DOLOMITE STABILITY INVESTIGATION OF THE PROPOSED FULCRUM EXTENSION 10, SITUATED ON THE REMAINDER OF PORTION 81 OF THE FARM RIETFONTEIN 128-IR, EKURHULENI METROPOLITAN MUNICIPALITY, GAUTENG, FOR THE DEVELOPMENT OF A SHOPPING CENTRE, OTHER COMMERCIAL BUILDINGS, A FILLING STATION AND A TAXI RANK

1. INTRODUCTION

J P Venter Consulting Services was appointed by Dijalo Property Services (Pty) Ltd. to investigate an proposed township at the corner of Tonk Meter Road and Kgaswane Street in the southern part of Springs for the development of a shopping centre, other commercial buildings, a filling station and a taxi rank.

The proposed township is referred to as Fulcrum Extension 10 and the location in the larger Springs area is shown on Figure 1.

2. BACKGROUND

The township is situated on the southern side of a large farm portion previously known as Portion 81 of the farm Rietfontein 128 IR. Southern, eastern and northern parts of the farm portion have been mined for fire and brickmaking clays by Vereeniging Refractories and Corobrik. For ease of reference the area was divided into areas A to G as shown on the Google image (Figure 2). Areas A and C were investigated in 1996/97 for use as waste disposal sites and a permit was issued by the Department of Water Affairs and Forestry (DWAF) in 1997. Areas D, E and F were investigated for use as waste disposal sites in 2011/2012 and a permit application has been submitted to the relevant authorities. The southern and western parts of Area G was left for other development types. Detailed dolomite stability investigations were carried out for the waste disposal areas. These studies were reported on in a number of reports. These reports were all submitted to the Council for Geoscience (CGS) and comment letters were received. A number of percussion holes were also drilled in Area G but apart from some results obtained west of Area D these results have not yet been reported on. The reports on Areas A, B, C, D, E and F are listed and discussed in Section 9: “Available information”.

When the layout of the proposed commercial township in the southern corner of Area G was received a number of borehole profiles were therefore already available. This report describes the dolomite stability investigations undertaken on the proposed commercial township Fulcrum X10.

3. PURPOSE OF THE INVESTIGATION

The purpose of the investigation was to:

- Investigate the dolomite stability conditions of the township and to make recommendations regarding the suitability of the area for the proposed developments;

- Make recommendations on and reference to the precautionary measures which must be implemented for the development;

4. METHOD OF INVESTIGATION

As mentioned above a number of boreholes have already been drilled on the area. The area was therefore studied and another three borehole locations were selected to provide improved cover. Depending on the results it can then be decided whether additional or footprint drilling is required.

5. SITE SELECTION AND DESCRIPTION

The location of the site is shown on Figures 1 and 2. The site is situated at the corner of Tonk Meter Road and Kgaswane Street. Tonk Meter Road is not the actual boundary but a powerline servitude situated just west of Tonk Meter Road. The township of Selcourt is east of Tonk Meter Road and Kwa Thema Extension 3 is situated to the south just across Kgaswane Street.

The total area of the proposed township is 18,98 ha. The streets, which mainly occupy the northwestern side of the township measure 3,74 ha and the four erven 15,28 ha.

The area is fairly flat and the western part is mainly covered by grass. Scattered bluegum trees are present towards the eastern part. The tipping of rubbish and builders rubble is a problem in the area. Scattered tipping took place in the west but much more illegal tipping, especially the tipping of builders rubble, occurred in the east. A rock dump is visible on the Google image (and shown on the other figures). Some small piles of these rocks are present on the northeastern part of the site. Part of the rock dump also extends onto the township and will have to be removed.

6. TOPOGRAPHY

As mentioned above the area is fairly flat but the area has been disturbed by the excavation of sand in the area south of the rock dump (Figure 3). The excavation is not deep as the sand deposit (probably aeolian) is fairly shallow. It, however, impedes drainage and causes elevated water tables. In one borehole (V11) water was found at 0,3 m from surface 24 hours after drilling a dry hole. On the southewestern part of the site the fall is towards the northeast at a slope of about 2,7 per cent and in the east the fall is towards the northwest at about 2,2 per cent. The slope is more shallow in the northeastern area. Both slopes are towards the excavated area. This area probably drains to the north towards the south eastern boundary of Area B and the south western corner of Area A. The drainage of the township, especially the central northern part, therefore requires attention. Even though the underlying dolomite is protected by thick deposits of Karoo Supergroup rocks, ponding in dolomitic areas cannot be allowed and the township and surrounding areas must be drained properly.

