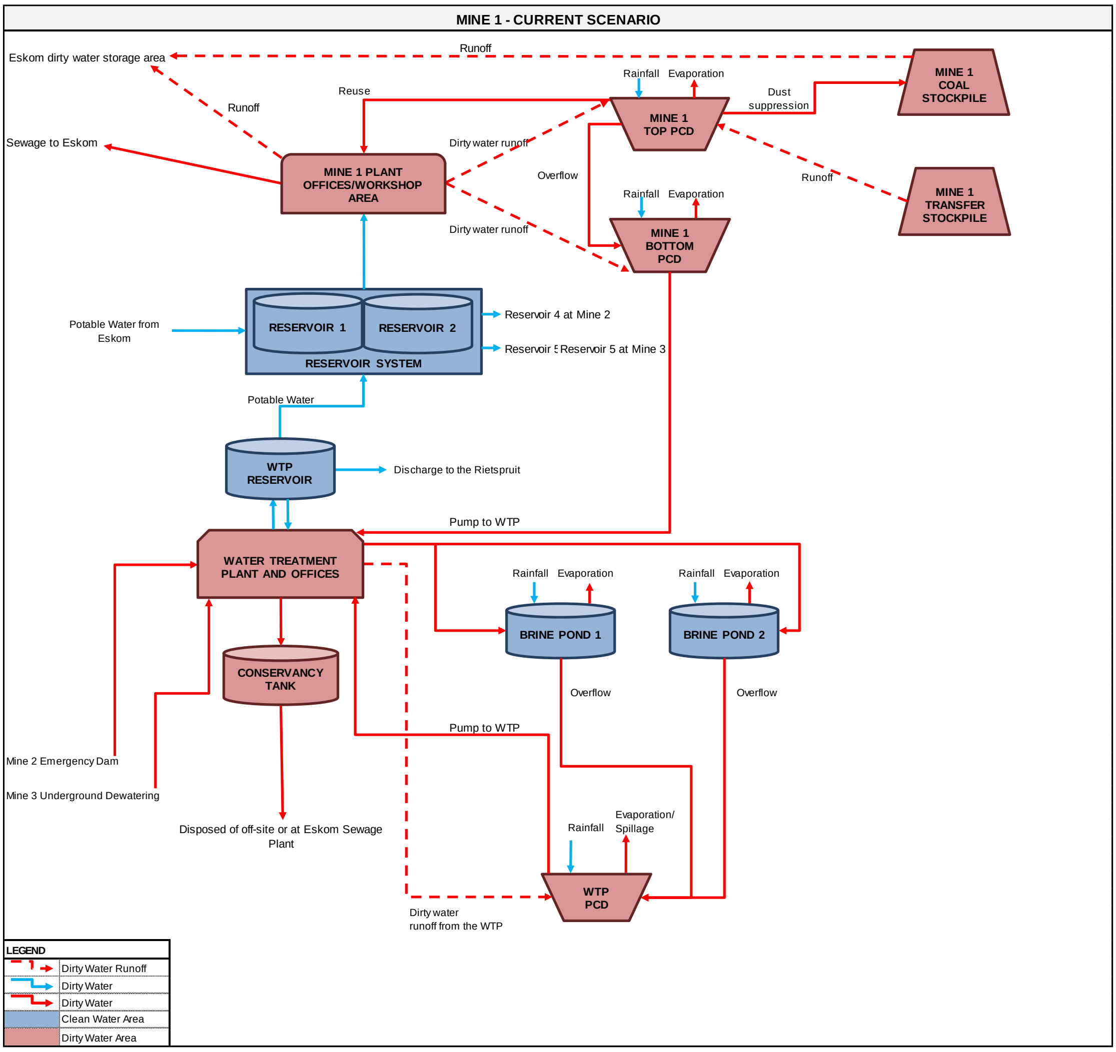

Figure 3.2: PFD for the current Mine 1 water balance

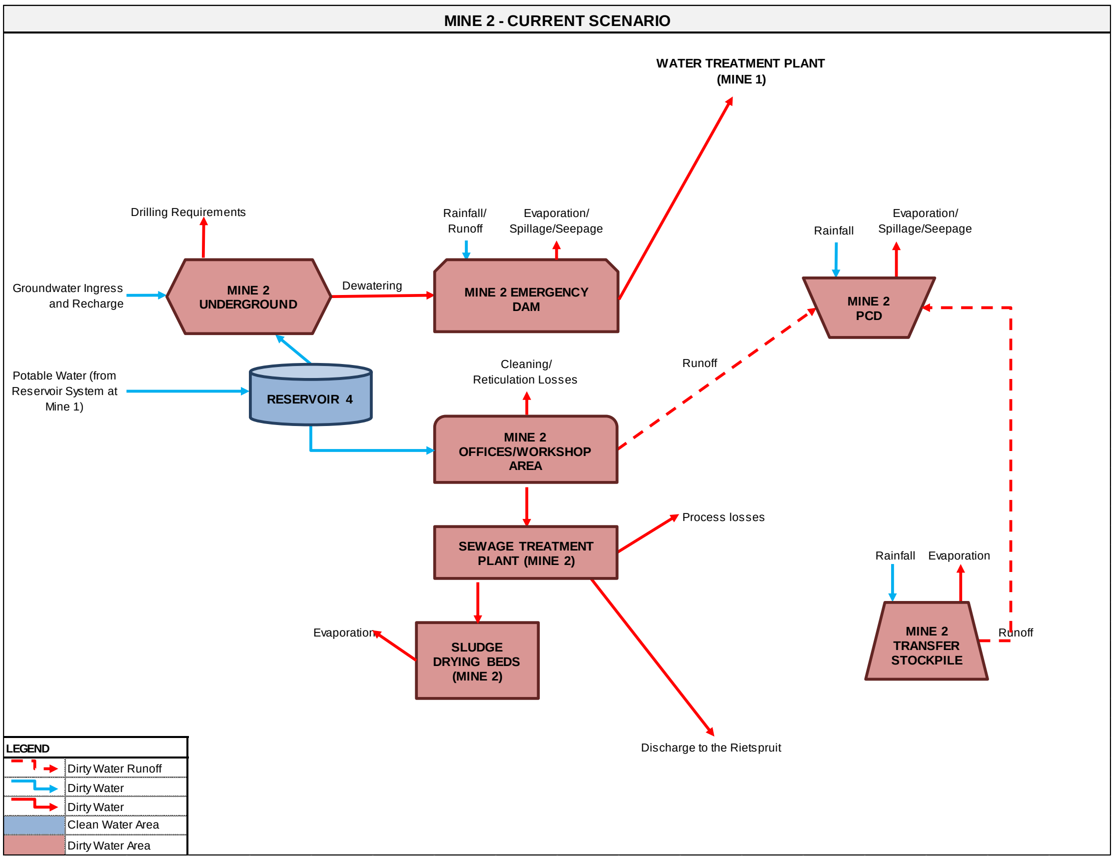

Figure 3.3: PFD for the current Mine 2 water balance

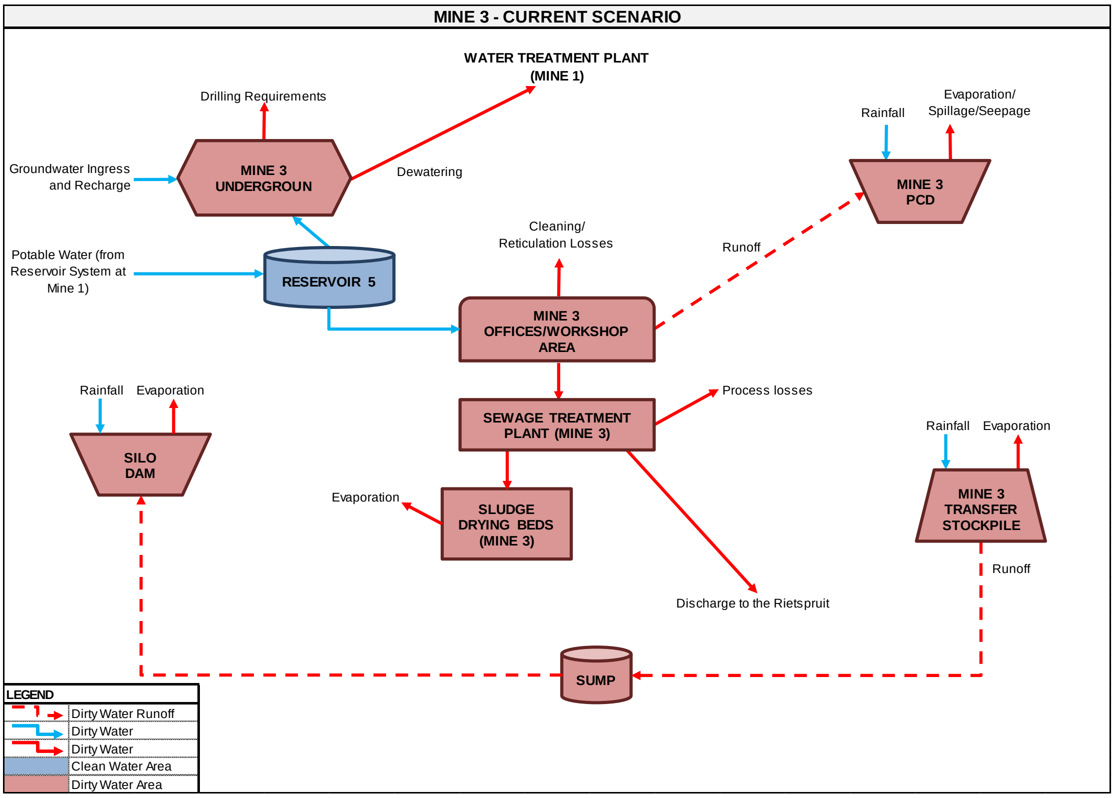

Figure 3.4: PFD for the current Mine 3 water balance

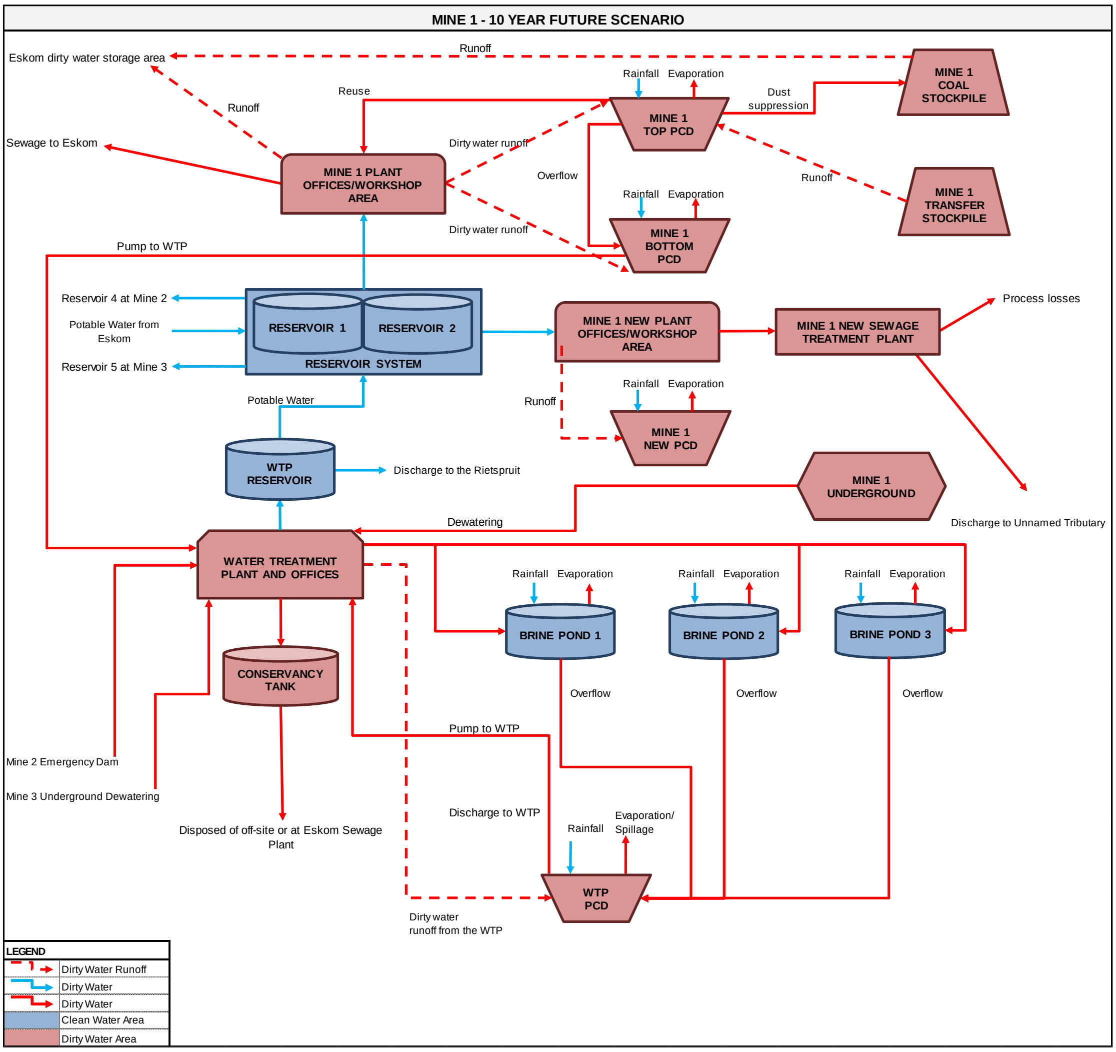

Figure 3.5: PFD for the future Mine 1 water balance

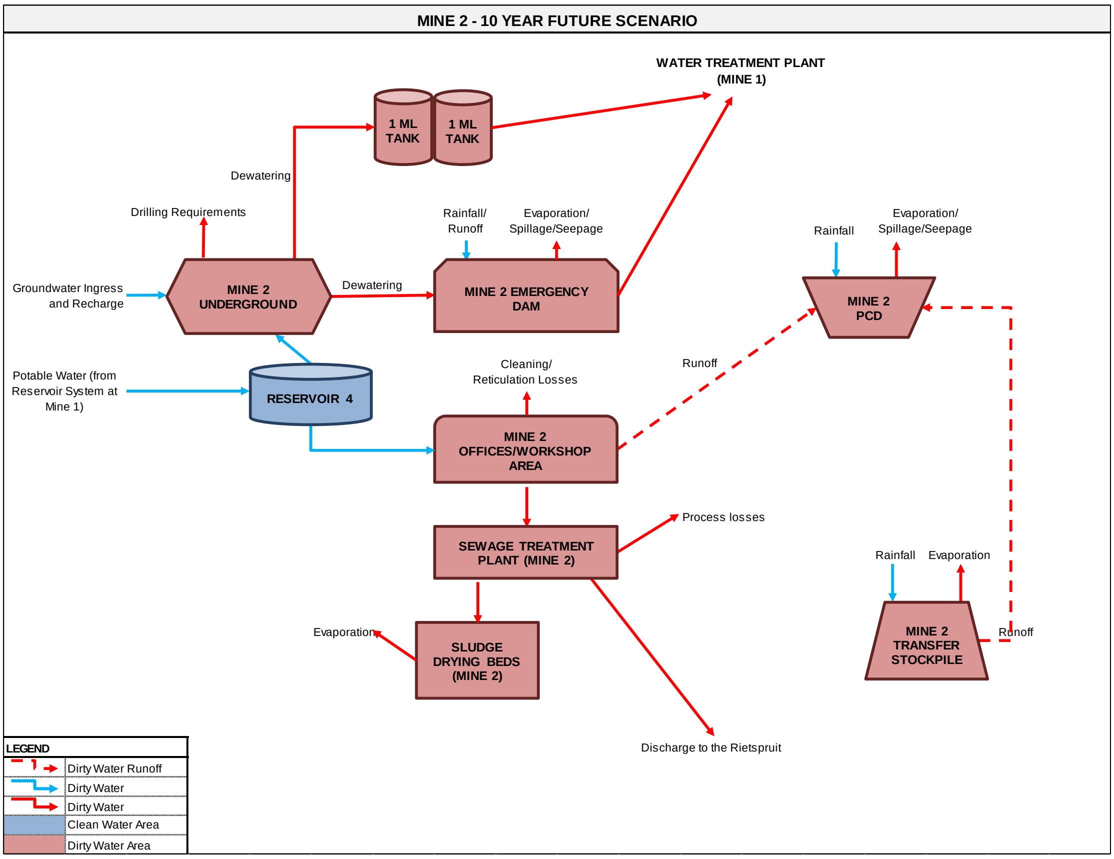

Figure 3.6: PFD for the future Mine 2 water balance

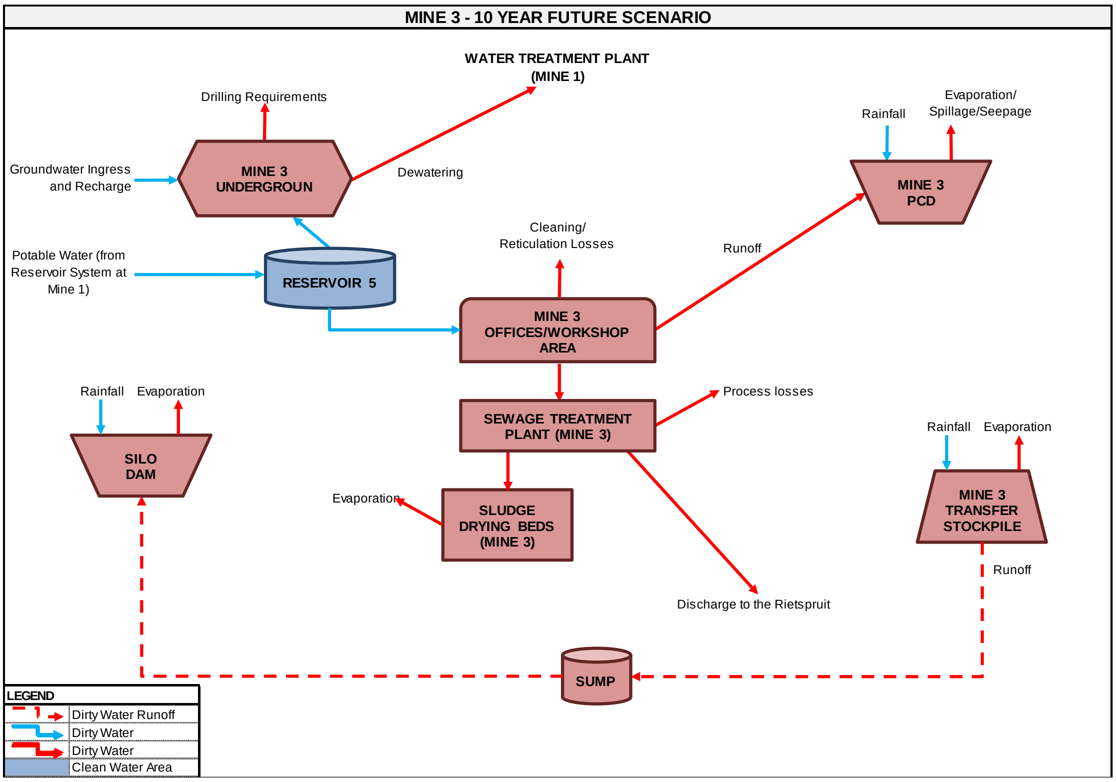

Figure 3.7: PFD for the future Mine 3 water balance

3.3.2 Current Water Balance

The current mine water balance for the Matla Coal Mine is presented in Table 3.1 to Table 3.3. The following summarises key results of the current water balance:

- Approximately 2 369 721 m^3/year (6 492 m^3/d) is required to send to the Water Treatment Plant (WTP). Treated discharges from the WTP into the Rietspruit were calculated at 1 149 965 m^3/year (3 150 m^3/day) and 1 214 756 m^3/year (3 328 m^3/day) is pumped for potable use on the Matla Coal Mine.
- A total of 2 555 000 m^3/year (7 000 m^3/day) is dewatered from the underground workings at Mine 2 and Mine 3;
- A total of 26 106 m^3/year (71.5 m^3/day) can be reused for dust suppression on the Mine 1 Coal Stockpile from the Top PCD. If more dust suppression is required, the pumping to the WTP from the Bottom PCD can be reduced;
- Approximately 50 000 m^3/year (137 m^3/day) from Mine 2 Sewage Treatment Plant and 35 000 m^3/year (96 m^3/day) from Mine 3 Sewage Treatment Plant are potentially discharged into the Rietspruit.

Table 3.1: Average annual water balance for Mine 1 (current)

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	Quantity (m3/a)	Water Circuit/stream	Quantity (m3/a)	
Water Treatment Plant (10ML)	Mine 2 Emergency Dam	1 161 317	Brine Pond 1	75 629	
	Mine 3 Underground Dewatering	1 277 500	Brine Pond 2	75 629	
	WTP PCD Spillage	-	WTP Reservoir	2 369 721	
	Mine 1 Bottom PCD Spillage	82 163			
	Total	**2 520 980**		**2 520 980**	**-**
Water Treatment Plant Offices (conservancy tank)	WTP Reservoir (Potable Water)/Potable water from Eskom	5 000	Disposed of off-site/at Eskom Sewage Plant	2 550	
			Consumption (potable)	2 450	
	Total	**5 000**		**5 000**	**-**
WTP Reservoir	Water Treatment Plant and offices	2 369 721	Reservoir System (Reservoir 1 & 2)	1 214 756	
			Water Treatment Plant Offices	5 000	
			Discharges to Rietspruit	1 149 965	
	Total	**2 369 721**		**2 369 721**	**-**
Reservoir System (Reservoir 1 & 2)	WTP Reservoir (Potable Water)/Potable water from Eskom	1 214 756	Mine 1 Plant, Offices & Workshop area	488 481	
			Reservoir 4 at Mine 2	520 269	
			Reservoir 5 at Mine 3	206 007	
	Total	**1 214 756**		**1 214 756**	**-**
Mine 1 Plant, Offices & Workshop area	Reservoir System	488 481	Disposed of off-site/at Eskom Sewage Plant	341 936	
			Consumption (potable)	146 544	
	Total	**488 481**		**488 481**	**-**
Mine 1 Top PCD	Dirty water runoff (Mine 1 plant, offices &workshops)	16 407	Dust suppression (Mine 1 Coal Stockpile)	26 106	
	Rainfall	13 968	Mine 1 Bottom PCD (overflow)	17 404	
	Runoff (Mine 1 Transfer Stockpile)	1 571	Evaporation	32 400	
	Consumptive Return (9%)	43 963	Reuse (Mine 1)	-	
	Total	**75 910**		**75 910**	**-**
Mine 1 Bottom PCD	Rainfall	34 920	Evaporation	81 000	
	Mine 1 Top PCD (overflow)	17 404	Pump to WTP	82 163	
	Dirty water runoff (Mine 1 plant, offices &workshops)	8 259			
	Consumptive Return (21%)	102 581			
	Total	**163 163**		**163 163**	**-**
Mine 1 Transfer Stockpile	Rainfall	5 238	Evaporation/Seepage/Entrainment	3 667	
			Runoff (Mine 1 Top PCD)	1 571	
	Total	**5 238**		**5 238**	**-**
Mine 1 Coal Stockpile	Dust supression (Mine 1 Top PCD)	26 106	Evaporation/Seepage/Entrainment	149 141	
	Rainfall	175 764	Runoff (Eskom dirty water storage area)	52 729	
	Total	**201 870**		**201 870**	**-**
Brine Pond 1	Water Treatment Plant and offices	75 629	Evaporation	40 500	
	Rainfall	19 594	Overflow to WTP PCD (emergency)	-	
			Storage	54 724	
	Total	**95 224**		**95 224**	**-**
Brine Pond 2	Water Treatment Plant and offices	75 629	Evaporation	40 500	

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	Quantity (m3/a)	Water Circuit/stream	Quantity (m3/a)	
	Rainfall	19 594	Overflow to WTP PCD (emergency)	-	
			Storage	54 724	
	Total	**95 224**		**95 224**	**-**
WTP PCD	Runoff (Water Treatment Plant & Offices)	1 804	Evaporation	3 341	
	Rainfall	1 536	Spillage to WTP	-	
	Overflow from Brine Pond 1 (emergency)	-			
	Overflow from Brine Pond 2 (emergency)	-			
	Total	**3 341**		**3 341**	**-**
Total Water Balance		**7 238 907**		**7 238 907**	**-**

Table 3.2: Average annual water balance for Mine 2 (current)

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	Quantity (m3/a)	Water Circuit/stream	Quantity (m3/a)	
Mine 2 Underground	Groundwater Ingress & Recharge	1 277 500	Dewatering (Mine 2 Emergency Dam)	1 277 500	
	Total	**1 277 500**		**1 277 500**	**-**
Reservoir 4	Potable water from Reservoir System at Mine 1	520 269	Mine 2 Offices & Workshop Area	156 081	
			Potable Underground Users	364 188	
	Total	**520 269**		**520 269**	**-**
Mine 2 Emergency Dam	Mine 2 Underground Dewatering	1 277 500	Evaporation/Seepage/Spillage	236 250	
	Rainfall	101 850	Water Treatment Plant Mine 1	1 161 317	
	Runoff	18 217			
	Total	**1 397 567**		**1 397 567**	**-**
Mine 2 Offices & Workshop Area	Reservoir 4 (Potable water supply)	156 081	Sewage Treatment Plant Mine 2	52 027	
			Consumption (Potable)	104 054	
	Total	**156 081**		**156 081**	**-**
Mine 2 PCD	Dirty water runoff (Mine 2 offices & workshop area)	10 705	Evaporation	27 775	
	Rainfall	15 714			
	Mine 2 Transfer stockpile runoff	1 356			
	Total	**27 775**		**27 775**	**-**
Sewage Treatment Plant Mine 2	Mine 2 Offices & Workshop Area Sewage	52 027	Process losses	1 951	
			Discharge to Rietspruit	**50 000**	
			Sludge beds 2a - 2d at Mine 2	76	
	Total	**52 027**		**52 027**	**-**
Sludge Drying beds 2a - 2d	Sewage Treatment Plant Mine 2	76	Evaporation	134	
	Rainfall	58			
	Total	**134**		**134**	**-**
Mine 2 Transfer Stockpile	Rainfall	6 780	Evaporation/Seepage/Spillage	5 424	
			Runoff to Mine 2 PCD	1 356	
	Total	**6 780**		**6 780**	**-**
Total Water Balance		**3 438 132**		**3 438 132**	**-**

Table 3.3: Average annual water balance for Mine 3 (current)

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	Quantity (m3/a)	Water Circuit/stream	Quantity (m3/a)	
Mine 3 Underground	Groundwater Ingress & Recharge	1 277 500	Dewatering (Water Treatment Plant Mine 1)	1 277 500	
	Total	**1 277 500**		**1 277 500**	**-**

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	Quantity (m3/a)	Water Circuit/stream	Quantity (m3/a)	
Reservoir 5	Potable water from Reservoir System at Mine 1	206 007	Mine 3 Offices & Workshop Area	123 604	
			Potable Underground Users	82 403	
	Total	**206 007**		**206 007**	-
Mine 3 Offices & Workshop Area	Reservoir 5 (Potable water supply)	123 604	Sewage Treatment Plant Mine 3	36 051	
			Consumption (Potable)	87 553	
	Total	**123 604**		**123 604**	-
Mine 3 PCD	Dirty water runoff (Mine 3 offices & workshop area)	9 095	Evaporation/Seepage/Spillage	33 946	
	Rainfall	24 851			
	Total	**33 946**		**33 946**	-
Sewage Treatment Plant Mine 3	Mine 3 Offices & Workshop Area Sewage	36 051	Process losses	1 028	
			Discharge to Rietspruit	35 000	
			Sludge beds 3a - 3d at Mine 3	23	
	Total	**36 051**		**36 051**	-
Sludge Drying beds 3a - 3d	Sewage Treatment Plant Mine 3	23	Evaporation	81	
	Rainfall	58			
	Total	**81**		**81**	-
Mine 3 Transfer Stockpile	Rainfall	2 212	Evaporation/Seepage/Spillage	1 548	
			Runoff to to Sump	663	
	Total	**2 212**		**2 212**	-
Sump	Mine 3 Transfer Stockpile	663	Silo Dam	663	
	Total	**663**		**663**	-
Silo Dam	Sump	663	Evaporation	5 028	
	Rainfall	4 365			
	Total	**5 028**		**5 028**	-
Total Water Balance		**1 685 093**		**1 685 093**	-

3.3.3 Future Water Balance (10 year)

The future water balance for the Matla Coal Mine is presented in Table 3.4 to Table 3.6. The following summarises key results of the future water balance:

- Approximately 3 681 868 m^3/year (10 0087 m^3/d) would have to be treated at the WTP. Treated discharges from the WTP into the Rietspruit were calculated at 2 256 105 m^3/year (6 181 m^3/day) and 1 420 763 m^3/year (3 892 m^3/day) is pumped for potable use on the Matla Coal Mine.
- The calculated dewatering rate from the underground workings at the New Mine 1, Mine 2 and Mine 3 could be 3 832 500 m^3/year (10 500 m^3/day);
- A total of 26 106 m^3/year (71.5 m^3/day) could be reused for dust suppression on the Mine 1 Coal Stockpile from the Top PCD. If more dust suppression is required, the pumping to the WTP from the Bottom PCD can be reduced;
- Approximately 50 000 m^3/year (137 m^3/day) from Mine 2 Sewage Treatment Plant and 35 000 m^3/year (96 m^3/day) from Mine 3 Sewage Treatment Plant could be discharged into the Rietspruit.

Table 3.4: Average annual water balance for future Mine 1 water balance (future - 10 year)

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	**Quantity (m³/a)**	**Water Circuit/stream**	**Quantity (m³/a)**	
New Mine 1 Underground	Groundwater Ingress & Recharge	912 500	Dewatering (Water Treatment Plant)	912 500	
	Total	**912 500**		**912 500**	**-**
Water Treatment Plant (10ML)	Mine 2 Emergency Dam	730 000	Brine Pond 1	78 338	
	Megalitre Tank 1	365 000	Brine Pond 2	78 338	
	Megalitre Tank 2	365 000	Brine Pond 3	78 338	
	Mine 3 Underground Dewatering	1 460 000	WTP Reservoir	3 681 868	
	New Mine 1 Underground Dewatering	912 500			
	WTP PCD	-			
	Mine Bottom PCD	84 381			
	Total	**3 916 881**		**3 916 881**	**-**
Water Treatment Plant Offices (conservancy tank)	WTP Reservoir (Potable Water)/Potable water from Eskom	5 000	Disposed of off-site/at Eskom Sewage Plant	2 550	
			Consumption (potable)	2 450	
	Total	**5 000**		**5 000**	**-**
WTP Reservoir	Water Treatment Plant and offices	3 681 868	Reservoir System (Reservoir 1 & 2)	1 420 763	
			Discharge to Rietspruit	2 256 105	
			Water Treatment Plant Offices	5 000	
	Total	**3 681 868**		**3 681 868**	**-**
Reservoir System (Reservoir 1 & 2)	WTP Reservoir (Potable Water)/Potable water from Eskom	1 420 763	Mine 1 Plant, Offices & Workshop area	488 481	
			Reservoir 4 at Mine 2	520 269	
			Reservoir 5 at Mine 3	206 007	
			New Mine 1 Plant, Offices & Workshop area	206 007	
	Total	**1 420 763**		**1 420 763**	**-**
Mine 1 New Plant, Offices & Workshop Area	Reservoir System	206 007	Disposed of off-site/at Eskom Sewage Plant	30 901	
			Consumption (potable)	175 106	
	Total	**206 007**		**206 007**	**-**
Mine 1 New Sewage Treatment Plant	Mine 1 New Plant, Offices & Workshop Area	30 901	Process Losses	1 236	
			Discharge to Unnamed Tributary	29 665	
	Total	**30 901**		**30 901**	**-**
Mine 1 New PCD	Runoff (Mine 1 New Plant, Offices & Workshop Area)	7 607	Evaporation	9 450	
	Rainfall	4 074	Dust suppression (Conveyor Belt)	2 231	
	Total	**11 681**		**11 681**	**-**
Mine 1 Plant, Offices & Workshop area	Reservoir System	488 481	Disposed of off-site/at Eskom Sewage Plant	341 936	
			Consumption (potable)	146 544	
	Total	**488 481**		**488 481**	**-**
Mine 1 Top PCD	Dirty water runoff (Mine 1 plant, offices &workshops)	16 407	Dust suppression (Mine 1 Coal Stockpile)	26 106	
	Rainfall	13 968	Mine 1 Bottom PCD (overflow)	17 404	
	Runoff (Mine 1 Transfer Stockpile)	1 571	Evaporation	32 400	
	Consumptive Return (9%)	43 963	Reuse (Mine 1)	-	
	Total	**75 910**		**75 910**	**-**
Mine 1 Bottom PCD	Rainfall	34 920	Evaporation	81 000	
	Mine 1 Top PCD (overflow)	17 404	Pump to WTP	84 381	
	Dirty water runoff (Mine 1 plant, offices &workshops)	10 476			
	Consumptive Return (21%)	102 581			
	.	**165 381**		**165 381**	**-**

Mine 1 Transfer Stockpile	Rainfall	5 238	Evaporation/Seepage/Entrainment	3 667	
			Runoff (Mine 1 Top PCD)	1 571	
	Total	**5 238**		**5 238**	**-**
Mine 1 Coal Stockpile	Dust supression (Mine 1 Top PCD)	26 106	Evaporation/Seepage/Entrainment	29 598	
	Rainfall	4 365	Runoff (Eskom dirty water storage area)	873	
				-	
	Total	**30 471**		**30 471**	**-**
Brine Pond 1	Water Treatment Plant and offices	78 338	Evaporation	45 450	
	Rainfall	19 594	Overflow to WTP PCD (emergency)	-	
			Storage	52 481	
	Total	**97 932**		**97 932**	**-**
Brine Pond 2	Water Treatment Plant and offices	78 338	Evaporation	45 450	
	Rainfall	19 594	Overflow to WTP PCD (emergency)	-	
			Storage	52 481	
	Total	**97 932**		**97 932**	**-**
Brine Pond 3	Water Treatment Plant and offices	78 338	Evaporation	45 450	
	Rainfall	19 594	Overflow to WTP PCD (emergency)	-	
			Storage	52 481	
	Total	**97 932**		**97 932**	**-**
WTP PCD	Runoff (Water Treatment Plant & Offices)	1 804	Evaporation	3 341	
	Rainfall	1 536	Spillage to WTP	-	
	Overflow from Brine Pond 1 (emergency)	-			
	Overflow from Brine Pond 2 (emergency)	-			
	Overflow from Brine Pond 3 (emergency)	-			
	Total	**3 341**		**3 341**	**-**
Total Water Balance		**11 243 217**		**11 243 217**	**-**

Table 3.5: Average annual water balance for future Mine 2 water balance (future - 10 year)

Facility Name	**Water In**		**Water Out**		**Balance**
	Water Circuit/stream	**Quantity (m3/a)**	**Water Circuit/stream**	**Quantity (m3/a)**	
Mine 2 Underground	Groundwater Ingress & Recharge	1 460 000	Dewatering (Mine 2 Ememergency Dam)	730 000	
			Dewatering (2 Megalitre Tanks)	730 000	
	Total	**1 460 000**		**1 460 000**	**-**
Reservoir 4	Potable water from Reservoir System at Mine 1	520 269	Mine 2 Offices & Workshop Area	156 081	
			Potable Underground Users	364 188	
	Total	**520 269**		**520 269**	**-**
Megalitre Tanks 1 & 2	Dewatering of Mine 2 underground	730 000	Water Treatment Plant mine 1	730 000	
	Total	**730 000**		**730 000**	**-**
Mine 2 Emergency Dam	Mine 2 Underground Dewatering	730 000	Evaporation/Seepage/Spillage	155 925	
	Rainfall	101 850	Water Treatment Plant Mine 1	694 142	
	Catchment Runoff	18 217			
	Total	**850 067**		**850 067**	**-**
Mine 2 Offices & Workshop Area	Reservoir 4 (Potable water supply)	156 081	Sewage Treatment Plant Mine 2	52 027	
			Consumption (Potable)	104 054	
	Total	**156 081**		**156 081**	**-**

Mine 2 PCD	Dirty water runoff (Mine 2 offices & workshop area)	10 705	Evaporation	27 775	
	Rainfall	15 714			
	Mine 2 Transfer stockpile runoff	1 356			
	Total	**27 775**		**27 775**	**-**
Sewage Treatment Plant Mine 2	Mine 2 Offices & Workshop Area Sewage	52 027	Process losses	1 951	
			Discharge to Rietspruit	50 000	
			Sludge beds 2a - 2d at Mine 2	76	
	Total	**52 027**		**52 027**	**-**
Sludge Drying beds 2a - 2d	Sewage Treatment Plant Mine 2	76	Evaporation	134	
	Rainfall	58			
	Total	**134**		**134**	**-**
Mine 2 Transfer Stockpile	Rainfall	6 780	Evaporation/Seepage/Spillage	5 424	
		-	Runoff to Mine 2 PCD	1 356	
	Total	**6 780**		**6 780**	**-**
Total Water Balance		**3 073 132**		**3 073 132**	**-**

Table 3.6: Average annual water balance for future Mine 3 water balance (future - 10 year)

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	Quantity (m3/a)	Water Circuit/stream	Quantity (m3/a)	
Mine 3 Underground	Groundwater Ingress & Recharge	1 460 000	Dewatering (Water Treatment Plant Mine 1)	1 460 000	
	Total	**1 460 000.00**		**1 460 000.00**	**-**
Reservoir 5	Potable water from Reservoir System at Mine 1	206 007	Mine 3 Offices & Workshop Area	133 904	
			Potable Underground Users	72 102	
	Total	**206 006.72**		**206 006.72**	**-**
Mine 3 Offices & Workshop Area	Reservoir 5 (Potable water supply)	133 904	Sewage Treatment Plant Mine 3	41 201	
			Consumption (Potable)	92 703	
	Total	**133 904.37**		**133 904.37**	**-**
Mine 3 PCD	Dirty water runoff (Mine 3 offices & workshop area)	9 095	Evaporation/Seepage/Spillage	33 946	
	Rainfall	24 851			
	Total	**33 946.31**		**33 946.31**	**-**
Sewage Treatment Plant Mine 3	Mine 3 Offices & Workshop Area Sewage	41 201	Process losses	6 125	
			Discharge to Rietspruit	35 000	
			Sludge beds 3a - 3d at Mine 3	77	
	Total	**41 201.34**		**41 201.34**	**-**
Sludge Drying beds 3a - 3d	Sewage Treatment Plant Mine 3	77	Evaporation	135	
	Rainfall	58			
	Total	**135.00**		**135.00**	**-**
Mine 3 Transfer Stockpile	Rainfall	2 212	Evaporation/Seepage/Spillage	1 548	
			Runoff to to Sump	663	
	Total	**2 211.60**		**2 211.60**	**-**
Silo Dam	Sump	663	Evaporation	5 028	
	Rainfall	4 365			
	Total	**5 028.48**		**5 028.48**	**-**
Total Water Balance		**1 882 433.83**		**1 882 433.83**	**-**

4 ALTERNATIVES

This section describes the project alternatives which have been considered, including alternative land uses.

Several Alternatives that were assessed are discussed in the sections that follow:

4.1 Mining Method alternative

Alternatives considered for mining method of the stooping of pillars are briefly discussed in the section that follows.

4.1.1 Stope and fill

Where large bulk ore bodies are to be mined at great depth, or where leaving pillars of ore is uneconomical, the open stope is filled with backfill, which can be a cement and rock mixture, a cement and sand mixture or a cement and tailings mixture. This method is popular as the refilled stopes provide support for the adjacent stopes, allowing total extraction of economic resources.

This method is not preferred due to it being economically unviable due to the material required for filling.

4.1.2 Development of Open Cast Pits

Open-pit mining (as opposed to underground mining) has several advantages:-

- Low cost of recovery - large trucks can enter the mine, get filled up with rock from a large excavator and drive away to the processing plant.
- No need to leave stability pillars, necessary to hold up underground mine workings but which may contain valuable ore that is effectively lost to the mining company.
- Ease of beneficiation - surface mines are usually composed of materials (oxides in the case of metalliferous mines) that are easier to handle and easier to treat in order to recover their marketable product as a result of being so close to surface.
- Safer environment - so much less problem of rock falls, hanging wall collapse resulting in a lower injury rate than in underground mine.

However the areas proposed to be stooped, are too vast for the development of opencast pits, and would prove economically non-viable.

In addition, this method will have a greater impact on the biophysical environment. As with all forms of large-scale mineral extraction, opencast mining can have a negative impact on the surrounding environment and ecosystems. The removal of the overburden destroys the pre-existing landscape and contributes to erosion. Even after final rehabilitation of the pits have been completed, the geology of the area is completely destroyed, which will cause ongoing issues, especially in terms of decant water.

4.2 No-Go Alternatives

If the mining operation were not to proceed, the potential environmental impacts associated with mining is not expected to occur, and the continued impacts associated with current agricultural and livestock grazing practices would continue.

If the mining operation were to proceed then the proposed project would have the following anticipated positive social impacts:

- Increase the longevity of the mine, enabling long term employment opportunities;
- The continued contribution to the local municipal tax base;
- The continued involvement of Matla with regards to training and capacity building of its employees and subsequent improvement of the livelihoods of the employees' families; and
- The commitment of Matla with regards to social development project and support.

If the proposed mining operation does not proceed, then all the potential positive benefits, as described, would not materialise.

4.3 Need and desirability of the proposed activities

The proposed project/activity will result in extension of the life of mine with additional six (6) years which will take the LoM to possibly 2041. The additional coal resources will supply Eskom with coal for power generation. The activity will also impact positively on the local as well as regional economy. Should this project be approved, and the life of mine increased, the district municipality will continue to benefit from the mining operations. In addition the proposed activity will have less impacts in the environment as it is to be situated in an area already zoned for mining activities and already impacted by mining.

The LOM extension will ensure:

- Employment opportunities for a further six (6) years. With the increase in job cuts in the mining sector at present, job security is of vital importance;
- Continued positive impact on the local economy; and

- Continued coal supply to Eskom's Matla Power Station for power generation during a time when Eskom is struggling to meet the electricity demand.

5 BASELINE ENVIRONMENTAL DESCRIPTION

5.1 Geology

5.1.1 Regional Geological Setting

The underlying geology of the study area is typical of the coalfields on the Mpumalanga Highveld, and is dominated by sandstones and shales of the Karoo Sequence (Vryheid formation). Recent alluvial deposits occur along the larger drainage line that traverse the area, while small isolated outcrops of medium-grained porphyritic granite occur immediately to the north of sites 1 and 2. The sandstones typically weather to form sandy soils that are allow easy infiltration of rainwater and limit runoff (only 4.7 % of rainfall ends up as runoff), and which are conducive to the formation of extensive hillslope seepage wetlands in those areas where an aquitard (i.e. an impermeable layer, e.g. sandstone or a plinthic layer) creates perched water tables. Pans are also common in the area.

Currently the area surrounding the sites is used extensively for agricultural purposes; mostly dry land cultivation of maize, but also livestock grazing. Extensive mining activities also take place within the general area, both opencast and underground mining.

The Karoo Supergroup in the Matla area comprises the Ecca Group and the Dwyka Formation. The Ecca sediments consist predominantly of sandstone, siltstone, shale and coal. Combinations of these rock types are often found in the form of interbedded siltstone, mudstone and coarse-grained sandstone. The Ecca sediments overlie the Dwyka Formation (loosely referred to as the Dwyka tillite). The latter consists of a proper tillite, sandstone and sometimes a thin shale development. The upper portion of the Dwyka sediments may have been reworked, in which case carbonaceous shale and even inclusion of coal may be found. The Dwyka sediments are underlain by felsitic rocks of the Bushveld Complex.

5.1.2 Presence of Dykes, Sills and Faults

Tectonically, the Karoo sediments are practically undisturbed. Faults are rare; however, fractures are common in rocks such as sandstone, and coal.

Dolerite intrusions, in the form of sills or dykes, cause various mining problems, i.e. devolatised coal, weakened roof strata and/or displaced coal seams. The intrusion of a sill in the Mine 1 area caused extensive devolatisation of the overlying 2 Seam, resulting in the exclusion of Mine 1, 2 seam from mineable reserves. Pressure on the overlying strata, due to the intrusion, resulted in two intersecting joint patterns, which generally have a NE - SW and NW - SE strike respectively. Dolerite from the underlying sill intruding the overlying strata through the joint patterns resulted in a high frequency of dykes in the Mine 1 area.

In the Mine 2 underground shortwall mining area there are almost no intrusions, except for one small dyke, and this therefore affords Matla Colliery the opportunity to utilise underground shortwall mining methods.

5.1.3 Underground Mine Geology/Coal Distribution

The coal deposit at Matla forms part of the Highveld Coalfield. The coal seams are found within the Vryheid Formation of the Karoo Supergroup. The stratigraphic sequence within the Matla area includes five coal seams that are numbered from the bottom upwards from 1 to 5. Economic reserves are found in the 2 seam, 4 seam (lower) and the 5 seam. The seam depths vary but are on average as follows:

- Seam: - 35 to 50 m below surface;
- 4 Seam: - 75 to 85 m below surface; and
- 2 Seam: - 100 to 120 m below surface.

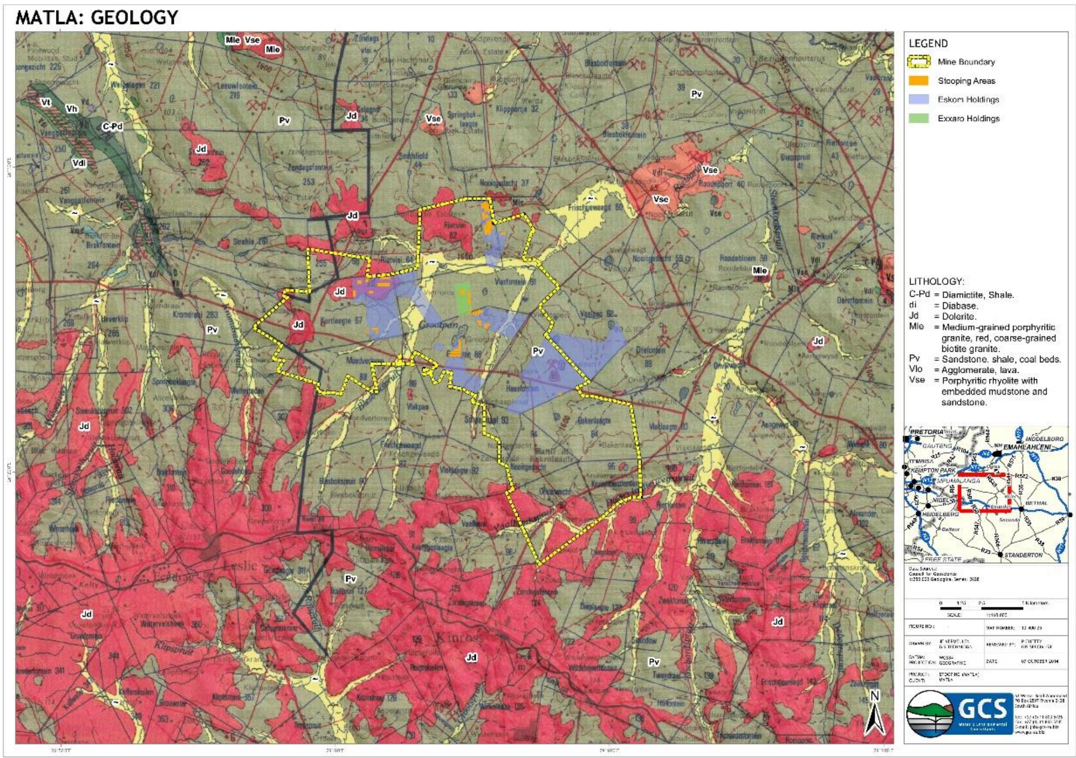

Figure 5.1: Geology of study area

5.2 Topography

The surface elevations within the Matla Coal mining area lies between 1565 to 1650mamsl, and the area consists of gently rolling hills and valleys draining toward the north. The slope of the area varies between three to eight percent (3 % - 8 %) and between zero to three percent (0 % - 3 %). The slope length varies from 500 meters to 1000 meters and the slope shape varies from convex to concave. In various areas, the topography has been altered due to surface subsidence of undermined areas, which in some places has resulted in the formation of ponds and wetlands.

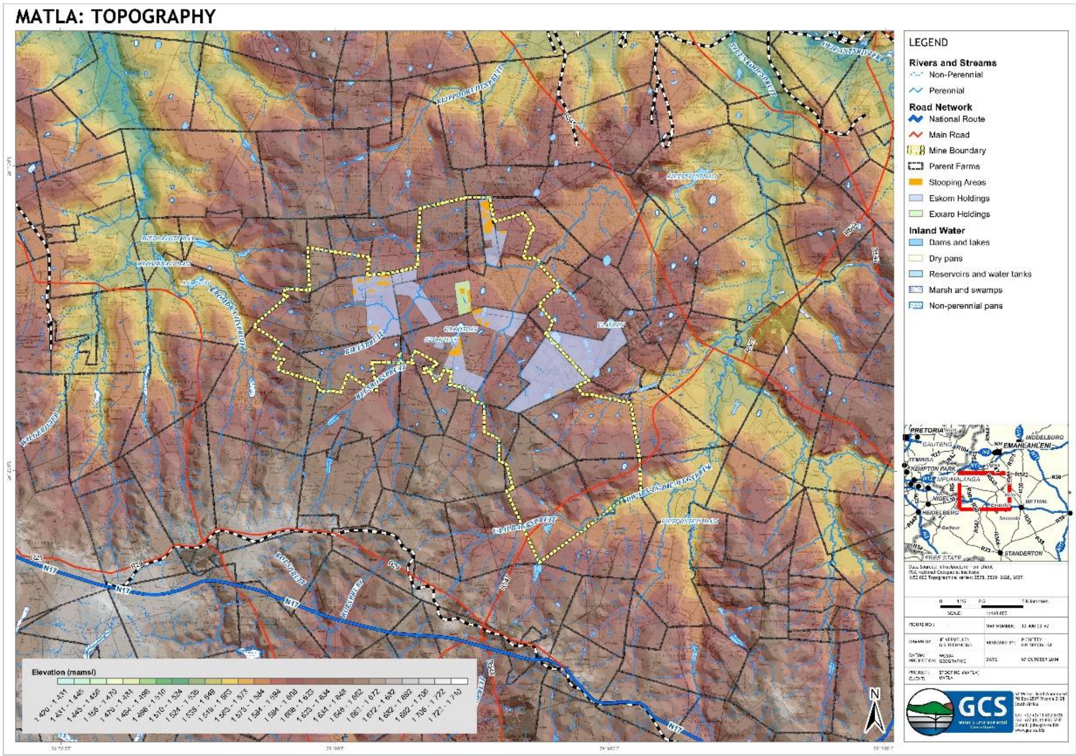

Figure 5.2: Topography of the Matla Area

5.3 Climate

5.3.1 Regional Climate

The climate is a typical Highveld climate and is generally dry with moderate summers and cold winters. The mean monthly and mean annual rainfall is 59 mm and 711 mm respectively. The maximum rainfall intensity measured over a 24-hour period, as measured at Kriel Police Station in 1955, is 205 mm. The mean monthly wind direction is north-west, whilst the mean monthly wind speed is approximately 4.4 m/sec. The Kriel area has the following features (Shultze, 1974):

- Warm to hot summers with average temperatures being 27ºC, extremes of up to 35ºC are sometimes encountered;
- Cold winters with average temperatures being 15ºC, extremes of up to –10ºC are sometimes encountered;
- Drought periods during the rainy season are frequent to occasional;
- 0 - 9 rain days per month may be expected;
- Low lying topographical areas experience heavy mist from April to September;
- Hail occurs on average 2.8 days per annum; and
- Frost occurs from 120 - 150 days per annum from April to September.

Information on climatic conditions prevailing in the vicinity of Matla Colliery has been obtained from the South African Weather Services and mine records.

5.3.2 Temperature

Temperatures in the vicinity of the mine are warm to hot during summer and cold in the winter. Mean temperatures vary from 26ºC in the summer to 15ºC in the winter (Table 5.1).

Table 5.1: Temperature in the Matla Colliery region

Month	**Average Daily Maximum Temperature (°c)**	**Average Daily Minimum Temperature (°c)**
January	25.6	13.8
February	25.2	13.2
March	24.6	11.8
April	21.8	8.6
May	19.5	4.4
June	16.5	0.8
July	17.1	1.0
August	19.9	3.8
September	23.2	7.5
October	23.9	9.9
November	24.0	11.8
December	25.3	13.1
Annual	*22.2*	*8.3*

5.3.3 Monthly and Annual Rainfall

The annual average precipitation at Matla Colliery (Table 5.2) is relatively low and variable. Annual rainfall values range from 550 mm– 800 mm with an average of approximately 754 mm per annum.

Most precipitation occurs over the period November to January with an average of approximately ninety (90) rain days per annum. Rainfall over the period May to September is generally low or absent, with a noticeable increase in the months of October to April. Rainfall events in the region occur mainly in the form of thunderstorms and heavy showers.

Table 5.2: Rainfall in the Matla Colliery Region

Month	**Average monthly rainfall data (mm)**
January	146
February	96.6
March	82.7
April	41.7
May	12.8
June	11.0
July	1.0
August	9.2
September	21.2
October	93.1
November	120.9
December	118.1
Annual	*754.3*

5.3.4 Extreme Conditions

Rainfall and temperature extremes are indicated in Table 5.3. The highest recorded rainfall event over a 24-hour period was 205 mm on 24 December 1995. The highest monthly average rainfall was reported in 1983, and was recorded as 287 mm. The highest temperature recorded at the Matla Colliery was 34.4ºC in 1983 and the lowest daily maximum was -9.2ºC in 1964.

Table 5.3: Rainfall and Temperature Extremes in the Matla Colliery Region

Condition	**Parameter**	**Recorded Extreme Values**
Rainfall	Maximum In 24 Hours	205 mm (1955/12/24)
	Highest Monthly	287 mm (1983)

Condition	Parameter	Recorded Extreme Values
Temperature	Highest Daily Maximum	34.4°C (1983)
	Lowest Daily Maximum	-9.2°C (1964)

5.4 Soils, Landuse and Land Capability

5.4.1 Soil Characterisation

The soils encountered can be broadly categorised into four major groupings, with a number of dominant and sub dominant forms that characterise the area of concern.

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

The generally flat to slightly undulating topography has resulted in the in-situ formation of many of the soils, and a moderately predictable pedogenisis for the site, albeit that the retention of soil water within the vadose zone (lack of preferred horizontal flow) has resulted in the creation of an inhibiting layer (calcrete/ferricrete) within some of the soil profile.

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

It is hypothesised that the ferricrete layer that is found associated with the shallow iron rich and horizontally bedded sediments, is responsible for the restrictive layer that is holding water within the soil profile and resulting in the development of moderately extensive areas of wet based soils and evaporites.

The occurrence of calcrete and/or ferricrete horizons within the soil profile classify as “relic” land forms for the most part, albeit that significant area of more recent laterite development was mapped in association with the lower lying river floodplains and alluvial environs.

The relic land forms are commonly associated with hillside seeps and “sponge zones”, both of which are associated with possible wetland development. These ferricrete layers occasionally outcrop at surface as “ouklip” or hardpan ferricrete/laterites and are the basis for some of the pan structures found within the sedimentary profile and landscape that typifies the coalfields in this region.

These features are important to the ecological and biodiversity cycle, and are regarded as sensitive to highly sensitive features. In addition, and as part of these sensitive systems, are the "transition zones" often associated with the deeper sandy loams, and which store and transmit the soil water to the wetlands. These soils are in essence the catchment system for the wetlands, and as such are considered sites of significance and potentially areas of high sensitivity.

The dominant soils classified are described in terms of their physical and chemical similarities and to some extent their topographic position and resultant pedogenisis. Their spatial distribution is of importance to the management recommendations and overall mitigation strategy (Figure 5.3). The major soil groupings are described in more detail later in this section.

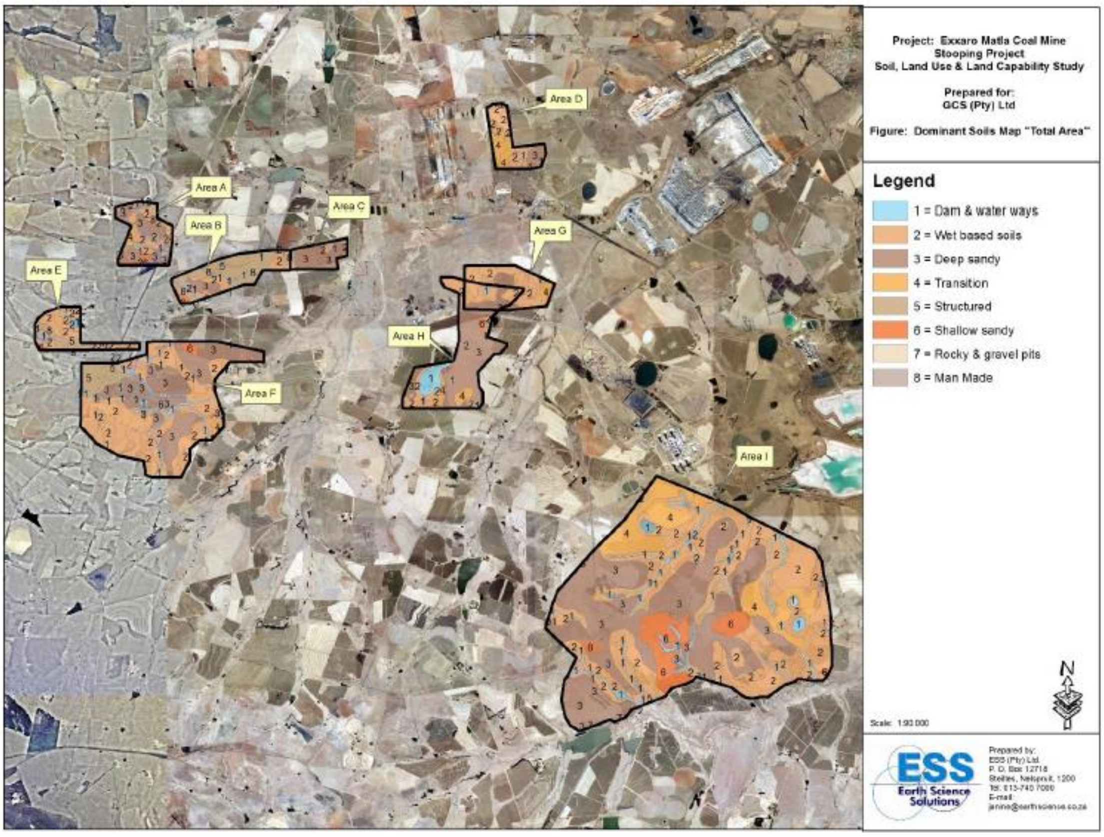

Figure 5.3: Soil Map indicating the dominant soils types as identified with the Exxaro Matla Coal Mine's proposed Stooping Project areas (Areas A-I)

The soils mapped range from shallow sub-outcrop and outcrop of hard plinthite and parent materials (Sediments and intrusive dolerite) to moderately deep sandy loams and sandy clay loams, all of which are associated with either a hard rock base to the "C" horizon, a thin saprolitic layer (weathering rock) or ferricrete/laterite at differing depths. The saprolitic horizons are generally quite thin, with soil occurring on hard bedrock in most instances mapped.

When considering the sensitivity of a soil, the overall rooting depth, depth to wetness, or an inhibiting layer (physical or chemical) and the amount of redox reaction present (noted in the degree of mottling and more importantly the greyness of the matrix soil) are considered important, while the texture and structure of the soil are also noted. The sensitivity of wetlands is important and is a consideration legislated in terms of the DWS and the "wetland delineation classification" due mainly to the important contributions that wetlands have for the ecological status and biodiversity of an area. These translate into sensitivity and potential vulnerability when disturbed.

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

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

The friability of the ferricrete will also have an effect on the amount of clay mineralisation that the soil contains within this horizon, and will in turn influence the water holding characteristics of the soil and the degree of structure. In addition to the soil system of classification, a specific system has been developed for the describing and classification of ferricrete. This has been used in better understanding the resultant land forms mapped.

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

As with any natural system, the transition from one system to another is often complex with multiple facets and variations over relatively small/short distances.

However, in simplifying the trends mapped, the following major soil groupings have been grouped into a number of dominant groupings. These include:

The deeper and more sandy loam soils are considered soils/materials with high potential in terms of their ecosystem services and are distinguished by their better than average depth of relatively free draining soil (> 1,200mm).

This group is recognisable by the lack of any wetness indicators or, where present the subtleness of the mottling (water within the profile for less than 30% of the season), and their occurrence at depths of greater depths within the profile (>500mm) and the land capability is rated as moderate intensity grazing and/or arable depending on their production potential. These soils are generally significantly lower in clay than the associated wet based soils and more structured colluvial derived materials, have a distinctly weaker structure and are deeper and better drained (better permeability). The ability for water to permeate through these profiles is significantly better.

The more sandy texture of this soil group renders them more easily worked and renders them of a lower sensitivity (Deep >500mm).

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

The third group comprise those that are associated with the hard pan ferricrete layer and perched soil water (wet based soils). This group of soils has a set of distinctive characteristics and nature that are separated out due to their inherently much more difficult management characteristics. These soils are characterised by relatively much higher clay contents (often of a swelling nature), poor intake rates, poor drainage, generally poor liberation of soil water and a restricted depth – often due to the inhibiting barrier within the top 700mm of the soil profile. These soils are generally associated with a wet base.

These soils will be more difficult to, work in the wet state, store, and re-instate at closure. These soils are associated with the pan structures and natural occurring waterholes. Groundwater is generally relatively deep (>15m) for the majority of the area of study and is reported (hydrogeologists) to have little to no influence on the soil water and water found within the vadose zone.

No perched aquifers (groundwater) are reported, albeit that a significant area of well-developed ferricrete was mapped within the vadose zone on a number of the areas mapped. The development of wet based soils and moist grassland environments are mapped in association with these soil forms.

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

In addition, but not separated from the wet based structured soils, are the group of materials that reflect wetness (wet based soils) within the top 500mm. These soils are easily recognised by the mottled red and yellow colours that occur on low chroma background to the soil. These soils are regarded as highly sensitive, and areas that will require authorisation/permission if they are to be impacted. The legal implications (licensing) will need to be considered if these soils are to be considered within the zone of development.

The concentrations of natural salts and stores of nutrients within these soils are again a sensitive balance due to the extremes of rainfall, wind and temperature. The ability of a soil to retain moisture and nutrients, and in turn influence the sustainability of vegetative growth and dependence of animal life, is determined by the consistency and degree of soil moisture retention within the profile, but out of the influence of evaporation.

These conditions and associated sensitivities should be noted in terms of the overall bio-diversity balance if the sustainability equation is to be managed and mitigation engineered. Pan structures and the associated shallow wet based soils is an important contributor to the ecological cycle.

5.4.2 Soil Chemical and Physical Characteristics

A suite of representative samples from the differing soil forms were taken and sent for analyses for both chemical and physical parameters (Table 5.4). A select number of samples were submitted, each sample containing a number of sub samples from a particular soil Form which is representative of the area in question. Each sample comprises a “composite sample”, and is representative of the Soil Form rather than a specific point sampled.

Table 5.4: Composite Sample - Analytical Results

Sample No.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Soil Form	Gc	Ka/Kd	We	Pn	Sd/Hu	Av	Av	Kd	Rg	Pn
Constituents mg/kg										
pH	6.5	6.9	5.8	6.2	6.4	7.1	6.2	6.2	5.2	6.2
"S" Value	5.6	22.4	11.6	10.2	22.8	12.1	8.9	22	33	18.2
Ca Ratio	72	54	58	72	68	72	70	49	62	65
Mg Ratio	33	33	20	26	34	30	24	28	34	33
K Ratio	0.7	10	22	4	4	7	4	8	9	2
Na Ratio	1.8	0.4	0.4	0.3	0.4	0.8	0.3	0.3	0.8	1.5
P	5	18	111	22	12	14	22	15	20	6
Zn	0.9	1.7	7	2	2	1.6	2	1.4	1.1	1.1
Sand	48	21	44	36	42	45	42	21	16	62
Silt	40	24	34	46	26	35	36	27	26	30
Clay	12	55	22	18	32	20	22	52	58	8
Sample No.	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20
Soil Form	We	Hu	Gc	Pn	Ka	Hu	Cv/Gf	Cv	Dr	Gc
Constituents mg/kg										
pH	6.2	5.8	5.6	6.2	5.8	6.6	5.2	6	6.3	5.5
"S" Value	5.8	5.2	22.1	14.8	31	11	3.8	11.2	5.2	4.1
Ca Ratio	65	58	66	65	62	65	66	59	70	66
Mg Ratio	10	12	30	32	34	22	22	16	28	22
K Ratio	12	12	1	1	7	4	5	18	0.6	5
Na Ratio	0.2	0.2	0.2	1.6	1.1	0.5	0.3	0.2	1.4	0.1
P	82	80	8	6	17	10	11	111	5	10
Zn	1.6	1.6	1	1.1	1.4	1.5	1.4	7.2	1	1.1
Sand	44	42	34	46	18	52	45	45	58	50
Silt	35	34	38	46	22	30	43	39	34	38
Clay	21	24	28	8	60	18	12	16	8	12

5.4.2.1 Soil Chemical Characteristics

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

On-going sampling and monitoring of the in-situ conditions will be necessary throughout the operational phase to accurately define the post-operational conditions if the rehabilitation is to be successful.

The results of the laboratory analysis returned a variety of materials that range from very well sorted sandy loams with lower than average nutrient stores and moderate clay percentages (<20% - B2/1), to soils with a moderately stratified to weak blocky structure, sandy loam to clay loam texture and varying degrees of utilisable nutrients on the colluvial derived materials, while high clays and extremes of structure are associated with the wet based and wetland soils that dominate the alluvial derived and bottom land floodplain wetlands.

In general, the pH ranges from slightly acidic at around 5.5 to neutral and slightly alkaline at 7.5, a base status ranging from 3me% to 7me% (Eutrophic (slight leaching status) to Mesotrophic (moderate leaching status)), and nutrient levels reflecting generally high levels of calcium and sodium, but deficiencies in the levels of magnesium, potassium, phosphorous, copper, aluminium and zinc, with low to very low stores of organic carbon matter.

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

The growth potential on soils with these nutrient characteristics is at best moderate to poor and additions of nutrient and compost are necessary if commercial returns are to be achieved from these soils. They are at best moderate to good grazing lands.

Soil fertility

The soils mapped returned, at best, moderate levels of some of the essential nutrients required for plant growth, with sufficient stores of calcium and magnesium. However, levels of Na, Zn, P, and K are generally lower than the optimum required, and the organic carbon stores are low. These conditions are important in better understanding the land capability ratings that are recorded, with the majority of the study area being rated as low intensity grazing land.

These poor conditions for growth were further compounded by the low organic carbon (<1.0%).

There are no indications of any toxic elements associated with the soils that are likely to limit natural plant growth.

Nutrient Storage and Cation Exchange Capacity (CEC)

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

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

Low CEC values are an indication of soils lacking organic matter and clay minerals. Typically a soil rich in humus will have a CEC of 300 me/100g (>30 me/%), while a soil low in organic matter and clay may have a CEC of as low as 1me/110g to 5 me/100g (<5 me/%).

Generally, the CEC values for the soils mapped in the area are moderate.

Soil organic matter

The soils mapped are generally low in organic carbon. This factor coupled with the moderate to low clay contents (generally < 25%) for the majority of the soils mapped will adversely affect the erosion indices for the soils.

5.4.2.2 Soil Physical Characteristics

The majority of the soils mapped exhibit apedal to weak crumbly structure, low to moderate clay content and a dystrophic leaching status. The texture comprises sandy to silty sands for the most part, with much finer silty loams and clay loams associated with the colluvial and alluvial derived materials associated with the lower slope and bottom land stream and river environs respectively.

Of significance to this study, and a feature that is moderately common across the site where the soils are associated with the sedimentary host rocks (albeit that it often occurs below the 1.5m auger depth on the deeper soils), is the presence of a hard pan ferricrete (plinthite) layer within the soil profile.

The semi-arid climate (negative water balance) combined with the geochemistry of the host rock geology are conducive to the formation of evaporites, with the development of ferruginous layers or zones within the vadose zone.

The accumulation and concentration of iron and manganese rich fluids in solution will result in the precipitation of the salts and metals due to high evaporation (negative water balance). This process results in the development of a restrictive or inhibiting layer/zone within the profile over time.

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

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

This classification is taken from - Petrological and Geochemical Classification of Laterites - Yves Tardy, Jean-Lou, Novikoff and Claude Roquid (1991), and forms the basis to classify the hard pan ferricrete or lateritic portion of the soil horizon in terms of its workability (engineering properties) and storage sensitivities.

The soil classification system takes cognisance of ferricrete and has specific nomenclature for these occurrences (Refer to the Taxonomic Soil Classification (Mac Vicar et al, 2nd edition 1991), a system for South Africa – See list of references).

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

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

5.4.3 Soil Erosion and Compaction

Erodibility is defined as the vulnerability or susceptibility of a soil to erosion. It is a function of both the physical characteristics of a particular soil as well as the treatment of the soil.

The resistance to, or ease of erosion of a soil is expressed by an erodibility factor (“K”), which is determined from soil texture/clay content, permeability, organic matter content and soil structure. The Soil Erodibility Nomograph (Wischmeier et. al, 1971) was used to calculate the “K” value.

With the "K" value in hand, the index of erosion (I.O.E.) for a soil can then be determined by multiplying the "K" value by the "slope" measured as a percentage. Erosion problems may be experienced when the Index of Erosion (I.O.E.) is greater than 2.

The majority of the soils mapped can be classified as having a moderate to high erodibility index in terms of their organic carbon content and clay content, albeit that this rating is off-set and tempered by the undulating to flat terrain to an index of moderate or resistant.

However, the vulnerability of the "B" horizon to erosion once the topsoil and/or vegetation are removed must not be underestimated when working with or on these soils. These horizons (B2/1) are vulnerable and rate as medium to high when exposed.

The concerns around erosion and inter alia compaction, are directly related to the disturbance of the protective vegetation cover and topsoil layer that will be disturbed during any construction and operational phases of the mining venture. Once disturbed, the effects and actions of wind and water are increased and will increase erosion across the site.

Loss of soil (topsoil and subsoil) is extremely costly to any operation, and is generally only evident at closure or when rehabilitation operations are compromised.

Well planned management actions during the planning, construction and operational phases will save time and money in the long run, and will have an impact on the ability to successfully "close" an operation once completed.

5.4.4 Land Capability Description

The area to be disturbed by the underground stooping operation (Areas "A" to "I") and its associated surface infrastructure development comprises a range of land capability classes, with significant areas of friable and good grazing potential class soil, significant and sensitive sites that returned shallow and wet based soil conditions, and sites of structured and moderately sensitive materials that occur within the planned development footprint. The underground workings planned for stooping are overlain by the full suite of soil sensitivities and land capability, with a significantly large spatial area of more sensitive to highly sensitive wetland soil ratings associated with the rivers and associated transition zone wet based soils, sensitive to moderately sensitive sandy loams and sandy clay loams associated with the middle and upper mid-slope positions and the more sensitive to high sensitivity shallow soils associated with the ridge slopes and erosive environment.

Figure 5.4 illustrates the distribution of land capability classes across the total study area, while Figure 5.5 and Figure 5.9 illustrate the land capability distribution for the areas that are to be mined as part of the Phase 1 Project.

