FINAL BASIC ASSESSMENT REPORT FOR THE PROPOSED PIET RETIEF EXTENSION 22

On Portion 100 (A Portion of Portion) of the Farm Piet Retief Town and Townlands 149 HT; Mkhondo Local Municipality in Mpumalanga Province.

REF NR: 17/2/3 GS-239 **JULY 2015**

Part 1 of 4

B O K A M O S O

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FINAL BASIC ASSESSMENT REPORT

1. DESCRIPTION OF THE ENVIRONMENT

Zarafusion (Pty) Ltd is planning the proposed **Piet Retief Extension 22** Shopping Mall development that is situated on a Portion of Portion 100 (Portion of Portion 1) of the farm Piet Retief Town and Townlands 149 HT (to be known as Portion 126). The study area is furthermore situated on the south-eastern quadrant of the intersection between Brand Street (R543) (which runs in a west-east direction) and Kerk Street (N2) (which runs in a south-north direction). Brand Street runs along the northern boundary of the study area and Kerk Street runs along the western boundary of the study area. One of the proposed accesses to the study area will be from Brand Street and the other access point will be in Kerk Street.

(Refer to Figure 1 and Figure 2 below and Appendix G for Enlarged Figures)

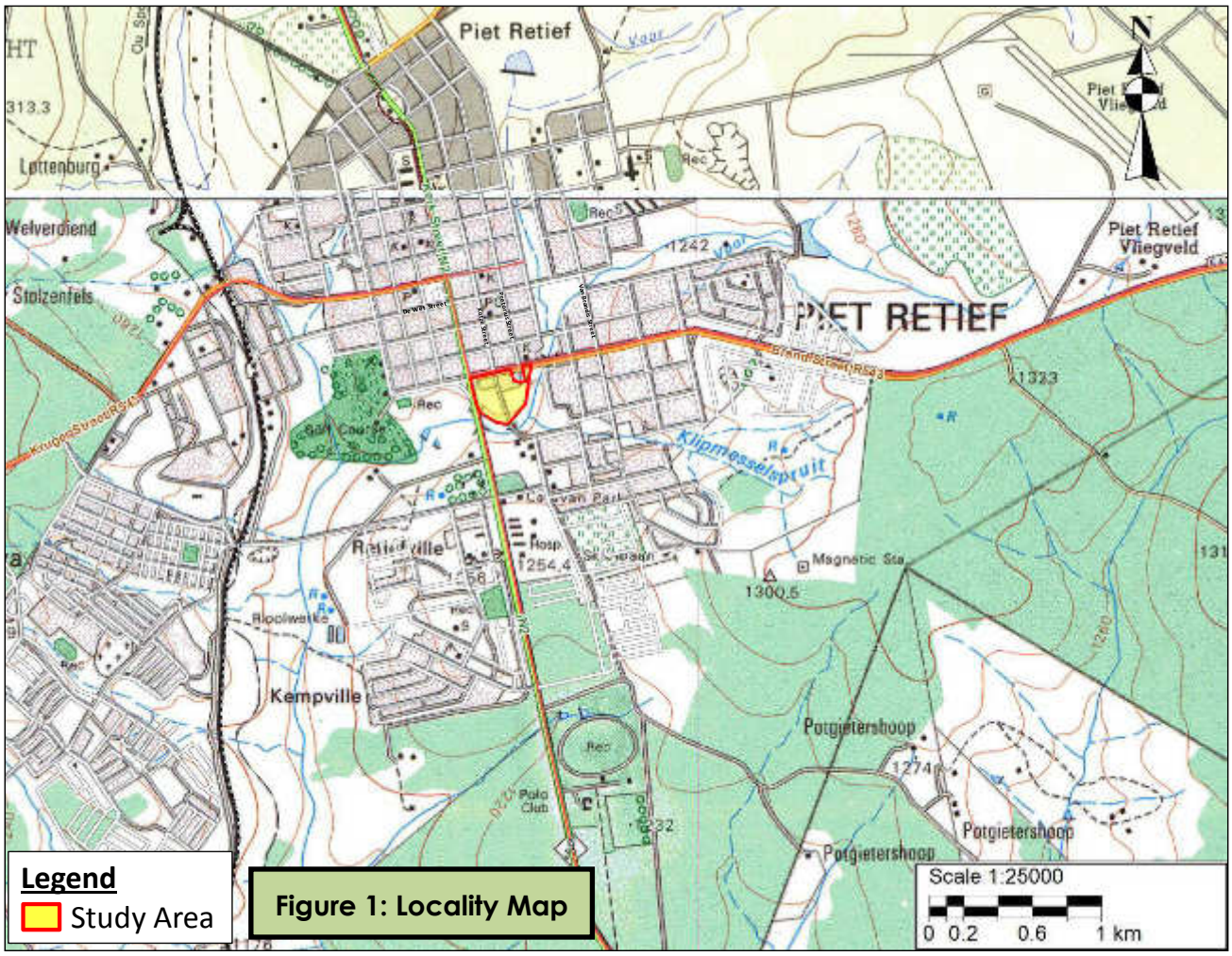


Figure 1: Locality Map

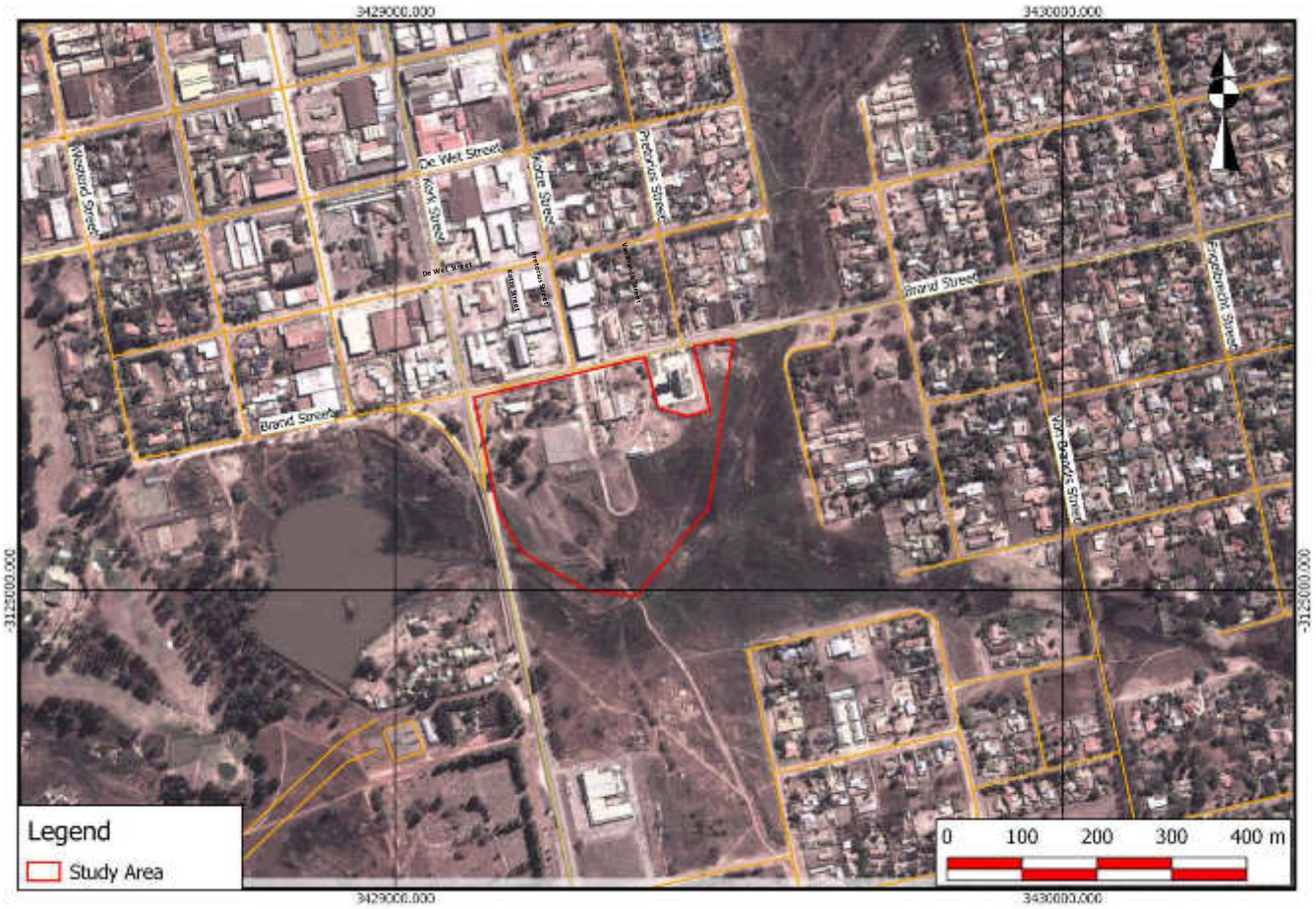


Figure 2: Aerial Map

The study area is approximately 7.516 ha in size and is situated near the geographical centre of Piet Retief Town, which falls under the **Mkhondo Local Municipality** and within the area of the **Gert Sibande District Municipality, Mpumalanga Province.**

The property descriptions of the application site are presented in **Table 1**.

