Altra Watech

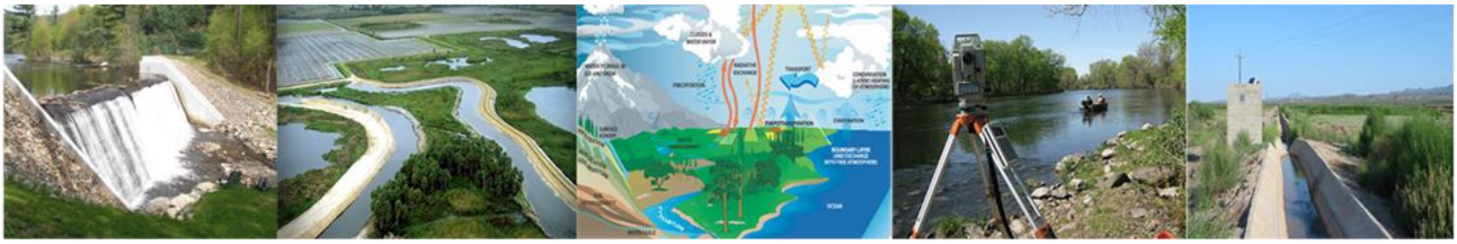
Hydrological Assessment for Ipelegeng Wastewater Treatment Works

Report

Version – 1

07 June 2023

Client Reference: Ipelegeng WWTW - Hydrological Assessment



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Report

DOCUMENT VERIFICATION

TITLE: Ipelegeng WWTW - Hydrological Assessment	
Report Number	**22- 1001 - 05**
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SPECIALIST DECLARATION:

Altra Watech (Pty) Ltd has objectively undertaken this assessment, even if this results in views and findings that are not favourable to the client. Altra Watech has the expertise required to undertake specialist hydrological assessment studies, including flood risks, and this report presents the results objectively. The report's author is a hydrologist with an MSc degree in Hydrology with 8 years of experience in various hydrology, water resources assessment, planning, and management studies. Mr. Mazibuko is registered with the South African Council of Natural Scientific Professions under Hydrological Sciences Category.

Verification	Name	Signature	Date
Author	Sbongiseni Mazibuko (Hydrologist) ***Pr. Sci. Nat***	[signature]	April 2023
Reviewer	Lungile Lembede (Hydrologist) ***Pr. Sci. Nat***	[signature]	June 2023
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SPECIALIST DETAILS AND DECLARATION

Specialist Details

Sbongiseni Mazibuko is a hydrologist, focusing on hydrological perspectives of land use management and climate change. Throughout his university career, he has mastered numerous models and tools relating to water resources assessments, mine and flood hydrology, static and dynamic water balances, stormwater and water conservation water demand management plans, remote sensing, and GIS. Some tools he has widely used include HEC-RAS, WRSM2000, WRYM, ArcGIS, QGIS, PCSWMM, WSART, and GoldSIM. He has some basic programming skills in the Python and Google Earth Engine scripting platforms.

Sbongiseni has worked on numerous projects for various clients ranging from mining, agriculture, and public entities, including hydrological assessments, water balances, stormwater planning and management, floodline modelling, catchment yield assessments, and water conservation and water demand management plans.

Declaration

This report has been prepared in accordance with Section 13: General requirements for environmental assessment practitioners (EAP) and specialists, as well as per Appendix 6 of GNR 982 – Environmental Impact Assessment Regulations and the National Environmental Management Act (NEMA No. 107 of 1998 as amended 2017) and Government Notice 704 (GN 704). It has been prepared independently of influence or prejudice by any parties.

I, *Sbongiseni Christian Mazibuko*, declare that –

- I act as the independent specialist in this application,
- I consider the information contained in this report to be true and correct,
- I do not have any vested interest (i.e., business, financial, personal, or other) in the project other than remuneration for work performed in terms of the EIA Regulations, 2014
- I conducted the work relating to the project in an objective manner in line with my profession and regulatory body and within the confines of the applicable legislation.

Mr. Sbongiseni Christian Mazibuko

MSc Hydrology, (*Pr.Sci.Nat* reg number: 011204)

LIST OF ACRONYMS

BGIS	Biodiversity Geographic Information System
CMA	Catchment Management Agency
DFFE	Department of Forestry, Fisheries and the Environment
DSM	Digital Simulation Model
DWS	Department of Water and Sanitation
EDTEA	Dept. of Economic Development, Tourism and Environmental Affairs
EIA	Environmental Impact Assessment
EMPr	Environment Management Programme
GIS	Geographic Information System
GPS	Geographic Positioning System
IWULA	Integrated Water Use License Application
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NNMDM	Ngaka Modiri Molema District Municipality
NWA	National Water Act (Act No. 36 of 1998)
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
RM	Rational Method
RQOs	Resources Quality Objectives
SDF	Standard Design Flood
WMA	Water Management Area
WR2012	2012 South African Water Resources Study
WULA	Water Use License Application
WUL	Water Use License
WWTW	Wastewater Treatment Works

EXECUTIVE SUMMARY

Enviroworks (Pty) Ltd, on behalf of Moedi Consulting Engineers (Pty) Ltd, appointed Altra Watech (Pty) Ltd to carry out a hydrological assessment for the proposed Ipelegeng Wastewater Treatment Works (WWTW), which comprises four oxidation ponds and an artificial wetland that receive sewage from Ipelgent Township. The site is located on farm portion 01 of Farm 65 Schweizer-Reneke Town and Townlands within Mamusa Local Municipality in the North-West Province of South Africa. The Harts River drains its runoff with quaternary C12A to C12F of the Lower Vaal Water Management Area (WMA) and flows past the Wentzel Dam which is located could potentially cause impacts on the surface water receptor in the study site and its surroundings. This, therefore, necessitated a need to conduct a hydrological assessment study that will identify, evaluate, quantity and draw mitigation measures of the identified impacts that the implementation of the proposed project could cause. Results from the specialist study were aimed at supporting the Water Use Licence Application (WULA) in terms of the National Water Act (NWA 36 of 1998) and the Environmental Authorisation (EA) process of Environmental Impact Assessment (EIA) Regulations of 2014, as amended on 07 April 2017 as part of the National Environmental Management Act (NEMA 107 of 1998) and, for, respectively.

Ipelegeng WWTW surroundings are characterised by a relatively flat landscape dominated by grassland, dry agricultural land and formal and informal settlements. The analysis of the 90-year records from the 2012 South African Water Resources Study (WR2012) indicated the Mean Annual Precipitation (MAP) and Mean Annual Evaporation (MAE) for the study area were calculated at 506 mm and 1 830 mm, 11mm, respectively (Bailey & Pitman, 2015). A 30m Advanced Land Observation System (ALOS) global Digital Simulation Model (DSM) data were used to delineate catchment draining to the proposed site of development, catchment hydraulic characteristics used in the determination of a floodline while a 5m contour data were used to derive the river geometry used in the 1-D hydraulic model through the use of HEC-RAS software. Information collected during the site visit, together with the visual assessment of Google Earth (historic) satellite imagery were also used to evaluate land use/cover and riparian elements that could affect flood water through setting the Manning n coefficient values, drive the impact assessment of the identified surface water-related features that could be at risk as a result of the construction, operating, decommissioning and closure of the proposed WWTW.

The Rational Method was employed to determine the 1:100-year flood peak volume for the events at the study using the Utility Programmes for Drainage (UPD) software for the sub-drainage area downstream of Wentzel Dam. This was primarily based on the assumption that the flood volumes from the areas upstream of the dam would be attenuated and only the overspill from this dam will contribute to the overall peak flood volume. Therefore, the effect of the dam was not included in the peak flow calculations which indicated a magnitude of 110.1m3/s. Simulation results show that the WWTW site is prone to flooding as the infrastructure falls within the 1:100-yr flood line. However, there were discrepancies in the 5m contour data that did not adequately represent the flood inundation areas. These data show a topography with a width of 400 m which the infrastructure falls within and does not account for actual variation on the ground. Hozirontal flow profiles also show that the expected water depth for the calculated flow peaks does not exceed 0.2m – contributing to the uncertainty from what is expected. While these results were observed, Section 21 of the NWA stipulation indicates that the infrastructure is compliant as it is located away from a 100m horizontal line from the Harts River's edge.

Sensitivity analysis of the identified water features shows that all wetland features in the area surrounding the study site are unprotected and the proposed WWTW structure falls outside of the SANBI buffer zone. Surface water impacts for the identified sensitive receptor show that during the **construction phase**: *Increased surface runoff, erosion and siltation of the downstream water resources could affect water quality downstream due to the surface compaction as a result of heavy machinery, removal and topsoil and vegetation cover. Surface water pollution due to accidental oil spillages, improper on-site waste handling, storage and disposal of chemicals. Alteration of the site's natural, pre-existing surface water drainage patterns influencing local hydrology and the existing swamps. Damage to the infrastructure and potential life loss due to the flooding of the Harts River be implemented*. **During the operational phase**: *Pollution of the surrounding (environment) and downstream water resources due to non-compliant effluent discharged to the environment, accidental fuel/chemical/hydrocarbon spills on site and the lack of proper system performance management and maintenance*. **During the decommissioning and closure phases of the project:** *the pollution of the surrounding (environment) and downstream water resources as a result of contaminants washing off from the WWTW infrastructure and accidental spillages during the demolition and rehabilitation process. Modifying the local hydrologic conditions may change groundwater recharge patterns and overland runoff and introduce alien invasive plants*.

The following recommendations were made: **during the construction phase of the WWTW**, (i) clearing of the construction site be kept to a minimum extent while the movement of heavy machinery is also limited, (ii) installation of silt traps and the construction of temporal ponds to collect stormwater in the lowest point of the construction site is also recommended, while (iii) on-site waste and spill collection and disposal plans need to be implemented, and (iv) construction site must be located outside the 100m horizontal line from the Harts River to reduce flooding risks that are likely to occur during summer. **During the operational phase**, (i) routing maintenance of the WWTW system and its water quality monitoring plan needs to be implemented to ensure that the efficiency of the WWTW system is monitored to reduce the risks of discharging non-compliant effluent to the downstream water resources, (ii) surface water monitoring plan must be drafted and implemented while the performance of the WWTW must ensure that it complies with the WWTW discharge limits as well as ensure that the targets of the RQOs for the water resources in the WMA are met or improved. Compliance with the recommended activities during the decommissioning and closure phases of the project is recommended to protect against the deterioration of the surface water in the surrounding environment during the **decommissioning and closure phases** of the project.

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SPECIALIST DETAILS AND DECLARATION

Specialist Details

Sbongiseni Mazibuko is a hydrologist focusing on hydrological perspectives on land use management and climate change. Throughout his university career, he has mastered numerous models and tools relating to water resources assessments, mine and flood hydrology, static and dynamic water balances, stormwater and water conservation, water demand management plans, and remote sensing and GIS. Some tools he has widely used include HEC-RAS, WRSM2000, WRYM, ArcGIS, QGIS, PCSWMM, WSART, and GoldSIM. He has basic programming skills in the Python and Google Earth Engine scripting platforms.

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I, *Sbongiseni Christian Mazibuko*, declare that –

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- I do not have a conflict of interest in this project, and
- I conducted the work relating to the project objectively in line with my profession and regulatory body and within the confines of the applicable legislation.

Mr. Sbongiseni Christian Mazibuko

MSc Hydrology, (*Pr.Sci.Nat* reg number: 011204)

1 INTRODUCTION

Enviroworks (Pty) Ltd, on behalf of Moedi Consulting Engineers (Pty) Ltd, appointed Altra Watech (Pty) Ltd to conduct a hydrological assessment for the Ipelegeng Wastewater Treatment Works (WWTW) located in farm portion 01 of Farm 65 Schweizer-Reneke Town and Townlands within Mamusa Local Municipality in the North-West Province of South Africa. The study site is in the headwater of quaternary catchment C31F of the Vaal Water Management Area (WMA) and the site flows adjacent to the Harts River downstream of the Wentzel Dam.

The local municipality proposes a site to locate and construct an oxidation pond system to treat wastewater from the Ipelegeng township. A desktop sensitivity assessment for the proposed site conducted by Enviroworks identified surface water as one of the potential receptors that could be affected by the oxidation pond system's construction, operation, and closure. Therefore, a hydrological study was required to evaluate all relevant elements that could be affected by the construction, operation, decommissioning, and closure of the proposed oxidation pond system. Results from this specialist assessment study report are in support of the Water Use Licence Application (WULA) in terms of the National Water Act (NWA 36 of 1998) and Environmental Authorisation as per the National Environmental Management Act (NEMA 107 of 1998) and Environmental Impact Assessment (EIA) Regulations of 2014, as amended on 07 April 2017.

