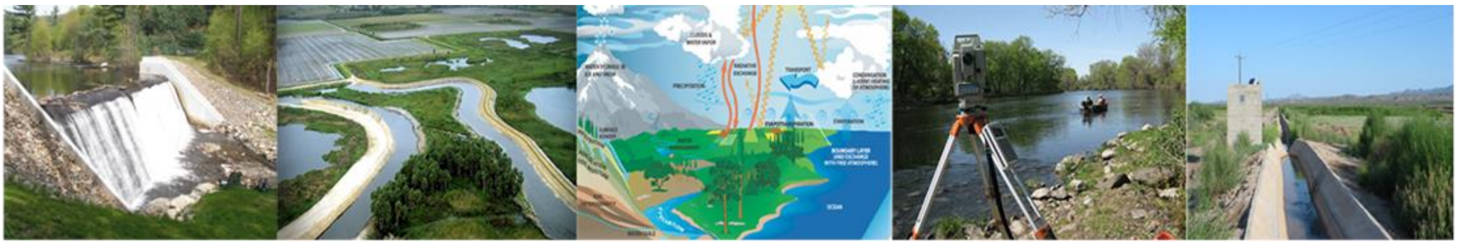
Hydrological Assessment for the Proposed Lindley Wastewater Treatment Works

Report

Version – 1

30 May 2023

Client Reference: Lindley WWTW - Hydrological Assessment



Hydrological Assessment for Lindley Wastewater Treatment Works

Report

Version – 1

DOCUMENT VERIFICATION

TITLE: Lindely WWTW - Hydrological Assessment	
Report Number	**22- 1001 - 04**
Date	**30 May 2023**
Report Version	**1**

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 author of the report is a hydrologist holding an MSc degree in Hydrology with 8 years of experience in various hydrology, water resources assessment, planning, and management studies.

Verification	Name	Signature	Date
Author	Sbongiseni Mazibuko (Hydrologist) ***Pr. Sci. Nat***		April 2023
Reviewer	Lungile Lembede (Hydrologist) ***Pr. Sci. Nat***		May 2023
Authorised	Sbongiseni Mazibuko (Hydrologist) ***Pr. Sci. Nat***		May 2023

SPECIALIST DETAILS AND DECLARATION

Specialist Details

Sbongiseni Mazibuko is a hydrologist, whose focus is specifically on hydrological perspectives of land use management and climate change. Sbongiseni has – over the past 8 years – worked on numerous projects for a variety of clients ranging from mining, agriculture, and public entities which included hydrological assessments, water balances, stormwater planning and management, floodlines 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 (EAPs) 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 regard 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, and
- 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.Nat.Nat* reg number: 011204)

LIST OF ACRONYMS

DFFE	Department of Forestry, Fisheries and the Environment
DSM	Digital Simulation Model
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
GIS	Geographic Information System
GPS	Geographic Positioning System
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NWA	National Water Act (Act No. 36 of 1998)
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
RQOs	Resources Quality Objectives
WMA	Water Management Area
WR2012	2012 South African Water Resources Study
WULA	Water Use License Application
WWTW	Wastewater Treatment Work
SABS	South African Bureau of Standards
SAWS	South African Weather Service

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Introduction

NSVT Consultants cc – as the independent Environmental Practitioner (EAP) to conduct the Environmental Impact Assessment (EIA) – requested Altra Watech (Pty) Ltd to conduct a hydrological assessment study for the proposed Lindley Wastewater Treatment Works (WWTW). The project site is located on Portion 00 of Farm 19 Brandhoek, west of Ntha township of Lindley, within the Nketoana Local Municipality, in the Free State Province of South Africa (Figure 1.1). The proposed oxidation pond system is located along the Vals River, which drains its water with quaternary catchments C60A to C60B of the Vaal Water Management Area (WMA).

The construction, operation and closure of the proposed oxidation pond system will involve activities that could pose risks to the surrounding surface-water-related features as well and other water users in the downstream areas. These risks need to be identified, quantified and mitigation measures drawn to ensure that any direct or indirect impacts are mitigated. A hydrological assessment specialist study results presented in this report are, therefore, in support of the Water Use Licence Application (WULA) in terms of the National Water Act (NWA 36 of 1998) and the EIA process as per Regulations of 2014, as amended on 07 April 2017, of the Environmental Management Act (NEMA 107 of 1998).

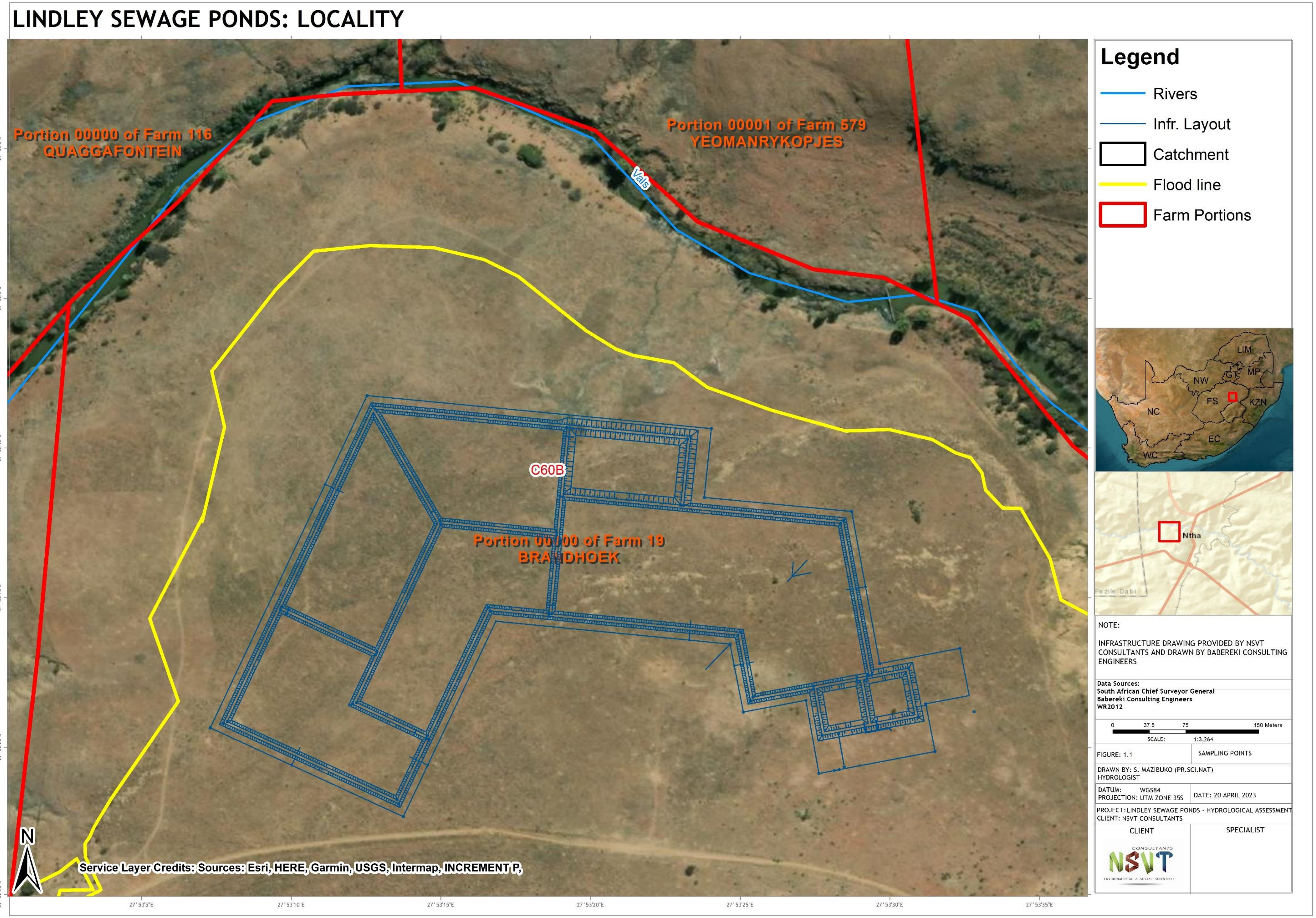


Figure 1.1: Study locality.

2 SCOPE OF WORK

The scope of work is defined as follows:

1. The desktop study, Information Sourcing and Site Visit
    - Relevant data and information collection; and
    - Review existing literature and the applicable regulations and guidelines concerning environmental regulations and water use licensing for the proposed infrastructure development.
2. Hydrology:
    - Catchment delineation and drainage characteristics.
    - A general preview of meteorological (climate, temperature, rainfall and evaporation) and hydrological analysis of Mean Annual Precipitation (MAP), Mean Annual Runoff (MAR) and Mean Annual Evaporation (MAE) will be verified.
    - Calculation of the design rainfall and peak flow volumes (1:50, 1:100, and 1:200-year return period event).
3. Water Quality Analysis and Monitoring Plan:
    - Collection of in-situ water quality parameters, and analysis of the laboratory results of the collected samples, and
    - Development of the surface water monitoring plan for the operation of the WWTW
4. Impact Assessment and Monitoring Plan:
    - Identify, evaluate, and quantify water impact elements related to the proposed development,
    - Surface Water Monitoring plan and derive mitigation measures.
5. Reporting:
    - A report detailing the activities' results was compiled, including conclusions and recommendations.

3 METHODOLOGY

3.1 Desktop Study and Information Sourcing

Applicable national and regional legislation and guidelines relating to water use license application and environmental impacts for WWTW were evaluated together with the other relevant reports relating to the study. Hydrometeorological data (rainfall or evaporation) for the study site were collected and prepared for statistical analysis to establish a baseline understanding of the hydroclimatic patterns for the area which are likely to affect all project phases. Up-to-date Land use/cover data were obtained to derive sensitivity mapping for surface water-related features that could be affected due to the proposed development.

