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Hydrogeological Investigation and impact assessment for the proposed Ntuzuma sewer pipeline

Report

Version - Final

13 September 2020

Project Number:

Client Reference:

LWANDISA HOLDINGS



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Director	Sphesihle Mdlalose	[signature]	13 September 2020

DECELERATION OF INDEPENDENCE

ILZ Consulting (Pty) Ltd (ILZ) was appointed to conduct this specialist groundwater study and to act as the independent hydrogeological specialist. ILZ performed the work in an objective manner, even if this results in views and findings are not favourable. ILZ has the expertise in conducting the specialist investigation and will not engage in conflicting interests in the undertaking of this study. This report presents the findings of the investigations which include the activities set out in the scope of work.

EXECUTIVE SUMMARY

ILZ Consultants (Pty) Ltd (ILZ) was appointed by Lwandisa Holdings to undertake a hydrogeological investigation for the proposed Ntuzuma sewer pipeline to be developed in Ntuzuma, Kwa-Zulu Natal Province.

Project Background

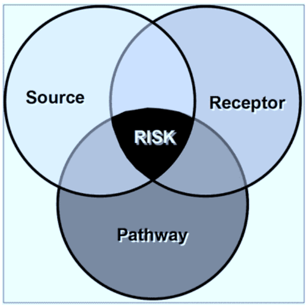
eThekwini municipality proposes to upgrade the existing sewer system within Ntuzuma area located approximately 15km north of Durban CBD.

The geohydrological assessment is required to assess the existing and likely future GW and surface water related impacts, and to supplement Water Use Licence Application (WULA) for the site.

Approach and Methodology

A logical and holistic approach was adopted in order to assess the study area. The Best Practice Guidelines for Impact Prediction (G4) (Department of Water Affairs and Forestry [DWAF], 2008), was considered in order to define and understand the three basic components of the hydrogeological risk:

- **Source term** - The source of the risk;
- **Pathway** - The pathway along which the risk propagates; and
- **Receptor** - The target that experiences the risk.



The approach was used to assess:

1. How the existing / proposed site activities could impact groundwater *Quality*; and
2. How the existing / proposed site activities could affect the groundwater *Quantity*.

Site Assessment

- **Desktop Assessment**
  - ✓ The literature review reveal that the site is underlain by Dwyka Group tillites, Natal Group Sandstone and Pietermaritzburg shales.
  - ✓ Soils depth at the site varies from 0.5 to 1m depending on the topography with deeper soils encountered within low topography and shallow soil at higher altitudes.
  - ✓ The site hydrogeology is characterized by fractured aquifer system with borehole yields ranging from 0.1 to 0.5 l/s.

  - ✓ NGA and KRIP borehole databases indicated no groundwater users within 5km radius from the site.

- Field Assessment
  - ✓ The field assessment confirmed the site geology as described in the desktop study.
  - ✓ Shallow groundwater conditions were observed on the northeastern side of the study area where the site is underlain by Natal Group sandstone.
  - ✓ Several streams within the proposed area for the sewer line construction were identified.
  - ✓ Evidence of leaking sewer manholes and illegal dumping of waste in the river was observed.
- Baseline water quality
  - ✓ Laboratory analysis indicated that the streams identified at the site have been negatively impacted by the illegal dumping as well as the existing sewer pipe network.
  - ✓ High E.coli, feacal coliforms and total coliforms were measured in all surface water samples collected from the streams.
  - ✓ Shallow groundwater from the spring indicated microbiological contamination with elevated E.coli, Total coliforms and feacal coliforms.
  - ✓ The surface water resources at the site indicated high ammonia and ammonium concentration.

<u>Hydrogeological Impact and Risk Assessment</u>

The anticipated impact on GW users is insignificant as there are no groundwater users identified downstream of the proposed Ntuzuma sewer pipeline construction. Based on the source-pathway-receptor principle, the following receptors of potential pollution are noted

- The vadose zone and the subsequent aquifer; and
- Non-perennial drainage systems, and Rivers.

The project is unlikely to have an impact on the GW quantity (i.e. reduction of GW recharge), due to its small scale of the development.

<u>Recommendations</u>

The following recommendations are made:

- All waste generated during construction on site (i.e. building rubble, used oil and paint containers etc.) must be stored in designated areas which are isolated from surface drains. Waste storage facilities should be covered to prevent dust and litter from leaving the containment area, and to prevent rainwater ingress.
- Minimise the amount of exposed ground and stockpiles of building material (i.e. sand, cement, wood, metal, paint, solvents etc.) to prevent suspended solid transport loads and leaching of rocks/materials. Stockpiles can be covered, and sediment fences constructed from a suitable geotextile.
- Routine inspection along the sewer line should be conducted in order to visually check for possible oil spills from machinery and equipment.
- The Department of Environmental Affairs (DEA) published a generic Environmental Management Plan (EMP) for substations and powerlines (22 March 2019). It is proposed that the mitigation and monitoring plan presented in this report be further supplemented by the generic EMP document.
- It is proposed that water quality monitoring be implemented as discussed in Section 6, to monitor the impact of thedevelopment on the receiving environment.

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LIST OF ACRONYMS

Acronym	Description
µg	microgram
BA	Basic Assessment
BF	Baseflow
BH	Borehole
BHN	Basic Human Needs
CRT	Constant Rate Test
d	day
DMEA	Department of Mineral and Environmental Affairs
DTM	Digital Terrain Model
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
E	East
EC	Electrical Conductivity
EU	Existing Use
Fm	Formation
G3	Best Practice Guidelines: Monitoring
G4	Best Practice Guidelines: Impact Prediction
GCS	GCS Water and Environment (Pty) Ltd
GPS	Global Positioning System
GRAII	Groundwater Resource Assessment Ver. 2
GRDM	Groundwater Resource Directed Measures
GRIP	Groundwater Resource Information Project
GW	groundwater
IGRD	Intermediate Groundwater Reserve Determination
IWULA	Integrated Water Use License Application
km	kilometre
K-value	hydraulic conductivity
KZN	KwaZulu-Natal
l	litres
m	metres
MAE	Mean Annual Evaporation
Mag	magnetometer
mamsl	metres above mean sea level
MAP	Mean Annual Precipitation
mbcl	metres below collar level
mbgl	metres below ground level
mg	Milligram
mm	Millimetres
mS	Milli Siemens
n	Porosity
N	North
NGA	National Groundwater Archive
nT	magnetic intensity
NWA	National Water Act, 1998
Re	Recharge
Rem	Remainder
s	second
S	South
SA	South Africa
SCM	Site Conceptual Model
SPR	Source-Pathway-Receptor
SRTM	Shuttle Radar Topography Mission
T	Transmissivity
W	West
WL	Water level
WMA	Water Management Area
WRC	Water Research Council
WULA	Water Use License Application

1 INTRODUCTION

ILZ Consulting (PTY) LTD hereafter referred to as "ILZ" was appointed by Lwandisa Holdings to conduct a groundwater study and hydrogeological impact assessment for the proposed sewer line in Ntuzuma area.

