COROBRIK MIDRAND FACTORY SITE-WIDE WATER BALANCE REPORT

Project Location: Gauteng, South Africa
Company Name: Corobrik (Pty) Limited - Midrand

Prepared By: CM Eclectic (Pty) Limited

PO Number: MIDRAND 1102912 OR
Project Number: CB.0056.25
Report Number: Report: Final
2024/04/29

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Report Information

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Executive Summary

A steady state site-wide water balance model has been developed to understand the flows at the Midrand Factory during average dry, wet, and average climate conditions using available information. A Microsoft Excel spreadsheet model was used to represent the flows within the operational water circuit using available information. The water balance methodology included site verification, water balance modelling and reporting.

The Midrand Factory operations include mining, stockpiling, and processing of clay materials mined at the on-site quarry as well as imported from other Corobrik sites. The limits of the water balance for Midrand are confined to the operation of infrastructure, which comprises:

- Midrand Quarry, including rehabilitated quarry areas;
- Site Dam Quarry - a rehabilitated water-filled worked-out quarry;
- The clay processing and brick-making factory and brick stockpiles, positioned in the south of the plant; and,
- Clay stockpiles west and north of the brick making processing yard.

Midrand Factory provided monthly rainfall data from 2001 to 2023 as well as annual rainfall for the period starting from 1989 to 2023. The annual rainfall dataset indicated a marginal increase in rainfall over the years.

There are four operational water meters in place at the site distributed as follows:

- Borehole: Abstraction for the brick-making factory.
- Big Meter and Small Meter: Municipality water supplied for domestic uses.
- Site Dam meter: Abstraction for dust suppression and irrigation of lawns.

The brick factory operations' water usage prioritises reusing quarry water through the storage dam quarry for on-site dust suppression. Stormwater from around the production plant runoff is collected in a stormwater collection point sump and routed to the Site Dam. Sewage effluent is disposed of in the municipal system.

An average groundwater inflow of 156 m^3/month is estimated for the quarry sump, and the storage dam quarry is estimated at 6,142 m^3/month, equivalent to water demand from the dam (220 m^3/d). The groundwater inflows need to be assessed and improved should the quarry start undertaking water level measurements in the dam.

Considering the municipal withdrawal of 220m^3/ day for the 100 employees, per capita water use is estimated at 123 l/person/day. This is a relatively average usage rate compared to typical domestic usage, which ranges from 90l—280 l/person/day in the mining sector.

From the monthly average records, the biggest water uses are dust suppression and irrigation, which are supplied by the site dam (an old quarry). The quarry comprises runoff water, plant overflows, and groundwater ingress. The water abstracted from the borehole for factory uses comprises 19% of the total water used at Midrand Factory,

Municipal water is only used for domestic purposes and, therefore, accounts for only 4% of the total water used at Midrand Factory.

The assessed water balance is indicative of average operating conditions at Midrand and will suffice for environmental licence applications. For optimum water management, the following recommendations are proposed:

- Additional water meters/measurement locations are recommended to improve water balance data collection and confidence in the model:
    - A meter/ record of dewatering from the quarries as and when it is carried out; and,
    - Dust suppression records separated from the irrigation water from the recorded volumes at the dam.
- Periodic estimation of the volume of water in the Site Dam, as best as possible, will assist in refining the model for groundwater contribution.
- Any discharge from the site, including the current sewer discharges, should be subject to water quality analysis before discharge.
- Monthly record keeping of water meter records to be able to provide trends.

Declaration of Independence

I, Chenai E Makamure, declare that -

- I act as the independent Hydrology Practitioner;
- I will perform the work relating to the project in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting hydrogeological assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations, and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority and - the objectivity of any report, plan, or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me are true and correct; and
- I will perform all other obligations as expected from a hydrology practitioner regarding the Act and the constitutions of my affiliated professional bodies.

Signature of Specialist	[signature]
Designation	Principal Hydrologist
Qualification and SACNASP Registration Number	MSc GIS and Earth Observation Integrated Watershed Modelling and Management - Environmental Hydrology; BSc Applied Environmental Science Pr. Sci. Nat 400150/16
Name of company	CM Eclectic (Pty) Ltd
Years of Experience	16

Table of Contents

List of Tables

List of Figures

Table of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
DWS	Department of Water and Sanitation
FAO	Food and Agriculture Organisation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
Pr. Sci. Nat	Professional Natural Scientist
SANRAL	South African National Road Agency
SAWS	South Africa Weather Services
WMA	Water Management Area
WR2005	Water Resources of South Africa 2005 Study
WULA	Water Use License Application
WR2012	Water Resources of South Africa 2012 Study

Table of Units

m^3	Cubic metres
m^3/a	Cubic meters per annum
m amsl	Metres above mean sea level
Ha	Hectares
m^2	Square metres
l/day	Litres per day
Km^2	Square kilometres
mm	millimetres
m^3/s	Cubic meters per second
Mcm	Million cubic metres

1 Introduction

1.1 Background

CM Eclectic Pty Ltd (CM Eclectic) was appointed by Corobrik Midrand Factory to prepare a site-wide water balance model and report for the operational brick-making factory and clay mining located in Olifantsfontein, Midrand, within the Gauteng Province of South Africa. Corobrik Midrand is one of Corobrik 15 factories operated around South Africa. The Midrand Factory, comprising of an existing brick factory, is situated on Portion 113 of the Farm Olifantsfontein 402 JR, and Erf 1256 and Erf 1257 of the township of Clayville Extension 14 JR.

Using available information, a steady state, site-wide water balance model has been developed to understand the flows at the Midrand Factory operational water circuit during average dry and wet seasons.

1.2 Site Process Description Summary

Midrand Factory mines and beneficiates various earth's raw materials. Various clays are quarried and stockpiled on site, while some are supplied from other Corobrik Operations. The various clay types include Creamy Grey, Plastic Clay, Fireclay, Carbonaceous Plastic Clay, and Carbonaceous Fireclay. The clays are drawn by front end loader from the different stockpiles and pre-blended by volume before being fed into the brick making plant. The pre-blended clays pass through crushers all along the mechanical preparation process, further mixing, and enhancement of the mix takes place. Water is added to the material when it passes through the mixers then passed on to the extrusion point. At the extrusion point, the stiffness of the mix, as well as the dimensions of the column, is determined and controlled for the next stage of cutting. The cut bricks get loaded onto kiln cars. The loaded cars proceed through to a tunnel dryer for final controlled drying to the desired moisture content. The bricks are then passed through the tunnel kiln (firing). Before the bricks are packed, they pass through a de-hacking process, where they are dipped into the water at the dipping station. Once dipped, the bricks are carried by forklift, to the stock bins, ready for dispatch to the customers.

