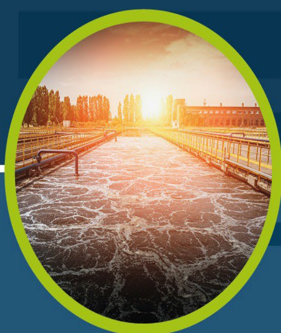
Appendix G6:
Hydrology


Royal HaskoningDHV
Enhancing Society Together

forestry, fisheries
& the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

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SPECIALIST DECLARATION FORM – AUGUST 2023

Specialist Declaration form for assessments undertaken for application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

REPORT TITLE

Hydrology Assessment for the Proposed Soufflet Malting Facility

Kindly note the following:

1. This form must always be used for assessment that are in support of applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting, where this Department is the Competent Authority.
2. This form is current as of August 2023. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.dffe.gov.za/documents/forms.
3. An electronic copy of the signed declaration form must be appended to all Draft and Final Reports submitted to the department for consideration.
4. The specialist must be aware of and comply with '*the Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the act, when applying for environmental authorisation - GN 320/2020)'*, where applicable.

1. SPECIALIST INFORMATION

Title of Specialist Assessment	Hydrology assessment
Specialist Company Name	GCS Water & Environmental consultants (pty)Ltd
Specialist Name	Hendrik Botha
Specialist Identity Number	[redacted]
Specialist Qualifications:	MSc. Environmental Science (Geohydrology & Geochemistry)
Professional affiliation/registration:	[redacted]
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Telephone	[redacted]
Cell phone	[redacted]
E-mail	[redacted]

2. DECLARATION BY THE SPECIALIST

I, Hendrik Botha declare that –

- I act as the independent specialist in this application;
- I am aware of the procedures and requirements for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (NEMA), 1998, as amended, when applying for environmental authorisation which were promulgated in Government Notice No. 320 of 20 March 2020 (i.e. "the Protocols") and in Government Notice No. 1150 of 30 October 2020.
- I will perform the work relating to the application 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 the specialist report relevant to this application, 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 in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the NEMA Act.

[redacted]
9:23:58
Pr.Sci.Nat (400139/17)

Signature of the Specialist

GCS (pty)Ltd

Name of Company:

20 Jun 2024

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, _ Lee-Mari Badenhorst_________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

[redacted]

Signature of the Specialist

GCS Water & Environmental (Pty) Ltd

Name of Company

20.06.2024

Date

[redacted]

Ms. L Badenhorst

Signature of the Commissioner of Oaths

20 Jun 2024

Date

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Hydrology Assessment for the Proposed Soufflet Malting Facility

Report

Version – Final 2

17 September 2024

RHDHV

GCS Project Number: 24-0032

Client Reference: PO 111909

Royal HaskoningDHV
Enhancing Society Together

Report
Version – Final 2

17 September 2024

RHDHV

24-0032

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Title	Hydrology Assessment for the Proposed Soufflet Malting Facility		
	Name	**Signature**	**Date**
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Director	Hendrik Botha (MSc, Pri. Sci. Nat)	[redacted]	17 September 2024

LEGAL NOTICE

DECLARATION OF INDEPENDENCE

GCS (Pty) Ltd was appointed to conduct this specialist groundwater study and to act as the independent surface water specialist. GCS objectively performed the work, even if this resulted in views and findings that were not favourable. GCS has the expertise to conduct the specialist investigation and does not have a conflict of interest in undertaking this study. This report presents the findings of the investigations, which include the activities set out in the scope of work.

EXECUTIVE SUMMARY

GCS Water and Environment (Pty) Ltd (GCS) was appointed by Royal HaskoningDHV (RHDHV) to undertake this hydrology assessment to supplement the Environmental Impact Assessment (EIA) and Water Use License (WUL) for the proposed Soufflet Maltings Plant situated in Graceview Industrial Park, in the Sedibeng District of Gauteng, near Garthdale, Gauteng Province.

This hydrology assessment report was requested to supplement the Water Use License Application (WULA) and EIA and to evaluate surface water drainage, stormwater and flooding risks associated with the project area and proposed activities.

This study found that the project falls within quaternary catchment C22D of the Vaal Water Management Area (WMA). Elevations for the site area range from 1450 to 1500 metres above mean sea level (mamsl) and extend to 1650 mamsl towards the western extents of the project area. The project falls in an area with a MAP in the order of 642 mm/yr and an EMA in the order of 1527 mm/yr.

The surface geology of the study is characterised by alluvium sands (~) along the Klip River floodplain, ferruginous shale and quartzite (Vt) of the Timball Hill Formation and dolomite & chert (Vdm) of the Malmani Formation of the Pretoria and Chuniespoort Supergroups, of the Transvaal Sequence. The presence of dolomite underlying the site has been confirmed by several consultants (refer to Section 5.1).

Three (3) hydrological response units (HRU) describe the drainage of the local area and are bound towards the east by the Klip River. Surface water drainage is towards the east of the site and from the western hilltops via a perennial tributary of the Klip River, which joins the Klip River approximately 3 km north of the site. The Klip River drains into the Vaal River approximately 30km downstream of the site.

The site itself is devoid of any recognised drainage lines or rivers/streams, and free flow from overland drainage from the site towards the R59 is noted. Water then passes under the road via several stormwater culverts (both box and circular variants) and free flows towards the Klip River. The closest perennial stream is towards the northwest of the site at a distance of ~1.17 km (dry during the site assessment), and the Klip River, a major river system, is situated approximately 2.5 km downstream east of the site.

According to the Water Allocation Registration Management System (WARMS, 2024), there are 17 WARMS users within a 5 km buffer of the project area, of which 4 groundwater and 1 surface water user falls within the HRU. Based on the WARMS data collected, it is noted that the existing groundwater use is in the order of 0.9 Mm^3/yr, and surface water use is in the order of 4.2 Mm^3/yr.

A flood line assessment of all recognised rivers/streams was undertaken for rivers falling within a 1 km radius of the site (refer to Section 5). There is no flooding risk associated with the proposed development.

- A stormwater managed plan is presented in Section 6 and is summarised as follows:
    - It is important to note that Graceview Park is not yet complete. According to the Graceview Industrial Park - Services Report for the Construction of Roads, Stormwater Drains, Water and Sewer Reticulation (Willie Coetzee Engineers CC, 2007), the following should be kept in mind for the project area:
    - The stormwater reticulation will be sized to accommodate a 1-5-year storm.
    - The lie of the land has a granular slope of approximately 0.8% from the high-lying western boundary to the low-lying eastern boundary along the R59 Freeway,
    - Due to the lie of the land, stormwater will accumulate along the eastern boundary of the site in the stormwater attenuation pond.
    - It was recommended that these attenuation ponds be built with suitably designed outlet structures to reduce the downstream runoff to the 1–50-year pre-development volumes.
    - Considering the above-mentioned and the existing stormwater systems on the Site, it is proposed that future systems be sized to accommodate a 1–10-year storm. The stormwater systems for the proposed Project should tie into the existing bulk roads and stormwater system.
- A conceptual water balance is presented in Section 7 of this report and is based on the potential water usage and distributions for the factory.
    - The quantity of water that will be consumed during phase 1 and phase 2 stages of the project is estimated to be 250,000 m^3/year and 325,000 m^3/year, respectively.
    - The quantity of wastewater that will be discharged during phase 1 and phase 2 stages of the project is estimated to be 200,000 m^3 /year and 260,000 m^3/year, respectively.
- Several hydrological risks were identified and presented in Section 8, and several mitigation measures can be considered. A water monitoring plan is available in Section 9.

No avoidance areas were identified as part of this assessment. However, it is proposed that the preferred option, as discussed above, be considered for the discharge of the treated effluent. This will minimise the water liabilities for the applicant associated with direct discharge to the Klip River.

Based on the findings of this assessment, GCS believes that the proposed activities pose a low risk to the hydrological environment. The approval of the activity should be considered to enable the applicant to expand their operations. It is further assumed that mitigation options to offset negative impacts, as predicted by this study, will be implemented into the EMPr during the operational and closure phases of the project.

APPENDIX 6 OF THE EIA REGULATION – CHECKLIST AND REFERENCE FOR THIS REPORT

Table 1 - Requirements from Appendix 6 of GN 326 EIA Regulation 2017

Requirements from Appendix 6 of GN 326 EIA Regulation 2017	**Chapter**
(a) Details of: (i) The specialist who prepares the reports; and (ii) the expertise of that specialist to compile a specialist report, including a curriculum vitae	Document Issue (Page ii) Appendix E.
(b) Declaration that the specialist is independent in a form as may be specialities by the competent authority	Appendix E.
(c) Indication of the scope of, and purpose for which, the report was prepared	Section 1. and 3.
(cA) Indication of the quality and age of base data used for the specialist report	Sections 1, 2 and 7.
(cB) A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 7.
(d) Duration, Date and seasons of the site investigation and the relevance of the season to the outcome of the assessment	Section 1.2.
(e) Description of the methodology adopted in preparing the report or carrying out the specialised process, including equipment and modelling used	Section 2.
(f) Details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associate's structures and infrastructure, inclusive of a site plan identifying alternative	Sections 1, 2, 3 and 5.
(g) Identification of any areas to be avoided, including buffers	Section 9.1
(h) Map superimposing the activity and associated structures and infrastructure on environmental sensitivities of the site, including areas to be avoided, including buffers	Sections 1, 2, 5 and 6.
(i) Description of any assumptions made and uncertainties or gaps in knowledge	Sections 1.3, 5.3, and 7.
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Executive summary, Section 7.
(k) Mitigation measures for inclusion in the EMPr	Section 9.1
(l) Conditions for inclusion in the environmental authorisation	Refer to recommendations in Section 9.
(m) Monitoring requirements for inclusion in the EMPr or environmental authorisation	Refer to recommendations in Section 9.
(n) Reasoned opinion – (i) as to whether the proposed activity, activities or portions thereof should be authorised. (a) regarding the acceptability of the proposed activity or activities and (ii) if the opinion is that the proposed activity, activities, or portions thereof should be authorised, and avoidance, management, and mitigation measures should be included in the EMPr, and where applicable, the closure plan	Section 9.3
(o) Description of any consultation process that was undertaken during preparing the specialist report	*None required.*
(p) A summary and copies of any comments received during any consultation process and, where applicable, all responses thereto	*None required.*
(q) Any other information requested by the competent authority	*None required.*

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GENERAL LIST OF ACRONYMS

Acronym	Description
ADD	Average Daily Demand
BA	Basic Assessment
BOD	Biological oxygen demand
COD	Chemical oxygen demand
CM	Concentrated Molasses
CSWMP	The conceptual stormwater management plan
DEM	Digital Elevation Model
DWS	Department of Water and Sanitation
GCS	GCS Water and Environment (Pty) Ltd.
GN704	General Notice 704
ha	Hectare
HRU	Hydrological Response Unit
IWULA	Integrated Water Use Licence Application
m^3	Cubic Metres
MAE	Mean annual evaporation
MAR	Mean Annual Runoff
MIPI	Midgley and Pitman
NEMA	National Environmental Management Agency
n-Value	Manning's Roughness Coefficients
NWA	National Water Act, 1998 (Act No. 36 of 1998)
PCD	Pollution Control Dam
PFD	Process flow diagram
SDF	Standard design flood
SAR	Sodium Absorption Ratio
SW	Surface Water
TDS	Total dissolved solids
TIN	Triangulated Irregular Network
WMA	Water Management Area
WR2012	Water Resources of South Africa 2012
IFR	Instream Flow Requirements
EWR	Ecological Water Requirements
EIS	Ecological Importance and Sensitivity

1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) was appointed by Royal HaskoningDHV (RHDHV) to undertake this hydrology assessment to supplement the Environmental Impact Assessment (EIA) and Water Use License (WUL) for the proposed Soufflet Maltings Plant situated in Graceview Industrial Park, in the Sedibeng District of Gauteng, near Garthdale, Gauteng Province (refer to Figure 1-1 and Figure 3-2). The project falls within Quaternary catchment C22D of the Vaal Water Management Area (WMA) (DWS, 2016).

1.1 Background

The Soufflet Malting Facility is to be established at Graceview Industrial Park in Sedibeng, which is located in the southern part of Gauteng. The site has been zoned as an industrial development area, and the outline scheme reports have been handed over to the council by the original developers of the property. Graceview Industrial Park is selected as the best location for the following reasons:

- Strategically located next to the Heineken Sedibeng facility.
- Availability of ample land for industrial zone development.
- Located near the national highway network.
- Ease of access to raw materials.
- Availability of a variety of types of labour and creation of employment opportunities.

The objective of the project is to establish a malt production plant for the local market with an annual capacity of 100 kT in Phase 1 and 135 kT in Phase 2. The Soufflet Malting Project greatly contributes to import substitution and the enhancement of barley production for the agricultural sector in the country (RHDHV, 2024).

Figure 1-1: Proposed site layout

One of the major environmental aspects of the malt project is its high-water consumption. During the operational phase, the proposed project will require large quantities of water, i.e. for steeping, germination, cleaning, sanitary purposes, laundry, landscaping, etc. The quantity of water that will be consumed during phase 1 and phase 2 stages of the project is estimated to be 250,000 m³/year and 325,000 m³/year, respectively. It is further envisioned that the backup water supply will be from two (2) boreholes, namely Malt BHT3 and Malt BHT4, with a provisional amount of 300 m³/day reserved for the combined boreholes. The use of groundwater will be supplementary for processing water to the plant (backup purposes only). It should be noted that the usage of the boreholes is still to be determined but included in this investigation to evaluate the potential risks.

While the project is operational, it will likely generate wastewater. It is anticipated that wastewater will be generated from the industrial processing and sanitation facilities (refer to Table 1-1). The quantity of wastewater that will be discharged during phase 1 and phase 2 stages of the project is estimated to be 200,000 m³ /year and 260,000 m³/year, respectively. The wastewater is likely to be significant. Table 1-2 depicts the quality concentration of wastewater that will be generated from the proposed project.

There are currently two options for the treatment and discharge of wastewater considered, namely (RHDHV, 2024)

- **The preferred** treatment is at the on-site wastewater treatment plant (WWTP), and then the tie-in is to the existing ERWAT infrastructure and the pump station (owned by Midvaal).
- **Alternative** – treatment at the on-site WWTP and then transport of the effluent in a pipeline that runs adjacent to the ERWAT pipeline to a discharge point in the Klip River.

Table 1-1: Effluent quality concentration estimation for the two project phases (RHDHV, 2024)

	Daily Volume m^3	Concentration mg/l				
		COD	BOD	SST	P_t	N total
Scenario 1	548	4000	2160	720	24	120
Scenario 2 (after expansion)	712					

Table 1-2: Effluent estimated constituents' daily loads for the two scenarios (RHDHV, 2024)

	Load kg/d				
	COD	BOD	SST	P_t	N total
Scenario 1	2192	1184	395	13	66
Scenario 2 (after expansion)	2849	1539	513	17	85

This hydrology assessment report was requested to supplement the Water Use License Application (WULA) and EIA and to evaluate surface water drainage, stormwater and flooding risks associated with the project area and proposed activities.

1.2 Objectives

The objectives of this study were as follows:

- Identify natural and man-made drainage lines on a desktop level.
- Evaluate the site's hydrological setting (i.e., climate, rainfall, drainage, etc.).
- Determine the 1:10, 1:20, 1:50, and 1:100-year peak flows for the major rivers and drainage streams associated with the project area.
- Evaluate stormwater runoff potential at the site.
- Evaluate sedimentation risk and highlight high stormwater risk areas.
- Evaluate the existing stormwater management system.
- Indicate potential improvements to mitigate stormwater runoff and control sedimentation.
- Develop a conceptual water balance and process flow diagram for the site.
- Undertake a hydrological risk assessment and compile mitigation measures; and

- Compile a surface water monitoring plan to monitor the impact on the receiving environment.

1.3 Study relevance to the season in which it was undertaken

This study was undertaken as a once-off study and relies on historical hydrological and climate data for the site, as well as recognised geological and water resource databases for South Africa. Data generated during this time is seasonally bound as the study was undertaken in a winter month. As averaging was applied, a follow-up assessment may not necessarily add value; however, there may be a chance to collect water samples from the dry perennial streams as identified during this report. This is, however, not a fatal flaw in terms of the hydrological impact and risk assessment undertaken.

1.4 Scope of work

The scope of work completed was as follows:

1. **Baseline Hydrology Review:**
    a. Hydro-meteorological data collection and analysis.
    b. Catchment delineation and drainage characteristics.
    c. Determination of catchment hydraulic and geometric parameters.
2. **Peak flows & flood line modelling:**
    a. Peak flood volume calculation for the 1:10, 1:20, 1:50, and 1:100-year recurring events.
    b. Flood line modelling using HEC-RAS hydraulic software – 1:50 and 1:100-year flood lines were presented, and
    c. Analysis of the modelling results.
3. **Conceptual Storm Water Management Plan and Stormwater Monitoring:**
    a. Identification of stormwater sub-catchments (i.e., clean and dirty areas)
    b. Determination of stormwater flows and volumes (1:5, 1:10, 1:20, 1:50 and 1:100-year return periods) was undertaken.
    c. Indications and explanations of the placement of stormwater attenuation infrastructure were offered.
    d. A stormwater monitoring system plan was drafted to ensure that the impact of stormwater discharge on the environment is managed and controlled.
4. **Water balance assessment:**
    a. A process flow diagram and associated water balance were developed for the plant based on the information provided by the client.

5. **Risk assessment:**
    a. A hydrological risk assessment was undertaken to contextualize the project's potential surface water risk.
6. **Surface Water Monitoring Plan:**
    a. A surface water monitoring plan was developed.
7. **Reporting:**
    a. This report was compiled using the components above.

2 METHODOLOGY

The methodological approach for the study is described in the sub-sections below.

2.1 Legal considerations

The National Water Act (Act 36 of 1998) (NWA) governs the use of water and protection of water resources in South Africa. The following legislation applies:

- Government Notice No. 704, 4 June 1999, National Water Act, 1998 (No. 36 of 1998): Regulations on the use of water for mining and related activities aimed at the protection of water resources (GN704).
- Government Notice No. 1352, 12 November 1999, National Water Act, 1998 (No. 36 of 1998): Regulations requiring that water use be registered.
- GNR.810 of 17 September 2010: Regulations for the Establishment of a Water Resource Classification System (Government Gazette No. 33541).
- GN R. 1036 of 31 October 2007: Regulations on financial assistance to resource-poor farmers (Government Gazette No. 30427).
- GNR.131 of 17 February 2017: Regulations requiring that the taking of water for irrigation purposes be measured, recorded, and reported (Government Gazette No. 40621).
- GNR. 267 of 24 March 2017: Regulations regarding the procedural requirements for water use licence applications and appeals (Government Gazette No. 40713).

In terms of Section 144 of the National Water Act of 1998 (Act 36 of 1998), a flood line, representing the highest elevation that would probably be reached during a storm with a return interval of 100 years, must be indicated on all plans for the establishment of townships. The term "establishment of townships" includes the subdivision of stands or farm portions in existing townships/development if the 100-year flood lines are not already indicated on these plans or when the land-use category of a particular portion of land is changed.

The National Environmental Management Act (Act 107 of 1998) (NEMA) stipulates that all relevant factors be considered for proposed developments to ensure that water pollution and environmental degradation are avoided. Section 2 of the Act establishes a set of principles that apply to the activities of all organs of the state that may significantly affect the environment. These include the following:

- Development must be sustainable.
- Pollution must be avoided or minimized and remedied.
- Waste must be avoided or minimized, reused, or recycled.
- Negative impacts must be minimized.

The requirements laid down by the National Building Regulations and Building Standards Act (Act 103 of 1977) in terms of development within the 1:50-year flood line area are based only on safety considerations without proper consideration and understanding of the underlying natural streamflow processes. The Town Planning and Townships Ordinance (Ordinance 15 of 1986) also makes provision in Regulation 44(3) for the extension of flood line areas up to 32 m from the centre of a stream in instances where the 1:50-year flood line is less than 62 m wide in total (CSIR, 2005). This regulation has also recently been replaced by SPLUMA and Municipal Bylaws and was evaluated accordingly for the project area.

Appendix 6 of GN 326 EIA Regulation 2017 further governs hydrology assessments for EIAs. This hydrology report conforms to Appendix 6 of the EIA regulations, which include the aspects listed in ***Table 1 (in front of this report).***

2.2 Hydrological overview

Hydrometeorological data for the study area were obtained from various sources, including the South African Water Resources Study WR2012 database (Bailey & Pitman, 2015), South African Atlas of Agrohydrology and Climatology (Schulze, 1997), and the Daily Rainfall Data Extraction Utility (Lynch, 2004). Moreover, sources such as the Köppen Climate Classification (Kottek, et al., 2006), World Climate Data CMIP6 V2.1 (Eyring, 2016), and Meteoblue (Meteoblue, 2023) were used to refine hydrological data.