7. GEOLOGY

The geology of the area is shown on the 1:250000 map (Figure 4) and in more detail on the 1:50000 map (Figure 5). The site is underlain by sedimentary rocks (mainly mudstone and shale) of the Vryheid Formation of the Ecca Group, Karoo Supergroup and these are mined at present in Area E for brickmaking purposes. The Vryheid Formation is underlain by the glacial deposits of the Dwyka Group. The Dwyka Group is the lowermost formation of the Karoo Supergroup and was deposited on an uneven topography of the dolomite of the Chuniespoort Group, Transvaal Supergroup. The surface was probably an unweathered and unevenly scoured glaciated rock surface. The following is an extract from a report by Meyer (CSIR, 1997) "*Through exploration boreholes in search of the presence of the gold deposits*

associated with the Central and West Rand Groups of the Witwatersrand Supergroup, extensive deep drilling has occurred in the area around the Rietfontein Site. These boreholes indicated that to the northwest of the site (Portion 81) the Karoo sedimentary succession is directly underlain by conglomerate reefs of the Witwatersrand Supergroup. Closer to Portion 81 the Karoo rocks are underlain by >100 m of dolomite which increases in thickness towards the east. The dolomite is underlain by the Black Reef Formation which in turn is followed by the quartzites of the Witwatersrand. None of the available borehole records indicated the presence of rocks of the Ventersdorp Supergroup." The existence of mine dumps (now reclaimed) on portions of the farm Rietfontein originating from the gold mining in close proximity to Rietfontein are proof of active gold mining in the region. According to Mr Peter Kelly of the Department of Mineral Resources (e-mail dated 16 August 2012) the area is shallowly underlain by the Black Reef Formation but that reef has not been mined. The Kimberley Reef is at about 800 m and has also not been mined. The only Reef that has been mined in the area is the Main Reef which is in excess of 1000 m deep.

The boreholes and the results of the geophysical surveys confirm the presence of a prominent dyke striking at about 150 degrees west of the Rand Water Servitude. The approximate location of the dyke is indicated on Figure 2 and boreholes 20/12 and V13 confirms the southerly continuation of the dyke by intersecting fairly thick dolerite sills or part of the dyke. It was also confirmed in discussions with the geophysicist (R Day Pr.Sci.Nat) that the dyke is likely to continue south through the township along the elongation of the line proved to the north by magnetic traverses.

It is unknown whether intrusions of different ages are present but intrusions into the Karoo sediments show that some or all of the intrusions are post Karoo. In the report all the intrusions are considered to be post-Karoo dolerite intrusions.

8. GEOHYDROLOGY OF THE LARGER AREA

An extensive geohydrological study of Portion 81 was carried out by R Meyer and is reported on in the report "An assessment of the geohydrological conditions at the proposed Tonk Meter road landfill site, Springs, Mpumulanga" (Report No.014/2012 dated December 2012).

It is concluded that two distinctly different ground water level situations are present

i) a shallow perhaps perched water level associated with the mudstone and carbonaceous shale of the Vryheid Formation and dolerite intrusions; and

ii) a deeper water level associated with the tillite and dolomite of the Dwyka and Malmani Groups respectively. Water levels in the Vryheid Formation range between approximately 2 and 39 m below ground surface (1580 and 1616 mamsl). In terms of groundwater movement the contour map indicates a flow towards the central and western part of Portion 81 (i.e Area D and the northern part of Area G) from the north, east and south (the Fulcrum X10 area).

The north-south directed dolerite intrusion is not considered to act as a barrier as no indication to that effect is displayed by the individual water level measurements. As a general observation it should, however, be stated that the water levels to the east of the dolerite intrusion are generally above 1600 mamsl, whereas those on the western side are below 1600 mamsl.

Water level depths in the Dwyka Malmani Group rocks range between approximately 10 m and 67 m below ground surface i.e. between approximately 1550 and 1600 mamsl. Water levels recorded in the tillite and dolomite rocks are in general approximately 20 – 30 m below those present in the Vryheid Formation.

