ENGINEERING

HARMONY MPONENG PRE-FEASIBILITY STUDY WATER BALANCE

GOLDEN CORE TRADE AND INVESTMENT (PTY) LTD

ATTENTION: Suryna van Huyssteen

EMAIL: svhuyssteen@harmony.co.za

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AUTHOR: Raees Abdulla

raees@ecoe.co.za

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WATER BALANCE REPORT

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NATURE OF SIGNOFF	RESPONSIBLE PERSON	ROLE / RESPONSIBILITY	QUALIFICATION / ENTITY
Author	Raees Abdulla	Hydrologist	BSc. (Hons) (Hydrology and Geohydrology)
Technical Reviewer	Kayle Whitehead	Civil Engineer (Pr. Eng.)	B.Eng. (Civil Engineering) B.Eng. (Hons) (Electrical Engineering

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EXECUTIVE SUMMARY

Eco Elementum (Pty) Ltd (Eco E) was appointed by Golden Core Trade and Investment (Pty) Ltd to perform a Water Balance (WB) model for a pre-feasibility study in the study area (Mponeng Operations). Gold mining at the Mponeng Operations, formerly known as the West Wits Operations, commenced in 1958. The Mponeng Operations comprise three deep-level mines: Mponeng, Tau Tona and Savuka. Among these, Mponeng is the deepest mine in the world, reaching a depth of 3,891 meters below datum and 2,062 meters below sea level (mbsl).

The main purpose of this water balance report is to ensure that the sizes of the proposed and existing components of the Mponeng Tailings Storage Facility (TSF) dirty water management are adequate and to ensure that the mine complies with the requirements as contained in the National Water Act (NWA), Act 36 of 1998, and the regulations on water usage for mining activities as set out in the Government Notice Nr. GN704 dated June 1999.

According to the Department of Water Affairs and Forestry's (currently known as the Department of Water and Sanitation) Best Practice Guideline (2006, p.1), the water and salt balance models are undertaken to determine the following:

- To assist with the storage requirements and to ensure that dirty water containment facilities are still compliant to contain all dirty water inflows and to prevent any chance of the system spilling more than once in 50 years.
- To provide the required information to aid in the development and implementation of water management strategies.
- To assist in the decision-making process for water management by simulating and analysing various water management options prior to implementation.
- To identify and quantify excessive water consumption or waste locations, as well as pollution sources. When the balances are utilized as an auditing and assessment tool, seepage and leakage spots can also be found and quantified.

Following the findings and the results of the water balance model, it is clear that:

- Excess water in the RWD is at risk of overflowing into the downstream environment when both the Upper and Lower TSFs are operational, with the potential to degrade the surface and groundwater qualities of surrounding areas. It is critical that water from Mponeng is sent to the Savuka Operations to ensure that the proposed RWD is adequately sized to accommodate all the dirty water inflows.
- The total proposed capacity for dirty water containment at the Mponeng TSF operations is approximately 327,000 m^3, and this capacity is sufficient to contain all dirty water inflows without the dam spilling more than once in 50 years.

The table below summarises the average flows for the Mponeng TSF Operations, for the pre-feasibility study:

Table 0-1: Mponeng TSF Water Balance Summary (Mℓ/day) – Average Flows

Source	Destination	Rate (Mℓ/day)
Upper TSF	Lower TSF	1.60
Lower TSF	RWD	9.28
RWD	Savuka Plant	3.03
RWD	Mponeng Plant	6.16
RWD	Dust Suppression	0.56
Upper and Lower TSF	Interstitial Storage	5.01
Savuka Plant	Water in Tailings (Lower TSF)	11.91
Mponeng TSF	Water in Tailings (Upper TSF)	1.57

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ABBREVIATION	TERM
AEP	Annual Exceedance Probability
AWBM:	Australian Water Balance Model
CLR	Carbon Leader Reef
HGM	Harmony Gold Mining Company Limited
MAE:	Mean Annual Evaporation
MAP:	Mean Annual Precipitation
MAMSL:	Meters Above Mean Sea Level
MBSL:	Meters Below Sea Level
NWA	National Water Act
PFD:	Process Flow Diagram
RoR:	Rate of Rise
RWD:	Return Water Dam
TSF:	Tailings Storage Facility
WB:	Water Balance
WMA:	Water Management Area

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KEY PROJECT INFORMATION

Table 0-2: Project Information

PROJECT	Harmony Mponeng Pre-Feasibility Study – Water Balance
Trading name (if any):	Golden Core Trade and Investment (Pty) Ltd
Contact person:	Suryna van Huyssteen
Email:	svhuyssteen@harmony.co.za
Pr. Engineer:	Kayle Whitehead (Professional Engineer)
Contact person:	Kayle Whitehead for Eco Elementum Engineering (Pty) Ltd.
Postal address:	472 Botterklapper Street, Block@Nature, Block B, Die Wilgers, Pretoria
Postal code:	0184
Telephone:	012 807 0383
E-mail:	kaylew@ecoe.co.za / info@ecoe.co.za
Qualifications & relevant experience	11 Years' experience in Water Resource and Water Utilization Engineering

1 INTRODUCTION

1.1 Activity Background

Eco Elementum (Pty) Ltd, hereinafter referred to as “EcoE”, was appointed by Golden Core Trade and Investment (Pty) Ltd to undertake a Pre-Feasibility Study for the re-commissioning of the existing Mponeng Lower Compartment Tailings Storage Facility (TSF). A dynamic water balance is required to ensure that the sizing of the proposed components of the site-wide dirty water management is adequate, and to ensure that the mine complies with the requirements as contained in the NWA, Regulation no 7 of 1999 (GN 704).

Gold mining at the Mponeng Operations, formerly known as the West Wits Operations, commenced in 1958. The Mponeng Operations comprise three deep-level mines: Mponeng, Tau Tona, and Savuka. Among these, Mponeng is the deepest mine in the world, reaching a depth of 3,891 meters below datum and 2,062 meters below sea level (mbsl). The mine is located on the northwestern margin of the Witwatersrand Basin in South Africa, which hosts one of the world's most significant gold deposits. The Carbon Leader Reef (CLR) at Tau Tona is extracted via the Mponeng Shaft, which is the sole operational shaft within the Mponeng Operations. In 2017, closure procedures began for the Savuka and Tau Tona mines (Agreenco, 2023).

The purpose of the Pre-Feasibility Study is to determine a viable design for the re-commissioning of the Mponeng Lower Compartment TSF. The design must be both cost-effective and likely to receive approval from the Department of Water and Sanitation (DWS).

The water balance is conducted to ensure that the mine is compliant with the Department of Water Affairs and Forestry’s Best Practice Guideline (2006, p. 1). According to the guideline, water and salt balance models are undertaken to determine the following:

- To assist with the storage requirements and to ensure that dirty water containment facilities are still compliant to contain all dirty water inflows and to prevent any chance of the system spilling more than once in 50 years.
- To provide the required information to aid in the development and implementation of water management strategies.
- To assist in the decision-making process for water management by simulating and analysing various water management options prior to implementation.
- To identify and quantify excessive water consumption or waste locations, as well as pollution sources. When the balances are utilized as an auditing and assessment tool, seepage and leakage spots can also be found and quantified.

1.2 Locality

The Mponeng operations forms part of the HGM Wes Wits Operations in the West Rand area and is situated approximately 9 km southwest of Carletonville in the Gauteng Province within the Merafong City Local Municipality and West Rand District Municipality. The layout of the TSF and the relative infrastructure pertinent to the site is shown in Figure 1-1.

