TENBOSCH MINING (PTY) LTD

TENBOSCH COAL MINE

HYDROLOGICAL IMPACT ASSESSMENT

JULY 2023

Letsolo Reference: LWES 118

Letsolo Water and Environmental Services cc
Reg No: 2010/005979/23
Tax Ref No: 9170/262/18/3
VAT No: 4380258477

Tel: 012 321 0073 Cell: 082 821 6621
Fax: 0866 134 794
Email: ishmael@lwes.co.za
Website: www.lwes.co.za

Address:
Suite 14 Parkfield Court, 1185 Park Street, Hatfield Pretoria.
Suite 2 Block A Midlands Office Park, No 2 Walter Sisulu Street, Middelburg.

Project Name	Hydrological Impact Assessment Tenbosch Mining
Client Details	Tenbosch Mining (Pty) Ltd 8 Victor Phol Street, Duvha Park Witbank 1034 Contact person: Mr Raymond Zulu Cell: 082 953 9832 Tel: 013 691 1034 Email: gme@telkomsa.net
Letsolo Ref. Number	LWES 1118
Declaration	Letsolo Water and Environmental Services cc. is an independent consultant providing professional services to the client.
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Authored by	**Reviewed by**	**Authorized by**
Lebohang Makola	Thembisile Gamede	Ishmael Phalane

Revision History		
Reviewed by	Date	Summary of changes

LIST OF ABBREVIATIONS

Abbreviation	Description
BPG	Best Practice Guidelines
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
GN	Government Notice
LoM	Life of Mine
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NEMA	National Environmental Management Act, 107 of 1998
NWA	National Water Act, 36 of 1998
SWMP	Storm Water Management Plan
RSA	Republic of South Africa
WMA	Water Management Area

DECLARATION

I, Lebohang Makola declare that I am an independent specialist working under Letsolo Water and Environmental Services. I, Lebohang Makola, and Letsolo Water and Environmental Services do not benefit in any way from our client Tenbosch Mining (Pty) Ltd whether directly or indirectly apart from the consultation work we conduct based on their requests. I further declare that I, and Letsolo Water and Environmental Services have no interest and are not in business, have personal investments and other forms of benefits with regards to the proposed Tenbosch Mining in Komati, Mpumalanga of Tenbosch Mining (Pty) Ltd.

Signature

AUTHOR DETAILS

Name	Lebohang
Surname	Makola
Occupation	Hydrologist
Qualification	BSc Honours in Geography
Experience	2 years

EXECUTIVE SUMMARY

Letsolo Water and Environmental Services was appointed by Tenbosch Mining (Pty) Ltd (The Applicant) to undertake a Hydrological Impact Assessment for supporting Water Use Licence Application (WULA) and for Environmental Impact Assessment for the proposed Tenbosch Coal Mine in the Mpumalanga Province. It is required to predict and quantify the potential impacts on surface water resources as well as to recommend reasonable mitigation measures for the proposed mining of iron ore project. The Applicant proposes to develop an underground coal mine at the Farm Tenbosch 162-JU (on portion 18, 21, 55, 64, 69, 85, and 213), Farm Turfbelt 593-JU (on portion 2, 5, and 6), and Remaining Extend of the Farm Tecklenburg 548-JU within Nkomazi Local Municipality of the Ehlanzeni District Municipality.

The application area falls within the primary catchment (X) and quaternary catchments X24H, X13K, and X13L. The proposed coal mining project fall within the quaternary catchment X13L of the Inkomati Water Management Area (WMA 5) found in the eastern part of South Africa. The regional topography is considered gentle with elevation that varies between 250 and 180 meters above mean sea level (mamsl). Drainage within the proposed mining area occurs from the Ngweti River which cuts across the Application Area in the south. The Ngweti River is a perennial river that originate from the mountains west of the study area. It flows in an easterly direction where it joins the Komati River. The Komati River continues to flow eastwards and confluence with the Crocodile River after the Komati town to form the Inkomati River which flows into Mozambique.

Water quality assessment was conducted from the Komati River and the Ngweti River with its tributaries on the 11th of April 2022 to determine the baseline water quality of the area before proposed mining activity commences as well for the understanding of the general characterisation of the site. Water samples were collected from eight sampling points, namely Ngweti (NG) 01 and NG 02, Ngweti tributaries 01 to 03 (IGMT 01 to 03), and After Confluence (AC). The water quality results outlined that the Ngweti River and its tributaries are not suitable for domestic use due to the exceedance of the domestic water quality guideline by TDS, Ca, Mg, and Na. Although the Ngweti system has poor water quality in terms of domestic use, it can be used for other activities such as irrigation and livestock. The Komati system showed good water quality.

Stormwater management infrastructures were designed following BPG 1: Stormwater Management. The proposed infrastructure was assessed in terms of clean and dirty nature. All the surface dirty infrastructure such as waste rock, overburden and coal (product) stockpiles will be grouped to form the dirty water catchment. A system of vegetated berms will be placed around the dirty catchment to prevent the mixing of clean and dirty runoff.

Floodlines were delineated to check compliance with Condition 4 of the GN 704 and to assess the risk of flooding to the proposed mine infrastructures. The proposed surface infrastructure are outside the 1:100-year inundation boundary and the 100m watercourse buffer. Therefore, according to Condition 4 of the GN 704, the mine is permitted to mine at the proposed Tenbosch mining area.

The purpose of this report is to assess the impact of the proposed mine on the hydrological components of the area of interest. An impact assessment was conducted to determine the potential impact of the overburden stockpiles, dirty water infrastructures, open cast pits, and the conveyor belt on surface water bodies. The proposed infrastructures (excluding underground shaft) have medium impacts before mitigation and would remain medium after mitigation, except for the dirty water infrastructures. The common impact these infrastructures has is the deterioration of water quality through siltation (runoff from overburden stockpiles), overflow of PCDs, and decanting contaminated water from underground mining. These impacts can be mitigated by putting in place stormwater infrastructures to contain dirty water.

GLOSSARY OF TERMS

Applicant	Any person who applies for an authorisation to undertake an activity or to cause such activity to be undertaken as contemplated in the National Environmental Management Act (Act 107 of 1998), as amended, and the Environmental Impact Assessment Regulations, 2014. In this report, Applicant refers to Tenbosch Mining (Pty) Ltd.
Borehole	A generic term used for any drilled or hand-dug hole used to abstract or monitor groundwater, irrespective of diameter or construction.
Catchment	The area from which any rainfall will drain into the watercourse or watercourses or part of the water course, through the surface flow to a common point or common points.
Contamination	The introduction into the environment of any substance by the action of man.
Environment	All physical, chemical, and biological factors and conditions that influence an object and/or organism; the surroundings within which humans exist and are made up of the land, water, atmosphere, plant, and animal life (micro and macro), the interrelationship between the factors and the physical or chemical conditions that influence human health and well-being.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting, and assessing the potential positive and negative social, economic, and biophysical impacts of any proposed project, plan, programme, or policy that requires authorisation of permission by law and which may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental Management Plan	A legally binding working document, which stipulates environmental and socio-economic mitigation measures that must be implemented by responsible parties throughout the proposed project.
Hydrological	The study of movement, distribution, and quality of surface water
Study Area	Refers to the entire study area compassing the total area of the land parcels as indicated on the study area map of Tenbosch Mining.
Sustainable Development	Development that has integrated social, economic, and environmental factors into planning, implementation, and decision-making, to ensure that it serves present and future generations.
Topography	The study and description of the physical features of an area.
Water quality	This means the physical, chemical, toxicological, biological (including microbiological), and aesthetic properties of water that determine sustained (1) healthy functioning of aquatic ecosystems and (2) fitness for use (e.g., domestic, recreational, agricultural, and industrial). Water quality is therefore reflected in (a) concentrations or loads of substances (either dissolved or suspended) or micro-organisms, (b) physio-chemical attributes (e.g., temperature), and (c) certain biological responses to those concentrations, loads, or physio-chemical attributes.
Water Use License	An authorisation from the Department of Water and Sanitation to a designated water user to use water. The authorisation will provide details on the time-frames and conditions for the designated water use.

Water Resource	A water resource includes any watercourse, surface water, estuary, or aquifer. Watercourses include rivers, springs, and natural perennial and non-perennial channels. Wetlands, lakes, dams, or any collection identified as such by the Minister in the Government Gazette.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION AND OVERVIEW

1.1. Introduction

The proposed Tenbosch Mining Project (hereafter referred to as TMP) is owned by Tenbosch Mining (Pty) Ltd who is the applicant for the required authorisations including the Water Use Licence Application (WULA) and Environmental Authorisation (EA). The applicant applied for a Mining Right for coal over multiple farms (approximately 7766.99 hectares) in the Nkomazi Local Municipality, the application reference number is MP30/5/1/2/2/10259MR. The proposed mining right area is anticipated to have 30 years Life of Mine (LOM).

Letsolo Water and Environmental Services cc. (referred to herein as Letsolo) was appointed by Tenbosch Mining (Pty) Ltd to conduct Hydrological Impact Assessment (HIA) for WULA and EIA for the proposed Tenbosch Mining Project. The principal aim for the HIA is to predict and quantify the potential impacts on surface water resources as well as to recommend reasonable mitigation measures. In order to fulfil this principal aim, this assessment covers site specific aspects such as:

- Flood calculations;
- Stormwater management;
- Floodlines delineation;
- Water quality monitoring;
- Water and salt balance; and
- Impact Assessment.

1.2. Purpose of the study

The Hydrological Impact Assessment is required to predict and quantify the potential impacts on surface water resources as well as to recommend reasonable mitigation measures. This assessment is fundamental to the discipline of environmental management and is a requirement of the environmental authorisation, the Environmental Impact Assessment Environmental Management Programmes (EIA / EMPr), and WULA. In each instance, there is a need to understand the future impact of a proposed activity and then determine whether the management measures applied to that activity are appropriate or whether they should be modified. The legal purpose of this Hydrological Assessment is to ensure that:

- The effect is given to the objectives of the National Water Act (NWA) 36 of 1998 and National Environmental Management Act (NEMA) 107 of 1998.
- The hydrological regime applicable to the Tenbosch Mining Project is understood.
- Systems are in place to enable effective management of impacts on the water resources.
- Consistent and sustainable implementation of water management hierarchy at the proposed facilities that have the potential to impact on the water resource.

1.3. Scope of work

The scope of work for the Hydrological Impact Assessment allows for the following:

- Analysis of the physical hydrological conditions for the Quaternary Catchment and its larger surrounding areas with a specific focus on the Area of Influence (AoI). The physical hydrological conditions include defining the flow as high/low/pond/dam/pumped and recording physical parameters including water temperature and Electrical Conductivity (EC);
- Evaluation of the physical hydrological conditions such as slope, permeability, and vegetation cover, for delineated site-specific catchment areas. These physical characteristics were used to calculate the peak flows for the 1:50-year and 1:100-year storm events;
- Delineation of surface water catchments in the proposed mining area;
- To undertake the baseline Hydrological impact assessment and baseline surface water and Water and Salt Balance;
- To propose management measures as well as stormwater management;
- To propose management and mitigating measures that will ensure that the natural environment is preserved and protected as far as possible;
- Design stormwater facilities to separate clean and dirty water according to the BPG1: Stormwater Management; and
- Floodlines were delineated to assess the location of the proposed infrastructure in detail. GN 704 provides regulations for the location of dirty water infrastructure (and mine infrastructure). In instances where dirty water or mining infrastructure is located within the 100m buffer or the 1: 100 years flood area mitigation and management were proposed.

1.4. Background

Coal mining in the Klip Rivier coalfields stretches around many pockets in Mpumalanga and KZN, on various top and bottom seams, giving the mineral resource at different depths. The proposed TMP targets bottom coal seams for underground mining. The underground will be accessed via a boxcut adit. The production is planned for a period of +/- 30 years. Approximately 20 million tons per annum (Mtpa) of high-grade coal will be mined out.

The coal is planned to be processed onsite through crushing, screening, washing, and sorting targeting a primary export thermal product and a middling product for potential sale to market. The other proposed site infrastructure includes disposal dump, Pollution Control Dams (PCDs), access and haul roads with necessary security, admin office block, workshop, stockpiling area for topsoil, subsoils, overburden, ROM and product stockpile materials, and conveyor belt. Figure 1-1 below illustrates the location of the proposed infrastructure. It is proposed that the boxcut, plant and associated mine infrastructure be located on the farm Tecklenburg's Ranch 548 JU Portion

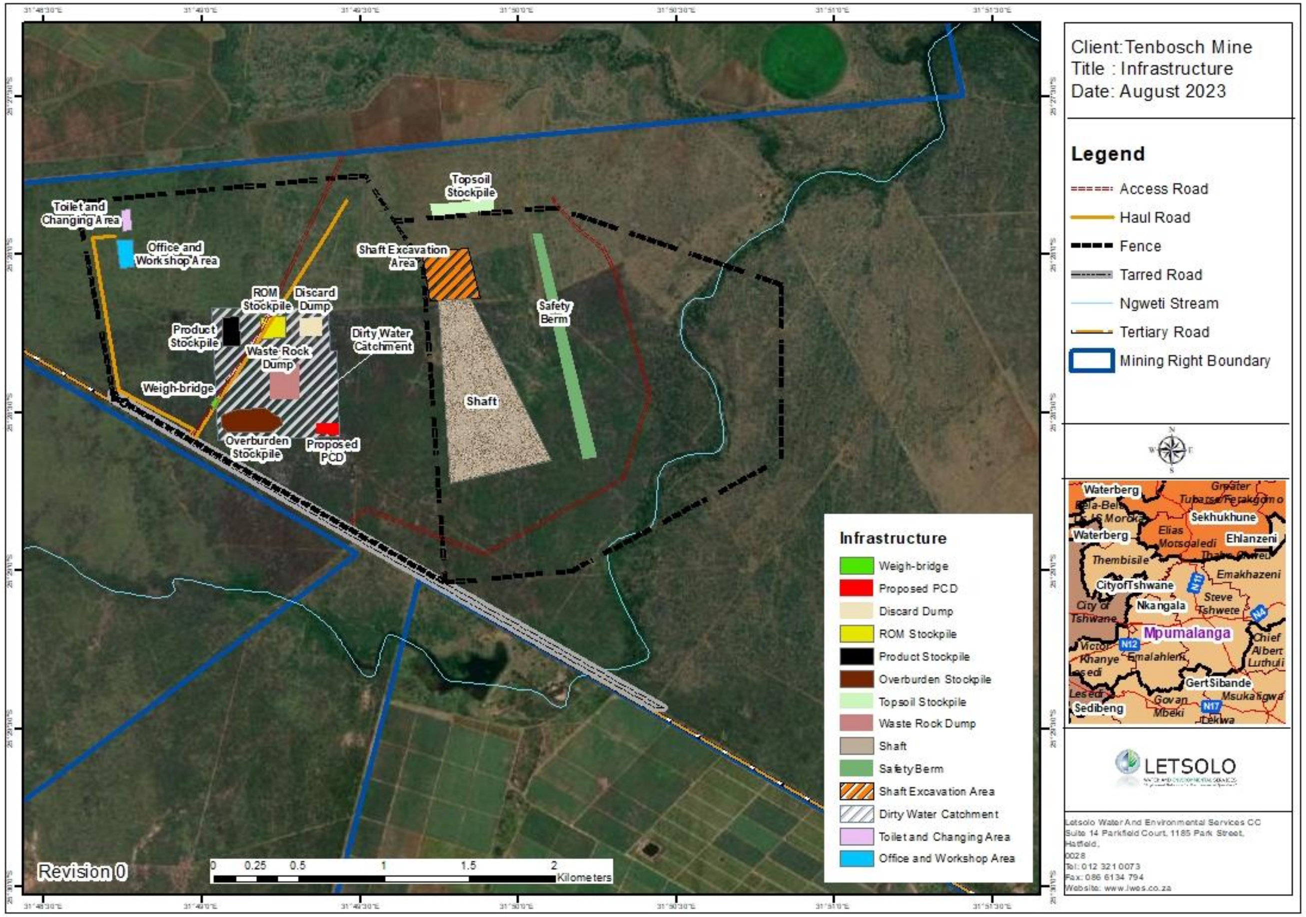


Figure 1-1: Location of the proposed site infrastructure

1.5. Date and season of the site investigation

The site visit was conducted on the 11th of April 2022 during the beginning of the dry season to conduct further investigations. The site investigation made allowance for the following:

- Records of the current state which is still a greenfields area;
- Identification of areas that may be hydrologically affected by the proposed mining activity;
- Logging of areas of interest for mapping purposes;
- Identification of nearby streams; and
- Characterisation of tributaries in terms of their perennial or non-perennial nature; and
- Collect water samples for baseline water quality assessment.

1.6. Site Location

The site is situated in the eastern parts of Mpumalanga Province of South Africa, next to the town of Komatipoort (approximately 13 km to east). The site is accessed through the N4 to the Lebombo Border post which is approximately 20 km from the site. The area is bordered by Swaziland in the south. The applicant proposes to develop an underground coal mine at the Farm Tenbosch 162-JU (on portion 18, 21, 55, 64, 69, 85, and 213), Farm Turfbelt 593-JU (on portion 2, 5, and 6), and Remaining Extend of the Farm Tecklenburg 548-JU within Nkomazi Local Municipality of the Ehlanzeni District Municipality (Limp Earth & Environmental (Pty) Ltd, 2020).

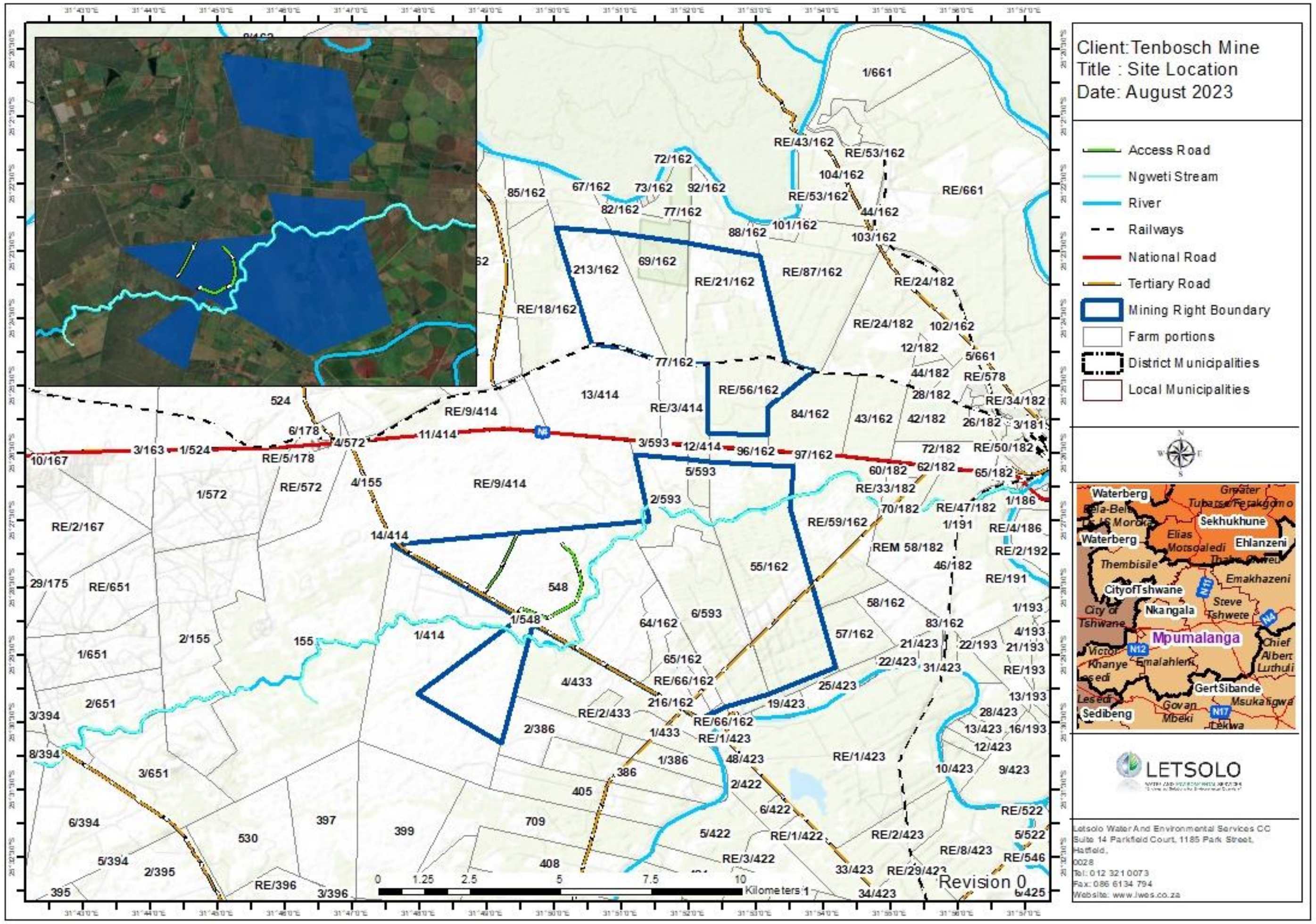


Figure 1-2: Site Location map.

2. LEGAL REVIEW

The Bill of Rights in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) enshrines the concept of sustainability, specifying rights regarding the environment, water, access to information, and just administrative action. These rights and other requirements are further legislated through the National Water Act (NWA), 1998 (Act 36 of 1998). The latter is the primary statute providing the legal basis for water management in South Africa and has to ensure ecological integrity, economic growth, and social equity when managing and using water. The use of water for mining and related activities is also regulated through regulations that were updated after the promulgation of the Government notice No. GN704 dated 4 June 1999, National Water Act, 1998 (Act 36 of 1998) (NWA), and National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA).

2.1. Constitution of South Africa, 1996 (Act 108 of 1996)

The Bill of Rights contained in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) states that everyone has a right-

a) to an environment that is not harmful to their health or wellbeing; and
b) to have the environment protected for the benefit of the present and future generations through reasonable legislative and other measures that –
   i. prevent pollution and ecological degradation;
   ii. promote conservation; and
   iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

2.2. National Water Act, 1998 (Act 36 of 1998)

The NWA introduced the concept of Integrated Water Resource Management (IWRM), comprising all aspects of the water resource, including water quality, water quantity, and the aquatic ecosystem quality (quality of the aquatic biota and in-stream and riparian habitat). The IWRM approach provides for both resource-directed and source-directed measures. Resource-directed measures aim to protect and manage the receiving environment.

The NWA, therefore, provides for the protection, usage, development, conservation, management, and control of the country's water resources in an integrated manner. The Act provides the legal basis upon which to develop tools and means to give effect to the said activities. One of these tools is the authorisation of water use as defined in Chapter 4 of the National Water Act. Section 21 of the National Water Act lists 11 water uses that can only be legally undertaken through the water use authorisation issued by the Department of Water and Sanitation (DWS).

