HUMBA ENVIRONMENTAL CONSULTANCY

HYDROLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED STEAMBOAT GRAPHITE MINE PROJECT WITHIN THE BLOUBERG LOCAL MUNICIPALITY, LIMPOPO PROVINCE

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DISCLAIMER AND APPROACH

This report provides a description and assessment of identified local hydrological regimes and the larger study area. It also provides a concise description of the proposed development and identifies potential project-related impacts and mitigation measures.

This study does not provide detailed descriptions of the geology, soils, climate of the area, hydrology of the aquatic environments, assessments of surface water quality (sampling), detailed descriptions of aquatic and terrestrial flora and fauna, or provide a detailed review of the legal constraints associated with potential project-related impacts on the environment. It has been assumed for the purposes of this report that these aspects will be the subject of separate specialist studies during the EIA/WUL application processes.

DECLARATION

I, Celia Siebani declare that I –

- act as an independent specialist consultant in the fields of hydrological science;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report; and
- will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

Celia Siebani (***BESc Hydrology and Water Resources***)

Executive Summary

Introduction

Diphororo Development (Pty) Ltd has appointed Humba Environmental Consultancy (Pty) Ltd to undertake a hydrological impact assessment study for the proposed Steamboat Graphite Mine Project situated along the Mogalakwena River, Limpopo Province.

The project name is the Steamboat Graphite Mine Project, related to the farm name on which the project occurs, "Steamboat". Cuchron (Pty) Ltd holds a valid Prospecting Right (LP/5/1/1/2/10321PR) for Graphite over the farm's Steamboat 306MR and Inkom 305MR, covering a combined area of 1,453 hectares. Steamboat Graphite (Pty) Ltd will establish a Beneficiation Plant in proximity to the mine, to beneficiate and process the graphite for a broader market.

This study contributes to a suite of specialist studies as required for environmental and water use authorisation processes in terms of the requirements of the National Environmental Management Act (Act 107 of 1998) and the National Water Act (Act No. 36 of 1998).

The Receiving Environment

The project is located on the farm's Steamboat 306MR and Inkom 305MR, which are situated approximately 36km south-west of Alldays and 54 km north-west of Vivo in the Blouberg Local Municipality, Capricorn District of Limpopo Province.

The Steamboat Project Mining Right Area is located within Quaternary catchment A63B in the Limpopo Water Management Area. Quaternary catchment A63B is drained by the perennial Mogalakwena River flowing in a northerly direction and which is fed by the westward-flowing Lekoeng, Seepabana, Matlalane, Klein Mogalakwena rivers and a number of unnamed tributaries. The area around the project site is generally flat, with elevation ranging between 748 and 1008 mamsl.

The catchment Mean Annual Precipitation (MAP), and Mean Annual Evaporation (MAE), respectively, are 398.1 mm and 2003.2 mm, respectively. The evaporation in the area is relatively higher than the amount of rainfall this catchment receives.

The region generally experiences a hot semi-arid climate. Summer days are hot with temperatures varying between 28°- 34° C from October to March, and winter day temperatures vary between 19.6°- 25.2° C from April to September.

The naturalised runoff around the project site is simulated at a unit runoff of 15 mm per annum. The runoff, when expressed as a percentage of rainfall, equates to 1.5%. Streamflow data for station Leniesrus (A6H035) at Mogalakwena River was obtained to understand the streamflow and used to calculate peak flows.

Flood line Determination

Sub-catchments were delineated for the determination of flood lines on the Mogalakwena River reach that would be influenced by the proposed Steamboat graphite mine project.

The topographical data formed the foundation for the HEC-RAS model and was used to extract elevation data for the river profiles together with the river cross-sections. The topographical data was also used to determine the positions at which the cross-sections were taken along the river profile, so that the watercourse could be accurately modelled and thus formulate a deterministic and definitive potential for the risk of negative impacts from the proposed mining activities.

Floodlines for the 1:50-year and 1:100-year recurrence intervals were determined for the Mogalakwena River passing through the project site. The proposed project and mine surface infrastructure were determined to be located outside the 1:50- and 1:100-year floodlines. The proposed project and mine surface infrastructure were also located outside the 100m buffer from the watercourse.

Surface Water Impact Assessment

Informed by the site layout, baseline hydrological regime and floodline assessment results, the potential impacts of the proposed activities on surface water receptors and the sensitivity of the surface water resources were discussed and presented along with a summary of mitigation measures and monitoring requirements.

The impacts of the proposed activities and the infrastructure were identified and then assessed based on the individual impact's magnitude, duration, probability, extent, severity and consequences and the receptor's sensitivity. This analysis then culminated in the determination of the impact significance which indicated the most important impacts and those that required management. The local surface water resources were assessed to be of low sensitivity against the proposed mining activities.

Recommendations

The following recommendations were made:

- It was recommended that a site-wide water balance, that considered extremes of climate, unsteady processing/production rates and storage within any aspect of the operation (such as would be required to fill process water dams prior to initial start-up or drawdown stored water through the dry season) be formulated.
- A surface water quality monitoring program starting with an establishment of a baseline water quality must be undertaken. The water quality must be compared against the permissible guidelines provided by the DHSWS.
    - Water quality monitoring must be undertaken at rivers in proximity as well as sediment ponds before discharge into the environment.
- A stormwater management plan consisting of detailed stormwater design and sizing of channels and storage containment facilities was also recommended.

In addition to the measures presented and discussed throughout this report, the following management measures should be implemented:

- Good housekeeping practices must be implemented and maintained by the immediate cleaning up of accidental spillages and ensuring all dislodged materials such as debris and run-of-mine stockpile during blasting are kept within confined storage footprints.
- A service/maintenance plan must be compiled and implemented. The plan must encompass procedures to minimize any impacts on the surrounding environment.
- Dirty water trenches must be constructed around stockpile areas to capture all dirty water runoff and must be channeled to a dirty water containment structure.

- Concurrent rehabilitation is encouraged during the operation of the mine to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff
- Revegetation of disturbed areas with indigenous plant species should be performed immediately following application of a suitable growth medium to avoid erosion.
- Phasing/scheduling of earthworks can minimise the footprint that is at risk of erosion at any given time, or schedule works according to the seasons as far as operably possible.
- In the case of linear earthworks, phasing of working areas and concurrent rehabilitation will be necessary to minimise the footprint of a disturbed area at any given time.
- Wastewater with noxious chemicals from bulk tank cleaning should be collected through appropriate on-site or offsite treatment prior to discharge.

All measures implemented to mitigate impacts should be regularly reviewed as best practice and compliance with various licenses issued on site by authorities. It is the view of the author of this report that the project can continue if all mitigation and monitoring measures are to be implemented as no fatal flaws were identified.

Table of Contents

List of Figures

List of Photographs

List of Appendices

List of Tables

Acronyms and Abbreviations Used

Alt.	Alternative
DEM	Digital Elevation Model
DHSWS	Department of Human Settlement, Water and Sanitation
DMRE	Department of Mineral and Energy
EIA	Environmental Impact Assessment
GN 704	Government Notice 704
ha	Hectare
HEC-RAS	Hydrologic Engineering Centre's River Analysis System
km	Kilometre
LC	Length to Centroid
m^3/s	Cubic Metres
MAE	Mean Annual Evaporation
mamsl	Metres above Mean Sea Level
MAP	Mean Annual Precipitation
MIPI	Midgley and Pitman
mm	Millimetre
MR	Mining Right
MRA	Mining Right Area
n	Gauckler (manning Coefficient)
NWA	National Water Act (Act No. 36 of 1998)
NASADEM	National Aeronautics and Space Administration Digital Elevation Model
NEMA	National Environmental Management Act (Act No.107 of 1998)
RM2	Rational Method 2
Sanral	South African National Road Agency
SC	Sub-catchment
SDF	Standard Design Flood
SRTM	Shuttle Radar Topography Mission
WMA	Water Management Area
WR	Water Resource
WRC	Water Research Commission

1. Terms of Reference

Diphororo Development (Pty) Ltd (hereafter referred to as the Client) has appointed Humba Environmental Consultancy (Pty) Ltd (hereafter referred to as Humba) to undertake a hydrological impact assessment study for the proposed Steamboat Project (hereafter referred to as the 'Project') situated along the Mogalakwena River, Limpopo Province (Figure 1-1).

1.1. Project Background

The project name is the Steamboat Graphite mining Project, related to the farm name on which the project occurs, "Steamboat". Cuchron (Pty) Ltd (hereafter referred to as Cuchron) holds a valid Prospecting Right (LP/5/1/1/2/10321PR) for Graphite over the farm's Steamboat 306MR and Inkom 305MR, covering a combined area of 1,453 hectares. Steamboat Graphite (Pty) Ltd (hereafter referred to as Steamboat Graphite) will establish a Beneficiation Plant in proximity to the mine, to beneficiate and process the graphite for a broader market.

A Mining Right Application was submitted by Cuchron for the proposed mine development, and acceptance was received on the 12th of November 2020.

Two Environmental Authorisation Applications have been submitted to date:

- Cuchron has applied for Environmental Authorisation for the mine development and associated infrastructure
- Steamboat Graphite has applied for the Environmental Authorisation for the beneficiation plant and associated infrastructure.

Approval has been received from Department of Mineral Resources and Energy (DMRE) to follow a joint and consolidated approach to the Environmental Impact Assessment (EIA) process and produce combined reports for the two applications as envisaged in terms of Regulation 11(4) of the EIA regulations 2014 (as amended).

1.2. List of Mining Activity Alternatives

1.2.1. Open Pit Mining

No site location alternatives have been considered as mining can only be undertaken in areas where economically mineable resources occur. This area was established through extensive prospecting and geological modelling.

1.2.2. Mining Workshops and Offices

Two alternative positions are being considered for the placement of the mine workshops and offices. The selection of the two alternatives were based on preliminary environmental factors such as topography and hydrology.

1.2.3. Beneficiation Plant

Two site location alternatives were considered for both the beneficiation plant and its associated infrastructure and the discard stockpile. The selection of the two alternatives was based on preliminary environmental factors such as topography and hydrology.

