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Report to Umgeni Water on the Results of a Hydrogeological Investigation for the Proposed Groundwater Sampling Boreholes at Howick Waste Waterworks in KwaZulu-Natal

Reference: 290-17.R01 Revision 0

Dated: 29 November 2017

Level 1 BEE Contributor

• Postal Address: PO Box 1461, Westville, 3630, South Africa
• Physical Address: 122 Intersite Avenue, Umgeni Business Park, Durban, 4001, South Africa
• Tel: +27 (0)31 266 0458 / 0861 GEOSURE (436 7873) • Fax: 086 689 5506 • Mobile: +27 (0)82 784 0544
• E-Mail: geosure@iafrica.com / deven@geosure.co.za

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GEOSURE (PTY) LTD
Geotechnical, Environmental & Groundwater Engineering Consultants
Civil Engineering Soils Laboratory

Head Office & Laboratory
122 Intersite Avenue, Umgeni Business Park, Durban, 4001, South Africa
PO Box 1461, Westville, 3630

Head Office
Tel.: 031 266 0458 (International +2731 266 0458)
Fax: 086 689 5506 (International +2786 689 5506)
Cell: +27 (0)82 784 0544
E-mail: geosure@iafrica.com /deven@geosure.co.za

Civil Engineering Laboratory
Tel: 031 701 9732
Fax: 086 684 9785
Cell: 082 567 9870
E-mail: lab@geosure.co.za

Gauteng Branch
P.O. Box 32381, Kyalami,1684
South Africa
Tel: 0861GEOSURE (436 7873)
Cell: 083 447 3556
E-mail: gauteng@geosure.co.za

www.geosure.co.za

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Document prepared by:

Geosure (Pty) Ltd
122 Intersite Avenue
Umgeni Business Park
Durban
South Africa
4001

Tel: 031 266 0458/ 0861 GEOSURE (436 7873)
Fax: 086 689 5506
E-mail: geosure@iafrica.com / deven@geosure.co.za
Website: www.geosure.co.za

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Report Title	Report to Umgeni Water on the Results of a Hydrogeological Investigation for the Proposed Groundwater Sampling Boreholes at Howick Waste Waterworks in KwaZulu-Natal			
Report Reference	290-17.R01	**Responsible Person**	Ms. N. Dlamini	
Client Name	Umgeni Water	**Client Contact Details**	Tel: 083 950 8445 Neliswa.dlamini @umgeniwater.co.za	

Revision	Date	Revision Details/Status	Author	Reviewer
0	29 November 2017	Hydrogeological report with recommendations	N. Govender	D. Naidoo

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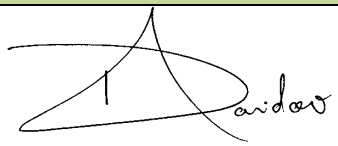
Approval

Author Signature		**Reviewer Signature**	
Name	Nishen Govender Pr. Sci. Nat	**Name**	Deven Naidoo Pr. Sci. Nat
Title	Engineering and Hydrogeologist	**Title**	Managing Director

Abbreviations and definitions

Abbreviation	Definition
bgl	below ground level
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation (formerly DWA)
E	east
EC	electrical conductivity
EGL	existing ground level
EXP	exposure
Geosure	Geosure (Pty) Ltd
km	kilometre (s)
ℓ	litres
ℓ/hr	litres per hour
m	metre(s)
mbgl	metres below ground level
mm	millimetre(s)
N	north
No.	number
pH	power hydrogen
S	South
SANAS	South African National Accreditation System
SANS	South African National Standards
T1, T2	Traverse 1, traverse 2,…
W	west

Report to Umgeni Water on the Results of a Hydrogeological Investigation for the Proposed Groundwater Sampling Boreholes Project at the Howick Waste Waterworks, KwaZulu-Natal

Reference: 290-17.R01 Revision 0 **Date: 29 November 2017**

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Report to Umgeni Water on the Results of a Hydrogeological Investigation for the Proposed Groundwater Sampling Boreholes Project at Howick Waste Waterworks, KwaZulu-Natal

Reference: 290-17.R01 Revision 0 **Date: 29 November 2017**

1. TERMS OF REFERENCE

Geosure (Pty) Ltd, hereafter referred to as Geosure, was requested by Umgeni Water, hereafter referred to as the client, to provide a proposal and cost estimate to carry out a hydrogeological investigation for the proposed groundwater sampling boreholes at Howick Waste Waterworks, KwaZulu-Natal.

Umgeni Water issued a tender document referenced Tender No. 2018/002 which included a detailed scope of works and bill of quantities.

Geosure completed the abovementioned tender document and submitted it to Umgeni Water under cover of a letter from Geosure referenced p477-17 (Howick WWTW)/ng and dated 10 August 2017.

Subsequently, Geosure was authorised by Umgeni Water to proceed with the investigation as proposed by issuing Geosure with purchase order no. 4500006798 dated 28 August 2017.

2. SCOPE OF REPORT

This report details the results of a hydrogeological investigation undertaken at Howick Waste Waterworks premises, KwaZulu-Natal.