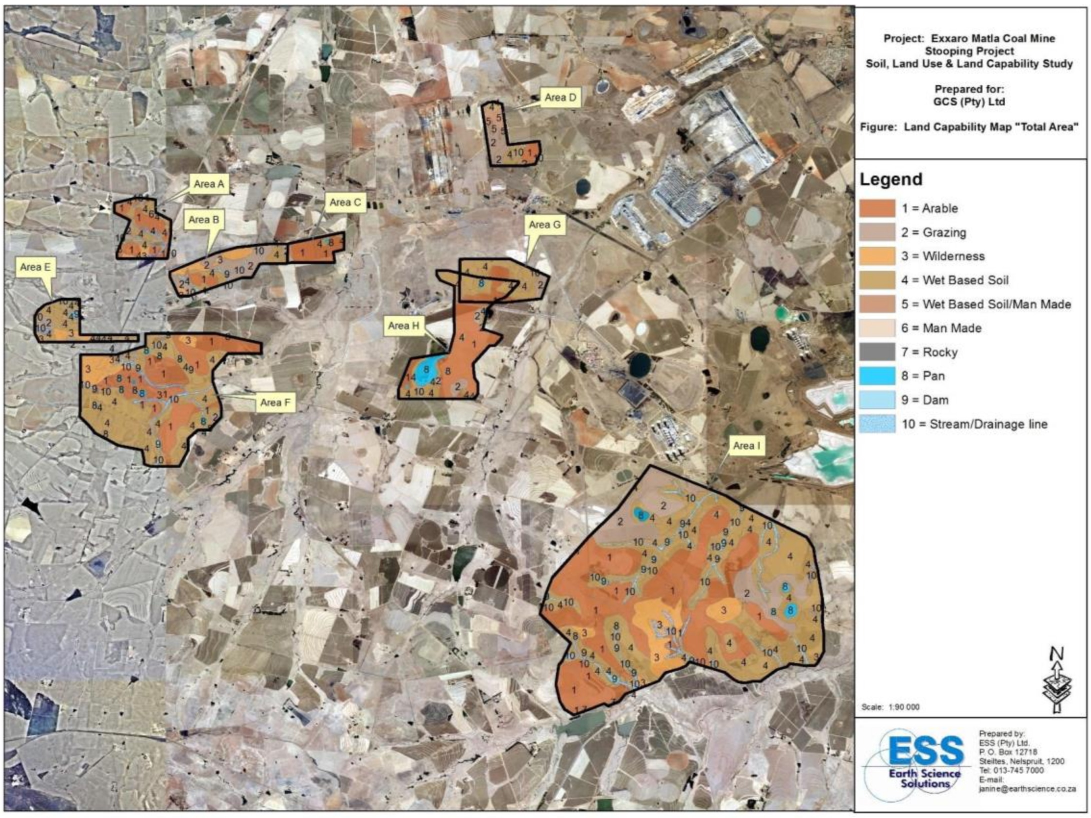

Figure 5.4: Land Capability Map of the Exxaro Matla Coal Mine Proposed Stooping Project Area (Areas A to I)

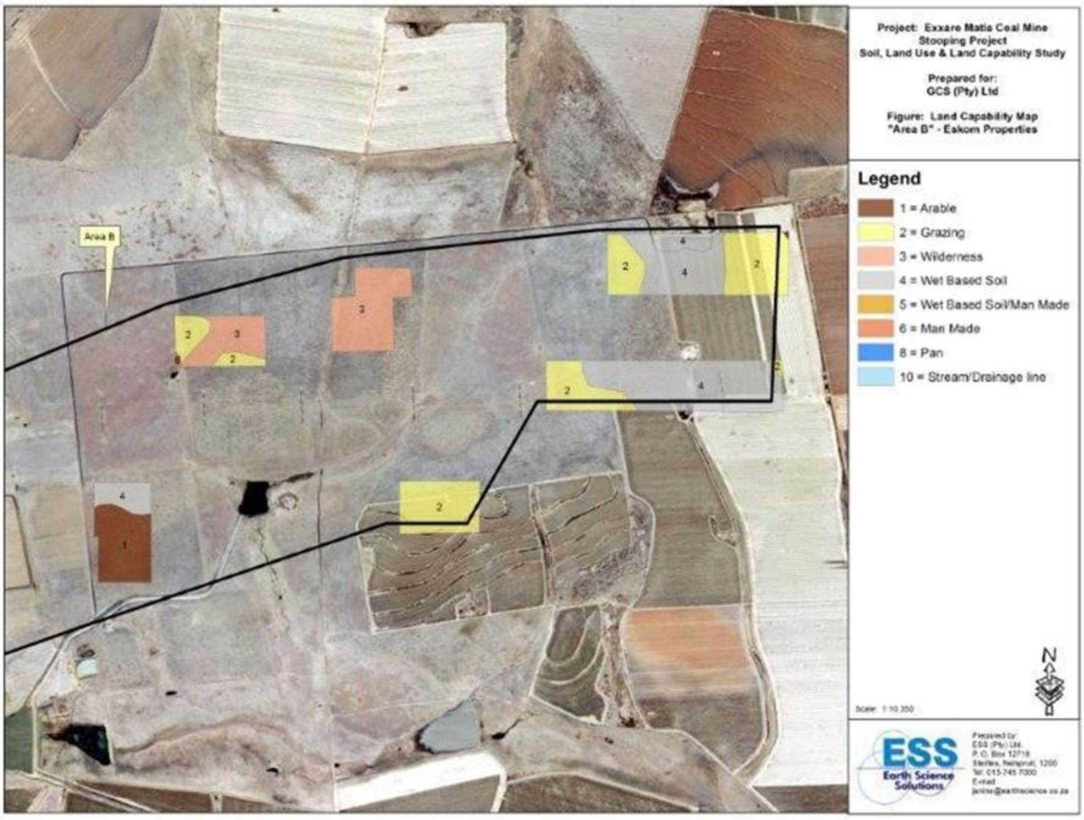

Figure 5.5: Land Capability Map of Area B - Stooping Project

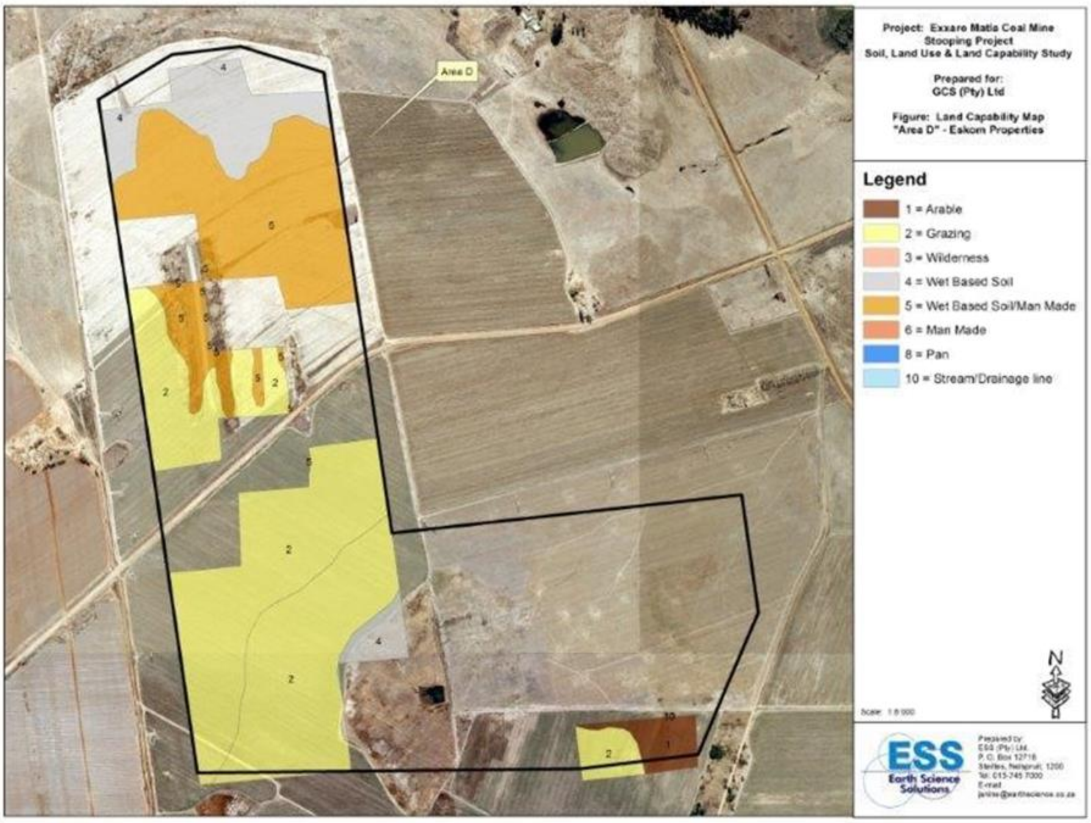

Figure 5.6: Land Capability Map of Area D - Stooping Project

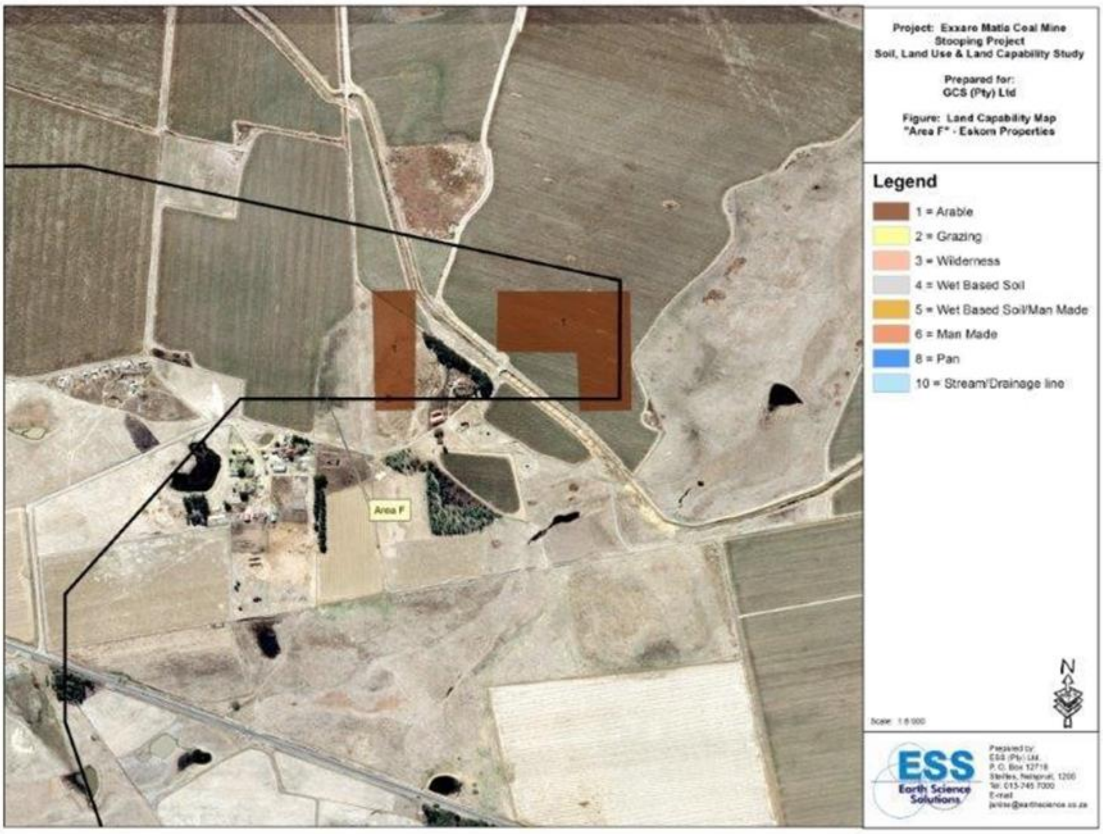

Figure 5.7: Land Capability Map of Area F - Stooping Project

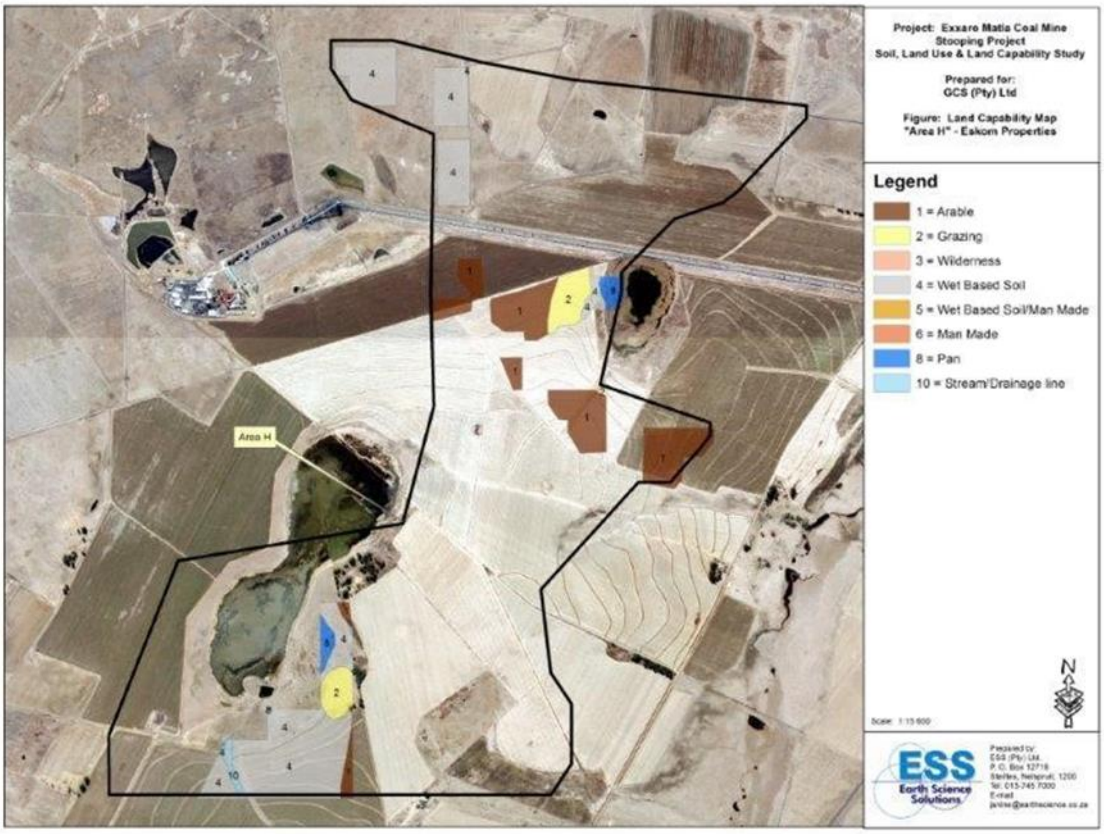

Figure 5.8: Land Capability Map of Area H - Stooping Project

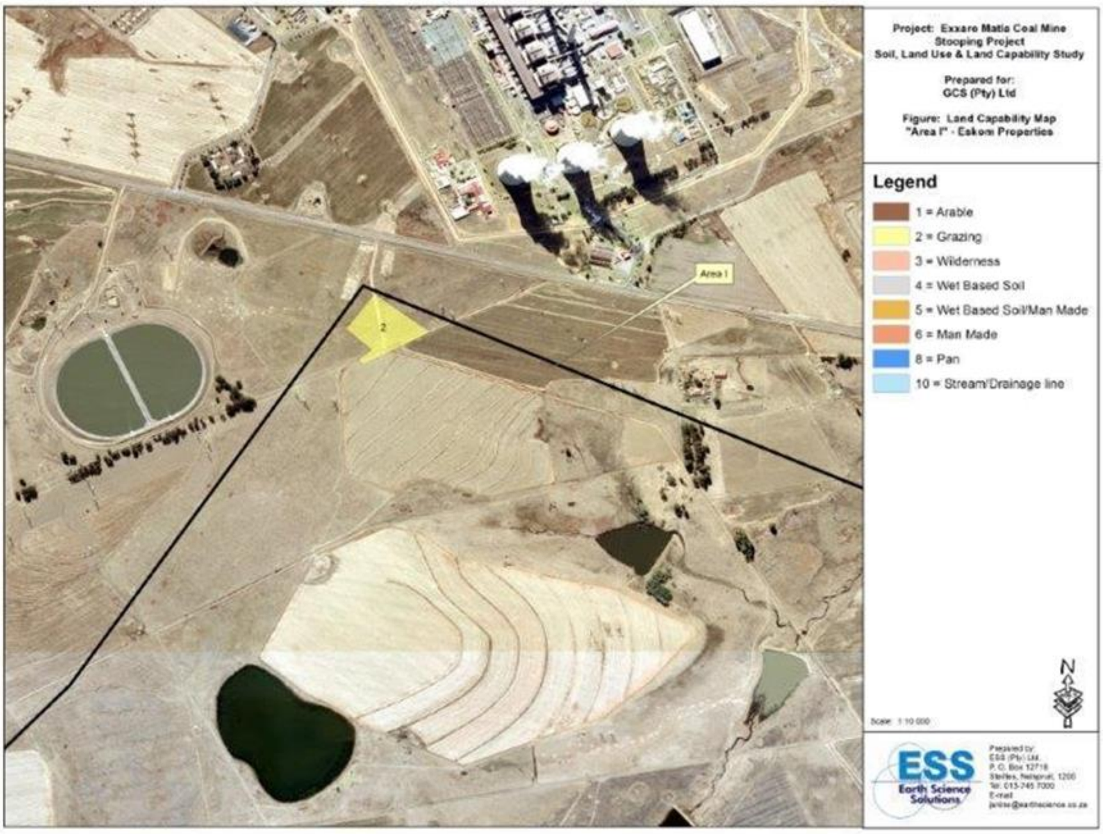

Figure 5.9: Land Capability Map of Area I - Stooping Project

5.4.4.1 Arable Land

Arable potential land is confined almost entirely to the deep and more friable soil forms, with the majority of the areas in question rather returning moderate to good quality grazing land.

These ratings are in spite of the fact that some soil depths are reflective of an arable status (>750mm), with the growth potential (nutrient status and soil water capabilities) and ability of these soils to return a cropping yield equal to or better than the national average is lacking. This is due mainly to the low than acceptable nutrient stores and the variable climatic conditions. These variables reflect the natural conditions, and do not include any man induced additives such as fertilisers or water (irrigation).

5.4.4.2 Grazing Land

The classification of grazing land is generally confined to the shallower and transitional zones that are well drained. These soils are generally darker in colour, and are not always free draining to a depth of 750mm but are capable of sustaining palatable plant species on a sustainable basis, especially since only the subsoil's (at a depth of >500mm) are periodically wetted. In addition, there should be no rocks or pedocrete fragments in the upper horizons of this soil group. If present it will limit the land capability to wilderness land.

The majority of the study area classifies as moderate to low intensity grazing land and/or wilderness status.

5.4.4.3 Wilderness/Conservation Land

The shallow rocky areas and soils with a structure that is stronger than Vertic (strong blocky) are characteristically poorly rooted, and support at best very low intensity grazing or more realistically are of a wilderness land capability rating and character.

5.4.4.4 Wetland (Areas with wetland status soils)

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

These zones (wetlands) are dominated by hydromorphic soils (wet based) that often show signs of structure, and have plant life (vegetation) that is associated with seasonal wetting or permanent wetting of the soil profile (separate study).

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

A significant but relatively small proportion of the study area classifies as having wet based soils.

These should not be mistaken as wetlands in terms of the delineation document, but should be highlighted as potential zones of sensitivity with the potential for highly sensitive areas associated with the prominent waterway that cross cut the mining development.

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

5.4.5 Current Land Use

The land use in the study area was assessed using a number of data sets, both historical as well as information obtained from the recent field studies, the aerial photographic coverage and discussions with the project team. In addition, the time spent in field while mapping the soils and classifying the land capability added to the understanding of the land use and land coverage (Figure 5.10, Figure 5.11 and Figure 5.15).

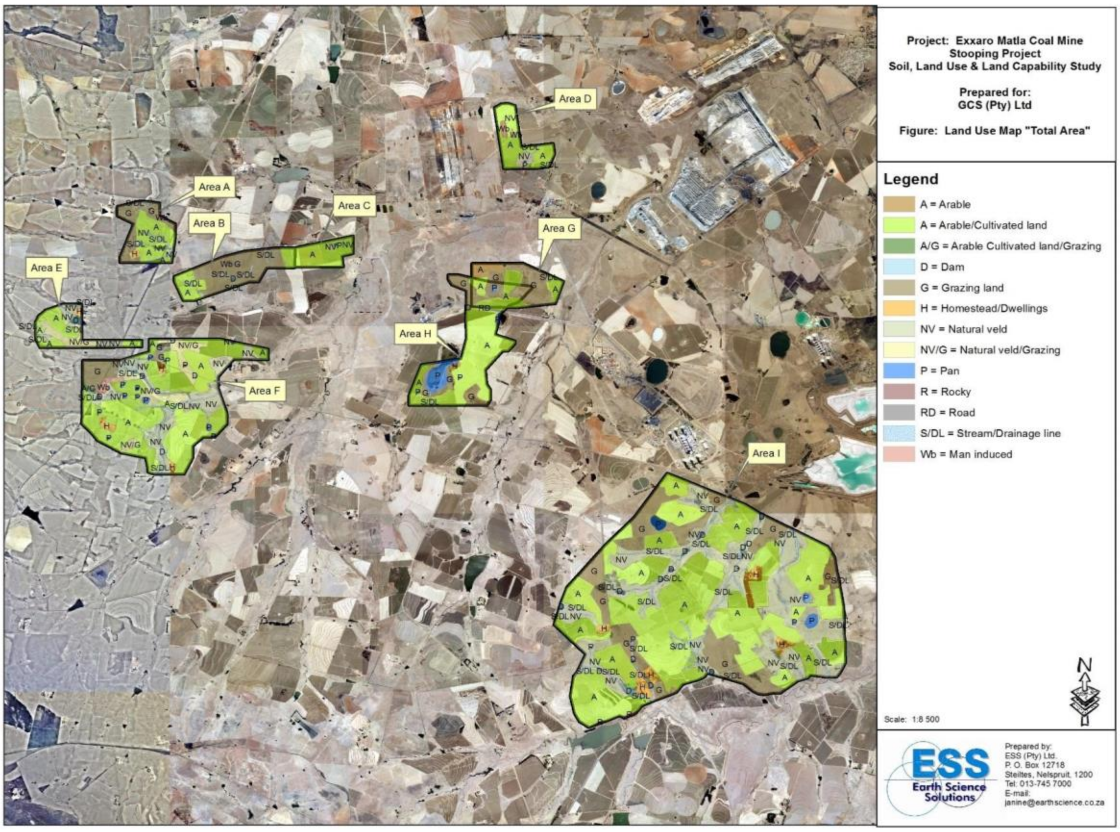

Figure 5.10: Pre-construction Land Use Map of the Exxaro Matla Coal mine Stooping Project area (Total Areas A-I)

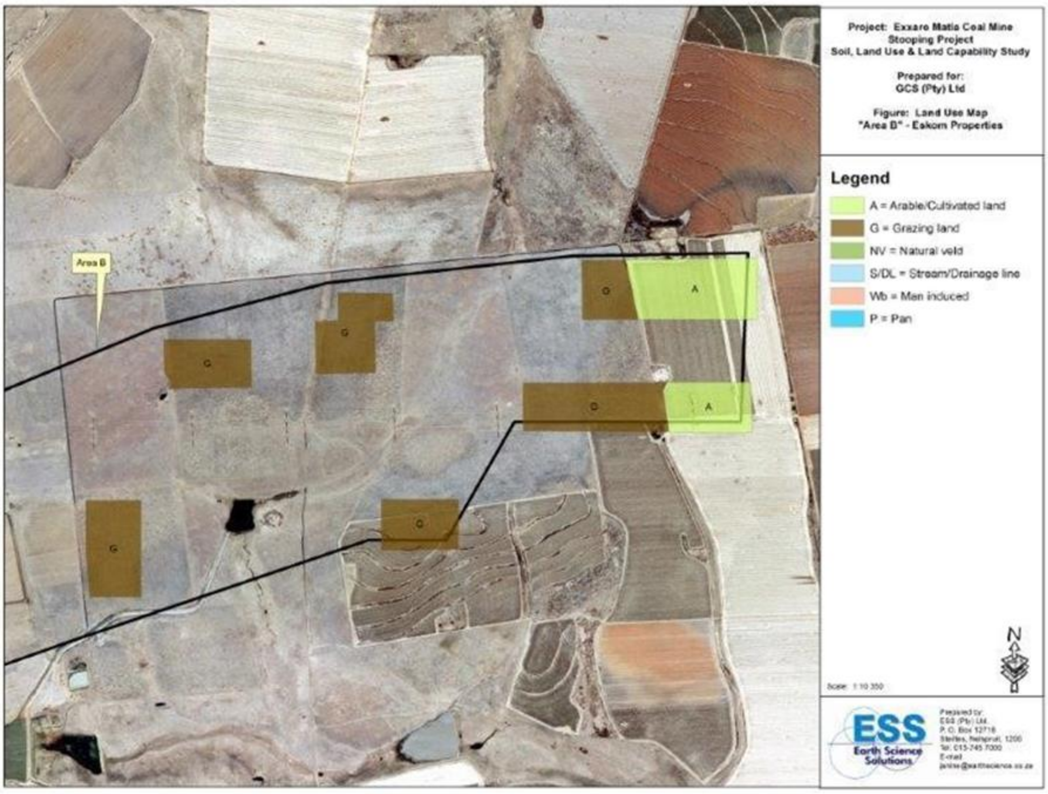

Figure 5.11: Pre-construction Land Use Map of Exxaro Stooping Project (Area B)

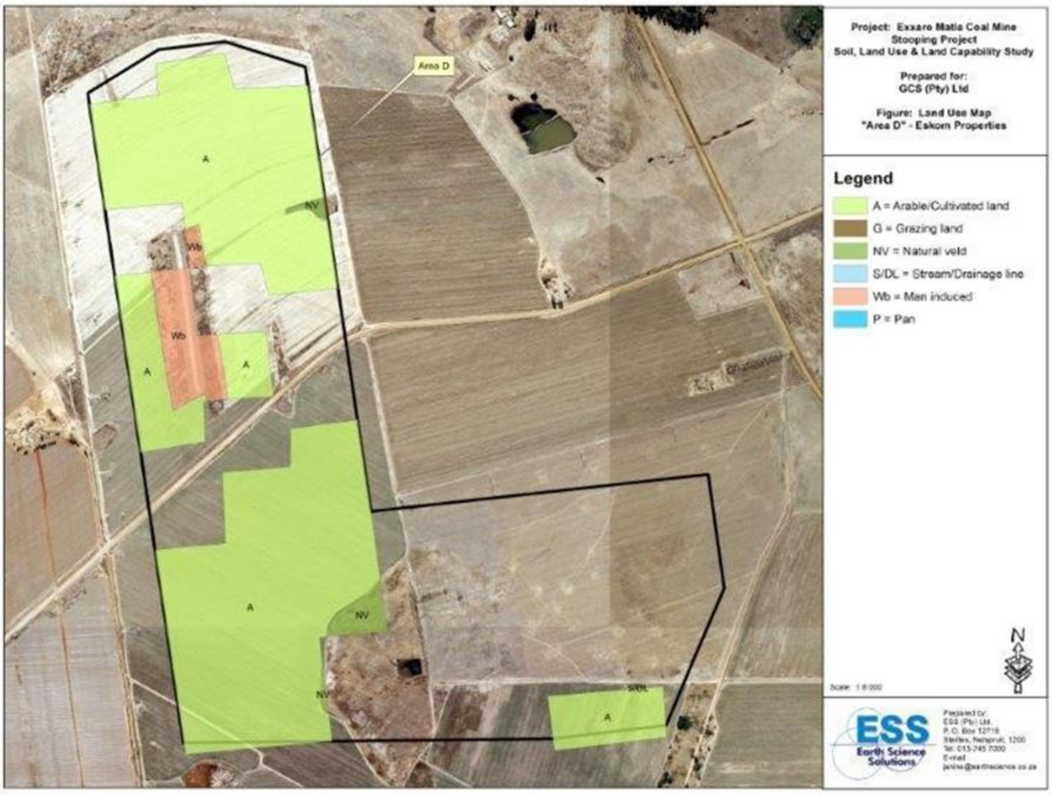

Figure 5.12: Pre-construction Land Use Map of Exxaro Stooping Project (Area D)

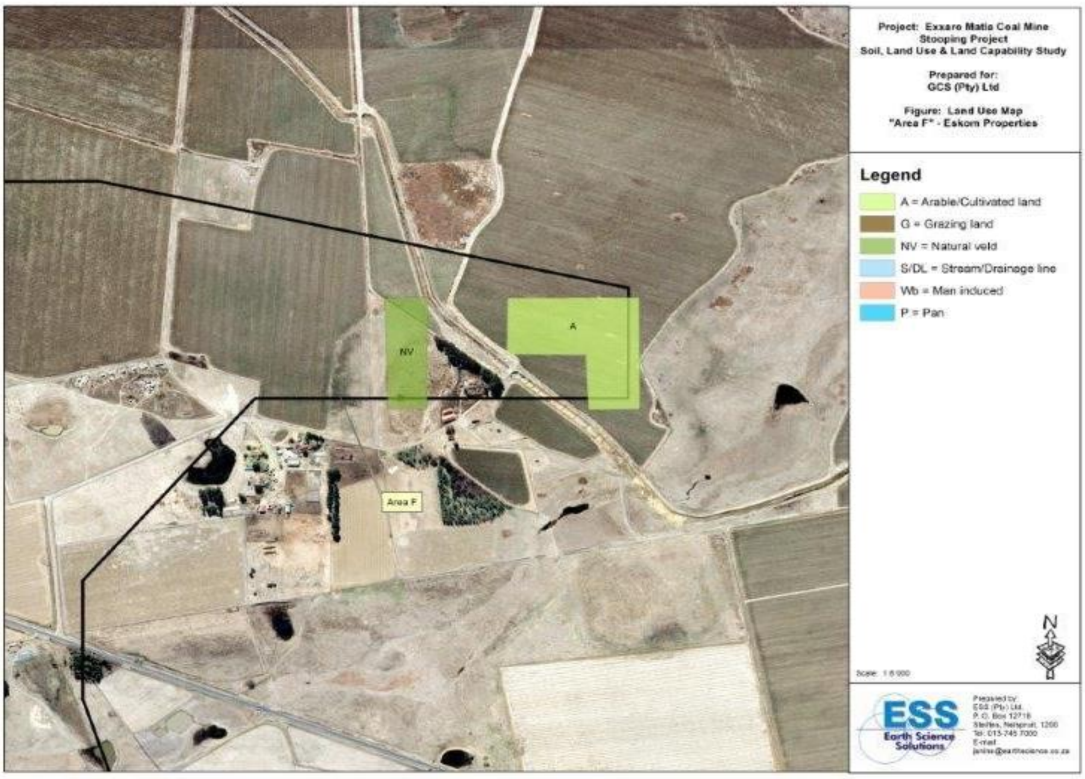

Figure 5.13: Pre-construction Land Use Map of Exxaro Stooping Project (Area F)

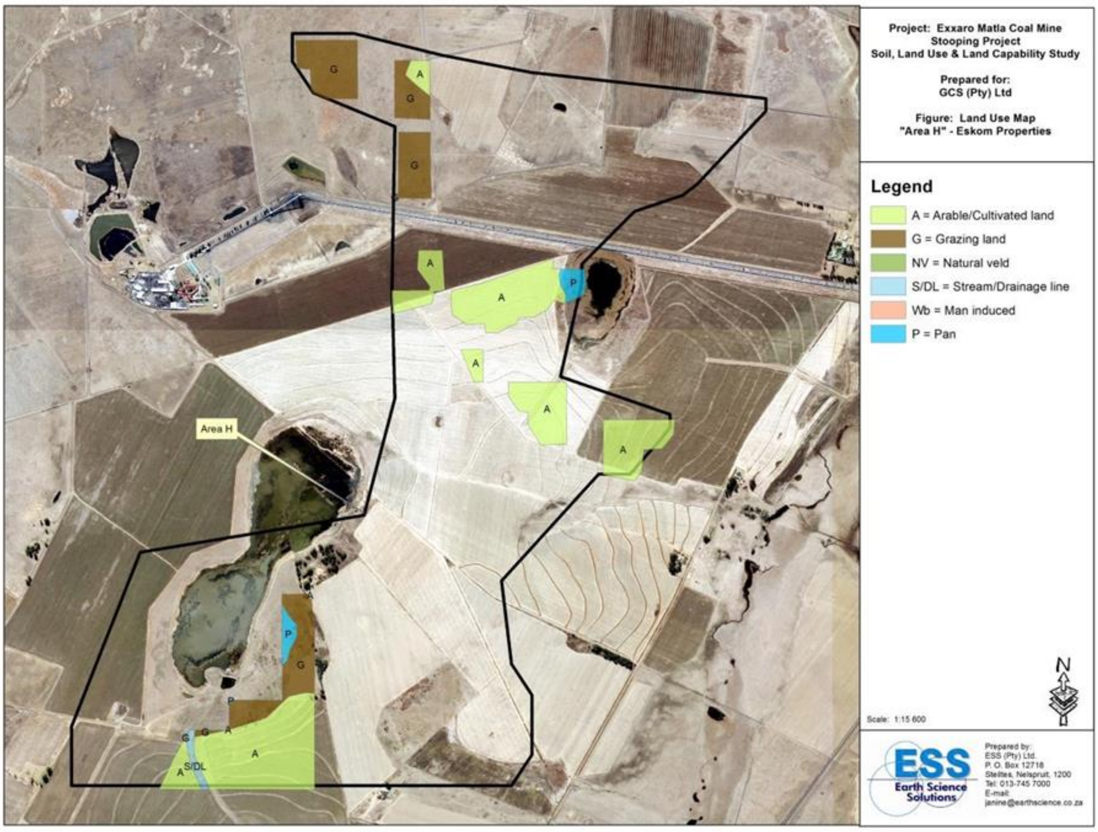

Figure 5.14: Pre-construction Land Use Map of Exxaro Stooping Project (Area H)

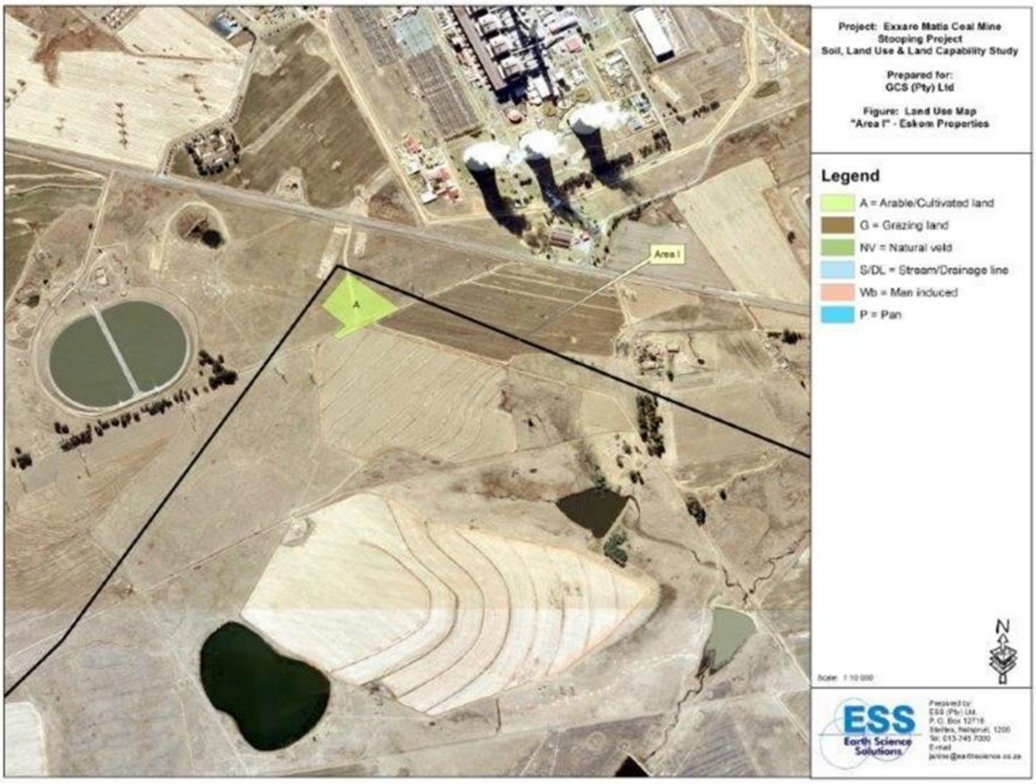

Figure 5.15: Pre-construction Land Use Map of Exxaro Stooping Project (Area I)

In general, the land use of the study area is considered to be altered, with a significant portion of the area having been changed from its original grassland biome to commercial farmlands.

The lower lying areas associated with the wetlands and wet based soils are for the most part unchanged, albeit that cultivation and utilisation of areas within this zone for livestock grazing and crop production were noted. On balance, the remainder of the site has been developed to either intensive grazing of the natural veld grasses or to commercial crops and cultivated pastures.

There is little to no subsistence farming practiced in the area, and no other commercial industry or urban dwellings exist. Homesteads and farm employees living on the land are the only other dwellings noted on the area.

Areas of historical and more recent coal mining are evident within the area of concern, albeit that the majority of the mining has been by underground bord and pillar system to date.

A more intensive study of the particular crop varieties and livestock ventures has not been undertaken, with the socio economic study having better access to these information and data sets.

5.5 Hydrology

The information contained in this section of the report was obtained from the Baseline Hydrology Assessment conducted by GCS (Pty) Ltd (Appendix D) and from the updated report for the consolidation process by SD hydrological Services (Pty) Ltd, attached herewith as Appendix F

5.5.1 Regional Hydrology and Topography

The project area falls within the quaternary catchments B11D, B11E and B20E, with majority of the Matla Mine boundary falling within quaternary catchment B11E. The quaternary catchments B11D, B11E and B20E have a net mean annual runoff (MAR) of 24.56 million cubic meters (mcm), 20.68 mcm and 19.28 mcm respectively (WR2005). Major rivers include the Rietspruit which drains quaternary catchment B11E, with most of the runoff emanating from the mid to northern sections of the Matla Mine boundary being drained by the mentioned river. Minor tributaries of the Steenkoolspruit drain the southern section of Matla Mine boundary which falls within quaternary catchment B11D. Due to the Rietspruit being a tributary of the Steenkoolspruit, most of the runoff eventually ends up in the Steenkoolspruit. Only a small portion of runoff emanating from the furthest north western boundary of the Matla Mine is drained north westerly into the Wilgerivier.

Average elevations at the quaternary catchments range from 1600 meters above mean sea level (mamsl) to 1630 mamsl, with average catchment slopes within the project area falling below 3% and is therefore characterised as relatively flat.

The hydrological setting of the project site is indicated in Figure 5.16. The digital elevation model (DEM) was sourced from the USGS website (http://hydrosheds.cr.usgs.gov/dataavail.php).

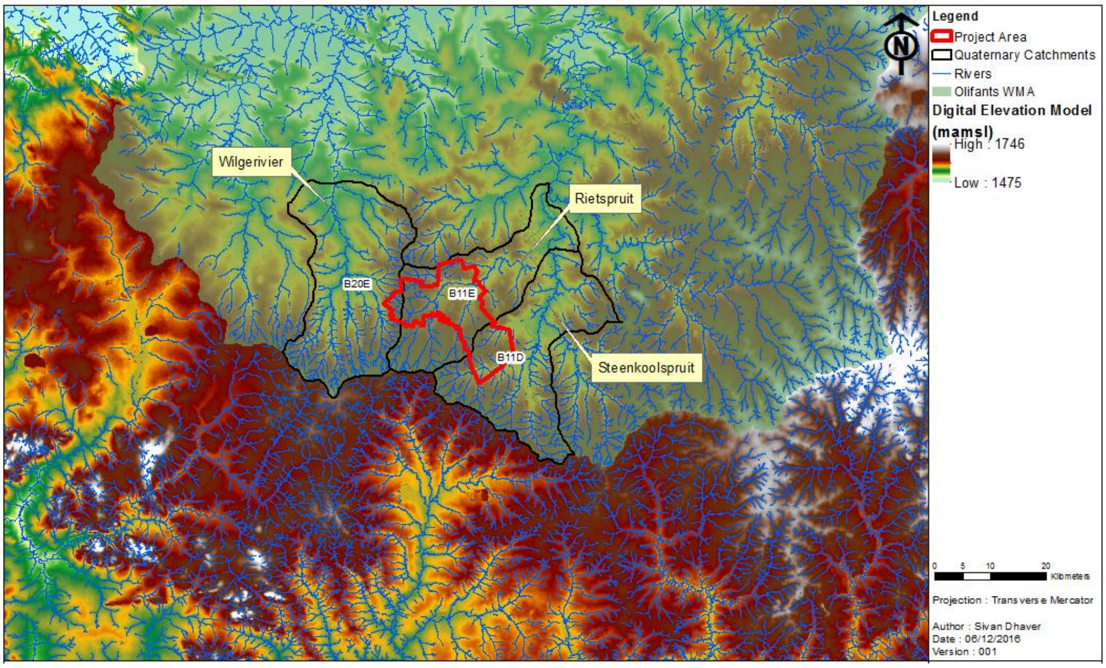

Figure 5.16: Hydrological setting

5.5.2 Catchment hydrology

Discretisation into sub-catchments is based on the topography of the study area, as shown in Figure 5.17 to Figure 5.20. This was undertaken in order to determine the clean water and dirty water catchment areas. No designation of the clean and dirty water catchments was carried out as there are no dirty water generating activities taking place on the surface. The parameters used to model the overland flow are listed in Table 5.5. Manning's 'n' coefficient used in the model for the impervious areas and pervious areas were 0.013 (float finish, concrete) and 0.15 (veld type vegetation), respectively (McCuen, 1996).

The soils were identified as being in the sandy loam group (WR2012). The model uses these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The sandy loam group resulted in a Suction Head of 110.1 mm, a Hydraulic Conductivity of 21.8 mm/hr and an Initial Deficit of 0.36 being used in the modelling. Simulated runoff volumes are summarised in Table 5.5 for the 50-year recurrence interval storm event.

Table 5.5: Catchment parameters used in the modelling of the overall SWMP

Name	Area (ha)	Flow Length (m)	Slope (%)	Runoff Volume (m^3)	Peak Runoff (m^3/s)
S1.	21.7	1093	1.7	3350	0.92
S2.	1.6	55	1.7	660	0.52
S3.	0.3	30	1.7	120	0.12

Name	Area (ha)	Flow Length (m)	Slope (%)	Runoff Volume (m^3)	Peak Runoff (m^3/s)
S4.	1.5	50	1.7	650	0.54
S5.	9.8	230	1.5	3040	1.37
S6.	5.2	100	3.3	2140	1.52
S7.	0.6	35	3.3	290	0.31
S8.	2.2	55	3.2	960	0.87
S9.	4.6	105	1.8	1790	1.15
S10.	2.9	105	0.3	880	0.39
S11.	0.4	25	0.3	160	0.12
S12.	3.1	70	0.5	1150	0.68
S13.	4.9	250	1.5	1480	0.64
S14.	13.2	380	3	3890	1.64
S15.	5.6	110	2.8	2230	1.51
S16.	0.8	95	0.5	260	0.14
S17.	0.6	60	0.4	210	0.12
S18.	3.7	90	1.4	1450	0.94
S19.	0.3	35	1.5	130	0.12
S20.	0.8	55	1.4	350	0.26
S21.	1.8	60	1.4	730	0.53
S22.	4.0	120	1.1	1420	0.79
S23.	4.4	140	0.8	1430	0.70
S24.	4.0	110	1.3	1480	0.88
S25.	16.4	220	1.5	5160	2.37
S26.	14.3	180	1.7	4860	2.50
S27.	4.5	125	2.2	1730	1.08
S28.	4.1	90	1.5	1610	1.05
S29.	5.8	140	1.3	2020	1.09
S30.	5.0	155	0.9	1620	0.78
S31.	13.0	300	2.2	3920	1.71
S32.	5.3	210	3.8	1930	1.10
S33.	15.3	200	3.7	5560	3.22
S34.	2.0	90	5.1	870	0.70
S35.	1.8	105	3	730	0.51
S36.	1.4	80	1.8	560	0.39
S37.	2.8	135	3.2	1090	0.71
S38.	2.6	80	6.7	1160	1.05
S39.	4.4	120	2.9	1730	1.15
S40.	4.6	150	2.6	1710	1.03
S41.	2.7	105	3.9	1100	0.79
S42.	19.3	200	2.3	6620	3.48
S43.	0.7	65	1.2	300	0.21

Name	Area (ha)	Flow Length (m)	Slope (%)	Runoff Volume (m^3)	Peak Runoff (m^3/s)
S44.	2.1	95	1.2	790	0.49
S45.	12.4	300	2.5	3830	1.71
S46.	4.5	115	2.5	1770	1.17
S47.	2.4	105	2	930	0.60
S48.	16.0	625	2	3520	1.17
S49.	5.5	90	3.3	2290	1.67
S50.	2.3	97	2.9	930	0.65
S51.	0.8	64	2	340	0.26
S52.	31.7	616	2.3	7270	2.48
S53.	37.8	620	4.6	10030	3.84
S54.	2.8	115	5.2	1160	0.84
S55.	4.5	110	1.6	1710	1.06
S56.	12.1	200	1.5	3910	1.87
S57.	15.8	175	0.8	4840	2.14
S58.	10.5	115	0.8	3640	1.93
S59.	28.2	255	1.9	8790	3.98
S60.	6.8	150	0.3	1830	0.72
S61.	9.6	190	1.3	3090	1.47
S62.	3.5	155	2.1	1260	0.72
S63.	4.1	170	2	1440	0.79
S64.	6.1	200	0.5	1630	0.63
S65.	8.3	115	1.2	3030	1.74
S66.	14.0	200	2.2	4790	2.49
S67.	5.7	135	2.1	2140	1.29

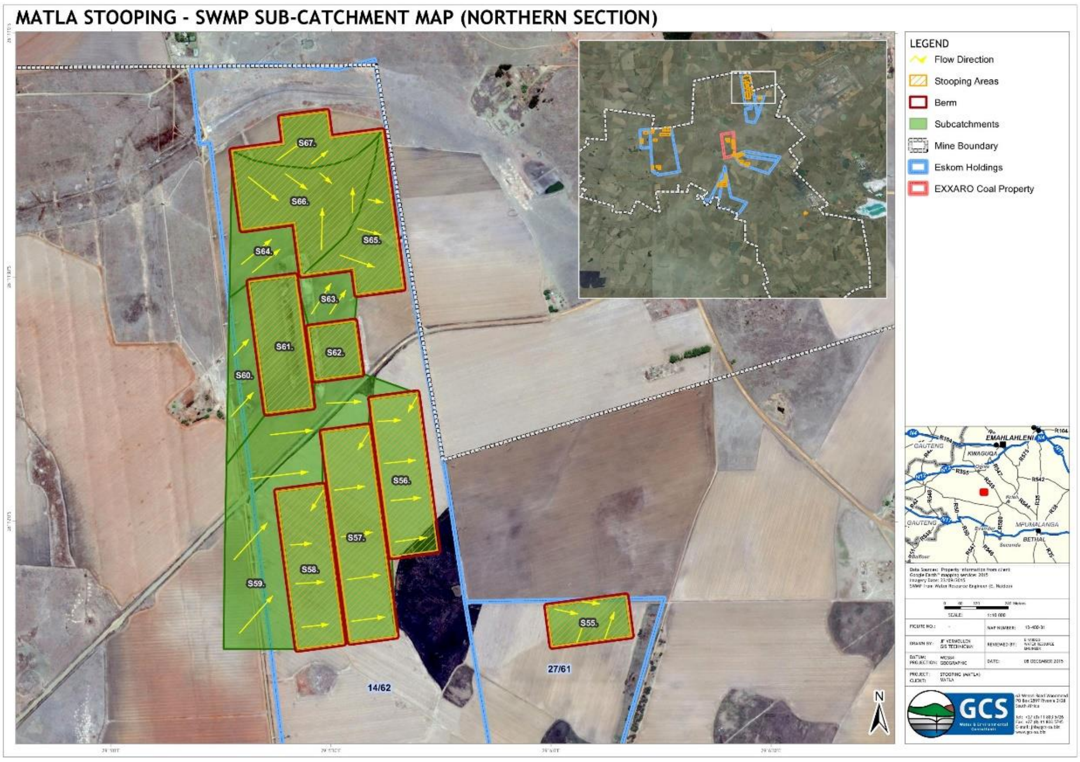

Figure 5.17: Layout and extent of the discretised surface water sub-catchments- Northern section

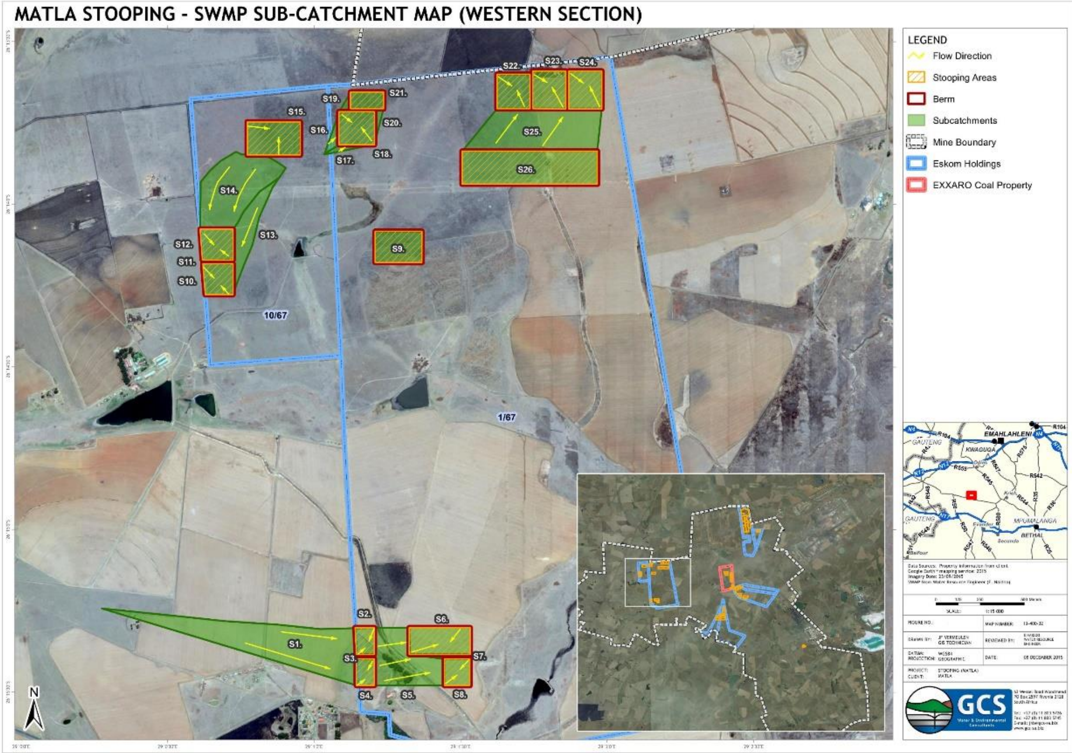

Figure 5.18: Layout and extent of the discretised surface water sub-catchments- Western section

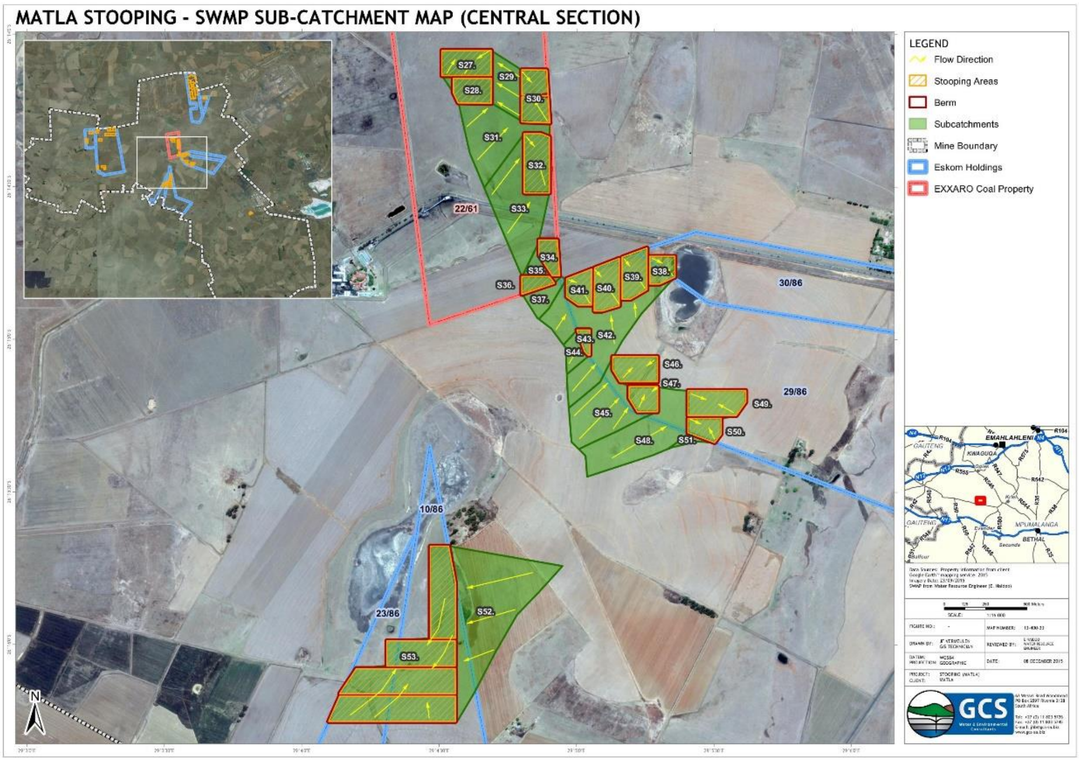

Figure 5.19: Layout and extent of the discretised surface water sub-catchments- Central section

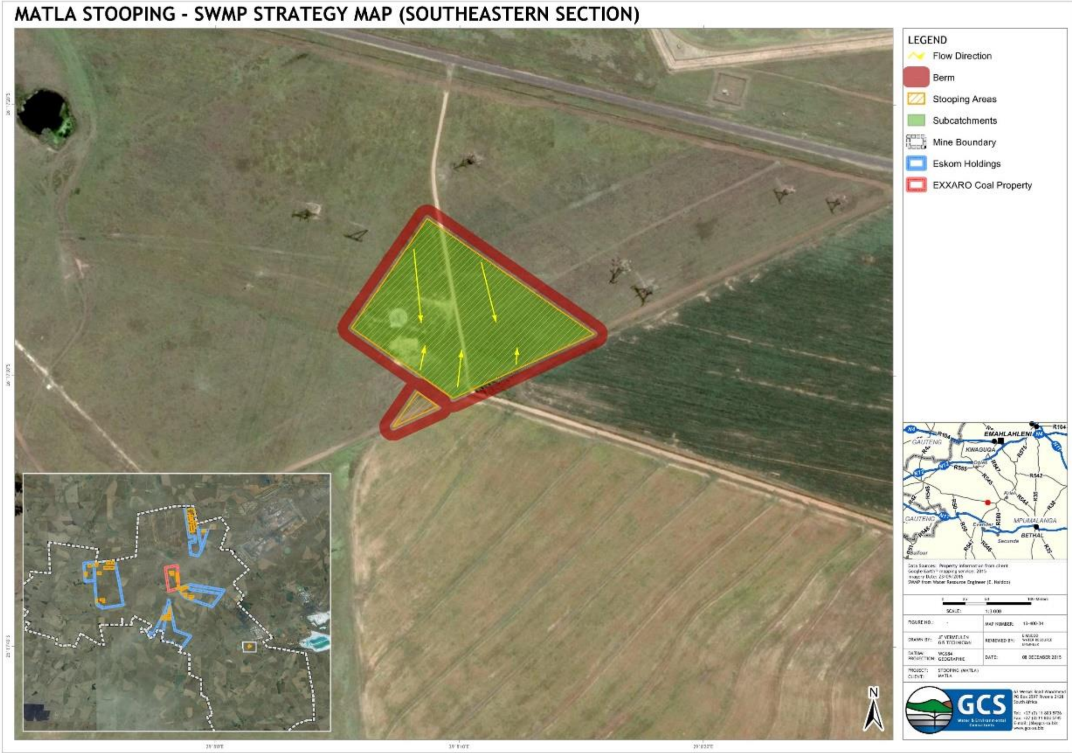

Figure 5.20: Layout and extent of the discretised surface water sub-catchments- South-Eastern section

5.5.3 Water Quality

The water quality for Matla was divided into zones for ease of reference. For each zone the pH, iron, sulphate and sodium concentrations will be analysed to identify annual trends and whether or not the parameter exceeds the South African Water Quality Guidelines. Not all pH graphs are included as pH is normally within the SAWQG Limit.

A total of 9 arbitrary zones where used to group the various water quality monitoring locations throughout the Matla Mine lease boundary. The allocated zones are named Zone 1 – 9 (Figure 5.21).

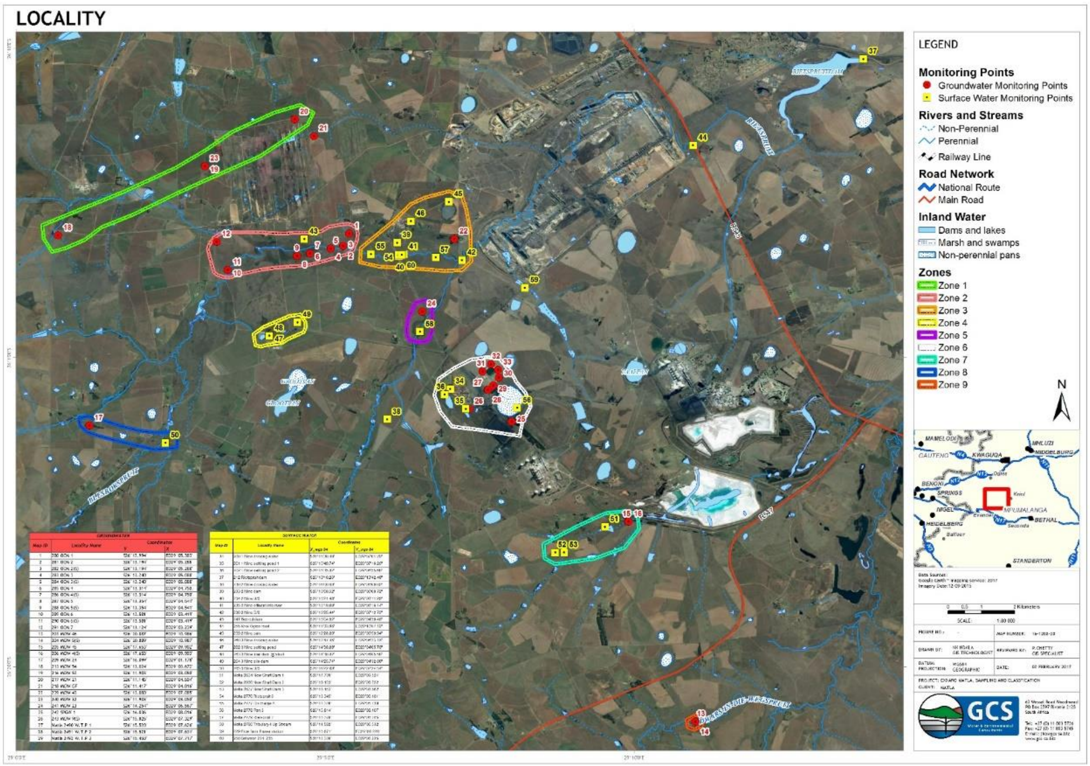

Figure 5.21: Surface and groundwater monitoring localities divided into zones

Surface water monitoring points are located in all the mentioned zones with the exception of Zone 1 and Zone 9. Therefore in the sections to follow they are intentionally left out.

5.5.3.1 Zone 2 Surface Water Quality

In Zone 2 there is only one surface monitoring point. The pH remained within the monitoring limits throughout the monitoring period. The sodium, Figure 5.23, and sulphate, Figure 5.24, annually peak in September/October with the most noteworthy increase occurring in 2015. Iron concentration, Figure 5.22, varies dramatically and consistently, throughout the monitoring period, exceeds the SAWQG Limit.

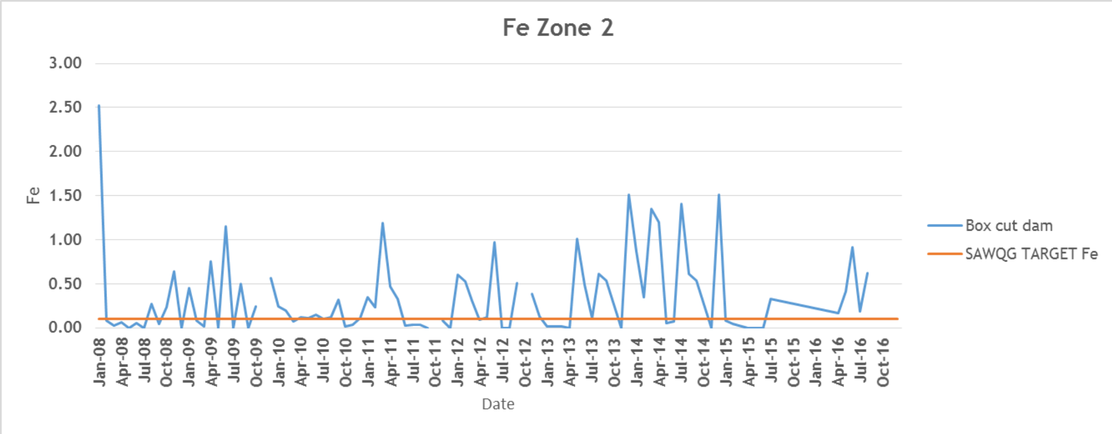

Figure 5.22 Iron Concentration, Zone 2, Box Cut Dam (GCS, 2017)

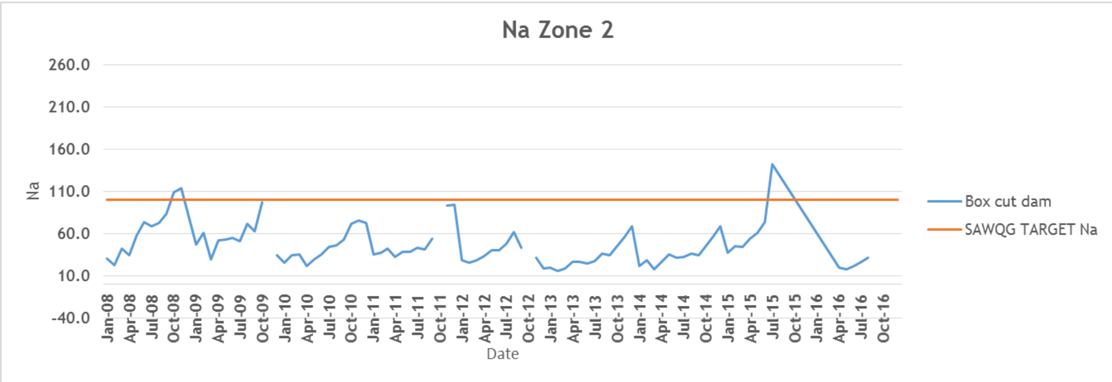

Figure 5.23 Sodium Concentration, Zone 2, Box Cut Dam (GCS, 2017)

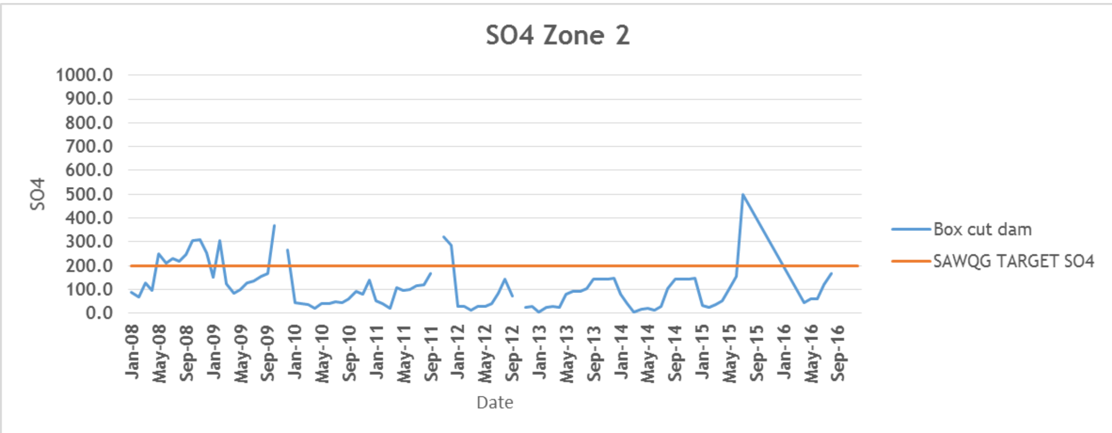

Figure 5.24 Sulphate Concentration, Zone 2, Box Cut Dam (GCS, 2017)

5.5.3.2 Zone 3 Surface Water Quality

The pH, Figure 5.25, for Emergency dam (previously 2 Mine Pan), Discharge 8 and Rietspruit 7 was satisfactory and within SAWQG Limits. Rietspruit 6 also had satisfactory pH with the exception of a sudden decrease in the beginning of 2016. The pH in 2 Mine Dam was elevated in the beginning of the monitoring period but has decreased. Sodium and sulphate concentration, Figure 5.27 and Figure 5.28, in 2 Mine Dam and Emergency dam follow the same trend; with the concentration of both decreasing throughout the monitoring period in 2 Mine Dam. Sodium and sulphate concentrations in Discharge 8 and Rietspruit 6 and 7 were initially high but decreased and currently remain within SAWQG Limits but are increasing. Rietspruit 6 had high iron concentration, Figure 5.26, in the beginning of the monitoring period but had decreased. Rietspruit 7 and Discharge 8 show varied iron concentrations exceeding the SAWQG Limit.

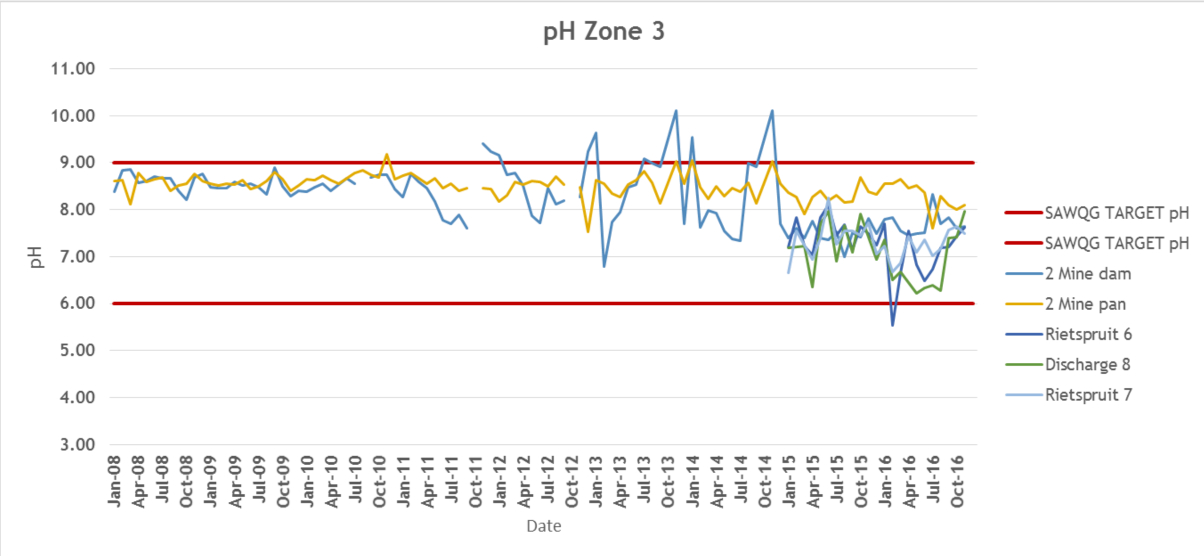

Figure 5.25: pH in surface water monitoring points, Zone 3

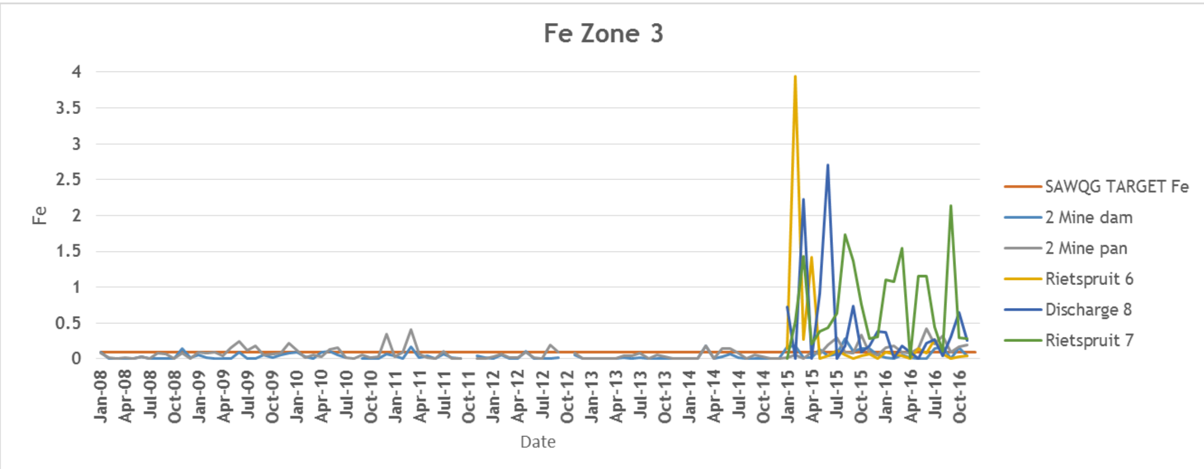

Figure 5.26: Iron concentration in surface water monitoring points, Zone 3

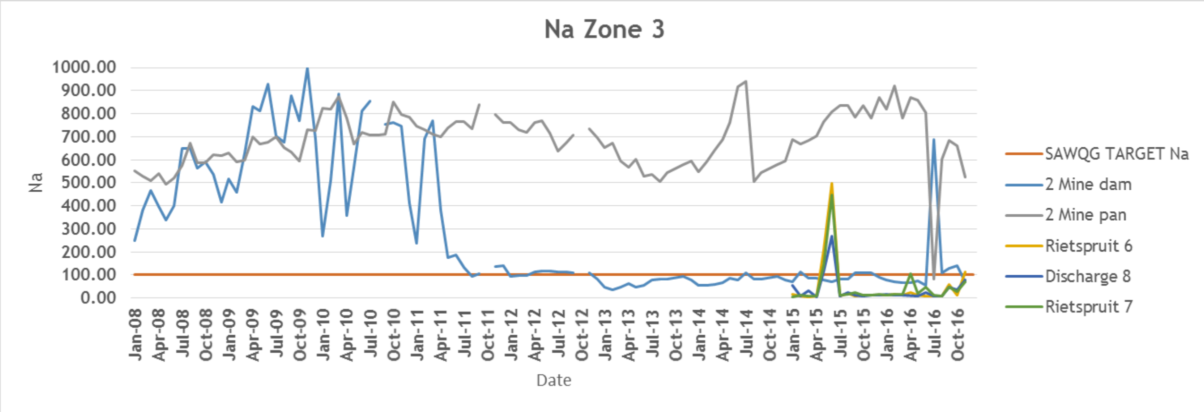

Figure 5.27: Sodium concentration in surface water monitoring points, Zone 3

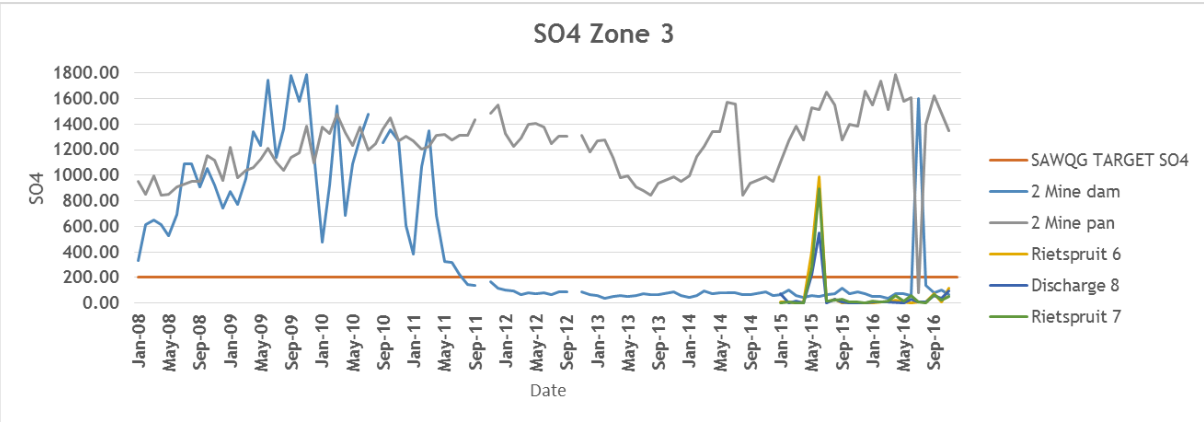

Figure 5.28: Sulphate concentration in surface water monitoring points, Zone 3

5.5.3.3 Zone 4 Surface Water Quality

The water quality in 3 Mine silo is consistently poor throughout the monitoring period with an elevated pH, increasing sodium and sulphate and varying iron concentrations with the most notable spike occurring in April 2012 with an iron concentration of 47.6 mg/l. Water quality in 3 Mine Final Dam at Shaft has progressively become poorer with pH, sodium, sulphate and iron concentrations increasing throughout the monitoring period. The water quality in 3 Mine Settling Pond has remained consistent with iron, pH and sulphate remaining constant and only sodium increasing and consistently exceeding the SAWQG Limit. Water quality for Zone 4 is depicted in Figure 5.29 to Figure 5.32.

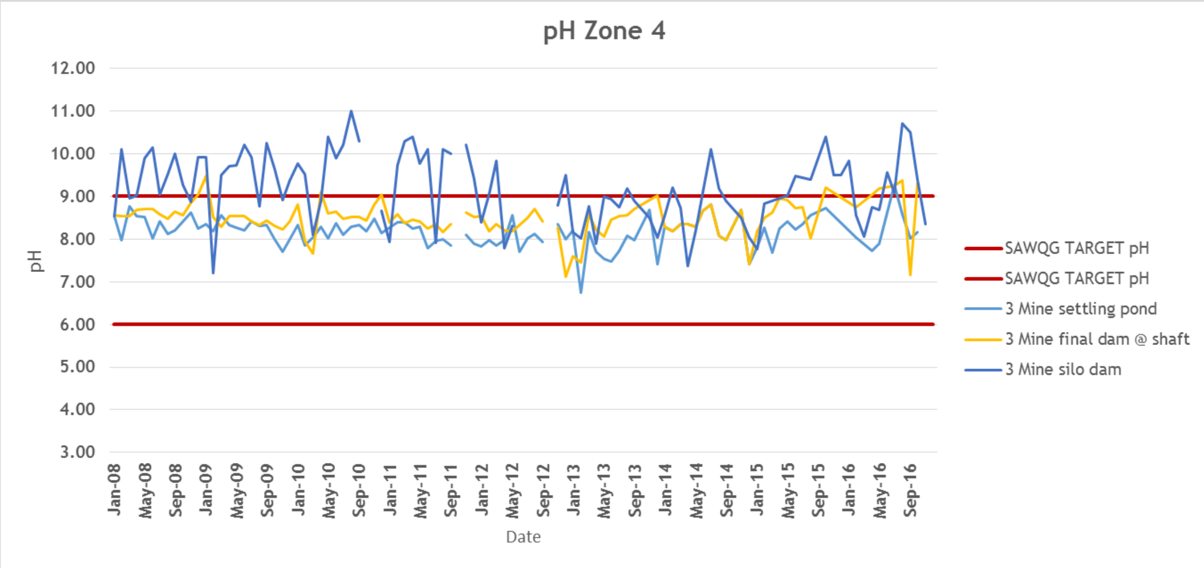

Figure 5.29: pH in surface water monitoring points, Zone 4

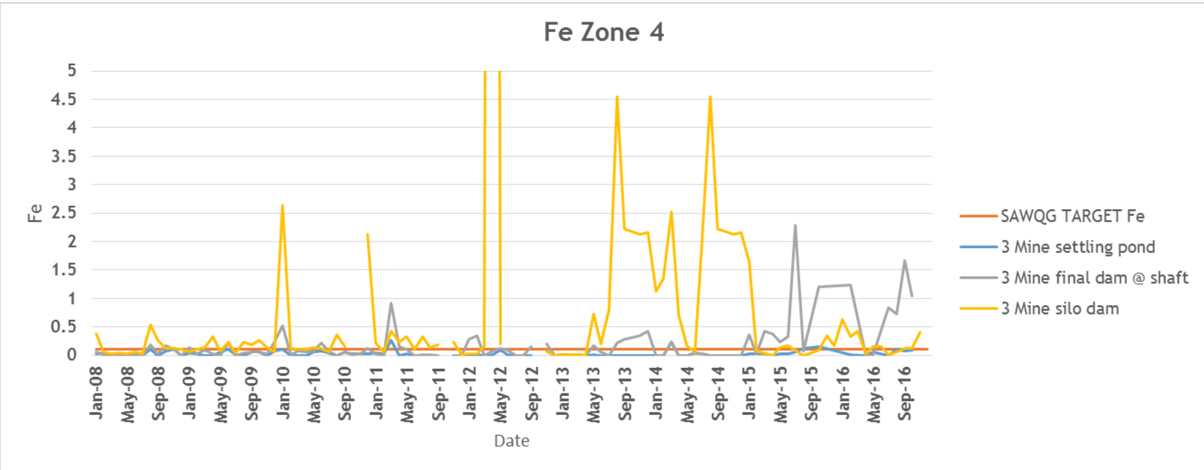

Figure 5.30: Iron concentration in surface water monitoring points, Zone 4

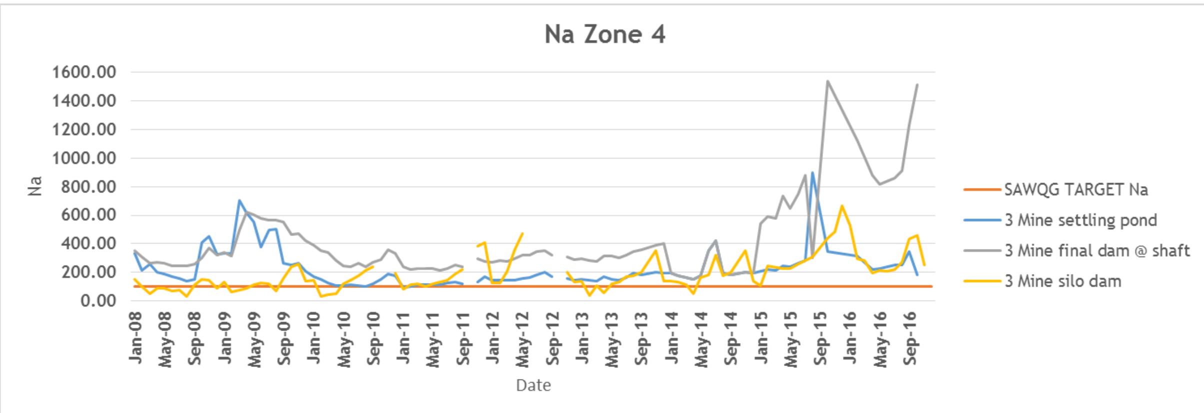

Figure 5.31: Sodium concentration in surface water monitoring points, Zone 4

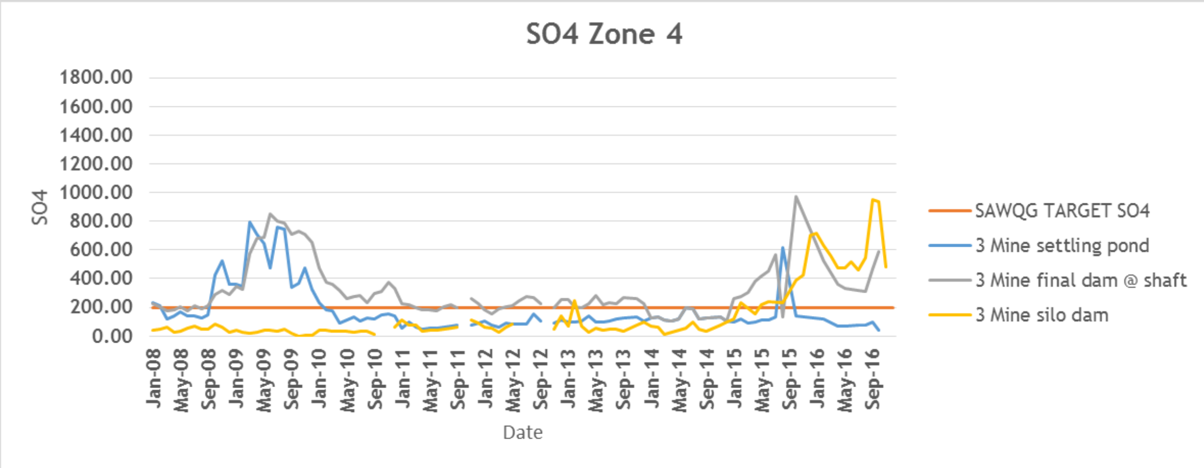

Figure 5.32: Sulphate concentration in surface water monitoring points, Zone 4

5.5.3.4 Zone 5 Surface Water Quality

Monitoring commenced in 2015 and large variation is seen in water quality over the two monitoring years. There was a decrease in pH, Figure 5.33, from September 2015 to March 2016 but has since increased to within the SAWQG Limit range. Iron concentration, Figure 5.34, has decreased during the monitoring period but exceeds the SAWQG Limit. Sodium concentration, Figure 5.35, has decreased but still remains above the limit whereas sulphate concentration, Figure 8.14, also exceeds the limit and has an annual spike during August/July.