3.2 Site Visit

Altra Watech's Hydrologist undertook a site visit to identify elements that could affect and the surrounding surface water features of the proposed site of the WWTW and collected baseline water quality samples. Other relevant site information was collected to guide the study and make an interpretation of the results. During the site visit, in-situ readings for basic water quality parameters of the Vals River were collected at the site locations where surface water sampling was done.

3.2.1 Sampling Procedure

Surface water sampling was conducted in accordance with the SABS ISO 5667-1: 2006 Part 1: Guidance on the design of sampling programs and sampling techniques, ISO 5667-6: 2005 Part 6: Guidance on sampling of rivers and streams, and ISO 5667-3: 2003 Part 3: Guidance on preservation and handling of samples.

3.2.2 Sampling Methodology

Plastic bottles with a plastic cap with no liner within the cap were used for the inorganic sampling. Sampling bottles were rinsed along with the lid before sample collection. Bottled samples were kept in an ice box immediately after collection of samples and submitted to a SANAS-accredited laboratory for comprehensive analysis according to SANAS 241-1:2011 for drinking water. Analyses were carried out in accordance with methods prescribed by the South African Bureau of Standards (SABS) in terms of the Standards Act, Act 30 of 1982.

3.3 Hydrology

3.3.1 Baseline Hydrology

The delineation of the catchment area draining to the site of interest was conducted using topographic survey data or 30 m ALOS Digital Simulation Model (DSM) data from the Japanese Aerospace Exploration Agency (JAXA) (Tadono, et al., 2014). Rainfall data were derived from a rainfall station (with long records) located within the vicinity of the study sites or from quaternary catchment average rainfall records obtained from the 2012 South African Water Resources study (Bailey & Pitman, 2015). These datasets will be used to derive baseline hydrological settings such as the MAP and MAE for the study sites. Detailed, up-to-date land cover/land use data from the Department of Forestry, Fisheries, and the Environment (DFFE) was used to derive the elements likely to affect local hydrological flow regimes of the study site as well as the interpretation of impact assessment.

3.4 Water Quality Analysis

The collected water samples were submitted to a SANAS-accredited laboratory, where analyses were carried out according to methods prescribed by the South African Bureau of Standards (SABS). The parameters analyzed for surface water quality were based on recommendations for a comprehensive water quality analysis study (see Table 3.1).

Table 3.1: Proposed water quality parameters to be analysed

Surface Water Analysis	
pH Value @ 20°C	Manganese, Mn
Conductivity mS/m @ 25°C	Arsenic, As
Total Dissolved Solids	Cadmium, Cd
Dissolved Oxygen	Copper, Cu
Calcium, Ca	Chromium, Cr
Magnesium, Mg	Chromium (VI), Cr^{6+}
Sodium, Na	Mercury, Hg
Potassium, K	Lead, Pb
Total Alkalinity as $CaCO_3$	Selenium, Se
Chloride, Cl	Zinc, Zn
Sulphate, SO_4	Chlorine
Nitrate as N	Cyanide, CN
Nitrate as NO_3	Total Hardness
Nitrite as N	Calcium Hardness as $CaCO_3$
Nitrite as NO_3	Magnesium Hardness as $CaCO_3$
Ammonia, NH_3	PO_4 (as SRP)
Ammonium, NH_4	Orthophosphate as P
Fluoride, F	Bicarbonate, HCO_3
Aluminium, Al	Carbonate, CO_3
Iron, Fe	Total Petroleum Hydrocarbons (TPH) TPH C10-C40 C10- C16 C16-C22 C22- C30 C30-C40

3.5 Water Uses

Existing water uses that have a potential direct impact as a result of the operations of the WWTW were assessed by conducting a desktop-based water availability assessment. This entails incorporating all the identified water users upstream and quantifying the potential impacts on the downstream users. The up-to-date South African Water use Authorisation Registration Management System (WARMS) database was used to identify legal water users upstream and downstream of the WWTW site. This database provides each user's location, water user types, and water quantity allocation at a quaternary scale.

3.6 Surface Water Impact Assessment

3.6.1 Surface Water Impact Assessment

An impact assessment on the site, and local and regional sensitive water receptors resulting from the construction, operation and decommissioning phases of the WWTW 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 was addressed in a standard manner so that a wide range of impacts is comparable.

A risk-based approach was employed in undertaking this study's impact assessment and ranking. This approach uses a typical risk matrix in the 5 x 5 configuration (Figure 3.1), which considers likelihood and consequence in analysing the potential impact risk. The aim is to ensure that the identified impacts are reduced in terms of their impact and occurrence to be, ideally, less impact and the rare likelihood of occurring.

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

3.6.2 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 3.2. The *consequence* was determined by assessing the spatial scale, duration, and severity (see Table 3.3, and the *significance* was then determined and assigned either a low, medium or high.

Table 3.2: Likelihood 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 3.3: Consequences 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 impacts are evaluated using the computation presented in Table 3.4.

Table 3.4: 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

3.6.3 Impact Mitigation Actions

After the *likelihood*, *consequence* and *significance* determinations, impact mitigation measures are proposed. As per the NEMA EIA Regulations, 2014, mitigation means "*to anticipate and prevent negative impacts and risks, then to 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, impact specifically for the constructed chicken houses.

3.6.4 Risk-Based Approach - After Impact Mitigation Action Determination

After mitigation measures were established, the likelihood and consequence were reassessed regarding the criteria presented in Table 3.2 and Table 3.3, 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 reassessed to determine whether the proposed mitigation measures and action plans lessen the importance of the identified impact.

3.6.5 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 the impacts 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 impact mitigation action implementation, 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.

3.7 Monitoring Plan

A surface water monitoring plan for the proposed WWTW was drafted and recommended for implementation during the infrastructure's construction, operation, and decommissioning phases. The monitoring plan aims to ensure that the WWTW operations align with the regulation that aims at protecting water resources and other receptors in the downstream areas.

3.8 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.
- Seasonal changes in the hydrological regimes affecting the water quality of the area were not accounted for in the analysis, however, the static water quality values were compared with the South African National Standards (SANS) 241-1:2015 as well as the recommendations from the RQOs measures for the Middle Vaal WMA.
- In line with the proposed infrastructure layout, it was assumed that the engineering specialist would design and draw the plan for the on-site stormwater management system. Thus, the conceptual delineation of clean and dirty water areas was done for this study's surface water impact assessment exercise.
- All oxidation ponds were assumed to be lined to reduce seepage to the groundwater.
- It was also assumed that the infrastructure is safe from flooding because it is located out of the 1:100-yr flood lines. Thus flooding risk was not included in the assessment.
- 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. This study was conducted in accordance and 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 in order to ensure the protection of 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. DWS is responsible for effective and efficient water resources management to ensure sustainable economic and social development in line with the NWA. DWS is also responsible for evaluating and issuing licenses pertaining to water use (i.e., Water Use Licenses (WULs) and/or registration of General Authorisations (GAs) where this is applicable.

A "water use" is defined in Section 21 of the NWA and includes the following:

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.

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

1. An owner of land, a person in control of the 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.

4.1.2 National Environmental Management Act

Section 24 of 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, while the Listing Notices (LN) GNR 327).

4.2 Desktop Tools

The summary and description of the datasets utilised in the desktop assessment are presented in Table 4.1.

Table 4.1: Summary of the dataset and information during the desktop study of this assessment

DATASET/TOOL	SOURCE	RELEVANCE
Hydrological Data	SAWS and WR2012 Study	Determine the hydrometeorological characteristics of the study site
Google Earth Pro™ Imagery	2022 Google Imagery	Survey the current and historical imagery of the study area to determine the changes in the land-use practices
Reserve Desktop Classification for the Middle Vaal River	DWS (2016)	To evaluate water quality limits in the study site, identify the potential impacts of WWTW activities.

5 BASELINE HYDROLOGY

The hydrometeorological characteristics applicable to the Lindley WWTW site and its surrounds are presented in this section. Understanding derived from this section was also used to conduct the impact assessment of the study.

5.1 Physiographic Setting

The proposed site for Lindley WWTW (27°52'13" S, 27°53'21" E) is on a relatively flat terrain comprising the headwater reaches of quaternary catchment C60B of the Middle Vaal WMA. Based on the topographic nature of this area, natural surface runoff generated from the areas surrounding the proposed WWTW site flows towards the Vals River, which originates about 20 km east of Bethlehem. The area has natural grassland dominating s surroundings and Ntha township in the upstream areas of the WWTW site drains into a small channel towards the site.

5.2 Baseline Hydrology

5.2.1 Temperature

Figure 5.1 shows that hot-wet summers and cold winters dominate the area surrounding Lindley. January is the hottest month, with an average temperature of 26°C, while an average low temperature of about 2°C is experienced in July.