The scope of work comprised the following:

i. Determine key geological and hydrogeological conditions of the site;
ii. Carry out a geophysical survey to identify strategic positions for drilling of boreholes to facilitate the sampling of groundwater;
iii. Supervise the installation of sampling boreholes;
iv. Collect groundwater samples for laboratory analysis; and
v. Prepare a comprehensive hydrogeological report based on the fieldwork and laboratory results.

This report details the results of (i) and (ii) above. The key geological and hydrogeological conditions on site are described and recommendations are made for strategic positioning of boreholes within the Howick Waste Waterworks premises.

3. GUIDELINES FOR INVESTIGATION

The services performed by Geosure were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the hydrogeological profession practising under similar conditions in the locality of the project. No other warranty, expressed or implied, is made. The investigation was carried out according to standard practice codes and guidelines relevant to hydrogeological investigations.

The nature of these investigations is such that variations in soil, lithological and groundwater conditions may occur even where sites seem to be consistently uniform. Variations to what is reported here may become evident during construction and it is thus imperative that an appropriately qualified, experienced and Competent Person inspects all critical stages of development including but not limited to excavations to ensure that conditions at variance with those predicted do not occur and to undertake an interpretation of the facts supplied in this report.

The opinions provided in this report can only be based on what was visible at the time the investigation was conducted.

This report was prepared for use by Umgeni Water and their professional team, for the purpose stated and should not be relied upon for any other purpose.

4. INFORMATION SUPPLIED

The following information was utilised to assist with the fieldwork and preparation of the report:

i. A copy of survey drawing No. K2352-10-102 Rev.Z, titled "*Howick Sewage Works Site Layout and Setting Out Details*", dated 09 December 1993, prepared by Knight Piesold Consulting Engineers to a scale of 1:250;

ii. A copy of drawing titled "*UW Howick Waste Water Works*" prepared by Umgeni Water showing the layout of the site;

iii. A copy of the Water Use License for Howick Waste Waterworks dated 24 June 2010;

iv. Council for Geoscience Geological Map Sheet "*2930 Durban*"(1988), to a scale of 1:250 000;

v. The 1:500 000 Hydrogeological Map titled "*2928 Durban*", published by the Department of Water Affairs (DWA), 1998; and

vi. Low-resolution aerial imagery sourced from Google Earth.

5. SITE DESCRIPTION

The Howick Water Waterworks site is located approximately 2.5km northeast of Howick West at latitude and longitude 29.493107 S and 30.234751 E, respectively (refer to Plate 1).

The site comprises the following infrastructure:

i. 4No. Clarifiers;
ii. 2No. Reactor rooms;
iii. Aeration basin;
iv. Anoxic basin;
v. Sludge drying beds;
vi. Screens and degritters;
vii. Administrative building; and
viii. Parking areas.

The site can be accessed along Main Road. The Umgeni River flows along the north western and north eastern most portion of the site. A golf course forms the eastern and south eastern boundary of the site, with vacant lots along the northern and southern boundaries of the site.

Topographically, the site is gentle to moderately sloping in a northerly direction.

Plate 1 provides the locality of the site.