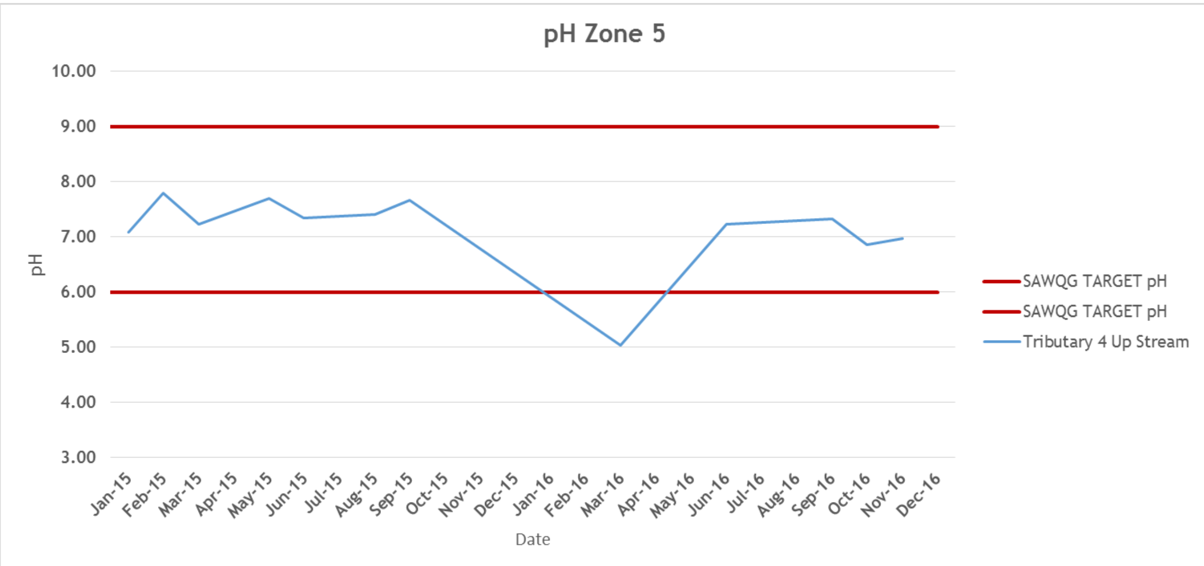

Figure 5.33: pH in surface monitoring pint, Zone 5

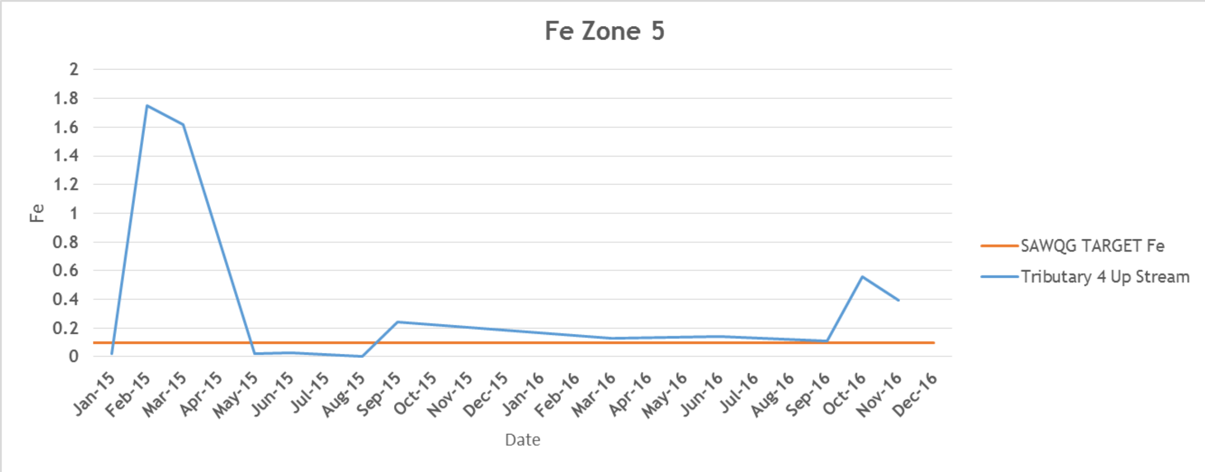

Figure 5.34: Iron concentration in surface water monitoring point, Zone 6

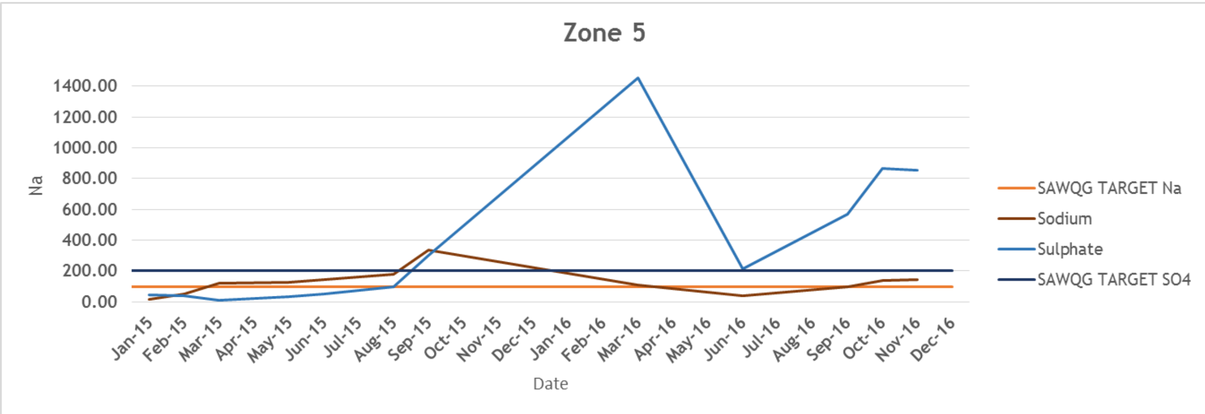

Figure 5.35: Sodium and sulphate concentration in surface water monitoring point, Zone 5

5.5.3.5 Zone 6 Surface Water Quality

Sodium and sulphate concentrations, Figure 5.37, in 1 Mine Settling Pond 1 and 2 were increasing gradually until a sudden increased occurred in 2015 whereas the concentrations remains constant in Pan 3, Figure 5.38. All three surface monitoring points do however exceed the SAWQG Limits for sodium and sulphate. Iron concentration, Figure 5.36, varies drastically in 1 Mine Settling Pond 1 and 2 with a slight increase occurring in Pan 3.

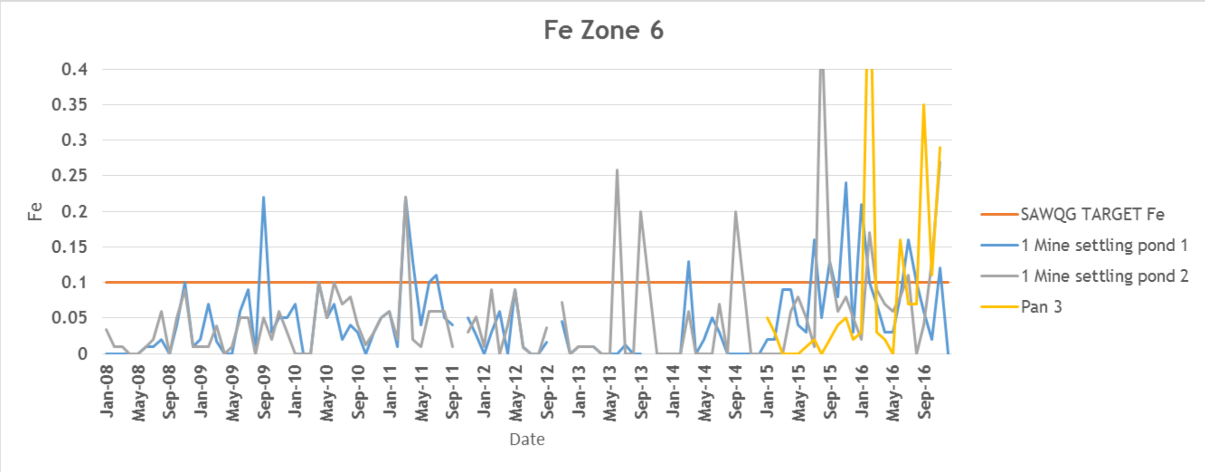

Figure 5.36: Iron concentration in surface water monitoring point, Zone 6

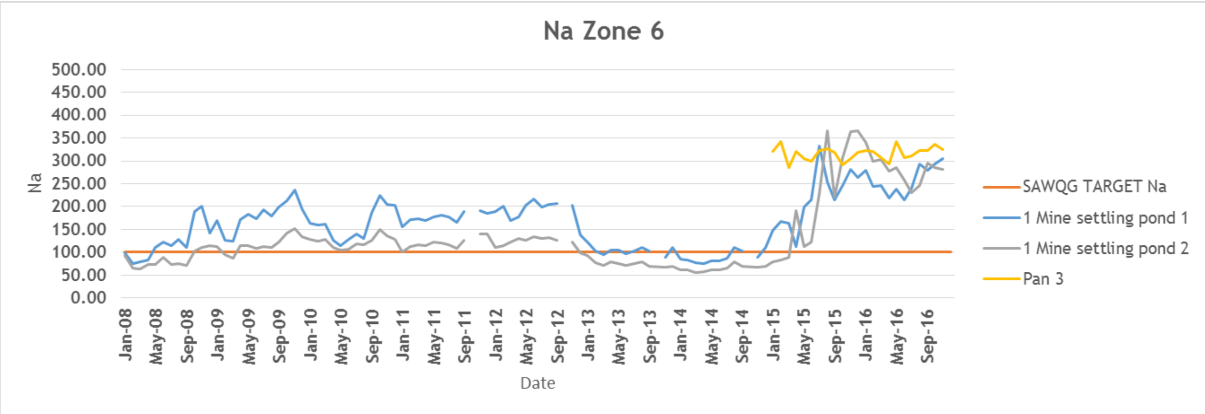

Figure 5.37: Sodium concentration in surface water monitoring point, Zone 6

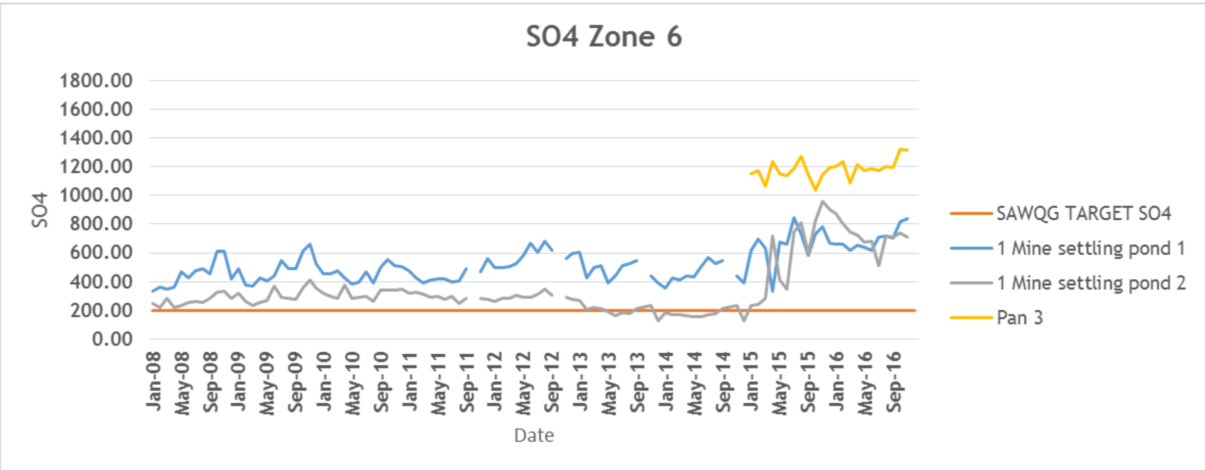

Figure 5.38: Sulphate concentration in surface water monitoring point, Zone 6

5.5.3.6 Zone 7 Surface Water Quality

The sulphate, Figure 5.41, and sodium, Figure 5.40, concentration in New Shaft Dam 2 has gradually been increasing with sulphate exceeding the SAWQG Limits. Of all three dams New Shaft Dam 1 has the highest and most varied iron concentrations,Figure 5.39. Sodium in New Shaft Dam 1 decreased for most of the monitoring period but since September 2016 has started increasing slightly whereas sulphate concentrations were constant until a decrease occurred in July 2016. The iron concentration, New Shaft Dam 3, remained constant for most of the monitoring period until a sudden increased occurred in October 2016. The sodium and sulphate concentrations, of New Shaft Dam 3, follow the same trend increasing and decreasing at the same time.

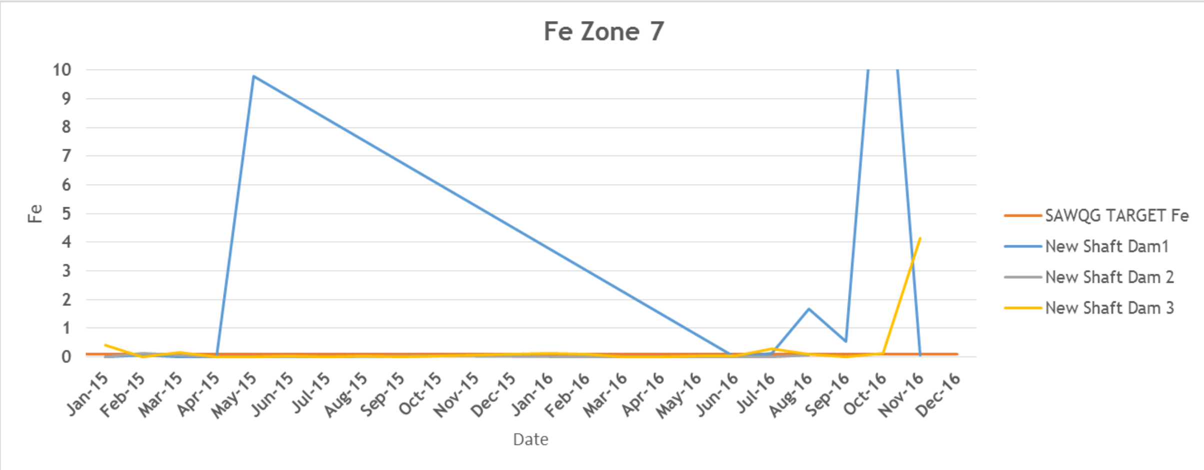

Figure 5.39: Iron concentration in surface water monitoring points, Zone 7

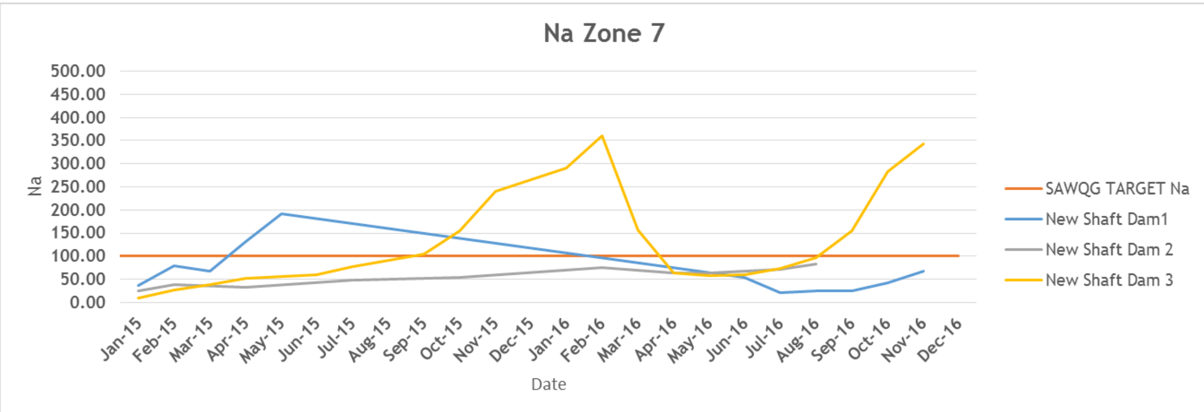

Figure 5.40: Sodium concentration in surface water monitoring points, Zone 7

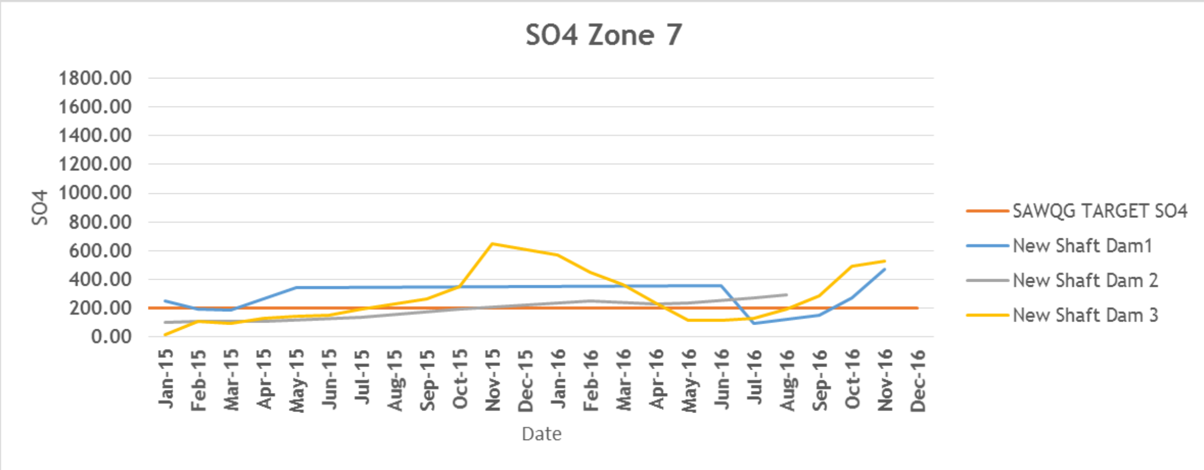

Figure 5.41: Sulphate concentration in surface water monitoring points, Zone 7

5.5.3.7 Zone 8 Surface Water Quality

Zone 8 has one surface water monitoring point, 2 Mine U/P. The iron concentration, Figure 5.42, Figure 5.43 varies greatly and consistently exceeds the SAWQG Limit. Sodium and sulphate concentrations, Figure 8.22, also vary following similar trends with an irregular increase occurring in 2016.

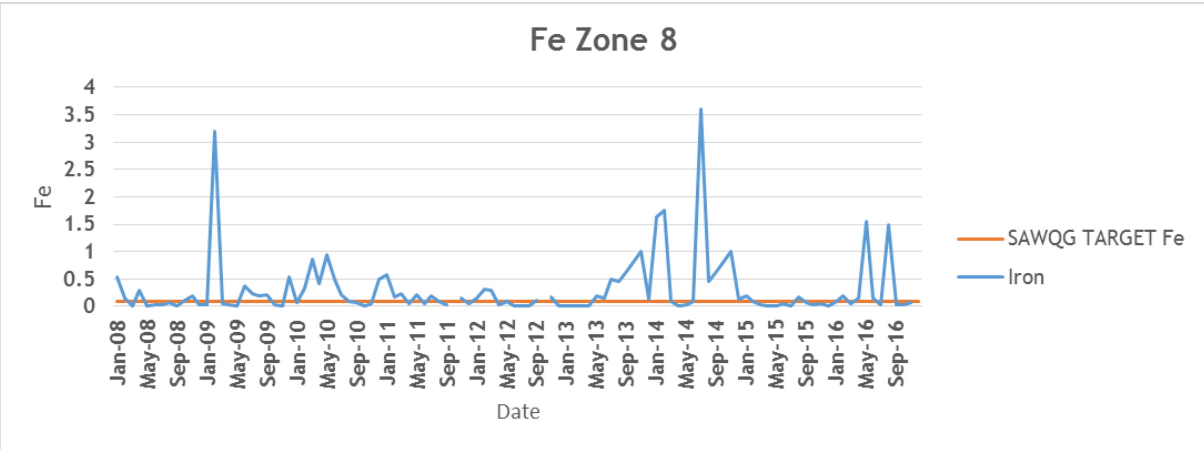

Figure 5.42: Iron concentration in surface water monitoring point, Zone 8

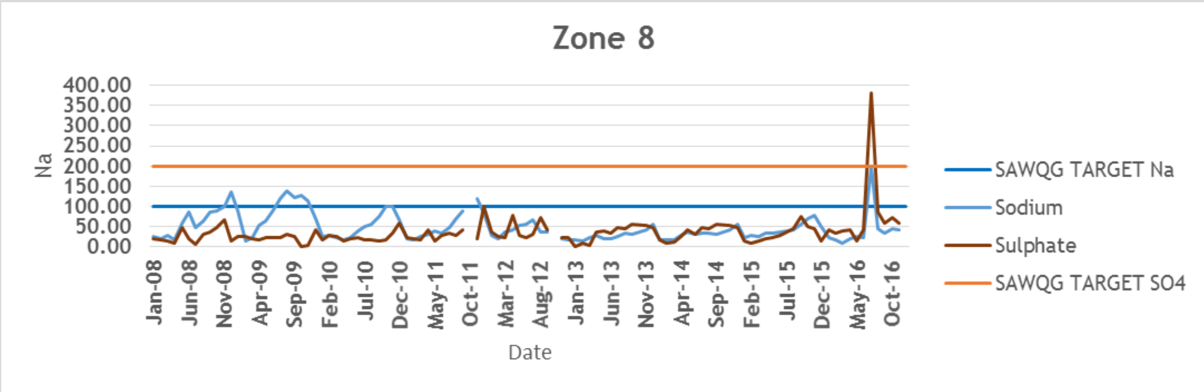

Figure 5.43: Sulphate and sodium concentrations in surface water monitoring point, Zone 8

5.5.3.8 Drinking Water Monitoring Points

The drinking water samples were not included in their respective zones to allow for a better comparison. 1 Mine Drinking Water and 3 Mine Drinking Water are located in Zone 1 and 3 respectively and 2 Mine Drinking Water is not in an allocated zone. The pH, Figure 5.44, and iron concentration, Figure 5.45, in all three drinking water samples is satisfactory. Turbidity, Figure 5.46, varies in all three drinking water samples but has shown a decrease over the monitoring period.

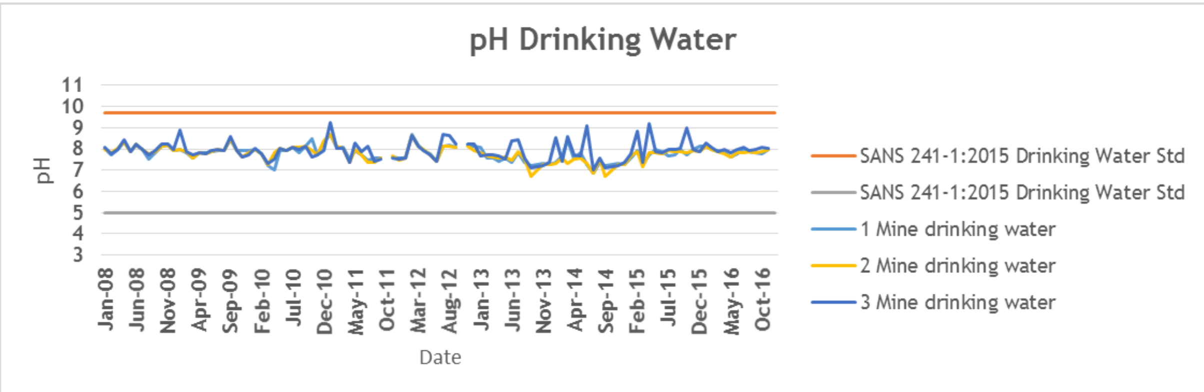

Figure 5.44: pH of all drinking water sampled

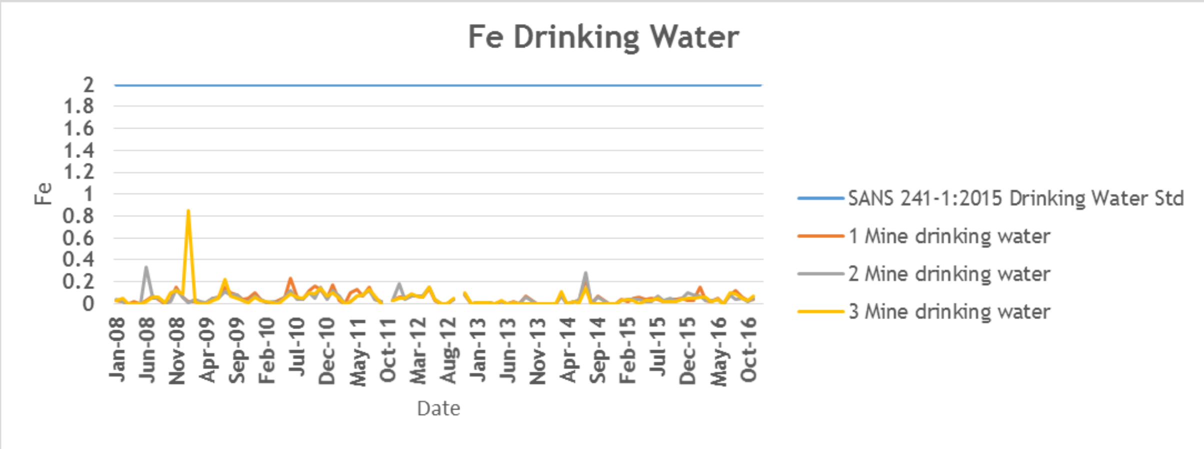

Figure 5.45: Iron concentration of drinking water samples

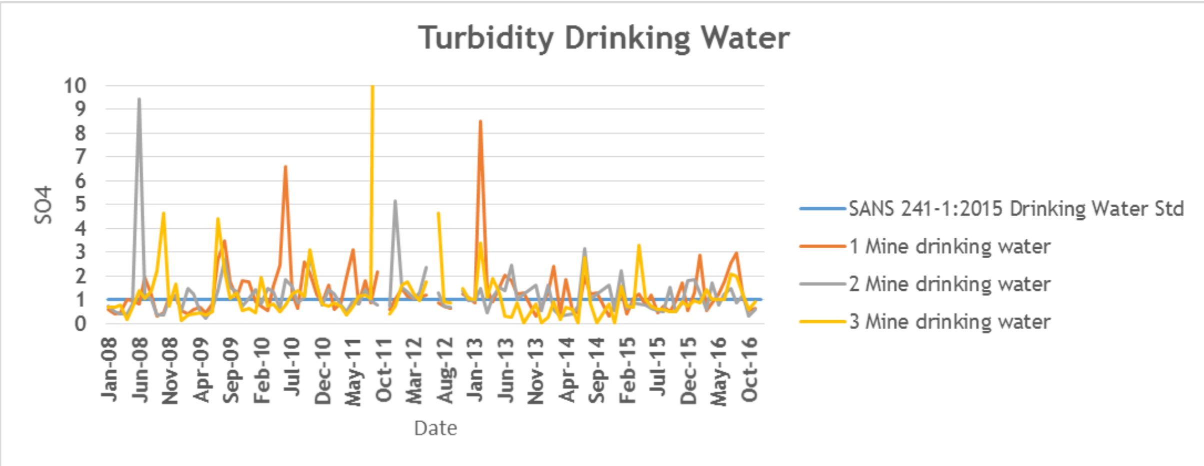

Figure 5.46: Turbidity of drinking water samples

5.5.3.9 Surface Water Quality with no Allocated Zones

A decrease is observed in the sodium, iron and sulphates concentrations of the Flow from Power Station. The Rietspruit Dam showed consistent low sodium and sulphate concentrations with varies iron concentrations. The sampling point, Kriel Ogies Road, is located downstream east of the Matla Coal Mine and shows varying iron, that has increased in 2016 and a decrease in sulphates has also occurred over the monitoring period. The iron, sodium and sulphate concentration, for Kriel Ogies Road monitoring point, can be seen in Figure 5.47 to Figure 5.49.

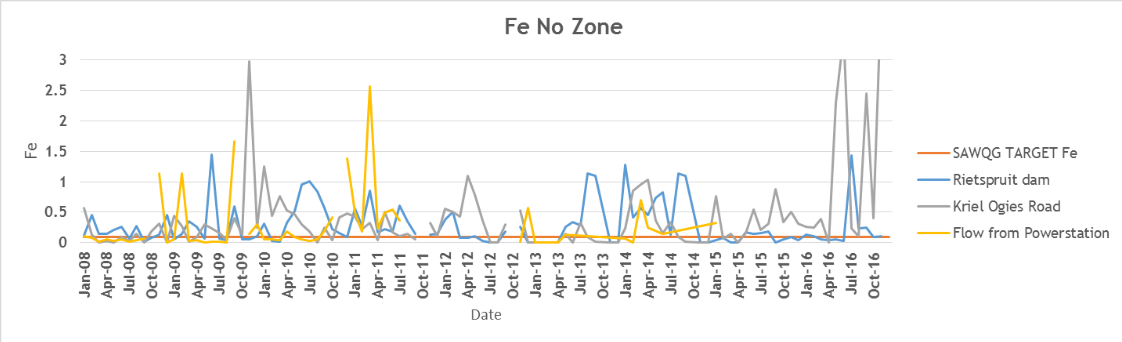

Figure 5.47: Iron concentration in varies unzoned monitoring points

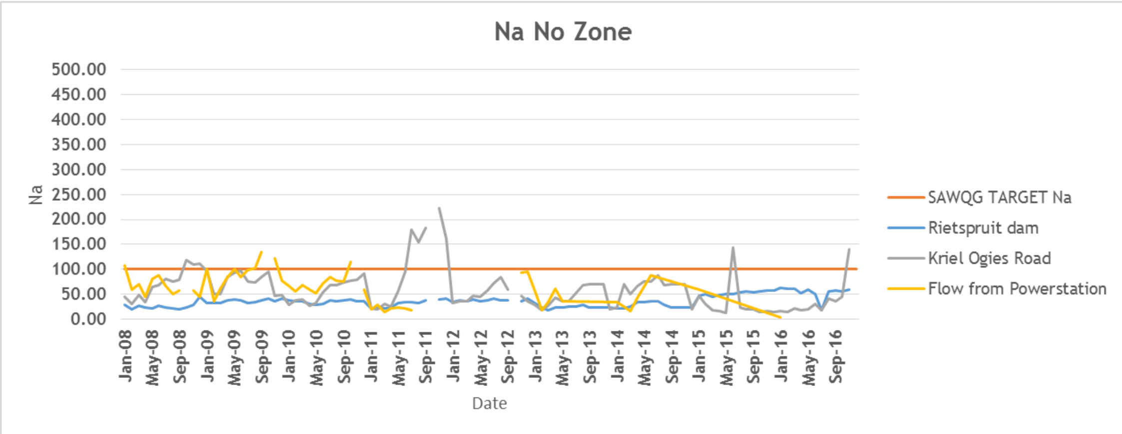

Figure 5.48: Sodium concentration in varies unzoned monitoring points

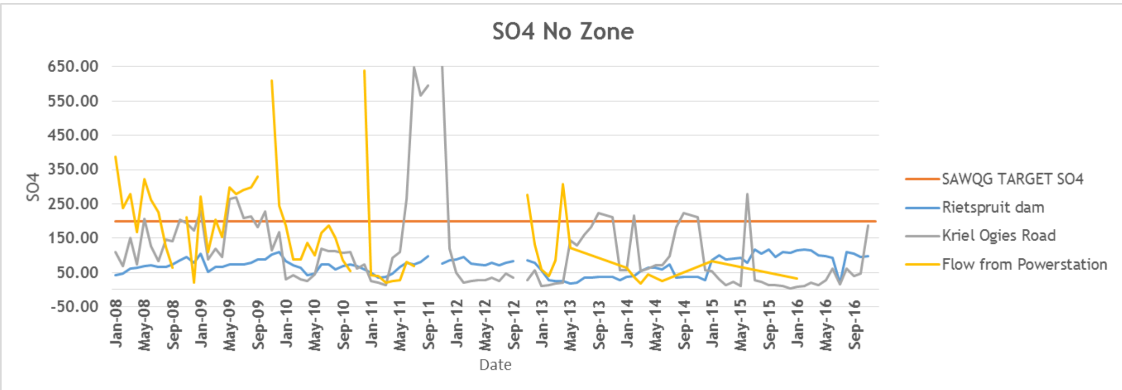

Figure 5.49: Sulphate concentration in varies unzoned monitoring points

5.6 Geohydrology

The information contained in this section of the report was obtained from the Baseline Hydrogeology Assessment conducted by GCS (Pty) Ltd (Appendix D) and from the updated report for the consolidation process by Groundwater Complete (Pty) Ltd, attached herewith as Appendix F

A conceptual model is in reality our holistic understanding of the workings and nature of the aquifer regime underlying the Matla mining area. A good understanding of the hydrogeological environment is key to the accurate assessment of potential groundwater impacts associated with the mining activities. All components of the conceptual model are discussed in as much detail as possible in the following subsections.

5.6.1 Results of the Hydrocensus/User Survey

Comprehensive hydrocensus/users surveys were conducted for the Matla mine lease area and immediate surrounding during four individual groundwater related studies:

- Mining operations at Mine 1, Mine 2 and Mine 3 (*GCS, 2006*),
- New access shaft and overland conveyor for Mine 1 (*Groundwater Square, 2008*),
- Information review and gap analysis to support the EIA for stooping and opencast mining (*Golder 2011*), and
- The stooping of existing underground mining areas located on Eskom and Exxaro owned land surface areas (*GCS, 2016*).

The results of the hydrocensus surveys are summarised in the hydrogeological report, while borehole positions are indicated in Figure 5.50.

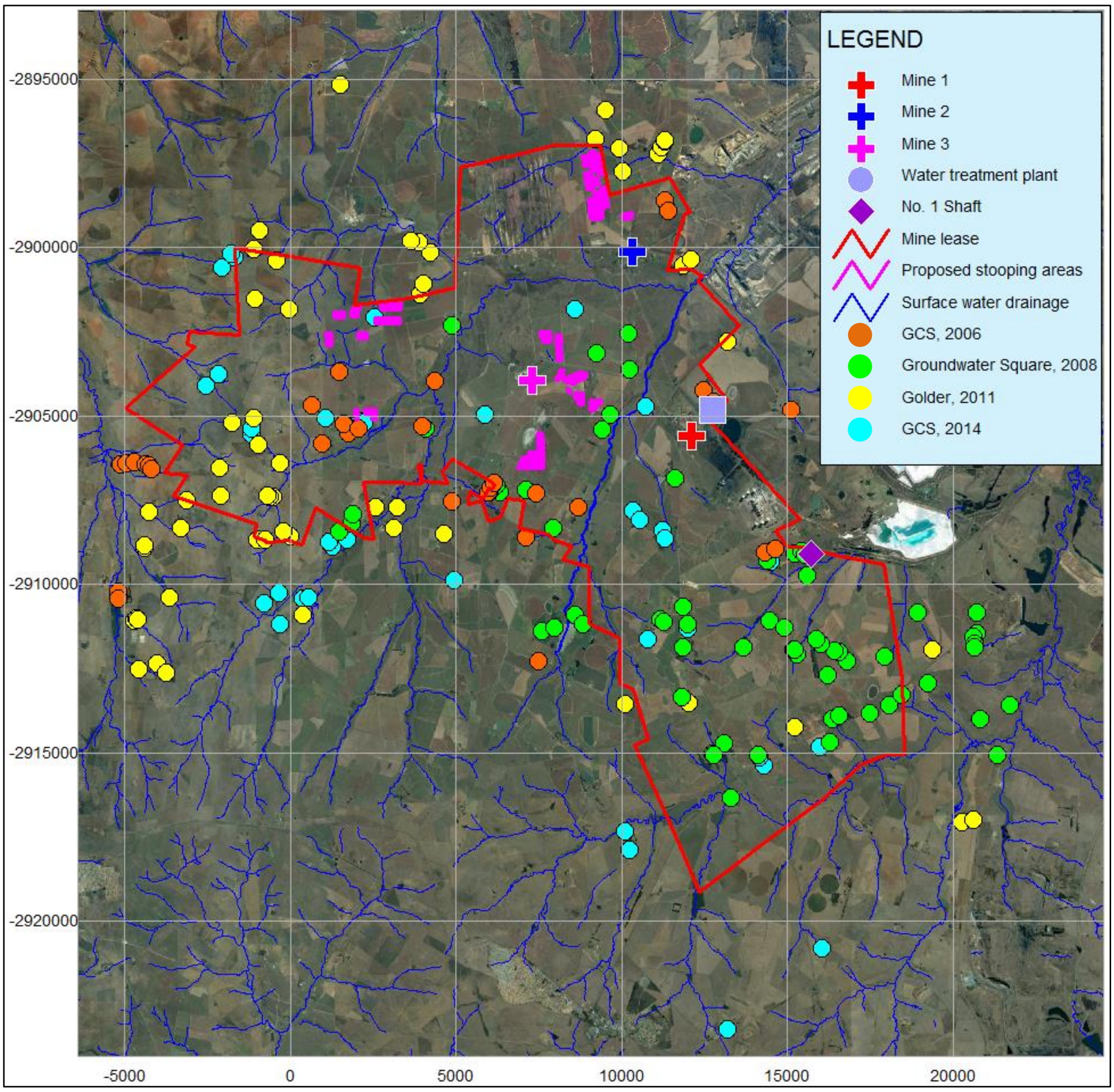

Figure 5.50: Positions of boreholes located during the various hydrocensus and user surveys

5.6.2 Aquifer Delineation

Because the main aquifer is a fractured rock type and fractures could assume any geometry and orientation, the physical boundary or 'end' of the aquifer is very difficult to specify or quantify. Aquifer boundary conditions that are generally considered during the delineation process are described below:

- No-flow boundaries are groundwater divides (topographic high or low areas/lines) or impermeable geological structures across which no groundwater flow is possible.
- Constant head boundaries are positions or areas where the groundwater level is fixed at a certain elevation and does not change (perennial rivers/streams or dams/pans).

Topographic highs and lows were used to roughly delineate the aquifer system underlying the Matla mine lease area (Figure 5.51). The aquifer was estimated to cover an area of roughly 1 000 km^2. Please note that geological structures such as dykes are known to occur within the area and have the ability to act as aquifer boundaries, thus subdividing the regional aquifer into various 'sub-aquifers' or compartments. The structural integrity of these potential boundaries remains an uncertainty, therefore aquifer boundaries as indicated in Figure 5.51 are considered to be conceptual and based on topographic controls only.

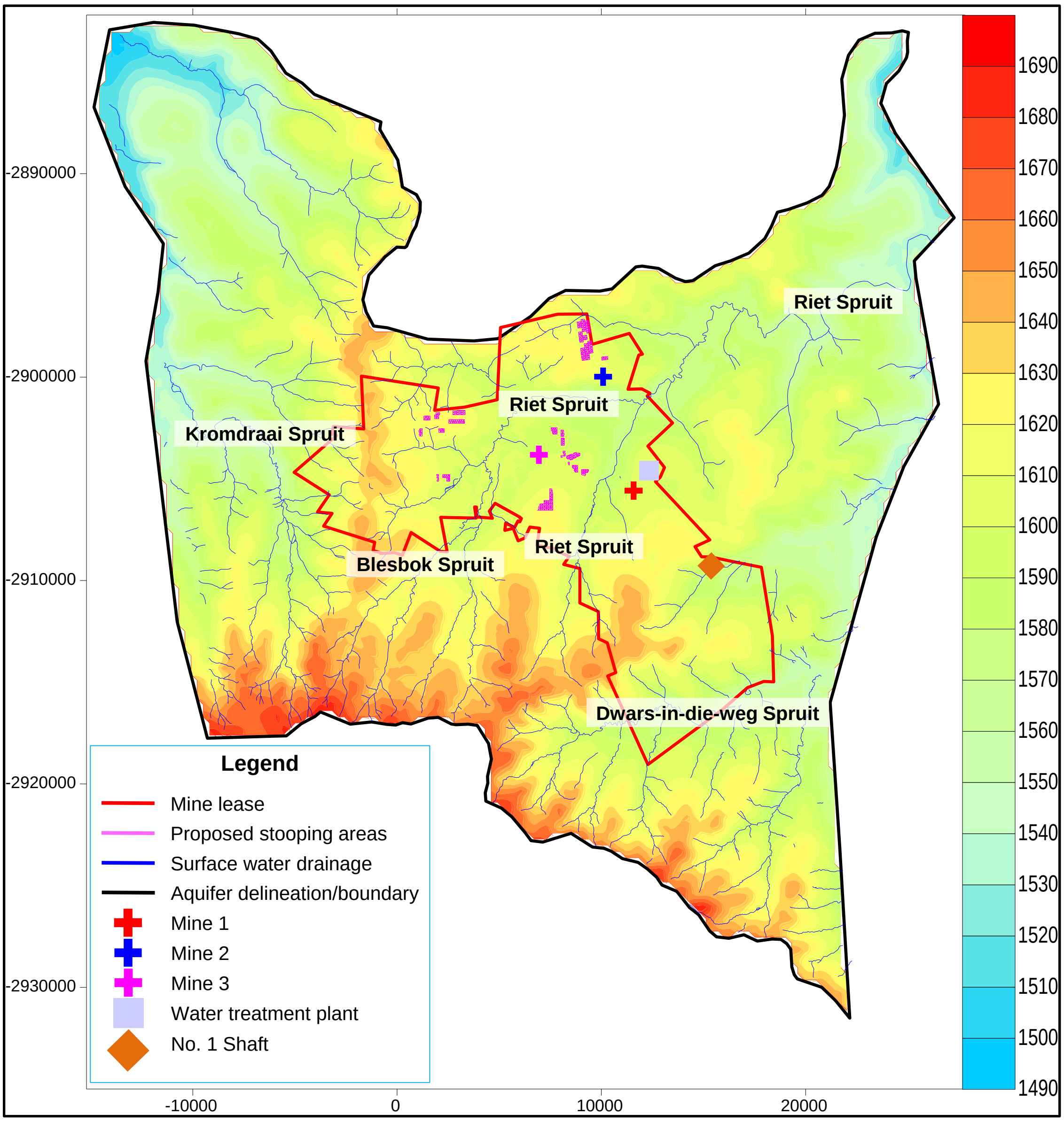

Figure 5.51: Aquifer delineation for project area

5.6.3 Groundwater Level Depth

Groundwater level information was collected during a hydrocensus conducted by GCS in 2014. A thematic groundwater level map of the entire mining area is provided in Figure 5.54. These water levels are essential as they were used in the generation of static groundwater level elevations with the use of the Bayesian interpolation method Figure 5.55.

Regional static groundwater levels generally vary between ± 2 and 22 meters below surface (Figure 5.54). Due to the generally low aquifer transmissivity the pumping causes deep drawdown of the groundwater level/piezometric head and a depression cone forms that is deep, but very limited in lateral extent. This concept is explained in Figure 5.52.

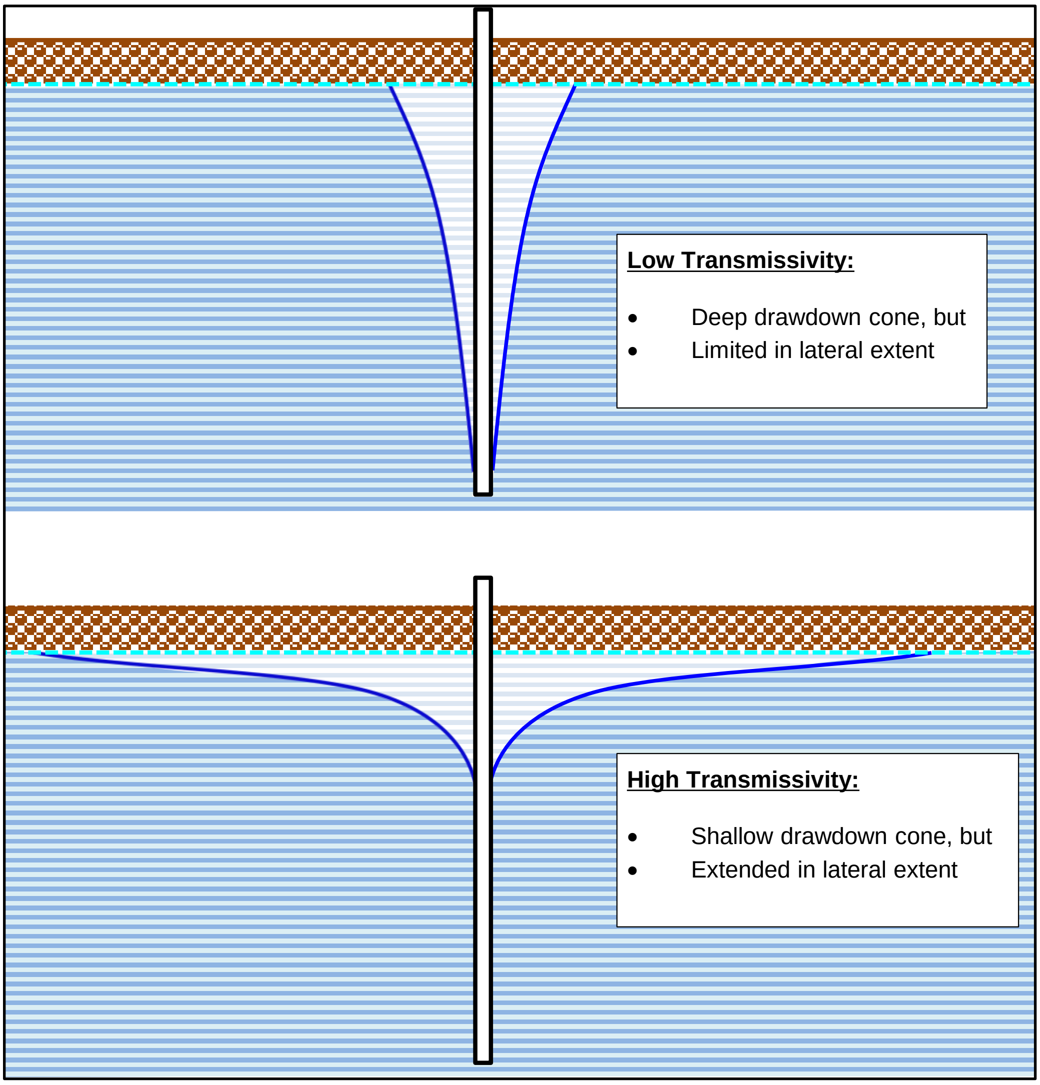

Figure 5.52: Effect of aquifer transmissivity on depression cone

The static groundwater elevation contour map provided in Figure 3.6 was constructed through the utilisation of the Bayesian interpolation technique. The Bayesian interpolation technique utilises the natural relationship that exists between the surface topography and the depth-to-groundwater level to estimate groundwater levels in areas where borehole data is scarce.

Because impacts on the natural groundwater level already exist due to mine dewatering and/or groundwater abstraction for domestic, irrigation and mining purposes, only boreholes where the linear correlation between borehole collar elevation and groundwater level elevation exists were used in the interpolation.
The static groundwater contours presented in Figure 5.55 therefore represent conditions without impacts from sources or actions other than natural conditions.

A graph of borehole collar elevation versus groundwater level elevation is presented in Figure 5.53, where the linear correlation of approximately 97% can be seen. It should be noted that groundwater levels from some boreholes (generally those in excess of ten meters deep) were discarded because impacts associated with groundwater abstraction affect the natural groundwater level/topography relationship.

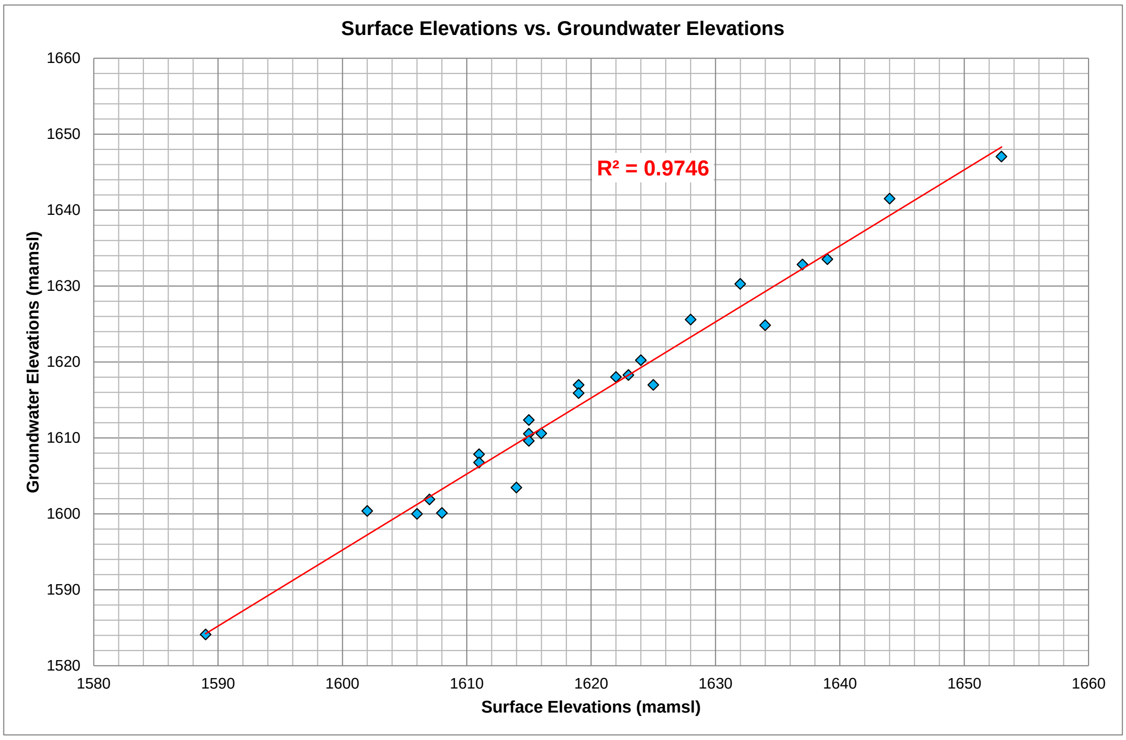

Figure 5.53: Relationship between surface- and groundwater elevations

The highest static water level elevation within the mine lease area is approximately 1 650 mamsl and occurs in the topographic higher regions. The lowest static water level elevation where no impact from abstraction occurs is at approximately 1 560 mamsl. Groundwater flow directions within the modelled area are also indicated in Figure 5.55 with the use of blue arrows.

Seen in the light of water level differences because of mining, pumping and recharge effects, filtering and processing of water levels are required to remove water levels considered anomalous high or low. The final interpolated potentiometric surface of the water levels is thus bound to contain local over- or under estimations of the actual water levels, but it will be representative of the general regional trend of the static groundwater level.

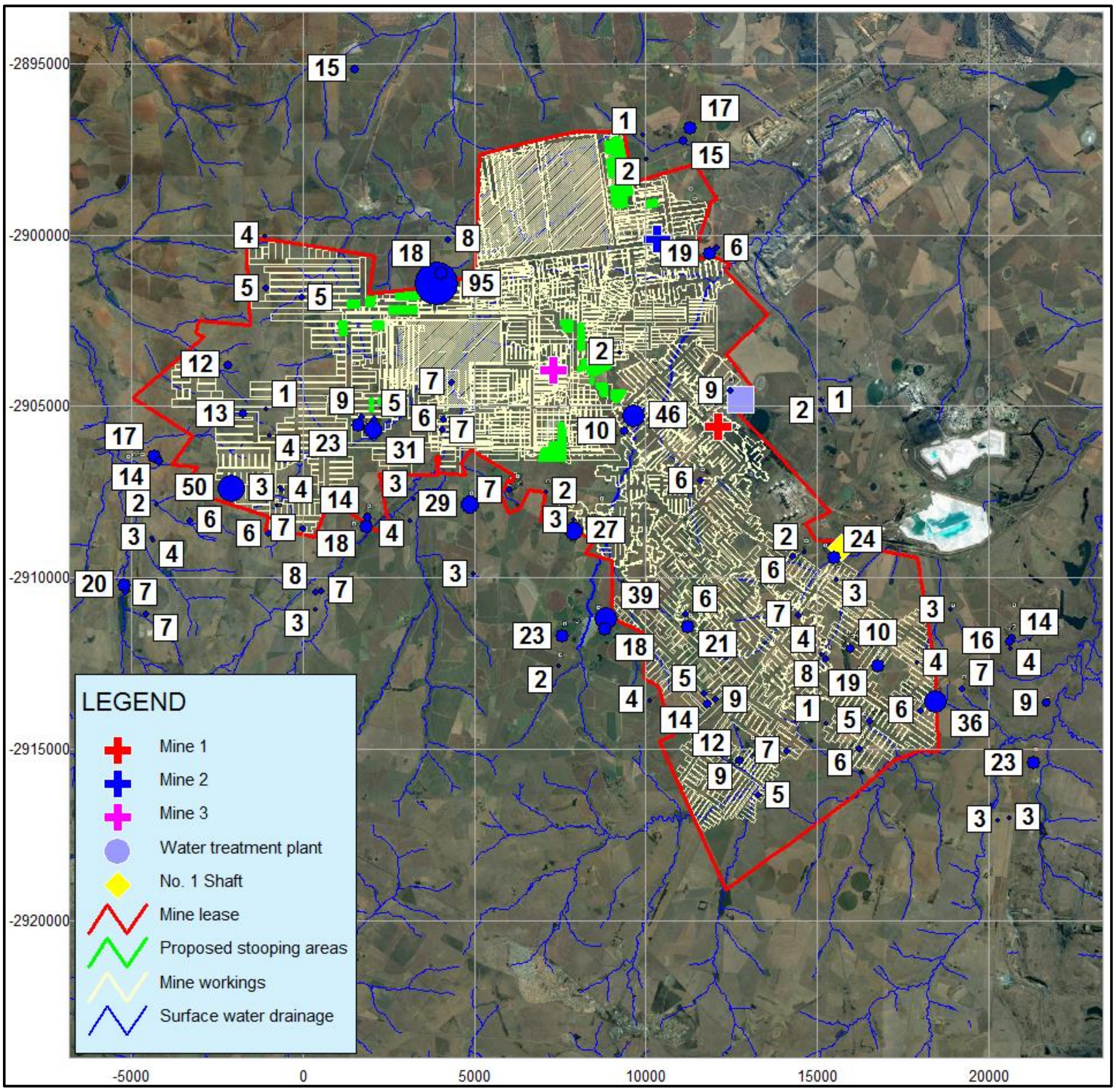

Figure 5.54: Thematic map of measured groundwater level depths (mbs)

Notes: - The numbers in the above figure indicate the groundwater level depth below surface in meters,

-The size of the blue circles is directly proportional to the groundwater level depth, hence the largest circle represents the deepest water level.

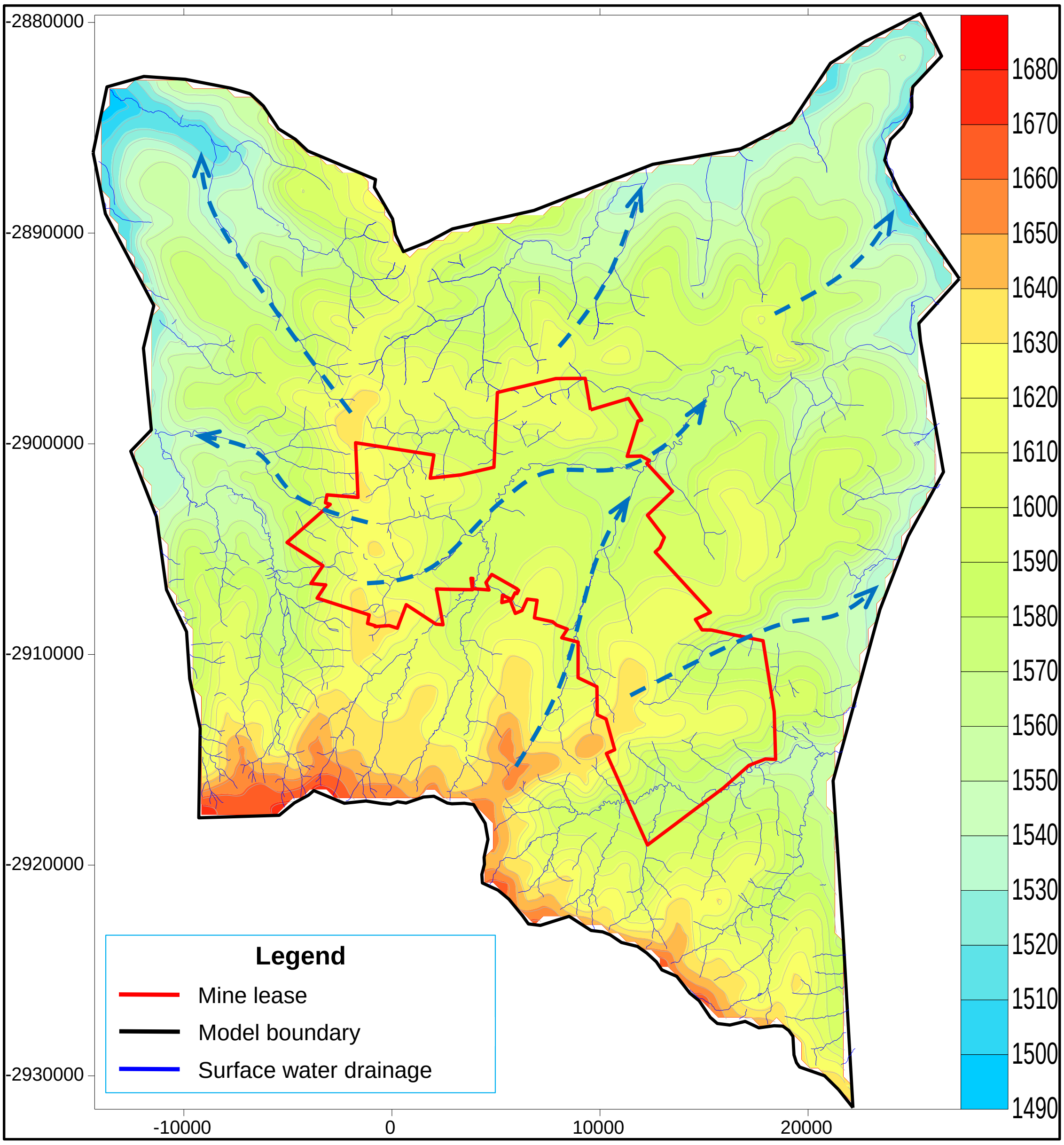

Figure 5.55: Bayesian interpolated groundwater elevation contour map of the modeled area (mamsl)

5.6.4 Groundwater Flow Evaluation (directions, gradients and velocities)

Contours of the static water levels or piezometric heads in and around the mining area are indicated in Figure 5.55. Path lines or flow lines of groundwater particles are lines perpendicular to the contours, as indicated with arrows. Flow occurs faster where contours are closer together and gradients are thus steeper. Natural groundwater drainage from the Matla mine lease area is towards the west/north-west and north-east.

The groundwater gradient is calculated with the following formula:

i = dH/dL

Where: i = Hydraulic gradient

dH = Head difference

dL = Lateral distance over which gradient is measured

Groundwater gradients were calculated with the above formula from the water level elevation data Figure 5.55. By substituting the hydraulic head difference over lateral distance an average hydraulic gradient of approximately 0.7% was calculated for the mine lease area Figure 5.56.

The groundwater flow gradient was in turn used to calculate the rate of groundwater movement (the so-called 'Darcy flux') in the mine lease area, which is also indicated in Figure 5.56. The following equation was used in the calculations (after Fetter, 1994):

$$v = \frac{KI}{\phi}$$

Where: v = flow velocity (m/day)

K = hydraulic conductivity (m/day) = 0.14 (GCS, 1998)

I = average hydraulic gradient (%) = 0.7%

□ = probable average porosity = 0.06 (Groundwater Square, 2008)

The hydraulic conductivity and average porosity were chosen so as to provide a liberal estimation of seepage velocity. The actual seepage through the aquifer matrix should be lower than the products calculated, but highly transmissive fracture zones or areas of steeper gradient might cause higher transport rates.

The hydraulic conductivity and the average hydraulic gradient are known parameters. By making use of these values, the average steady state flow velocity *(Darcy flux)* in the mining area was calculated to be in the order of 5.8 m/y Figure 5.56.

These estimates do however not take into account all known or suspected zones in the aquifer like preferential flow paths formed by igneous contact zones like intrusive dykes that have higher than average hydraulic properties. In secondary fractured aquifer media, the transport velocity is usually significantly higher than the average velocities calculated with this formula and may increase several meters or even tens of meters per year under steady state conditions. Under stressed conditions such as at groundwater abstraction areas the seepage velocities could increase another order of magnitude.

Table 5.6: Summary of groundwater flow evaluation

Groundwater flow direction	Groundwater flow gradient	Groundwater flow velocity (m/d)	Groundwater flow velocity (m/y)
West/north-west and north-east	0.7%	0.016	5.8

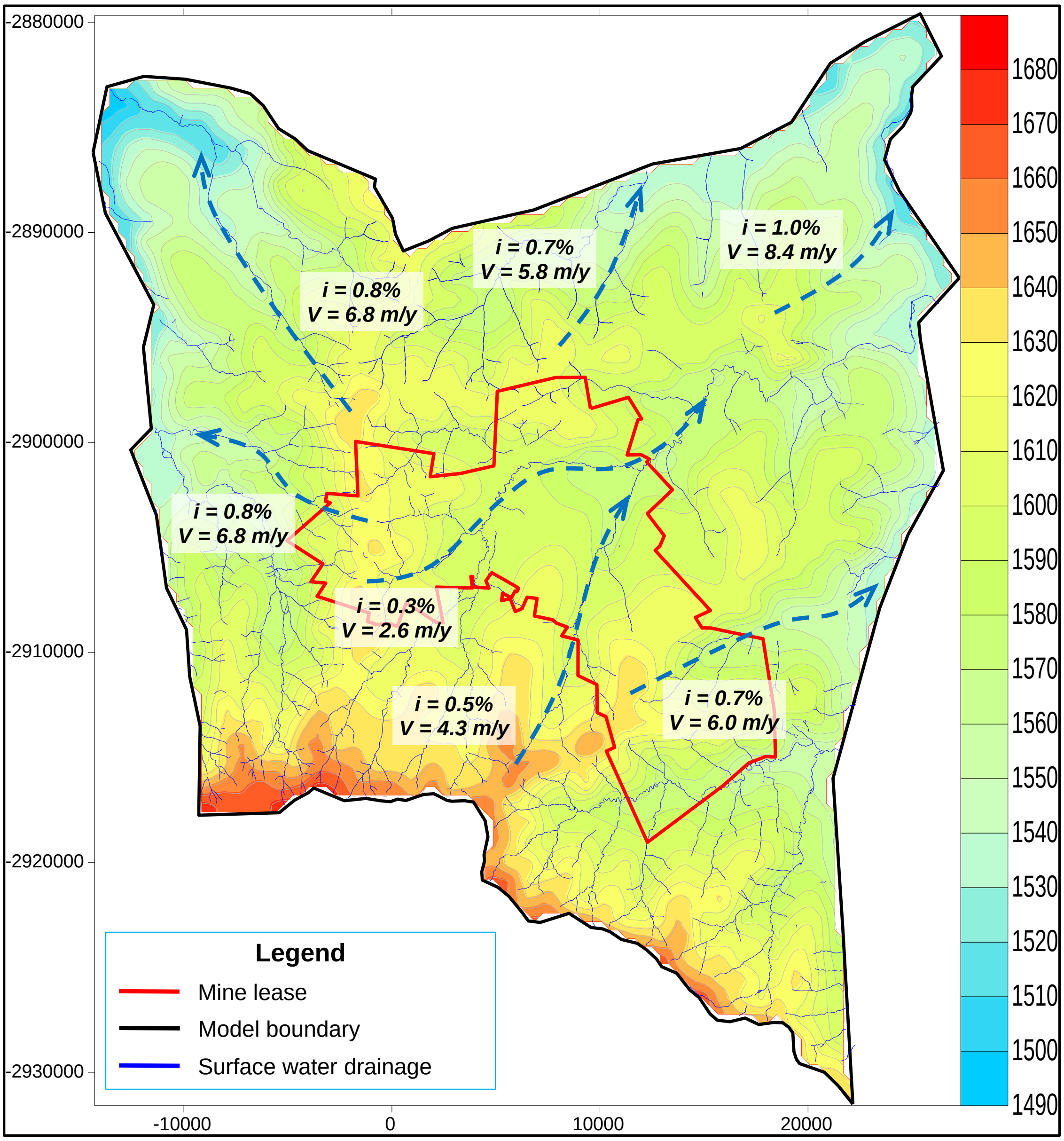

Figure 5.56: Average groundwater gradients and velocities

5.6.5 Aquifer Types

Two main types of aquifers are believed to be present in the mine lease area. For the purpose of this study an aquifer is defined as a geological formation or group of formations that can yield groundwater in economically useable quantities. Aquifer classification according to the Parsons Classification system is summarised in Table 5.7.

The **first aquifer** is a shallow, **semi-confined or unconfined aquifer** that occurs in the transitional soil and **weathered bedrock zone** or sub-outcrop horizon. Depending on the depth of the groundwater level and extent/depth of weathering, this aquifer may occur at depths of between 0 and 12 meters. Yields in this aquifer are generally low (less than 0.5 l/s) and the aquifer is usually not fit for supplying groundwater on a sustainable basis. Consideration of the shallow aquifer system becomes important during seepage estimations from pollution sources to receiving groundwater and surface water systems. The shallow weathered zone aquifer plays the most important role in mass transport simulations from process and mine induced contamination sources because the lateral seepage component in the shallow weathered aquifer often dominates the flow.

According to the Parsons Classification system, this aquifer is usually regarded as a minor- and in some cases a non-aquifer system.

Due to the mainly lateral flow and sometimes phreatic nature of the weathered zone aquifer, it is usually only affected by opencast mining or by high extraction or shallow underground mining where subsidence occurs and the entire roof strata above the mined area is destroyed. Where mining becomes deeper the weathered zone aquifer is usually affected to a very limited extent. The shallow aquifer system is undeveloped/absent in areas where the groundwater level is deeper than the contact between the weathered zone and fresh bedrock.

The **second aquifer** system is the deeper **secondary fractured rock aquifer** that is hosted within the sedimentary rocks of the Karoo Supergroup and occurs at depths generally exceeding 12 meters below surface. Groundwater yields, although more heterogeneous, can be higher. This aquifer system usually displays semi-confined or confined characteristics with piezometric heads often significantly higher than the water-bearing fracture position. Fractures may occur in any of the co-existing host rocks due to different tectonic, structural and genetic processes. Groundwater flow is fully restricted to open fractures and discontinuities, which become increasingly scarce at depths exceeding 30 meters below surface.

According to the Parsons Classification system, the aquifer could be regarded as a minor aquifer system, but also a sole aquifer system in some cases where groundwater is the only source of domestic water.

Table 5.7: Parsons Aquifer Classification (Parsons, 1995)

Sole Aquifer System	An aquifer that is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
Major Aquifer System	Highly permeable formation, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (less than 150 mS/m).
Minor Aquifer System	These can be fractured or potentially fractured rocks that do not have a primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large volumes of water, they are important both for local suppliers and in supplying base flow for rivers.
Non-Aquifer System	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although impermeable, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.
Special Aquifer System	An aquifer designated as such by the Minister of Water Affairs, after due process.

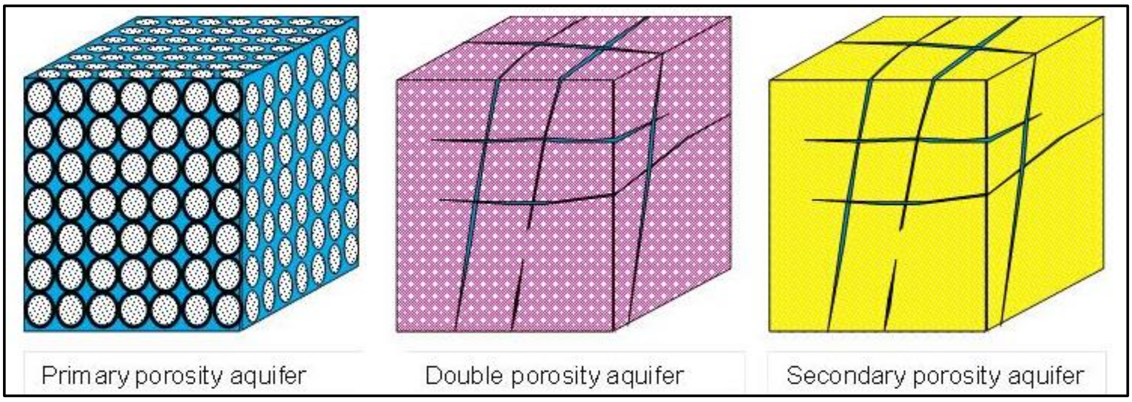

Figure 5.57: Types of aquifers based on porosity

5.6.6 Aquifer Transmissivity and Storativity

No aquifer testing was performed for the purpose of this investigation. All previously conducted groundwater related studies were consulted in order to obtain a better indication of the average hydraulic properties of the aquifer underlying the mining area.

Aquifer transmissivity is defined as a measure of the amount of water that could be transmitted horizontally through a unit width of aquifer by the full-saturated thickness of the aquifer under a hydraulic gradient of 1. Transmissivity is the product of the aquifer thickness and the hydraulic conductivity of the aquifer, usually expressed as m^2/day ($Length^2$/Time).

Storativity (or the storage coefficient) is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in piezometric head. Storativity (a dimensionless quantity) cannot be measured with a high degree of accuracy in slug tests or even in conventional pumping tests. It has been calculated by numerous different methods with the results published widely and a value of 0.002 to 0.01 is taken as representative for the proposed mining area. The storage coefficient values calculated from the pump tests proved to be in this order of magnitude.

The fractured rock aquifer underlying the mining area is known for being highly heterogeneous, which may result in significant variations in aquifer transmissivity/storativity over relatively short distances.

The average hydraulic conductivity (permeability) of the shallow weathered zone aquifer is 0.14 m/d, which based on an average aquifer thickness of approximately 12 meters, translates to a transmissivity of around 1.7 m^2/d (GCS, 1998).

Pumping tests that were performed on the deeper fractured rock aquifer revealed transmissivity values of between 0.1 m^2/d and 7 m^2/d (GCS, 1998), confirming the aquifer to be highly heterogeneous.

5.6.7 Aquifer Recharge and Discharge Rates

According to Figure 5.58, the mean annual recharge to the aquifer underlying the Matla mine lease area is in the region of 32 mm, which based on an average rainfall of approximately 754 mm/a (Figure 5.51) translates to a recharge percentage of just over 4%. During the model calibration process, changes are made to the aquifer recharge (among other model input parameters) until an acceptable correlation is achieved between the model simulated and measured/actual groundwater elevations. During this calibration process for the Matla Stooping Project, a much lower recharge of between 0.6% and 1.2% was eventually assigned to the aquifer regime underlying the mine lease area.

Where outcrop occurs, the effective recharge percentage can be slightly higher while in low-lying topographies where discharge generally occurs and thicker sediment deposits, the effective recharge will be lower or even zero. Based on this estimate, the mean annual recharge to the aquifer regime as defined in (Figure 5.51) should be ± 34.6 Mm^3.

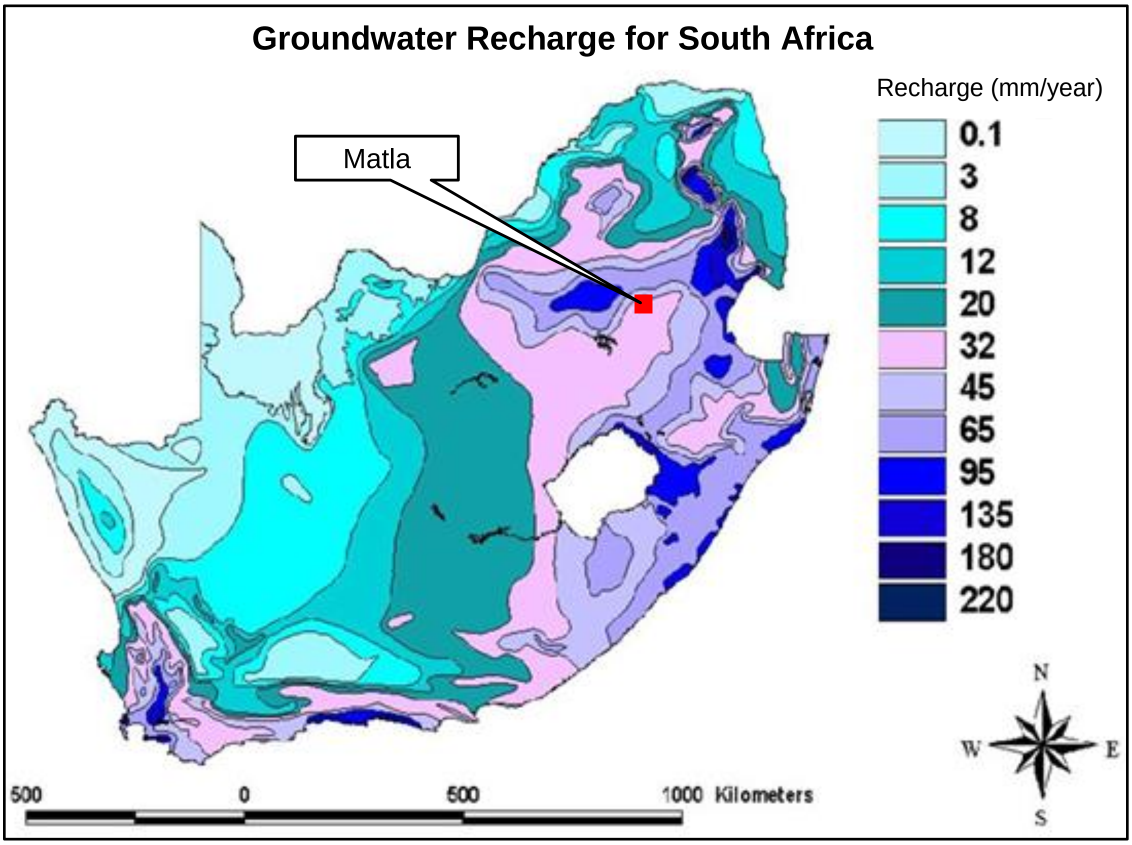

Figure 5.58: Mean annual aquifer recharge for South Africa (Vegter, 1995)

5.6.8 Groundwater Quality Characteristics

Please note that data collected during the GCS hydrocensus/user survey of 2014 were used to characterise the groundwater quality conditions.