1.3 Scope of Work

A steady state site-wide water balance model has been developed to understand the flows during dry, wet, and average climate conditions. The water balance update is guided by the Department of Water and Sanitation (DWS) Best Practice Guidelines (BPG) G2 – Water and Salt Balances (DWS, 2006). In addition to the Midrand Factory's water balance, which is necessary to inform improvement needs on the operational water management and record keeping, the water balance is also required to fulfil the requirement of a Water Use Licence Application (WULA).

The scope of work comprises the following:

- Define the water circuit, including a review of information on the water meters audit;

- Developing input parameters and operational rules for the water components;
- Develop a monthly average water balance model, which is run for the average wet, dry, and average climatic conditions. This includes analysing the water demand during the operational circuit using water records, as well as understanding makeup water requirements, likelihoods of water shortages and spillage risks; and
- Compile a report on the operational water balance and recommend further work needed to optimise water management and water reporting at the Midrand Factory.

The limits of the water balance are the factory operations and infrastructure, which comprise:

- Midrand Quarry, including rehabilitated quarry areas;
- Site Dam - a rehabilitated water-filled worked-out quarry;
- The clay processing and brick making factory and brick stockpiles, positioned in the southerly; and,
- Clay stockpiles west and north of the brick making processing yard.

Figure 1-1 presents the site infrastructure layout at the Corobrik Midrand site.

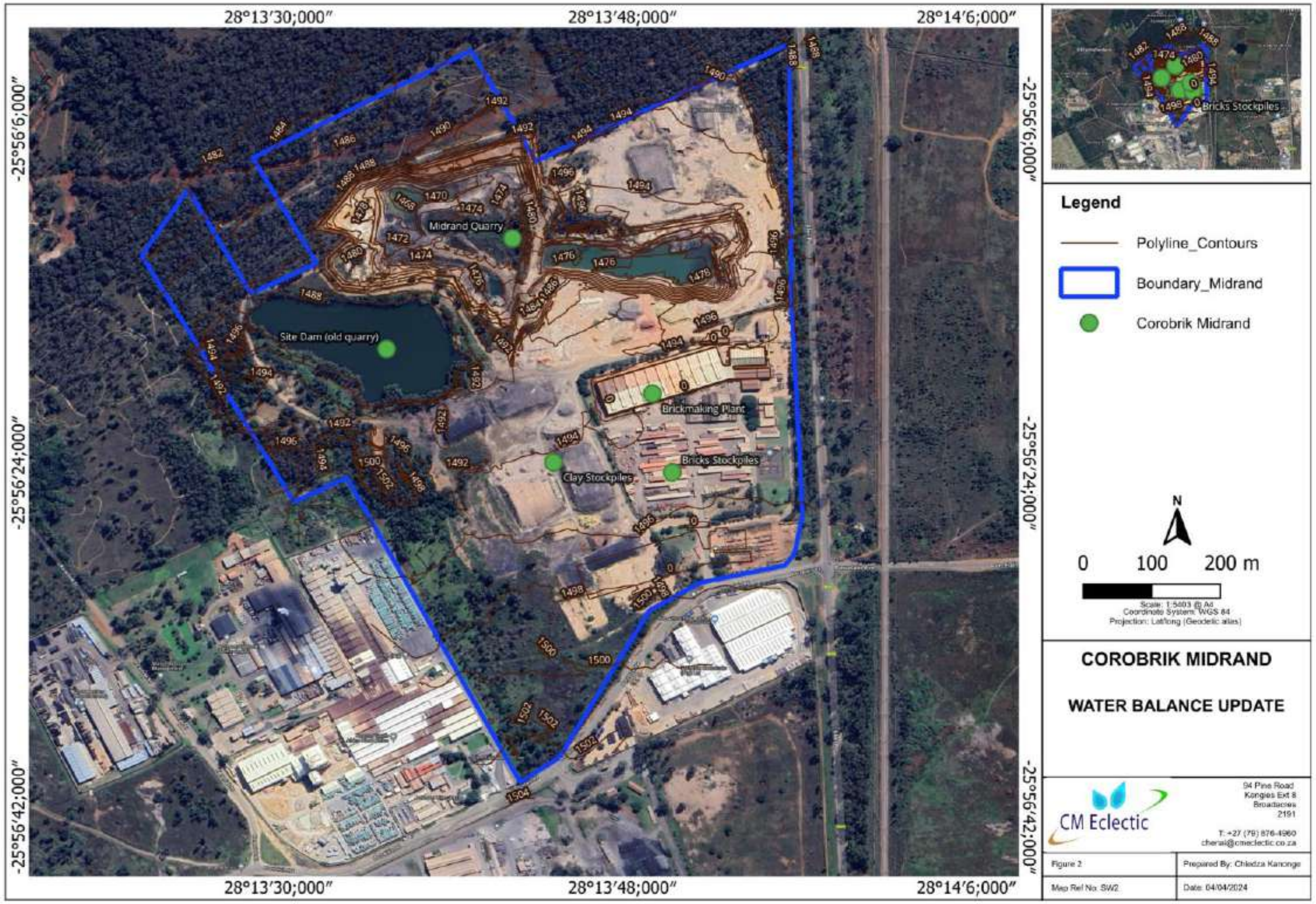


Figure 1-1: Corobrik Midrand Site Layout

2 Water Balance Methodology

2.1 Site Verification

A CM Eclectic Hydrologist visited the factory on 26 February 2024 with the following objectives:

- Site walkover – meet key site personnel to discuss water management practices at the site.
- Define the water circuit – improve the understanding of the water schematic flow chart showing the main water components.
- Water meter audit – review of flow metering and water usage monitoring network.
- Preliminary information gathering – obtain hard copies of information, request soft copy information, and establish communication channels for water balance information requirements.

2.2 Water Circuit, Reuse Strategy and Audits

A Microsoft Excel spreadsheet water balance model was developed using available information to represent the water sources and sinks within the operational water circuit. Where information was not available, model inputs and assumptions were based on other applicable studies.