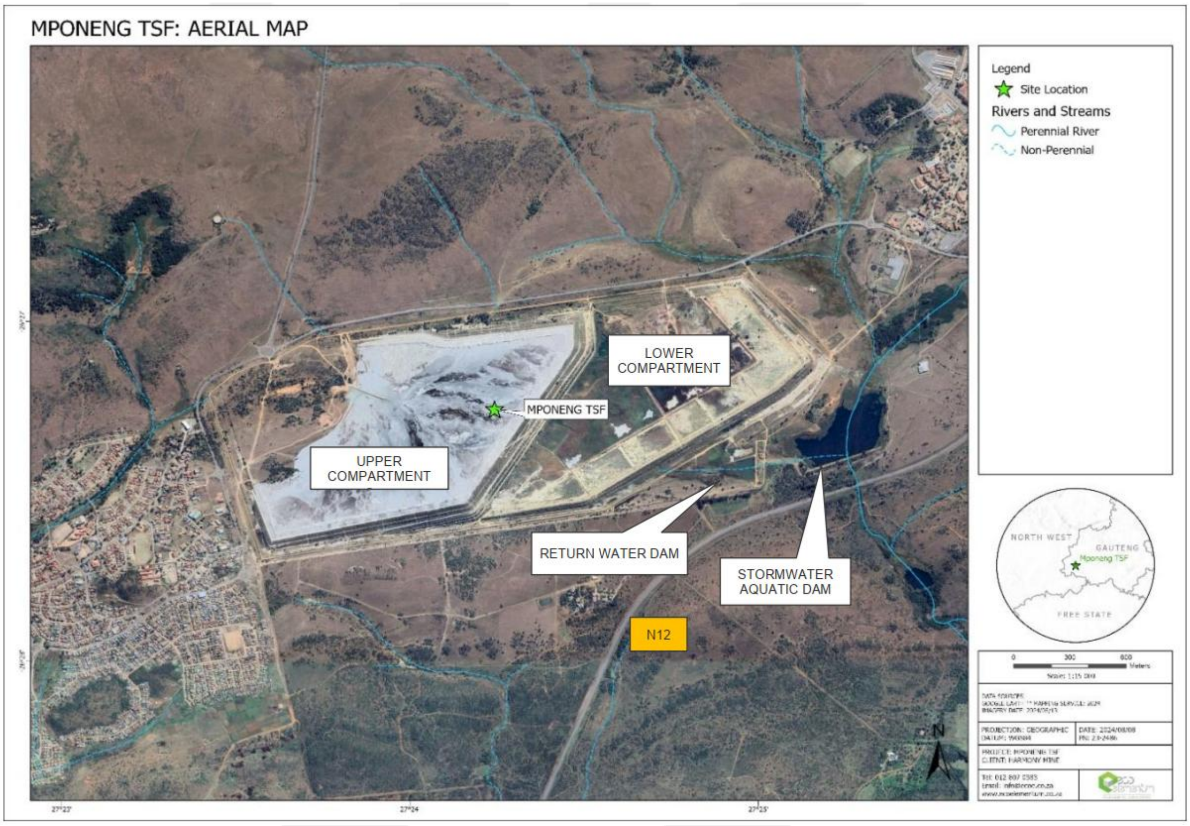

Figure 1-1: Mponeng TSF – Aerial Map

2 DESCRIPTION OF THE CURRENT ENVIRONMENT

2.1 Water Management Area – Locality and Physical Characteristics

The Mponeng falls within the Upper Vaal Water Management Area (WMA), and more specifically within the northern region of the C23J quaternary catchment. The site generally slopes from north to south, eventually draining into the Klipdrift Dam. The position of the site relevant to the quaternary catchment is shown in Figure 2-1.

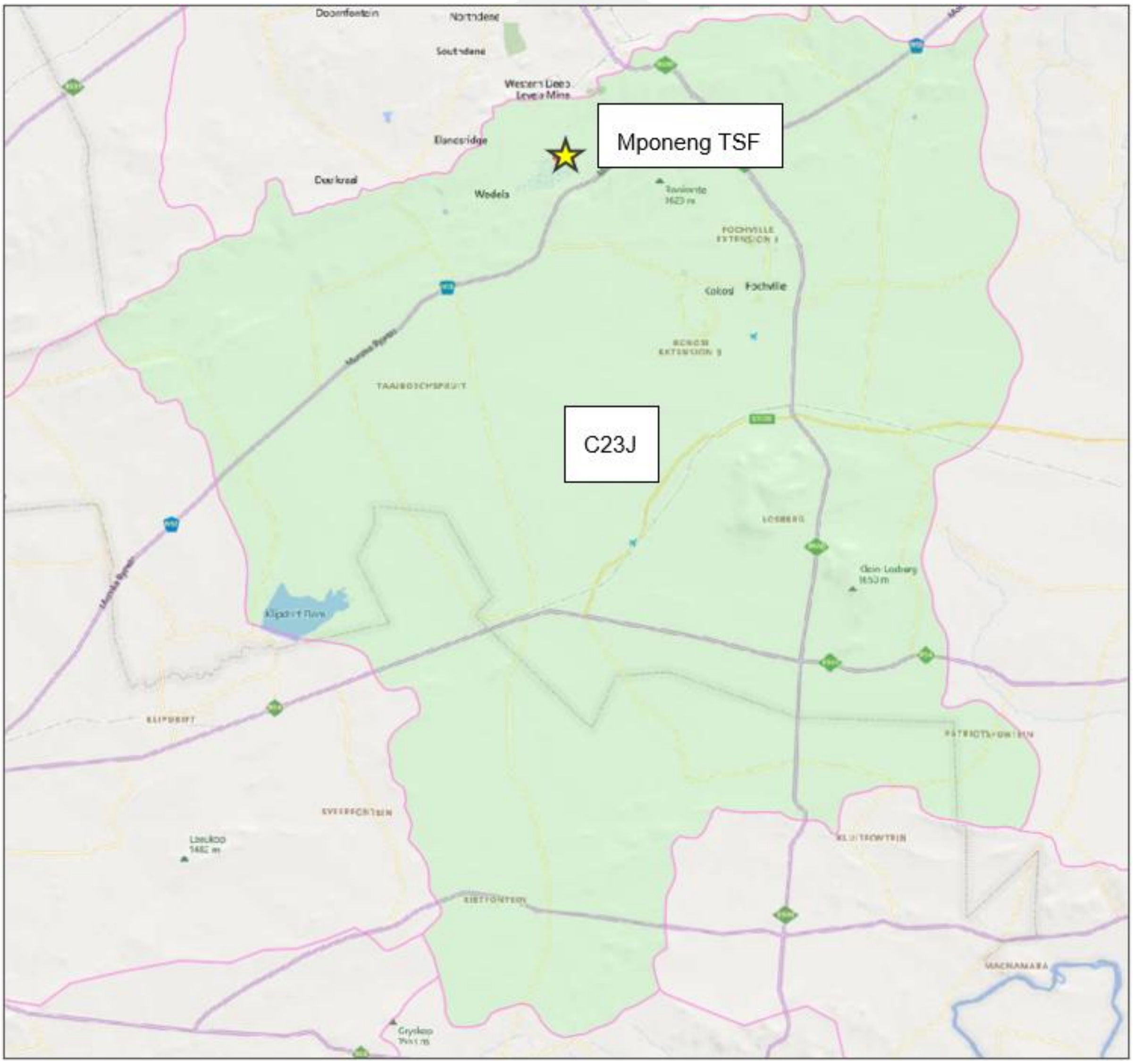

Figure 2-1: Quaternary Catchment C23J

3 CLIMATIC CONDITIONS

3.1 Rainfall and Evaporation

The Savuka operations fall within the summer rainfall region of South Africa, which is warm temperate, with cold dry winters and warm summers. The summer rainfall is sporadic, with frequent thunderstorms, associated with high-intensity rainfall events.

The Blyvooruitsig (GM) Weather Station (0474684_W) is the closest station (6.5 km) to the study area with extremely reliable (97%) and long-term (59 years: 1941 – 2000) historic rainfall data that correlates with the recorded rainfall readings. The Mean Annual Precipitation (MAP) at this weather station is 705 mm per annum. Daily rainfall depths were extracted using the daily rainfall data extraction utility developed by Richard Kunz, from the Institute for Commercial Forestry Research (ICFR), in conjunction with the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, Pietermaritzburg, South Africa. This utility will assist the user in extracting observed and infilled daily rainfall values from a database that was developed by Steven Lynch during a Water Research Commission (WRC) funded research project (K5/1156) awarded to BEEH. The project, titled "The development of a raster database of annual, monthly and daily rainfall for southern Africa", was completed in March 2003.

