Geohydrological Assessment and Borehole Siting at Checkers Gordon’s Bay Mall, Western Cape.

10 May 2017
EXECUTIVE SUMMARY

GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd – was appointed by Erwin Bartseh from GBI Landscape Consultants to complete a geohydrological assessment at the Checkers at the new Gordon’s Bay Mall. The aim of this study is to locate areas for groundwater development.

The study included an initial remote geological and topographical investigation preceding the site visit. No photo lineations were observed for the site. The site is likely underlain by greywacke and mudrock of the Tygerberg Formation. This is locally covered by sandy deposits.

The regional aquifer directly underlying the site is classified by the Department of Water Affairs and Forestry as fractured with an average borehole yield potential of 0.5 – 2 L/s. The regional groundwater quality is indicated as marginal (70 – 300 mS/m).

Resistivity data were acquired along one profile to delineate areas of increased fracturing and water saturation that can be targeted for drilling water supply boreholes. The resistivity data indicated a very uniform formation underlying the site. The resistivity is low and suggests that the formation is still highly weathered at depth along the profile. The resistivity indicated a shallow unconsolidated aquifer that can be targeted for development of a water supply borehole. The details of the drill targets are shown in the table below.

<table>
<thead>
<tr>
<th>ID</th>
<th>Latitude (WGS84)</th>
<th>Longitude (WGS84)</th>
<th>Drilling depth (m)</th>
<th>Drill conditions* (approximate depths)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CGB_Drill1</td>
<td>-34.150039</td>
<td>18.882004</td>
<td>&gt;40 m</td>
<td>0 – 12 m sand &gt;12 m weathered and fractured shale</td>
</tr>
</tbody>
</table>

The following recommendations are made for the drilling and development of the borehole for groundwater utilisation:

- The borehole can be drilled up to a depth of at least 40 m, but up to a depth of about 100 m. Should sufficient water be intersected before then, the drilling should continue for 10 m beyond this water strike. If the formation is favourable, the drilling can continue beyond this depth. The initial target for drilling is the shallow surficial deposits, but drilling must be extended into the underlying weathered shale to determine if the formation is favourable for drilling of a water supply borehole.

- During the borehole drilling, geological samples must be collected for every 1 m drilled and the depth of fractures and associated yields noted. A hydrogeologist must then log the borehole details. Ideally a hydrogeologist should be on site when the borehole is drilled. When drilling a borehole the main issue is “when is the borehole deep enough” and this issue is best addressed by a hydrogeologist.

- The borehole should be developed with compressed air for at least one hour upon completion of the borehole (if successful).
The borehole, once drilled, should be tested to determine the groundwater yield available. This is to be done according to scientifically acceptable standards (as outlined by the SABS) and will form part of the groundwater use license application process. **Please note that non-SABS yield tests (Farmer method or constant-head) are not accepted by Department of Water and Sanitation (DWS) during a license application.**

- A sample of the groundwater should be submitted to an accredited laboratory for analysis to determine if the quality is suitable for its intended use.
- Licensing of the water use should be addressed upon successful completion of the borehole.
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ABBREVIATIONS

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<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
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<tr>
<td>Bh</td>
<td>borehole</td>
</tr>
<tr>
<td>CGS</td>
<td>Council for Geoscience</td>
</tr>
<tr>
<td>DD</td>
<td>Decimal Degrees</td>
</tr>
<tr>
<td>DWAF</td>
<td>Department of Water Affairs and Forestry (now DWS)</td>
</tr>
<tr>
<td>DWS</td>
<td>Department Water and Sanitation (used to be Department of Water Affairs and Forestry)</td>
</tr>
<tr>
<td>EC</td>
<td>electrical conductivity</td>
</tr>
<tr>
<td>L/s</td>
<td>litres per second</td>
</tr>
<tr>
<td>m</td>
<td>metres</td>
</tr>
<tr>
<td>mS/m</td>
<td>milliSiemens per metre</td>
</tr>
<tr>
<td>NGA</td>
<td>National Groundwater Archive</td>
</tr>
<tr>
<td>ohm.m</td>
<td>ohm metre (measure of resistivity)</td>
</tr>
<tr>
<td>WARMS</td>
<td>Water Authorisation Registration Management System</td>
</tr>
<tr>
<td>WGS84</td>
<td>Since the 1st January 1999, the official co-ordinate system for South Africa is based on the World Geodetic System 1984 ellipsoid, commonly known as WGS84.</td>
</tr>
</tbody>
</table>

GLOSSARY OF TERMS

Aquifer: a geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].