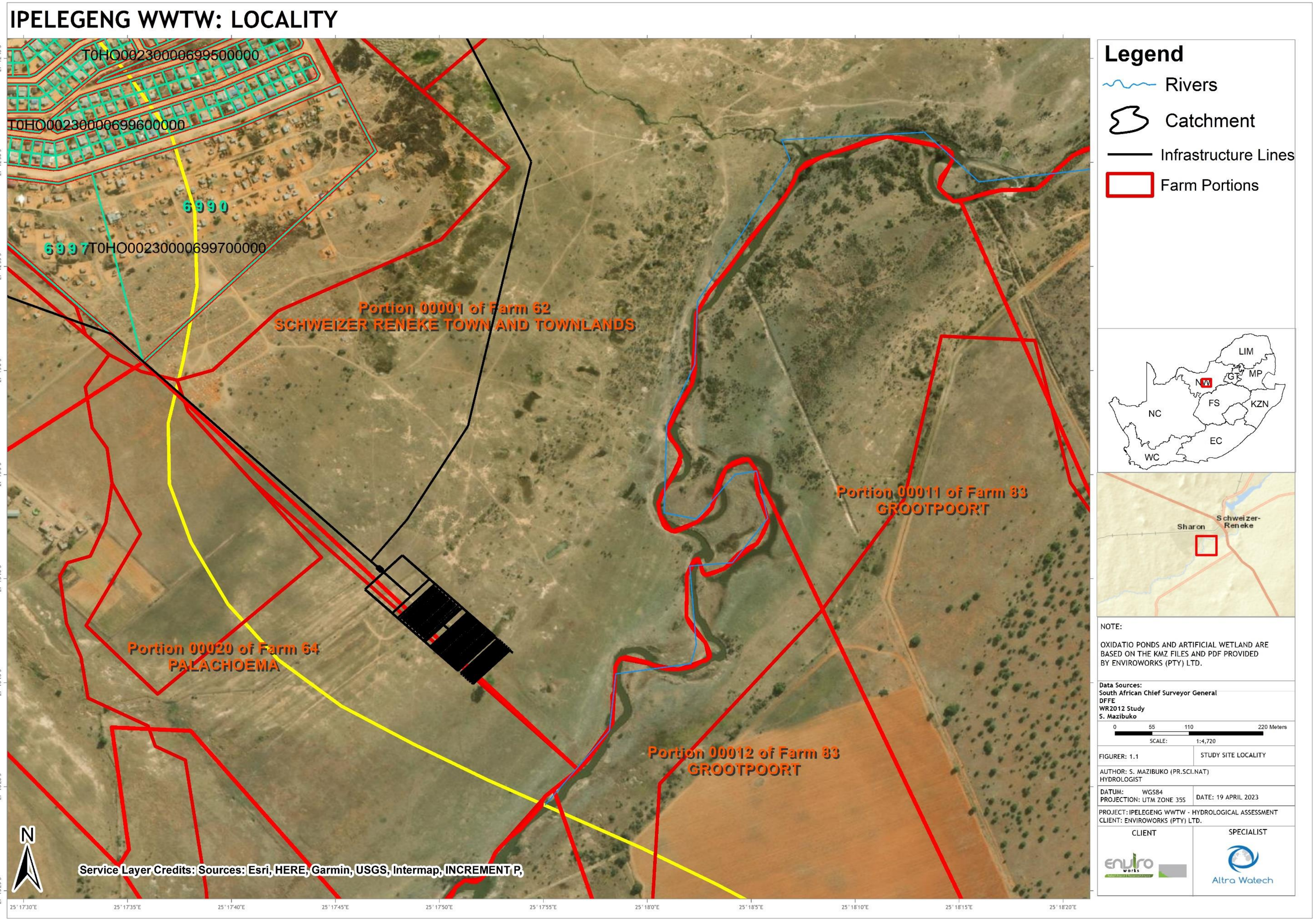


Figure 1.1: Location of the proposed Ipelegeng WWTW's Oxidation Ponds

2 SCOPE OF WORK

The scope of work for this study was defined as follows:

1. Site Visit:
    - Site visit to identify all surface water receptors and obtain in-situ water quality data of the water features in the area.
2. Desktop Study and Information Sourcing:
    - Relevant data and information collection, and
    - Review the existing literature and applicable regulations and guidelines on water and environmental aspects for the WWTW site, Water Use Licence Applications, and Environmental Impact Assessment processes.
3. Baseline Hydrology:
    - Delineation of the catchment and the physiological setting,
    - A general preview of previous meteorological (climate, temperature, rainfall and evaporation) and hydrological analysis (Mean Annual Precipitation (MAP), and Mean Annual Evaporation (MAE) will be verified and updated where required,
    - Drainage characteristics and the calculation of the design rainfall, peak flow volumes (1:100-year return period event), runoff, and evaporation volumes.
4. Flood Line Assessment:
    - Setting up the HEC-RAS hydraulic modelling software for the river sections (Figure 1.1) to be modelled; and
    - Mapping and analysis of the flood lines modelling results.
5. Surface Water Impact Assessment:
    - Identify, evaluate and quantify surface water impact elements related to the construction, operation and decommissioning of the proposed, and
    - Derive mitigation measures.
6. Reporting:
    - A report detailing the results of all the activities listed above will be compiled, and this will include conclusions and recommendations.

3 METHODOLOGY

3.1 Desktop Study and Information Sourcing

A review of the applicable national and regional legislation relating to environmental authorisation and water use licensing for the WWTW was evaluated and applied in the context of this study. Additional reports relating to the study in the context of hydrology, design and operational philosophy were also obtained to guide the study. Essential information on water use and other elements that affect the movement and distribution of water in the upstream area. Hydrometeorological data representing the study site were collected and analysed to formulate a baseline understanding of local hydroclimatic regimes. Satellite imagery retrieved via Google Earth Pro, the 2020 land use/land cover database from the Department of Forestry Fisheries and Environment (DFFE) and the information obtained during the site visit were used to derive land use and land cover characteristics to describe the existing conditions. The three data sources were also used to derive information on operations and elements that could affect the environment due to the construction, operation and decommissioning and closure of the WWTW, as well as to estimate catchment parameters that affect the calculation of peak flows.

3.2 Site Visit and Baseline Water Quality

A site visit was undertaken on the 27th of January 2023 to have a site walk-over to gather essential information about the proposed WWTW location and its surrounding environment and identify elements that could affect peak flow calculations. Various natural features relating to surface water were identified as a receptor of potential impacts that may arise from the construction and operation of the proposed Ipelegeng WWTW. A multiprobe water quality meter (Aquaprobe AP-800) was used to record in-situ water quality basic parameters on the Harts River at a point slightly downstream of the proposed development site. In-situ sampling followed surface water sampling procedures from the DWS water quality sampling guidelines. Parameters included Temperature (°C), Electric Conductive (EC), Total Dissolved Solids (TDS), and pH (-).

Data from in situ water quality parameters were recorded to provide information on the state of baseline water quality within the area and identify elements of water pollution that could result from the proposed WWTW. These data were compared with the regional water quality data from DWS, as well as the published measures of the Resource Quality Objective measures (RQOs) within the Lower Vaal WMA (DWS, 2016) in line with the goals of the proposed National Water Resources Strategy, vision 3 (DWS, 2021).

3.3 Baseline Hydrology

3.3.1 Hydrometeorology

The 30 m ALOS Digital Simulation Model (DSM) data from the Japanese Aerospace Exploration Agency (JAXA) (Tadono, et al., 2014) was used to delineate the boundary of the catchment to the outlet point. Rainfall data for the study sites were obtained from the 2012 South African Water Resources (WR2012) Study (Bailey & Pitman, 2015). These data sets represented average rainfall estimates in the basin and were used to derive baseline hydrological settings such as Mean Annual Precipitation (MAP). The WR2012 database was also used to derive the Mean Annual Evaporation (MAE) and Mean Annual Runoff (MAR) for the study sites to have essential insights into the significant catchment water balance losses.

For floodlines assessment, the 24-hour design rainfall depths were derived using the Daily Rainfall Extraction Utility (Smithers & Schulze, 2002) software and were used to calculate the peak flow volume. Furthermore, detailed, up-to-date land cover/land use data from the Department of Forestry, Fisheries and the Environment (DFFE) and information obtained during the site visit were used to derive catchment elements that are likely to be affected by the operations of the WWTW and the local hydrological flow regimes of the study site.

3.3.2 Design Rainfall and Peak Flow Calculations

The design rainfall depths and the determination of the peak flow discharge volume for the 1:100-year return period event were calculated for the delineated drainage area. The design rainfall depths are essential for calculating the peak flow volume methods widely used in South Africa. The computed peak flow volumes were then routed in a hydraulic model to simulate the 1:100-year flood event for the modelled river.

The appropriate methodology to calculate peak flow volume depends mainly on the size of the contributing catchment and the level of hydrological data available (e.g., gauged peak flow values and design rainfall data) for a particular catchment. While it is a common practice to use at least three methods, in the case of this study, the methodology used to calculate the peak discharge values associated with the large catchments was adopted. Procedures for using the Standard Design Flood (SDF), Rational Method and Rational Method Alternative are explained in the South African Drainage Manual (SANRAL, 2013).

3.3.3 Rational Method

The peak flow equation for the Rational Method is based on a runoff coefficient, the catchment's average rainfall intensity, and the catchment's effective area. Calibration of the runoff coefficients for the drainage area was guided by understanding the effective runoff-generating processes and land cover attributes derived from the visual assessment of Google Earth images. The resulting peak flows calculated using the selected methods are evaluated and their values provide inputs into the HEC-RAS 1-dimensional steady-state hydraulic model. Design rainfall depths are one of the essential inputs into the Rational Method. Design rainfall depths for the study site catchment were obtained from the Design Rainfall Estimation Program (Smithers and Schulze, 2003). The determination of the catchments' applicable average design rainfall intensity was undertaken by calculating the following variables for the study catchment:

- The time of concentration (T_c) to determine the relevant design rainfall depth for the study site catchment,
- The point rainfall intensity at the catchment centroid (centre of the catchment),
- The areal reduction factor to account for the spatial distribution of the rainfall intensity over the study catchment, and
- The average rainfall intensity over the study catchment.

3.3.4 Standard Design Flood Method

The SDF method was developed by Alexander (2002) to provide a uniform approach to flood calculations. The method is based on a calibrated discharge coefficient for a recurrence period of 2 to 100 years. Calibrated discharge parameters are based on historical data and were determined for 29 homogeneous basins in South Africa. The other inputs used in the SDF method for calculating the maximum discharge value of 1:100 years are the catchment area, the length of the longest river course, the catchment height difference, the annual maximum rainfall, and the average days when thunder was heard. This method was chosen due to the size of the catchment.

3.4 Flood Line Modelling

The river hydraulic geometry data were prepared using catchment characteristics information from a 30m Digital Simulation Model (DSM) data using the HEC-RAS software (US Army Corps of Engineers, 2018). A 1D hydraulic model for the modelled river section was constructed to route a steady-state flow regime using the derived peak flows software and the visual assessment of Google Earth imagery (Google, 2022). These included slopes, hydraulic length, and Manning's n values for the modelled river section. The resulting calculated peak flow values were used to simulate the 1:100-year flood lines and were mapped in Geographic Information System (GIS) software and included a 100 m buffer per Section 21 of the NWA.

3.5 Impact Assessment

3.5.1 Sensitivity Assessment

Identified surface water features considered sensitive within and surrounding the oxidation pond's proposed site were conducted using the information obtained during the site visit and the existing open water bodies and wetland features from the SANBI database. This aimed to ensure that the proposed development is not conducted on the surface water features classified as projected or with endangered habitat.

3.5.2 Surface Water Impact Assessment

An impact assessment on the legal and regional hydrology was undertaken using the impact assessment methodology guidelines provided regarding the NEMA EIA regulations, 2014. An impact assessment aimed to identify and assess all impacts that may arise from the construction, operation, and closure of the proposed Ipelegeng WWTW. In doing so, the calculated significance of each identified potential impact is used to guide the relevant competent authorities and other stakeholders in the decision process associated with either authorising the activity to go ahead or not. This decision is based on the impacts, the potential to mitigate their negative effects on the receiving environment or the irreversibility of the potential impacts. As part of broader Environmental Impact Assessments, Environmental Authorisations are conducted to analyse and predict the nature, extent, duration, magnitude and likelihood of significant environmental impacts due to the specific activity.

An impact assessment on the local and regional hydrology resulting from the activity in question was undertaken using the impact assessment methodology guideline derived from the EIA Regulations of the NEMA (Act No. 107 of 1998). The assessment of the identified potential impacts on the activities of the proposed Ipelegeng WWTW was addressed in a standard manner so that a wide range of impacts are comparable. The impacts, in this case, are generally classified as follows.

- ***Direct impacts*** are impacts caused directly by the activity and generally occur at the same time and the place of the activity. These impacts are usually associated with the operation or maintenance of activity and are generally evident and quantifiable.

- ***Indirect impacts*** of an activity are indirect or induced changes that may occur due to the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or that occur at a different place as a result of the activity.

- ***Cumulative impacts***, in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities.

Figure 3.1 shows a graphic representation of a risk-based approach employed in undertaking the impact assessment and the ranking. This approach uses a typical risk matrix in the 5 x 5 configuration which considers likelihood and consequence in analysing the potential impact risk.

Reporting Matrix		1	2	3	4	5
		Insignificant	Minor	Moderate	Major	Catastrophic
5	Almost certain					
4	Likely					
3	Moderate					
2	Unlikely					
1	Rare					

Figure 3.1: Risk-based reporting matrix

3.5.3 Risk-Based Approach - Mitigation Measures

The *likelihood* of an impact occurring was determined by assessing the frequency of the identified activity, the frequency of the impact, the extent to which the activity is regulated and the ability to detect the occurrence of the impact, according to the criteria in Table 3.1. The *consequence* was determined by assessing the spatial scale, duration, and severity (see Table 3.2, and the *significance* was then determined and assigned either a low, medium or high.

Table 3.1: Frequency and detection components of the impact assessment

1. FREQUENCY OF THE ACTIVITY	
DESCRIPTION	**RATING**
Annually or less	1
6-monthly	2
Monthly	3
Weekly	4
Daily	5
2. FREQUENCY OF THE IMPACT	
DESCRIPTION	**RATING**
Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5
3. REGULATION	
No guidelines, standards, or legislation	3
Covered by guidelines, standards, or legislation	1
4. DETECTION	
DESCRIPTION	**RATING**
Immediately	1
Without much effort	2
Needs some effort	3
With major effort	4
Remote or difficult to detect	5

Table 3.2: Likelihood components of the impact assessment

1. SPATIAL SCALE	
DESCRIPTION	**RATING**
Area specific (at impact site)	1
Entire site (entire project area)	2
Local (5 km of site)	3
Regional / neighbouring areas (5 – 50 km of site)	4
National	5
2. DURATION	
DESCRIPTION	**RATING**
One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity (permanent)	5
3. SEVERITY	
DESCRIPTION	**RATING**

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

The components of the identified impacts are evaluated using the computation presented in Table 3.3.

Table 3.3: Matrix calculation

DESCRIPTION	CALCULATION
Consequence	= Severity + Spatial Scale + Duration
Likelihood	= Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk	= Consequence X Likelihood
Priority factor	= (Public response + Cumulative impact + loss of resource) / 3
Prioritised risk	= Significance x Priority factor

3.5.4 Impact Mitigation Actions

Impact mitigation actions are proposed after the likelihood, consequence, and significance determinations. According to the 2014 NEMA EIA Regulations, mitigation means 'to *anticipate and prevent negative impacts and risks, then minimise them, rehabilitate or repair impacts to the extent feasible*." Under this condition, impact mitigation actions, which strive to align with the impact management outcomes identified, are impact specific for the project phases.