Evaporation data was obtained from the closest DWS meteorological station (C2E009). Moderately high levels of evaporation occur in the area. The maximum evaporation rate occurs from October until January, with a mean rate of 6.4 mm per day. Evaporation is greater than rainfall for all months of the year resulting in a marked moisture deficit in the region. The average rainfall and average evaporation figures are shown in Table 3-1.

Table 3-1: Summary of Rainfall and S-Pan evaporation data

Month	Mean Precipitation (mm)	Mean Evaporation (mm)
January	115.8	188.4
February	98.6	159.8
March	91.7	147.8
April	60.7	114.4
May	20.2	95.4
June	9.0	76.6
July	5.6	85.3
August	6.9	119.7
September	20.6	160
October	71.9	186.9
November	97.7	189.9
December	106.0	198.7
Mean Annual Total	**705**	**1 723**

3.2 Historical Site Rainfall

Historical monthly rainfall data for the study area is available and will be incorporated into the calibration of the water balance model. This dataset provides long-term records of precipitation trends, enabling a comprehensive understanding of seasonal and interannual variability. The data will be analysed to identify wet, dry, and average conditions, ensuring the model accurately reflects real-world hydrological conditions. The dataset over the 17-year period spans from January 2008 until the present date.

Table 3-2: Summary of Site Rainfall

Month	Mean Precipitation (mm)
January	154.8
February	147.6
March	105.6
April	75.9
May	28.4
June	11.5
July	5.8
August	5.9
September	16.9
October	58.1
November	99.2
December	170.2
Mean Annual Total	**880**

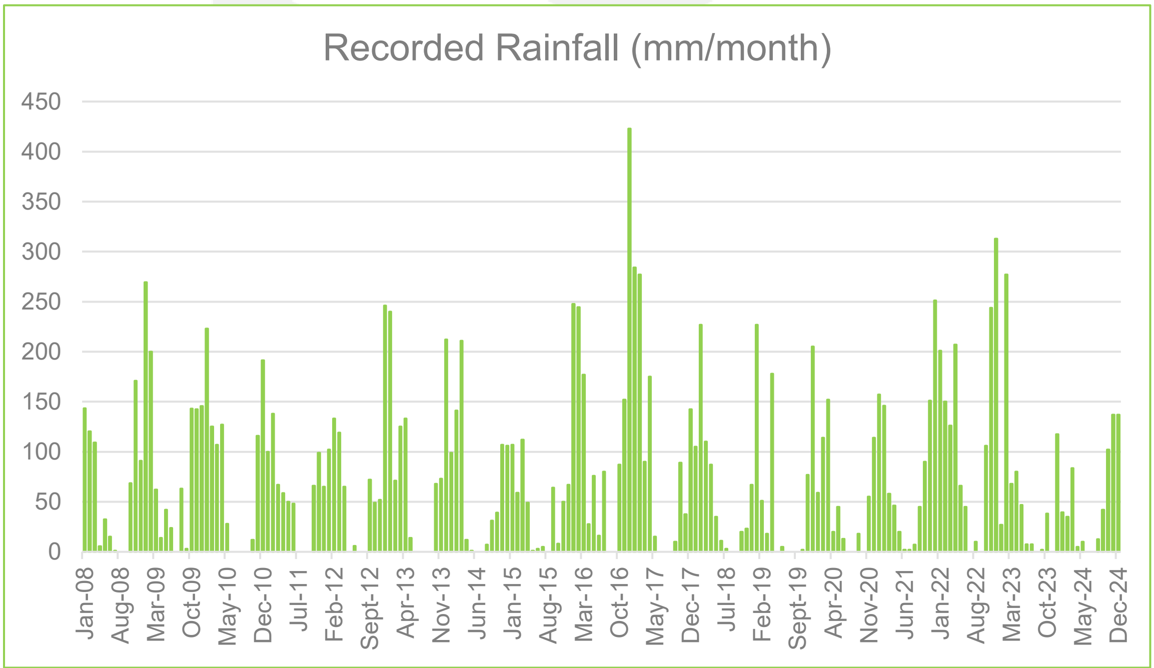

Figure 3-1: Recorded Rainfall

4 WATER BALANCE MODEL – MODEL COMPONENTS

The formulation of the water balance model was done to determine if the dirty water management systems are sized adequately to accommodate all dirty water inflows without the existing facilities spilling more than once in 50 years. The model was designed to provide the necessary data to assist in the decision-making process for water management, as well as to determine and quantify excessive water consumption or waste locations, including pollution sources. Additionally, the water balance model was conducted to ensure that the mine complies with the requirements as contained in the NWA, Regulation no. 7 of 1999 (GN 704).

4.1 Model Overview

The water balance model is a continuous stochastic model formulated using the GoldSim simulation software package. Figure 4-1 illustrates the interface, as well as an overview of the main elements used in the GoldSim Software for Mponeng. GoldSim water balance models utilize a Monte Carlo simulation engine to assess the current operational functionality of the system against multiple potential future outcomes and try to quantify the potential risks associated with the different water management scenarios.

The core of a water balance model usually includes the formulation of a deterministic model in which the various components are represented by the aid of using averaged values of the system variables. When real-time and measured data is not available for the various site-specific operations at hand, the averaged values can be defined based on assumed values from similar operations. All these respective system element variables, that form part of the water balance cycle, will then be simulated over predetermined time steps to indicate how the overall system will operate.

However, due to the probabilistic nature of the hydrological and processing plant water requirements, and using their averaged values, limits the accuracy and usefulness of the model outputs. Monitoring data can give an incomplete and sometimes vague account of the past. It is therefore only valid, and representative of the water system monitored in the past, and of the climate sequence that occurred during that specific period.

The use of the stochastic model gives the capability to simulate the model components that were not monitored. The system can also be tested against the different climatic events that could potentially be encountered (dry spells, wet spells, extreme storm events, etc.) and the expected timing of these events throughout the simulation.

The quantification and likelihood of these events occurring during the design life of the system at hand will greatly contribute to ensuring the system meets the design criteria and the constraints from the regulatory approval procedures.

Figure 4-1: Goldsim Interface for Mponeng Water Balance Model

The water balance model will include / incorporate the following focus areas:

- Tailings Storage Facilities (TSFs).
- Return Water Dam (RWD).
- Wash Plant.
- Dirty runoff areas (TSF and Side Walls).

The main components of the water balance model will include:

- Rainfall generator model: Stochastic rainfall generation based on historic local rainfall patterns.
- Catchment model: Run-off and recharge simulation of the various dirty water areas.
- Water use model: The allocation of collected dirty water.
- Pond model: The storage and transfer of water from the containment facilities (RWDs).

4.2 Water Reticulation and Scope of Work

Information supplied by the Client included the water reticulation components for the operation at the Mponeng Section. Figure 4-2 illustrates the water reticulation for the Mponeng and Savuka operations (supplied by the client). The primary focus of this water balance is the Mponeng Upper and Lower TSF and their respective return flows (circled in red). Additional information was obtained from a monthly water balance conducted by Harmony. There were some imbalances noted, and due to the lack of updated and missing data, some of the modelling parameters were based on assumptions. These assumptions include and are not limited to:

- All runoff from the TSF side walls areas will be conveyed to the RWD via trenches.
- Excess water in the RWD will be pumped to Savuka Operations to ensure GN 704 compliance.
- Dust Suppression is supplied at a maximum rate of 400,000 m^3/annum (as per the water balance provided by the client).
- The operating levels of the dirty water containment facility kept the RWD at roughly 40% of its proposed capacity to avoid spills.

The scope of work addressed is summarised as follows:

- Evaluate the required Return Water Dam (RWD) capacity to accommodate the proposed TSF expansion.
- Evaluate the quantity of water in the slurry and the quantity of return water to assist with sizing the pumps and associated infrastructure.
- The water balance model solely focuses on sizing the infrastructure for the proposed Mponeng TSF operations.
- Potable water is not included in the water balance model.
- The water balance is not a site-wide water balance (Underground Mining, Sewage, Plant PCD, PSE dams are not included).