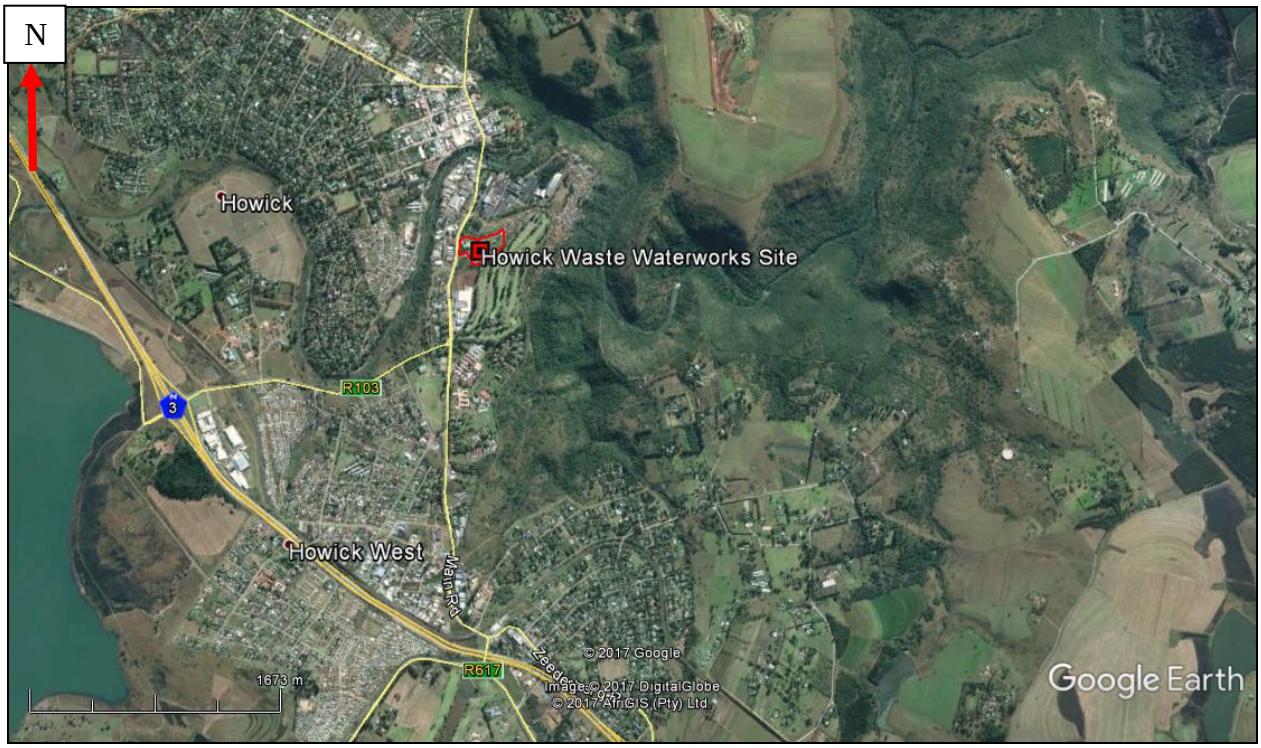

Plate 1: View of the locality of the Howick Waste Waterworks Site

6. DESKTOP STUDY

Prior to commencing with the field investigation, a review of literature and existing information related to the site was carried out at desktop level to infer the topography and associated landforms, geology, hydrogeology and related features of hydrogeological significance.

7. FIELDWORK

The fieldwork for the investigation was carried out over the period 06 November 2017 to 07 November 2017 and comprised the following:

i. Terrain Appraisal; and
ii. Geophysical survey.

7.1 Terrain Appraisal

Prior to commencing with the investigation, a preliminary reconnaissance survey of the site was carried out to identify and photograph the topography and associated landforms, map the surface geology and note associated features of hydrogeological significance.

7.2 Geophysical Survey

Geophysical methods are commonly used to locate suitable borehole drilling targets and the geophysical survey was carried out at the site to identify suitable positions to drill groundwater monitoring boreholes.

The magnetic method using the Geotron Precision Proton Memory Magnetometer was utilised for this project and this method is considered suitable for groundwater investigations in the study area where there is predominantly shale lithology with dolerite intrusions. Six traverses, designated T1 to T6, were carried out at the site to identify strategic groundwater monitoring borehole positions.

The investigation was undertaken to delineate any lithological and in some cases structural anomalies. These anomalies may be but not limited to the following: dykes, faults, geological contact zones and fracture zones.

The results of the geophysical survey are given in Appendix A.

8. GEOLOGY AND ANTICIPATED SOILS

According to an extract of the 1:250 000 scale geological map "Durban 2930" (Plate 2 refers), the regional geology of the area comprises Volksrust Formation shale that has been sporadically intruded by Jurassic age dolerite bedrock.

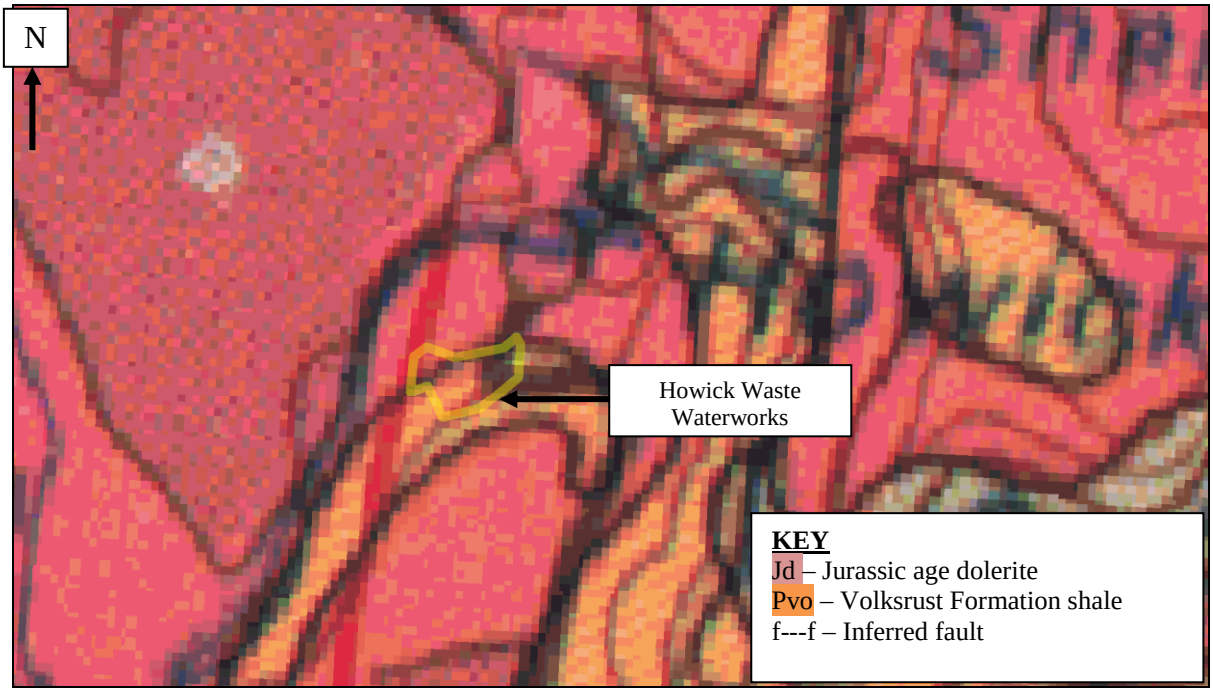

Plate 2: Regional geology of the site (Geoscience Sheet 2930)

9. HYDROGEOLOGICAL SETTING

9.1 Hydrogeology of the Area

According to *"Hydrogeological Map Series"* (Refer to Plate 3 published by the Department of Water Affairs (DWA, 1998), the region consists of a fractured aquifer system relating to shale and dolerite lithology with inferred borehole yields in the range 0.5ℓ/s to 2.0ℓ/s indicated by d3.