The information on all the boreholes (83 boreholes drilled on Areas A to G) was used to do an aquifer classification. From the available information 75 per cent are classified as having a sustainable yield of $\geq$ 0,1 ℓ/s. In terms of groundwater significance and based on the borehole yield information, the aquifers associated with the Vryheid Formation and Dwyka and Malmani Groups are considered to be "non-aquifers" It is clear that the overall aquifer classification for the Portion 81 area is one of low potential sustainable yield and poor to good groundwater quality depending on the historical impact of mining and possible future impact from waste disposal activities.

9. AVAILABLE INFORMATION

As mentioned in Section 2: Background, large parts of Portion 81 have been investigated in detail. Some of the more important reports (in which other studies done in the area are also listed) are given below.

Information on other studies done in adjacent areas was requested from the CGS. The study areas is shown on Figure 6 received from the CGS. These studies are discussed following the discussion on the reports on Portion 81 (Areas A, B, C, D, E and F).

- The investigation of Areas A and C for the waste disposal permitting of these areas. This report includes dolomite stability investigations i.e. geophysical surveys on traverse lines and percussion drilling.

  BKS (Pty) Ltd 1997
  Verref Rietfontein Springs Waste Disposal Site: Feasibility study report Volumes 1, 2A and 2B
  Report No. I08/570 to Eastern Gauteng Services Council Project No.P539131 dated May 1997

- The investigation of Area B (the Rand Scrap Landfill area) to determine the extent, nature and recommended rehabilitation methods for the landfill

  BKS (Pty) Ltd. 2003
  Geotechnical and geohydrological investigation of the Verref – Rietfontein Area B waste landfill site – Springs
  Report No. I08/800 to Rand Scrap Iron , Project No. H169701 dated October 2003

- The dolomite stability investigation of Areas D, E and F for waste disposal landfill permitting. A gravity survey was done over the whole remainder Portion 81 area. The existing waste sites on Areas A, B and C was excluded but area G and the area of the proposed Fulcrum Extension 10 were included in the gravity survey. The gravity survey was followed by percussion drilling on anomalies and to provide good cover. The report was submitted to the CGS for comments.

Dr J P Venter Consulting Services 2011
Dolomite stability investigation of part of portion 81 of the farm Rietfontein 128-IR for the development of waste disposal facilities
Report No 2011/02 dated July 2011

- Comments by CGS on the abovementioned report
  Council for Geoscience (CGS) 2011
  Comment letter: Waste disposal site: Remainder of Portion 81, Rietfontein 128-IR
  Reference No: F3849 Rem of Portion 81, Rietfontein 128-IR dated 12 August 2011.

- An investigation of Area G was started in 2013. Whereas no poor conditions were found during the 1997 and 2011 studies of the waste disposal areas, limited poorish conditions were found at depth at or near the contact with the dolomite below the thick Karoo Super group deposits. Such conditions were found in three holes in Area G ie. holes 15/13 and 19/17 in the south and hole 33/33 west of Area D towards Kwa Thema. As this could influence the waste disposal facility, further investigations were done in the area west of Area D and on the proposed waste disposal areas D and E. Following the investigations an Addendum Report was compiled. It was concluded that the localised soft or looses zones were present in the lower part of the deeper Dwyka deposits. The additional holes on Area D and E did not show conditions which would adversely influence the waste disposal operation. The report was submitted to the CGS for comments and positive comments were received.

  JP Venter Consulting Services and J D Geotechnical Services CC, 2013
  Dolomite stability investigation of parts of portion 81 of the farm Rietfontein 128-IR for the development of waste disposal facilities.
  Addendum report
  Report No. 2013/03 dated May 2013

- Comments by the CGS on the abovementioned report
  Council for Geoscience (CGS) 2013
  Comment letter: Waste disposal facilities: Parts of Portion 81, Rietfontein

128-IR
Reference: F3849.2 Parts of Portion 81, Rietfontein 128-IR dated 23 May 2013

- Relly Dr B H 1974
  A geological report on the proposed township of Selcourt No.3
  Report dated December 1974

  The area indicated as F2247 is shown on Figure 6. It includes the large area east of Tonk Meter road including a part of the existing Selcourt township protruding into the area. The report deals with a 79 ha area to the west of the existing Selcourt. A gravity survey on a 30 m grid was done and five boreholes were drilled. It is concluded that "although dolomite is present, it is overlain by a continuous cover of Karoo System (Supergroup) sediments and (in parts) by a diabase sill that together everywhere, exceed 30 m in thickness. Consequently the potential for sinkholes is extremely remote. The two boreholes which intersect the dolomite subsurface encountered no wad, and the remainder continued to 45 m without encountering wad or dolomite. It therefore seems very unlikely that the ordinary lowering of the water table could affect the stability of the area."