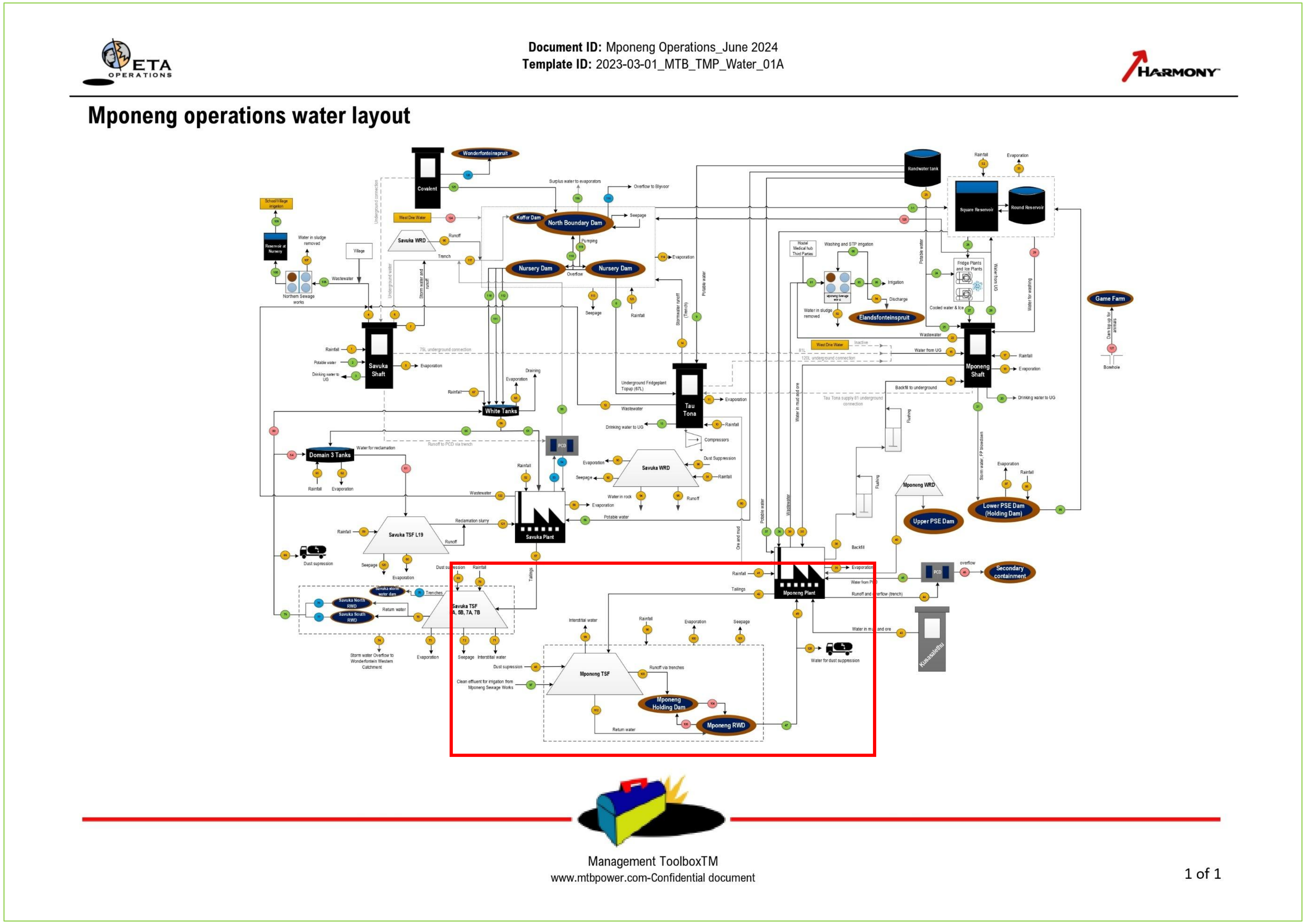

Figure 4-2: Water Reticulation – Mponeng operations water layout (ETA Operations, 2024)

4.3 Rainfall-Run-Off Generator

The available historical rainfall data, for any area of interest, gives a representation of the past rainfall patterns that took place, but limited information regarding the risk of droughts or flood-like activities can be obtained from this data. To ensure that the current dirty water management system is evaluated against a whole range of different rainfall sequences and recurrence intervals, a stochastic rainfall generation model will be implemented in the GoldSim water balance model.

The stochastic rainfall generator is based on Boughton's model (Boughton W.C., 1999). This specific rainfall generation model can generate annual, monthly, and daily simulated rainfall sequences that statistically correlate to the historical observed rainfall data.

The selection of station 0474684_W is made since this is the closest station to the study area with a near-perfect reliability record and minimal patched data (patching of rainfall data requires filling in the missing data with data from nearby stations based on statistical rainfall parameters).

4.4 Stormwater Run-Off Criteria

The Australian Water Balance Model (AWBM) was used to determine the expected run-off and recharge volumes from rainfall in the study area (Figure 4-3). This specific run-off model is non-linear, and the assumption made, is that the expected volume of run-off will be lowest during periods of low rainfall. This is due to the initial rainfall first saturating the ground surface by infiltration. Following the saturation of the ground, less water will infiltrate the ground and will thus generate more run-off.

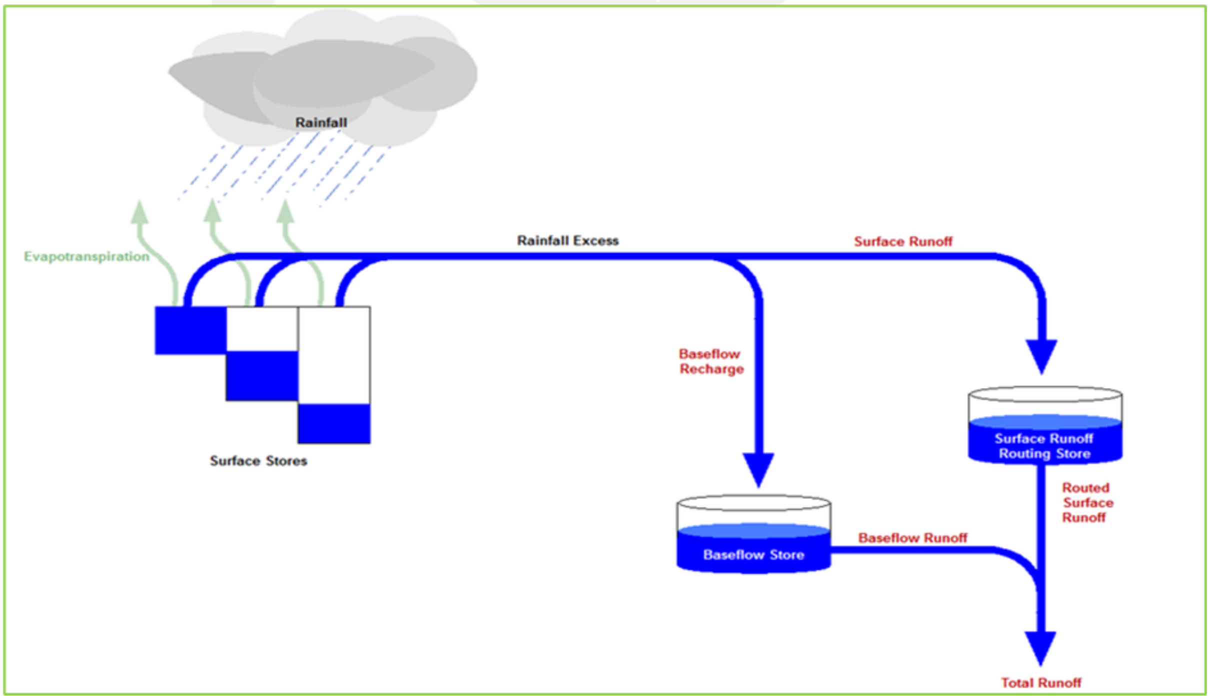

Figure 4-3: Structure of the AWBM (Goldsim)

The non-linear model comprises of a range of conceptional containers that represent the surface storage capacity of the catchment. As mentioned earlier as soon as these surface stores become saturated the catchment area will start generating run-off. The generated run-off is divided into surface run-off and baseflow. A portion of the baseflow contributes to groundwater recharge.