2.3. Government Notice 704

Government Notice 704 (GN704) regulates the use of water by mines and related activities and aim to protect water resources. The protection is governed by Restriction 4 which states that no person in control of a mine or activity may:

- *(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100-year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole, or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;*

- *(b) except in relation to a matter contemplated in regulation 10 (pertaining to sand mining), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is the greatest.*

3. METHODOLOGY

The following sub-sections describe the methodologies used:

- Flood calculations;
- Stormwater management;
- Floodlines delineation;
- Water quality monitoring;
- Water and salt balance; and
- Impact Assessment.

3.1. Flood calculations

The common hydrological methods for flood calculation that were applied are rational methods and the standard design flood method (SDF).

3.1.1. Rational Methods

The Rational method is based on a simplified representation of the law of conservation of mass. Rainfall intensity is an important input in the calculations; because uniform aerial and time distributions of rainfall must be assumed, therefore, the method is suitable for catchments that have a surface area smaller than 15 km^2 (SANRAL, 2013) and was used to calculate site-specific peak flows. The Rational method was selected as the most reliable method for the site-specific catchments, based on their surface area as well as the reliability of input data. It was also used to calculate site-specific peak flows.

Field observation data were used to calculate the runoff coefficient (c). The runoff coefficient represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception; all of which affect the time distribution and peak rate of runoff.

The runoff coefficient is the variable of the Rational method, least susceptible to a precise determination, and requires judgment and understanding on the part of the designer. This coefficient differs from site to site as it depends on site conditions, as observed during the site visit (SANRAL, 2013). The conditions that have an impact on the runoff coefficient are slope, vegetation cover, and permeability. The 1085 m (10% and 85% of the hydraulic length) height difference refers to the difference between elevation height at 10% and 85% of the length of the watercourse. This height difference is then divided by the length of the watercourse to determine the 10-85 slope (SANRAL, 2013).

3.1.2. Standard Design Flood Method (SDF)

The SDF method is applied/used on calibrated discharge coefficients for recurrence periods between 2 and 100 years (SANRAL, 2013). The method is suitable for catchments with large surface areas and was used to conduct flood calculations of the stream-based catchments.

3.2. Stormwater management

The Utility Programs for Drainage software was used to calculate peak flows for site conditions pre- and post-development. The peak flows were then used to design suitable channels, culverts, and sumps that will manage the increased runoffs post-development.

3.3. Floodlines delineation

The public domain and internationally accepted software package HEC-RAS developed by the US Army Corps of Engineers was used to hydraulically model the river system. Floodlines were delineated to assess the risk of flooding to the proposed infrastructure and compliance with GN 704 Condition 4. The system consists of three components i.e., flow data, geometric data, and simulation options. These components are described in more detail below.

3.3.1. Survey data

A topographical survey was sourced from the United States Geological Survey (USGS) database to get the latest survey information. A Topographical Survey is a 2-D representation of what is happening in the real world (3-D). The characteristics of a topographical survey can vary, but some of the most common elements include:

- Contours - A contour line shows the peaks and the valleys of the land. The smaller the cumulative drop, the more detailed the survey becomes.
- Vegetation and physical attributes - The streams and creeks as well as any easily identified area, were captured in the imagery. These attributes were identified by the land surveyor after the aerial survey and details regarding the location of those attributes were obtained and used for other specialists' studies.
- Utilities - Any artificial infrastructure was identified and shown on the topographical survey. Overhead utility lines, streetlights, electric boxes, pipeline markers, and any visible evidence can be shown on the drawing.

When the survey was conducted, four standard items were key deliverables and were produced from each cross-section with each surveyed section.

- The baseline is a two or three-point line feature. Baseline features with only one point were ignored. The acceptable and defined baseline feature had a minimum of three points, chainages, and those to the right positive.

- The left bank was used to identify the left bank point on the river cross-section. A single point is expected.
- The right bank was used to identify the right bank point on the river cross-section. A single point is expected.
- The water level identifies the water level of the river at the time of the survey.

3.3.2. Cross-sections

The survey was used to generate and extract river cross-sections from a model. When selected, a property sheet like that shown in Figure 3-1 below, was produced. HEC RAS model was used to superimpose profiles from the Digital Terrain Model (DTM) onto the river cross-sections.

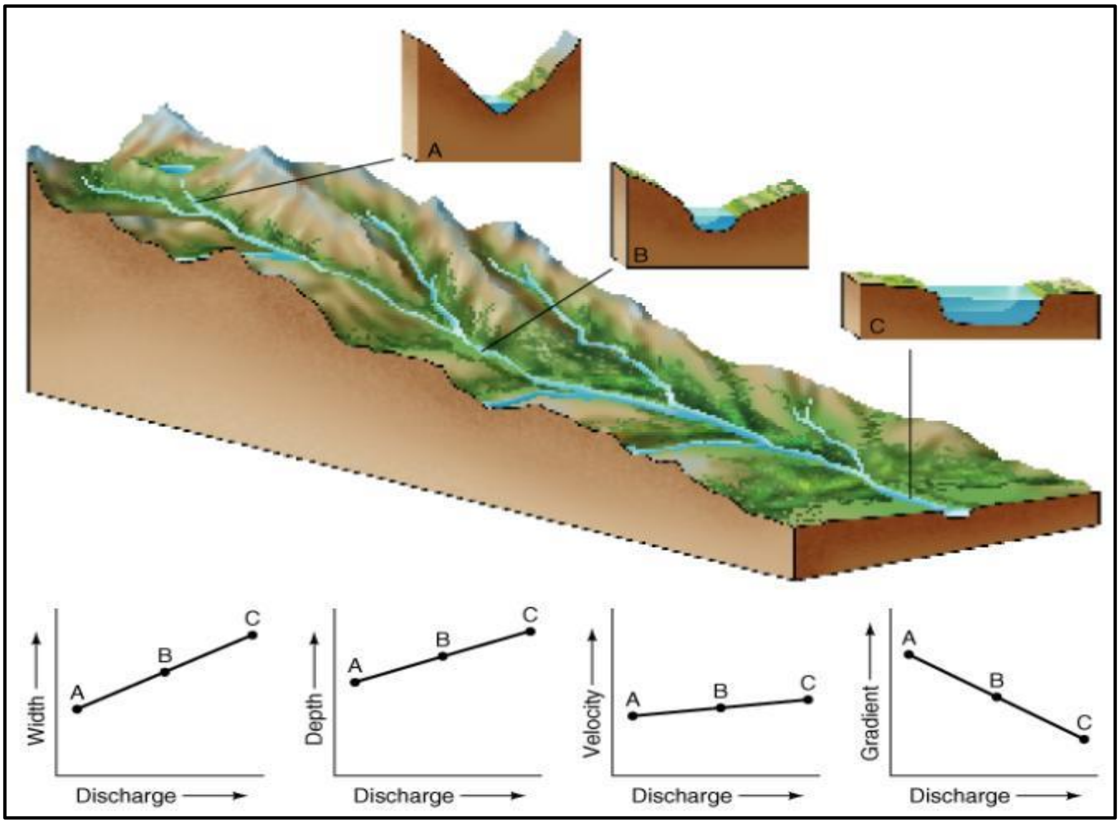


Figure 3-1: Typical River Cross Section

Cross-sections were drawn perpendicular to the stream, from left to right, and from the upstream point to the downstream point. They were labelled with the highest number from the upstream point to the lowest number at the downstream point (Figure 3-2).

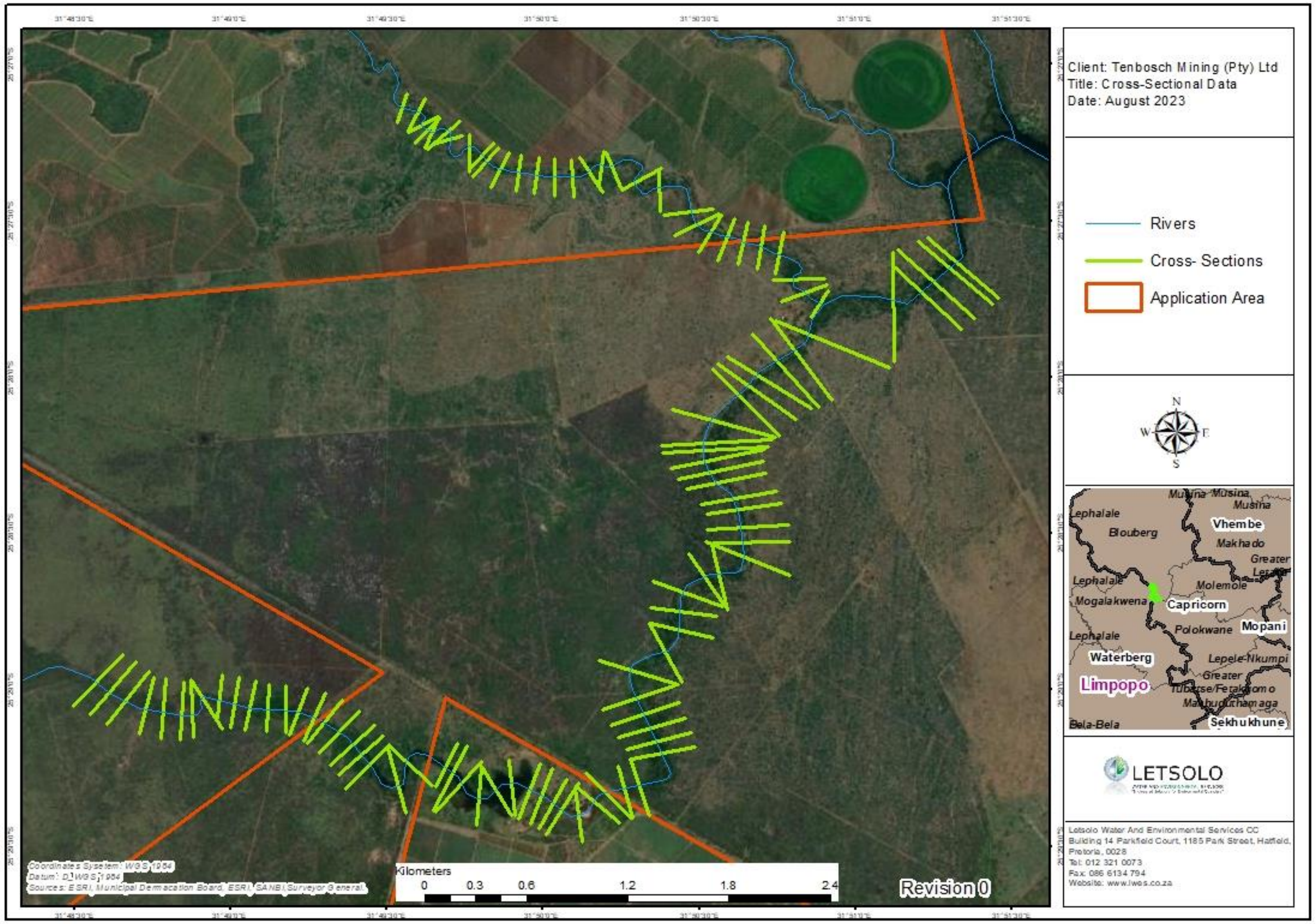


Figure 3-2: Floodlines topological data

3.4. Baseline water quality

The following instruments were used on site:

- Handheld pH/EC/TDS meter for measuring field physical parameters, including temperature;
- GPS for digitizing the location of points;
- Camera for site pictures;
- Water bottles for storing water samples, and
- Cooler box for preserving samples.

3.4.1. Water sampling

All fieldwork was conducted based on the protocols and specifications and code of practice contained in the SABS ISO 5667. These international standards address all aspects of the sampling methods as well as sample preservation and related aspects. The sampling and sample preservation were undertaken according to the following guidelines:

- SABS ISO 5667-2: 1991 Guidance on sampling techniques;
- SANS 5667-3 Part 3: Guidance on the preservation and handling of water samples;
- SANS 5667-14:2016 (Edition 2) on Water quality sampling, part 14: Guidance on quality assurance and quality control of environmental water sampling and handling; and
- SANS 5667-6, Part 6: Guidance on sampling of rivers and streams.

All samples were collected using sterilised bottles. Before a sample was collected, a prescribed sampling bottle was labelled in correspondence with the monitoring point from which sampling was done. Grab sampling method was used to sample the surface water along the streams. A hand-held pH/EC/TDS meter was used to record the following in-situ parameters: pH, EC, TDS, and temperature. A hand-held GPS was used to mark the geographic coordinates of the sampled sites. As recommended in SANS 5567-3, after samples have been collected, sampling bottles were stored in a cooler box at a temperature below 4^{0}C and then transported to the laboratory within 48 hours of sampling for analysis.

3.5. Water and Salt Balance

Spreadsheet-based water and salt balances methodology was applied. The advantages of these types of balances are:

- Calculations are done automatically.
- Data and results can be viewed relatively easily in various ways, e.g., graphs or tables.

- Data transfer is easy.
- Updates are easily effected when necessary.

The Water and Salt Balance were conducted following the Best Practice Guidelines, BPG 2- Water and Salt Balance (BPG, 2006). The calculations were based on the basic principle of mass conservation, which forms the foundation of mass balances. The principle can be simplified to the basic equation for a mass of species x and a processing unit: (rate of x into process unit) = (rate of x out of process unit).

NOTE: The salt loads were converted to Kilogrammes per annum as follows

Salt load = *Concentration*Mean annual Runoff*

$= mg/l * m^3/a$

$= 0.001 g/l * m^3/a$ *(Convert mg to g)*

$= 0.000001 kg/l * m^3/a$ *(Convert g to kg)*

$= 0.001 kg/m3 * m^3/a$ *(convert l to m^3)*

3.6. Impact assessment methodology

An aspect and impact matrix were used to assist in identifying potential interactions between surface water bodies and project activities. Where interactions were deemed likely, the interactions were further rated to determine if impacts could potentially be created which require the development and implementation of management and mitigation measures beyond standard best-practice. The matrix made provision for the identification of potential interactions for all phases of the project (either positive or negative).

3.6.1. Impact rating

The identification of potential impacts also made provision for the identification of potential:

- Direct impacts – interactions and impacts which could be caused by an activity or action and occur at the same time and place (e.g., direct footprint of project infrastructure locations);
- Indirect impacts – interactions and impacts caused by an action and occur later or farther removed in distance, or which may cause an impact on another environment or water body but are still reasonably foreseeable, e.g., soil erosion due to exposure of surfaces is the direct impact and siltation of surface water as a result of the erosion, is the indirect impacts; and

- Cumulative impacts - impact on the environment, which results from the incremental impact of the action when added to other past, present, associated, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Where cumulative impacts can be expected, to ensure consistency, similar Impact Rating Definitions were applied for current and future activities.

The following aspects are used to assess the impact of the activity on the environment:

- Severity – How severe does the aspect impact the environment and water quality characteristics (Table 3-1).
- Spatial scale – How big is the area that the aspect is impacting on (Table 3-2).
- Duration – How long does the aspect impact the environment and water quality (Table 3-3).
- Frequency of activity – How often is the specified activity being done (Table 3-4).
- Frequency of incident/impact – How often does the activity impact the environment (Table 3-5).
- Legal issues - How is the activity governed by legislation (Table 3-6).
- Detection – How quickly can the impacts of the activity be observed on the environment, people, and property.

Ratings were based on the following scoring scheme:

Table 3-1: Severity

1 = Insignificant	2 = Small	3 = Significant	4 = Great	5 = Disastrous.
The impact is non-harmful.	The impact is potentially harmful.	The impact is slightly harmful.	The impact is harmful.	The impact is extremely harmful and/or wetland(s) involved

Table 3-2: Spatial scale

1 = Localised	2 = Confined to site	3 = Wider area of Influence	4 = National	5 = Global
Localised to a specific area of activities.	Confined to the whole site.	The extent of the impacts will be regional.	Importance of the impact is of provincial or national importance	Importance of the impact is of global importance

Table 3-3: Duration

1 = Short term	2 = Short to medium Term	3 = Medium Term	4 = Long Term	5 = Permanent
Possible to immediately or within a short period mitigate / immediate or fairly quick progress with management implementation. One day to one month.	One month to one year. Areas impacted will have no change in status.	One year to 10 years, impacted area to a lower environmental value status but can be improved over this period through mitigation.	Life of the activity, environmental importance permanently lowered.	More than the life of the mine/operation.

Table 3-4: Frequency of the activity

1 =Annually	2 = 6 months	3 = Monthly	4 = Weekly	5 = Daily
The activity will be done once off on an annual basis.	The activity will be done twice after six months.	The activity will be done on a monthly basis.	The activity will be done on a weekly basis.	The activity will be done on a daily basis.

Table 3-5: Frequency of the incident/impact

1 = Almost never	2 = Very seldom	3 = Infrequent	4 = Often	5 = Daily
It is almost impossible for the activity to impact on the environment >20%.	It is highly unlikely for the activity to impact on the environment >40%	It is unlikely for the activity to impact on the environment >60%.	The activity regularly impacts on the environment >80%.	The activity definitely impacts on the environment >100%.

Table 3-6: Legal issues

1 = No legislation	5 = Covered by legislation
No legislation governs the activity.	The activity is fully covered by legislation.

Table 3-7: Detection

1 = Immediately	2 = Without much effort	3 = Need some effort	4 = Remote and difficult to observe	5 = Covered
Impact can be detected immediately.	Impact can be detected without much effort.	Impact needs some effort like water quality testing to detect.	Impact is remote and difficult to observe	Covered

Table 3-8: Significance

RATING	CLASS	MANAGEMENT DESCRIPTION
1 - 55	(L) Low Risk	Acceptable as is or consider a requirement for mitigation. The impact on the environment is small and easily mitigated. Wetlands may be excluded.
56 - 169	(M) Moderate Risk	Risk and impact on the environment are notable and require mitigation measures on a higher level, which costs more and affects sensitive areas.
170 - 300	(H) High Risk	Always involves sensitive environments. The impacts of the activity are such that they impose a long-term threat on a large scale and lowering of the Natural Reserve.

4. PHYSICAL CHARACTERISTICS

Komatipoort (approximately 13 km from the site) is the nearest town to the study area, therefore, average monthly temperatures and rainfall (Weather Online, 2022) from this town will be used to interpolate weather conditions in the study area.

4.1. Temperature

The temperature in Komatipoort fluctuates across different months of the year. Minimum day and night temperatures are noted in June and July. Maximum day temperatures are noted from November to March. Maximum night temperatures are noted from December to February. Maximum day temperature in summer (December to February) reaches an average of 30°C and maximum night temperature reaches an average of 20 °C. Maximum day temperature in winter (June to August) reaches an average of 25°C and maximum night temperature reaches an average of 13°C (Figure 4-1).

Minimum day temperature reaches an average of 29°C and 23°C in summer and winter periods respectively. Minimum night temperature reaches an average of 20°C and 12°C in summer and winter periods respectively.

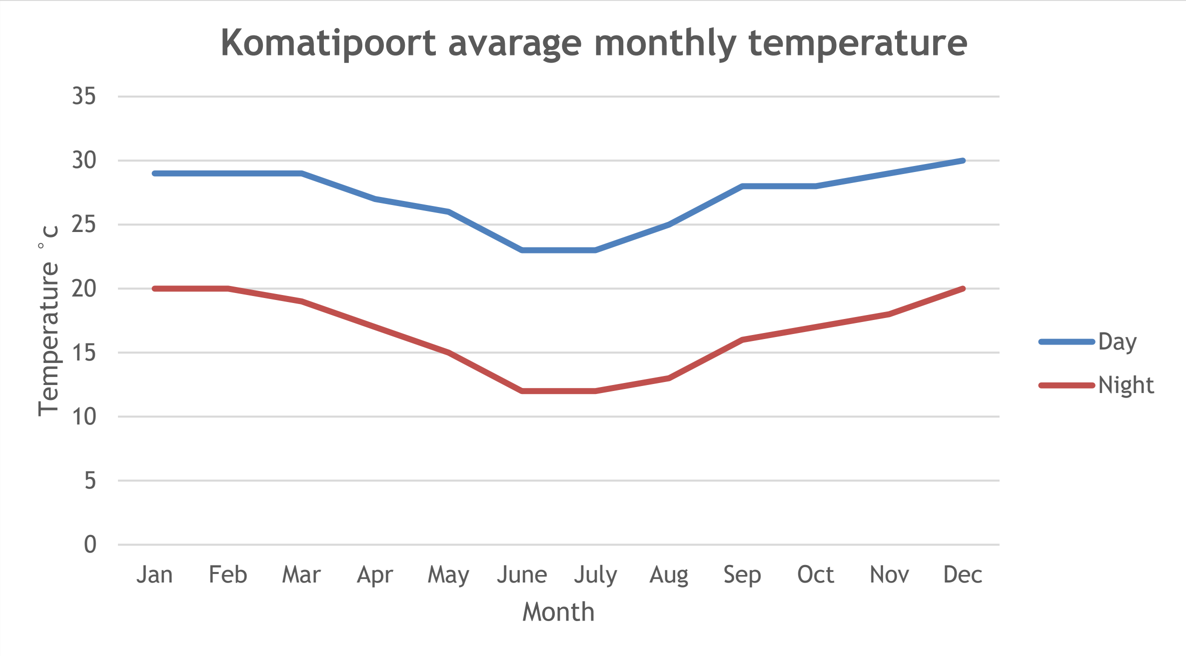


Figure 4-1: Average temperature for Komatipoort

4.2. Rainfall and evaporation

In Komatipoort, the highest rainfall is received in the summer period, with January receiving the most rainfall (147 mm). Minimum precipitation is noted in winter (with July receiving the least rainfall at 4 mm) as this is the driest period in Komatipoort (Figure 4-2). This means that precipitation is not uniform across a year, thus some months receive more precipitation than others. The calculated Mean Annual Precipitation (MAP) for the site is 695.6 mm/a which is the sum of the annual rainfall. The Mean Annual Evaporation (MAE) used for peak flow, water and salt balance calculations was also sourced from the WR2012. The average catchment MAE is 1500 mm/a. The MAE is larger than the MAP showing that the area has water deficit.