1.3. Study Objectives

This study contributes to a suite of specialist studies as required for water use and environmental authorisations processes in terms of the requirements of the National Water Act (Act No. 36 of 1998) (NWA) and National Environmental Management Act (Act No.107 of 1998) (NEMA).

1.4. Scope of work and Report Structure

The scope of work and structure of the report is as follow:

- The Receiving Environment – Chapter 2 presents a review and analysis of various sources of rainfall and evaporation data. The section also presents the characterisation of the site's baseline hydrology and surroundings, including topography, watercourse network, and catchment delineation.
- Floodlines – Chapter 3 presents the 1:50-year and 1:100-year floodlines for the Mogalakwena River reach near the proposed project. Floodlines were plotted with the proposed mine infrastructure to identify any potential encroachment.
- Impact Assessment – Chapter 4 presents a quantitative impact assessment of the significance of the project's impact on the baseline surface water environment, a range of mitigation measures to minimise the impacts, and recommendations on the monitoring required.
- Alternatives Assessment – Chapter 5 presents an assessment of alternatives to various mining activities.
- Conclusions and Recommendations – Chapter 6 summarises this report's main conclusions and a summary of the recommendations made based on this study.

1.4.1. Information Sourcing and Literature Review

A review of various information sources was undertaken to define the baseline climatic and hydrological conditions of the site and surroundings. A hydro-meteorological analysis and floodline assessments were carried out using the data obtained from the following sources:

- The South African Water Resources Commission Database (WR2012) (WRC, 2021) database to characterise the regional climate.
- The South African Atlas of Climatology and Agro-hydrology (WRC, 2008) was used to classify general land cover.
- Topographical survey data provided by the client (1m contour and survey points data).
- NASADEM for understanding the regional topography and drainage pattern.
- Aerial Imagery on the world map (Google Earth).

1.5. Legislation and Policy Context

The following pieces of legislation were taken into account during this assessment:

1.5.1. The National Water Act (Act 36 of 1998)

Water resources management in South Africa is governed by the NWA. The Department of Human Settlements, Water and Sanitation (DHSWS) must, as custodians of water, ensure that resources are used, conserved, protected, developed, managed and controlled sustainably for the benefit of all persons and the environment. The NWA repealed many of the powers and functions of the Water Act of 1956. Key provision applying to the current study include:

- Catchment Areas - Any disturbance to a watercourse, such as the construction and operation of surface mining infrastructure, may require authorisation from DWS.

1.5.2. Regulations on the use of Water for Mining and Related Activities

Government Notice 704 (Government Gazette 20119 of June 1999) (hereafter referred to as GN704) was established to provide regulations on the use of water for mining and related activities aimed at the protection of water resources. The primary condition of GN704 applicable to this project is:

- Regulation 4 – indicates that no person in control of a mine or activity may locate or place any residue deposit, dam, reservoir, together with any structure of other facilities within the 1:100-year flood line or within a horizontal distance of 100-metre from any watercourse.

1.5.3. Implications for the proposed project:

- Any proposed water uses must be specified and registered, and licensed.
- Any modifications to natural drainage lines on site must be investigated in terms of water use requirements.
- The developers are responsible for taking reasonable measures to prevent water resources pollution that it owns, controls, occupy or uses on the land in question.
- The developers must remedy a situation where pollution of a water resource occurs following an emergency incident and where it is responsible for the incident or owns or is in control of the substance involved.
- The applicant must take all reasonable measures to minimise the incident's impacts, undertake clean-up procedures, remedy the effects of the incident, and implement measures as directed.

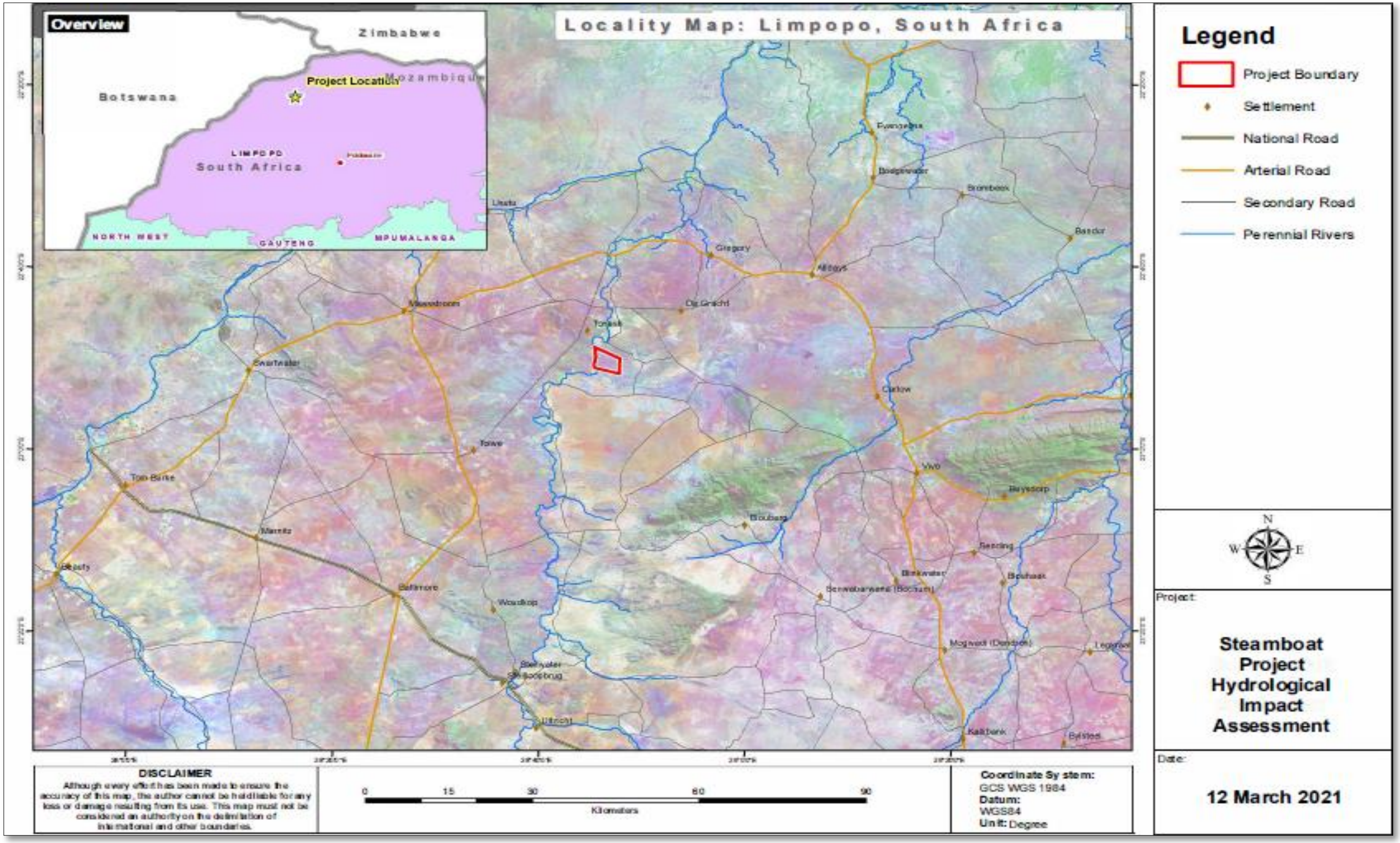


Figure 1-1: Location of the Proposed Project

2. The Receiving Environment

This section describes the baseline description of the proposed project's environment, which provided a fundamental understanding of the hydrological impact assessment.

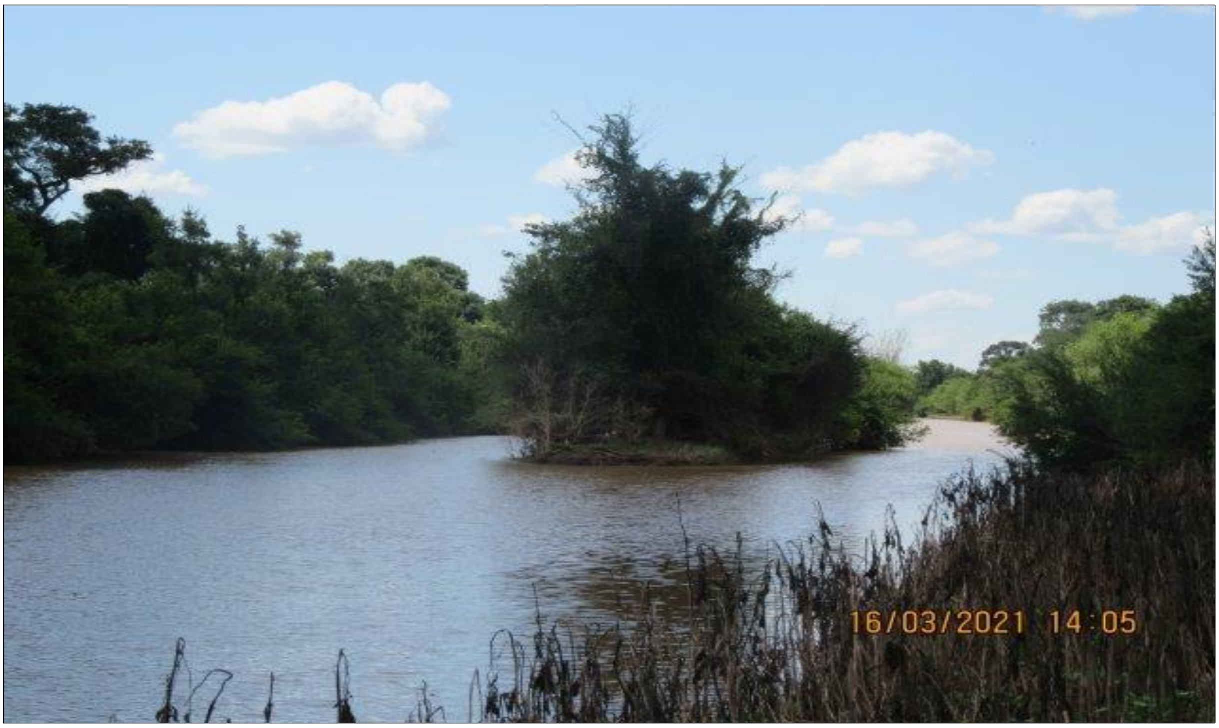
2.1. Locality

The project is located on the farm's Steamboat 306MR and Inkom 305MR, which is situated approximately 36km south-west of Alldays and 54 km north-west of Vivo in the Blouberg Local Municipality, Capricorn District of Limpopo Province. The total extent of the properties is 1453.6 ha.