  The profile of borehole S3-B7/13 (indicated on the CGS plan as 7/13) shows carbonaceous siltstone and shale, grey shale, coal and carbonaceous shale and medium grey siltstone/ sandstone (i.e Vryheid Formation sediment) to 45 m (EOH). Hole 14/34 drilled further to the east also show non-dolomitic material down to 45 m (EOH). Dolomite was encountered at a more shallow depth (32 m) in borehole A33/22 (S3-A33/22) further to the north opposite Corobrik.

- Soilcraft CC 2009
  Report on the dolomite stability conditions for the proposed establishment of Selcourt Extension ten, Springs
  Report 2009/J071B/FIR to First Trading and Invest 4 (Pty) Ltd dated 2009

  The area is shown with reference F3750 on Figure 6. A geophysical survey was carried out followed by the drilling of 23 holes and later another four holes. It was found that the Vryheid Formation underlies the whole site with dolomite at depth. During initial investigations the site was divided into two zones i.e Inherent Risk (hazard) class (IHC) 2 and class IHC 2/4(b). The second class could not be

classified as IHC 2 due to the fact that drilling did not proceed to a depth of 60 m. Afterwards it was, however, decided to drill near the 2/4(b) boreholes in an attempt to class them as class 2. The four additional holes were drilled and rezoned as class 2. Only one zone (IHC2) therefore applied to the site. The shallowest depth at which Chuniespoort rocks (dolomite) occurred underneath the Vryheid Formation may be 35 m but in many boreholes Vryheid Formation rocks occur down to the 60 m depth drilled. Water levels were measured from 2,5 m to 36,0 m.

In a CGS letter dated 8 December 2009 it is stated that Soilcraft has classified the area as IHC 2 but requested that the entire site must be considered IHC 1 with an NHBRC classification of D2. The CGS did not object to this request.

- Geo-logic Hydro Geological Consultants CC 2009
  Geohydrological assessment study for the proposed establishment of Selcourt Extension 10, Springs
  Report No.: G2009/110 to First Trade and Invest 4 (Pty) Ltd dated December 2009

  The report was done on the same area as the Soilkraft report and is shown as F3750 on Figure 6.

  In the report it was concluded that:

  - "The Vryheid Formation and Chuniespoort Group are both low yielding aquifers with limited groundwater movement
  - No signs of abnormal groundwater abstraction or dewatering of the aquifers could be detected;
  - An assessment was made based on possible groundwater movement. No areas of high probability of groundwater movement can be delineated;
  - Low probability of groundwater movement was interpreted for the total area based on depths ranging from 37 to more than 60 metres to hard rock dolomite, slow groundwater velocity and low groundwater abstraction figures in the region;
  - Fluctuation in groundwater levels is not expected;
  - The probability of sinkhole forming is rated to be very limited"

- Occurrences of sinkholes and subsidences in the area

  A request to the CGS about sinkholes and subsidences being present within 3 km from the site received a negative response. There are no known instability features within 3 km from the site. Large portions of the area surrounding the site have been developed for a long time.

10. INVESTIGATION PROCEDURES

10.1 Background

As mentioned in Section 2 (Background) holes have already been drilled in Area G but not reported on. The holes in the south showed good conditions but air loss occurred below some limited soft zones. Possible small openings were encountered in two of the holes at great depth and very great depth i.e in holes 15/13 and 19/17. The soft or possible cavity or openings conditions were encountered for 0,8 m from 38,2 m to 39 m in hole 15/13 and for 1,7 m from 48,5 to 50,2 m in hole 19/17. The location of these holes is shown on the Fulcrum Extension 10 layout plan (Figure 7). Similar conditions were encountered (among the other holes that did not show such conditions) in a hole situated more than 800 m to the northwest of Area D. Investigations using a borehole camera in holes drilled close to this hole showed that the conditions are limited in horizontal and vertical extent and that it probably represents localised loose areas in the lower part of the Dwyka Group close to the contact with the dolomite rock. No wad was encountered (JP Venter Consulting Services and J D Geotechnical Services CC, 2013). On the proposed Fulcrum X10 township area, borehole 15/13 is situated on the township and hole 19/17 just next to the township boundary. Another two holes 20/12S and 24/08 have been drilled on the township with hole 18/23 just west of the township. These holes all showed excellent profiles with thick Vryheid Formation and Dwyka Group sediments. In some holes no dolomite was encountered as the Vryheid Formation and Dwyka Group sediments extend beyond 60 m depth (maximum depth of holes). Extensive dolerite was encountered in hole 20/12S. This may represent part of the dyke or a thick sill just west of the dyke.