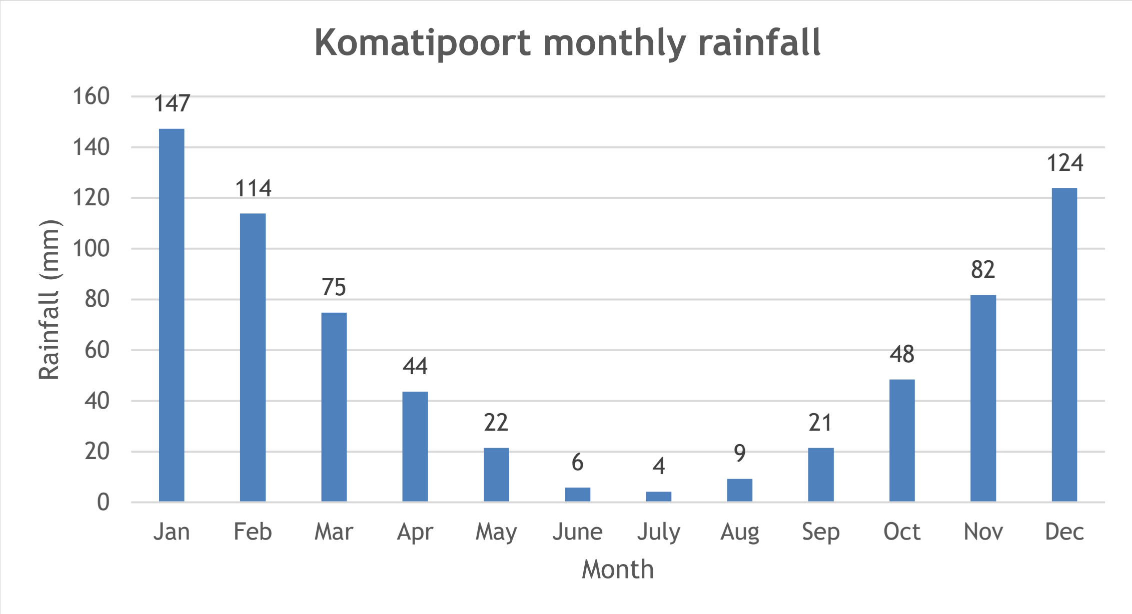


Figure 4-2: Komatipoort monthly average precipitation.

4.3. Mean Annual Runoff

The Mean Annual Runoff (MAR) calculations are highly dependent on the surface area. Runoff figures were analysed statistically in a similar manner as rainfall. Surface runoff often occurs because impervious areas (such as tar road and pavement) do not allow water to soak into the ground. The MAR is not constant throughout the country. However, smaller catchment areas were delineated, and the MAR was determined for smaller catchment areas. The MAR for the study area was also sourced from the WR2012. The average MAR is 18.4 mm/a. The calculated catchment-based MARs are presented in Table 4-1 and site-specific MARs are presented in Table 4-2.

Table 4-1: Catchment-specific MAR

Catchment	Description	Area (m^2)	MAR (m/a)	MAR (m^3/a)
NG 01	Ngweti upstream catchment	129	0.184	23820846
NG 02	Ngweti downstream catchment	224	0.184	41262148
NGT 01	Ngweti Tributary 01 catchment	32	0.184	5947162
NGT 02	Ngweti Tributary 02 catchment	10	0.184	1846895

NGT 03	Ngweti Tributary 03 cathment	20	0.184	3753908
KOM 01	Komati upstream catchment	319	0.184	58769246
KOM 02	Komati downstream catchment	346	0.184	63623821
AC	after confluence catchment	881	0.184	162022429

Table 4-2: Site-specific MAR

Catchment	Area (km^2)	MAR (m/a)	MAR (m^3/a)
C 1	0.57	0.184	3093250
C 2	0.30	0.184	1651239
C 3	0.67	0.184	3657473
C 4	2.71	0.184	14716734
C 5	0.48	0.184	2609304
C 6	0.23	0.184	1233549
C 7	1.35	0.184	7364125

4.4. Topography

Steep topography results in higher flow velocities and affects the resultant flood volumes under various associated conditions as infiltration is minimised. The potential flood is the source of the water, generally, an unusual amount of rainfall, which may be characterised by great water more than that which can be absorbed by the ground or evaporated into the air directly or through vegetation collects in the stream channels that drain the area.

Once in the stream system, the runoff flows to the outlet through channels that, like the trunk of a network of streams, progressively increase in size as contributions are received from tributary streams. Topography plays a vital role in flood events; steep slopes increase peak flows at a given point during heavy rainfalls. The surface topography on site varies between 150 and 450 mamsl with average topographic slopes of around 1V:5H (Figure 4-3).

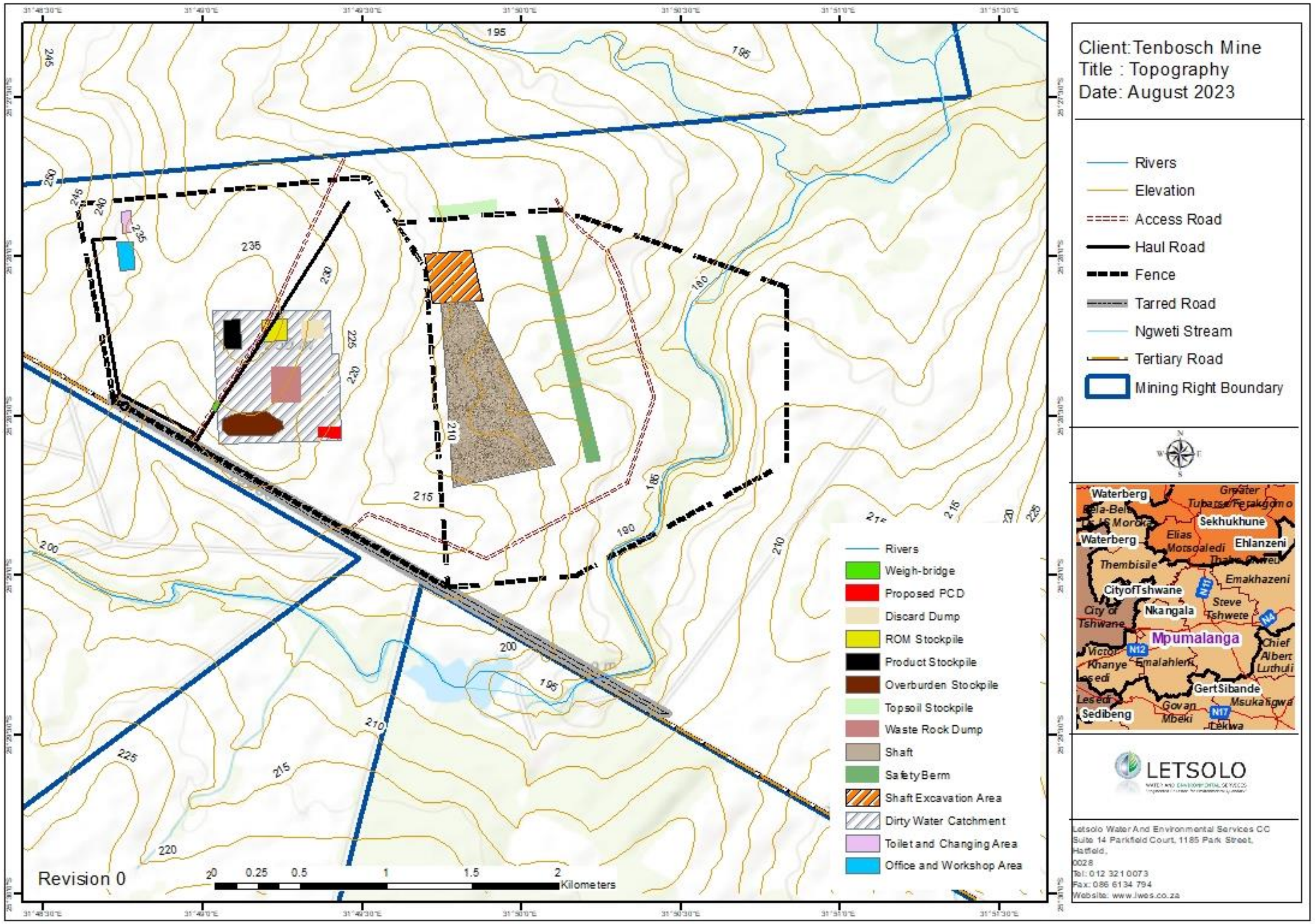


Figure 4-3: Topographic map of the study area

4.4.1. Relevance of topography to the hydrological patterns

Topography was considered for the catchment delineation and location of infrastructure. The channel system is a relatively permanent characteristic of a drainage basin throughout the life of the mine. Some influential changes may take place in this system; for example, variations in seasonal vegetation along the banks may affect the hydraulic conveyance, floods may scour or deposit sediments and old bends may be cut through and new ones created. Therefore, a maintenance programme must be in place to ensure the longer life of the infrastructure.

5. SURFACE HYDROLOGY

The hydrological analysis is simplified in the subsections below.

5.1. Water Management Area

The water management areas were revised in line with Government Gazette No. 35517, regulations 547 of 16 September 2016. The study area falls within the Inkomati Water Management Area (WMA 5). The WMA 5 lies in the eastern part of South Africa (National Water Resources Strategy, 2016). The major river in the WMA 5 includes the Komati, Crocodile, Nwanedzi, and Sabie Rivers.

5.2. Drainage and Quaternary Catchment

A catchment or watershed is derived from the topographical landscape. It is sectioned by a water divide, a high land separating two or more water systems. A quaternary catchment is the land and water surface area that contributes to the discharge at the system outlet. The application area falls within multiple quaternary catchments namely X24H, X13K, and X13L. The proposed infrastructure falls within the primary catchment (X) and quaternary catchment X13L, therefore, only catchment characteristics (MAP and MAR) of this quaternary catchment will be used for calculations.

Surface drainage in the study area is well defined. It is drained by the Crocodile River in the north and the Komati River in the south. Drainage within the proposed mining area occurs from the Ngweti River which cuts across the Application Area in the south. The Ngweti River is a perennial river that originate from the mountains west of the study area. It flows in an easterly direction where it joins the Komati River. The Komati River continues to flow eastwards and confluence with the Crocodile River after the Komati town to form the Inkomati River which flows into Mozambique.

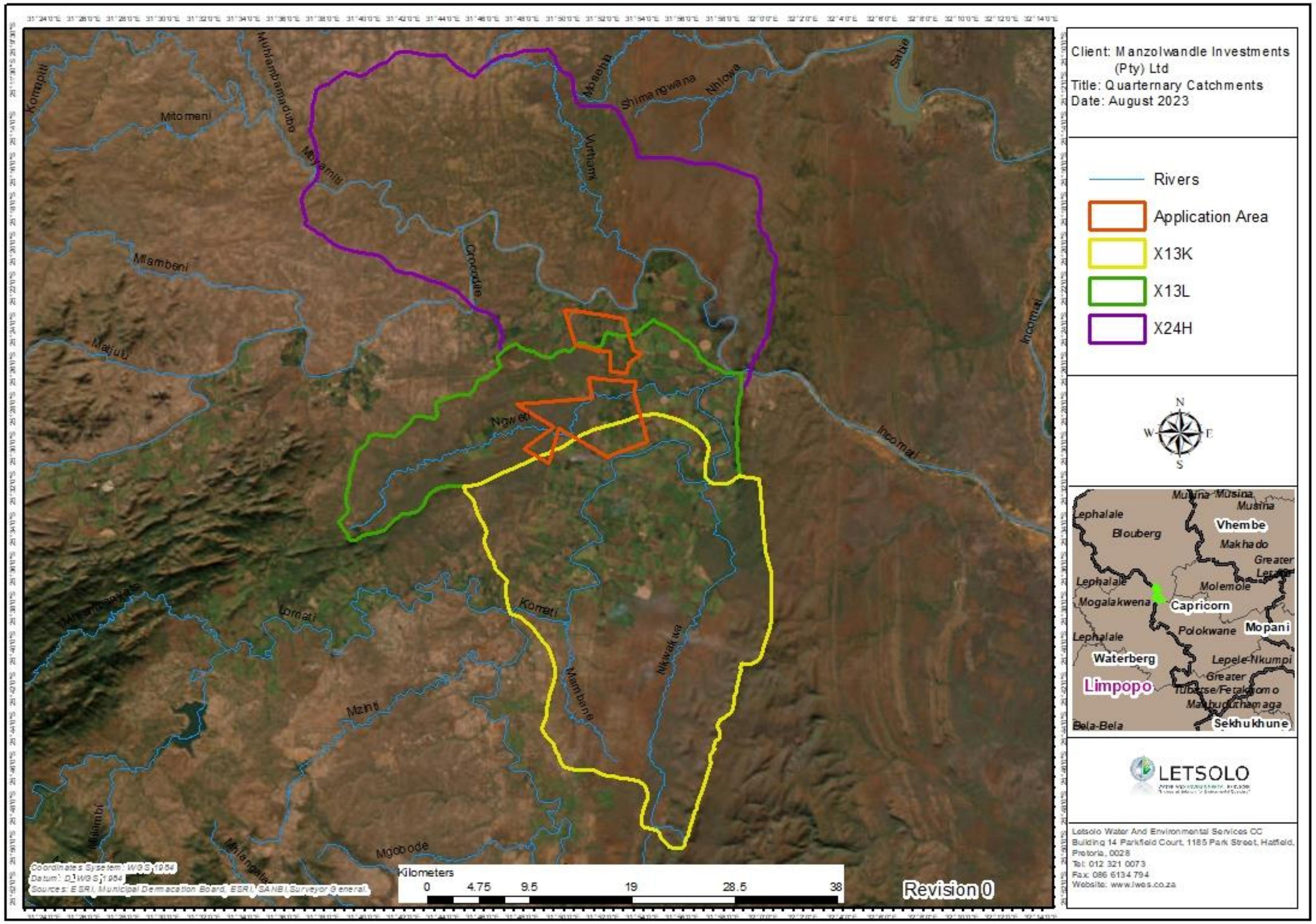


Figure 5-1: Quaternary catchments

5.3. Delineated Catchments

Eight sub-basins (Figure 5-2) were delineated for peak flow calculations and modelling purposes. To systematise the necessary tabulations, the sub-basins were named in accordance with the system illustrated (Ngweti -NG and Komati – KOM) in Table 5.1. The sub-basins of the tributary system (Ngweti Tributary – NGT) are then named in the same manner as those of the mainstream, down to the sub-basin immediately above the confluence (After Confluence – AC) of the tributary with the mainstream.

Table 5-1: Delineated river-based catchments

Catchment	Area (km^2)	Hydraulic Length (m)	Hight difference (m)	Slope
NG 01	129	28.52	169	0.0002
NG 02	224	41.82	214	0.0002
NGT 01	32	11.17	113	0.0001
NGT 02	10	5.00	40	0.0001
NGT 03	20	5.89	55	0.0001
KOM 01	319	29.25	33	0.0009
KOM 02	346	35.09	43	0.0008
AC	881	52.66	67	0.0008

Runoff collects at the lowest area of a catchment, being the drainage line, and continues to flow downstream. Until this water discharges to the receiving catchment or at sea. Several factors affect the hydrological characteristics of a catchment. These include the Hydraulic Length and Height difference. The stream or drainage density is the ratio between the total length of all streams within the drainage basin and the total area of the basin and is an indication of the drainage development.

For hydrological calculations, the length of the longest streams and/or reaches were measured to determine the stream density and the area-distance distribution. The number of small headwater streams shown on the topographic maps would vary with the season and the wetness of the particular year during which the survey was made. This length, when divided by the mean velocity of flow will give the time of concentration as used in the rational formula for the computation of flood volume at discharge points.

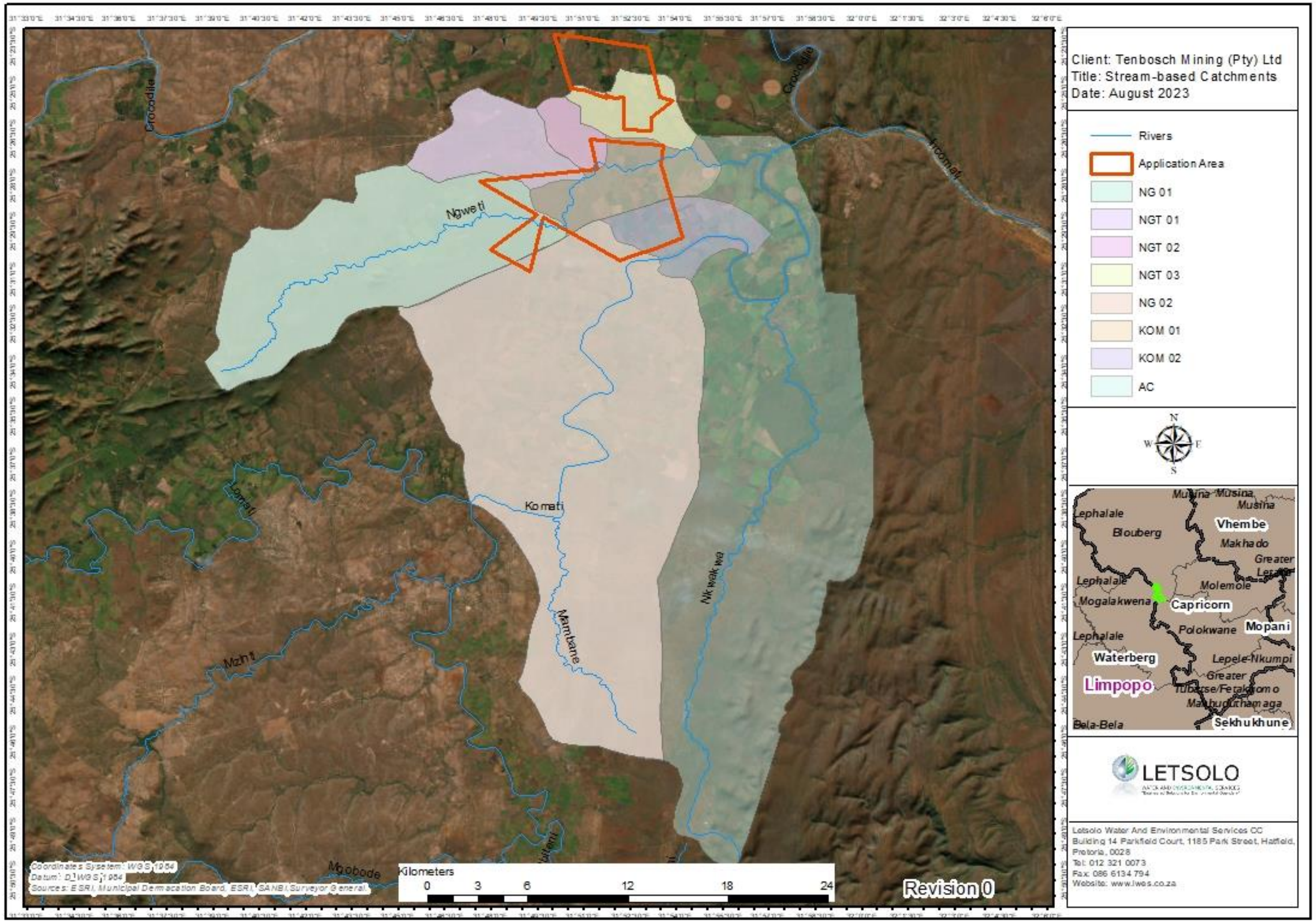


Figure 5-2: Delineated catchments

5.4. Site-specific Catchments

Site-specific catchments (Figure 5-3) were delineated around the study area to determine the drainage line and discharging point for stormwater management. As indicated in Table 5-2, to produce site-specific hydrological yields, seven catchments were separated from each other, and the relevant runoff coefficients were applied for accurate peak flows.

Table 5-2: Site-specific catchments

Catchment	Area (km^2)	Longest watercourse (m)	Change in height (m)	Slope
C1	0.6	0.50	11	0.022
C2	0.3	0.89	18	0.020
C3	0.7	1.09	15	0.014
C4	2.7	2.33	41	0.018
C5	0.5	0.34	1	0.003
C6	0.2	0.54	5	0.009
C7	1.4	1.92	6	0.003

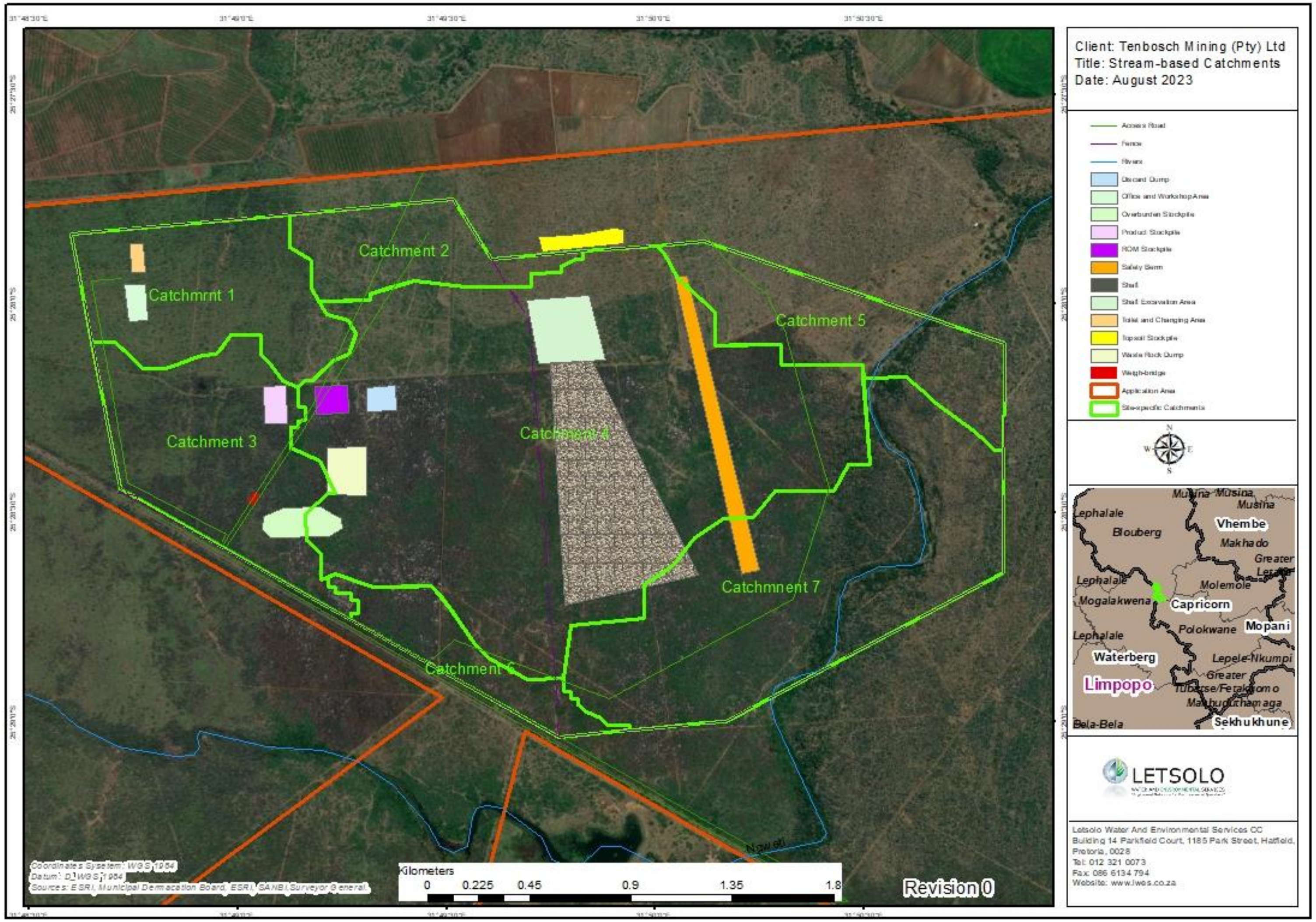


Figure 5-3: Site-specific catchments

6. HYDROLOGICAL CALCULATIONS

After the delineation of catchment areas, flood calculations were conducted based on the hydrological characteristics and flood calculation methods discussed below.