Table 1: Property Description of the application site

Property Description:	Surveyor-General 21 Digit Site Reference Number	Title Deed Number
Portion 100 (A Portion of Portion 1) of the farm Piet Retief Town & Townlands 149-HT	TOHT000000000014900100	T 50461/1990

The proposed zoning for the property is as follows:

The proposed development buildings erected will be used for purposes of shops, businesses, offices places of refreshments, dry cleaners, motor dealers and motor display, as well as related uses subservient to the above.

The proposed development will entail the following:

The proposed height	**:**	Not exceed 2 storeys
FAR	:	The floor area ratio shall not exceed 0.6.
Coverage	**:**	Not exceed 60%
Parking	:	Parking shall be in accordance with provision Clause 19, Table E of the Piet Retief Town-planning Scheme, 1980.

<u>Aspects affecting the proposed development will be described in terms of the geographical, biophysical, social, economical and cultural aspects:</u>

1.1 Geographic Aspects

1.1.1 Geographical Location

Piet Retief is located in the south eastern part of Mpumalanga province, next to Swaziland. Piet Retief is considered to be a centrally placed town that services not only the formal towns but surrounding smaller towns and rural villages as well. The position of the activity has been indicated below, using the latitude and longitude of the centre point of the site.

	Latitude (S):	**Longitude (E):**
Piet Retief x 22	**27° 0'38.90"S**	**30°48'22.07"E**

1.1.2 Locality

- **Local Context *(Refer to Figure 1 & 2 above and Appendix G for Enlarged Figures)***

The area investigated forms a portion of Portion 100 of the farm Piet Retief Town and Townlands 149 HT in Piet Retief, Mpumalanga. The area identified is approximately 7.516 ha in size and is situated near the geographical centre of the town.

The site is situated on the corner of the N2 highway (Church Street) and the R543 (Brand Street) that leads to the Piet Retief landing strip. To the west of the site is the town's golf course and south west is the public cemetery. The site is bordered to the north by the R543, while the western boundary is formed by N2 highway (national road between Ermelo and Richardsbay). To the south and east of the site are open veld areas.

- **Regional Locality**

Piet Retief is located in the south eastern part of Mpumalanga province, next to Swaziland. Piet Retief is considered to be a central place town that services not only the formal towns but surrounding smaller towns and rural villages as well.

1.2 Biophysical Aspects

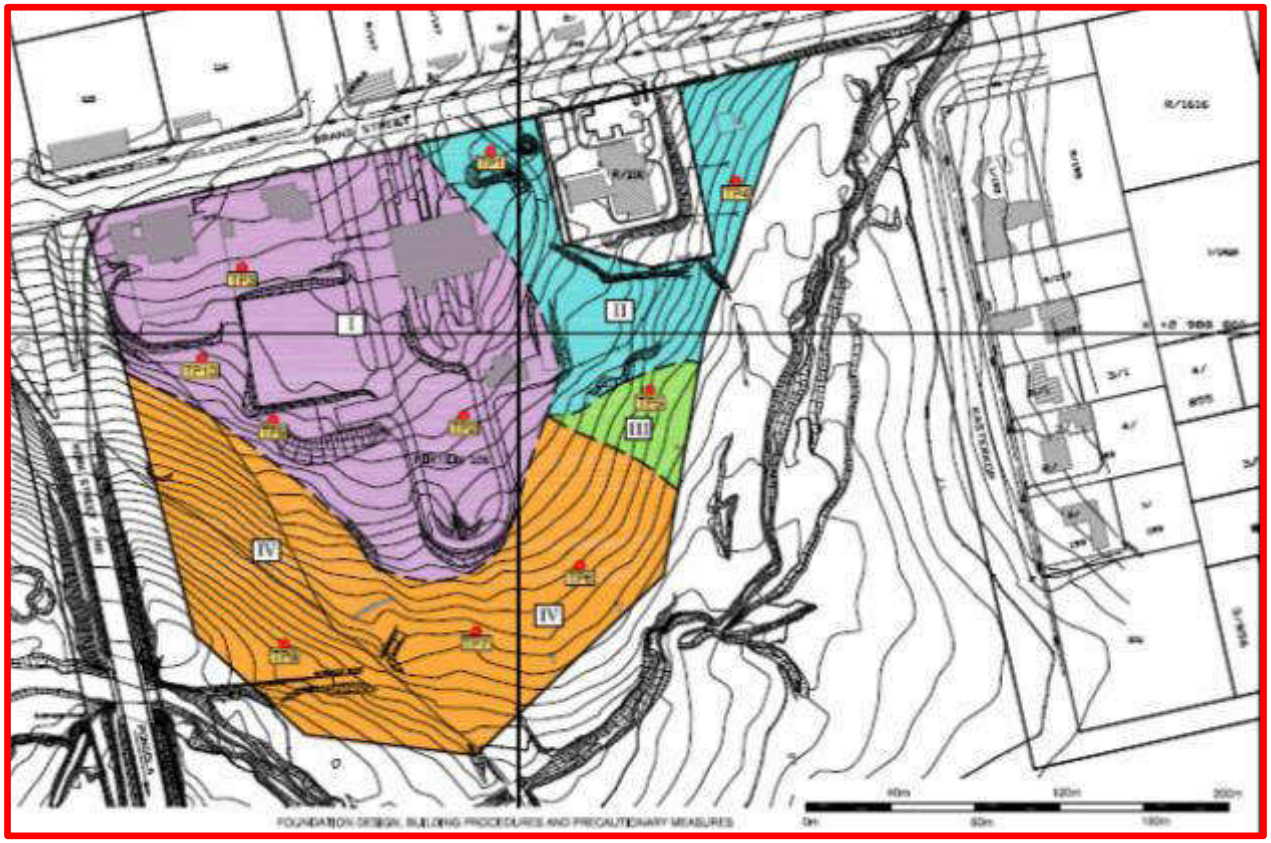
1.2.1 Geology and Soils

Study 1: (Refer to Appendix D1 for a copy of the Geotechnical Report compiled by Soilkraft CC)

A Geotechnical Site Investigation was compiled by **Soilkraft CC** for the proposed Piet Retief X22. The aim of the investigation was to determine the geological and engineering properties of soil material present on the site, as well as to report on the stability of soil materials, prevailing founding conditions, drainage, topography and general characteristics of the site.

- **General Geology:**

Regional geological information indicates that the site is situated on the Mozaan or Nsuze Groups, associated with the Pongola Sequence. These Groups contain materials which are largely derivatives of granite. Parent materials include medium to coarse grained biotite granite, porphyritic biotite or coarse grained hornblende granite.



FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

ZONE	GEOTECHNICAL CLASS	% OF TOTAL AREA	ESTIMATED SOIL MOVEMENT	SOIL PROFILE	DEVELOPMENT POTENTIAL	CONSTRUCTION TYPE	FOUNDATION DESIGN	ASSOCIATED PROBLEMS
I	P_{FB} /S1/H1	45.0	Up to and exceeding 20mm settlement and up to 15mm unrestrained heave	Problematic fill underlain by residual granite	Intermediate	Modified	Reinforced strip footings	Corrosive soils Problematic fill Difficult excavation (fill)
II	P_{FB} /H-H1	15.9	Up to 15mm unrestrained heave	Problematic fill underlain by residual dolerite	Intermediate	Modified	Reinforced strip footings	Corrosive soils Cornstones Bedrock outcrop Problematic fill
III	$H3/P_{Marsh}$	3.2	Up to 30mm unrestrained heave	Colluvium overlying residual dolerite	Not suitable	N/A	N/A	Corrosive soils Cornstones Marshes
IV	S1/H1	35.9	Up to and exceeding 20mm settlement and up to 15mm unrestrained heave	Limited soil cover overlying residual granite	Intermediate	Modified	Reinforced strip footings	Corrosive soils

Figure 3: Geology

- **Soils:**

Trial holes revealed that the soil profile is deeply weathered. As a result, no bedrock was encountered in any of the trial holes. Majority of the site are found to be underlain by imported fill materials and residual granite dominates in situ soils. In minority, residual dolerite and colluvial soils are found on the site.