These sources provided means of determining the Mean Annual Precipitation (MAP), Mean Annual Runoff (MAR), and Mean Annual Evaporation (MAE) of the study site as well as the design rainfall data. Data was applied to the site water balance calculations, runoff peak flow estimates for flood line modelling and stormwater runoff peak flow estimates for stormwater system sizing (where applicable to this study).

2.2.1 Catchment description and delineation

A 30 m Digital Terrain Model (DTM) data from the Advanced Land Observing Satellite (ALOS) (JAXA, 2024) were used to delineate the area draining to the streams relevant to this study, sub-catchment flow path as well as to derive river geometry characteristics. These characteristics (area, slopes, and hydraulic parameters) are used to parameterise the site hydraulic model for flood line modelling, water balance modelling or stormwater modelling.

2022 South African (SA) National Land Cover Data (DFFE, 2021) was used to characterise the sub-catchment vegetation and derive Manning’s surface roughness (n-values) coefficients.

2.2.2 Design rainfall and peak flow

The Design Rainfall Estimation Software (Smithers & Schulze, 2002) data from the rainfall stations surrounding the study site were used to calculate the 24-hour design rainfall depths for various return periods. Critical storm durations for Rational Methods Alternative 3 were calculated using the Modified Hershfield Equation (Adamson, 1981).

The streams/drainage sections that were modelled applying the three widely used methods were used to calculate 1:10, 1:20, 1:50, and 1:100-year peak flows. These are the Rational Method, Midgley and Pitman (MIPI), and the Standard Design Flood (SDF) methods. A brief description of each of the peak flow methods can be seen in Table 2-1.

Methodologies for using the applied peak flow models are explained broadly in the South African Drainage Manual (SANRAL, 2013). The calibration of the runoff coefficients for the drainage areas was guided by the manual, as well as the understanding of the runoff-generating processes and land cover attributes. The resulting peak flows calculated using the selected methods were evaluated, and conservative values were provided as inputs into the 1D HEC-RAS flood line model.

Table 2-1: Summary of peak flow methods

Rational Method The rational method was developed in the mid-19th century and is one of the most widely used methods for the calculation of peak flows for small catchments (< 15 km^2). The formula indicates that Q = CIA, where I is the rainfall intensity, A is the upstream runoff area, and C is the runoff coefficient. Q is the peak flow**.** There are 3 alternatives to the Rational Method, which differ in the methodology used to calculate rainfall intensities. The first alternative (RM1) uses the depth-duration frequency relationships approach, the second uses the modified Hershfield equation, and the third alternative uses the Design Rainfall software for South Africa (SANRAL, 2013).
Midgley and Pitman The Midgley and Pitman (MIPI) method is an empirical method that relates peak discharge to catchment size, slope, and distance from the drainage point to the centroid of the catchment (Campbell, 1986). The MIPI method uses 10-unit hydrographs for 10 zones in South Africa. The method does not consider overland flow as a component separate from streamflow but considers only the total longest flow path (Campbell, 1986).
Standard Design Flood Method The Standard Design Flood (SDF) method was developed specifically to address the uncertainty in flood prediction under South African conditions (Alexander, 2002). The runoff coefficient (C) is replaced by a calibrated value based on the subdivision of the country into 26 regions or Water Management Areas (WMAs). The design methodology is slightly different and looks at the probability of a peak flood event occurring at any one of a series of similarly sized catchments in a wider region, while other methods focus on point probabilities (SANRAL, 2013).

2.3 Flood line modelling

A 30 m ALOS digital terrain model (DTM) (JAXA, 2024) was used to derive the hydraulic and river geometry parameters. River/stream cross-sections and flow paths were prepared using RAS Mapper software and provided input into a 1D HEC-RAS (US Army Corps of Engineers, 2016) flood model. Visual assessment of riverbanks from the Google Earth Imagery and land cover types (DEA, 2020) was used to estimate Manning's 'n' coefficients along the river/streamlines. The 1:50 and 1:100-year flood lines were generated and mapped in Global Mapper and ArcGIS (ESRI, 2018).

2.4 Conceptual stormwater management plan (CSWMP)

The SWMP was designed in conjunction with the provided existing infrastructure layout plans and available topographical data. Dynamic stormwater modelling was undertaken using the EPA Stormwater Management Model (SWMM). Peak flows were modelled using meteorological data for the closest rainfall site. Stormwater infrastructure was sized based on the peak flows modelled and based on public topography data.

The conceptual SWMP was designed to consider relevant South African legislation – the National Water Act (1998) (NWA, 1998) and the Council for Scientific and Industrial Research (CSIR) Human Settlement Planning and Design guidelines (CSIR, 2005).

2.5 Water balance assessment

The study commenced with a desktop assessment of the area of interest and included the identification of existing data and literature about the area. The aim was to develop an average daily water balance based on 2024 rainfall, evaporation and site-measured data. Climate data were obtained from the South African Weather Service (SAWS) and/or databases of WR2012. Water usage data and potential reticulation were derived from available bulk services layout reports.

Relevant software employed throughout the study included:

- ArcView10.3 for Geographic Information Systems (GIS) work and mapping;
- Global Mapper 2023;
- Excel software for creating Process Flow Diagrams (PFDs) and
- Excel Software for Water Balance Modelling.

This study was undertaken with adherence to the relevant South African Best Practice Guidelines. The Water Balance was undertaken according to the Department of Water Affairs and Forestry; DWAF (currently Department of Water and Sanitation; DWS) Guidelines; Best Practice Guidelines (BPG) G2: Water and Salt Balances (DWAF, 2006).

2.6 Hydrological risk assessment

Due to the assessment forming part of a larger risk assessment for the study area, the potential impacts and the determination of impact significance were assessed. The process of assessing the potential impacts of the project encompasses the following four activities:

1. Identification and assessment of potential impacts.
2. Prediction of the nature, magnitude, extent, and duration of potentially significant impacts.
3. Identification of mitigation measures that could be implemented to reduce the severity or significance of the impacts of the activity and
4. Evaluation of the significance of the impact after the mitigation measures have been implemented, i.e., the significance of the residual impact.

Per GNR 982 of the EIA Regulations (2014), the significance of potential impacts was assessed in terms of the following criteria:

I. Cumulative impacts.
II. Nature of the impact.
III. The extent of the impact.
IV. Probability of the impact occurring.
V. The degree to which the impact can be reversed.
VI. The degree to which the impact may cause irreplaceable loss of resources and
VII. The degree to which the impact can be mitigated.

Table 2-2 provides a summary of the criteria used to assess the significance of the potential impacts identified. An explanation of these impact criteria is provided in Table 2-3.

[Consequence = (Duration + Extent + Irreplaceability of resource) x Severity]

Equation 1

The environmental significance of an impact was determined by multiplying the consequence by probability.

[Environmental Significance = (Consequence x (Probability + Reversibility))]

Equation 2

Table 2-2: Proposed Criteria and Rating Scales to be used in the Assessment of the Potential Impacts

Criteria	Rating Scales	Notes
Nature	Positive (+)	An evaluation of the effect of the impact related to the proposed development.
	Negative (-)	
Extent	Footprint (1)	The impact only affects the area in which the proposed activity will occur.
	Site (2)	The impact will affect only the development area.
	Local (3)	The impact affects the development area and adjacent properties.
	Regional (4)	The impact extends beyond municipal boundaries.
	National (5)	The impact extends beyond more than 2 regional/provincial boundaries.
	International (6)	The impact extends beyond the country's borders.
Duration	Temporary (1)	The duration of the activity associated with the impact will last 0-6 months.
	Short-term (2)	The duration of the activity associated with the impact will last 6-18 months.
	Medium-term (3)	The duration of the activity associated with the impact will last 18 months-5 years.
	Long-term (4)	The duration of the activity associated with the impact will last more than 5 years.
Severity	Low (1)	Where the impact affects the environment in such a way that natural, cultural, and social functions and processes are minimally affected.
	Moderate (2)	Where the affected environment is altered, but natural, cultural, and social functions and processes continue, albeit in a modified way, and valued, important, sensitive, or vulnerable systems or communities are negatively affected.
	High (3)	Where natural, cultural, or social functions and processes are altered to the extent that the natural process will temporarily or permanently cease, and valued, important, sensitive, or vulnerable systems or communities are substantially affected.
Potential for impact on irreplaceable resources	No (0)	No irreplaceable resources will be impacted.
	Yes (1)	Irreplaceable resources will be impacted.
Consequence	Extremely detrimental (-25 to -33)	A combination of extent, duration, intensity, and the potential for impact on irreplaceable resources.
	Highly detrimental (-19 to -24)	
	Moderately detrimental (-13 to -18)	
	Slightly detrimental (-7 to -12)	
	Negligible (-6 to 0)	
	Slightly beneficial (0 to 6)	
	Moderately beneficial (7 to 18)	
	Highly beneficial (19 to 24)	
	Extremely beneficial (25 to 33)	
Probability (the likelihood of the impact occurring)	Improbable (0)	It is highly unlikely or less than 50% likely that an impact will occur.
	Probable (1)	It is between 50 and 70% certain that the impact will occur.
	Definite (2)	It is more than 75% certain that the impact will occur or the impact will occur.
Significance	Very high – negative (-49 to -66)	A function of Consequence and Probability.
	High – negative (-37 to -48)	
	Moderate – negative (-25 to -36)	
	Low – negative (-13 to -24)	
	Neutral - Very low (0 to -12)	
	Low–positive (0 to 12)	
	Moderate–positive (13 to 24)	
	High–positive (24 to 48)	
	Very high – positive (49 to 66)	

Table 2-3: Explanation of Assessment Criteria

Criteria	Explanation
Nature	This is an evaluation of the type of effect the construction, operation, and management of the proposed development would have on the affected environment. Will the impact of change on the environment be positive, negative, or neutral?
Extent or Scale	This refers to the spatial scale at which the impact will occur. The extent of the impact is described as footprint (affecting only the footprint of the development), site (limited to the site), and regional (limited to the immediate surroundings and closest towns to the site). The extent of scale refers to the actual physical footprint of the impact, not to the spatial significance. It is acknowledged that some impacts, even though they may be of a small extent, are of very high importance, e.g., impacts on species of very restricted range. To avoid "double counting, specialists have been requested to indicate spatial significance under "intensity" or "impact on irreplaceable resources" but not under "extent" as well.
Duration	The lifespan of the impact is indicated as temporary, short, medium, and long-term.
Severity	This is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Does the activity destroy the impacted environment, alter its functioning, or render it slightly altered?
Impact on irreplaceable resources	This refers to the potential for an environmental resource to be replaced should it be impacted. A resource could be replaced by natural processes (e.g., by natural colonization from surrounding areas), through artificial means (e.g., by reseeding disturbed areas or replanting rescued species) or by providing a substitute resource, in certain cases. In natural systems, providing substitute resources is usually not possible, but in social systems, substitutes are often possible (e.g., by constructing new social facilities for those who are lost). Should it not be possible to replace a resource, the resource is essentially irreplaceable, e.g., red data species that are restricted to a particular site or habitat to a very limited extent.
Consequence	The consequence of the potential impacts is a summation of the above criteria, namely the extent, duration, intensity, and impact on irreplaceable resources.
Probability of occurrence	The probability of the impact occurring is based on the professional experience of the specialist with environments of a similar nature to the site and/or with similar projects. It is important to distinguish between the probability of the impact occurring and the probability that the activity causing a potential impact will occur. Probability is defined as the probability of the impact occurring, not as the probability of the activities that may result in the impact.
Significance	Impact significance is defined as a combination of the consequence (as described below) and the probability of the impact occurring. The relationship between consequence and probability highlights that the risk (or impact significance) must be evaluated in terms of the seriousness (consequence) of the impact, weighted by the probability of the impact occurring. In simple terms, if the consequence and probability of an impact are high, then the impact will have a high significance. The significance defines the level to which the impact will influence the proposed development and/or environment. It determines whether mitigation measures need to be identified and implemented and whether the impact is important for decision-making.
Degree of confidence in predictions	Specialists and the EIR team were required to indicate the degree of confidence (low, medium, or high) in the predictions made for each impact based on the available information and their level of knowledge and expertise. The degree of confidence is not considered in the determination of consequence or probability.
Mitigation measures	Mitigation measures are designed to reduce the consequence or probability of an impact or to reduce both consequence and probability. The significance of impacts has been assessed both with mitigation and without mitigation.

2.7 Surface water monitoring plan

The monitoring network is based on the principles of a monitoring network design as described by the DWAF Best Practice Guidelines: G3 Monitoring (DWAF, 2007). The methodological approach that the monitoring plan follows is represented in Figure 2-1.

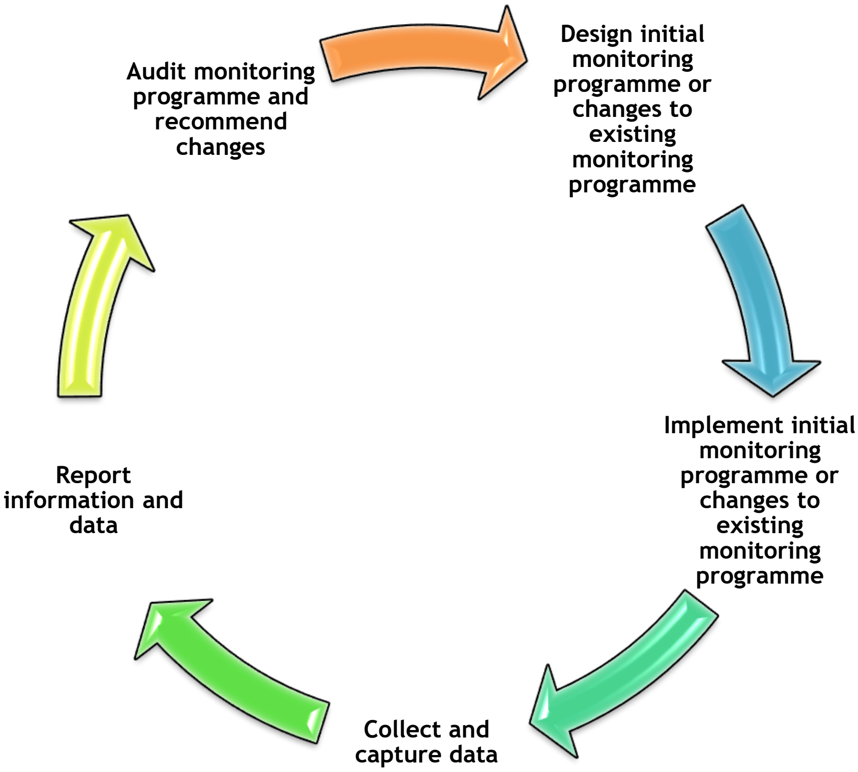


Figure 2-1: Monitoring Process

A surface water and stormwater monitoring plan was drafted and is based on the hydrological risks identified for the site.

3 SITE OVERVIEW AND HYDROLOGY

As mentioned previously, the project falls within the quaternary catchment C22D of the Vaal Water Management Area (WMA) (DWS, 2016). Elevations for the site area range from 1450 to 1500 metres above mean sea level (mamsl) and extend to 1650 mamsl towards the western extents of the project area.

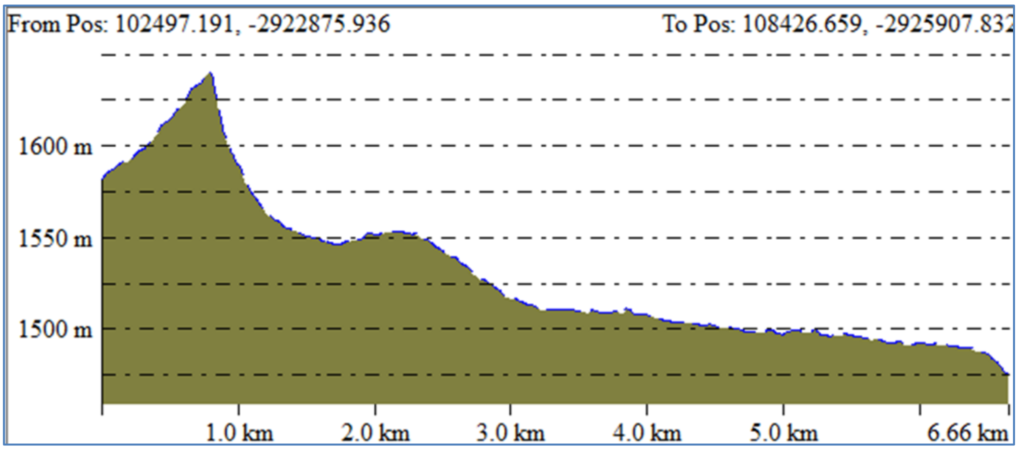


Figure 3-1: Typical cross section from headwaters to the project area

3.1 Sub-catchments/hydrology response units

Three (3) hydrological response units (HRU) describe the drainage of the local area and are bound towards the east by the Klip River – refer to Figure 3-2 Surface water drainage is towards the east of the site, and from the western hilltops via a perennial tributary of the Klip River, which joins the Klip River approximately 3 km north of the site. The Klip River drains into the Vaal River approximately 30 km downstream of the site.

HRU01 describes the overall drainage flow path associated with the proposed Maltings Plant, and it is further noted that no rivers or streams are associated with this HRU. The site itself is devoid of any recognised drainage lines or rivers/streams, and free flow from overland drainage from the site towards the R59 is noted. Water then passes under the road via several stormwater culverts (both box and circular variants) and free flows towards the Klip River. A photographic log taken from the middle region of the proposed development boundary is available in Table 1-1. The closest perennial stream is towards the northwest of the site at a distance of ~1.17 km (dry during the site assessment), and the Klip River, a major river system, is situated approximately 2.5 km downstream east of the site.

Table 3-1: Photographic log of site observations

 The northern portion of the site	 The western portion of the site
 The eastern portion of the site	 Crossing at the tributary of the Klip River, the northeastern region of the site.

3.2 Land cover and slope

Natural grassland dominates the sub-catchments (DFFE, 2021) – refer to Figure 3-3. The slope rise (%) for the sub-catchment was determined using an ALOS 30 m DTM and can be seen in Figure 3-4. The sub-catchment parameters are captured in Table 3-2.

Table 3-2: Sub-catchment parameters

Sub-Catchment		HRU1	HRU2	HRU3
Area (km²)		1.725	5.563	40.725
Longest Drainage Line (km)		2.32	3.84	14.07
Average Slope (%)		1.04%	0.77%	1.19%
Slope (%)	< 3	71.01%	59.33%	15.44%
	3 - 10	27.25%	38.42%	58.74%
	10 - 30	1.74%	2.22%	20.88%
	> 30	0.00%	0.03%	4.95%
Land Cover	Thick bush & plantation	65.88%	48.96%	24.67%
	Light bush & farm-lands	0.10%	0.53%	0.04%
	Grasslands	20.32%	44.84%	58.10%
	No Vegetation	13.70%	5.67%	17.19%

3.3 Local geology and soils

According to the 1:150 000 geology series (2628 East Rand) maps for the area (DMEA, 1998f), the surface geology of the study is characterised by alluvium sands (~) along the Klip River flood plain, ferruginous shale and quartzite (Vt) of the Timball Hill Formation and dolomite & chert (Vdm) of the Malmani Formation of the Pretoria and Chuniespoort Supergroups, of the Transvaal Sequence - refer to Figure 3-5.

According to the Land Types of South Africa databases (ARC, 2006), the soils in the area fall within the Ab types. Soils associated with these groups typically entail:

- Ab - Freely drained, red and yellow, dystrophic/mesotrophic, apedal soils comprise > 40% of the land type (yellow soils < 10%).

According to Soil Conservation Service (SCS) data for the project area, the soils are divided into “Type C” soils. SCS curve number is a function of the ability of soils to allow infiltration of water, land use and the antecedent soil moisture condition. Table 3-3 provides a summary of the hydrological characteristics of the different SCS soil types.