6.1. Peak flow calculations

Peak flow refers to the maximum rate of discharge caused by high runoff during heavy rainfall. Peak flow estimation is very important for the design of infrastructures to be built near a stream. Peak flows for different sites are influenced by the following parameters:

- Area of catchment

This refers to the footprint area for each activity. This area was measured using the proposed infrastructure layout.

- Mean Annual Precipitation (MAP)

The MAP was determined from hydrological data.

- Length of the longest watercourse

Survey data was used to delineate the hydrological path for each proposed area. This path is referred to as the Length of the longest watercourse.

- Average slope

Flat surfaces are associated with low peak flows and steep surfaces are associated with high peak flows. The slope was determined for each area to determine the peak flows.

- Time of concentration

Time of concentration is a concept used in hydrology to measure the response of a watershed to a rain event. It is defined as the time needed for water to flow from the most remote point in a watershed to the watershed outlet. It is a function of the topography, geology, and land use within the watershed.

- Run-off factor

The runoff coefficient (c) represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception; all of which affect the time distribution and peak rate of runoff.

- Combined - C

The total runoff coefficient considers slope, permeability, and land cover.

6.1.1. Catchment-based peak flows

The catchment-based peak flows were calculated for floodlines purpose. Due to larger catchment size, the SDF method was used to calculate these peak flows. The peak flows for the NG system range between 302 and 386 m^3/a for the 1 in 50 years return period, while for the 1 in 100 years return period the range is between 380 and 486 m^3/a (Table 6-1). For the NG tributaries, the upstream catchment (NGT 01) recorded peak flows of 163 and 205 m^3/a for the 1 in 50 and 1 in 100 years return periods respectively. The lower most catchment of the (NGT 03) recorded the highest peak flows in the system with 146 and 184 m^3/a for the 1 in 50 and 1 in 100 years return periods respectively. The after confluence (AC) catchment incorporates the Ngweti and Komati systems, it recorded 791 and 995 m^3/a for the 1 in 50 and 1 in 100 years return periods respectively.

Table 6-1: Catchment-based peak flows

Catchment	Peak floods m^3/s	
	1:50-year	1:100-year
NG 01	302	380
NG 02	386	486
NGT 01	163	205
NGT 02	63	55
NGT 03	146	184
KOM 01	423	532
KOM 02	419	527
AC	791	995

6.1.2. Site-specific peak flows

The rational method was used for the peak flow calculations of site-specific catchments due to their smaller surface area. The site-specific peak flows range between 9.57 and 55.68 m^3/a for the 1:50-year return period and range between 11.91 and 69.29 m^3/a for the 1:100-year return period (Table 6-2). The sub-catchment with the large surface area (C4) recorded the highest peak flows of 55.68 and 69.29 m^3/a for the 1:50 and 1:100-year return periods, respectively.

Table 6-2: Site-specific peak flows

Catchments	Peak Flows (m^3/s)	
	Rational method	
	1:50 year	1:100 year
C1	13.85	13.95
C2	4.99	6.46
C3	11.86	15.31
C4	40.73	52.53
C5	8.31	10.74
C6	2.54	3.290
C7	15.14	19.56

7. CONCEPTUAL STORMWATER MANAGEMENT

Stormwater management involves the control of surface runoff. The volume and rate of runoff substantially increase as land development occurs. Stormwater runoff occurs when precipitation from rain flows over the land surface. The addition of roads, driveways, parking lots, rooftops, and other surfaces that prevent water from soaking into the ground to our landscape greatly increases the runoff volume created during storms.

A Stormwater Management Plan (SWMP) is based on the principles and guidelines outlined in the GN 704 of the National Water Act of 1998 and the BPG G1: Stormwater Management Plan (DWF, 1999). The primary objectives of the SWMP according to the BPG 1 are:

- To address the impact that mining operations have on water flow and quality during different hydrological cycles;
- To determine the impacts the hydrological cycle has on mining activities;
- To protect life and property from floods; and
- To protect and conserve the environment and water resources.

The objectives of a SWMP are site-specific but some general objectives include:

- Protection of life (prevent loss of life) and property (reduce damage to infrastructure) from flood hazards;
- Planning for drought periods in a mining operation;
- Prevention of land and watercourse erosion (especially during storm events);
- Protection of water resources from pollution;

- Ensuring continuous operation and production through different hydrological cycles;
- Maintaining the downstream water quantity and quality requirements;
- Minimising the impact of mining operations on downstream users; and
- Preservation of the natural environment (water courses and their ecosystems).

7.1. Surface infrastructure influenced by stormwater

The mine proposed the following surface infrastructure:

- Underground shaft – According to BPG 1, underground shafts are considered dirty water catchments that contaminate water bodies by introducing suspended solids (SS) and other contaminants formed during the extraction of coal.
- Overburden stockpiles – These are residues deposited during the mining activity such as fines, carbonaceous shales, and waste rock dumps.
- They are regarded as dirty water catchments by BPG 1.
- PCDs - PCDs are designed to collect and store dirty water runoff at the mining area. It also stores water pumped from the underground shaft. They are regarded as dirty water facilities as they store dirty water. They are not allowed to overflow more than once in a 50-year return period.
- Offices – Suspended Solids are the main water contaminants at offices; therefore, they can be considered clean water catchments.
- Roads – With regards to tarred roads, the BPG 1 regard them as clean water catchment as they are not expected to be contaminated by waste coal. Haul roads on the other hand are regarded as dirty water catchments because they may contain dissolved and suspended contaminants.
- Plant, stockpile, and workshop area – These are considered dirty facilities due to the coal stockpiling area, hazardous substances storage and handling and washing of machinery.

7.2. Change in Peak Flows

The previous Chapter presented pre-mining site-specific peak flows (Table 6-2) of the study area. To design stormwater infrastructure, post-mining peak flows were calculated for channels. Pre-mining peak flows refer to peak flows before the proposed project commences.

Post-mining refers to the estimated peak flows during and after mining. Table 6-3 presents a change in peak flow in the study area. The table shows that the peak flow of catchments with no surface infrastructure (C2, C5, and C6) did not change for the pre- and post-mining activities Table 6-2 and Table 7-1).

Four catchments (C1, C3, C4, and C7) recorded a change in peak flows. Catchment 1 recorded an increase from 13.85 to 13.95 m^3/a for the 1:50-year return period and an increase from 17.93 to 18.01 m^3/a for the 1:100-year return period. Catchment 3 recorded an increase from 11.60 to 11.86 m^3/a for the 1:50-year return period and an increase from 15.01 to 15.31 m^3/a for the 1:100-year return period. Catchment 4 recorded an increase from 31.25 to 40.73 m^3/a for the 1:50-year return period and an increase from 40.39 to 52.53 m^3/a for the 1:100-year return period. Catchment 7 recorded an increase from 11.08 to 15.14 m^3/a for the 1:50-year return period and an increase from 14.32 to 19.56 m^3/a for the 1:100-year return period. This increase is due to the addition steep slope features like stockpiles, clearance of vegetation, addition of roofs, and the compaction of soil.

Table 7-1: Change in site-specific peak flows due to infrastructure development

Catchments	Peak Flows (m^3/s)	
	Rational method	
	1:50 year	1:100 year
C1	13.95	18.01
C2	4.99	6.46
C3	11.60	15.01
C4	31.25	40.39
C5	8.31	10.74
C6	2.54	3.290
C7	11.08	14.32

7.3. Clean and dirty water catchment

The purpose of designing stormwater management facilities is to ensure that the surface runoff from clean catchments does not mix with the surface runoff from dirty catchments. Dirty catchments include all the areas where coal will be handled such as underground shaft, overburden dumps, sorting and stockpiling areas. Clean catchments are area that hosts clean infrastructure such as topsoil stockpile. Figure 7-1 below illustrates clean and dirty catchments.

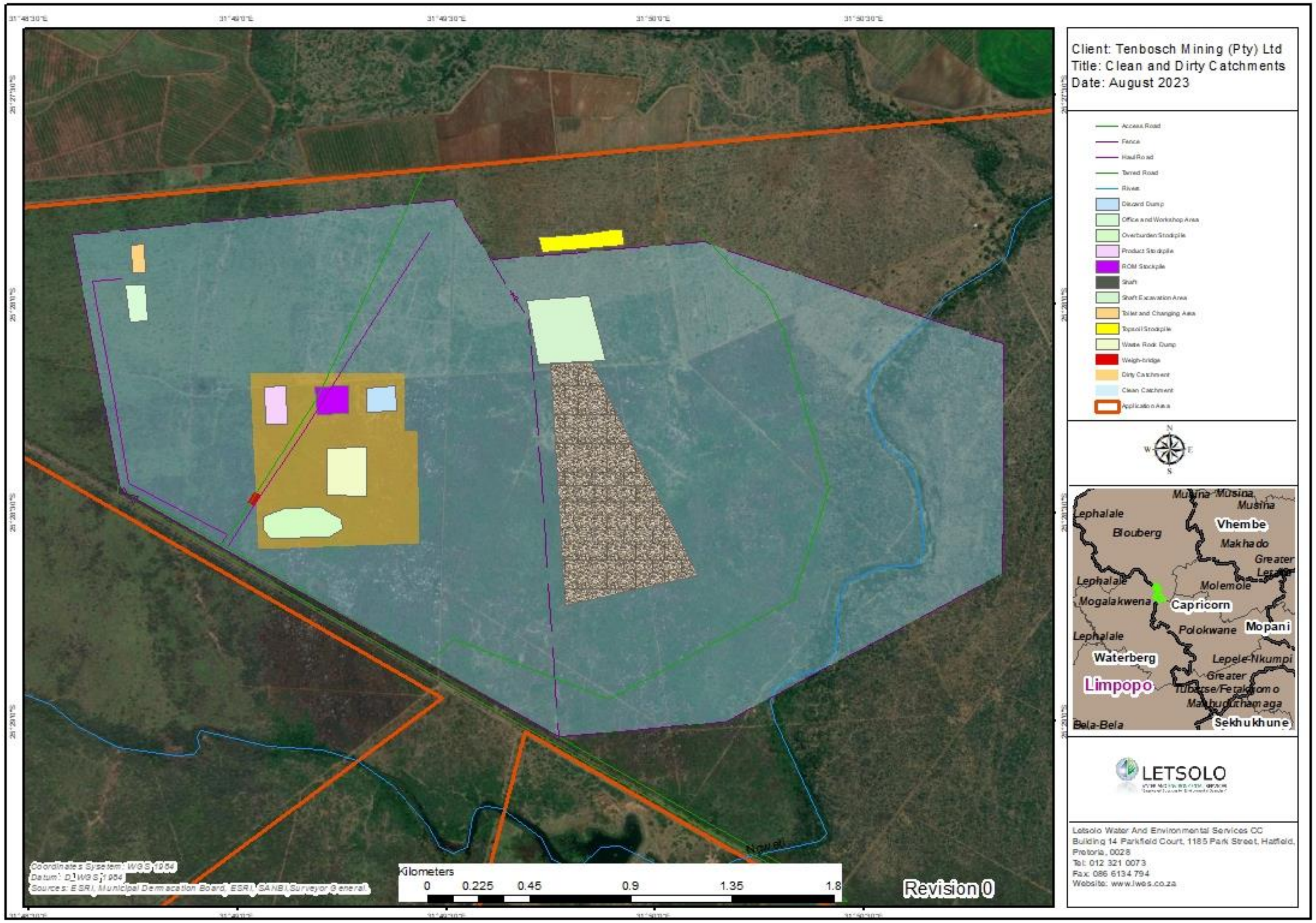


Figure 7-1: Clean and dirty water catchments

7.4. Stormwater Infrastructure

The previous subsection presented the increase in peak flow influenced by the introduction of surface infrastructure in the study area. This subsection presents the proposed stormwater infrastructure that will manage the increase in peak flow and flood volume.

7.4.1. Berms

Berms serve as catchment dividers and separate clean water catchments from dirty water catchments. A system of vegetated and compacted berms (Figure 7-2) should be built around the dirty catchments to contain dirty runoff and divert it into dirty water containment facilities such as PCDs. The berms will also prohibit the clean runoff from entering the dirty water catchment and divert it back to the environment. They should also be built around haul roads to prevent the washing away of contaminants from the roads to a clean environment. The berms should also be constructed around the sorting plant, stockpiling area, and workshop area to prevent external runoff from entering. They should also be constructed outside the 1:100-year flood inundation boundary and the 100m watercourse buffer to ensure compliance with the GN 704 which will be discussed in the next chapter.

7.4.2. Channels

All channels should be placed inside the berms (at dirty water catchment); and they should be trapezoidal with a slope of 0.5% (1V:1.5H). To prevent erosion and seepage of contaminants, all channels should be lined with impervious surface such as concrete or plastic. A HDPE liner plastic that is 1.5 mm in thickness is proposed for all channels. The main purpose of channels is to convey surface runoff into the dirty water containment facilities. A silt trap should be fitted where the channel discharge into the PCD to prevent siltation at the PCD.

The channels were sized to convey the increased peak flow. Table 7-2 presents sizing specific of the proposed channels. According to the conceptual design of stormwater channels, plastic lined trapezoidal channels with a normal depth of 1 m, top width of 3.012 m, and a bottom width of 1.012 m will be sufficient enough to convey surface runoff during the worst-case scenario of a peak flow of 11.90 m^3/a into a designated dirty water catchment facility.

Table 7-2: Channel sizing summary

	Concrete Trapezoidal
Worst-case peak flow (m^3/a)	11.90
Roughness coefficient ($s/m^{1/3}$)	0.014
Normal depth (m)	1
Side slopes (V:H)	1:1.5

Bottom width (m)	1.012
Top width (m)	3.012
Velocity (m/s)	5.915

7.4.3. Dirty water containment facilities

Dirty water containment facilities are facilities designed to capture and store dirty water from dirty catchments such as PCD and stormwater sump. The PCD will be situated at the lowest of the dirty water catchment area (Figure 7-3) and the shaft sump will be located at the mouth of the shaft. At the workshop, an oil trap sump will be required to collect runoff mixed with oil and chemicals.

Figure 7-3 present proposed stormwater infrastructure for the dirty water catchment area and the shaft excavation area.

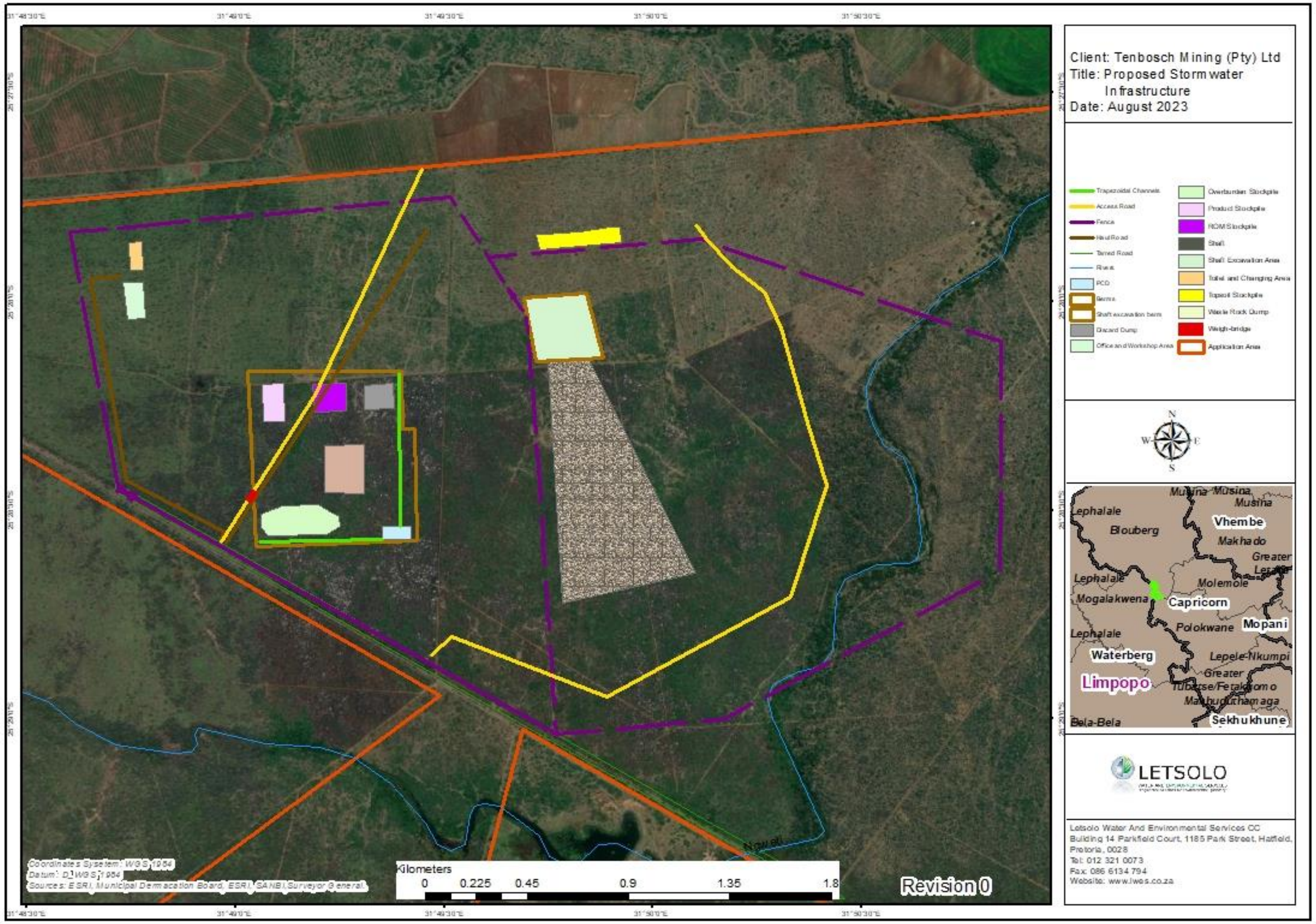


Figure 7-2: Proposed stormwater management infrastructure

8. FLOODLINES

The peak flows obtained from Table 6-1 were used as the input for the delineation of the 100 years flood event. The output tables (Appendix 1) indicate that the difference between 1 in 50 and 1 in 100 floodlines is minimal among the output variables. Therefore, only the 1:100 years flood lines were mapped to indicate the worst-case buffer zone.

The output variables include the following (Appendix A);

- Crit W.S - Critical Water Surface Elevation,
- E.G. Slope - Slope for the energy grade line,
- Flow Area - Total Area of cross-section active flow,
- Froud # Chnl - Froude Number for the main channel,
- Q total - Total flow in cross-section
- Top W Chnl - Top Width of the main channel, and
- Vel Chnl - Average Velocity of flow in the main channel

Floodlines for the 1:100-year return period were determined for the streams passing through the study area. Floodlines delineation is governed by Government Notice (GN) 704 Restriction 4 which states that no person in control of a mine or activity may (DWF, 1999):

- *(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100-year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole, or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;*

- *(b) except in relation to a matter contemplated in regulation 10 (sand mining), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is the greatest.*

Figure 8-1 illustrates the proposed surface infrastructure against the 1:100-year flood inundation boundary and the 100m watercourse buffer. The figure indicates that all the surface infrastructure from both operations is outside the flood inundation boundary and the 100m watercourse buffer. Therefore, according to Restriction 4 of GN 704, the applicant can mine ore on the proposed locations.

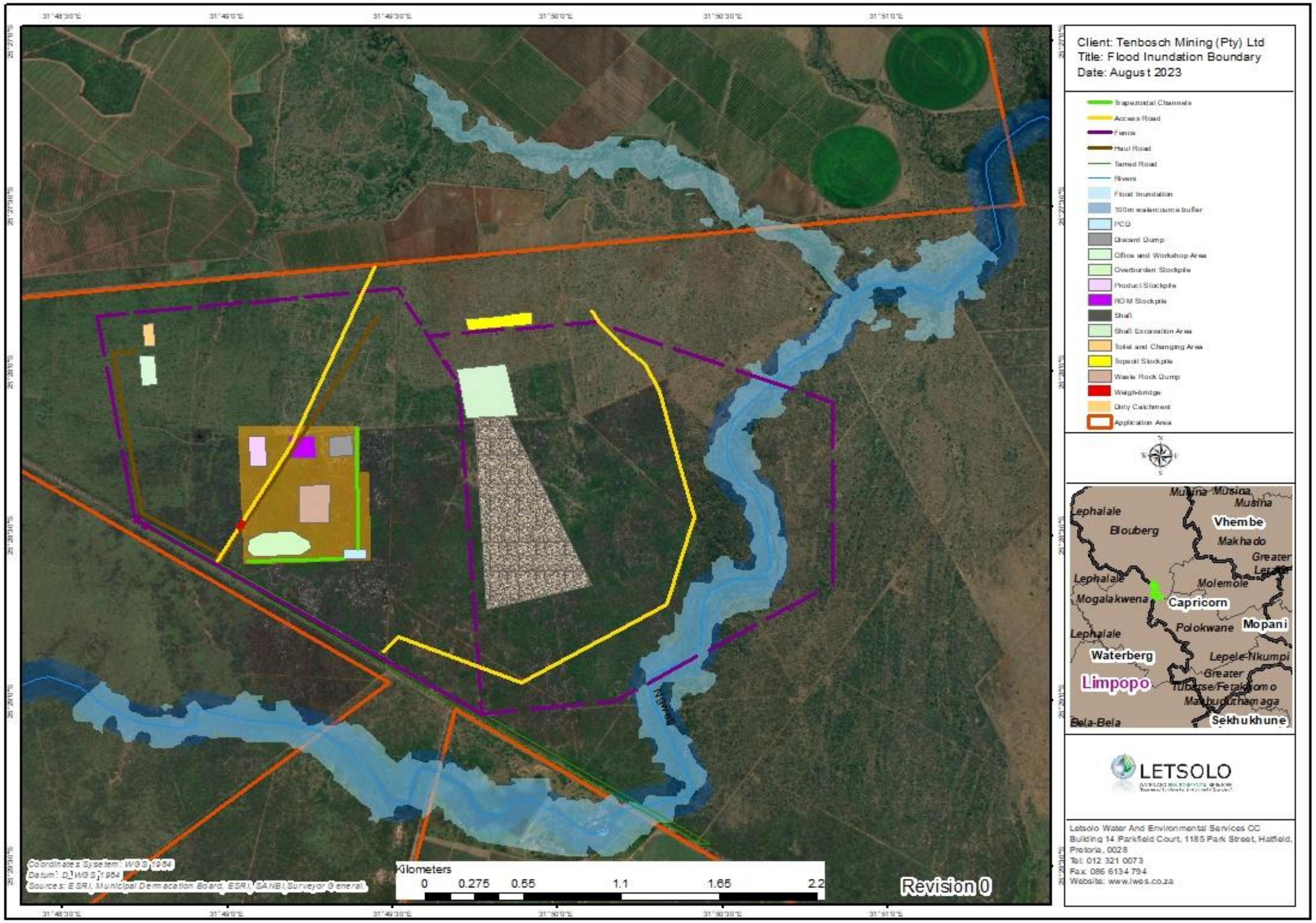


Figure 8-1: Flood inundation for the 1:100-year return period and 100m watercourse buffer zones

9. WATER BALANCE

In hydrology, a water balance equation can be used to describe the flow of water in and out of a system. A system can be one of several hydrological domains, such as a drainage basin. Water Balance equations use the principles of conservation of mass in a closed system, whereby any water entering a system (via precipitation), must be transferred into either evaporation, or surface runoff (eventually reaching the channel and leaving in the form of discharge, or stored in the ground. This equation requires the system to be closed, and where it is not (for example when surface runoff contributes to a different basin), this must be considered.