- **Site Classification:**

The following must be taken into consideration:

- Properties of heave: Tests have indicated that that the residual dolerite soils have the potential to be moderately to very highly expansive. The residual granite made up thick horizons of the soil profile of the site.
- Properties of Settlement: The results of both samples of the consolidation settlement show an over-consolidated state. The one has a pre-consolidation pressure of 250kPa and the other 100kPa. These high pre-consolidated pressures imply that significant volumes of historical overlying material had been removed from the site.
- Problematic Fill: Fill materials around the existing facilities are considered problematic. The fill material on site differs in composition, origin and compaction and this poses a great effect on future structures.

Implications for the development:

- Precautionary measures is recommended to protect exposed and buried steel objects;
- It is recommended that uPVC pipes be used for the sewage and water supply;
- It is recommended that mass earthworks be undertaken on the site to create construction terraces as well as to import suitable soil replacement platforms for construction;
- All materials for the construction of layer works should be imported;
- The minimum pre-consolation pressure of 100kPa suggest that little settlement will take place if this figure is not exceeded;
- It is recommended that the area occupied by existing structures or buildings be investigated in more detail once the buildings are demolished or not in use;
- Site drainage should be planned cautiously in order to warrant that surface runoff does not drain towards the newly proposed structures;

- Surface water must be channelled away from the structures and the accumulation of surface water should not be allowed within 1.5m from structures;
- Due to the probable marshy conditions and surface seepages it is recommended that a network of sub-surface drains be installed. Instead, bulk earthworks can be manipulated to reclaim the saturated area; and
- A professional engineer must be appointed for the structural and services designs and this must be made a prerequisite for building plan approval.

Study 2: (Refer to Appendix D1 for a copy of the Geotechnical Report compiled by Geo Simplicity Geotechnical Engineering (Pty) Ltd)

A Geotechnical Site Investigation was compiled by ***Geo Simplicity Geotechnical Engineering (Pty) Ltd*** for the proposed Piet Retief X22. The aim of the investigation was to determine the geological and engineering properties of soil material present on the site, as well as to identify any problematic soils which may influence the pile type, determine design parameters for pile design purposes and to provide the most effective pile types.

- **General Geology and Soils:**

Regional geological information indicates that the site is underlain by medium to coarse grained biotite granite, porphyritic biotite granite or coarse grained hornblende granite of the Pongola Sequence. Majority of the site are found to be underlain by imported fill materials and residual granite dominates in situ soils. Other test holes revealed alluvium transported, pedogenic soils.

- **Site Results:**

- No collapsible grain structure was noted on the site.
- Areas with higher load cases, time related settlement in excess of acceptable tolerances (>20mm) are expected to occur, should conventional foundations be placed on top or within the fill, transported, reworked residual and residual soils encountered on site.
- There is low to medium activity as far as potential heave is concerned.
- Groundwater seepage was not generally encountered on the site. The

assessment was conducted in the dry period and it is therefore possible that groundwater seepage may form part of the permanent works.

- Excavatibility varies across the site. Side walls do become unstable in areas where there is high in-situ moisture content and poor soil consistency, therefore, allowance should be made for temporary casings.
- The soils on the site classifies as being not corrosive.

Implications for the development:

- Subsurface services should be treated/ sleeved to prevent possible damages due to corrosion.
- A piled foundation solution should preferably be adopted.
- All recommendations for piling in the Geotechnical report should be followed.
- A professional engineer must be appointed for the structural and services designs and this must be made a prerequisite for building plan approval.

1.2.2 Climate

Climatically the area may thus be described as sub-humid. The area receives summer rainfall with a mean annual precipitation of 746mm. Frost is not commonly found in Piet Retief. The average maximum summer temperature is at its highest in January at 26.2^{0}C and the coldest in June at 19.4^{0}C. Winters are cool to cold with an average minimum in June of 3.2^{0}C.

Implications for the development:

- The climatic character of the region will not have a significant impact on the development potential of the study area;
- Should the construction phase be scheduled for the summer months, frequent rain could cause very wet conditions, which makes construction and environmental rehabilitation works extremely difficult;
- Such wet conditions often cause delays to building projects and the draining of water away from the construction works (in the case of high water tables) into the nearby water bodies, could (if not planned and managed correctly) have an impact on the water quality of these water bodies; and
- If dry and windy conditions occur during the construction phase, dust pollution could become a problem. Recommendations to mitigate dust pollution will be

made in the Environmental Management Plan (EMP) ***(Refer to Appendix E1 for the EMP)***

1.2.3 Topography

(Refer to Figure 4 below and Appendix G for Enlarged Figures)

The application site is characterised by a fairly steep slope towards a drainage feature, which runs along the south-western, southern and south-eastern boundaries of the study area. The site varies in altitude from 1215m and 1233m above mean sea level and the natural gradient of the site has been altered through earthworks and imported materials. The gradients on site vary between 2% and 12%.

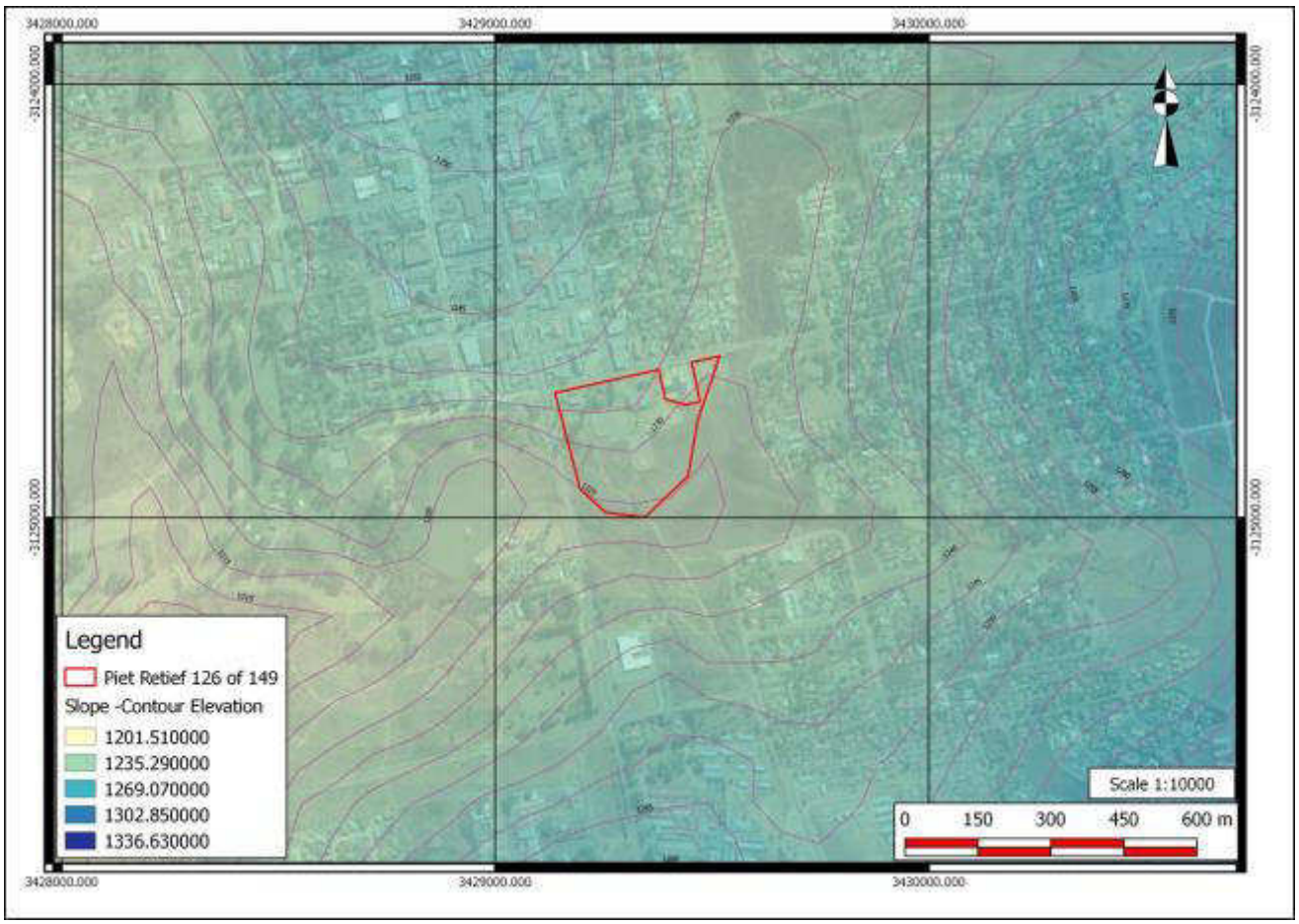


Figure 4: Contour Elevation

Implications for the development:

- The current topographical character of the study area will have no detrimental effect on the development potential of the site;

- Stormwater management across the study area (during the construction and operational phases of the development) will be extremely important. The storm water management measures to be implemented must prevent erosion, siltation and water pollution. It must also incorporate effective flood attenuation and management measures;
- Earthworks must preferably be planned in such a way to create terraces and to import suitable replacement platforms for construction; and
- No cut and fill exercises should be allowed below the 1:100 year flood line.