To obtain better coverage it was decided to drill three additional boreholes i.e. V11, V12 and V13 as shown on Figure 7.

10.2 Geophysical surveys

As mentioned before an extensive gravity survey was carried out to cover all the areas apart from the existing waste disposal sites (Areas A, B and C). The positioning of the original boreholes in the southern area was done to cover gravity anomalies and to provide good coverage. A geophysical report by EEGS (R Day Pr.Sci.Nat) is attached in Appendix A.

10.3 Rotary percussion drilling

Five boreholes were drilled on or close to the township area in November 2012 by H Erwee Drilling Contractor. The same contractor and drilling team drilled the additional three holes in November 2013 using a 1900 kPa compressor delivering 27,6m³/min. The township area is about 19 ha in size with the erven (excluding the street erven on the northwestern boundary and at the southern corner) about 16 ha in size. Eight holes were drilled close to or on the area which gives a drilling density of about 0,5 holes/ha. The profiles are given in Appendix B. Summaries of the profiles are shown on Figure 8. The nature of the materials and drilling results are summarised in Table 10.3.

10.4 Shallow foundation investigation

A shallow foundation investigation was carried out by ARQ Consulting Engineers. The results are discussed in the report “Kwa Thema shopping centre near Springs. Geotechnical Investigation Report (ARQ, 2013)” Thirty test pits were excavated. No severely adverse conditions were found and founding recommendations are given in the report.

11. GEOHYDROLOGY OF THE FULCRUM X10 AREA

The geohydrological information obtained from the drilling of the eight holes close to and on Fulcrum X10 on the southern part of Portion 81 is given in Table 11.1.
The first five boreholes were drilled at the end of November 2012 and V11 – V13 at the beginning of November 2013, just after the first rains. All the holes were dry when drilled apart from hole 24/08 where strong inflow was encountered at 45 m depth. As the holes are close to an area where about 1 m or more of fine sand was

excavated it is likely that some of the water levels were influenced by ponding and seepage in the aeolian sands away from this area. The deeper water levels are more likely to represent a water table i.e. holes 18/23, V12 and V13 in which the water levels vary from 47,3 to 37,4 and 36,0 in depth (1576,3 – 1583,4 and 1589,0 mamsl respectively). As only very limited soft zones or openings were encountered near the contact with the dolomite it is very unlikely that a movement of the water table will have an influence on the dolomite stability of the area.

12. STABILITY EVALUATION

12.1 Nature of the blanketing layer and mobilisation potential

As mentioned before and in the previous reports the dolomite in the area is overlain by rocks of the Vryheid Formation underlain by tillite of the Dwyka Group. A dolerite dyke and probably some irregularly shaped sills are also present on the eastern side of the township area. The typical profile is a transported sandy silt of 1 to 1,5 m thickness followed by ferrugenised silty clay. The ferrugenised silty clay is the top of the residual Vryheid mudrock and usually extends to depths of about 5 to 5,5 m. The level of ferrugenisation decreases with depth and is followed by thick residual mudrock (silty clay) – the so-called “yellow clay” which is used for brickmaking. The “yellow clay” extends to depths typically from 20 to 25 m. Below the yellow clay the profile is more variable with carbonaceous shale and coal being present in various thicknesses. These deposits are lens-like and are not present in all the profiles. The so-called plastic clay layers and fire clay layers are also present below the “yellow clay” and occur above and below the coal deposits. These deposits are part of the Vryheid Formation of the Ecca Group and are underlain by tllite of the Dwyka Group. The tillite is almost invariably chert-rich but clayey layers with some chert were also observed at depth eg. from 34 m depth in borehole 15/13. Hard rock dolomite was not encountered down to the depths drilled in two holes i.e 49 m in hole 15/13 and 57 m in hole 19/17. Tillite was encountered down to 60 m (EOH) in holes 20/12S and V13. In the other holes the minimum depths to dolomite (including slightly weathered dolomite) vary from 38,2 to 52,5 m. The tillite is usually a cemented competent material. As previously mentioned and discussed in other reports (JPV and JD, 2013) loose zones of limited lateral and horizontal extent are occasionally present at great depth, usually close to the contact of the Dwyka Group with slightly weathered dolomite followed by hard rock dolomite.