3.5.5 Risk-Based Approach – After Impact Mitigation Action Determination

After mitigation measures were established, the likelihood and consequence were re-assessed in terms of the criteria presented in Table 3.1 and Table 3.2, considering the proposed impact mitigation actions. Through this process, the analysis of the potential impact risk following the impact mitigation action plan's implementation was determined. The significance was re-assessed to determine whether the mitigation measures and action plans proposed serve to lessen the significance of the identified impact.

3.5.6 Risk-Based Approach Visual Representation

The identified impacts before mitigation were plotted in the corresponding single square on the Risk-Based Reporting Matrix to identify ways to move implications from almost certain and catastrophic risk zones to insignificant and rare risk zones in the Risk-Based Reporting Matrix illustrated in Figure 3.1. In this way, the risks associated with each impact, with or without the implementation of impact mitigation actions, can be visually presented and will easily show how, through the implementation of appropriate impact mitigation actions, the likelihood and consequence of identified impacts can be improved.

3.6 Assumptions and Limitations

In accordance with the EIA Regulations GN R982 Appendix 1(3)(o), the following constraints and assumptions may have affected this hydrological assessment:

- The information provided by the client forms the basis of guiding the study.
- EnviroWorks provided the position and layout of the proposed Ipelegeng WWTW and this study was entirely based on the location provided. If the layout is changed in anyway, it was assumed that the amended layout will be submitted to the Altra Watech specialist and this report amended (if required).
- Seasonal changes in the hydrological regimes affecting the area's water quality were not accounted for in the analysis.
- This study did not include water quality analyses through a SANAS-accredited laboratory, and thus a handheld Aqua probe AP-800, which was calibrated prior to use, was utilised to measure the in-situ water quality.
- All oxidation ponds were assumed to be lined to reduce seepage to the groundwater.
- The assessment of impacts and recommendation of mitigation measures drawn were informed by site-specific issues based on the specialist’s working knowledge and experience with similar activity projects and were conducted explicitly for the project.

4 DESKTOP ASSESSMENT

The following sub-sections present the dataset and information obtained during the desktop phase of the hydrological assessment study.

4.1 Applicable Legislation

This study was conducted in accordance with consideration of the following legislation and regulation:

4.1.1 National Water Act

The National Water Act, 1998 (Act No. 36 of 1998) (NWA) was developed to protect water resources in South Africa. The NWA recognises that water resource management aims to achieve the sustainable use of water for the benefit of all users. Following the provisions of the National Water Act (No. 36 of 1998) (NWA), all "water uses "must be licensed with the Competent Authority. The DWS is responsible for the effective and efficient management of water resources to ensure sustainable economic and social development in accordance with the NWA. DWS is also responsible for evaluating and issuing licences about water use (i.e., Water Use Licences (WULs) and/or registration of General Authorisations (GAs) where this is applicable.

A "water use" considered for this study defined, as defined in Section 21 of the NWA, includes the underlined activities:

a) Taking water from a water resource,
b) Storing water,
c) Impending or diverting the flow of water in a watercourse,
d) Engaging in streamflow reduction activity contemplated in Section 36 of the NWA,
e) Engaging in a controlled activity identified as such in Section 37 (1) or declared under Section 38 (1) of the NWA,
f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduits,
g) Disposing of waste in a manner which may detrimentally impact a water resource,
h) Disposing of waste in a manner of water which contains waste from, or which has been heated in any industrial or power generation process,
i) Altering the bed, banks, course, or characteristics of a watercourse,
j) Removing, discharging, or disposing of water found underground if it is necessary for the efficient continuation of an activity or the safety of people, and
k) Using water for recreational purposes.

In relation to Section 21 (g & h) of the NWA, the location of wastewater storage dams and wastewater disposal sites must be allocated –

a) outside of a watercourse,
b) above the 100-year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, which ever is further; and
c) on land that is not, or does not, overlie, a Major Aquifer (identification of a Major Aquifer will be provided by the Department upon written request).

Section 19 of the NWA deals with the prevention and remedying effects of pollution to water resources and includes the following:

1. An owner of land, a person in control of land or a person who occupies or uses the land on which –
   a) any activity or process is or was performed or undertaken; or
   b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.
2. The measures referred to in subsection (1) may include measures to –
   a) cease, modify or control any act or process causing the pollution;
   b) comply with any prescribed waste standard or management practice;
   c) contain or prevent the movement of pollutants;
   d) eliminate any source of the pollution;
   e) remedy the effects of the pollution; and
   f) remedy the effects of any disturbance to the bed and banks of a watercourse.

DWS General Notice 509 read with the interpretation of Section 21(i) of the NWA water uses mean the regulated area of the a watercourse relates to:

a) The outer boundary of the 1:100year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse;

c) A 500m radium from the delineated boundary of any wetland or pan

4.1.2 National Environmental Management Act

The National Environmental Management Act (Act No. 107 of 1998) (NEMA) pertains to Environmental Authorisations (EAs), and requires that the potential consequences for, or impacts of, listed or specified activities on the environment be considered, investigated, assessed, and reported on to the competent authority. The 2014 Environmental Impact Assessment (EIA) Regulations, as amended (GNR 326) published under NEMA, prescribe the process to be followed when applying for EA.

The activities listed in Table 4.1 triggered the Section 24G process of the NEMA:

Table 4.1: Applicable General Notices for the triggered activities

Name of activity	Applicable listing notice (GNR 544, GNR545, GNR546)
Construction	11. Construction of— (iv) dams, and (ix) infrastructure or structure covering 50m2 or more Where such than 25 000 chicks younger than 20 days per facility situated outside an urban area.
	18. The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from a watercourse
	55a. The construction of facilities for the treatment of effluent, wastewater or sewage with a daily throughput capacity of more than 2000 cubic metres but less than 15 000 cubic metres
	5. The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent and which is not identified in Notice No. 544 of 2010 or included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply.
	13. The clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, except where such removal of vegetation is required for: (1) the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the National Environmental Management Waste Act, 2008 (Act No. 59 of 2008) in which case the activity is regarded to be excluded from this list.

4.2 Desktop Tools

The summary and the description of the datasets ustilised in the desktop assessment are presented in Table 4.2.

Table 4.2: Summary of the dataset and information during the desktop study of this assessment

DATASET/TOOL	SOURCE	RELEVANCE
Hydrological Data	2012 South African Water Resources Study (WR2012)	Determine the regional hydrological characteristics of the site (e.g. Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE), Mean Annual Runoff (MAR), Mean Annual Temperature (MAT) and the general flow direction into, through and out of the study area.
Google Earth Pro™ Imagery	2021 Google Imagery	Survey the current and historical imagery of the study area to determine changes in land use practises and thus identify potential impacts.
National Freshwater Ecosystem Priority Areas (NFEPA) river and wetland inventories (GIS coverage)	Council for Scientific and Industrial Research (CSIR) (2011)	Ascertain which freshwater resources have been categorised as essential and/or sensitive habitats at a national scale, and thus those that will require conservation
Wetland Vegetation Dataset of South Africa	SANBI (2018)	Determine the presumed natural hydrophilic vegetation communities within the study area to determine how the change in land use practices has altered the natural cover.
South African national land cover (GIS coverage)	GeoTerraImage (2015)	Compare what is presented in the dataset against what is currently observed on-site, thus identifying potential disturbances/impacts.
Reserve Desktop Classification for the Lower Vaal River	DWS (2020)	To evaluate the state of water quality in the study site, identify the potential impacts of WWTW activities.

5 HYDROLOGICAL ASSESSMENT

5.1 Physiographic Setting

The area is dominated by predominantly flat or gently undulating topography, interspersed with low hills defining the drainage boundary. The Harts River is the main river draining water from the boundaries of the Middle and Lower Vaal quaternary catchments. Water resources play an essential role in the water supply to domestic and agricultural uses in the area – through the Wentzel Dam located upstream of Schweizer-Reneke town. Land use is predominantly urban (formal and informal) and agricultural (stock watering and irrigation). The dominant land use within the basin upstream of the study site is agriculture with mixed crop and stock farming (Figure 5.1). Savannah biome is the dominant vegetation type found in the area. The area's closure to the proposed development site is predominantly grasslands (Figure 5.2) in the river valleys and urban and informal settlements in the hilly areas.

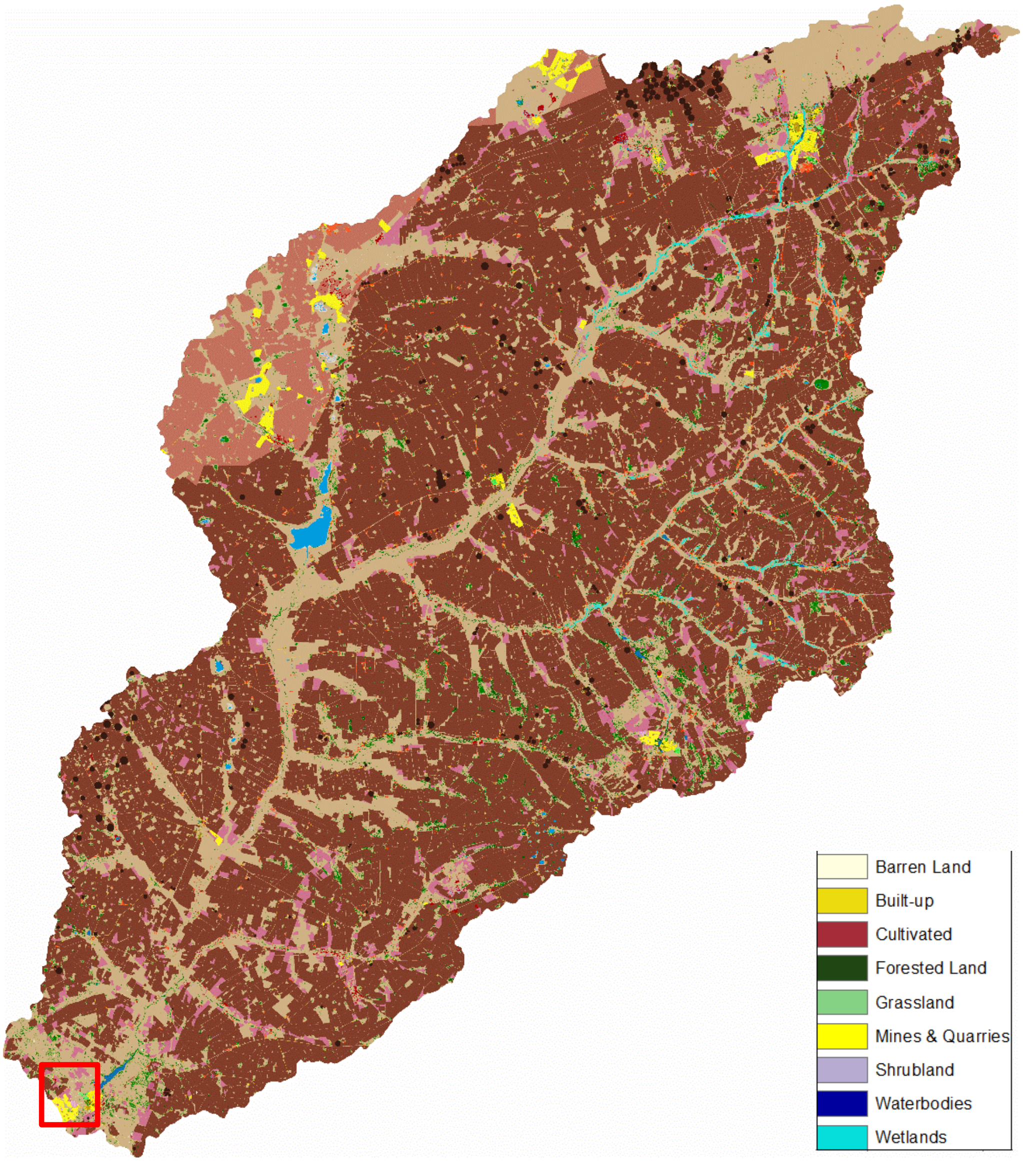


Figure 5.1 Land use and cover of the basin draining to the Ipelegeng area.

Figure 5.2: A panoramic view of the vegetation cover in the surrounding area of the proposed site

5.2 Baseline Hydrology

In Ipelegeng, average monthly temperatures range from 19ºC in June to 31ºC in December. The larger region is the coldest during July, which can reach a minimum of 6ºC (see Figure 5.3). Ipelegeng receives about 506 mm of rain annually, with rainfall occurring mainly during the summer and winter months receiving less rainfall. High seasonal variation in rainfall and evaporation is prevalent in the areas where January is the wettest month, whereas June is the driest month. The calculated Mean Annual Evaporation (MAE) for the study site, estimated from the long-term data from the WR2012, is 1 830mm. The monthly statistical distribution of rainfall and evaporation are graphically presented in Figure 5.4.