1.2.4 Hydrology

(Refer to Figure 5, 6 & 7 below, Appendix G for Enlarged Figures and Appendix D2 and D6 for specialist reports)

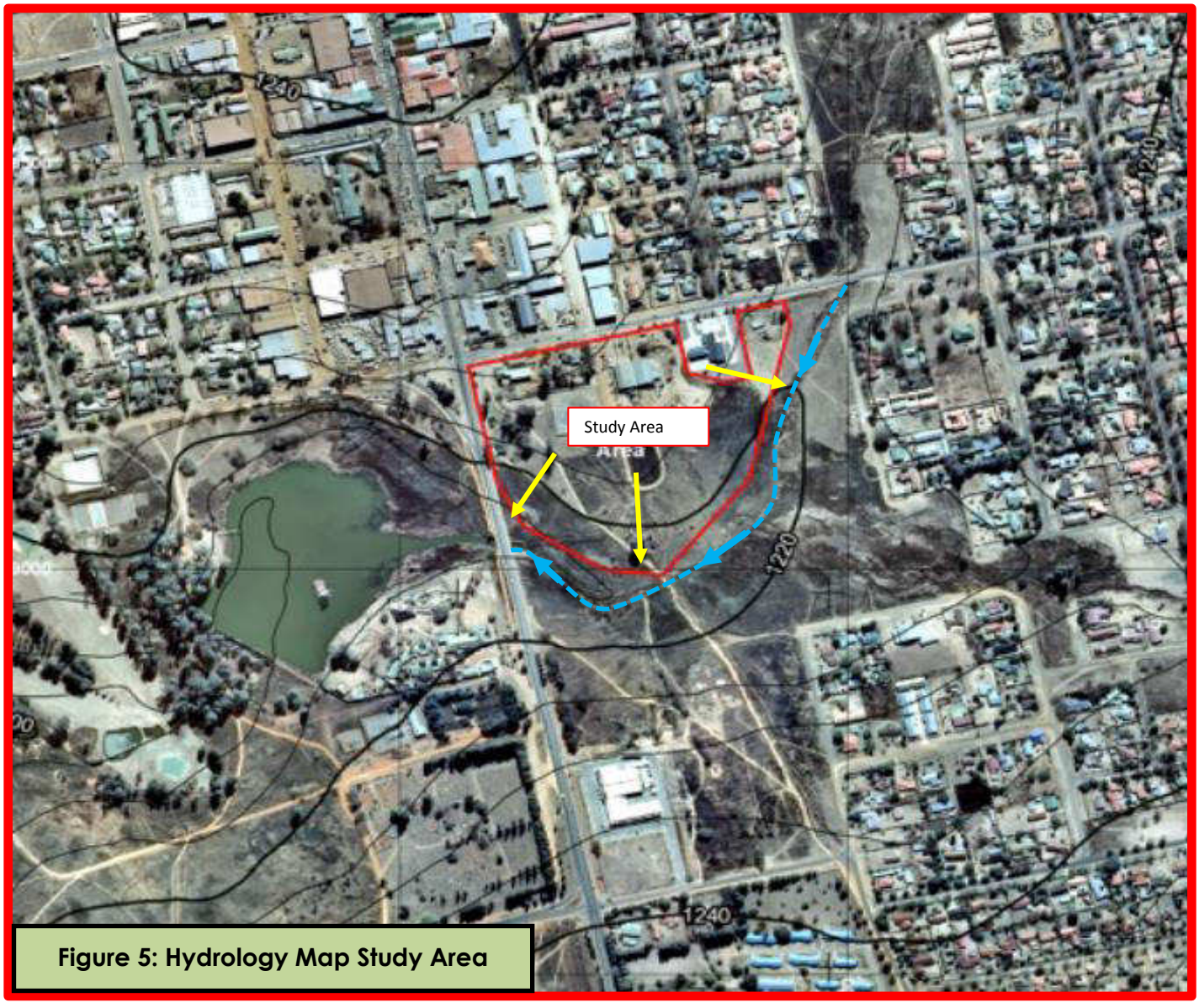


Figure 5: Hydrology Map Study Area

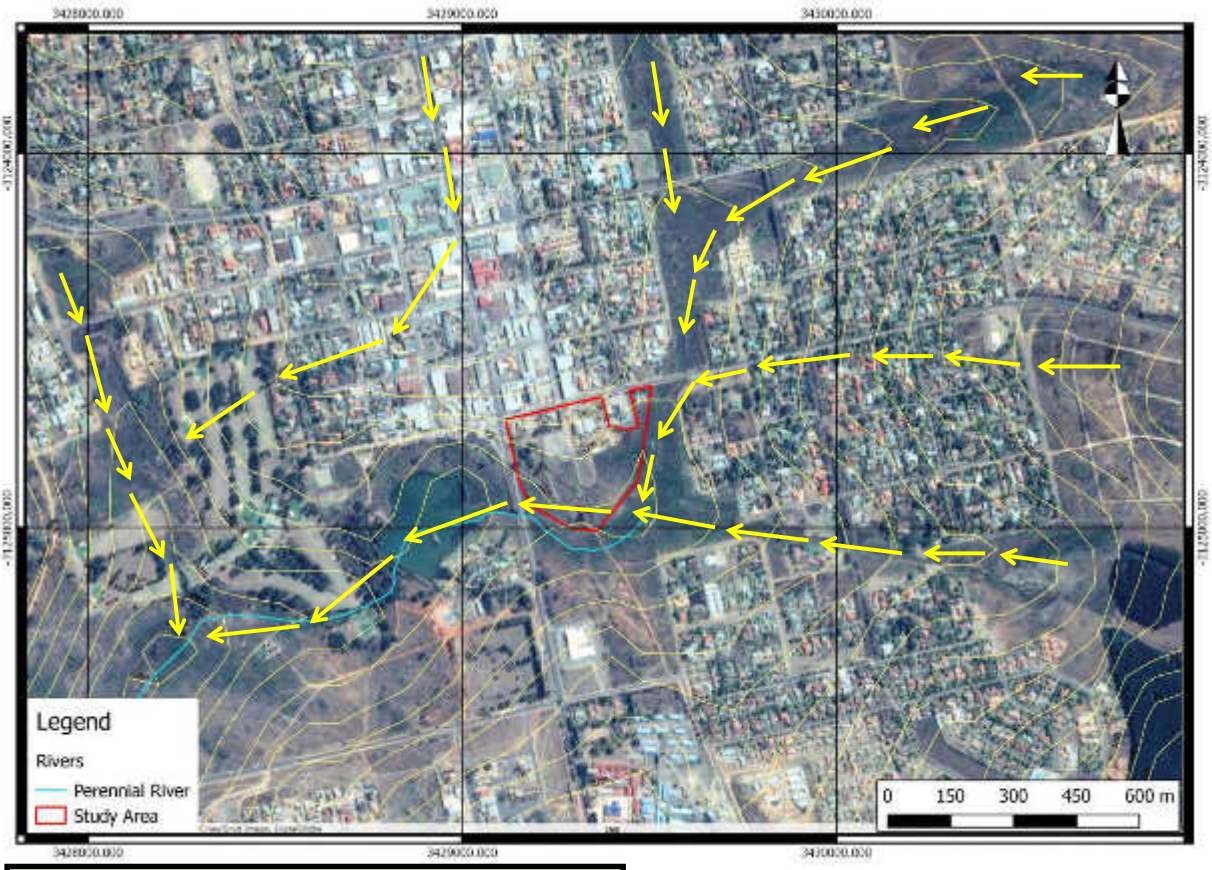


Figure 6: Hydrology Map Larger Area

- **Surface Hydrology:**

General:

The study area is located on the southern edge of the Town of Piet Retief alongside the N2 National Road and adjacent to a perennial stream that tributes to the Assegaai River further to the south. This perennial stream forms the eastern and southern boundaries of the proposed development, flowing in a south-westerly direction. The site has a steep slope towards the stream. The drainage of the study area comprises of surface drainage, but at least two storm water outlets from developments to the north of the study area currently discharge storm water on the study area. Some man-made wetland/ marshy conditions established around the storm water outlet in the north-eastern section of the study area.