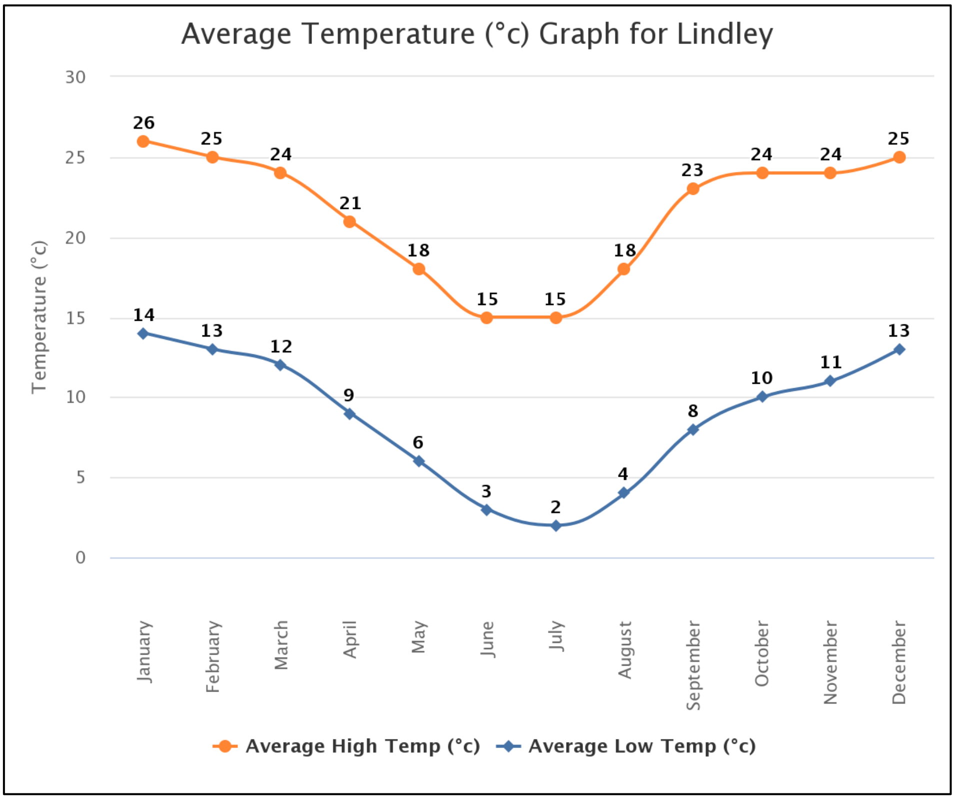


Figure 5.1: Monthly average minimum and maximum temperature distribution (Source: WorldWeatherOnline, 2022)

5.2.2 Rainfall

The average rainfall for the WWTW area is based on the nearest South African Weather Service (SAWS) managed rainfall gauging station. This station is called Lindley (SAWS Reference: 0366743_W) and is situated 3.6 km southeast of the project area. The monthly average rainfall for the site is based on the available records from the rainfall gauge as recorded from 1878 to 2010 and is presented in Table 5.1.

Table 5.1: Average Monthly Rainfall – Lindley 0366743_W

Month	Rainfall (mm)
January	100.24
February	83.62
March	78.82
April	45.14
May	21.92
June	9.94
July	8.68
August	13.73
September	24.14
October	59.13
November	76.50
December	98.16
Total	**620**

Therefore, the percentile distribution of the total annual rainfall (hydrological year starts on 1 September) for the recorded period is presented in Figure 5.2.

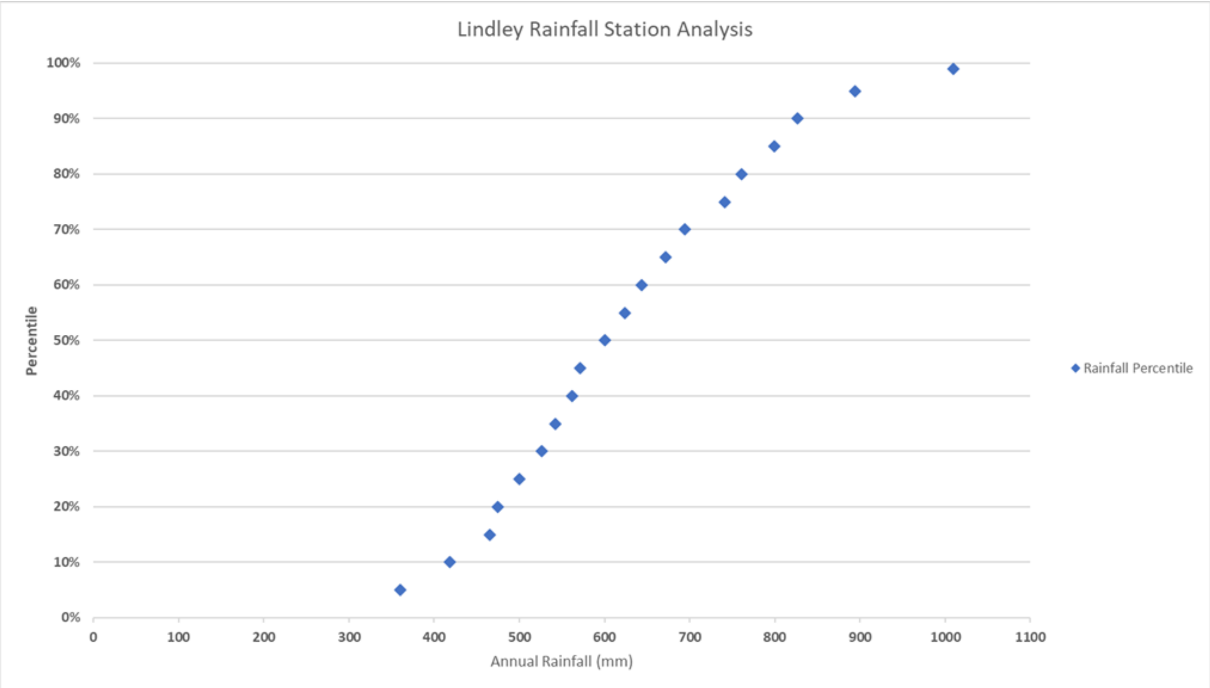


Figure 5.2: Percentile Distribution of Annual Rainfall Totals 1878-2010 (Lindley)

The station's mean annual precipitation (MAP) is 620 mm (Table 5.1). Figure 5.2 shows a significant variation in annual rainfall where 30% of the years in the rainfall record experienced less than 526 mm and 30% experienced more than 694 mm of annual rainfall. Whilst the driest year experienced only 360 mm of rain, the wettest year experienced 1 009 mm of rainfall.

Table 5.2 provides a summary of the wettest multi-day periods observed at Lindley. This table displays the maximum rainfall at the station during a range of 1 to 7 consecutive days. The highest recorded rainfall over 7 days was 194.2 mm, which is about 32% of the MAP. It is concluded that significant rainfall periods have occurred whilst MAP in this area is low.

Table 5.2: Wettest Periods Recorded on Consecutive Days (Lindley)

Days	Rainfall (mm)
1	130.3
2	149.1
3	158.0
4	169.9
5	177.1
6	186.0
7	194.2

5.2.3 Evaporation

The average monthly evaporation for the project site is based on the WR2012 Symon's Pan Evaporation C60B data (Table 5.3). A pan coefficient was then used to convert the recorded S-pan evaporation to open-water evaporation applicable for a conventional dam or pond.

Table 5.3: Monthly Average Evaporation – WR2012 C60B

Month	S-pan (mm)	Open Water Evaporation (mm)	A-pan (mm)
Oct	162.4	131.5	201.0
Dec	168.6	138.2	208.0
Jan	183.1	152.0	224.0
Oct	181.0	152.0	222.0
Dec	145.9	128.4	184.0
Jan	132.6	116.7	169.0
Oct	96.9	85.3	131.0
Dec	73.1	63.6	105.0
Jan	55.9	47.6	87.0
Oct	62.5	51.8	94.0
Dec	90.6	73.4	124.0
Jan	127.4	103.2	164.0
Total	**1 480**	**1 243.7**	**1 913**

5.3 Site Visit

During the site visit undertaken on the 19th of April 2023, various elements were observed which may have potential impacts on the surrounding environment due to the construction, operation, decommissioning and closure of Lindley WWTW. The sampling points for the baseline conditions that exist before the project's three phases were selected to account for all elements that could impact the water quality of the Vals River. This involved selecting an accessible site in the upstream areas to represent water quality conditions that are not affected by the activities of the proposed WWTW. An intermediate site was also selected along the Vals River to represent cumulative impacts from all activities from Ntha township before the treated water from the WWTW is discharged. The last point at the most downstream site of the proposed WWTW (along the Vals River) was also selected to account for all water impacts resulting from the discharged effluent and stream flow coming from the upstream areas.

Pictures in Figure 5.3 summarise the accessible sites selected from sampling and to be proposed for the surface water monitoring plan presented later in this report. All these sites are accessible and assumed to represent the water quality regimes in the upstream and downstream areas of the proposed WWTW.

.

Figure 5.3: Observation made during the site visit

6 WATER QUALITY ANALYSIS

6.1 Sampling

During the site visit, in-situ water quality readings were recorded using a hand-held Aquaprobe AP-800 was used to measure in situ water quality parameters such as pH, salinity, temperature, Electrical Conductivity (EC), and Total Solids Dissolved (TDS). The results of the *in-situ* readings are presented in Table 6.1 and the description of the sites of the surface water sampling points are also given in this table, while mapping of these sampling points are mapped in Figure 6.1.

Site S1 Weir is located at the DWS stream flow gauge, representing water quality in the upstream and total runoff from the town of Lindley. This site was selected as “ambient” to the proposed WWTW site, which will be used to interpret surface water quality. Point S2 is midstream representative of water quality including runoff collected by the unnamed tributary arising west of Ntha township. Water quality indicators from this site will provide the basis for comparison of the treated effluent from the WWTW discharge point. Sampling point S3 is located in the furthest downstream point and represents water quality with all cumulative impacts upstream. The effect of the treated water from the WWTW will reflect from this sampling point. During the site visit, runoff on the unnamed tributary (see insert in Figure 6.1) had a sewage spill from the Ntha township. These were expected to affect in-situ results.