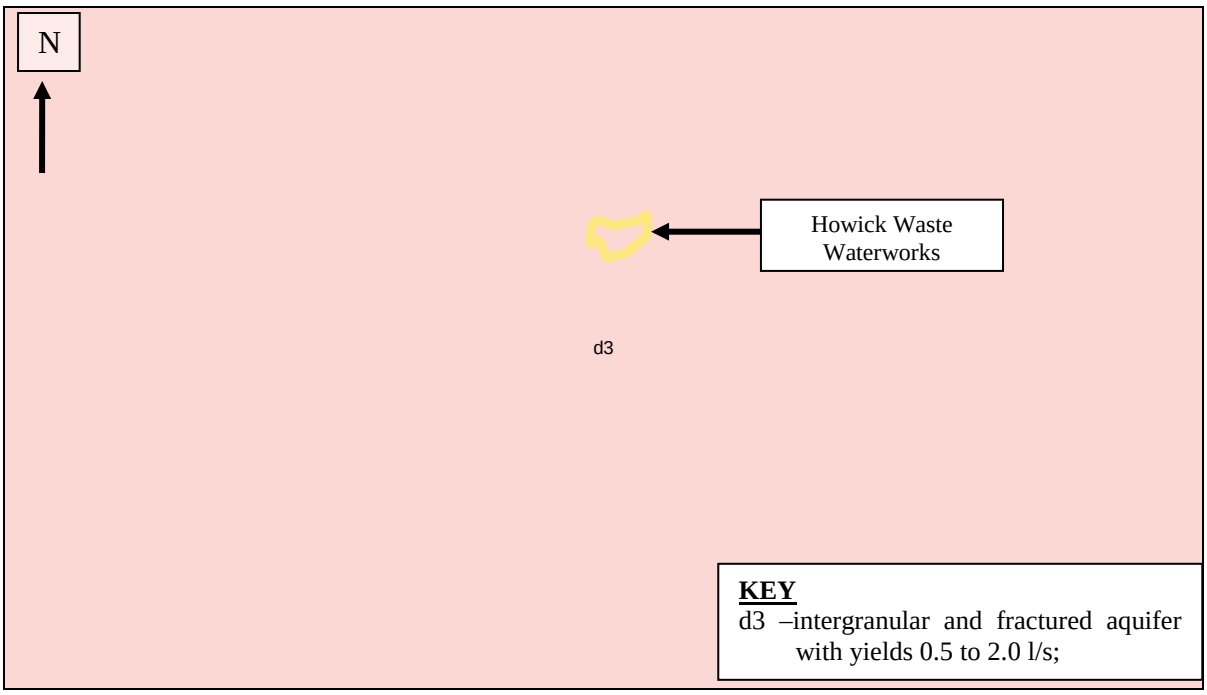

Plate 3: Hydrogeology Map of the study area sourced from 1:500 000 hydrogeological map series (DWA, 1998)

According to the aquifer classification map of South Africa (refer to Plate 4), the area constitutes a *minor aquifer system*. This classification indicates that it is a low yielding aquifer system of variable water quality.

According to the groundwater quality classification map of South Africa (refer to Plate 5), the area is characterized by groundwater with EC values less than 70 mS/m. These values are an indication of relatively good drinking water quality.

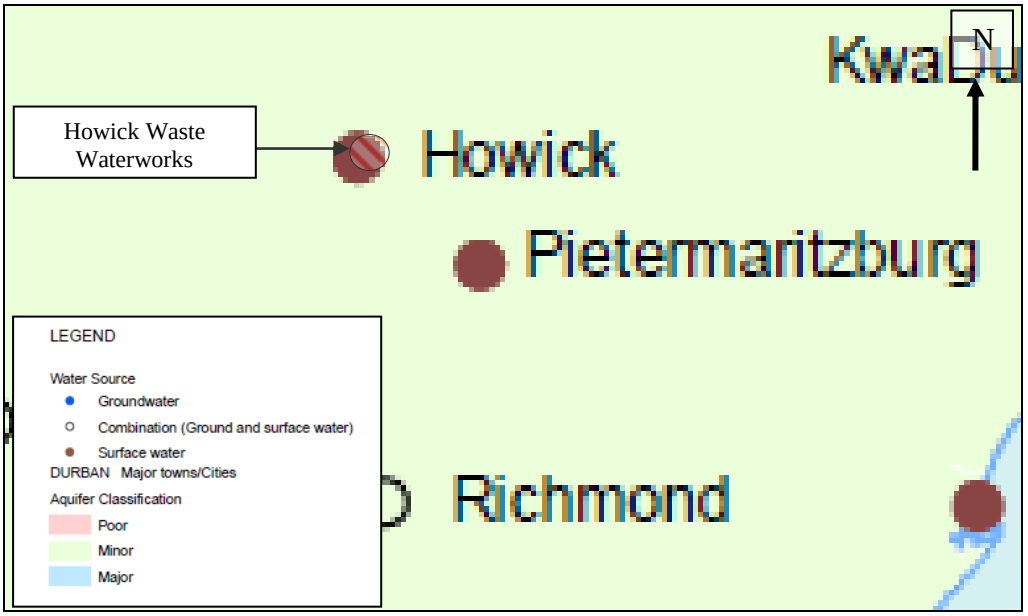

Plate 4: Aquifer Classification Map of South Africa (DWA, 2012)