The study area is affected by a 1:100 year floodline and a wetland/ watercourse, but the proposed development layout has been designed to avoid the area below the 1:100 year flood line and the areas within the proposed natural watercourse buffer of

32m. No buffer is proposed around the man-made seepage wetland in the north-eastern section of the study area, which is associated with a storm water discharge point. Furthermore, the poor drainage area associated with a pipe in the south-western section of the study area is not regarded as a man-made wetland or watercourse and therefore no watercourse delineations or buffers were identified for this poor drainage area. ***Refer to Figure 7 for Wetland Delineation Map***

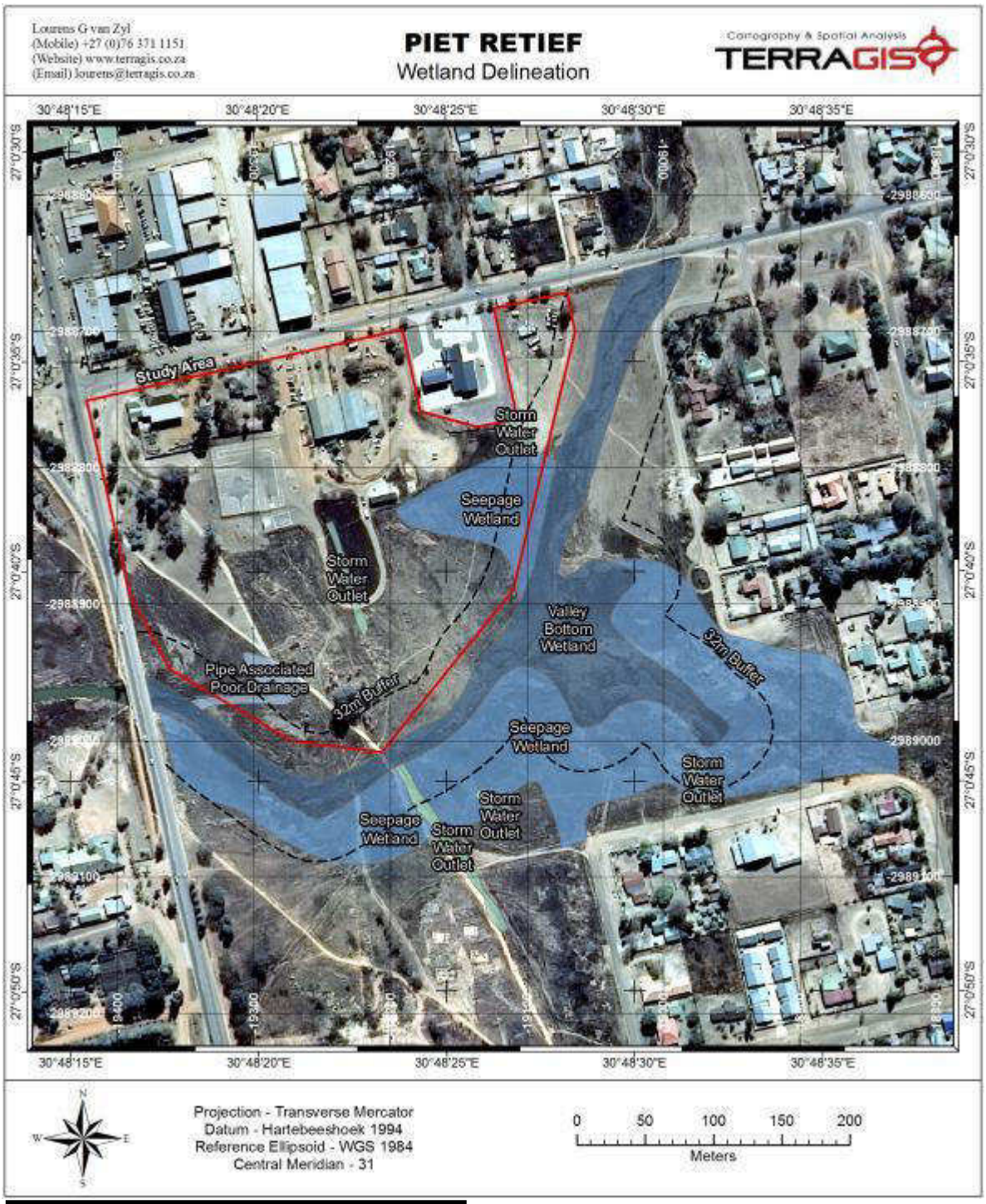


Figure 7: Wetland Delineation Map

Wetlands:

Wetland consultant, Terrasoil Science, was appointed to conduct a wetland delineation and management report for the study area. Seepage wetland areas have been identified on the site and have been modified by human activities. Since 2003 changes occurred on the site in the form of additional paving and storm water runoff. The valley bottom wetland is greatly impacted upon through erosion and excavation, there is also significant amounts of litter and invasive plants throughout the channel. Figure 5 illustrates the delineated wetland with the proposed/ recommended buffer zone. The specialist recommends that the construction activities should be limited to a distance of 30m from the water course except if adequate storm water management and containments structures are constructed to minimise high energy flows into the stream channel. The seepage wetland has no recommended buffer zone due to it being situated immediately downslope of paved up areas.

- **Sub-Surface Hydrology**

According to the geotechnical engineer, during the trial holes no perched water or seepage was encountered. An abundance of moisture in the soil profile is anticipated on a seasonal basis due to the site being situated within the bend of the watercourse. Close to the stream, marshy conditions and surface seepage is likely to occur at the end of the rainy season. This is due to the shallow groundwater which has accumulated in the soil profile. At depths of less than ten meters, in pores and fractures, ground water is expected to occur.

Implications for the development:

- The study area is affected by a natural and man-made wetland area;
- Should the natural wetland area be impacted upon, a proper wetland rehabilitation plan should be followed during the construction and operational phases;
- Untreated waste water must not be discharged into the wetland or watercourse;
- Mitigate the velocity and point of discharge of storm water to prevent erosion and siltation;
- The application for a Water Use License is probable due to the wetland within 500m of the proposed development and due to the proposed development across the seepage wetland (man-made wetland);

- Due to probable marshy conditions on site it is recommended by the geotechnical engineer that a network of sub-surface drains be installed to remove the moisture. Instead, bulk earthworks can be manipulated to reclaim the saturated area;
- The above mentioned moisture removal measures could however have a detrimental impact on the integrity of the existing wetland on the study area and the other watercourses and riparian zones associated with the drainage feature and therefore such moisture removal measures must be compiled in collaboration with the wetland and storm water management specialists.

1.2.5 Agricultural Potential

(Refer to Figure 8 below and Appendix G for Enlarged Figures)

According to a GIS Desktop study, the application site has a medium agricultural potential and is not recognized as arable land.

Figure 8: Agricultural Potential Map

Bokamoso is however of the opinion that due to the current size of the subject property, it will not be possible for the study area to function as a viable economical agricultural unit.

Furthermore, the study area is located on the corner of Brand and Church Street, on the periphery of the Piet Retief Business node/ CBD and residential areas and the site's accessibility and ideal location contributes to the site's very high development potential. If one compares the medium agricultural potential of the site with the high development potential, the development potential outweighs the agricultural potential, especially from an economical point of view.

Implications for the development:
Not significant.

1.2.6 Flora and Fauna

(Refer to Appendix G for Enlarged Figure and Refer to Appendix D3 for Ecological Assessment)

A Flora and Fauna Assessment report was compiled by Enviro-Insight CC for the proposed Portion of Portion 100 (Portion of Portion 1) of the farm Piet Retief Town and Townlands 149 HT, Mpumalanga. The study determined that the site is located in the KaNgwane Montane Grassland (a regional type of grassland) that is considered Vulnerable.

Sections of the site was found to have been disturbed or transformed. A stream and stream buffer area is located adjacent to the site.

The study determined that the following Fauna were of concern: Water Rat *Dasymys incomtus* (Near Threatened); Spotted-neck otter *Lutra maculicollis* (IUCN Near Threatened) and the Striped Weasel *Poecilogale albinucha* (Data Deficient). These three Fauna species were considered as "trigger" species that were deemed in need of protection. It was recommended that the movement of any red listed species should not be restricted and that their habitats should be buffered.

The Flora found on the site were noted to predominantly species found in disturbed areas, species such as *Melinis repens* and *Pennisetum clandestinum* (determined to be the dominant species on the site).

The site is classified as being non-sensitive and it's not expected that any Red-Listed species will occur. It was recommended that the stream/ stream buffer habitat areas should be buffered in order to maintain corridor movement of birds and aquatic faunal species. Any alien or invasive plants should also be removed from the site.