Table 6.1: Description and location of the surface water monitoring points

Sample Point	Lat	Long	pH	EC (*mS/m*)	TDS (*mg/l*)	Temp (°C)
S1 Weir	27°52’18”	27°54’42”	8.01	419	209	18.9
S2 Downstream	27°52’05”	27°53’09”	7.7	419	209	19.6
S3 Downstream	27°52'22"	27°52'16"	8.02	413	206	21

6.2 Baseline Water Quality

Various DWS Water Quality Guidelines limits and RQOs measures values were assessed to determine the essential receptors and/or potential surface water users in the area and to ensure that the operations of Lindley WWTW are in line with the limits. To achieve this, the following were determined to be of most relevance:

- Wastewater discharge – General;
- Wastewater discharge – Special Limits; and
- DWS Resource Quality Objective – Resource Target Values for the Middle Vaal WMA.

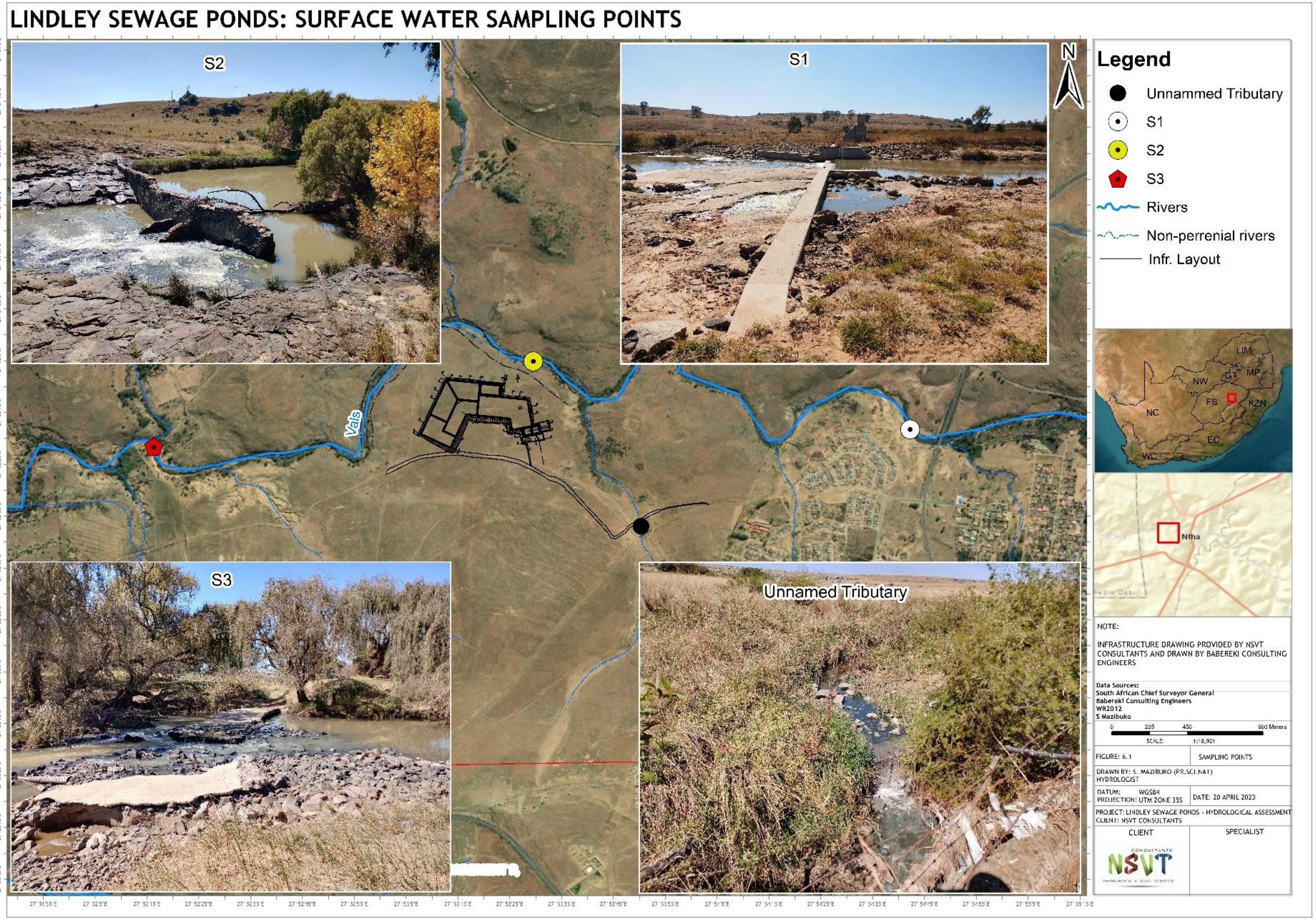


Figure 6.1: Surface water sampling points and other surface water feature observation

Table 6.2 provides the water quality guidelines limits which the water quality results were compared. It should be noted that many of the values identified are related to the DWS Wastewater Discharge Limits guidelines.

Table 6.2: Water Quality Guideline Requirements

Analyses in mg/ℓ (Unless specified otherwise)	UOM %	Method ID	Wastewater Discharge Limits *	
			General Limits*	Special Limits*
pH - Value @ 25 ºC	7.7	WLAB065	5.5-9.5	55-7.5
Electrical Conductivity in mS/m @ 25°C	7	WLAB065	**	***
Suspended Solids at 105°C	8.6	WLAB004	<25	<10
Free Residual Chlorine as Cl_2	---	WLAB036	<0.25	0
Fluoride as F	---	WLAB014	<1	<1
Nitrate as N	4.8	WLAB046	#	##
Nitrate as N	3	WLAB046	#	##
Ortho Phosphate as P	14	WLAB046	<10	****
Free Cyanide as CN	---	WLAB056	<0.02	<0.01
Chemical Oxygen Demand as O_2 (Total)	5.6	WLAB018	<75	<30
Oil & Grease	---	WLAB034	<2.5	0
Faecal Coliform Bacteria (MPN/100 mℓ)	5.3	WLAB021	<1000	0
Free and Saline Ammonia as N	10	WLAB046	<6	<2
Arsenic as As (Dissolved)	9.6	WLAB050	<0.02	<0.01
Boron as B	9.7	WLAB015	<1	<0.5
Cadmium as Cd (Dissolved)	8.5	WLAB050	<0.005	<0.001
Hexavalent Chromium as Cr	3.2	WLAB032	<0.05	<0.02
Copper as Cu (Dissolved)	---	WLAB050	<0.01	<0.002
Iron as Fe (Dissolved)	8.1	WLAB015	<0.3	<0.3
Lead as Pb (Dissolved)	9.7	WLAB050	<0.01	<0.006
Manganese as Mn (Dissolved)	8.3	WLAB015	<0.1	<0.1
Mercury as Hg	16	WLAB050	<0.005	<0.001
Selenium as Se (Dissolved)	9.4	WLAB050	<0.02	<0.02
Zinc as Zn (Dissolved)	8	WLAB015	<0.1	<0.04

* = Revision of general authorizations in terms of section 39 of the national water act, 1998 (act. No. 36 of 1998). Special limits apply in certain specific catchment areas.
** = Not more than 70 mS/m increase above intake to a maximum of 150 mS/m
*** = Not more than 50 mS/m increase above intake to a maximum of 100 mS/m
**** = <1 mg/l (median); <2.5 mg/l (maximum)
# = General limit for combined nitrate and nitrite of <15

As mentioned, the water quality results were compared against the DWS guidelines for Wastewater Discharge Limits. The relevant water quality results for the sampled points used in this study are shown in Table 6.3. The water quality analysis results were mostly within the water guidelines range except for a few exceedances. These results are further summarised as follows:

- Exceedances in Suspended Solids:
  - Suspended Solids values exceed the Wastewater Discharge Limits in all sampled points.
- Exceedances in Faecal Coliform Bacteria (MPN/100 mℓ)
  - Faecal Coliform Bacteria values exceed the Wastewater Discharge Limits at the S2 downstream point. This could be attributed to the sewage from the township in the uphill areas. During the sure visit, sewer water was observed flowing from an unnamed tributary draining to the Vals River, as shown in Figure 6.1.

Table 6.3: Surface Water Quality Results

Analyses in mg/ℓ (Unless specified otherwise)	Sample Results		
	S1 Weir	S2 Downstream	S3 Downstream
pH - Value @ 25ºC	8.2	8.1	8.3
Electrical Conductivity in mS/m @ 25°C	43.1	44.6	44.5
Suspended Solids at 105°C	29	26	31
Free Residual Chlorine as Cl_2	0.1	0.1	0.1
Fluoride as F	0.2	0.2	0.2
Nitrate as N	<0.1	0.2	0.5
Nitrate as N	<0.05	<0.05	0.05
Ortho Phosphate as P	<0.1	<0.1	<0.1
Free Cyanide as CN	<0.010	<0.010	<0.010
Chemical Oxygen Demand as O_2 (Total)	16	20	16
Oil & Grease	1	<1	<1
Faecal Coliform Bacteria (MPN/100 mℓ)	610	1400	650
Free and Saline Ammonia as N	0.1	0.3	<0.1
Arsenic as As (Dissolved)	0.001	0.001	0.001
Boron as B	<0.025	<0.025	<0.025
Cadmium as Cd (Dissolved)	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr	<0.010	<0.010	<0.010
Copper as Cu (Dissolved)	<0.001	<0.001	<0.001
Iron as Fe (Dissolved)	<0.025	<0.025	<0.025
Lead as Pb (Dissolved)	<0.001	<0.001	<0.001
Manganese as Mn (Dissolved)	<0.025	<0.025	<0.025
Mercury as Hg	<0.001	<0.001	<0.001
Selenium as Se (Dissolved)	<0.001	<0.001	0.001
Zinc as Zn (Dissolved)	<0.025	<0.025	<0.025

While this faecal exceedance was observed at S2, the concentration of bacteria reduced in the downstream areas.