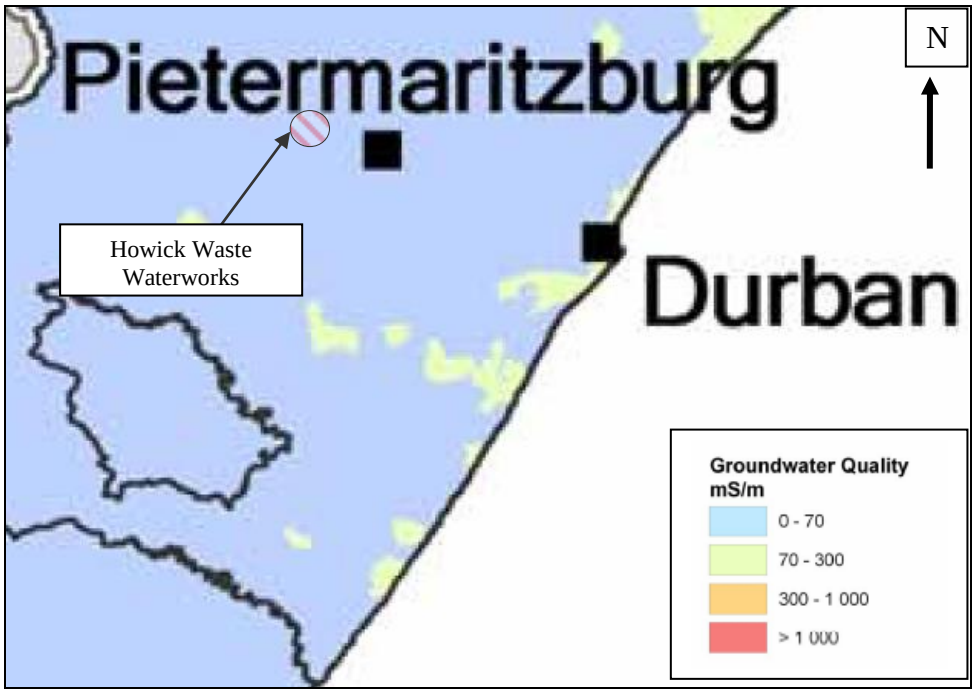

Plate 5: Groundwater Quality Map of the site and surrounds (DWA, 2012)

According to the groundwater level map of South Africa (refer to Plate 6), groundwater levels in the study site, within the aquifer, are inferred to occur at depths in the range 17m to 35m below EGL.