1.1 Project Background

eThekwini municipality proposes to upgrade the existing sewer system within Ntuzuma area located approximately 15km north of Durban CBD.

The geohydrological assessment is required to assess the existing and likely future GW and surface water related impacts, and to supplement Water Use Licence Application (WULA) for the site.

1.2 Study objectives

- To understand baseline groundwater (GW) and surface water (SW) quantity and quality that can be used as a benchmark for future comparison purposes.
- To assess the current status of GW resources in general and any fatal flaws and /or sensitive areas.
- Understand all GW risks associated with the proposed activities on the GW environment.
- Present findings in a suitable format to support decision-making.

1.3 Scope of Work

The scope of work included:

1. **Desktop Assessment:**
    a. All available reports relating to the site were assessed, including a review of all geohydrology, hydrology, hydrochemistry, and geology literature data.
    b. A desktop level hydrocensus was conducted. Both the National Groundwater Archive (NGA, 2018) and the Groundwater Resource Information Project (GRIP, 2016) databases were assessed to identify existing groundwater users in the area.
2. **Hydrogeological and Geological Conceptual model:**
    a. A hydrogeological and geological site conceptual model was developed with data obtained for the study area.
3. **Hydrogeological Risk and Impact Assessment:**
    a. A preliminary risk assessment was conducted based on the source-pathway-receptor principle.

   b. Potential risk and sensitive GW areas were evaluated with the DRASTIC model developed by the United States Environmental Protection Agency (USEPA).

4. **Monitoring Plan:**

   a. A GW and SW monitoring plan, with mitigation measures, was developed for the site based on the baseline assessment of the site conditions.

5. **Reporting:**

   a. This hydrogeological report encompassing all work done as well as a groundwater risk assessment and monitoring plan was compiled.

1.4 Study limitations

The following study limitations are recognized:

- No exploratory drilling was conducted as part of this study. Although data in this assessment is extracted from reliable data sources, the risk assessment is considered preliminary until groundwater data is verified with intrusive site work (i.e. drilling of onsite boreholes, on-site water quality and quantity testing).
- No GW balance was undertaken as part of this study, due to no GW abstraction being proposed as part of this project. The proposed sewer lines will be confined to small areas; and no impact in terms of groundwater recharge is anticipated.

2 SITE OVERVIEW

The following supply an overview of the hydrogeological and geological conditions of the project area, as per the desktop information reviewed for this assessment. The following sources were utilised:

- Groundwater Resource Information Project (GRIP, 2016) borehole data.
- 2829 Durban – 1:500 000 Hydrogeological map series (King *et al.*, 1998).
- 2930 Durban – 1:250 000 Geological map series (DMEA, 1998).
- Literature on similar geology and hydrogeology:
  - A South African Aquifer System Management Classification (Parsons, 1995);
  - Aquifer Classification of South Africa (DWA, 2012);
  - Karoo Aquifers: Their Geology, Geometry and Physical Properties. Water Research Council (WRC) Report No: 457/1/98 (Botha *et al.*, 1998);
  - Karoo Groundwater Atlas Volume 2 (Woodford *et al.*, 2013); and
  - The relationship between South African geology and geohydrology (Lourens, 2013);

- Hydrogeological setting and hydrogeochemical characteristics of the Durban Metropolitan District, eastern South Africa. (Ndlovu et. al., 2019).

2.1 Regional setting, topography, drainage, and climate

The proposed area for the sewer pipeline is located within Ntuzuma area, north of Durban in KZN. The altitude of the Ntuzuma settlement area ranges from to 120 to 240 mamsl. Steep slopes are a key feature of this area. The study area falls within the lower Mgeni River catchment, north of the Gobogobo River. The Piesangs River and its tributaries also flow through Ntuzuma, joining the uMhlangane River, which ultimately merges with the Mngeni before it enters the sea.

This region has a subtropical climate receiving rainfall in summer months. The average Mean Annual Precipitation (MAP) is in the range 900- 1000 mm/annum and Mean Annual evaporation (MAE) is in the range of 1 100- 1200mm/annum (S-Pan) for the catchment.

2.2 Local Geology and soils

The geology of Ntuzuma is comprised of Dwyka Tillite (mainly to the west of the site) and Natal Group Sandstone to the east (refer to Figure 2-1). Soils derived from sandstones generally have a low fertility, and the majority of the area is unsuitable for the growing of crops due to steep slopes and the unavailability of land.

Soil depth across the study area varies between 0.5 and 1 metre, with deeper soils (1-2 m) concentrated in river courses. There are some rocky outcrops to the east of the study area, and soils <0.5 m in depth in areas of higher altitude.

2.3 Geohydrology

The hydrological conditions within Ntuzuma area characterised by fractured aquifer system of the Dwyka Group and the Natal Group sandstone. According to the 1:500 000 hydrogeological map series of south Africa, sheet 2928: Durban area, the Ntuzuma area falls within a d2 borehole yield class with borehole yield ranging from 0.1 to 0.5l/s. Groundwater quality is characterised by low electrical conductivity values ranging from 0 to 70 mS/m.

2.3.1 Groundwater levels and flow direction

The KZN groundwater resource information projects (GRIP) and the national groundwater archives (NGA) databases did not show any boreholes within 5km radius from the study area. Therefore, no groundwater information is available for the study area.