2.2. Site Walkover

Humba's specialists undertook a site walkover on the 16th of March 2021 to understand the natural drainage around the area and observe catchment characteristics. The study area's overall hydrological regime was studied and understood. Pictorial evidence was also gathered as presented between Photograph 2-1 and Photograph 2-3.

Photograph 2-1: The Mogalakwena River and its Floodplain



Photograph 2-2: The Mogalakwena River Channel

Photograph 2-3: Evidence of Flooding on the Mogalakwena River Bed.

2.3. Topography

The area around the project site is generally flat, with elevation ranging between 748 and 1008 mamsl. The project falls within the South African topographical division Central Mountain Plateau, there is a marked drop in altitude to the south of tertiary catchment A6. The Central Mountain Plateau forms a largely flat, tilted surface which, as indicated above, is highest in the east, sloping gently downwards to the west (at about 1,000 m above sea level). To the north of the plateau, the terrain becomes undulating and slopes down towards the Limpopo River Valley while flat plains occur to the west.

2.4. Climate

The region generally experiences a hot semi-arid climate. Summer days are hot with temperatures varying between 28°- 34° C in October to March, and winter day temperatures vary between 19.6°- 25.2° C in April to September. The average rainfall is 400 - 650 mm. The rainfall period occurs from November to February. The highest rainfall occurs in January and December.

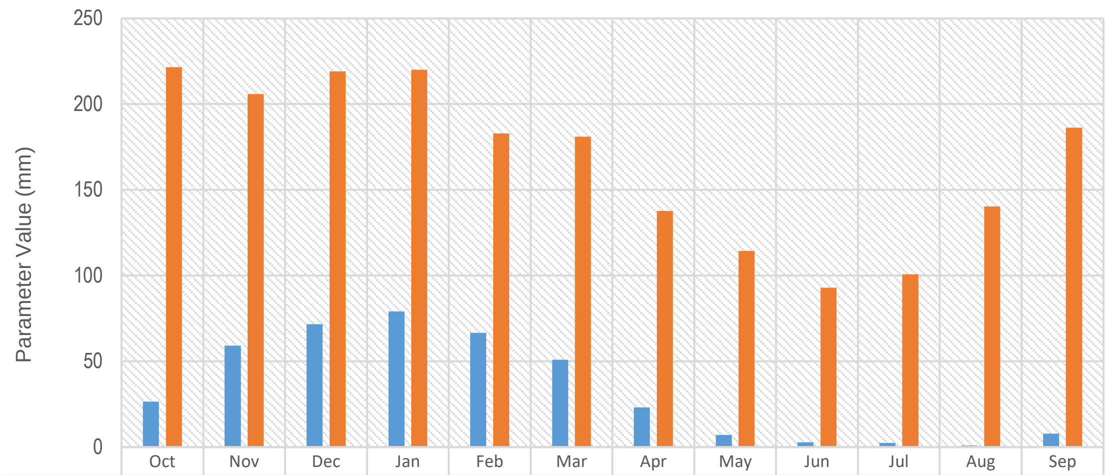
2.4.1. Meteorological Characteristics

This project site climate data was obtained from the Water Resources study (WR2012) study (WRC, 2021), which comprises the climatic and catchment information of each quaternary catchment in South Africa. The average hydro-meteorological parameters were calculated for quaternary catchment A63B. The hydro-meteorological parameters are summarised in Table 2-1.

The catchment Mean Annual Precipitation (MAP), and Mean Annual Evaporation (MAE), respectively, are to be 398.1 mm and 2003.2 mm, respectively. The evaporation in the area is relatively higher than the amount of rainfall this catchment receives. The monthly distribution of the rainfall and evaporation are presented in Figure 2-1.

Table 2-1: Summary of Hydro-climatic Parameters around the Project Site (WRC, 2021) (mm)

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Mean
Rainfall	26.5	59.1	71.8	79.1	66.6	50.9	23.1	7.2	2.7	2.4	0.9	7.8	398.1
Evaporation	221.6	205.8	219.2	220	183	181	137.8	114.4	93	100.8	140.4	186.2	2003.2
Runoff	0.02	0.24	0.47	1.56	2.39	1.06	0.18	0.02	0.01	0.01	0.01	0.01	5.99



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall	26	59	72	79	67	51	23	7	3	2	1	8
Evaporation	222	206	219	220	183	181	138	114	93	101	140	186

Figure 2-1: Rainfall and Evaporation distribution around the Project Site.

2.5. Local and Regional Hydrology

The proposed project falls in quaternary catchment A63B located within the Limpopo Water Management Area (WMA 1). Quaternary catchment A63B is drained by the perennial Mogalakwena River flowing in a north direction fed by the westward-flowing Lekoeng, Seepabana, Matlalane, Klein Mogalakwena and a number of unnamed tributaries. The hydrology around the site is presented in Figure 2-3.

2.5.1. Catchment Runoff

The WRSM2000/Pitman Software is a mathematical model that simulates the movement of water through an interlinked system of catchments, river reaches, reservoirs, irrigation areas and mines (WRC, 2012). WRSM2000 simulates naturalised runoff around the project site at a unit runoff of 15 mm per annum. The runoff, when expressed as a percentage of rainfall, equates to 1.5%. The monthly runoff is likely to be distributed as presented in Table 2-1.

2.5.2. Streamflow

Streamflow data for station Leniesrus (A6H035) at Mogalakwena River was obtained to understand the streamflow and used to calculate peak flows. A peak stream flow value of 661 m^3/s was recorded in the year 2000.

