

For the attention of: Ingerop

GROUNDWATER ASSESSMENT AT THE CAPE TOWN INTERNATIONAL AIRPORT'S PRECINCT 3

1 INTRODUCTION

AECOM was commissioned by Ingerop South Africa (Pty) Ltd (Ingerop) on behalf of the Airport Company South Africa (ACSA) to assess the groundwater conditions at the Cape Town International Airport's Precinct 3. The investigation is aimed at confirming the groundwater level and quality in terms of its aggressiveness towards concrete.

Note: This report is not intended to provide a comprehensive contamination assessment and/or any geotechnical design information.

2 AVAILABLE INFORMATION

The following information was available and consulted when compiling this report:

- Ingerop South Africa, Test Pit Layout, ACSA – Cape Town International Airport: Development of Precinct 3 and Bulk Service, September 2023.
- AECOM, Geotechnical Investigation – ACSA – AA2073 – Installation of Bulk Services and Access Road at Cape Town International Airport's Precinct 3, February 2023.
- GIS Earth Imagery and available aerial photographs.
- Frederik D. J. Stapelberg, The Engineering Geology of Bellville and Environs, Western Cape, South Africa - Explanation of Sheet 3318DC, Scale: 1:50 000.
- Council for Geoscience (formerly Geological Survey of SA) 1:50 000 Geological Series Map Sheet 3318 DC Bellville.
- Council for Geoscience (formerly Geological Survey of SA) 1:250 000 Geological Series Map Sheet 3318 Cape Town.

3 SCOPE OF INVESTIGATION

In order to achieve the aim of this investigation, AECOM completed the following activities.

3.1 Desk Study

Available information including reports, geological maps and images were studied in order to obtain information regarding the subsurface conditions that were likely to be encountered. Furthermore, AECOM conducted a hydrocensus study within a 1500m radius of the site in order to understand groundwater background conditions.

3.2 Site Investigation

The site investigation was completed on the 20th of October 2023 by Steyn-Wilson Laboratories under AECOM's supervision. The investigation included the advancement of eight (no. 8) trial pits using a tractor-loader-backhoe (TLB) which were terminated between 1.850 and 2.700m depths. Trial Pits (TP 1 and TP2) fall outside of the ACSA's cadastral boundary and could not be investigated due to access to this area being refused. All intrusive positions were sited using a hand-held GPS and are shown in **Table 1** and **Appendix A**.

Table 1. Trial Pit Positions

Trial Pit	X (m)	Y(m)	Elevation (Z) m amsl	Excavation depth m bgl	Reason for termination
TP3	-3758956.811	-35271.799	51.122	2.600	TLB's maximum reach
TP4	-3759046.742	-35190.233	50.000	2.300	excavation walls collapsing and unstable
TP5	-3759157.588	-35227.879	50.500	2.000	
TP6	-3759285.165	-35098.211	50.784	1.850	
TP7	-3759383.461	-35087.754	51.000	2.100	
TP8	-3759452.478	-35002.005	51.000	2.400	TLB's maximum reach
TP9	-3759517.312	-35163.045	51.799	2.650	
TP10	-3759548.684	-34985.274	51.500	2.700	

m amsl – metres above mean sea level m bgl - metres below ground level

4 GEOLOGY AND GENERAL SUBSOILS

According to the geotechnical investigation conducted by AECOM in February 2023, Precinct 3 is underlain by topsoil and reworked transported horizon noted as fine to very fine sand containing roots, localised occurrence of treesoil like material and evidence for mole activities. An Isolated instance of an imported layer in the form of granitic gravel lenses (related to the old rail track) was noted at shallow depths. Furthermore, fine to medium sand transported horizon was confirmed below the topsoil/imported/reworked layers up to a confirmed depth of 3.5m. With reference to the geology map (3318BC), the aforementioned transported and reworked transported sands are likely to belong to the Witzand Formation of the Sandveld Group.

The trial pit investigation during October 2023 recorded layers of topsoil, reworked transported and transported soils which are generally comparable to the previous investigation. The encountered profiles are summarised below, and **Table 2** as well in **Appendix B**.