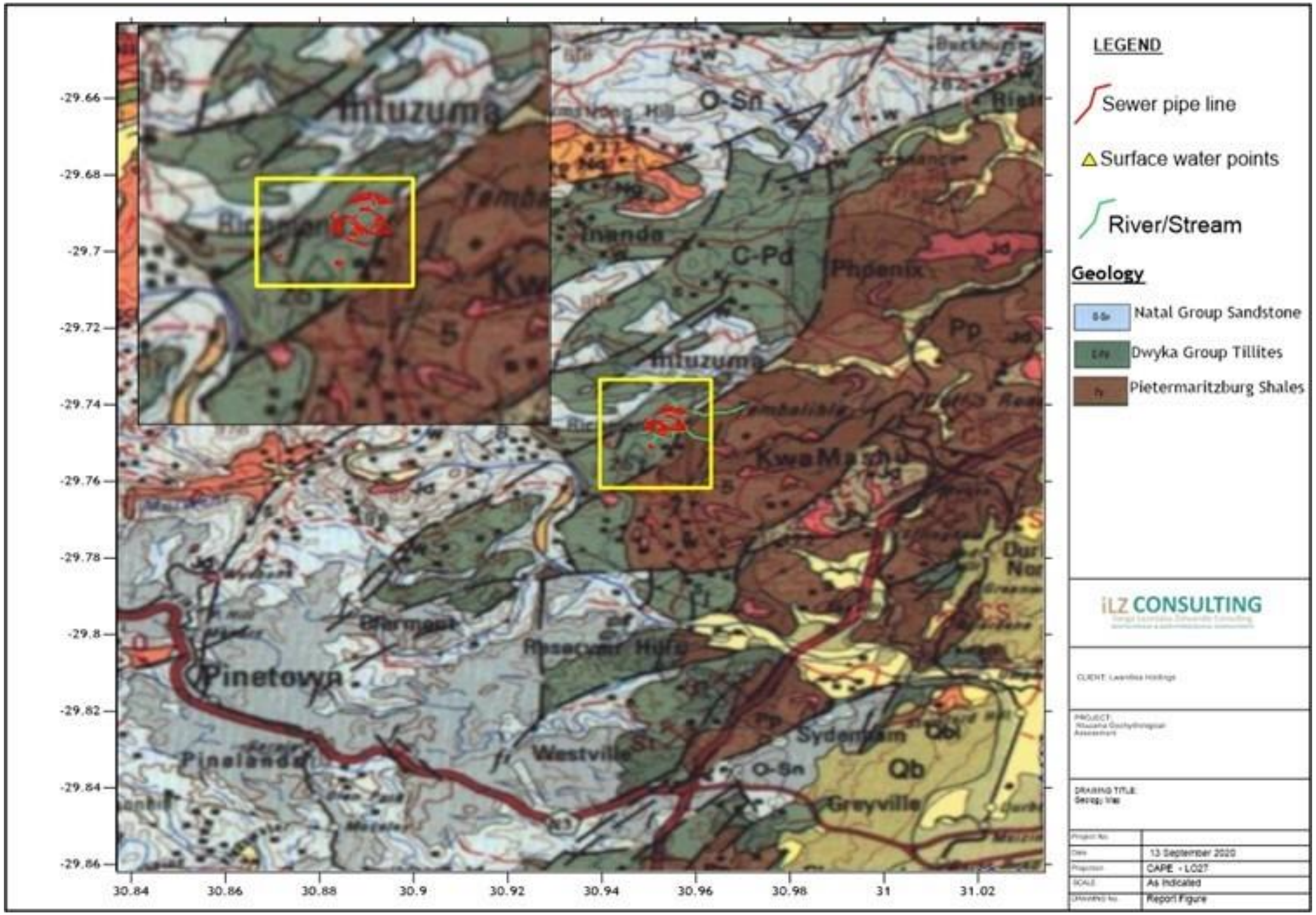

Figure 2-1: Geology map showing the underlying surface geology of the site

3 HYDROCENSUS AND WATER SAMPLING

A hydrocensus was undertaken on Thursday, the 13 August 2020, to map groundwater and surface water resources and sensitive areas that can be negatively impacted by the proposed sewer pipeline construction such as wetlands, springs and/or rivers.

No groundwater and users were identified within the study area. Several streams flow through the site and the proposed sewer pipeline plan indicates that the pipes will be crossing some of the streams or will be parallel to the streams. During the hydrocensus, it was noted that the residents have been dumping garbage into the stream. Furthermore, the existing sewer pipes at the site were noted to be leaking and the leakage is flowing directly into the steam. Refer to Figure 3-1 for the pictures showing stream pollution at the site.

During the hydrocensus, three (3) surface water samples were collected for baseline hydro-chemical analysis by a SANAS accredited laboratory. Two (2) surface water sample were collected from the stream and one surface water sample was collected from the spring. The details of the sampling points are shown in Table 3-1 and the positions of the sampling points are shown in Figure 3-1.

Picture Number	Picture	Description
1		Photo taken at one of the streams flowing through the site. Visible on the picture is the dumping of waste in the stream. The waste includes plastics, bottles, old food etc.
2		Photo taken from the site near the stream. Shown on the picture is the leaking sewer manhole. The water from this manhole flows directly into the steam.

Figure 3-1: Photo log showing pictures of the stream pollution noted during the hydrocensus survey

Table 3-1: Sample points coordinates and photos

Sample Point Name	Latitude	Longitude	Description	Site Photo
SW-1	-29.741795°	30.958716°	Surface water point collected from the stream on the eastern portion of the site. The stream is flowing strong. No dumping was noted on this stream and the water is clear with no sewer smell.	
SW-2	-29.747053°	30.958381°	Surface water point south of the site. The sample was collected were the stream flowing through the site merge and flow as one stream. Dumping of domestic waste was noted on the streams upstream of the sampling point.	
Spring-1	-29.741307°	30.958651°	Spring on the eastern end of the site, near SW-1. The spring discharges from a Natal Sandstone outcrop. The area around the spring shows signs of wetland.	