The water balance can be illustrated using a water balance graph which plots levels of precipitation and evapotranspiration often on a monthly scale. Water balance calculations can be used to help manage water supply and predict where there may be water shortages or excesses that may need additional dirty water containment facility. Water balance calculations presented below area estimated, detailed calculations will be conducted after the installation of flow meters and the availability of flow meter readings.

9.1. Water circuits

Each water circuit was assessed individually to indicate all water sources, losses, and storage as summarised in Figure 9-2. To distinguish between clean and dirty water, different colours were used in the sketch (Figure 9-2).

The Water Balance sketch demonstrates the balance between inputs and outputs. The inputs in the system include the following:

- Rainfall
- Runoff from upstream areas
- Water abstracted for usage and top-up

The outputs include the following:

- Catchment losses like capillary and infiltration water
- Evaporation
- Water re-use

9.1.1. Domestic

The source of domestic water onsite is a borehole. The borehole will be used to supply domestic water at all the farms. It is anticipated that a total of 11 984 m^3/a of water will be pumped from the borehole. Based on the distribution of personnel, it is anticipated that grey water distribution will be as follows for all sites (Figure 9-1):

- 40% will be collected at the plant;
- 20% will be collected at the workshop septic tank,
- 20% will be collected at the security checkpoint and weigh bridge septic tank,
- The remaining 20% will be allocated to the admin block septic tank.

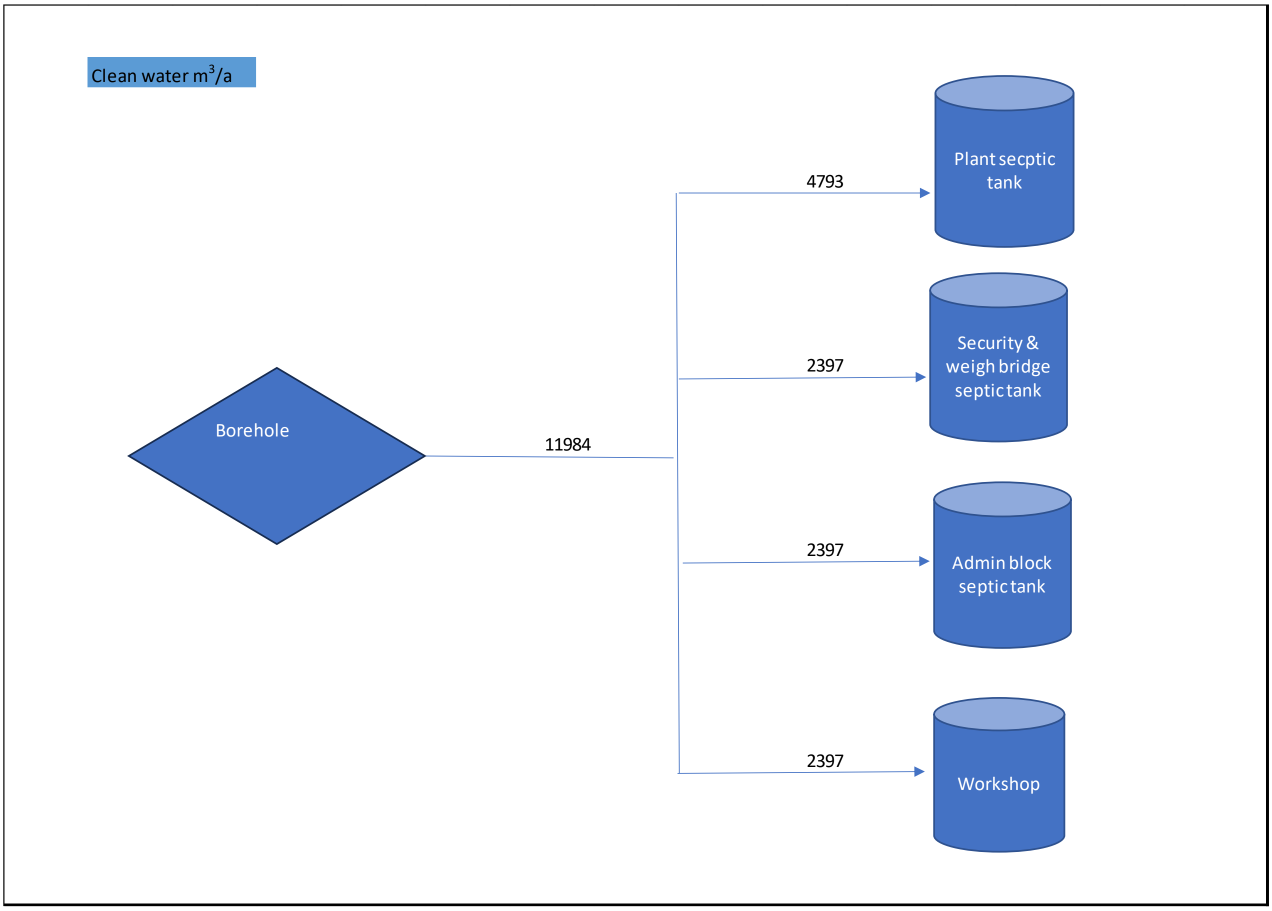


Figure 9-1: Domestic water distribution diagram

9.1.2. Wash plant area

The plant area will be used for the crushing, screening, and washing of coal; therefore, it is regarded as a dirty water facility. The sources of water in this area are direct rainfall and water pumped from the PCD for spraying during the crushing and washing of coal. The area will lose water through evaporation and surface runoff. Table 9-1 presents wash plant area water balance calculations.

Table 9-1: Wash Plant Area water balance

Wash Plant Area			
Water in	Volume (m^3/a)	Water out	Volume (m^3/a)
Rainfall	9687	Evaporation	24005
Pumped from PCD	18483	Runoff	4166
Total in	28170	Total Out	28170
		Surplus/deficit	0

9.1.3. Coal stockpile

Coal stockpiles are piles of coal after the processing activity. This stockpile is a dirty water facility due to the presents of coal. It will receive water from direct rainfall and water retained on coal. It will lose water naturally through evaporation and runoff. Table 9-2 present detailed coal stockpile water balance calculations

Table 9-2: Coal Stockpile water balance

Coal Stockpile			
Water in	Volume (m^3/a)	Water out	Volume (m^3/a)
Rainfall	9314	Evaporation	23079
Water on coal	17770	Runoff	4005
Total in	27084	Total Out	27084
		Surplus/deficit	0

9.1.4. Discard dump

The discard dump is a dirty facility that will receive water from direct rainfall and water retained on the discard material. Table 9-3 present detailed water balance calculations for the discard dump.

Table 9-3: Discard dump water balance

Discard Dump			
Water in	Volume (m^3/a)	Water out	Volume (m^3/a)
Rainfall	8775	Evaporation	21744
Water on discard material	16742	Runoff	3773
Total in	25517	Total Out	25517
		Surplus/deficit	0

9.1.5. Overburden stockpile

Overburden stockpiles are residues deposited during the mining activity. This stockpile will receive water from rainfall and water retained on the surface of the overburden material. The water will be lost through evaporation and surface runoff. Table 9-4 present detailed water balance calculations for the overburden stockpile.

Table 9-4: Overburden stockpile water balance

Overburden Stockpile			
Water in	Volume (m^3/a)	Water out	Volume (m^3/a)
Rainfall	22540	Evaporation	55854
Dust suppression	43006	Runoff	9692
Total in	65546	Total Out	65546
		Surplus/deficit	0

9.1.6. Shaft opening sump

The shaft opening sump is a dirty water containment facility that will be designed capture runoff from the shaft excavation area. The sump will also store water pumped from underground workings. It will also receive natural water through direct rainfall. The sump will lose water through dewatering to the PCD and naturally through evaporation. Table 9-5 present shaft opening sump detailed water balance calculations.

Table 9-5: Shaft sump water balance

Shaft Opening Sump			
Water in	Volume (m^3/a)	Water out	Volume (m^3/a)
Rainfall	29208	Evaporation	72376
Shaft opening runoff	204457	Pumped to PCD	161289
Total in	233665	Total Out	233665
		Surplus/deficit	0

9.1.7. Pollution Control Dam

A Pollution Control Dam (PCD) is a dirty water containment facility. It will collect surface runoff from the hosting dirty catchment (Figure 7-1), and it will also receive water from rainfall. This facility will also be used to store water pumped from the shaft opening sump during dewatering process. The PCD will lose water through evaporation, water pumped for dust suppression and reuse at the workshop and wash plant. Table 9-6 presents water balance calculations for the PCD.

Table 9-6: PCD water balance

PCD			
Water in	Volume (m^3/a)	Water out	Volume (m^3/a)
Rainfall	12126	Evaporation	30048
Runoff from dirty catchment	127366	Reuse at plant	18483
Pumped from underground	161289	Reuse at wash bay	50450
		Dust suppression	189187
		Retained in PCD	12612
Total In	300781	Total out	300781
		Surplus/deficit	0

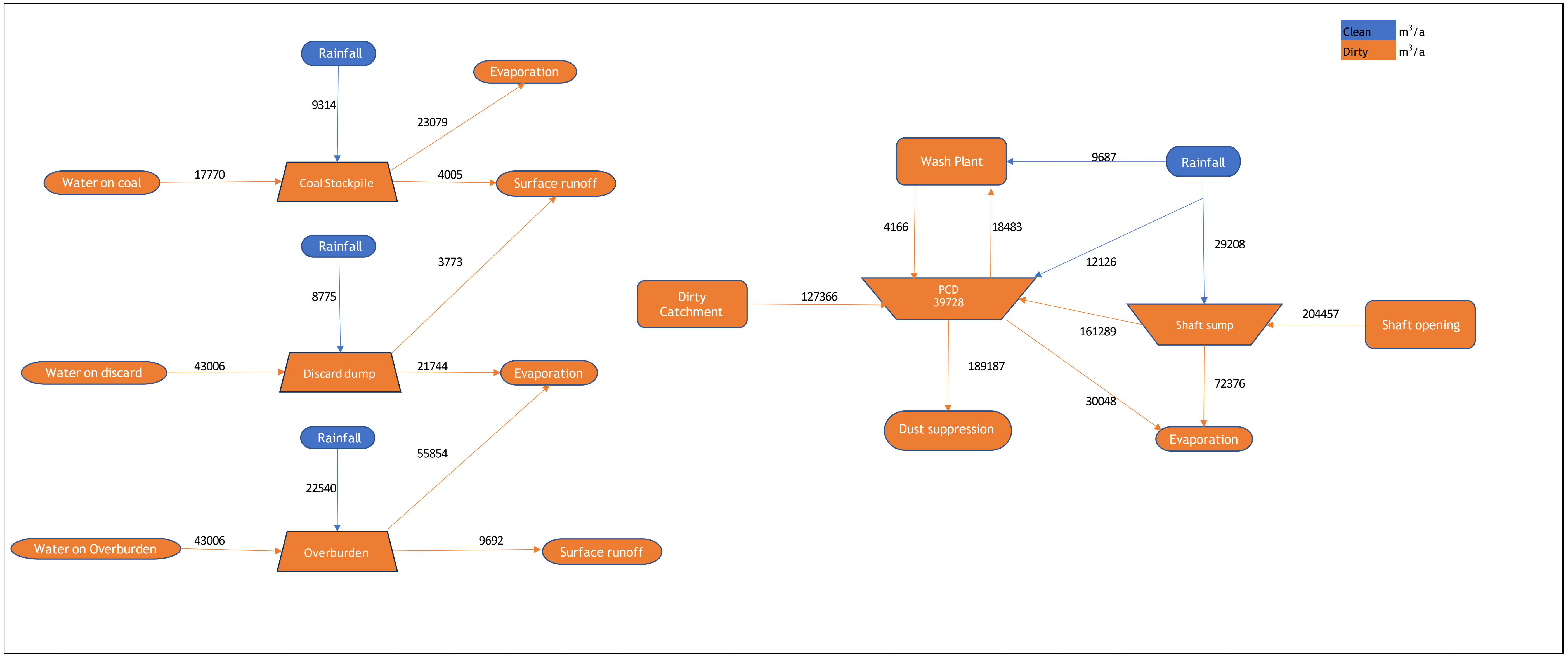


Figure 9-2: Water balance schematic diagram

10. BASELINE WATER QUALITY

Water samples from the monitoring points (Figure 10-1) were collected on the 10th of April 2022 to determine the water quality of the two systems. System 1 (Ngweti) cuts across the application area in the south hosts sampling points NG 01 and NG 02. It has three major tributaries that hosts sampling points NGT 01 (tributary 01), NGT 02 (tributary 02), and NGT 03 (tributary 03). The second tributary was dry during the day of sampling. The second system (Komati) is located outside the southern parts of the application area. It hosts sampling points KOM 01 and KOM 02. The sampling point AC is located east of the application area; and it is after the confluence of the main system (Komati) and its tributary (Ngweti). Table 10-1 shows the geographic coordinates of all the monitoring points. Figure 10-1 illustrate the location of the sampling points.

Table 10-1: Geographic coordinates of the sampling points

Sampling Point	Latitude	Longitude
NG 01	-25.4888	31.83718
NG 02	-25.4561	31.91593
NGT 01	-25.4354	31.81885
NGT 02	-25.4365	31.83578
NGT 03	-25.442	31.90127
KOM 01	-25.5072	31.87864
KOM 02	-25.4985	31.93844
AC	-25.4465	31.95605

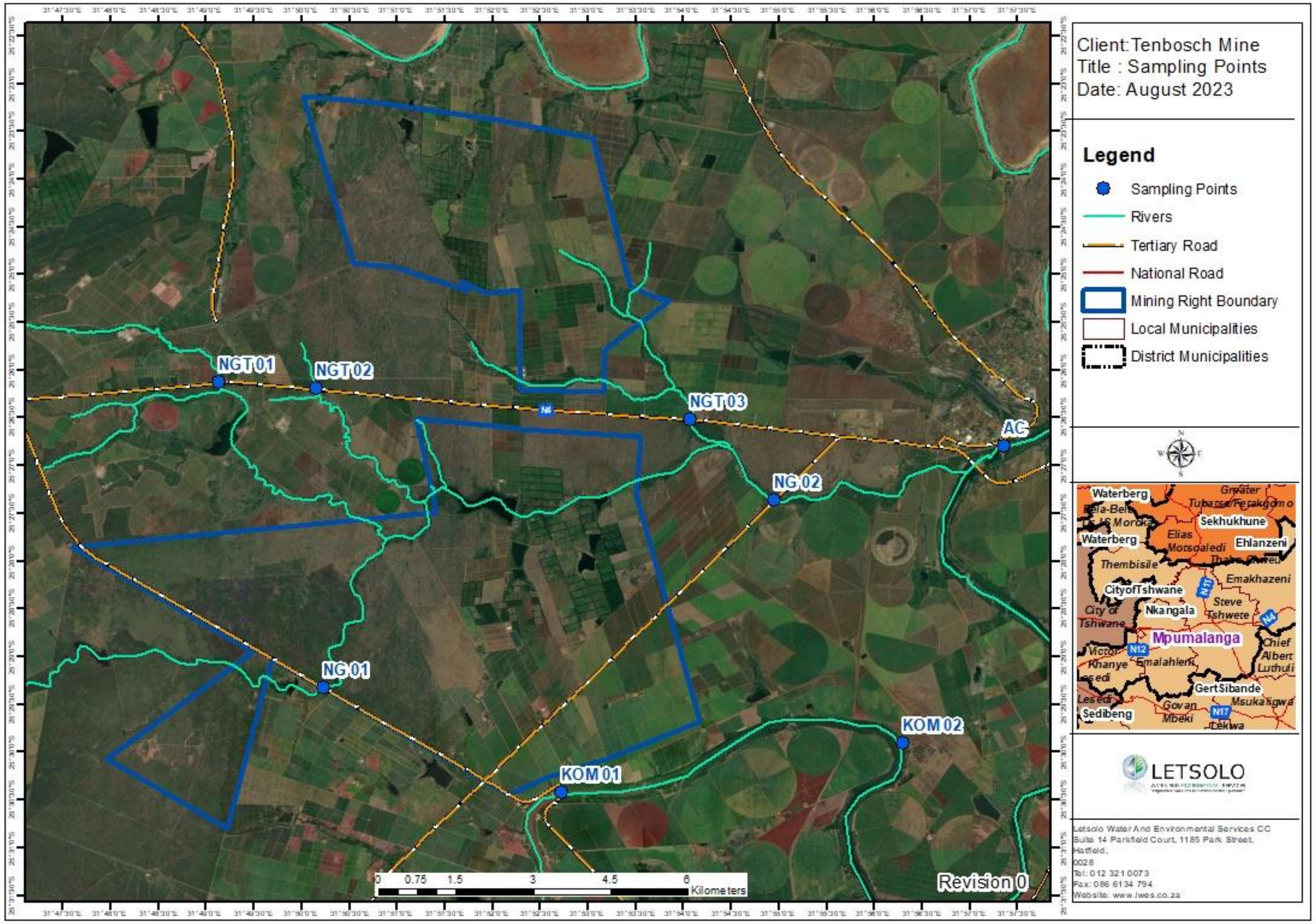


Figure 10-1: Sampling points

The chemical analysis from the sampling points were compared against various water quality guidelines set by the DWS to assess water quality in the study area. The surface water in the study area is mostly used for irrigation, livestock, and domestic use. The guidelines used are (DWAF, 1996):

- Volume 1: Domestic [additionally SANS 241 (2015) for domestic];
- Volume 4: Irrigation;
- Volume 5: Livestock watering

In terms of water quality guidelines, the Komati River is of good quality for all the observed water uses. Most of the chemical parameter were not exceeded by any of the sampling points, except for the irrigation limit for pH which exceeded by the AC sampling point and the domestic limit for Aluminium (Al) which was exceeded by the KOM 01 point (Table 10-2). The Komati River is used for fishing near KOM 01 sampling point, the aluminium material used by the fishermen might be the contributor of Al in this point.

The Ngweti River and its tributaries showed poor water quality in terms of EC which exceeded all the water quality guidelines. This river is surrounded by farms which uses fertilisers and pesticides that may wash of into the river during rainfall and irrigation. The river is not suitable for domestic use as all the sampling points exceeded the domestic limit for TDS, Ca, and Mg. It can be used for other purposes such as irrigation and livestock. It can be concluded from the chemical analysis results (Table 10-2) that the majority of the chemical parameters such as the EC, TDS, SO_4, as well the cations i.e., Ca, Mg, and Na, were higher in the tributary when compared to the main system.

Table 10-2: Baseline water quality for surface water bodies around the study area

Chemical Parameters	Water use guidelines					Sampling Points							
	Domestic	Irrigation	Livestock	SANS241:2015		NG 01	NG 02	NGT 01	NGT 02	NGT 03	KOM 01	KOM 02	AC
pH	6.0 - 9.0	6.5 - 8.4	-	≥ 5 and ≤9.7	Exceedance in all guidelines	8.3	7.9	8.4	Dry	8.3	8.3	8.3	8.5
EC	0 - 70	≤ 40		≤ 0.17		189	122	92		108	27.5	28.1	32.4
TDS (mg/l)	0 - 450	-	-	≤ 1200		1187	801	559		703	171	162	194
Alk - mg CaCO3/l	-	-	-	-		618	373	258		341	110	96.3	116
Cl (mg/l)	100	≤ 100		≤ 300		357	194	89.3		131	31.9	30.7	36.9
SO4 (mg/l)	200	-	1000	≤ 500		13.7	111	107		117	11.9	12	16.2
NO3 (mg/l)	-	5	10	≤ 11		<0.194	3.8	2.3		5	0.6	0.6	0.7
NO2 (mg/l)	6	5	10	≤ 0.9		0.1	0.1	0.1		0.1	0.1	0.1	0.1
NH4 (mg/l)	-	-	-	-		0.1	0.1	0.1		0.0	0.1	0.1	0.1
F (mg/l)	1	≤ 2	2	≤ 1.5		0.9	0.4	<0.263		0.5	<0.263	<0.263	<0.263
Ca (mg/l)	32	-	1000	-		36.6	96.6	50.3		70.2	13.6	15.2	17.5
Mg (mg/l)	30	-	500	< 200		52.8	67.0	38.8		53.9	12.8	12.7	14.8
Na (mg/l)	100	≤ 70	2000	≤ 200		347.0	86.1	95.0		97.8	29.5	28.1	32.8
K (mg/l)	50	-	-	-		1.7	1.1	10.7		2.3	1.6	1.6	1.6
Al (mg/l)	0.15	≤ 5	5	0.3 - 0.5		<0.002	<0.002	<0.002		<0.002	0.269	0.088	0.051
Fe (mg/l)	0.1	≤ 5	10	-		<0.004	<0.004	<0.004		<0.004	<0.004	<0.004	<0.004
Mn (mg/l)	0.05	≤ 0.02	10	≤ 0.4		<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001
TSS mg/l	-	-	-	-		14.0	35.0	24.0		7.0	7.0	36.0	<4.5
TON mg/l	-	-	-	-		0.3	3.9	2.3		5.1	0.6	0.7	0.8

<Below detection level

11. SALT BALANCE

Under normal circumstances, when determining water balances, one tends to only refer to the hydraulic balance, i.e., the accounting of all the in- and output volumes entering and leaving a system. In opposed to this, a water and salt balance uses the hydraulic balance, but then also accounts for the dissolved solids carried in the water streams. In other words, a water and salt balance is a means of accounting for all the products carried in a system where one value can be used to verify the accuracy of the other. A Water and Salt balance can best be described as a management tool, which assists the user in determining not only the concentration of dissolved solids in a body of water but also, more importantly, to determine the mass of salts carried in a dynamic system.