Table 3-3: Summary of SCS soil type hydrological characteristics (Muthu, 2015)

Hydrological Soil	Type of soil	Runoff Potential	Final Infiltration Rate (mm/hr)	Remarks
Group A	Deep, well-drained sands and gravels	Low	>7.5	High rate of water transmission
Group B	Moderately deep, well-drained with moderately fine to coarse textures	Moderate	3.8-7.5	Moderate rate of water transmission
Group C	Clay loams, shallow sandy loam, soils with moderately fine to fine textures	Moderately high	1.3-3.8	Moderate rate of water transmission
Group D	Clay soils that swell significantly when wet, heavy plastic and soils with a permanent high water table	High	<1.3	Low rate of water transmission

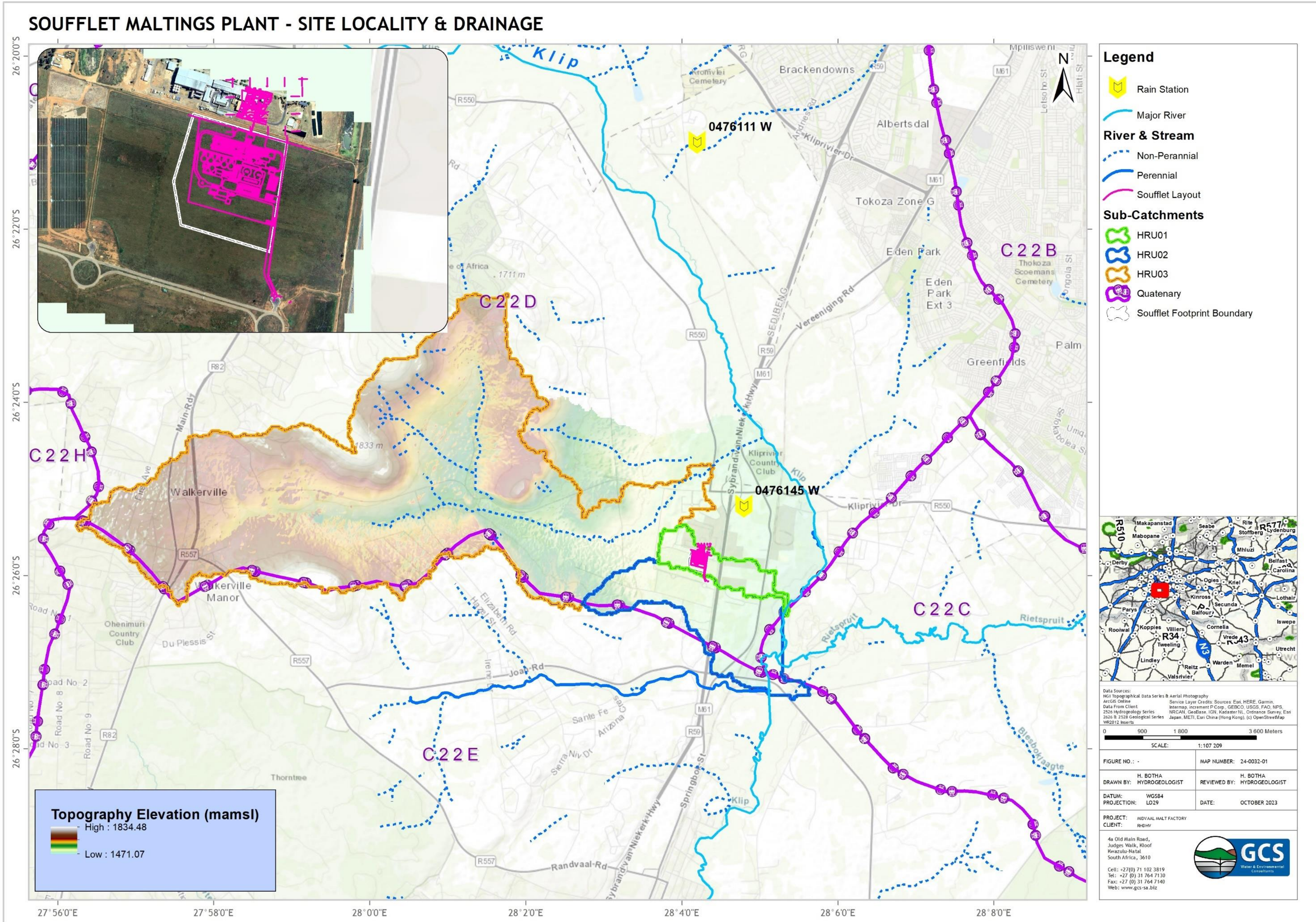


Figure 3-2: Site locality & drainage

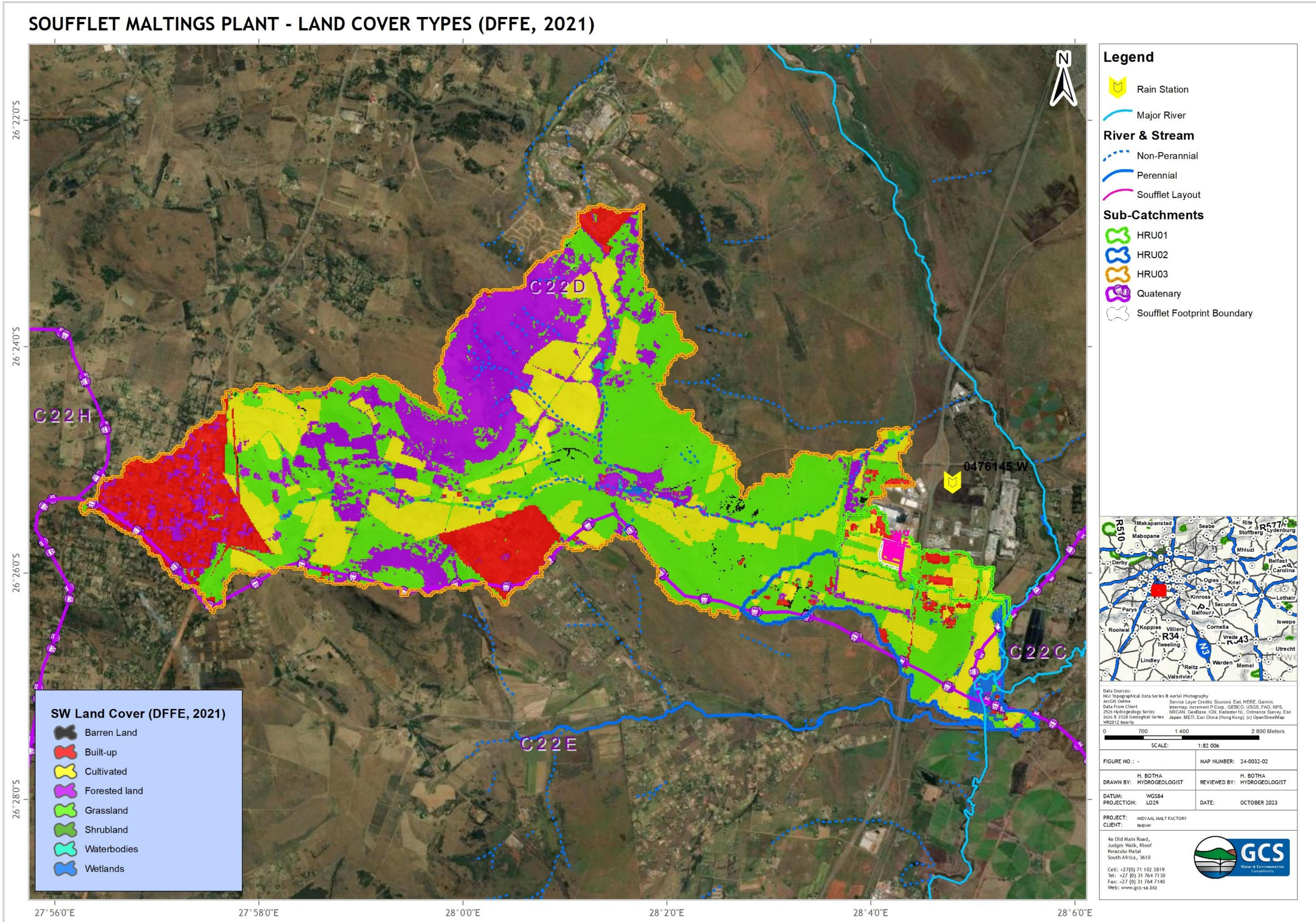


Figure 3-3: Sub-catchments and land cover types (DFFE, 2021)

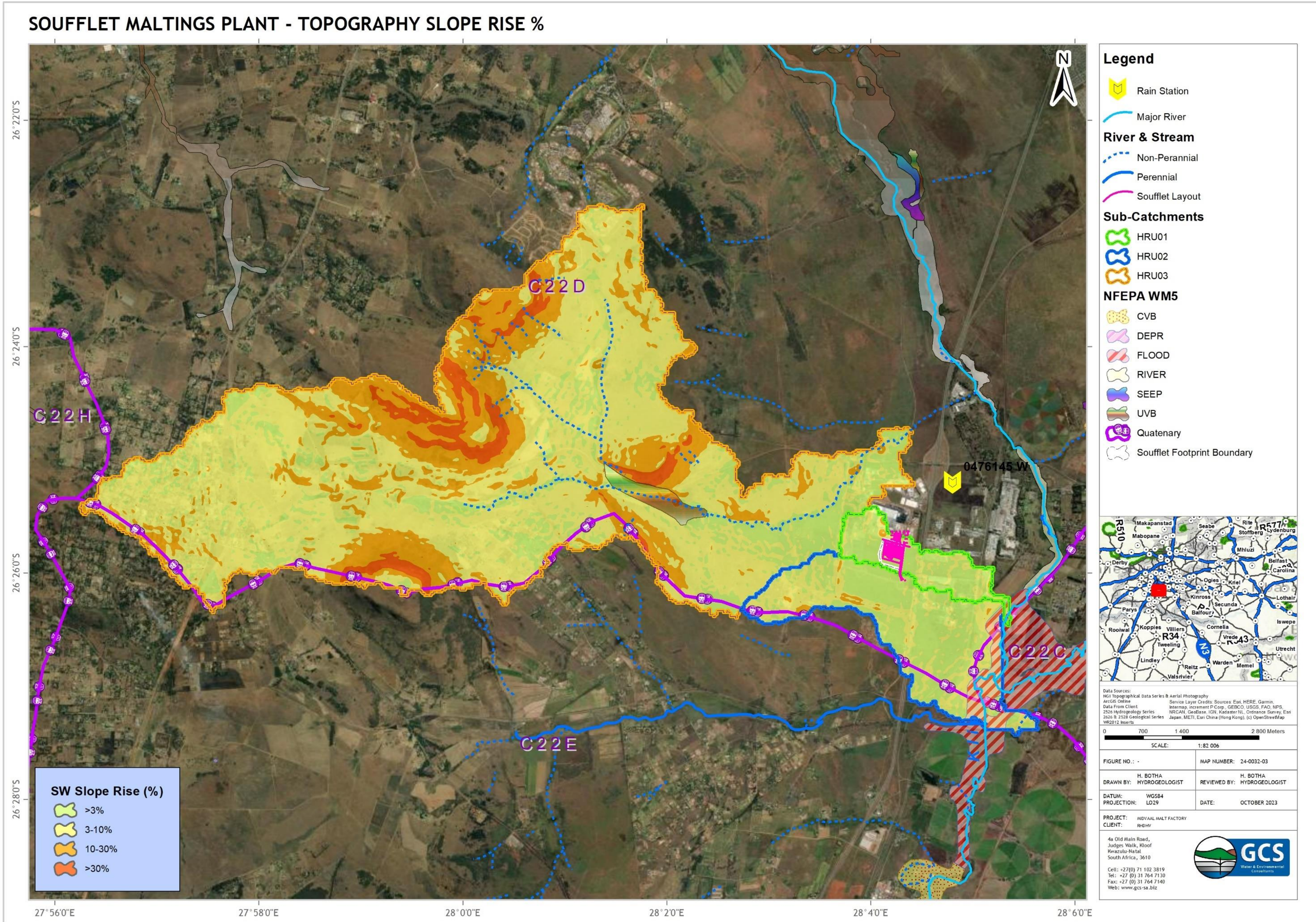


Figure 3-4: Sub-catchments and topography slope rise %

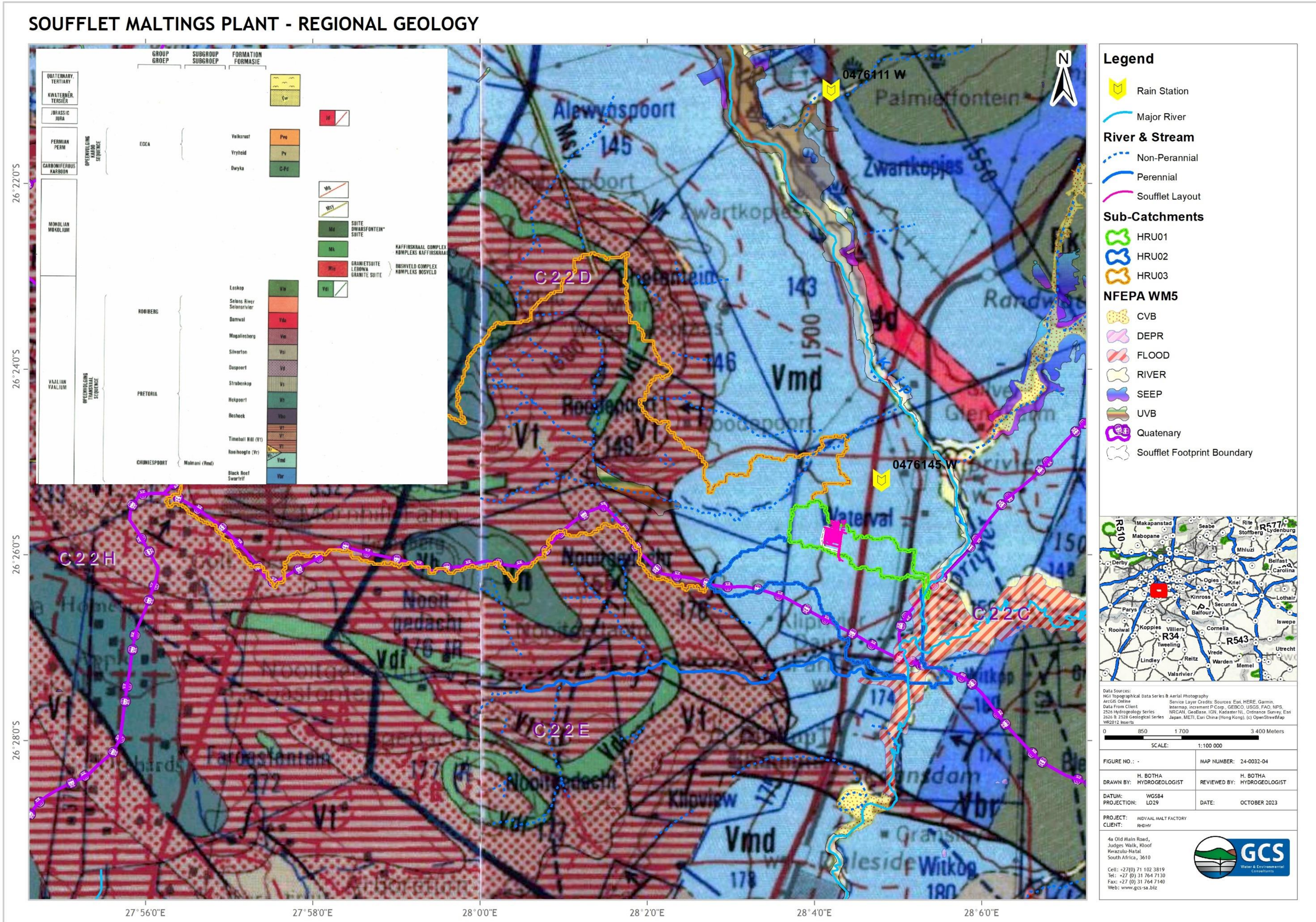


Figure 3-5: Regional surface geology

3.4 Climate

Climate, amongst other factors, influences soil-water processes, runoff, and peak flows. The most influential climatic parameter is rainfall. Rainfall intensity, duration, evaporative demand, and runoff were considered in this study to indicate rainfall partitioning within the project area.

3.4.1 Temperature

The average yearly temperature (refer to Figure 3-6) for the project area ranges from 23 to 33°C (high) and -4 to 4°C (Low). As per the Köppen Climate Classification (Kottek, et al., 2006), The study area is situated in a temperate highland tropical climate with dry winters (Köppen: Cwb).

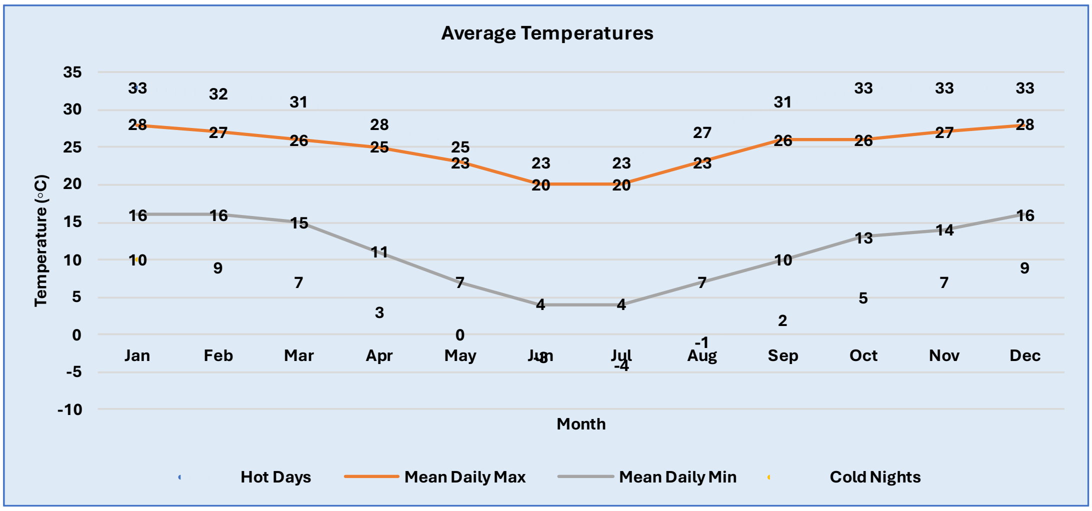


Figure 3-6: Average yearly temperatures (Meteoblue, 2024)

3.4.2 Wind speed and direction

Figure 3-7 shows the modelled wind rose for the project area (site used as reference) and presents the number of hours per year the wind blows from the indicated direction.

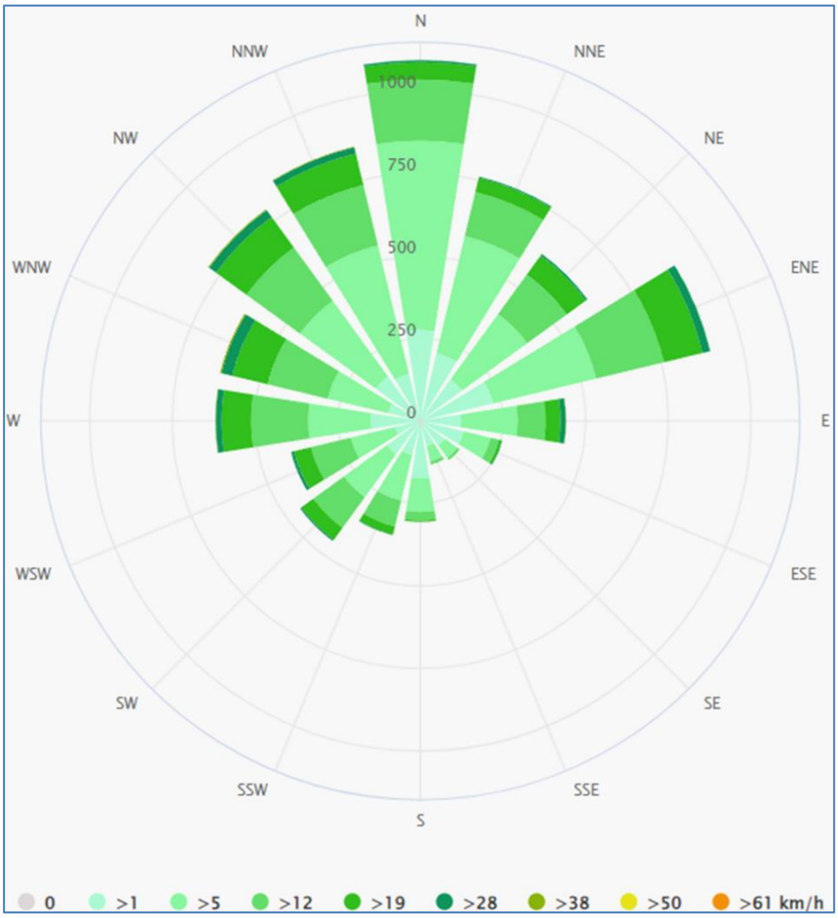


Figure 3-7: Wind rose (Meteoblue, 2024)

3.4.3 Rainfall and evaporation

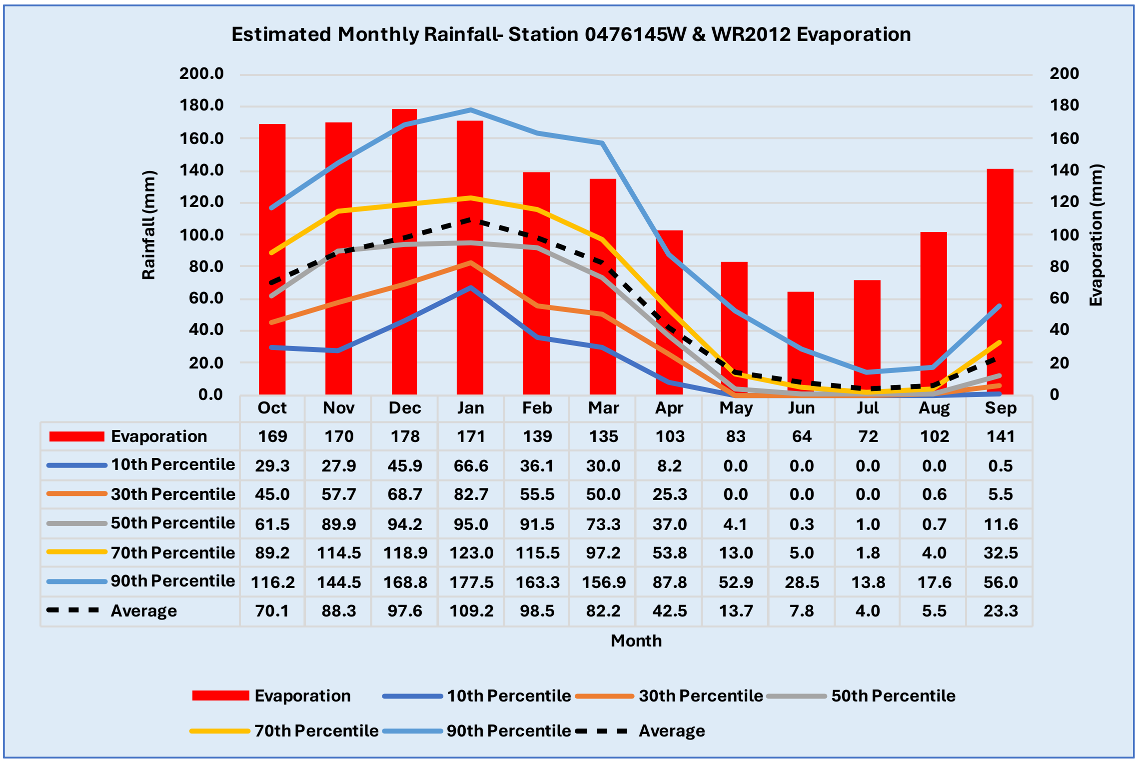
The project area is situated in rainfall zone C2B. The Mean Annual Precipitation (MAP) recorded at the nearest rainfall stations is summarised in Table 3-4 (WRC, 2015). The MAP for several sites is in the same order of magnitude.