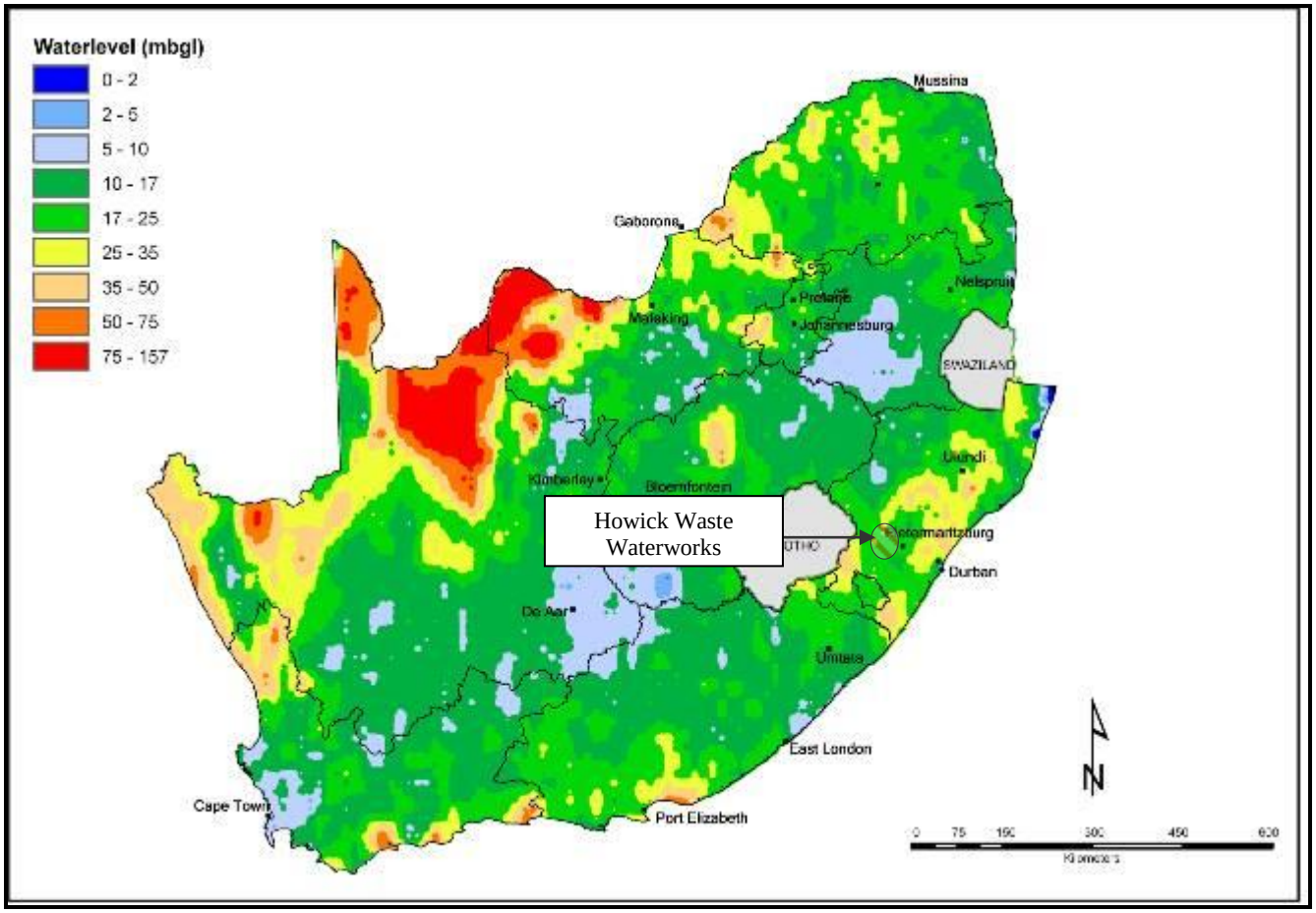

Plate 6: Groundwater Level Map of South Africa (DWA, 2010)

10. DISCUSSION

10.1 Proposed Development

Information supplied by the client indicates that at a minimum of three groundwater monitoring boreholes are required for the site to comply with the minimum requirements of the Water Use License agreement.

10.2 Geophysical Survey Results

A combination of criteria was used to determine suitable drilling targets and not entirely reliant on the geophysical investigation. In this regard, the following criteria were utilised:

i. The accessibility of the drilling rig at the site;
ii. The location of natural drainage channels;
iii. The topography and elevation of the land; and
iv. The anomalies identified in the geophysical survey.

Plates 7 and 8 below provide a summary of the geophysical results, Plate 9 shows the geophysical traverses and Plate 10 the proposed borehole positions.