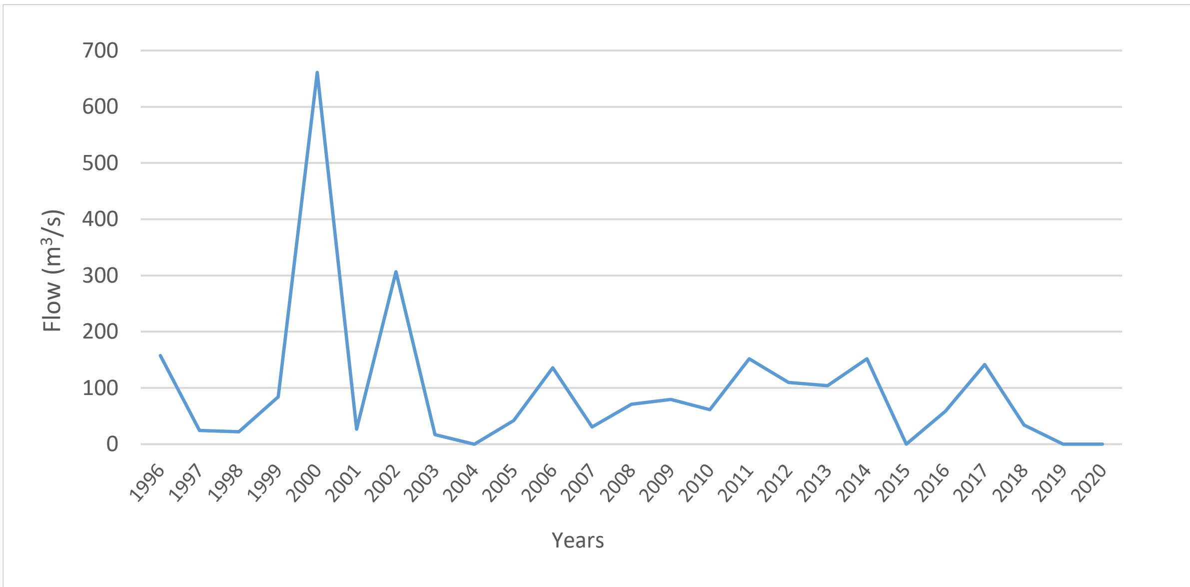


Figure 2-2: Streamflow Distribution for Station A6H035

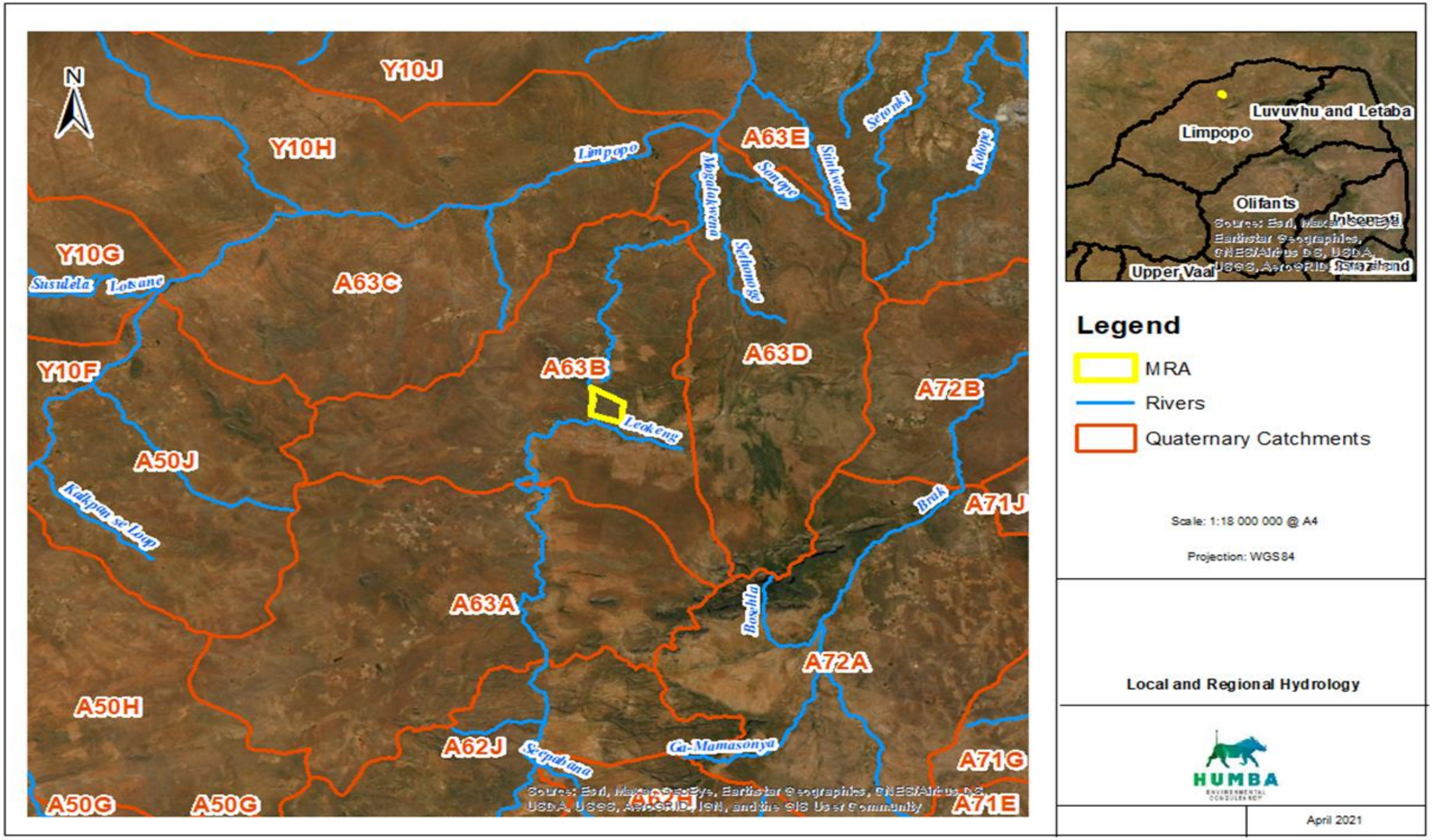


Figure 2-3: Local and Regional Hydrology around the Project Site

3. Floodlines Determination

3.1. Methodology

The floodline determination and assessment methodology followed is discussed in the subsections below.

3.1.1. Topographical Data

The topographical data forms the foundation for the HEC-RAS model and is used to extract elevation data for the river profile together with the river cross-sections. The topographical data is also used to determine placement positions for the cross-sections along with the river profile so that the watercourse can be accurately modelled.

A digital elevation model (DEM) was obtained for the greater catchment from the NASADEM data products at 1 arc second resolution. NASADEM extends the legacy of the Shuttle Radar Topography Mission (SRTM) by improving the DEM height accuracy and data coverage and providing additional SRTM radar-related data products. The improvements were achieved by reprocessing the original SRTM radar signal data and telemetry data with updated algorithms and auxiliary data not available at the time of the original SRTM processing. The NASADEM was used for catchment delineation and to develop a floodlines model.

3.1.2. Flood Hydrology Calculations

Seven (7) methods were used to determine design flood peaks for the delineated catchment including upstream contributing catchments (**Error! Reference source not found.**) at the site. The underlying assumption is that the largest possible peak flow will be observed when the storm rainfall event has a duration equal to the time of concentration of the catchment, i.e., the time required for the entire catchment to contribute runoff at the outlet (SANRAL, 2013). The seven methods that were used to evaluate the relevant design flood peaks for the site are as follows:

- Rational Method (RM2), as implemented by the DHSWS.
- Rational Method Alternative 3.
- Empirical Method (Midgley and Pitman) (also referred to as MIPI).
- Standard Design Flood (SDF) method as developed at the University of Pretoria.
- The Unit Hydrograph method.
- Log Pearson III method.
- Log Pearson Normal method.

3.2. Floodlines Hydraulic modelling

Floodlines for the watercourse were determined for the 1:50-year and 1:100-year recurrence interval storm events. The Mogalakwena River reach included in the analysis was agreed upon in the proposal phase of this study.

3.3. Choice of Software

HEC-RAS 5.0.7 (US Army Corps of Engineers, 1995) was used to model the flood elevation profile for the 1:50-year and 1:100-year flood event. HEC-RAS is a hydraulic programme designed to perform one- or two-dimensional hydraulic calculations for a range of applications, from a single watercourse to an entire network of natural or constructed channels. The software is used worldwide and has consequently been thoroughly tested through numerous case studies.

3.4. Assumptions in the hydraulic model

In line with the development of the floodlines, the following assumptions were made:

- The topographic data used is of sufficient accuracy and coverage to enable hydraulic modelling at a suitable level of detail;
- The Manning's 'n' value used is considered suitable for use in all the modelled storm events (1:50 and 1:100-year events), as well as in representing both the channel and floodplain;
- Levees have been added to confine the modelling to the observed channels;
- Steady-state hydraulic modelling was undertaken, which assumes the flow is continuous at the peak rate: and,
- The latest layout of the proposed mine was used.

3.5. Limitations

The surveyed data (Contour data) provided did not cover the entire floodplain of Mogalakwena River. A such, the NASADEM was used for modelling purposes. The floodlines are therefore indicative floodlines and are deemed sufficient for planning purposes. For detailed mine infrastructure design, these should be updated using site wide surveyed data.

3.6. Flood hydrology

3.6.1. Catchment delineation

One sub-catchment was delineated for the purposes of modelling the Mogalakwena River reach. The sub-catchment characteristics are shown in Table 3-1 and Figure 3-1.

Table 3-1: Sub-Catchment Characteristics

Parameter	Parameter Value
Subcatchments Name (SC)	SC1
Area (km^2)	9095
Length of the longest watercourse (km)	386.0
LC - Distance to catchment centroid (km)	249.6
Equal area height difference (m)	177
Slope	0.002

*LC – is the distance from the catchment centroid to the catchment outlet along the longest river.

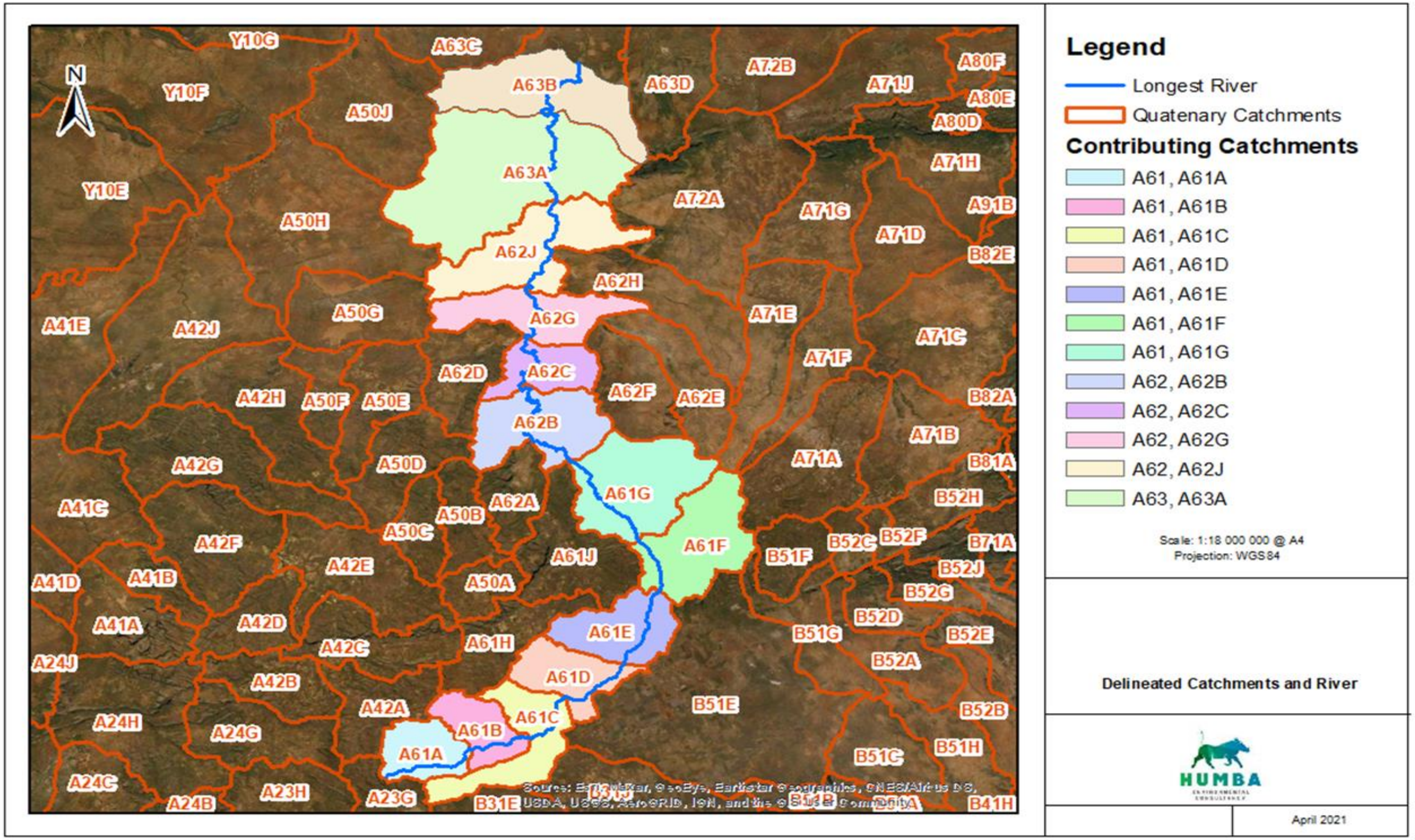


Figure 3-1: Quaternary Catchments Contributing to Peakflows

3.6.2. Flood Peak Estimates and boundary conditions

Design peak flows for the 1:50- and 1:100-year recurrence intervals were computed for the study site's watercourse using the methodologies listed in Section 3.1.2. This was undertaken to compare the results obtained by these methods. The comparison of the different flood peaks using different methods can be seen in Table 3-2.

Table 3-2: Results of the Deterministic Flood Peak Calculations in m^3/s

Method	Recurrence Interval	
	1:50-year	1:100-year
Rational Method 2 (RM2)	782.1	1013.2
Alternative Rational Method (RM3)	**1252.7**	**1584.0**
Unit Hydrograph	580.0	808.2
Standard Design Flood Method	1236.8	1573.7
Empirical Method (MIPI)	466.5	583.1
Statistical Method: Log-Normal	544.4	696.8
Statistical Method: Log Pearson III	611.5	910.4

The RM3, SDF, and Unit Hydrograph methods resulted in flood peaks of similar magnitude while MIPI resulted in flood lowest peaks. Flood Peaks calculated using the RM3 were adopted because they were deemed as the most conservative.