Once all the water volume data was assessed and confirmed by the mathematical equations, water quality was then introduced to the spreadsheet calculations. Water quality data was sorted for each unit with water quality monitoring data. It is important to note that with Salt load calculations, the monitoring point with the poorest water quality data may not necessarily reflect the worst salt loads. Another determining factor is the volumes concerned. The same basic principles for the water balance apply to the salt balance, i.e., the conservation of mass across a system:

Total salt load in = Total salt load out

Whereby:

Salt load (kg/day) = Flow (m^3/annum) x Salt concentration (mg/l)

The mg/l was converted to kg/m^3.

The amount of salts dissolved in water is normally expressed as a concentration such as in mg/l. This indicates the concentration of the dissolved salt but does not provide any information on the actual amount of salt dissolved in the system. If, however, the volume and the flow rate of the water are brought into the equation, a more meaningful result can be achieved. In this case, not only the concentration of the dissolved substance but also the mass of the substance flowing past a specific point for a specific period can be calculated. Expressions such as Kg/hour or Tons/day will now be the type of units used. When evaluating a dynamic system (i.e., moving as opposed to stagnant water) then the latter method is far more meaningful.

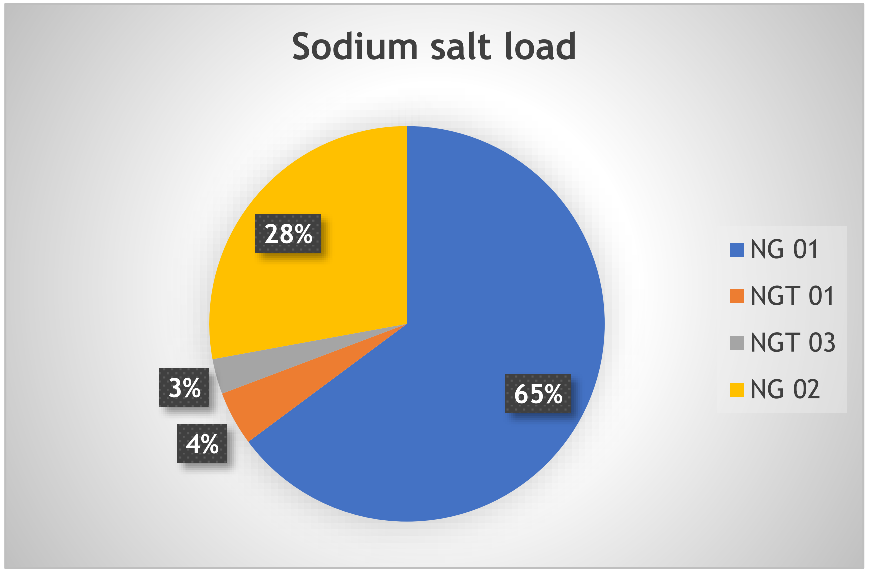
11.1. Salt load calculations

Only selected variables were averaged for analyses and further usage in calculating the salt loads (Table 11-1). The chemical parameters were selected because they can form common salt complexes such as sodium chloride (NaCl), potassium chloride (KCl), and potassium sulphate (K_2SO_4). Only stream-based salt load calculations were done as there are no dirty water containment facilities on site yet.

Table 11-1: Catchment-based salt load calculations

Sampling point	TDS (Kg/m)	SO_4 (kg/m)	Cl (kg/m)	Na (kg/a)	K (kg/m)	Salt Retained-Load (kg/m)
KOM 01	86022	5986	16047	178080	790	286926
NG 01	235628	2720	70867	826583	337	1136135
NGT 01	27704	5303	4426	56498	530	94461
NGT 03	21992	3660	4098	36713	72	66535
NG 02	275425	38167	66707	355267	378	735945
KOM 02	88226	6535	16719	183641	882	296004
AC	261936	21873	49822	531434	2201	867266

Table 11-2: Ngweti system catchment-based salt findings

<table>
<tr>
<td>In the Ngweti system, the upstream point (NG 01) retained the most Na salts at 65% and the downstream point (IGM 03) retained the least at 28%. The tributaries contributed a total of 7% of Na salts.

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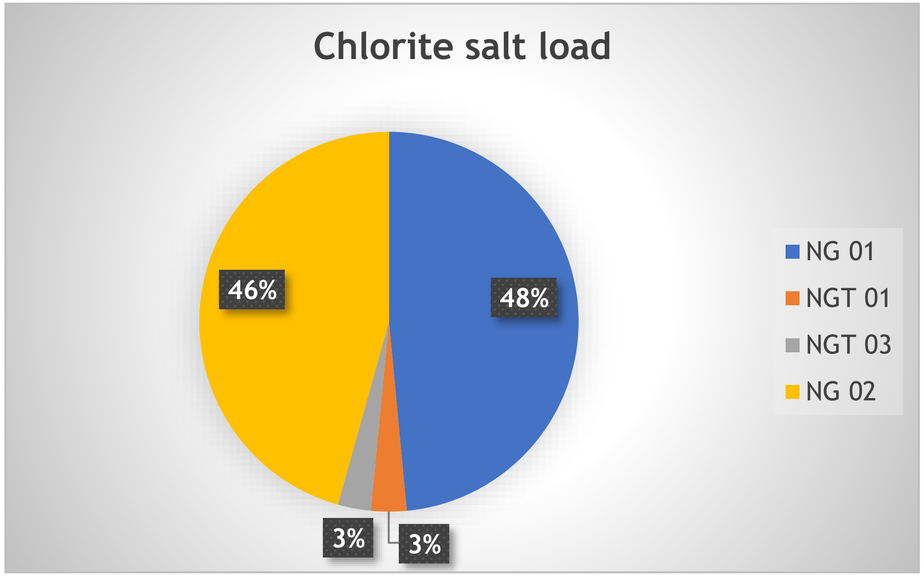
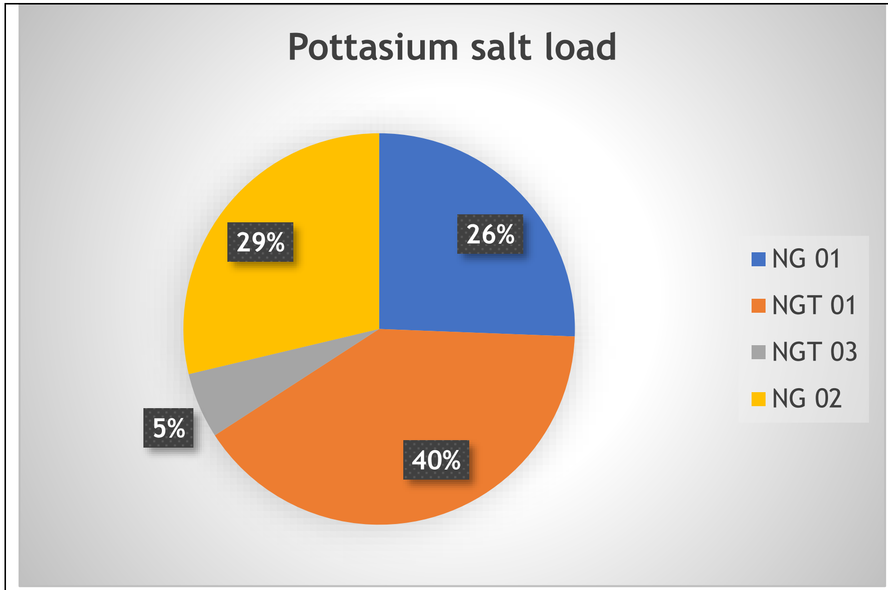
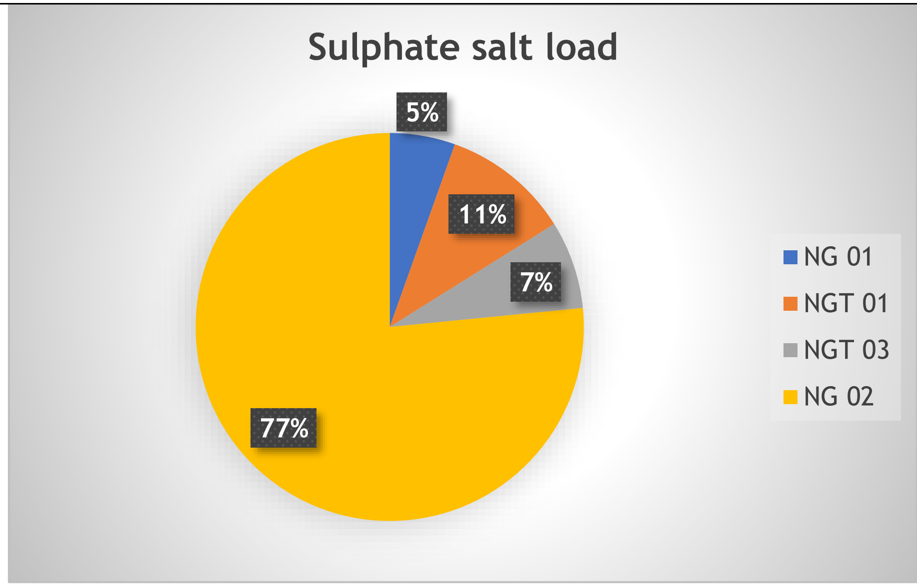
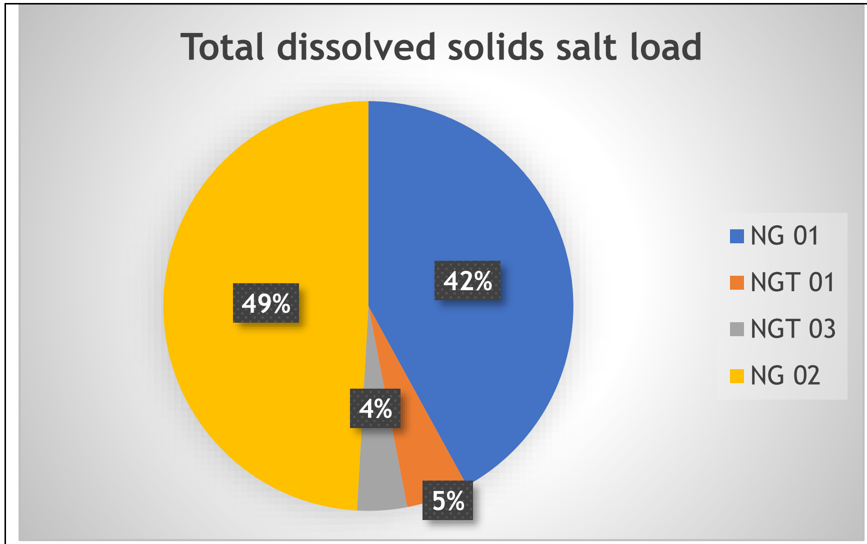
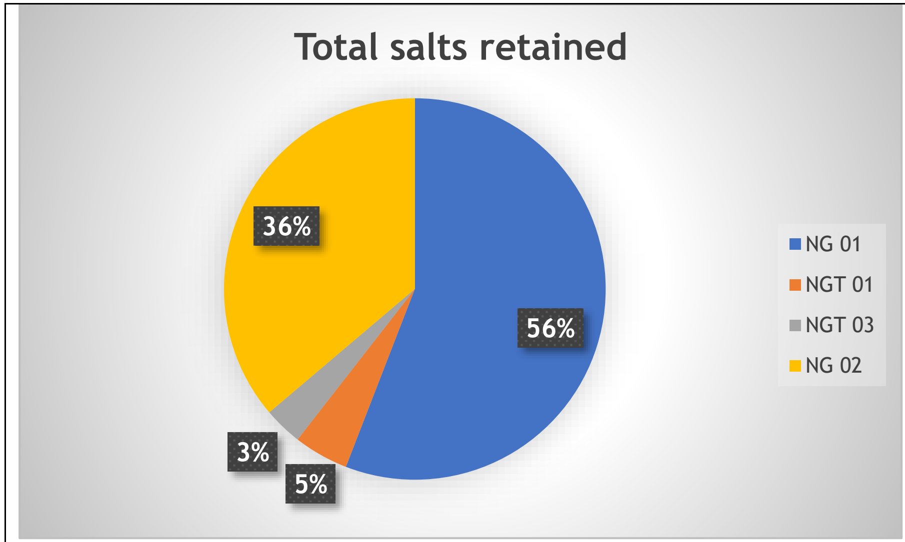
<td>The upstream point of the Ngweti system retained most of the Cl salts at 48% while the downstream point retained the least at 46%. The tributaries contributed 6% of Cl salts into the Ngweti system.

</td>
</tr>
<tr>
<td>In terms of K salts, tributary 1 retained the most at 40%. The tributaries together contributed 45% of K salts into the main system. In the main system, the downstream point retained the most K salts at 29%, while the upstream point retained the least at 26%.</td>
<td>The downstream point retained the most of SO_4 salts at 77%. The upstream point retained the least at 5% while the tributary contributed 18%.</td>
</tr>
</table>

	
The most TDS salts were retained at the downstream point with 49% and the least were retained at the upstream point with 42%. The tributary contributed 9% to the main system.	



Total salts retained

- The NG 01 point retained most of the total salts at 1 136 135 kg/m which accounted for 56% of salts at the Ngweti system. The adjacent area on the right-hand bank of the stream is mostly used for farming. Salts from the farm washes off into the river during rainfall and irrigation, increasing the amount of salts retained in the stream at the upstream point.
- The stream is covered with dense vegetation between the upstream and downstream points, these vegetation serves as natural rehabilitators to the stream, reducing the amount of salts retained in the stream.
- The salts retained decreases from the upstream point to the downstream point, indicating rehabilitation of water.
- The tributaries contributed 160 996 kg/m which accounted for 8% of total salts into the main system.


Total salts retained
36%
56%
3%
5%
NG 01
NGT 01
NGT 03
NG 02

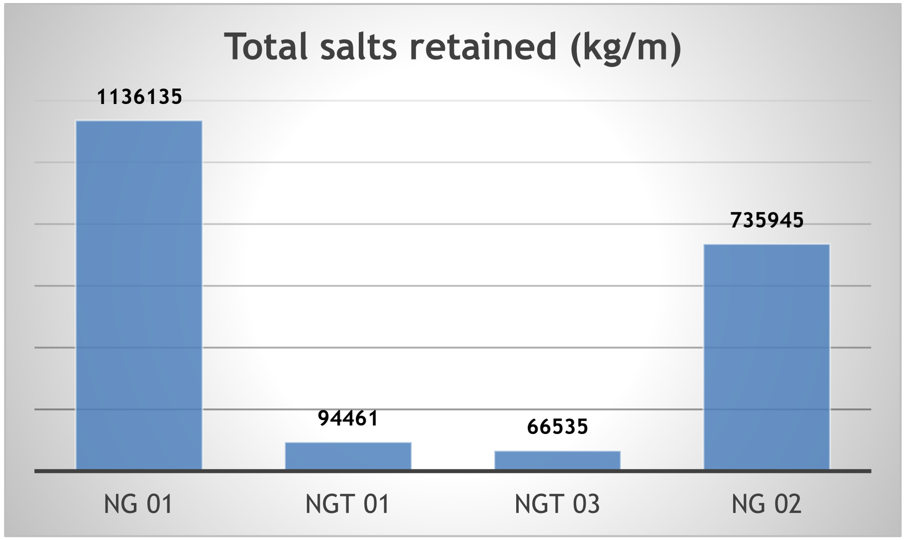
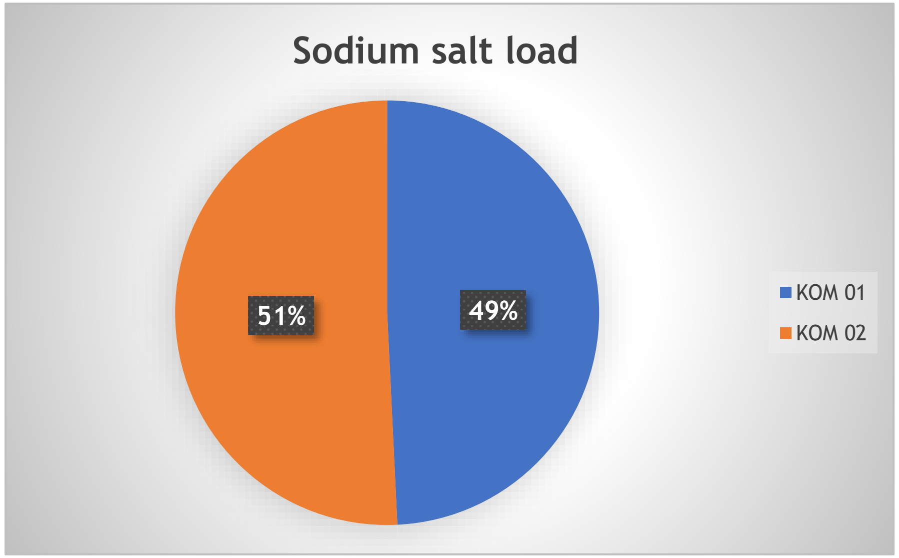
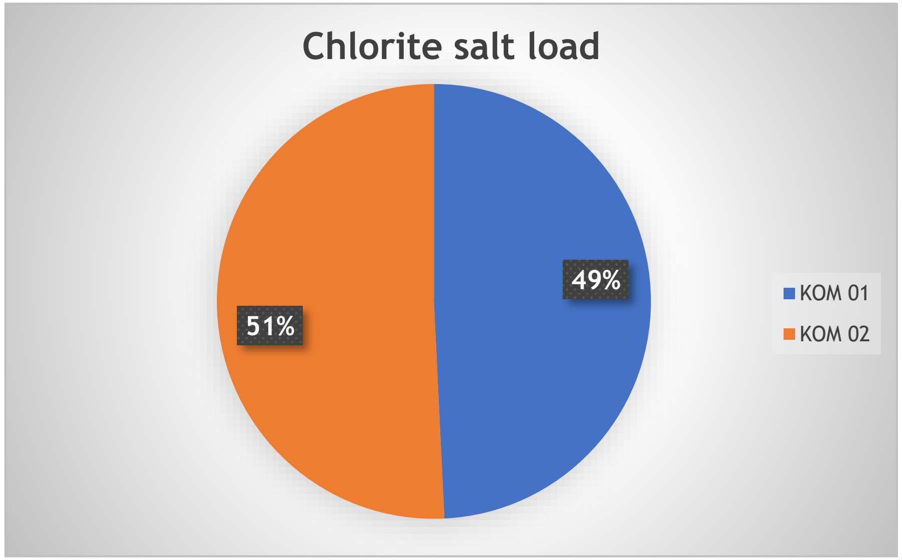
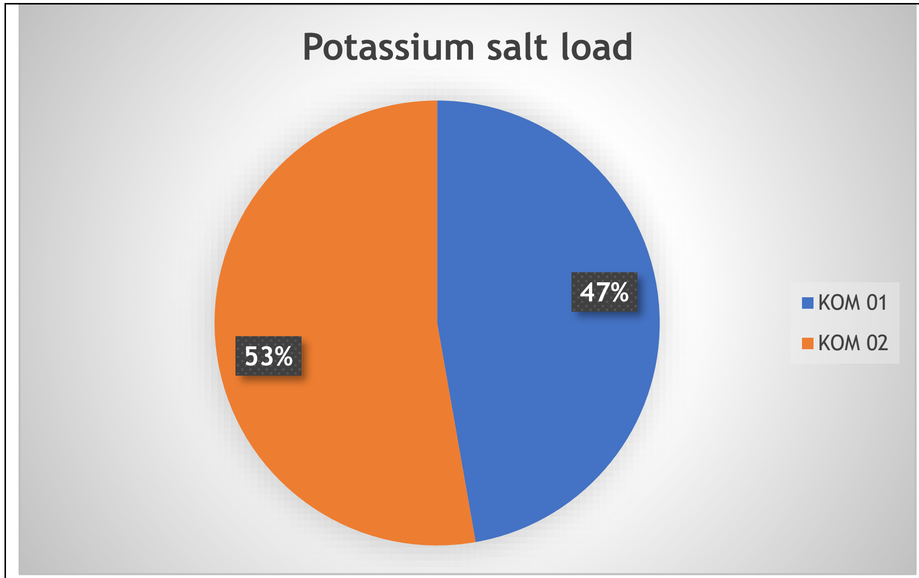
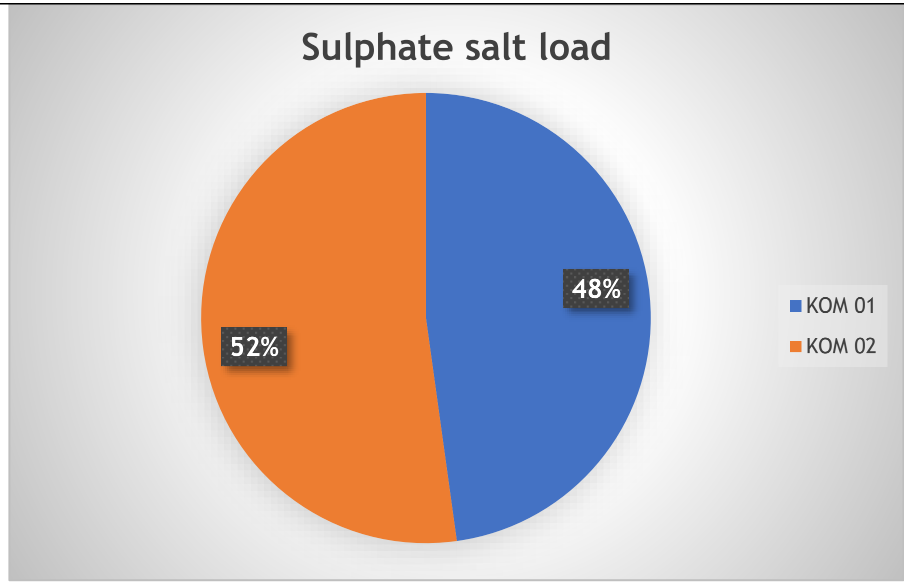

Total salts retained (kg/m)
1136135
94461
66535
735945
NG 01
NGT 01
NGT 03
NG 02

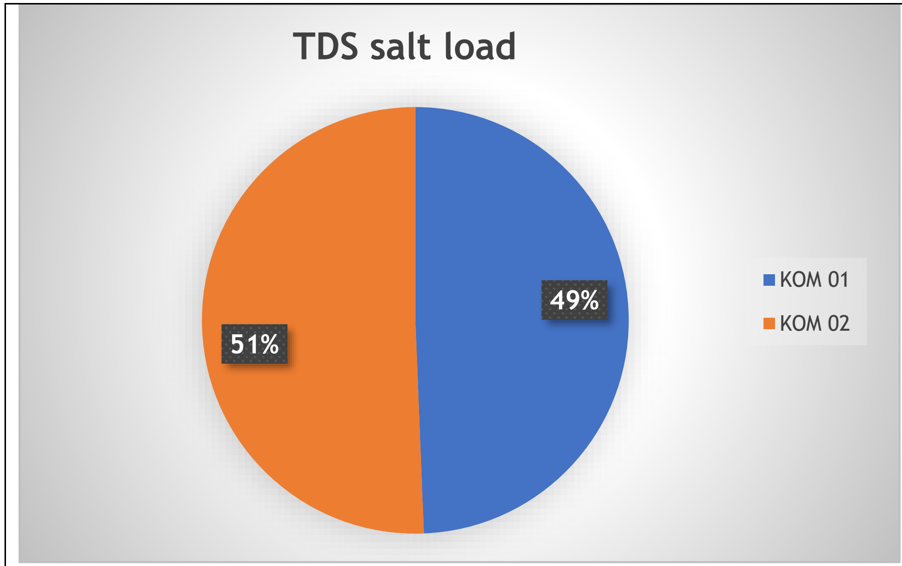
Table 11-3: Komati system catchment-based salt findings

At the Komati system, the upstream point (KOM 01) retained the least Na salts at 49% while the downstream point (KOM 02) retained the more at 51%. 	The downstream point retained most of the Cl salts at 51% while the upstream point retained the least at 49%. 
The downstream point retained most of the K salts at 53% while the downstream point retained the least at 47%.	The upstream point retained most of the S04 salts at 52% while the downstream point retained the least at 48%.