2.2.1 Water Circuit

The water circuit is defined as follows:

Water sources (inflows) are as follows:

- Groundwater and stormwater ingress into the quarry and the site dam;
- Stormwater is collected into the stormwater collection point from the plant catchment;
- Potable water from the Municipality; and,
- Process water from the water supply borehole.

Water sinks (losses) through the following:

- Water evaporation from the quarry sump, the site dam, and stockpiles;
- Interstitial lockup in the stockpiles;
- Water loss during the drying and firing processes in the drier and kilns;
- Dust suppression at the stockpiles, including road dust control; and,
- Potable water consumption, losses to the municipal sewer system

Stormwater, groundwater, and process water are collected within the following storage facilities for reuse including:

- Site storage dam quarry; and

- Quarry sumps.

The simplified schematic in Figure 2-1 presents the site infrastructure layout at the Corobrik Midrand Factory.

2.2.2 Water Reuse Strategy

The brick factory operations' water usage prioritised reusing quarry water through the storage dam quarry for onsite dust suppression. However, the brickmaking and dehacking are currently using clean water from the borehole. Any domestic water uses are supplied from the municipal water supply line. During the site visit, there was water in the site dam and quarry. Stormwater from around the production plant is collected in a stormwater collection point sump and routed to the Site Dam. Sewage effluent is disposed to the municipal system.

2.2.3 Water Meter Audits

There are four operational water meters in place at the site, two of which record the intake of potable water supplied by the Municipality. The water meter distribution is detailed in Table 2-1.

Table 2-1: Summary of Monitoring meters on site and considered in Water Balance

Meter ID	Location in Water Balance
Borehole	The abstraction for the brick-making factory
Big Meter and Small Meter	Water supplied by the municipality for domestic uses
Site Dam meter	Abstraction for dust suppression and irrigation of lawns

Currently, there is no monitoring of water accumulating in the quarry and no groundwater model of inflows into the quarries. Furthermore, the network of water meters does not provide a comprehensive understanding of the internal distribution of water consumption (dust suppression vs water for irrigation of lawns). Water meters are recommended to improve data collection at the Midrand Factory as follows:

- A meter/ record of dewatering from the quarry as and during the three months of mining per year;
- Measurement of dust suppression at the quarry during mining (three months per year); and
- Periodic estimation of the water level in the Site Dam will assist in refining the model for groundwater contribution.

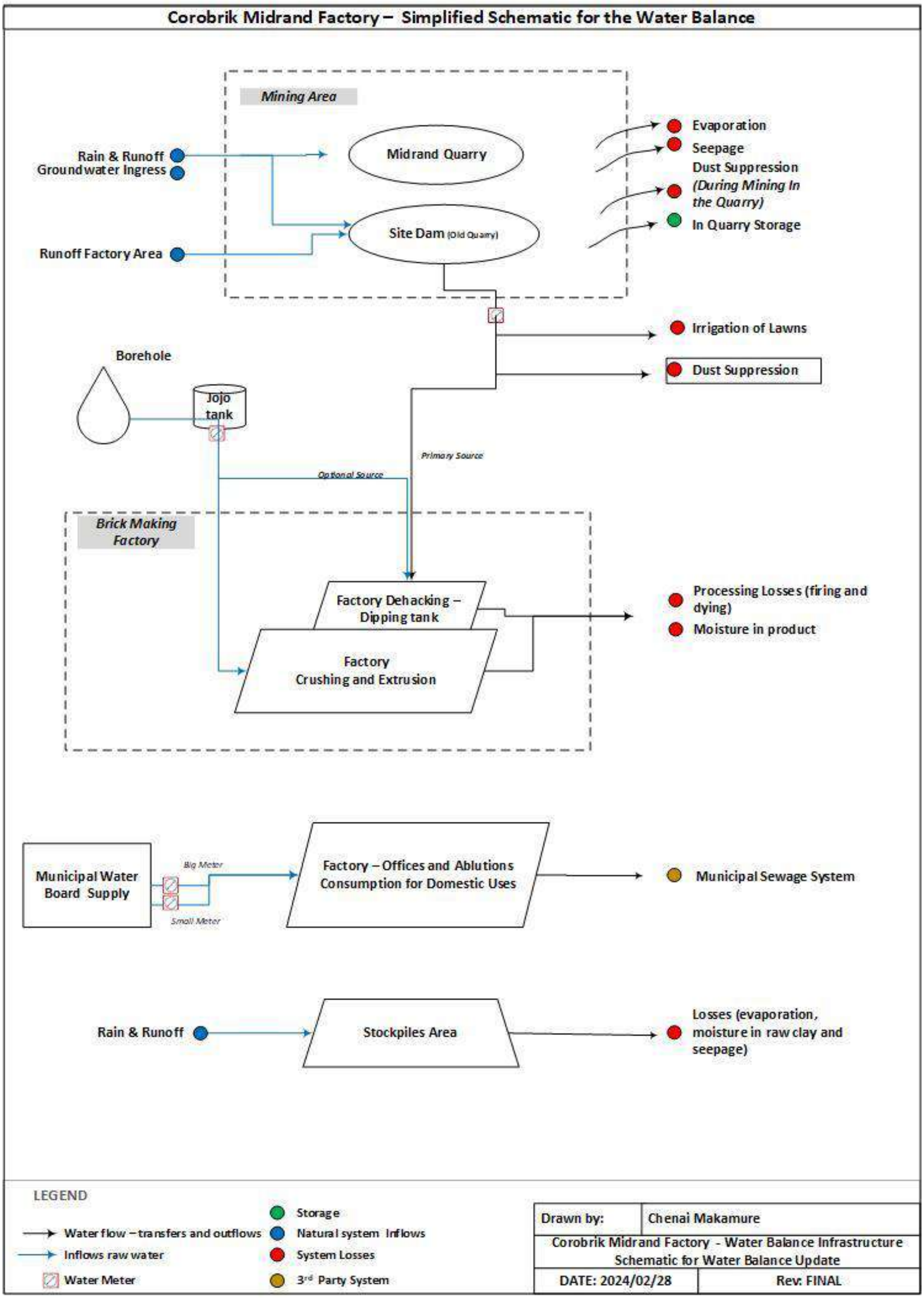


Figure 2-1: Simplified Schematic for Corobrik Midrand Operations

3 Water Balance Assumptions and Input Parameters

This section presents the various input parameters used to model each of the main water components of the water balance. The inputs were determined from available records, and assumptions were made where there are no records. The estimations and assumptions should be updated when additional information becomes available.