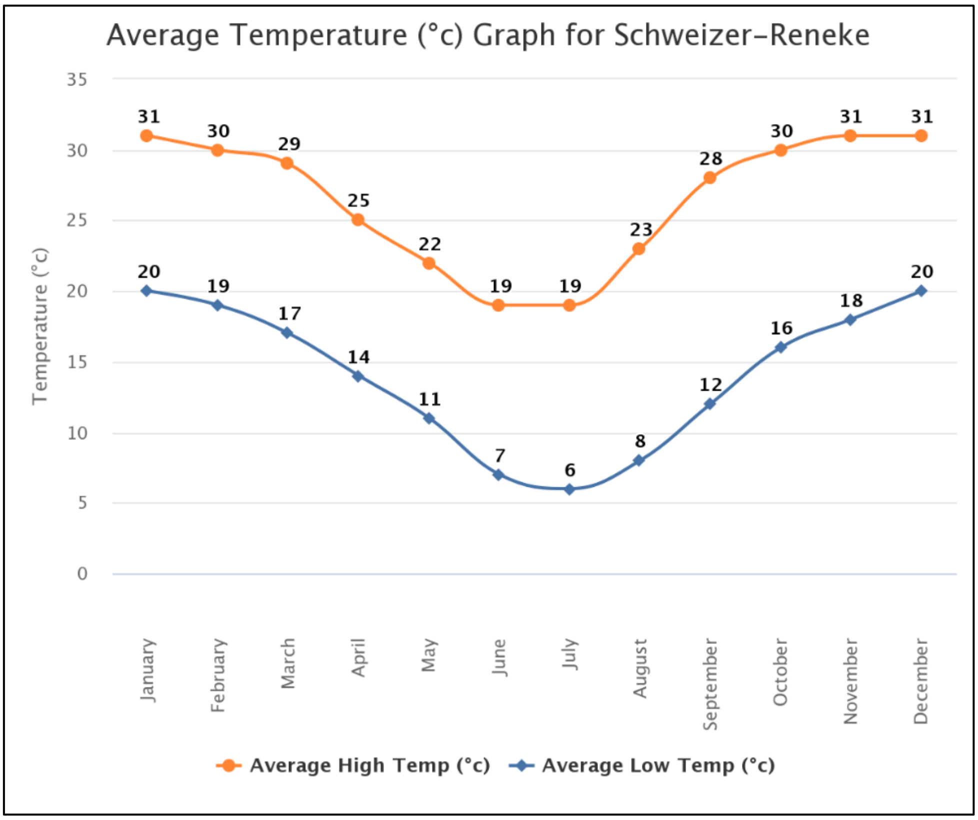
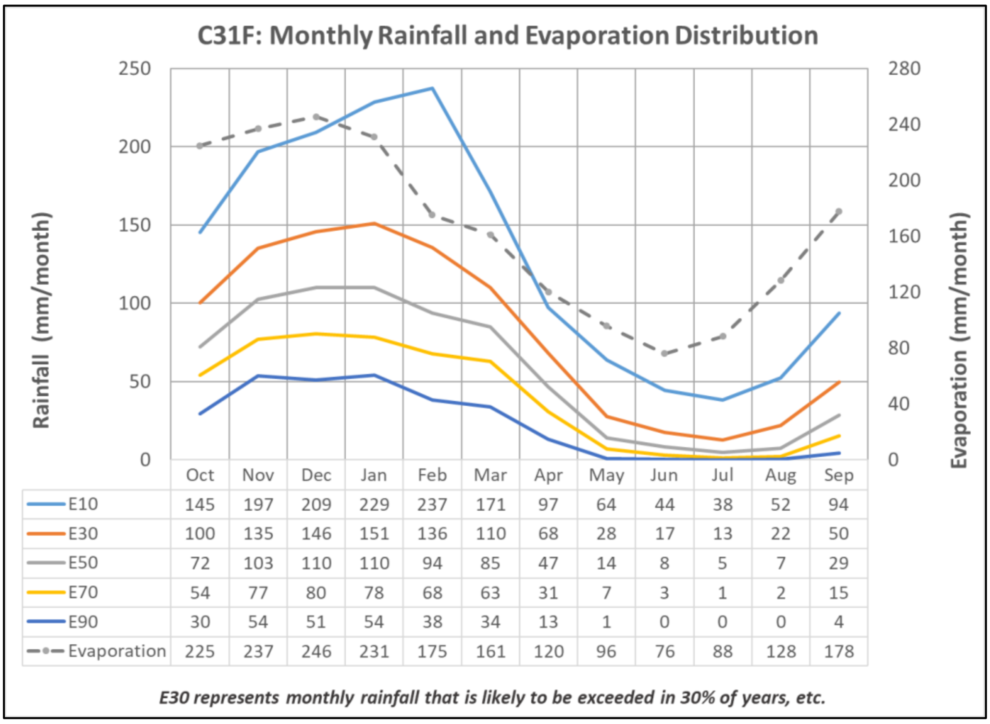


Figure 5.3: Average monthly temperature for the area (WorldWeatherOnline, 2022)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
E10	145	197	209	229	237	171	97	64	44	38	52	94
E30	100	135	146	151	136	110	68	28	17	13	22	50
E50	72	103	110	110	94	85	47	14	8	5	7	29
E70	54	77	80	78	68	63	31	7	3	1	2	15
E90	30	54	51	54	38	34	13	1	0	0	0	4
Evaporation	225	237	246	231	175	161	120	96	76	88	128	178

Figure 5.4: Monthly average rainfall and evaporation (Bailey & Pitman, 2015)

5.3 Site Visit

During the site visit, a visual investigation of the proposed study area was conducted to identify any on-site and upstream impacts from both the surrounding land-use activities and environmental/hydrological processes which may have influenced the overall health and functionality of the surrounding watercourses as a result of the construction, operation and closure of the WWTW. The elements observed, and the condition of the study area was photographed, documented, and related to professional experience.

Figure 5.5 shows a typical generic view of the study site. The uphill areas are generally sloping towards the river valley, and informal settlements are in the Ipelegeng Township's boundaries. Runoff from the upstream area flows through the gravesite towards the Harts River. The river generally flows in relatively flat terrain and has a laminar flow. Riparian vegetation along the Harts Riverbanks is dominated by reeds connected to wetland features.

Other surface water-related features that were observed during the site visit are shown in Figure 5.6. These features resemble wetlands and are directly fed from the groundwater system. Features presented in the figure are the only the highlighted in the areas surrounding the proposed development site. Other typical features were also identified in the upper reaches adjacent to the graveyard.

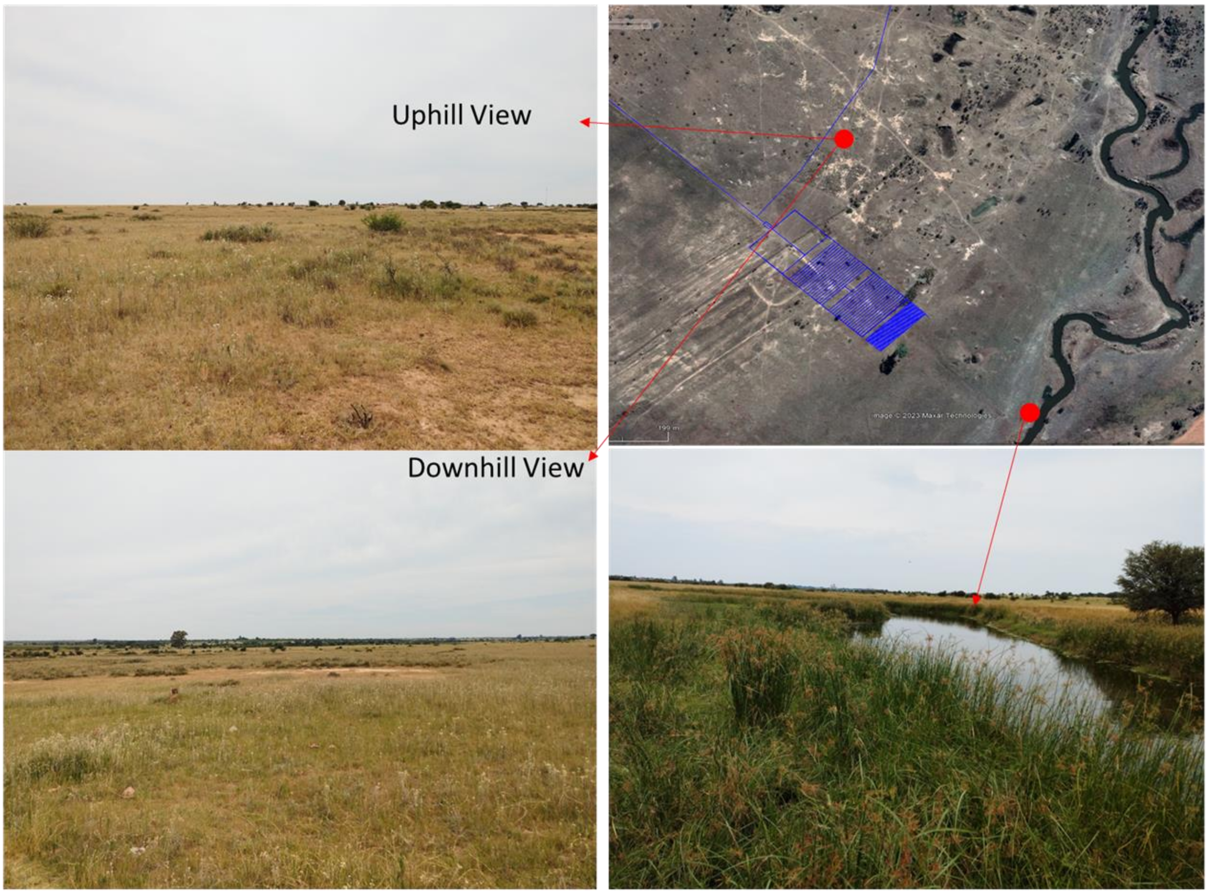


Figure 5.5: Top left is the upstream view, bottom-right is the downstream view and bottom-right is the riparian view of the Harts River

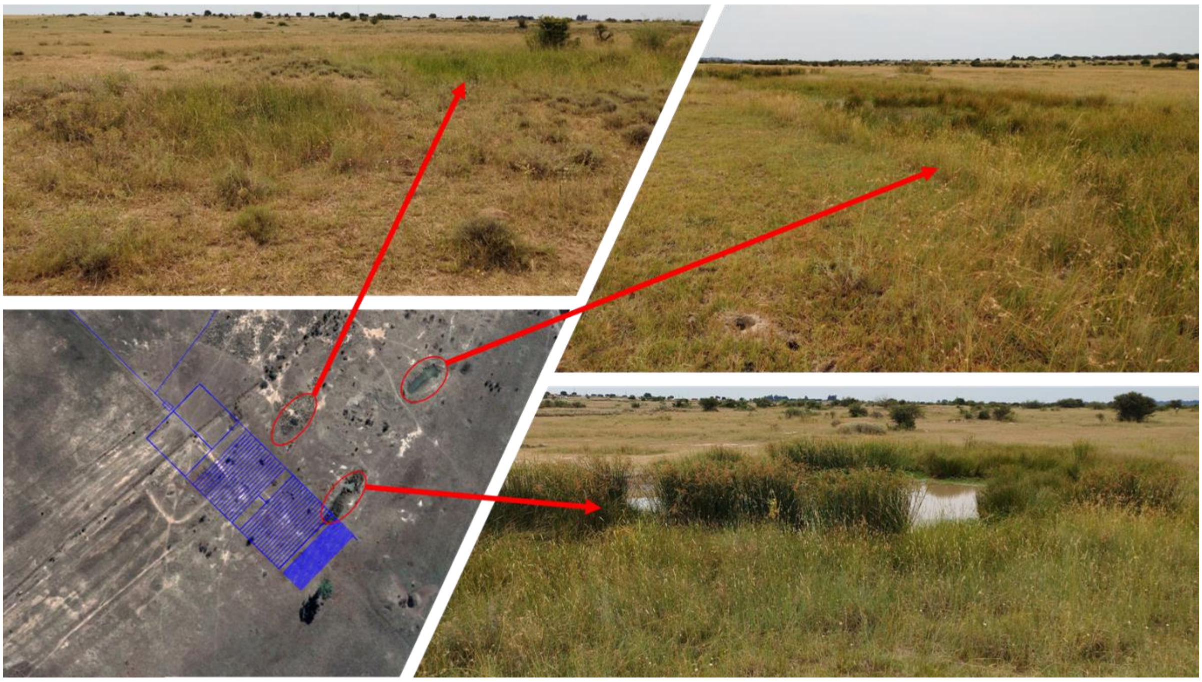


Figure 5.6: Wetland features observed during the site visit.

5.4 Physiochemical Water Quality

A field assessment of the watercourses within the study area associated with the proposed development was conducted on the 27th of January 2023. During this field survey, in-situ water quality analyses were conducted by an Altra Watech specialist who has experience in implementing the SANAS and DWS protocols and guidelines for water sampling. The Aquaprobe AP-800 meter was used to measure in situ water quality parameters such as pH, Temperature, Electrical Conductivity (EC), and Total Dissolved Solids (TDS) and their results are given in Table 5.1. A high concentration of salts (EC) were recorded, possibly indicating irrigation return flows from the upstream areas while TDS was also heightened due to the turbidity of the river during the time f sampling. Compared with the RQOs for the Lower Vaal WMA, pH was within the limit while EC exceeded the compliance levels.

Table 5.1: Description and location of the surface water monitoring points

Sample Point	Lat	Long	pH	EC (*mS/m*)	TDS (*mg/l*)	Temp (°C)
Lower Vaal RQOs			**6.5- 8.8**	**<85**	**-**	**-**
Harts River	27°13’18”	25°17’57”	8.2	660	328	28.4

5.5 Peak Flow Calculations

5.5.1 Catchment Characteristics

Catchment C-factors required as input for the Rational Method are determined by accounting for catchment land use and land cover types. These consist of the catchments, rural (C_1) component, urban (C_2) component and water body (C_3) component. Based on the dominant land use and cover in the area, runoff coefficient calibration focused on the rural setting (C_1), which consists of three sub-components, namely vegetation (C_v); soil permeability (C_p), and catchment slope (C_s). Dominant agricultural land in a relatively flat terrain suggested that soils are well-developed and have a good water-holding capacity.

5.5.2 Upstream Dam Effect

The proposed site of the Ipelegeng ponds is along the Harts River which has the Wentzel Dam located upstream of Schweizer-Reneke Town. This spillway level of the dam is 1 297 m (Consulting, 2020) and it was assumed that the dam would attenuate the runoff volume generated upstream quaternary (C31F). Thus, only the drainage area downstream of this dam to the point upstream of the confluence of an unnamed tributary was considered for the peak flow calculation. A typical delineation of the extent is presented in Figure 5.7.

5.5.3 Peak Flow Volumes

Peak volumes of the area draining to the study site were calculated using the methods presented in section 3.3.3 of this report and their summarised results are shown in Figure 5.8. Details of the parametric data used to calculate the peak flow volumes are given in the Appendices. The magnitudes of the 1:100-yr flood events from the Rational Method were chosen because the runoff coefficients are calibrated based on the observed catchment features and their relation to hydrology. These estimates were considered conservative for this study and used in flood simulation. The attributes and parameters used in the calculation are given in the table provided in Figure 5.9.