Table 3-4: Summary of MAP recorded at nearest rainfall stations

Site	Id	Record	Map
KLIPRIVIER (POL)	0476145_W	64	618
ZWARTKOPJES (RWB)	0476111_W	92	684
NATALSPRUIT	0476228_W	48	693
NEW MARKET	0476227_W	67	696
VARKENSFONTEIN	0475840_W	28	670
Average			**672.2**

The monthly rainfall that represents the site was obtained from WR2012 rainfall station 0476145W (Klipriver Pol). The rainfall record is for the period 1940 to 2003 (64 years). Monthly rainfall for the site is likely to be distributed, as shown in Figure 3-8. Available rainfall data suggest a MAP ranging from 391 (30^{th} percentile) to 1183 (90^{th} percentile) mm/yr. The average rainfall is in the order of 642 mm/yr.

The project area falls within evaporation zone 11A, of which Mean Annual Evaporation (MAE) ranges from 1 500 to 1 600 mm/yr. The MAE far exceeds the MAP for the site, which implies greater evaporative losses when compared to incident rainfall. Monthly evapotranspiration for the site is likely to be distributed, as shown in Figure 3-8.

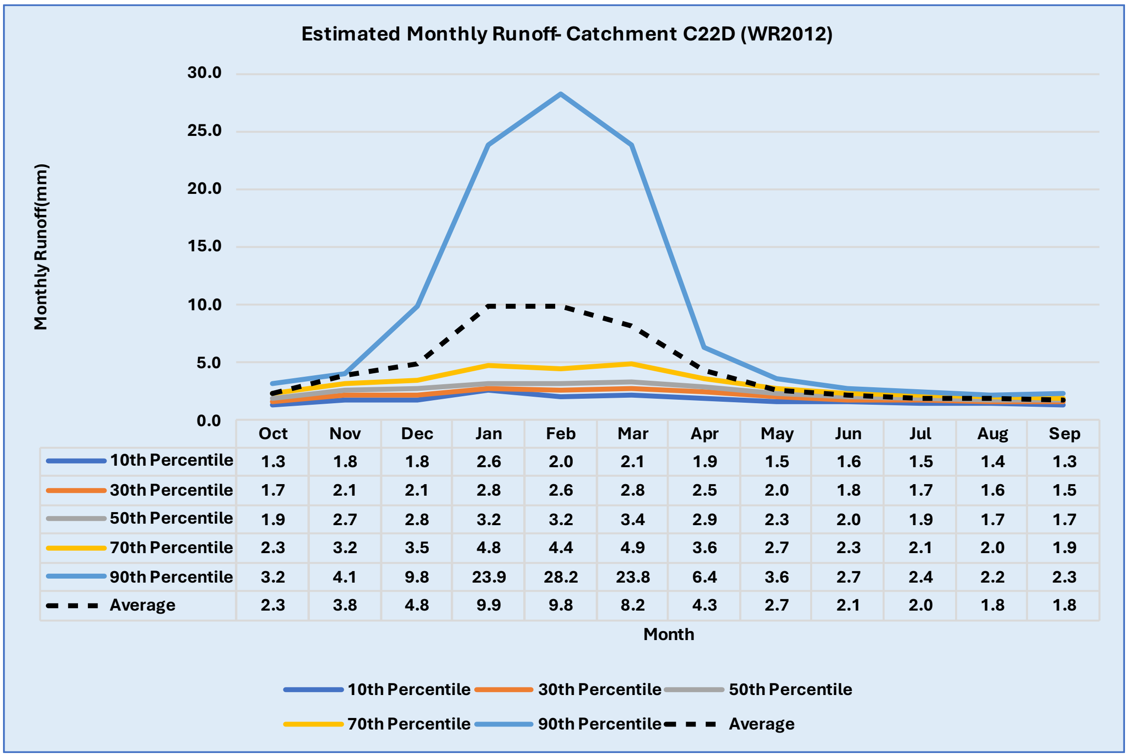


	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation	169	170	178	171	139	135	103	83	64	72	102	141
10th Percentile	29.3	27.9	45.9	66.6	36.1	30.0	8.2	0.0	0.0	0.0	0.0	0.5
30th Percentile	45.0	57.7	68.7	82.7	55.5	50.0	25.3	0.0	0.0	0.0	0.6	5.5
50th Percentile	61.5	89.9	94.2	95.0	91.5	73.3	37.0	4.1	0.3	1.0	0.7	11.6
70th Percentile	89.2	114.5	118.9	123.0	115.5	97.2	53.8	13.0	5.0	1.8	4.0	32.5
90th Percentile	116.2	144.5	168.8	177.5	163.3	156.9	87.8	52.9	28.5	13.8	17.6	56.0
Average	70.1	88.3	97.6	109.2	98.5	82.2	42.5	13.7	7.8	4.0	5.5	23.3

Figure 3-8: Average rainfall for Station 0476145W & WR2012 evaporation

3.4.4 Runoff

Runoff from natural (unmodified) catchments for the quaternary C22D is simulated in WR2012 (WRC, 2015) as being equivalent to 53.6 mm/yr (or 8% of the MAP) - refer to Figure 3-9.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10th Percentile	1.3	1.8	1.8	2.6	2.0	2.1	1.9	1.5	1.6	1.5	1.4	1.3
30th Percentile	1.7	2.1	2.1	2.8	2.6	2.8	2.5	2.0	1.8	1.7	1.6	1.5
50th Percentile	1.9	2.7	2.8	3.2	3.2	3.4	2.9	2.3	2.0	1.9	1.7	1.7
70th Percentile	2.3	3.2	3.5	4.8	4.4	4.9	3.6	2.7	2.3	2.1	2.0	1.9
90th Percentile	3.2	4.1	9.8	23.9	28.2	23.8	6.4	3.6	2.7	2.4	2.2	2.3
Average	2.3	3.8	4.8	9.9	9.8	8.2	4.3	2.7	2.1	2.0	1.8	1.8

Figure 3-9: Simulated natural (unmodified) runoff for C22H

3.4.5 Considerations on climate change

Based on available climate change models for the project area, derived from World Climate Data CMIP6 V2.1 (Eyring, 2016), RCP 4.5 and 8.5 scenarios were chosen, and the following is predicted for the project area:

- Temperature:
  - 2021 - 2050: increases by as much as 2.1ºC
  - 2050 - 2100: increases by as much as 2.3ºC
- Annual average hot days:
  - 2021 - 2050: additional 0.16ºC extremely hot days.
  - 2050 - 2100: additional 0.9ºC extremely hot days.
- Annual rainfall totals (MAP):
  - 2021 - 2050: decrease in rainfall by as much as 89 mm/yr.
  - 2050 - 2100: decrease in rainfall by as much as 133 mm/yr.
- The annual average number of extreme rainfall days:
  - 2021 - 2050: decrease by as much as 2.1 days.
  - 2050 - 2100: decrease by as much as 3.1 days.

Based on the above, it is predicted that there will be future temperature increases with more frequent extreme temperatures, which will result in fewer days of rainfall. Based on the rainfall decrease projections, it is concluded that there will be less frequent storm events (though not extreme) to facilitate the projected decreases in annual rainfall.

3.5 Surface water and groundwater users in the study area

According to the Water Allocation Registration Management System (WARMS, 2024), there are 17 WARMS users within a 5 km buffer of the project area, of which 4 groundwater and 1 surface water user falls within the HRU – refer to Figure 3-10. A review of SADAC GIP groundwater database boreholes further suggests several boreholes within a 5 km radius of the site with groundwater data available. The registry entry into WARMS for water use is summarised in Table 3-5. Based on the WARMS data collected, it is noted that the existing groundwater use is in the order of 0.9 Mm³/yr, and surface water use is in the order of 4.2 Mm³/yr.

Table 3-5: Summary of WARMS users within a 5 km radius of the site

ID	Latitude (WGS84)	Longitude (WGS84)	Status	Resource Type	WU Sector	Resource	Registered Volume (m³/yr.)
10000946	-26.45550	28.11290	ACTIVE	RIVER/STREAM	AGRICULTURE: IRRIGATION	RIETSPRUIT	175449
10005022	-26.40417	28.08333	ACTIVE	BOREHOLE	INDUSTRY (NON-URBAN)	NO NAME	550000
20011540	-26.47500	28.06111	ACTIVE	BOREHOLE	AGRICULTURE: IRRIGATION	NO NAME	105848
20011568	-26.47500	28.06111	ACTIVE	BOREHOLE	AGRICULTURE: IRRIGATION	NO NAME	135643
20022887	-26.42222	28.10833	ACTIVE	BOREHOLE	AGRICULTURE: IRRIGATION	NO- NAME	12200
20028989	-26.47500	28.06667	ACTIVE	RIVER/STREAM	AGRICULTURE: IRRIGATION	KLIPRIVER	600000
20029050	-26.43056	28.09861	ACTIVE	RIVER/STREAM	AGRICULTURE: IRRIGATION	KLIP RIVER	780000
20029069	-26.42222	28.08333	ACTIVE	BOREHOLE	INDUSTRY (NON-URBAN)	NO NAME	1200
20031644	-26.41062	28.09492	ACTIVE	RIVER/STREAM	AGRICULTURE: IRRIGATION	KLIPRIVER	62220
20037611	-26.46250	28.08472	ACTIVE	RIVER/STREAM	AGRICULTURE: IRRIGATION	KLIP RIVER	1145500
20037620	-26.46111	28.08611	ACTIVE	RIVER/STREAM	AGRICULTURE: IRRIGATION	KLIP RIVER	1460000
20042357	-26.40750	28.03380	ACTIVE	BOREHOLE	AGRICULTURE: IRRIGATION	UNKNOWN BOREHOLE	56301
20053647	-26.46891	28.06771	ACTIVE	BOREHOLE	INDUSTRY (URBAN)	BOREHOLE 1	19.88
20056163	-26.39592	28.01578	ACTIVE	BOREHOLE	AGRICULTURE: IRRIGATION	UNKNOWN BOREHOLE	40000
20056298	-26.42571	27.95522	ACTIVE	BOREHOLE	INDUSTRY (URBAN)	UNNAMED BOREHOLE	300
20059767	-26.43061	28.08252	ACTIVE	BOREHOLE	INDUSTRY (NON-URBAN)	BOREHOLE NO 1	500
20060443	-26.44070	28.12082	ACTIVE	BOREHOLE	INDUSTRY (URBAN)	BOREHOLE	600

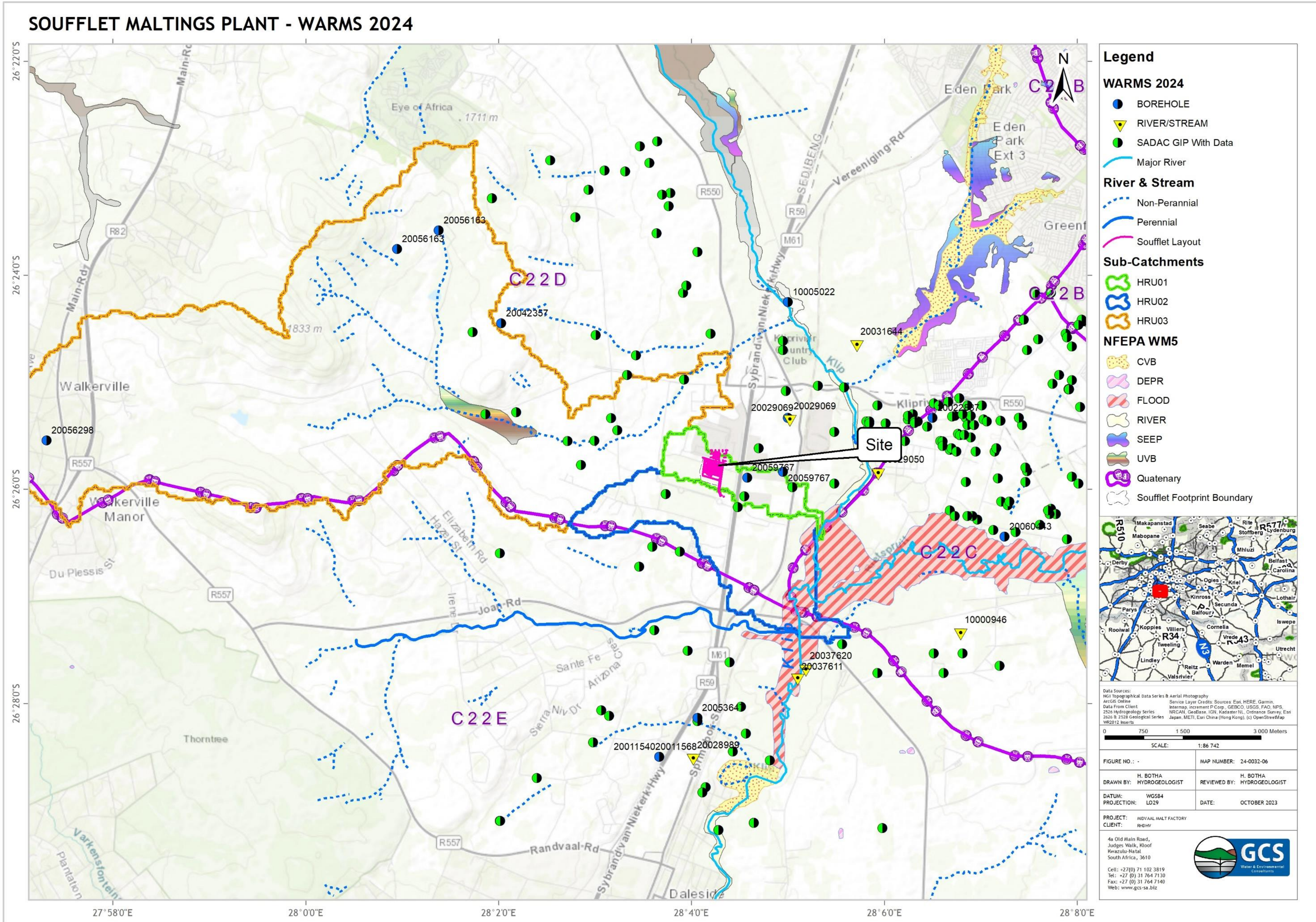


Figure 3-10: WARMS users identified in the project area

3.6 Depth to groundwater

The site falls within National Quaternary catchment C22D, which forms part of the Middle Klip River dolomite compartment. No springs have been recorded within the Upper Vaal Water Management Area (WMA). According to WR2012 (Bailey & Pitman, 2015) and DWAF GRAII (DWAF, 2006) data, the groundwater level in the project area average is in the order of 15.7 mbgl (metre below ground level). During geotechnical and dolomite studies conducted by ARUP (2019), it was noted that none of the boreholes had water strikes. The water rest level was also recorded after 24 hours as dry for all boreholes drilled. Available SADAC GIP and field hydrocensus data suggest a local water table in the order of 20 mbgl and that the groundwater table - refer to the GCS Hydrogeology Report (GCS, 2024)

3.7 Desktop wetland and ecological areas

Based on available National Wetland Freshwater Ecosystem Priority Areas (NFEPA) (Van Deventer, 2018) evaluated on a desktop level, there are no wetland areas associated with the project area. However, the NFEPA WM5 indicates the Klip River flood plain as a riverine system – refer to Figure 3-2.

In terms of river geo-hydrology, baseflow is considered the most important contributor to stream and wetland health. Baseflow (refer to Figure 3-11) is a non-process-related term that signifies low amplitude high-frequency flow in a river during dry or fair-weather periods. Baseflow is not a measure of the volume of groundwater discharged into a river or wetland, but it is recognised that groundwater contributes to the baseflow component of a river or wetland flow.

Available literature (WRC, 2015; DWAF, 2006) suggests groundwater contribution to baseflow ranges from 6 mm/yr (PITMAN MODEL) to 13 mm/yr (HUGHES MODEL). This relates to approximately 0.1% to 3% of rainfall.

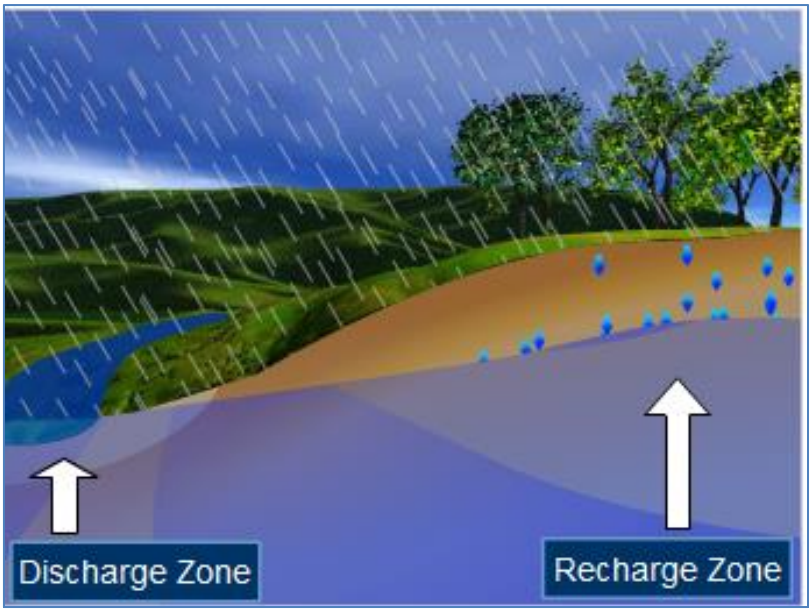


Figure 3-11: Groundwater baseflow concept (DWAF, 2007)

3.8 Present ecological state (PES) and environmental sensitivity and ecological importance (EIS)

Table 3-6 provides a summary of the PES, EIS and EWR (as a percentage of the MAR) for the quaternary catchments associated with the project area. The same conditions are inferred to apply to delineated sub-catchments.