Aquatico Laboratory (a South African National Accreditation System (SANAS) accredited laboratory according to ISO/IEC 17025:2005 standards No: T0374) in Pretoria, South Africa, was commissioned to undertake the analytical testing for the collected groundwater samples. Samples were collected from six boreholes located during the GCS hydrocensus/user survey of 2014 and their positions are indicated in Figure 5.60. The results of the groundwater analyses are provided Table 5.8 together with the guidelines used in the assessment.

Groundwater quality data was evaluated with the aid of diagnostic chemical diagrams and by comparing the inorganic concentrations to the:

- Department of Water Affairs'(DWA) South African Water Quality Guidelines (SAWQG) target range, Volume 1, Domestic Use (1996), and
- SABS South African National Standards for Drinking Water (SANS 241:2011).

The four main factors usually influencing groundwater quality are:

- **Annual recharge** to the groundwater system,
- **Type of bedrock** where ion exchange may impact on the hydrogeochemistry,
- **Flow dynamics** within the aquifer(s), determining the water age and
- **Source(s) of pollution** with their associated leachates or contaminant streams.

Where no specific source of groundwater pollution is present up gradient from the borehole, only the other three factors play a role.

One of the most appropriate ways to interpret the type of water at a sampling point is to assess the plot position of the water quality on different analytical diagrams like a Piper, Expanded Durov and Stiff diagrams. Of these three types, the Expanded Durov diagram probably gives the most holistic water quality signature.

Although never clear-cut, the general characteristics of the different fields of the diagram could be summarized as follows:

- Field 1:
  - Fresh, very clean recently recharged groundwater with HCO_3 and CO_3 dominated ions.
- Field 2:
  - Field 2 represents fresh, clean, relatively young groundwater that has started to undergo mineralization with especially Mg ion exchange.
- Field 3:
  - This field indicates fresh, clean, relatively young groundwater that has undergone Na ion exchange (sometimes in Na - enriched granites or felsic rocks) or because of contamination effects from a source rich in Na.
- Field 4:
  - Fresh, recently recharged groundwater with HCO_3 and CO_3 dominated ions that has been in contact with a source of SO4 contamination or that has moved through SO_4 enriched bedrock.
- Field 5:

- Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4 and NaCl mixing/contamination or old stagnant NaCl dominated water that has mixed with clean water.

- Field 6:
  - Groundwater from field 5 that has been in contact with a source rich in Na or old stagnant NaCl dominated water that resides in Na rich host rock/material.
- Field 7:
  - Water rarely plots in this field that indicates NO_3 or Cl enrichment or dissolution.
- Field 8:
  - Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4, but especially Cl mixing/contamination or old stagnant NaCl dominated water that has mixed with water richer in Mg.
- Field 9:
  - Old or stagnant water that has reached the end of the hydrogeological cycle (deserts, salty pans etc.) or water that has moved a long time and/or distance through the aquifer or on surface and has undergone significant ion exchange because of the long distance or residence time in the aquifer.

The layout of the fields of the Expanded Durov diagram (EDD) is shown in Figure 5.59.

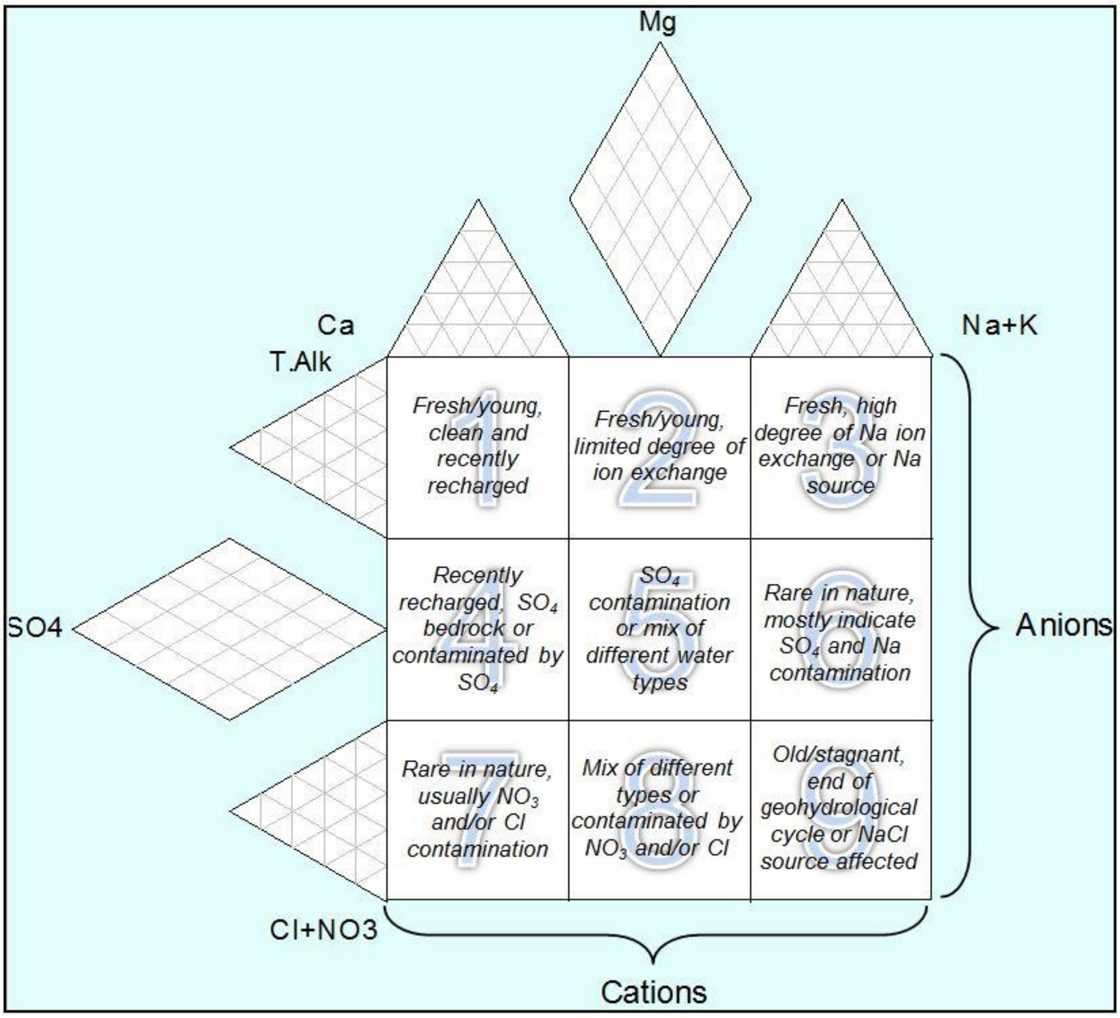

Figure 5.59: Layout of fields of the Expanded Durov diagram

Another way of presenting the signature or water type distribution in an area is by means of Stiff diagrams. These diagrams plot the equivalent concentrations of the major cations and anions on a horizontal scale on opposite sides of a vertical axis. The plot point on each parameter is linked to the adjacent one resulting in a polygon around the cation and anion axes. The result is a small figure/diagram of which the geometry typifies the groundwater composition at the point. Groundwater with similar major ion ratios will show the same geometry. Ambient groundwater qualities in the same aquifer type and water polluted by the same source will for example display similar geometries.

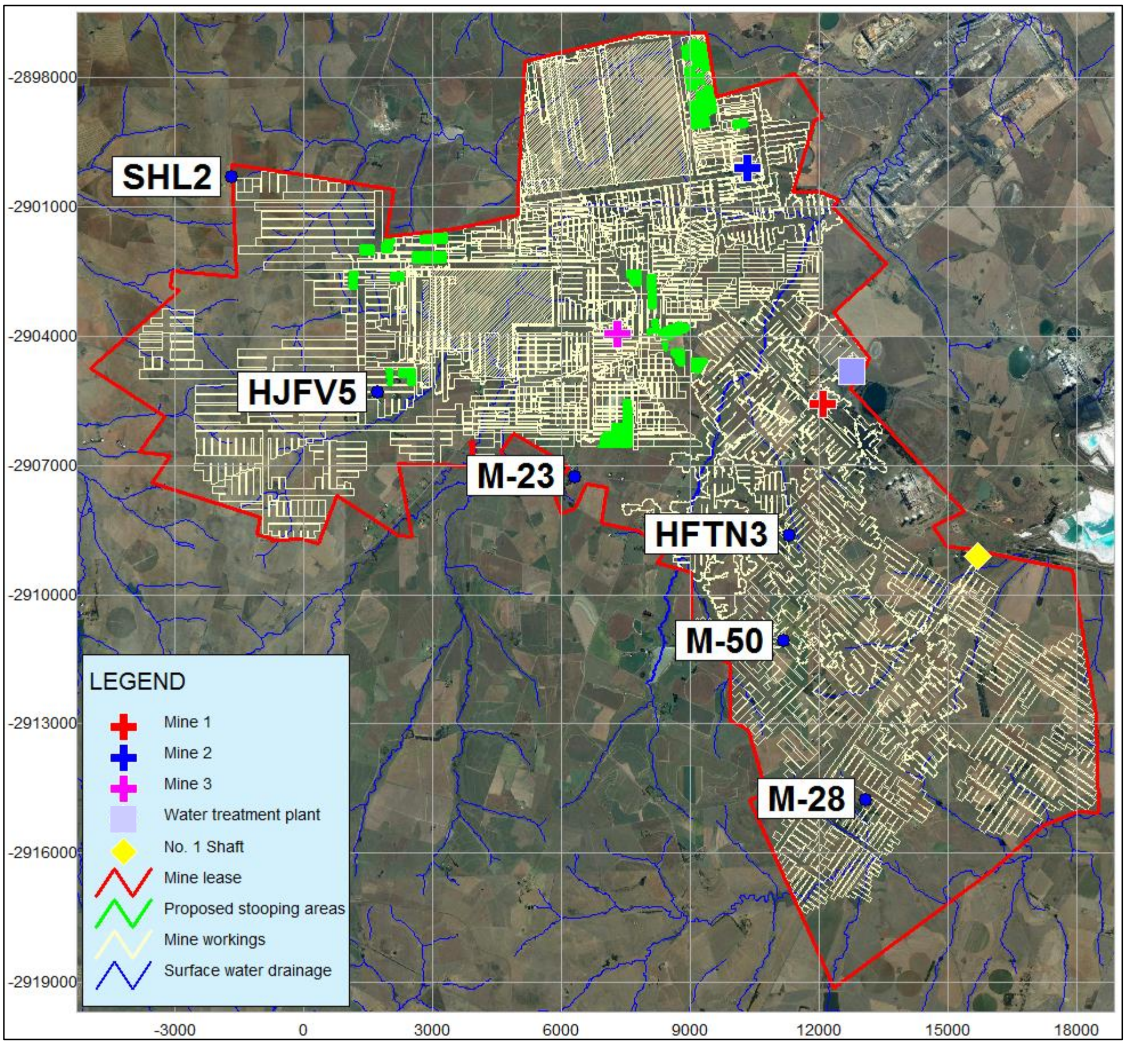

Figure 5.60: Positions of boreholes sampled

The electrical conductivity (EC) of the groundwater varies between 24 mS/m and 66 mS/m. Groundwater pH varies between 7.4 and 8.1 (pH unit), indicating neutral to slightly alkaline conditions. The elevated electrical conductivity and subsequent total dissolved solids (TDS) readings observed in borehole SHL2 can be attributed to the elevated calcium concentrations.

An analysis of the major ionic constituents was undertaken using Expanded Durov (Figure 5.61) and Stiff (Figure 5.62) diagrams to assess the proportions of these constituents and broadly characterise the aquifer water type/s. Groundwater is mainly dominated by calcium and magnesium cations, while bicarbonate alkalinity dominates the anion content. The dominant plot positions of groundwater in fields one and two of the EDD are indications of fresh, clean, relatively young groundwater that has undergone natural magnesium and sodium ion exchange.

In general, the water from the sampled boreholes is considered to be of good quality. Comparison with relevant guidelines/standards is summarized in the following bullet points:

Major Ionic Constituents Parameters:

- The concentrations of cations and anions reported from the various sample locations are below the relevant DWA SAWQG and SANS 241-1 water quality criteria for domestic/drinking water use, except for calcium.
- Calcium exceeded the DWA SAWQG quality tolerance level of 32 mg/L at M50, SHL2, HJFV5, M28 and HFTN3. Although, no health effect is associated with the elevated calcium concentrations, potential scaling and lathering of soap impairments are expected.

Metals/Metalloids Constituents:

- All metals/metalloids reported from the various sample locations are below the relevant DWA SAWQG and SANS 241-1 water quality criteria for domestic/drinking water use.

Nitrogen-species parameters:

- Nitrate (NO3 as N) concentrations at M28 and M23 exceed the DWA SAWQG quality tolerance level of 6 mg/L, while concentrations at SHL2 also exceed the SANS 241-1 quality tolerance level of 11 mg/L.
- Accordingly to the relevant guidelines, the potential health effects associated with the elevated nitrate concentrations include methaemoglobinaemia in infants and/or mucous membrane irritation in adults.

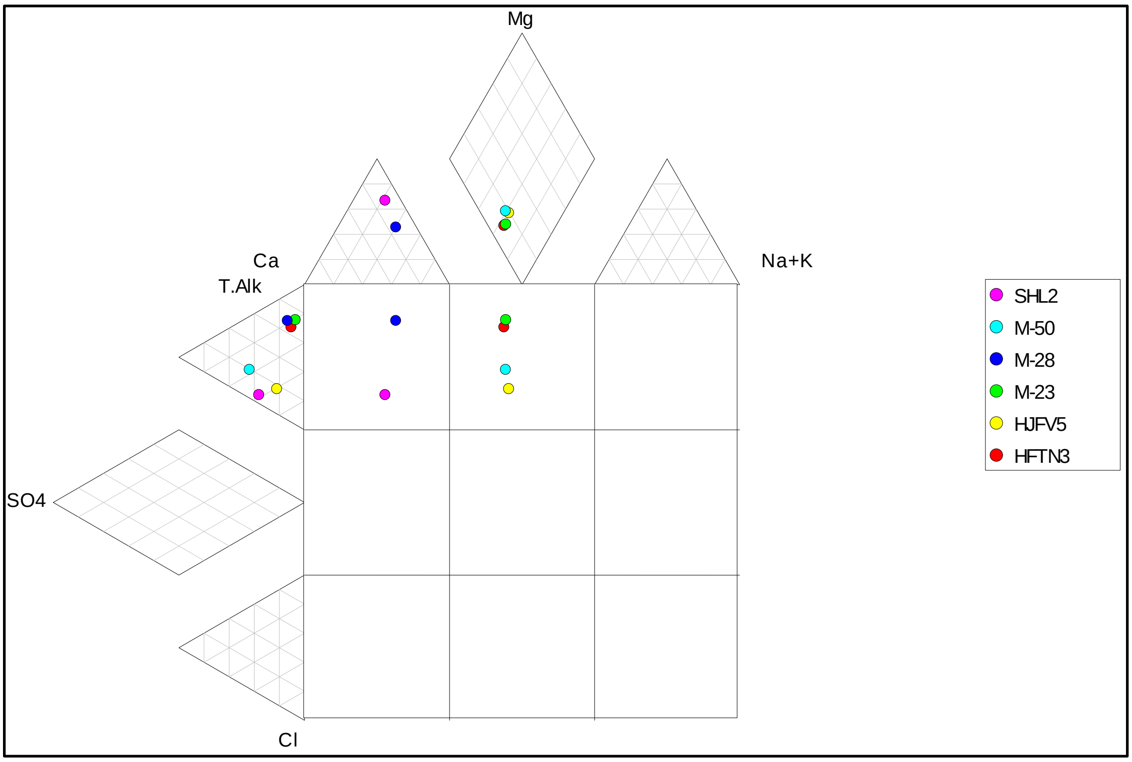

Figure 5.61: Expanded Durov diagram of groundwater chemistries

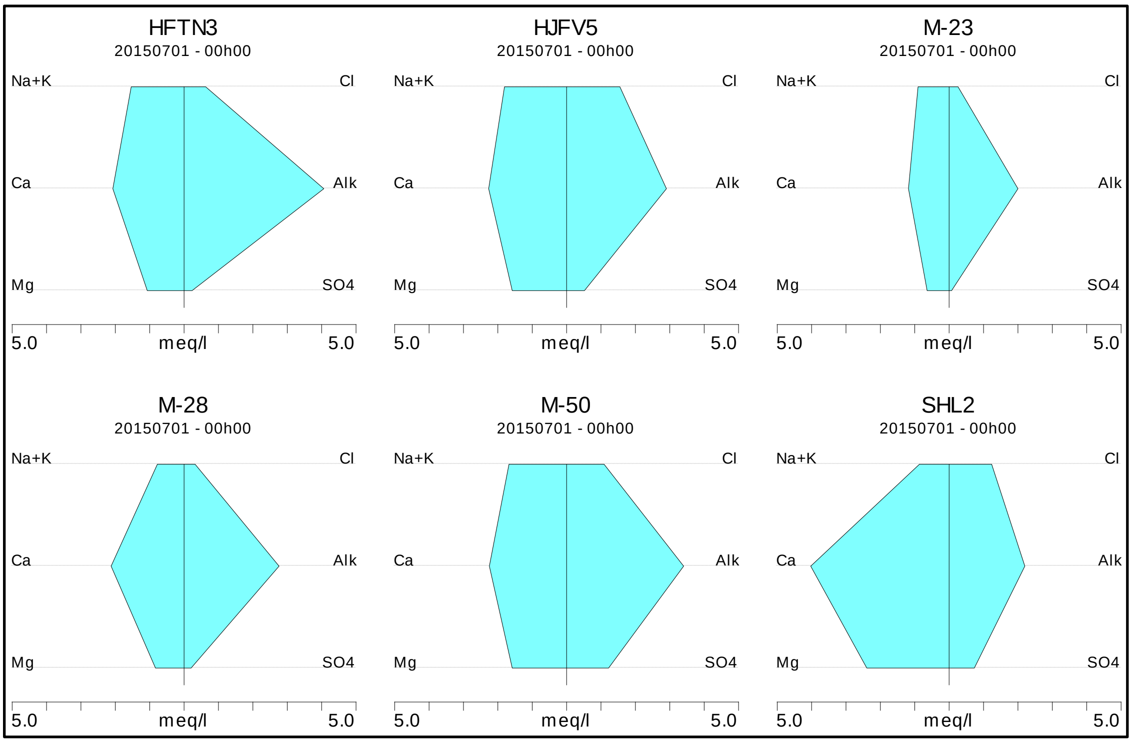

Figure 5.62: Stiff diagrams of groundwater chemistries

Table 5.8: Results of physical and chemical analyses of groundwater samples

Analyses	Unit	Detection Limit	DWA SAWQTV	SANS 241-1	M50	SHL2	HJFV5	M28	HFTN3	M23	*Minimum*	*Maximum*	*Mean*	*Geomean*
							Physio-Chemical Parameters							
pH	pH unit	n/a	6 - 9	5 - 9.7	7.99	7.7	7.35	7.68	8.13	7.43	*7.35*	*8.13*	*7.71*	*7.71*
Electrical Conductivity	mS/m	0.1	<70	<170	48.3	66.1	49.6	33.3	41.6	24	*24*	*66.1*	*43.8*	*41.7*
Total Dissolved Solids	mg/L	10	<450	<1200	310	452	299	222	253	160	*160*	*452*	*283*	*269*
Total Alkalinity	mg $CaCO_3$/L	2.477	NS	NS	170	110	145	138	203	100	*100*	*203*	*144*	*140*
Total Hardness	mg $CaCO_3$/L	n/a	NS	NS	191	321	192	148	157	91	*91*	*321*	*183*	*171*
							Inorganic and Metal Parameters							
							Major Ionic Constituents							
Calcium	mg/L	0.0259	<32	NS	45	80.6	45.4	42.5	41.5	23.7	*23.7*	*80.6*	*46.5*	*43.6*
Magnesium	mg/L	0.009	<30	NS	19.2	29.1	19.2	10.1	13	7.77	*7.77*	*29.1*	*16.4*	*14.9*
Potassium	mg/L	0.018	<50	NS	5.98	4.46	8.69	4.01	9.06	8	*4.01*	*9.06*	*6.7*	*6.38*
Sodium	mg/L	0.013	<100	<200	35	17.2	36.4	15.5	30	16.1	*15.5*	*36.4*	*25.03*	*23.4*
Sulphate	mg/L	0.04	<200	<500	58.6	35.2	24.9	9.83	11.2	3.42	*3.42*	*58.6*	*23.86*	*16.38*
Chloride	mg/L	0.423	<100	<300	38.6	43.8	54.9	11.4	22.3	9.17	*9.17*	*54.9*	*30.03*	*24.5*
							Fluoride and Phosphorus Constituents							
Fluoride	mg/L	0.055	<1	<1.5	0.132	0.128	0.172	0.132	0.218	0.17	*0.128*	*0.218*	*0.159*	*0.156*
Orthophosphate	mg/L	0.008	NS	NS	0.009	0.013	0.014	0.027	0.012	0.02	*0.009*	*0.027*	*0.016*	*0.015*

Analyses	Unit	Detection Limit	DWA SAWQTV	SANS 241-1	M50	SHL2	HJFV5	M28	HFTN3	M23	*Minimum*	*Maximum*	*Mean*	*Geomean*
Metals/Metalloids Constituents														
Aluminium	mg/L	0.003	<0.15	NS	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Cadmium	mg/L	0.001	<0.005	<0.003	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Cobalt	mg/L	0.001	NS	<0.5	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Copper	mg/L	0.001	<1	2	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Chromium (total)	mg/L	0.001	NS	0.05	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Iron	mg/L	0.003	<0.1	2	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Manganese	mg/L	0.001	<0.05	0.5	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Nickel	mg/L	0.001	NS	<0.15	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Lead	mg/L	0.004	<0.01	0.01	BDL	BDL	BDL	BDL	BDL	BDL	*na*	*na*	*na*	*na*
Zinc	mg/L	0.002	<3	5	BDL	0.035	0.063	0.05	BDL	0.021	*0.021*	*0.063*	*0.042*	*0.039*
Nitrogen-Species Parameters														
Ammonia	mg/L	0.005	<1	<1.5	0.083	0.089	0.091	0.098	0.092	0.224	*0.083*	*0.224*	*0.113*	*0.105*
Nitrate	mg/L	0.017	<6	<11	0.935	39.3	4.71	9.87	0.293	6.77	*0.29*	*39.3*	*10.31*	*3.88*

Note/s:

- mS/m - milli Siemens per metre,
- mg/L - milli grams per Litre,
- mg $CaCO_3$/L - milli grams calcium carbonate per Litre,
- NS - no standards/guideline trigger values,
- BDL - below detection limit,
- na - not applicable.

5.6.9 Potential for Acid Mine Drainage

Metal sulphides, of which pyrite is the most common, are very prone to oxidation when brought into contact with water and oxygen. The chemical reactions are collectively referred to as acid mine drainage (AMD). The root of the problem lies in the chemical and bacteriological oxidation of the metal sulphides, which is explained/illustrated with the following reaction train:

$2FeS_2 + 7O_2 + 2H_2 – 2FeSO_4 + H_2SO_4$ (1)

$4FeSO_4 + 2H_2SO_4 + O2 – 2Fe_2 (SO_4)_3 + 2H_2O$ (2)

$3Fe_2 (SO_4)_3 + 12H2O – 2HFe_3(SO_4)_2 (OH)_6 + 5H_2SO_4$ (3)

The pH and bicarbonate values of the water are expected to decrease. Metals go into solution and sulphate (SO_4) and Total Dissolved Solids (TDS) values increase. As the water leaves the mining area, it usually mixes with better quality water and the pH and bicarbonate values will be buffered back to more acceptable levels. Metals then also precipitate and the sulphate and TDS concentrations decrease again.

Acid Base Accounting (ABA) is done to determine the net acid generating and neutralising potentials of material. The main principles of acid-base accounting are:

- Samples are exposed to complete oxidation of all sulphide-bearing minerals.
- This generates acid, which is counteracted by the natural base potential of the material.
- The initial pH before oxidation and the oxidised pH are recorded for each sample.

Little or no drop in pH occurs whenever the base potential exceeds the acid potential. The opposite holds true when the acid potential exceeds the base potential – such a sample is therefore expected to generate acidic conditions when exposed to oxygen and water.

No acid base accounting was performed for the purpose of this investigation, however the surrounding mines are known to generate acid (GCS, 1998). The weathered sandstone, shale, and the 5 seam roof and floor all have the potential for acidification. Groundwater flowing through these areas is likely to generate acid when exposed to oxygen and water. The coarse sandstone, on the other hand, has a very large neutralising potential and will give groundwater flowing through it an alkaline character (GCS, 2006).

5.6.10 Potential Sources of Contamination

A source area is defined as an area in which groundwater contamination is generated or released from as seepage or leachate. Source areas are subdivided into two main groups:

Point sources:

The contamination can easily be traced back to the source and typically includes mine infrastructure such as a processing plant, overburden/waste rock dump, pollution control dam, underground workings, ROM stockpile, etc.

Diffuse sources:

Diffuse sources of groundwater contamination are typically associated with poor quality leachate formation through numerous surface sources.

An evaluation of the mining area and related activities revealed numerous potential source areas, which are listed and briefly discussed in Table 5.9.

Table 5.9: Potential sources of groundwater contamination

Source	Contamination risk	Comments
1) Plant area	High	- Impact on the groundwater only occurs through leachate formation from surface. Impacts thus only occur as a result of rainfall recharge or when water is introduced in some form where leachate can form that seeps to the groundwater.
2) Transfer stockpile area	High	- Effective recharge through waste rock dumps and stockpiles is much higher than the natural recharge of the area due to lower evaporation rates. - Surface water run-off originating from these source areas, toe-seeps and seepage through the base may potentially be of poor quality and could cause adverse groundwater quality impacts should it enter the aquifer. - Seepage from waste rock dumps and stockpiles is likely to be affected by acid mine/rock drainage and therefore high in iron and sulphate content.

Source	Contamination risk	Comments
3) Underground mining areas	High	- Contamination will only leave these areas after groundwater levels have recovered from the impacts of mine dewatering. - Water collecting in these areas is usually characterised by high concentrations of iron and sulphate and low pH due to acid mine drainage.
4) Dirty water retaining facilities (water treatment plant, pollution control dam, sewage, etc.)	Low/Medium	- These facilities are developed and constructed for the sole purpose of containing dirty/affected water and therefore minimising the risk of it contaminating the groundwater. Mismanagement of these facilities may however lead to spills and/or leakages that have the potential to contaminate the underlying groundwater.
5) Workshops and washing/cleaning bays	Low/Medium	- Impact on the groundwater only occurs through leachate formation from surface. Impacts thus only occur as a result of rainfall recharge or when water is introduced in some form where leachate can form that seeps to the groundwater. - Organic contaminants are usually the main pollutants of concern (e.g. oil, grease, diesel, petrol, hydraulic fluid, solvents, etc.).

5.6.11 Potential Pathways for Contamination

In order for contamination to reach and eventually affect a receptor/s, it needs to travel along a preferred pathway. The effectiveness of a pathway to conduit contamination is determined by three main factors, namely:

- Hydraulic conductivity of pathway,
- Groundwater hydraulic gradient, and
- Area through which flow occurs.

All three abovementioned factors have a linear relationship with the flow of contamination through a preferred pathway, meaning an increase in any one of the three will lead to an increase in flow.

The following potential pathways were identified in the mine lease area:

5.6.11.1 Saturated weathered zone (weathered zone aquifer)

As discussed in Section 3.5 of the groundwater impact assessment report, the weathered zone aquifer is composed of soil and weathered bedrock, which depending on the weathering depth and depth to groundwater level may be between 0 and 12 meters thick. The rate of flow depends on the hydraulic conductivity of the aquifer and groundwater hydraulic gradient that were already discussed in Section 3.4 (of the groundwater impact assessment report). Groundwater/contaminant flux in this aquifer is expected to be in the order of 6 m/y, which is considered to be relatively slow. Please note that the weathered zone aquifer system is undeveloped in areas where the groundwater level is deeper than the contact between the weathered zone and fresh bedrock.

5.6.11.2 Geological structures

Dykes and faults are known to occur throughout the mine lease area, which may act as sufficient pathways for contamination. The crystalline nature of an igneous dyke is characteristic of an aquiclude, however rapid cooling during intrusion caused highly transmissive fracture zones to form along the contact between the intrusive and surrounding rock. The flow may increase by several orders of magnitude should a transmissive geological structure be located in the down gradient groundwater flow direction and if it is also orientated parallel to the local flow direction.

5.6.12 Potential Receptors of Contamination

A receptor of groundwater contamination usually occurs in the form of a groundwater user that relies on groundwater for domestic, irrigation or livestock watering purposes. Surface water features (stream, river, dam, etc.) that rely on groundwater base flow for the sustainment of the aquatic environment are also considered to be important receptors.
Numerous groundwater users were located during the user surveys and their positions are indicated in Figure 5.50. Numerous perennial surface water streams cut through the mine lease area, which are also considered to be potential receptors.

5.6.13 Mine Water Balance and Post Closure Decant

Numerous water balance models have been done for Matla throughout the years, of which the most recent one was completed in June 2015 by Mine Water Consultants.

5.6.13.1 Water currently residing in the workings

The proposed stooping areas are located within existing underground mining areas:

- 1 Mine – 4 seam mining (bord- and pillar only),
- 2 Mine – 2 seam mining (bord- and pillar and longwall),
- 2 Mine – 5 seam mining (bord- and pillar and longwall),
- 3 Mine – 2 seam mining (bord- and pillar only), and
- 3 Mine – 4 seam mining (bord- and pillar and longwall).

These areas are either partially or completely flooded and would require dewatering before Matla can safely commence with their planned stooping activities. For this reason it is important to have a good understanding of the dewatering requirements. The bulk water volumes that are currently (June 2015) present in the underground workings was calculated by Mine Water Consultants and are indicated in Figure 5.63 and Figure 5.64.

The labels shown in the two abovementioned figures indicate the water level elevation and the volume of water in the compartments. Only the major compartments are labelled. The indicated volumes represent the maximum amount of water currently residing in the underground workings. The current presence of water in the underground workings may (and should) differ from the calculated results as the latter indicates maximum rather than measured values.

Most of the areas outside the service lines (main development) are closed off with walls to improve ventilation of the workings. Although these ventilation walls are not designed to be watertight they will have a restraining effect on the water bodies. This may result into sections with more water or sections with less water than calculated. Confirmation of water levels inside these sections is needed to accurately calculate the volumes of water inside the various compartments of the workings.

Old Anglo opencast workings are located directly adjacent and north of Matla's Mine 3, which depending on the structural integrity of the barrier or boundary pillars, could affect water balance calculations due to intermine flow. Future water balance calculations should therefore take into consideration this possible scenario, which could either cause an increase or decrease in the total volume of water residing in Matla's underground workings depending on flow directions.

5.6.13.2 Recharge calculations – Lateral recharge component (groundwater)

When a mine cavity is abandoned water will enter the void. The time it takes to fill the void is dependent on numerous factors like type of mining, depth of mining, type of overlaying strata, water level in the direct surroundings and the amount of annual rainfall. The mining void will slowly be filled by water from a lateral source (groundwater) and by recharge water from above. Unless mining goes through major faults and/or sheer zones the recharge from groundwater will be very small in comparison with recharge from rainfall.

Darcy's Law is used to calculate the recharge from groundwater flow (lateral recharge). The average lateral recharge value for all the workings combined is 12.9 m^3/d. The recharge per working is expected to be below 3 m^3/d (Mine Water Consultants, 2015).

5.6.13.3 Recharge calculations – Vertical recharge component (rainfall)

The projections are made under average annual rainfall conditions of 678 mm/a as measured at Kriel weather station. As long as there is enough space in the mine to accommodate excess recharge during excessively wet years, this prediction is valid. Over a period of 10 years or more, predictions average out and average rainfall may be used in the model. The combined daily recharge for all five underground workings (lateral and recharge from rainfall which take place from the top) varies from a low recharge range value of 8 800 m^3/d to a high range of 17 000 m^3/d, with an average of approximately 12 900 m^3/d (Mine Water Consultants, 2015).

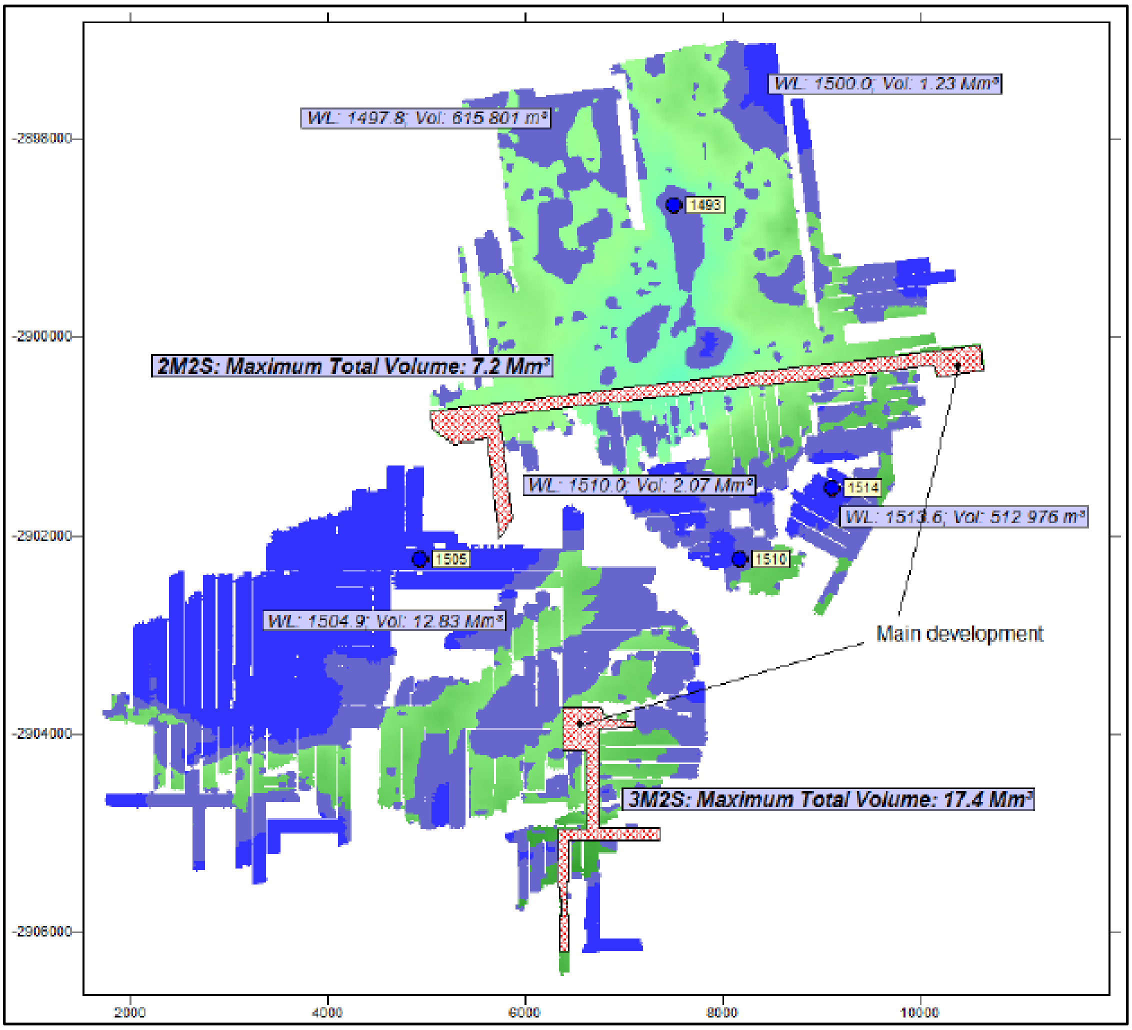

Figure 5.63: Potential water in the 2 seam mines (Mine Water Consultants, 2015)

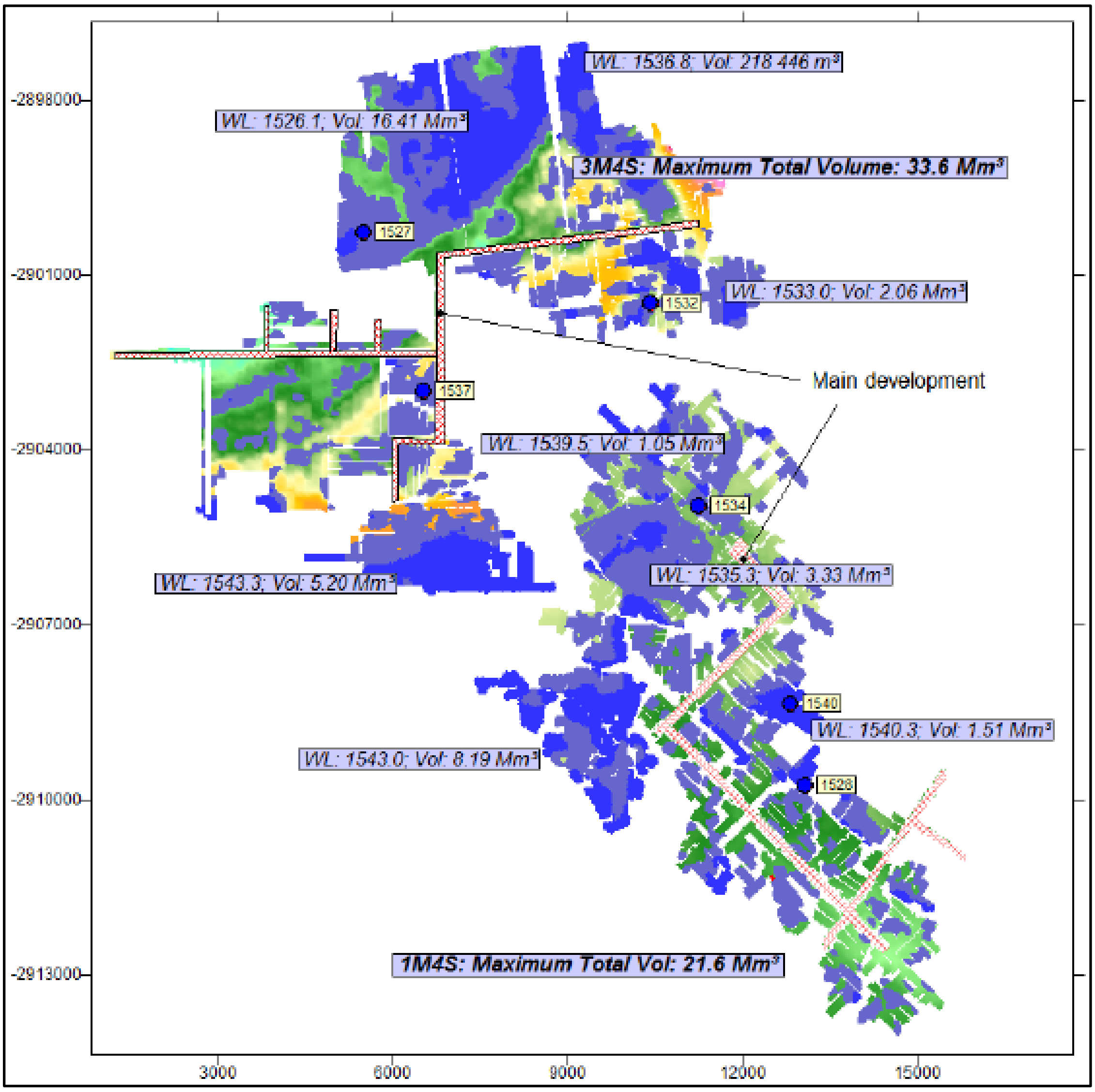

Figure 5.64: Potential water in the 4 seam mines (Mine Water Consultants, 2015)

5.6.13.4 Post closure decant

Decanting of a mine void generally occurs as a result of an excess volume of water that cannot be "absorbed" by the aquifer system. This excess water is generated by the increased recharge from surface (vertical recharge component) due to roof collapse and ensuing surface subsidence. Decanting is expected to occur at the lowest undermined surface elevation/s, provided that it is hydraulically connected to the underground void by means of a transmissive geological structure (fracture/fault), exploration borehole, shaft, etc.

The average vertical recharge to the underground workings was estimated by Mine Water Consultants (2014) to be in the order of 12 900 m^3/d. Once the entire underground void has been flooded, this is the same volume of water expected to decant. Potential decant positions/areas are indicated in Figure 5.65.

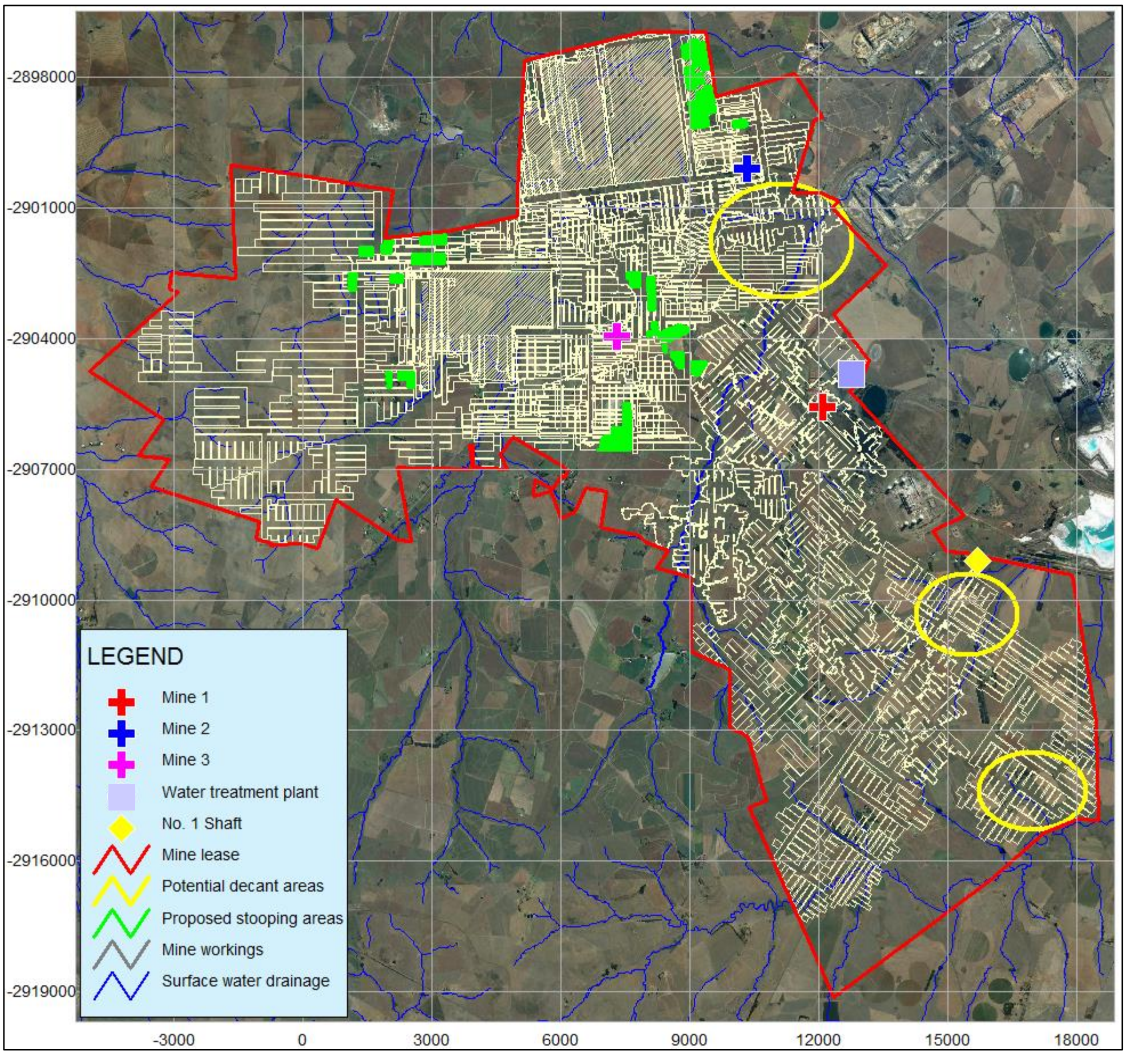

Figure 5.65: Potential decant areas

5.6.14 Summary of Conceptual Model

A vertical cross section of the mine lease area is provided in Figure 5.66. Based on our assessment of all groundwater related aspects and previous groundwater studies, we conceptualize the hydrogeological system underlying the Matla mine lease area as follows:

- The mine lease area is underlain by sedimentary rocks (mainly sandstone, siltstone, shale and coal) of the Ecca Group, Karoo Supergroup.
- Two aquifer systems are present, namely a shallow aquifer composed of soil and weathered bedrock and a deeper fractured rock aquifer hosted within the solid/unweathered bedrock.

- The average transmissivity of the weathered zone aquifer is approximately 1.7 m2/d, while the transmissivity of the more heterogeneous fractured rock aquifer generally varies between 0.1 m2/d and 7 m2/d.
- Approximately 4% of the mean annual rainfall reaches the groundwater table to recharge the aquifer.
- Natural groundwater drainage from the Matla mine lease area is towards the west/north-west and north-east.
- The average hydraulic gradient was calculated to be in the order of 0.7%, resulting in a groundwater seepage velocity/flux of approximately 5.8 m/y.
- Groundwater levels around the mining area generally vary between ± 2 and 22 meters below surface (mbs).
- Groundwater levels in excess of ten meters deep are considered to be affected (be it from groundwater abstraction for domestic/other purposes or mine dewatering), however impacts are largely restricted due to the generally low hydraulic properties of the aquifer host rock.
- Groundwater is considered to be of good quality according to the two sets of guidelines used in the assessment of the chemical and physical groundwater analyses.
- Numerous potential sources of groundwater contamination occur within the mine lease area. Studies have shown that the coal and waste material have the potential to generate acidic leachate due to acid mine/rock drainage, significantly increasing the source's potential to adversely affect groundwater quality.
- The saturated weathered zone and geological structures (dykes and faults) within the mine lease area were identified as possible pathways along which groundwater and potential contamination may migrate at accelerated rates.
- Numerous groundwater users and perennial surface water streams occur throughout the mine lease area, which are considered to be important receptors of contamination that may potentially originate from the coal mining or other activities such as agriculture.
- The planned stooping areas are either partially or completely flooded and would require dewatering before Matla can safely commence with their stooping activities.

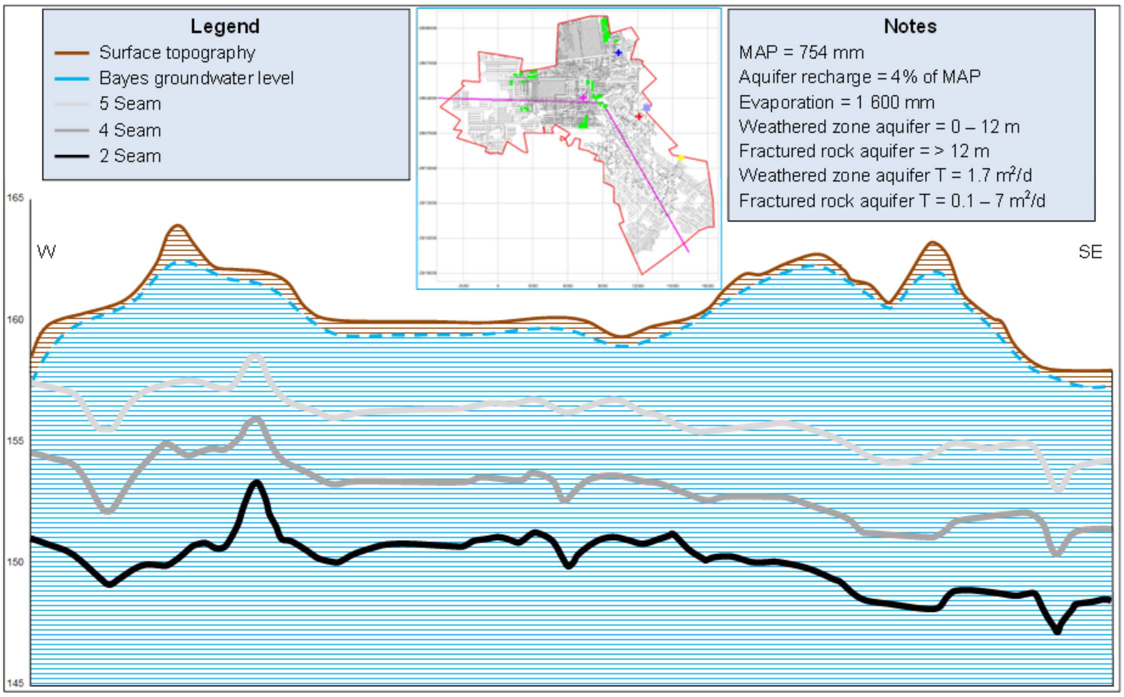

Figure 5.66: Vertical cross section through mine lease area

5.7 Wetlands

5.7.1 2014 Assessment

The information contained in this section of the report was obtained from the Baseline Wetland and Aquatic Assessment conducted by Wetland Consulting Services (Pty) Ltd, attached herewith as Appendix D

A number of different wetland types were identified and delineated within the study area, with wetlands covering roughly 36.5 % of the study site. The most common wetland type was found to be hillslope seepage wetlands, which covered 32.5 % of the site and made up almost 90 % of the wetland area, followed by valley bottom wetlands (2.8 % of the wetland area), pan wetlands (2.7 %), and dams (2.7 %). The very high percentage of hillslope seepage wetlands and relatively low percentage of valley bottom wetlands is at least partly the result of the proposed mining sites being located away from the large valley bottom wetlands of the area. However, hillslope seepage wetlands do typically form the majority of wetland habitat within the Mpumalanga Highveld.

Figure 5.67 illustrates all of the wetlands delineated within the study area, while Table 5.10 and Table 5.11 provides details on the wetland extent.

Table 5.10: Overall extent of the various wetland types delineated across the proposed Exxaro Matla Coal Mine's Stooping Project area within the mining right area of Exxaro Matla Coal Mine

Wetland Type	Area (ha)	% of wetland area	% of study area
Channelled valley bottom	75.0	2.8%	1.0%
Unchannelled valley bottom	46.2	1.8%	0.6%
Hillslope seepage	2350.7	89.2%	32.5%
Pan	72.0	2.7%	1.0%
Dam	71.3	2.7%	1.0%
River diversion	3.8	0.1%	0.1%
Quarry	8.1	0.3%	0.1%
Subsidence wetland	8.0	0.3%	0.1%
TOTAL	**2635.1**	**100.0%**	**36.5%**

Table 5.11: Extent of wetlands delineated across the proposed Exxaro Matla Coal Mine's Stooping Project area within the mining right area of Exxaro Matla Coal Mine

Proposed Site	Size of site (ha)	Extent of wetlands on site (ha)	% of wetlands on site
Uitvlugt Stooping area (A)	237.6	39.2	16.5%
Block B & C	405.6	21.2	5.2%
Block D	173	36.9	21.3%
Block E	192.3	29.4	15.3%
3 Mine Stooping area (F, G & H)	2111.2	763.6	36.2%
LOMP Stooping area (I)	4103.3	1744.7	42.5%
TOTAL	**7222.6**	**2635.1**	**36.5%**

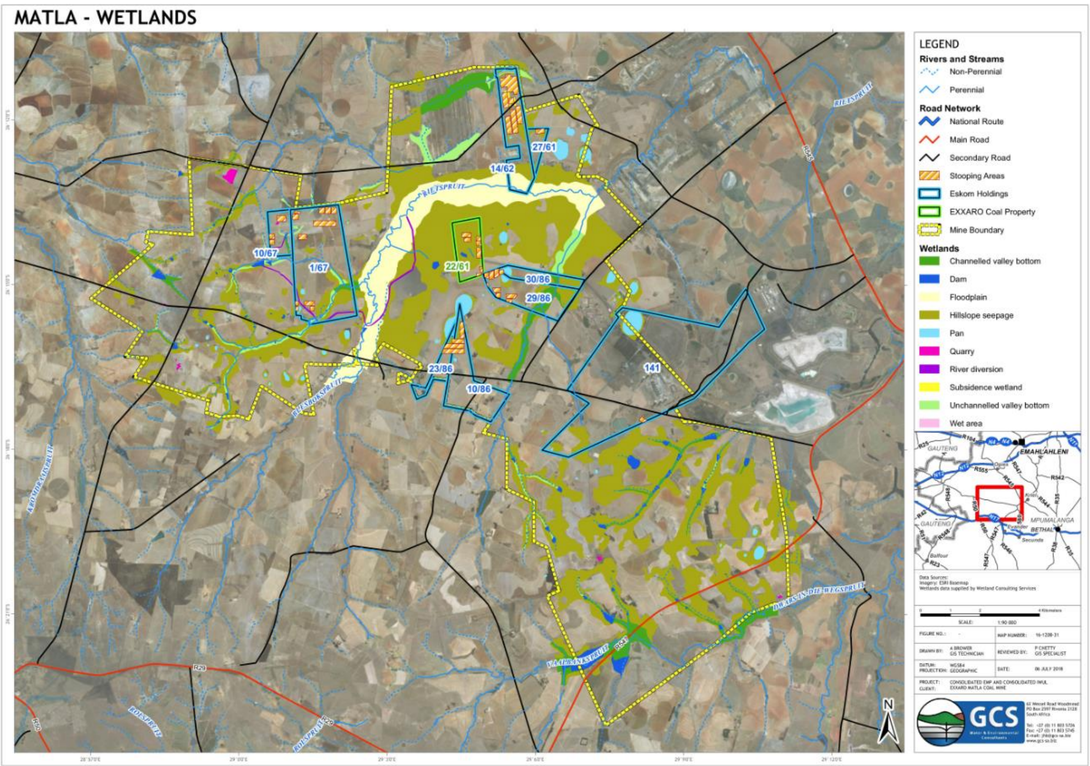

Figure 5.67: Map of the delineated wetlands within the entire Matla study area

5.7.2 Functional Assessment

Within the study area the wetlands represent the virtually the only remaining areas of indigenous vegetation within a landscape largely altered by agriculture and mining, as well as infrastructure and activities associated with the Matla Power station. Most of the areas on site that were once characterised by terrestrial grassland have been cultivated and now provided limited habitat for faunal species, though a number of bird species do nonetheless utilise these cultivated areas for feeding purposes. Mining and the Matla Power Station further add to disturbances and habitat transformation within the area.

Only the wetland areas are still characterised by extensive areas of indigenous vegetation, even if many of the hillslope seepage wetlands have also been substantially impacted by cultivation in the past and are now characterised by secondary vegetation. Despite these disturbances, the wetlands play an important role at the local and regional scale in supporting biodiversity, not only wetland dependent and adapted species, but also terrestrial grassland species given the near complete transformation of terrestrial grassland habitat. Certain wetlands on site are also considered important at a national scale in biodiversity support as they support threatened species such as the African Grass Owl as well as Greater Flamingo.

In addition to biodiversity support, other functions typically attributed to wetlands include nutrient removal (and more specifically nitrate removal), sediment trapping (and associated with this is the trapping of phosphates bound to iron as a component of the sediment), stream flow augmentation, flood attenuation, trapping of pollutants and erosion control. Most of these functions can be described as indirect use functions – beneficial services which the wetlands provide through ecological process and functions. Many of these functions attributed to wetlands are wetland type specific and can be linked to the position of wetlands in the landscape as well as to the way in which water enters and flows through the wetland. Thus not all wetlands can be expected to perform all functions, or to perform these functions with the same efficiency.

However, based on the hydro-geomorphic wetland type which classifies wetlands on the way that water moves through the wetland as well as the position of the wetland within the landscape, certain assumptions on the functions supported by wetlands can be made.

5.7.2.1 Hillslope Seepage Wetlands

Hillslope seepage wetlands make up 82 % of the wetlands on site and over 33 % of the land area. Hillslope seeps support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile, and are thus thought to contribute to water quality improvement and/or the provision of high quality water. The greatest importance of the hillslope seepage wetlands on site is thus taken to be the movement of clean water through the hillslope seepage wetlands and into the adjacent valley bottom wetlands. Given the serious water quality concerns experienced in the upper Olifants River catchment, this provision of clean water assumes even greater importance. However, the seepage wetlands merely reflect the movement of this clean water through the landscape (in the sub-surface) and do not themselves produce the clean water.

As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquiclude, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). However, by retaining water in the landscape and then slowly releasing this water into adjacent valley bottom or floodplain wetlands, hillslope seepage wetlands contribute to stream flow augmentation, especially during the rainy season and early dry season. From an overall water yield perspective there is evidence that they contribute to water loss. The longer the water is retained on or near the surface the more likely it is to be lost through evapo-transpiration (McCartney, 2000). Hillslope seepage wetlands are not generally considered to play an important role in flood attenuation, though early in the season, when still dry, the seeps have some capacity to retain water and thus reduce surface run-off. Later in the rainy season when the wetland soils are typically saturated, infiltration will decrease and surface run-off increase. Further flood attenuation can be provided by the roughness of the wetland vegetation; the greater the surface roughness of a wetland, the greater is the frictional resistance offered to the flow of water and the more effective the wetland will be in attenuating floods (Reppert et al., 1979). In terms of the hillslope seepage wetlands on site, the surface roughness is taken to be moderately low, given that the seepage wetlands are characterised by typical grassland vegetation offering only slight resistance to flow.

From a biodiversity perspective, hillslope seepage wetlands support plants in particular, and associated insects, birds and small mammals adapted to the seasonal moisture regime. The mosaic of moisture regimes within the hillslope seepage wetlands, ranging from temporary wetness in the rainy season to near permanent wetness in some areas results in a wide range of microhabitats within the hillslope seepage wetlands on site. Of all the wetland types on site, seepage wetlands displayed the highest species richness.

5.7.2.2 Valley Bottom Wetlands

Valley bottom wetlands make up roughly 10.4 % of the wetland area on site, with channelled valley bottom wetlands, unchannelled valley bottom wetlands and a portion of the Rietspruit floodplain occurring on site.

Channelled valley bottom wetlands receive water typically from surface run-off in the upslope catchment and convey it via the channel to the downslope catchment. Under normal flow conditions water is confined to the channel, though flood flows can overtop the channel banks and spread across the wetland. Under these conditions the valley bottom wetlands can contribute to flood attenuation and sediment trapping as flows overtopping the channel banks are spread out and slowed down through the surface roughness provided by the vegetation, leading to sediment deposition. In instances where flow is confined to the channel, for example under normal flow conditions or in instances where a deeply incised channel prevents overtopping, sediment transport rather than sediment deposition is the dominant process, which is evidence by the erosion of a channel through the wetland. Channel erosion may be both vertical and/or lateral. Given the limited contact time between the water and the wetland soils as well as the limited deposition of sediments, the channelled valley bottom wetlands on site are not expected to perform important water quality functions.

By providing a habitat differing from the surrounding terrestrial grasslands and hillslope seepage wetlands, the channelled valley bottom wetlands play a role in maintaining biodiversity within the landscape.

Un-channelled valley bottom wetlands reflect conditions where surface flow velocities are such that they do not, under existing flow conditions, have sufficient energy to transport sediment to the extent that a channel is formed. In addition to the biodiversity associated with these systems it is expected that they play an important role in retaining water in the landscape as well as in contributing to influencing water quality through for example mineralisation of rain water. In general, these wetlands could be seen to play an important role in nutrient removal, including ammonia, through adsorption onto clay particles.

5.7.2.3 Pan Wetlands

Pans account for around 3.7 % of the wetland area in the study site. Given the position of many pans within the landscape, which is usually isolated from any stream channels, the opportunity for pans to attenuate floods is fairly limited, though some run-off is stored in pans. In the cases where pans are linked to the drainage network via seep zones, the function of flood attenuation is somewhat elevated. Pans are also not considered important for sediment trapping, as many pans are formed through the removal of sediment by wind when the pan basins are dry. Some precipitation of minerals and de-nitrification is expected to take place within pans, which contributes to improving water quality. Some of the accumulated salts and nutrients can however be exported out of the system and deposited on the surrounding slopes by wind during dry periods.

5.7.2.4 Direct Use Benefits

Direct uses of the wetlands on site include the use of water for livestock watering purposes (through the building of small dams within the wetlands), grazing and crop production (through cultivation within the wetland areas on site). As all of the wetlands are located on private land, access to the wetlands is limited and little use is made of the wetlands in terms of recreational activities such as fishing or bird watching, even though opportunities for such activities exist, most notably in the various large pans (in terms of bird watching) and the numerous farm dams (fishing).

No information regarding potential cultural value of the wetlands on site was available or could be found. However, given that all of the study has been privately owned for numerous years and that access to the land is thus limited, it is considered unlikely that the wetlands hold any significant cultural value.

5.7.3 Present Ecological Status (PES) Assessment

The present ecological state assessment (PES) was undertaken using the Level 1 WET-Health methodology (Mcfarlane et al., 2009) for all wetlands excluding pans, for which the PES was assessed using the 1999 RDM methods (DWAF, 1999).

Table 5.12: Table showing the rating scale used for the PES assessment

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

5.7.3.1 PES - Rietvlei Study area

Two large hillslope seepage wetlands and a very small depression/pan occur within the Rietvei study area. These wetlands have been impacted by agricultural activities that extend into the wetland areas. Portions of these wetlands are currently under cultivation and were completely bare of vegetation at the time of the site visit. Large areas are characterised by planted pasture and were heavily grazed, with the remainder of the seepage wetlands characterised by secondary vegetation due to past cultivation. Flow through the wetlands has also been impacted by a small farm dam, a number of farm track crossings and several old drains. As a result, these wetlands were considered to be in a largely modified condition (PES category D).

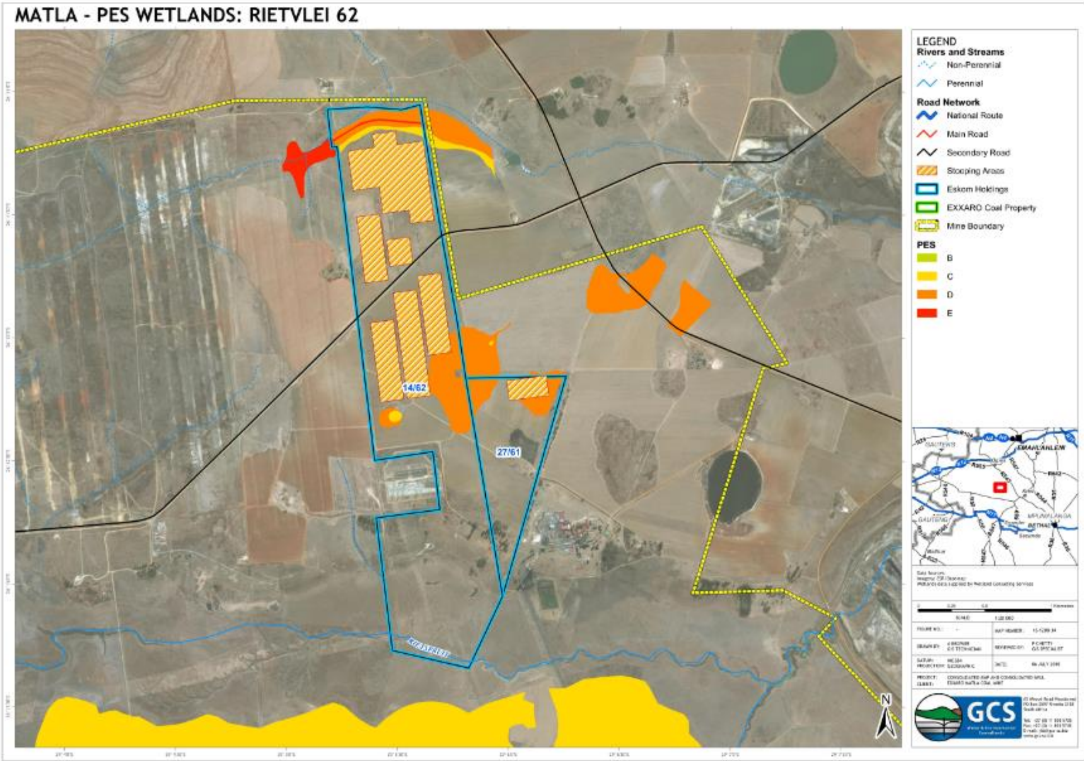

Figure 5.68: Map showing the results of the PES assessment for wetlands in the Rietvlei Study Area

5.7.3.2 PES – Matla Power Station area

Within the Matla Power Station area the wetlands have been mostly impacted by agricultural activities. These have had a marked impact on the vegetation component of especially the hillslope seepage wetlands, which in most cases are now characterised by secondary vegetation. Cultivation would also have impacted on the runoff characteristics of the landscape through a likely marginal increase in surface runoff, as well as increase sediment transport into the wetlands.

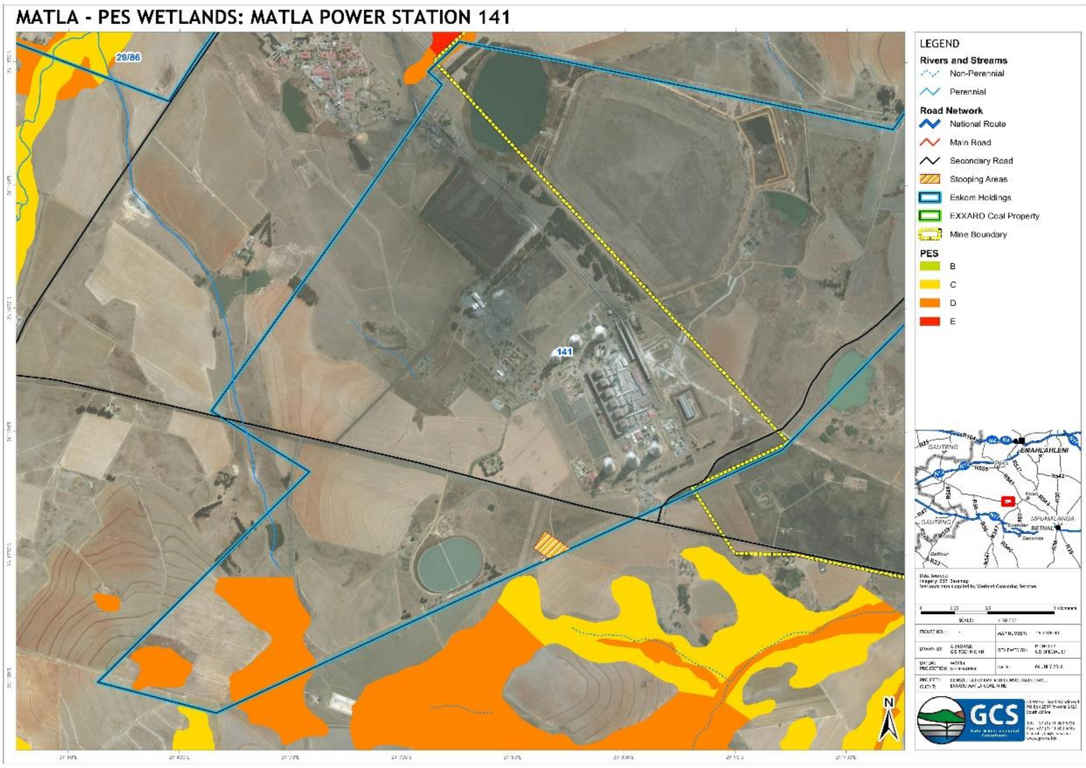

Figure 5.69: Map showing the results of the PES assessment for wetlands in the Matla Power Station area

5.7.3.3 PES - Kortlaagte Study Area

Within the Kortlaagte Study Area, the wetlands have been mostly impacted by agricultural activities. These have had a marked impact on the vegetation component of especially the hillslope seepage wetlands, which in most cases are now characterised by secondary vegetation. Cultivation would also have impacted on the runoff characteristics of the landscape through a likely marginal increase in surface runoff, as well as increase sediment transport into the wetlands.

Hydrological impacts have been more severe within the south draining wetlands. The large Blesbokspruit river diversion originates in this area and intercepts and diverts all flows from these wetlands, resulting in the remaining wetland habitat immediately downslope of the diversion being seriously modified due to decreased flows. Discharge of water into one of the wetland systems (the eastern unchannelled valley bottom wetland) has also largely altered the hydrology supporting this wetland.

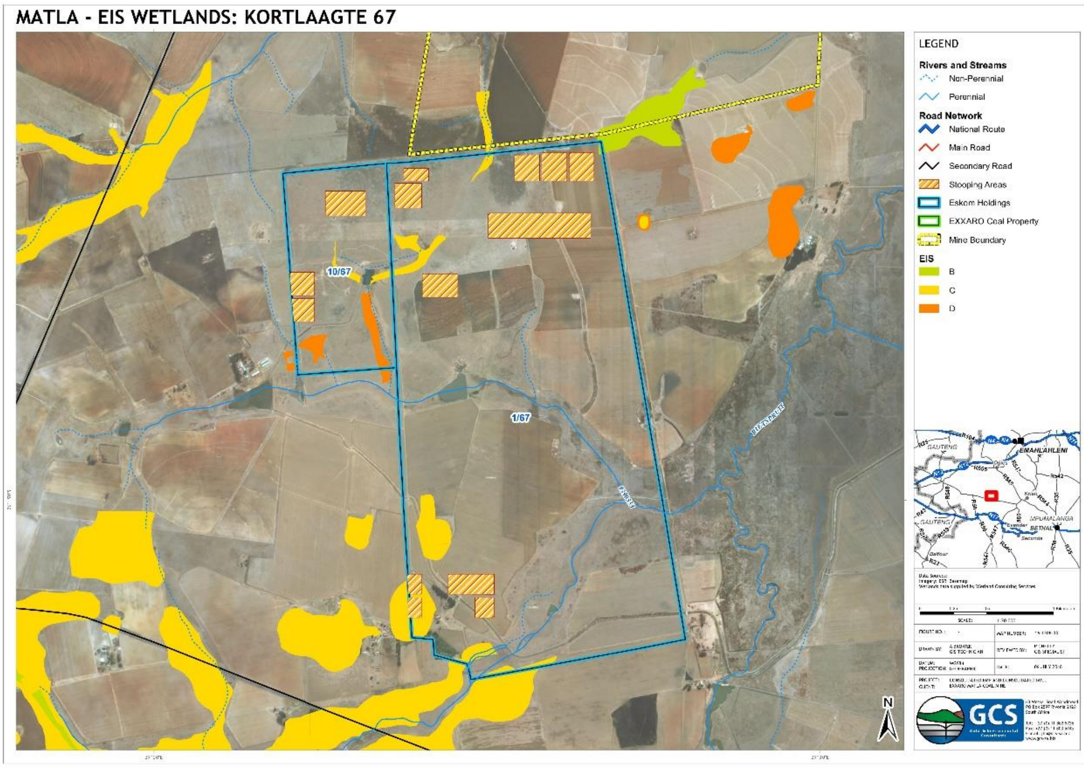

Figure 5.70: Map showing the results of the PES assessment for wetlands in the Kortlaagte area.

5.7.3.4 PES – Vierfontein Sudy area

As is the case with the rest of the study sites, this study area has been subjected to extensive agricultural activities over many years. The impact of this land use on the wetlands is apparent in a number of changes that most of the wetland systems on site have undergone.

The impacts to vegetation are mostly associated with a complete transformation of habitat due to cultivation within the wetland boundaries. Historically, the extent of cultivation on site was markedly more extensive than the currently actively cultivated areas. Recognition by farmers that planting maize within seasonally saturated soils provides limited yields has resulted in cultivation being withdrawn from these areas. Such previously cultivated areas were then either converted to planted pastures (generally *Eragrostis* pastures), or were left fallow and natural succession has resulted in these areas being characterised by secondary grassland.

Impacts to hydrology are again mostly related to changes in the distribution and retention of water within the wetlands as the water inputs to the wetlands are expected to have remained largely the same.

Extensive cultivation surrounding the wetlands provides considerable sediment sources to the wetlands that get transported by surface flow following heavy rain as well as wind deposition. In addition, the altered hydrology provides increased capacity for sediment transport out of the wetlands, resulting in the geomorphology of most of the wetlands being moderately modified.

The Pan system present within the Vierfontein Study area is largely natural with the adjacent Hillslope seep wetlands being moderately modified.

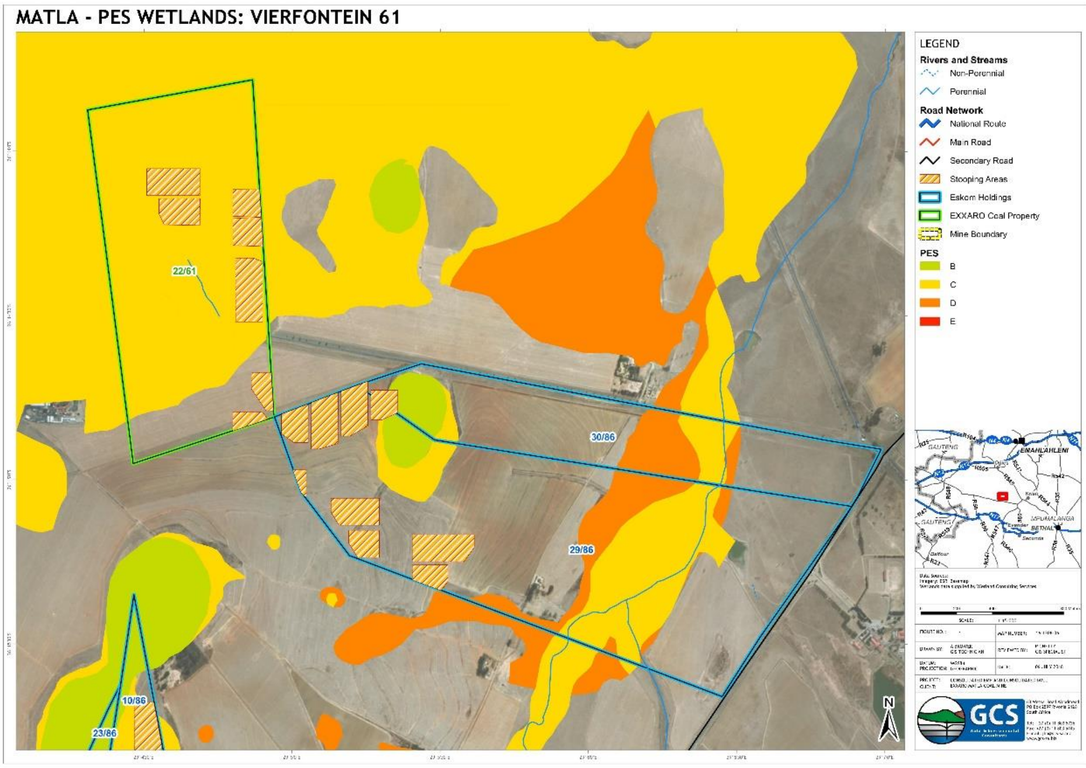

Figure 5.71: Map showing the results of the PES assessment for wetlands in the Vierfontein Study Area

5.7.3.5 PES – Grootpan Study Area

As is the case with the rest of the study sites, this study area and surrounds have been subjected to extensive agricultural activities over many years. The impact of this land use on the wetlands is apparent in a number of changes that most of the wetland systems on site have undergone. The Pan system present within the Grootpan block is largely natural with the adjacent Hillslope seep wetlands being moderately modified.