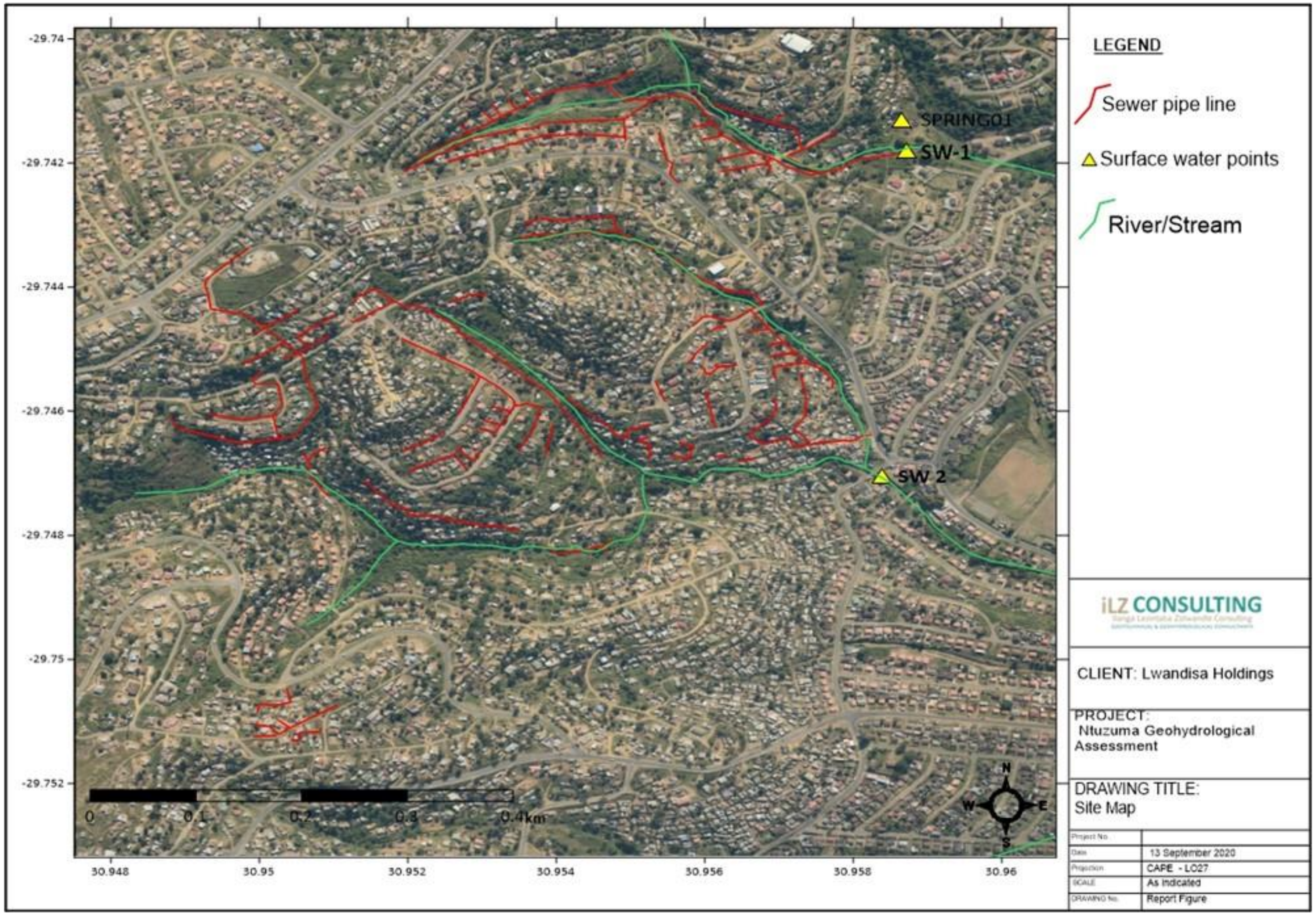

Figure 3-2: Site Map showing the positions of the sampling points.

4 BASELINE WATER QUALITY

The laboratory results for the three (3) surface water samples collected from the Ntuzuma area are tabulated in Table 4-1. The results are compared with DWA Domestic use standards and SANS 241-1 drinking water standards. The values with light red fill exceed the SANS limits and the values with yellow fill exceed the DWA limits. Based on the results, it can be seen that the streams within the site have been strongly impacted by the existing sewer system. Elevated microbiological contamination is evident from all sample points. The shallow groundwater conditions around the area of spring 1 appear to be strongly impacted as well. The seepage water from the spring display high microbiological contamination which is likely the results of the leakage from the sewer pipes and seepage from the pit latrines.

Table 4-1: Baseline water quality results

Determinands	Units	SW-1	SW-2	Spring	1996 DWAF	2015 SABS
		13/08/2020	13/08/2020	13/08/2020	Domestic Use	SANS 241-1-
pH at 25°C	pH Units	7.6	7.3	7.5	6 , 9	5 , 9.7
Electrical conductivity at 25°C	mS/m	41	46.1	43.7	70	170
Total Dissolced Solids (TDS)	mg/l	326	332	334	70	250
Dissolved calcium	mg/l	11	13	3.92	32	n/s
Dissolved magnesium	mg/l	13.7	12.3	10.2	30	n/s
Sodium	mg/l	44	46	62	100	200
Potassium	mg/l	1.85	4.92	0.63	50	n/s
Chloride	mg/l	41	63	47	100	300
Sulphate	mg/l	25.8	25.5	31	200	250
Bicarbonate alkalinity	mg/l	107	120	83	n/s	ns
Carbonate alkalinity	mg/l	3	3	3	n/s	n/s
Nitrate*	mg/l	3.37	2.82	0.04	6	11
Dissolved iron	mg/l	0.142	0.111	0.415	0.5	2
Dissolved manganese	mg/l	0.025	0.025	0.025	0.1	0.5
Total alkalinity	mg/l	107	120	83	n/s	
Fluoride*	mg/l	0.09	0.11	0.08	1	1.5
Dissolved aluminium	mg/l	0.176	0.1	0.732	0.15	0.3
Ammonia	mg/l	0.11	4.71	0.11	0.1	
Ammonium	mg/l	0.11	4.7	0.11	0.1	
Suspended solids at 105°C	mg/l	38	18	2412	-	-
Faecal coliforms	MPN/100ml	4110	19860	19860	0	0
Total coliforms	MPN/100ml	61300	72700	57900	5	10
e-coli	MPN/100ml	2420	1986	53	0	0
Total BOD	mg/l	<10	<10	12	n/s	n/s

5 PRELIMINARY RISK AND IMPACT ASSESSMENT

The following preliminary risk and impact assessment is based on the information collected during the desktop study, literature review and field work assessment. The potential risks to groundwater and surface water contamination during the Construction Phase and operation Phase of the sewer pipeline exist.

There are various ways to assess the hydrogeological risk, and in this assessment, a source-Pathway-receptor principle was applied in this investigation. This is a simple and practical way to assess risk and impacts on the hydrogeology for a given project.

Risk assessment entails the understanding of the generation of a hazard, the probability that the hazard will occur and the consequences if it should occur. The anticipated geohydrological impacts during construction and operational phases are indicated in **Figure5-1** and discussed in **Table 5-1.** and **Table 5-2**, below. The risk assessment methodology is describedin **Appendix A**.