3.7. Roughness coefficients

The Manning's roughness factor "n" is used to describe a specific surface's flow resistant characteristics. Based on the site visit undertaken, it was observed that Mogalakwena River is a clean, straight, full stage, no rifts or deep pools type of a channel. Based on the Manning's n for Channels (Chow, 1959), an "n" value of 0.03 was assigned to the channel and 0.33 to the banks (floodplains).

3.8. Floodline Delineation

Floodlines for the 1:50-year and 1:100-year recurrence intervals were determined for the river passing through the project site. The proposed project and mine surface infrastructure are located outside the 1:50- and 1:100-year floodline. The delineated floodlines are presented in Figure 3-2. The proposed project and mine surface infrastructure are also located outside 100m buffer from the watercourse; this is presented in Figure 3-3. The longitudinal flood profile is provided in Appendix A.

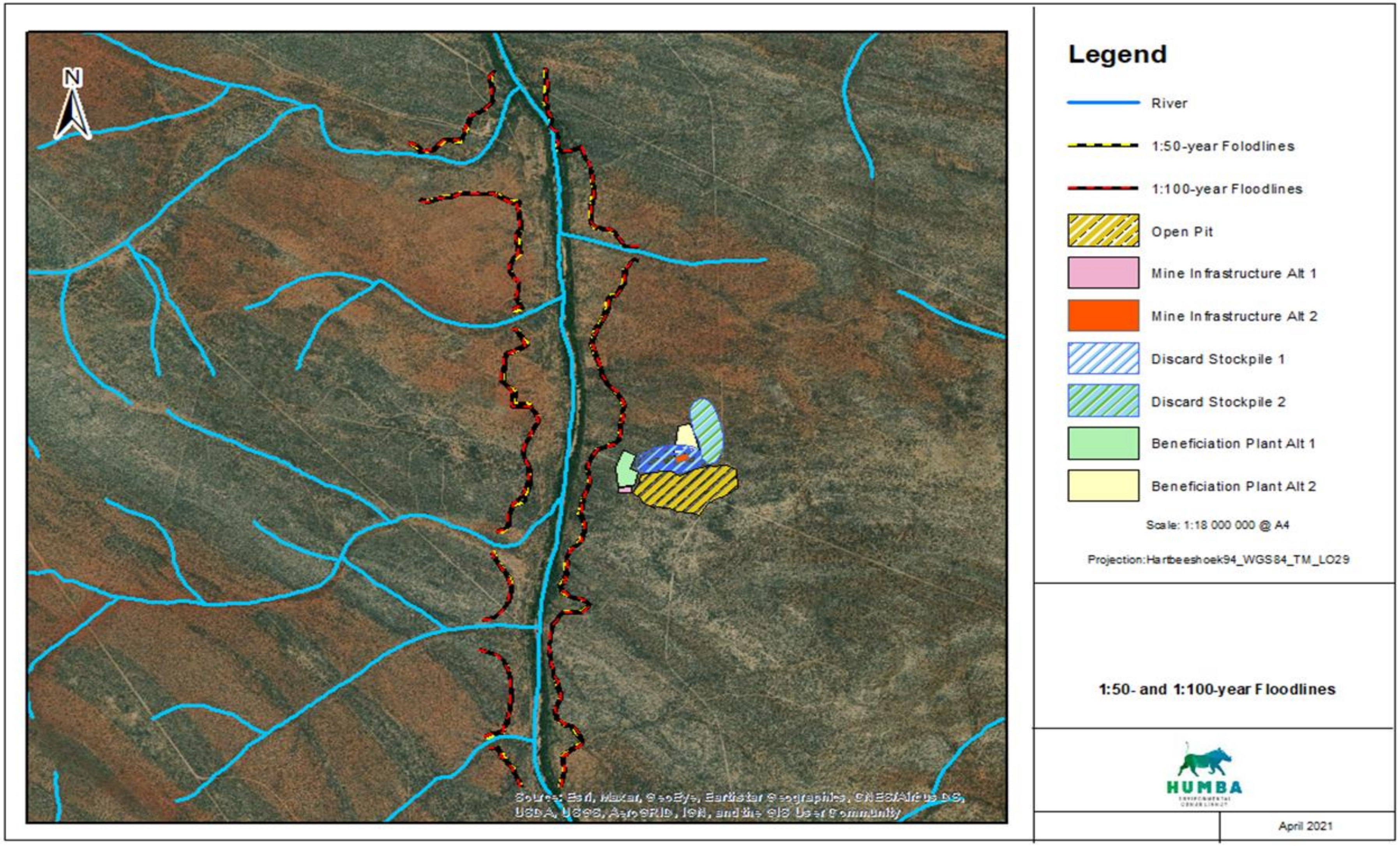


Figure 3-2: 1:50-year and 1:100-year floodlines for the Mogalakwena River

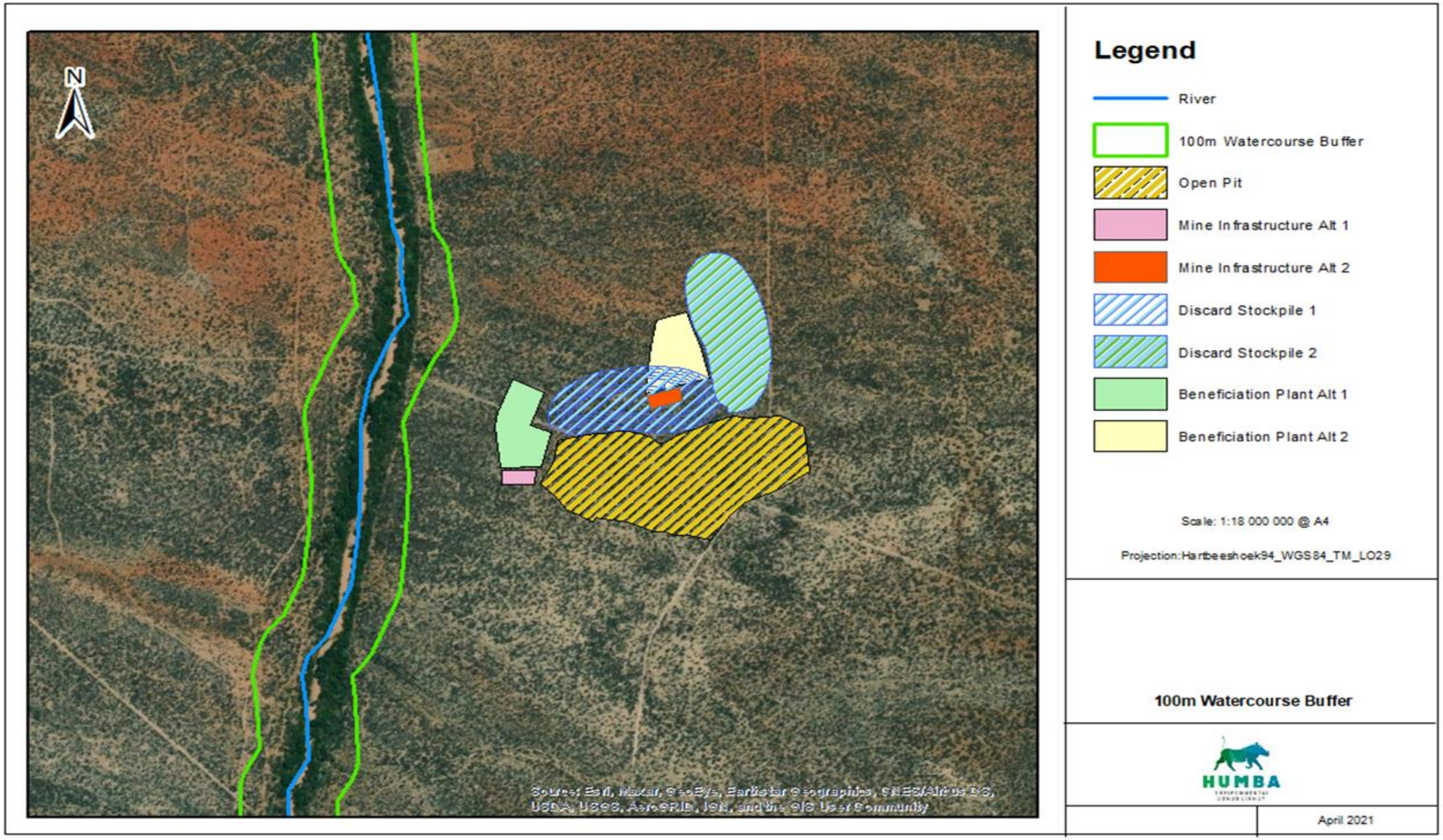


Figure 3-3: 100m Watercourse Buffer

4. Surface Water Impact Assessment

Informed by the site layout, baseline hydrology and floodlines results, the potential impacts of the proposed activities on surface water receptors and the sensitivity of the surface water resources are discussed in this section and presented along with a summary of mitigation measures and monitoring requirements.

4.1. Surface Water Sensitivity

The local surface water resources are of high sensitivity; the rationale for this sensitivity assessment is as follows:

- The project site is in the low-lying areas of the quaternary catchment A63B, which are largely rural. The catchment is mostly taken up by rural areas where natural flows are through preferential flow and natural drainage, as such, the probability of the catchment self-rehabilitating is high.
- Based on a review of the project description and listed activities in the previous section, a total of about 1453.6 ha (14.54 km^2) is proposed for mining and supporting infrastructure. This area is 0.28% of the total extent of quaternary catchment A63B, thereby implying a small, disturbed area of impacts.
- It was also observed that the Mogalakwena River has been flooded numerous times with high-water marks on the banks evident as can be seen in Photograph 2-3 and as such, it is of high sensitivity as the area receives relatively large amounts of rainfall and storms of higher magnitude.

4.2. Impact Assessment methodology

Identification of the possible impacts posed by the conducting of significant activities on the surface water resources has been undertaken for the three main stages of the project life cycle, namely the construction, operation and decommissioning and closure phases.