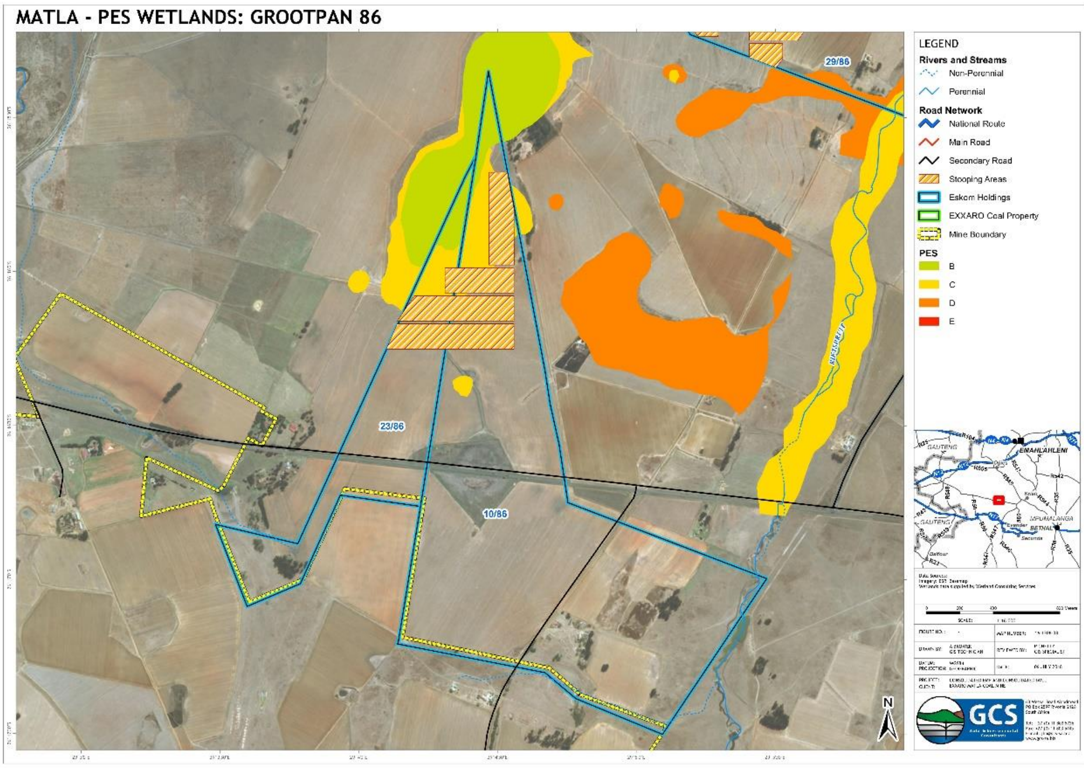

Figure 5.72: Map showing the results of the PES assessment for wetlands in the Grootpan Study Area

5.7.4 Ecological Importance and Sensitivity (EIS)

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and
- Direct Human Benefits

The scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services (the WETEcoServices tool). Based on this methodology, an EIS assessment was undertaken for all the delineated wetlands on site, with the results discussed and illustrated in the sections that follow.

The wetlands within the study area all form part of the Olifants River Primary catchment which is a heavily utilised and economically important catchment. Wetlands and rivers within the Olifants River Catchment upstream of Loskop Dam have been greatly impacted upon by various activities, which include mining, power stations, water abstraction, urbanization, agriculture etc. As a result of these impacts serious water quality concerns and also water quantity concerns have been raised within the sub-catchment, also specifically within the Steenkoolspruit sub-catchment, which is feed by the Steenkoolspruit River. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all wetlands and rivers within the catchment that have as yet not been seriously modified. Within this context an EIS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the EIS assessment include:

- The location of the study area within a vegetation type (Eastern Highveld Grassland) considered to be extensively transformed and threatened, and classed as Vulnerable.
- The wetland ecosystem type of the area, Mesic Highveld Grassland Group 4 wetlands, is considered to be Critically Endangered.
- The classification of the Blesbokspruit and Rietspruit wetland systems as FEPA wetlands.
- The extensive transformation of habitat that has occurred on site, as reflected in the Mpumalanga Biodiversity Sector Plan 2013 which classified only a very small area of the study area as a Critical Biodiversity Area – Irreplaceable, and some additional areas as Critical Biodiversity Area – Optimal, but most of the site as heavily modified.
- The results of the PES assessment of the wetlands on site which revealed most wetlands as being moderately modified, though a significant percentage also as heavily modified.
- The presence of Red Data species such as Greater Flamingo and African Grass Owl in some of the wetlands on site.

It is these considerations that have informed the scoring of the systems in terms of their ecological importance and sensitivity. The results of the assessment and rankings based on our current understanding of the wetlands is illustrated in Figure 5.73 and Figure 5.74, and summarised in Table 5.15.

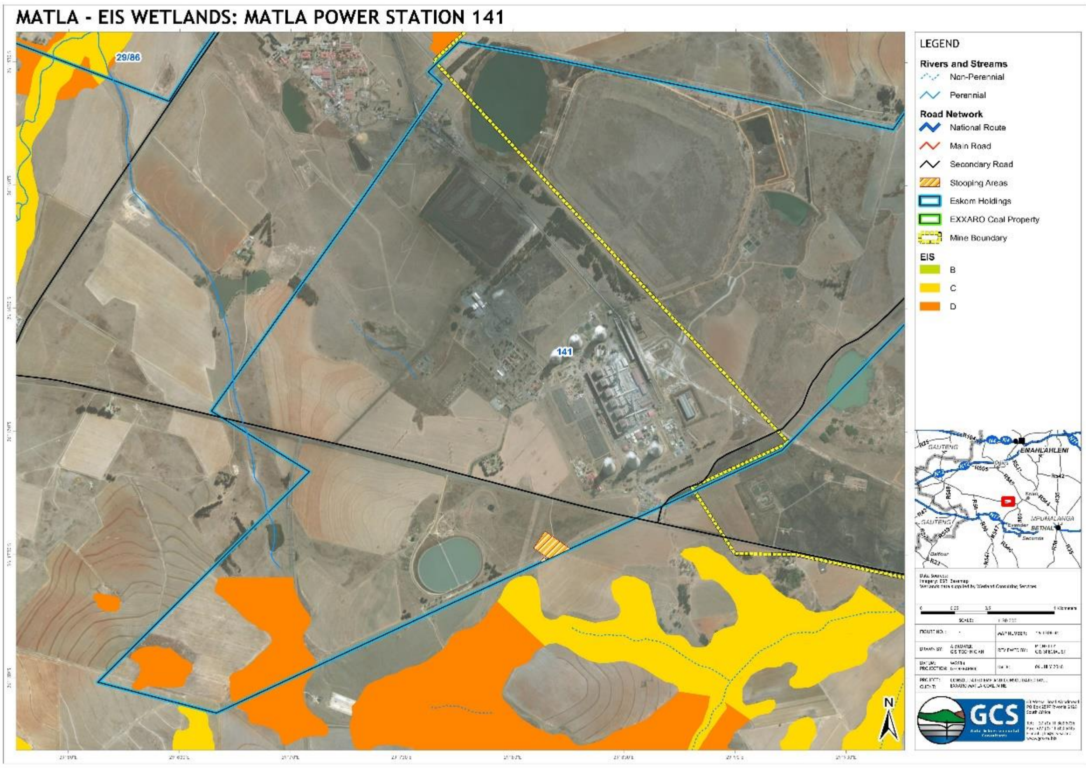

Figure 5.73: Results of the EIS assessment of wetlands in the Matla power Station study area.

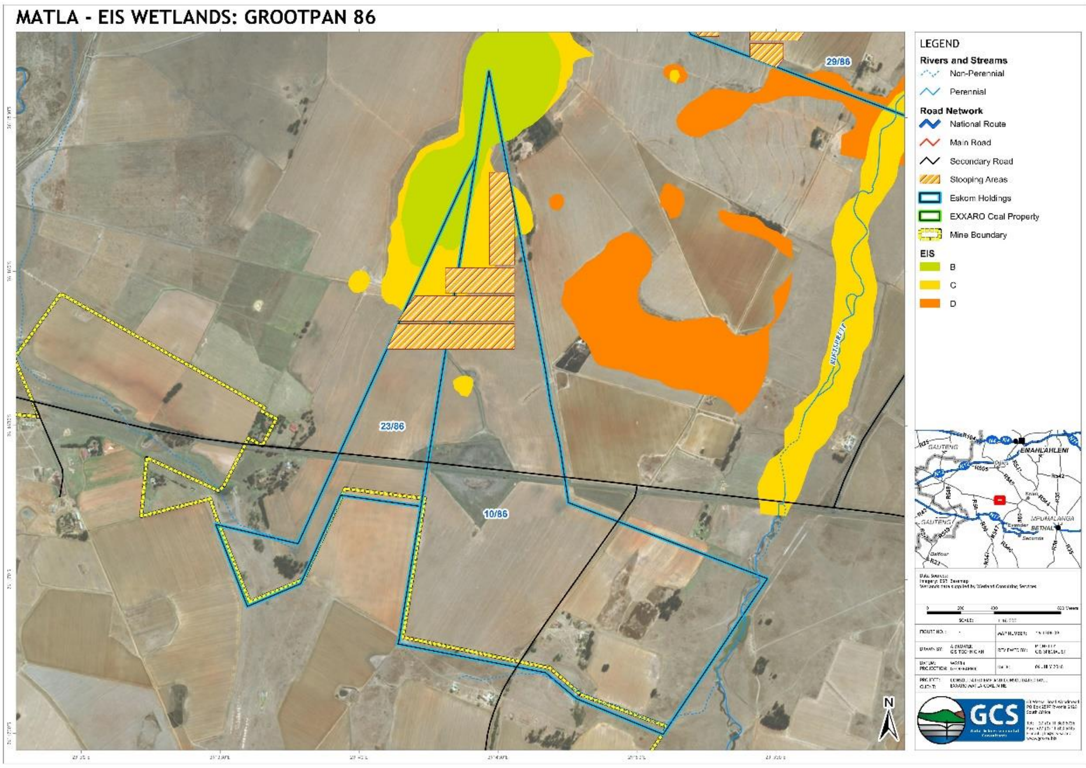

Figure 5.74: Results of the EIS assessment of wetlands in the Grootpan study area

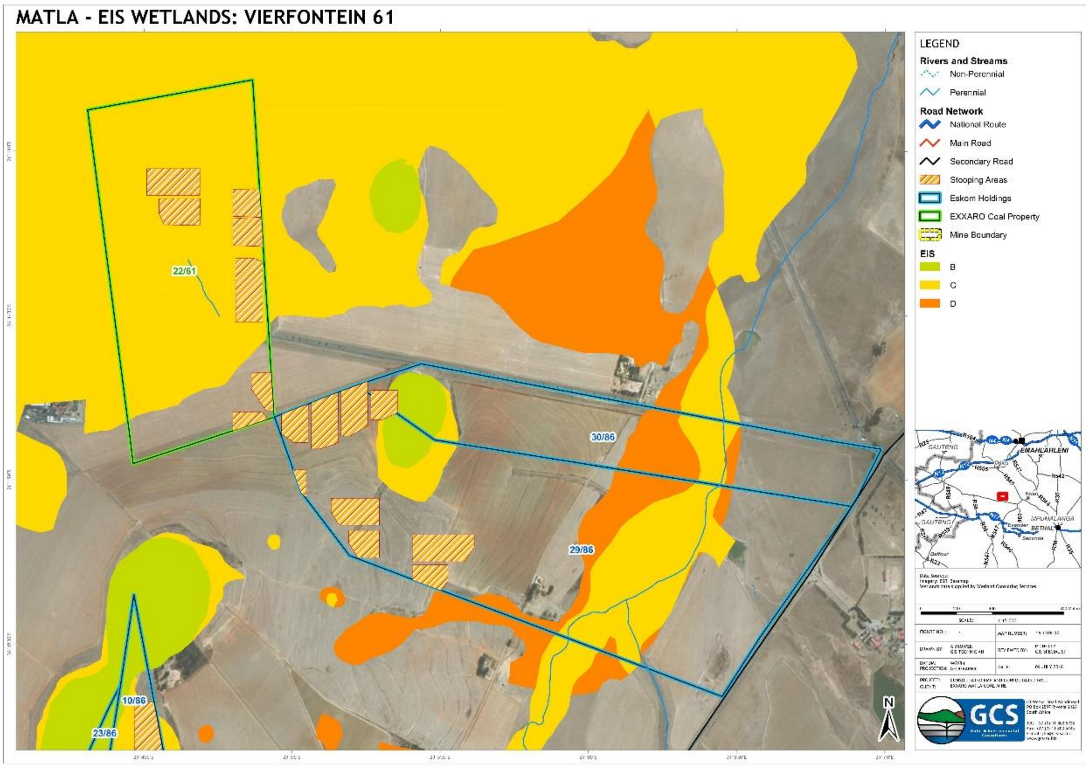

Figure 5.75: Results of the EIS assessment of wetlands in the Vierfontein study area

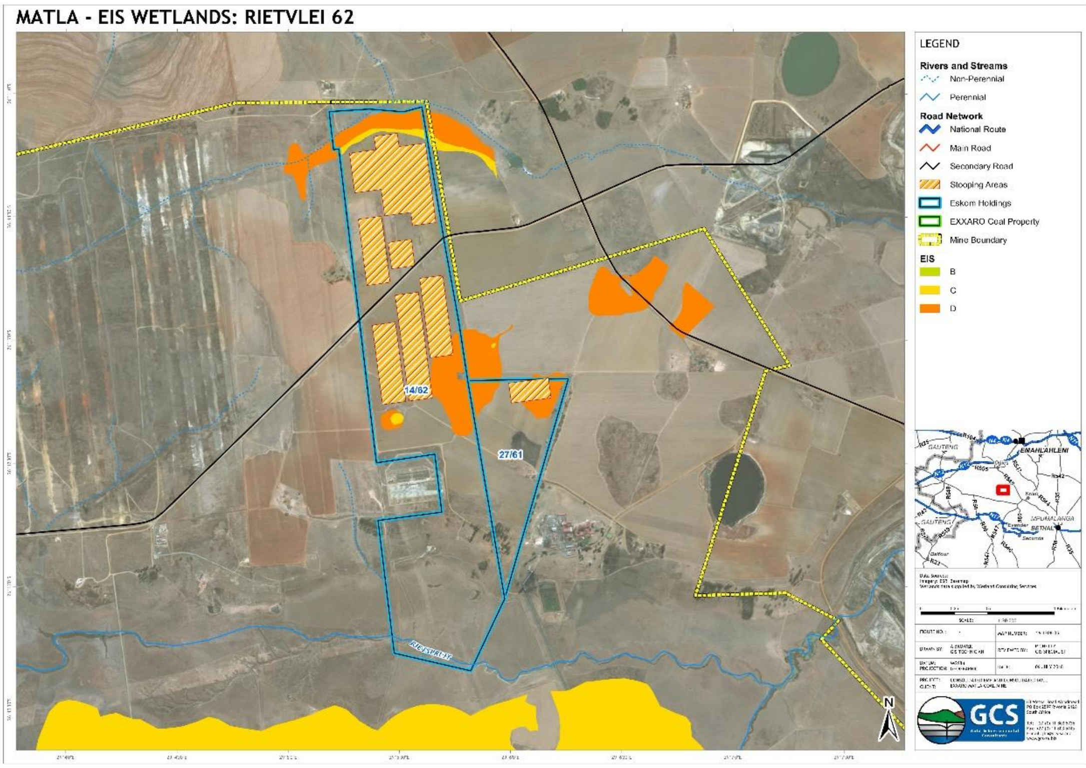

Figure 5.76: Results of the EIS assessment of wetlands in the Rietvlei study area

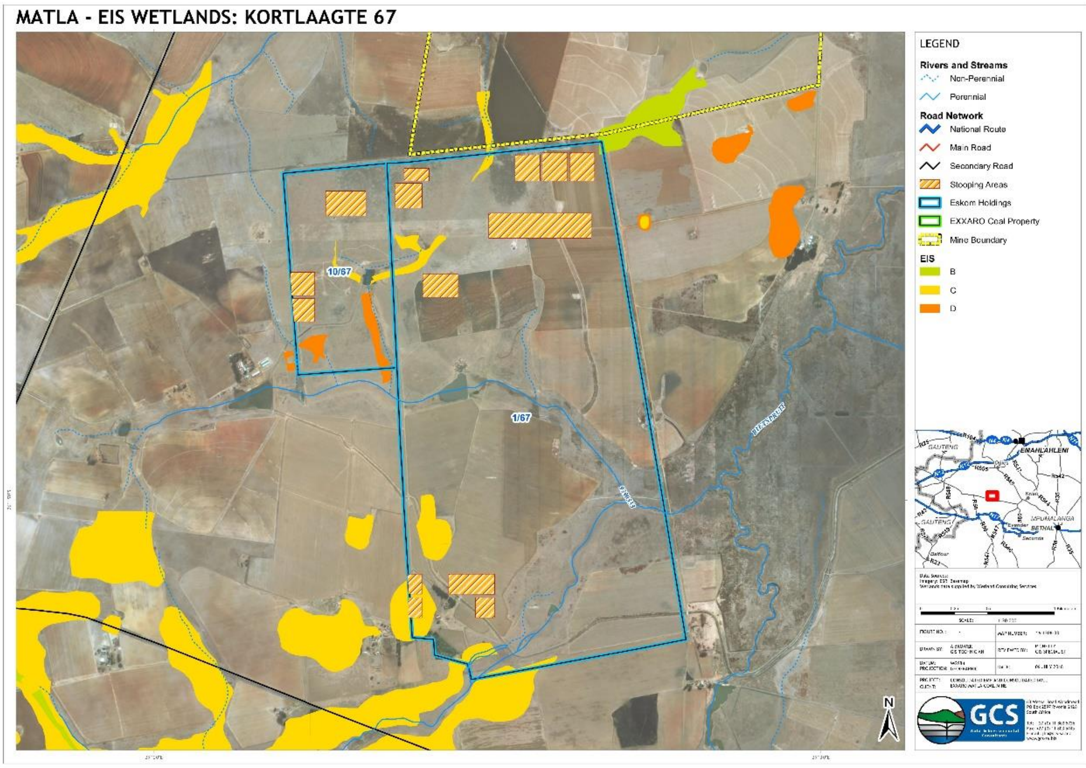

Figure 5.77: Results of the EIS assessment of wetlands in the Kortlaagte study area

Majority of the wetlands on site are considered to be of Moderate to Low ecological importance and sensitivity, with only a small amount considered as High ecological importance and sensitivity. The wetlands that rated High consisted mostly of pan wetlands, but included one or two seepage wetlands known to support African Grass Owls.

5.7.5 2017 update

The information contained in this section of the report was obtained from the Wetland and Aquatic Assessment conducted by Digby Wells Environmental, attached herewith as Appendix E

5.7.5.1 Wetland delineation and classification

The Matla Mine 2 Project Area is characterised by multiple wetland systems totalling 1494.8 ha. Fourteen HGM Units were identified on site, with the largest system being a Channelled Valley Bottom wetland which drains to the east of the project area and is fed by various hillslope seeps and valley bottom wetlands. The breakdown of the wetland types per area is detailed in Table 5.13 and illustrated in Figure 5.78.

Table 5.13: Wetland HGM Units

HGM Unit	HGM Unit Type	Area (ha)
1	Seep	63.9
2	Channelled Valley Bottom (and associated hillslope seeps)	1096.0
3	Seep	42.9
4	Seep	37.2
5	Depression	1.7
6	Depression	8.1
7	Depression	29.1
8	Depression (water)	27.2
9	Depression	9.9
10	Depression	6.3
11	Depression	0.8
12	Un-channelled Valley Bottom	43.3
13	Channelled Valley Bottom	148.5
14	Un-channelled Valley Bottom	43.8

The buffer zones relating to the wetlands are illustrated in Figure 5.79. Zones of Regulation of 100m around each wetland have been assigned according to Government Notice 704 (GN 704), section 4(b), which states that no underground mining or opencast mining, prospecting or any other operation or activity may take place within 100 m from any watercourse.

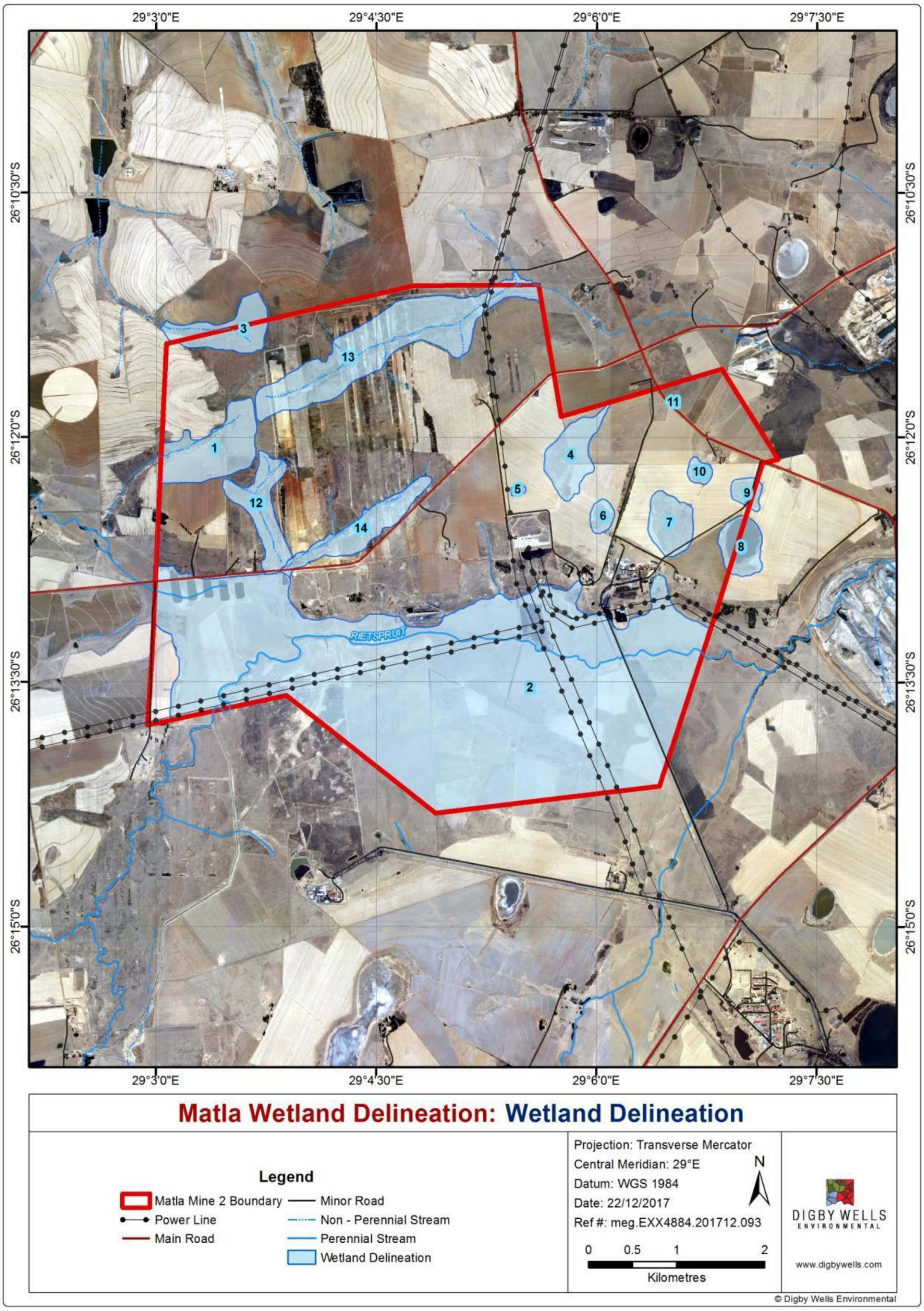

Figure 5.78: Wetland Delineation

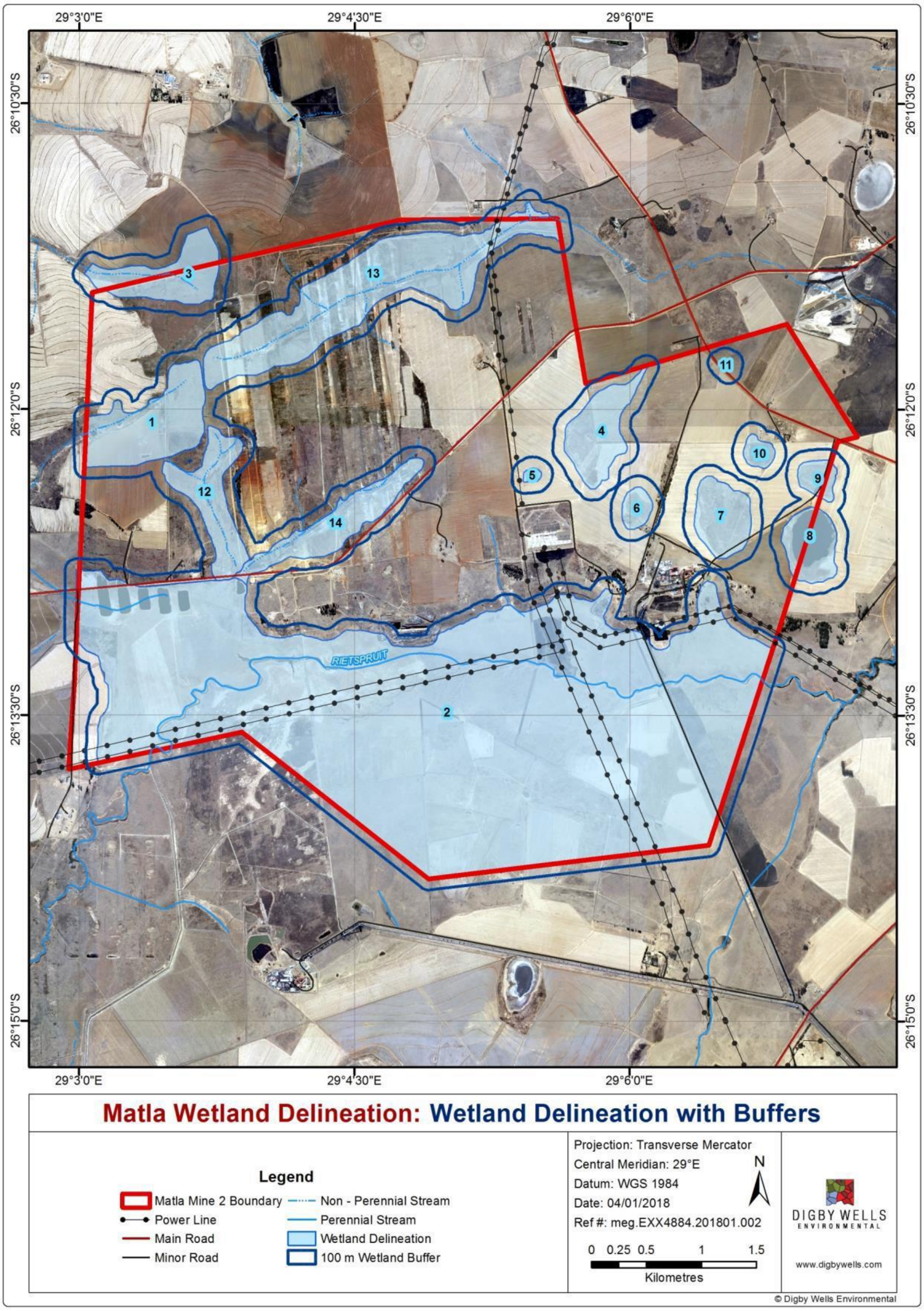

Figure 5.79: Wetland Regulation Zones

5.7.5.2 Present Ecological State

Table 5.14 indicates the PES scores for the various HGM Units. The wetlands within the Project Area exhibit a variety of PES values, ranging from *Seriously Modified* (Category E), to *Largely Natural* (Category B).

HGM Unit 8 and HGM 10 are classified as *Largely Natural* (Category B) wetlands. These pans have not been impacted on to a great extent. The geomorphological and hydrological regimes have not been altered significantly and very little disturbance was observed with regards to vegetation.

Eight *Moderately Modified* (Category C) wetlands were identified (HGM units 2, 3, 4, 5, 6, 7, 9 and 11). These wetlands were mainly impacted on by cultivation and/or grazing with few geomorphological impacts.

Two *Largely Modified (*Category D*)* wetlands are present in the Project Area - HGM Unit 1 and HGM Unit 12. The *Largely Modified* category is mainly attributed to the subsidence in the area.

Two *Seriously Modified* (Category E) wetlands were present. HGM Unit 13 and HGM Unit 14 have been seriously impacted on through subsidence, which has altered the hydrology of the wetland significantly as the subsidence has occurred perpendicular to the flow of the original wetlands, unlike that of HGM Unit 12, where subsidence occurred parallel to the wetland, therefore not completely altering the natural hydrology. Some canals have been constructed through the crests of the subsidence areas of HGM 13 and 14 to allow water to flow in the same direction of the original wetlands, however, the flow has been significantly impacted on.

Table 5.14: Present Ecological Health Scores

HGM Unit	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score	PES Score
1	7.5	4	5.5	5.9	D
2	1	3	6.7	3.2	C
3	0	0.3	8.1	2.4	C
4	3.5	0.1	7	3.5	C
5	1	0.2	5.4	2	C
6	2	0.4	6.1	2.2	C
7	2	0.4	5.7	2.6	C

HGM Unit	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score	PES Score
8	2	0.2	3.2	1.8	B
9	3.5	0.5	4.6	2.9	C
10	1	0.2	4.2	1.7	B
11	3	0.4	6	3.1	C
12	7	0.2	8.1	5.3	D
13	8.5	3.3	8.3	7	E
14	8.5	2.4	7.6	6.5	E

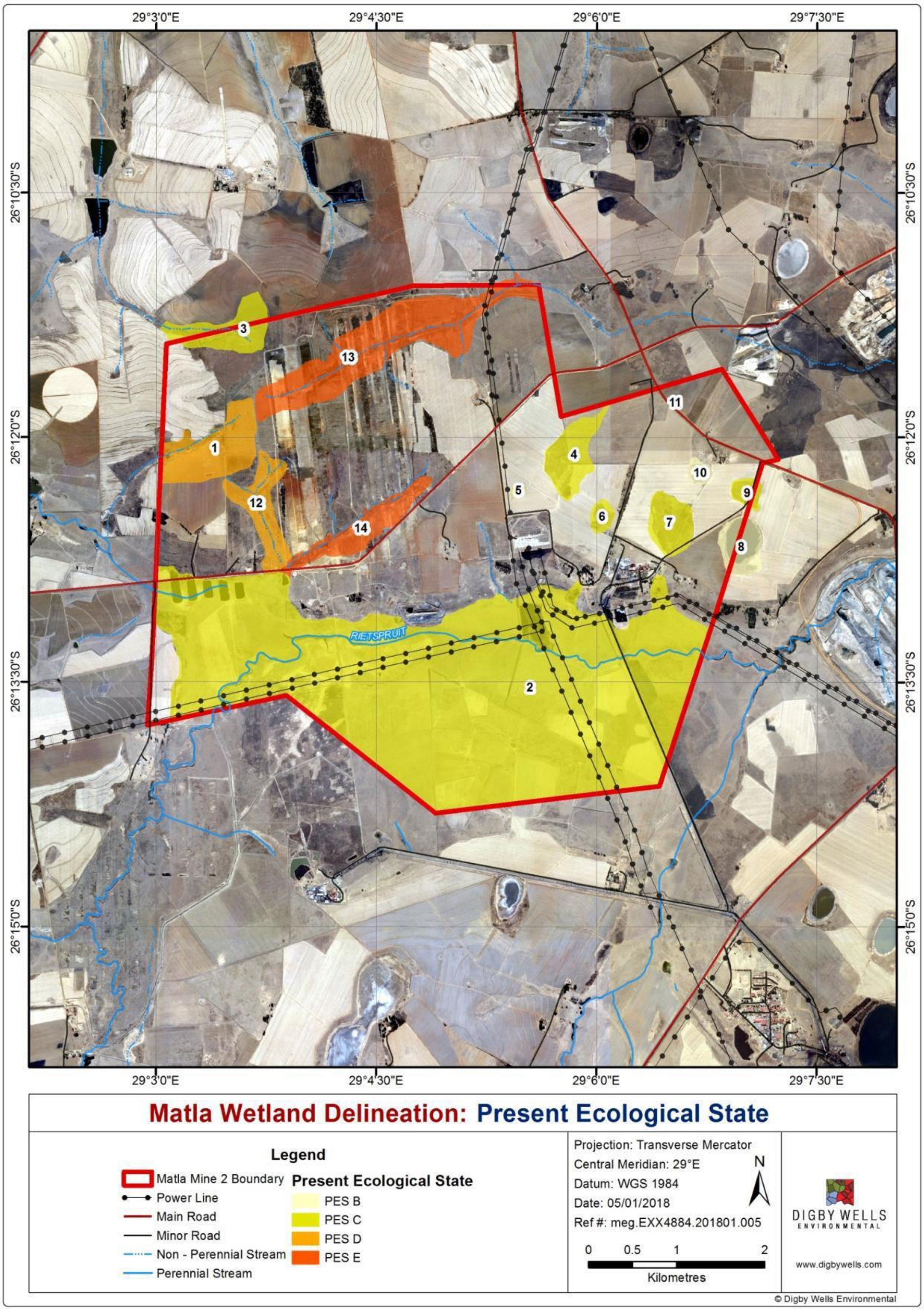

Figure 5.80: Present Ecological States

5.7.5.3 Ecological Importance and Sensitivity

Table 5.15 indicates the EIS scores for the various HGM Units with the final EIS score for the wetlands ranging from *Low* (0.7) to *Very High* (3.1).

Although the wetlands are modified, they do still provide predominantly *Moderate* to *Low* hydrological importance services (mostly ranging between 0.5 and 1.7), such as flood attenuation and assimilation of toxicants and nitrates. HGM Unit 2 is an exception, with a *High* score.

The Ecological Importance and Sensitivity category is ranging from *Low* (0.7) to *Very High* (3.1). Some HGM units have been completely transformed and therefore provide little habitat for fauna and flora, whilst others HGM units such as HGM Unit 2, still have intact vegetation where red data species were observed.

In general, the values are *Low* for 'Direct Human Benefits' (most ranging between 0.1 and 1) as these wetland mainly fall within the mine fences and mining rights area and therefore are not utilised as they would be in a unrestricted area. HGM unit is the only exception (2.5) as it is contains standing water utilised for fish purposes.

Table 5.15: EIS Scores

HGM Unit	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score	Final EIS Category
1	1.4	1.4	0.2	1.4	C
2	3.1	2.1	0.6	3.1	A
3	1.8	1.6	0.4	1.8	C
4	1.8	1.5	0.5	1.8	C
5	1.9	1.7	0.8	1.9	C
6	1.8	1.7	1	1.8	C
7	2.1	1.7	0.8	2	C
8	1.8	1.7	2.5	2.5	B
9	1.8	1.7	1	1.8	C
10	1.9	1.7	1	1.9	C
11	1.4	1	0.4	1.4	C
12	0.9	0.6		0.9	D
13	0.7	0.5	0.1	0.7	D
14	0.8	0.5	0.1	0.8	D

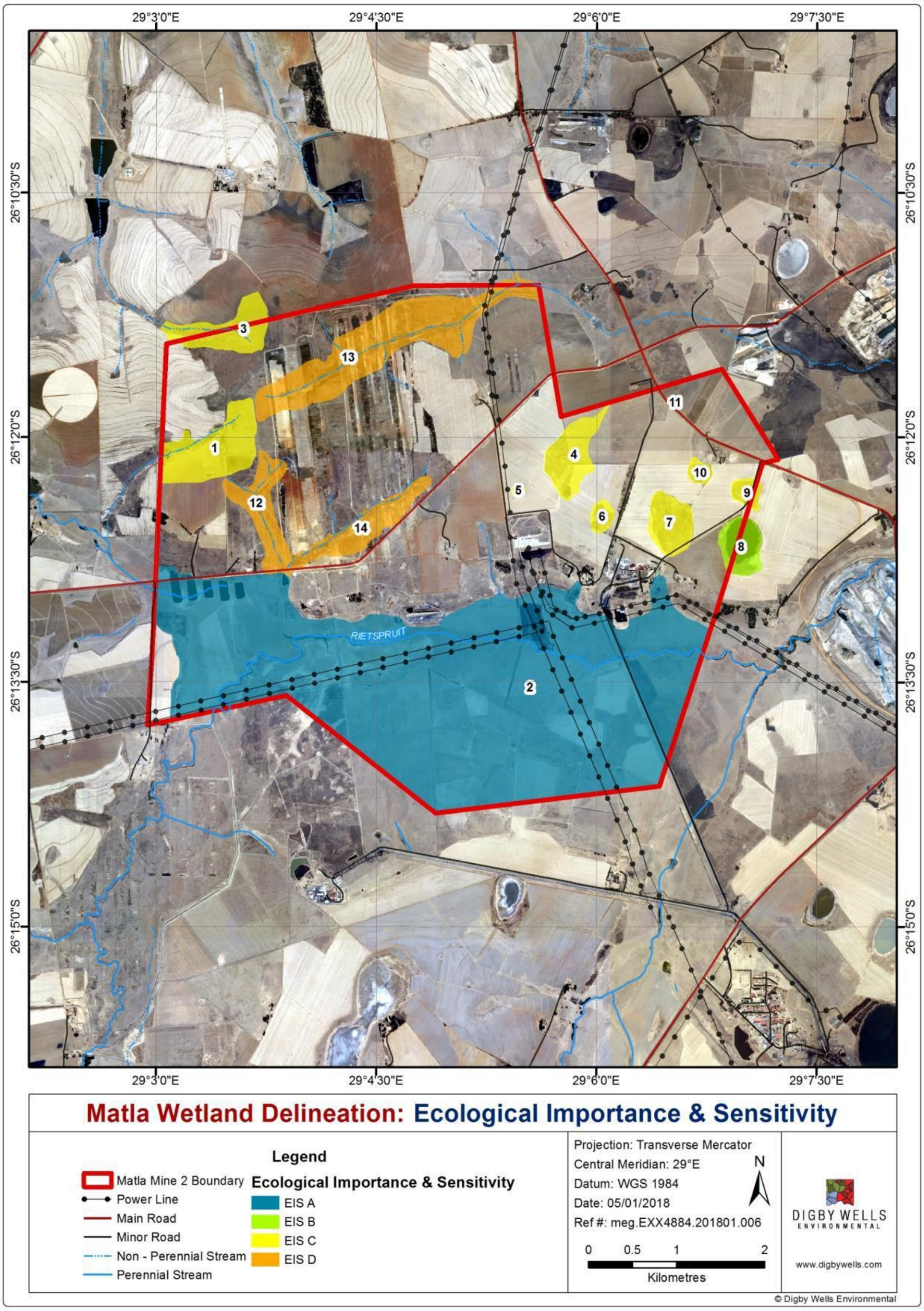

Figure 5.81: Ecological Importance and Sensitivity

Table 5.16: Wetland Summary

HGM unit	HGM unit Type	Size	PES	EIS
1	Seep	63.9	D	C
2	Channelled Valley Bottom (and associated hillslope seeps)	1096.0	C	A
3	Seep	42.9	C	C
4	Seep	37.2	C	C
5	Depression	1.7	C	C
6	Depression	8.1	C	C
7	Depression	29.1	C	C
8	Depression (water)	27.2	B	B
9	Depression	9.9	C	C
10	Depression	6.3	B	C
11	Depression	0.8	C	C
12	Un-channelled Valley Bottom	43.3	D	D
13	Channelled Valley Bottom	148.5	E	D
14	Un-channelled Valley Bottom	43.8	E	D

5.8 Aquatics

The information contained in this section of the report was obtained from the Baseline Wetland and Aquatic Assessment conducted by Wetland Consulting Services (Pty) Ltd, attached herewith as Appendix D, and the Biomonitoring Report compiled by Digby Wells Environmental for 2017, attached as Appendix E

5.8.1 2014 Assessment

5.8.1.1 Sampling Sites

The aquatic sampling sites are illustrated in Figure 5.82 and summarised in Table 5.17. Aquatic ecosystems sampled included permanent pans (Mine 2 Pan and Pan 3) and seasonal pans (P1, P2, P4, P7, P12, Grootpan, Pan 16 and P10), channelled valley bottom wetlands (M4, M7, Ktrib) and rivers (Rietspruit, Dwars-in-die-Wegspruit, Blesbokspruit and Kromdraaispruit). The Blesbokspruit is a seasonal tributary of the Rietspruit and essentially consisted of a series of pools at the time of sampling. The Blesbokspruit has also been diverted in its upper reaches, this diversion further decreasing flows within the main channel.

Grootpan will potentially be undermined, as it falls within the 3 mine stooping area. However, it was dry at the time of sampling. It is recommended that baseline aquatic survey be conducted of this pan, together with Pan 10 (also dry at the time of sampling), before the commencement of mining activities. Both pans were additionally assessed as part of the Wetland Assessment Report and were only assessed in terms of aquatic habitats in this report.

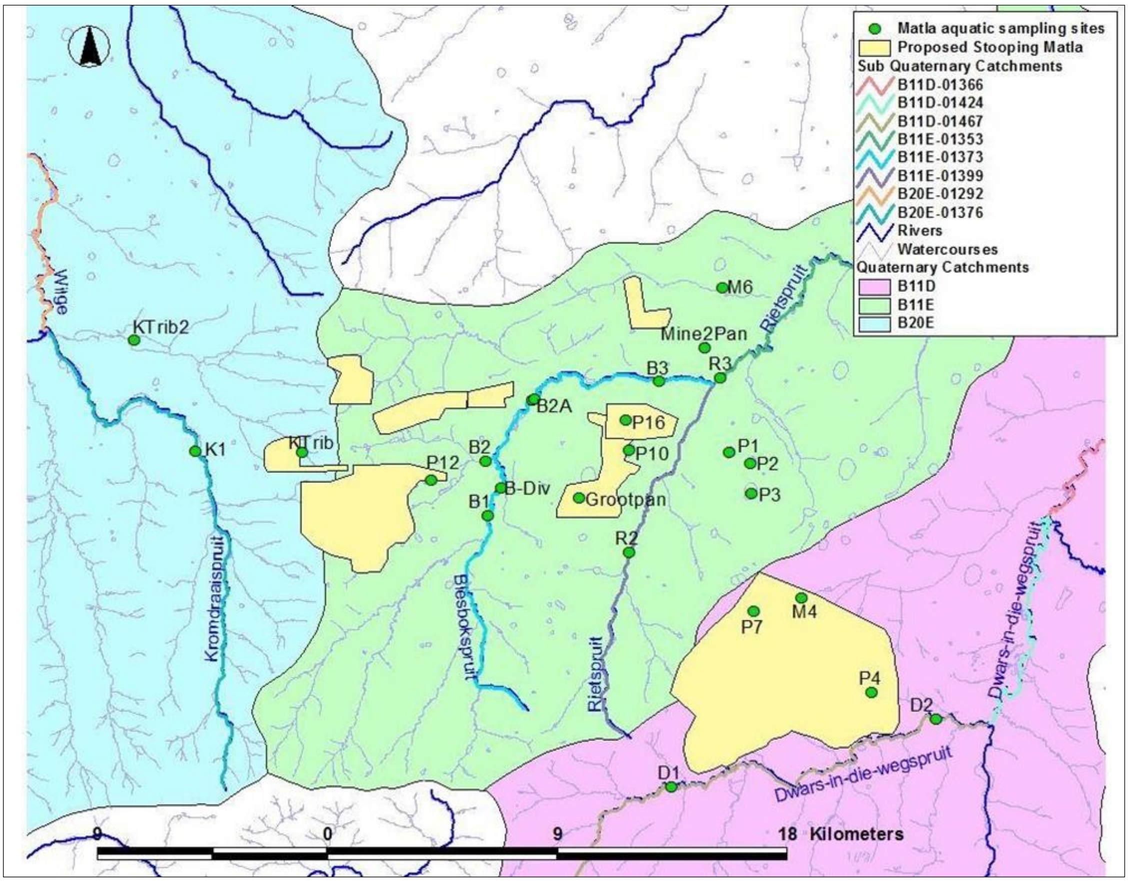

Figure 5.82: Aquatic sampling sites relative to the proposed mining expansions at Exxaro Matla

Table 5.17: Aquatic samplings sites for the Exxaro Matla mining expansion project

Site	Components sampled	Rationale/Classification
PANS		
P1	Aquatic macroinvertebrates, diatoms, on-site water quality, habitat integrity	Included in the Water Treatment Plant Study and duplicated here for the sake of completeness
P2		
P3		
Mine 2 Pan		

Site	Components sampled	Rationale/Classification
P4	Aquatic macroinvertebrates, water quality, habitat integrity	Seasonal pan, within stooping area
P7	Aquatic macroinvertebrates, water quality, habitat integrity	Seasonal pan, within stooping area
Grootpan	Habitat integrity	Seasonal pan, within stooping area
P10	Habitat integrity	Seasonal pan, within stooping area
P12	Aquatic macroinvertebrates, habitat integrity	Seasonal Pan, within stooping area
P16	PES (assessed in Wetland Assessment Report only)	Seasonal Pan/Depression. This system functions mainly as a hillslope seepage wetland rather than an endorheic pan and was dry at the time of sampling.
WATERCOURSES		
R2	SASS5, water quality, fish, habitat integrity	Rietspruit, upstream of proposed open-cast mining but downstream of stooping
R3	SASS5, water quality, diatoms, fish, habitat integrity	Rietspruit, downstream of proposed mining
B1	SASS5, water quality, diatoms, fish, habitat integrity	Blesbokspruit, upstream of mining and the diversion
B-Div	SASS5, water quality, habitat integrity	Reach of the original Blesbokspruit excluded from the diversion (i.e. within the natural channel between the start and end of the diversion).
B2 (Trib)	SASS5, water quality, habitat integrity	Tributary of the Blesbokspruit, downstream of proposed stooping, flowing into the original Blesbokspruit (excluded from the diversion)
B2A	SASS5, habitat integrity	Blesbokspruit, immediately downstream of the diversion - downstream of stooping, upstream of proposed open-cast mining
B3	SASS5, water quality, diatoms, fish, habitat integrity	Blesbokspruit, downstream of present and proposed mining.
D1	SASS5, water quality, diatoms, fish, habitat integrity	Dwars-in-die-Wegspruit, upstream of proposed stooping

Site	Components sampled	Rationale/Classification
D2	SASS5, water quality, diatoms, fish, habitat integrity	Dwars-in-die-Wegspruit, downstream of proposed stooping
K1	SASS5, water quality, diatoms, habitat integrity	Kromdraaispruit, downstream of proposed stooping, within the Wilge River Catchment.
VALLEY BOTTOM WETLANDS		
M4	SASS5, diatoms, water quality, habitat integrity	Valley bottom wetland, downstream of stooping. This wetland drains past the Kriel Power Station and into the Steenkoolspruit.
M6	diatoms	Valley bottom wetland, downstream of stooping, draining into the Rietspruit. This is a mostly unchnnelled system unsuitable for aquatic sampling.
Ktrib	Water quality	Valley bottom wetland draining towards the Kromdraaispruit. Dry at the time of sampling (water quality sampled from a dam)
Ktrib2	Water quality	Valley bottom wetland draining towards the Kromdraaispruit. Dry at the time of sampling (water quality sampled from a dam)

5.8.1.2 Habitat Integrity

The following human activities have impacted on habitats at aquatic sampling sites:

<u>Pans</u>

Current impacts to pans within the study area were mainly due to agriculture – trampling and water quality impacts due to cattle grazing, as well as runoff containing pesticides and fertilizers from irrigated lands. Pan 3, Mine Pan 2 and Pan 10 were additionally impacted by mining:

- Pan 3 and Mine Pan 2 are both used for storage by the mine and were considered Largely Modified. Not only has water quality been seriously affected but the hydrological regimes have been modified from seasonal to permanent inundation.
- Pan 1 was a seasonal pan relatively unmodified with only minor impact from surrounding cultivated fields (receiving runoff containing sediment and possibly fertilizers or pesticides).
- Pan 2 was a seasonal pan that was considered naturally saline. This pan may have received limited water quality impacts from surrounding agricultural activities. The pan is surrounded by a considerable seepage wetland.

- Pan 4 was considered near-pristine with the only impacts evident being from cattle grazing. The seepage wetland surrounding this pan supported a large number of marsh owl. This seepage area also serves as a buffer against further agricultural impacts on the pan itself.
- Pan 7 was impacted by surrounding cultivated fields as well as cattle grazing. This has resulted in highly eutrophic water that supports prolific algal growth. Water birds and frogs (tadpoles) were abundant at this site. The low salinity of water in this pan suggests that it may have groundwater links and is near-permanent in its hydrology.
- Pan 10 was also highly eutrophic and similarly supported an abundant bird life and prolific algal growth. Water quality has been impacted by agricultural runoff, as well as by the adjacent conveyor.
- Pan 12 was impacted by grazing cattle but few other impacts were observed. The low volume of water within this seasonal pan, mean that water quality impacts are more concentrated.
- Grootpan has been impacted by cattle grazing but the extensive seepage wetland surrounding it has acted as an effective buffer.

Pans 1, 2, 4 and Grootpan all have a seasonal hydrology. As such they are likely to support aquatic invertebrate fauna that have become highly specialised as an adaptation to such variable conditions (e.g. ostracods, copepods, cladocerans, etc.). These, in turn, may support animals higher up in the food chain (such as flamingos and other water birds). Pan 7 is more permanent in nature, with possible groundwater links.

Watercourses:

Most aquatic sampling sites were classified as Moderately Modified (Category C) in terms of aquatic habitat integrity. The most notable present impacts on aquatic habitats were attributed to water abstraction, flow modification, bed modification, channel modification, inundation and bank erosion. These systems have become channelized and eroded as a result of dams, abstraction (lowering of the water table), overgrazing, trampling by cattle and road crossings.

Water abstraction results in reduced flows and a lowered water table, and hence, reduced habitat diversity and suitability for aquatic biota. Flow modification within the study area is attributable to dams, weirs, abstraction and diversions (the Blesbokspruit diversion). These have resulted in decreased flows, especially during the dry season, which may have a negative impact on some fish species (especially those with a preference for fast flowing habitats). Dams and weirs also create migration barriers for fish and provide suitable habitats for alien fish species.

The lower reach of the Rietspruit has been seriously impacted by mining. R3 was inundated upstream of the Kriel Colliery diversion. Considerable water quality impacts were evident at this site, together with the presence of aquatic weeds and algae which further compromise benthic and marginal habitats.

The upper section of the Blesbokspruit was considered Largely Natural in terms of aquatic habitat integrity. There was a gradual decline in integrity in a downstream direction. While there were impacts due to erosion, dams and diversions, water quality remained relatively unimpacted upstream of site B3. Site B3 was considered Largely to Seriously Modified in terms of aquatic habitat integrity, the main impacts being due to flow modification and water quality. Dams and diversions, as well as possible loss of surface water to groundwater, has resulted in lowered dry season flows, with longer no-flow periods.

Otter spoor were evident along the length of the Blesbokspruit as well as the Dwars-in-die-Wegspruit. It is important, therefore that habitat continuity be maintained for these animals, together with water quality levels that support their preferred prey (crabs).

Table 5.18: Summary of Habitat Integrity Assessed for aquatic sampling sites for the Matla Colliery Mining Survey - Rivers and Valley Bottom Wetlands

INSTREAM HABITAT INTEGRITY	K1	R 2	R 3	B1	B-Div	B2 (Trib)	B2A	B3	D1	D2	M4
WATER ABSTRACTION	11	18	8	3	6	8	5	8	8	8	8
FLOW/HYDROLOGICAL MODIFICATION	11	20	18	7	7	12	12	12	15	14	12
BED MODIFICATION /SEDIMENTATION	6	8	15	8	7	8	8	8	12	12	4
CHANNEL/STRUCTURAL MODIFICATION	10	5	16	8	8	2	7	12	3	5	3
WATER QUALITY	7	12	12	3	3	3	6	16	3	3	6
INUNDATION	0	5	17	3	0	0	0	0	0	0	0
EXOTIC MACROPHYTES	1	2	8	5	1	2	1	2	1	2	2
RUBBISH DUMPING	1	4	3	4	0	1	0	2	0	2	0
Total Score	**69**	**48**	**35**	**81**	**78**	**78**	**76**	**57**	**72**	**70**	**78**
RIPARIAN/MARGINAL INTEGRITY											
VEGETATION REMOVAL	2	2	1	0	3	0	0	0	0	0	2
EXOTIC VEGETATION	4	3	3	3	1	1	1	3	2	3	4
BANK EROSION	12	7	5	12	6	11	12	17	15	15	11
CHANNEL MODIFICATION	10	5	15	5	11	5	8	15	2	3	4

WATER ABSTRACTION	4	6	4	1	7	6	10	7	3	3	5
INUNDATION	0	4	15	0	0	0	0	0	0	0	0
FLOW/HYDROLOGICAL MODIFICATION	3	7	14	2	8	10	12	17	4	5	3
WATER QUALITY	2	3	3	1	4	1	3	6	0	3	2
Total Score	**71**	**81**	**48**	**77**	**72**	**73**	**60**	**36**	**75**	**72**	**75**
Estimated Overall PES	C	C	D/E	B/C	C	C	C	D/E	C	C	C

Table 5.19: Summary of Habitat Integrity Assessed for aquatic sampling sites for the Matla Colliery Mining Survey - Pans

HABITAT INTEGRITY	**P4**	**P7**	**Grootpan**	**P10**	**P12**	**Pan 1**	**Pan 2**	**Pan 3**	**Mine 2 Pan**
WATER ABSTRACTION	0	4	0	0	0	0	0	0	0
FLOW/HYDROLOGICAL MODIFICATION	0	4	2	0	2	5	5	20	18
BED MODIFICATION /SEDIMENTATION	7	7	5	7	8	8	6	12	8
CHANNEL/STRUCTURAL MODIFICATION	0	2	2	8	2	2	2	5	3
WATER QUALITY	8	11	10	14	12	4	8	15	15
INUNDATION	0	0	0	0	0	0	0	16	15
EXOTIC MACROPHYTES	2	3	2	1	1	3	0	0	0
RUBBISH DUMPING	0	1	1	0	0	0	0	3	3
Total Score	**17**	**32**	**22**	**30**	**25**	**22**	**21**	**71**	**62**
Estimated Overall PES	A/B	B/C	B	B/C	B	B	B	D	D

5.8.1.3 Water Quality

It is important to note that the purpose of this section is not to provide a detailed surface water quality report of the study area, but purely to use the results of selected measurements obtained during the specialist assessment to assist in the interpretation of the biological data.

Electrical conductivity (EC) levels were the lowest in the upper Dwars-in-die-wegspruit (D1), and upper Rietspruit. Salinity generally increased markedly towards the downstream sites and was highest within the lower Blesbokspruit (B3) upstream of its confluence with the Rietspruit. The Dwars-in-die-Wegspruit showed the lowest elevation in salinity, pointing to limited land use impacts on salinity between upstream and downstream sites.

The effects of increased salinities are difficult to predict but usually involves a change in community patterns as sensitive species are lost and tolerant species increase. An increase in salinity tends to improve the clarity of water, with consequent implications for increased algal production (associated with lower dissolved oxygen concentrations during the day) and algal species composition. Salinity levels exceeding 250mg/ℓ can change the algal species composition (Chutter and Walmsley 1994). Freshwater invertebrates are generally tolerant of elevated salinities of up to about 1000 mg/ℓ, providing the changes are not sudden (Chutter and Walmsley 1994). Fish are generally tolerant of salinities of up to 750mg/ℓ, although juveniles and eggs are significantly more sensitive (Chutter and Walmsley 1994). Water at site B3 (lower Blesbokspruit) is therefore likely to be limiting to fish and certain sensitive invertebrate species.

Sulphates, which are generally associated with coal mining, were high at site B3 within the Blesbokspruit, downstream of the diversion, but were low within the diversion itself and within tributaries draining into the diversion. Sulphates were also elevated within the Kromdraaispruit (although this was possibly due to coal dust entering the river from haul trucks crossing the bridge). Sulphates can form complex reactions that affect the pH, and therefore the solubility of metals and other substances. For example, under anaerobic conditions sulphate ions are reduced by bacteria to hydrogen sulphide, which is highly toxic to aquatic biota (Dallas and Day 1993).

Pans are often naturally saline so it is not always easy to detect contamination based on salinity alone. Therefore, where sulphate levels equal or exceeded chloride levels, this was taken as an indication of mining-related contamination. This was clearly the case in Pan 3, as well as Mine 2 Pan, to a lesser extent.

Results are summarized in Table 5.20 and Table 5.21.

Table 5.20: Water quality results for aquatic sampling sites for the Exxaro Matla mining expansion project.

	Kromdraaispruit		Rietspruit		Blesbokspruit					Dwars-in-die-Wegspruit		
	K1	Ktrib	R2	R3	B1	B-Div	B2	B2A	B3	D1	D2	M4
pH	8.67	8.88	8.04	7.00	7.97	8.30	7.15	8.73	6.65	7.89	8.26	7.02
Ec (mS/m)	95	93	54	103	90	74	77	100	138	56	84	118
Fluoride (1.5)	0.5	1.2	0.9	21.1	0.7	0.9	0.8	0.7	1.3	0.5	1.7	0.9
Nitrite (4.0)	0.1	0.1	0.0	2.3	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0

	Kromdraaispruit		Rietspruit		Blesbokspruit					Dwars-in-die-Wegspruit		
	K1	Ktrib	R2	R3	B1	B-Div	B2	B2A	B3	D1	D2	M4
Nitrate (44.0)	0.2	0.2	0.6	4.8	0.0	0.2	0.0	0.2	4.6	1.6	1.6	0.0
Chloride (250)	50	77	61	181	22	146	128	142	119	43	37	224
Sulphate (500)	260	89	20	43	130	27	24	19	321	122	67	150
Phosphate	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0
Carbonate (20.0)	9.9	16.2	0.0	0.0	0.0	1.5	0.0	14.1	0.0	0.0	0.0	0.0
Bicarbonate	224	229	190	305	284	80	148	281	331	237	301	166
Sodium (400)	81	91	46	121	103	90	99	106	188	57	50	93
Potassium (400)	9.9	18.6	12.0	25.3	6.9	5.6	12.9	10.6	6.3	3.2	4.9	23.4
Calcium (200)	61.9	35.6	25.1	45.0	47.3	23.7	30.3	52.8	50.0	44.0	65.3	90.7
Magnesium (100)	50.9	42.5	19.3	26.6	31.5	20.7	24.1	40.1	40.5	23.3	56.8	43.9
Boron (1.5)	0.0	0.0	0.0	0.9	0.1	0.0	0.1	0.0	0.8	0.4	0.1	0.2
Total Dissolved Solids	657	508	281	623	482	365	393	558	896	413	436	709

Table 5.21: Water quality results for aquatic sampling sites for the Exxaro Matla mining expansion project - pans

	Pan 4	Pan 7	Mine Pan 2	Pan 1	Pan 2	Pan 3
pH	8.52	7.14	8.26	8.69	8.90	8.68
Ec (mS/m)	155	32	61	188	339	265
Fluoride (1.5)	1.1	0.1	0.7	40.2	7.8	1.0
Nitrite (4.0)	0.0	0.0	0.0	12.1	0.0	0.0
Nitrate (44.0)	0.0	0.0	4.0	44.0	3.7	2.9
Chloride (250)	91	23	43	396	657	176
Sulphate (500)	39	4	43	32	178	978
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0
Carbonate (20.0)	16.2	0.0	0.0	24.6	36.3	0.0
Bicarbonate	694	159	262	532	828	125
Sodium (400)	347	19	51	401	770	276
Potassium (400)	21.9	17.7	15.9	30.6	13.3	51.8
Calcium (200)	21.0	38.0	39.8	21.7	24.7	210.8
Magnesium (100)	10.5	9.8	24.3	32.7	18.0	29.4
Boron (1.5)	0.6	0.1	0.2	0.2	0.8	9.7
Total Dissolved Solids	896	190	353	1301	2123	1797

5.8.1.4 Diatoms

The European numerical diatom index, the Specific Pollution Sensitivity Index (PSI) was used to interpret Diatom results.

Seasonal pans, which have naturally elevated salts and nutrient levels, were excluded from these analyses as the SPI was developed for flowing freshwater systems and may result in misleading interpretations for standing water and pans. Analyses of diatoms were therefore based on measures of relative abundance and species composition (i.e. assemblage patterns) to infer baseline water quality conditions at these sites.

Table 5.22: Classification of sites based on diatoms sampled from Matla sampling sites: Generic diatom based ecological classification.

Site	pH	Salinity	Organic nitrogen	Oxygen levels	Trophic status
P1	Alkaline	Fresh-brackish	Needing periodically elevated concentrations of organically bound nitrogen	Low (>30% saturation)	Eutrophic
P2	Alkaline	Brackish-fresh	Tolerating elevated concentrations of organically bound nitrogen	Moderate (> 50% saturation)	Eutrophic
P3	Alkaline	Brackish-fresh	Tolerating elevated concentrations of organically bound nitrogen	Moderate (> 50% saturation)	Eutrophic
P7	Alkaline	Fresh-brackish	Tolerating elevated concentrations of organically bound nitrogen	Moderate (> 50% saturation)	Eutrophic
M4	Alkaline	Fresh-brackish	Tolerating very small concentrations of organically bound nitrogen	Moderate (> 50% saturation)	Eutrophic
B1	Alkaline	Fresh-brackish	Tolerating very small concentrations of organically bound nitrogen	Fairly High (> 75% saturation)	Eutrophic
B-Div	Alkaline	Fresh brackish	Elevated concentrations of organically bound nitrogen	Continuously high (~100% saturation)	Eutrophic
B2A	Alkaline	Fresh brackish	Elevated concentrations of organically bound nitrogen	Continuously high (~100%	Meso-eutrophic

Site	pH	Salinity	Organic nitrogen	Oxygen levels	Trophic status
				saturation)	
B3	Alkaline	Fresh-brackish	Tolerating elevated concentrations of organically bound nitrogen	Low (>30% saturation)	Eutrophic
D1	Alkaline	Fresh-brackish	Tolerating very small concentrations of organically bound nitrogen	Fairly High (> 75% saturation)	Eutrophic
D2	Alkaline	Fresh-brackish	Tolerating elevated concentrations of organically bound nitrogen	Fairly High (> 75% saturation)	Eutrophic
R3	Circumneutral (pH of +/-7)	Fresh-brackish	Tolerating elevated concentrations of organically bound nitrogen	Moderate (> 50% saturation)	Eutrophic
K1	Alkaline	Fresh brackish	Elevated concentrations of organically bound nitrogen	Moderate (>50% saturation)	Eutrophic

Table 5.23: Classification of sites based on diatoms sampled from Matla sampling sites: Classification based on the Specific Pollution Sensitivity Index (SPI).

Site Name	NB spec.	%PTV	SPI	Ecological Category (EC)	Class
P1	20	8	10.9	Inconclusive due to high salinity (possibly natural)	
P2	9	10	2.8		
P3	17	13.5	2.8		
M6	18	1	15.9	Good quality	B
M4	30	3.3	15.9	Good quality	B
B1	30	3.3	15.9	Good quality	B
B1-Div	28	15.3	6,9	Moderate quality	C
B2A	39	12	13	Moderate quality	C
B3	38	26.8	8.9	Poor quality	D
D1	24	2.3	13.6	Good quality	B/C
D2	56	18.3	12.6	Moderate quality	C
R 3	47	20.3	7.2	Poor quality	D/E
K1	25	21.5	6.9	Poor quality	D/E

**organic pollution present

The results of the diatom analyses are described below. Species contributing 5% or more to the total count were classified as dominant species:

- At sites P1, M6 and B1 *Achnanthidium minutissimum* is the prevalent taxon. At sites M4 and D2 *A. minutissimum* is relatively less prevalent. This taxon is often associated with clean, high oxygenated, freshwaters (Slàdecek, 1986; Leclercq and Maquet, 1987; Prygiel and Coste, 2000).

- Sites P2 and P3 are characterised by prevalent taxon *Amphora veneta*, a species found in electrolyte-rich waters often linked to mining and industrial effluent but can also occur in pans with natural high salinities. This taxon can also favour high nutrient concentrations.
- Site P3 has a significant number of taxa *Nitzschia amphibia, Navicula veneta* and *Nitzschia palea* indicating heavily eutrophic, electrolyte-rich conditions. These species are often linked to agricultural and industrially impacted waters.
- At site R3, the species composition is comprised of pollution tolerant species such as *Nitzschia palea, Sellaphora pupula, Mayamaea atomus* and *Navicula rostellata* indicative of electrolyte and nutrient inputs from anthropogenic activities. Water was classified as poor quality at this site.
- At sites D1, D2, B1, M6 and M4, the presence of *Epithemia adnata*, a pollution sensitive taxon found in slow flowing/standing alkaline waters with moderate to high electrolyte content, implies that the water quality is in relatively good condition.
- The diatom species composition at site M4 indicates reasonably good water quality. Taxa are characteristic of slow flowing/stagnant waters, tolerant of osmotic fluctuations, with moderate to high electrolyte content, such as *Rhopalodia gibba, Nitzschia liebetruthii* and *Nitzschia inconspicua*.
- Site B-Div was classified as having moderate water quality. At this site *Achnanthidium minutissimum* was the prevalent taxon. This taxon is often associated with clean, high oxygenated, freshwaters (Slàdecek, 1986; Leclercq and Maquet, 1987; Prygiel and Coste, 2000). However, studies have also revealed that A. minutissimum can be abundant at sites contaminated with sulphates and various metals often associated with mining effluent (e.g. Pb, Cd, Zn, Cu) (Deniseger et al., 1986; Genter et al., 1987; Medley and Clements, 1998; Ivorra et al., 1999, Gold et al., 2002, 2003, Cattaneo et al., 2004, Ferreira da Silva et al., 2009). Measurements of heavy metal concentrations are required to distinguish between the two responses. However, at site M-Div, the presence of *Epithemia adnata*, a pollution sensitive taxon found in slow flowing/standing alkaline waters with moderate to high electrolyte content, implies that the water quality is in relatively good condition at this site.
- Site B2A was classified as having moderate water quality. The prevalent taxon for this site was *Cymbella tumida*, which prefers oligo- to mesotrophic waters with moderate electrolyte content. The diatom species composition at site B2A indicated reasonably good water quality. The prevalent taxa were characteristic of weakly alkaline waters, tolerant of osmotic fluctuations, with moderate to high electrolyte

content, such as *Fragilaria tenera* and *Gomphonema acuminatum*. The presence of *Nitzschia* species indicates slight nutrient and organic enrichment.

- Site K1 was considered to have poor water quality. Dominant species included Navicula capitatoradiata, Fragilaria tenera, Nitzschia palea, Cyclotella meneghiniana, Stephanodiscus hantzschii, Nitzschia linearis, Nitzschia dissipata and Gomphonema truncatum. These species all have preferences for poor water quality. Navicula capitatoradiata was the dominant species. This species prefers eutrophic, high electrolyte and as well brackish waters and is tolerant of critical levels of pollution. The dominance of Cyclotella meneghiniana and Stephanodiscus hantzschii point to elevated salinities. Indicator species for industrial related impacts (Nitzschia palea) occurred at high abundance.

It should be noted that diatom results give a snapshot view of conditions at a specific sampling site over a period of time (weeks to months) and therefore do not represent conditions over an entire subcatchment or river reach. Because flows were low or absent at most sites at the time of sampling (October), this effect was amplified, so that a single pollution source (e.g. a road crossing) would have had a greater impact on water quality than it would have under higher flow conditions (e.g. at site K1).

5.8.1.5 Aquatic Macroinvertebrates

It should be noted that conditions were extremely dry at the time of sampling (October) and flows were reduced to a trickle or altogether absent. Most watercourses, especially small tributaries, consisted of a series of pools. As such, the use of the SASS5 methodology, which is designed specifically for flowing systems, was limited. Analysis was therefore based largely on taxonomic diversity and the presence or absence of sensitive or specialized taxa. Aquatic macroinvertebrate results are given in Appendix B and summarised in the sections that follow. As taxon composition is expected to differ between pans and flowing water (watercourses), these ecosystems are discussed separately without direct comparison.

Watercourses

The Present Ecological State of sites, based on their aquatic macroinvertebrate fauna, was classified according to Dallas (2007), with responses to water quality, flow and habitat modifications also taken into consideration (based on Thirion, 2008). The PES categories are shown in Table 5. It should be noted that most of the watercourses on site were originally valley bottom wetlands that have become eroded to various degrees. For this reason, it is difficult to accurately determine reference conditions and, thus, the degree of modification.

Aquatic macroinvertebrate diversity was highest within the lower Dwars-in-die-Wegspruit (D2), Steelpoort tributary (site M4) and all upstream Blesbokspruit sites (all sites upstream of site B3). These sites also had the highest prevalence of sensitive taxa that are intolerant of changes in water quality. Sensitive taxa included atyid shrimps, lestid damselflies and dixid midges. The Dwars-in-die-Wegspruit sites had additional sensitive taxa, including two species of baetid mayfly, aeshnid dragonflies (at D1 and D2) and hydraenid beetles (at M4).

The upper Blesbokspruit (B1, D-Div, B2A), the lower Dwars-in-die-Wegspruit (D2) and Steelpoort tributary (M4) were considered to be Largely Natural to Moderately Modified (Category B/C) in terms of aquatic macroinvertebrates. The relatively high prevalence of sensitive taxa points to relatively good water quality. However, channelization has affected the availability of marginal habitats, while habitat modification due to reduced or altered flows (diversions, dams, road crossings) was also evident. This has affected the invertebrate assemblage to some extent. The Steelpoort tributary (site M4) was considered to be the least modified in terms of aquatic macroinvertebrates.

Diversity was low at the Kromdraaispruit site (K1), as well as at the lower Rietspruit and Blesbokspruit sites (sites R3 and B3). The downstream Blesbokspruit and Rietspruit sites (B3, and R3) were considered to be Category D-E (Largely to Seriously Modified) for aquatic macroinvertebrates. The low diversity of invertebrates within the Blesbokspruit and Kromdraaispruit was at least partly due to extreme low flows at the time of sampling and thus a dearth of suitable habitats (e.g. for atyid shrimps), while site K1 was affected by low flows and coal dust from haul trucks crossing the bridge adjacent to the site.

The upper Rietspruit site (R2) had a slightly higher prevalence of sensitive taxa (including dixid midges) than the downstream site (R3) and was considered Moderately Modified (Category C). The upper Dwars-in-die-Wegspruit site (D1) has a lower diversity and ASPT than the downstream site, pointing to a loss of sensitive taxa in response to water quality impacts. This site was also considered Category C.

Otter tracks and scats were observed along the entire Blesbokspruit, together with its primary prey item, crabs. As such, the ecological importance of this stream should consider ecosystem services and processes – i.e. the provision of migration corridors and aquatic invertebrate prey items for wetland mammals such as otter and water mongoose.

Table 5.24: Summarised SASS5 data for the aquatic sampling sites sampled for the Matla mining expansion project.

	Kromdraai spruit	Rietspruit		Blesbokspruit					Dwars-in-die-Wegspruit		
SITE	**K1**	**Riet 2**	**Riet 3**	**B1**	**BDIV**	**B2 (trib)**	**B2**	**B3**	**D1**	**D2**	**M4**
Temp (°C):	22.9	25	20.8	25	21	24.6	21.3	24.3	23.5	24.2	20
pH:	8.69	8.04	8.03	7.9	8.43	7.15	7.85	8.1	7.89	8.26	7.03
Cond (mS/m):	99.3	54	90.5	90	74.7	77	107	133.1	56	84	103.4
Stones	1	0	0	2	0	0	0	0	0	0	0
Aquatic veg	0	1	2	2	1	1	1	0	1	1	2
Marginal veg	2	3	3	2	3	2	3	2	2	2	3
Gravel/Sand /Mud	2	1	1	1	2	1	1	1	1	1	1
TOTAL No. SASS TAXA	**11**	**13**	**10**	**14**	**15**	**9**	**14**	**9**	**14**	**17**	**22**
SASS Score	**44**	**64**	**45**	**73**	**80**	**37**	**78**	**35**	**67**	**89**	**110**
Average Score per Taxon	**4**	**4.9**	**4.5**	**5.2**	**5.3**	**4.1**	**5.2**	**3.9**	**4.8**	**5.2**	**5**
PES	**D**	**C**	**D**	**B/C**	**B/C**	**D**	**B/C**	**E**	**C**	**B/C**	**B**

Pans

It should be noted that:

- SASS5 was developed specifically for flowing systems (rivers and streams) and should be applied to pans with caution. For this reason, the biotic integrity of pans, based on aquatic macroinvertebrates, was analysed in terms of diversity and the presence of specialized, rare or sensitive taxa, and not according to SASS5 guidelines.
- PES categories have been subjectively assigned, based on comparisons with over 20 pans sampled across the highveld. No published interpretation guidelines are available for aquatic macroinvertebrate fauna in pans.

Pan 7 had a far higher diversity of aquatic macroinvertebrates than any other pan. Sensitive hydraenid beetles were present within this pan. As such, it was estimated to be Category B (Largely Natural) in terms of aquatic macroinvertebrates. The higher diversity within this pan also reflects the prolific marginal vegetation (Typha, Juncus and grasses) and high productivity of this eutrophic ecosystem.

Pans 4 and 12 had a moderate diversity that reflected their seasonal hydrology and the low diversity of marginal vegetation. They were estimated to be Category B/C (Largely Natural to Moderately Modified). Seasonal pans have specialized taxa that are adapted to periods of temporary dryness, thus increasing the overall aquatic biodiversity of an area. These pan-adapted taxa (such as ostracods, copepods and cladocerans) are important food sources for water birds and amphibians, resulting in a higher abundance and diversity of water birds and amphibians associated with pans than with channeled watercourses.

Diversity was exceptionally low at the mine-impacted pans (Mine 2 Pan and Pan 3) – with only 6-8 recorded taxa and an absence of sensitive taxa.

Pan 2 also recorded a low diversity and sensitivity score (SASS5 score). However, unlike the mine impacted pans, Pan 2 had caenid mayflies, ostracods, and pleids and leeches, all of which were absent from Pan 3 and Mine 2 Pan. As such, it resembled Pan 1 more closely in terms of its invertebrate assemblage and its low diversity may be more related to an absence of available marginal habitats than to water quality impacts.

Table 5.25: Summarised results for aquatic macroinvertebrates sampled from pans for the Matla mining expansion project.

Pans							
SITE	**Mine Pan 2**	**1**	**2**	**3**	**Pan 4**	**Pan 7**	**Pan 12**
Temp (°C):	24.1	24.6	24,3	25	23.6	22.8	
pH:	8.14	9.26	9.36	8.7	8.52	7.14	
Cond (mS/m):	320.6	167.5	278.8	229	155	32	
Stones	0	0	0	0	0	0	0
Aquatic vege	0	3	0	2	1	4	1
Marginal vege	3	3	2	2	2	4	1
Gravel/ Sand /Mud	1	1	1	1	1	1	1
TOTAL No. SASS TAXA	**8**	**11**	**8**	**6**	**8**	**16**	**8**
SASS Score	**26**	**44**	**33**	**24**	**35**	**73**	**34**
Average Score per Taxon	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

5.8.1.6 Fish

Habitat Composition

The habitat diversity or biotopes available for fish varied between the different sites. No fast habitats were available at the time of sampling, being representative of the end of dry season conditions. The lack of flow was however aggravated by impacts such as flow modification (as described above). The only velocity-depth classes available for fish was therefore slow-deep and slow-shallow (slow and deep pools). Cover features for fish were also generally limited, mostly being provided in the form of overhanging vegetation (reeds) with limited aquatic macrophytes and substrate (stones) also available at some sites (Table 5.26).

Table 5.26: Habitat composition and diversity for fish at different sampling sites.