3.1 Climate Variables

The site is in quaternary catchment A21B, and the Water Resources of South Africa 2012 Study (WR2012)[1] database information is obtained for this quaternary catchment as follows:

- Water Management Area (WMA) - Limpopo (formerly Crocodile West and Marico)
- Quaternary Catchment - A21B
- Mean Annual Precipitation (MAP) - 672 mm/year
- Mean Annual Evaporation (MAE) - - 1700 mm/year
- Rain Zone - A2A
- Evaporation Zone - 3A

Midrand Factory provided monthly rainfall data from 2001 until 2023. Furthermore, the Midrand factory provided annual rainfall for the period starting in 1989 until 2023. The annual rainfall is used to understand the general trend in rainfall and shows that there is a marginal increase in rainfall over the years, as presented in Figure 3-1.

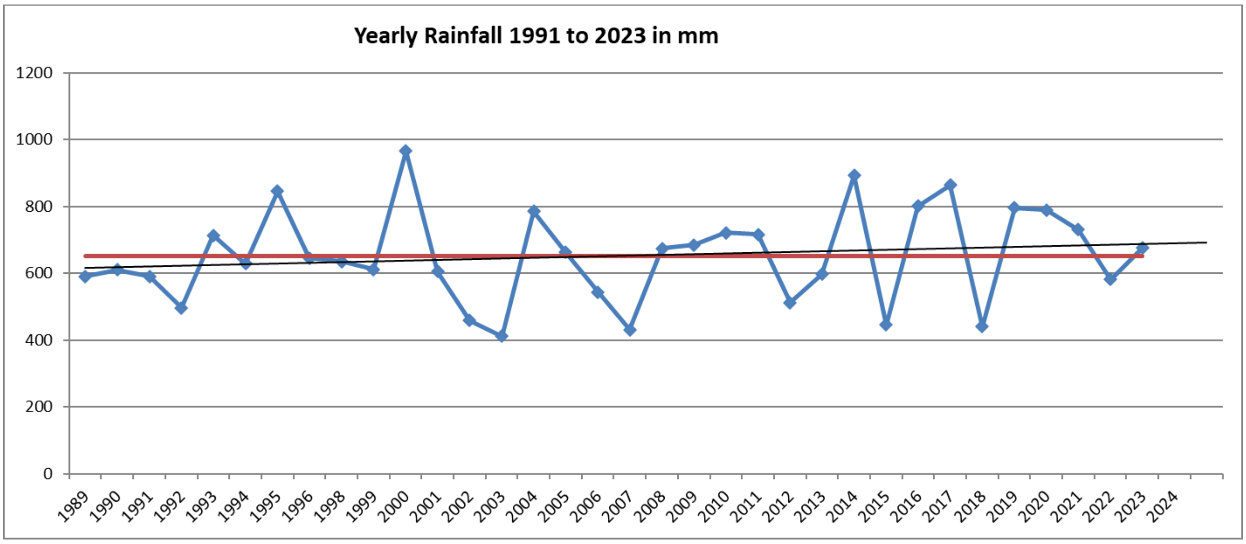
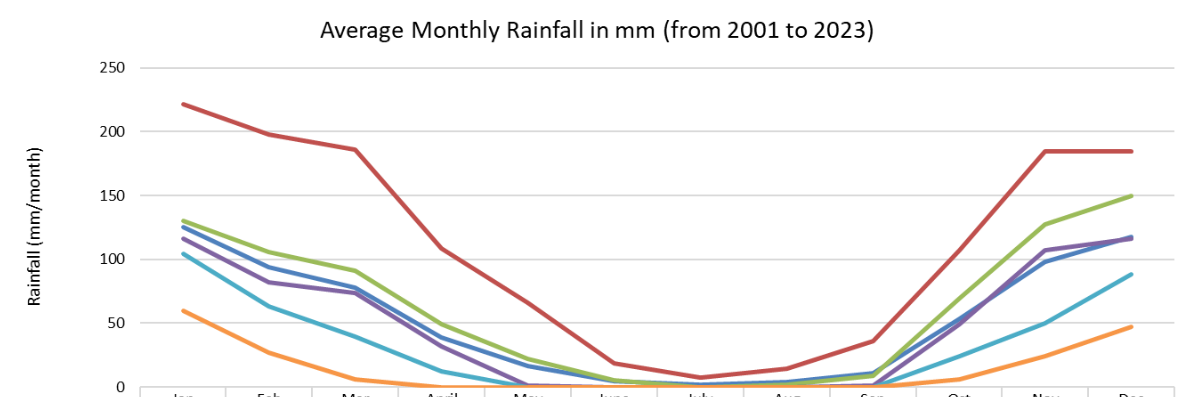


Figure 3-1: Yearly Rainfall at Midrand Quarry in mm

[1] Water Resources of South Africa, 2012 (WR2012) (WRC Project No. K5/2143/1)

The average monthly distribution of rainfall is based on the received records, and the monthly distribution is shown in Figure 3-2. The E10 to E90 represents a range of exceedance probability of events – this is the likelihood of rainfall of a certain magnitude being exceeded. The median (exceeded 50%) presented by the E50 is close to the average for the wet months, while it records zero in the dry months, which is more realistic. As a result, the average rainfall series was used in the water balance model; however, the model only calculates runoff if rainfall is above 10mm.



	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Average	125	94	78	39	17	5	2	4	11	53	98	118
E10	221	198	186	109	66	19	8	15	36	107	184	184
E30	130	106	91	49	22	6	0	2	9	70	127	150
E50	116	82	74	32	1	0	0	0	1	49	107	116
E70	104	63	40	12	0	0	0	0	0	24	50	89
E90	60	27	6	0	0	0	0	0	0	6	24	47

Figure 3-2: Monthly Average Rainfall Distribution

No evaporation measurements were taken on site; therefore, the evaporation for the project site, was obtained from WRC reports. WR2012 provides evaporation as Symon's Pan (S-pan) evaporation and pan coefficients obtained from the (WR90)[2] project converted the S-pan evaporation to open water evaporation applied in the model for dam and pond. Table 3-1 presents the monthly distribution of rainfall and open water evaporation for the project site.