Impacts are assessed cumulatively where possible, in that the assessment considers the currently impacted environment. The impact rating methodology is presented in Appendix B.

4.3. Impact Description

Identification of the impact of the major activities on the surface water resources have been carried out for the three main stages of the project namely the construction, operation and closure phases and are discussed in subsections below and are summarised in Table 4-1.

4.3.1. Surface Water Resources Contamination due to Mining activities.

There are several potential sources of pollution in various project phases that can potentially pollute surface water, particularly in the unmitigated scenario. In the construction, decommissioning and closure phases, these potential pollution sources are temporary and diffuse. Although these sources may be temporary during the construction and decommissioning, and closure phases, they will be regular during the operational phase. The operational phase will present more long-term potential sources of pollution.

Deterioration of water quality may be as a result of the following:

- Clearing the surface and site preparations for the mine infrastructure resulting in the exposure of soil surfaces to erosion. When a large area of vegetation is cleared and topsoil disturbed, it exposes a large area of loose material which is susceptible to erosion. During rainfall events, runoff from the exposed site will transport the soil material into the Mogalakwena River.
- Poor management of waste during the construction phase, if not adequately managed, may occur and cause pollution. Typically, the following pollution sources may exist at the site: fuel and lubricants, chemicals, general waste, and erosion of particles from exposed soils in the form of suspended solids.
- The discharge of wastewater into the river, depending on the waste discharge options, may compromise the Mogalakwena River's water quality status.

4.3.2. Alteration of Drainage and Flow due to Mine Surface Infrastructure

Natural drainage across the project area is via preferential flow paths (natural drainage line). The development of the mine will alter the affected area's hydrologic response and, potentially, the entire catchment. Development of the mine and associated surface infrastructure implies that beneficial vegetation will be replaced by impervious surfaces, reducing the site's pre-developed evapotranspiration and infiltration rates. The proposed mine infrastructure covers 0.28% of quaternary catchment A63B.

The location of surface infrastructure in relation to surface water bodies is imperative to understanding the impacts of alteration of drainage and natural flow. Construction and operation of the mine infrastructure such as offices, workshops and the mine plant may increase runoff reporting to the Mogalakwena River through an acceleration of runoff on impervious surfaces.

With adequate rehabilitation and closure, some of the catchment is returned to self-sustaining systems, and natural drainage patterns will be restored.

4.3.3. Soil Erosion and Sedimentation

Site clearing, digging of trenches and topsoil removal will be undertaken during construction of various infrastructures such as the beneficiation plant, offices, workshops, the discard stockpile, and open pit might lead to erosion and consequently siltation of watercourses.

The project could cause water resources pollution through sediment transport and other chemical parameters from runoff from the surface operations. The impact of sedimentation is directly linked to erosion, as eroded soil particles will end up in nearby watercourses as sedimentation. The resultant consequences of sedimentation may be elevated turbidity that is likely to impact macroinvertebrates and other aquatic species.

Table 4-1: Summary of Project Activities, Interaction, Potential Impacts and Corrective Measures to Surface Water Resources

Impact	Project Activities	Impact Description	Mitigation Measures
Construction Phase			
Water Quality Deterioration	Operation of construction machinery and vehicles and storage of potential pollutants associated with site clearing, stripping and stockpiling of soil resources, and construction of surface mine infrastructure (Open-pit, office, workshop, beneficiation plant and discard stockpile)	Deterioration of water quality as a result of the following • Clearing the surface and site preparations for the mine infrastructure will result in the exposure of soil surfaces to erosion factors. During rainfall events, runoff from the exposed site will transport the eroded soil material into the nearby water resources. • Uncontrolled spills of contaminants such as fuel and oils from moving vehicles and machinery, and subsequent washing away of these into the surface water resources.	• Drip trays should be placed under all standing machinery. • Oil recovered from any vehicle or machinery on-site should be collected, stored and disposed of by accredited vendors for recycling. • Traffic and movement over stabilised areas should be controlled (minimised and kept to specific paths), and damage to stabilised areas should be repaired timeously. • A water quality monitoring plan must be formulated before construction.
Soil Erosion and Sedimentation	Initial earthworks linked to Site clearing, stripping and stockpiling of soil resources, preparations and construction of new surface infrastructure.	• Site clearing, digging of trenches, and topsoil removal will be undertaken during the construction of various mine infrastructure such as mine plant, beneficiating plant, which might lead to erosion and consequently siltation of watercourses. • The project could cause water resources pollution through sediment transport and other chemical parameters from runoff from the surface operations. • The risk of sedimentation is directly linked to the risk of erosion, as eroded soil particles will end up in nearby watercourses as sedimentation.	• Construction must be undertaken during the dry season (i.e., between April and August). This will significantly reduce the potential for sedimentation through erosion due to construction activities. • Concurrent rehabilitation of disturbed land and revegetation should be carried out to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.
Alteration of Flow and Drainage	Construction of surface infrastructure such as mine plants, offices and stockpiles.	• A reduction of runoff water quantity to the surface water resources system will occur due to mine infrastructure. The catchment area for runoff will be reduced by 0.28%.	• A construction work method statement must be compiled by the applicant/contractor for all activities and phases associated with the construction process.

			• A stormwater and management plan study must be undertaken.
	Operational Phase		
Water Quality Deterioration	Operation of the open pit mining, stockpiling, processing and operation of surface infrastructure (stockpiles, workshops & offices, crushing and screening plant).	Deterioration of water quality as a result of the following: • Potential pollutants such as oils, solvents, paints, fuels and waste materials and discharge of dirty water into the catchment when extreme events do occur. Some of the structures may have the potential for seepage, such as the stockpile area • The project could cause pollution of water resources through sediment transport and other chemical parameters from runoff from the pit waste and plant areas.	• Drip trays should be placed under all standing machinery. • Water quality monitoring as per the described monitoring plan specified in Section 4.6 • A stormwater management plan that separates dirty and clean water must be developed.
Soil Erosion and Sedimentation	Operation of open pit and stockpiles.	• Increased soil erosion emerging from uncompacted soils around the pit and stockpiles.	• A service/maintenance plan must be compiled and implemented. The plan must encompass procedures to minimise any impacts on the surrounding environment. • Dirty water trenches must be constructed around stockpile areas to capture all dirty water runoff and must be channeled to a dirty water containment structure. • Concurrent rehabilitation is encouraged during the operation of the mine to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff
Alteration of Flow and Drainage	Moving vehicles during operation phase could result in compacted surfaces. Potential abstraction of water from the River. Discharge of excess water.	Impacts on hydrological regime due to operational activities such as: • Increased runoff emerging from compacted paved surfaces. • There may be a need to abstract water from Mogalakwena or discharge of excess water to the environment after processing reuse. The excess water discharge could result in an alteration of	• A stormwater management plan that channels runoff and separate dirty and clean water must be formulated as per the requirements of GN704. • A water balance study must be undertaken

		the flow regime of the streams. This impact was not assessed because a water balance study was not provided.	
Closure-Decommissioning Phase			
Water quality Deterioration	Cessation of the mining and the removal and demolition of surface infrastructure and rehabilitation.	• Removal and handling of hazardous waste offsite and waste storage facilities, damage to waste handling facilities resulting in water quality deterioration. • Impacts on water quality due to maintenance activities around the watercourses.	• Drip trays should be placed under all standing machinery. • Water quality monitoring as per the described monitoring plan specified in Section 4.6.
Soil Erosion and Sedimentation	Cessation of the mining and the removal and demolition of surface infrastructure and rehabilitation.	• Increased soil erosion emerging from uncompacted soils around the demolished mine.	• Decommissioning activities must be undertaken during the dry season (i.e., between April and August). This will significantly reduce the potential for sedimentation and erosion. • Concurrent rehabilitation of disturbed land should be carried out to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.
Alteration of Flow and Drainage (Positive Impact)	Cessation of the mining and the removal and demolition of surface infrastructure and rehabilitation.	• With adequate rehabilitation and closure, some of the catchment is returned to a self-sustaining system. Return of natural drainage patterns as a result of freely draining topography.	• No mitigation required since this is a positive impact the natural environment is rehabilitated.

4.4. Impact Rating

This section assesses the significance of potential unmitigated impacts (unrealistic worst-case scenario), and residual impacts of the project after considering the design mitigation measures proposed within this report using the quantitative assessment presented in Appendix B.

4.4.1. Construction Phase

Table 4-2: Impact Rating for Construction Phase

Issue	Site Description /Activities	Corrective measures	Impact rating criteria					
			Nature	Extent	Duration	Magnitude	Probability	Significance
Water Quality Deterioration	Construction of an open pit	No	Negative	3	1	8	5	60
		Yes	Negative	2	1	6	3	27
	Construction of offices and workshops (alt. 1)	No	Negative	3	1	8	5	60
		Yes	Negative	2	1	6	4	36
	Construction of offices and workshops (alt. 2)	No	Negative	3	1	6	4	40
		Yes	Negative	3	1	4	3	24
	Construction of beneficiation plant (alt. 1)	No	Negative	4	1	8	5	65
		Yes	Negative	3	1	6	4	40
	Construction of beneficiation plant (alt. 2)	No	Negative	3	1	8	4	48
		Yes	Negative	2	1	6	3	27
	Construction of discard stockpile (alt. 1)	No	Negative	4	1	8	5	65
		Yes	Negative	3	1	6	4	40
	Construction of discard stockpile (alt. 2)	No	Negative	3	1	8	4	48
		Yes	Negative	3	1	6	3	30
Alteration of Drainage and Flow	Construction of an open pit	No	Negative	4	1	8	4	52
		Yes	Negative	3	1	6	3	30
	Construction of offices and workshops (alt. 1)	No	Negative	3	1	6	5	50
		Yes	Negative	2	1	4	4	28
	Construction of offices and workshops (alt. 2)	No	Negative	3	1	6	3	30
		Yes	Negative	2	1	4	3	21
	Construction of beneficiation plant (alt. 1)	No	Negative	3	1	8	5	60
		Yes	Negative	2	1	6	3	27
	Construction of beneficiation plant (alt. 2)	No	Negative	3	1	8	3	36
		Yes	Negative	2	1	6	4	36
	Construction of discard stockpile (alt. 1)	No	Negative	3	1	8	4	48
		Yes	Negative	2	1	6	3	27
	Construction of discard stockpile (alt. 2)	No	Negative	3	1	8	4	48
		Yes	Negative	2	1	6	3	27
Sedimentation	Construction of an open pit	No	Negative	4	1	8	5	65
		Yes	Negative	3	1	6	4	40