7 EXISTING CATCHMENT WATER USES

Water use in the Vals River catchment is dominated by irrigation, which represents 80% of the local requirements for water. About 20% of the requirements are for domestic use.

7.1 Infrastructure

There are solar power plants in the lower Vals River and a growing urban population, all of which have high demands for reliable water supply. As a result, a significant amount of infrastructure has been developed over the years to meet these needs. There is also an impoundment of water in dams, which usually significantly impacts downstream hydrology and must therefore be considered when modelling streamflow.

Interception of streamflow, evaporation from the reservoir surface, abstractions and controlled or uncontrolled releases downstream play a role in changing the hydrological regime. Two dams supply water to Lindley (Figure 7.1), the Piekniekdraai Dam and Grootkrans Dam, operated by Nketoana Local Municipality and these dams have a total storage capacity of 330 000 m^3 (Table 7.1).

Table 7.1: Water sources and actual abstraction for the Lindley Town Area

Raw Water Source	Storage Capacity (m^3)	Yield (m^3/year)	Average Abstraction (m^3/yr) 2021
Grootkrans Dam	110 000	110 000	unknown
Piekniekdraai Dam	220 000	400 000	unknown

Figure 7.1 Location of the storage dams

7.2 Irrigation, Afforestation and Invasive Alien Plants

The irrigation requirements within quaternary catchments C60A and C60B are based on an irrigated area of 382 ha, as given in Table 7.2. There are no afforestation and invasive alien plants in the C60A and C60B quaternary catchment.

Table 7.2: Irrigation water requirement with C60A and C60B

Quaternary Catchment	Irrigation Area (km^2)	Irrigation Requirements Estimate(m^3/yr)
C60A	1.96	1 195 600.00
C60B	1.89	1 152 900.00

8 SURFACE WATER IMPACT ASSESSMENT

The impact assessment on the sensitive features relating to surface water features within and surrounding the construction area was identified and quantified and mitigation measures were drawn for the proposed Lindley WWTW. The following potential impacts were identified during the project's three phases and are discussed below.

8.1 Construction Phase

Table 8.1 lists a summary of the potential impacts identified associated with the construction of the Lindley WWTW. These include the increase in surface runoff due to soil compaction, erosion and siltation from vegetation and topsoil removal as well as mishandling of on-site waste and spillages that could result in the deterioration of downstream water quality.

Table 8.1: Identified impacts during the construction phase.

Aspects Assessment - Construction Phase				
No.	**Phase**	**Activity**	**Aspect (cause)**	**Potential Impact (effect on environment)**
1	Construction	Removal of topsoil and vegetation	Erosion and siltation	Siltation of water resources
2	Construction	Heavy machinery and vehicle movement	Soil surface compaction	Increased surface water runoff
3	Construction	Hydrocarbon, fuel or chemical handling and spillage	Surface water pollution	Pollution of surface water due to spillages, seepages and improper waste handling, storage and disposal.
4	Construction	On-site waste	Deterioration of water quality	Deterioration of water quality downstream
5	Construction	Washing down of the construction material	Ineffective stormwater plan	

8.2 Operational Phase

Potential impacts associated with the projects' operational phase are listed in Table 8.2. These are (i) ensuring that the plant operation meets the minimum requirement for treated effluent standards/limits, (ii) monitoring the inflows into the plant to prevent wastewater overflow and (iii) management of oil spills and hydrocarbons.

Table 8.2: Identified impacts during the operation phase.

Aspects Assessment - Operation				
No.	**Phase**	**Activity**	**Aspect (cause)**	**Potential Impact (effect on environment)**
1	Operation	Overspilling of oxidation ponds	Spill of polluted water to the environment	Pollution of the water resources in the surrounding environment
2	Operation	Hydrocarbon, oil spillages	Water quality deterioration	Deterioration of water quality due to hydrocarbon spillages
3	Operation	Discharging non-compliant effluent into the river	Deterioration of water quality due to poor quality	Pollution of surface water resources downstream

8.3 Decommissioning and Closure Phase

The impacts identified during the decommissioning and closure phases of the WWTW are listed in Table 8.3. 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 and siltation due to compaction because of heavy machinery on site and sewer outflow pipeline closure.

Table 8.3: Identified impacts during the decommission and closure phase.

Aspects Assessment - Decommissioning and Closure				
No.	**Phase**	**Activity**	**Aspect (cause)**	**Potential Impact (effect on environment)**
1	Decommissioning Closure	Heavy machinery and vehicle movement	Soil surface compaction	Siltation of water resources
2	Decommissioning Closure	Demolition of infrastructure	Deterioration of water quality	Contaminants from the infrastructure may pollute the environment
3	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.

Table 8.4: Surface water impact assessment for the operation and decommissioning phases of the project before mitigation measures.

Impact Assessment				Likelihood									Consequence							Significance	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		
1	Removal of topsoil and vegetation	Surface water siltation	Siltation of water resources	Monthly	3	Infrequent / unlikely / seldom / >60%	3	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	2	Medium
2	Heavy machinery and vehicle movement	Soil surface compaction	Increased surface water runoff	Monthly	3	Infrequent / unlikely / seldom / >60%	3	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	2	Medium
3	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.	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	Small / potentially harmful	2	2	2	Medium
4	On-site waste	Surface water pollution	Deterioration of surface water features in the downstream area	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)	1	Insignificant / non-harmful	1	1	2	Medium
5	Washing down of construction material	Ineffective stormwater plan	Siltation and contaminants to the Vals River	6 monthly	2	Infrequent / unlikely / seldom / >60%	3	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
OPERATION PHASE																					
1	Overspilling of the oxidation ponds	Spill surface water pollution	Pollution of the water resources in the surrounding environment	Annually or less	1	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	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	Significant / slightly harmful	3	3	2	Medium
3	Discharging water into the environment	Deterioration of water quality due to poor quality	Pollution of surface water resources downstream	6 monthly	2	Infrequent / unlikely / seldom / >60%	3	Covered by guidelines, standards or legislation	1	Without much effort	2	3	Whole site (entire project area)	2	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
DECOMMISSIONING AND CLOSURE PHASE																					
1	Heavy machinery and vehicle movement	Soil surface compaction	Siltation of water resources	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 day to one month (immediate)	1	Insignificant / non-harmful	1	1	2	Medium
2	Demolition of infrastructure	Deterioration of water quality	Contaminants from the infrastructure may pollute the environment	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Without much effort	2	3	Whole site (entire project area)	2	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
3	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 day to one month (immediate)	1	Insignificant / non-harmful	1	1	2	Medium

Table 8.5: Surface water impact assessment for the project's operation, decommissioning and closure phases after mitigation measures.

Mitigation Assessment				Likelihood									Consequence							Significancee	
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	Removal of topsoil and vegetation	Siltation of water resources	• Retain maximum surface vegetation cover. • Restrict vegetation clearance to a minimum footprint area.	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	• Keep the construction footprint small and use minimal road access	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
3	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 bundled areas containing 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.	6 monthly	2	Almost never / almost impossible / >20%	1	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	On-site waste	Surface water pollution	• Construction camps must have all necessary sanitation and waste collection and disposal system • All waste generated on-site must be disposed of off-site in a manner that is not detrimental to the environment	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
5	Washing down of construction material	Ineffective stormwater plan	• Stormwater runoff shall be considered and its flow controlled on the construction site. • Excavated area must not be left open for the period longer than four weeks. • Proper on-site stormwater management measures must be put in place. No surface water ponding must be allowed on site.	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
OPERATION PHASE																					
1	Overspilling of oxidation ponds	Pollution of the water resources in the surrounding environment	• Monitor, control and regulate inflows into the WWTW ponds	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
2	Hydrocarbon spillages	Deterioration of water quality due to hydrocarbon spillages	• All hazardous substances must be stored and handled on impervious substrates and bundled areas containing potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines.	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 month to one year (Short term)	2	Insignificant / non-harmful	1	2	1	Low
3	Discharging water into the environment	Pollution of surface water resources downstream	• 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	Need some effort	3	3	Local (within 5km)	3	One day to one month (immediate)	1	Insignificant / non-harmful	1	3	2	Medium
DECOMMISSIONING AND CLOSURE PHASE																					
1	Heavy machinery and vehicle movement	Siltation of water resources	• Implement correct procedures for chemical handling and storage to minimise spillages. • Address chemical and water spillages promptly through accepted corrective actions.	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	Demolition of infrastructure	Contaminants from the infrastructure may pollute the environment	• Ensure that the surface and groundwater monitoring program is drafted and implemented	Monthly	3	Very seldom / highly unlikely / >40%	2	Covered by guidelines, standards or legislation	1	Need some effort	3	3	Whole site (entire project area)	2	One month to one year (Short term)	2	Small / potentially harmful	2	2	2	Medium
3	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 bundled areas containing potential spillage. • Waste handling and storage facilities must be located away from surface water resources and drainage lines.	Monthly	3	Infrequent / unlikely / seldom / >60%	3	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	Small / potentially harmful	2	2	2	Medium

Table 8.6 presents the risk-based matrix results for this assessment before and after the mitigation measures. The overall identified impacts show that deterioration of water quality due to spilling wastewater that has not undergone the treatment process has the potential to affect water resources downstream. The matrix scores relating to the likelihood and consequence of the identified impacts are reduced when the mitigation measures are to be implemented. While most impacts can be easily identified, proper implementation of mitigation measures has the potential to have these impacts insignificant.