Borehole: includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].

Groundwater: water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.

Pseudo-section: data is plotted along a traverse and at a depth specified by an intersection angle of 45 ° to produce a cross-section of the measured parameter (resistivity in this case).

Resistivity: is an intrinsic property of earth materials that defines how strongly a given material opposes the flow of electric current. Low resistivity is indicative of a material that allows easy flow of electric current.

Tomography: imaging of sections through the use of a penetrating wave for e.g. electrical flow.

Suggested reference for this report:

Cover photo:
The construction site at the new Checkers, Gordon’s Bay Mall, looking north.

GEOSS project Number:
2017_03-2049

Reviewed by:
1. INTRODUCTION

GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd – was appointed by Erwin Bartsch from GBI Landscape Consultants to complete a geohydrological assessment at the Checkers at the new Gordon’s Bay Mall. The aim of this study is to locate areas at the shopping mall for potential groundwater development. The groundwater will be used for irrigation of the landscaping.

The study included an initial remote geological and topographical investigation of the area; this preceded the site visit. The site visit included a hydrocensus, an evaluation of the site geology and geophysics. The geophysics was carried out using the resistivity method. The resistivity method measures the resistivity of the subsurface using direct current coupling; the resistivity of the subsurface is likely to be lower in areas of increased fracturing and water saturation. This report documents the borehole siting as well as the associated requirements and recommendations.

2. SITE GEOLOGY AND GEOHYDROLOGY

The Geological Survey of South Africa (now the Council for Geoscience (CGS)) has mapped the area at 1:250 000 scale (3318 Cape Town, 3318 Cape Town). The geological setting is shown in Figure 1 and the main geology of the area is listed in Table 1.

<table>
<thead>
<tr>
<th>Code</th>
<th>Formation/Pluton</th>
<th>Group/Suite</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qg</td>
<td>-</td>
<td>-</td>
<td>Alluvium</td>
</tr>
<tr>
<td>Nt</td>
<td>Tygerberg Formation</td>
<td>Malmesbury Group</td>
<td>Quartzose greywacke and mudrock</td>
</tr>
<tr>
<td>N-Cs</td>
<td>Stellenbosch Pluton</td>
<td>Cape Granite Suite</td>
<td>Mostly coarse grained, porphyritic granite.</td>
</tr>
</tbody>
</table>

The bedrock of the Gordon’s Bay Mall area likely consists of quartzose greywacke and mudrock of the Tygerberg Formation (Nt), Malmesbury Group. This is partly covered by loam and sandy loam (Qg). The mountains to the south comprise mostly sandstone from the Table Mountain Group (blue colours on the map) and some granite (pink colour on the map) outcrops to the northeast.
The regional aquifer directly underlying the site is classified by the Department of Water Affairs and Forestry (DWAF 2001) as fractured with an average borehole yield potential of 0.5 – 2 L/s. Based on the DWAF (1998) classification, the domestic groundwater quality, as indicated by electrical conductivity (EC), has been classified as “marginal”. The EC of groundwater in the area ranges from 70 – 300 mS/m.
3. SITE VISIT AND DISCUSSION

A site visit was carried out on 25 April 2017 to conduct the hydrocensus, assess the geology and conduct the geophysical survey. The site has been levelled for construction.

3.1 Desktop study and hydrocensus

A desktop study was initially carried out using a one-kilometre search radius around the mall site to determine if there are any groundwater users in the area. A search of the National Groundwater Archive (NGA), which provides data on borehole positions, groundwater chemistry and yield, was carried out. These sites are verified in the field and provide background information on the area, should they exist. No boreholes occur within the 1 km search radius.

There are no registered (WARMS) boreholes indicated within the 1 km radius of the mall.

From this information it would seem that groundwater is not generally used.

An aerial photo analysis was done for the area. There are a number of prominent lineations visible within the sandstone mountains towards the south, but they do not extend into the underlying shale. No photo lineations were delineated on or near the property. The area is covered by sand and developed, which masks any geological features that might have been present.

During the hydrocensus, all existing boreholes around the site are identified and information is obtained where possible. No boreholes were found in the neighbourhood around the Checkers Gordon’s Bay property.

3.2 Geophysics

The resistivity method was used to locate lateral and vertical changes in electrical properties that may be related to changes in the formation properties. The resistivity tomography method was used for the soil resistivity survey.