Issue	Site Description /Activities	Corrective measures	Impact rating criteria					
			Nature	Extent	Duration	Magnitude	Probability	Significance
	Construction of offices and workshops (alt. 1)	No	Negative	3	1	8	5	60
		Yes	Negative	2	1	6	4	36
	Construction of offices and workshops (alt. 2)	No	Negative	3	1	8	5	60
		Yes	Negative	2	1	6	4	36
	Construction of beneficiation plant (alt 1)	No	Negative	3	1	8	4	48
		Yes	Negative	2	1	6	3	27
	Construction of beneficiation plant (alt. 2)	No	Negative	3	1	8	4	48
		Yes	Negative	2	1	6	3	27
	Construction of discard stockpile (alt. 1)	No	Negative	3	1	8	5	60
		Yes	Negative	2	1	6	4	36
	Construction of discard stockpile (alt. 2)	No	Negative	3	1	8	4	48
		Yes	Negative	2	1	6	3	27

4.4.2. Operation Phase

Table 4-3: Impact Rating for Operational Phase

Issue	Site Description /Activities	Corrective measures	Impact rating criteria					
			Nature	Extent	Duration	Magnitude	Probability	Significance
Water Quality Deterioration	Operation of an open pit	No	Negative	5	4	8	4	68
		Yes	Negative	4	4	6	3	42
	Operation of mine offices and workshops (alt. 1)	No	Negative	3	4	6	4	52
		Yes	Negative	2	4	4	3	30
	Operation of mine offices and workshops (alt. 2)	No	Negative	3	4	4	3	33
		Yes	Negative	2	4	2	2	16
	Operation of beneficiation plant (alt. 1)	No	Negative	4	4	8	4	64
		Yes	Negative	3	4	6	3	39
	Operation of beneficiation plant (alt. 2)	No	Negative	4	4	6	3	42
		Yes	Negative	3	4	4	2	22
	Operation of discard stockpile (alt. 1)	No	Negative	4	4	8	4	64
		Yes	Negative	3	4	6	3	39
	Operation of discard stockpile (alt. 2)	No	Negative	4	4	8	3	48
		Yes	Negative	3	4	4	2	22
Alteration of Drainage and Flow	Operation of an open pit	No	Negative	4	4	8	5	80
		Yes	Negative	3	4	6	3	39
		No	Negative	3	4	8	3	45

Issue	Site Description /Activities	Corrective measures	Impact rating criteria					
			Nature	Extent	Duration	Magnitude	Probability	Significance
	Operation of offices and workshops (alt 1)	Yes	Negative	2	4	6	2	24
	Operation of offices and workshops (alt. 2)	No	Negative	3	4	4	2	22
		Yes	Negative	2	4	2	2	16
	Operation of beneficiation plant (alt. 1)	No	Negative	4	4	6	5	70
		Yes	Negative	3	4	4	3	33
	Operation of beneficiation plant (alt. 2)	No	Negative	3	4	6	3	39
		Yes	Negative	2	4	4	2	20
	Operation of discard stockpile (alt. 1)	No	Negative	3	4	6	4	52
		Yes	Negative	2	4	4	3	30
	Operation of discard stockpile (alt. 2)	No	Negative	3	4	6	4	52
		Yes	Negative	2	4	4	3	30
Sedimentation	Operation of an open pit	No	Negative	5	4	8	5	85
		Yes	Negative	4	4	6	4	56
	Operation of offices and workshops (alt. 1)	No	Negative	4	4	4	3	36
		Yes	Negative	3	4	2	3	27
	Operation of offices and workshops (alt. 2)	No	Negative	4	4	4	3	36
		Yes	Negative	3	4	2	2	18
	Operation of beneficiation plant (alt. 1)	No	Negative	4	4	8	4	64
		Yes	Negative	3	4	6	3	39
	Operation of beneficiation plant (alt. 2)	No	Negative	4	4	6	3	42
		Yes	Negative	3	4	4	2	22
	Operation of discard stockpile (alt. 1)	No	Negative	5	4	8	4	68
		Yes	Negative	4	4	6	3	42
	Operation of discard stockpile (alt. 2)	No	Negative	5	4	8	3	51
		Yes	Negative	4	4	6	2	28

4.4.3. Decommissioning Phase

Table 4-4: Impact Rating for Closure and Decommissioning Phase

Issue	Site Description /Activities	Corrective measures	Impact rating criteria					
			Nature	Extent	Duration	Magnitude	Probability	Significance
Water Quality Deterioration	Closure and decommissioning of an open pit	No	Negative	4	2	6	4	48
		Yes	Negative	3	1	4	3	24
	Closure and decommissioning of mine offices and workshops (alt. 1)	No	Negative	3	2	4	3	27
		Yes	Negative	2	1	2	2	10

Issue	Site Description /Activities	Corrective measures	Impact rating criteria					
			Nature	Extent	Duration	Magnitude	Probability	Significance
	Closure and decommissioning of offices and workshops (alt. 2)	No	Negative	3	2	4	2	18
		Yes	Negative	2	1	2	2	10
	Closure and decommissioning of beneficiation plant (alternative 1)	No	Negative	4	2	6	3	36
		Yes	Negative	3	1	4	2	16
	Closure and decommissioning of beneficiation plant (alt. 2)	No	Negative	3	2	6	3	33
		Yes	Negative	2	1	4	3	21
	Closure and decommissioning of discard stockpile (alt. 1)	No	Negative	4	2	6	2	24
		Yes	Negative	3	1	6	2	20
	Closure and decommissioning of discard stockpile (alt. 2)	No	Negative	3	2	6	3	33
		Yes	Negative	2	1	4	2	14
Alteration of Drainage and Flow (Positive Impact)	Closure and decommissioning of an open pit	N/A	Positive	3	3	8	5	70
	Closure and decommissioning of offices and workshops (alt. 1)		Positive	3	3	6	5	60
	Closure and decommissioning of offices and workshops (alt. 2)		Positive	3	3	4	5	50
	Closure and decommissioning of beneficiation plant (alt. 1)		Positive	3	3	6	5	60
	Closure and decommissioning of beneficiation plant (alt. 2)		Positive	3	3	4	5	50
	Closure and decommissioning of discard stockpile (alt. 1)		Positive	3	3	8	5	70
	Closure and decommissioning of discard stockpile (alt. 2)		Positive	3	3	8	5	70
Sedimentation	Closure and decommissioning of an open pit	No	Negative	4	2	8	4	56
		Yes	Negative	3	2	6	3	33
	Closure and decommissioning of offices and workshops (alt. 1)	No	Negative	3	2	6	3	33
		Yes	Negative	2	1	4	2	14
	Closure and decommissioning of offices and workshops (alt. 2)	No	Negative	2	2	4	2	16
		Yes	Negative	1	1	2	2	8
	Closure and decommissioning of beneficiation plant (alt. 1)	No	Negative	3	3	6	4	48
		Yes	Negative	3	2	4	3	27
	Closure and decommissioning of beneficiation plant (alt. 2)	No	Negative	3	3	4	3	30
		Yes	Negative	2	2	2	2	12
	Closure and decommissioning of discard stockpile (alt. 1)	No	Negative	4	3	8	4	60
		Yes	Negative	3	2	6	3	33
	Closure and decommissioning of discard stockpile (alt. 2)	No	Negative	3	2	6	3	33
		Yes	Negative	2	1	2	2	10

4.5. Additional Mitigation Measures

Mitigation, through the use of appropriately designed measures, have been developed to ensure legislative and standards compliance and have been discussed in detail in Chapter 1.5. The followings additional mitigation measures were identified:

- During concurrent rehabilitation of disturbed areas in the operational phase, a suitable growth medium should be applied along the contours as far as can be achieved, safely and practically.
- Good housekeeping practices must be implemented and maintained by the immediate cleaning up of accidental spillages and ensuring all dislodged materials such as debris during blasting are kept within confined storage footprints.
- Revegetation of disturbed areas with indigenous plant species should be performed immediately following application of a suitable growth medium to avoid erosion.
- Phasing/scheduling of earthworks can minimise the footprint that is at risk of erosion at any given time, or schedule works according to the seasons as far as operably possible.
- In the case of linear earthworks, phasing of working areas and concurrent rehabilitation will be necessary to minimise the footprint of a disturbed area at any given time.
- Wastewater with noxious chemicals from bulk tank cleaning should be collected through appropriate on-site or offsite treatment prior to discharge.
- A Rehabilitation Strategy Implementation Plan (RSIP) must be enforced from the commencement of the mining activities and must be updated bi-annually to ensure compliance to the specifications for concurrent and post-rehabilitation activities within a predetermined audit criteria. This will assist to ascertain whether the remediation has been successful and, if not, to recommend and implement further measures.

4.6. Monitoring and Reporting Recommendations

A monitoring programme is an essential tool to identify any risks of potential impacts as they arise and to assist in impact management plans. Monitoring should be implemented throughout the life of the project. Recommendations on surface water monitoring are presented in Table 4-5 below.

Table 4-5:Surface Water Monitoring Programme

Description	Monitoring Location	Frequency of sampling	Frequency of Reporting
	Soil Erosion		
Soil erosion and sedimentation monitoring in all soil erosion potential sources	Cleared and compacted areas where the infrastructure will be built. The downstream areas of dams and road crossings.	Monitoring of erosion should occur during construction after every rainstorm or flood event, and during the operational phase monthly during first the wet season or during routine maintenance inspections, as applicable.	After every major rainstorm / flood. Monthly monitoring report compiled by the appointed ECO during the construction phase.
	Surface Water Quality		
Ensure that water quality monitoring is implemented up and downstream at the	Immediately upstream and downstream of the Mogalakwena River. GPS co-ordinates of the monitoring	Motoring should be undertaken quarterly.	Reporting should be undertaken after each sampling activity.