Table 3-1: Average Monthly Rainfall and Evaporation

Month	Monthly average rainfall (mm)	Open water Evaporation (mm)
January	125	160
February	94	137
March	78	128
April	39	95
May	17	75
June	5	58
July	2	66
August	4	93

[2] Surface Water Resources of South Africa 1990 - Volume 1 Appendices. WRC Report 298/1.1/94

Month	Monthly average rainfall (mm)	Open water Evaporation (mm)
September	11	129
October	53	159
November	98	161
December	118	168
Annual Total	**643**	**1 427**

3.2 Water Meter Records – Water Demands

Corobrik Midrand provided average water meter records for the borehole water, storage dam water and municipal water, which are the primary water sources at Midrand Factory. Water uses were summarised to provide an average monthly volume for the water balance calculation. The records provided by Midrand Factor included the following:

Table 3-2: Water use averages measured by Midrand Factory

Water Use	Volume (m^3/day)	Volume (m^3/month)	Volume m^3/annum	Volume m^3/week
Site Dam for dust suppression and irrigation	220.0	6 141.7	73 700.0	1535.4
Borehole for processing uses	53.0	1 478.4	17 740.8	369.6
Municipal for domestic uses	12.3	344.0	4 128.0	86.0

3.3 Groundwater Ingress

Groundwater ingress rates in the quarry and the dam were unavailable; therefore, an estimation method by E Lukas and D. Vermeulen (2015[3]) was used. In the method, the recharge is proportional to the total area and annual rainfall. An average recharge percentage of 3% is assumed for the quarry sumps. It is assumed that groundwater inflows equal the water demand for plant uses for the Site Dam, considering that the water levels do not appear to change notably. The groundwater ingress is kept constant at the rate of 220 m^3/day. Furthermore, it is assumed that no water seeps between the Site Dam to the Midrand Quarry.

3.4 Stormwater

All footprint areas used in the water balance calculation are based on measurements from the imagery provided by Midrand Factory surveyed in 2023 and were kept constant for calculating runoff and evaporation losses from the pool areas.

All runoff in the plant yard reaches the stormwater collection point and is conveyed to the site dam. Most of the rainfall received in the stockpiles yard is lost to evaporation and interstitial

[3] E. Lukas and D. Vermeulen. 2015. A Management Plan towards the Flooding of an Open-Cast Mine with Adjacent Underground Sections. 10th International Conference on Acid Rock Drainage & IMWA Annual Conference

storage, and any residual runoff is assumed to flow to the nearest quarry as some few erosion rills were observed on small sections of the quarry walls.

The infrastructure footprints are presented in Table 3-3.

Table 3-3: Combined Assessments Results

Area	Footprint (m^2)
Plant	65 560
Quarry	97 336
Quarry Pool Area (area of ponded water in quarry)	16 519
Dam Area Catchment	62 880
Dam Area	35 031
Stockpiles runoff to Dam	87 670
Stockpiles Total	174 623

Different runoff ratios were used for the estimation of runoff:

- Quarries = 0.25
- Stockpiles = 0.1
- Irrigation Dam upstream catchment = 0.3
- Plant yard = 0.65

3.5 Model inputs and assumptions summary

The following assumptions apply to the water balance:

- Rainfall-related inflows and evaporation were estimated based on:
  - average values during the driest months of the year (June to August);
  - average values during the wettest months of the year (November, December, January, and February); and,
  - annual average values.
- Groundwater ingress rates were unavailable; therefore, an average recharge percentage of 3% is assumed and is kept as a constant percentage of annual rainfall.
- Site Dam is an old quarry which is unlined; therefore, groundwater inflows were also assumed to equal the abstraction for factory and dust suppression uses.
- Water meter records received from Midrand were assumed to be adequately representative.
- All footprint areas are based on measurement in GIS from a 2023 imagery and are assumed to be representative.

- Runoff coefficients are constant in each catchment and not influenced by antecedent climatic conditions.
- Municipal sewer recovery was estimated, assuming 85% inflow to the public sewerage system (FAO (1992)[4]).
- Evaporation from the measured quarry sump and Site Dam surface occurs if there is water in the dam.
- This water balance model is calculated for only steady state average wet and dry seasons and does not consider storage; therefore, flow in = flow out.

3.6 Limitations

The water balance limitations include:

- The water balance is based on an average steady state. It does not consider storage volumes or spillage from the Site Dam, which are usually derived through a dynamic daily time step water balance, which requires more data. For the current scope, the steady state water balance model and current updates are adequate to capture wet and dry season variations driven by the runoff at the site
- Groundwater water inflows into the quarries are not quantified and inflow rates were assumed based on an estimated recharge.
- The model is based on conservative values and assumes that all areas generate runoff.

3.7 Results

An average groundwater inflow of 156 m^3/month is estimated for the Midrand quarry sumps, and the Storage Dam is estimated at 6 142 m^3/month, equivalent to water demand from the dam (220 m^3/d). The groundwater inflows need to be assessed should the quarry start undertaking water level measurements in the dam.

Considering the municipal withdrawal of 220m^3/ day for the 100 employees, per capita water use is estimated at 123 l/person/day. This is a relatively average usage rate compared to typical domestic usage, which ranges from 90l—280l/person/day in the mining sector.

From the monthly average records, the biggest water uses are dust suppression and irrigation, which are supplied by the Site Dam The quarry comprises runoff water, plant overflows, and groundwater ingress. The water abstracted from the borehole for factory uses comprises 19% of the total water used at Midrand Factory, as presented in the pie chart in Figure 3-3. Municipal water is only used for domestic uses, therefore only account for 4% of total water used at Midrand Factory.