All the different dirty water run-off areas were divided into catchment specific areas to be applied accordingly in the run-off calculations (Figure 4-4). Table 4-1 provides a summary of the different footprint sizes of the various run-off areas and their downstream dirty water containment system where the run-off water will be captured.

Table 4-1 Run-off areas

Description	Area (m^2)	Containment Area
Upper TSF Side Slope	247,762	RWD
Lower TSF Side Slope	462,867	RWD
Wet and Dry Beach Upper TSF	786,470	Upper TSF Pool
Wet and Dry Beach Lower TSF	672,766	Lower TSF Pool

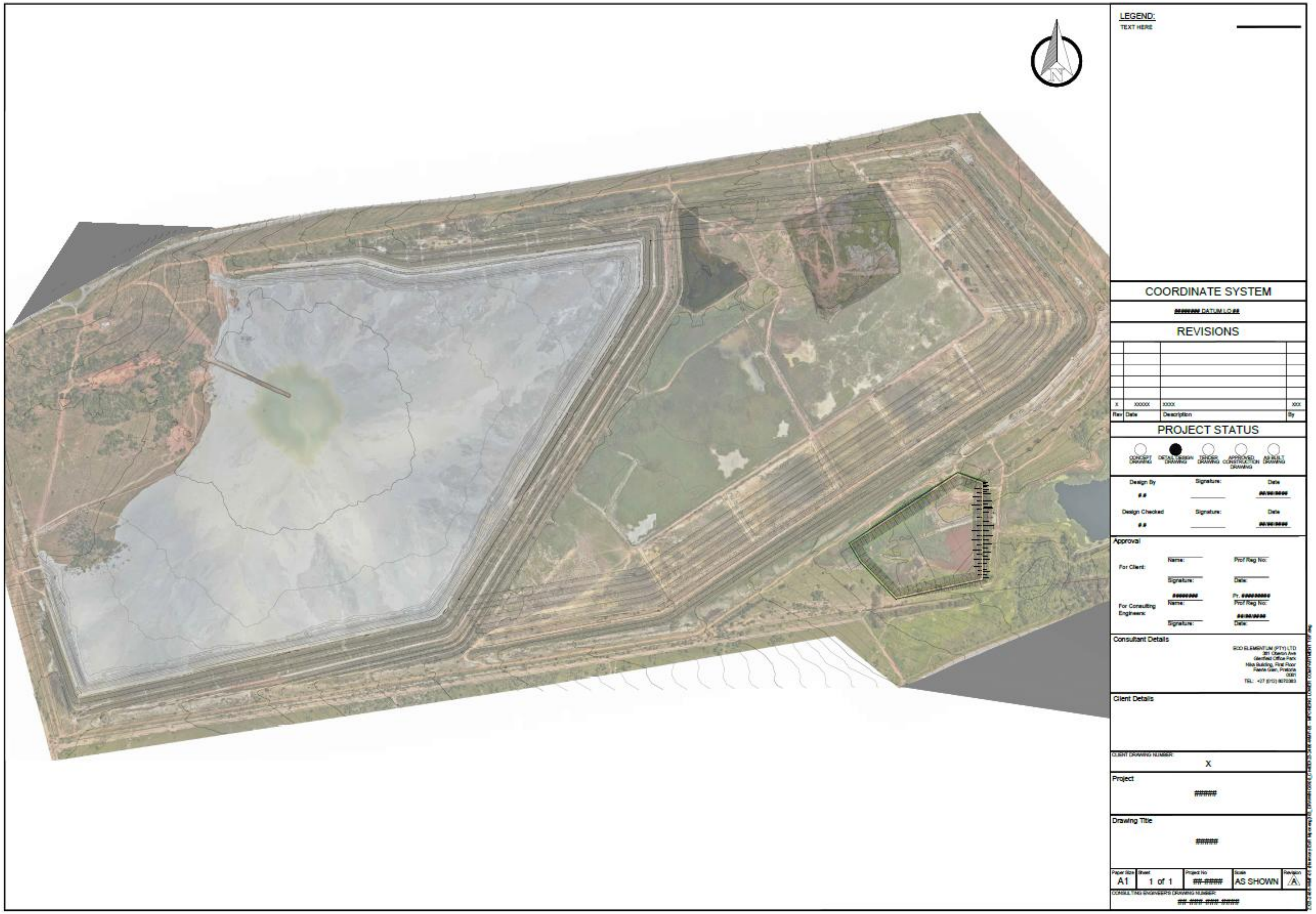

Figure 4-4: Mponeng TSF Dirty Water Catchments

4.5 Dam Model

The GoldSim software provides a "Pool" element (dam) that calculates the additions and withdrawals into the pool element by computation of the Euler integration method, based on the specific demands of the mentioned pool element. This element will be incorporated to solve the water balance of the dirty water containment entity (RWD) in the water balance model. The conceptual schematic of the RWD is shown in Figure 4-5.

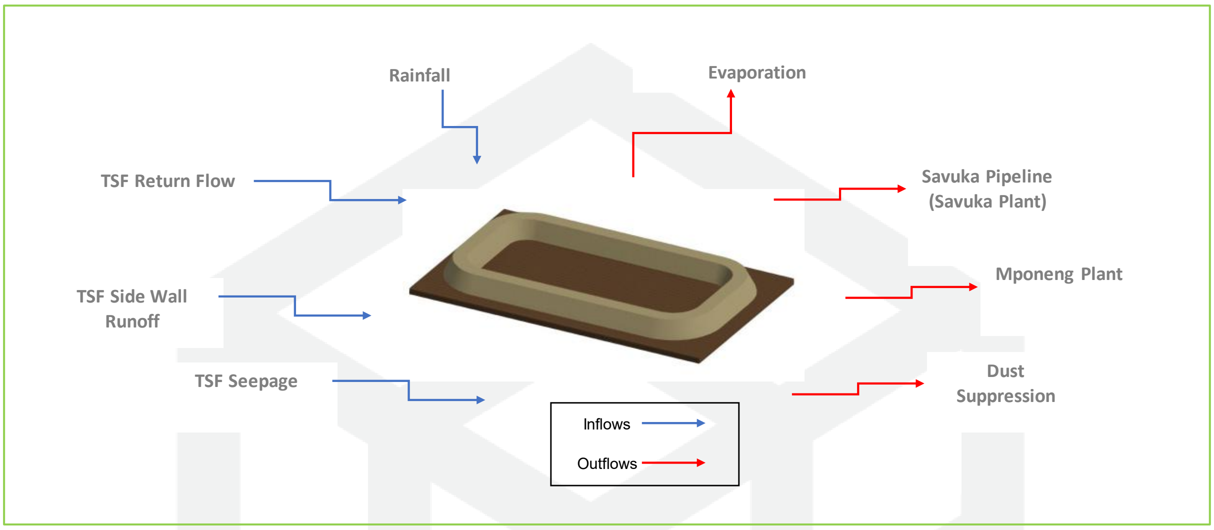

Figure 4-5: Conceptual illustration of the Proposed Mponeng RWD

Typical inflows into these elements will usually include:

- Direct Rainfall.
- TSF Return Flow.
- TSF Side Wall Runoff.
- TSF Seepage.

Typical outflows into these elements will usually include:

- Evaporation (surface of the body of water).
- Water Transferred to Mponeng Plant.
- Excess Water pumped to Savuka Plant.
- Dust Suppression.

The RWD will need to be a lined facility that will not have any seepage outflows according to the requirements of GN704.

4.6 Flow Meter Records

Flow measurement on all the main dirty water transfer pipelines is done on a daily basis on-site and this flowmeter data indicated the average pumping rates, as well as, the maximum possible pumping rates that can be achieved. These pumping rates will be applied in the water balance model. The maximum and average pump rates (from the Savuka and Mponeng RWD) achieved throughout the measurement period can be seen summarized in Table 4-2.