Table 8.6: 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	**0**	**0**	**1**	**0**	**0**
3	Moderate	**4**	**1**	**2**	**0**	**0**
2	Unlikely	**1**	**2**	**1**	**0**	**0**
1	Rare	**0**	**0**	**0**	**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	**6**	**2**	**0**	**0**	**0**
2	Unlikely	**1**	**1**	**0**	**0**	**0**
1	Rare	**1**	**0**	**0**	**0**	**0**

The suggested implementation tools and their support for all identified impacts are given in the prioritization list in Table 8.7. Priority list results in the table indicate that keeping a footprint small and reducing surface compaction which can result in increased surface runoff which could wash material on-site and other potential contaminants during construction and targeting compliant effluent discharge to the environment should be prioritised. Regulation and monitoring of the inflows to reduce potential overspill should also be prioritised to ensure that the WWTW does not fail.

Table 8.7: Prioritisation table of the derived mitigation measures

Prioritisation													
No.	**Aspect**	**Potential Impact**	**Mitigation Measures**	**Significance before Mitigation**	**Significance After Mitigation**	**Public Response**	**Rate**	**Cumulative Impact**	**Rate**	**Loss of resource**	**Rate**	**Prioritisation**	**Prioritisation**
1	Surface water siltation	Siltation of water resources	• Retain maximum surface vegetation cover. • Restrict vegetation clearance to a minimum footprint area as far as possible.	Medium	Low	Low	1	Low	1	Low	1	1	Low
2	Soil surface compaction	Increased surface water runoff	• Keep the construction footprint small and use minimal road access	Medium	Low	Low	1	Medium	3	Low	1	3	Medium
3	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. • All vehicles and equipment must be kept in good working order and regularly serviced.	Medium	Low	Low	1	Low	1	Low	1	1	Low
4	Surface water drainage patterns altered	Potential to alter the sites natural, pre-existing surface water drainage patterns influencing local hydrology	• Revegetation of exposed areas with indigenous vegetation as an erosion control option. • Keep denuded areas moist or vegetated to lessen dust liberation.	Medium	Low	Low	1	Low	1	Low	1	1	Low
5	Erosion and sedimentation entering receiving surface water bodies	Alteration of the natural pre-existing surface water drainage patterns and slopes of the area may result in increased erosion and sedimentation	• Keep the construction footprint small and use minimal road access	Medium	Low	Low	1	Low	1	Low	1	1	Low
6	Spill surface water pollution	Pollution of the water resources in the surrounding environment	• Monitor, control and regulate inflows into the WWTW ponds	Medium	Low	Medium	3	Medium	3	Low	1	3	High
7	Deterioration of water quality due to poor quality	Pollution of surface water resources downstream	•Ensure that wastewater goes through the treatment process before being released into the environment	Medium	Low	Medium	3	Medium	3	Medium	3	3	Medium
10	Deterioration of water quality	Contaminants from the infrastructure may pollute the environment	• Ensure that a surface and groundwater monitoring program is implemented and where necessary, improvements should be implemented on an ad hoc basis	Medium	Medium	Low	1	Low	1	Low	1	1	Low

9 SURFACE WATER MONITORING PLAN

9.1 Monitoring Plan

Monitoring is required to ensure that the receiving environment surrounding the proposed WWTW is suitably safeguarded against the identified potential impacts and that the environmental management requirements are adequately implemented and adhered to during the project's operational phase. This monitoring plan only focuses on surface water resources.

The monitoring objectives include the following:

- Compliance monitoring - checking compliance with environmental consents (limits), legal requirements or relevant guidelines (including the WRC Guidelines for the Utilisation and Disposal of Wastewater Sludge / prevailing guidelines);
- System performance monitoring - evaluating the effectiveness of effluent and sludge treatment and control; and
- Environmental monitoring - determining the potential impact on the water resources downstream and evaluating the need for further remedial actions or mitigating measures.

9.2 Implementation Programme

The implementation programme for surface water monitoring is provided in Table 9.1 and Table 9.2. Sampling and analyses shall be carried out in accordance with methods prescribed by the South African National Standards (SANS) and using surface water sampling procedures from the DWS Water Quality Sampling guidelines. All samples shall be analysed in a SANAS-accredited laboratory for analysis. The monitoring locations of the effluent inlet and discharge points, together with the baseline sites are shown in Figure 9.1.

9.3 Resources and Competence

All staff working at Lindley WWTW must be competent and skilled to perform their designated functions and to ensure that water and waste are adequately managed.

Training and awareness creation must be undertaken to foster a general attentiveness amongst the staff at the WWTW to sensitive environmental features (including surface) and an understanding of implementing environmental best practices. All staff must undergo induction and attend regular training on the requirements of the WUL and the environmental management requirements on the site. This also includes the surface water sampling procedures and protocols.

Table 9.1: Strategic monitoring implementation

Water Quality Monitoring					
Comments	**Objectives**	**Actions and Targets**	**Performance Indicators**	**Methodology**	**Resource Requirements**
Surface water quality sampling	• Ensure that the Water Quality of the Vals River is not altered due to WWTW operations.	• Water quality monitoring will be conducted as per WUL conditions for the WWTW.	• Baseline water quality (as per the water quality indicators of sampling points S2 and S3) be maintained throughout the lifetime of WWTW. • Water quality variables listed in the water analyses certificates (Appendices) will be measured and the monitoring during the operation of the WWTW to compare the results with the baseline results obtained during the site visit of this study.	• Water quality monitoring checklist (status quo of the watercourse during sampling). • Measurements of the quality of the water resource at specific intervals.	Hand-held testing equipment, sampling bottle, magnesium sulphate solution and iodide azide for dissolved oxygen

Table 9.2: Details of monitoring implementation programme

Monitoring Type		Parameters / Factors	Locations	Frequency
Effluent	Quality	As per the DWS' WWTW WWTW effluent discharge limits	WWTW's Inflow point WWTW's Ouflow point	Monthly
Surface Water	Instream Water Quality	As per the DWS' WWTW effluent dicharge limits	• S1, S2, and S3 (as per Figure 9.1)	Monthly
	Biomonitoring	• Aquatic macroinvertebrates • Habitat integrity • Fish assemblages	• S1 and S3	Biannual (high and low flow)

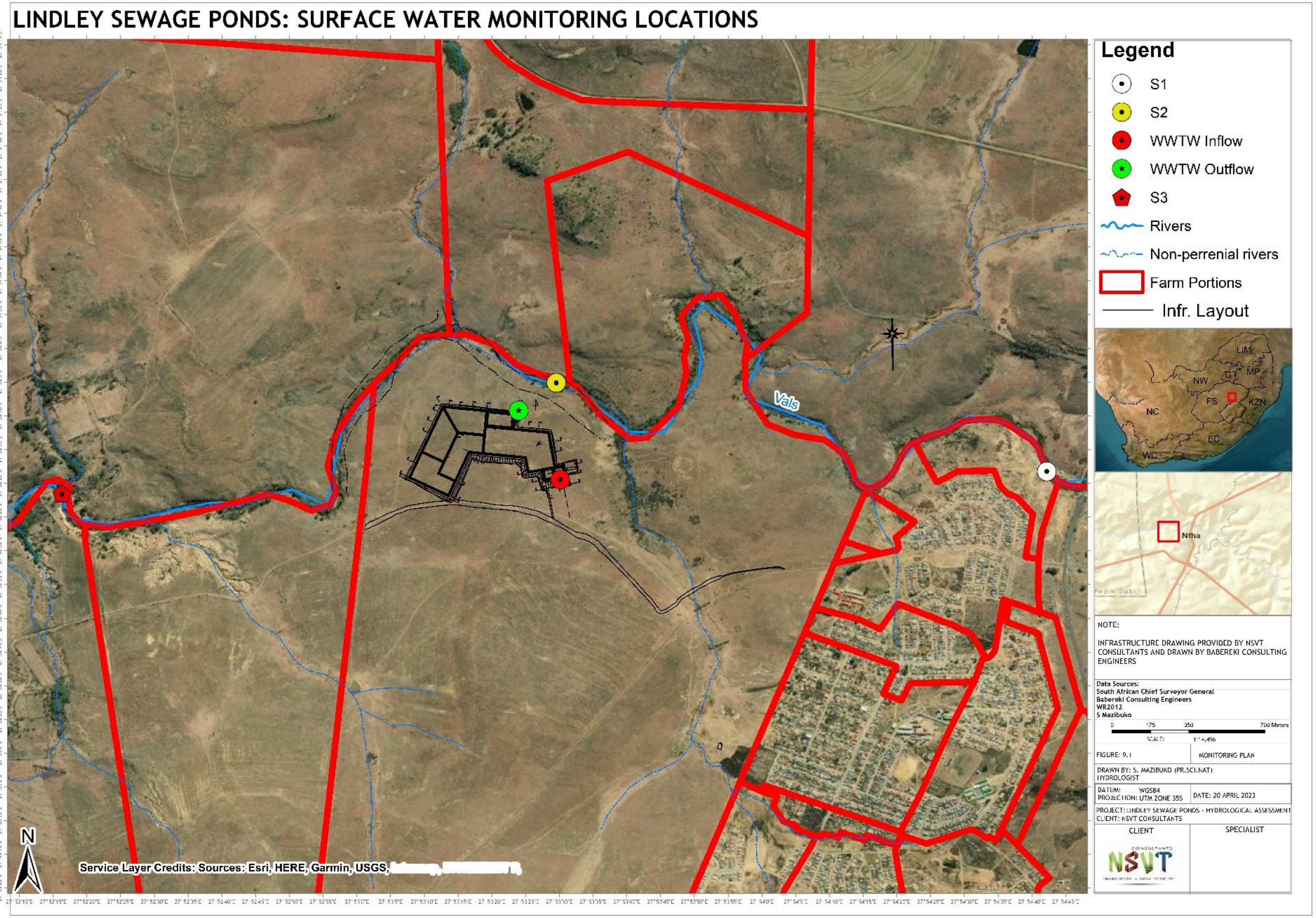


Figure 9.1: Proposed surface water monitoring locations for the monitoring plan

9.4 Incident Management

According to the NWA, an “incident" includes any incident or accident in which a substance pollutes or has the potential to pollute a water resource or has, or is likely to have, a detrimental effect on a water resource. For the purposes of this report, an incident also refers to a loss of control of the system due to unforeseen and emergencies.