Table 3-6: Summary of PES, EIS and EWR

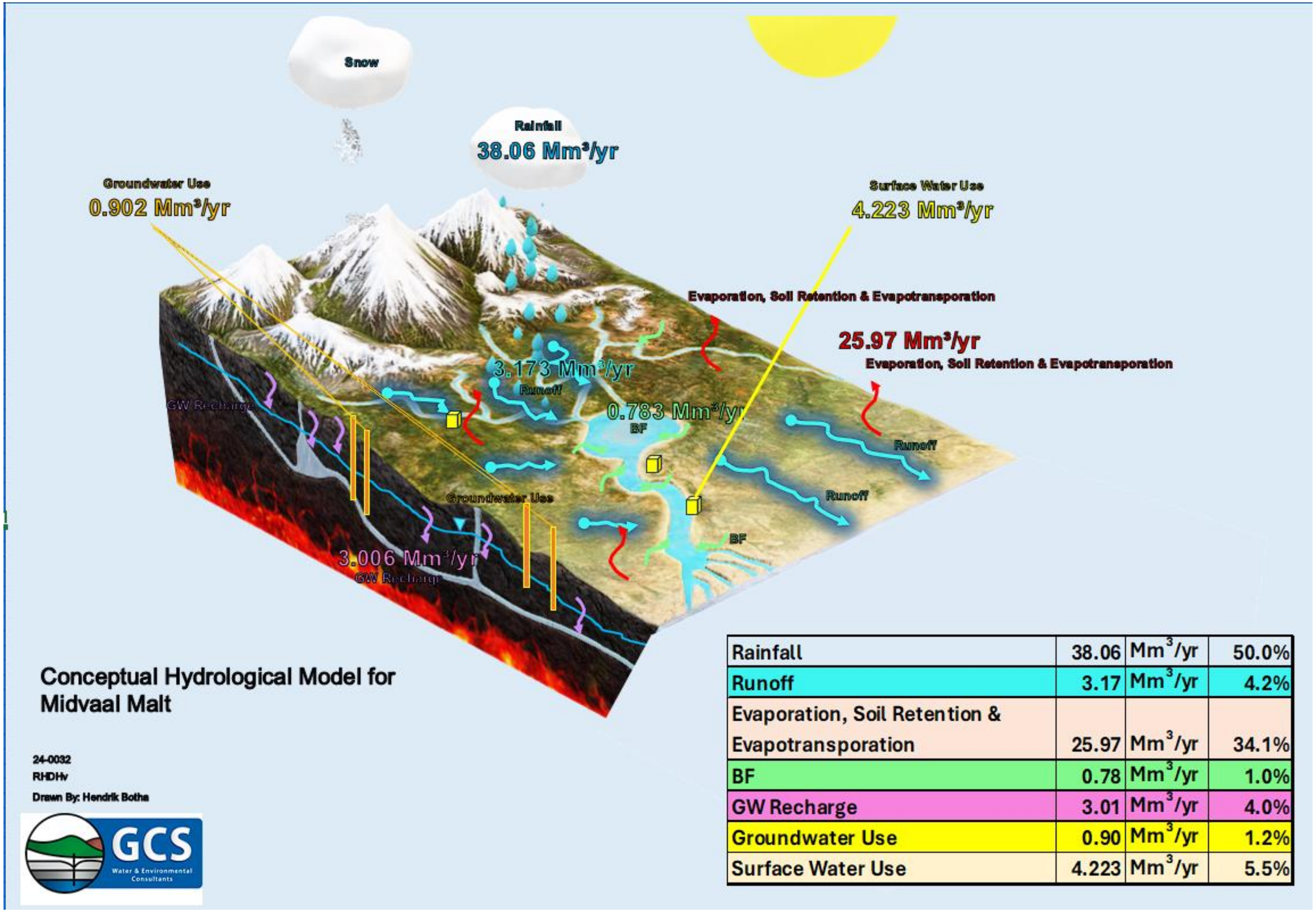
Quat	PES	EIS	Reserve (EWR) % of NMAR	Source
C22H	C Modified	Moderate	20-40%	WR2012

3.9 Overview of site hydrological cycle

Based on the information attained for the study area (as presented in this section), existing groundwater and surface water users, climate, runoff and estimated baseflow to wetland/river areas, a sub-catchment-specific hydrological cycle was developed (refer to Figure 3-12). *The impact of the proposed/existing activities at the site on the cycle was considered in the hydrological impact assessment.*

With regards to the hydrological cycle for the combined sub-catchment area, the following are estimated:

- Average rainfall accounts for a volume in the order of 38.06 Mm³/yr (50% of the total water budget);
- Average runoff accounts for a volume in the order of 3.17 Mm³/yr (4.2% of the total water budget);
- The average groundwater contribution to baseflow to rivers/wetlands/streams is in the order of 0.78 Mm³/yr (1% of the total water budget).
- Evaporation, soil retention and evapotranspiration account for a volume in the order of 25.9 Mm³/yr (34.1% of the total water budget);
- Groundwater use is estimated in the order of 0.9 Mm³/yr (1.2% of the total water budget); and
- WARMS surface water use is in the order of 4.223 Mm³/yr (5.5% of the total water budget).



Rainfall	38.06	Mm^3/yr	50.0%
Runoff	3.17	Mm^3/yr	4.2%
Evaporation, Soil Retention & Evapotransporation	25.97	Mm^3/yr	34.1%
BF	0.78	Mm^3/yr	1.0%
GW Recharge	3.01	Mm^3/yr	4.0%
Groundwater Use	0.90	Mm^3/yr	1.2%
Surface Water Use	4.223	Mm^3/yr	5.5%

Figure 3-12: Simplified overview of the hydrological cycle at the site (averages presented)

4 SURFACE AND GROUNDWATER QUALITY

The groundwater quality for the region will be variable and will depend on the underlying geology and hydrogeology characteristics associated with groundwater recharge (i.e., older rock and aquifers with ion exchange will have higher EC, and recently recharged more permeable younger rocks will have lower EC). Literature and available hydrogeology maps for the area (refer to Figure 4-1) suggest that the electrical conductivity (EC) for the underlying aquifers generally ranges from 0 to 70 mS/m (milli Siemens/metre). The pH for the region ranges from 6 to 8. Natural dolomitic groundwater is essentially a Ca/Mg $(HCO_3)_2$ type - alkaline. In-situ parameters measured on-site correspond to the literature ranges. This means that groundwater abstracted from the aquifer can generally be used for domestic and recreational use (DWAF, 1996b). Where groundwater contributes to baseflow, similar water quality is expected.

As there are no surface water rivers and streams associated with the site, no surface water quality is available. Furthermore, the perennial stream towards the northwest of the site was also dry during the site walkover assessment.

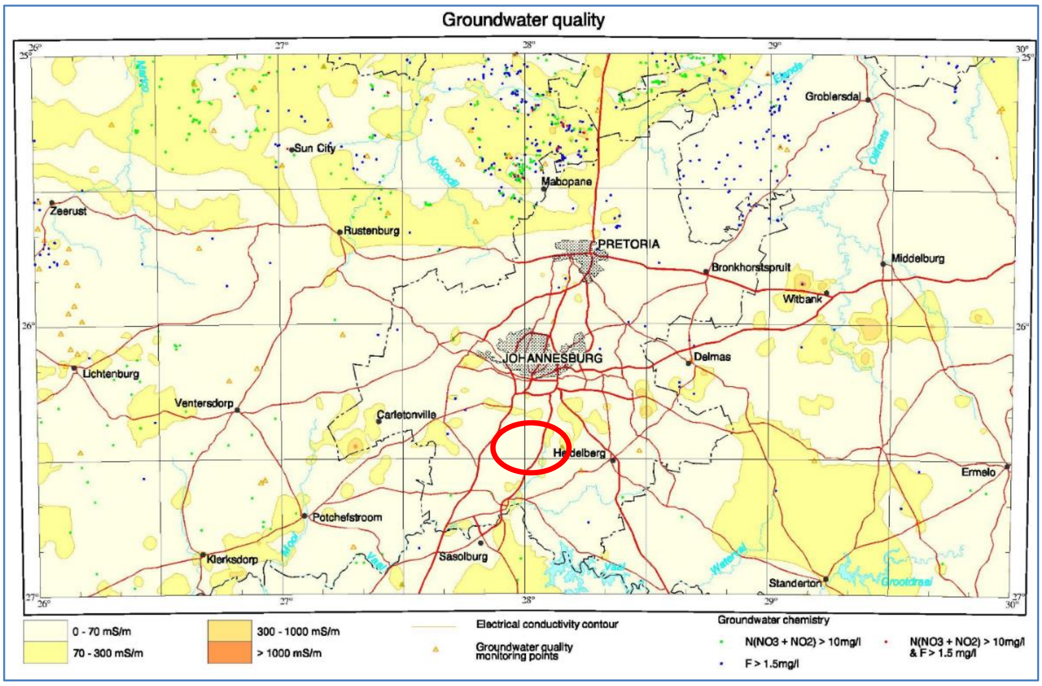


Figure 4-1: Groundwater quality (King, 1998)

5 PEAK FLOWS AND FLOOD LINE ASSESSMENT

Flood peak flows for the delineated sub-catchments were calculated using the Rational Method (RM3), Midgley and Pitman (MIPI) and the SDF methods (refer to **Appendix A**). Design rainfall was retrieved from station 0476145W and used to calculate peak flow volumes. Table 5-1 provides a summary of the design rainfall data used to calculate peak flows. The upper "U" rainfall intensity values were used, and catchment-based time concentration estimates were used in the estimation of the return period peak flows.

Table 5-1: Summary of design rainfall data used for peak flow estimates

Duration	Return Period (years)						
	2	5	10	20	50	100	200
5 min	10.2	14.1	17.1	20.2	24.9	28.9	33.4
10 min	14.9	20.6	24.9	29.6	36.4	42.3	48.8
15 min	18.7	25.8	31.2	37	45.5	52.9	61
30 min	23.6	32.6	39.4	46.7	57.5	66.8	77
45 min	27	37.3	45.1	53.6	66	76.6	88.3
1 hr	29.8	41.1	49.7	59.1	72.7	84.4	97.3
1.5 hr	34.2	47.2	57	67.7	83.3	96.8	111.6
2 hr	37.6	52	62.8	74.6	91.8	106.6	122.9
4 hr	43.9	60.6	73.3	87	107	124.3	143.3
6 hr	48	66.3	80.1	95.1	117.1	135.9	156.8
8 hr	51.1	70.6	85.4	101.4	124.8	144.9	167.1
10 hr	53.7	74.2	89.7	106.5	131.1	152.2	175.5
12 hr	55.9	77.3	93.4	110.9	136.5	158.5	182.7
16 hr	59.6	82.3	99.5	118.2	145.4	168.9	194.7
20 hr	62.6	86.5	104.6	124.2	152.8	177.4	204.6
24 hr	65.2	90.1	108.9	129.3	159.1	184.7	213
1 day	56.5	78	94.3	112	137.8	160	184.6
2 days	68	93.9	113.5	134.8	165.8	192.6	222.1
3 days	75.8	104.6	126.5	150.2	184.8	214.6	247.5
4 days	82.9	114.5	138.5	164.4	202.3	234.9	270.9
5 days	89	122.9	148.5	176.4	217	252	290.6
6 days	94.2	130.1	157.3	186.8	229.8	266.9	307.8
7 days	98.9	136.6	165.1	196	241.2	280.1	323

5.1 Calculated flood peak flows

Calculated peak flows are summarised in Table 5-2. The Geometric Mean of the dataset was applied to the HEC-RAS model. The flood line assessment is aimed at providing a worst-case inundation scenario to evaluate potential flooding risks associated with recognised rivers and streams associated with the study area.

Table 5-2: Summary of design peak flows for the delineated sub-catchments (m^3/s)

Catchment				HRU1	HRU2	HRU3
Area			km²	1.73	5.56	40.73
Time Concentration (Lc)			min	44.13	73.03	167.87
Method	RM (3)	1:20yr	(m3/s)	7	15	72
		1:50yr		10	24	110
		1:100yr		14	33	154
	SDF	1:20yr		19	41	148
		1:50yr		28	60	217
		1:100yr		35	76	274
	MIPI	1:20yr		14	30	93
		1:50yr		19	42	130
	Geometric Mean	1:20yr		12	27	100
		1:50yr		17	39	146
		1:100yr		23	51	191

5.2 Post-development peak flows

The flood lines generated are based on the existing land use, and no increases or decreases are anticipated. Considering the position of the proposed infrastructure, no increases in peak flows are expected.

5.3 Flood line modelling

5.3.1 Software

HEC-RAS 6.4.1 was used to model the flood elevation profile for the 1:50 and 1:100-year flood events. HEC-RAS is a hydraulic programme designed to perform one-dimensional hydraulic calculations for a range of applications, from a single watercourse to a full network of natural or constructed channels. The software is used worldwide and has consequently been thoroughly tested through numerous case studies.

5.3.2 Topography profile data

A triangulated irregular network (TIN) from the 30 m DTM (JAXA, 2023) formed the foundation for the HEC-RAS model and was used to extract elevation data for the river profile together with the river cross-sections. Furthermore, the TIN was used to determine placement positions for the cross-sections along with the river profile so that the watercourse could be accurately modelled to the resolution of the provided topographical data. The positions of the river sections were further refined by evaluating Google Earth Imagery and its correlation to the DTM elevations (i.e., does the actual position of a river/stream correlate to the sub-catchment drainage line generated).

5.3.3 Manning's roughness coefficients

Manning's roughness factor (n) is used to describe the channel and adjacent floodplain's resistance to flow. A Manning's factor of 0.02 to 0.03 best represents the frictional characteristics of the sub-catchment drainage areas, streams, and riverbank areas. This is due to isolated flow paths noted in the field, with a mixture of dense shrubs and bushels.

5.3.4 Inflow and boundary conditions

Based on the HRUs and the confirmed drainage lines/streams in the project area, a total of two (2) HEC-RAS rivers was defined, consisting of both critical depth (upstream) and normal depth slope boundary conditions. The normal depth slope was determined based on the ALOS DTM slope rise for the given sub-catchment drainage line.

5.3.5 Hydraulic structures

Hydraulic structures were not incorporated into the HEC-RAS model. Modelling these hydraulic structures would have been hampered by the lack of good-resolution topographical data (better than 30 m ALOS data). As such, including these structures would have been ineffective in the hydraulics of the streams as well as ineffective areas that were raised (i.e., roads, dam walls, buildings, culverts, etc.). Similarly, canals and diversion canals could not be modelled due to them not being captured by accurate topography elevation or lidar survey data.

5.3.6 Model assumptions

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

- The topographic data provided was of sufficient accuracy and coverage to enable hydraulic modelling at a suitable level of detail.
- The Manning's 'n' values used are considered suitable for use in the flooding events modelled, representing all the channels and floodplains.
- No abstractions or discharges into the stream sections were considered during the modelling.
- Hydraulic structures, other than the water storage dams, were not included in the model due to the resolution of available topography data.

- Steady-state hydraulic modelling was undertaken, which assumes the flow is continuous at the peak rate.
- A mixed flow regime that is tailored to both subcritical and supercritical flows was selected for running the steady-state model.

5.4 Model results

The 1:50 and 1:100-year flood areas modelled for the recognised rivers and streams within a 1km buffer zone of the site are shown in Figure 5-1. There is no flooding risk associated with the proposed development.

5.5 Limitations

Steady-state flood modelling was undertaken, which is a conservative approach as it ignores the effect of storage within the system and, therefore, produces higher flood levels than would be expected to occur. A steady-state model will result in worst-case (conservative) estimates of flooding, and resultant flood levels and floodplain extents would decrease if unsteady state modelling were undertaken using an inflow hydrograph as opposed to continuous peak flow.

Despite the above-mentioned Manning's 'n' coefficients for the vegetation observed and the medium-low resolution topographic data, the flood risk to the surface infrastructure has been adequately assessed for the project area. No further flood modelling work is considered necessary and would only be considered necessary when more detailed topographical data is available.

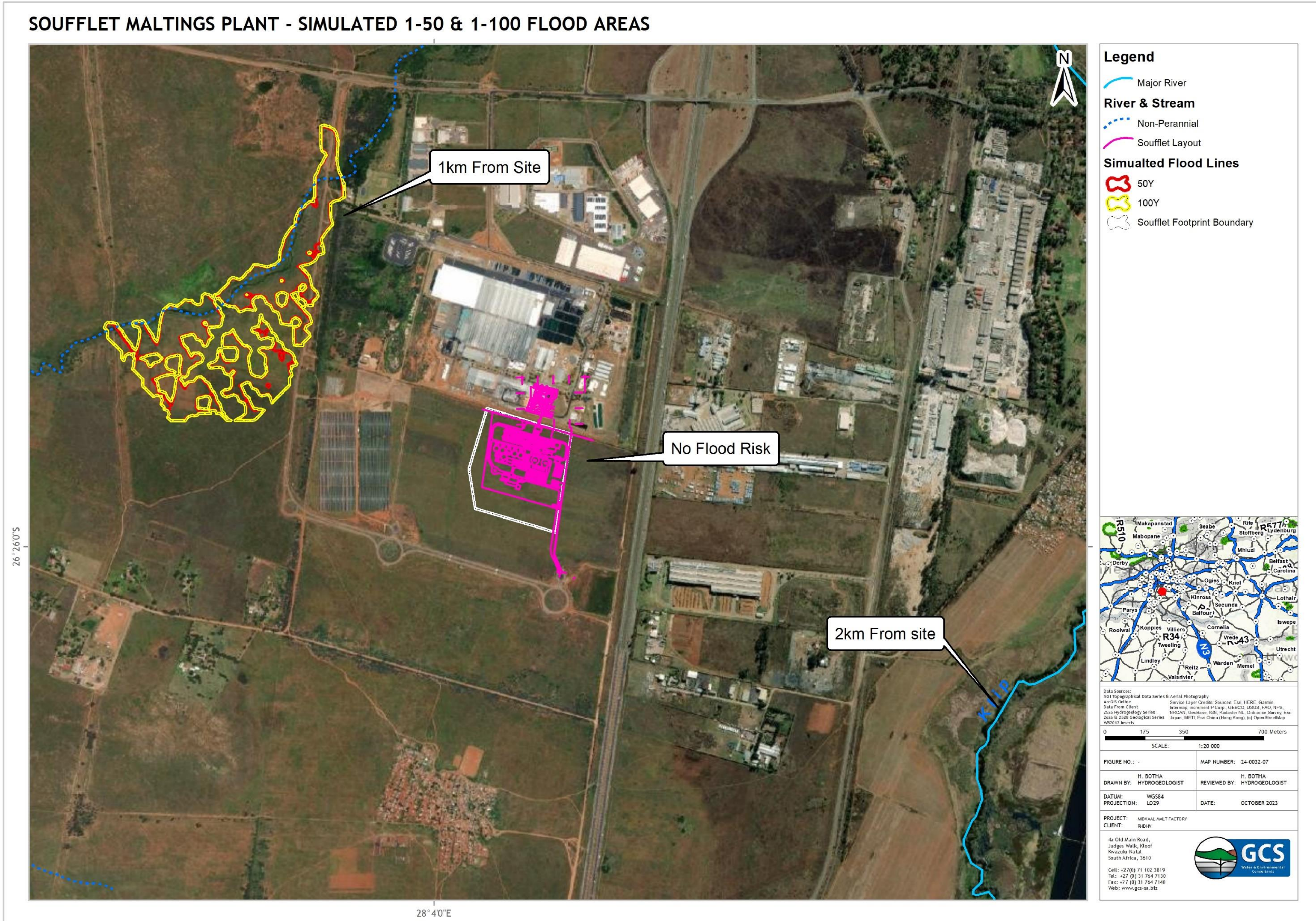


Figure 5-1: **Simulated 1-50- and 1-100-year flooding areas for recognised drainage lines**

6 STORMWATER MANAGEMENT

The following section describes the CSWMP developed and is based on available hydrological data, the walkover assessment data gathered and available site layout data.

6.1 Aim of the stormwater management plan

The CSWMP aims to:

- Illustrate likely stormwater sub-catchments (HRUs) and preferential overland runoff flow paths.
- Determine likely dirty and clean water HRUs (if any).
- Provide water containment and diversion systems to prevent the mixing of clean and dirty water, prevent soil erosion and flooding.
- Attenuate stormwater back to the natural environment (if possible and feasible based on the natural geological and soil conditions).

6.2 Existing stormwater infrastructure and drainage

The project is zoned in an area of the Graceview Industrial Park where there has not been major stormwater infrastructure installation. The following is, however, known about the larger site-scale stormwater system:

- Several stormwater culverts and drains connect the Graceview Industrial Park area to the downstream environment towards the Klip River.
- Stormwater that is generated on the property (existing development areas, which include the Heineken Sedibeng Brewery Factory as well as the existing access roads) conveys stormwater to an existing unlined attenuation pond situated near the R59. Water then passes under the road via several stormwater culverts (both box and circular variants) and free flows towards the Klip River.
- There are several stormwaters drains associated with the existing access roads. Stormwater is conveyed to the attenuation pond mentioned above.
- The attenuation pond has been constructed specifically to store the post-development 1:25-year flood event and release the pre-developed 1:5-year flow.
- The pond discharge is channelled into a lined side-drain running south for approximately 130m along the western side of the R59 with outlets via two existing culverts (each 0.45 m high x 1.20 m wide) positioned under the R59 discharging onto open land to the east of the highway.

As expressed earlier in this report, free drainage currently occurs at the proposed development Site. There are also no recognised drainage lines, rivers or streams associated with the property. Micro-sub catchment style drainage occurs, where rainwater that does not run off to the downstream environment ponds and seeps into the soils. The primary drainage direction is towards the east.

6.3 Future stormwater considerations

It is important to note that Graceview Park is not yet complete. According to the Graceview Industrial Park - Services Report for the Construction of Roads, Stormwater Drains, Water and Sewer Reticulation (Willie Coetzee Engineers CC, 2007), the following should be kept in mind for the project area:

- The stormwater reticulation will be sized to accommodate a 1-5-year storm.
- The lie of the land has a granular slope of approximately 0.8% from the high-lying western boundary to the low-lying eastern boundary along the R59 Freeway,
- Due to the lie of the land, stormwater will accumulate along the eastern boundary of the site in the stormwater attenuation pond.
- It was recommended that these attenuation ponds be built with suitably designed outlet structures to reduce the downstream runoff to the 1–50-year pre-development volumes.

Considering the above-mentioned and the existing stormwater systems on the Site, it is proposed that future systems be sized to accommodate a 1–10-year storm. The stormwater systems for the proposed Project should tie into the existing bulk roads and stormwater system.