Table 4-2 Flow Meter Records (January 2024 – December 2024)

Water Source	Water Destination	Average Flow (m^3/day)	Max Flow (m^3/day)
Savuka RWD	Savuka Plant	3,441	9,248
Mponeng RWD	Mponeng Plant	5,302	9,714
Savuka Plant	Savuka Tailings	12,224	13,917
Mponeng Plant	Mponeng Tailings	8,832	10,033

4.7 Tailings Storage Facilities (TSFs)

According to the Mponeng Lower Compartment Tailings Storage Facility Pre-Feasibility Study Basis of Design (compiled by EcoE, 2025), tailings are currently being deposited in the Upper Compartment using hydrocyclones. It is proposed that the same deposition method be applied to the Lower Compartment, as this approach supports a higher Rate of Rise (RoR).

Cyclone deposition, a refinement of wet deposition methods, is designed to separate and dewater the coarse fraction of tailings slurry. The slurry is pumped under pressure through a cone-shaped hydrocyclone, where centrifugal forces facilitate the separation of coarse and fine particles. The resulting dewatered coarse material, known as the underflow, is discharged from the cyclone apex and used to form a stable, load-bearing embankment. Meanwhile, the finer particles and excess water, termed the overflow, are directed through a spigot line for deposition across the tailings beach.

Initial estimates and calculations during the Pre-feasibility phase of the proposed Lower Compartment TSF, together with assumptions and measurements from available aerial imagery (of the existing Upper TSF), indicated that the following TSF footprints can be expected.

Table 4-3 TSF Footprints (Hectares)

DESCRIPTION	UPPER TSF (HECTARES)	LOWER TSF (HECTARES)
Top Area	85.5	72.3
Expected Pool Area	6.9	5.1
Expected Wet Beach Area	31.0	34
Expected Dry Beach Area	47.6	33.2

4.8 Seepage Assessment

The following section is abstracted from the Groundwater Assessment for the Mponeng TSF Complex report (GCS, 2019) - GCS Project Number: 18-0701:

"The seepage assessments were conducted using SEEP/W (2007) version 7.20, which is a Windows based software programme from Geo-Slope. SEEP/W is a finite element software programme used for analysing groundwater seepage and excess pore-water pressure dissipation problems within porous materials such as soil and rock. Its comprehensive formulation allows the user to consider analyses ranging from simple, saturated steady-state problems to sophisticated, saturated/ unsaturated time dependent problems. For this project, the seepage models were analysed for steady-state conditions. Under steady state conditions, the flux entering and leaving an elemental volume is the same at all times.

The purpose of the seepage modelling is to determine the location of the phreatic surface and foundation seepage range. The seepage models were calibrated using the phreatic surface results obtained from the 2013 piezocone testing and standpipe piezometer data at various cross sections."

Two preliminary scenarios were simulated to provide an initial assessment of potential seepage from the Mponeng Tailings Storage Facility (TSF). These scenarios considered final elevations of 60 m (1599 mamsl) and 66 m (1581 mamsl) for the lower and upper TSF compartments, respectively, in addition to the current operational elevations. A summary of the modelled outcomes is presented in Table 4-4.

Table 4-4 Summary of the Seepage Flux Range (GCS, 2019)

TSF	ELEVATION (mamsl)	SEEPAGE FLUX RANGE (m^3/day/ha)	
Mponeng Lower TSF	Current Elevation – 1540 mamsl	0.010	0.305
	Final Elevation – 1581 mamsl	0.046	0.967
Mponeng Upper TSF	Current Elevation – 1577 mamsl	0.010	0.527
	Final Elevation – 1599 mamsl	0.016	0.880

4.9 Slurry Deposition

The following section is obtained from the pre-feasibility study (EcoE, 2025), the basis of design for pumping to Mponeng is aligned with the criteria previously used for the transfer of tailings to the Savuka TSFs, which is considered adequate for the current scope of work. This section of the report outlines the design basis that will guide the pre-feasibility phase of the slurry transfer system. An average of 330,000 tonnes/month of slurry is to be deposited on the proposed lower TSF compartment (via Savuka Plant).

Utilising the monthly water balance provided by the client (containing on site measurements), an average of 130,000 tonnes/month was deposited on the upper Mponeng TSF over the past year and the following was incorporated into the water balance model.

The basic tailings properties (Table 4-5) were obtained from the pre-feasibility study (EcoE, 2025) and the 2024 monthly water balance provided by the client. The following was used to calculate the water in the slurry and utilised in the water balance model.

Table 4-5 Slurry Properties

MPONENG & SAVUKA SLURRY DEPOSITION PROPERTIES	
Savuka Average Dry Deposition (tonnes/month)	330,000
Mponeng Average Dry Deposition (tonnes/month)*	130,000
Solids Density (tonne/m^3) – Savuka	2.73
Solids Density (tonne/m^3) – Mponeng*	2.70
Average Slurry Density (tonne/m^3) - Savuka	1.43
Average Slurry Density (tonne/m^3) – Mponeng*	1.30
Water in Slurry – Savuka (m^3/hr)	500.3
Water in Slurry – Mponeng (m^3/hr)	307.6

**Indicates Values obtained from the 2024 monthly water balance*

4.10 Pumping Rates and Control Philosophy

Flow measurement on all the main dirty water transfer pipelines is done monthly on-site and this flowmeter data indicates the average and maximum pumping rates that can be achieved. These pumping rates were obtained from the 2024 plant water balance sheet provided by the client.

A control philosophy was incorporated in the water balance model, to try and replicate the current operating conditions on site and to ensure that the transfer of dirty runoff and TSF return water is done in a timeous manner for future simulations. The control philosophy also manages the water volumes in the RWD. The transfer rate and operational philosophy for each containment facility used in the water balance model are listed in Table 4-6.

The plant top-up water demand supply is controlled by an “Allocator” element in the GoldSim model. This element allocates an incoming signal (the make-up water demand) to several outputs according to a specified set of demands and priorities. The outputs in this case being the transfer of dirty water from the RWD. The allocator element then keeps track of the total amount of occurrences that the plant top-up water could not be fully supplied from the return flow supply from the dirty water dams.

Table 4-6: Pumping Philosophy

Source	Max Rate (m^3/day)	Destination	Operating Philosophy
Mponeng RWD	9,248	Savuka Plant	If RWD > 50%: Pump at Max Rate until Plant Demand is met. If RWD > 40%: Pump at Max Rate for 12 hours until Plant Demand is met. If RWD < 40%: No Pumping. If Plant Demand is met, No Pumping.
Mponeng RWD	9,714	Mponeng Plant	If RWD > 40%: Pump at Max Rate until Plant Demand is met. If RWD < 40%: No Pumping. If Plant Demand is met, No Pumping.
Mponeng RWD	1,096	Dust Suppression	If RWD > 40%: Pump at Max Rate until Dust Suppression Demand is met. If RWD < 40%: No Pumping. *If Rainfall > 0mm/day: No Pumping.*

4.11 Size of the Containment Facility

The resulting required size and footprints obtained following the simulations as well as characteristics of the proposed dirty water containment facility on site is summarised in Table 4-7 below. The RWD has a starting (initial) level of 0% of the dam's capacity, as the dam is a newly proposed facility.

Table 4-7: Storage Facility Characteristics

Containment Facility	Original Capacity (m^3)	Surface Area (m^2)
RWD	327,000	65,985

5 WATER BALANCE RESULTS

The water balance model was designed to indicate if the proposed infrastructure is adequately sized to contain water inflows and to prevent any chance of the dirty containment facilities spilling more than once in 50 years. The model simulation was run with 250 realisations in the GoldSim software over 20 years. The following sections will discuss the analyses of the results and findings.

5.1 Goldsim Inputs

The pre-feasibility water balance was run using the following model settings and assumptions:

- Simulation Time: 20 years (Daily Time Steps).
- Realisations: 250.
- Simulated values focused on hydrological processes (rainfall, runoff, evaporation).
- All runoff from both the Upper and Lower TSF side walls will be contained in the RWD.
- A maximum pumping rate of 9,714 m^3/day (as per the monitoring results) was incorporated for the transfer from the RWD to the Mponeng Operations.
- Excess water in the RWD was pumped to the Savuka Operations to manage the water levels in the RWD.
- A maximum pumping rate of 9,248 m^3/day (as per the recorded figures provided by the client) was incorporated for the transfer from the Mponeng RWD to the Savuka Operations.
- Dust Suppression was supplied at a maximum rate of 400,000 m^3/annum (as per the 2024 plant water balance provided by the client).
- The operating levels of the dirty water containment facility kept the RWD at roughly 40% of its design capacity.
- Interstitial Storage was based on the calculations provided by the client and the following figures were provided by the operations team:
  - Average Dry Density = 1.25 t/m^3.
  - Tailings Solid Density = 2.7 t/m^3.
  - Specific Gravity of Solids = 2.63.