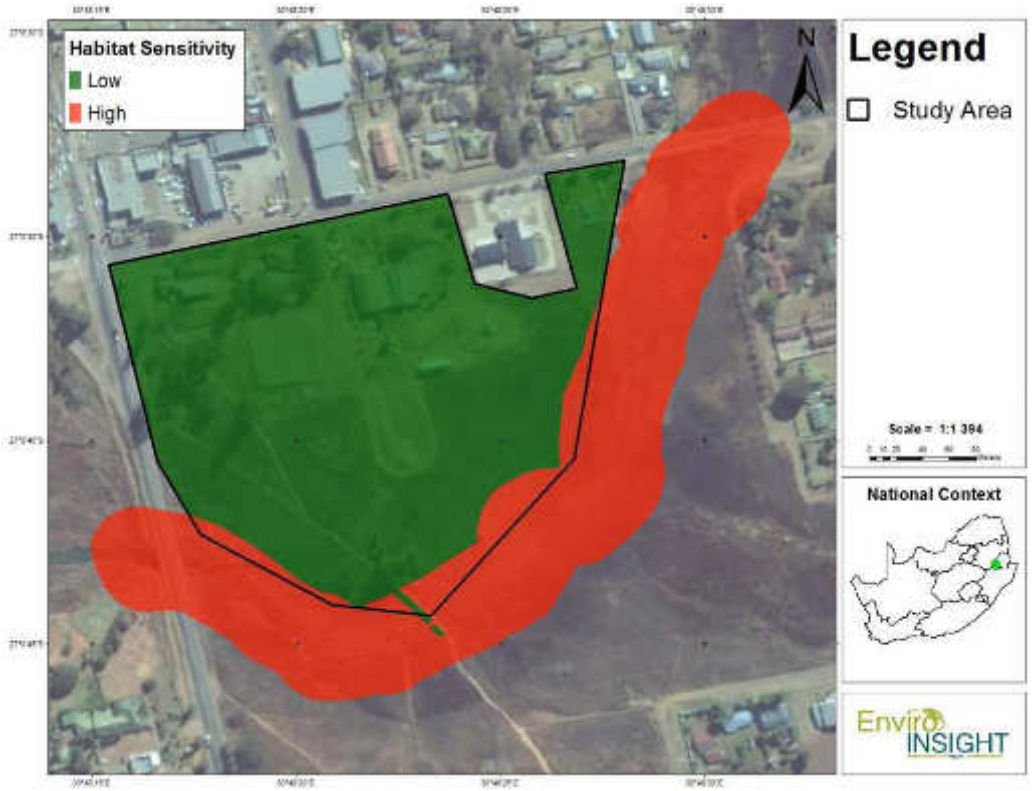


Figure 9: Sensitivity Map

Implications for the development:

- It is recommended that only indigenous flora be used for landscaping;
- An alien invasive eradication and monitoring programme should be implemented;
- Sediment barriers should be placed above and below the construction site in pairs of three to reduce sediment entering the system lower down in the catchment area; and
- The stormwater leaving the site downstream must be clean and of the same quality as in situ before it enters the construction site (upstream). Pre-construction measures must be in place to ensure that sedimentation is trapped.

1.1 Social Aspects

1.3.1 Archaeology

(Refer to Appendix D9 for Specialist's Report)

In terms of Section 38 of the National Heritage Resources Act, 1999, SAHRA must be notified of developments on areas that are larger than 5000m². SAHRA has been informed of the proposed development during the notification process, which formed part of the public participation process.

The northern section of the study area accommodates municipal buildings which consist of storage facilities, offices, a licensing department, vehicle testing grounds and structures previously by the fire department. The Disaster Management Centre of Gert Sibande District Municipality is found on a portion of portion 100 (to the north-east of the study area – along Brand Street) but is excluded from the proposed development site and is fenced off. Apart from the Disaster Management Centre, all other municipal structures on the study area will be demolished. The applicant must apply for demolition permits at the local heritage authority prior to the construction phase for the demolition of buildings older than 60 years. The aforementioned was confirmed by the specialists. No other restrictions or negative impacts in terms of heritage are associated with the site and therefore in terms of the heritage the project can proceed.

Implications for Proposed Development:

- Should any human remains be disturbed, exposed or uncovered during excavations for the proposed project, these should immediately be reported to the South African Heritage Resource Agency (SAHRA) and/or a museum. Sub-surface remains should not be disturbed or removed until inspected by an archaeologist;
- Site preparation activities must be monitored for the occurrence of any other archaeological material (historic waste disposal sites etc.) and similar sub-surface findings;
- The above recommendations will also be included in the Environment Management Program (EMP) for the proposed project; and
- It should be noted that if any structures older than 60 years will be earmarked for demolition for purposes of the proposed development a demolition permit should be obtained from the Mpumalanga Heritage Authority.

1.3.2 Existing and Proposed Zoning and Land-use

➢ **Existing and Surrounding Zoning and Land Use:**

Currently the site is used for municipal purposes, which consist of storage facilities, offices, licensing department, vehicle testing grounds and structures used previously for the fire department.

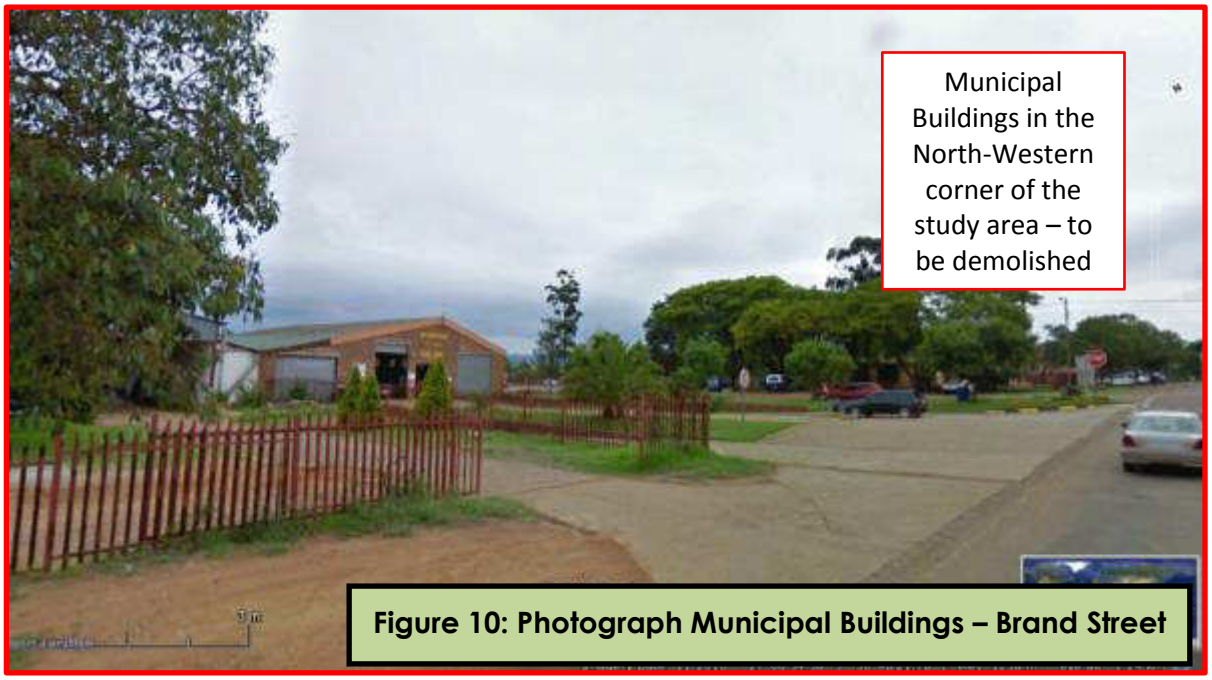


Figure 10: Photograph Municipal Buildings – Brand Street

Figure 11: Municipal Buildings on Corner of Brand Street and Kerk Street

Figure12: Municipal Buildings Brand Street

The Disaster Management Centre of Gert Sibande District Municipality is found on a portion of portion 100 but is excluded from the proposed development site and fenced off. The Disaster Management Centre will not be demolished and the proposed mall will be designed around this centre.

Figure 13: Photograph Disaster Management Facility

The areas to the east, south and west of the study area are mainly open spaces associated with the watercourses, wetlands and riparian areas that stretch through the

town. The natural vegetation of the study area has already been disturbed through former human intervention.

The Piet Retief CBD is situated to the north and north-west of the study area and this area is already built up. Residential areas are mainly located to the east and south-east of the study area and the drainage feature along the southern and eastern boundary of the study area forms the buffer area between the proposed new shopping mall and the residential areas. A tourism/accommodation facility associated with the dam area, is situated to the south west of the study area.

A hardware facility, namely Cashbuild is situated to the south of the drainage feature and the study area, and to the west of a residential area. Apparently the owner of the property only utilized some of the commercial rights on the property when he developed Cashbuild. He is still planning to develop the balance of the commercial rights.

The town's golf course is located further to the west and a public cemetery is situated further to the south west. The current zoning for the site is Municipal.