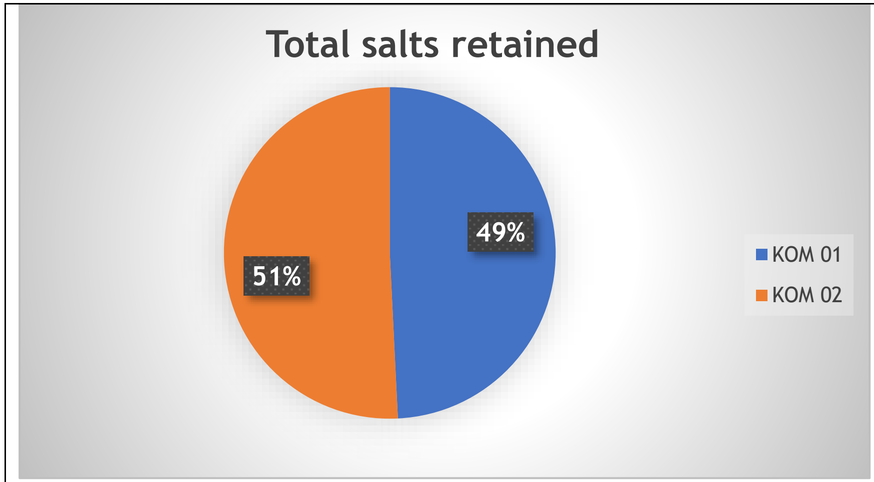


The most TDS salts were retained at the upstream point with 51% and the least were retained at the downstream point with 49%.



<u>Total salts retained</u>

- At the Komati system, the downstream point retained the most salts at 296 004 kg/m which accounted for 51% of total salts retained in the Komati system. This is more than the upstream point which retained 286 926 kg/m, accounting for 49% of total salts.
- The salt calculations results show that salts in the Komati system increase from upstream to downstream, this indicates declining water quality moving downstream.



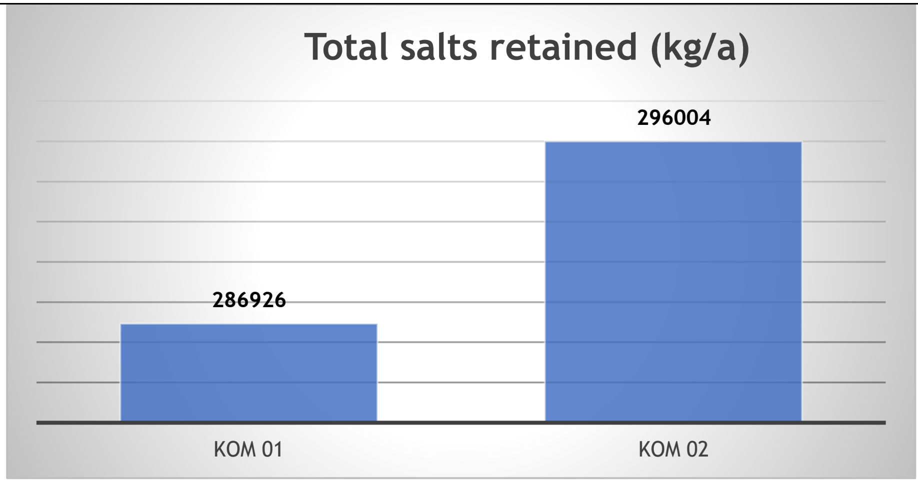
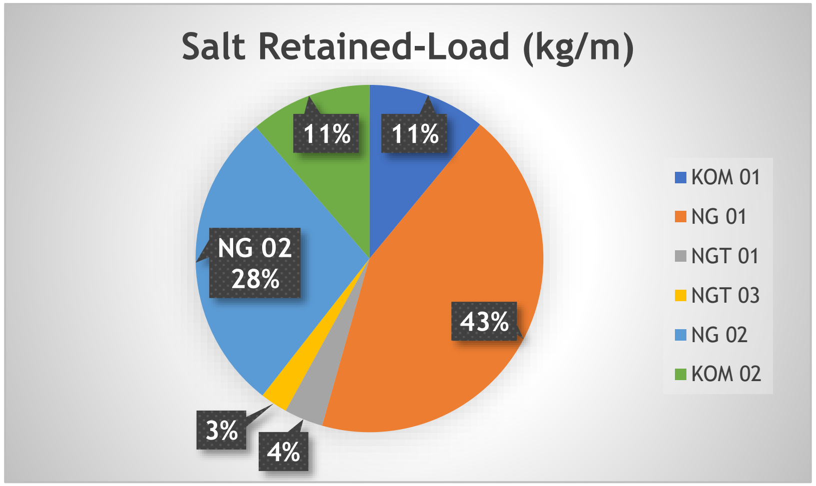
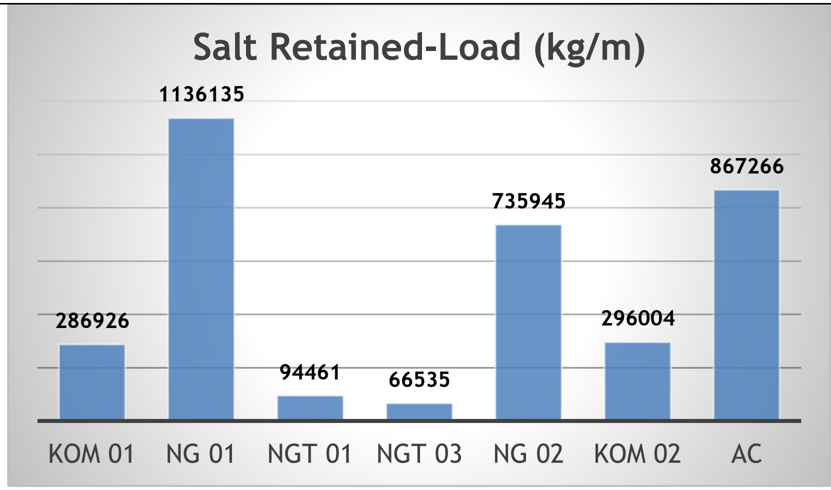


Table 11-4: Total salts retained in the surface water system

Total salts retained   • The salt load calculations for the surface water system around the application area show that the upstream point of the Ngweti system retained most of the calculated salts at 1 136 135 kg/m which accounted for 43% of salts retained in the river systems.   • The farming activity adjacent to the Ngweti River is the main contributor of salts in the system. The surface runoff during rainfall and watering of crops constantly introduces pesticides, herbicides, and fertilisers in the tributary. This increases the number of salts in the tributary system.


Salt Retained-Load (kg/m)
11%
11%
NG 02
28%
43%
3%
4%
KOM 01
NG 01
NGT 01
NGT 03
NG 02
KOM 02


Salt Retained-Load (kg/m)
1136135
867266
735945
286926
296004
94461
66535
KOM 01
NG 01
NGT 01
NGT 03
NG 02
KOM 02
AC

12. POTENTIAL IMPACTS

This section looks at the potential impacts of the proposed activity on the surface waterbodies around. The tables below contain a description of the activities which can result in impacts on the hydrological regime specifically related to the activities that are proposed. This is followed by an assessment of the impacts related to these activities.

Table 12-1: Construction and Site establishment

Impact Component	**Hydrological Yield**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Site establishment and construction of required infrastructure		
Risk/ Impact	• Change in flow regime • Increase in hydrological yield • Change in catchment characteristics		
Project Phase	CO = construction, OP = operational,		
Nature of Impact	Negative		
Type of Impact	Direct: Artificial infrastructure like channels and berms, may have a significant impact on the flow regime due to the change in flow direction and velocity.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Severity	Construction of infrastructure will change the hydrological yield of the hosting catchment by reducing surface runoff through containment of dirty water. The construction of impervious surfaces may also increase the surface runoff.	3	2
Spatial scale	Whole site	2	2
Duration	Life of a mine	4	3
Frequency of activity	Containment of dirty runoff will be daily.	5	3
Frequency of incident/impact	Without mitigation, the activity will definitely impact on the environment.	5	2

Legal issues	Fully covered in legislation	5	5
Detection	An effort is needed to determine the change in the flow regime.	3	3
Consequence	Severity + Spatial scale + Duration	3+2+4 = 9	2+2+3 = 7
Likelihood	Frequency of Activity + Frequency of incident + Legal issues + Detection	5+5+5+3=18	3+2+5+3 = 13
Impact/Risk	Consequence x Likelihood	9x18 = 162	7x13 = 91
Mitigating and Monitoring Requirements			
Required Management Measures	• The proposed infrastructure may not impede or divert the flow unless authorised by the DWS. • Efforts should be made to minimise the dirty water catchment. • Berms will be constructed to prevent the mixture of clean and dirty water. Clean water will be allowed to return to environment to prevent further decrease in hydrological yield.		
Required Monitoring (if any)	Water and Salt Balance study must be conducted and amended annually. The quantity component of this report can be used as an early warning for change in flow regime. The outcomes of the study must be used as a management tool as well as a means of investigating the latest technologies for water management.		
Responsibility for implementation	Environmental Officer and Mine Manager		

Table 12-2: Overburden and Waste Rock? stockpiles

Impact Component	Stockpiling dirty material	Significance prior to Mitigation	Significance with Mitigation
Activity	Overburden Stockpiling		
Risk/ Impact	Contamination and siltation of water bodies		
Project Phase Nature of Impact	CO = construction, OP = operational, Negative		
Type of Impact	Direct: Surface runoff from overburdened stockpiles will cause contamination and siltation in water bodies.		

	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Severity	Overburden stockpiles contain residue material from the mining of coal. These stockpiles are susceptible to erosion and will easily wash away to nearby streams causing widespread contamination and siltation of water bodies, if not prevented.	5	3
Spatial scale	Area-specific	3	1
Duration	Medium term	3	2
Frequency of activity	Seasonally	3	2
Frequency of incident/impact	Regularly	4	3
Legal issues	Fully covered in legislation	5	5
Detection	Need some effort	3	3
Consequence	Severity + Spatial scale + Duration	5+3+3 = 11	3+1+2 = 6
Likelihood	Frequency of Activity + Frequency of incident + Legal issues + Detection	3+4+5+3 = 15	2+3+5+3 = 13
Impact/Risk	Consequence x Likelihood	11 x 15 = 165	6x13 = 78
Mitigating and Monitoring Requirements			
Required Management Measures	• Ensure that all overburdened stockpiles are outside the 1:100-year floodlines or the 100m watercourse buffer, whichever is the greatest. • Construct suitable berms to separate dirty runoff from stockpiles and clean runoff. • Limit erosion on overburden stockpiles by constructing toe and perimeter berms. • The dirty water separations should be maintained until the area is fully rehabilitated and draining freely. • Direct runoff from the stockpile through channels to dirty water infrastructures. • During the rehabilitation period, erosion control measures should be put in place and maintained.		

Required Monitoring (if any)	A maintenance schedule for the repair of eroded berms and stockpiles must be established.
Responsibility for implementation	Environmental Officer and Mine Manager

Table 12-3: Dirty water infrastructures impact assessment

Impact Component	Dirty Water Infrastructure	Significance prior to Mitigation	Significance with Mitigation
Activity	Maintenance and operation of dirty water infrastructure.		
Risk/ Impact	Spillages from dirty water infrastructure Flood events		
Project Phase Nature of Impact	CO = construction, OP = operational, Negative		
Type of Impact	Direct: Dirty water management measures as discussed in this report must be implemented.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Severity	Overflow of PCD may introduce different salts in surface water bodies.	4	1
Spatial scale	In the event of contamination, contaminants will easily travel downstream and affect a neighbouring site.	3	1
Duration	One day to one month	1	1
Frequency of activity	Once off	1	1
Frequency of incident/impact	The activity regularly impacts on the environment	4	2
Legal issues	Fully covered in legislation	5	5
Detection	An effort is needed to determine the change in the flow regime.	3	3
Consequence	Severity + Spatial scale + Duration	4+3+1 = 8	1+1+1 = 3

Likelihood	Frequency of Activity + Frequency of incident + Legal issues + Detection	1+3+5+3 = 12	1+2+5+3 = 11
Impact/Risk	Consequence x Likelihood	8x12 = 96	3x11 = 33
Mitigating and Monitoring Requirements			
Required Management Measures	• The shaft opening sump and PCD must be designed, constructed, maintained, and operated in such a way that it is not likely to spill into any clean water system more than once in 50 years. • PCD must have a minimum freeboard of 0.8m above the full supply level. • All dirty water infrastructure needs regular maintenance. • Oil separators and dirty water trenches have to be cleaned regularly, and SWMP must be compiled and adhered to throughout the Project. • Discharges from the final effluent must comply with the conditions that will be raised by the DWS when the IWUL is issued.		
Required Monitoring (if any)	Monthly surface water quality monitoring must be conducted at the proposed monitoring points in Section 13.		
Responsibility for implementation	Environmental Officer and Mine Manager		

Table 12: Underground shaft impact assessment

Impact Component	Underground shaft	Significance prior to Mitigation	Significance with Mitigation
Activity	Underground mining and storage of dirty water.		
Risk/ Impact	• Reduction in catchment area • Decrease in hydrological yield • Change in catchment characteristics • Formation of Acid Mine Drainage (AMD)		
Project Phase	CO = construction, OP = operational, CL = Closure and post-closure		
Nature of Impact	Negative		

Type of Impact	Direct: Excavation of the shaft will reduce contributing catchment, reducing water quantity in watercourses. Water accumulating underground can react with sulphur rich material causing AMD which can decant into water bodies.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Severity	Reducing stream flow may result in drought. Decanting AMD can cause widespread contamination of water bodies.	5	3
Spatial scale	Regional	3	2
Duration	Medium term	3	2
Frequency of activity	Mining is proposed daily	5	5
Frequency of incident/impact	Often (without mitigation)	4	2
Legal issues	Fully covered in legislation	5	5
Detection	An effort is needed to determine the change in the flow regime, and occurrence of AMD.	3	3
Consequence	Severity + Spatial scale + Duration	5+3+3 = 11	3+2+2 = 7
Likelihood	Frequency of Activity + Frequency of incident + Legal issues + Detection	5+4+5+3 =17	5+2+5+3 = 15
Impact/Risk	Consequence x Likelihood	11x17 = 187	7x15 = 105
Mitigating and Monitoring Requirements			
Required Management Measures	• Ensure that the shaft opening is outside the 1:100-year flood lines or outside of the 100 m watercourse buffer, whichever is greater. • Berms and cut off trenches should be placed around the shaft excavation area to prevent clean water from entering. • Develop an underground sump so that water diverts away from coal seams and carbonaceous shale. • Correctly rehabilitate the shaft (clean material at the top) so that the catchment characteristics return to pre-mining conditions.		

Required Monitoring (if any)	Water and Salt Balance study must be conducted and amended annually. The outcomes of the study must be used as a management tool as well as a means of investigating the latest technologies for water management. Water quality monitoring should be conducted monthly.
Responsibility for implementation	Environmental Officer and Mine Manager

13. MONITORING PROGRAMME

A monitoring programme is a crucial tool to identify and manage any risk arising from the potential impacts identified earlier. The proposed monitoring should be practiced throughout the life of the proposed project. The monitoring plans are discussed further below.

13.1. Stormwater infrastructure maintenance

The purpose of the monitoring excise is to identify any malfunctioning of the stormwater infrastructures that are designed to protect water resources. An example of malfunctions includes blockages of culverts and channels by debris and silt, and overflowing of dirty water containment facilities. The proposed stormwater infrastructures should be monitored and maintained regularly to ensure efficiency in dirty water management. A site inspection should be conducted to inspect the conditions of the infrastructure.

The site inspection should be conducted by an internal environmental officer on a weekly basis during the rainy season and immediate after every heavy storm. The inspections should be recorded and must indicate the date of inspection, photographs of the conditions of the proposed infrastructures, actions to be taken to fix issues (if found), and the duration taken. The inspections in form of a report should be submitted to the Mine Manger on a weekly basis.

13.2. Water quality

The water quality monitoring programme is a well-structured document indicating the routine monitoring of the selected points which aims to trace changing water quality. Continuous water quality monitoring is necessary to determine the potential impact of the mine and other activities on the nearby water resources. Such impacts would indicate whether the water resources protection measures in place are efficient or not.

Monitoring should be according to South African National Standard (SANS) sampling standards in accordance with methods prescribed by and obtainable from the South African Bureau of Standards (SABS). Table 13-1 presents the geographic coordinates of the proposed monitoring points and Figure 13-1 illustrates the location of the points.

Table 13-1: Geographic coordinates of the proposed water quality monitoring points

Proposed Monitoring Points	Latitude	Longitude
NG 01	-25.488825	31.837181
NG 02	-25.462522	31.853494
KOM 01	-25.507153	31.878642
KOM 02	-25.450017	31.950822
Shaft Sump	-25.469201	31.83041
PCD	-25.476201	31.823166

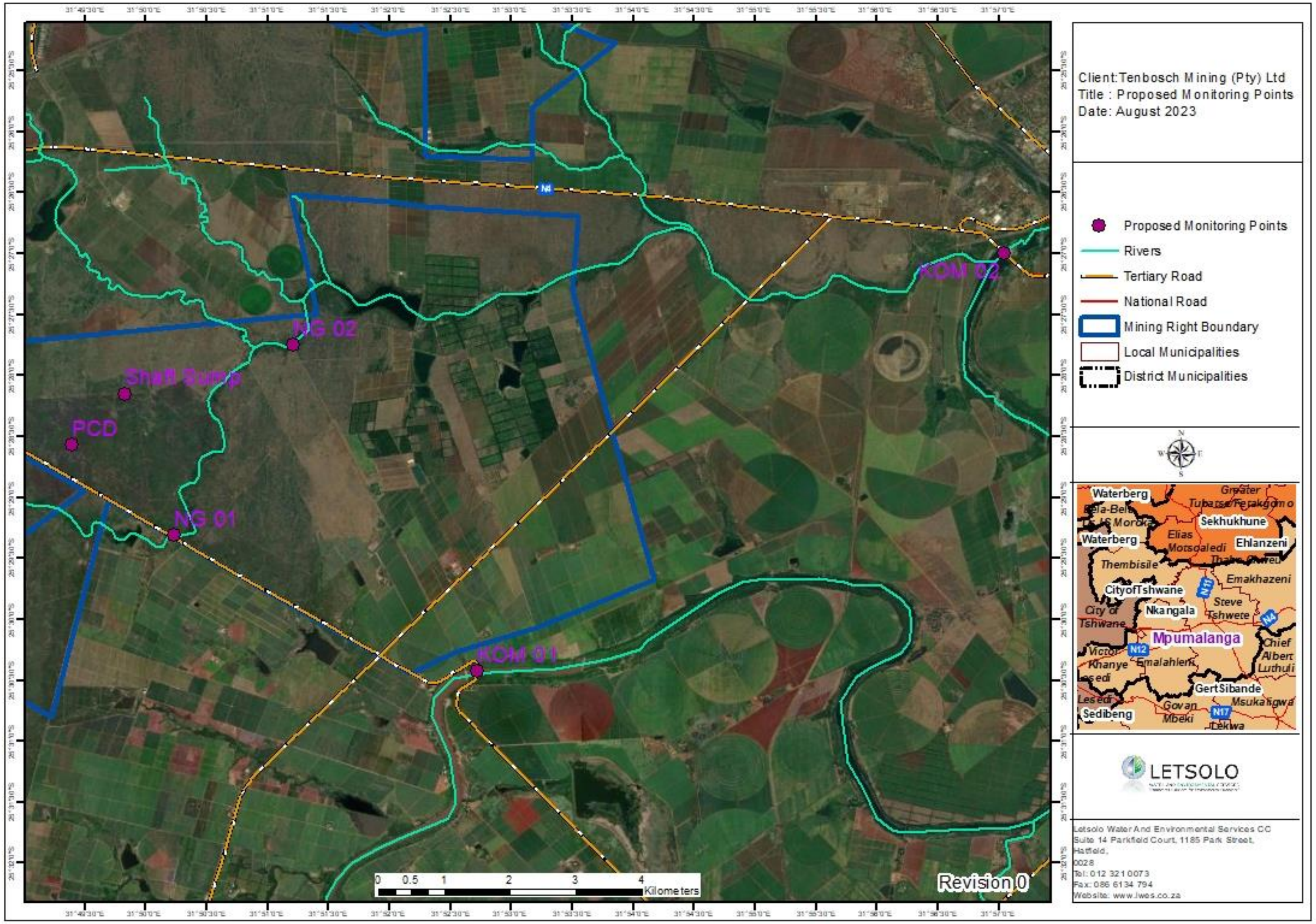


Figure 13-1: Proposed surface water monitoring points

14. CONCLUDING REMARKS

The objectives of this study were to address the potential impact of proposed mining operations on the water flow and water quality processes of the hydrological cycle, and the associated upstream and downstream environmental impacts. The receiving sensitive water resource for this study is the Ngweti River. The Ngweti River is a perennial river that originate from the mountains west of the study area. It flows in an easterly direction where it joins the Komati River within the quaternary catchment X13L of the Inkomati Water Management Area 5.