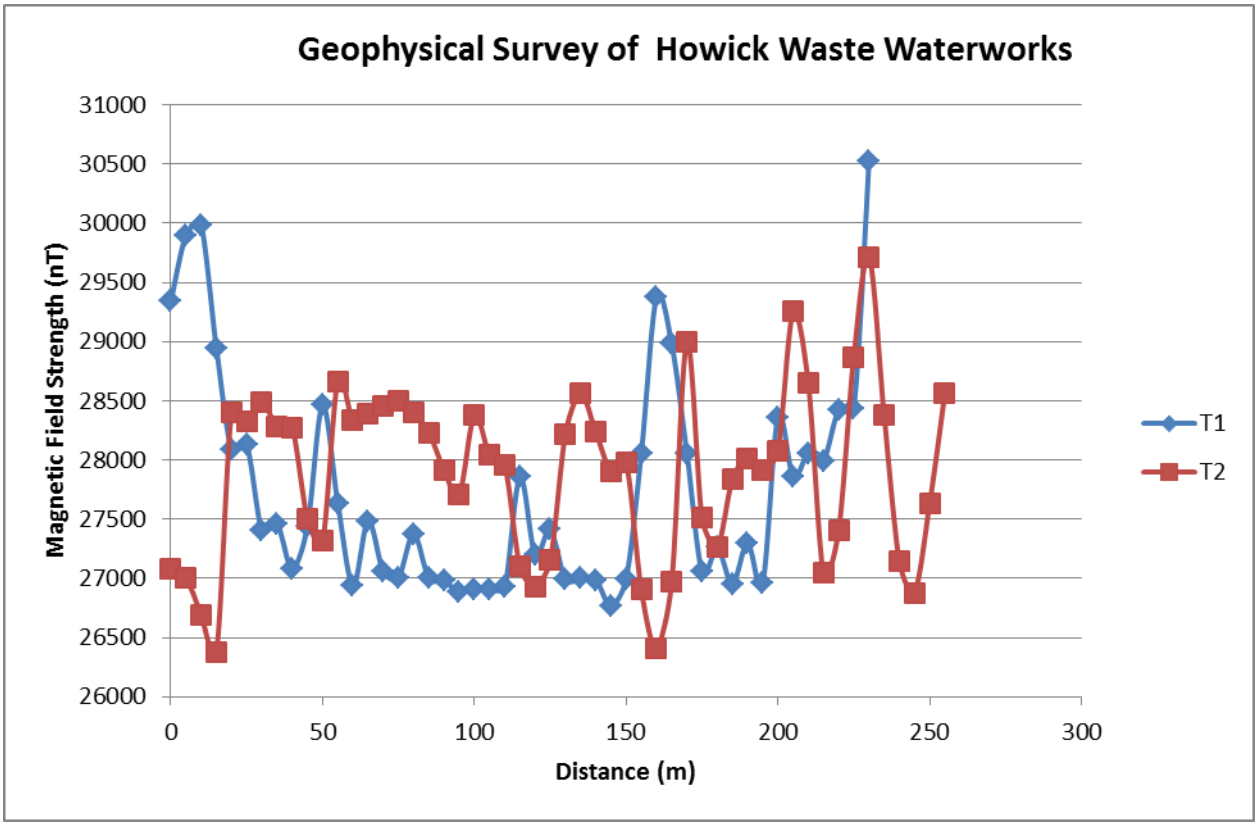

Plate 7: Geophysical Survey Results of T1 and T2

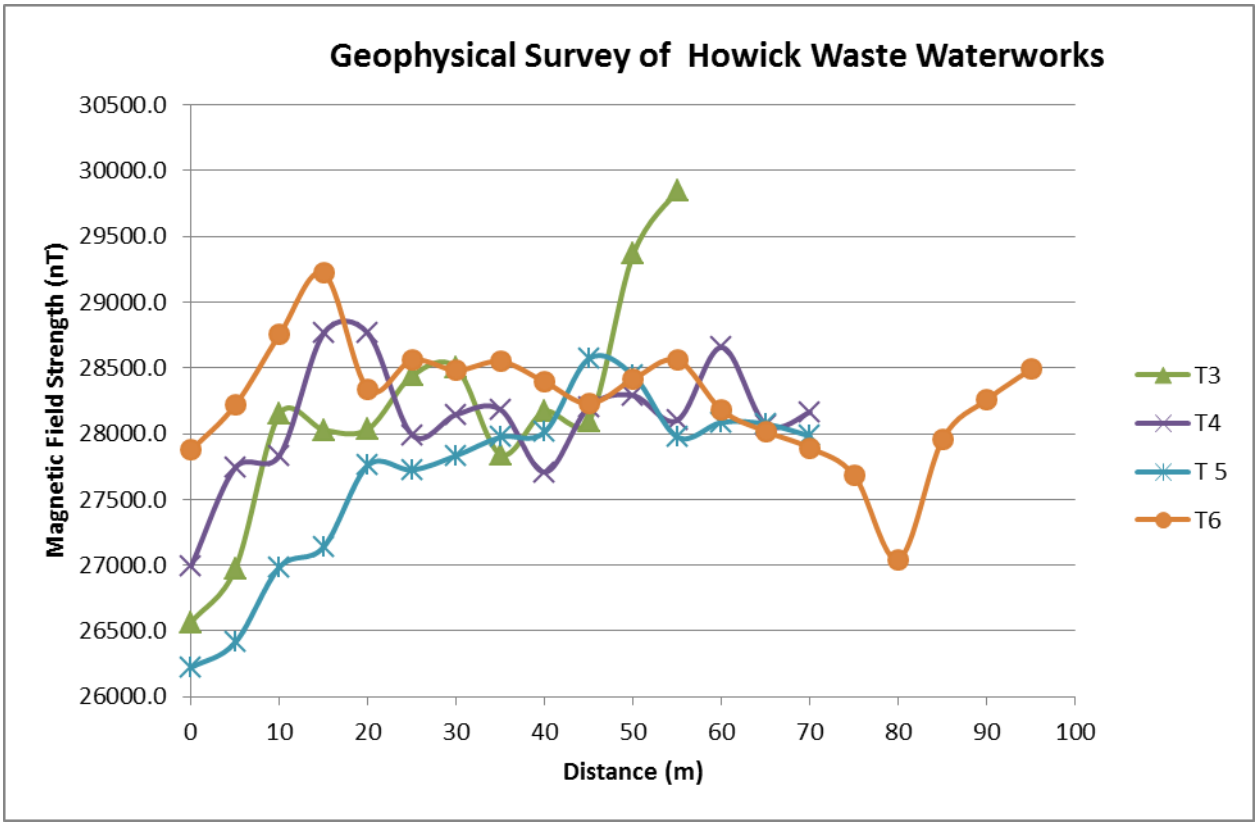

Plate 8: Geophysical Survey Results of T3 to T6

Various anomalies were encountered during the geophysical survey as indicated below:

i. T1 – Between 40m and 45m, and 150m and 155m intervals;
ii. T2 – Between 120m and 125m intervals;
iii. T3 – Between 30m and 35m intervals;
iv. T4 – Between the 5m and 25m intervals;
v. T5 – Between 40m and 55m intervals; and
vi. T6 – Between 10m and 25m, and 75m and 85m intervals.

The above anomalies are inferred to be fractures within the subsurface or weathered bedrock that have a potential to transmit water.

Plate 9: Geophysical Survey Traverses T1 to T6

Based on the results of the geophysical investigation, approximately six borehole sites have been identified and are summarised in Table 1 below.

Borehole ID	Latitude (S)	Longitude (E)
Reference Borehole	-29.493661	30.235084
Borehole 1	-29.492899	30.235357
Borehole 2	-29.493266	30.233470
Borehole 3	-29.492468	30.233577
Borehole 4	-29.492381	30.235435
Borehole 5	-29.492500	30.236280

Plate 10 below provides the approximate location of the proposed groundwater monitoring boreholes.