Examples of incident triggers at a WWTW include the following:

- Non-compliance with operational monitoring criteria;
- Inadequate performance of a WWTW discharging to source water;
- Spillage of a hazardous substance into source water;
- Failure of the power supply to an essential component at the WWTW;
- Extreme rainfall in a catchment;
- Detection of unacceptable levels of metals, ammonia, etc.;
- Unusual odour or appearance of returned effluent water;
- Detection of microbial indicator parameters, including unusually high faecal indicator densities and unusually high pathogen densities in returned effluent; and
- Public health indicators or a disease outbreak for which water is a suspect vector.

9.5 Reporting

An operator of the WWTW shall conduct the following audits, which will be updated to ensure alignment with the requirements of the Water Use Licence:

- Annual internal audits on compliance with the conditions of the WUL. The audit reports shall be submitted to DWS;
- Annual audits by an independent external auditor on compliance with the conditions of the WUL. The audit reports shall be submitted to the DWS;
- Annual audits of the implementation of and adherence to the WUL conditions; and
- Annual audits of the effectiveness of the Monitoring Programme

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The following findings were derived from the study:

- The proposed Lindley WWTW site comprises the oxidation pond systems and will receive wastewater from Ntha township and the treated effluent will be discharged to the Vals River system.
- The area draining to the study site is predominantly rural and covered by grassland. The SAWS rain gauge (0366743_W)) for Lindley indicates that the area surrounding the WWTW has a Mean Annual Precipitation (MAP) of 620 mm while the WR2012 database indicated the Mean Annual Evaporation (MAE) of 1 480 mm.
- In-situ generic water quality parameters recorded during the site visit along the Vals River indicated a consistent reading of Electric Conductivity (EC), Total Dissolved Solids (TSD) and pH. Surface water analysis from a SANAS-accredited laboratory for the sampled points along the Vals River shows a high concentration of suspended solids while a mid-stream point (S2) indicated high levels of Faecal Coliform Bacteria. This could be attributed to the sewage spill observed on the unnamed tributary draining from the western part of Ntha township.
- Registered water users (based on the WARMS database) that could be impacted due to the operation of Lindley WWTW are predominantly abstractions for irrigation and no identified water abstractions for domestic use.
- Surface water impact assessment for the receptor of water-related features was identified and quantified. The mitigation measures were drawn for the impact of the project's construction, operation, decommissioning and closure phases.
- Results show that during the removal of topsoil and vegetation, heavy machinery and vehicle movement, on-site generated waste, hydrocarbon, fuel or chemical mishandling and spillage and washing down of the construction material pose a risk of water quality deterioration during the *construction phase*.
- Non-compliance with the treated effluent standards/limits, prevention and containment of any oil, or hydrocarbon spill as well as the prevention of ponds overspill – through regulation of the effluent inflow were identified as the potential impacts during the *operational phase* of the project.

- Increased soil erosion due to the demolition of the WWTW infrastructure, improper waste handling, and poorly developed vegetation can affect water features during the *decommissioning and closure phases* of the project.
- Surface water monitoring plan was drafted to represent a river section that is (i) not impacted by the operations of the WWTW, (ii) indicative of the impacts coming from Ntha, (iii) WWTW inflow and outflow, and (iv) downstream point to representative of the cummulative impacts upstream.

10.2 Recommendations

The following recommendations were made for the construction phase of the project:

- Development, implementation, and maintenance of the construction site stormwater management measures and prevention of ponding surfaces to reduce erosion on site.
- All waste generated on-site be contained and discharged off-site to reduce the potential of contamination on site.
- It is recommended that clearing vegetation cover, removal of topsoil and construction footprint be kept minimal to reduce soil erosion. Heavy machinery movement should also be kept small to minimise soil compaction, which increases runoff generated on-site.
- It is also recommended that any spillages of oil and hydrocarbons on-site be contained and cleaned to reduce their impact on contributing to the deteriorating water quality in the downstream areas during the entire construction period.
- Construction should predominantly be during the dry season to prevent stormwater events that can affect the local hydrology on site.
- Discharging non-compliant effluent medium impact on the quality of water resources downstream. *Compliance with wastewater discharge/limits regulations and continuous monitoring is recommended throughout the operational phase.*
- On-site, proper regulation of the inflows into the WWTW ponds has the potential to reduce the overflow of wastewater from the ponds. *Plant operating guidelines and sustaining ponds storage volume capacity – through sludge disposal are recommended*.

- Decommissioning of the infrastructure, hydrocarbon and fuel spill has the potential to release pollutants into the surrounding environment resulting in the deterioration of water quality in the surrounding area. *Proper handling of spills and keeping to the footprint of infrastructure demolition is recommended*.
- Heavy machinery movement and vegetation removal have the potential to compact the topsoil and increase surface runoff and sedimentation from the plant footprint t the downstream area. *Keeping a small footprint and plating vegetation after the demolition have the potential to restore the landscape and reduce erosion in the plant footprint*.
- The utilisation of a small footprint for demolition of the infrastructure while reducing leaks of hydrocarbons to the environment is recommended during the decommissioning and closure of the WWTW, while continuous monitoring of the surface water in areas is recommended through a surface water monitoring plan.
- A further recommendation on the appropriate *implementation of a surface water monitoring program is made to ensure that the WWTW site's efficiency is achieved as well as the protection of surface water resources* in the larger region.

11 REFERENCES

Bailey, A., & Pitman, W. (2015). *Water Resources of South Africa 2012 Study (WR2012): Executive Summary Version 1. WRC Report No. K5/2143/1.* Gezina, South Africa: Water Research Commission Report.

Google. (2022). *Google Earth™ mapping service: 2017, Imagery date: 15th of March 2017.* Google.

JAXA. (2018). *Advanced Land Observation Satellite (ALOS) Global Digital Surface Model (DSM).* Tokyo: Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA).

NWA. (1998). *The South African National Water Act.* South Africa.

SANRAL. (2013). *Drainage Manual. 6th Edition.* Pretoria: South African National Road Agency Soc Ltd (SANRAL).

Smithers, J., & Schulze, R. (2002). *Design Rainfall and Flood Estimation, WRC Report No. K5/1060.* Pretoria: Water Research Commission.

Tadono, T., Ishida, H., Oda, F., Naito, S., Minakawa, K., & Iwamoto, H. (2014). Precise Global DEM Generation by ALOS PRISM, ISPRS Annals of the Photogrammetry. *Remote Sensing and Spatial Information Sciences*, 71-76.

US Army Corps of Engineers. (2018). HEC-RAS River Analysis System. Hydraulic Reference Manual. Version 5.06.

12 APPENDICES – WATER QUALITY ANALYSES CERTIFICATE

WATERLAB (Pty) Ltd
Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Persequor Techno Park
Meiring Naudé Drive
Pretoria

P.O. Box 283, Persequor Park, 0020
Tel: +2712 - 349 - 1066
Fax: +2786 - 654 - 2570
e-mail: admin@waterlab.co.za

sanas Testing Laboratory
T0391

CERTIFICATE OF ANALYSES

GENERAL WATER QUALITY PARAMETERS

Date received: 2023-04-20 **Date completed:** 2023-04-28
Project number: 1000 **Report number:** 119756 **Order number:**

Client name: Altra Watech **Contact person:** Sbongiseni Mazibuko
Address: P.O Box 2747, White River, 1240 **e-mail:** altrawatech@gmail.com
Telephone: 081 428 6832 **Facsimile:** **Mobile:** 083 623 2156