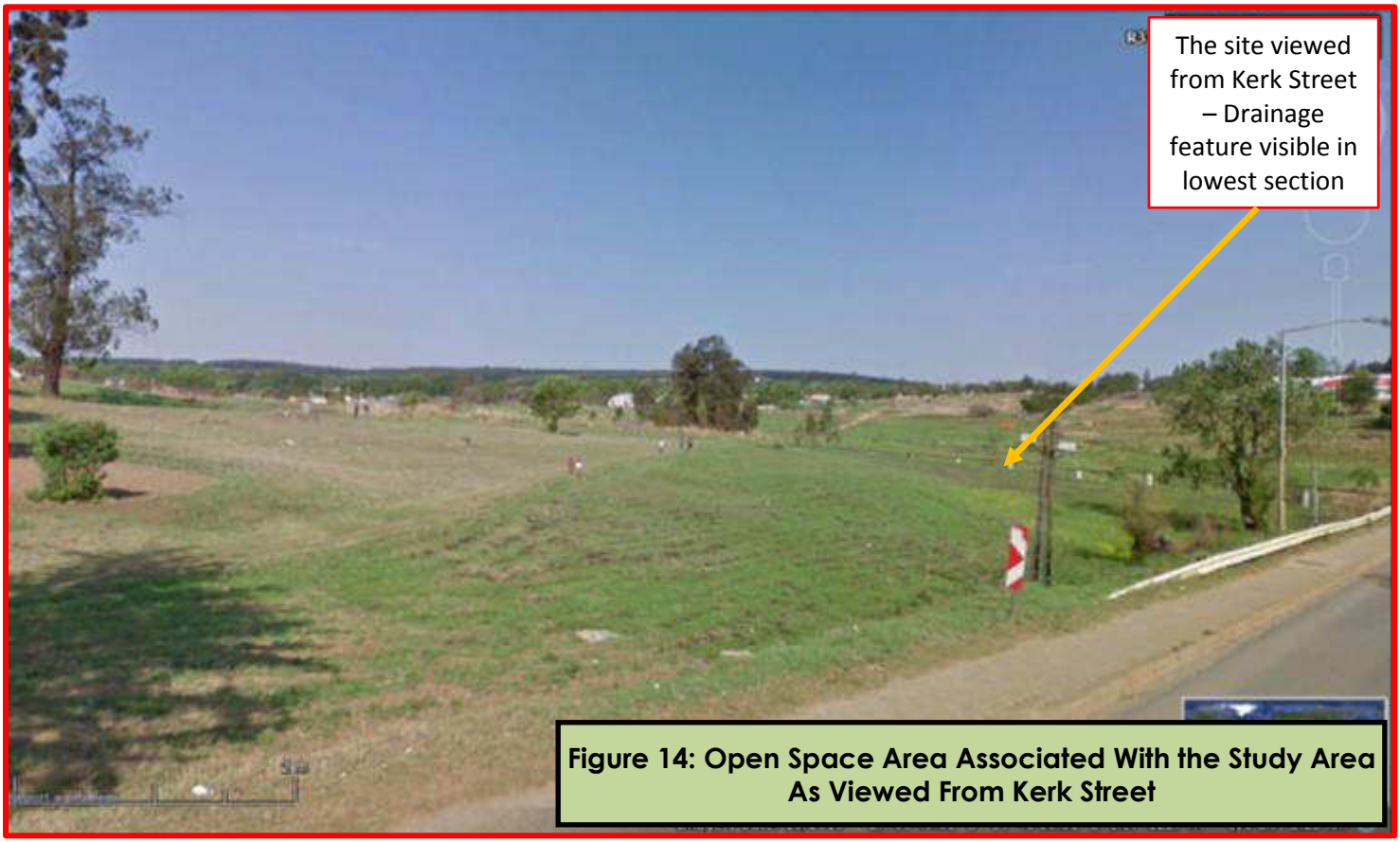


Figure 14: Open Space Area Associated With the Study Area As Viewed From Kerk Street