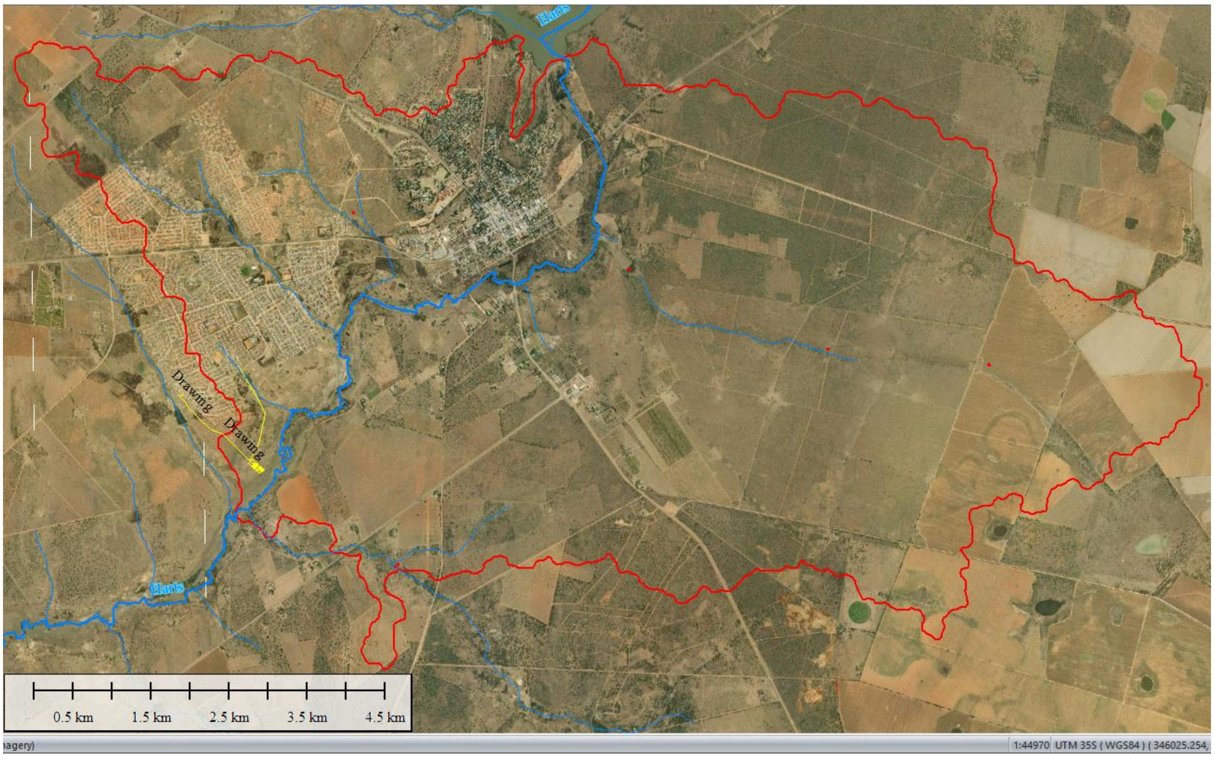


Figure 5.7: Catchment area considered from peak flow calculation.

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Ipelegeng WWTW - Hydrological Assessment
Analysed by: Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river: Harts River
Description of site: Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Filename: C:\Users\mazibukosc\My Drive\4. Consulting\3. Alcatech\10. North West Provi
nce WWTW - Hydrological Assessments\4-Working Documents\11. Hydraulic\IpelegengWWTW.fld
Date: 23 November 2022

Printed: 06 May 2023 Page 1

Summary of peak flows (m³/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational	27.95	39.39	51.51	65.60	87.68	110.81		70
Alternative rational	29.34	51.13	69.23	88.53	114.24	136.52		80
Unit hydrograph	19.75	32.38	46.80	64.73	96.42	131.62		70
Standard design flood	4.510	15.84	26.35	38.26	56.03	70.95		60
Empirical			39.02	53.21	74.50	94.60		65

Figure 5.8: Summary of the peak flow calculations

The eastern part of the drainage area is predominantly characterised by grassland and cultivated land, whereas the urban settlement dominates the interior and the western part. It was assumed that the overall soils in the area are semi-to-permeable on a relatively flat topography. These factors play a vital role in calibrating the runoff coefficient used to account for runoff generated after the rainfall event.

Utility Programs for Drainage
Flood calculations

Sinotech

Project name:	**Ipelegeng WWTW - Hydrological Assessment**
Analysed by:	**Sbongiseni Mazibuko (Pr.Sci.Nat.)**
Name of river:	**Harts River**
Description of site:	**Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds**
Filename:	**C:\Users\mazibukosc\My Drive\4. Consulting\3. Alcatech\10. North West Province WWTW - Hydrological Assessments\4-Working Documents\11. Hydraulic\IpelegengWWTW.fld**
Date:	**23 November 2022**

Printed: 07 May 2023 **Page 1**

Flood Frequency Analysis: Rational Method

Project	= Ipelegeng WWTW - Hydrological Assessment
Analysed by	= Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river	= Harts River
Description of site	= Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Date	= 11/23/2022
Area of catchment	= 67.0 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 504.00 mm
Length of longest watercourse	= 9.9 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 5.0 m
Rainfall region	= Inland
Area distribution	= Rural: 80 %, Urban: 20 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	5	Houses	60	City centre	10
Sandy, steep (>7%)	0	Flats	10	Suburban	5
Heavy soil, flat (<2%)	3	Light industry	5	Streets	2
Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	0	Very permeable	50	Thick bush & forests	0
Flat area	95	Permeable	35	Light bush & cultivated land	35
Hilly	5	Semi-permeable	10	Grasslands	65
Steep areas	0	Impermeable	5	Bare	0

Average slope	= 0.00067 m/m
Time of concentration	= 6.45 h
Run-off factor	
Rural - C1	= 0.257
Urban - C2	= 0.569
Lakes - C3	= 0.000
Combined - C	= 0.319

The HRU, Report 2/78, Depth-Duration-Frequency diagram was used to determine the point rainfall.

Return Period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m³/s)
1:2	6.45	36.5	99.1	5.6	0.75	26.8	27.95
1:5	6.45	49.7	98.7	7.6	0.80	27.8	39.39
1:10	6.45	62.9	98.4	9.6	0.85	28.8	51.51
1:20	6.45	77.7	98.0	11.8	0.90	29.9	65.60
1:50	6.45	101.0	97.4	15.3	0.95	30.9	87.68
1:100	6.45	124.3	96.8	18.7	1.00	31.9	110.81

Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable catchments

Figure 5.9: Peak flow volume using the Rational Method

5.6 Floodlines Delineation

Floodlines simulations were undertaken using HEC-RAS version 6.3 software, where several cross-sections were created throughout the Harts River profile adjacent to the proposed oxidation ponds site. River cross-sections were assigned Manning's n-values corresponding to the identified elements on riverbanks, particularly for the sections observed during the site visit. This was aimed at ensuring that different types of land cover and riparian vegetation along the riverbanks accounted for their role in frictional losses in the routing of a flood.

Reeds and grass are dominant in both riverbanks with a relatively large area resembling wetland features (Figure 5.10). The hydraulic characteristics of the modelled river and its geometric setting are summarised in Table 5.2, while hydraulic geometric is in Figure 5.11.

Figure 5.10: Riparian vegetation along the modelled sections of the Harts River

Table 5.2: Hydraulic characteristics of the modelled catchment

Site	River	Area (km^2)	Hydraulic Length (L)	Distance to Centroid (L_c)	Ave. Slope (m/m)	Manning's n	
						Banks	Channel
Ipelegeng WWTW	Harts	67	9.9	4.5	0.0009	0.39	0.31

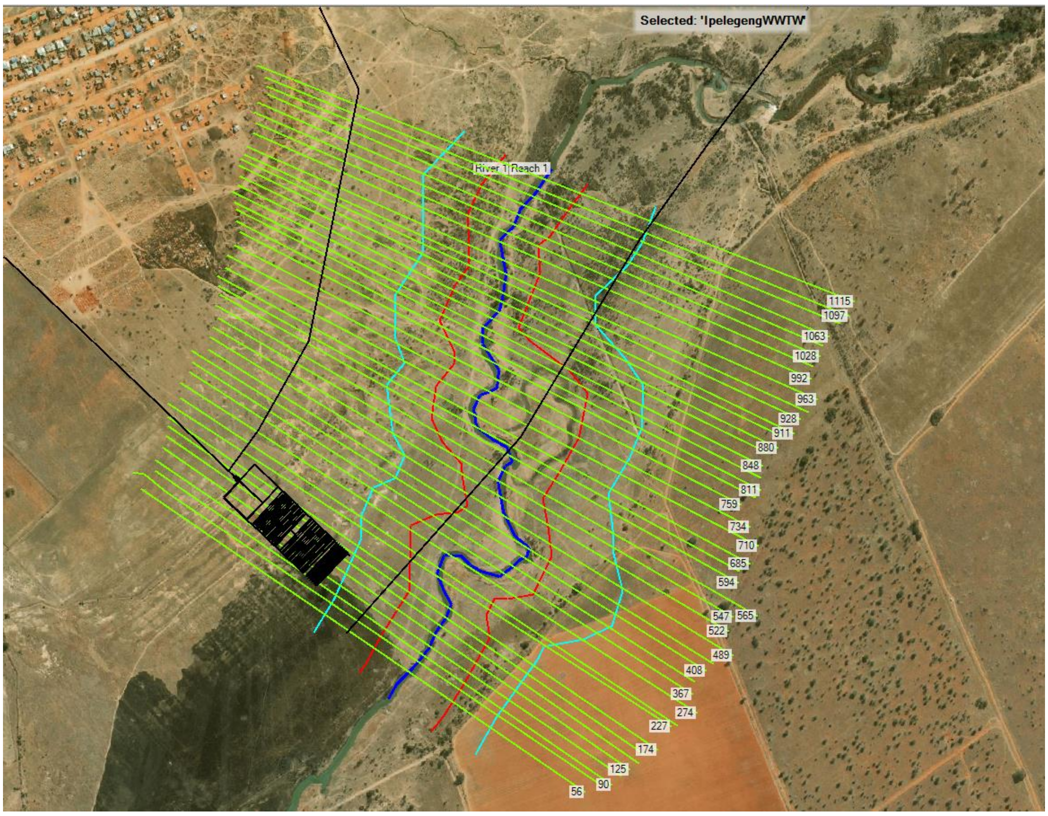


Figure 5.11: Modelled River section indicating cross-sections, flow paths and banks

6 FLOODLINES

Floodlines were simulated for the Harts River flowing adjacent to the proposed site of the Ipelegeng WWTW system for the 1:100-year return period peak volume generated from the upstream catchment area. Results presented in Figure 6.1 show the aerial extent of the proposed infrastructure is prone to flooding due to the generated peak flow. While these results are observed, it is worth noting that the floodplain area is relatively flat and the 5 m contour lines that were used to derive terrain data for the hydraulic model in HEC-RAS do not account for the minor variations in topography along the riverbanks. Under these conditions, where a hydraulic model is set, the routed flood wave occupies the complete topographic base of the profile, where all low-lying areas become inundated.

Based on the location of the proposed infrastructure setting, the downslope edge of the artificial wetland is located about 185 m away from the Harts River centerline. This location is within a similar contour interval and thus is within the 1:100-yr flood line. Water elevation profiles (Figure 6.2) of the cross-sections used in the hydraulic model were further evaluated to check the validity of the simulation results. The insert on the left of the figure shows that each profile has a horizontal surface of roughly 400 m represented by a uniform topography. This suggests the flow will not vary as expected on the ground. Figure 6.3 shows the longitudinal profile of the flood volume along the modelled river section. The figure's results indicate a water flood depth of 0.2 m, which shows a slight variation in the water-energy gradient as more water flows laterally than is confined into a channel.

While Section 21 of the NWA (Act 36 of 1998) stipulates that the location of wastewater storage dams must be located *above the 100-year flood line, or alternatively, more than 100 metres from the edge of a water resource*, the results from this hydraulic modelling are indicating that the structure falls within the floodline. However, due to the discrepancies presented in the above paragraph, the location of the proposed WWTW is about 185 m away from the edge of the Harts River and is considered compliant.