6.4 Delineation of clean and dirty water areas

Based on the proposed activity (malting factory and associated infrastructure, as well as a WWTP), a “mixed” type of runoff is predicted. Among the contaminants, hydrocarbons are a major source of soil pollution, with petrol and diesel being the chief contributors, which can be easily transported by rainfall run-off.

It is expected that there would be very little hydrocarbon run-off from the planned infrastructure, and as such, it would be impractical and costly to install an oil-separator at the attenuation pond due to the flushing effect of stormwater run-off. Also, these require constant maintenance, which would be a burden on the local Municipality.

Mixed is used when the runoff can be either clean or “compromised” due to activities or incidents. Inherently, the stormwater runoff is predicted to be clean. It is therefore proposed that the facility itself be handled as a separate isolated stormwater system and that the external area be diverted or captured and released to maintain natural stormwater flow functions. Based on this, two (2) stormwater sub-catchments named C1 and C2 were delineated – refer to Figure 6-1.

6.5 Assumptions and limitations

The following assumptions pertain to the CSWMP:

- The ALOS DTM is used to delineate the stormwater drainage areas and is assumed to be of sufficient resolution to accurately describe the runoff from the site(s).
- Conceptual stormwater modelling and sizing were undertaken, as well as the application of the RM (3) methods to determine 1-2 and 1-100-year stormwater peak flows.
- No dynamic engineering level stormwater modelling or stormwater sizing was undertaken (not part of this Hydrology scope). It is assumed that the concepts presented in this report will be modelled and developed by a professional civil engineer and integrated into the mine master layout plan.

6.6 Stormwater peak flows

The rational method was used to calculate the stormwater peak flows for the stormwater sub-catchments. The predicted stormwater peak flows for C1 were calculated, as the runoff is free drainage for C2.

24-hour design rainfall for the closest rainfall station (0476145W) is available in Table 6-1. The soils in the study area have an SCS rating of C soil types (runoff coefficient in the order of 53%), with an erodibility rating in the order of 4. Based on the vegetation observed during the site walkover assessment (thick bushels), the combined runoff coefficients (C) are placed in the order of 25%. For the post-development, it is assumed that the rating will change to 50%.

1:2, 1:5, 1:10, 1:50 and 1:100 yr return periods are presented and are tabulated in Table 6-2. The values presented represent the peak runoff volumes at the recurrence interval, which can be expected for catchment C1.

Table 6-1: Design rainfall – 24-hour storm – Rainfall station 0476145W

Duration	Return Period (years)						
	2	5	10	20	50	100	200
24 hr	65.2	90.1	108.9	129.3	159.1	184.7	213

Table 6-2: Stormwater return period estimates – pre and post-development

Storm HRU	Q2 -m³/s	Q5-m³/s	Q10 -m³/s	Q50 -m³/s	Q100 -m³/s
C1-Pre	0.435	0.347	0.727	1.062	1.233
C1-Post	0.870	0.694	1.454	2.124	2.465

6.7 Temporary stormwater management measures during the construction phase

Based on the proposed activities and considering the runoff patterns associated with the site, temporary stormwater management is proposed as an overall stormwater management strategy. This would involve using temporary berms, sandbags, revegetation of eroded areas and silt fences to convey stormwater around active work areas. Temporary structures used to control stormwater at the site should divert water to the nearest existing drains connected to the bulk existing Graceview Park stormwater system.

6.8 Temporary and permanent stormwater considerations

From a more permanent stormwater basis, <u>and **assuming** it will take some time for the areas upstream and downstream of the Maltings Plant to be developed</u>, the following is proposed:

1. Lined stormwater channels will be developed alongside the roadways to convey runoff to the attenuation pond.
2. Roads should be regressed in order to assist with the conveying of the larger storm runoffs to the existing stormwater system.
3. All stormwater from the plant itself should be captured and conveyed to internal lines drains to tie into the existing stormwater system.
4. Due to the flatness of the land, most roads will have to be constructed with a longitudinal grade under 1% with 2-3% crossfalls allowing runoff into the side trenches. Existing and all proposed roads should be constructed with dedicated curb drains or lined drainage/rainwater ditches.
5. The proposed conceptual stormwater management system is shown in Figure 6-2.

The following factors also need to be considered during the preparation, operational, and closure phases of the site.

- Ensure that all stormwater systems are kept clean of any debris and silt to reduce flooding risk.
- Ensure that eroded areas are re-vegetated to reduce sedimentation risk and runoff volumes in the streams.
- Have fuel/oil spill kits on-site for immediate clean-up of any hydrocarbons during the proposed activities. Park vehicles in dedicated areas with drip trays to manage potential leakages.
- Regular inspections and maintenance of the site should be conducted to ensure that vegetation cover is adequate and no rivulets are generated.

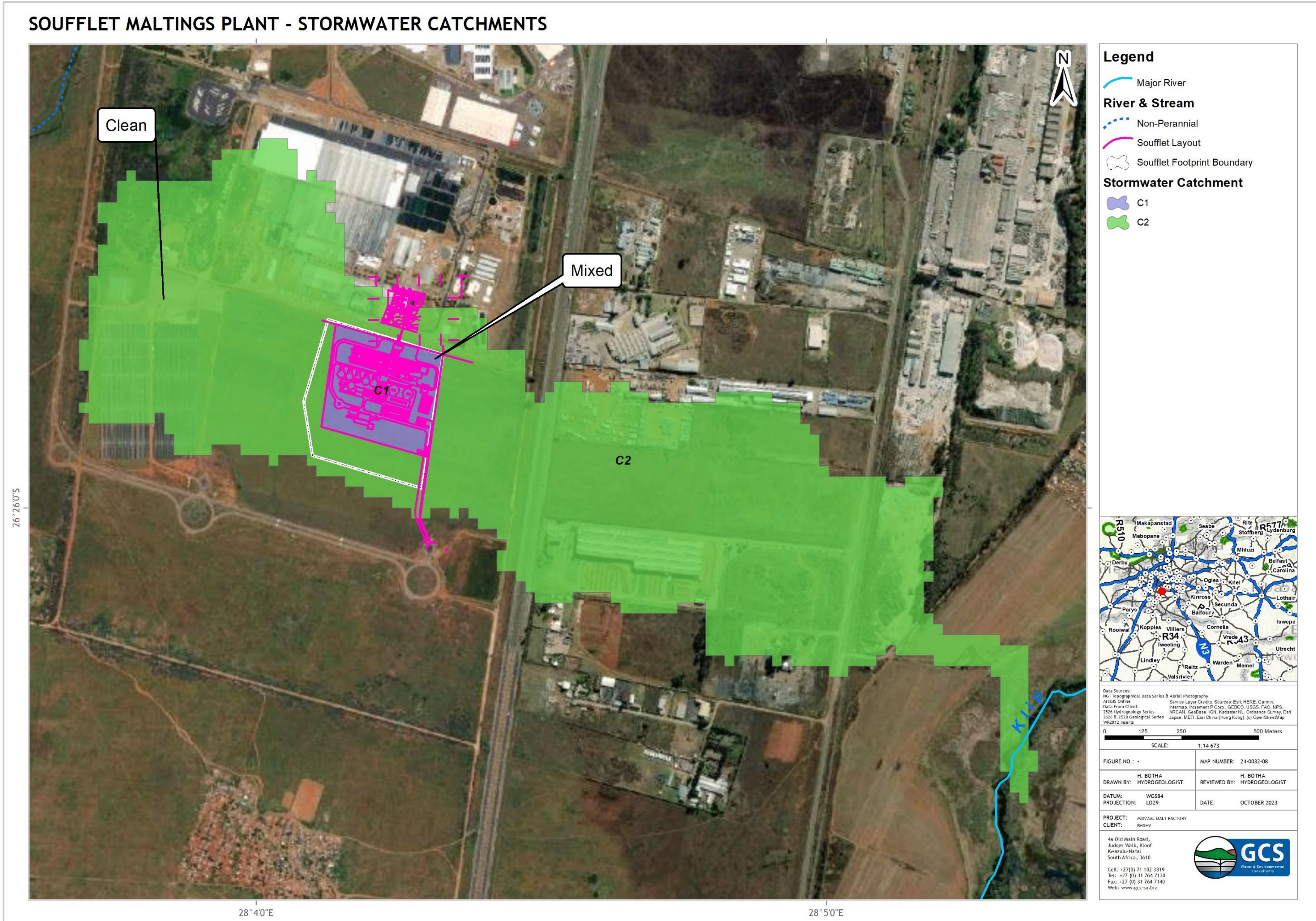


Figure 6-1: Delineated stormwater catchments

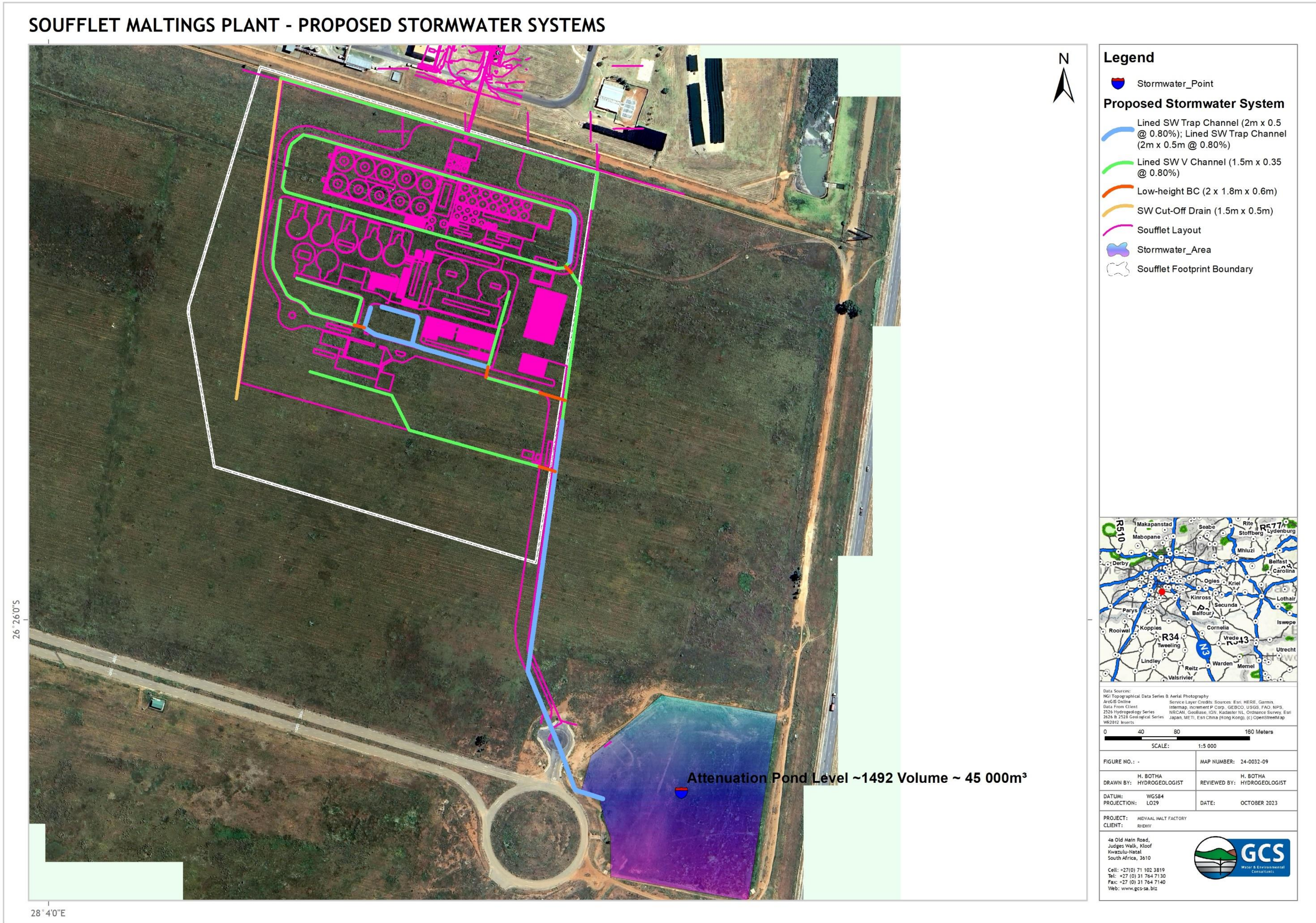


Figure 6-2: **Proposed stormwater systems**

7 CONCEPT WATER BALANCE

The conceptual water balance aims to illustrate the potential water usage volumes and allocations for the operational phase of the Malting Plant. As mentioned previously, the proposed project will require large quantities of water, i.e. for steeping, germination, cleaning, sanitary purposes, laundry, landscaping, etc. The quantity of water that will be consumed during phase 1 and phase 2 stages of the project is estimated to be 250,000 m^3/year and 325,000 m^3/year, respectively.

It is further envisioned that the backup water supply will be from two (2) boreholes, namely Malt BHT3 and Malt BHT4, with a provisional amount of 300m^3/day reserved for the combined boreholes. The use of groundwater will be supplementary for processing water to the plant (backup purposes only). It should be noted that the usage of the boreholes is still to be determined.

It is anticipated that wastewater will be generated from the industrial processing and sanitation facilities. The quantity of wastewater that will be discharged during phase 1 and phase 2 stages of the project is estimated to be 200,000 m^3 /year and 260,000 m^3/year, respectively.

There are currently two options for the treatment and discharge of wastewater considered, namely (RHDHV, 2024)

- **The preferred** treatment is at the on-site wastewater treatment plant (WWTP), and then the tie-in is to the existing ERWAT infrastructure and the pump station (owned by Midvaal).
- **Alternative** – treatment at the on-site WWTP and then transport of the effluent in a pipeline that runs adjacent to the ERWAT pipeline to a discharge point in the Klip River.

In the water balance, the average annual water balance is presented for the operational phase, Phase 2.

7.1 Water balance assumptions

The following additional assumptions pertain to the water balance calculations:

- Evaporation is used as a sink and in the order of 30% of the MAE.
- It is assumed that the peak sewer flow and process water component to the WWTP will be in the order of 260 000 m^3/yr (RHDHV, 2024).
- A runoff coefficient in the order of 50% is assumed for the post-development setting.

7.2 Model boundaries

The model boundaries consist of sources and sinks and are summarised as follows:

- Water from the municipality and backup boreholes – source.

- Direct rainfall and generated runoff – source.
- Evaporation - sinks.
- Estimated runoff to the stormwater systems – sinks.
- Discharge into the soil/environment from the WWTP – sink.

7.3 Limitations of the water balance

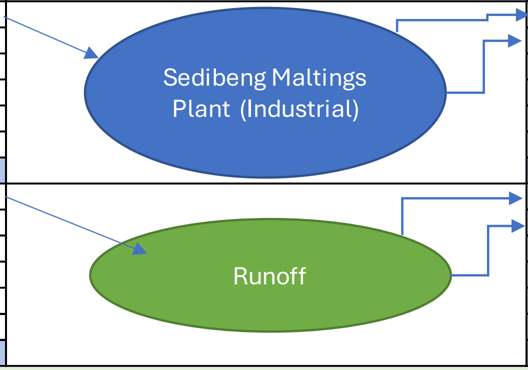
No formal process flow diagram or bulk services report was provided to GCS for this investigation. Moreover, the water balance could not be calibrated as there is no water usage information available for the project.

7.4 Conceptual water balance

The estimated average annual water balances are presented in Table 7-1 (wet year) and Table 7-2 (dry year).

Table 7-1: Average annual water balance (wet year)

In	Amount		Midvaal Malt Concept Daily Water Balance (Wet Year)	Out	Amount	
From: Municipality	475,500.00	m³/yr		To: Processing & Production	325,000.00	m³/yr
From: Backup Boreholes	109,500.00	m³/yr		To: WWTP	260,000.00	m³/yr
Total	**585,000.00**	**m³/yr**		**Total**	**585,000.00**	**m³/yr**
From: Drainage Servitude / Runoff	56,885.43	m³/yr		To: Environment / Stormwater	39,819.80	m³/yr
				To: Evaporation	17,065.63	m³/yr
Total	**56,885.43**	**m³/yr**		**Total**	**56,885.43**	**m³/yr**
Net Balance					**-**	**m³/yr**

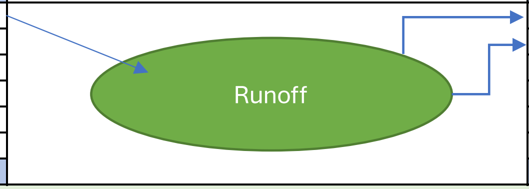


Key	
Measured Values	(green)
Calculated Values	(yellow)
Assumed Values	(orange)

Comments:

The net balance is 0. Please note the limitations to the water balance. No calibration data is available.
There may be some potential for rain harvesting at the site, due to high runoff volumes.

Table 7-2: Average annual water balance (dry year)

In	Amount		Midvaal Malt Concept Daily Water Balance (Dry Year)	Out	Amount	
From: Municipality	475,500.00	m^3/yr		To: Processing & Production	325,000.00	m^3/yr
From: Backup Boreholes	109,500.00	m^3/yr		To: WWTP	260,000.00	m^3/yr
Total	**585,000.00**	**m^3/yr**		**Total**	**585,000.00**	**m^3/day**
From: Drainage Servitude / Runoff	18,791.39	m^3/yr		To: Environment / Stormwater	13,153.98	m^3/yr
				To: Evaporation	5,637.42	m^3/yr
Total	**18,791.39**	**m^3/yr**		**Total**	**18,791.39**	**m^3/yr**
Net Balance					**-**	**m^3/yr**

Key		Comments:
Measured Values		
Calculated Values		The net balance is 0. Please note the limitations to the water balance. No calibration data is available.
Assumed Values		There may be some potential for rain harvesting at the site, due to high runoff volumes.

8 HYDROLOGICAL RISK ASSESSMENT

The anticipated hydrological risk concerning the preparation, operational and closure phase of the proposed project was evaluated. The activities entail:

- Construction phase:
  - Clearing of the vegetation and movement of heavy machinery and equipment at the site that can potentially cause soil pollution (i.e., hydrocarbon spills).
  - Temporary storage and holding facilities and contractors camps during the construction phase, as well as portable toilets and storage of hazardous material (i.e. paints, oils, lubricants, etc) during the construction phase.
  - Construction of the plant and associated facilities, including the wastewater treatment works.
- Operational phase:
  - Run of the plan and associated facilities.
  - Vehicles entering and parking on site could cause hydrocarbon spills.
  - Abstraction of groundwater (proposed but not confirmed)
  - Sewage and effluent storage on site. The options are currently:
    - **The preferred** treatment is at the on-site wastewater treatment plant (WWTP), and then the tie-in is to the existing ERWAT infrastructure and the pump station (owned by Midvaal).
    - **Alternative** – treatment at the on-site WWTP and then transport of the effluent in a pipeline that runs adjacent to the ERWAT pipeline to a discharge point in the Klip River.
- Closure phase (likely not to occur, seeing that the area is an industrial economic zone):
  - Demolition of the plant and associated facilities.
  - Rehabilitation and decommissioning of groundwater boreholes.

The source-pathway-receptor (SPR) model (DWAF, 2008) was used to evaluate potential pollution sources and primary receptors within the study area. Risk assessment entails understanding the generation of a hazard, the probability that the hazard will occur, and the consequences if it should occur. The net consequence is established by the following equation:

Consequence = (Duration + Extent + Irreplaceability of resource) x Severity

The environmental significance of an impact was determined by multiplying the consequence by probability. The risk significance rating is summarised in Table 8-1.

Table 8-1: Risk rating scale

Criteria	Rating Scales
Significance	Very high – negative (-48 to -66)
	High – negative (-36 to -48)
	Moderate – negative (-24 to -36)
	Low – negative (-12 to -24)
	Neutral - Very low (0 to -12)
	Low–positive (0 to 12)
	Moderate–positive (12 to 24)
	High–positive (24 to 48)
	Very high – positive (48 to 66)

Several hydrological risks relating to water infiltration and runoff onto the local soils were identified and are listed in Table 8-2 (preparation phase), Table 8-3 (operational phase) and Table 8-4 (closure phase). **There are no surface water-related risks associated with the site, as there are no recognised drainage lines on site or close to the site. The closest perennial stream is towards the north-west of the site at a distance of ~1.17 km, and the Klip River, a major river system, is situated approximately 2.5 km downstream east of the site.**

8.1 Preparation phase

The following activities are anticipated during the construction phase of the project:

- Typical earthworks are required to clear the areas.
- Construction of access roads, housing foundations and buildings.
- Excavation for the wastewater storage areas and treatment plant.
- Establish service platforms, material handling areas, and other temporary infrastructure.
- Dust suppression of access roads.
- Placing of topsoil in designated areas; and
- Constructing laydown areas and temporary stormwater systems and berms.

The identified possible hydrological impacts for the preparation phase include (refer to Table 8-2):

- The destruction of the vadose zone sediments by clearing activities. This impact is permanent and is therefore not included in the impact table, as no mitigation measures can be recommended. This could lead to sediment runoff.
- Clearing topsoil from footprint areas will influence the rate of infiltration of water to the shallow groundwater system and/or baseflow components.