Sites:	D1	D2	B1	B3	R 2	R 3
SLOW-DEEP (>0.5m; <0.3m/s)						
Abundance	4	3	3	2	1	3
Overhanging vegetation	4	4	2	1	1	1
Undercut banks and Root-wads	1	1	0	2	0	0
Substrate	0	0	3	0	0	0
Macrophytes	3	1	3	1	2	2
SLOW-SHALLOW (<0.5m; <0.3m/s)						
Abundance	1	3	3	3	3	3
Overhanging vegetation	3	4	3	2	3	2
Undercut banks and Root-wads	0	1	0	1	0	1
Substrate	0	0	2	0	0	0
Macrophytes	2	1	2	1	3	2
FAST-DEEP (>0.3m; >0.3m/s)						
Abundance	0	0	0	0	0	0
Overhanging vegetation	0	0	0	0	0	0
Undercut banks and Root-wads	0	0	0	0	0	0
Substrate	0	0	0	0	0	0
Macrophytes	0	0	0	0	0	0
FAST-SHALLOW (<0.3m; >0.3m/s)						
Abundance	0	0	0	0	0	0
Overhanging vegetation	0	0	0	0	0	0
Undercut banks and Root-wads	0	0	0	0	0	0
Substrate	0	0	0	0	0	0
Macrophytes	0	0	0	0	0	0

Abundance of velocity-depth classes and cover are estimated according to: 0 – absent; 1 – rare; 2 – sparse; 3 – common; 4 – very abundant

Fish Species Composition

During the October 2011 baseline fish survey performed in the study area, only three indigenous fish species were sampled (Table 5.27). These included the Chubbyhead barb (*Barbus anoplus),* Sharptooth catfish (*Clarias gariepinus*) and Southern mouthbrooder (*Pseudocrenilabrus philander*) (Table 5.27). *Pseudocrenilabrus philander* was the most widespread species, sampled at most sites (all three river systems). *Clarias gariepinus* was only sampled in the Dwars-in-die-wegspruit (site D1) and Rietspruit (site D3), while *Barbus anoplus* was only sampled in the Dwars-in-die-wegspruit (sites D1 and D2).

Two alien fish species were also sampled, namely Mosquito fish (*Gambussia affinis*) and Common carp (*Cyprinus carpio*) (Table 5.27). Mosquito fish were present with alarmingly high abundance, and it can be expected that the presence of this species in such high numbers is currently impacting negatively on the indigenous fish assemblages.

Table 5.27: Fish species (no. of individuals) sampled during October 2011 at the selected sampling sites.

SPECIES		LOCALITY					
ABBREVIATION	**SCIENTIFIC NAME**	**D1**	**D2**	**B1**	**B3**	**R2**	**R3**
BANO	*Barbus anoplus*	15	24				
CGAR	*Clarias gariepinus*	1					1
PPHI	*Pseudocrenilabrus philander*	6	10	2		1	
CCAR*	Cyprinus carpio		2				2
GAFF*	*Gambusia affinis*			>100	2	20	
Sampling effort (minutes electrofishing)		**17**	**23**	**17**	**15**	**16**	**15**

*Exotic (alien) alien species

To enable the determination of the biotic integrity (present state in relation to that expected under natural conditions) of the study area in terms of its fish assemblage, it is necessary to estimate which species would have occurred here under natural (pre-disturbance) conditions. No historic (pre-disturbance) information is known to exist, or has been published, for the exact study area covered by this study. The approach therefore used to determine which species could have occurred under reference conditions is based on all available fish information of the region together with an estimation of habitat composition under reference conditions.

Based on all available information, seven indigenous fish species have a known distribution range overlapping the Matla study area, or have been sampled previously or during the current survey in the rivers and streams flowing through the Matla study area (Table 5.28). One indigenous fish species, namely the Smallmouth yellowfish (*Labeobarbus aeneus*) has been translocated from the Vaal River system into the upper reaches of the Olifants River (Table 5.28). Three alien (exotic) species with natural occurrence outside of South Africa are also currently present within the study area. It must be noted that the presence of translocated/introduced indigenous fish species, as well as alien species, have a negative impact on the indigenous fish species through competition for food and habitat, as well as the possibility of hybridization. The presence of these species, both indigenous and exotic, is therefore seen as an impact on the indigenous fish assemblage of the study area, and interpreted and discussed as such.

As mentioned above, the presence of only three of the expected seven indigenous fish species was confirmed during the baseline survey in the study area. *Barbus neefi*, a moderately intolerant species, has a low to moderate probability of occurrence. The absence of this species during the baseline survey may be a reflection of poor biotic integrity, especially related to reduced water quality, flow and alien predatory fish species. The same goes for *Labeobarbus polylepis*, another moderately intolerant species that was not sampled during the baseline survey. This species has a preference for fast habitat, and therefore habitat limitations may have been a determining factor for its absence from the study area during the baseline survey. Flow modification, and to a lesser degree water quality deterioration, may contribute to the absence or scarcity of this species in this area. It is estimated that there is still a high probability that it occurs within and downstream of the Matla study area. *Barbus paludinosus* and *Tilapia sparrmanii* are both tolerant species, and although not sampled during the baseline survey, there is a high probability that these species still occur in the study area.

Table 5.28: Estimated probability of occurrence of fish species in the study area under natural and present conditions.

Abbreviation	SCIENTIFIC NAME	Dwars-in-die-weg-spruit		Blesbokspruit		Rietspruit		Downstream reaches (including Steenkoolspruit & Olifants River)	
		B11D-01467		B11E-01373		B11E-01399, B11E-01353		B11D-01424, B11D-01366, B11E-01297, B11F-01274	
		Natural	Present[1]	Natural	Present[1]	Natural	Present[1]	Natural	Present[1]
BANO	*BARBUS ANOPLUS* WEBER, 1897	High	Definite	High	Moderate	High	Moderate	High	High
BNEE	*BARBUS NEEFI* GREENWOOD, 1962	High	Low	High	Moderate	High	Moderate	High	Low
BPAU	*BARBUS PALUDINOSUS* PETERS, 1852	High	Low	Moderate	Moderate	High	High	High	Low
BPOL	*LABEOBARBUS POLYLEPIS* BOULENGER, 1907	High	Low	?	?	High	High	High	Moderate

Abbreviation	SCIENTIFIC NAME	Dwars-in-die-weg-spruit		Blesbokspruit		Rietspruit		Downstream reaches (including Steenkoolspruit & Olifants River)	
		B11D-01467		B11E-01373		B11E-01399, B11E-01353		B11D-01424, B11D-01366, B11E-01297, B11F-01274	
		Natural	Present[1]	Natural	Present[1]	Natural	Present[1]	Natural	Present[1]
CGAR	*CLARIAS GARIEPINUS* (BURCHELL, 1822)	High	Definite	High	Moderate	High	Definite	High	High
PPHI	*PSEUDOCRENILABRUS PHILANDER* (WEBER, 1897)	High	Definite	High	Definite	High	Definite	High	High
TSPA	*TILAPIA SPARRMANII* SMITH, 1840	High	Low	High	Moderate	High	High	High	High
BAEN#	*LABEOBARBUS AENEUS* (BURCHELL, 1822)	n/e	n/e	n/e	n/e	n/e	Moderate	n/e	Moderate
GAFF*	*GAMBUSIA AFFINIS* (BAIRD & GIRARD, 1853)	n/e	High	n/e	Definite	n/e	High	n/e	High
CCAR*	*CYPRINUS CARPIO* LINNAEUS, 1758	n/e	Definite	n/e	High	n/e	Definite	n/e	High
MSAL*	*MICROPTERUS SALMOIDES* (LACEPÈDE, 1802)	n/e	Low	n/e	Low	n/e	Low	n/e	Moderate

n/e not expected

? - uncertain

*Exotic (alien) alien species

- Introduced/translocated indigenous species.

Habitat preference and intolerance to environmental degradation

The indigenous fish species of the study area differ in their preferences for different habitat types (Table 5.29). Most the fish species in the study area have a preference for slow habitats with overhanging vegetation, aquatic macrophytes and water column as cover (Table 5.29). One species, *Labeobarbus polylepis*, has a high preference and requirement for fast flowing water over substrate of good quality, as well as adequate depth in pools (water column) (Table 5.29). Examples of activities often responsible for degradation in different fish habitat features are given in Table 5.30 and caution should be taken with any of these activities, especially those that may influence the preferred habitats of the fish species known to occur in the study area.

Table 5.29: Habitat preferences (flow-depth and cover features) of the expected fish species (Kleynhans, 2003)

ABBREVIA TION	SCIENTIFIC NAME	ENGLISH COMMON NAME	HABITAT PREFERENCE								
			SLOW-DEEP (<0.3 m/s; >0.5 m)	SLOW SHALLOW (<0.3 m/s; <0.5 m)	FAST DEEP (>0.3 m/s; >0.3 m)	FAST SHALLOW (>0.3 m/s; <0.3 m)	OVERHANGING VEGETATION	BANK UNDERCUT	SUBSTRATE	AQUATIC MACROPHYTES	WATER COLUMN
BANO	*BARBUS ANOPLUS* WEBER, 1897	CHUBBYHEAD BARB	4.1	4.3	0.9	2.5	4	2.7	2.3	3.2	1.1
BNEE	*BARBUS NEEFI* GREENWOOD, 1962	SIDESPOT BARB	3.3	4.7	1	1.7	3.9	3.3	4.4	0.5	0.2
BPAU	*BARBUS PALUDINOSUS* PETERS, 1852	STRAIGHTFIN BARB	3.9	3.9	2.2	2.6	4.2	2.4	1.9	3.6	3.5
BPOL	*LABEOBARBUS POLYLEPIS* BOULENGER, 1907	SMALLSCALE YELLOWFISH	4.2	2.9	3.7	4.3	1	1.6	5	0	3.6
CGAR	*CLARIAS GARIEPINUS* (BURCHELL, 1822)	SHARPTOOTH CATFISH	4.3	3.4	1.2	0.8	2.8	2.9	2.8	3	2.6
PPHI	*PSEUDOCRENILABRUS PHILANDER* (WEBER, 1897)	SOUTHERN MOUTHBROODER	2.6	4.3	0.5	0.9	4.5	3.2	1.9	2.9	0.3
TSPA	*TILAPIA SPARRMANII* SMITH, 1840	BANDED TILAPIA	3	4.3	0.9	1.5	4.5	1.9	2.5	3.6	1.1

0 = NO PREFERENCE, IRRELEVANT

>0 -0.9 = VERY LOW PREFERENCE -COINCIDENTAL

>1-1.9 = LOW PREFERENCE

>2-2.9 =MODERATE PREFERENCE

>3-3.9 =HIGH PREFERENCE

>4-5 =VERY HIGH PREFERENCE

Table 5.30: Human activities that are often responsible for degradation in specific fish habitat features (important habitats for fish in study area shaded)

Velocity depth class or Habitat feature	General impacts and activities.
Slow deep & slow shallow	Increased flows as result of regulation, water transfer schemes, irrigation releases. Sedimentation of pools as a result of catchment and bank erosion.
Fast deep and fast shallow	Decreased flows as a result of water abstraction (for agriculture, domestic, mining or industry), flow modification as a result of dams, weirs and channelization.
Overhanging vegetation	Clearing of vegetation on stream banks for the purpose of stream crossings (conveyer belts, roads, haul roads), clearing of riparian zones for construction activities, exotic vegetation encroachment replacing natural vegetation and also causing increased bank erosion, and to a lesser extent water quality deterioration (increased toxins could result in decreased availability of vegetation while increased nutrients could result in excessive growth or domination by single or a few species).
Undercut banks	Alteration of natural water levels (through water abstraction, flow alterations, etc.). Physical disturbance of banks through construction or agricultural activities.
Substrate	Increased sedimentation (related to erosion), excessive algal growth (especially associated with irrigation return flows and WWTW effluents), sand mining, trampling by livestock, disturbance by bottom-feeding alien species such as Common carp, etc.
Aquatic macrophytes	Altered flow regimes, use of herbicides, presence of alien Grass carp.
Water column	Decreased flows (through abstraction, constructions of dams, etc.)

Relative intolerance of fish to environmental change

The fish species of the study area also differ in their tolerance level to disturbance of the environment (Table 5.31). All the fish species expected or observed within the study area are classified as being overall tolerant, moderately tolerant or moderately intolerant to environmental change (Table 5.31). The most intolerant of all species are the Sidespot barb (*Barbus neefi*), which is intolerant to trophic, habitat and flow alterations and water quality deterioration (Table 5.31). The Smallscale yellowfish (*Labeobarbus polylepis*) is also classified as being overall moderately intolerant, being especially intolerant to habitat and flow modification. These two species, if still present within the study area under natural conditions, should be the most important indicator fish species to use in future to detect changes as a result of activities such as mining operations.

Table 5.31: Relative intolerance ratings of expected fish species (Kleynhans, 2003)

ABBREVIATION	SCIENTIFIC NAME	ENGLISH COMMON NAME	INTOLERANCE RATINGS				
			TROPHIC SPECIALIZATION	HABITAT SPECIALIZATION	FLOW REQUIREMENT	REQUIREMENT: UNMODIFIED WATER QUALITY	AVERAGE OVERALL INTOLERANCE RATING
BANO	*BARBUS ANOPLUS* WEBER, 1897	CHUBBYHEAD BARB	2.8	2.8	2.3	2.6	2.6
BNEE	*BARBUS NEEFI* GREENWOOD, 1962	SIDESPOT BARB	3.3	3.4	3.4	3.4	3.4
BPAU	*BARBUS PALUDINOSUS* PETERS, 1852	STRAIGHTFIN BARB	1.6	1.4	2.3	1.8	1.8
BPOL	*LABEOBARBUS POLYLEPIS* BOULENGER, 1907	SMALLSCALE YELLOWFISH	3	3.3	3.3	2.9	3.1
CGAR	*CLARIAS GARIEPINUS* (BURCHELL, 1822)	SHARPTOOTH CATFISH	1	1.2	1.7	1	1.2
PPHI	*PSEUDOCRENILABRUS PHILANDER* (WEBER, 1897)	SOUTHERN MOUTHBROODER	1.3	1.4	1	1.4	1.3
TSPA	*TILAPIA SPARRMANII* SMITH, 1840	BANDED TILAPIA	1.6	1.4	0.9	1.4	1.3

0-1.9 = TOLERANT; >2-2.9 = MODERATELY TOLERANT
>3-3.9 = MODERATELY INTOLERANT >4-5.0 = INTOLERANT

Conservation status

None of the fish species expected or observed in the study area are classified as threatened on any scale (international, national or regional). The Chubbyhead barb, Sharptooth catfish, Threespot barb, Southern mouthbrooder and Banded tilapia are all widespread and common species. The Sidespot barb is classified as least concern (does not currently qualify for threatened status), but is becoming scarcer in areas where it was previously common. Its trend of occurrence in South Africa and Mpumalanga are uncertain due to data deficiency. The Smallscale yellowfish was classified as "least concern" by Wolhuter & Impson (2007). As for most yellowfish in South Africa, their natural distribution range is shrinking, but they are however still widely distributed and relatively abundant in many rivers (Roux, F: in Wolhuter & Impson, 2007).

Alien and introduced fish species

The Common carp (*Cyprinus carpio*) was sampled in the Dwars-in-die-wegspruit and Rietspruit during the current study. Common carp can be seen as equivocal, having a negative impact on the environment they occur in, but being valued by certain interest groups such as sport fishermen. They are widely regarded as a pest, and are held responsible for the introduction of numerous fish parasites. They compete with other fish for food, they eat the spawn of other fish and disrupt nestbuilding activities of some fish. Furthermore, they cause habitat degradation by their feeding behaviour of grubbing in the mud for food, which causes the destruction of vegetation, rooting up of marginal vegetation and disturbing of the bottom sediments which increases turbidity (de Moor & Bruton, 1988).

Gambusia affinis, the other alien species being very abundant in the study area, has been introduced to aquatic systems in South Africa as a biological control method for mosquitoes (de Moor, 1988). It feeds on living animals, including mosquito- and fish larvae. They may alter the ecosystem by reducing the population of zooplankton and aquatic insect larvae. They also feed on the eggs and larvae of other fish and have been known to nip at the fins of larger fish (de Moor & Bruton, 1988). The high abundance of this species in the study area is of concern and may have a significant impact on the indigenous fish assemblage.

Another alien fish species, namely the Largemouth bass (*Micropterus salmoides*) has a low to moderate probability of occurrence within this quaternary catchment. The potential presence of this species is always alarming and the expected impact can be detrimental, as this aggressive predator can have a large impact on the indigenous fish species, especially small species and juveniles of larger species.

Biotic integrity based on fish

The present ecological status (PES) or biotic integrity, based on fish, of the different river reaches of the study area was determined through the application of the Fish Response Assessment Index (FRAI) (Kleynhans, 2007). It provides an indication of the present status of the fish assemblage, in relation to what could be expected under natural or unmodified conditions.

Dwars-in-die-Wegspruit

According to the FRAI calculations, the present ecological status (PES) of the Dwars-in-diewegspruit is in the best ecological status, in terms of fish assemblages, of the three river ecosystems in the study area. The Dwars-in-die-wegspruit is however still in a deteriorated state, with a FRAI score of 59% calculated for this reach, falling in a category C/D (moderately to largely modified from natural conditions). Most aspects of the fish assemblage have been altered from its natural unperturbed state.

Blesbokspruit

According to the FRAI calculations, the present ecological status (PES) of the Blesbokspruit reach is in the worst ecological status, in terms of fish assemblages, of the three river ecosystems in the study area. A FRAI score of only 48% was calculated for this reach, indicating largely modified conditions (category D). Most aspects of the fish assemblage have been altered from its natural unperturbed state.

Rietspruit

According to the FRAI calculations, the present ecological status (PES) of the Rietspruit reach is in also in a deteriorated ecological status, in terms of fish assemblages, with a FRAI score of only 52% calculated for this reach. It therefore indicates that this reach falls in a category D, reflecting largely modified from natural condition.

5.8.2 2017 biomonitoring

For the biomonitoring the selection of sites was based on the approved WUL conditions which stipulated the location of various sites. In addition, sites were selected based on the previous studies which have taken place in the project area (e.g. No 3 Mine River diversion sampling sites). It is further noted that sites have been selected around certain infrastructures and activities such as discharge points and conveyor crossings. Figure 5.83 presents the sites related to biomonitoring.

5.8.2.1 In situ Water Quality Analyses

Table 5.32 presents the in situ water quality results for the river biomonitoring points considered during the study. Table 5.33 presents the in situ results obtained during the March 2017 high flow survey for the tested PCDs and pans.

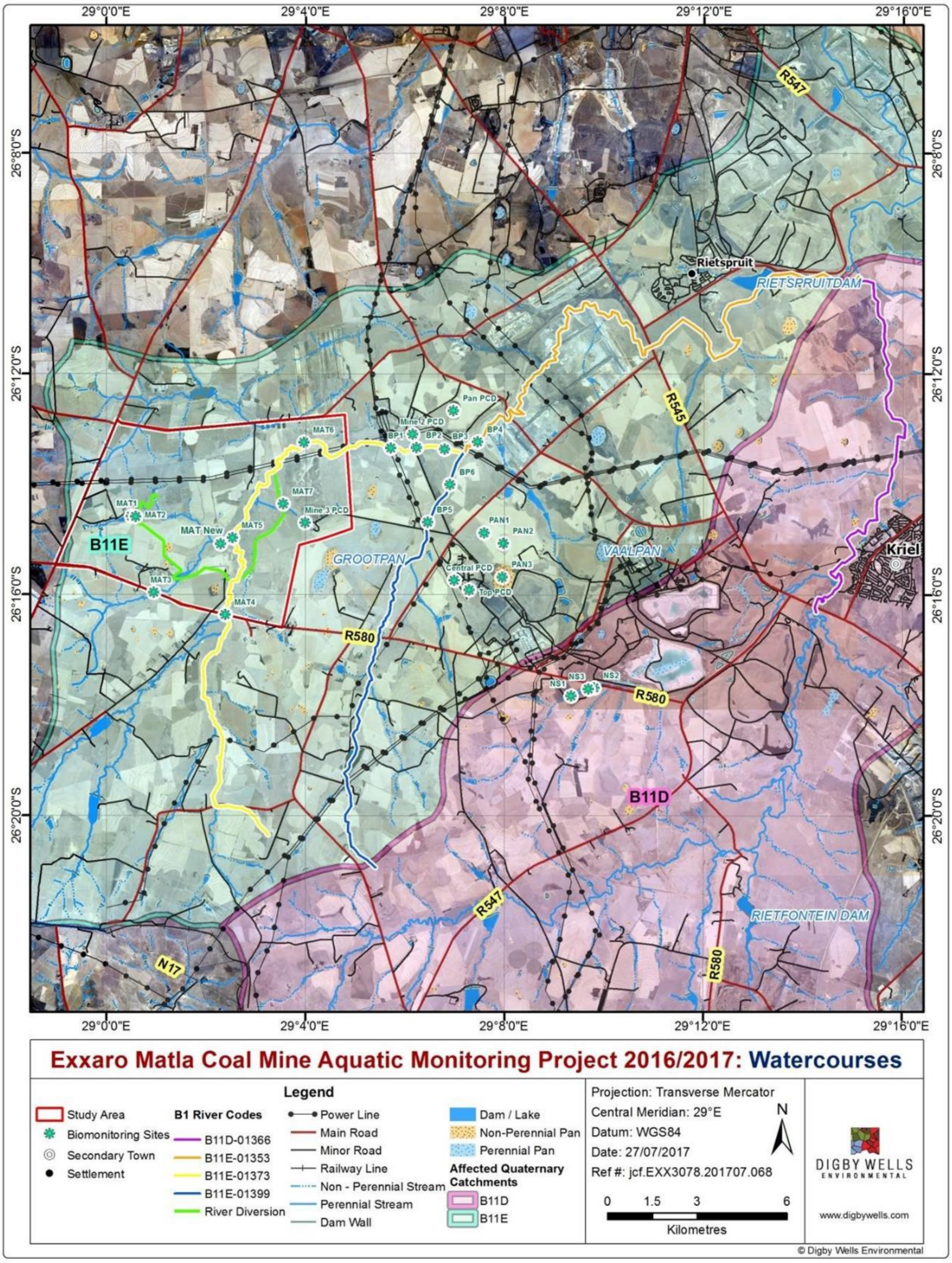

Figure 5.83: Biomonitoring sites associated with Matla Coal Mine

Table 5.32: In situ water quality results for the October 2016 and March 2017 surveys (rivers)

Site	Guidelines	MAT3	MAT4	MAT5	MAT6	MAT7	MAT New	BP1	BP2	BP3	BP4	BP5	BP6	NS1	NS2	NS3
Low flow (October 2016)																
pH	6.5-9	DRY	7.3	DRY	6.9	DRY	-	6.5	7.7	6.4	6.6	DRY	DRY	DRY	6.2	6.6
Temperature °C	5-30	DRY	21	DRY	20	DRY	-	25	28	25	26	DRY	DRY	DRY	26	25
Conductivity	<700	DRY	470	DRY	308	DRY	-	37.0	185	73.0	730	DRY	DRY	DRY	635	160
Dissolved oxygen	>5	DRY	6.7	DRY	7.0	DRY	-	7.9	8.2	5.8	4.2	DRY	DRY	DRY	2.0	4.2
High flow (March 2017)																
pH	6.5-9	6.8	7.3	7.3	7.5	7.7	7.2	7.6	8.1	8.7	7.8	DRY	DRY	7.1	6.6	7.6
Temperature °C	5-30	24	28	23	25	21	24	23	24	24	26	DRY	DRY	21	24	23
Conductivity	<700	20.0	183	192	165	15.0	220	350	270	293	274	DRY	DRY	250	587	224
Dissolved oxygen	>5	3.2	6.1	4.6	5.2	5.1	4.1	6.0	6.1	5.7	6.1	DRY	DRY	3.0	2.5	7.6
*Red shading indicates water quality constituents that exceed the recommended guideline values stipulated by DWAF (1996).																

Table 5.33: In situ water quality results for the March 2016 survey (impoundments and pans)

Site	Guidelines	Pan 1	Pan 2	Central PCD	Top PCD	Mine 2 PCD	Mine 3 PCD	Pan PCD
pH	6.5-9	9.5	9.2	9.4	8.8	8.2	11	8.8
Temperature °C	5-30	28	30	25.5	24.4	26	25	25
Conductivity	<700	6000	1600	1448	1680	370	4200	2300
Dissolved oxygen	>5	2.1	3.2	5.12	3.73	5.1	4.5	6.1

*Red shading indicates water quality constituents that exceed the recommended guideline values stipulated by DWAF (1996).

The pH at BP3 and NS2 did not fall within the recommended guideline values during the low flow survey. The conductivity values at BP4 as well as the dissolved oxygen concentration at BP4, NS2 and NS3 did not meet the recommended guideline values during the low flow survey. The dissolved oxygen concentration at MAT3, MAT5, MAT New, NS1 and NS2 were the only water quality values (for the river biomonitoring sites) that did not meet the recommended guidelines during the high flow survey.

5.8.2.2 Ex-Situ Water Quality Analyses

The chemical analysis of the water samples taken from the various river biomonitoring sites as well as the PCDs and pans are represented in Table 5.34, Table 5.35 and Table 5.36.

Table 5.34: Chemical analysis of water (in mg/l) from the upper Rietspruit sites and site NS2 along the New Shaft Tributary (March 2017)

Constituent/Site	MAT2	MAT5	MAT6	MAT7	MAT New	NS2
Al	<0.100	<0.100	<0.100	0.230	<0.100	<0.100
As	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cd	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Co	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Cu	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fe	0.480	0.181	0.079	0.382	0.073	<0.025
Mn	0.496	0.029	0.081	<0.025	<0.025	<0.025
Ni	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Pb	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sulphate	<2.000	16.00	20.00	14.00	<2.000	38.00
Nitrate	<0.100	0.200	<0.100	0.300	0.200	0.400
Nitrite	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphate	2.800	2.500	0.200	10.00	<0.200	13.00
Ammonia	1.200	0.300	0.600	0.300	0.400	0.300
Bold values indicate elements in high concentrations and should be carefully monitored in future studies.						

Table 5.35: Water quality results of sites (in mg/l) associated with the pumping of treated effluent in March 2017 (Lower Rietspruit sites)

Constituent/Site	BP1	BP2	BP3
Al	<0.100	0.190	0.253
As	<0.010	<0.010	<0.010
Cd	<0.003	<0.003	<0.003
Co	<0.025	<0.025	<0.025
Cr	<0.025	<0.025	<0.025
Cu	<0.010	<0.010	<0.010
Fe	0.117	0.272	0.321
Mn	<0.025	<0.025	<0.025
Ni	<0.025	<0.025	<0.025
Pb	<0.010	<0.010	<0.010
Sulphate	35.00	25.00	34.00
Nitrate	0.400	0.300	0.300
Nitrite	<0.050	<0.050	<0.050
Phosphate	0.300	4.800	1.400
Ammonia	0.200	0.200	0.100

Table 5.36: Chemical analysis of water from the pollution control impoundments and pans (mg/l)

Constituent/Site	Pan PCD	Top PCD	Central PCD	Mine 2 PCD	Mine 3 PCD	Pan 1	Pan 2
Low flow							
Al	<0.100	<0.100	<0.100	<0.100	0.100	DRY	DRY
As	<0.010	<0.010	0.011	<0.010	<0.010	DRY	DRY
Cd	0.009	0.003	0.006	<0.003	<0.003	DRY	DRY
Co	0.091	0.078	0.087	<0.025	<0.025	DRY	DRY
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	DRY	DRY
Cu	<0.010	<0.010	<0.010	<0.010	<0.010	DRY	DRY
Fe	0.036	0.044	0.091	0.116	0.028	DRY	DRY
Mn	<0.025	<0.025	<0.025	0.060	0.268	DRY	DRY
Ni	<0.025	<0.025	<0.025	<0.025	0.032	DRY	DRY
Pb	0.014	0.041	<0.010	<0.010	<0.010	DRY	DRY

Constituent/Site	Pan PCD	Top PCD	Central PCD	Mine 2 PCD	Mine 3 PCD	Pan 1	Pan 2
Sulphate	1427	782.0	580.0	39.00	139.0	DRY	DRY
Nitrate	0.600	0.100	0.200	0.200	<0.100	DRY	DRY
Nitrite	<0.050	0.200	0.300	<0.050	<0.050	DRY	DRY
Phosphate	0.400	<0.200	0.700	0.600	4.700	DRY	DRY
Ammonia	0.700	0.300	0.200	3.600	0.100	DRY	DRY
High flow							
Al	<0.100	<0.100	<0.100	<0.100	<0.100	11.00	0.201
As	0.013	0.021	<0.010	<0.010	<0.010	<0.010	<0.010
Cd	<0.003	<0.003	<0.003	<0.003	<0.003	0.010	<0.003
Co	0.030	<0.025	<0.025	<0.025	<0.025	0.082	<0.025
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Cu	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fe	<0.025	<0.025	<0.025	0.172	<0.025	8.840	1.940
Mn	0.054	<0.025	0.354	0.058	0.192	0.293	0.630
Ni	<0.025	<0.025	<0.025	<0.025	<0.025	0.033	<0.025
Pb	0.015	0.014	0.022	<0.010	<0.010	0.043	0.013
Sulphate	937.0	828.0	495.0	41.00	92.00	686.0	6.000
Nitrate	0.100	0.400	<0.100	0.100	<0.100	1.500	<0.100
Nitrite	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphate	0.300	0.700	1.000	0.700	6.500	3.900	0.700
Ammonia	0.300	0.200	1.100	0.200	4.600	0.100	9.800
Bold values indicate elements in high concentrations and should be carefully monitored in future studies.							

5.8.2.3 Toxicity

The results of the toxicity assessment in the pollution control dams are presented in Table 5.37

Table 5.37: Toxicity results for the impoundments during the March 2017 survey

Site	Taxa			Weight (%)	Hazard
	Water Fleas	Guppies/ *Selanstrum*	Algae		
Top PCD	<1	<1	<1	0	No acute/chronic hazard
Central PCD	<1	<1	<1	0	No acute/chronic hazard
Mine 2 PCD	>100	>100	<1	67	High acute hazard
Mine 3 PCD	>100	>100	<1	67	High acute hazard
Pan PCD	<1	<1	<1	0	No acute/chronic hazard

Mine 2 and Mine 3 PCDs were the only samples that showed toxicity hazard and were classified as class IV samples (high acute environmental hazard). This is to be expected from PCDs. Water is assumed to be contained and downstream monitoring is currently being undertaken.

5.8.2.4 Diatoms

All diatom samples from the PCDs and Pans were prepared for analysis. However, there were insufficient diatom valves in the Pan 2 and Mine 2 PCD samples in order make correct environmental inferences as illustrated in Table 5.38.

Table 5.38: Diatom species and their abundances for the PCDs and Pans

Taxa	Mine 3 PCD	PAN1	PAN2	PAN PCD	Top PCD	Central PCD	Mine 2 PCD
Achnanthes oblongella Oestrup	0	0	0	0	0	12	0
Achnanthes subaffinis Cholnoky	6	0	13	5	0	15	0
Achnanthidium exiguum (Grunow) Czarnecki	0	0	0	0	0	22	0
Achnanthidium minutissimum (Kützing) Czarnecki	0	0	0	0	0	4	0
Amphora copulata (Kütz) Schoeman & Archibald	0	0	0	4	0	0	0
Amphora ovalis (Kützing) Kützing var.*ovalis*	0	10	0	0	0	6	0
Amphora veneta Kützing	0	33	0	0	0	6	0
Anomoeoneis sphaerophora (Ehr.) Pfitzer	25	0	0	0	0	0	0
Aulacoseira granulata (Ehr.) Simonsen	0	0	0	0	0	38	0
Caloneis bacillum (Grunow) Cleve	0	0	0	0	6	6	0
Cocconeis pediculus Ehrenberg	0	0	0	0	5	0	0
Cocconeis placentula Ehrenberg var. *placentula*	0	0	0	3	0	0	0

Taxa	Mine 3 PCD	PAN1	PAN2	PAN PCD	Top PCD	Central PCD	Mine 2 PCD
Craticula buderi (Hustedt) Lange-Bertalot	6	0	18	0	6	0	0
Craticula halophila (Grunow ex Van Heurck) Mann	0	0	16	0	0	0	0
Cyclotella meneghiniana Kützing	3	0	0	80	19	11	6
Cymbella turgidula Grunow	0	0	0	0	6	0	0
Diadesmis confervacea Kützing var. *confervacea*	0	0	0	0	0	3	2
Diploneis ovalis (Hilse) Cleve	0	0	0	0	8	0	0
Encyonema minutum (Hilse in Rabh.) D.G. Mann	0	0	0	3	0	2	0
Encyonema species	0	0	0	0	0	3	0
Eolimna subminuscula (Manguin) Moser Lange-Bertalot & Metzeltin	5	0	9	0	0	0	0
Epithemia *adnata* (Kützing) Brebisson	6	0	0	0	27	20	0
Fragilaria capucina Desmazieres var.*capucina*	0	0	0	4	0	0	12
Frustulia crassinervia (Breb.) Lange-Bertalot et Krammer	0	0	0	0	19	0	0
Gomphonema affine Kützing	0	0	0	0	6	0	0
Gomphonema gracile Ehrenberg	0	0	0	2	6	8	0
Gomphonema minutum(Ag.) Agardh f. *minutum*	0	0	8	9	6	0	0
Gomphonema parvulum (Kützing)	0	0	0	8	0	0	0
Luticola goeppertiana (Bleisch in Rabenhorst) D.G. Mann	0	0	0	0	0	9	0
Luticola mutica (Kützing) D.G. Mann	0	0	11	0	0	11	0
Mastogloia smithii Thwaites	0	0	0	0	51	6	0
Melosira varians Agardh	0	0	0	0	0	31	0
Navicula antonii Lange-Bertalot	30	0	15	50	7	6	0
Navicula cryptotenella Lange-Bertalot	6	0	0	0	0	0	0
Navicula cryptocephala Kützing	3	0	0	0	15	5	0
Navicula erifuga Lange-Bertalot	3	0	0	31	19	0	6
Navicula gregaria Donkin	22	0	0	4	0	0	0
Navicula rostellata Kützing	3	0	0	10	0	0	0
Navicula symmetrica Patrick	6	0	0	0	0	0	0
Navicula trivialis Lange-Bertalot var. *trivialis*	0	0	0	22	16	6	0
Navicula veneta Kützing	15	15	0	49	0	10	0
Navicula zanoni Hustedt	0	0	0	0	20	0	0
Nitzschia amphibia Grunow f.*amphibia*	26	35	36	22	6	42	5

Taxa	Mine 3 PCD	PAN1	PAN2	PAN PCD	Top PCD	Central PCD	Mine 2 PCD
Nitzschia palea (Kützing) W.Smith	119	145	105	50	36	54	20
Nitzschia sp.1	0	132	0	12	16	10	3
Planothidium frequentissimum(Lange-Bertalot) Lange-Bertalot	0	0	0	0	0	3	0
Planothidium rostratum (Oestrup) Lange-Bertalot	0	0	0	0	0	0	2
Planothidium engelbrechtii (Choln.) Round & Bukhtiyarova	0	0	0	0	0	6	0
Pleurosigma salinarum (Grunow) Cleve & Grunow	0	0	0	3	65	14	0
Pseudostaurosira brevistriata (Grun.in Van Heurck) Williams & Round	0	0	0	0	0	6	0
Tabularia fasciculata (Agardh)Williams et Round	0	30	0	29	22	25	0
Tryblionella hungarica (Grunow) D.G. Mann	116	0	19	0	7	0	0
Tryblionella littoralis (Grunow in Cl. & Grun.) D.G. Mann	0	0	0	0	6	0	0
Total	400	400	250	400	400	400	56
Nutrients							
Salinity							
Dominant							
Insufficient cells							

A total of 53 diatom species were recorded in PCDs and Pans. The dominant diatom species recorded at the sites, included *Nitzschia palea* and *Nitzschia amphibia* which indicate eutrophic and polluted waters. The subdominant species, *Tabularia fasciculata* and *Nitzschia* sp. also indicate eutrophic waters and polluted conditions. Table 5.39 provides the ecological classification for water quality at the PCDs and Pans according to the sampled diatom assemblages.

Table 5.39: Ecological descriptors for the PCDs and Pans

Sites	pH	Salinity	Nitrogen uptake	Oxygen requirements	Saprobity	Trophic state
Mine 3 PCD	Alkaline	Brackishfresh	N-autotrophic tolerant	Low	α-mesosaprobic	Eutrophic

Sites	pH	Salinity	Nitrogen uptake	Oxygen requirements	Saprobity	Trophic state
PAN 1	Circumneutral	Freshbrackish	N-heterotrophic facultative	Low	Polysaprobic	Hypereutrophic
PAN PCD	Alkaline	Brackishfresh	N-heterotrophic obligatory	Low	α-meso-polysaprobic	Eutrophic
Top PCD	Alkaline	Freshbrackish	N-autotrophic tolerant	Moderate	α-mesosaprobic	Eutrophic
Bot PCD	Alkaline	Freshbrackish	N-autotrophic tolerant	Moderate	α-mesosaprobic	Eutrophic

The diatom assemblages mainly comprised of species with a preference for fresh brackish (<500 µS/cm) to brackish-fresh (500 - 1000 µS/cm), circumneutral (pH 7) to alkaline (pH >7) waters and eutrophic to hypereutrophic conditions. The %PTV scores for the diatom samples are provided in Table 5.40.

Table 5.40: Diatom index scores for the PCDs and Pans

Sites	%PTV	SPI	BDI	Ecological Water Quality
Mine 3 PCD	35.8	7.1	6.3	Poor
PAN1	33	3.3	4.4	Bad
PAN PCD	6	6.4	7.9	Moderate
Top PCD	7.3	9.8	11.9	Moderate
Central PCD	3.3	8.9	9.2	Moderate

The %PTV scores varied amongst the sites ranging from 3.3% at the Central PCD to 35.8% at Mine 3 PCD indicating good to bad water quality.

5.8.2.5 Habitat Quality

The results of the assessment of the New Shaft Tributary are presented in Table 5.41.

Table 5.41: IHIA results for the New Shaft Tributary (NS1-NS3)

Criterion	Average	Score	Category
Instream			
Water abstraction	16.50	9.24	E
Flow modification	20.00	10.40	
Bed modification	16.00	8.32	
Channel modification	20.00	10.40	
Water quality	13.50	7.56	
Inundation	20.00	8.00	
Exotic macrophytes	5.00	1.80	
Exotic fauna	10.00	3.20	
Solid waste disposal	5.00	1.20	
Total Instream			39.88
Riparian			
Indigenous vegetation removal	19.00	9.88	E
Exotic vegetation encroachment	12.00	5.76	
Bank erosion	10.00	5.60	
Channel modification	12.50	6.00	
Water abstraction	17.50	9.10	
Inundation	20.00	8.80	
Flow modification	17.50	8.40	
Water quality	13.50	7.02	
Total Riparian			39.44

The results of the habitat assessment in the New Shaft Tributary indicates that both riparian and instream habitats are seriously modified (class E).

The results of the IHIA for the un-channelled wetland system (SQR) referred to as the Conveyor Tributary in this study is presented (Table 5.42).

Table 5.42: IHIA results for the Conveyor Tributary (BP5-BP6)

Criterion	Average	Score	Category
Instream			
Water abstraction	9.33	5.23	D
Flow modification	12.67	6.59	

Criterion	Average	Score	Category
Bed modification	13.67	7.11	
Channel modification	13.67	7.11	
Water quality	15.00	8.40	
Inundation	11.67	4.67	
Exotic macrophytes	6.00	2.16	
Exotic fauna	15.00	4.80	
Solid waste disposal	5.00	1.20	
Total Instream			52.75
Riparian			
Indigenous vegetation removal	9.67	5.03	C
Exotic vegetation encroachment	8.00	3.84	
Bank erosion	9.67	5.41	
Channel modification	11.33	5.44	
Water abstraction	10.00	5.20	
Inundation	11.00	4.84	
Flow modification	10.00	4.80	
Water quality	10.00	5.20	
Total Riparian			60.24

The results of the habitat assessment in the Conveyor Tributary indicate that the riparian habitat is largely modified (class D) with the instream habitat as moderately modified (class C).

The results of the IHIA for the Rietspruit are presented in Table 5.43.

Table 5.43: IHIA results for the Rietspruit (MAT1-BP4)

Criterion	Average	Score	Category
Instream			
Water abstraction	10.00	5.60	D
Flow modification	21.67	11.27	
Bed modification	23.33	12.13	
Channel modification	21.67	11.27	
Water quality	11.67	6.53	

Criterion	Average	Score	Category
Inundation	9.33	3.73	
Exotic macrophytes	5.00	1.80	
Exotic fauna	10.00	3.20	
Solid waste disposal	5.00	1.20	
Total Instream			43.27
Riparian			
Indigenous vegetation removal	8.33	4.33	D
Exotic vegetation encroachment	10.00	4.80	
Bank erosion	18.33	10.27	
Channel modification	18.67	8.96	
Water abstraction	9.33	4.85	
Inundation	6.67	2.93	
Flow modification	16.67	8.00	
Water quality	8.33	4.33	
Total Riparian			51.52

The results of the habitat assessment in the Rietspruit indicates that both riparian and instream habitats are largely modified (class D).

5.8.2.6 Aquatic Macroinvertebrate Assessment

The results of the biotope assessment are presented in Table 5.44.

Table 5.44: Biotope ratings for the 2016/2017 survey

Site	Biotope Rating (%)	Interpretation
Low Flow		
NS2	8	Poor
NS3	18	Poor
BP1	28	Poor
BP2	50	Good
BP3	28	Poor
BP4	19	Poor
MAT4	9	Poor
MAT6	11	Poor

Site	Biotope Rating (%)	Interpretation
High Flow		
NS1	12	Poor
NS3	22	Poor
BP1	24	Poor
BP2	49	Good
BP3	33	Fair
BP4	24	Poor
MAT3	4	Poor
MAT4	7	Poor
MAT5	9	Poor
MAT6	13	Poor
MAT7	20	Poor
MAT NEW	26	Poor

The majority of the macroinvertebrate habitat at the sites was classified as poor according to the biotope ratings. The habitat at BP2 was classified as good during the low flow survey with the habitat at BP3 being classified as fair and at BP2 as good during the high flow survey. The results of the IHAS assessment are provided in Table 5.45.

Table 5.45: IHAS results for the 2016/2017 survey

Site	IHAS Score	Interpretation
Low Flow		
NS2	21	Poor
NS3	43	Poor
BP1	46	Poor
BP2	58	Fair
BP3	40	Poor
BP4	52	Poor
MAT4	29	Poor
MAT6	33	Poor
High Flow		
NS1	44	Poor
NS3	44	Poor

MAT3	36	Poor
MAT4	37	Poor
MAT5	34	Poor
MAT6	39	Poor
MAT7	49	Poor
MAT NEW	60	Fair
BP1	58	Fair
BP2	74	Good
BP3	37	Poor
BP4	62	Fair

5.8.2.7 SASS5

The results of the SASS5 are provided in Table 5.46.

Table 5.46: SASS5 results for the low and high flow surveys (2016/2017)

Site	SASS	Taxa	ASPT	Category
Low Flow				
NS2	6	3	2.0	E/F
NS3	64	15	4.3	D
MAT4	56	13	4.3	D
MAT6	38	9	4.2	E/F
BP1	57	15	3.8	D
BP2	113	23	4.9	B
BP3	100	21	4.8	B
BP4	62	15	4.1	D
High Flow				
NS1	67	15	4.5	C
NS3	83	16	5.2	B
MAT3	42	12	3.5	E/F
MAT4	52	13	4.4	D
MAT5	35	10	3.5	E/F
MAT6	53	11	4.8	C
MAT7	114	23	5.0	B

Site	SASS	Taxa	ASPT	Category
MAT NEW	79	16	4.9	B
BP1	63	13	4.8	D
BP2	102	19	5.4	B
BP3	75	15	5.0	B
BP4	90	18	5.0	B

5.8.2.8 MIRAI

The results of the MIRAI for the New Shaft Tributary are presented in Table 5.47.

Table 5.47: MIRAI for the New Shaft Tributary (2016/2017)

Invertebrate Metric Group	Score Calculated
Flow modification	43.4
Habitat	51.6
Water Quality	44.2
Ecological Score	46.4
Invertebrate Category	D

The overall MIRAI ecological category for the new Shaft Tributary is class D or largely modified. The results of the MIRAI in the Rietspruit are presented in Table 5.48.

Table 5.48: MIRAI for the Rietspruit (2016/2017)

Invertebrate Metric Group	Score Calculated
Flow modification	54.7
Habitat	50.0
Water Quality	49.4
Ecological Score	51.47
Invertebrate Category	D

The overall MIRAI ecological category for the Rietspruit is class D or largely modified.

5.8.2.9 Fish Assessment

Photographs of the fish species sampled during the study are presented in the table (Table 5.49). Table Table 5.50 represents the expected species and the distribution of the sampled species sampled along the Rietspruit. The results of the FRAI for the Rietspruit are presented in Table 5.51.

A total of ten different species were sampled during the study. Three of the ten species were alien invasive species. These ranged from habitat modifiers (*Cyprinus carpio*) to aquatic predators such as *Micropterus salmoides*.

A total of seven of the nine expected indigenous fish species were sampled during the study. *Barbus trimaculatus* and *Chiloglanis pretoriae* were not sampled during any of the surveys. Only a single *Cyprinus carpio* (invasive habitat modifier) and a single *Micropterus salmoides* (invasive predator) were sampled during the study.

According to the FRAI the fish community in the Rietspruit is in a largely modified state (class D).

Table 5.49: Fish species sampled at the Matla Colliery during the 2016/2017 survey

Fish Species	Photograph	Conservation status
Barbus anoplus		LC
Barbus neefi		LC
Barbus paludinosus		LC
Labeo umbratus		LC

Fish Species	Photograph	Conservation status
*Cyprinus carpio		LC
Clarias gariepinus		LC
Tilapia sparmanni		LC
Pseudocrenilabrus philander		LC
*Gambusia affinis		LC
*Micropterus salmoides		LC
* Depicts alien invasive species		

Table 5.50: Species expected and captured at the lower (BP1-BP4) and upper (MAT4MAT7) Rietspruit sites during the high and low flow surveys (2016/2017)

Site	*Barbus anoplus*	*Barbus anoplus*	*Barbus trimaculatus*	*Barbus paludinosus*	*Labeo umbratus*	**Cyprinus carpio*	*Clarias gariepinus*	*Chiloglanis pretoriae*	*Tilapia sparmanni*	*Pseudocrenilab rus philander*	**Gambusia affinis*	**Micropterus salmoides*
BP1	□	•	•	•	•	•	•	•	•	•	□	•
BP2	□	□	•	□	□	•	□	•	□	□	□	□
BP3	•	•	•	•	•	□	•	•	□	□	□	•
BP4	□	•	•	□	•	•	•	•	□	□	□	•
MAT4	•	•	•	•	•	•	•	•	•	□	•	•
MAT5	•	•	•	•	•	•	•	•	□	•	□	•
MAT6	□	•	•	□	□	•	□	•	□	•	•	•
MAT7	□	□	•	□	□	•	•	•	•	•	□	•

Table 5.51: FRAI results for the Rietspruit

Species	Expected Frequency of Occurrence rating	Recorded Frequency of Occurrence rating
Barbus anoplus	4	4
Barbus neefi	3	3
Barbus paludinosus	4	4
Barbus trimaculatus	1	0
Labeo umbratus	3	3
Clarias gariepinus	3	3
Chiloglanis pretoriae	3	0
Tilapia sparmanni	3	4
Pseudocrenilabrus philander	4	4
Adjusted FRAI %	55.3	
Ecological Category	Class D	

5.8.2.10 Present Ecological Status

The results of the PES assessment are presented in Table 5.52 for the New Shaft Tributary, Table 5.53 for the Conveyor Tributary and Table 5.54 for the Rietspruit. Based on the PES assessments completed the three river courses considered have been all classified as largely modified or class D.

Table 5.52: Present Ecological Status of the New Shaft Tributary for 2016/2017

Instream Vegetation Ecological Category	39.8
Riparian Habitat Category	39.4
Macroinvertebrate Ecological Category	46.4
Present Ecological Status	Class D

Table 5.53: Present Ecological Status of the Conveyor Tributary for 2016/2017

Instream Ecological Category	52.75
Riparian Habitat Category	60.24
Present Ecological Status	Class D

Table 5.54: Present Ecological Status of the Rietspruit for 2016/2017

Instream Vegetation Ecological Category	43.27
Riparian Ecological Category	51.52
Macroinvertebrate Ecological Category	51.47
Fish Ecological Category	55.3
Present Ecological Status	Class D

5.9 Biodiversity

The information contained in this section of the report was obtained from the Baseline Terrestrial Biodiversity Assessment conducted by Bathusi Environmental Consulting, attached herewith as Appendix D.

5.9.1 Biophysical Attributes

5.9.1.1 2014 Assessment

The respective stooping areas are respectively situated within the Govan Mbeki and Emalahleni District Municipalities. Summarised information for these municipalities is as follows:

- Govan Mbeki DM comprises approximately 295,496 ha, of which 182,735 ha (61.8%) is regarded untransformed (38.2 % transformed). No formally protected conservation areas or Ramsar sites are spatially present within this district municipality; and
- Emalahleni DM comprises approximately 267,761 ha, of which only 137,489 ha (51.3%) is regarded untransformed (48.7 % transformed). The Witbank Nature Reserve (889.1 ha, 0.33 %) is the only formally protected area within this district municipality. No Ramsar sites are spatially present within this district municipality.

Commercial agriculture (dry land maize production) and grazing represent the major land use activities of the region, while mining and associated industrial land use activities contributed secondarily to habitat transformation and losses on local and regional scales. The general region consists primarily of a combination of 'Cultivated land' and 'Untransformed grassland', which is strongly associated with ecotonal wetland/ grassland interface.

A number of wetland habitat types are present within the site, including perennial and non-perennial drainage lines, rivers, hillslope seepages, channelled and unchannelled valley bottoms, dams, and endorheic pans.

The study area is divided into two land morphological categories that are similar in broad physical appearances, namely 'Slightly irregular undulating plains and hills' and 'Moderately undulating plains and pans'. No habitat of significant physical variability, such as ridges, mountains, escarpments or hills, are present within the study area and the topography is relatively flat or slightly undulating. Various shallow drainage lines intersect the landscape. Altitude varies between 1,555 and 1,655 meters above sea level. No biosphere, conservancy or other declared areas of conservation are present in the immediate surroundings of the study area. Land types Ab9 and Bb4 are spatially represented in the study area.

The Mpumalanga Biodiversity Conservation Plan (MBCP) (Lötter & Ferrar, 2006) maps the distribution of Mpumalanga Province's known biodiversity into six categories, three of which are represented in the respective study sites:

- No Natural Habitat Remaining;
- Least Concern; and
- Important and Necessary.

Areas included in the 'Important and Necessary' category represent significantly important areas of natural vegetation that play an important role in meeting biodiversity targets. The designation seeks to minimise conflict with competing land uses and represents the most efficient selection of areas to meet biodiversity targets. No significant increase in the transformation of remaining natural habitat should be permitted and every opportunity to revert to economic options using natural land cover should be taken. Some agricultural land uses may be permitted but with best-practice guidelines made conditional and aimed at benefiting the biodiversity assets and reducing the vulnerability of each site.

The MBCP suggests that areas included in the Important and Necessary, Least Concern and No Natural Habitat Remaining categories incorporate increasing options for different types of land use that should be decided by the application of EIA procedures and negotiation between stakeholders.

The proposed development relates to 'Urban and Industrial Land Uses' (Land Use Type 14 – Underground Mining). Restrictions in terms of major developments according to the MBCP place most of the study area within the 'Permitted' category. Specialist studies however, still need to indicate that the proposed development will not adversely affect any sensitive floristic or faunal attributes that occur, or potentially could occur, within the study area or on a local and regional scale.

5.9.1.2 Botanical Assessment

The study areas are located in the Mesic Highveld Grassland Bioregion, more specifically defined by Mucina and Rutherford (2006) as the Eastern Highveld Grassland (Endangered). The study area also includes isolated portions of the Eastern Temperate Freshwater Wetlands (Vulnerable) vegetation type are spatially included within the principal study area.

Information obtained from the SANBI database indicates the known presence of approximately only 122 plant species within the ¼-degree grids that are sympatric to the study area and is therefore not an accurate reflection of the true floristic diversity of the region, considering that 235 species were identified in the study area alone during the survey period.

The only threatened species that is known to occur in the ¼-degree grids in which the Phase I study areas are situated is *Frithia humilis* (Endangered). Due to the high paucity of accurate sampling records within the general region, it is regarded likely that other threatened plant taxa could persist within the study areas when the extent and status of remaining natural habitat is considered. A relative low number of plants included in lower conservation categories are known to persist in the immediate region, as follows:

- Boophone disticha (Declining);
- Crinum bulbispermum (Declining); and
- *Kniphofia typhoides* (Near Threatened).

These species are mostly associated with wetland and pristine grassland habitat types and flowers during the summer period. A total of 5 (five) conservation important plant species were recorded within the principal study area, namely:

- *Crinum bulbispermum* (Declining Status);
- *Gladiolus elliotii* (Protected Plant, Schedule 11 (Mpumalanga Nature Conservation Act 10 of 1998);
- *Gladiolus* species (Protected Plant, Schedule 11 (Mpumalanga Nature Conservation Act 10 of 1998);
- *Kniphofia porphyrantha* (Protected Plant, Schedule 11 (Mpumalanga Nature Conservation Act 10 of 1998); and
- *Nerine krigei* (Protected Plant, Schedule 11 (Mpumalanga Nature Conservation Act 10 of 1998).

The following species are furthermore known to persist in the immediate region and are therefore regarded likely to persist in the study area:

- Boophone disticha (Declining);
- Hypoxis hemerocallidea (Declining);
- Gladiolus robertsoniae (Near Threatened);
- *Kniphofia typhoides* (Near Threatened); and
- Nerine gracilis (Vulnerable).

A species richness of 236 plant taxa was recorded during the field investigations. This diversity is regarded representative of the regional ecological types that is spatially represented in the study area. The grassland physiognomy (within areas of natural/ habitat) of the region is reflected by a well-developed and diverse herbaceous layer, comprising of 114 forbs, 49 grass species, and 15 geophytes. Although the wetlands of the study area are likely to be more diverse as indicated in this report, the 23 sedge species recorded in this habitat type indicates that most of the wetlands comprises relatively natural habitat. The absence of a diverse shrub or tree component (other than exotic species) reflects the grassland physiognomy. The floristic diversity comprises of 58 plant families, dominated by Poaceae (50 species), Asteraceae (41 species), Cyperaceae (22 species), and Fabaceae (14 species).

Results of the photo analysis and site investigations revealed the presence of the following macro habitat types) and habitat variations within the stooping properties:

- Transformed Habitat, including:
    - Agricultural Fields (low floristic sensitivity);
    - Buildings, Homesteads, Infrastructure & Existing Developments (low floristic sensitivity);
    - Mining Areas (low floristic sensitivity);
    - Roads & Linear Infrastructure (low floristic sensitivity);

- Degraded Habitat, including;
  - Cultivated fields/ Pastures (medium-low floristic sensitivity);
  - Dams/ Impoundments - Artificial (low floristic sensitivity);
  - Exotic Stands (low floristic sensitivity);
- Wetland Habitat, including:
  - Channelled Valley Bottoms (high floristic sensitivity);
  - Dams/ Impoundments – Natural (medium floristic sensitivity);
  - Endorheic pans (high floristic sensitivity);
  - Unchannelled Valley Bottoms (high floristic sensitivity);
- Grassland Habitat, including;
  - Degraded Grassland (medium floristic sensitivity);
  - Hillslope Seeps (high floristic sensitivity); and
  - Natural Grassland (high floristic sensitivity).

The present ecological status of terrestrial grassland varies greatly across the study area. Considering the extent of habitat transformation on a local and regional scale, the high floristic importance ascribed to remaining portions of natural grassland does not only reflect the national status (Endangered), but also the effect of fragmentation, isolation factors and general degradation that results from land use, particularly cultivation and inappropriate grazing strategies. The conservation of natural grasslands of the area should therefore be prioritised through the implementation of site-specific biodiversity action plans.

5.9.1.3 Faunal Assessment

Grasslands represent the habitat of large herds of antelope, as well as many smaller animals. The grassland biome is one of the most threatened in South Africa; the development of the forestry, mining and development industries have irreversibly transformed 60-80 % of grasslands in South Africa, with only 2 % formally conserved. Grasslands are characterised by high levels of species richness and endemism:

- Mammals: 89 species (18 endemic, 9 threatened);
- Reptiles: 84 species (17 endemic, 4 threatened);
- Amphibians: 36 species (18 endemic, 2 threatened); and
- Invertebrates: unknown (? endemic, 16 threatened).

It is important to view the study area on an ecologically relevant scale; consequently, all sensitive animal species (specific faunal groups) known from Mpumalanga were included in this assessment. Animals known to be present in the Q-grids 2629AA and 2629AC were considered potential inhabitants of the study area, but all species known from Mpumalanga were included in the assessment to limit known effects of sampling bias.

During the field investigations, which were conducted during July 2011 (dry season) and January 2012 (wet season), 61 animals were recorded across the principal study area, which included one spider, one centipede, one tick, two damselflies, two dragonflies, one termite, one cricket, one bug, nine beetles, twelve butterflies, one fly, one bee, four frogs, two reptiles and twenty-one mammals. Three of the mammals recorded in the study area represent introduced (alien) species and one species is listed as Red Data. In addition, invertebrates from 36 families were recorded in the study area.

Animals recorded in the study area during the two deployment periods represent typical grassland-wetland faunal communities of the fragmented landscape of the southwestern Mpumalanga Province (pers. obs.).

A total of 88 conservation important animals are known to occur in the Mpumalanga (butterflies, frogs, reptiles and mammals). This includes 26 listed as Data Deficient (DD), 31 as Near Threatened (NT), 20 as Vulnerable (VU), 8 as Endangered (EN) and 3 as Critically Endangered (CR). Subjective estimations of the PoC for these animals within the principal study area revealed the following results:

- low PoC – 69 animals have a in the study area;
- moderate-low PoC – 10 animals;
- moderate PoC – 6 animals;
- high PoC – 2 animals; and
- 1 species was recorded in the study area, namely Serval.

The close relationship between vegetation units and specific faunal composition has been noted in several scientific studies. For the purpose of this investigation, floristic units were therefore considered representative of the faunal habitat types. The following habitat types (vegetation units or ecological units are indicated:

- Transformed Habitat, including
  - Agricultural Fields (medium-low faunal sensitivity);
  - Pastures (low faunal sensitivity);
  - Buildings, Homesteads, Infrastructure & Existing Developments (medium-low faunal sensitivity); and
  - Roads & Linear Infrastructure (low faunal sensitivity);
- Degraded Habitat, including;
  - Exotic Stands (medium-low faunal sensitivity);

- Wetland Habitat, including:
  - Channelled Valley Bottoms (medium-high faunal sensitivity);
  - Unchannelled Valley Bottoms (high faunal sensitivity);
  - Hillslope seepage (medium-high faunal sensitivity);
  - Dams/ Impoundments – Natural (medium-high faunal sensitivity);
  - Dams/ Impoundments – Artificial (medium-low faunal sensitivity); and
  - Endorheic pans (high faunal sensitivity);
- Grassland Habitat, including;
  - Degraded Grassland (medium faunal sensitivity); and
  - Natural Grassland (high faunal sensitivity).

Two distinct groups of natural faunal habitats exist in the study area, namely terrestrial grasslands, including cultivated fields, degraded grassland and natural grassland, and wetland habitat types, including channelled valley bottoms, artificial dams, natural dams, endorheic pans, hillslope seepage and unchannelled valley bottoms. Both of these groups of habitats have unique ecological characteristics that influence the faunal communities, assemblages and species that are associated with it.

Extensive parts of the study area have been transformed and degraded. Most of the study area is characterized by impacts resulting from commercial crop agriculture (agricultural fields, homesteads and farming infrastructure) and coal mining (excavations, artificial impoundments and linear infrastructure such as pipelines, conveyors and roads). These areas are all considered to be transformed faunal habitat and contain, at best, only trace elements of the original ecological characteristics of the region (terrestrial and wetland-associated). Remaining untransformed faunal habitats include terrestrial grassland (natural grassland and degraded grassland) and wetland associated habitat (channeled valley bottoms, endorheic pans and hillslope seepage).

Grasslands and wetlands of the study area exhibit high species richness, species diversity, biodiversity value, effective ecological functionality, are well linked and act as refuges for many animal species, including a significant number of threatened taxa. Two Red Data wetland animals are estimated to have a high probability of occurring in the study area, namely the Forest Shrew (*Myosorex varius*) and the Marsh Sylph (*Metisella meninx*). Both these species are well known from the region in which the study area is located and all of their habitat requirements are met within the study area's boundaries (pers. obs.). One wetland red data species were confirmed to occur in the study area, namely the Serval.

5.9.1.4 Avifaunal Assessment

The Matla Phase 1 study area is characterised by four broad habitat types that range from:

- Natural grassland (comprising of untransformed undulating grassland and secondary grazed grassland);
- Wetland-associated landscape features (i.e. endorheic pans, manmade impoundments and drainage lines);
- Agricultural land; and
- Exotic plantation.

Agricultural land is prominent on the study site, and is mainly used for the production of *Zea mays* (maize). The remaining extent consists mainly of a combination of wetland features, natural grassland and degraded grassland. The grassland units are predominantly used for grazing purposes. In addition, high stocking rates and overgrazing are responsible for the occurrence of secondary and degraded graminoid compositions (e.g. *Eragrostis plana* and *E. curvula*) and poor floristic richness. Nevertheless, part of the study area is occupied by wetland features represented by natural entities (e.g. hillslope seeps and endorheic pans) and artificial dams.

The importance of the study area, especially from an avifaunal perspective, is confined to the endorheic pans on the Farm Grootpan. These features are of great interest based on recent anecdotal observations:

- Many waterbird species tend to congregate (or moult) on the pans during winter due to the non-perennial nature of the marshes and palustrine wetlands that occur in the region;
- Some of the pans provide important breeding platforms for a diversity of Anatid taxa. These function as important source areas for the nearby impoundments through population recruitment, thereby maintaining population viability;
- These pans provide ephemeral foraging habitat for "near-threatened' species, in particular flamingo species (genus Phoenicopterus) and Maccoa Duck (*Oxyura maccoa*); and
- The drainage lines (mainly hillslope seeps and valley bottom seeps) are also daily flyways for a variety of bird species, especially in a landscape affected by intense agricultural activities. These features were especially prominent on Portion 29 and 30 of the Farm Grootpan, Portion 14 of the Farm Rietvlei and Portion 1 of the Farm Kortlaagte.

- According to the South African Bird Atlas Project (SABAP1: Harrison et al., 1997), an average of 197.8 bird species have been recorded from the study region based on four quarter degree squares that are sympatric to the study area (2629AA = 195 spp., 2628BD = 196 spp., 2628BB = 201 spp. & 2629AC = 199 spp.). This equates to 20 % of the approximate 970 species listed for the southern African subregion . However, the SABAP2 database suggests that study area is more likely to sustain an average 63.2 species (www.sabap2.adu.org.za). Nevertheless, 128 bird species were recorded during the site visits (representing a dry and wet season survey) of which six are considered to be of global and regional conservation concern. The SABAP2 statistic was obtained from five pentad grids. On a national scale, the species richness on the study area is considered low-moderate.

The observed totals are within the limit (> 50 %) of the number of species likely to occur and provide a realistic indication of the thoroughness and general coverage of the study site. Despite the fact the study site is dominated by grassland species, it was poorly represented by biome-restricted and endemic bird species (e.g. Southern Bald Ibis *Geronticus calvus* & Botha's Lark *Spizocorys fringillaris*) unlike the compositions expected from the eastern Mpumalanga highlands and escarpment.

An analysis of bird data generated from the point counts showed that the Zitting Cisticola (*Cisticola juncidis*), a species confined to moist grassland areas and pastures, was the most dominant species on the study site. Other prominent taxa include the Black-smith Lapwing (*Vanellus armatus*), Red-knobbed Coot (*Fulica cristata*) and the Egyptian Goose (*Alopochen aegyptiacus*). Examination of the dominant taxa shows a prominent wetland-dependant and grassland composition dominated by members of the Cisticolidae, Anatidae and Ploceidae. The study site is represented by two distinct avifaunal communities:

- A community confined to Highveld grassland seres. Typical members include cryptic taxa including a high diversity of cisticolas (including Cloud Cisticola *Cisticola textrix*, Wing-snapping Cisticola *C. ayresi* and Levaillant's Cisticola *C. tinniens*), Long-tailed Widowbird (*Ploceus progne*), African Pipit (*Anthus cinnamomeus*) and Cape Longclaw (*Macronyx capensis*); and
- A species-rich and diverse community restricted to areas of open surface water and associated shoreline habitat. Typical species include waterfowl and wader taxa such as the Red-knobbed Coot (*Fulica cristata*), Black-smith Lapwing (*Vanellus armatus*), Yellow-billed Duck (*Anas undulata*), Red-billed Teal (*Anas erythrorhyncha*) and Reed Cormorant (*Phalacrocorax africanus*).

A comparison between the grassland and wetland counts showed increased species numbers of more than 50 % on wetland features. It clearly indicates that the various wetland features are more diverse than the surrounding grasslands. The wetland features also sustained higher numerical abundances when compared to the grassland seres.

The only species of conservation concern recorded on the study area were the globally near-threatened Maccoa Duck (*Oxyura maccoa*) and the nationally near-threatened species Greater Flamingo (*Phoenicopterus ruber*). *O. maccoa* was represented by small rafts (numbering 1-4 individuals) of post-breeding birds, and was confirmed from the pan system located on the Farm Grootpan. However, this pan system also provides ephemeral foraging habitat for the "near-threatened' Greater Flamingo *Phoenicopterus ruber*). It is also worth mentioning that the nationally endangered African Marsh Harrier (*Circus ranivorus*) could be present on the palustrine wetlands on the Farm Kortlaagte. It was confirmed upstream and downstream of the Farm Kortlaagte along the upper catchment of the Rietspruit system.

Areas of high avifaunal importance include:

- The endorheic pans on the Grootpan farm portions facilitate moulting of waterfowl (when many individuals have lost their ability to fly);
- The endorheic pans is responsible for > 50 % of the observed avifaunal diversity and support high numbers of waterbird species;
- The endorheic pans on the Grootpan farm portions conform to an interconnected pan system with high variability amongst each other in terms of depth, salinity and water levels. Therefore, based on seasonality, these systems are highly dynamic and experience a frequent turnover of bird species. In addition, they provide foraging habitat for the globally '"near-threatened' Maccoa Duck (*O. maccoa*) and the "near-threatened" Greater Flamingo (*Phoenicopterus ruber*);
- The endorheic pan system on Portion 10 and 23 of the Farm Grootpan shows extensive areas of mudflats which are important foraging habitat for small Charadrius plovers (e.g. Common Ringed Plover *Charadrius hiaticula*) and Palaearctic migrants, e.g. scolopacid shorebirds (up to 400 and 130 Little Stints *Calidris minuta* and Ruffs *Philomachus pugnax* counted respectively); and
- The hillsslope seeps, valley bottom seeps and their associated grassland seres represent local flyways and dispersal networks for wading birds and waterfowl (mainly herons, cormorants, ibises, ducks and geese) – any development within these areas will have a definite and significant impact on the avifaunal diversity of the area. These areas also provide suitable foraging habitat for the "endangered" African Marsh Harrier (*Circus ranivorus*).

Areas of medium-high avifaunal importance include:

- Grassland patches, and although often of secondary floristic composition, they provide ephemeral foraging habitat for the Secretarybird (*Sagittarius serpentarius*) and Blue Korhaan (*Eupodotis caerulescens*) while maintaining high ecological connectivity with adjacent grassland units.

5.9.2 2017 Monitoring

Digby Wells Environmental undertook Fauna and Flora Monitoring (Appendix E) for the Mine 3 River Diversion area which overlaps with some of the stooping areas. Figure 5.84 presents the transects sampled

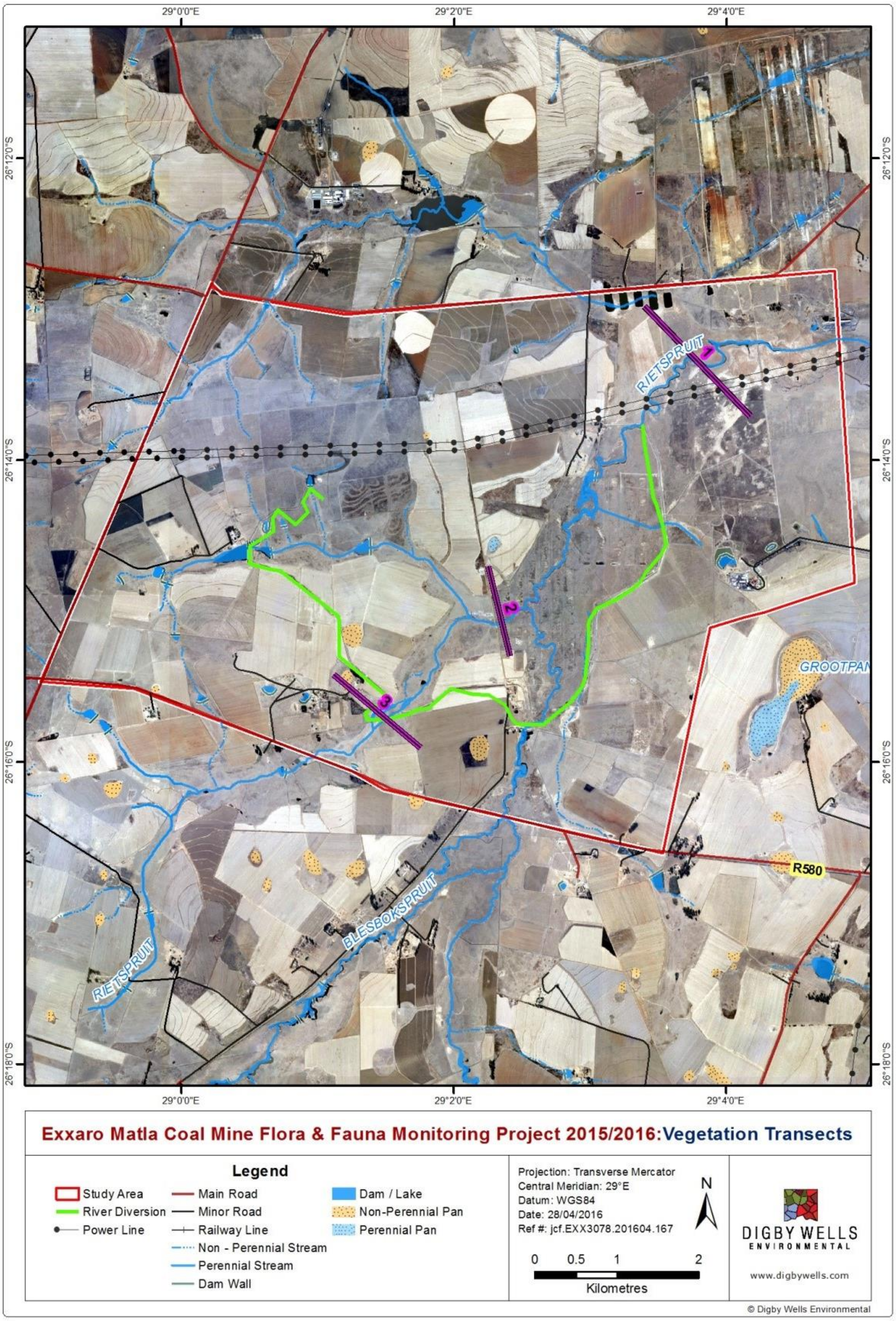

Figure 5.84: Fauna Flora monitoring transects

5.9.2.1 *Vegetation Analysis*

The three transects were assessed on the 30th of June 2017. Due to the lack of identifiable characteristics (such as flowers/fruits) during the winter season, identified species richness is expected to be lower compared to the previous assessment.

Overgrazing is evident in all transects, predominantly Transect 1, where the majority of the area has been trampled and basal cover has been reduced significantly. Increaser 2 grass species are dominant in all transects, further indicting overgrazed veld. It is important that this is rectified as the Wetland Monitoring and Management Plan (Golder, 2008) states that cattle should be excluded from all wetland areas as a condition of the approved Water Use Licence. Table 5.55 lists the pertinent details of the vegetation transects which are further described in this section. Plant species recorded along the transects are listed in Appendix A of the Fauna and Flora report (Digby Wells, September 2017). No protected species were identified in any of the transects.

Table 5.55: Species richness and dominant species recorded along the different transects

Transect	Species Richness		Dominant species
	2016 (#)	2017 (X)	
1	39	11	• *Setaria sphacelata #, X* • *Eragrostis plana #,X* • *Sporobolus Africana #* • *Typha capensis #* • *Berkheya erysithales #* • *Paspalum dilatatum #*
2	60	33	• *Themeda triandra #, X* • *Cynodon dactylon X* • *Eragrostis gummiflua X* • *Imperata cylindrical X* • *Cosmos bipinnatus #* • *Eragrostis plana #* • *Leersia hexandra (host plant for Marsh Sylph butterfly)#*
3	33	25	• *Agrostis lacnantha #, X* • *Cynodon dactylon, #* • *Eragrostis plana #, X* • *Sporobolus Africana #, X* • *Cyperus esculentus #*

Transect 1

Transect 1 represents wetland features interspersed between terrestrial habitats that have formed due to subsidence in the vicinity. At the time of the survey, a large proportion of the site was inundated with water. The Rietspruit River was vegetated with riparian species and well utilised by bird species. *Setaria sphacelata* (African Bristlegrass), *Eragrostis plana* (Tough Love Grass), *Sporobolus africana* (Rat's-tail Dropseed) and patches of *Typha capensis* (Bulrush) were the dominant species, with a total of 11 plant species recorded. Plant species were almost impossible to identify due to the extent of overgrazing; plants has been grazed almost to ground level, with the exception of a few unpalatable species. As a result, only 11 species were identified. Alien invasive species identified on site include *Cirsium vulgare* (Spear Thistle) (NEMBA: Category 1b), *Verbena bonariensis* (Tall Verbena) (NEMBA: Category 1b). The indigenous weed, *Berkheya erysithales* was also prevalent on site.

Transect 2

Transect 2 exhibited a higher species richness (33 species) than the other transects as well as a good basal cover. The most dominant species identified were *Themeda triandra* (Red Grass), *Cynodon dactylon* (Couch Grass), and *Eragrostis gummiflua* (Gum Grass). Wetland species were also evident, with *Imperata cylindrica* (Cottonwool Grass) and *Juncus effusus* (Soft Rush) being dominant. Various alien species were present, including: *Bidens pilosa* (Black Jacks), which formed dense stands along the road edge, *C. vulgare* (NEMBA: Category 1b), and *Verbena bonariensis* (NEMBA: Category 1b). Native weeds include *B. erysithales, Seriphium plumosum* (Bankrupt Bush) and *Gomphocarpus fruticosus* (Milkweed).

Transect 3

Transect 3 represents the area associated with the river diversion. *Agrostis lachnantha* (Bent Grass), *C. dactylon, E. plana* and *S. africana* were the dominant species in this transect. Contrary to the previous year's survey of Transect 3, hydromorphic species are now abundant *(I. cylindrica, A. lachnantha, Cyperus sp., Juncus sp.*), with a fair amount of water present. Various forbs were also present, such as *Plantago* and *Hypoxis* species. Twenty-five species were encountered along the transect. Six invasive species were identified. *V. bonariensis* (NEMBA: Category 1b), *V. brasiliensis* (NEMBA: Category 1b), and *Pennisetum clandestinum* (Kikuyu Grass) which is a highly invasive grass in wetland areas (NEMBA: Category 1b).

Alien Plant Species Inspection

Ten alien plant species were recorded during the transect walks as listed in Table 5.56. Some native species showed invasive habit in response to overgrazing, such as *B. erysithales* and *S. plumosum*. Alien Invasive plant species in South Africa have been classified according to

NEMBA (Act No. 10 of 2004), as published in NEMBA: Regulation on Alien Invader Species (GN R599 in GG 37886 of 1 August 2014) into the following categories:

- Category 1a: Species requiring compulsory control;
- Category 1b: Invasive species controlled by an invasive species management programme;
- Category 2: Invasive species controlled by area; and
- Category 3: Invasive species controlled by activity.