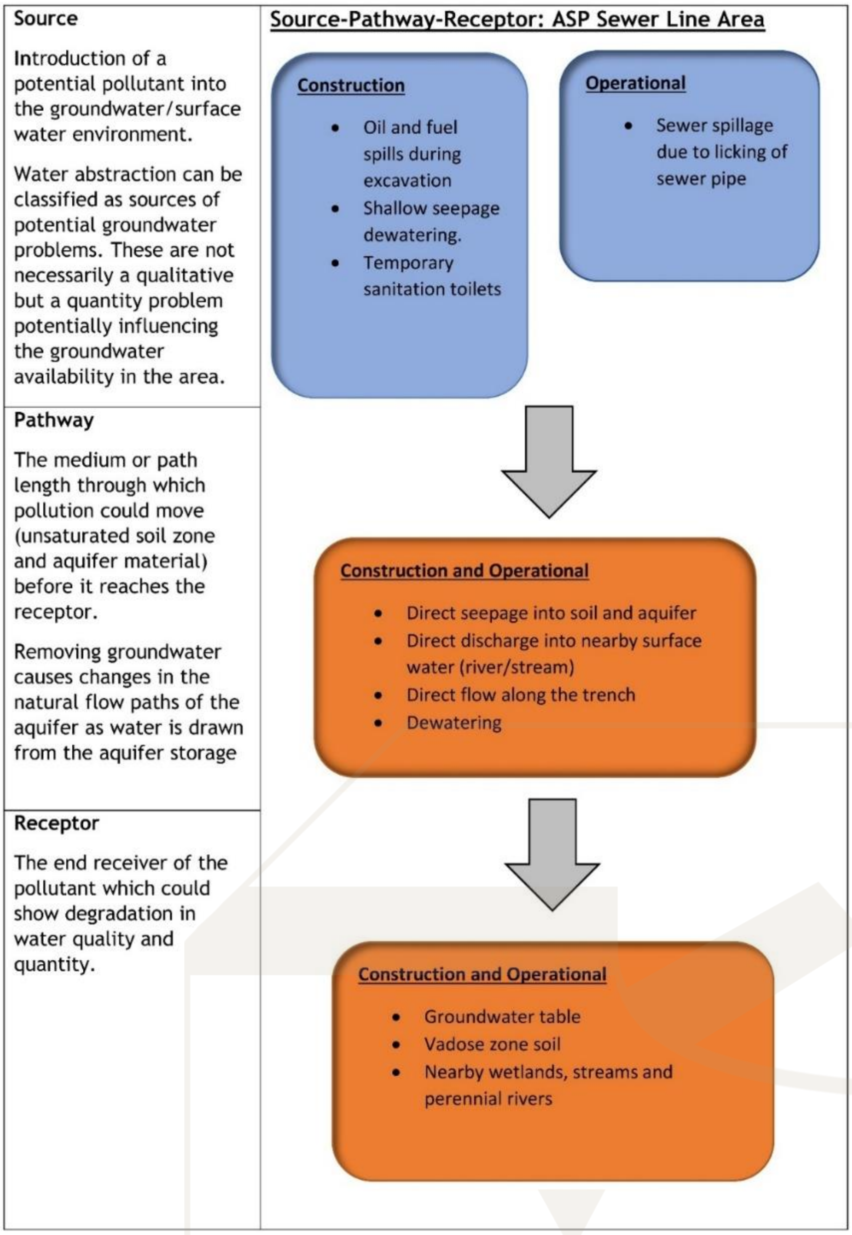

Figure 5-1: SPR for the Ntuzuma sewer pipeline construction

Table 5-1: Potential geohydrological impacts and mitigation measures during the construction phase

Hydrogeological Component Being Impacted On	Activity Which May Cause the Impact	Environmental Impact											Recommended Mitigation Measures
		Impact Type	Nature	Spatial extent	Duration	Intensity	Frequency	Probability	Irreplaceability	Reversibility	Significance	Confidence	
Matters Pertaining to Hydrogeology (Anticipated Groundwater Related Impacts) - Construction													
Vadose zone and regional water table / groundwater aquifer	Disturbing vadose zone during soil excavations / construction activities.	Direct impacts	Negative	Local	Short-term	Low	Once Off	Probable	Low irreplaceability of resources	High reversibility of impacts	Low	High	Only excavate areas applicable to the project area. Backfill the material in the same order it was excavated to reduce contamination of deeper soils with shallow oxidised soils. Cover excavated soils with a temporary liner to prevent contamination. Keep the site clean of all general and domestic wastes.
	Poor quality seepage from machinery used to excavate soils. Oil, grease and fuel leaks could lead to hydrocarbon contamination of the vadose zone which could percolate to the shallow aquifer.	Direct impacts	Negative	Local	Short-term	Negligible	Once Off	Probable	Low irreplaceability of resources	Moderate reversibility of impacts	Low	Medium	Water quality monitoring of the downstream surface water. Park heavy machineries in lined areas and place drip trays under vehicles at the site. Visual soil assessments for signs of contamination.
	Poor quality seepage from the proposed Ntuzuma Sewer line and parked service vehicles, during construction of the facilities. Seepage may percolate into the shallow aquifer zone.	Direct impacts	Negative	Site specific	Short-term	Negligible	Once Off	Probable	Low irreplaceability of resources	Moderate reversibility of impacts	Low	Medium	
Primary Surface Water Receivers - > rivers and streams	Degradation of water quality of non-perennial and perennial river systems situated within the sewer line areas the site is likely to occur if: 1. Equipment and vehicles are washed in the water bodies; and 2. Material stockpiles are placed on the banks of the river and streams which occur in the project area. Erosion of stockpiles may occur during wet seasons, leading to siltation of the water bodies (overland runoff),	Direct impacts	Negative	Local	Short-term	Low	Once Off	Probable	Low irreplaceability of resources	High reversibility of impacts	Medium	Medium	Water quality monitoring and visual assessments. Install a temporary cut off trench to contain poor quality runoff. Routine inspections of all sewer related infrastructure. Cover material stockpiles with a temporary liner to prevent contamination.
Groundwater Users in the Area	Available GRIP (2016)/ NGA (2018) data indicated that no groundwater boreholes fall downstream of the project area. The aquifer is poorly exploited and due to the scale of the activity, impact on groundwater users will be insignificant	*No Impact*											No mitigation required.

Table 5-2: Potential geohydrological impacts and mitigation measures during the operation phase

Hydrogeological Component Being Impacted On	Activity Which May Cause the Impact	Environmental Impact											Recommended Mitigation Measures
		Impact Type	Nature	Spatial extent	Duration	Intensity	Frequency	Probability	Irreplaceability	Reversibility	Significance	Confidence	
Matters Pertaining to Hydrogeology (Anticipated Groundwater Related Impacts) - Operational													
Vadose zone and regional water table / groundwater aquifer	Poor quality seepage from cracks or broken sewer lines, individual soakaway systems, sewage pump station areas and the WWTW could percolate to the shallow aquifer.	Direct impacts	Negative	Local	Permanent	Low	Intermittent	Probable	Low irreplaceability of resources	Moderate reversibility of impacts	Low	Medium	Visual soil assessment for signs of contamination along the installed sewer line, WWTW area, pump station and soakaway systems. Routine sewer hydraulic flow testing.
Primary Surface Water Receivers - > river and streams	Degradation of water quality of non-perennial and perennial river systems situated downstream of the entire sewer network is likely to occur if: 1. Poor quality seepage or runoff from the, above mentioned sources, into the surface water bodies downstream of the site occurs.	Direct impacts	Negative	Local	Permanent	Low	Intermittent	Probable	Low irreplaceability of resources	Moderate reversibility of impacts	Low	High.	Water quality monitoring and visual assessments. Installation of piezometric seepage boreholes if pollution is evident. Install a temporary cut off trench to contain poor quality runoff. Routine inspections of all sewer related infrastructure (hydraulic monitoring)

6 WATER MONITORING

The monitoring network is based on the principles of a monitoring network design as described by the DWAF Best Practice Guidelines: G3 Monitoring (DWAF, 2007). The methodological approach which the monitoring plan follows is represented by Figure 6-1, below.