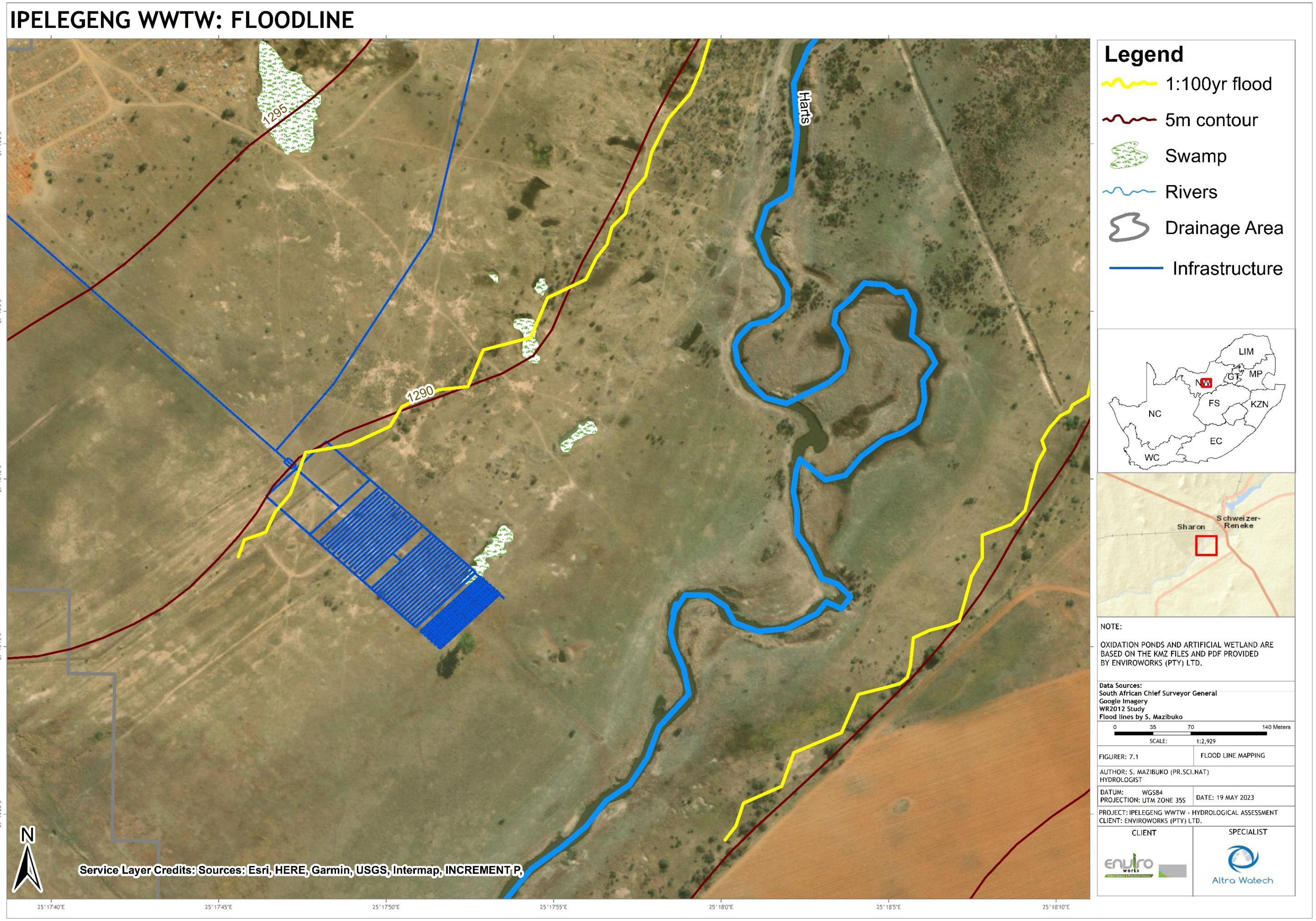


Figure 6.1: Simulated 1:100-yr flood lines

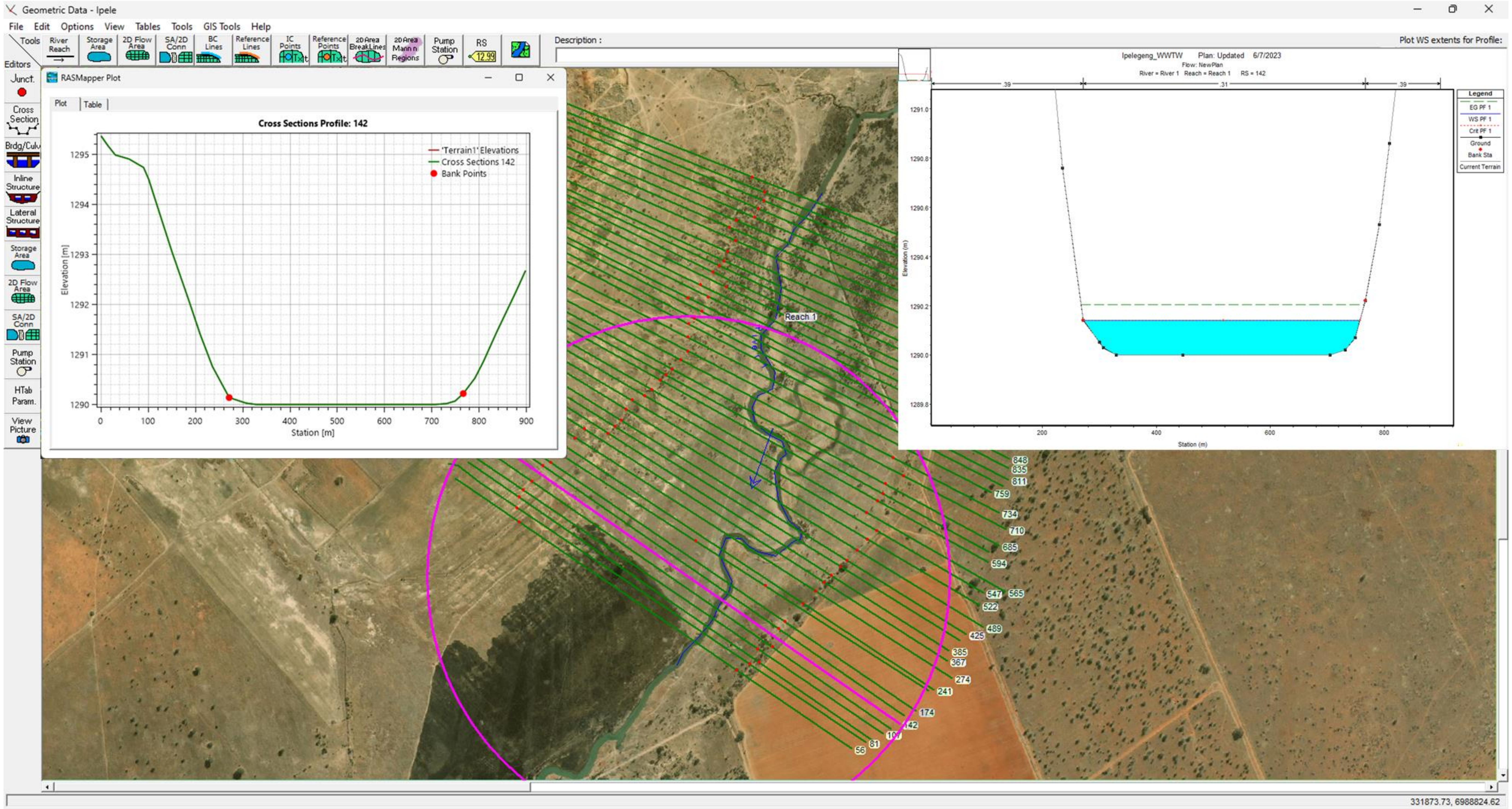


Figure 6.2: Cross-section profile adjacent to the proposed infrastructure.

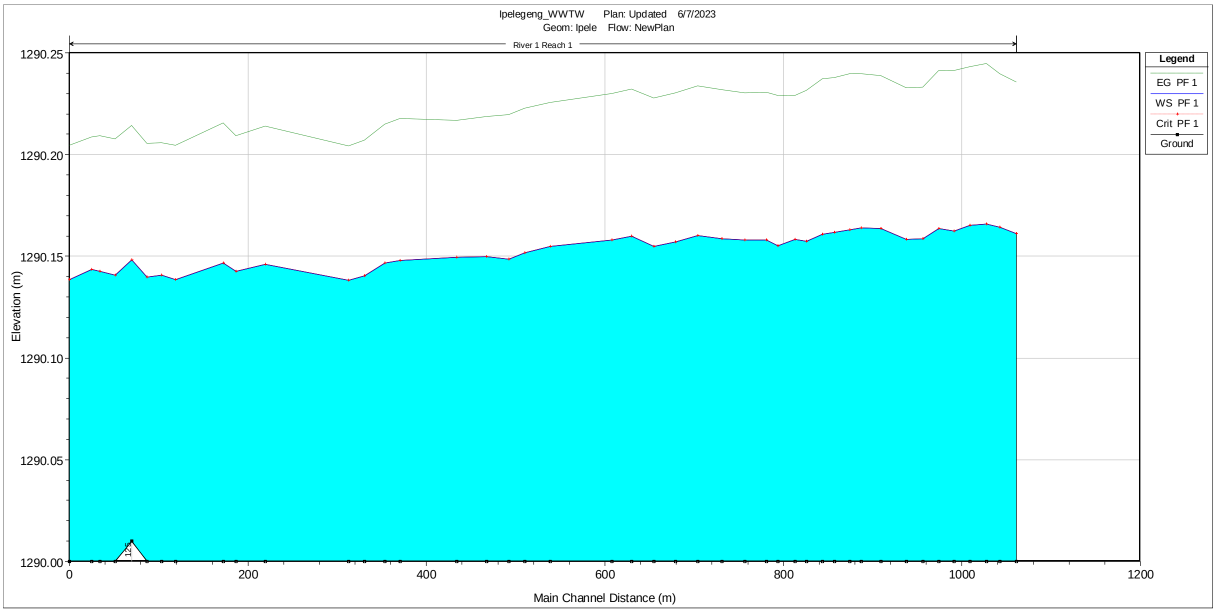


Figure 6.3: Longitudinal profile of a flood volume along the modelled river section. The left side is downstream and the right is upstream

7 SURFACE WATER IMPACT ASSESSMENT

The impact assessment on the receptors related to surface water features within and surrounding the proposed site of the Ipelegeng oxidation ponds site was identified, quantified, and mitigation measures were drawn for the operation and decommissioning phases of the infrastructure. The following potential impacts were identified.

7.1 Sensitivity Mapping

Figure 7.1 shows the areal extent of the proposed oxidation ponds and the identified water bodies (“swamps”) during the site visit. The figure shows that while the majority of the identified swamps areas, only one in the downstream areas overlaps the section of the artificial wetland layout. A layer of the National Wetland Database from SANBI was added to identify the protection and risk status of the other wetland features in the surrounding area. Results in the map (Figure 7.1) show that these wetlands are not protected, suggesting that the biodiversity on these wetlands is not at high risk. However, these are to be considered for the operation of the WWTW.

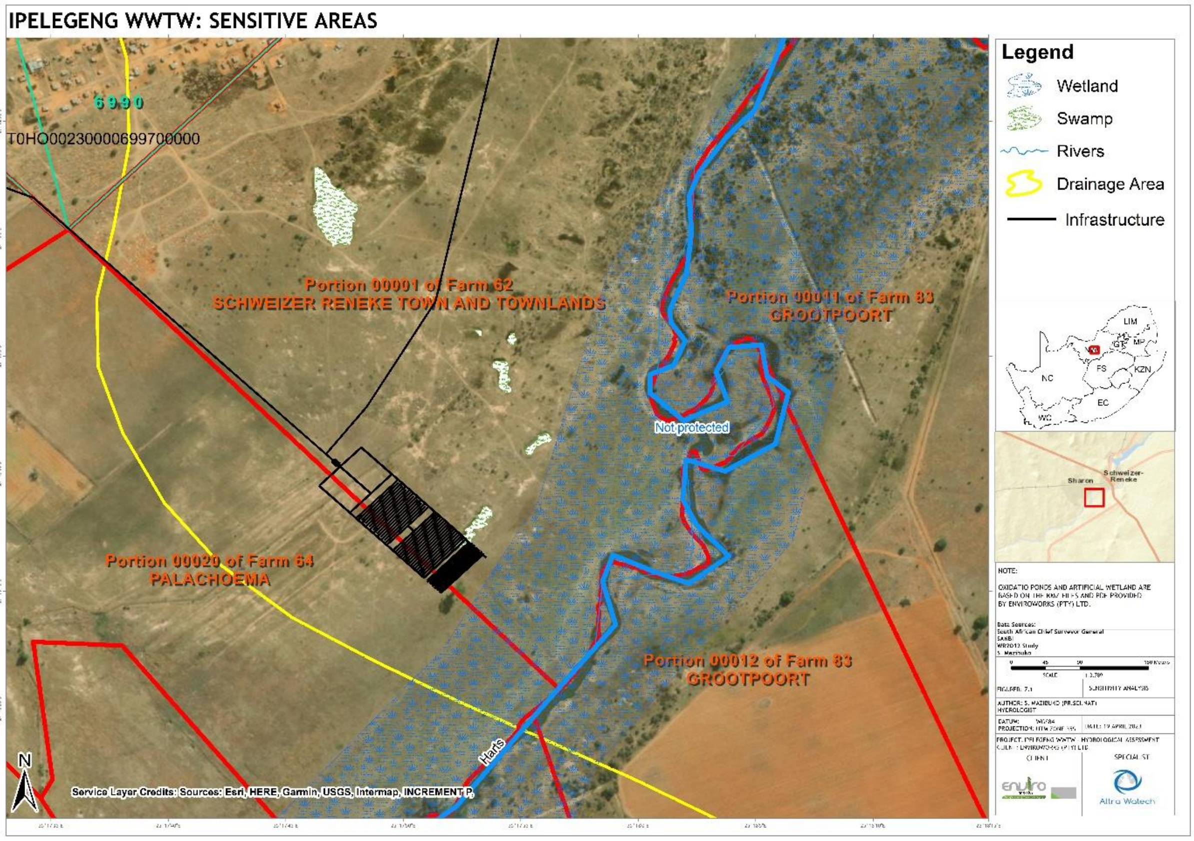


Figure 7.1: Sensitive surface water features present in the areas surrounding the proposed Ipelegeng WWTW site.

7.2 Construction Phase

Table 7.1 lists a summary of the potential impacts associated with constructing the proposed oxidation ponds at Ipelegeng. Potential surface water pollution as a result of the accidental spills (hydrocarbons, oil, and fuel) which might runoff to the Harts River and the modification of the existing swamps on site, together with their related hydrological processes, were identified as having medium impacts. Construction site clearance, removal of natural vegetation cover, and increased surface compaction due to the movement of heavy machinery on site were identified as elements likely to cause siltation in the downstream water resources due to erosion on loose soil. Waste generated on-site during this project phase also poses a risk to surface and groundwater resources due to potential contaminants that can percolate into the groundwater system or wash as part of surface runoff. The Harts River also pose a risk of flooding the construction site during the heavy rainfall season.

Table 7.1: Identified impacts during the construction phase

Aspects Assessment - Construction Phase					
No.	**Phase**	**Activity**	**Aspect (cause)**	**Potential Impact (effect on the environment)**	**Ability to influence**
1	Construction	Clearance of Vegetation and Topsoil	Surface Water Siltation	Increased erosion and siltation of the downstream water resources	Low/None
2	Construction	Heavy machinery and vehicle movement	Soil surface compaction	Increased surface water runoff	Low/None
3	Construction	Hydrocarbon, fuel or chemical handling and spillage	Surface water pollution	Surface water pollution due to accidental oil spillages, improper waste handling, storage and disposal of chemicals.	Medium
4	Construction	Oxidation Ponds and Wetland Construction	Alteration of natural surface water drainage patterns	Alter the site's natural, pre-existing surface water drainage patterns influencing local hydrology and the existing swamps	Medium
5	Construction	On-Site Generated Waste	Surface and groundwater pollution	Contamination of surface and groundwater resource	Low/None
6	Construction	Flooding	Infrastructure damage	Damage to the infrastructure and potential life loss	Medium

7.3 Operational Phase

Potential impacts identified associated with the operational phase of the WWTW are summarised in Table 7.2. These include (i) ensuring that the minimum requirement for treated water standards is met, (ii) proper maintenance of the artificial wetland, (iii) containment and disposal of any accidental oil or effluent spills and (iv) monitoring to identify any effluent spillages on the WWTW site to reduce surface and groundwater contamination in the plant's surrounding and downstream areas.

Table 7.2: Identified impacts during the operation phase.