The graph (Figure 5-1), presented in the following section, depicts a variable analysis of rainfall patterns over 20 years, showcasing simulated probabilities. Through statistical modelling, this visualization sheds light on the variability and potential future trends in precipitation utilising the rainfall-runoff generator mentioned in Section 4.3. The graph unveils a series of probability results generated through a simulated model. These results, depicted by shaded green regions, represent a range of potential outcomes based on statistical analysis and modelling techniques. By exploring various scenarios, this simulation provides insights into the probabilistic nature of rainfall patterns, allowing for informed decision-making and risk assessment during wet and dry periods.

The 98% threshold was selected for dam overflow analysis as it corresponds to a 1-in-50-year probability event. The return period (or recurrence interval) represents the likelihood of a particular event occurring in any given year. A 1-in-50-year event has a 2% annual exceedance probability (AEP), meaning there is a 2% chance of this event occurring in any given year. By analysing the 98th percentile of the data, extreme conditions are captured that align with this probability, ensuring that the assessment accounts for rare but significant overflow events.

5.1.1 Mponeng RWD

The RWD volume probability results following the 250 realisations over a 20-year period from the GoldSim model can be seen in Figure 5-1. The RWD has a design capacity of 327,000 m^3 and the total mean average daily volume of dirty water contained in the RWD during the simulation period is approximately 137,783 m^3 (Roughly 42% of the dam's design capacity). Referring to the figure below, the RWD reaches a maximum capacity of 327,000 m^3 on one occasion during a simulated storm event (98th Percentile – 1:50 Year Probability). Given the RWD's maximum capacity of 327,000 m^3 and referring to Figure 5-2, it is clear that the RWD does not spill more than once throughout the simulation (hence it is adequately sized and operated in line with the proposed operational philosophy).

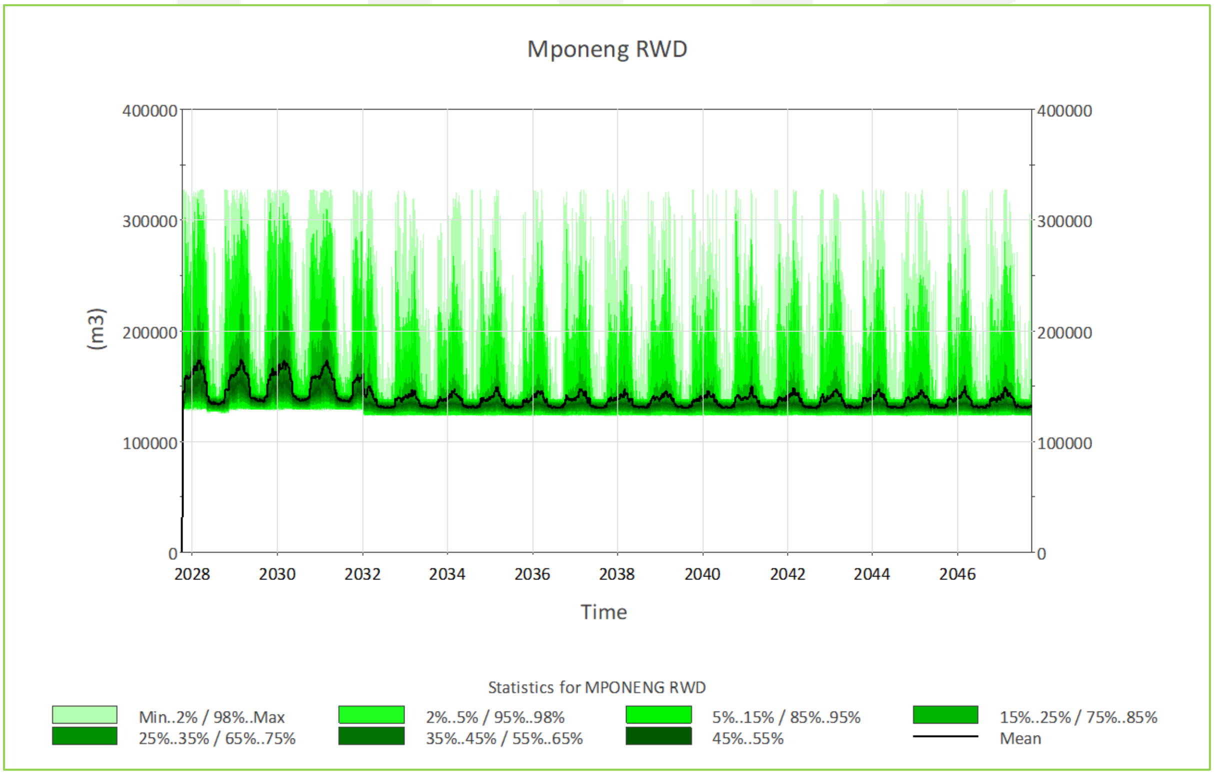

Figure 5-1: Volume Probabilities for the Mponeng RWD

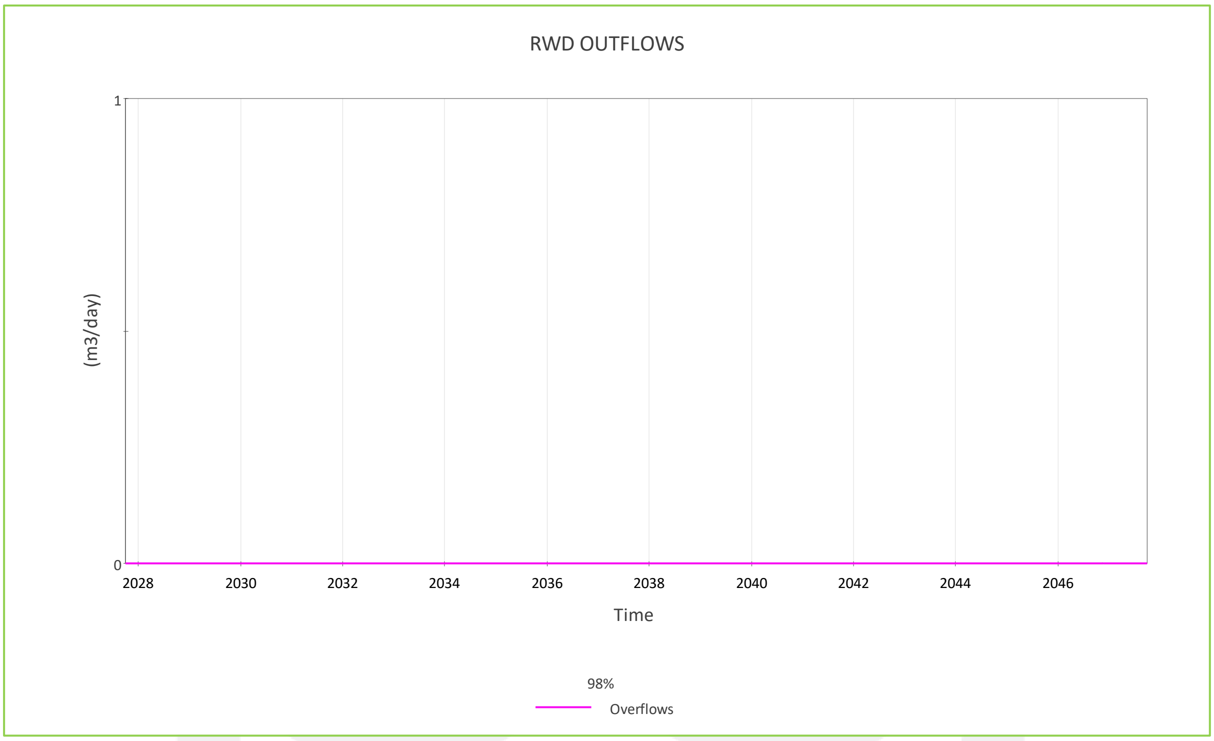

Figure 5-2: Mponeng RWD Overflows

5.2 Water Balance Result Summary

The following is a high-level summary of the simulation results for the Mponeng Section for the proposed operations (pre-feasibility phase) on site:

- The total proposed capacity for dirty water containment at Mponeng TSF operations is 327,000 m^3 (Mponeng RWD).
- The total mean average daily volume of dirty water contained in the RWD is approximately 137,783 m^3.
- The total 98th percentile (1:50-year) daily volume of dirty water contained in the South RWD is approximately 186,990 m^3.
- The total mean average daily volume of water in the tailings transferred from the Mponeng Plant and deposited on the Upper Mponeng TSF is approximately 1,569.2 m^3/day.
- The total mean average daily volume of water entrained (interstitial storage) at the Upper Mponeng TSF is approximately 390.1 m^3/day.
- The total mean average daily volume of water returned from the Upper Mponeng TSF to the Lower Mponeng TSF is approximately 1,598.5 m^3/day.
- The total mean average daily volume of water in the tailings transferred from the Savuka Plant and deposited on the Lower Mponeng TSF is approximately 11,908.5 m^3/day.
- The total mean average daily volume of water entrained (interstitial storage) at the Lower Mponeng TSF is approximately 4,620.0 m^3/day.
- The total mean average daily volume of water returned from the Lower Mponeng TSF to the RWD is approximately 9,275.4 m^3/day.
- The total mean average daily volume of water transferred from the RWD to the Mponeng Plant is approximately 6,157.2 m^3/day.
- The total mean average daily volume of water transferred from the RWD to the Savuka Plant is approximately 3,033.4 m^3/day.
- The total mean average daily volume of water transferred from the RWD and utilised to control excessive dust on the TSFs is approximately 559.5 m^3/day.

The average daily water balance for the Mponeng Lower TSF Compartment Pre-feasibility phase is shown in Figure 5-3 below, and the annual water balance volumes are provided in Table 5-1.

MPONENG LOWER TSF COMPARTMENT WATER BALANCE 2025

WATER BALANCE FLOW DIAGRAM

DIRTY AREAS - RUNOFF

	IN (m^3/d)	OUT (m^3/d)	
Upper TSF Side Walls	206.3	591.7	RWD
Lower TSF Side Walls	385.4	604.4	Upper TSF
Upper TSF Tailings Runoff	604.4	517.0	Lower TSF
Lower TSF Tailings Runoff	517.0		
TOTAL	1713.1	1713.1	TOTAL

MPONENG UPPER TSF

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	134.7	289.5	Evaporation
Tailings Runoff	604.4	390.1	Interstitial Storage
Water in Tailings	1569.2	1598.5	Lower TSF
		32.5	Seepage (Lower TSF)
TOTAL	2308.3	2310.6	TOTAL
Decrease in Storage	2.3	0.0	Increase in Storage

MPONENG LOWER TSF

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	99.7	223.4	Evaporation
Tailings Runoff	517.0	4620.0	Interstitial Storage
Slurry Water	11908.5	9275.4	Return Flow (RWD)
Upper TSF	1598.5	34.0	Seepage
Upper Seepage	32.5		
TOTAL	14156.2	14152.8	TOTAL
Decrease in Storage	0.0	3.5	Increase in Storage

MPONENG RWD (327,000 m³)

	IN (m^3/d)	OUT (m^3/d)	
Rainfall	129.9	248.2	Evaporation
Lower TSF	9275.4	559.5	Dust Suppression
Lower TSF Side Wall Runoff	385.4	6157.2	Mponeng Plant
Lower TSF Seepage	34.0	3033.4	Savuka Plant
Upper TSF Side Wall Runoff	206.3		
TOTAL	10031.0	9998.3	TOTAL
Decrease in Storage	0.0	32.7	Increase in Storage

Figure 5-3: Water Balance Simulation – Daily Average Flows

Table 5-1: Water Balance Simulation – Annual Average Flows

MPONENG LOWER TSF COMPARTMENT WATER BALANCE 2025						
WATER BALANCE FLOW DIAGRAM (m³/annum)						
Facility Name	Water In		Water Out		Balance	Comment
	Water Stream	Quantity	Water Stream	Quantity		
DIRTY AREAS - RUNOFF	**Upper TSF Side Walls**	75 294	**RWD**	215 957		
	Lower TSF Side Walls	140 663	**Upper TSF**	220 617		
	Upper TSF Tailings Runoff	220 617	**Lower TSF**	188 721		
	Lower TSF Tailings Runoff	188 721				
	Total	625 295	Total	625 295	0.00	Balanced
MPONENG UPPER TSF	**Rainfall**	49 158	**Evaporation**	105 676		
	Tailings Runoff	220 617	**Interstitial Storage**	142 368		
	Water in Tailings	572 746	**Lower TSF**	583 453		
	Decrease in Storage	831	**Seepage (Lower TSF)**	11 854		
	Total	843 351	Total	843 351	0.00	Balanced
MPONENG LOWER TSF	**Rainfall**	36 399	**Evaporation**	81 532		
	Tailings Runoff	188 721	**Interstitial Storage**	1 686 285		
	Slurry Water	4 346 594	**Return Flow (RWD)**	3 385 537		
	Upper TSF	583 453	**Seepage**	12 401		
	Upper Seepage	11 854	**Increase in Storage**	1 265		
	Total	5 167 021	Total	5 167 021	0.00	Balanced
MPONENG RWD (327,000 m³)	**Rainfall**	47 430	**Evaporation**	90 605		
	Lower TSF	3 385 537	**Dust Suppression**	204 219		
	Lower TSF Side Wall Runoff	140 663	**Mponeng Plant**	2 247 367		
	Lower TSF Seepage	12 401	**Savuka Plant**	1 107 196		
	Upper TSF Side Wall Runoff	75 294	**Increase in Storage**	11 939		
	Total	3 661 326	Total	3 661 326	0.00	Balanced

6 CONCLUSION AND ASPECTS TO CONSIDER

The main purpose of this water balance is to ensure that the sizes of the proposed components of the Mponeng Lower TSF compartment dirty water management are adequate and to ensure that the mine complies with the requirements as contained in the NWA, Regulation no 7 of 1999 (GN 704).

Following the findings and the results of the water balance model, it is clear that:

- Excess water in the RWD is at risk of overflowing into the downstream environment when both the Upper and Lower TSFs are operational, with the potential to degrade the surface and groundwater qualities of surrounding areas. It is critical that water from Mponeng is sent to the Savuka Operations to ensure that the proposed RWD is adequately sized to accommodate all the dirty water inflows.
- The total proposed capacity for dirty water containment at the Mponeng TSF operations (pre-feasibility) is approximately 327,000 m^3, and this capacity is sufficient to contain all dirty water inflows without the dam spilling more than once in 50 years.

The table below summarises the average flows for the Mponeng TSF Operations, for the pre-feasibility study:

Table 6-1: Mponeng TSF Water Balance Summary (Mℓ/day) – Average Flows

Source	Destination	Rate (Mℓ/day)
Upper TSF	Lower TSF	1.60
Lower TSF	RWD	9.28
RWD	Savuka Plant	3.03
RWD	Mponeng Plant	6.16
RWD	Dust Suppression	0.56
Upper and Lower TSF	Interstitial Storage	5.01
Savuka Plant	Water in Tailings (Lower TSF)	11.91
Mponeng TSF	Water in Tailings (Upper TSF)	1.57

Following the findings and the results of the overall update, the following is recommended to the client to ensure an accurate water balance model with a high confidence level:

- Monitor rainfall data in daily rainfall increments.
- Accurately monitor flow meter data between the various dirty water flow streams to ensure an accurate water balance model.
- Verify / Calibrate flow meters to ensure correct figures are recorded.
- Record the levels of the RWD on site in appropriate intervals to aid with the calibration of the water balance model, ensuring more accurate results.