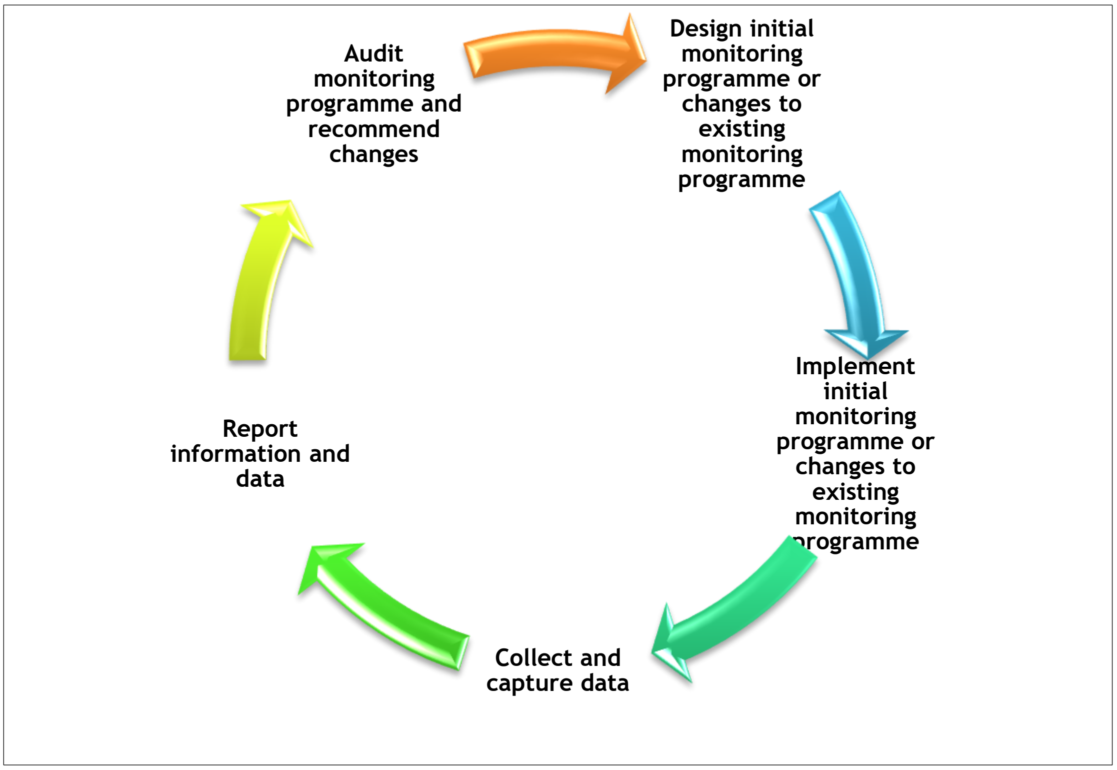

Figure 6-1: Monitoring process

6.1 Development of the monitoring network

Currently no GW and surface water (SW) monitoring is taking place. It is proposed that a proper monitoring programme be implemented to monitor both the water quality and quantity of the surrounding environment, respective to the proposed sewer and powerline. The monitoring programme is divided into two phases:

- Phase 1: Monitoring during construction activities (temporary monitoring); and
- Phase 2: Monitoring after development expansion (long term or for a period after the activity).

6.1.1 Phase 1 monitoring

It is proposed that, during the construction phase, water and soil monitoring focus on active excavation and equipment / heavy machinery parking or housing areas. Regular visual inspections of these areas need to be undertaken. Moreover, placement and monitoring of drip trays underneath parked construction vehicles will help to determine which vehicles need to be repaired/taken off-site to prevent contamination while in service.

6.1.2 Phase 2 monitoring

From the risk assessment undertaken, it is anticipated that the vadose zone, perennial streams, and non-perennial streams, are the only receptors of likely pollution. Therefore, when construction is complete monitoring should focus on these areas.

Due to the proposed sewer line, some degree of GW quality monitoring is proposed. This would involve installing several hand auger piezometric boreholes (up to 3 m) upstream and downstream of these areas, to serve as an early detection system of poor-quality seepage. If pollution is evident, deeper boreholes (up to 30 m) can be considered to determine the impact on the local aquifer system.

It is proposed that SW monitoring also be conducted at the site. All poor-quality GW seepage will most likely be transported to the downstream SW bodies. Only monitoring of the perennial river systems are proposed.

6.2 Monitoring duration

In terms of monitoring duration, it is proposed that monitoring take place up to 6 months after the completion of the development. The need for further monitoring of the site can be evaluated by the local environmental authorities or DWS representative.

6.3 Monitoring responsibility

It is proposed that the applicant or/ developer be responsible for Phase 1 and Phase 2 monitoring. The proposed monitoring type, frequencies, and constituents to monitor are listed in Table 6-1 below.

Preliminary monitoring positions are indicated in **Figure 6-2**. Actual monitoring positions needs to be established during Phase 1 and maintained throughout the project.