Table 5.56: Plant species recorded on site (July 2017(x) and February 2016(#))

Family	Species	CARA/ NEMBA	Transect		
			1	2	3
Agavaceae	Agave sisalana	2; 2		#	
Amaranthaceae	Amaranthus hybridus	Not listed		#	X
	Gomphrena celesioides	Not listed		#	
Asteraceae	*Bidens pilosa*	Not listed	#, X	#, X	#, X
	Campuloclinium macrocephalum	1; 1b		#	X
	Cirsium vulgare	1; 1b	#, X	#, X	#
	Conyza albida	Not listed	#, X	#, X	#
	Cosmos bipinnata	Not listed		#	
	Taraxacum offinale	Not listed	#	#	
	Senecio sp.	Not listed			#
	Tagetes minuta	Not listed	#	X	
Fabaceae	*Trifolium repens*	Not listed			X
Poaceae	*Pennisetum clandestinum*	Category 1b in wetlands			X
	Paspalum dilatatum	Not listed	#		#
Polygonaceae	*Rumex crispus*	Not listed			X
Solanaceae	*Datura stramonium*	1; 1b	#	#	
	Physalis peruviana	Not listed		#	
	Solanum panduriforme	Not listed			#
Verbenaceae	*Verbena bonariensis*	1b	#, X	#, X	#, X
	Verbena bonariensis	1b	#	#	#, X

<u>Protected Plant Species</u>

Boophone disticha (Declining), *Crinum bulbispermum* (Declining), *Kniphofia typhoides* (Near threatened) are expected species in the quarter degree squares (QDS) 2629AC, whilst *Frithia humilis* (Endangered) is expected in QDS 2629AA. None of these species were recorded in any of the three transects in this survey.

No provincially protected species listed in Schedule 11 or specially protected species as listed in Schedule 12 of the Mpumalanga Nature Conservation Act (No. 10 of 1998), were identified on site.

5.9.2.2 Fauna

Mammals

A database search for mammal species that have been recorded in the QDS 2629 AA in which the study area occurs was completed on the virtual museum of the Animal Demography Unit (ADU) (http://www.adu.org.za). In the database, no recent records of mammals have been formally uploaded in the study area. Mammal species that have been recorded near the project area in the Mpumalanga Province, and that possibly occur in the area of interest are discussed herewith.

Mammal species expected to occur in the study area include 3 protected species, Table 5.57, one being confirmed, as per ADU database. The species identified visually during the surveys are, Steenbuck (*Raphicerus campestris*), Bushpig (*Potamochoerus larvatus*) and Black Backed Jackal (*Canis mesomelas*). The animals of which signs were recorded included Cape Clawless Otter (*Aonyx capensis*) droppings and foraging marks of the Cape Porcupine (*Hystrix africaeaustralis*) and Shrub Hare (*Lepus saxatilis*). Serval (*Leptailurus serval*) was recorded on camera traps during the 2016 survey period. The variety of vegetation types occurring in the study area allows for an ecologically diverse assemblage of plant species which may support a variety of mammal species. Considering this, the expected species list for this study may potentially be more extensive than is currently recorded.

The evidence of dung and spoor suggests that animals were present in the area although very few were recorded during the surveys. A number of burrows seen in the general project area indicates that there is a dense population of rodents, likely multimammate mice. As in 2016, despite high abundances of small mammals in the project area, low diversity of species was recorded thus leading to a relatively low overall biodiversity of small mammals. However, high abundances of small mammals are important to avian, amphibian and reptilian diversity as they contribute toward a valuable food source for these animals.

Table 5.57: List of mammal species expected and observed in the project area

Scientific name	Common name	Red list category	2015/2016	2017
Aonyx capensis	Cape Clawless Otter	Protected (NEMBA) MPB: Protected	Yes	Yes
Atilax paludinosus	Marsh Mongoose	LC		
Canis mesomelas	Black-backed Jackal	LC	Yes	Yes
Cryptomys hottentotus	Common Mole-rat	LC		
Cynictis penicillata	Yellow Mongoose	LC	Yes	Yes
Galerella sanguinea	Slender Mongoose	LC		
Hystrix africaeaustralis	Cape Porcupine	LC	Yes	Yes
Ichneumia albicauda	White-tailed mongoose	LC		Yes
Lepus saxatilis	Shrub Hare	LC		Yes
Lutra maculicollis	Spotted-necked Otter	EN (IUCN) MPB: Protected		
Mastomys coucha	Multimammate Mouse	LC	Yes	
Otomys irroratus	Vlei Rat	LC	Historically recorded in surrounding area	
Sylvicapra grimmia	Common Duiker	LC		
Potamochoerus larvatus	Bushpig	LC	Yes	Yes
Raphicerus campestris	Steenbuck	LC, MPB: Protected	Yes	Yes
Leptailurus serval	Serval	NT	Yes	
Tatera brantsii	Highveld Gerbil	LC		

Avifauna

In the aquatic biomonitoring report of August 2013 it is mentioned that 26 bird species were recorded during that specific project (Golder, 2013). The 2016 study recorded 38 species and 2017 study recorded 37 species during the two seasonal site visits that covered all available habitats in the project area. According to the South African Bird Atlas Project (SABAP2), approximately 300 species of birds have been identified in the general area; the majority of these birds are comprised of grassland species. All birds that could be present within study area (QDS 2629 AA) were considered during this project. Of these species, 23 have been assigned a red data status one critically endangered, 13 near threatened, one endangered and eight vulnerable with four endemic to South Africa. The species recorded are listed in Table 5.58.

The dominant habitat of the river diversion and surrounding area generally includes mesic Highveld grassland dominated by agriculture (maize production and grazing).

During the site visit a number of bird species were observed in the farming areas which were predominated by agricultural fields and farm roads.

Throughout the natural grassland vegetation type of the study area an African Grass-Owl (*Tyto capensis*) was previously observed in the form of two roosting sites located in close proximity to the water treatment dams north of river diversion. This species is considered vulnerable in South Africa according to The Red Data Book of Birds of South Africa, Lesotho and Swaziland, with between 1 000 and 5 000 birds remaining in this country (Barnes, 2000).

Although not observed during the 2016 or 2017 survey, a number of birds of prey should be present periodically throughout the year and would in all likelihood include Red Data summer migrants species such as Pallid Harrier (*Circus macrourus*), African Marsh Harrier (*Circus ranivorus)* and Montagu's Harrier (*Circus pygargus)*. These species do however prefer the less impacted grassland areas to sustain their preferred prey species.

The grasslands and agricultural fields of the study area harbour a number of typical Highveld endemics. These included White Storks along with widow, weaver and bishop species (within the wetter areas). A number of Marsh Owls (*Asio capensis)* and African Quailfinch's (*Ortygospiza fuscocrissa*) were also observed within the grasslands – the latter species generally feed on the seeds of the wetter grass species and are renowned wetland indicators. African Pipit (*Anthus cinnamomeus*) and Orange throated Longclaw (*Macronyx capensis*) were observed throughout the study area. The study area is also ideal habitat for quail and button-quail species, although these species are highly nomadic and were not identified during the site investigation.

A number of water birds were identified within the open water of the farm dams within the project area and include species such as Common Sandpiper (*Actitis hypoleucos*), Cattle Egret (*Bubulcus ibis*), Egyptian Goose (*Alopochen aegyptiaca)*, Spurwinged Goose (*Plectropterus gambensis*), Sacred Ibis (*Threskiornis aethiopicus*), Red-knobbed Coot (*Fulica cristata*), African Snipe (*Gallinago nigripennis*), Goliath Heron (*Ardea goliath)*, Yellowbilled Duck (*Anas undulata*), White-faced Duck (*Dendrocygna viduata*), Cattle Egret *(Bubulcus ibis)*, and Three-banded Plover (*Charadrius tricollaris*).

Table 5.58: Bird species recorded in the 2016/2017 study period

Species	Common Name	Conservation Status	2016	2017
Recurvirostra avosetta	Avocet, Pied	MPB: Protected	#	

Species	Common Name	Conservation Status	2016	2017
Euplectes orix	Bishop, Southern Red	MPB: Protected	#	x
Pycnonotus tricolor	Bulbul, Dark-capped	MPB: Protected	#	x
Fulica cristata	Coot, Red-knobbed	MPB: Protected	#	x
Phalacrocorax lucidus	Cormorant, White Breasted			x
Microcarbo africanus	Cormorant, Reed			x
Corvus albus	Crow, Pied	MPB: Protected	#	x
Anhinga rufa	Darter, African			x
Streptopelia senegalensis	Dove, Laughing	-	#	x
Oena capensis	Dove, Namaqua	MPB: Protected	#	
Streptopelia turtur	Dove, Turtle			x
Anas undulata	Duck, Yellow-billed	MPB: Protected	#	x
Bubulcus ibis	Egret, Cattle	MPB: Protected	#	x
Egretta garzetta	Egret, Little	MPB: Protected	#	x
Ceryle rudis	Kingfisher, Pied	MPB: Protected		x
Elanus caeruleus	Kite, Black-shouldered	MPB: Protected		x
Falco amurensis	Falcon, Amur	MPB: Protected	#	
Lanius collaris	Fiscal, Common (Southern)	MPB: Protected	#	
Phoenicopterus ruber	Flamingo, Greater	SA Red Data: NT IUCN: NT NEMBA, TOPS: MPB: Protected	#	
Scleroptila levaillantii	Francolin, Red Winged	MPB: Protected		x
Pternistis swainsonii	Francolin, Swainson	-		x

Species	Common Name	Conservation Status	2016	2017
Chroicocephalus cirrocephalus	Gull, Grey headed	MPB: Protected		x
Corythaixoides concolor	Go-away-bird, Grey	MPB: Protected	#	
Alopochen aegyptiacus	Goose, Egyptian	-	#	x
Plectropterus gambensis	Goose, Spur Winged	MPB: Protected		x
Tringa nebularia	Greenshank, Common	MPB: Protected	#	
Tachybaptus ruficollis	Grebe, Little	MPB: Protected		x
Numida meleagris	Guineafowl, Helmeted	MPB: Protected	#	x
Scopus umbretta	Hamerkop, Hamerkop	MPB: Protected	#	x
Ardea melanocephala	Heron, Black-headed	MPB: Protected	#	
Ardea goliath	Heron, Goliath	MPB: Protected		x
Threskiornis aethiopicus	Ibis, African Sacred	MPB: Protected	#	
Plegadis falcinellus	Ibis, Glossy	MPB: Protected	#	x
Bostrychia hagedash	Ibis, Hadeda	MPB: Protected	#	x
Elanus caeruleus	Kite, Black-shouldered	MPB: Protected	#	x
Vanellus armatus	Lapwing, Blacksmith	MPB: Protected	#	
Vanellus coronatus	Lapwing, Crowned	MPB: Protected	#	x
Macronyx capensis	Longclaw, Cape	MPB: Protected	#	x
Cisticola fulvicapilla	Neddicky	MPB: Protected	#	
Asio capensis	Owl, Marsh	MPB: Protected		x
Anthus cinnamomeus	Pipit, African	MPB: Protected	#	
Charadrius tricollaris	Plover, Three-banded	MPB: Protected	#	x
Prinia subflava	Prinia, Tawny-flanked	MPB: Protected		x

Species	Common Name	Conservation Status	2016	2017
Ortygospiza atricollis	Quailfinch, African	MPB: Protected	#	
Sagittarius serpentarius	Secretarybird	SA Red Data: VU IUCN: VU NEMBA, TOPS: MPB: Protected	#	x
Lanius collurio	Shrike, Red-backed	MPB: Protected	#	
Gallinago nigripennis	Snipe, African	MPB: Protected	#	
Pternistis swainsonii	Spurfowl, Swainson's	MPB: Protected	#	
Ciconia ciconia	Stork, White	MPB: Protected	#	
Himantopus himantopus	Stilt, Black-Winged	MPB: Protected		x
Anas capensis	Teal, Cape	MPB: Protected		x
Anas erythrorhyncha	Teal, Red billed	MPB: Protected		x
Motacilla capensis	Wagtail, Cape	MPB: Protected		x
Ploceus capensis	Weaver, Cape	MPB: Protected	#	
Euplectes progne	Widowbird, Long-tailed	MPB: Protected	#	
Vidua macroura	Whydah, Pin tailed	MPB: Protected		x
Accipiter melanoleucus	Sparrowhawk, Black	MPB: Protected	#	
Ploceus velatus	Weaver, Masked	MPB: Protected	#	x

Reptiles

No baseline information was available for the species richness or diversity for reptiles in the project area. Further to this, no reptiles were recorded during the surveys for this project. However according to the animal demography unit's virtual museum a total of 40 species have been recorded in this QDS in the past (http://sarca.adu.org.za/). Of these species, one has been assigned a Red Data status, the Giant Girdled Lizard (*Smaug Giganteus*) (NT) and these species are listed in the Fauna and Flora Report (Digby Wells, September 2017). Twelve species in this list are designated as endemic to the Highveld.

Amphibians

According to Carruthers (2001), a number of factors influence the distribution of amphibians, but because amphibians have porous skin they generally prosper in warm and damp habitats. The presence of suitable habitat within the study area should provide a number of different species of amphibians. During the surveys a total of three amphibian species were identified.

Limited baseline data was available from previous reports with regards to amphibians, however the Giant Bullfrog (protected) was identified previously. Amphibians expected to occur on site are listed in the Fauna and Flora Report (Digby Wells, September 2017). (http://sarca.adu.org.za/).

Within the study area, further niche differentiation was encountered by means of geographic location, this differentiation includes, banks of dams, open water, inundated grasses, reed beds, trees, rivers and open ground. Three frog species were previously identified on site during the 2016 survey, namely: the Clicking Stream Frog (*Strongylopus grayii*), Giant Bullfrog *(Pyxicephalus adspersus)* and Common River Frog (*Amietia angolensis*). Only the Clicking Stream Frog (*Strongylopus grayii*) was recorded in 2017. This result is attributed to the timing of the survey.

Invertebrates

Butterflies provide an indication of the habitats available in a specific area (Woodhall 2005). Although many species are eurytropes (able to use a wide range of habitats) and are widespread and common, South Africa has many stenotrope species (species with specific habitat requirements with populations concentrated in a small area) which may be very specialised (Woodhall 2005). Butterflies are useful indicators as they are relatively easy to locate and catch and identify. It is for this reason that Lepidoptera will be used as the primary focus for the invertebrate survey. The Red Data species possibly found on site is the Marsh sylph (*Metisella meninx*). The larval host plant of *Metisella meninx* is rice grass, *Leersia hexandra* (G.A. Henning & Roos 2001). Unlike many other threatened butterfly species in South Africa, no specific association with ant species is present in the early stages of the life cycle of the *Metisella meninx*. The ideal habitat of *Metisella meninx* is treeless marshy areas where *Leersia hexandra* (rice grass) is abundant. Some treeless marshy habitats are present along the major streambeds in the area. There may be suitable habitat for *Metisella meninx* on the site along the water courses and also the small marshes and seasonal water course in open grassland.

5.10 Noise

The intention is to mine the coal reserves by means of the Stooping process. No additional noise levels or impacts will be experienced as this will be a continuation of the current mining with no additional infrastructure.

5.11 Heritage sites

5.11.1 2014 Assessment

Refer to Appendix D for the Heritage Impact Assessment Report. The Heritage Assessment was conducted by Archaetnos in 2012 and a follow up studies were undertaken in 2014 and 2015. Additional Heritage studies were undertaken in 2017 by Digby Wells Environmental, for the consolidation process (Appendix F).

The entire area was already surveyed during 2012. The latest survey served as confirmation of specific areas to be mined as well as the heritage resources found during the previous survey.

Aspects concerning the conservation of cultural resources are dealt with mainly in two acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

According to the National Heritage Resources Act the following is protected as cultural heritage resources:

- Archaeological artifacts, structures and sites older than 100 years
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography
- Objects of decorative and visual arts
- Military objects, structures and sites older than 75 years
- Historical objects, structures and sites older than 60 years
- Proclaimed heritage sites
- Grave yards and graves older than 60 years
- Meteorites and fossils
- Objects, structures and sites or scientific or technological value.

The National Environmental Management Act states that a survey and evaluation of cultural resources must be done in areas where development projects, that will change the face of the environment, will be undertaken. The impact of the development on these resources should be determined and proposals for the mitigation thereof are made.

The evaluation of heritage sites is done by using the following criteria:

- The unique nature of a site
- The integrity of the archaeological deposit
- The wider historic, archaeological and geographic context of the site
- The location of the site in relation to other similar sites or features
- The depth of the archaeological deposit (when it can be determined or is known)
- The preservation condition of the site
- Uniqueness of the site and
- Potential to answer present research questions.

The surveyed area is mostly disturbed due to previous human activities on the site. This includes mainly agricultural activities such as ploughing and the planting of maize and other crops, as well as grazing. Certain areas are covered by grass, which were of different lengths. Some plantation areas (blue gum, poplar, wattle etc.) are also found, in certain cases reasonably inaccessible.

The Matla Power Station dominates the landscape and current mining operations and infrastructure are also to be found nearby.

The fieldwork undertaken during 2012 revealed thirty sites of cultural heritage significance. During the 2014 survey it was found that only fourteen remained within the area to be impacted (the stooping area) (Figure 5.85). An additional site was also identified, making the total number of sites fifteen.

Significant sites included Grave yards, farm houses and outbuildings. It was also noted that this is the main area where the Battle of Bakenlaagte was fought (Personal communication: B. Roux). One however needs to realize that a battle is fought over a large area and that almost the entire mining area may have been part of this particular battle. No photograph was taken as no feature or structure from the battle remains.

For the purpose of this report only the fifteen sites within the stooping area will be discussed. The site numbers from the 2012 report will however be kept in order not to confuse matters. The fourteen remaining sites are 4, 10, 11, 12, 14, 15, 16, 17, 18, 21, 22, 23, 24 and 30. The new site is numbered 31.

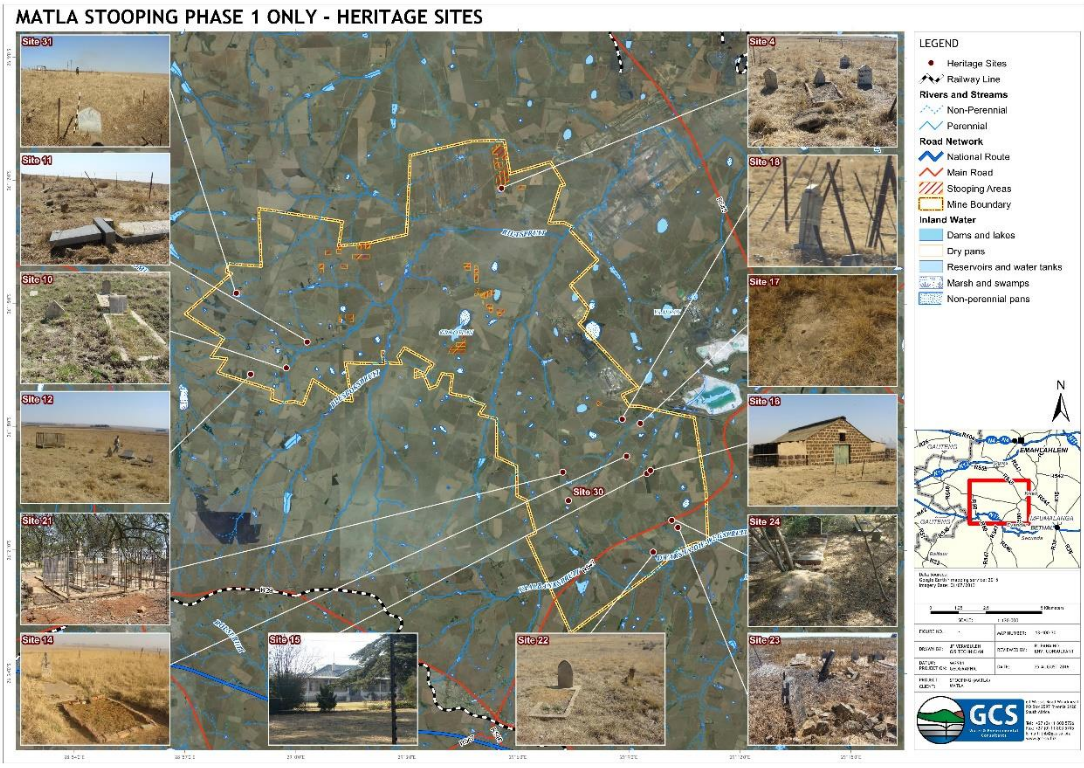

Figure 5.85: Heritage sites associates with the Matla stooping areas

5.11.1.1 Site 4 – grave yard

This is a grave yard consisting of at least 9 graves. The oldest date identified is 1919 and the youngest 1955 (Figure 5.86; Figure 5.87). Various types of graves are evident – cement dressing with cement headstones, granite slabs, heaps of soil, brick borders and some with metal barriers etc. Some of the surnames identified include Mabena, Hlowu and Mloka.

Graves are always given a rating of high cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°12.211'S

28°35.469'E

Usually there are two options when dealing with graves. The first option is to leave the graves *in situ*. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. Should the mine decide it best to go this route, it has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

Figure 5.86: One of the graves at site no. 4.

Figure 5.87: More graves at site no. 4

5.11.1.2 Site 10 – grave yard

This is a grave yard consisting of at least 9 graves (Figure 5.88). The graves all have cement borders and headstones, but some re without headstones.

The oldest date identified is 1922 and the youngest 1985. One surname was identified, being Mahlangu.

Graves are always given a rating of high cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°16.572'S

28°59.740'E

Figure 5.88: Some of the graves at site no. 10.

Usually there are two options when dealing with graves. The first option is to leave the graves *in situ*. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. Usually this option is only allowed if there is a direct impact on the site. Although this area would be an underground mining area, it may collapse resulting in damage to the graves.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.3 Site 11 – grave yard

This is a grave yard consisting of at least 27 graves (**Figure 5.89**). Four types of grave features are visible – stone dressing and headstones, heaps of soil, cement dressing or borders and headstones and granite dressings or borders and headstones.

The oldest date identified is 1951 and the youngest 1990. Some have no dates indicated. The only surname identified is Nkosi.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°15.940'S
29°00.302'E

Figure 5.89: Graves at site no. 11.

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. Although the graves are in an area where underground mining is planned, it may collapse as a result of these activities.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.4 Site 12 – grave yard

This is a graveyard with at least 12 graves (**Figure 5.90**). One of the graves has a steel fence around it. Some have granite headstones, stone headstones or cement headstones and most have cement or stone borders.

The oldest date identified is 1958, but some are without dates. Two surnames that were identified are Mthombe and Kumalo.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°16.727'S
28°58.778'E

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

Figure 5.90: Graves at site no. 12.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. Since the graves may collapse during underground mining activities, this option should be considered.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.5 Site 14 – grave yard

This is a grave yard consisting of at least 15 graves between (**Figure 5.91**). Various types of graves are evident – brick borders, cement dressing with cement headstones etc.

Only one grave has legible information on its headstone. The date of death on this grave is 1991 and the surname is Mputi.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°18.717'S
29°08.931'E

Figure 5.91: Graves at site no. 14.

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. Although the mining will be underground, this may cause the graves to collapse.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.6 Site 15 – Bakenlaagte farm house

Site no. 15 is the farm house on the farm Bakenlaagte, belonging to Mr. JH Jacobs (**Figure 5.92**). The house seems to have been built shortly after the Anglo-Boer War and therefore is older than 100 years. The style is Edwardian.

The building is given a rating of **medium** cultural significance due to it not being very unique and due to it having been changed over the years. It nevertheless is a typical example of farm houses from this era. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°19.137'S
29°09.482'E

The first option would be to re-use the house for instance for offices or something similar. However, any change thereto should be communicated to the Provincial Heritage Resources Agency (PHRA) of Mpumalanga, who will issue the necessary permits in this regard.

The house falls within the underground mining area which may result in it being damaged, for instance if the soil would cave in. Therefore the recommendation is that the house be documented in full so that the information is preserved. Should any damage then occur, the mine may apply for a demolition permit from the Mpumalanga PHRA.

Figure 5.92: The farm house on the farm Bakenlaagte.

5.11.1.7 Site 16 – Bakenlaagte outbuilding

Site no. 16 is an outbuilding on the farm yard of Bakenlaagte, belonging to Mr. JH Jacobs (**Figure 5.93**). It used to be a wagon house and is very likely older than 100 years. Some other outbuildings, which might be slightly younger is also found here.

The building is given a rating of **medium** cultural significance. It is a very good example from this era and still is in a good condition. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°19.062'S
29°09.580'E

The first option would be to re-use the building. However, any change thereto should be communicated to the Provincial Heritage Resources Agency (PHRA) of Mpumalanga, who will issue the necessary permits in this regard.

As the building falls within the underground mining area, it may be damaged during mining activities. For instance, the soil may cave in. Therefore the recommendation is that the house be documented in full so that the information is preserved. Should any damage then occur, the mine may apply for a demolition permit from the Mpumalanga PHRA.

Figure 5.93: Outbuilding (wagon house) named site no. 16

5.11.1.8 Site 17 – grave yard

This is a grave yard consisting of at least 2 graves (**Figure 5.94**). Both are covered with cement slabs. No dates or biographical information are indicated.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°17.915'S
29°09.305'E

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

Figure 5.94: Graves at site no. 17

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. In this case the area will be used for underground mining which may eventually lead to the caving in of the graves.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.9 Site 18 – grave yard

This is a graveyard consisting of at least three graves (**Figure 5.95**). However the vegetation cover is dense and there may be more. The graves have granite headstones and borders.

The date of death on one of the graves is 1891 and on another one 1933. The surnames identified are Oosthuysen and Du Toit.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°17.813'S
29°08.818'E

Figure 5.95: Graves at site no. 18

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. It should be noted that the graves may cave in as a result of it being located on the underground mining area.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.10Site 21 – grave yard

This is a grave yard consisting of 9 graves (**Figure 5.96**). The graves have either cement borders and headstones or granite headstones and borders. Some also have metal fencing around it.

The oldest date identified is 1943 and the youngest 2002. Two surnames were identified, being Van den Berg and Van den Heever.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°19.106'S
29°07.213'E

Figure 5.96: The graves at site no. 21

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. The site lies within the underground mining area. The mining activities may cause the site to cave in.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.11Site 22 – grave yard

This is a grave yard consisting of at least 7 graves (**Figure 5.97**). Some of the graves are stone packed, with or without headstones. Others have cement borders and headstones.

Only one date was identified, being 1938. No biographical information was legible on any of the graves.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

Figure 5.97: One of the graves at site no. 22

GPS: 26°21.050'S
29°09.659'E

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. The site may cave in during mining activities as it is situated in the underground mining area.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.12Site 23 – grave yard

This is a grave yard consisting of at least 41 graves. The graves have different grave dressings – stone packed, cement or granite headstones and borders and some only have a stone headstone (**Figure 5.98**).

The site seem quite recent – the oldest date identified being 1923 and the youngest 1997. However some of the graves does not indicate a date of death. Only one surname was identified being Mgcina, Tholakele, Nkabinde and Mahlangu. Unknown graves, referring to date of death, count 27.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°20.449'S
29°10.323'E

Figure 5.98: Some of the graves at site no. 23.

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. In this case the site is within the underground mining area, which may cave in during mining activities.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.13Site 24 – grave yard

This is a grave yard consisting of at least 9 graves (**Figure 5.99**). The graves have different dressings being granite dressings or borders and headstones, stones with masonry and brick borders with tile dressings.

The oldest date identified is 1915 and the youngest 1952. Three surnames were identified namely Oosterhuis, Van den Berg and Geldenhuys. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves.

GPS: 26°20.274'S

29°10.157'E

Figure 5.99 : Graves at site no. 24.

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. As the graves are inside of the underground mining area, the soil may cave in.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.1.14Site 30 – Battle of Bakenlaagte

This is the main area where the Battle of Bakenlaagte was fought (Personal communication: B. Roux). One however needs to realize that a battle is fought over a large area and that almost the entire mining area may have been part of this particular battle. No photograph was taken as no feature or structure from the battle remains. A map of the battle is however included (**Figure 5.100**).

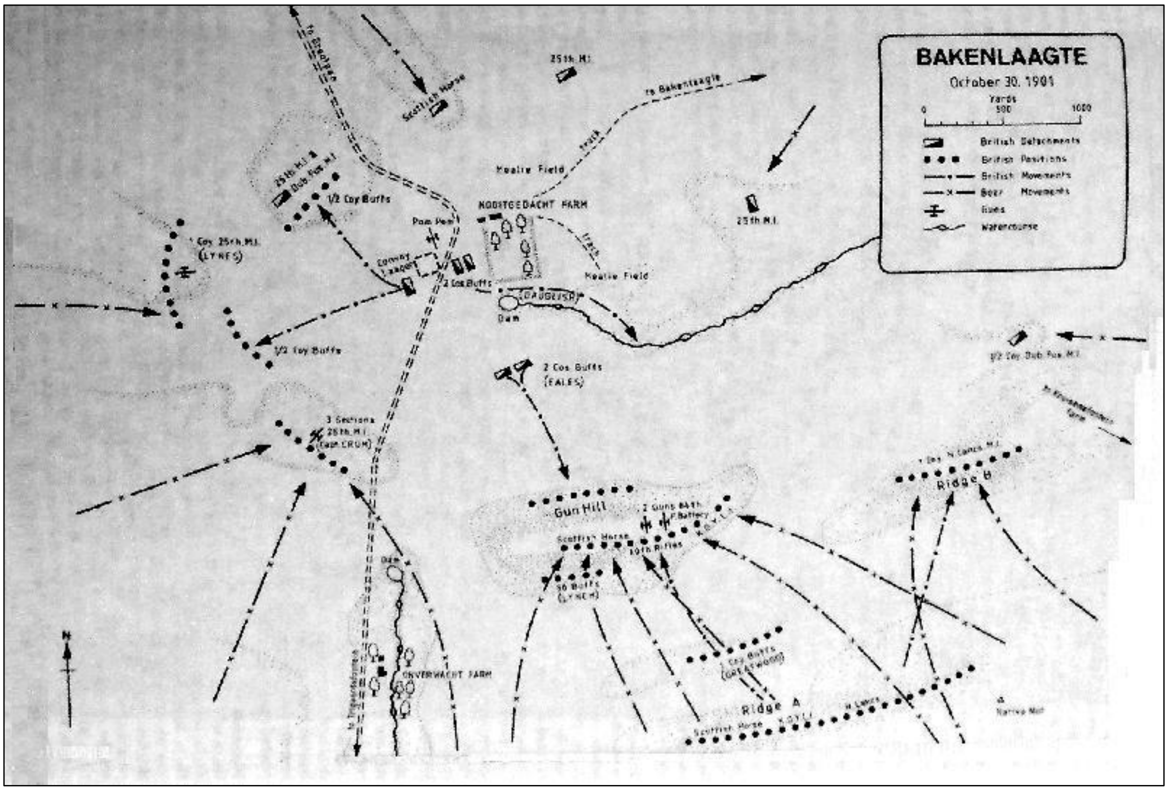

Figure 5.100: Map of the Battle of Bakenlaagte.

As the Anglo-Boer War was an important event in the history of South Africa, the site is given a rating of **high** cultural significance. However the lack of features has to be taken into consideration. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

GPS: 26°19.800'S
29°07.365'E

The site lies right within the underground mining area. However there is no visible evidence of the battle and therefore the site cannot be preserved. The battle can be commemorated via a plaque as close as possible to the site. It is also recommended that, should any artifact related to the battle be unearthed or found during activities on site, an archaeologist should immediately be contacted to investigate the find.

5.11.1.15Site 31 – grave yard

This is a grave yard consisting of at least 17 graves (**Figure 5.101**). The graves have different dressings being cement dressings or borders and headstones or stone packed, with or without headstones. No date or surname could be identified as it was not legible.

Graves are always given a rating of **high** cultural significance due to it being a sensitive matter. Graves with an unknown date are always handled as if older than 60 years. Graves older than 60 years are regarded as heritage graves. It receives a field rating of Local Grade IIIB. It should be included in the heritage register and may be mitigated.

Figure 5.101: Graves at site no. 31

GPS: 26°14.750'S
28°58.393'E

Usually there are two options when dealing with graves. The first option is to leave the graves ***in situ***. This would be possible should there be no direct impact on the graves. However, there always is a secondary impact as descendants may find it difficult to visit the site once mining has commenced. Therefore the site should be fenced in and a management plan should be written for the preservation and maintenance thereof. Such a fence should be erected at least 50 m from the perimeter of the site as blasting closer than that will definitely have a negative impact on the graves.

The Management Plan would detail aspects such as the fence and site management and maintenance. In addition, the plan would provide details on how it will be possible for descendants that might wish to visit the graves, when access will be granted as the mine is compelled to grant access. The fence and site will need to be managed and maintained. The management plan includes inter alia arrangements for security and safety measures. Other measures would include the preservation and maintenance of the site where aspects such as cleaning and upkeep will be dealt with. Such a plan should be written and then monitored annually by an independent heritage specialist.

The plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA). SAHRA has specific guidelines for management plans and these will have to be followed.

The second option is to exhume the graves and have the bodies reburied. This usually is only allowed if there is a direct impact on the site. As the graves are inside of the underground mining area, the soil may cave in.

Such a process has to be motivated to SAHRA and permits needs to be applied for. It is a lengthy process and includes social consultation in accordance with legislation in order to obtain permission from descendants or at least proof that a concerted effort has been made to do such consultation.

Graves younger than 60 years are handled by a registered undertaker. Graves older than 60 years and those of an unknown date is regarded as heritage graves. In such a case an archaeologist is also involved in the process.

In this case, since it will be underground mining, option 1 would be the way to go. However, one will have to be aware of the possible caving in of soil due to the mining activities. Should this be encountered, option 2 will definitely have to be utilized.

5.11.2 2017 update

5.11.2.1 Site-specific geological and paleontological context

The regional study area is primarily underlain by lithologies associated with the Ecca Group within the Karoo Supergroup. Formations within the Ecca Group include:

- The Pietermaritzburg Formation, which rarely forms good outcrops and fossils are rare and difficult to find. This formation is of moderate palaeontological sensitivity;
- The Vryheid Formation, which is the main coal-producing formation in South Africa. This formation has produced a number of fossils, including extensive Glossopteris assemblages. Other fossils reported from this formation include: trace fossils, rare insects, possible conchostracans (bivalve crustaceans and shrimp clams, which are presently still extant), non-marine bivalves and fish scales; and

- The Volksrust Formation: monotonous sequence of grey shale. Fossils are significant but rare and include: temnospondyl amphibian remains, invertebrates and minor coal with plant remains, petrified wood and trace fossils assemblages (Groenewald & Groenewald, 2014).

The site-specific study area is associated with Karoo dolerites and the Vryheid Formation (Rubidge, 2008; Rubidge, 2013a; Rubidge, 2013b). The Karoo dolerites are intrusive diatremes9 classified as plutonic igneous rocks. These features include no fossiliferous material and their palaeo-sensitivity is negligible (Rubidge, 2013a; 2013b; SAHRA, 2013a; 2017). The Karoo dolerite suite is therefore considered no further in this report.

The *Vryheid Formation* has a very-high palaeo-sensitivity (SAHRA, 2013b; 2017) and is the primary potential fossil-bearing layer underlying the site-specific study area. The formation corresponds to the basal unit of the Ecca Group, which was deposited roughly 180 mya in a deltic10 environment. Shales, sandstones, mudstones and coal feature all constitute this formation (Bamford, 2016).

Coal is formed through the compression and heat alteration of plant matter. During the formation of coal, alteration happens to such an extent that potential plant fossil remains are no longer recognisable. The shales between the coal horizons, however, have the potential to preserve very good examples of plant fossils (Bamford, 2014; 2016). To a lesser extent, the sandstone surface outcrops may also preserve fossil plants. Common fossil plants that could be expected within the Vryheid Formation include *Glossopteris* leaves, roots and inflorescences; and *Calamites* stems. These potential plant fossils are illustrated in Figure 5.102. Coal deposits can potentially also include fossils of mammal-like reptiles and mammals. These are however, rarely, if ever, preserved with plant fossils (Bamford, 2012; 2016).

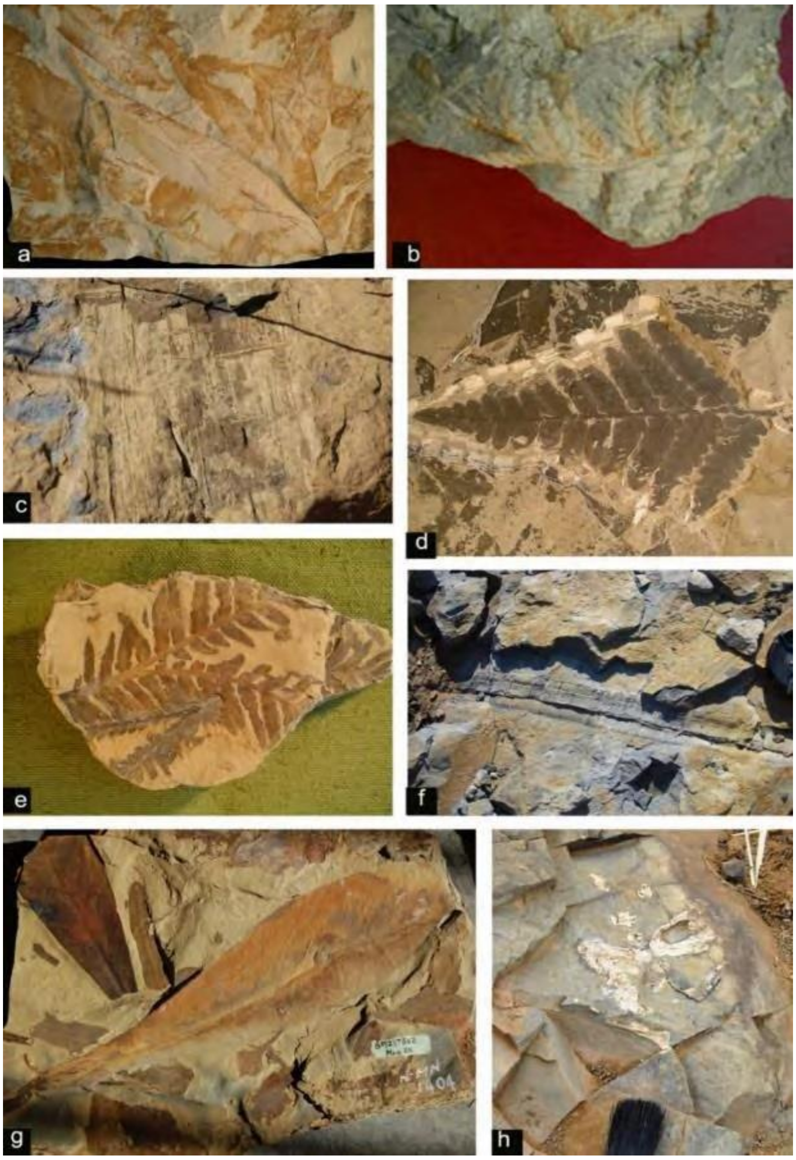

Figure 5.102: Composite of possible Karoo-aged fossil plants that may be identified within the site-specific study area (Bamford, 2016)

5.11.2.2 Site-specific cultural heritage baseline

A Heritage Site Management Plan (HSMP) was developed for a single grave identified within the boundaries of Mine 2.The grave belongs to Helena Booyens (1852-1934). The grave is located on the farm Rietvlei 62 IS Portion 3 (within the ELM area). The HSMP aims to mitigate or avoid negative impacts on the *in situ* grave that may be caused by various mining activities undertaken within Mine 2, most notably potential subsidence caused by the total extraction mining method used at the site.

A survey undertaken by Van Vollenhoven (2012; 2014)11 included areas of development for the Matla Coal Mine project area, across an area of approximately 22 000 ha. The survey identified 31 sites within the Matla MRA, as illustrated in Figure 5.103. These include:

- A Battlefield (1 record);
- Burial Grounds and Graves (26 records); and
- Historical Built Environment sites (4 records).

Burial grounds were most commonly recorded heritage resource within the site specific study area, accounting for 83.9% of all sites. In terms of sites representing the historical built environment, structural complexes (i.e. *werwe*) are the most common. No Stone Age accumulations have been recorded in the Matla MRA to date.

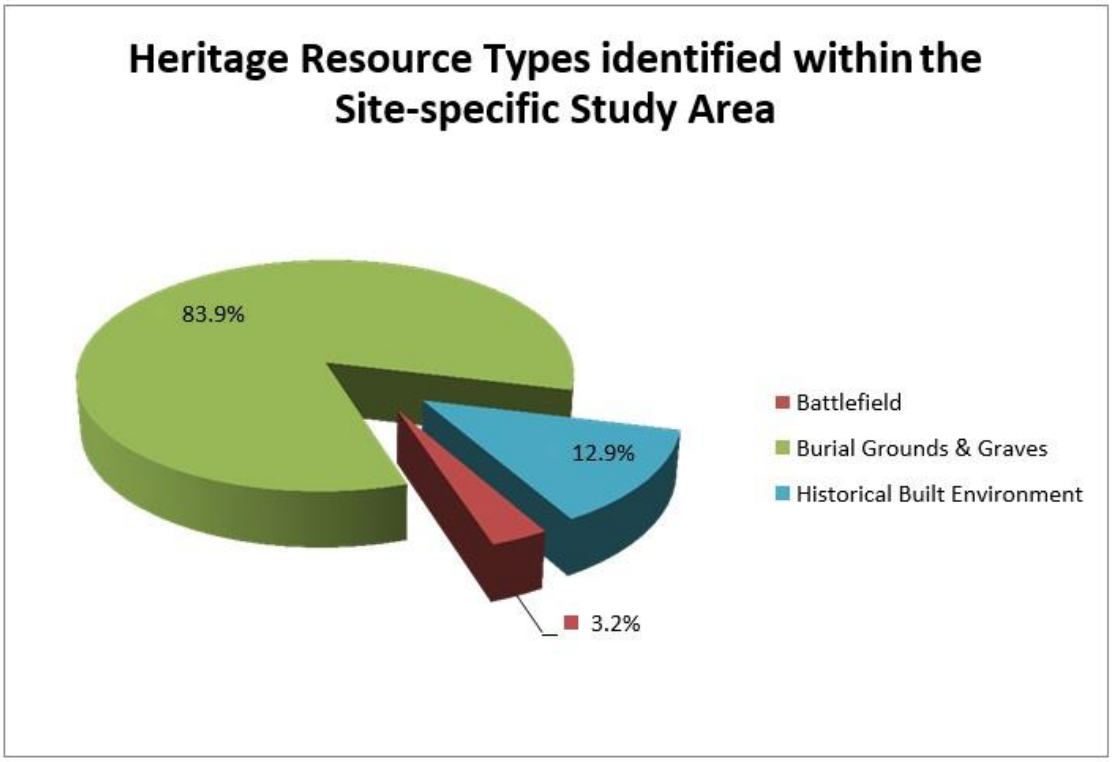

Figure 5.103: Heritage resource types previously identified within the Matla MRA

The battlefield identified by Van Vollenhoven relates to the Battle of Bakenlaagte. The Battle of Bakenlaagte was the climax to a series of events and occurred within 20 km of the sitespecific study area.

Lieutenant Colonel George Benson's No. 3 Flying Column moved from the farm Syferfontein, marching north-west to the Bakenlaagte farmstead, where they intended to camp. The advance guard reached the farmstead and set up the camp, but by midday, the rear-guard had been hampered by unfavourable weather and were still some distance away from the farm. General Botha of the Boer commando and his 800 reinforcements planned to attack Benson's Column and this division of the force provided the Boers with an advantage. Outnumbered four to one, the Boers decimated the rear-guard in a gun battle that lasted just 20 minutes; but the attack did allow the main column to deploy and set up a defensive perimeter. This perimeter prevented the Boers from capturing the main column as they had envisaged and the Boers left with what spoils they could. The British transported their 134 wounded to the entrenched camp during the night (Pakenham, 1979; Willsworth, 2006; Wessels, 2010; von der Heyde, 2013). British losses included at least 66 dead, 120 were taken prisoner and the loss of two British guns. Boer casualties included at least 52 who were killed or wounded (Wessels, 2010). Figure 5.104 presents a plan of the battle.

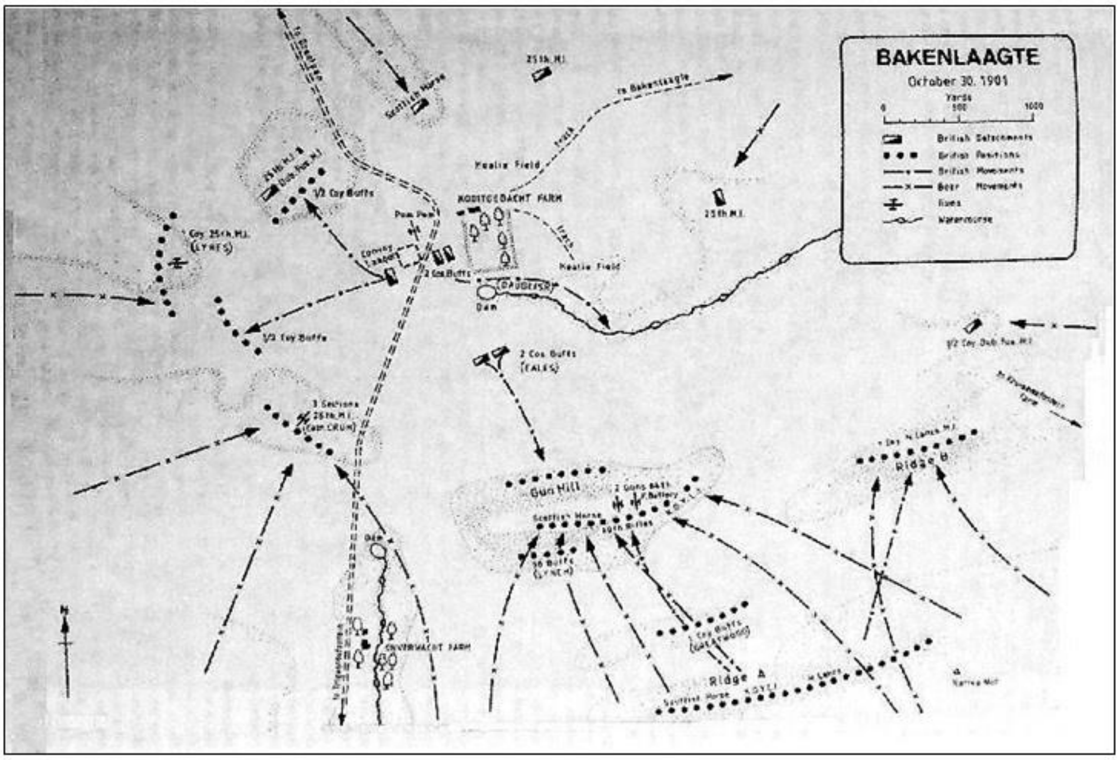

Figure 5.104: Plan of the Battle of Bakenlaagte (Price, 1992)

5.11.2.3 Results of field survey

Table 5.59 lists the heritage resources that were identified during the pre-disturbance survey undertaken during November and December 2017. A full list of all the relevant heritage resources identified within the site-specific study area through these and previous surveys is included in Appendix C of the Heritage Impact Assessment Report (Digby Wells, January 2018). Figure 5.105 provides some examples of the types of heritage identified in the survey.

Table 5.59: Heritage Resources identified through the pre-disturbance surveys

Site Name	Latitude	Longitude	Description
11829/BGG-001	-26.2093260	29.1011310	3 potential unmarked graves (piles of soil and brick, covered in vegetation) near occupied houses and a rubbish heap.
11829/BGG-002	-26.2100440	29.0501820	Burial ground with 24 visible graves demarcated by a wire fence with a gate. Graves have cement headstones with and without cement fittings and granite headstones and fittings. Surnames identified include: Mahlangu, Radebe, and Mtshweni and what may be Skozana and legible dates ranged from 1952-2001. Large exotic plants growing in graveyard. Some headstones have fallen over
11829/BGG-003	-26.2110090	29.0502720	Burial ground within sight of BGG-002; also demarcated by a fence and with large exotic plants (overgrown). Three graves are visible, but it is likely that there are more (overgrown and lots of space in the fenced off area). No writing was legible on the headstones (cement). Not as well maintained as BGG-002
11829/BGG-004	-26.2103670	29.0544550	Single grave, which is the focus of the Digby Wells HSMP compiled for Exxaro Matla (Du Piesanie, 2017a).
11829/BGG-005	-26.2288440	29.0502230	Single grave with a cement headstone which has been weathered slightly and is difficult to read, but may read: GAMEISISBAN and 1994. The grave is within a maize field and a small buffer has been left uncultivated around it.
11829/BGG-006	-26.2575190	29.0399710	Burial ground with two graves, one of which is a double-grave with a granite headstone and fittings belonging to the Marthinus family. Both interred passed away on the same day in 1952. The single grave has a marble headstone, with the surname Meyer and dates to 1927. The graves used to be enclosed by a wire fence, which has since fallen away. [102/Site 7: reported only the Meyer surname].

Site Name	Latitude	Longitude	Description
11829/BGG-007	-26.2536389	29.0420556	Burial ground surrounded by a wire fence including 16 visible graves and potentially four more (which may be marked by metal plates/boards within enclosed area). Cement headstones with or without fittings and granite headstones. The graveyard is fairly overgrown, although some graves have been cleared. Identified surnames include: Mathebe, Shoba, Kabini, Tshoba, Mahlangu and Ntuli. Dates range from 1962-1981, although many are illegible. One grave may potentially be a double grave. [102/Site 6: grave includes at least 28 graves and oldest date is 1965]
11829/BGG-008	-26.3185820	29.1201800	Burial ground with 9 visible graves, two of which are double graves. Both double graves belong to the Van den Berg family (1943 and possibly 1953) (1913 and 1932). The graveyard is surrounded by a wire fence and (open) gate. Another double grave belongs to the Van der Heever family (2002) and is the only grave not belonging to the Van den Berg family. Dates range from 1913 to 2002. All headstones are marble or granite and some are very ornate. [102/Site 21: oldest date is 1943, not 1913].
11829/BGG-009	-26.3379470	29.1692540	Graveyard including 9 graves with marble and cement headstones and fittings. 1 headstone was damaged by a fallen tree and may potentially be a double grave. Surnames identified include: Geldenhuys, Van Wyk, Van den Berg and Oosterhius and dates range from 1915 and 1952. The graveyard was demarcated by a wire fence with a gate, which has since fallen away.
11829/BGG-010	-26.3192890	29.1216430	Single burial with a cement headstone and brick dressing and two more burials surrounded by brick and soil. The writing on the cement headstone is barely legible and appears to date to either 1912 or 1942. The graves are not demarcated or fenced off and are between a fence-line and a farm-road. One of the unmarked graves has been disturbed by erosion (or the soil has been replaced over the grave). Visible from BGG-011.
11829/BGG-011	-26.3192620	29.1219400	Appears to be a grave of heaped soil and brick/stone with no headstone in a void within a maize field. Visible from BGG-010.

Site Name	Latitude	Longitude	Description
11829/BGG-012	-26.2788470	28.9795010	Graveyard with six visible graves and two more potential headstones and one potential unmarked grave. Graves have granite headstones and fittings, cement headstones and fittings or just cement headstones. One grave was surrounded by a metal fence with a locked gate. Visible inscriptions included the surnames Kumalo and Mthombe and dates: 1958 and 1972. [102/Site 12: graveyard of at least 12 graves].
11829/BGG-013	-26.3589180	29.1239570	Two graves on the side of a (overgrown) farm road, not demarcated or surrounded by a fence. Both gravestones (and fittings) are made of cement. One headstone was not inscribed, but included an epitaph written using metal wire. The headstone was damaged and so the epitaph was only partially legible but looks to date to 1964. Small coloured marbles/rounded glass were added to the headstone and corners of the cement fittings. The other headstone was not legible. The area was very overgrown and could potentially include more graves.
11829/BGG-014	-26.2089940	29.0996840	Graveyard with 7 visible graves and another 3 possible graves (although there could potentially be more as the area is very overgrown). Not surrounded by a fence. The graves include: cement headstones, with or without cement or brick fittings and granite headstones and fittings. Inscriptions include: Ncema (or Ngema), Mashiane, and Defries and dates range from 1979-1987, although not all dates were legible. 3 graves were protected by wire fencing, which has since fallen away.
11829/BGG-015	-26.2753690	29.0962890	Single (double) grave belonging to the Robertson family ('*vader*' and '*moeder*' – father and mother in German or Afrikaans). Dates to 1958 and 1973. Headstone and fittings are marble and the grave is protected by a strong fence.

Site Name	Latitude	Longitude	Description
11829/BGG-016	-26.3101890	29.1099680	Burial ground with two sections - one fenced and one section unfenced. The graveyard includes a total of approximately 155 identified graves (51 in the unfenced section and 104 in the fenced section) as well as 16 additional potential graves (7 unfenced and 9 fenced). These potential graves include areas which have been fenced off (double or single graves) with no headstone or visible signs of burial. A tree has fallen over in the unfenced section which could be obscuring more potential graves. Graves are marked by cement headstones with or without cement or brick fittings, granite headstones and fittings, a stone/brick headstone only or with a metal cross and heaps of stone and soil. Many headstones have fallen over. Includes child graves. Surnames identified outside the fenced-off area include: Sebande (and Sibande), Tholo, Dube, Masuku, Kuken and Mbonani. Dates range from 1963 to 1989, although many are not legible. Within the fencing, graves were marked by granite headstones with granite or cement fixings, cement headstones with or without cement fixings, cement headstones with cement slabs, stone/brick headstones or heaps of stone or brick and soil. Surnames identified here include: Mahlangu, Motau, Mthombeni, Sithole, Masimula, Dlamini and Mthimunye. Dates range from 1920 to 2004. The Mthimunye (1969) grave was at a 90 degree angle to the other graves.
11829/BGG-017	-26.2340550	29.1031980	Graveyard of 9 visible graves, potentially with one more grave (although the site is overgrown and there may be more graves). The site is at the intersection of some fences but is not bounded by fences. Graves are marked by cement headstones with cement slabs or cement or brick fittings, or a stone headstone (marker). Only one surname (Dinamsweni) was legible; no dates were legible. Some headstones have fallen over.

Site Name	Latitude	Longitude	Description
11829/BGG-018	-26.2939800	29.1510740	Graveyard of 13 graves and one potential additional grave. The graves are marked by cement headstones and fittings, granite headstones and fittings and a metal marker with brick fittings. There is potentially one burial marked with a heap of soil and brick/stone. Two surnames were identified: Sibiya (or Sibija) and Tsale. Dates range from 1924 to 1979. Includes child burials. The graveyard was demarcated with a fence, which has since fallen away.
11829/BGG-019	-26.2969650	29.1469700	Three graves bounded by a fence which is starting to rust away, in the middle of a field. The vegetation is very overgrown. The only name and date legible was that of Du Toit (1891). [102/Site 18: noted Oosthuysen and 1933]. All three headstones are cement, with cement fittings.
11829/LFC-001	-26.2721610	28.9658610	Pile of stone that suggests it is collapsed stone walling near a maize field.
11829/STE-001	-26.2594680	29.0400160	Very close to WF-001 (and therefore a historical layering point). Two small structures (one may be a pump house, the other is not known) remain inside an elaborate gate with the remains of an intercom system. Some building rubble. Age unknown
11829/STE-002	-26.3385570	29.1680250	Small building with the roof missing. The structure includes two rooms (with no communication between), two doors leading outside and one window with metal bars (no glass). There is some collapse of the outer walls. 4 concrete pillars (with some wire remaining) surround the structure.
11829/STE-003	-26.3384220	29.1673210	Large stone structure with no roof and some collapse. Structure includes four 'rooms' (including a 'courtyard') with several doorways/entrances and one room has three windows (no other rooms have windows). Two of the rooms have long concrete slabs with several metal rings embedded in the concrete and three metal rings were embedded in the wall of the courtyard at different heights. A brick ramp-type inclined structure is nearby, between this structure and STE-002. A small structure in a state of disrepair was constructed of the same, or similar, material and so may be associated as well. Near a historical layering waypoint.

Site Name	Latitude	Longitude	Description
11829/STE-004	-26.3383960	29.1668440	Two buildings in a state of disrepair. Both structures are missing their roofs and have some wall collapse. Some corrugated iron lean-tos/informal structures have been attached to the outer walls of the larger building, which is used for storing refuse. The larger structure has an electrical box and so may be recent. Near a historical layering waypoint (same as STE-003).
11829/STE-005	-26.2773200	28.9821190	Foundations of a long and narrow rectangular structure very near to WF-005 (may be associated). The structure is made of stone and cement, with some metal pieces and metal rings embedded in the cement. Four short walls remain in a small square and there are five visible post holes around the one wall of this small square.
11829/STE-006	-26.3191790	29.1580380	Bakenlaagte farmhouse (belonging to and occupied by Mr. JH Jacobs and his family). Mr. Jacobs confirmed the farmhouse was approximately 100 years old, having been built shortly after the South African War.
11829/STE-007	-26.3134030	29.1075050	Remains of a one-roomed structure with the roof missing and two walls collapsed.
11829/WF-001	-26.2589990	29.0399710	Remains of a farmhouse and associated outbuildings (milking shed/barn, troughs, another building and two possible reservoirs). The house is in good condition with some windows with glass still in them and others which have been broken. The doors all appear to have been plastered up. Surrounded by wire fence and (locked) gate. Age unknown, but close to historical layering point and so may be older than 60 years.
11829/WF-002	-26.2633650	29.0394640	Farmhouse and associated outbuildings. The farmhouse is in the process of being demolished and looks to be raided for bricks. An abandoned caravan parked behind the building suggests the structure was recently abandoned. Water tanks, outbuildings and a gate remain, marked with caution tape.
11829/WF-003	-26.3194760	29.1192060	Remains of a farmhouse with a pump house and water pump nearby. The farmhouse is still standing and is in fairly good condition, and still has its roof. There is some building rubble in the "yard". Some windows of the farmhouse are covered with corrugated iron.

Site Name	Latitude	Longitude	Description
11829/WF-004	-26.2764570	28.9815780	Abandoned farmhouse/barn with outbuildings, including another structure, remains of what appears to be 4 brick pillars and 4 silos. The ages of the buildings are unknown, but '1949' is written into the cement of one of the silos. There are rubbish heaps over the site and the silos are also being used as refuse storage. The additional structure is a four-roomed structure with a chimney and "Room 1" written above the lintel. Both structures still have their roofs and show no collapse. Two small brick squares occur between the structure and the silos.
11829/WF-005	-26.2433620	29.0023610	Farmhouse near to historical layering waypoint that is currently occupied. The farmhouse was therefore observed from a distance but appears to be in a good condition (roof and walls intact, some windows covered with corrugated metal). Another structure lies in ruins near the farmhouse and there appears to be a pump house as well.
11829/WF-006	-26.3176240	29.1598700	Outbuildings (including a wagon house and what may have been a pig sty) associated with the Bakenlaagte farmhouse, although Mr. Jacobs did not know the age of the buildings (younger than the farmhouse). The outbuildings are historical (the wagon house matches historical layering). The wagon house and the piggery are in good condition; there are some small structures that are also in good condition but are being used for refuse storage (intended function unknown). There is also a water pump and silo.

Figure 5.105: Examples of identified heritage resources

6 PUBLIC PARTICIPATION PROCESS

6.1 Purpose of Public Participation

6.1.1 Legal Requirements

The Public Participation Process (PPP) forms an integral part of the environmental authorization application in terms of the following legislative processes:

- MPRDA: Section 48 (f) and 49(f) respectively of the MPRDA regulation R527, published in terms of Section 107(1) of the MPRDA Government Gazette No. 26275, dated 23 April 2004;
- NEMA: Chapter 6, GN R982, Government Gazette No. 38282 dated 4 December 2014 (as amended); and
- NWA: Section 41 (4) of the NWA and Regulation 17 to 19 of GN R267, Government Gazette No. 40713 dated 24 March 2017.

Due to the legislative requirements listed above, the PPP has been integrated as far as possible to present all environmental authorization application processes to I&APs.

6.2 Identification of Interested and Affected Parties (I&APs)

The following stakeholder groups were identified and informed of the project:

- Landowners;
- Lawful occupiers of land;
- Relevant authorities;
- Utilities; and
- Members of the public within the Kriel area.

The stakeholder database for Matla is provided in Appendix C of this report.

6.2.1 Landowner Consultation

Landowners were consulted in the following manner:

- Written communication sent via email, and fax;
- Scoping Phase Public Meeting held on Thursday, 9 November 2017 at the Kriel Golf club.
- EIA phase Public meeting to be held on 16 August 2018 at the Kriel Golf club.

See Figure 6.1 for surrounding and neighbouring land owners

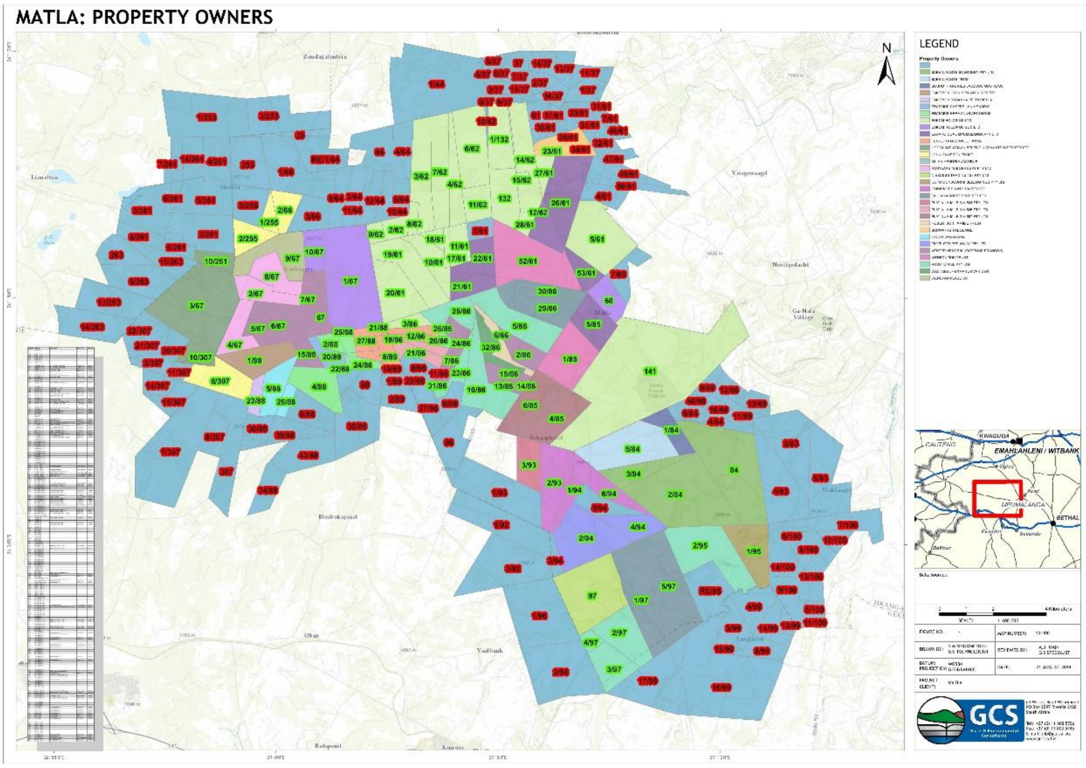

Figure 6.1: Matla MRA and surrounding landowners

6.2.2 List of Authorities Consulted

The following authorities were informed, in writing, of the project application processes being undertaken and provided with documents for review:

- Department of Minerals and Resources (DMR);
- Department of Water and Sanitation (DWS);
- South African Heritage Resources Agency (SAHRA);
- Mpumalanga Tourism and Parks Agency (MTPA);
- Department of Agriculture, Forestry and Fisheries (DAFF);
- Department of Roads, Transport and Public Works (DRTPW); and
- Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA).

These authorities were automatically registered as I&APs on the stakeholder database developed for the project.

6.3 Notification of Stakeholders

Various methods of written notification were utilized to inform the I&APs. These are discussed in the sections that follow. The process undertaken thus far is described in this section of the report and proof thereof is included in the Stakeholder Engagement Report attached herewith as Appendix C.

The notification letter, site notice, advertisement and the BID documents which were used to notify stakeholders and the public of the project contained the following information:

- The geographic location of the project;
- The name of the applicant;
- The reference number for the environmental authorization application which were issued by the DMR;
- The applications being undertaken in terms of the MPRDA, NEMA and NWA;
- The listed activities being applied for in terms of the NEMA regulations and listed activities in terms of the NWA;
- An invitation to register as an I&AP;
- The contact details for registration; and
- Notification that a public meeting will be held to present the project (as part of the NEMA and NWA).

6.3.1 Site Notices

Site notices were placed at six (6) locations around the proposed project area. The locations can be seen on Figure 6.2. A copy of the site notices is included in the proof of public participation document included as Appendix I.

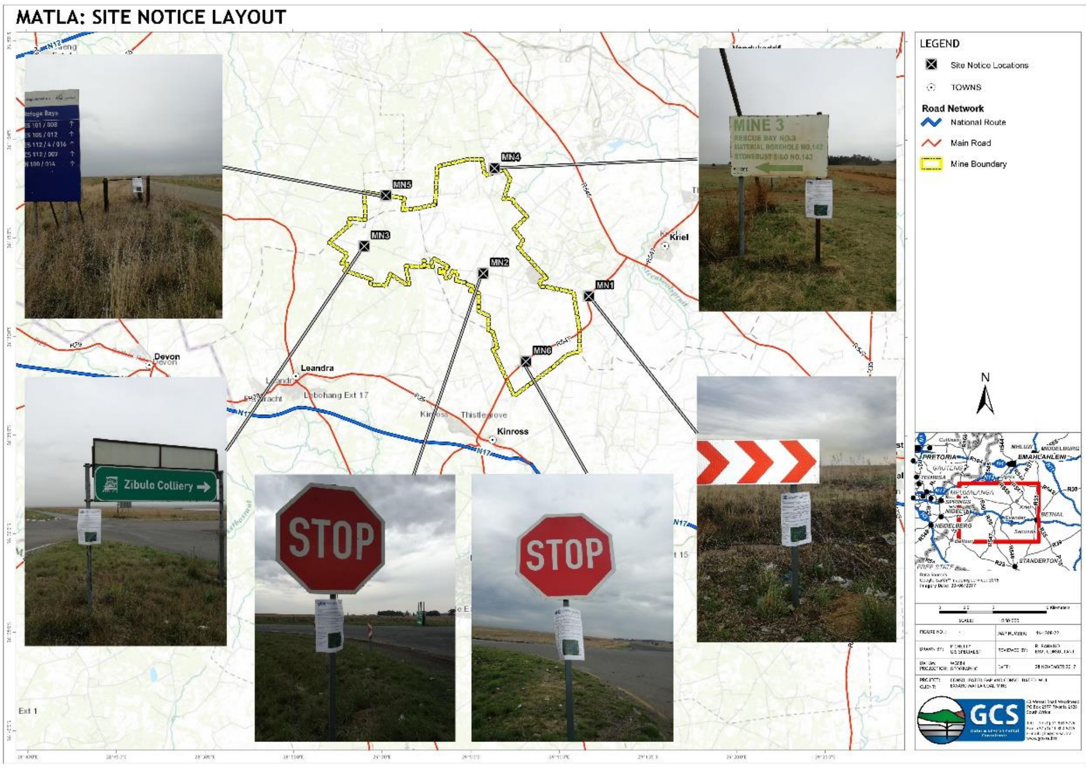

Figure 6.2: Site Notices Map

6.3.2 Media Advertisement

Advertisements, according to Regulation 41 of NEMA regarding the project background, the assessment process being followed, the availability of the draft Scoping Report (DSR) for public comment and a public meeting were placed on 27 October 2017 in both the Witbank News and the Ridge Times. Proof of Advertisements can be seen in Appendix C.

Advertisements, according to Regulation 17 of GN R267 of the NWA regarding the project background, the assessment process being followed, the availability of the draft IWULA/IWWMP report for public comment were placed on 29 June 2018 in both the Witbank News and the Ridge Times. Proof of Advertisements can be seen in Appendix C.

The draft EIA/EMP reports will be advertised in the same papers and proof thereof included in the final EIA/EMP.

6.3.3 Background Information Documents

Background Information Documents (BIDs) were distributed via email and fax to the following people listed on the Matla stakeholder database:

- Landowners of the properties within the proposed Project Area;
- Local, provincial and national authorities;
- All I&APs who contacted GCS following the placement of the advertisements, and
- BIDs (including registration forms) were placed on the table at the Public Meeting.

6.3.4 SMS and Email Notification

The existing database was notified via SMS an Email notifications prior to meetings. Further notifications was sent whenever documentation was placed on the GCS website for public review. Proof of notification can be viewed in Appendix C

6.4 Public Meetings

6.4.1 Introductory and Scoping Phase Public Meeting

A public Meeting was held on Thursday, 9 November 2017 at the Kriel Golf Club in Kriel. Minutes and an attendance register were taken and are presented in Appendix CAppendix I.

6.4.2 EIA/EMP phase

During the draft EIA/EMP phase, a Public Open Day and Meeting will be held on Thursday 16 August 2018. Minutes and an attendance register will be taken.

6.4.3 Authorities Consultation Meetings

Meetings were held with the competent Authorities (DWS – 23 November 2016 and DMR – 6 December 2016) prior to submission of the application form, in order to confirm the listed activities for stooping and process going forward with regards to the consolidation of the EMPs and the IWULs. Another meeting will be scheduled by the time of submission of the final EIA/EMP.

6.5 Stakeholder Database

The existing Database for the Matla mine was updated for the proposed development. The database contains the contact details of the landowners, local, provincial and national authorities as well as all people who requested registration. This is included in Appendix C.

6.6 Issues and Response

6.6.1 Issues raised by the public

Issues and concerns raised to date have been recorded and included in the Issues and Response document. These issues can be seen in Table 6.1.

6.6.2 Issues raised by the commenting Authorities

Any issues received from Commenting Authorities will be recorded and presented as the process progresses.

6.7 Document Review

The Draft Reports of the ESR was made available for public review on the GCS website for the period 26 October 2017 to 27 November 2017. The draft IWULA/IWWMP was made available for Public review on the GCS website and at the Kriel Library from 29 June 2018 until 28 August 2018. SMS, fax and email notification was sent to the stakeholders to notify them of the documents available for review.

The EIA/EMP will be placed in public domain for public review and comments from 27 July 2018 until 27 August 2018

Table 6.1: Issues and Response

No	Comment Raised	By Whom	Where and Date	Response by EAP
1	Would like to offer medical services to the mine	Sue Naidoo	telephomically 07/11/2017	Contact person at mine's details were sent.
2	Eskom is not a commenting authority rather an interested and affected party. Please change this on the front page of the scooping report. • On the second page the subject line states " Scooping report for listed activities associated with Mining Right and/or Bulk sampling activities including trenching in cases of Alluvial Diamond Prospecting" Is this not supposed to be for coal mining instead of diamond?	Shumani Mavhungu	Email, 14/11/2017	Comment noted, and the EAP also informed the IAP that the template was a standard template used, and therefore the title on the Page.
3	Questioned how the condition of the groundwater will change, and will there be any seepage of polluted water. He also stated that they have problems with boreholes drying up with the mining taking place.	Dirk Grobler	Scoping public meeitng, 09/11/2017	Explained that the groundwater study will look at what the current status of the groundwater is. She stated that after mining, the groundwater should return to normal levels and that the groundwater study will also look at how long it will take for the groundwater to return to the normal groundwater level. She stated further that the specialist will be able to tell how far the pollution plume will migrate, if any, and how long this will take to reach a steady state after mining. Also, she mentioned that Matla is undertaking groundwater monitoring which is usually done quarterly as a minimum. The data recorded from the monitoring will be included in the reports and made available to you so that you can see what the trends were for the past 4 years. Further she stated that with stooping there will not be an increased discharge or abstraction from the mine and that it is just a continuation of what is currently happening.
4	Queried the location of the new shaft.	A. Boshoff	Scoping public meeitng, 09/11/2017	Stated that it will be in the South-East area of the mine (pointing it out on the screen)
5	Wanted to know when the shaft will be built	A. Boshoff	Scoping public meeitng, 09/11/2017	They wanted to start building the shaft 5 years ago, but it will cost R 1.8 billion to establish the shaft and all other infrastructure. SB said that they are in a captive agreement with Eskom, so they are waiting for Eskom to provide the funding for the shaft's construction. He stated that Eskom has already approved it, but it is delayed because the Minister of Public Enterprises still has to approve it. He concluded that they will start with construction of the shaft when the money is there, but they don't know when that will be.
6	Raised his concern about where the people are going to live during the construction of the shaft and how they will get to work, because he is worried that the construction workers will trespass or settle on his property during the construction phase of the shaft.	A. Boshoff	Scoping public meeitng, 09/11/2017	Explained that before construction starts, there will be a site establishment the area will be fenced and guarded by security. There will be strict access control.
7	Stated that she is concerned about where the workers, during the shaft's construction, will live, and that she is worried they will build houses nearby and then trespass on her property and also dump garbage on her property. She also wanted to know if there is going to be a noise impact study because they already have a problem with noise.	N. Boshoff	Scoping public meeitng, 09/11/2017	Explained that with regards to noise pollution, the application for the new shaft was already done and was completed, so we are just consolidating everything in one document. Thus, the noise impact was already assessed and we are just putting together all the studies into one document. She stated further that in terms of the stooping, we have not included noise studies because this activity takes place underground. RJvR: Responded by stating that Matla will have to appoint an ECO (whether internal or external) to manage construction. In terms of the original Environmental Management Plan (EMP) that was done there would be certain activities identified to be undertaken during construction phase. There would be demarcation of the area, then land clearance and after that the construction will start. So the ECO has a legal duty in terms of the National Environmental Management Act (NEMA) to make sure that all of those issues and the decisions made and agreed to within that construction plan is implemented on site. She explained that one of their responsibilities is exactly one of your concerns around where people are staying. It is up to the ECO to determine that people are not staying on the neighbouring farms without permission. The ECO has to do monthly audits through to the Department when they are doing the construction, and this is in terms of NEMA and the Mineral and Petroleum Resources Development Act (MPRDA), both being managed by the Department of Mineral Resources (DMR). It is important to understand who the ECO is at the time of construction, and that that person has to communicate with every person in the area that is affected. The ECO has to be on site every day during the time of construction which is usually a 12 month to a 2 year process. You as the public would then report any issues to that person and he/she will

No	Comment Raised	By Whom	Where and Date	Response by EAP
				then report on the issues to the department. Usually noise monitoring will be more from a health and safety perspective, but it also includes some of the environmental acoustic noise. She said that she hasn't seen that EMP, however she would assume there will be some noise monitoring that would take place.
8	Sated that she doesn't see any rehabilitation being undertaken. She complained about dust from the ash dumps when there are strong winds, which is so bad that she can't see where she is driving. She stated that she would like to know how the rehabilitation will take place.	N. Boshoff	Scoping public meeitng, 09/11/2017	Responded by stating that the consolidation report addresses all of the impacts currently on site in terms of all the activities. So it would look at the rehabilitation of the water treatment plant, it would look at the rehabilitation of the entire plant area. She explained further that the consolidation is trying to take all of the bits and pieces from the various authorisations and putting them into one document so that it makes it easier for the mine to manage their commitments. The mine has multiple rights, so to audit each one separately they easily start losing track of what's going on. The whole aim of what we are doing is to bring that into one process so that the mine has a better understanding of what the requirements are of them, and better controls can be put into place to be able to manage it. In terms of the rehabilitation, it is a long term process. Rehabilitation on average is up to 3 years depending on what you rehabilitate. The problem with the ash dumps are something that should be taken up with Eskom as it is on their properties. From Matla's perspective, through doing this consolidation, they will be able to put in a monitoring plan for the entire site. Matla does monitoring already, it's now just a matter of streamlining it and making sure that everything is addressed. Legally the new requirements under NEMA requires an annual or 2 year audit depending on what the department says of the entire mining right area, in terms of that EMP. Those audits now need to be released to the public. You will have the same information at hand as what Matla does. You will be able to see where the issues lie, and you have the opportunity to hold them accountable to that. Changes in legislation in the last 2 years have empowered the I&AP's. The new EMP will fall under that process.
9	Stated that he is concerned about people walking over his land. He also queried how the shaft is going to be constructed? Will there be any blasting because his house is quite old.	A. Boshoff	Scoping public meeitng, 09/11/2017	Stated that it is an incline shaft that will be developed, so essentially you will dig until you find solid ground using normal excavators and then once you get to solid ground there will be blasting taking place but it will go underground. So with the blasting there will be the necessary monitoring equipment to monitor the blasting underground and the air blast. There are two things that might impact on infrastructure, the air blast and the vibration, and both those two things will be monitored.
10	Wanted to know if the land is currently vacant where the blasting is going to take place and are there any people residing nearby and is there a plan if the blasting will indeed affect those people?	Thozamile Ndaba	Scoping public meeitng, 09/11/2017	there aren't any people living in the vicinity of those areas to their knowledge. He also stated that it is Eskom property and they have a land manager that manages leases on all properties and they have given Matla the go-ahead to those areas. He concluded that if there are indeed relocation, it would be on Eskom's side, as they are the land-owner. Indicated on the screen that all the stooping areas will be underground, and that those pillars will be excavated and not blasted. She stated that there won't be blasting for mining and that blasting will only be for the new shaft. Explained that the stooping areas were chosen in areas where it will not affect surface infrastructure, or communities. It will also not be directly under rivers and streams.
11	Wanted to know about the remaining areas and if they will also be subject to stooping	Dirk Grobler	Scoping public meeitng, 09/11/2017	Explained that the mine is very old, and that it started in 1978. He stated that since stooping is a very technical mining method, you cannot go back to old areas. It is an extensive process where they would first assess the stability before certain pillars can be stooped. If you stoop old pillars, it may pose a safety risk to the workers.
12	Wanted to know how she can give her comments to be included in the document.		Scoping public meeitng, 09/11/2017	Answered that if she received the invitation via sms, then she can reply with her comments on the sms and we will receive it, and then include the comments in the comments register.
13	asked if the mine will appoint local people to construct the new shaft, and how will the local people know about it.	Thozamile Ndaba	Scoping public meeitng, 09/11/2017	answered that it does form part of the mine's Social and Labour Plan (SLP), to first look at employing local people and making use of local small business' to contract for work.