[4] FAO. (1992) M.B. Pescod. Wastewater treatment and use in agriculture - FAO irrigation and drainage paper 47. FAO, Rome. 144 pp

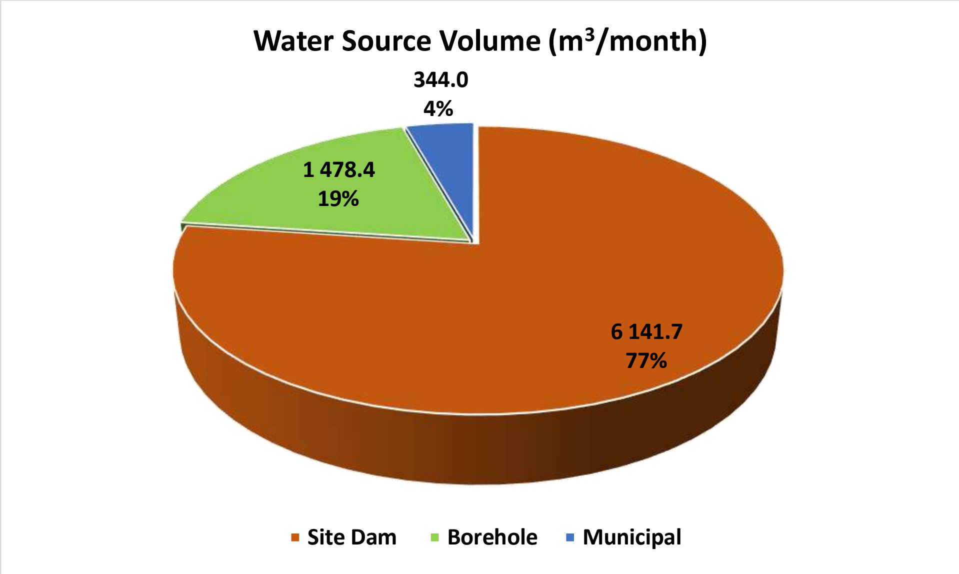


Figure 3-3: Midrand Factory Monthly water sources distribution by volumes

Table 3-4 and Figure 3-4 through to Figure 3-6 summarise the calculated average wet season, average dry season and average climate conditions water balances, respectively. All three climate conditions indicate a balance in storage for the overall site balance.

Table 3-4: Average Monthly and Annual Water Balance Summary

Facility Name	Water In			Water Out		
	Water Stream	**Monthly (m^3/mon)**	**Annual (m^3/annum**	**Water Stream**	**Monthly (m^3/mon)**	**Annual (m^3/annum**
Domestic and Potable Water	Small and Big Meter Municipal Supply	344	4 128	Consumption	52	619
				Municipal Sewer Discharge	292	3 509
	Subtotal	**344**	**4 128**	**Subtotal**	**344**	**4 128**
Midrand Quarry	Rainfall-runoff	1 281	15 377	Pit dust suppression uses and losses	1 214	14 571
	Groundwater Ingress and Recharge	156	1 877	Quarry Dewatering to Site Dam	224	2 682
	Subtotal	**1 438**	**17 253**	**Subtotal**	**1 438**	**17 253**
Site Dam	Rainfall-runoff - Upstream Catchment	2 537	30 447	Water Tanks Dust Suppression	6 142	73 700
	Direct Rainfall	1 774	21 286	Losses and Storage	2 917	35 000
	Groundwater Ingress and Recharge	6 142	73 700	Storage	1 394	16 733
	Subtotal	**10 453**	**125 434**	**Subtotal**	**10 453**	**125 434**
Factory	Site Dam	0	0	Processing losses (firing and drying)	1 478	17 741
	Borehole	1 478	17 741			
	Subtotal	**1 478**	**17 741**	**Subtotal**	**1 478**	**17 741**
Stockpiles	Rainfall runoff	920	11 034	Losses (Evaporation and Interstitial)	920	11 034
	Subtotal	**920**	**11 034**	**Subtotal**	**920**	**11 034**
Total Water in Circulation		**14 633**	**175 590**		**14 633**	**175 590**