- **Topsoil:** Topsoil material consisting of dry, very loose to loose silty sand containing rootlets was encountered from 0.00 to 0.650m below the existing ground level.
- **Reworked transported soil:** Except in TP7, topsoil is directly underlain by reworked transported horizon noted as, dry to very moist, loose to medium dense, fine to very fine sand containing roots extending to 1.300m depth.
- **Transported soil:** A transported horizon noted as moist to becoming wet, medium dense, fine to medium sand from 0.100 to a maximum depth of 2.700m confirmed across the site. Groundwater seepages were intercepted within this layer between 1.400 and 2.500m depths.

Table 2. Encountered horizons during October 2023.

Trial Pit	Encountered soil horizon: m - m			Groundwater Level: m
	Topsoil	Reworked Transported	Transported	
TP3	0.000 – 0.650	0.850 – 1.300	1.300 – 2.600+	2.500
TP4	0.000 – 0.100	0.100 – 1.300	1.300 – 2.300+	1.700
TP5	0.000 – 0.050	0.050 – 0.800	0.800 – 1.500 1.500 - 2.000+	1.400
TP6	0.000 – 0.050	0.050 – 0.400	0.400 – 1.000 1.000 - 1.850+	1.500
TP7	-	0.000 – 1.100	1.100 – 2.100	1.800
TP8	0.000 – 0.100	-	0.100 – 2.400+	-
TP9	0.000 – 0.050	0.050 – 0.600 0.600 – 1.200	1.200 – 2.650+	2.300
TP10	0.000 – 0.100	0.100 – 0.400	0.400 – 0.500 0.500 – 1.000	-

Trial Pit	Encountered soil horizon: m - m			Groundwater Level: m
	Topsoil	Reworked Transported	Transported	
			1.000 – 1.800+	
			1.800 – 2.700+	

5 GEOHYDROLOGY AND HYDROLOGY

Based on the Engineering Geology of Bellville and Environs by Frederik D.J. Stapelberg, sands of the Sandveld Group classify as intergranular aquifers due to their largely unconsolidated and porous character. The unconsolidated free draining nature of these materials corresponds to a medium to high permeability rate.

A surface water body exists towards the northwest of the site, at the same position that a 1930's borrow pit was located based on historical aerial photography. Given the relatively high permeability of the in-situ soils, the surface water is likely to be in hydraulic continuity with the site's groundwater.

Based on the National Groundwater Archive (NGA) database, there are five (no. 5) registered boreholes within a 1 500 m radius (as shown in **Table 3**). However, these boreholes could not be ground truthed or assessed due to access being denied by security personnel.

Table 3. NGA Registered boreholes

Registered Borehole	X (m)	Y(m)
3318DC00194	-3757629.572	-36050.684
3318DC00249	-3757857.856	-36573.661
3318DC00268	-3759181.901	-36171.052
3318DC00269	-3759908.258	-36166.901
3318DC00270	-3760908.555	-35780.894

Groundwater seepages that were measured in the trial pits were calculated to be between 48.300 and 49.499m amsl as shown in **Table 4**. These groundwater elevations indicate a rise in the water table when compared to the previous (AECOM, February 2023) investigation.

Table 4. Elevation of groundwater seepage during October 2023

Trial Pit	Elevation (Z): masl	Groundwater depth: m bgl	Groundwater elevation: mamsl
TP3	51.122	2.500	48.622
TP4	50.000	1.700	48.300
TP5	50.500	1.400	49.100
TP6	50.784	1.500	49.284
TP7	51.000	1.800	49.200
TP8	51.000	-	-
TP9	51.799	2.300	49.499
TP10	51.500	-	-

Based on the calculated groundwater elevations, groundwater is likely to be flowing towards the northwest, in the direction of an old borrow pit/surface water body.

6 LABORATORY ANALYSIS

Groundwater (TP5) and surface water (SW) samples were collected and submitted to Waterlab (Pty) Ltd for a Basson's analytical suite shown in **Table 6** and **Appendix C**. The collected samples were collected to assess their aggressiveness towards concrete and to understand the surface-groundwater interaction within the site. Aggressive indices for standard conditions were derived using methods detailed within the relevant South African National Standards (SANS) and compared against guidelines contained in Beushausen et al, 2021¹ and **Table 5**.