Aspects Assessment - Operational Phase					
No.	**Phase**	**Activity**	**Aspect (cause)**	**Potential Impact (effect on the environment)**	**Ability to influence**
1	Operation	Sewage Seepage into Groundwater	Spill surface water pollution	Pollution of the water resources in the surrounding environment	Medium
2	Operation	Hydrocarbon spillages	Water quality deterioration	Deterioration of water quality due to hydrocarbon spillages	Medium
3	Operation	Discharging water into the environment	Non-compliant Effluent	The untreated effluent may affect the quality of the resource together with its associated biodiversity/aquatic life	High
4	Operation	Wastewater seepage	Groundwater pollution	Pollution of groundwater water and surrounding wetlands	Medium
5	Operation	Wetland Poor Maintenance	Inadequate effluent treatment	Discharging effluent with potential pollutants can affect the water quality downstream. Reduce the optimum operation of the WWTW	Medium

7.4 Decommissioning and Closure Phase

The decommissioning and closure phases impact are given in Table 7.3. These are (i) contaminants that are part of the building and plan components, (ii) the spilling of fuel, oil and hydrocarbons, and (iii) increased runoff due to compaction as a result of heavy machinery on-site during the demolition process and (iv) changes in the local hydrological processes as a result of modified landscape might increase groundwater recharge and on-site water uses in the case of the introduction of alien vegetation.

Table 7.3: Identified impacts during the decommissioning and closure phase.

Aspects Assessment - Decommissioning and Closure Phase					
No.	**Phase**	**Activity**	**Aspect (cause)**	**Potential Impact (effect on the environment)**	**Ability to influence**
1	Decommissioning Closure	Demolition of infrastructure	Deterioration of water quality	Contaminants from the infrastructure may pollute surface and groundwater resources. Increased runoff and siltation	Medium
2	Decommissioning Closure	Hydrocarbon, fuel or chemical handling and spillage	Surface water pollution	Pollution of surface water due to spillages, seepages or leaks and improper waste handling, storage and disposal.	Medium
3	Decommissioning Closure	Landscape Rehabilitation	Changed local hydrology	Potential for alien invasive plant growth, reduced overland flow	Low/None

Results relating to the likelihood, consequence and significance of the identified impacts before and after the mitigation measures are drawn are presented in Table 7.4 and 7.5. The proposed mitigation measures for all identified impacts for the project's three phases generally indicated that the impacts would be reduced significantly as their significance scored a low rating.

Table 7.4: Surface water impact assessment for the construction, operation and decommissioning phases of the project BEFORE mitigation measures

Impact Assessment - Construction Phase				Likelihood									Consequence							Significance	
No.	Activity	Aspect	Potential Impact	Freq. of activity	Rate	Freq. of impact	Rate	Legal Issues	Rate	Detection	Rate	Likelihood	Spatial scale	Rate	Duration	Rate	Severity	Rate	Consequence	Rate	
1	Clearance of Vegetation and Topsoil	Surface Water Siltation	Increased erosion and siltation of the downstream water resources	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
2	Heavy machinery and vehicle movement	Soil surface compaction	Increased surface water runoff	Weekly	4	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	4	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	2	Medium
3	Hydrocarbon, fuel or chemical handling and spillage	Surface water pollution	Surface water pollution due to accidental oil spillages, improper waste handling, storage and disposal of chemicals.	Weekly	4	Infrequent / unlikely / seldom / >60%	3	Covered by guidelines, standards or legislation	1	Without much effort	2	4	Whole site (entire project area)	2	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
4	Oxidation Ponds and Wetland Construction	Alteration of natural surface water drainage patterns	Alter the site's natural, pre-existing surface water drainage patterns influencing local hydrology and the existing swamps	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	3	Area specific (at impact site)	1	One month to one year (Short term)	2	Insignificant / non-harmful	1	2	2	Medium
5	On-Site Generated Waste	Surface and groundwater pollution	Contamination of surface and groundwater resource	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
6	Flooding	Infrastructure damage	Damage to the infrastructure and potential life loss	Annually or less	1	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	1	Local (within 5km)	3	One year to 10 years (medium term)	3	Significant / slightly harmful	3	3	2	Medium
Impact Assessment - Operational Phase				**Likelihood**									**Consequence**							**Significance**	
1	Sewage Seepage into Groundwater	Spill surface water pollution	Pollution of the water resources in the surrounding environment	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	2	Whole site (entire project area)	2	One month to one year (Short term)	2	Significant / slightly harmful	3	3	2	Medium
2	Hydrocarbon spillages	Water quality deterioration	Deterioration of water quality due to hydrocarbon spillages	Weekly	4	Infrequent / unlikely / seldom / >60%	3	Covered by guidelines, standards or legislation	1	Immediately	1	4	Whole site (entire project area)	2	One month to one year (Short term)	2	Significant / slightly harmful	3	3	2	Medium
3	Discharging water into the environment	Deterioration of water quality due to poor quality	The untreated effluent may affect the quality of the resource together with its associated biodiversity/aquatic life	6 monthly	2	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	2	Local (within 5km)	3	One month to one year (Short term)	2	Significant / slightly harmful	3	3	2	Medium
4	Wastewater seepage	Groundwater pollution	Pollution of groundwater water and surrounding wetlands	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Without much effort	2	2	Whole site (entire project area)	2	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
5	Wetland Poor Maintenance	Inadequate effluent treatment	Discharging effluent with potential pollutants can affect the water quality downstream. Reduce the optimum operation of the WWTW	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	2	Local (within 5km)	3	One day to one month (immediate)	1	Significant / slightly harmful	3	3	2	Medium
Impact Assessment - Decommission and Closure Phase				**Likelihood**									**Consequence**							**Significance**	
1	Demolition of infrastructure	Deterioration of water quality	Contaminants from the infrastructure may pollute surface and groundwater resources. Increased runoff and siltation	Weekly	4	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Without much effort	2	4	Area specific (at impact site)	1	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
2	Hydrocarbon, fuel or chemical handling and spillage	Surface water pollution	Pollution of surface water due to spillages, seepages or leaks and improper waste handling, storage and disposal.	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Without much effort	2	3	Area specific (at impact site)	1	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
3	Landscape Rehabilitation	Changed local hydrology	Potential for alien invasive plant growth, reduced overland flow	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	2	Area specific (at impact site)	1	One month to one year (Short term)	2	Insignificant / non-harmful	1	2	1	Low

Table 7.5: Surface water impact assessment for the project's operation, decommissioning and closure phases AFTER mitigation measures.

Mitigation Assessment - Construction Phase				Likelihood									Consequence							Significance	
No	Activity	Potential Impact	Mitigation Measures	Freq. of activity	Rate	Freq. of impact	Rate	Legal Issues	Rate	Detection	Rate	Likelihood	Spatial scale	Rate	Duration	Rate	Severity	Rate	Consequence	Rate	
1	Clearance of Vegetation and Topsoil	Increased erosion and siltation of the downstream water resources	• Restrict vegetation clearance and topsoil removal to a minimum footprint area. • Prior to site clearance, potential silt traps must be installed downstream of the construction area and located at the lowest point on the site	Monthly	3	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
2	Heavy machinery and vehicle movement	Increased surface water runoff	• Use minimal road access for heavy machinery and construction vehicles. • Manage stormwater from the impervious surfaces (e.g., temporal parking lot) by diverting to small temporal attenuation ponds.	Monthly	3	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislzation	1	Immediately	1	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
3	Hydrocarbon, fuel or chemical handling and spillage	Surface water pollution due to accidental oil spillages, improper waste handling, storage and disposal of chemicals.	• All hazardous substances must be stored and handled on impervious substrates and bunded areas that are able to contain potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines. • All vehicles and equipment must be kept in good working order and regularly serviced.	Monthly	3	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Small / potentially harmful	2	2	1	Low
4	Oxidation Ponds and Wetland Construction	Alter the site's natural, pre-existing surface water drainage patterns influencing local hydrology and the existing swamps	• Re-vegetation of exposed areas with indigenous vegetation as an erosion control option. • Maintain overland slope during land rehabilitation	Monthly	3	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Without much effort	2	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
5	On-Site Generated Waste	Contamination of surface and groundwater resource	• Keep the construction footprint small and use minimal road access	Monthly	3	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	3	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
6	Flooding	Damage to the infrastructure and potential life loss	• Stay outside of a 100m horizontal line from a river course or away from a 1:100 yr flood line. • Allow for the attenuation of peak flood events	Annually or less	1	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	1	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
Mitigation Assessment - Operational Phase				Likelihood									Consequence							Significance	
1	Sewage Seepage into Groundwater	Pollution of the water resources in the surrounding environment	• All hazardous substances must be stored and handled on impervious substrates and bunded areas that are able to contain potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines.	Annually or less	1	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Without much effort	2	2	Area specific (at impact site)	1	One month to one year (Short term)	2	Insignificant / non-harmful	1	2	1	Low
2	Hydrocarbon spillages	Deterioration of water quality due to hydrocarbon spillages	• Ensure that wastewater goes through the treatment process before being released into the environment	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	2	Whole site (entire project area)	2	One day to one month (immediate)	1	Insignificant / non-harmful	1	2	1	Low
3	Discharging water into the environment	The untreated effluent may affect the quality of the resource together with its associated biodiversity/aquatic life	• Implement correct procedures for sewege water circulation. • Address chemical and water spillages promptly through accepted corrective actions. • Comply with the set WWTW discharge limits	Annually or less	1	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	2	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
4	Wastewater seepage	Pollution of groundwater water and surrounding wetlands	• Ensure that the surface and groundwater monitoring program is drafted and implemented	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Without much effort	2	2	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
5	Wetland Poor Maintenance	Discharging effluent with potential pollutants can affect the water quality downstream. Reduce the optimum operation of the WWTW	• Maintainance of the WWTW circulation systems and artificial wetland must be adhered to. • Routinely check the WWTW water quality indicators to monitor and improve efficiency	Annually or less	1	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Immediately	1	1	Area specific (at impact site)	1	One day to one month (immediate)	1	Small / potentially harmful	2	2	1	Low

Mitigation Assessment - Decommissioning and Closure Phase				Likelihood									Consequence							Significance	
1	Demolition of infrastructure	Contaminants from the infrastructure may pollute surface and groundwater resources. Increased runoff and siltation	• Demolish the infrastructure during the dry season and keep the food print small.	6 monthly	2	Almost never / almost impossible / >20%	1	Covered by guidelines, standards or legislation	1	Without much effort	2	2	Area specific (at impact site)	1	One day to one month (immediate)	1	Insignificant / non-harmful	1	1	1	Low
2	Hydrocarbon, fuel or chemical handling and spillage	Pollution of surface water due to spillages, seepages or leaks and improper waste handling, storage and disposal.	• All hazardous substances must be stored and handled on impervious substrates and bunded areas that are able to contain potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines.	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Immediately	1	1	Area specific (at impact site)	1	One month to one year (Short term)	2	Small / potentially harmful	2	1	1	Low
3	Landscape Rehabilitation	Potential for alien invasive plant growth, reduced overland flow	• Use indigenous vegetation planted following the site slopes	6 monthly	2	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Without much effort	2	1	Whole site (entire project area)	2	One month to one year (Short term)	2	Insignificant / non-harmful	1	1	1	Low

Table 7.6 presents a risk-based matrix for this assessment before and after implementing the mitigation measures of the identified impacts. Soil compaction, accidental oil/fuel spills and washing-off contaminated debris from the WWTW infrastructure had a high likelihood of occurrence, while discharging non-compliant effluent to the environment also indicated a moderate level of impacting the surrounding water resources. The mitigation measures drawn for all identified impacts show a significant potential reduction of the consequence of the identified effects, as none scored above 3. Matrix risk score improves significantly if the mitigation measures are to be implemented such that it would have minor significance with relatively rare cases of event.

Table 7.6: Risk-based mitigation matrix before and after mitigation measures.

Without Mitigation		1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
5	Almost certain	**0**	**0**	**0**	**0**	**0**
4	Likely	**1**	**2**	**1**	**0**	**0**
3	Moderate	**2**	**2**	**0**	**0**	**0**
2	Unlikely	**0**	**2**	**3**	**0**	**0**
1	Rare	**0**	**0**	**1**	**0**	**0**
		3	6	5	0	0

After Mitigation		1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
5	Almost certain	**0**	**0**	**0**	**0**	**0**
4	Likely	**0**	**0**	**0**	**0**	**0**
3	Moderate	**4**	**1**	**0**	**0**	**0**
2	Unlikely	**3**	**2**	**0**	**0**	**0**
1	Rare	**3**	**1**	**0**	**0**	**0**

The mitigation measures suggested for the identified surface water receptors that could be affected due to the operation of the Ipelegeng WWTW were ranked in terms of priority for implementation based on public response, cumulative impact and loss of the resource. Table 7.7 lists the results of prioritisation to be implemented during the phases covered in this assessment. Surface compaction, accidental spillages, protection of the existing swamps, and compliance with flood protection were among those that must be prioritised during construction. Adequate and compliant treated effluent discharge to the environment must be prioritised through effective system monitoring during the operational phase. Proper rehabilitation of the and scape and prevention of alien invasive plants from materialising after the closure of the WWTW need to be prioritised to protect and restore local hydrological conditions of the site.