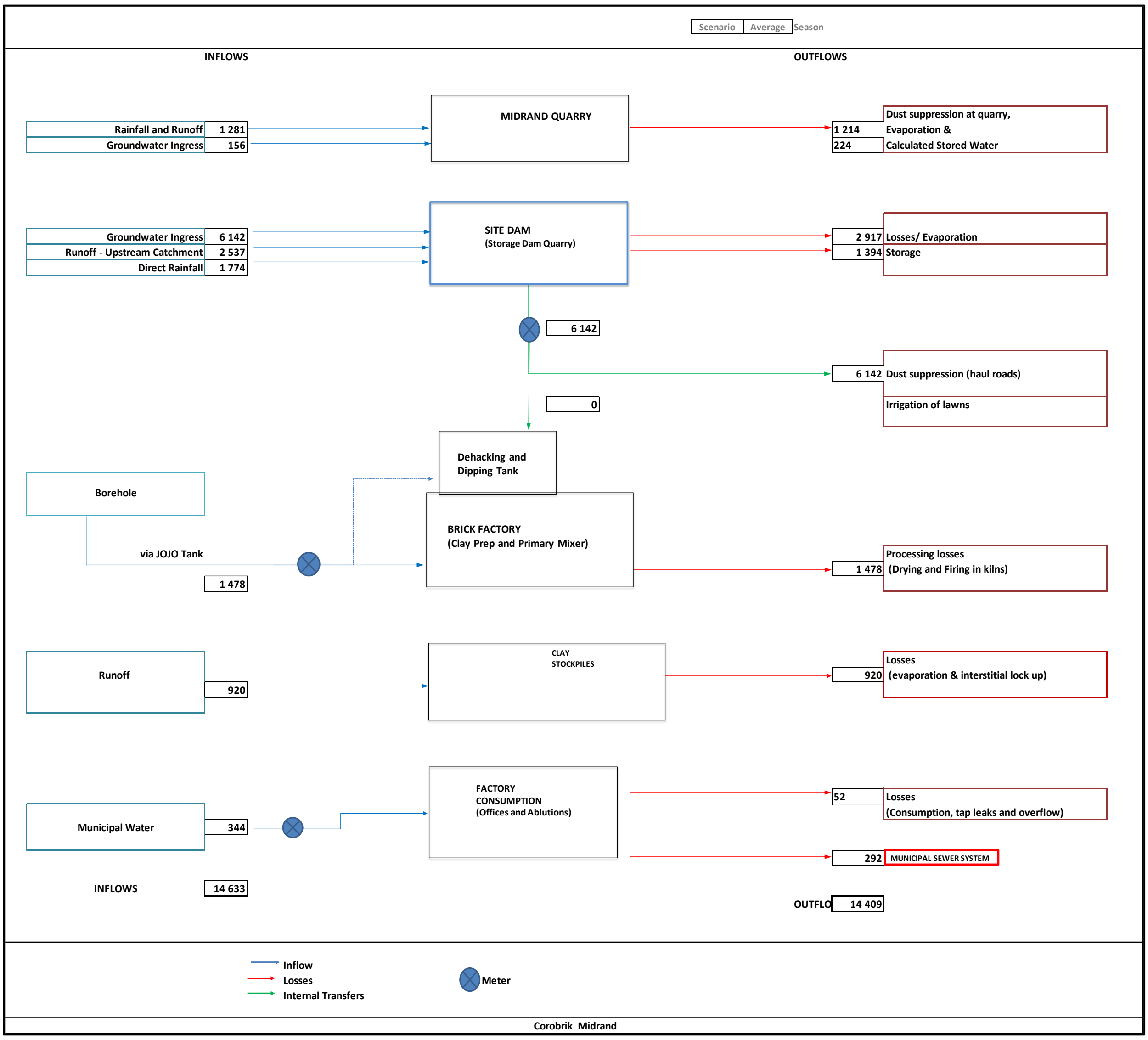


Figure 3-4: Annual Average Water Balance

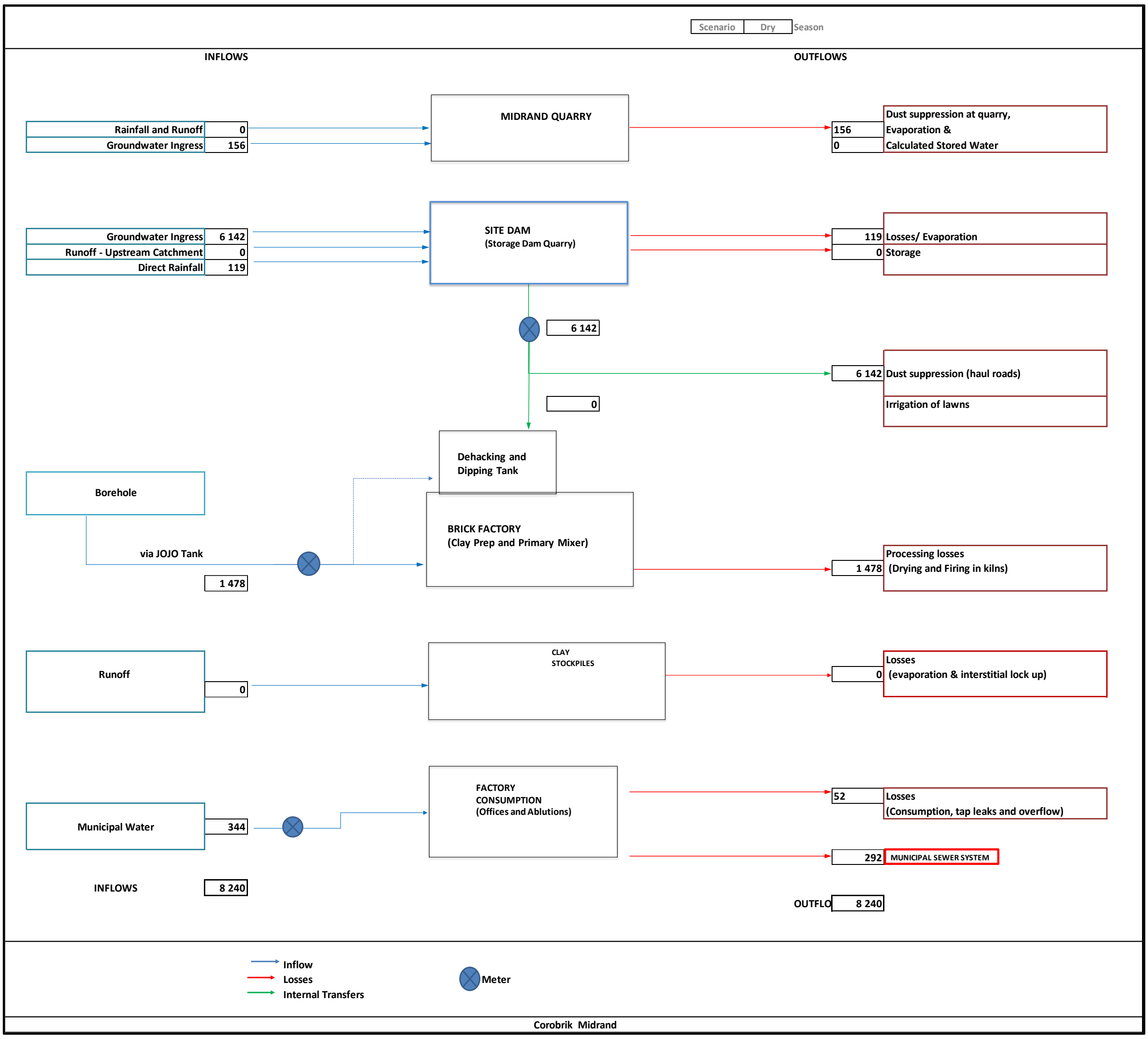


Figure 3-5: Average Dry Season Water Balance

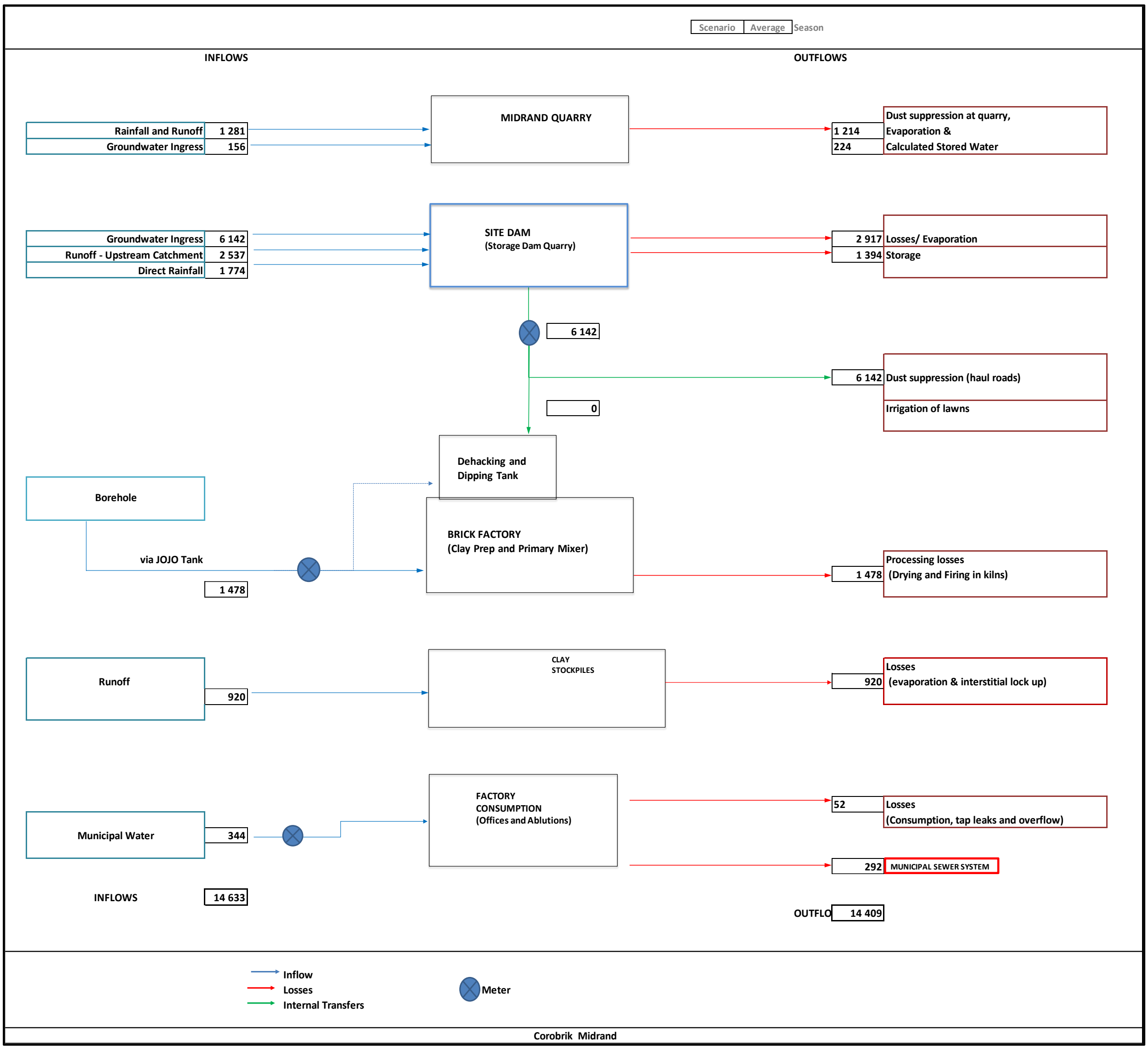


Figure 3-6: Average Wet Season Water Balance

4 Conclusions and Recommendations

A steady state site-wide water balance model has been developed to understand the flows at the Midrand Factory during average dry, wet and average climate conditions using available information. A Microsoft Excel spreadsheet model was used to represent the flows within the operational water circuit using available information. The factory operations and infrastructure included in the water balance scope comprise:

- Midrand Quarry including rehabilitated quarry's areas;
- Site Dam - a rehabilitated water-filled worked-out quarry;
- The clay processing and brick-making factory and brick stockpiles; and,
- Clay stockpiles west and north of the brick making processing yard.

Midrand Factory provided monthly rainfall data from 2001 until 2023. Furthermore, Midrand Factory provided annual rainfall for the period 1989 until 2023. The annual rainfall is used to understand the general trend in rainfall. Data shows that that there is a marginal increase in rainfall over the years.

There are four operational water meters in place at the site, two of which records intake of potable water supplied from the municipality, while the other meters monitor distribution from a supply borehole and the storage dam.

The brick factory operations' water usage prioritised reusing quarry water through the storage dam quarry for onsite dust suppression. Stormwater from around the production plant runoffs is collected in a stormwater collection point sump and routed to the Site Dam. Sewage effluent is disposed of in the municipal system.

The water balance results are presented in tables and pie chart, and the assessed water balance is indicative of average operating conditions at Midrand Factory and will suffice for WULA. For optimum water management, the following recommendations are proposed:

- Additional water meters/measurement locations are recommended to improve water balance data collection and confidence in the model:
    - A meter/ record of dewatering from the quarries as and when it is carried out; and
    - Dust suppression records separated from the irrigation water from the recorded volumes at the Site Dam.
- Periodic estimation of the volume of water in the Site Dam, as best as possible will assist in refining the model for groundwater contribution.