- Handling waste and transporting material can cause various types of spills (domestic waste, sewage water, hydrocarbons), which can infiltrate and contaminate the soils and groundwater system.
- Oil and fuel spills and leakages at vehicle park areas and in the project areas may cause poor-quality seepage and soil contamination.

Visual monitoring of the site on an ongoing (monthly) basis will serve as a 1st order detection system for any soil and water pollution that may take place. The collected information should be used as part of an active water management system and act as an early warning system for the application of mitigation measures. The identified impacts are not likely to negatively affect the commencement of the proposed projects.

8.2 Operational phase

The possible hydrological impacts for the operational phase of the project are likely to be (refer to Table 8-3):

- Potential poor-quality seepage into the soils and underlying groundwater table from any environmental incidents (i.e. oil spills, fuel spills, spillages from the effluent storage tanks and treatment plant, etc.) is the highest risk at the site.
- The direct discharge of treated effluent into the Klip River (<u>if this takes place</u>) could impact surface water quality. The preferred option is to discharge to the municipal sewer main, which is already available in the area (Midvaal).

In general, the operational phase risk associated with the project is predicted to be low, and it is foreseen that the impacts can be managed. This is based on the type of project that is proposed.

8.3 Closure and decommissioning phases

The closure and decommissioning phases will be per an agreed and approved closure plan for the Soufflet Maltings Plant. The potential risks are captured in Table 8-4 is summarised as follows:

- Decommission the plant and other supporting infrastructure.
- Rehabilitation of the site.

Closure of the site is predicted to be beneficial to the area and will enable long-term stabilisation of the project site.

8.4 Alternatives considerations

No alternatives were considered during this assessment; however, it is proposed that the preferred option, as discussed above, be considered for the discharge of the treated effluent. This will minimise the water liabilities for the applicant associated with direct discharge to the Klip River.

8.5 Cumulative impacts and impacts on the hydrological cycle

Based on the unique hydrology conditions of the site and proposed stormwater management options, no impacts to the hydrological cycle are anticipated. Runoff will still be allowed to enter the watercourses as well as stormwater to maintain ecological water requirements, and the impact of increased evaporation is considered marginal on a sub-catchment scale.

In terms of the preparation and operational phase, there are expected cumulative impacts on the soils associated with the site. The impact is predicted to improve at the closure of the site and if rehabilitation is rolled out.

Table 8-2: Impacts during the preparation phase

			Pre- Mitigation								Post Mitigation						
Component Being Impacted On	**Activity Which May Cause the Impact**	**Activity**	**Duration (D)**	**Extent (E)**	**Potential for impact on irreplaceable resources (I)**	**Severity (S)**	**Consequence (C)**	**Probability (P)**	**Significance**	**Recommended Mitigation Measures**	**Duration (D)**	**Extent (E)**	**Potential for impact on irreplaceable resources (I)**	**Severity (S)**	**Consequence (C)**	**Probability (P)**	**Significance**
Vadose zone soils and subsequent aquifer (groundwater table)	Disturbing vadose zone during soil excavations/construction activities.	Net Result of Earthworks	Medium Term (3)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-12)	Definite (2)	Low – negative (-13 to -24) (-24)	- Only excavated areas apply to the project area. - Backfill the material in the same order it was excavated to reduce contamination of deeper soils with shallow, oxidised soils. - Cover excavated soils with a temporary liner to prevent contamination. - Retain as much indigenous vegetation as possible. - Exposed soils are to be protected using a suitable covering or revegetating.	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (-6 to 0) (-6)	Probable (1)	Neutral/ Negligible (0 to -12) (-6)
	Poor quality seepage from machinery used to excavate soils. Oil, grease, and fuel leaks could lead to hydrocarbon contamination of the vadose zone - which could percolate into the shallow aquifer.	Net Result of Earthworks	Medium Term (3)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-12)	Definite (2)	Low – negative (-13 to -24) (-24)	- Park heavy machinery in lined areas and place drip trays under vehicles at the site. - Visual soil assessments for signs of contamination during construction (monthly)	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (-6 to 0) (-6)	Probable (1)	Neutral/ Negligible (0 to -12) (-6)

Table 8-3: Impacts during the operational phase

			Pre- Mitigation								Post Mitigation						
Component Being Impacted On	**Activity Which May Cause the Impact**	**Activity**	**Duration (D)**	**Extent (E)**	**Potential for impact on irreplaceable resources (I)**	**Severity (S)**	**Consequence (C)**	**Probability (P)**	**Significance**	**Recommended Mitigation Measures**	**Duration (D)**	**Extent (E)**	**Potential for impact on irreplaceable resources (I)**	**Severity (S)**	**Consequence (C)**	**Probability (P)**	**Significance**
Vadose zone soils	Poor quality seepage from the onsite effluent storage facilities and WWTP.	Storage of wastewater and processing thereof	Medium Term (3)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-12)	Definite (2)	Low – negative (-13 to -24) (-24)	- Park heavy machinery in lined areas and place drip trays under vehicles at the site. - Visual soil assessments for signs of contamination on site.	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (-6 to 0) (-6)	Probable (1)	Neutral/ Negligible (0 to -12) (-6)
	Poor quality runoff into the environment (if hydrocarbon contamination takes place at the site). The impact will be on local soils as there are no watercourses associated with the site.	Vehicles and trucks are parked and accessing the site.	Medium Term (3)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-12)	Definite (2)	Low – negative (-13 to -24) (-24)	- Have fuel cleanup kits available on site. - Ensure that stormwater is monitored annually for contaminants.	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (-6 to 0) (-6)	Probable (1)	Neutral/ Negligible (0 to -12) (-6)
Klip River water quality	If discharge takes place into the Klip River, there may be an impact on the water quality. This is subject to if the water quality is **not treated** to conform to General / Specialist Limits for Wastewater Discharge (NWA, 1999)	Poor quality effluent discharge	Medium Term (3)	Local (3)	Yes (1)	High (-3)	Highly detrimental (-19 to -24) (-21)	Definite (2)	High – negative (-37 to -48) (-42)	- Ensure that the water is treated to be in line with Limits for Wastewater Discharge (NWA, 1999)	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (-6 to 0) (-6)	Probable (1)	Neutral/ Negligible (0 to -12) (-6)

Table 8-4: Impacts during the closure phase/decommissioning phase

Component Being Impacted On	Activity Which May Cause the Impact	Activity	Pre- Mitigation							Recommended Mitigation Measures	Post Mitigation						
			Duration (D)	Extent (E)	Potential for impact on irreplaceable resources (I)	Severity (S)	Consequence (C)	Probability (P)	Significance		Duration (D)	Extent (E)	Potential for impact on irreplaceable resources (I)	Severity (S)	Consequence (C)	Probability (P)	Significance
Vadose zone soils and subsequent aquifer (groundwater table)	Rehabilitation of the plant and associated facilities.	Rehabilitation	Medium Term (3)	Site (2)	Yes (1)	High (3)	Moderately beneficial (7 to 18) (18)	Definite (2)	High–positive (24 to 48) (36)								
	Poor quality seepage from machinery used to decommission and rehabilitate the mine operations.	Rehabilitation	Medium Term (3)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-12)	Definite (2)	Low – negative (-13 to -24) (-24)	- Park heavy machinery in lined areas and place drip trays under vehicles at the site. - Visual soil assessments for signs of contamination during rehabilitation (monthly)	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (-6 to 0) (-6)	Probable (1)	Neutral/ Negligible (0 to -12) (-6)
	Rehabilitation of settlement dams will stabilise the soils in the project area.	Rehabilitation	Medium Term (3)	Site (2)	Yes (1)	High (3)	Moderately beneficial (7 to 18) (18)	Definite (2)	High–positive (24 to 48) (36)								

9 SURFACE WATER MONITORING

As there are no recognised drainage lines or surface water courses associated with the site, no formal surface water monitoring is proposed. Monthly visual assessments in work areas associated with the preparation, operational and closure phase activities should be sufficient. If visual and monitoring observations show areas of concern (i.e., where pollution is observed during the operational phase or in the wetland units), then mitigation measures should be formulated based on the scale of impact observed. Soil and water quality samples may also be required and will need to be determined in the field and based on the observations made at the time of site evaluation.

Stormwater monitoring would also require a visual component where the stormwater system is visually assessed every month to identify issues (i.e., clogged systems, erosion and sedimentation) and then rectify the issues observed. No dedicated stormwater monitoring points have been proposed. Visual stormwater monitoring is proposed quarterly and weekly during rainy months. Stormwater quality monitoring is also not proposed and is based on the expected water quality as observed in the existing stormwater dam.

It is proposed that the developer/land owner undertake the water monitoring program. The results should be reported to DWS on an annual basis if required. Otherwise, the results should be kept on record if DWS audits the site.

10 CONCLUSIONS

Based on the investigation undertaken, the following conclusions are made:

- The project falls within quaternary catchment C22D of the Vaal Water Management Area (WMA). Elevations for the site area range from 1450 to 1500 metres above mean sea level (mamsl) and extend to 1650mamsl towards the western extents of the project area. The project falls in an area with a MAP in the order of 642 mm/yr and an EMA in the order of 1527 mm/yr.
- The surface geology of the study is characterised by alluvium sands (~) along the Klip River floodplain, ferruginous shale and quartzite (Vt) of the Timball Hill Formation and dolomite & chert (Vdm) of the Malmani Formation of the Pretoria and Chuniespoort Supergroups, of the Transvaal Sequence. The presence of dolomite underlying the site has been confirmed by several consultants (refer to Section 5.1).
- Three (3) hydrological response units (HRU) describe the drainage of the local area and are bound towards the east by the Klip River. Surface water drainage is towards the east of the site and from the western hilltops via a perennial tributary of the Klip River, which joins the Klip River approximately 3 km north of the site. The Klip River drains into the Vaal River approximately 30km downstream of the site.
- The site itself is devoid of any recognised drainage lines or rivers/streams, and free flow from overland drainage from the site towards the R59 is noted. Water then passes under the road via several stormwater culverts (both box and circular variants) and free flows towards the Klip River. The closest perennial stream is towards the northwest of the site at a distance of ~1.17 km (dry during the site assessment), and the Klip River, a major river system, is situated approximately 2.5km downstream east of the site.
- According to the Water Allocation Registration Management System (WARMS, 2024), there are 17 WARMS users within a 5 km buffer of the project area, of which 4 groundwater and 1 surface water user falls within the HRU. Based on the WARMS data collected, it is noted that the existing groundwater use is in the order of 0.9 Mm^3/yr, and surface water use is in the order of 4.2 Mm^3/yr.
- A flood line assessment of all recognised rivers/streams was undertaken for rivers falling within a 1 km radius of the site (refer to Section 5). There is no flooding risk associated with the proposed development.
- A stormwater managed plan is presented in Section 6 and is summarised as follows:
    - It is important to note that Graceview Park is not yet complete. According to the Graceview Industrial Park - Services Report for the Construction of Roads, Stormwater Drains, Water and Sewer Reticulation (Willie Coetzee Engineers CC, 2007), the following should be kept in mind for the project area:

- The stormwater reticulation will be sized to accommodate a 1-5-year storm.
- The lie of the land has a granular slope of approximately 0.8% from the high-lying western boundary to the low-lying eastern boundary along the R59 Freeway,
- Due to the lie of the land, stormwater will accumulate along the eastern boundary of the site in the stormwater attenuation pond.
- It was recommended that these attenuation ponds be built with suitably designed outlet structures to reduce the downstream runoff to the 1–50-year pre-development volumes.
- Considering the above-mentioned and the existing stormwater systems on the Site, it is proposed that future systems be sized to accommodate a 1–10-year storm. The stormwater systems for the proposed Project should tie into the existing bulk roads and stormwater system.
- A conceptual water balance is presented in Section 7 of this report and is based on the potential water usage and distributions for the factory.
  - The quantity of water that will be consumed during phase 1 and phase 2 stages of the project is estimated to be 250,000 m^3/year and 325,000 m^3/year, respectively.
  - The quantity of wastewater that will be discharged during phase 1 and phase 2 stages of the project is estimated to be 200,000m^3 /year and 260,000 m^3/year, respectively.

- Several hydrological risks were identified and presented in Section 8, and several mitigation measures can be considered. A water monitoring plan is available in Section 9.

10.1 Identification of any areas that should be avoided

No avoidance areas were identified as part of this assessment. However, it is proposed that the preferred option, as discussed above, be considered for the discharge of the treated effluent. This will minimise the water liabilities for the applicant associated with direct discharge to the Klip River.

10.2 Mitigation measures for inclusion in the EMPr

The following mitigation measures can be implemented as part of the EMPr to further reduce the risk of flooding on site and contribute to stormwater generation potential:

- **Assess the site constraints and any site-specific concerns, including:**

  - Specific vegetation that may need to be identified and/or isolated from the site disturbance.
  - The type of construction should consider landform. Avoid slab-on-ground construction on steep sites.
  - Up-slope drainage catchments that may need to be diverted around the work site.
  - Workspace limitations may require site-specific sediment control measures and/or the extensive use of skips or bins for material storage and waste management.
  - Expected rainfall intensity during the period of disturbance (wet season vs dry season).

- **Stabilise the site entry/exiting points:**
  - A stabilised site access must be established and, if possible, limited to one point only. The access allows for construction vehicles to enter the work area while preventing the unnecessary tracking of sediment onto the nearby environment from multiple locations. A stabilised entry/exit point normally consists of a stabilised rock pad.
- **Prevent erosion & manage stockpiles:**
  - Suitable material storage areas must be located up-slope of the main sediment barrier (e.g., sediment fence).
  - Stockpiles kept on site for more than two weeks will require an impervious cover (e.g., builder's plastic or geofabric) to protect against raindrop impact. Stockpiles of sandy material located behind a sediment fence will only need a protective cover if the stockpiles are likely to be exposed to strong winds.
- **Manage site waste:**
  - Adequate waste containers must be provided on-site and maintained in a way that potential and actual environmental harm resulting from such material waste is minimised.

10.3 Reasoned opinion on whether EA/WULA should be considered

Based on the findings of this assessment, GCS believes that the proposed activities pose a low risk to the hydrological environment. The approval of the activity should be considered to enable the applicant to expand their operations. It is further assumed that mitigation options to offset negative impacts, as predicted by this study, will be implemented into the EMPr during the operational and closure phases of the project.

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APPENDIX A: PEAK FLOW ESTIMATES

HRU01

RATIONAL METHOD 3							
Description of catchment			HRU1				
River detail	Tribuatires of the Klip River (perennial)						
Calculated by	Hendrik Botha				Date	Wednesday, 05 June 2024	
Physical characteristics							
Size of catchment (A)	1.725	km^2		Rainfall region		C2B	
Longest watercourse (L)	2.32	km		**Area distribution factors**			
Average slope (S_{av})	0.0104	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1	0	0	
Mean annual rainfall(MAR)	618	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Vleis and pans (<3%)	71.01	0.03	2.13	**Lawns**			
Flat areas (3 - 10%)	27.25	0.08	2.18	Sandy,flat<2%	0	0.08	0
Hilly (10 - 30%)	1.74	0.16	0.28	Sandy,steep>7%	0	0.16	0
Steep Areas (>30%)	0.00	0.26	0.00	Heavy s,flat<2%	0	0.15	0
Total	100.00	0.53	4.59	Heavy s,steep>7%	0	0.3	0
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	80	0.04	3.20	Houses	0	0.5	0
Permeable	20	0.08	1.60	Flats	0	0.6	0
Semi-permeable	0	0.16	0.00	Industry			
Impermeable	0	0.26	0.00	Light industry	0	0.6	0
Total	100	0.54	4.80	Heavy industry	0	0.7	0
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	65.88	0.04	2.64	City centre	0	0.8	0
Light bush & farm-lands	0.1	0.11	0.01	Suburban	0	0.65	0
Grasslands	20.32	0.21	4.27	Streets	0	0.75	0
No vegatation	13.7	0.25	3.43	Max flood	0	1	0
Total	100	0.61	10.34	Total (C2)	0		0
Time of concentration (TC)							
Overland flow	Defined watercourse						
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$			Use Defined watercourse			
1.694 hours	0.736	hours					
Run-off coefficient							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1	0.197	0.197	0.197	0.197	0.197	0.197	0.900
Adjusted for dolomitic areas, C_{1D}	0.197	0.197	0.197	0.197	0.197	0.197	0.900
Adj factor for initial saturation, F_t	0.5	0.55	0.6	0.67	0.83	1	1.00
Adjusted run - off coefficient, C_{1T}	0.0986355	0.10849905	0.1183626	0.132	0.164	0.197	0.900
Combined run - off coefficient, C_T	0.0986355	0.10849905	0.1183626	0.132	0.164	0.197	0.900
Rainfall							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T	35.52	49.06	59.25	70.38	86.60	100.60	115.98
Point Intensity (mm/h), P_{it}	48.29	66.71	80.56	95.69	117.74	136.78	157.69
Area reduction factor (%),ARF_T	1.077	1.077	1.077	1.077	1.077	1.077	1.077
Average intensity (mm/hour),I_T	51.989	71.812	86.724	103.010	126.752	147.250	169.764
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)	2.457	3.733	4.919	6.524	9.944	13.92	73.21

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment		HRU1					
River detail	Tribuatires of the Klip River (perennial)						
Calculated by	Hendrik Botha				Date	05/06/2024	
Physical characteristics							
Size of catchment (A)	1.725	km^2		Days of thunder per year (R)		39	days
Longest watercourse (L)	2.32	km		Time of concentration, t		44.130	minutes
Average slope (S_{av})	0.010	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87 L^2}{1000 S_{AV}} \right]^{0.385}$		0.7355
SDF Basin	7						
2-year return period rainfall (M)	49	mm					
TR102 n-day rainfall data							
Weather Service Station				MAP		618	mm
Weather Service Station no.				Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$	21.2	35.8	46.8	57.8	72.4	83.4	94.5
Area reduction factor (%),ARF_T	1.077	1.077	1.077	1.077	1.077	1.077	1.077
Average intensity (mm/hour),I_T	31.1	52.4	68.5	84.7	106.0	122.1	138.3
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)		60		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T	0.150	0.312	0.397	0.467	0.546	0.600	0.648
Peak flow (m3/s)	2.23	7.84	13.04	18.93	27.73	35.11	42.95

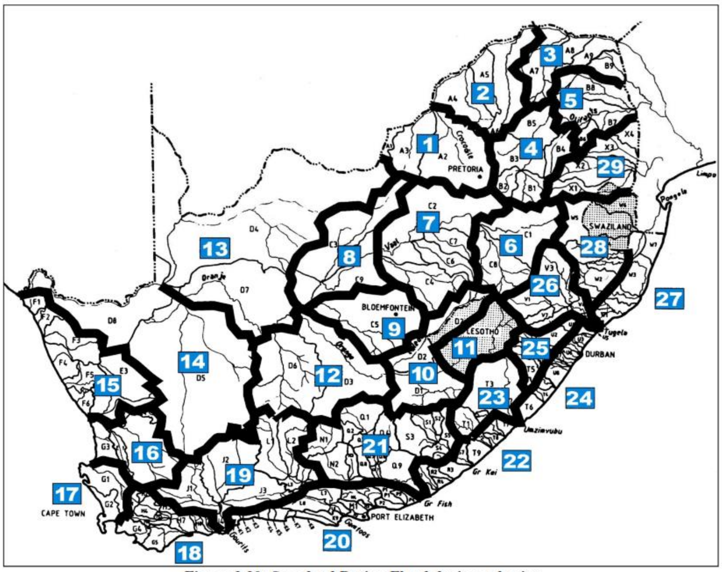
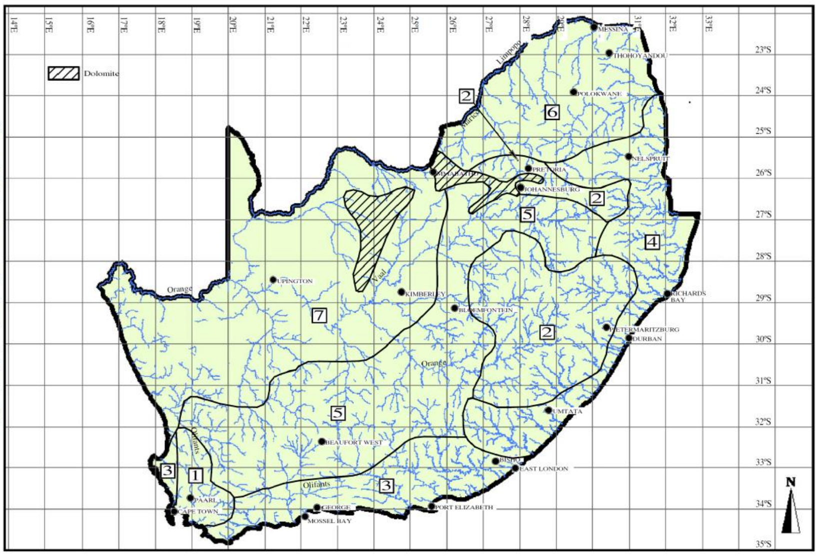