No	Comment Raised	By Whom	Where and Date	Response by EAP
				It is the mine's responsibility to identify all the possible candidates within the local community before appointing anyone. There will be some type of forum where people will be able to apply for jobs, and the mine will also have the database from this Public Participation Process to work from.
14	requested that GCS run through the presentation with her as she arrived late. stated that her property was Grootpan, Portion 86 and that she ran a guest house on the property called "Pa se Huis", and that she was concerned that any stooping operations would result in significant amounts of water referring to her property as she was at the lowest point in the area and she had previously been told by a consultant that any activities near her property would result in her property being flooded. ERW was concerned that any activities would result in a concentration of water at the low point of her property which would result in flooding. RJvR said that she would request the appointed specialists to consider this statement and address any such issues in their reports. Stated that a representative, Faith, from another mining company, Blue Nightingale, had approached her as the identified owner of Haasfontein, portion 6, stating that they had been awarded a Mining Right (MR) over the property. ERW stated that she was not the owner of Haasfontein portion 6, but in fact of Grootpan portion 86. ERW queried with the representative of the mining company how a MR had been approved if Matla had a MR over the area, and the representative replied that it was because they were going to be mining a different coal seam. ERW stated that the same representative indicated sometime thereafter that the process had been placed on hold until further notice. ERW provided RJvR with the contact details of the representative in order for GCS to request copies of the specialist assessments undertaken by them.	E. Robertson-Walker	Scoping public meeitng, 09/11/2017	GCS thanked her for the information provided and said that GCS would investigate the situation further.
	IWU:LA			
16	I wish to be registered as a concerned party since this will have a serious impact on the upper Oliphant's River catchment area. This stream feeds Klipfontein, Rietspruit and Witbank Dams and flows through my farm.	Paul Le Roux	Email, 02/07/2018	Paul was registered and comment added to the IRR
17	Coal Air Pollution Trust fund: The above matter and GCS Ref No:13-0400 and 16-1208 refer. In the Witbank News issue dated 29th June 2018 we were invited to raise any comments or concerns. It is a pity the applicant's notice does not include the e mail address of the relevant public official within the Department of Water and Sanitation. Consequently, we are highly limping because the principle of audi alteram partem rule may be scuppered. We do not have any qualms with the mining company being granted the concession applied for if compliant with all applicable legislation, but we humbly request the Department of Water and Sanitation to attach the following conditions to the concession: 1. That the mining company is required to formulate the Coal Air Pollution Trust Fund that is aimed to pay for the medical expenses of employees of the company as well as people in the mining areas of operation of the company who suffer from illnesses associated with coal air pollution including but not limited to TB, lung cancer, bronchitis and other cardiopulmonary diseases. The Deed of Trust attached hereinafter can be used by the company. 2. Compensation of house owners in the areas of operation of the mining company in the event their houses are affected by blasting, 3. Compliance with Broad Based Black Economic Empowerment (BBBEE) and 4. Lodging of Broad Based Black Economic Empowerment Plan.	Zenani France Sibanyoni-Jiyane	Email, 29/062018	Exxaro was notified.

No	Comment Raised	By Whom	Where and Date	Response by EAP
	The aforesaid measure is pursuant to Section 24(b) of the Constitution Act 200 of 1993 that welcomes legislative and other measures designed to protect the environment for the benefit of the current and future generations. It is also in tandem with Section 11 of the Constitution that states that everyone has a right to life. The coal mine pollutants like methane, particulate matter, sulphur dioxide, mercury, dust and carbon emissions will add to the 2 700 premature deaths of people that are recorded in our beloved Republic. The houses of our people will also crack as a result of blasting. These may lead to fatalities as the houses may collapse. The nature and purport of Broad Based Black Economic Empowerment Act, Act 53 of 2003 is that all the levels of Government must ensure that there is compliance with BBBEE prior to any Government Department granting any licenses, concessions or permits.			
18	I wish to be registered as a concerned party since this will have a serious impact on the upper Oliphant's River catchment area. This stream feeds Rietspruit Dam that is on my farm.	Wienand De Wet	Email, 09/07/2018	Paul was registered and comment added to the IRR The Stooping activities will have very little impact on the downstream water sources, as was determined by the Hydrology assessment.

7 IDENTIFICATION OF IMPACTS, MANAGEMENT MEASURES AND ACTION PLANS

7.1 Environmental Significance Rating

To ensure uniformity, the assessment of potential impacts will be addressed in a standard manner so that a wide range of impacts is comparable. For this reason a clearly defined rating scale will be provided to the specialist to assess the impacts associated with their investigation.

Each impact identified was assessed in terms of probability (likelihood of occurring), scale (spatial scale), magnitude (severity) and duration (temporal scale). To enable a scientific approach to the determination of the environmental significance (importance), a numerical value was linked to each rating scale.

The following criteria will be applied to the impact assessment for the EIA/EMP:

- Occurrence
  - Probability of occurrence (how likely is it that the impact may occur?); and
  - Duration of occurrence (how long may impact 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?).
- Status of Impact
  - +: Positive impact
  - -: Negative impact
  - N: Neutral (no impact)

In order to assess each of these factors for each impact, the following ranking scales were used:

Probability:=P	Duration:=D
5 – Definite/don’t know	5 – Permanent
4 – Highly probable	4 - Long-term (ceases with the operational life)
3 – Medium probability	3 - Medium-term (5-15 years)
2 – Low probability	2 - Short-term (0-5 years)
1 – Improbable	1 – Immediate

0 - None	
Scale:=S	Magnitude:=M
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	
Status of Impact	
+: Positive	
-: Negative	
N: Neutral	

Once the above factors have been ranked for each impact, the environmental significance of each was assessed using the following formula:

SP = (magnitude + duration + scale) x probability

The maximum value that can be achieved is 100 Significance Points (SP).Environmental effects were rated as follows:

Significance	Environmental Significance Points	Colour Code
High (positive)	>60	H
Medium (positive)	30 to 60	M
Low (positive)	<30	L
Neutral	0	N
Low (negative)	>-30	L
Medium (negative)	-30 to -60	M
High (negative)	<-60	H

7.2 Detailed Impact Assessment

Refer to Table 7.3 to Table 7.6 for the impacts associated with each phase, associated mitigation measures and action plans.

7.2.1 Geology

During stooping, remaining pillars will be mined from underground. Mitigation for this impact is not possible, except to remain within the design parameters of the project to avoid unnecessary removal of pillars under sensitive areas. A number of features occur on the surface area within Matla that needs to be protected. The surface features include dwellings, provincial roads, wetlands and farmhouses.

7.2.2 Topography

Subsidence will alter the topography. This in turn will alter the flow paths of wetlands and rivers, and cause damming or pooling. The impact can be mitigated through effective shaping of altered sites during rehabilitation.

7.2.3 Soils, Land Use and Land Use Capability

Collapse of the underground workings is a definite result that will potentially reflect at surface. The impact of surface collapse and the effect on the ferricrete will influence both the retention of soil water within the vadose zone with the braking of the inhibiting layer (ouklip) and the movement of water down the profile and the potential for the accumulation of water and the salinisation of the soils in areas were the water ponds and is unable to move out of the topography and down slope.

Infiltration of poor quality water along cracks formed due to collapse of the roof will potentially result in contamination of the soil water (vadose zone) and ultimately the ingress of poor quality water to the fractured rock aquifer. All of these results are considered negative and will impact on the soils, their land capability and the eco system services of the area in general.

7.2.4 Biodiversity

7.2.4.1 Displacement of waterbirds & large terrestrial bird taxa

Stooping are restricted to underground mining activities, thereby resulting in less intrusive noise generation compared to opencast mining activities. Therefore, it is predicted that the displacement of terrestrial taxa during stooping activities will be of temporary nature.

7.2.4.2 Water pollution caused by acid mine drainage (AMD)

Water pollution is probably one of the biggest problems that face the coal mining industry. In fact, water pollution caused by coal mining has a regional effect since pollutants are carried away in groundwater. However, AMD is probably the most common mining related source of water pollution, and the severity depends on the sulphur content of the coal (the higher the sulphur content of the pyrites in the coal, the more acidic the water becomes).

Coal mining activities (including underground mining activities) near drainage systems and pans are likely to alter the chemistry and specifically the pH of the surface water of such systems. This in turn will affect the availability of aquatic food resources for wetland-dependant fauna.

7.2.4.3 Changes in the avifaunal community structure during rehabilitation events

It is likely that the bird species composition will shift, due to rehabilitation effort. Rehabilitation will attract bird species with unspecialised and generalist life-histories, and it is predicted that these will persist for many years before conditions become suitable for succession to progress.

7.2.5 Wetlands

The proposed stooping activities will directly affect a total area of ~225.9 hectares, of which ~23.57 hectares (~10.43 %) will take place underneath wetlands. The majority of wetlands affected are hillslope seepage wetlands, but significantly approximately ~1.82 ha of pan habitat will also be directly affected. Consideration should be given to excluding these pans and their catchments from stooping activities, unless a monitoring plan as well as a management plan is developed by the mine.

Subsidence within wetland areas due to stooping activities will alter the patterns of water retention and distribution within the wetlands, leading to habitat degradation (lowering of the wetland PES) and habitat alteration as the vegetation and fauna adapt to the new patterns of water movement. Subsidence areas within wetlands, particularly in valley bottom positions and areas of more clayey soils, will form depressions within increased water retention. Increased water retention in these areas implies decreased water retention in other areas of the wetland. These impacts are already observable in other wetlands within the area where total extraction activities have taken place. Such changes can lead to habitat fragmentation and disruption of movement corridors through wetlands, especially where channels are interrupted, preventing the free movement of aquatic fauna.

Decreased flow in downstream wetlands will materialize in two ways. Firstly, depressions formed within wetlands due to subsidence will increase water storage within the wetlands, reducing flow to downstream wetlands. Secondly, surface subsidence and the associated subsurface fracturing of the rock strata can lead to increased ingress of surface water into the underground mine workings, reducing flow in downstream wetlands. The consequence of the above is likely to be more severe and extended low flow periods. Reduced flow will lead to habitat degradation as vegetation adjusts to the new flow regime, with ruderal and alien species potentially colonizing affected areas.

Disturbance to wetland habitat could provide opportunities for establishment and spread of alien and pioneer species. This could lead to further knock-on effects such as decreased flow within wetlands, increased erosion and exclusion of indigenous species.

Rehabilitation activities undertaken on subsided areas will require the movement of soil and the exposure of bare soil areas to erosion. Eroded sediments are likely to enter wetlands and watercourses leading to increased turbidity and increased sediment deposition. Areas of sediment deposition are likely to be colonized by robust pioneer species such as *Typha capensis* that exclude other species.

Post mining the underground workings are expected to fill with water as groundwater levels rebound. As groundwater levels rise, decant of such contaminated water out of the mine workings is possible. Decant could occur through boreholes, subsided areas or other low points along the mined out coal seam. The expected decant quality is not known, but is expected to be of high salinity with high sulphate loads. The long-term deterioration in water quality due to contaminated mine drainage (AMD) is considered as probably the most significant impact of coal mining on aquatic resources. Acidification and salinisation of surface water as a result of decant/AMD will have a negative impact on especially biota intolerant to water quality alterations, but depending on the severity, may be detrimental to the entire aquatic ecosystem.

7.2.6 Surface Water

The following section describes the potential impacts associated with the operational phase of the proposed project.

- The proposed operations proposed within the Matla Stooping Project (Phase 1) will marginally reduce the runoff volume reporting to the local streams. The maximum anticipated subsidence of 1.53m will result in surface depressions capable of collecting surface water runoff, therefore reducing the catchment area contributing runoff to the streams. Streamflow reduction will be a consequence of the reduction in catchment area. The impact of catchment reduction depends on the percentage of a particular area to be isolated and the consequence of isolating the area.

Catchments with an isolated area in excess of 10% can be considered to have an influence on the flow patterns and volumes in the receiving catchment. A review of the current catchment showed that the catchment flow would be reduced by up to 5%. A reduction in catchment flow of less than 10% can be deemed fairly small, and these values are therefore not likely to be significant. The project's influence on downstream catchment flows, however, should be monitored and investigated at a later stage once the infrastructure footprint develops. The impact was ranked as **medium** due to the loss of contributing catchment area. With the mitigation measures in place the impact ranking is reduced to **low**.

- The maximum anticipated subsidence of 1.53m will result in steep slopes being generated on the perimeter of the proposed stooping areas, and, owing to the tendency of steep slopes to erode, it is likely that soils could be regularly mobilised with extreme rainfall events. This could result in a deterioration of land capability, as well as the accumulation of sediment in the various water resources. The ranking will be reduced from **medium** to **low** if correct storm water management measures are installed.

7.2.7 Groundwater

The model constructed for the Stooping Project (*GCS, 2016)* was also used to simulate the combined impact of all potential surface source areas within the Matla mine lease area (for inclusion in the consolidation project) and is therefore discussed in more detail.

7.2.7.1 Modelling Results for the Planned Stooping of Underground Mining Areas (GCS, 2016)

<u>Model restrictions and limitations</u>

The numerical groundwater model, despite all efforts and advances in software and algorithms, remains a very simplified representation of the very complex and heterogeneous interacting aquifer systems underlying the site.

The integrity of a numerical model depends strongly on the formulation of a sound conceptual model and the quality and quantity (distribution, length of records etc.) of input data

All available information regarding the geological makeup (especially geological structures) of the mining area was considered in the construction of the numerical model. Geological structures such as dykes and faults, because the aquifer is of a secondary fractured nature, usually have higher transmissivities in comparison to the host rock and serve as preferred flow paths or conduits for groundwater movement. These structures therefore have the ability to significantly affect the outcome of a model. Areas still exist where such structural geological information is not available, therefore modelling (i.e. updating of the model) should be an ongoing process as new information becomes available with time.

No stooping schedules were available for the Phase 1 areas, therefore a worst case approach was followed whereby all the areas were simulated to be stooped during the same period.

Model domain and boundary conditions

The Processing Modflow 8 modelling package was used for the model simulations. The finite difference model grid constructed to include the entire Matla mine lease area is indicated in Figure 7.1. Model dimensions and aquifer parameters used in the construction and calibration of the model are provided in Table 7.1.

The following model boundaries were used to define the model area and are also indicated in Figure 7.1:

- **No-flow boundaries** in a model, as in nature, are groundwater divides (topographic high or low areas/lines) and geological structures (dykes) across which no groundwater flow is possible.
- **General head boundaries** are boundaries through which groundwater movement is possible. The rate at which the groundwater moves through the boundary depends on the groundwater gradients as well as the hydraulic conductivities on opposite sides of the boundary position.

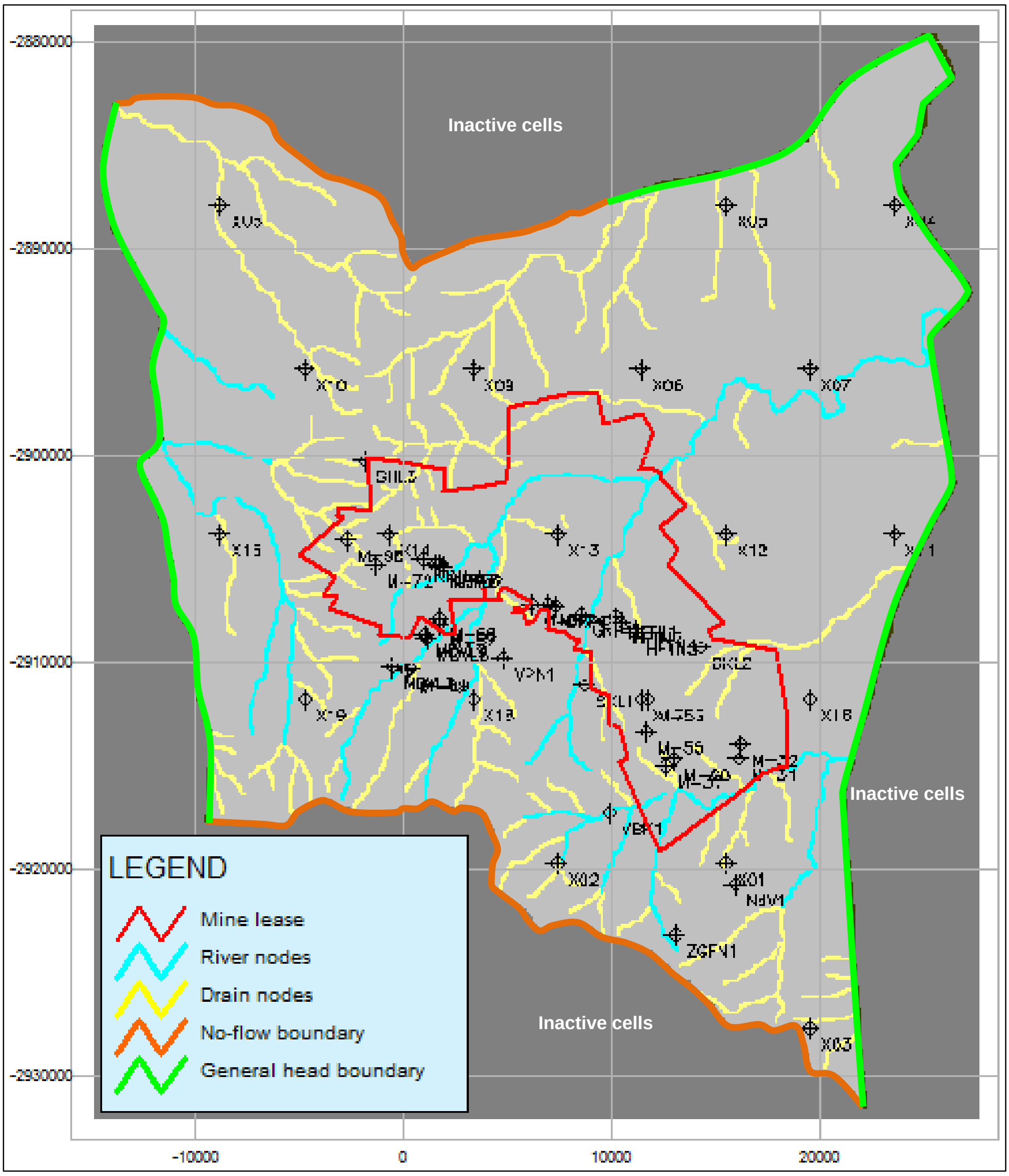

Figure 7.1: Numerical model grid

Table 7.1: Model dimensions and aquifer parameters

Grid size	Easting = 42 210m Northing = 52 640m
Rows and Columns	Rows = 752, Columns = 603
Cell size	70m by 70m
Transmissivity: Shallow aquifer	1.8 m^2/day
Transmissivity: Deeper aquifer	0.35 m^2/day

Specific yield: Shallow aquifer	0.06
Storage coefficient: Deeper aquifer	0.001
Effective porosity: Shallow aquifer	6%
Effective porosity: Deeper aquifer	2%
Recharge	0.6% - 1.2 % of MAP

Model calibration results

During the steady state calibration of the flow model changes were made to mainly the hydraulic properties (transmissivity) of the aquifer host rock and effective recharge (Table 7.1) until an acceptable correlation was achieved between the measured/observed groundwater elevations and those simulated by the model. Groundwater level information from user boreholes was used in the calibration process. A correlation of ± 97% was achieved with the calibration of the flow model and the results are provided in Figure 7.2

The calibrated groundwater elevations were exported from the flow model and used to construct a contour map of the steady state groundwater elevations (Figure 7.3). The lowest groundwater elevations were simulated to occur in the north-western and north-eastern down gradient directions. Groundwater elevations follow the surface topography and increase towards the south.

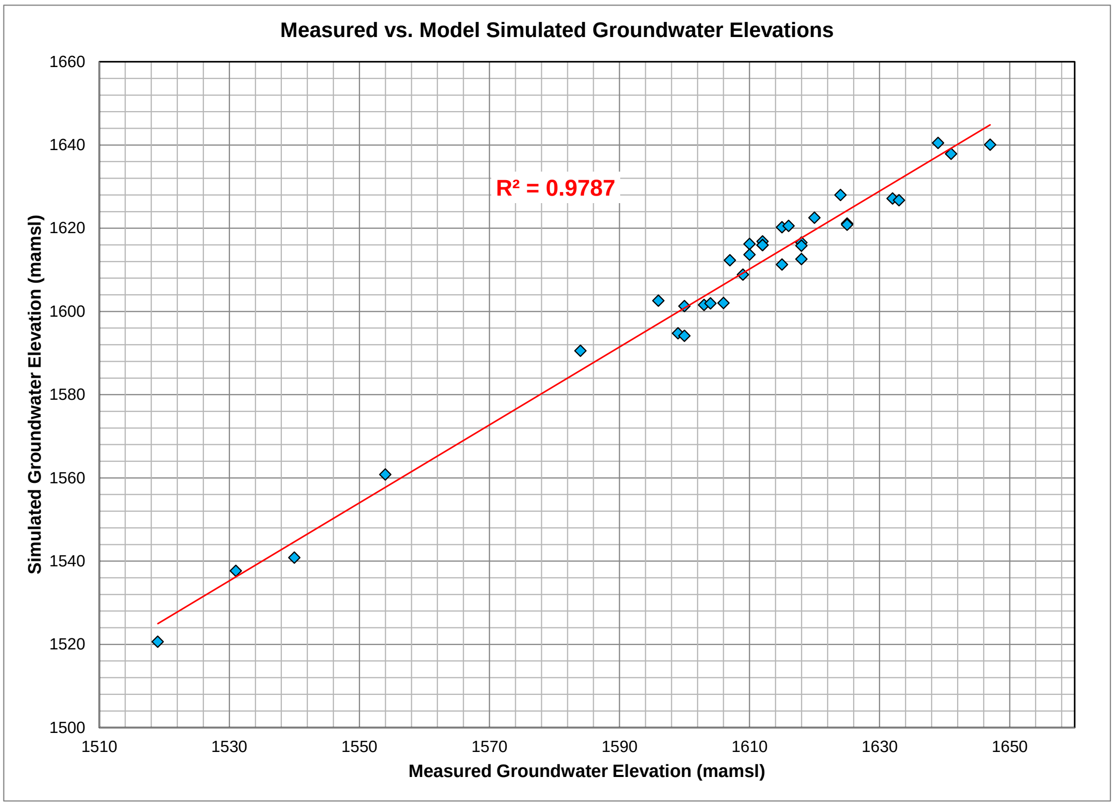

Figure 7.2: Numerical flow model calibration results

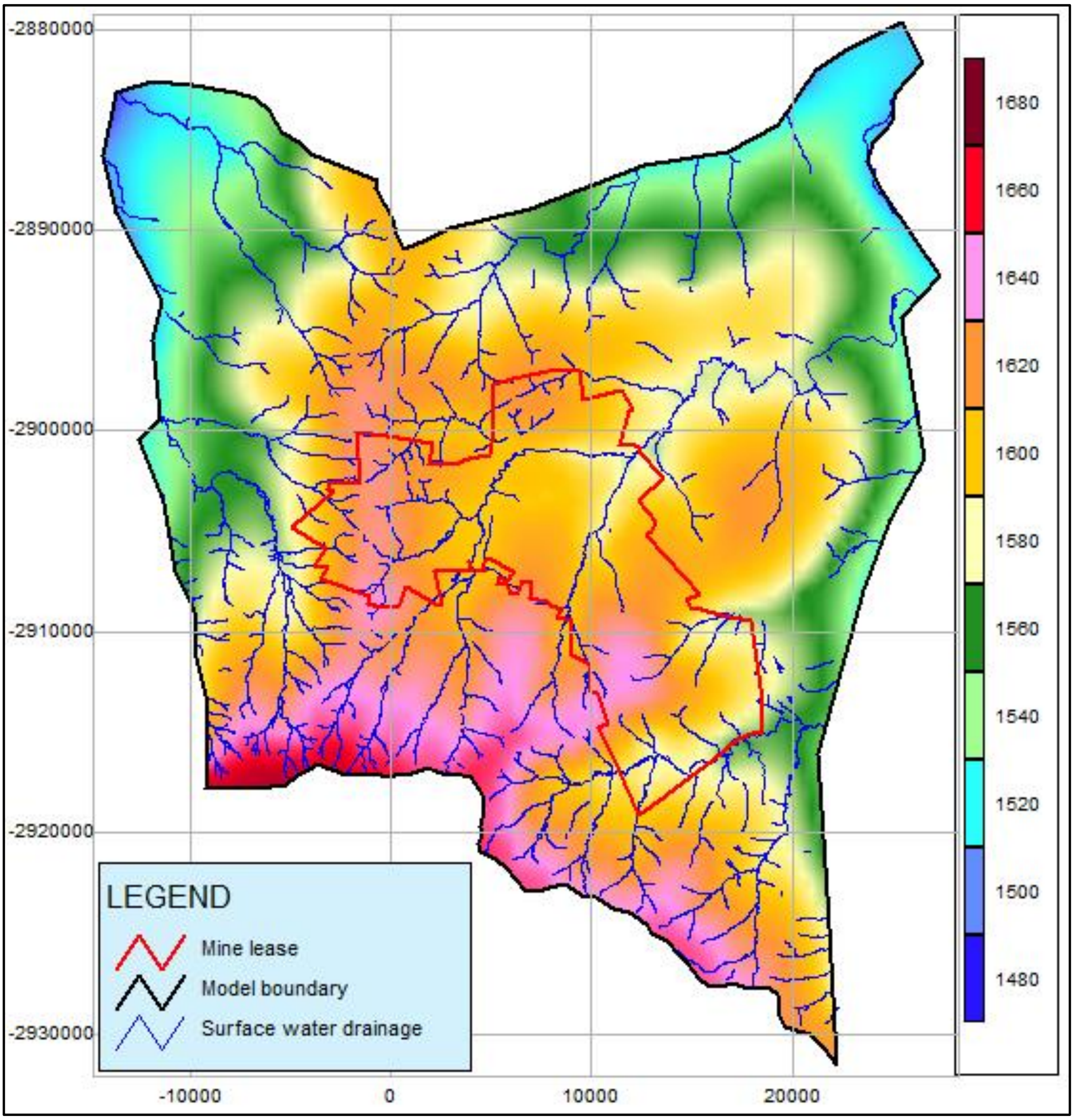

Figure 7.3: Model simulated steady state groundwater elevations (mamsl)

Flow model

Impacts on groundwater levels are expected to occur as a result of roof collapse followed by surface subsidence. The flow model was therefore used to simulate this potential impact. A mine plan and schedule are yet to be finalised for the planned stooping areas, which is considered to be a serious shortcoming in the model simulations.

The extent of the groundwater level impacts is governed by the hydraulic properties of the aquifer host rock and time. The influence of time on the radius/extent of the cone of depression (water level impact) is explained by means of the following equation *(Bear, 1979)*:

$$R(t) = 1.5(Tt/S)^{1/2}$$

Where
R = Radius (m),
T = Aquifer transmissivity (m^2/d),
t = Time (days),
S = Storativity.

The equation shows that an increase in time will lead to an increase in the radius of influence (extent of depression cone), which is why the mine plan/schedule plays such an important role in the model simulations. The same holds true for aquifer transmissivity, i.e. impacts on groundwater levels are expected to extend along transmissive geological structures. Such structures may also greatly increase groundwater discharge into the active mine workings.

The planned stooping was simulated to occur over an assumed time period of five years. We strongly recommend an update of the model simulations once the mine plan/schedule has been finalised.

In order to better indicate the impact of the planned stooping activities on the surrounding groundwater levels, initial groundwater elevations were subtracted from the simulated groundwater elevations at the end of year five. The difference between these two data sets therefore represents the total decrease in water level experienced over the simulation time. This data was used to construct a contour map of the model simulated groundwater depression cones, which are indicated in Figure 7.4. Groundwater user boreholes located within the mine lease area are indicated in the abovementioned figure with the use of blue place marks.

Summary of simulations:

A maximum groundwater level drawdown/decrease of 11 meters was simulated to occur in an area bordered by low transmissivity dykes (green lines in Figure 7.4). On average, drawdown was simulated to vary between approximately four and nine meters. A total area of ± 25 km^2 was simulated to experience decreases in water levels. Ten groundwater user boreholes are located within this affected area (Table 7.2):

Table 7.2: Potentially affected groundwater user boreholes

BH	Model simulated drawdown (m)
HJFV2	5
HJFV5	3
KRTL1	3
KRTL6	5

BH	Model simulated drawdown (m)
KRTL8	6
KRTL9	6
KRTL10	6
KRTL11	6
M-19	3
VFN1	2

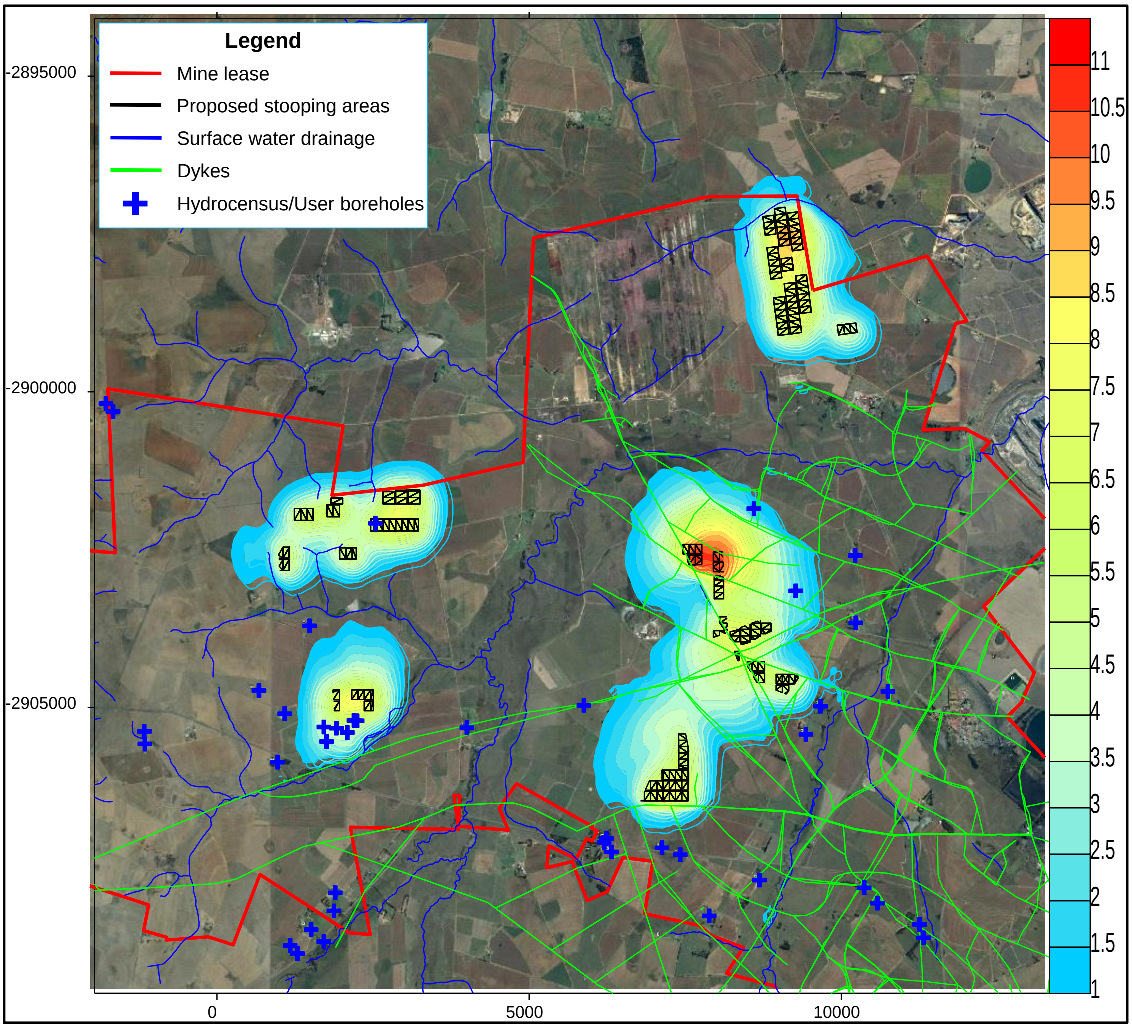

Figure 7.4: Model simulated groundwater depression cones (meters)

The Impact results were identified as follows:

- Ten groundwater user boreholes were simulated to be affected by the planned stooping activities.
- These boreholes were simulated to experience water level decreases of between two and six meters.

7.2.7.2 Results of Mass Transport Model Simulation to include all Major Potential Surface Source Areas

The mass transport model was constructed to simulate pollution migration in the aquifer system underlying the mine lease area. Five main source areas were identified and included in the model simulations:

- Pollution control dams at No 1 Shaft;
- Pollution control dams at Mine 1;
- Pollution control dams at Mine 2;
- Pollution control dams at Mine 3; and
- Water treatment plant and associated brine ponds.

In order to better indicate the impact of the potential sources on the surrounding groundwater quality conditions, contamination contours were exported from the mass transport model after a 25 and 50 years simulation runtime and used to construct the simulated contamination plumes, which are provided in Figure 7.5 and Figure 7.6 respectively.

The contamination was simulated by applying contaminated recharge to the entire surface areas of the potential sources listed above. The source areas were assigned a theoretical concentrations of 100%, therefore the results of the model simulations should be regarded as qualitative rather than quantitative.

<u>Summary of simulations:</u>
Impacts on groundwater levels are restricted and groundwater migration on a regional scale still follows the natural/pre-mining flow patterns/directions. Plumes were consequently simulated to follow the groundwater flow directions as indicated in Figure 3.7.

Plume migration is however quite slow as a result of the relatively low hydraulic properties of the aquifer host rock and low groundwater hydraulic gradients. Plumes were simulated to have migrated an average distance of ± 400 meters after a model runtime of 50 years, which translates to 8 meters per year. This is slightly higher than the 6 meters per year calculated with the *Fetter (1994)* equation.

User boreholes located during the *GCS 2014* hydrocensus/user survey are indicated in Figure 7.5 and Figure 7.6 with the use of yellow place marks. Please note that none of these boreholes are located within the areas simulated to be affected by the contamination plumes.

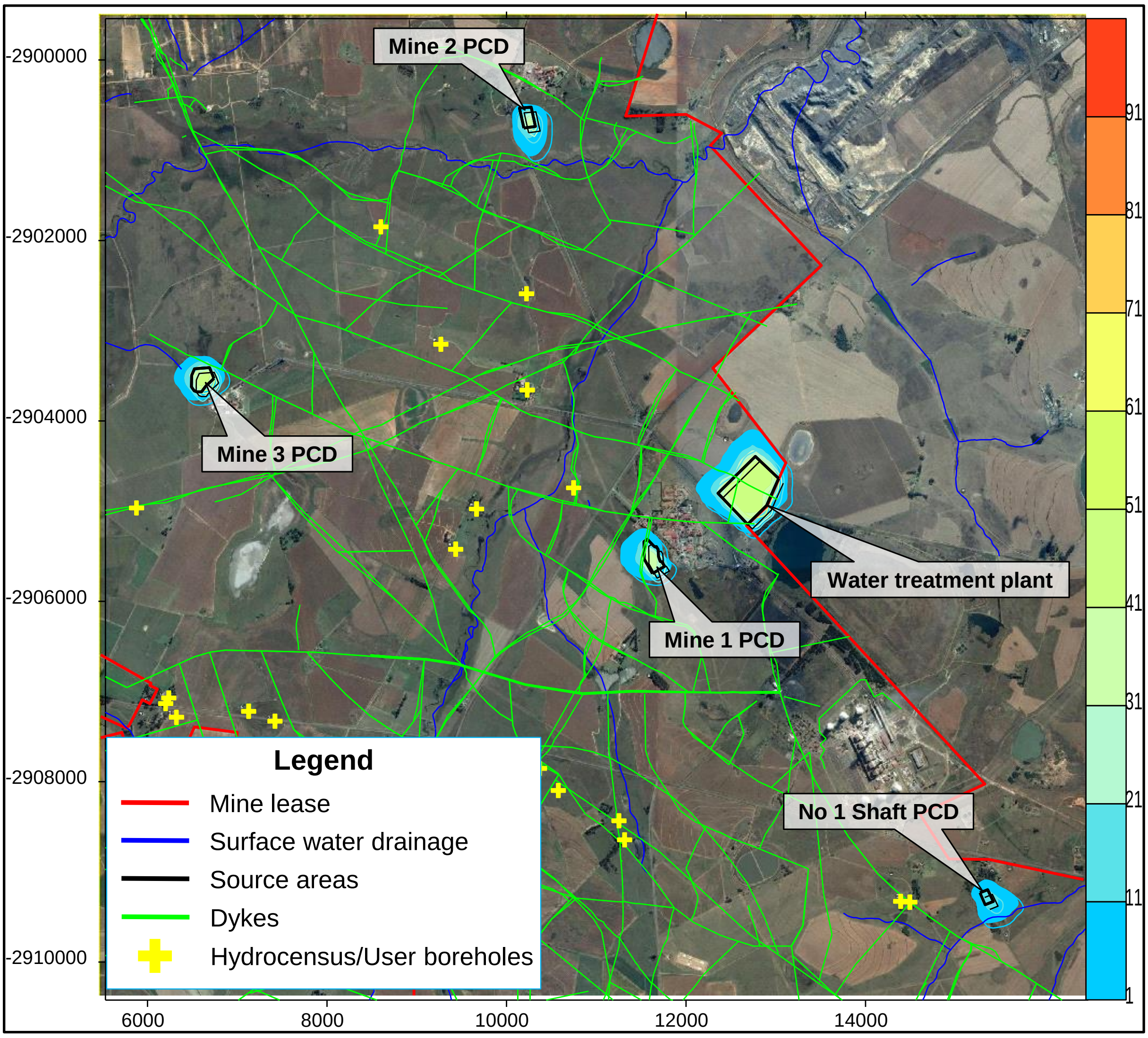

Figure 7.5: Simulated plume migration after 25 years (%)

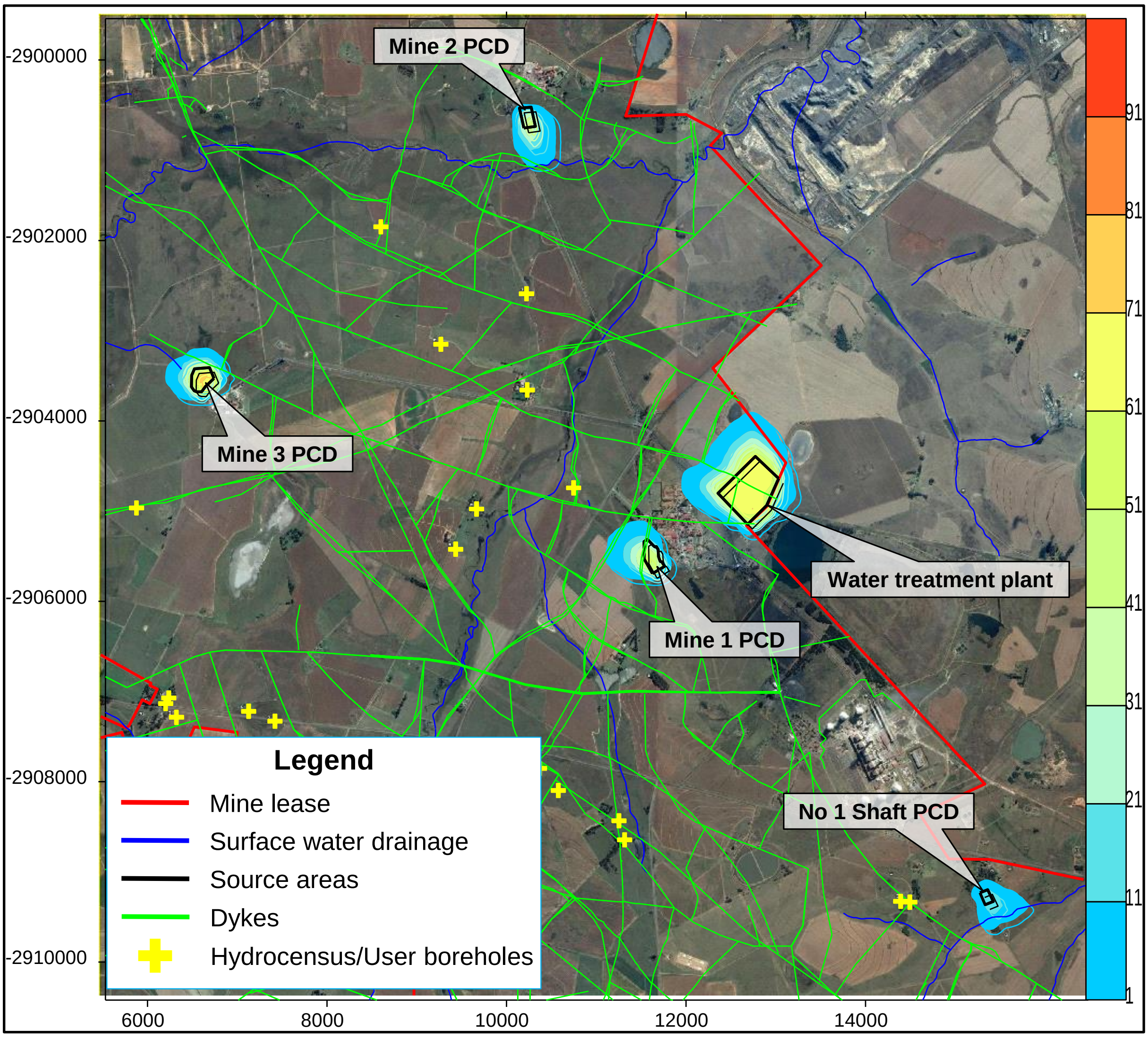

Figure 7.6: Simulated plume migration after 50 years (%)

7.2.8 Sites of historical and cultural importance

As some of these buildings fall within the underground mining area, it is possible that it may be damaged during mining activities. For instance, the soil may cave in. There is a possibility that Site 4, grave site, of the study undertaken by Van Vollenhoven in 2014, will be impacted on by the proposed stooping.

The mine will have to do regular inspections at all these sites (at least once a month) and at the first sign of a possible cave-in they should immediately start liaising with SAHRA about the exhumation and relocation of grave sites. However, should there be any danger of possible cave-in of these site or should the mine decide that it would be better for their operations to have these exhumed and relocated, this process should be followed. This may be allowed upon SAHRA approval

Table 7.3: Operational Phase Impacts

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
AREAS: 1. UNDERGROUND MINE AREA 2. SURFACE AREA ABOVE STOOPING																					
OPERATIONAL PHASE ACTIVITIES: 1. STOOPING (REMOVAL OF PILLARS)																					
Geology																					
Change in geological structure	1	1	8	5	1	5	70	-	H	Mitigation not possible, geology is permanently altered	8	5	1	5	70	-	H	No Action Plan required due to permanent alteration	na	na	na
Topography																					
Surface subsidence	2	1	8	5	1	5	70	-	H	Reshape topography	6	5	1	5	60	-	M	Adhere to surface rehabilitation plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Soil, Land Use and Land Capability																					
Erosion as a result of subsidence	2	1	10	4	1	5	75	-	H	Concurrent and timeous surface rehabilitation. Control and auditing of vehicle movements.	6	4	1	3	33	-	M	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Loss of soil resource and eco system services	2	1	8	4	1	4	52	-	M	Concurrent and timeous surface rehabilitation. Control and auditing of vehicle movements.	6	4	1	3	33	-	M	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Salinisation as a result of ponding	2	1	10	4	1	5	75	-	H	Concurrent and timeous surface rehabilitation. Contour and shape after subsidence. Ensure free are is free draining.	6	4	1	3	33	-	M	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Contamination of vadose zone as a result of ponded water ingress	2	1	8	4	1	4	52	-	M	Concurrent and timeous surface rehabilitation. Contour and shape after subsidence. Ensure free are is free draining.	6	4	1	3	33	-	M	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Change in landuse	2	1	10	4	1	5	75	-	H	Shape topography to avoid ponding Rehabilitate affected areas	4	3	1	3	24	-	L	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Change in land capability	2	1	8	5	1	4	56	-	M	Shape topography to avoid ponding Rehabilitate affected areas	4	3	1	3	24	-	L	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Biodiversity																					
Change in flora species of conservation importance	2	1	10	5	3	4	72	-	H	Exclude areas of high sensitivity where possible. Minimising operational footprints,	8	4	3	3	45	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Change in ecological connectivity & ecosystem functioning	2	1	8	4	3	4	60	-	M	Exclude areas of high sensitivity where possible. Minimising operational footprints,	8	4	3	2	30	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Indirect impacts (loss/ degradation/ pollution) on surrounding habitat	2	1	8	4	2	4	56	-	M	Ensure proper rehabilitation of affected areas	6	4	2	3	36	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Loss or degradation of natural vegetation/ sensitive habitat types	2	1	10	5	2	4	68	-	H	Ensure proper rehabilitation of affected areas	10	5	2	3	51	-	M	Implement Biodiversity Action Plan and	Operational Phase	Environmental Manager	Included in operational costs

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
																		Management Measures			
Direct impacts on fauna species of conservation importance	2	1	8	5	2	4	60	-	M	Exclude areas of high sensitivity where possible. Minimising operational footprints, Allow for faunal movement	6	5	2	2	26	-	L	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Loss or degradation of natural and sensitive faunal habitats	2	1	8	5	2	4	60	-	M	Exclude areas of high sensitivity where possible. Minimising operational footprints, Allow for faunal movement	6	5	2	3	39	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Disruption of ecological connectivity and local/regional migration routes	2	1	8	5	3	4	64	-	H	Exclude areas of high sensitivity where possible. Minimising operational footprints, Allow for faunal movement	8	4	3	3	45	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Wetlands																					
Degradation and alteration of wetland habitat	2	1	8	5	2	5	75	-	H	Consideration should be given to, as a minimum, exclude the pans and their catchments from stooping activities, unless a monitoring plan as well as a management plan is developed by the mine. Close cracks formed by subsidence. Recreate and maintain flow paths	6	5	3	5	70	-	H	Implement wetland rehabilitation plan	Operational Phase	Environmental Manager	Included in operational costs
Decreased flow in downstream wetlands	2	1	6	5	3	5	70	-	H	Recreate and maintain flow paths. Reinstate drainage to impounded areas	6	5	2	4	52	-	M	Implement wetland rehabilitation plan	Operational Phase	Environmental Manager	Included in operational costs
Increase in alien vegetation	2	1	6	5	2	3	39	-	M	Control and minimise alien vegetation	2	2	1	3	15	-	L	Implement wetland rehabilitation plan	Operational Phase	Environmental Manager	Included in operational costs
Increased sediment movement into wetlands	2	1	6	2	2	4	40	-	M	All sediment moving activities within wetlands should be undertaken during low flow periods. Rapid revegetation of disturbed soils is vital and must be insured. Limit movement of sediment away from the disturbed area.	4	2	1	3	21	-	L	Implement wetland rehabilitation plan	Operational Phase	Environmental Manager	Included in operational costs
Hydrology																					
Catchment reduction	2	1	6	3	3	3	36	-	M	Effective diversion of clean storm water, by implementation of the proposed storm water management plan should reduce the impacts of reduced catchment runoff.	6	2	2	2	20	-	L	Adhere to Storm Water Management Plan. Adhere to Rehabilitation plan to implement a free flowing landscape.	Operational	Environmental Manager	Included in operational costs
Erosion and sediment accumulation in the surface depressions (subsided areas)	2	1	6	2	3	3	33	-	M	Rehabilitate open areas as soon as practically possible. Vegetate open areas as soon as practically possible. Manage storm water systems and runoff.	4	2	1	2	14	-	L	Adhere to Storm Water Management Plan. Adhere to Rehabilitation plan to implement a free flowing landscape.	Operational	Environmental Manager	Included in operational costs
Hydrogeology																					

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
Ingress of water into underground workings, and reduction of available water from the overlying aquifer.	1	1	6	4	2	4	48	-	M	Stooping should not be conducted below surface water courses, wetlands or any other surface water features where possible.	6	4	2	4	48	-	M	No specific action plans are proposed for the stooping areas	Operational	Environmental Manager	Included in operational costs
Heritage																					
Destruction of or damage to graves	2	1	4	5	2	3	33	-	M	Avoid damage to graves	4	5	2	2	22	-	L	Fencing and keeping track of location whiles stooping in close proximity. Exhumation and relocation if above stooping area.	Operational	Environmental Manager and Mine Manager	Included in operational costs

Table 7.4: Closure and Decommissioning Phase Impacts

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
AREAS: 1. UNDERGROUND MINE AREA 2. SURFACE AREA ABOVE STOOPING																					
Decommissioning and CLOSURE PHASE ACTIVITIES: 1. Post Stooping Subsidence 2. Rehabilitation																					
Geology																					
Change in geological structure	1	1,2	8	5	1	5	70	-	H	Mitigation not possible, geology is permanently altered	8	5	1	5	70	-	H	No Action Plan required due to permanent alteration	na	na	na
Topography																					
Surface subsidence	2	1, 2	8	5	1	5	70	-	H	Reshape topography	6	5	1	5	60	-	M	Compile a surface rehabilitation plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Soil, Land Use and Land Capability																					
Net Loss of soil volume and utilisation potential	2	1	10	3	1	4	56	-	M	Shape topography and rehabilitate affected areas	6	3	1	2	20	-	L	Implement Soil Management and Rehabilitation Plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
loss of nutrient base (de-nutrification)	2	1	10	3	1	4	56	-	M	Cultivate, amelioration and oxygenation of growing medium, the planting of required vegetative cover and irrigation	6	3	1	2	20	-	L	Implement Soil Management and Rehabilitation Plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
compaction, erosion and contamination	2	1, 2	10	3	2	5	75	-	H	Shape topography to avoid ponding Rehabilitate affected areas. Contour and stabilise slopes to be free draining, and rip compacted areas	6	3	1	3	30	-	M	Implement Soil Management and Rehabilitation Plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
increased footprint of rehabilitated grazing land potential	2	2	4	5	1	2	20	+	L	Shape topography to avoid ponding Rehabilitate affected areas	8	5	1	4	56	+	M	Implement Soil Management and Rehabilitation Plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Biodiversity																					
Change in ecological connectivity & ecosystem functioning	2	1, 2	8	4	1	4	52	-	M	Shape topography to avoid ponding Rehabilitate affected areas	6	4	1	3	33	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
Change in ecological connectivity & ecosystem functioning	2	1, 2	8	4	2	3	42	-	M	Ensure proper rehabilitation of affected areas	6	4	2	2	24	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Loss or degradation of natural vegetation/ sensitive habitat types	2	1, 2	6	4	2	3	36	-	M	Ensure proper rehabilitation of affected areas	8	4	2	2	28	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Change in flora species of conservation importance	2	1, 2	10	5	2	3	51	-	M	Ensure proper rehabilitation of affected areas	8	5	2	2	30	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Direct impacts on fauna species of conservation importance	2	1, 2	8	5	2	4	60	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	6	5	2	4	52	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Loss or degradation of natural and sensitive faunal habitats	2	1, 2	8	5	2	4	60	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	6	5	2	4	52	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Disruption of ecological connectivity and local/regional migration routes	2	1, 2	6	5	3	3	42	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	6	2	3	2	22	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Impacts on common fauna and interactions with structures and personnel	2	1, 2	6	3	2	3	33	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	4	1	2	1	7	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Wetlands																					
Increased sediment movement into wetlands	2	1, 2	6	2	2	4	40	-	M	All sediment moving activities within wetlands should be undertaken during low flow periods. Rapid revegetation of disturbed soils is vital and must be insured. Limit movement of sediment away from the disturbed area.	4	2	1	3	21	-	L	Implement wetland rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Increase in alien vegetation	2	1, 2	6	5	2	3	39	-	M	Reduce the spread of alien vegetation	2	2	1	3	15	-	L	Implement wetland rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Hydrology																					
Catchment reduction	2	1, 2	6	3	3	3	36	-	M	Effective diversion of clean storm water, by implementation of the proposed storm water management plan should reduce the impacts of reduced catchment runoff.	6	2	2	2	20	-	L	Adhere to Storm Water Management Plan. Adhere to Rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
																		to implement a free flowing landscape.			
Erosion and sediment accumulation in the surface depressions (subsided areas)	2	1, 2	6	2	3	3	33	-	M	Rehabilitate open areas as soon as practically possible. Vegetate open areas as soon as practically possible. Manage storm water systems and runoff.	4	2	1	2	14	-	L	Adhere to Storm Water Management Plan. Adhere to Rehabilitation plan to implement a free flowing landscape.	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Hydrogeology																					
Recovery of groundwater levels	1	2	6	4	2	5	60	+	M	No mitigation required	6	4	2	5	60	+	M	No action plan required	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Heritage																					
No additional impacts																					

Table 7.5: Residual Impacts

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
AREAS: 1. UNDERGROUND MINE AREA 2. SURFACE AREA ABOVE STOOPING																					
Residual impacts																					
Geology																					
Change in geological structure	1	1	8	5	1	5	70	-	H	Mitigation not possible, geology is permanently altered	8	5	1	5	70	-	H	No Action Plan required due to permanent alteration	na	na	na
Topography																					
Surface subsidence	2	1	8	5	1	5	70	-	H	Reshape topography	6	5	1	5	60	-	M	Compile a surface rehabilitation plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational and closure costs
Soil, Land Use and Land Capability																					
Settling of subsided areas	2	1	4	5	1	4	40	+	M	Shape topography to avoid ponding	8	5	1	4	56	+	M	Compile a surface rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Change in landuse	2	1	8	5	1	4	56	-	M	Shape topography to avoid ponding Rehabilitate affected areas	4	3	1	3	24	-	L	Compile a surface rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Change in land capability	2	1	8	5	1	4	56	-	M	Shape topography to avoid ponding Rehabilitate affected areas	4	3	1	3	24	-	L	Compile a surface rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Biodiversity																					
Loss or degradation of natural vegetation/ sensitive habitat types	2	1	6	5	2	4	52	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	6	5	2	4	52	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Impacts on ecological connectivity & ecosystem functioning	2	1	4	5	2	4	44	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope	4	5	2	4	44	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
										areas to facilitate suitable slopes and topographical features											
Residual impacts of pollution and habitat degradation	2	1	4	5	2	3	33	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	4	5	2	3	33	-	M	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Residual impacts on fauna species of conservation importance	2	1	10	5	2	4	68	-	H	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	8	4	1	2	26	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Residual loss or degradation of natural and sensitive faunal habitats	2	1	10	5	2	4	68	-	H	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	8	4	1	2	26	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Disruption of ecological connectivity and local/regional migration routes	2	1	10	5	3	3	54	-	M	Ensure proper rehabilitation of affected areas, establish a suitable ground cover of representative plant species, including a grass and herbaceous cover, prevent erosion, reslope areas to facilitate suitable slopes and topographical features	8	2	1	2	22	-	L	Implement Biodiversity Action Plan and Management Measures	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Wetlands																					
Water quality deterioration	2	1	10	5	3	5	90	-	H	Decanting of polluted water from the underground mine should be avoided. Treated released into the environment should be of acceptable standard as per the Water Use Licence	6	5	3	3	42	-	M	Implement wetland rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Decreased flow in downstream wetlands	2	1	8	5	3	5	80	-	H	Flow and drainage re-establishment should aim to maintain pre-mining flow rates and quantities. Release of the water should mimic the natural hydrology. Where impoundments are created by surface subsidence, reshaping such areas to again drain to downstream reaches should be investigated.	8	5	3	5	80	-	H	Implement wetland rehabilitation plan	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Hydrology																					
Change in runoff	2	1	6	3	3	3	36	-	M	Effective diversion of clean storm water, by implementation of the proposed storm water management plan should reduce the impacts of reduced catchment runoff.	6	2	2	2	20	-	L	Adhere to Storm Water Management Plan. Adhere to Rehabilitation plan to implement a free flowing landscape.	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Hydrogeology																					
Decant from underground workings	1, 2	1	8	4	2	5	70	-	H	Avoid decant of untreated water into the surface water environment	4	1	1	2	12	-	L	Implement water treatment plan for all decant.	Closure and rehabilitation	Environmental Manager	Included in Closure costs
Heritage																					
No additional impacts																					

Table 7.6: Cumulative Impacts (all phases)

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
AREAS: 1. UNDERGROUND MINE AREA 2. SURFACE AREA ABOVE STOOPING																					
Cumulative impacts																					
Geology																					
Change in geological structure	1	1	8	5	1	5	70	-	H	Mitigation not possible, geology is permanently altered	8	5	1	5	70	-	H	No Action Plan required due to permanent alteration	na	na	na
Topography																					
No significant cumulative impact																					
Soil, Land Use and Land Capability																					
Change in landuse	2	1	8	5	1	4	56	-	M	Shape topography to avoid ponding Rehabilitate affected areas	4	3	1	3	24	-	L	Compile a surface rehabilitation plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Change in land capability	2	1	8	5	1	4	56	-	M	Shape topography to avoid ponding Rehabilitate affected areas	4	3	1	3	24	-	L	Compile a surface rehabilitation plan	Operation, Closure and rehabilitation	Environmental Manager	Included in operational costs
Biodiversity																					
Impacts on SA's conservation obligations & targets	2	1	6	5	3	4	56	-	M	Minimize development footprint, compensate for loss of natural habitat, ensure proper restoration and rehabilitation subsequent to mining activities	4	4	3	3	33	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Increase in local and regional fragmentation/ isolation of habitat	2	1	4	5	3	4	48	-	M	Minimize development footprint, compensate for loss of natural habitat, ensure proper restoration and rehabilitation subsequent to mining activities	4	4	3	3	33	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Cumulative loss of sensitive faunal habitat	2	1	10	5	3	4	72	-	H	Minimize development footprint, compensate for loss of natural habitat, ensure proper restoration and rehabilitation subsequent to mining activities	8	5	3	2	32	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Cumulative isolation and fragmentation of natural faunal habitats and loss of ecological connectivity	2	1	10	5	3	4	72	-	H	Minimize development footprint, compensate for loss of natural habitat, ensure proper restoration and rehabilitation subsequent to mining activities	8	5	3	2	32	-	M	Implement Biodiversity Action Plan and Management Measures	Operational Phase	Environmental Manager	Included in operational costs
Wetlands																					
Degradation and alteration of wetland habitat	2	1	8	5	2	5	75	-	H	Consideration should be given to, as a minimum, exclude the pans and their catchments from stooping activities. Close cracks formed by subsidence. Recreate and maintain flow paths	6	5	3	5	70	-	H	Implement wetland rehabilitation plan	Operational Phase	Environmental Manager	Included in operational costs
Hydrology																					
Change in runoff and ponding	2	1	6	3	3	3	36	-	M	Effective diversion of clean storm water, by implementation of the proposed storm water management plan should reduce the impacts of reduced catchment runoff.	6	2	2	2	20	-	L	Adhere to Storm Water Management Plan. Adhere to Rehabilitation plan to implement a free flowing landscape.	Operational	Environmental Manager	Included in operational costs
Hydrogeology																					

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							ACTION PLAN	PHASE	RESPONSIBLE PERSON	ANNUAL MANAGEMENT COST
			M	D	S	P	TOTAL	STATUS	SP		M	D	S	P	TOTAL	STATUS	SP				
Ingress of water into underground workings, and reduction of available water from the overlying aquifer.	1	1	8	4	2	5	70	-	H	No mitigation possible for the greater area of subsidence.	6	4	2	4	48	-	M	Adhere to Rehabilitation plan to implement a free flowing landscape.	Operational	Environmental Manager	Included in operational costs
Heritage																					
No heritage sites are located in the direct vicinity of any phase 1 stooping areas.																					

8 FINANCIAL PROVISION FOR CLOSURE

GCS was provided with an escalated Closure Cost Assessment from the assessment previously submitted to the DMR. Due to ongoing communication and delays in final approval from ESKOM, an updated Closure Cost Assessment was not yet available.

Golder Associates (Pty) Ltd has been appointed to update the CCA as per GN1147.

This new report will be available for Eskom's review in November 2018 with submission to DMR in February 2019.

Refer to Appendix I for the escalated Closure Cost.

9 ENVIRONMENTAL IMPACT STATEMENT

The Mining Right Area of Matla boasts a large amount of wetlands, which is probably the best indication of the sensitivity of the site. Some of these wetlands however have undergone a significant amount of degradation due to agricultural activities. The only wetland types that remain in a largely natural state are the pans within the Mining Right area, and it is recommended that these pans be excluded from the stooping plan.

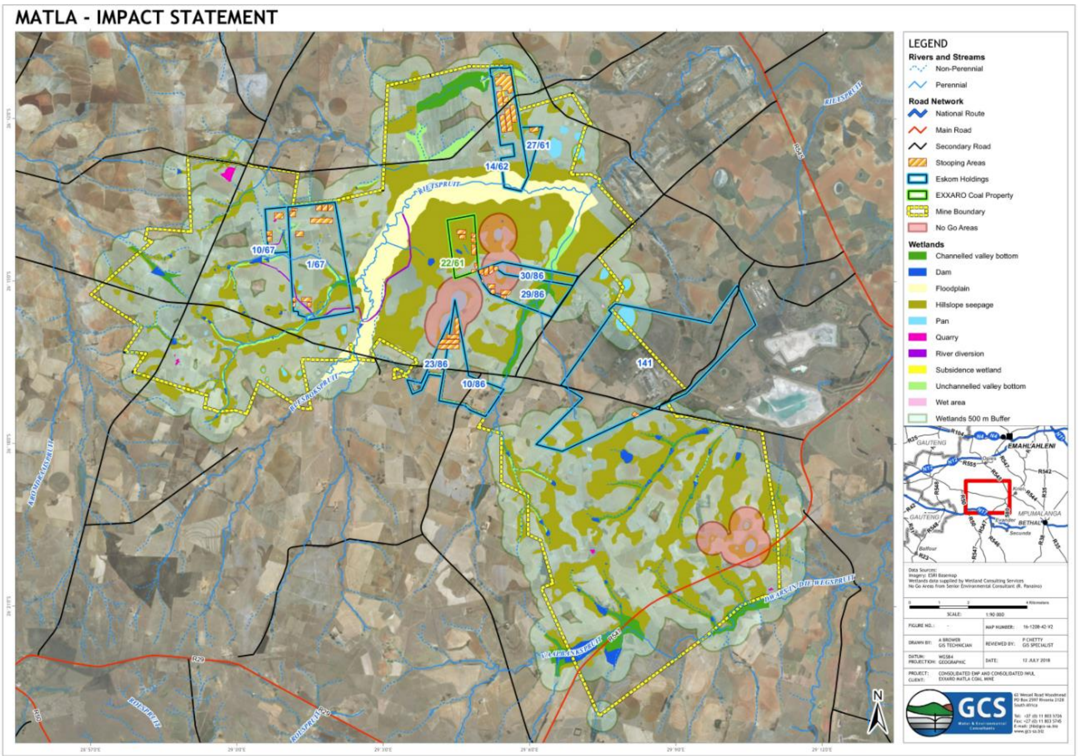

Figure 9.1: Sensitive landscapes related to stooping areas

After assessing the Impacts that could possibly occur due to the implementation of stooping at Matla, it was noted that majority of the impacts can be mitigated to a low to medium impact. Matla has proved that effective rehabilitation of subsided areas can be implemented and already has a working concurrent rehabilitation strategy for areas of total extraction.

The EAP is therefore of the opinion that the stooping project as presented herein can be successfully implemented.

This opinion is dependent on the commitment from the mine to continue implementing all identified management measures, monitoring and rehabilitation plans, as well as address all identified information gaps. Furthermore, the applicant must also continue to implement the social and labour plan as approved by the DMR.

In addition to the above commitments, the Applicant must continue with public consultation in order to ensure that the communities surrounding the operation are informed of developments on site throughout the life of mine. In this regard, a detailed communication strategy must be developed and implemented together with the development of a complaints register to be kept on site for the life of mine.

10 INFORMATION GAPS AND RECOMMENDATIONS

Note: Gaps and Assumptions still present themselves; however Matla commits to undertaking necessary steps to ensure that these issues are addressed prior to commissioning of the proposed activities.

10.1 Limitation in data

Information contained in this report is based on data/information supplied to GCS Water and Environment (Pty) Ltd (GCS) by the client and other external sources (including previous site investigation data and external specialist studies). It has been assumed that the information provided to GCS is correct and as such the accuracy of the conclusions made are reliant on the accuracy and completeness of the data supplied

10.2 Applicability of MPRDA Authorisation Process followed

It should be noted that during the various meetings the DMR proposed that a Section 102 process be followed for inclusion of the Matla Stooping process into the Matla Mining Right. It was further suggested by the DMR, that the One Environmental System to be followed for the MPRDDA, NEMA, and NWA approvals.

10.3 Specialist Studies

10.3.1 Soils, Land Use, Land Capability

It has been assumed that the total area of possible disturbance was included in the area of study (no go areas and sites of no access have been excluded), that the mining plan as tabled has documented and catered for all actions and activities that could potentially have an impact on the soils, land use and land capability, and that the recommendations made and impact ratings tabled will be re-assessed if the development plan changes.

Limitations to the accuracy of the pedological mapping (as recognised within the pedological industry) are accepted at between 50% (reconnaissance mapping) and 80% (detailed mapping), while the degree of certainty for the soils physical and chemical (analytical data) results has been based on “composite” samples taken from the dominant soil types mapped in the study area.

The area in question has been mapped on a comprehensive reconnaissance base, the intensity of mapping and geochemical sampling being considered and measured based on the complexity of the soils, the site specifics of the geomorphological aspects (ground roughness, slope, aspect and geology etc.) and a knowledge of the potential impacts that the mining activities being proposed could have on the physical and socio economics of the environment.

10.3.2 Biodiversity

Significant information gaps exist concerning animal species, their habitat requirements, current geographical ranges and consequently their status and sensitivity towards mining developments (such as the proposed project) on local, regional and even national and international scales. Some animal groups have been studied in relative depth and much is known about their ecological requirements; other such as some reptiles (notably the red data species *Homoroselaps dorsalis*) and most invertebrate groups are poorly studied and very little known is about their ecology or status. Many invertebrate groups are usually ignored during EIA assessments since usable information (sensitivities, statuses etc.) is not available and these groups are consequently not included in sensitivity analyses.

In the Red Data Fauna analysis all species listed in the various red data lists (IUCN Red List, EWT Mammal Red Data Assessment for South Africa, Red Data Book, SARCA, etc.) are used to compare the area investigated to other areas in region (based on available desktop information and personal experience and observations) and the different faunal habitats occurring within the study area. Red Data species confirmed or considered likely to be found in the study area are used as indicators of sensitive faunal habitat.

However, many of the “unknowns” (i.e. either poorly studied species, families or orders or species yet to be found and described) may turn out to shift our estimates about specific habitat sensitivity and conservation aims. Therefore, although all due care is applied during the Red Data assessment, it is based on information with a high paucity that could potentially indicate a skewed representation of true species’ and habitat sensitivities.

Time and budget constraints are crucial factors that limit the extent of any field investigation. The more time and sampling effort spend within a study area, the higher the species’ count and consequently the level of detailed, relevant information obtained used during assessments of sensitivity and, in the end, impact assessments and mitigation proposals. Unfortunately, it is not within the scope of environmental impact assessments to spend significantly long periods in the field and obtain large amounts of ecological information relevant to the study area. The field investigator was therefore selective in terms of habitat and animal group focus (i.e. rather focus on areas “known” to be sensitive and search for species “known” to be at risk) in order to maximise the time available in during the field investigation. The field investigation conducted for this project is deemed to include acceptable levels of detailed information obtained; the ecological data accumulated during the two field investigations (wet and dry season) provided an adequate picture of the faunal communities of the study area within the scope of acceptable impact assessment studies.

However, the field investigations were hampered by the exclusion of some of the farms within the study area – access to these areas were denied to the field investigator by the landowners of these properties at the time of the surveys.

10.3.3 Wetlands

While an effort was made to visit every wetland within the 4 additional wetland areas, not every wetland boundary was walked. Extensive cultivation along and within the boundaries of certain wetlands, which results in complete removal of wetland vegetation and disturbs the soil profile, also presented obstacles to accurate delineation of some wetland boundaries on site.

The scale of the remote imagery used (1:10 000 aerial photographs and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to delineated wetlands in the field, result in the delineated wetland boundaries being accurate to about 15m on the ground. Should greater mapping accuracy be required, the wetlands would need to be pegged in the field and surveyed using conventional survey techniques.

Groundtruthing and field verification of wetland boundaries was limited to the study area. Wetlands falling outside the study area boundary were not delineated in the field but are based on desktop mapping.

Reference conditions are unknown. This limits the confidence with which the present ecological category (PES) is assigned.

10.3.4 Hydrology

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

- No flow and rainfall data against which the runoff calculations might be calibrated were available. The runoff volumes were therefore calculated theoretically;
- Since no flow data were available for estimation of the roughness coefficients, the Manning's 'n' coefficients were estimated by comparing the vegetation and nature of the channel surfaces to published data (Barnes, 1967; Chow, 1959; Hicks and Mason, 1991).

10.3.5 Hydrogeology

No stooping schedules were available for the Phase 1 areas, therefore a worst case approach was followed whereby all the areas were simulated to be stooped during the same period.

10.3.6 Heritage Assessment

The following conditions and assumptions have a direct bearing on the survey and the resulting report:

- The significance of the sites, structures and artifacts is determined by means of their historical, social, aesthetic, technological and scientific value in relation to their uniqueness, condition of preservation and research potential. The various aspects are not mutually exclusive, and the evaluation of any site is done with reference to any number of these aspects.
- Cultural significance is site-specific and relates to the content and context of the site. Sites regarded as having low cultural significance have already been recorded in full and require no further mitigation. Sites with medium cultural significance may or may not require mitigation depending on other factors such as the significance of impact on the site. Sites with a high cultural significance require further mitigation.
- The latitude and longitude of any archaeological or historical site or feature, is to be treated as sensitive information by the developer and should not be disclosed to members of the public.
- It has to be mentioned that it is almost impossible to locate all the cultural resources in a given area, as it will be very time consuming. Developers should however note that the report should make it clear how to handle any other finds that might occur.
- In this particular case there were certain areas with dense vegetation which made archaeological visibility difficult. In some instances gates were closed making it impossible to view certain areas.
- It is extremely difficult to predict the position of graves in the landscape. It therefore always is a possibility that more sites than those identified are located inside the surveyed area. The report will however indicate how to deal with these.

10.3.7 Social Assessment

It was decided in 2015 that the social impact assessment will not be required as Phase 1 stooping will only be undertaken on Exxaro and Eskom owned properties.

10.4 Financial Provision

Due to ongoing communication and delays in final approval from ESKOM, an updated Closure Cost Assessment was not yet available.

Golder Associates (Pty) Ltd has been appointed to update the CCA as per GN1147.

11 SPECIFIC CONDITIONS FOR INCLUSION IN THE ENVIRONMENTAL AUTHORISATION

The following specific conditions should be enforced:

- Pan wetlands with a 500m buffer should be excluded from the stooping plan, or alternatively an offset strategy should be investigated before mining commences.

12 REASONED OPINION

The EAPs and environmental consultants responsible for the compilation of this document, and the associated PPP, are of the opinion based on the presented specialist assessments and impact assessment that the proposed operation **should be approved for mining on the condition that the management measures, action plans and monitoring plans are strictly adhered to**.

13 UNDERTAKING

This chapter of the report complies with Section 13 of the EMP Template:
(Section 1 - 13.1): The Environmental Management Programme will, should it comply with the provisions of section 39 (4) (a) of the Act and the right be granted, be approved and become an obligation in terms of the right issued. As part of the proposed Environmental Management Programme, the applicant is required to provide an undertaking that it will be executed as approved and that the provisions of the Act and regulations thereto will be complied with.

The signed undertaking is provided on the next page.

UNDERTAKING

(To be completed upon the final submission)

I, . , the undersigned and duly authorised thereto by Exxaro Resources (Pty) Ltd, have studied and understand the contents of this Environmental Management Programme (EMP) and duly undertake to adhere to the conditions as set out therein, unless specifically or otherwise agreed to.

Signed at , on this , day of 201__

Signature of Applicant

I, .____, the undersigned and duly authorised thereto by the DEPARTMENT OF MINERAL RESOURCES, have studied and approved the contents of this Environmental Management Programme (EMP).

Signed at , on this , day of 20__

Signature of Director

14 LIST OF SPECIALIST REPORTS

This chapter provides a list of the specialist reports which are appended to this EIA/EMP as required by section 2 – 11 and 2 – 16 of the DMR EIA/EMP Template:

The following Specialist studies were undertaken in the period from 2014 to 2015. These reports are attached as Appendix D to this EIA report:

- Hydrogeology Assessment;
- Hydrology Report;
- Soils, Land Use and Land Capability Assessment;
- Biodiversity Assessment including both Flora and Fauna Assessments;
- Heritage Assessment; and
- Wetland Assessment.

Additional studies as listed below, were undertaken in 2016 - 2017 for the consolidation of the EMP. These studies are also attached as Appendix F

- Hydrogeology Assessment;
- Hydrology Report;
- Biodiversity Assessment including both Flora and Fauna Assessments;
- Heritage Assessment; and
- Wetland Assessment.

Biomonitoring results from studies undertaken in 2017 as listed below, were also included where relevant and are attached as Appendix E:

- Fauna and Flora Monitoring of the River Diversion;
- Wetland Monitoring; and
- Biomonitoring.

15 APPENDICES

This EIA/EMP document must be read in conjunction with the following specialist reports, as attached as appendices:

APPENDIX A: A3 FIGURES

APPENDIX B: EMP

APPENDIX C: PUBLIC PARTICIPATION REPORT

APPENDIX D: SPECIALIST ASSESSMENTS FOR STOOPING

APPENDIX E: 2017 SPECIALIST ASSESSMENTS

APPENDIX F: SPECIALIST ASSESSMENTS FOR THE EMP CONSOLIDATION

APPENDIX G: ANGLO-EXXARO LAND SWOP

APPENDIX H: MATLA POLICIES AND PROCEDURES

APPENDIX I: CLOSURE COST ASSESSMENT