- A groundwater model can be used to estimate inflows into the quarry and the Site Dam. Once groundwater inflows information is available, and quarry storage volumes can be estimated, the water balance should be updated.

- Any discharge from the site, including the current sewer discharges, should be subject to water quality analysis before discharge.
- Monthly record keeping of water meter records to be able to provide trends.

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WR2012, *Water Resources of South Africa, 2012 Study (WR2012*), Water Research Commission, Pretoria.

Appendix A: Consultant Details Resume

Chenai E. Makamure (Pr. Sci. Nat)

Principal Consultant

Qualifications and Accreditation

Executive Certificate	2023	New York University - Corporate Sustainability
Pr. Sci Nat	2016	Professional Natural Scientist registered with SACNASP (400150/16)
MWISA	2019	Member Water Institute of Southern Africa (25046)
MSc	2010	Integrated Watershed Modelling and Management - Hydrology
BSc (Hons)	2005	Applied Environmental Science

Expertise

- Hydrological Impact Assessment
- Water Quality Monitoring
- Water and Salt Balance Modelling
- Stormwater Management Plan
- Flood Modelling
- GN704 Auditing
- Water Use licence Audits
- Integrated Water and Waste Management Plans
- Water Liability Assessments
- Water Conservation Water Demand Management Plans
- Sourcing
- Project Planning and Management

Chenai Makamure (Pr. Sci. Nat) holds a BSc In Applied Environmental Science and an M.Sc. Integrated Watershed Modelling and Management - Environmental Hydrology. She has over 16 years of work experience within the water and environmental sectors.

Chenai has broad experience consulting for various industrial sectors - manufacturing, infrastructure, construction, consulting, mining, agriculture, and energy.

Chenai inputs the various stages of project planning (gap analysis, scoping, and impact assessments) and project implementation.

Chenai leads the sourcing and supply of industrial packaging materials for the manufacturing industry.

Chenai possesses excellent interpersonal and communication skills

Chenai is passionate about corporate sustainability and water stewardship and seeks to expand her services into those areas.

Chenai has worked on projects in DRC, Sierra Leone, Liberia, Malawi, Mali, Ghana, South Africa, Zambia, and Zimbabwe.

Contact Details

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