The results therefore indicate that the dolomite is covered by at least 35 m and in some areas more than 60 m of low mobilisation potential non-dolomitic material.

12.2 Receptacle development

A number of boreholes in the larger Portion 81 area were drilled to extensive depths into the dolomite rock. No cavities were encountered in the dolomite apart from a small cavity which may be present in one of the SRK boreholes to the north (RSI). It is, however, assumed that receptacles are present in the dolomite bedrock. Some small receptacles may be present sporadically in the lower part of the Dwyka tillite but these conditions are very sporadic and limited and are protected by more than 35 m of mainly very low permeability materials.

12.3 Potential Development Space (PDS)

According to SANS 1936-2 the PDS is a function of the thickness and properties of the blanketing material. The properties of the blanketing material indicate a low hazard for any size of sinkhole.

12.4 Mobilising agencies

As the development type is commercial the potential mobilising agencies will be leakage from wet services pipes and ponding.

12.5 Sinkhole and subsidence hazard

Sinkhole hazard:

Low

Main reasons: Thick cover of low permeability and low mobilisation potential cover of Karoo sediments.

Absence or very sporadic occurrence of small receptacles at depth.

Absence of signs of extensive leaching on the Dwyka/dolomite interface.

Subsidence hazard:

Low

Ingress water: Almost complete absence of compressible materials and cover of low permeability materials.
Groundwater drawdown: Almost complete absence of compressible materials.

12.6 Inherent hazard class

The information indicates a low hazard for the formation of any size sinkhole. During discussions with the CGS on 26 November 2013 it was confirmed that the present guideline for IHC 1 areas requires a cover of more than 30 m of non-dolomitic material. This therefore supports an IHC 1 classification. The Inherent hazard class for the area is therefore IHC1.

12.7 Dolomite Area Designation

D2 according to SANS 1936-1 for C3 type developments.

13. CONCLUSIONS

Eight holes were drilled close to or on the proposed commercial township. The area is covered by sediments and rocks of the Vryheid Formation of the Ecca Group and of the Dwyka Group overlying dolomite of the Malmani Group. The conditions at the Dwyka/dolomite contact were generally found to be very good. Occasional soft zones of limited extent were found near the contact, probably in the lower parts of the Dwyka sediments in the boreholes drilled on or close to the site. These zones are, however, overlain by a minimum of 38 m of competent Karoo sediments. A dolerite dyke is present in the eastern part of the township but no poor conditions were encountered on the contact zones with the dolerite. The area is therefore considered to have a low hazard for sinkholes and subsidence of any size i.e. Inherent Hazard Class 1 and the Dolomite Area Designation is D2.

14. PROPOSED DEVELOPMENT TYPES AND FOOTPRINT DRILLING

The proposed development types for Fulcrum X10 are shown on Figure 9. It consists of a filling station on the northeastern erf next to Tonk Meter Road with commercial buildings and shops such as a Builders Warehouse and a KFC outlet on the adjacent Erf. The large Erf at the corner is earmarked for the construction of a large shopping

centre with parking while a supermarket with a taxi rank and ancillary building is planned for the western stand.

According to SANS 1936-1 Table 1, footprint drilling is required for structures on Inherent hazard classes 2 to 6.

During discussions on footprint drilling with the CGS on 5 November 2013 it was agreed that with a Karoo cover exceeding 30 m and even more than 60 m in some areas, it is unnecessary to carry out footprint drilling. No further drilling is therefore required on the proposed Fulcrum X10 township.

Precautionary measures

According to SANS 1936-1 Table 1 the development types classify at C3 and the dolomite Area Designation as D2. Al the precautionary measures as outlined in the SANS 1936 documents, especially Part 3: Design and construction of buildings, structures and infrastructure and Part 4: Risk Management must be implemented.

It is recommended that the planners, architects as well as structural and wet-services engineers have discussions with a competent person during the planning and design periods. This will assist in producing a design with a lower probability of leakage and a design for which it will be easy to compile a risk management plan which is efficient and easy to execute.

Copies of the risk management plans during the various stages of the development must be submitted to the CGS and the Geo-informatics section in the City Planning Department, Ekurhuleni Metropolitan Municipality (EMM) for their approval. A competent person must also inspect the excavations during construction and submit a construction report to the CGS and EMM.