Surface water samples were collected on the 11th of April 2022 to determine the baseline water quality in the area of interest. The water quality results outlined that the Ngweti River and its tributaries are not suitable for domestic use due to the exceedance of the domestic water quality guideline by TDS, Ca, Mg, and Na. Although the Ngweti system has poor water quality in terms of domestic use, it can be used for other activities such as irrigation and livestock. The Komati system showed good water quality.

Five selected chemical parameters (TDS, SO_4, Cl, K, and Na) were selected and used to determine salt distribution in the area of interest. The salt load calculation revealed that salt retention in the Ncandu River decreases from the upstream point to the downstream point, indicating an improvement in water quality. Salt retention in the iNguduma River increase from the upstream to the downstream point, the farming activity adjacent to the river is a likely source of salts in the river.

Stormwater management infrastructures were designed following BPG 1: Stormwater Management. The proposed infrastructure was assessed in terms of clean and dirty nature. All the surface dirty infrastructure such as waste rock, overburden and coal (product) stockpiles will be grouped to form the dirty water catchment. A system of vegetated berms will be placed around the dirty catchment to prevent the mixing of clean and dirty runoff.

Floodlines were delineated to check compliance with Condition 4 of the GN 704 and to assess the risk of flooding to the proposed mine infrastructures. The proposed surface infrastructure are outside the 1:100-year inundation boundary and the 100m watercourse buffer. Therefore, according to Condition 4 of the GN 704, the mine is permitted to mine at the proposed Tenbosch mining area.

15. RECOMMENDATIONS

Reasonable measures as recommended in this report must be implemented to reduce the impact on surface water resources. Given the above conclusions, the following recommendations are made:

- Surface water quality monitoring should be conducted on a monthly basis to determine any impact on the surface water bodies during operational phase of mining and possibly quarterly after closure. Although a bigger number of monitoring points were proposed, in instances where the infrastructure (like Pit) is not yet established, the findings on compliance should be based on other points where data is collected.
- For surface water bodies, use water quality guidelines state in Table 10-2 to ensure compliance with DWS. For dirty water infrastructures, use water quality limits that will be stated in IWUL to ensure compliance with the issued IWUL.
- Should any of the sampling point exceed any given water quality limit, the source of contamination should be traced and apply suitable mitigation measures.
- The stormwater proposed infrastructure especially berms, stormwater channels, and the main PCD should be constructed before the mining activity commences.
- The stormwater infrastructures should be monitored and maintained on regular basis to remove silts and debris from the stormwater channels and culverts. Records of maintenance can be kept for management purposes.
- A comprehensive water and salt balance should be developed and updated annually as soon the surface infrastructure are placed in order to:
  - Account for salt loads stored in the dirty water containment facilities;
  - Quantify the increase or decrease of salt loads leaving the system into the receiving environment; and
  - Assist the mine to manage its water and wastewater in a responsible manner.
- Install flow meters to record accurate water usage and install rain gauge on site for better water balance calculations.
- Reuse dirty water as far as possible to limit the use of clean water from the municipality/groundwater.
- The main PCD should be moved to the location of the Potential Future PCD so that it can efficiently capture dirty runoff.
- For the pits within the 1:100-year floodline, an GN704 exemption application should be lodged, including the pits in question.
- Rehabilitate the affected area so that the surface drainage can be restored.

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APPENDIX A: Profile output tables.

Reach	River sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S Elev (m)	Crit W.S (m)	E.G Elev (m)	E.G Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude #Chl
MAIN	71	1 in 50	301.87	212.61	213.79	213.79	214.19	0.013136	2.84	108.2	137.89	1.01
MAIN	71	1 in 100	379.78	212.61	213.96	213.96	214.37	0.012876	2.82	134.72	166.13	1
MAIN	70	1 in 50	301.87	209.84	213.51		213.53	0.000161	0.71	460.1	210.18	0.14
MAIN	70	1 in 100	379.78	209.84	213.74		213.77	0.00019	0.81	510.79	227.55	0.15
MAIN	69	1 in 50	301.87	211.57	212.97	212.97	213.44	0.011201	3.12	102.19	110.38	0.97
MAIN	69	1 in 100	379.78	211.57	213.14	213.14	213.66	0.010941	3.33	120.77	116.49	0.98
MAIN	68	1 in 50	301.87	209.81	211.21	211.21	211.61	0.010096	2.94	112.45	138.01	0.92
MAIN	68	1 in 100	379.78	209.81	211.35	211.35	211.8	0.00991	3.12	133.48	144.9	0.93
MAIN	67	1 in 50	301.87	208.16	210.56		210.68	0.001799	1.66	206.14	168.56	0.42
MAIN	67	1 in 100	379.78	208.16	210.8		210.93	0.001727	1.72	246.49	175.84	0.42
MAIN	66	1 in 50	301.87	207.26	210.48		210.56	0.000736	1.28	254.32	155.89	0.28
MAIN	66	1 in 100	379.78	207.26	210.7		210.8	0.000798	1.43	290.07	162.21	0.3
MAIN	65	1 in 50	301.87	208.24	210.16		210.44	0.006053	2.36	127.82	118.84	0.72
MAIN	65	1 in 100	379.78	208.24	210.36		210.68	0.005649	2.49	153.26	128.38	0.71
MAIN	64	1 in 50	301.87	207.39	210.17		210.21	0.000414	0.64	366.9	236.15	0.19
MAIN	64	1 in 100	379.78	207.39	210.39		210.43	0.000449	0.75	418.51	243.85	0.2
MAIN	63	1 in 50	301.87	208.71	209.77	209.71	210.13	0.009848	2.34	114.41	128.66	0.86
MAIN	63	1 in 100	379.78	208.71	209.97		210.35	0.008003	2.42	141.38	131.74	0.81

MAIN	**62**	**1 in 50**	**301.87**	**206.05**	**209.75**		**209.86**	**0.000963**	**1.58**	**221.37**	**159.68**	**0.33**
MAIN	**62**	**1 in 100**	**379.78**	**206.05**	**209.92**		**210.07**	**0.001165**	**1.79**	**250.15**	**168.67**	**0.36**
MAIN	**61**	**1 in 50**	**301.87**	**205.76**	**209.78**		**209.8**	**0.000181**	**0.81**	**471.76**	**282.99**	**0.15**
MAIN	**61**	**1 in 100**	**379.78**	**205.76**	**209.96**		**209.99**	**0.000215**	**0.92**	**525.67**	**293.18**	**0.16**
MAIN	**60**	**1 in 50**	**301.87**	**206.54**	**209.72**		**209.77**	**0.000442**	**1.12**	**318.96**	**187.65**	**0.22**
MAIN	**60**	**1 in 100**	**379.78**	**206.54**	**209.89**		**209.96**	**0.000528**	**1.28**	**351.21**	**190.29**	**0.25**
MAIN	**59**	**1 in 50**	**301.87**	**208.96**	**209.65**		**209.71**	**0.000949**	**0.6**	**291.3**	**249.53**	**0.26**
MAIN	**59**	**1 in 100**	**379.78**	**208.96**	**209.82**		**209.89**	**0.001023**	**0.7**	**333.48**	**260.28**	**0.27**
MAIN	**58**	**1 in 50**	**301.87**	**207.47**	**209.64**		**209.68**	**0.000295**	**0.69**	**370.77**	**179**	**0.17**
MAIN	**58**	**1 in 100**	**379.78**	**207.47**	**209.8**		**209.85**	**0.000368**	**0.82**	**399.68**	**182.72**	**0.19**
MAIN	**57**	**1 in 50**	**301.87**	**208.04**	**209.26**	**209.26**	**209.57**	**0.013472**	**2.56**	**123.62**	**196.39**	**0.99**
MAIN	**57**	**1 in 100**	**379.78**	**208.04**	**209.36**	**209.36**	**209.72**	**0.013312**	**2.75**	**143.58**	**201.88**	**1.01**
MAIN	**56**	**1 in 50**	**301.87**	**206.83**	**208.02**	**208.02**	**208.43**	**0.012741**	**2.82**	**107.02**	**133.88**	**1**
MAIN	**56**	**1 in 100**	**379.78**	**206.83**	**208.19**	**208.19**	**208.62**	**0.010706**	**2.93**	**133.1**	**176.34**	**0.94**
MAIN	**55**	**1 in 50**	**301.87**	**205.27**	**208.14**		**208.15**	**0.000116**	**0.53**	**599.04**	**328.61**	**0.11**
MAIN	**55**	**1 in 100**	**379.78**	**205.27**	**208.38**		**208.39**	**0.000126**	**0.59**	**678.36**	**328.61**	**0.12**
MAIN	**54**	**1 in 50**	**301.87**	**208.92**	**207.78**		**208.08**	**0.004635**		**123.96**	**85.54**	**0**
MAIN	**54**	**1 in 100**	**379.78**	**208.92**	**207.91**	**207.56**	**208.31**	**0.005699**		**135.48**	**88.36**	**0**
MAIN	**53**	**1 in 50**	**301.87**	**206**	**207.2**	**207.2**	**207.56**	**0.013066**	**2.48**	**116.11**	**165.19**	**0.97**
MAIN	**53**	**1 in 100**	**379.78**	**206**	**207.33**	**207.33**	**207.72**	**0.012709**	**2.64**	**138.55**	**177.47**	**0.98**
MAIN	**52**	**1 in 50**	**301.87**	**205.11**	**206.69**		**206.79**	**0.001797**	**1.37**	**229.72**	**218.68**	**0.4**

MAIN	52	1 in 100	379.78	205.11	206.84		206.96	0.001941	1.54	263.85	230.78	0.42
MAIN	51	1 in 50	301.87	205.07	205.95	205.95	206.24	0.014269	2.55	126.98	221.25	1.01
MAIN	51	1 in 100	379.78	205.07	206.05	206.05	206.38	0.013476	2.68	150.64	230.16	1
MAIN	50	1 in 50	301.87	204.02	204.77		204.91	0.002426	0.73	186.52	161.72	0.38
MAIN	50	1 in 100	379.78	204.02	204.98		205.14	0.002323	0.84	220.76	170.02	0.39
MAIN	49	1 in 50	301.87	203.02	204.68		204.78	0.001118	0.77	242.98	205.59	0.29
MAIN	49	1 in 100	379.78	203.02	204.88		204.99	0.001156	0.92	283.92	209.34	0.31
MAIN	48	1 in 50	301.87	202.31	204.69		204.72	0.000275	0.49	410.88	234.92	0.15
MAIN	48	1 in 100	379.78	202.31	204.89		204.93	0.000333	0.58	458.16	248.68	0.17
MAIN	47	1 in 50	301.87	205.59	204.24	204.24	204.63	0.013039		108.5	137.7	0
MAIN	47	1 in 100	379.78	205.59	204.39	204.39	204.82	0.012673		130.07	150.36	0
MAIN	46	1 in 50	301.87	202.13	203.73		203.82	0.002042	1.17	228.9	225.5	0.4
MAIN	46	1 in 100	379.78	202.13	203.92		204.02	0.001859	1.26	271.92	228.22	0.4
MAIN	45	1 in 50	301.87	199.57	203.75		203.77	0.000159	0.69	477.72	240.15	0.14
MAIN	45	1 in 100	379.78	199.57	203.94		203.96	0.000204	0.8	524.91	263.02	0.15
MAIN	44	1 in 50	301.87	202.69	203.32	203.32	203.68	0.01283	1.56	114.53	159.27	0.86
MAIN	44	1 in 100	379.78	202.69	203.44	203.44	203.86	0.012535	1.73	134.94	166.75	0.88
MAIN	43	1 in 50	301.87	200.73	201.73	201.73	202.09	0.013454	2.58	114.04	159.79	0.99
MAIN	43	1 in 100	379.78	200.73	201.87	201.87	202.26	0.012924	2.75	135.8	169.94	0.99
MAIN	42	1 in 50	301.87	198.29	201.07		201.08	0.000089	0.44	605.2	257	0.1

MAIN	42	1 in 100	379.78	198.29	201.27		201.29	0.000109	0.52	657.53	263.29	0.11
MAIN	41	1 in 50	301.87	198.91	201.06		201.08	0.000082	0.33	624.48	298.26	0.09
MAIN	41	1 in 100	379.78	198.91	201.26		201.28	0.0001	0.4	684.92	314.75	0.1
MAIN	40	1 in 50	301.87	198.07	201.06		201.07	0.000085	0.28	644.19	353.49	0.09
MAIN	40	1 in 100	379.78	198.07	201.26		201.27	0.000102	0.35	714.64	353.49	0.1
MAIN	39	1 in 50	301.87	199.37	200.59	200.59	201	0.013304	2.94	107.08	134.35	1.02
MAIN	39	1 in 100	379.78	199.37	200.74	200.74	201.19	0.012698	3.1	128.46	144.97	1.02
MAIN	38	1 in 50	301.87	197.45	199.34		199.42	0.001246	0.87	260.9	273.4	0.31
MAIN	38	1 in 100	379.78	197.45	199.47		199.57	0.001427	0.94	297.07	284.07	0.33
MAIN	37	1 in 50	301.87	198.03	198.84	198.84	199.19	0.010275	1.41	125.02	196.22	0.77
MAIN	37	1 in 100	379.78	198.03	199.06	199.06	199.34	0.0074	1.02	182.31	306.92	0.63
MAIN	36	1 in 50	301.87	196.01	198.23		198.35	0.001748	1.61	200.64	144.75	0.41
MAIN	36	1 in 100	379.78	196.01	198.46		198.6	0.001778	1.73	235.5	155.13	0.42
MAIN	35	1 in 50	301.87	195.23	198.18		198.25	0.000752	1.24	262.45	156.75	0.28
MAIN	35	1 in 100	379.78	195.23	198.41		198.49	0.000822	1.37	300.74	177.9	0.3
MAIN	34	1 in 50	301.87	195.36	197.94		198.01	0.000677	1.15	281.07	184.24	0.26
MAIN	34	1 in 100	379.78	195.36	198.15		198.23	0.000736	1.28	320.08	193.14	0.28
MAIN	33	1 in 50	301.87	194.37	197.92		197.96	0.000337	0.94	336.09	181.38	0.19
MAIN	33	1 in 100	379.78	194.37	198.12		198.18	0.000408	1.08	374.27	196.4	0.22
MAIN	32	1 in 50	301.87	195.76	197.81		197.91	0.001398	1.42	215.85	155.34	0.37
MAIN	32	1 in 100	379.78	195.76	197.99		198.11	0.001508	1.59	244.61	162.32	0.39

MAIN	31	1 in 50	301.87	196	197.43		197.66	0.006199	2.27	141.25	154.03	0.72
MAIN	31	1 in 100	379.78	196	197.61		197.86	0.005745	2.35	169.52	161.99	0.71
MAIN	30	1 in 50	301.87	194.74	197.36		197.43	0.000846	1.26	268.63	187.37	0.29
MAIN	30	1 in 100	379.78	194.74	197.52		197.61	0.000998	1.43	299.81	196.37	0.32
MAIN	29	1 in 50	301.87	195.59	196.81	196.81	197.11	0.013503	2.63	125	207.83	1
MAIN	29	1 in 100	379.78	195.59	196.93	196.93	197.26	0.013016	2.75	151.25	231.46	1
MAIN	28	1 in 50	301.87	194.36	196.65		196.66	0.000129	0.44	602.21	363.89	0.11
MAIN	28	1 in 100	379.78	194.36	196.85		196.86	0.000147	0.51	676.58	382.85	0.12
MAIN	27	1 in 50	301.87	194.11	196.35	195.89	196.57	0.003588	2.07	151.94	146.25	0.57
MAIN	27	1 in 100	379.78	194.11	196.48	196.11	196.75	0.004065	2.34	172.22	155.13	0.62
MAIN	26	1 in 50	301.87	193.87	195.7	195.7	195.97	0.009903	2.4	140.49	250.28	0.87
MAIN	26	1 in 100	379.78	193.87	195.79	195.79	196.1	0.010549	2.58	164.07	262.16	0.91
MAIN	25	1 in 50	301.87	190.45	195.04		195.05	0.000055	0.45	743.21	294.88	0.08
MAIN	25	1 in 100	379.78	190.45	195.27		195.28	0.000069	0.53	812.02	318.76	0.09
MAIN	24	1 in 50	301.87	191.37	195.01		195.03	0.000198	0.76	462.32	278.87	0.15
MAIN	24	1 in 100	379.78	191.37	195.23		195.26	0.000233	0.85	525.64	298.71	0.16
MAIN	23	1 in 50	301.87	192.9	194.47	194.47	194.94	0.009594	3.08	104.54	124.04	0.92
MAIN	23	1 in 100	379.78	192.9	194.67	194.67	195.16	0.008516	3.18	131.81	144.18	0.88
MAIN	22	1 in 50	301.87	190.63	193.07		193.14	0.000963	1.2	251.85	160.62	0.31
MAIN	22	1 in 100	379.78	190.63	193.28		193.37	0.001029	1.33	286.1	168.37	0.32
MAIN	21	1 in 50	301.87	189.85	193.01		193.07	0.000671	1.07	291.65	187.53	0.26

MAIN	21	1 in 100	379.78	189.85	193.22		193.29	0.000729	1.19	330.74	193.08	0.27
MAIN	20	1 in 50	301.87	191	192.46	192.46	192.88	0.012729	2.87	105.18	127.06	1
MAIN	20	1 in 100	379.78	191	192.6	192.6	193.08	0.012003	3.07	124.3	132.59	0.99
MAIN	19	1 in 50	301.87	189.01	191.86		192.04	0.003828	1.97	162.77	168.24	0.58
MAIN	19	1 in 100	379.78	189.01	192.07		192.26	0.003527	2.02	200.4	185.63	0.57
MAIN	18	1 in 50	301.87	187.23	191.93		191.96	0.000178	0.76	395.99	139.4	0.14
MAIN	18	1 in 100	379.78	187.23	192.14		192.18	0.000228	0.89	424.54	143.74	0.17
MAIN	17	1 in 50	301.87	188.07	191.87		191.93	0.000432	1.02	296.68	131.92	0.22
MAIN	17	1 in 100	379.78	188.07	192.06		192.13	0.00055	1.18	321.37	136.83	0.25
MAIN	16	1 in 50	301.87	189.92	191.42	191.42	191.81	0.013492	2.74	110.06	146.45	1.01
MAIN	16	1 in 100	379.78	189.92	191.57	191.57	191.99	0.012973	2.87	132.14	159.15	1.01
MAIN	15	1 in 50	301.87	189.04	190.18	190.18	190.53	0.013568	2.54	115.95	167.91	0.99
MAIN	15	1 in 100	379.78	189.04	190.31	190.31	190.7	0.013061	2.68	137.77	178.08	0.99
MAIN	14	1 in 50	301.87	188	189.92		190	0.001481	1.26	241.56	205.89	0.36
MAIN	14	1 in 100	379.78	188	190.18		190.26	0.001267	1.3	295.19	214.35	0.35
MAIN	13	1 in 50	301.87	187.16	189.91		189.96	0.000524	0.94	320.73	185.55	0.23
MAIN	13	1 in 100	379.78	187.16	190.17		190.22	0.000549	1.03	368.77	193.12	0.24
MAIN	12	1 in 50	301.87	187.44	189.34		189.73	0.007876	2.76	109.23	95.89	0.83
MAIN	12	1 in 100	379.78	187.44	189.54		189.98	0.008016	2.94	129.38	105.15	0.84
MAIN	11	1 in 50	301.87	185.21	189.5		189.52	0.000155	0.61	502.55	242.59	0.13
MAIN	11	1 in 100	379.78	185.21	189.72		189.74	0.000179	0.69	556.62	251.74	0.14

MAIN	10	1 in 50	301.87	186.28	189.43		189.49	0.000935	1.15	276	231.97	0.3
MAIN	10	1 in 100	379.78	186.28	189.64		189.71	0.000929	1.24	326.49	244.5	0.3
MAIN	9	1 in 50	301.87	186.93	189.14		189.35	0.003734	1.99	151.96	125.12	0.58
MAIN	9	1 in 100	379.78	186.93	189.32		189.56	0.004049	2.17	174.71	133.54	0.61
MAIN	8	1 in 50	301.87	186.42	188.1	188.1	188.45	0.012387	2.65	118.55	172.59	0.97
MAIN	8	1 in 100	379.78	186.42	188.23	188.23	188.61	0.012437	2.81	140.74	187.22	0.99
MAIN	7	1 in 50	301.87	184.85	186.92		187.22	0.007905	2.43	124.39	133.08	0.8
MAIN	7	1 in 100	379.78	184.85	187.1		187.43	0.007177	2.55	148.95	137.63	0.78
MAIN	6	1 in 50	296.48	184.04	186.75		186.84	0.0012	1.39	217.28	142.5	0.34
MAIN	6	1 in 100	372.99	184.04	186.89		187.02	0.001482	1.6	237.94	148.47	0.39
MAIN	5	1 in 50	296.48	183.62	186.7		186.7	0.000071	0.39	866.23	547.15	0.09
MAIN	5	1 in 100	372.99	183.62	186.83		186.84	0.000087	0.45	941.84	550.99	0.1
MAIN	4	1 in 50	296.48	185.79	186.36	186.36	186.65	0.007081	1.25	138.52	230.36	0.65
MAIN	4	1 in 100	372.99	185.79	186.5	186.5	186.78	0.007192	1.46	171.5	262.58	0.68
MAIN	3	1 in 50	296.48	184.25	185.56		185.66	0.001856	1.08	217.93	195.99	0.38
MAIN	3	1 in 100	372.99	184.25	185.73		185.85	0.002041	1.16	254.62	221.58	0.4
MAIN	2	1 in 50	296.48	183.66	184.86	184.86	185.2	0.012088	2.17	117.29	167.23	0.91
MAIN	2	1 in 100	372.99	183.66	184.99	184.99	185.36	0.012096	2.35	141	186.1	0.93
MAIN	1	1 in 50	296.48	181.81	182.92	182.92	183.29	0.013287	2.72	109.13	145.53	1
MAIN	1	1 in 100	372.99	181.81	183.06	183.06	183.47	0.012706	2.86	131.2	161.54	1