Table 5. Aggressive index (overall) values according to Beushausen et al, 2012

Aggressive index (Nc, overall)	Aggressiveness
< 300	None to mild
400 – 700	Mild to moderate
800 – 1 000	High
≥ 1 100	Very high

Based on the water results, **after correcting for stagnancy, temperature and wet-dry cycles**, the concrete infrastructure will be exposed to **none-mild** aggressiveness from the surrounding groundwater and surface water.

Table 6. Laboratory results

Parameters (mg/l, otherwise stated)	TP5		SW	
	Property	Index	Property	Index
pH value @25°C	7.600	380	7.600	380
Calcium-saturated pH value@25°C	7	-1200	6.800	-1600
Ca Hardness as CaCO ₃	238	576.400	346	338.800
Ammonia (NH ₄) as N	0	0	0.400	4
Magnesium ion (as Mg)	9	5.400	40	24
Total Sulphate ion (as SO ₄)	3	0.900	15	4.500
Chloride ion content (as Cl ⁻)	65	13	194	38.800
Total dissolved solids	572	-	1 014	-
Leaching Corrosion sub-index (LCS _{lc})		-33.300		-120.400
Spalling corrosion sub-index (SCS _{lc})		0.400		3.400
Aggressive Index (Nc, overall, rounded) Corrected for: Stagnancy (0.5), Temperature (0.94), Wet-dry cycles (varies 0.15 to 0.28)		0		-100

7 SUMMARY AND RECOMMENDATIONS

The investigation suggests that groundwater levels will fluctuate between 48.135 and 49.499m above mean sea level annually, and posing a none -mild aggressiveness towards concrete.

Although every effort has been made to ensure the accuracy of the information contained in this report, the results of the investigation are based upon fieldwork which provides a limited spatial view of the underlying groundwater i.e. groundwater

¹ Beushausen, H, Otieno, M & Alexander, MG, 2021. Durability of concrete, Page 432 of Chapter 12. In: Alexander, MG (Ed.). Fulton's Concrete Technology, 10th ed. Midrand: Cement and Concrete SA.


quality may differ within a short distance. We cannot be held responsible if localised groundwater contamination(s) are encountered and we are not afforded the opportunity to provide further input prior to and during excavation.

Appendix A: Site Plan

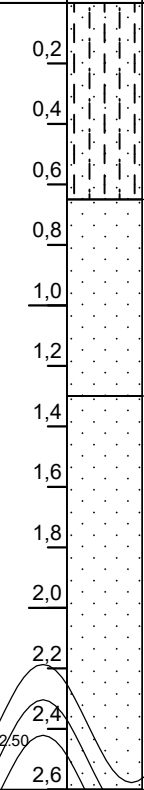
Legend

- Sampling Positions October 2023
- Fill
- Old Rail Track Location
- Old Borrowpit (1971)
- 0.5m Contours (INGEROP)



Project Title:	GROUNDWATER ASSESSMENT AT THE CIA'S PRECINCT 3		Scale 1:4 000 <small>(When page size is: A3 landscape)</small>		Figure 1	
Map Title:	Sampling Positions		Projection: Transverse Mercator Datum: Hartebeesthoek 1994 Central Meridian: 19.0		Sources: © OpenStreetMap (and) contributors, CC-BY-SA Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community	
Client:	INGEROP		Compiled By: J. van der Walt GIS QC By: MW. Wessels			
Whilst every care has been taken in compiling the information on this map, AECOM cannot accept responsibility for any inaccuracies.		Approved By: PD. Beales				
		Date Saved: 2023/11/16 Project Number: 60691934 Map Ref: ACSA_rev1.mxd Revision: 00				
		© Copyright				
						

Appendix B: Trial Pit logs

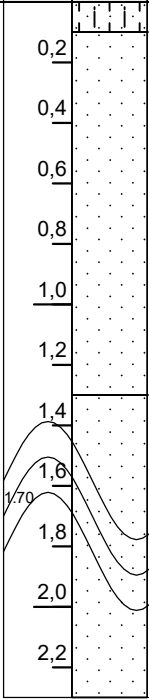
Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0,2 0,4 0,6 0,8 1,0 1,2 1,4 1,6 1,8 2,0 2,2 2,4 2,6		Dry becoming slightly moist, brown, loose becoming medium dense with depth, slightly silty fine SAND with roots. TOPSOIL Slightly moist, light brown, medium dense, fine SAND with occasional roots. REWORKED TRANSPORTED Moist becoming wet, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED

NOTES: 1: Seepage at 2.50m
2: Side walls collapse from 1.40m
3: Test pit stopped at 2.60m (Maximum reach)

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 51.122masl
X Coordinate: -3758956.811
Y Coordinate: -35271.799
Coordinate System:

Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2		0.10 Dry, brown, loose becoming medium dense with depth, slightly silty fine SAND with roots. Topsoil Slightly moist, light brown, medium dense, fine SAND with occasional roots. REWORKED TRANSPORTED 1.30 Very moist becoming wet, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED 2.30

NOTES: 1: Side walls collapse at 1.70m
2: Seepage at 1.70m
3: Test pit stopped at 2.30m due to side wall collapse

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 50.000masl
X Coordinate: -3759046.742
Y Coordinate: -35190.233
Coordinate System:

Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0.05		Dry, light grey, loose , slightly silty fine SAND with roots. Topsoil
	0.2		Slightly moist, light grey, medium dense, fine SAND with occasional roots. REWORKED TRANSPORTED
	0.4		
	0.6		
	0.8		
	0.80		
	1.0		Very moist becoming wet, brown, probably medium dense, fine to medium SAND. TRANSPORTED
	1.2		Wet, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED
	1.4		
	1.6		
	1.8		
	2.0		
	2.00		

NOTES: 1: Side walls collapse at 1.50m
2: Seepage at 1.50m
3: Test pit stopped at 2.00m due to side wall collapse

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 50.500masl
X Coordinate: -3759157.588
Y Coordinate: -35227.879
Coordinate System:

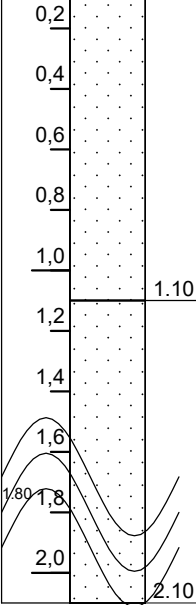
Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0,05		Dry, light grey, loose, slightly silty fine SAND with roots. Topsoil
	0,2		
	0,4	0,40	Slightly moist, light grey, medium dense, fine SAND with occasional roots. REWORKED TRANSPORTED
	0,6		
	0,8		Very moist becoming wet, brown, probably medium dense, fine to medium SAND. TRANSPORTED
	1,0	1,00	
	1,2		
	1,4		
	1,50		
	1,6		
	1,8		
	1,85		Wet, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED

NOTES: 1: Side walls collapse at 1.50m
2: Seepage at 1.60m
3: Test pit stopped at 1.85m due to side wall collapse

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 50.784masl
X Coordinate: -3759285.165
Y Coordinate: -35098.211
Coordinate System:

Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0,2 0,4 0,6 0,8 1,0 1,2 1,4 1,6 1,8 2,0		Dry becoming slightly moist, light brown, very loose to medium dense, silty fine SAND with occasional roots. REWORKED TRANSPORTED. Very moist to wet, brown, medium dense, silty fine SAND. TRANSPORTED.

NOTES: 1: Sidewall collapse at 1.10m
2: Seepage encountered at 1.90m.
3: Hole stopped due to side wall collapse at 2.10m

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 51.000masl
X Coordinate: -3759383.461
Y Coordinate: -35087.754
Coordinate System:



Client: Ingerop
Project Number: 60691934
Project: AA207300 - ACSA Groundwater Assessment
Site: Precinct 3

Hole Number: TP 8
Sheet 1 of 1

Sample Name and Type	Depth (m)	Graphic Log	Material Description
			0.10 Dry, light grey, very loose, silty fine SAND with rootlets. TOPSOIL.
	0,2		Moist, brown, medium dense, silty fine SAND. TRANSPORTED.
	0,4		
	0,6		
	0,8		
	1,0		
	1,2		
	1,4		
	1,6		
	1,8		
	2,0		
	2,2		
	2,4		
		2.40	

NOTES: 1: No Seepage was encountered.
2: Test Pit stopped at 2.40m (Maximum reach)

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 51.000masl
X Coordinate: -3759452.478
Y Coordinate: -35002.005
Coordinate System:

Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0.2		0.10 Dry, light grey, loose, slightly silty fine SAND with occasional roots. TRANSPORTED
	0.4		Moist becoming very moist, light grey stained brown, probably medium dense, fine to medium SAND with occasional roots. REWORKED TRANSPORTED
	0.6		0.50 Moist, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED
	0.8		Moist becoming very moist, light grey stained brown, probably medium dense, fine to medium SAND with occasional roots. TRANSPORTED
	1.0		1.00
	1.2		Very moist, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED
	1.4		
	1.6		
	1.8		1.80
	2.0		Very moist becoming wet, light brown, probably medium dense, fine to medium SAND. TRANSPORTED
	2.2		
	2.4		
	2.6		2.70

NOTES: 1: No Seepage was encountered.
2: Test Pit stopped at 2.70m (Maximum reach)

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 51.500masl
X Coordinate: -3759548.684
Y Coordinate: -34985.274
Coordinate System:

Sample Name and Type	Depth (m)	Graphic Log	Material Description
	0.05		Dry, light grey, loose, slightly silty fine SAND with rootlets. TOPSOIL
	0.2		
	0.4		Dry, light grey, loose, slightly silty fine SAND with occasional roots. REWORKED TRANSPORTED
	0.6		
	0.60		
	0.8		Moist becoming very moist, brown, probably medium dense, fine to medium SAND with occasional roots. REWORKED TRANSPORTED
	1.0		
	1.2		
	1.20		
	1.4		Very moist becoming wet, dark brown, probably medium dense, fine to medium SAND. TRANSPORTED
	1.6		
	1.8		
	2.0		
	2.2		
	2.30		
	2.4		
	2.6		
	2.65		

NOTES: 1: Seepage encountered at 2.50m
2: Test Pit stopped at 2.70m (Maximum reach)

Date excavated: 2023/10/20
Date profiled: 2023/10/20
Contractor: Steyn Wilson
Excavated by: T. Sibiya
Machine: TLB

Profiled by: S. Magcaba
Checked by: JvdW

Elevation: 51.799masl
X Coordinate: -3759517.312
Y Coordinate: -35163.045
Coordinate System:

Appendix C: Laboratory Report

CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2023 - 10 - 27		Date completed: 2023 - 11 - 06
Project number: 1000	Report number: 126019	Order number: POR03345
Client name: Steyn-Wilson Laboratories		Contact person: Varsha Lutchman Bhogal
Address: 11 Gooderson Road Blackheath Cape Town		e-mail: varsha@steynwilson.co.za
		e-mail: reece@steynwilson.co.za
Telephone: 021 905 0435	Facsimile:	Mobile: 071 330 2124

Analyses in mg/l (Unless specified otherwise)	Method Identification	Sample Identification:	
		Aecom TP5	Aecom SW
Sample Number		23-26267	23-26268
pH Value at 25°C	WLAB001	7.6	7.6
Electrical Conductivity in mS/m at 25°C	WLAB002	89.8	150
Total Dissolved Solids at 180°C	WLAB003	572	1 014
Total Alkalinity as CaCO₃	WLAB007	384	424
Total Hardness as CaCO₃	WLAB051	275	412
Calcium Hardness as CaCO₃	WLAB051	238	346
pH Saturation (pHs) at 20°C	WLAB053	7.0	6.8
Chloride as Cl	WLAB046	65	194
Sulphate as SO₄	WLAB046	3	15
Free & Saline Ammonia as N	WLAB046	<0.1	0.4
Ammonium as NH₄	WLAB046	<0.1	0.6
Calcium as Ca	WLAB015	96	139
Magnesium as Mg	WLAB015	9	40
Leaching Index [LCSI] *	---	-81	-294
Spalling Index [SCSI] *	---	2	12
Aggressiveness Index [N] *	---	-79	-282

* = Not SANAS Accredited

Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory.

Important notes:

1. The above aggressiveness index is only applicable for conditions of laminar flow at a mean annual temperature of 20°C.
2. For stagnant/turbulent conditions the aggressiveness index must be corrected.
3. For wet/dry cycling conditions (for example in tidal zones) the aggressiveness index must be corrected.
4. For mean annual temperatures lower/higher than 20°C the aggressiveness index must be corrected.

E. Nkabinde

Technical Signatory:

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