Table 6-1: Proposed monitoring points, frequencies and sample analyses

<table>
<tr><th>Type</th><th>Frequency</th><th>Field Measurements</th><th>Laboratory Analysis</th></tr>
<tr><td>Shallow borehole / auger holes (seepage holes)

If required.</td><td>Bi-Annually</td><td>pH
EC / TDS
Temp
Dissolved Oxygen
Groundwater Level (if applicable)</td><td rowspan="3">If field measurements indicate a contaminant trend, it is advised that a sample be submitted for analytical testing. The following should typically be screened:
pH, Conductivity, Total dissolved solids (TDS) and total suspended solids (TSS)
Biological oxygen demand (BOD).
Calcium, Magnesium, Sodium, Potassium, Carbonate, Bicarbonate, Chloride, Sulphate, Nitrate, Iron, Manganese, Fluoride, Aluminium, Total Alkalinity (TALK), Ammonia, Ammonium.
Total coliforms, E. Coli, Faecal coliforms.</td></tr>
<tr><td>Sewer lines, sewer pump stations and storm water drains
(hydraulic monitoring)</td><td>Quarterly</td><td>Visual assessment
Sample spillage if applicable.</td></tr>
<tr><td>Perennial Rivers
(Upstream & Downstream)</td><td>Bi-Annually</td><td>pH
EC / TDS
Temp
Dissolved Oxygen</td></tr>
</table>

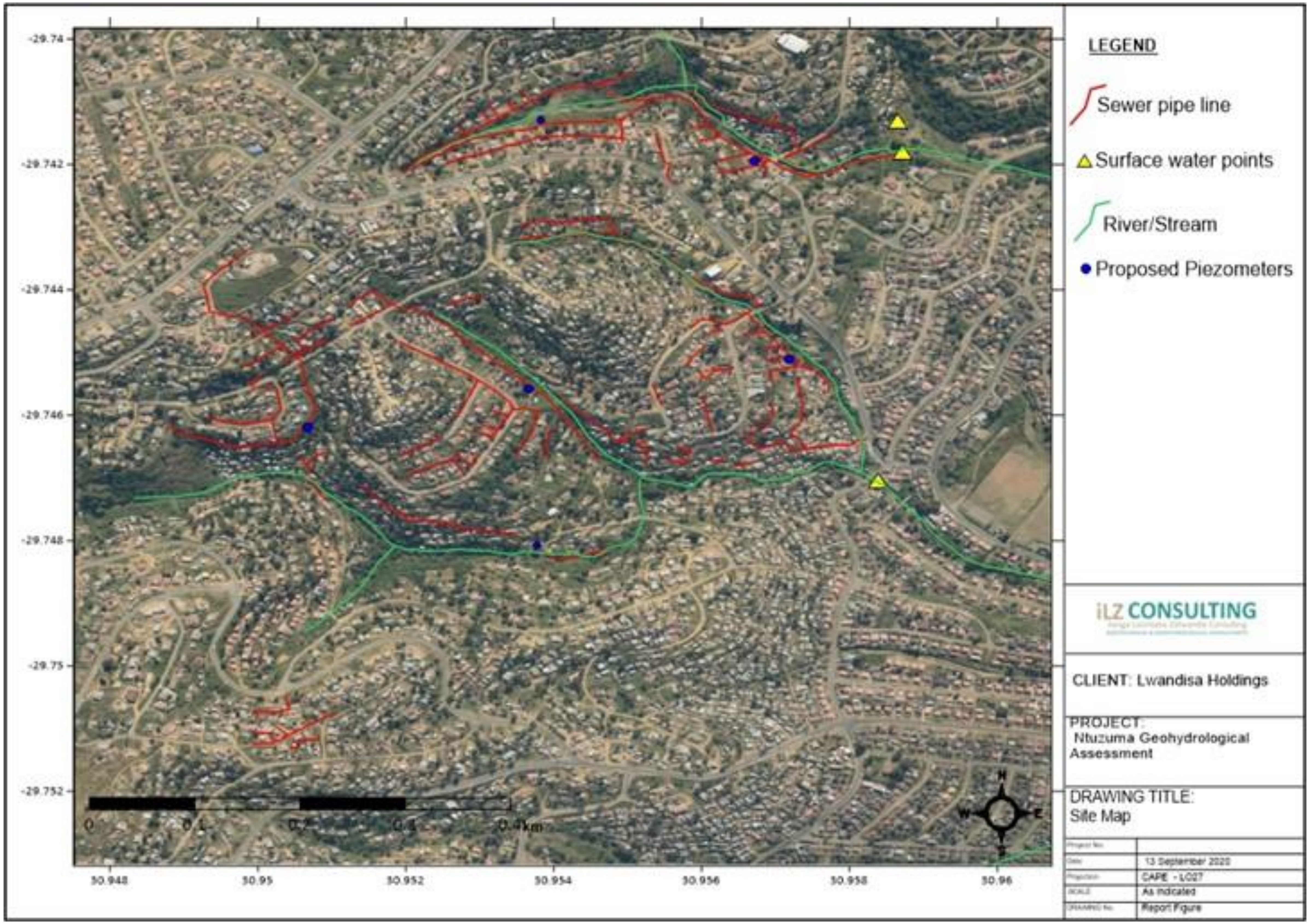

Figure 6-2: Proposed water monitoring map

7 CONCLUSIONS

The following conclusions were made following the results of the investigation:

- Desktop Study
  - ✓ The literature review reveal that the site is underlain by Dwyka Group tillites, Natal Group Sandstone and Pietermaritzburg shales.
  - ✓ Soils depth at the site varies from 0.5 to 1m depending on the topography with deeper soils encountered within low topography and shallow soil at higher altitudes.
  - ✓ The site hydrogeology is characterized by fractured aquifer system with borehole yields ranging from 0.1 to 0.5 l/s.
  - ✓ NGA and KRIP borehole databases indicated no groundwater users within 5km radius from the site.
- Field Assessment
  - ✓ The field assessment confirmed the site geology as described in the desktop study.
  - ✓ Shallow groundwater conditions were observed on the northeastern side of the study area where the site is underlain by Natal Group sandstone.
  - ✓ Several streams within the proposed area for the sewer line construction were identified.
  - ✓ Evidence of leaking sewer manholes and illegal dumping of waste in the river was observed.
- Baseline water quality
  - ✓ Laboratory analysis indicated that the streams identified at the site have been negatively impacted by the illegal dumping as well as the existing sewer pipe network.
  - ✓ High E.coli, feacal coliforms and total coliforms were measured in all surface water samples collected from the streams.
  - ✓ Shallow groundwater from the spring indicated microbiological contamination with elevated E.coli, Total coliforms and feacal coliforms.
  - ✓ The surface water resources at the site indicated high ammonia and ammonium concentration.
- Geohydrological Risk and impact Assessment
  - The anticipated impact on GW users is insignificant as there are no groundwater users identified downstream of the proposed Ntuzuma sewer pipeline construction. Based on the source-pathway-receptor principle, the following receptors of potential pollution are noted
  - The vadose zone and the subsequent aquifer; and
  - Non-perennial drainage systems, and Rivers.

- The project is unlikely to have an impact on the GW quantity (i.e. reduction of GW recharge), due to its small scale of the development.