Analyses in mg/ℓ (Unless specified otherwise)		UOM %	Method ID	Wastewater Discharge Limits *		Sample Identification	
						S1 Weir	S2 Downstream
Sample Number				General Limits*	Special Limits*	23-04627	23-04628
Date/Time Sampled						N/A	N/A
pH - Value @ 25 ºC	A	7.7	WLAB065	5.5-9.5	5.5 -7.5	8.2	8.1
Electrical Conductivity in mS/m @ 25°C	A	7.0	WLAB065	**	***	43.1	44.6
Suspended Solids at 105°C	A	8.6	WLAB004	<25	<10	29	26
Free Residual Chlorine as Cl_2	N	---	WLAB036	<0.25	0	0.1	0.1
Fluoride as F	N	---	WLAB014	<1	<1	0.2	0.2
Nitrate as N	A	4.8	WLAB046	#	##	<0.1	0.2
Nitrite as N	A	3.0	WLAB046	#	##	<0.05	<0.05
Ortho Phosphate as P	A	14	WLAB046	<10	****	<0.1	<0.1
Free Cyanide as CN	N	---	WLAB056	<0.02	<0.01	<0.010	<0.010
Chemical Oxygen Demand as O_2 (Total)	A	5.6	WLAB018	<75	<30	16	20
Oil & Grease	A	---	WLAB034	<2.5	0	1	<1
Faecal Coliform Bacteria (MPN/100 mℓ)	A	5.3	WLAB021	<1000	0	610	1400
Free and Saline Ammonia as N	A	10	WLAB046	<6	<2	0.1	0.3
Arsenic as As (Dissolved)	A	9.6	WLAB050	<0.02	<0.01	0.001	0.001
Boron as B	A	9.7	WLAB015	<1	<0.5	<0.025	<0.025
Cadmium as Cd (Dissolved)	A	8.5	WLAB050	<0.005	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr	A	3.2	WLAB032	<0.05	<0.02	<0.010	<0.010
Copper as Cu (Dissolved)	N	---	WLAB050	<0.01	<0.002	<0.001	<0.001
Iron as Fe (Dissolved)	A	8.1	WLAB015	<0.3	<0.3	<0.025	<0.025
Lead as Pb (Dissolved)	A	9.7	WLAB050	<0.01	<0.006	<0.001	<0.001
Manganese as Mn (Dissolved)	A	8.3	WLAB015	<0.1	<0.1	<0.025	<0.025
Mercury as Hg	A	16	WLAB050	<0.005	<0.001	<0.001	<0.001
Selenium as Se (Dissolved)	A	9.4	WLAB050	<0.02	<0.02	<0.001	<0.001
Zinc as Zn (Dissolved)	A	8.0	WLAB015	<0.1	<0.04	<0.025	<0.025

J. Ngobeza - Chemical Technical Signatory

M. Ramaboea - Microbiological Technical Signatory

A = Accredited N = Not Accredited S = Subcontracted UoM=Uncertainty Of Measurement
Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.
Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.

Sample condition acceptable unless specified on the report.
Microbiological standards dictate that zero cannot be reported in cases where no growth is observed. The requirement is to then report as <1cfu/g or ml. A result of <1 implies the absence of the specific test organism and is the lowest reportable result where no growth was detected.

Bacteriological parameters analysed on: 2023-04-20

Page 1 of 4

WATERLAB (Pty) Ltd
Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Persequor Techno Park
Meiring Naudé Drive
Pretoria

P.O. Box 283, Persequor Park, 0020
Tel: +2712 - 349 - 1066
Fax: +2786 - 654 - 2570
e-mail: admin@waterlab.co.za

T0391

CERTIFICATE OF ANALYSES

GENERAL WATER QUALITY PARAMETERS

Date received: 2023-04-20
Project number: 1000
Report number: 119756
Date completed: 2023-04-28
Order number:

Client name: Altra Watech
Address: P.O Box 2747, White River, 1240
Telephone: 081 428 6832
Facsimile:
Contact person: Sbongiseni Mazibuko
e-mail: altrawatech@gmail.com
Mobile: 083 623 2156

* = Revision of general authorizations in terms of section 39 of the national water act, 1998 (act. No. 36 of 1998). Special limits apply in certain specific catchment areas.
** = Not more than 70 mS/m increase above intake to a maximum of 150 mS/m
*** = Not more than 50 mS/m increase above intake to a maximum of 100 mS/m
**** = <1 mg/l (median); <2.5 mg/l (maximum)
# = General limit for combined nitrate and nitrite of <15

J. Ngobeza - Chemical Technical Signatory

M. Ramaboea - Microbiological Technical Signatory

A = Accredited N = Not Accredited S = Subcontracted UoM=Uncertainty Of Measurement
Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.
Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.

Sample condition acceptable unless specified on the report.
Microbiological standards dictate that zero cannot be reported in cases where no growth is observed. The requirement is to then report as <1cfu/g or ml. A result of <1 implies the absence of the specific test organism and is the lowest reportable result where no growth was detected.

Bacteriological parameters analysed on: 2023-04-20

Page 2 of 4

WATERLAB (Pty) Ltd
Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Persequor Techno Park
Meiring Naudé Drive
Pretoria

P.O. Box 283, Persequor Park, 0020
Tel: +2712 - 349 - 1066
Fax: +2786 - 654 - 2570
e-mail: admin@waterlab.co.za

sanas Testing Laboratory T0391

CERTIFICATE OF ANALYSES

GENERAL WATER QUALITY PARAMETERS

Date received: 2023-04-20 **Date completed:** 2023-04-28
Project number: 1000 **Report number:** 119756 **Order number:**

Client name: Altra Watech **Contact person:** Sbongiseni Mazibuko
Address: P.O Box 2747, White River, 1240 **e-mail:** altrawatech@gmail.com
Telephone: 081 428 6832 **Facsimile:** **Mobile:** 083 623 2156

Analyses in mg/ℓ (Unless specified otherwise)		UOM %	Method ID	Wastewater Discharge Limits *		Sample Identification
						S3 Downstream
Sample Number				General Limits*	Special Limits*	23-04629
Date/Time Sampled						N/A
pH - Value @ 25 ºC	A	7.7	WLAB065	5.5-9.5	5.5 -7.5	8.3
Electrical Conductivity in mS/m @ 25°C	A	7.0	WLAB065	**	***	44.5
Suspended Solids at 105°C	A	8.6	WLAB004	<25	<10	31
Free Residual Chlorine as Cl_2	N	---	WLAB036	<0.25	0	0.1
Fluoride as F	N	---	WLAB014	<1	<1	0.2
Nitrate as N	A	4.8	WLAB046	#	##	0.5
Nitrite as N	A	3.0	WLAB046	#	##	0.05
Ortho Phosphate as P	A	14	WLAB046	<10	****	<0.1
Free Cyanide as CN	N	---	WLAB056	<0.02	<0.01	<0.010
Chemical Oxygen Demand as O_2 (Total)	A	5.6	WLAB018	<75	<30	16
Oil & Grease	A	---	WLAB034	<2.5	0	<1
Faecal Coliform Bacteria (MPN/100 mℓ)	A	5.3	WLAB021	<1000	0	650
Free and Saline Ammonia as N	A	10	WLAB046	<6	<2	<0.1
Arsenic as As (Dissolved)	A	9.6	WLAB050	<0.02	<0.01	0.001
Boron as B	A	9.7	WLAB015	<1	<0.5	<0.025
Cadmium as Cd (Dissolved)	A	8.5	WLAB050	<0.005	<0.001	<0.001
Hexavalent Chromium as Cr	A	3.2	WLAB032	<0.05	<0.02	<0.010
Copper as Cu (Dissolved)	N	---	WLAB050	<0.01	<0.002	<0.001
Iron as Fe (Dissolved)	A	8.1	WLAB015	<0.3	<0.3	<0.025
Lead as Pb (Dissolved)	A	9.7	WLAB050	<0.01	<0.006	<0.001
Manganese as Mn (Dissolved)	A	8.3	WLAB015	<0.1	<0.1	<0.025
Mercury as Hg	A	16	WLAB050	<0.005	<0.001	<0.001
Selenium as Se (Dissolved)	A	9.4	WLAB050	<0.02	<0.02	0.001
Zinc as Zn (Dissolved)	A	8.0	WLAB015	<0.1	<0.04	<0.025

J. Ngobeza - Chemical Technical Signatory

M. Ramaboea - Microbiological Technical Signatory

A = Accredited N = Not Accredited S = Subcontracted UoM=Uncertainty Of Measurement
Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.
Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.

Sample condition acceptable unless specified on the report.
Microbiological standards dictate that zero cannot be reported in cases where no growth is observed. The requirement is to then report as <1cfu/g or ml. A result of <1 implies the absence of the specific test organism and is the lowest reportable result where no growth was detected.

Bacteriological parameters analysed on: 2023-04-20

Page 3 of 4

WATERLAB (Pty) Ltd

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Persequor Techno Park
Meiring Naudé Drive
Pretoria

P.O. Box 283, Persequor Park, 0020
Tel: +2712 - 349 - 1066
Fax: +2786 - 654 - 2570
e-mail: admin@waterlab.co.za

T0391

CERTIFICATE OF ANALYSES

GENERAL WATER QUALITY PARAMETERS

Date received: 2023-04-20 **Date completed:** 2023-04-28
Project number: 1000 **Report number:** 119756 **Order number:**

Client name: Altra Watech **Contact person:** Sbongiseni Mazibuko
Address: P.O Box 2747, White River, 1240 **e-mail:** altrawatech@gmail.com
Telephone: 081 428 6832 **Facsimile:** **Mobile:** 083 623 2156

* = Revision of general authorizations in terms of section 39 of the national water act, 1998 (act. No. 36 of 1998). Special limits apply in certain specific catchment areas.
** = Not more than 70 mS/m increase above intake to a maximum of 150 mS/m
*** = Not more than 50 mS/m increase above intake to a maximum of 100 mS/m
**** = <1 mg/l (median); <2.5 mg/l (maximum)
# = General limit for combined nitrate and nitrite of <15

J. Ngobeza - Chemical Technical Signatory

M. Ramaboea - Microbiological Technical Signatory

A = Accredited N = Not Accredited S = Subcontracted UoM=Uncertainty Of Measurement
Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.
Results marked "Subcontracted Test" in this report are not included in the SANAS Scope of Accreditation for this Laboratory.

Sample condition acceptable unless specified on the report.
Microbiological standards dictate that zero cannot be reported in cases where no growth is observed. The requirement is to then report as <1cfu/g or ml. A result of <1 implies the absence of the specific test organism and is the lowest reportable result where no growth was detected.

Bacteriological parameters analysed on: 2023-04-20