Figure 3.30: Standard Design Flood drainage basins

MIDGLEY & PITMAN (MIPI) METHOD															
River Detail	Catchment Area	MAP	S	L	Lc	Constant K_T				Catchment Parameter	Peak Flows				
	(km^2)	(mm)	m/m	km	km	1:10 year	1:20 Year	1: 50 year	1: 100 year	(Dimensionless)	1:10 year	1:20 Year	1: 50 year	1: 100 year
HRU1	1.725	618	0.0104	2.32	1.81	0.59	0.8	1.11	1.4	0.0419	10.11	13.71	19.02	23.99



HRU02

RATIONAL METHOD 3							
Description of catchment		HRU2					
River detail	Tribuatires of the Klip River (perennial)						
Calculated by	Hendrik Botha				Date	Wednesday, 05 June 2024	
Physical characteristics							
Size of catchment (A)	5.563	km^2		Rainfall region		C2B	
Longest watercourse (L)	3.84	km		Area distribution factors			
Average slope (S_{av})	0.0077	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1	0	0	
Mean annual rainfall(MAR)	618	mm					
Rural				URBAN			
Surface slope	%	Factor	C_s	Description	%	Factor	C2
Vleis and pans (<3%)	59.33	0.03	1.78	Lawns			
Flat areas (3 - 10%)	38.42	0.08	3.07	Sandy,flat<2%	0	0.08	0
Hilly (10 - 30%)	2.22	0.16	0.36	Sandy,steep>7%	0	0.16	0
Steep Areas (>30%)	0.03	0.26	0.01	Heavy s,flat<2%	0	0.15	0
Total	100.00	0.53	5.22	Heavy s,steep>7%	0	0.3	0
Permeability	%	Factor	C_p	Residential Areas			
Very permeable	80	0.04	3.20	Houses	0	0.5	0
Permeable	20	0.08	1.60	Flats	0	0.6	0
Semi-permeable	0	0.16	0.00	Industry			
Impermeable	0	0.26	0.00	Light industry	0	0.6	0
Total	100	0.54	4.80	Heavy industry	0	0.7	0
Vegetation	%	Factor	C_v	Business			
Thick bush & plantation	48.96	0.04	1.96	City centre	0	0.8	0
Light bush & farm-lands	0.53	0.11	0.06	Suburban	0	0.65	0
Grasslands	44.84	0.21	9.42	Streets	0	0.75	0
No vegetation	5.67	0.25	1.42	Max flood	0	1	0
Total	100	0.61	12.85	Total (C2)	0		0
Time of concentration (TC)							
Overland flow	Defined watercourse						
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$			Use Defined watercourse			
2.299 hours	1.217	hours					
Run-off coefficient							
Return Period (years)	2	5	10	20	50	100	PMF
Run-off coefficient, C_1	0.229	0.229	0.229	0.229	0.229	0.229	0.900
Adjusted for dolomitic areas, C_{1D}	0.229	0.229	0.229	0.229	0.229	0.229	0.900
Adj factor for initial saturation, F_t	0.5	0.55	0.6	0.67	0.83	1	1.00
Adjusted run - off coefficient, C_{1T}	0.1143355	0.12576905	0.1372026	0.153	0.190	0.229	0.900
Combined run - off coefficient, C_T	0.1143355	0.12576905	0.1372026	0.153	0.190	0.229	0.900
Rainfall							
Return Period (years)	2	5	10	20	50	100	PMF
Point rainfall (mm), P_T	38.54	53.29	64.37	76.46	94.07	109.25	125.95
Point Intensity (mm/h), P_{it}	31.67	43.78	52.89	62.81	77.29	89.76	103.48
Area reduction factor (%),ARF_T	1.040	1.040	1.040	1.040	1.040	1.040	1.040
Average intensity (mm/hour),I_T	32.922	45.516	54.983	65.305	80.355	93.316	107.584
Return Period (years)	2	5	10	20	50	100	PMF
Peak flow (m3/s)	5.817	8.846	11.657	15.461	23.567	32.97	149.62

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment		HRU2					
River detail	Tribuatires of the Klip River (perennial)						
Calculated by	Hendrik Botha			Date	05/06/2024		
Physical characteristics							
Size of catchment (A)	5.563	km^2		Days of thunder per year (R)		39	days
Longest watercourse (L)	3.84	km		Time of concentration, t		73.030	minutes
Average slope (S_{av})	0.008	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		1.2172
SDF Basin	7						
2-year return period rainfall (M)	49	mm					
TR102 n-day rainfall data							
Weather Service Station				MAP		618	mm
Weather Service Station no.				Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$	24.4	41.1	53.8	66.5	83.2	95.9	108.5
Area reduction factor (%), ARF_T	1.040	1.040	1.040	1.040	1.040	1.040	1.040
Average intensity (mm/hour), I_T	20.8	35.1	45.9	56.8	71.1	81.9	92.7
Run-off coefficient							
Calibration factors C_2 (%)	15		C_{100} (%)	60			
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T	0.150	0.312	0.397	0.467	0.546	0.600	0.648
Peak flow (m3/s)	4.83	16.95	28.20	40.95	59.96	75.93	92.88

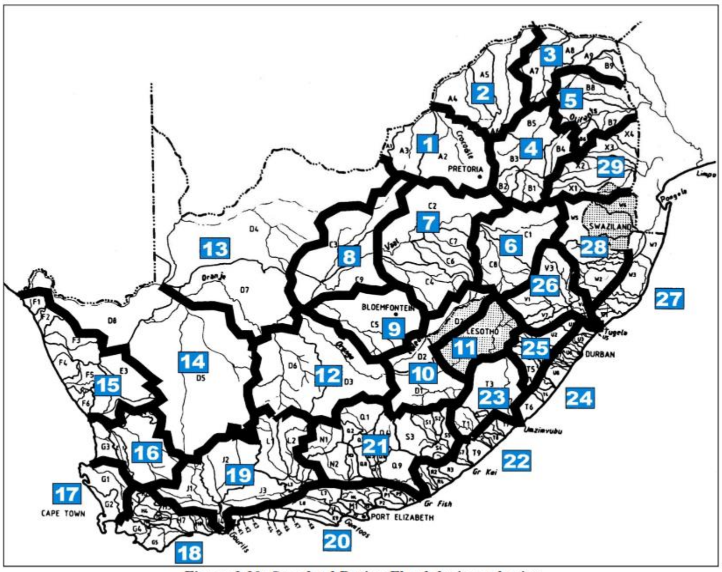


Figure 3.30: Standard Design Flood drainage basins

MIDGLEY & PITMAN (MIPI) METHOD														
River Detail	**Catchment Area**	**MAP**	**S**	**L**	**Lc**	**Constant K_T**				**Catchment Parameter**	**Peak Flows**			
	(km^2)	(mm)	m/m	km	km	1:10 year	1:20 Year	1: 50 year	1: 100 year	(Dimensionless)	1:10 year	1:20 Year	1: 50 year	1: 100 year
HRU2	5.563	618	0.0077	3.84	1.87	0.59	0.8	1.11	1.4	0.0680	22.48	30.48	42.30	53.35

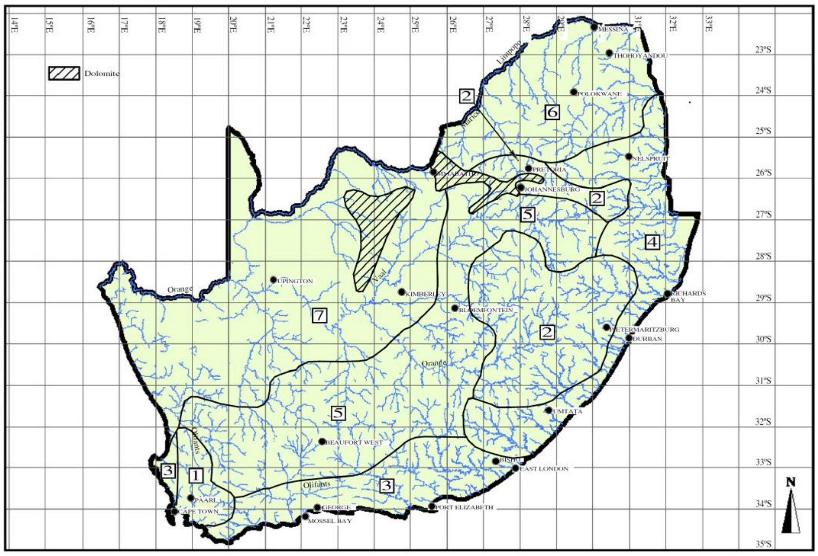


Figure 3.35: Homogeneous flood regions in South Africa

HRU03

RATIONAL METHOD 3							
Description of catchment	HRU3						
River detail	Tribuatires of the Klip River (perennial)						
Calculated by	Hendrik Botha				Date	Wednesday, 05 June 2024	
Physical characteristics							
Size of catchment (A)	40.725	km²		Rainfall region		C2B	
Longest watercourse (L)	14.07	km		**Area distribution factors**			
Average slope (S_{av})	0.0119	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		1	0	0	
Mean annual rainfall(MAR)	618	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Vleis and pans (<3%)	15.44	0.03	0.46	**Lawns**			
Flat areas (3 - 10%)	58.74	0.08	4.70	Sandy,flat<2%	0	0.08	0
Hilly (10 - 30%)	20.88	0.16	3.34	Sandy,steep>7%	0	0.16	0
Steep Areas (>30%)	4.95	0.26	1.29	Heavy s,flat<2%	0	0.15	0
Total	100.01	0.53	9.79	Heavy s,steep>7%	0	0.3	0
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	80	0.04	3.20	Houses	0	0.5	0
Permeable	20	0.08	1.60	Flats	0	0.6	0
Semi-permeable	0	0.16	0.00	Industry			
Impermeable	0	0.26	0.00	Light industry	0	0.6	0
Total	100	0.54	4.80	Heavy industry	0	0.7	0
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	24.67	0.04	0.99	City centre	0	0.8	0
Light bush & farm-lands	0.04	0.11	0.00	Suburban	0	0.65	0
Grasslands	58.1	0.21	12.20	Streets	0	0.75	0
No vegetation	17.19	0.25	4.30	Max flood	0	1	0
Total	100	0.61	17.49	Total (C2)	0		0
Time of concentration (TC)							
Overland flow	Defined watercourse						
$T_C = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$			Use Defined watercourse			
3.809 hours	2.798	hours					
Run-off coefficient							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Run-off coefficient, C_1	0.321	0.321	0.321	0.321	0.321	0.321	0.900
Adjusted for dolomitic areas, C_{1D}	0.321	0.321	0.321	0.321	0.321	0.321	0.900
Adj factor for initial saturation, F_t	0.5	0.55	0.6	0.67	0.83	1	1.00
Adjusted run - off coefficient, C_{1T}	0.1603995	0.17643945	0.1924794	0.215	0.266	0.321	0.900
Combined run - off coefficient, C_T	0.1603995	0.17643945	0.1924794	0.215	0.266	0.321	0.900
Rainfall							
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Point rainfall (mm), P_T	43.30	59.78	72.30	85.82	105.55	122.61	141.35
Point Intensity (mm/h), P_{it}	15.48	21.37	25.84	30.67	37.73	43.82	50.52
Area reduction factor (%),ARF_T	0.971	0.971	0.971	0.971	0.971	0.971	0.971
Average intensity (mm/hour),I_T	15.028	20.747	25.092	29.784	36.633	42.554	49.059
Return Period (years)	**2**	**5**	**10**	**20**	**50**	**100**	**PMF**
Peak flow (m3/s)	27.268	41.411	54.636	72.418	110.341	154.43	499.48

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment		HRU3					
River detail	Tribuatires of the Klip River (perennial)						
Calculated by	Hendrik Botha			Date	05/06/2024		
Physical characteristics							
Size of catchment (A)	40.725	km^2		Days of thunder per year (R)		39	days
Longest watercourse (L)	14.07	km		Time of concentration, t		167.868	minutes
Average slope (S_{av})	0.012	m/m		Time of concentration, T_c	$T_c = \left[\frac{0.87\,L^2}{1000\,S_{AV}}\right]^{0.385}$		2.7978
SDF Basin	7						
2-year return period rainfall (M)	49	mm					
TR102 n-day rainfall data							
Weather Service Station				MAP		618	mm
Weather Service Station no.				Coordinates			
Duration	**Return Period (years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$	29.6	49.9	65.3	80.7	101.0	116.4	131.8
Area reduction factor (%),ARF_T	0.971	0.971	0.971	0.971	0.971	0.971	0.971
Average intensity (mm/hour),I_T	10.3	17.3	22.7	28.0	35.1	40.4	45.7
Run-off coefficient							
Calibration factors / C_2 (%)	15		C_{100} (%)		60		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T	0.150	0.312	0.397	0.467	0.546	0.600	0.648
Peak flow (m3/s)	17.43	61.22	101.87	147.90	216.58	274.28	335.50

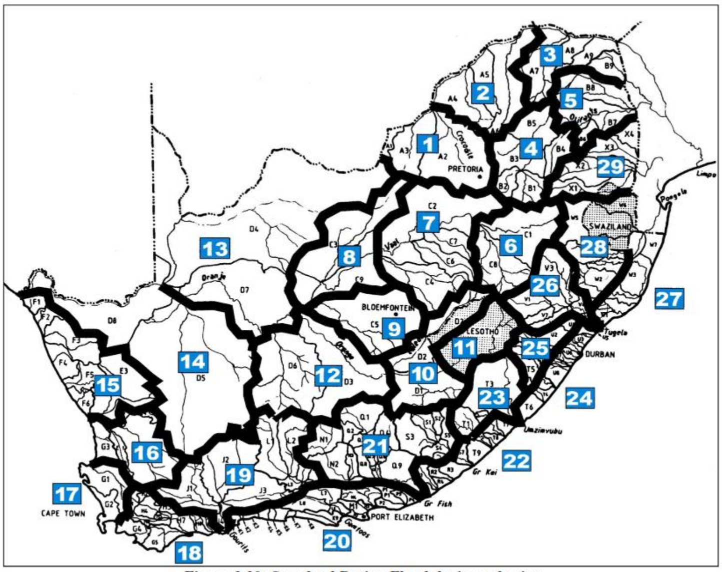


Figure 3.30: Standard Design Flood drainage basins

MIDGLEY & PITMAN (MIPI) METHOD														
River Detail	**Catchment Area**	**MAP**	**S**	**L**	**Lc**	**Constant K_T**				**Catchment Parameter**	**Peak Flows**			
	(km^2)	(mm)	m/m	km	km	1:10 year	1:20 Year	1: 50 year	1: 100 year	(Dimensionless)	1:10 year	1:20 Year	1: 50 year	1: 100 year
HRU3	40.725	618	0.0119	14.1	6.74	0.59	0.8	1.11	1.4	0.0468	68.90	93.43	129.63	163.50

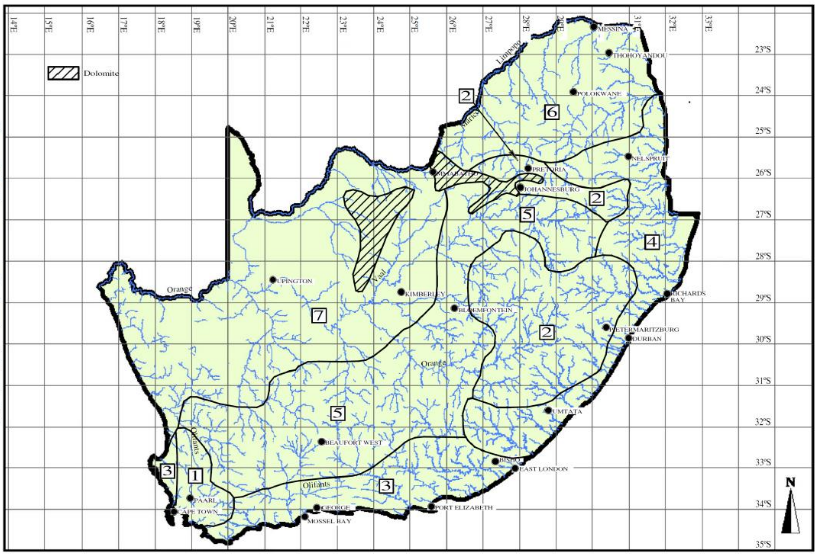


Figure 3.35: Homogeneous flood regions in South Africa

APPENDIX B: DISCLAIMER

The opinions expressed in this Report have been based on site /project information supplied to GCS (Pty) Ltd by Royal HaskoningDHV (RHDHV) and are based on public domain data and data supplied to GCS by the client. GCS has acted and undertaken this assessment objectively and independently.

GCS has exercised all due care in reviewing the supplied information. Whilst GCS has compared key supplied data with expected values, the accuracy of the results and conclusions are entirely reliant on the accuracy and completeness of the supplied data. GCS does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them.

The boreholes that were sited in this investigation are sited according to scientific principles that relate to sub-surface hydrogeological signatures/structures that may act as preferential groundwater flow paths. It should be noted that in some cases (3 out of 10 boreholes), the hydrogeological signatures may indicate high water potential, however, during drilling low yields are observed. For this reason, GCS recommends that a hydrogeological specialist supervises the drilling to ensure that drilling is stopped, or the method is adapted if hydrogeology differs from desktop and sitting data. Even with such oversight and scientific recommendations, a high-yielding borehole is not guaranteed, and GCS cannot be held responsible or liable for dry or low-yielding boreholes or for any hydrogeological or any other condition which may affect the yield volume or yield water quality.

Opinions presented in this report, apply to the site conditions, and features as they existed at the time of GCS's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this report, about which GCS had no prior knowledge nor had the opportunity to evaluate.

APPENDIX C: DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Hydrology Assessment for the Proposed Soufflet Malting Facility

SPECIALIST INFORMATION

Specialist Company Name:	GCS SA (Pty) Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	2	Percentage Procurement Recognition	
Specialist name:	Hendrik Botha			
Specialist Qualifications:	MSc Environmental Sciences (Hydrology & Geochemistry) BSc Hons. Environmental Sciences (Hydrology) BSc. Geology and Chemistry			
Professional affiliation/registration:	PR SCI NAT 400139/17			
Physical address:	23 Roggeveld Street, Vaal Park			
Postal address:				
Postal code:	1947	Cell:		
Telephone:	071 102 3819	Fax:		
E-mail:	hendrikb@gcs-sa.biz			

DECLARATION BY THE SPECIALIST

I, _Hendrik Botha, declare that –

- I act as the independent specialist in this application.
- I will perform the work relating to the application objectively, 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 the specialist report relevant to this application, 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 concerning 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 in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[redacted]

Pr.Sci.Nat (400139/17)

Signature of the Specialist

GCS SA (Pty) Ltd

Name of Company:

17 September 2024

Date

APPENDIX D: CV OF SPECIALIST

Hendrik Botha

Technical Director

LinkedIn:

CORE SKILLS

- Project management
- Analytical and numerical groundwater modelling
- Geochemical assessments and geochemical modelling
- Hydropedology, hydrological assessments & yield assessments
- Hydrology, floodline modelling & storm water management
- Groundwater vulnerability, impact, and risk assessments
- Technical report writing
- GIS and mapping

DETAILS

Qualifications

- BSc Chemistry and Geology (Environmental Sciences) (2012)
- BSc Hons Hydrology (Environmental Sciences) (2013)
- MSc Geohydrology and Hydrology (Environmental Sciences) (2014-2016)

Membership

- Groundwater Division of GSSA
- Groundwater Association of KwaZulu Natal Member
- International Mine Water Association (IMWA)

Languages

- Afrikaans – Speak, read, write.
- English – Speak, read, write.

Projects undertaken in

- South Africa
- Nigeria
- Namibia
- Liberia
- Malawi

PROFILE

Hendrik (Henri) Botha is currently the Technical Director at GCS Water and Environment. He holds an MSc in Environmental Science in Geohydrology & Geochemistry, and a BSc Hons. Degree in Hydrology. He is registered as a SACNASP Professional Natural Scientist in the Earth Science Field. Groundwater, geochemistry and surface hydrology, as well as knowledge of water chemistry together with GIS, and analytical and numerical modelling skills, are some of his sought-after expertise. General and applied logical knowledge are his key elements in problem-solving.

Professional Affiliations:

SACNASP Professional Natural Scientist (400139/17)

Areas of Expertise:

- Project Management of water and environmental projects for mining, industrial and agriculture sectors.
- Integrated Water Investigations
- Waste classification and Impact Assessments
- Aquifer vulnerability assessments
- Geochemical sampling, data interpretation and modelling
- Groundwater impact and risk assessments
- Numerical and Conceptual Visual Modelling (Visual Modflow, ModflowFLEX, Voxler, RockWorks, Surfer and Excel)
- Hydropedology (Hydrological Soil Types) & Soils Assessments
- Floodline Modelling (HEC-RAS)
- Conceptual Stormwater Management Assessments
- Surface Water Yield Assessments
- Water and Salt Balances

SCAN ME
PROJECT RECORD

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