7.1 Recommendations

The following recommendations are made:

- All waste generated during construction on site (i.e. building rubble, used oil and paint containers etc.) must be stored in designated areas which are isolated from surface drains. Waste storage facilities should be covered to prevent dust and litter from leaving the containment area, and to prevent rainwater ingress.
- Minimise the amount of exposed ground and stockpiles of building material (i.e. sand, cement, wood, metal, paint, solvents etc.) to prevent suspended solid transport loads and leaching of rocks/materials. Stockpiles can be covered, and sediment fences constructed from a suitable geotextile.
- Routine inspection along the sewer line should be conducted in order to visually check for possible oil spills from machinery and equipment.
- The Department of Environmental Affairs (DEA) published a generic Environmental Management Plan (EMP) for substations and powerlines (22 March 2019). It is proposed that the mitigation and monitoring plan presented in this report be further supplemented by the generic EMP document.
- It is proposed that water quality monitoring be implemented as discussed in Section 6, to monitor the impact of the development on the receiving environment.

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APPENDIX A: RISK ASSESSMENT METHODOLOGY

Due to the geohydrological assessment forming part of a larger risk assessment for the study area, the potential impacts and the determination of impact significance was assessed. The following list of conventions was applied to the risk and impact assessment:

- Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
- Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
- Cumulative impacts are those that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.
- Nature – the evaluation of the nature is impact specific. Most negative impacts will remain negative, however, after mitigation, significance should reduce:
    - Positive.
    - Negative.
- Spatial extent – the size of the area that will be affected by the impact:
    - Site specific.
    - Local (limited to the immediate areas around the site; < 2 km from site).
    - Regional (would include a major portion of an area; within 30 km of site).
    - National or International.
- Duration – the timeframe during which the impact will be experienced:
    - Short-term (0-3 years or confined to the period of construction).
    - Medium-term (3-10 years).
    - Long-term (the impact will only cease after the operational life of the activity).
    - Permanent (beyond the anticipated lifetime of the project).

- Intensity – this provides an order of magnitude of whether or not the intensity (magnitude/size/frequency) of the impact would be negligible, low, medium or high):
  - Negligible (inconsequential or no impact).
  - Low (small alteration of natural systems, patterns or processes).
  - Medium (noticeable alteration of natural systems, patterns or processes).
  - High (severe alteration of natural systems, patterns or processes).
- Frequency – this provides a description of any repetitive, continuous or time-linked characteristics of the impact:
  - Once Off (occurring any time during construction).
  - Intermittent (occurring from time to time, without specific periodicity).
  - Periodic (occurring at more or less regular intervals).
  - Continuous (without interruption).
- Probability – the likelihood of the impact occurring:
  - Improbable (very low likelihood that the impact will occur).
  - Probable (distinct possibility that the impact will occur).
  - Highly probable (most likely that the impact will occur).
  - Definite (the impact will occur).
- Irreplaceability – of resource loss caused by impacts:
  - High irreplaceability of resources (the project will destroy unique resources that cannot be replaced).
  - Moderate irreplaceability of resources (the project will destroy resources, which can be replaced with effort).
  - Low irreplaceability of resources (the project will destroy resources, which are easily replaceable).
- Reversibility – this describes the ability of the impacted environment to return/be returned to its pre-impacted state (in the same or different location):
  - Impacts are non-reversible (impact is permanent).
  - Low reversibility.
  - Moderate reversibility of impacts.

    - High reversibility of impacts (impact is highly reversible at end of project life).
- Significance – the significance of the impact on components of the affected environment (and, where relevant, with respect to potential legal infringement) is described:
    - Low (the impact will not have a significant influence on the environment and, thus, will not be required to be significantly accommodated in the project design).
    - Medium (the impact will have an adverse effect or influence on the environment, which will require modification of the project design, the implementation of mitigation measures or both).
    - High (the impact will have a serious effect on the environment to the extent that, regardless of mitigation measures, it could block the project from proceeding).
- Confidence – the degree of confidence in predictions based on available information and specialist knowledge:
    - Low.
    - Medium.
    - High.

APPENDIX B: DISCLAIMER AND DECELERAION OF INDIPENDENCE

The opinions expressed in this Report have been based on site /project information supplied to ILZ by Lwandisa Holdings and is based on public domain data, field data and data supplied to ILZ by the client. ILZ has acted and undertaken this assessment in an objective and independent manner.

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

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

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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

PROJECT TITLE

Geohydrological Assessment for the Proposed Ntuzuma Sewer pipeline construction

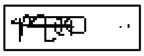
1.1 SPECIALIST INFORMATION

Specialist Company Name:	ILZ Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	2	Percentage Procurement recognition	
Specialist name:	Mzikayise Nkwane			
Specialist Qualifications:	MSc Environmental Science (Geohydrology and Geochemistry)			
Professional affiliation/registration:	Pr. Sci. Nat 009499			
Physical address:	Suite 7 Epcot Centre, 615 Umngeni Road, Morningside, Durban, 4001			
Postal address:				
Postal code:		Cell:	0832571409	
Telephone:		Fax:		
E-mail:	mzikayisen@ilzconsulting.com			

1.2 DECLARATION BY THE SPECIALIST

I, Mzikayise Nkwane declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Signature of the Specialist

ILZ Consulting

Name of Company:

13 September 2020

Date

APPENDIX C: SPECIALIST CV

MZIKAYISE NKWANE

Hydrogeologist

CORE SKILLS

- Groundwater exploration geophysics
- Drilling supervision and well construction design
- Aquifer testing design and data analysis
- Geological mapping
- Geotechnical site assessments
- Soil chemistry assessments and classification
- Hydrogeological assessment for IWULA.

DETAILS

Qualifications

- BSc geological Science degree, 2009
- BSc Geological Science honours, 2010
- MSc Hydrogeological Sciences, 2018

Memberships

- MGSSA – Member Geological Society of SA
- SACNASP (PriSciNat ,009499)
- Groundwater Association of KwaZulu Natal Member

Languages

- English - Speak, read, write
- Zulu - Speak, read, write
- IsiXhosa - Speak, read, write

Countries worked in:

South Africa
Mozambique
Sudan
Tanzania
Mali

PROFILE

Mzikayise Nkwane is a hydrogeologist/Engineering Geologist with more than eight (8) years of experience in groundwater resource development and rural water supply, hydrogeological impact and risk assessment, soil fertility assessments and mapping, soil classification and geotechnical studies. He has good leadership and project management skills. He is currently looking after water resources unit for the Durban and managing field technicians.

Mzikayise has special skills in the following areas:

- Project Management
- Resistivity, magnetics and electromagnetic methods of groundwater investigations
- Geophysics data analysis and interpretation, borehole siting, drilling supervision and well construction design, aquifer testing and aquafer testing data analysis.
- Water quality data analysis and interpretation
- Geotechnical soil profiling and logging
- Soil classification, Profiling, and chemistry interpretation
- Hydrogeological impact and risk assessments for EIAs
- Excellent report writing