Description	Monitoring Location	Frequency of sampling	Frequency of Reporting
periphery of the 200 m working area	locality can be established during the first monitoring.		
Ensure that monitoring is implemented up and downstream at the periphery of the 100 m working area	Monitoring must be undertaken at precisely the same locality as the pre-construction, operation and closure phases monitoring.	Once a month for six months after completion of construction.	Monthly report should be compiled.
Leakage events			
A leak and spill management plan must be formulated to monitor and detect as soon as possible. **Site walkovers to determine the condition of facilities and identify any leaks or overflows, blockages, overflows, and system malfunctions for immediate remedial action**	Roads and areas where vehicles commute and areas where chemical storage containers are located. Areas where leakage is visible/detected.	Identification of any leakage events should occur monthly during the rehabilitation and construction phase, or directly after a leakage has been detected and for the operational phase, during maintenance activities	Monthly monitoring report compiled by the appointed ECO during the construction, operational and closure phases; and Report should be compiled for all the three phases of the project.
Infrastructure Monitoring			
Inspection of the temporary channels, and bridges for signs of erosion, cracking and silting to ensure the performance of these remains acceptable.	All proposed infrastructure	Daily during maintenance	Daily. Should erosion occur, measures should be reinstated.

The monitoring plan should be reviewed periodically to ensure the appropriateness of sites and sampling frequency during operation.

Table 4-6: Surface Water Quality Parameters of Concern

Parameters	
pH	Nitrate as N
Electrical conductivity	Ammonia
Total dissolved solids	Potassium
Total suspended solids	Nickel
Aluminium	Manganese
Calcium	Magnesium
Fluoride as F	Iron
Total alkalinity as $CaCO_3$	Copper
Chloride as Cl	Lead
Sulphate as SO_4	Sodium
Uranium	*E.coli*

5. The rationale for Preferred Alternatives

5.1. Open Pit

No site location alternatives have been considered, as mining can only be undertaken in areas where economically mineable resources occur. This area was established through extensive prospecting and geological modelling.

5.2. Discard Stockpile

Considering the distance from the Mogalakwena River and the discard stockpile, Discard stockpile 2 is preferred for this project because it is located far from the floodlines and therefore has low impact to surface water resources.

5.3. Beneficiation Plant

Considering the distance from the Mogalakwena River and the discard stockpile, Beneficiation Plant Alternative 2 is preferred for this project because it is located far from the floodlines and has a low impact on surface water resources. Beneficiation plant alternative 2 is located closer to Discard Stockpile alternative 2, which implies the transportation of tailings and mine end-products will be curtailed, reducing the possibility of dropping tailings on the earth surface and its interaction with surface water resources.

5.4. Mining Infrastructure Area

Mine Infrastructure alternative 2 is preferred over alternative 1. The rationale is mine infrastructure alternative 2 is located further than 500m from the Mogalakwena River. The probability of it potential impacting surface water resources is limited.

6. Recommendations and Conclusion

6.1. Recommendations

The following studies are recommendations once the mine has been established:

6.1.1. Site-Wide Balance

A site-wide water balance that considers extremes of climate, unsteady processing/production rates and storage within any aspect of the operation (such as would be required to fill process water dams prior to initial start-up or drawdown stored water through the dry season) is recommended for the mine. The main purposes of the water balance will be to estimate water volumes available for reclaim/dust suppression, excess water discharge requirements (if needed) and freshwater requirements (if needed) under average and extreme hydrological conditions.

Additionally, it is recommended that a site-wide water balance model must accommodate the new and future expansion.

6.1.2. Water Quality

A surface water quality monitoring program starting with an establishment of a baseline water quality must be undertaken. The water quality must be compared against the permissible guidelines provided by the DHSWS.

Water quality monitoring must be undertaken at rivers in proximity as well as sediment ponds before discharge into the environment.

6.1.3. Stormwater Management Plan

A stormwater management plan consisting of detailed stormwater design is recommended:

- Sizing of channels and storage containment facilities must be undertaken during a detailed design;
- The detailed stormwater design plan should also take into account of the mine plant stormwater management;
- It is recommended that a pit water management system be put in place during the detailed design of the stormwater management plan;
- Peak flows and all detailed design criteria must be included in the stormwater management report; and
- The detailed designs of the channels should consider suitable erosion protection measures.

6.2. Conclusions

This surface water study was undertaken by a suitably qualified, experienced, and independent Hydrologist. The potential impacts of the proposed activities on surface water receptors as well as the sensitivity of the surface water resources were assessed, along with a summary of mitigation measures. The baseline hydrology and floodline assessment informed the impact assessment.

Floodlines for the 1:50- and 1:100-year recurrence intervals were determined for the Mogalakwena River draining adjacent to the project site. The local surface water resources are considered to be of high sensitivity.

The proposed mine infrastructure is located outside of the 1:50- and 1:100-year floodlines and thus, the project is deemed safe and has a low impact on the surface water resources should all mitigation and rehabilitation measures be implemented.

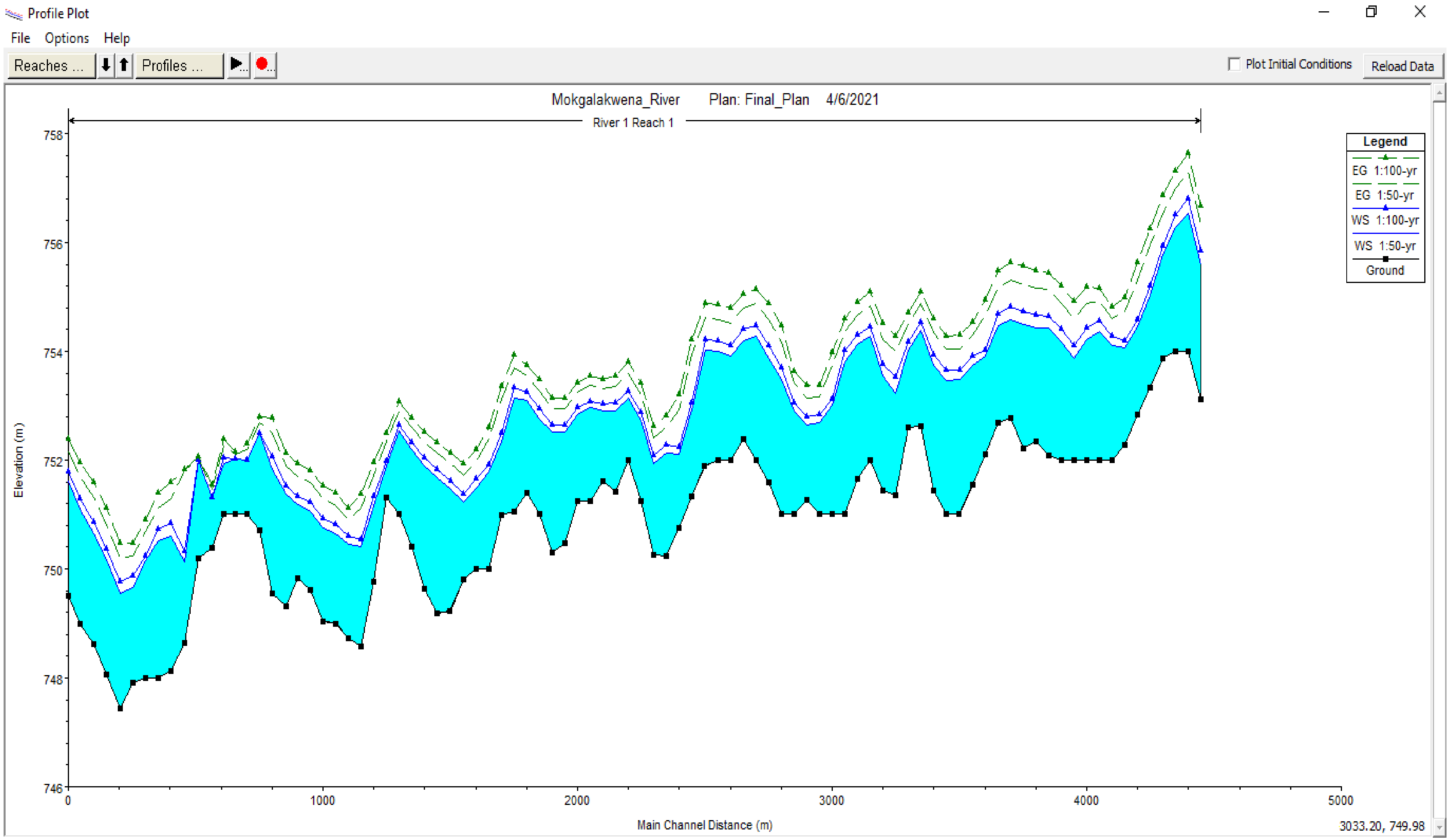
A monitoring programme is an essential tool to identify any risks of potential impacts as they arise and to assist in impact management plans by assessing if mitigation measures are operating effectively. Monitoring should be implemented throughout the life of the project.

All measures implemented to mitigate impacts should be regularly reviewed as best practice and compliance with various licenses issued on site by authorities. The project can continue if all mitigation and monitoring measures are to be implemented.

7. References

WRC (2012). Water Resources of South Africa 2012 Study (WR2012): WRSM/Pitman User Manual

Appendix A: Mogalakwena Reach Floodlines Longitudinal Profiles



Appendix B: Impact Assessment Methodology

Status of Impact

The impacts are assessed as either having a:

- Negative effect (i.e. at a `cost' to the environment),
- Positive effect (i.e. a `benefit' to the environment), or
- Neutral effect on the environment.

Extent of the Impact

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

Duration of the Impact; The length that the impact will last for is described as either:

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

Magnitude of the Impact; The intensity or severity of the impacts is indicated as either:

- (0) none,
- (2) Minor,
- (4) Low,
- (6) Moderate (environmental functions altered but continue),
- (8) High (environmental functions temporarily cease), or
- (10) Very high / unsure (environmental functions permanently cease).

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

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

Significance of the Impact

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

S= (E+D+M) P

The significance ratings are given below;

- **(<30) low** (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- **(30-60) medium** (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- **(>60) high** (i.e. where the impact must have an influence on the decision process to develop in the area).