Plate 10: Approximate position of proposed groundwater monitoring boreholes

Should budgeting form a significant role in the installation of boreholes, then it is suggested that at least three boreholes be constructed i.e. Reference Borehole, BH3 and BH5.

11. GROUNDWATER MONITORING PLAN

The groundwater monitoring plan has been developed based on the information provided in the following guidelines:

i. A Guideline For The Assessment, Planning And Management Of Groundwater Resources In South Africa, dated March 2008 and prepared by the Department of Water Affairs and Forestry; and

ii. Minimum Requirements For Water Monitoring At Waste Management Facilities, dated 1998 and prepared by the Department of Water Affairs and Forestry.

Based on the geology of the area, bedrock is anticipated to be at shallow depths, hence, hand tools will not be able to penetrate deep enough to install groundwater monitoring wells. Therefore, it is recommended that boreholes be drilled to sample groundwater. The following will need to be carried out;

i. Six boreholes are required, as shown in Plate 10.

ii. Should budgets be of concerns, then at least three boreholes should be considered i.e. two downslope and one upslope portion of the site.

iii. The boreholes need to be drilled by a suitable contractor that is registered with the Borehole Water Association and/or Groundwater Association of KwaZulu-Natal.

iv. Each borehole will need to be drilled to a depth of 15 m bgl to 20 m bgl.

v. The boreholes will need to be suitably cased with steel casing.

vi. A piezometer needs to be installed in the borehole with slotted screens at the bottom. The slotted screen will need to be at least 1 m in length.

vii. The boreholes will need to be backfilled with gravel or rock fragments of approved SANS quality (mixture of drilling samples and commercial gravel).

viii. A concrete seal/plinth will need to be placed around the borehole at the top to prevent any substances from entering the borehole.

ix. The boreholes need to have a lockable cap.

x. Laboratory testing will need to be carried out on groundwater samples on a quarterly basis.

xi. The water quality analysis should include macro nutrients, microbial organisms. Testing for hydrocarbon can be considered if there is a concern that petrochemicals have contaminated the aquifer.

xii. The chemical that are commonly used on site are "*Flopam EM 840 MEB*" and "*Chlorine*". Flopam EM 840 MEB contains hydrocarbons (C12-C15), n-alkalines, isoalkalines, cyclics and aromatics and groundwater needs to be tested for these.

xiii. Plate 11 below provides a basic illustration of a borehole design for monitoring.

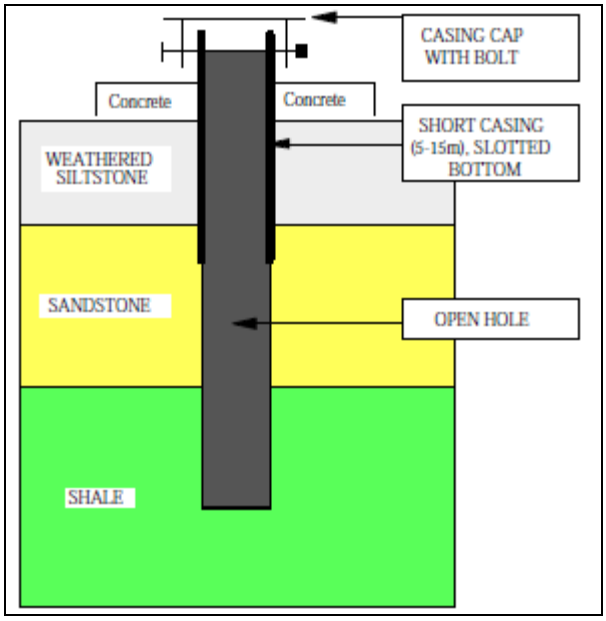

Plate 11: Basic borehole design, sourced from Department of Water Affairs and Forestry, Pollution Monitoring document, 1998

The groundwater sampling needs to be carried out following strict protocols, so that cross contamination or contamination of samples does not occur. Sterilised sample bottles need to be used and this can be obtained from the analytical laboratory.

During sampling, a sterile/unused bailer(s) will need to be used for each borehole to collect the water sample. Depending on the professional carrying out the work, sampling methods may vary, but it is imperative that sterile equipment is used. It is suggested that basic parameters such as pH and EC be recorded in the field.

The water sample will need to be kept cool, it is suggested that a cooler box with ice bricks be used for this purpose. A sampling data sheet will need to be completed for each sample taken and kept as document control for the work carried out.

The water samples will need to be submitted to a SANAS accredited laboratory for testing. A groundwater monitoring report will need to be compiled as per the DWA guidelines.

12. SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

This report details the results of a hydrogeological investigation undertaken at the Howick Waste Waterworks site in KwaZulu-Natal.

A summary of significant observations and recommendations are listed below:

i. The existing waste waterworks site is fully developed with minimal areas for the installation of groundwater boreholes;

ii. The site is inferred to be underlain by shale bedrock that has been intruded by Jurassic age dolerite;

iii. The site is situated on an intergranular and fractured aquifer system;

iv. Based on the results of the geophysical survey, approximately six borehole positions have been identified for drilling of groundwater monitoring boreholes; and

v. Detailed monitoring requirements are discussed in Section 11.

The ground and groundwater conditions given in this report refer specifically to the field tests carried out on site. It is, therefore, possible that conditions at variance with those given in this report could be encountered elsewhere on site.