Table 7.7: Prioritisation table of the derived mitigation measures

No.	Aspect	Potential Impact	Mitigation Measures	Significance before Mitigation	Significance After Mitigation	Public Response	Rate	Cumulative Impact	Rate	Loss of resource	Rate	Prioritisation	
Prioritisation - Construction Phase													
1	Surface Water Siltation	Increased erosion and siltation of the downstream water resources	• Restrict vegetation clearance and topsoil removal to a minimum footprint area. • Prior to site clearance, potential silt traps must be installed downstream of the construction area and located at the lowest point on the site	Low	Low	Low	1	Low	1	Low	1	1	Low
2	Soil surface compaction	Increased surface water runoff	• Use minimal road access for heavy machinery and construction vehicles. • Manage stormwater from the impervious surfaces (e.g., temporal parking lot) by diverting to small temporal attenuation ponds.	Medium	Low	Low	1	Medium	3	Low	1	3	Medium
3	Surface water pollution	Surface water pollution due to accidental oil spillages, improper waste handling, storage and disposal of chemicals.	• All hazardous substances must be stored and handled on impervious substrates and bunded areas that are able to contain potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines. • All vehicles and equipment must be kept in good working order and regularly serviced.	Medium	Low	Low	1	Medium	3	Low	1	3	Medium
4	Alteration of natural surface water drainage patterns	Alter the sites natural, pre-existing surface water drainage patterns influencing local hydrology and the exisiting swamps	• Re-vegetation of exposed areas with indigenous vegetation as an erosion control option. • Maintain overland slope during land rehabilitation	Medium	Low	Medium	3	Medium	3	Low	1	3	Medium
5	Surface and groundwater pollution	Contaminantion of surface and groundwater resource	• Keep the construction footprint small and use minimal road access	Low	Low	Low	1	Low	1	Low	1	1	Low
6	Infrastructure damage	Damange to the infrastucture and potential life loss	• Stay outside of a 100m horizontal line from a river course or away from a 1:100 yr flood line. • Allow for the attenuation of peak flood events	Medium	Low	Low	1	Medium	3	Low	1	3	Medium
Prioritisation - Operation Phase													
1	Spill surface water pollution	Pollution of the water resources in the surounding environment	• All hazardous substances must be stored and handled on impervious substrates and bunded areas that are able to contain potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines.	Medium	Low	Low	1	Low	1	Low	1	1	Low
2	Water quality deterioration	Deterioration of water quality due to hydrocarbon spillages	• Ensure that wastewater goes through the treatment process before being released into the environment	Medium	Low	Medium	3	Medium	3	Medium	3	3	Medium
3	Deterioration of water quality due to poor quality	The untreated effluent may affect the quality of the resource together with its associated biodiversity/acquatic life	• Implement correct procedures for sewege water circulation. • Address chemical and water spillages promptly through accepted corrective actions. • Comply with the set WWTW discharge limits	Medium	Low	Low	1	Medium	3	Low	1	3	Medium
4	Groundwater pollution	Pollution of groundwater water and surrounding wetlands	• Ensure that the surface and groundwater monitoring program is drafted and implemented	Medium	Low	Low	1	Medium	3	Medium	3	3	Medium
5	Inadequate effluent treatment	Discharging of effluent with potential pollutants can affect the water quality downstream. Reduce the optimum operation of the WWTW	• Maintainance of the WWTW circulation systems and artificial wetland must be adhered to. • Routinely check the WWTW water quality indicators to monitor and improve efficiency	Medium	Low	Medium	3	Medium	3	Medium	3	3	Medium
Prioritisation - Decommissioning and Closure Phase													
1	Deterioration of water quality	Contaminants from the infrastructure may pollute surface and groundwater resources. Increased runoff and siltation	• Demolish the infrastructure during the dry season and keep the food print small.	Medium	Low	Low	1	Low	1	Low	1	1	Low
2	Surface water pollution	Pollution of surface water due to spillages, seepages or leaks and improper waste handling, storage and disposal.	• All hazardous substances must be stored and handled on impervious substrates and bunded areas that are able to contain potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines.	Medium	Low	Low	1	Low	1	Low	1	1	Low
3	Changed local hydrology	Potential for alient invasive plant growth, reduced overland flow	Use indigenous vegetation planted following the site slopes	Low	Low	Low	1	Low	1	Low	3	3	Medium

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The following findings and recommendations were derived from the study:

- Ipelegeng Waste Water Treatment Works will receive sewage from the township of Ipelegeng and water will gravitate towards the site where four oxidation ponds and an artificial wetland will undertake treatment.
- The study site is located in quaternary catchment C31F along the Harts River of the Lower Vaal Water Management Area. Ipelegeng is characterised by a Mean Annual Precipitation of 506 mm and a Mean Annual Evaporation (MAE) of 1 830mm that varies seasonally. More rainfall occurring mainly during the summer and winter months have more evaporation losses.
- The catchment area draining toward the river section adjacent to the WWTW site is relatively flat and is predominantly agricultural land, urban settlement and wetlands along the riverbanks. Upstream of Schwizer-Reneke town, there is the Wentzel Dam that supplies the town and the surrounding township with water and – during the peak of the flooding events- this storage facility will have to fill its maximum storage capacity, which will attenuate the flood peak.
- In-situ water parameter reading at the sampling point adjacent to the proposed site of the WWTW indicated a non-compliant EC level when compared with the RQOs for the Lower Vaal WMA.
- The peak flow volume for the 1:100-yr return flood event (110.1m^3/s) was calculated using the Rational Method and was routed on the 1-D hydraulic model in HEC-RAS (based on a 5m contour topographic data) to evaluate the potential flooding risk posed by the Harts River on the WWTW. The calculated peak flow only accounted for the drainage area downstream of Wentzel Dam.
- Flood simulation results show that the Ipelegent WWTW site is prone to flooding as the infrastructure falls within the 1:100-yr flood line. Discrepancies in the 5m contour data suggest that the actual ground variations in topography are not adequately represented as the flood inundation areas occupy a uniform topography with a width of 400 m which the infrastructure falls within. Hozirontal flow profiles also show that the expected water depth for the calculated flow peaks does not exceed 0.2m – contributing to the uncertainty from what is expected. While these results were observed, Section 21 of the NWA stipulation indicates that the infrastructure is compliant as it is located away from a 100m horizontal line from the Harts River's edge.

- Sensitivity analysis of the identified water features shows that there are small patches of swamps in the eastern part of the proposed site for the WWTW. Their significance in terms of protection was assumed to the covered by a wetland specialist. However, the general SANBI wetlands database indicated that the riparian areas of the Harts River are unprotected wetlands and the proposed WWTW structure falls outside of the SANBI buffer zone.

- The surface water impact assessment indicated that during the
    - *Construction phase*:
        - Increased surface runoff, erosion and siltation of the downstream water resources could affect water quality downstream due to the surface compaction as a result of heavy machinery, removal and topsoil and vegetation cover.
        - Surface water pollution due to accidental oil spillages, improper on-site waste handling, storage and disposal of chemicals.
        - Alteration of the site's natural, pre-existing surface water drainage patterns influencing local hydrology and the existing swamps.
        - Damage to the infrastructure and potential life loss due to the flooding of the Harts River be implemented.
    - *Operation phase*:
        - Pollution of the surrounding (environment) and downstream water resources as a result of non-compliant effluent discharged to the environment, accidental fuel/chemical/hydrocarbon spills on site and the lack of proper system performance management and maintenance.
    - *Operation phase*:
        - Pollution of the surrounding (environment) and downstream water resources as a result of contaminants washing off from the WWTW infrastructure and accidental spillages during the demolition and rehabilitation process.
        - Modification of the local hydrologic conditions may change groundwater recharge patterns and overland runoff and give rise to alien invasive plants.

8.2 Recommendations

The following recommendations are drawn from this study:

- It is recommended that, during the construction phase of the WWTW, the clearing of the construction site be kept to a minimum extent while the movement of heavy machinery is also limited. Installation of silt traps and the construction of temporal ponds to collect stormwater in the lowest point of the construction site is also recommended, while waste and spill collection and disposal plans need to be implemented.
- The construction site must be located outside the 100m horizontal line from the Harts River to reduce flooding risks that are likely to occur during summer.
- Routing maintenance of the WWTW and its water quality monitoring plan needs to be implemented to ensure that the efficiency of the WWTW system is monitored to reduce the risks of discharging non-compliant effluent to the downstream water resources.
- The surface water monitoring plan must be drafted and implemented during the operational to closure phases of the project. At the same time, the performance of the WWTW must ensure that it complies with the WWTW discharge limits as well as ensure that the targets of the RQOs for the water resources in the WMA are met or improved.
- Compliance with the recommended activities during the decommissioning and closure phases of the project is recommended to protect against the deterioration of the surface water in the surrounding environment.

9 REFERENCES

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10 APPENDICES

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Ipelegeng WWTW - Hydrological Assessment
Analysed by: Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river: Harts River
Description of site: Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Filename: C:\Users\mazibukosc\My Drive\4. Consulting\3. Alcatech\10. North West Provi nce WWTW - Hydrological Assessments\4-Working Documents\11. Hydraulic\IpelegengWWTW.fld
Date: 23 November 2022

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Flood Frequency Analysis: Alternative Rational Method

Project	= Ipelegeng WWTW - Hydrological Assessment
Analysed by	= Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river	= Harts River
Description of site	= Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Date	= 11/23/2022
Area of catchment	= 67.0 km²
Dolomitic area	= 0.0 %
Length of longest watercourse	= 9.9 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 5.0 m
Area distribution	= Rural: 80 %, Urban: 20 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	5	Houses	60	City centre	10
Sandy, steep (>7%)	0	Flats	10	Suburban	5
Heavy soil, flat (<2%)	3	Light industry	5	Streets	2
Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	0	Very permeable	50	Thick bush & forests	0
Flat area	95	Permeable	35	Light bush & cultivated land	35
Hilly	5	Semi-permeable	10	Grasslands	65
Steep areas	0	Impermeable	5	Bare	0

Days on which thunder was heard	= 60 days/year
Weather Services station number	= 397581
Weather Services station location	= SCHWEIZER-RENEKE (SAP)
Mean annual precipitation (MAP)	= 504 mm

Duration	2	5	10	20	50	100	200
1 day	50	71	87	105	131	153	177
2 days	63	91	113	137	173	203	237
3 days	68	98	121	146	183	215	249
7 days	85	124	155	187	235	275	319

Linear interpolation between the calculated modified recalibrated Hershfield values and the 1-day point rainfall from TR102 was used to determine point rainfall.

Average slope	= 0.00067 m/m
Time of concentration	= 6.45 h
Run-off factor	
Rural - C1	= 0.257
Urban - C2	= 0.569
Lakes - C3	= 0.000
Combined - C	= 0.319

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m³/s)
1:2	6.45	38.80	97.9	5.89	0.75	26.8	29.34
1:5	6.45	65.12	97.9	9.88	0.80	27.8	51.13
1:10	6.45	85.04	97.9	12.91	0.85	28.8	69.23
1:20	6.45	105.00	97.9	15.93	0.90	29.9	88.53
1:50	6.45	131.00	97.9	19.88	0.95	30.9	114.24
1:100	6.45	151.51	97.9	22.99	1.00	31.9	136.52

Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable catchments

Utility Programs for Drainage
Flood calculations

Sinotech

Project name:	Ipelegeng WWTW - Hydrological Assessment
Analysed by:	Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river:	Harts River
Description of site:	Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Filename:	C:\Users\mazibukosc\My Drive\4. Consulting\3. Alcatech\10. North West Provi nce WWTW - Hydrological Assessments\4-Working Documents\11. Hydraulic\IpelegengWWTW.fld
Date:	23 November 2022

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Flood frequency analysis : Standard Design Flood method

Project name                              = Ipelegeng WWTW - Hydrological Assessment
Analysed by                               = Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river                             = Harts River
Description of site                       = Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Date                                      = 11/23/2022
Catchment characteristics:
Area of catchment                         = 67 km²
Length of longest watercourse             = 9.9 km
1085 height difference                    = 5 m
Average slope                             = 0.0007 m/m
Drainage basin characteristics:
Drainage basin number                     = 8
Mean annual daily max rain                = 47 mm
Days on which thunder was heard           = 29 days
Runoff coefficient C2                     = 5 %
Runoff coefficient C100                   = 20 %
Basin mean annual precipitation           = 380 mm
Basin mean annual evaporation             = 2100 mm
Basin evaporation index MAE/MAP           = 5.53
```

RAINFALL DATA

The rainfall data in the table below are derived from two sources. The daily rainfall is from the Department of Water Affair's publication TR102 for the representative site. The modified Hershfield equation is used for durations up to four hours. Linear interpolation is used for values between 4 hours and one day.

Weather Services station ex TR102 = 322071 @ DANIELSKUIL
Point mean annual precipitation = 380 mm

Dur:	RP =2	5	10	20	50	100	200
.25 h	13	22	29	36	45	52	59
.50 h	17	29	38	47	59	68	77
1 h	21	36	47	58	72	83	94
2 h	25	42	56	69	86	99	112
4 h	29	49	64	80	100	115	130
1 day	47	69	86	104	132	156	183
2 days	60	91	116	144	187	224	267
3 days	65	100	128	160	208	250	297
7 days	79	126	164	207	272	329	393

Runoff coefficients C2 = 5 % C100 = 20 %

Return period (years)	Time of concentration (hours)	Point precipitation (mm)	ARF (%)	Catchment precipitation (mm)	Runoff coefficient (%)	Peak flow (m³/s)
1:2	6.45	31.9	97.9	31.2	5.0	4.510
1:5	6.45	53.8	97.9	52.7	10.4	15.84
1:10	6.45	70.4	97.9	68.9	13.2	26.35
1:20	6.45	87.0	97.9	85.1	15.6	38.26
1:50	6.45	108.9	97.9	106.6	18.2	56.03
1:100	6.45	125.5	97.9	122.8	20.0	70.95

Utility Programs for Drainage
Flood calculations

Sinotech

Project name:	Ipelegeng WWTW - Hydrological Assessment
Analysed by:	Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river:	Harts River
Description of site:	Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Filename:	C:\Users\mazibukosc\My Drive\4. Consulting\3. Alcatech\10. North West Province WWTW - Hydrological Assessments\4-Working Documents\11. Hydraulic\IpelegengWWTW.fld
Date:	23 November 2022

Printed: 06 May 2023 Page 1

Flood Frequency Analysis: Unit Hydrograph Method

Project	= Ipelegeng WWTW - Hydrological Assessment
Analysed by	= Sbongiseni Mazibuko (Pr.Sci.Nat.)
Name of river	= Harts River
Description of site	= Flood risk Assessment of the proposed Ipelegeng Oxidation Ponds
Date	= 11/23/2022
Area of catchment	= 67.0 km²
Length of longest watercourse	= 9.9 km
Height difference along equal area slope	= 5.0 m
Distance to catchment centroid	= 4.9 km
Veld type	= Region 4
Duration interval	= 1 hour

Slope of longest stream	= 0.0005 m/m
Catchment index	= 2158.6
Catchment lag	= 5.229
Coefficient (Ku)	= 0.386 m³/s - hours/km²
Peak discharge of unit hydrograph (Qp)	= 4.946 m³/s

Return period	Storm duration (minutes)	Peak discharge (m³/s)
1:2 year	180	19.75
1:5 year	180	32.38
1:10 year	180	46.80
1:20 year	180	64.73
1:50 year	180	96.42
1:100 year	180	131.62

Calculated using Utility Programs for Drainage 1.1.0