The Lund imaging system is a completely automated resistivity tomography data acquisition system. The resistivity tomography method provides a pseudo-section of change in electrical properties in the subsurface along a specified profile line. Two multi-core cables with 16 electrode take-outs every 10 m were used. These cables were laid out on the ground end to end in a straight line (where possible). An electrode (metal stake) is inserted into the ground next to every electrode take-out on the cable, using a hammer. The electrode take-out is then connected to the electrode with a short cable jumper. The multi-core cables are connected to the ABEM electrode selector ES464 that controls the measurement sequence. The electrode selector is connected to the ABEM Terrameter SAS1000 that takes the apparent resistivity measurements. The data were collected using a
standard protocol with the Wenner array. All data were acquired for n = 1 to 8 and 10, 12, 14 and 16 where “n” is the electrode separation multiplication factor.

The apparent resistivity data acquired in the field were inverted using the RES2DINV software (Loke and Barker, 1996) to provide a true-depth resistivity section. The only pre-processing done was to erase obviously erratic data points (minimal). The resulting true resistivity pseudo-sections are used for the interpretation.

Data were acquired along a single profile across the site, along the northern boundary of the property (Figure 2). The profile was limited in extent and the associated depth of investigation is limited. The data for resistivity profile CGB_Res1\(^\text{§}\) were acquired from east to west, but the data profile was reversed for display purposes. The inverted resistivity data profile for resistivity line CGB_Res1 is shown in Figure 3. This resistivity profile in general shows:

- Low (4 – 17 ohm.m) resistivity at shallow to intermediate depth (<12 m), which is likely indicative of saturated sand, somewhat clay rich in places;
- Intermediate resistivity (>17 ohm.m) up to the full depth of investigation along the profile, which is likely indicative of weathered shale.

\(^\text{§}\) CGB stands for Checkers Gordon’s Bay, Res stands for resistivity – just a descriptor for the profile lines.
Figure 3: Inverted resistivity profile CGB_Res1, showing drill site CGB_Drill1.
The resistivity distribution along this profile is very uniform and very limited lateral variation is observed. This is likely indicative of a very uniform formation with no/limited vertical fractures. However, the depth of investigation is limited because of the limited length of the profile line. The resistivity at depth is low (< 100 ohm.m) indicating that the formation is not hard at this depth – there is thus still potential for fracturing at depth.

The shallow surficial material (blue colours on the resistivity profile) extends to a maximum depth of 12 m. The formation has a fairly low resistivity and this is likely indicative that the formation is saturated with water. It is suggested that the thickest section of this surficial material is targeted for drilling. Furthermore the drilling should be extended into the weathered bedrock to determine if the underlying formation has potential as an aquifer.

### 3.3 Borehole Siting

One drill target has been delineated for drilling of a water supply borehole. The drill target has been delineated within shallow unconsolidated sand and clay. The resistivity data indicated that there is a zone of marginally thicker surficial deposits towards the centre of the profile and this should be targeted for drilling. The drilling should be extended into the underlying weathered shale to determine if the formation is favourable for development of a water supply borehole. The details for the drill target is summarised in **Table 2**.

![Table 2: Details of drilling target: Checkers Gordon’s bay.](image)

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Should the drilling be successful, the borehole should be properly developed with compressed air for at least 1 hour upon completion. If successful, abstraction from the borehole will also need to be carefully managed to ensure sustainable use.

### 4. RECOMMENDATIONS

The following recommendations are made for the drilling and development of the borehole for groundwater utilisation:

- The borehole can be drilled up to a depth of at least 40 m, but up to a depth of about 100 m. Should sufficient water be intersected before then, the drilling should continue for 10 m beyond this water strike. If the formation is favourable, the drilling can continue beyond this depth. The initial target for drilling is the shallow surficial deposits, but drilling must be extended into the underlying weathered shale to determine if the formation is favourable for drilling of a water supply borehole.

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- A sample of the groundwater should be submitted to an accredited laboratory for analysis to determine if the quality is suitable for its intended use.
- Licensing of the water use should be addressed upon successful completion of the borehole.

The borehole, if successful, should also be equipped with monitoring infrastructure:
- Installation of a 40 mm OD (class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 10 - 20 m. This enables manual or automated water level monitoring.
- Installation of a timer switch set to pump according to recommendations made from the yield test.
- Installation of a sampling tap.
- Installation of a flow volume meter.

5. REFERENCES