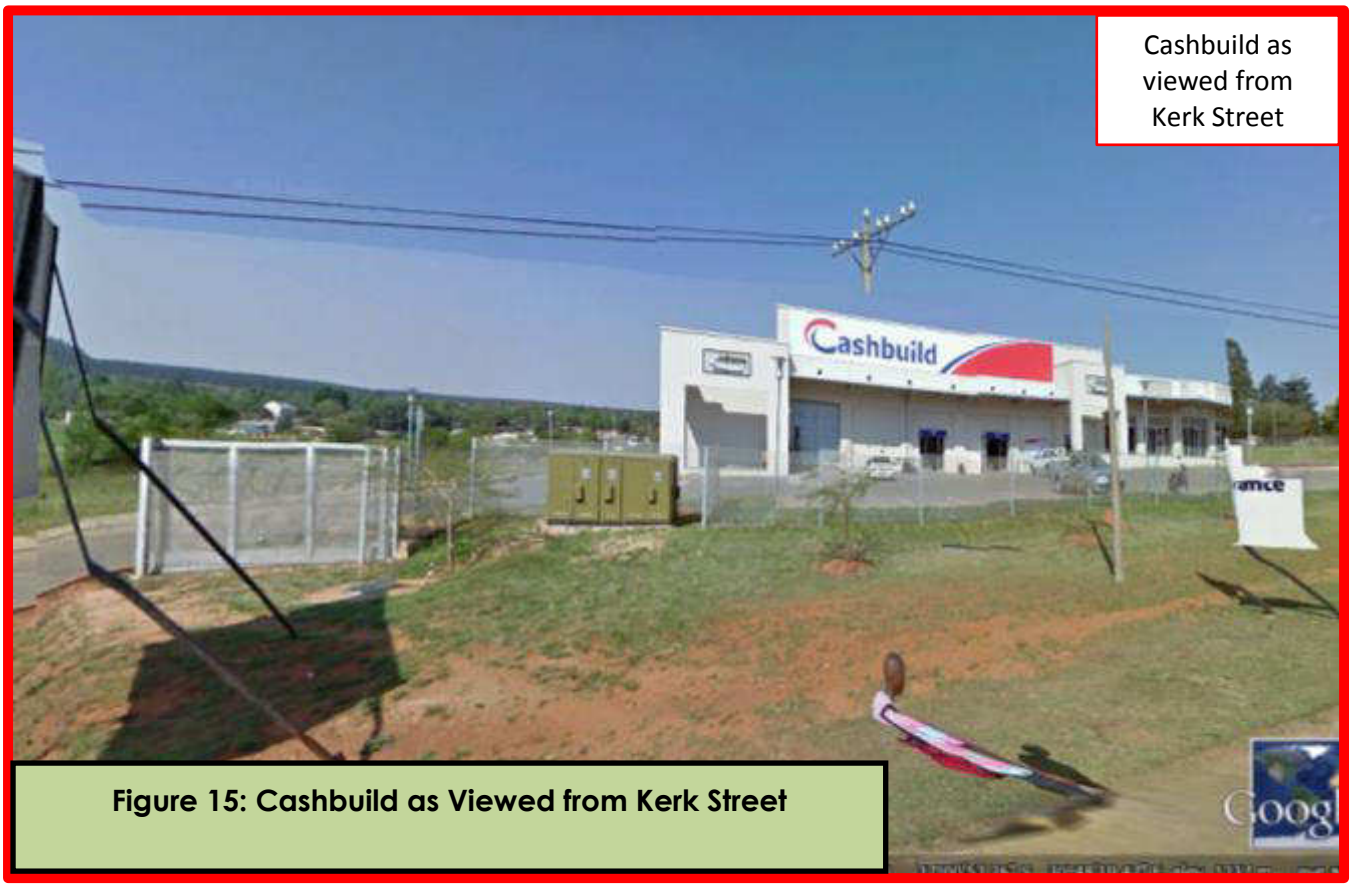


Figure 15: Cashbuild as Viewed from Kerk Street

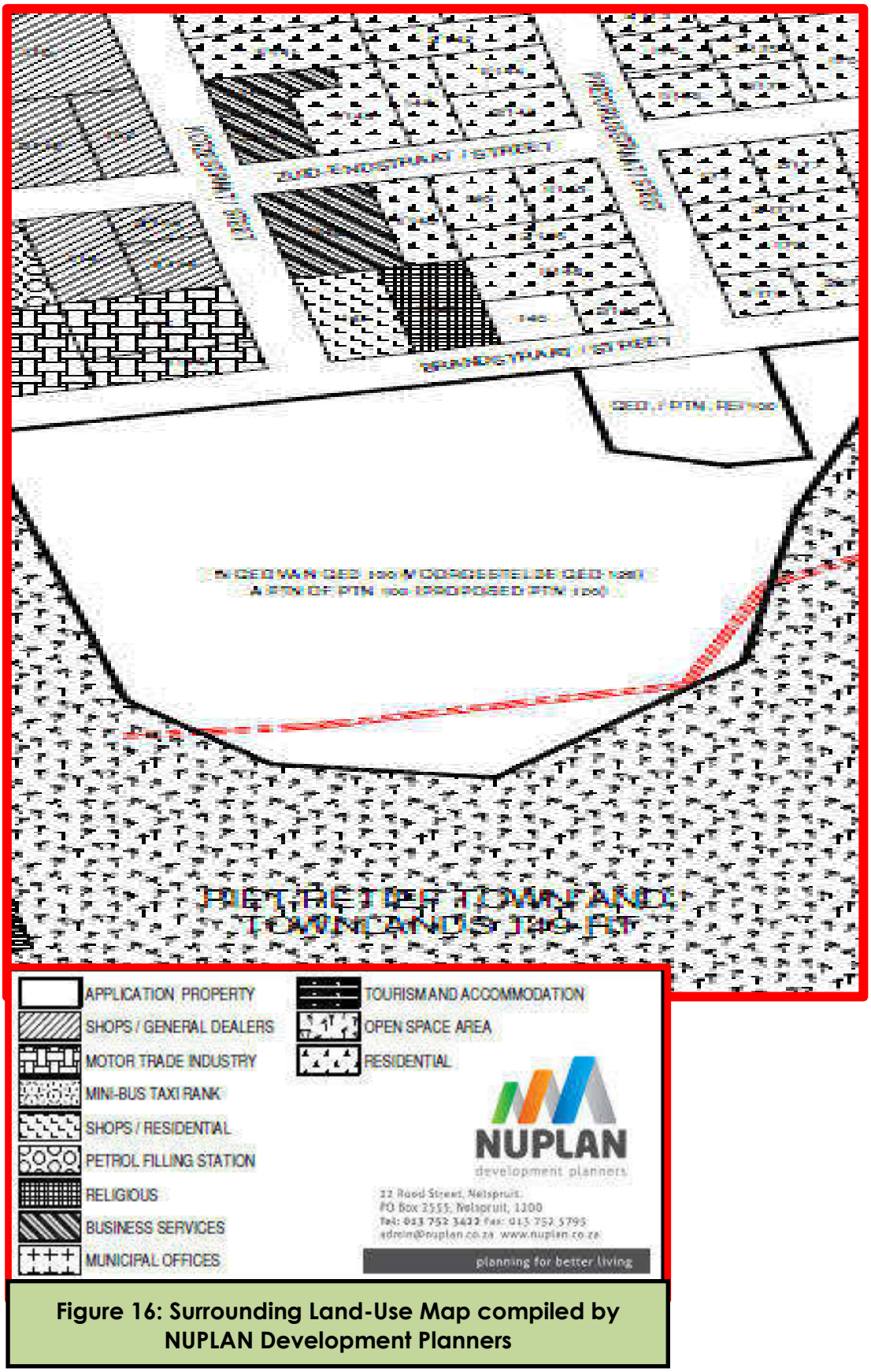


Figure 16: Surrounding Land-Use Map compiled by NUPLAN Development Planners

- **Social Facilities in the Surrounding Area**

Residential areas are mainly situated to the north-east, east and south-east of the study area and such residential townships accommodate a variety of social facilities. The police station, Mapulaneng hospital and schools are all within a 2 km radius from the proposed development. The provision of social facilities and services forms an important component of development and such facilities must be expanded or increased in accordance with the demand created through development.

Social facilities (i.e. schools, clinics, police stations etc.) are often a problem when developers apply for land-use rights in areas that are not regarded as priority development areas by local authorities and other government departments. In most cases such developments are outside or on the periphery of the urban areas (in many cases even outside the urban edge) and the implementation of services, infrastructure and social facilities are often not included in the short term budgets of the local authorities. This problem is often addressed through desperate developers that are forced to subsidize such social facilities or services until the budget becomes available, until the upgrading or the implementation of services and facilities in the area becomes a priority.

In the case of this development, the applicant agreed to replace the sub-standard municipal social facilities on the north-western corner of the study area with new facilities, on a site to the south-west of the study area, which has been identified by the local authority.

Implications for the Proposed Development

- The municipal infrastructure and services of the town of Piet Retief urgently needs some upgrading. Some of the existing roads in the town need resurfacing, general upgrading and maintenance and the proposed development creates an ideal opportunity for the upgrading of the roads and services around the study area;
- The town needs development, because the development will contribute to the rates and taxes payable to the local authority and this additional income will also increase the funds available for the upgrading and maintenance of the roads and infrastructure of the other services and roads of the town;

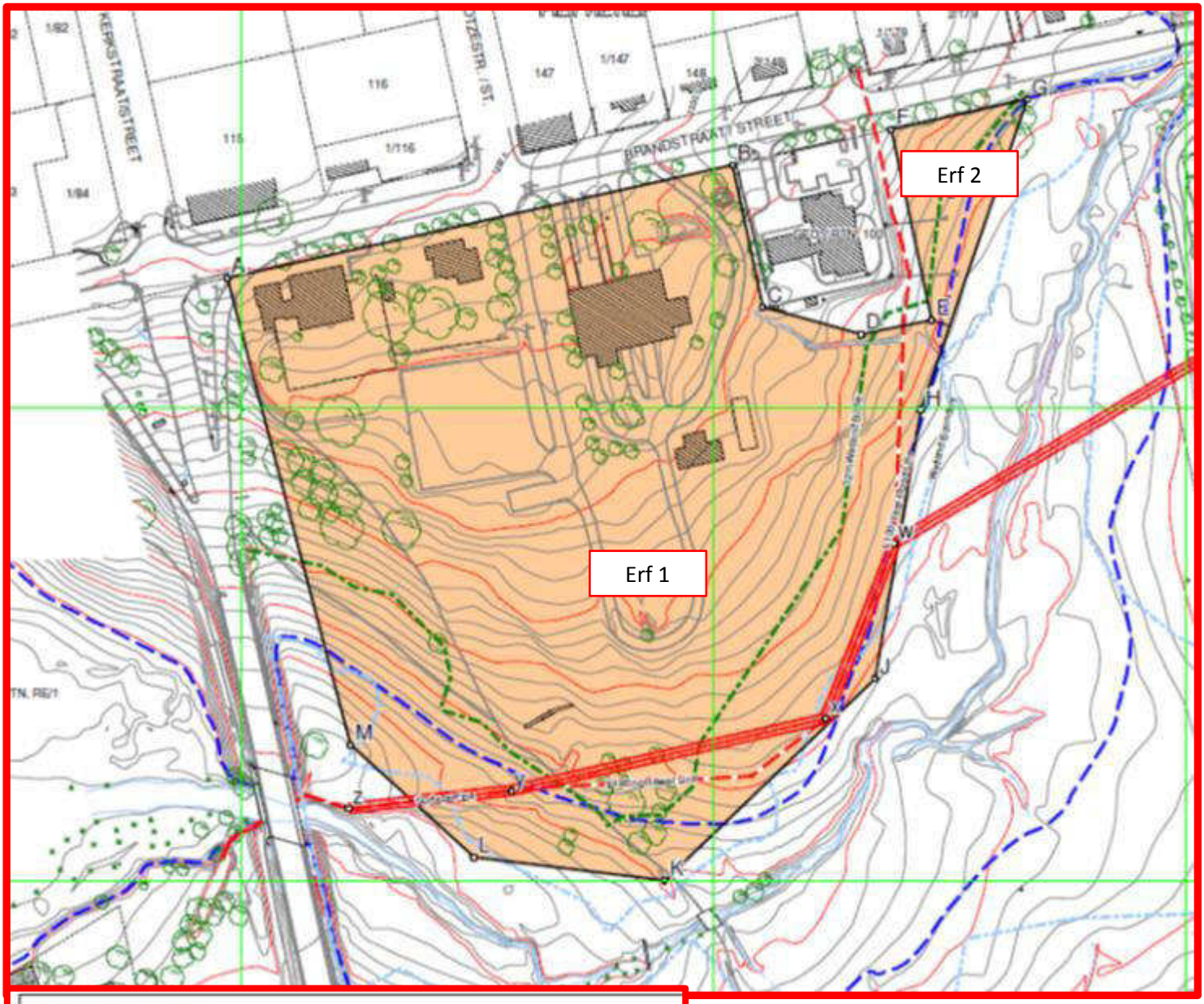
- The open space to the south of the study area is currently unitilised and the vegetation on this area is disturbed and invaded by exotics and weeds. A drainage feature, which is connected to the larger provincial open space system associated with watercourses, flows in an east-west direction along the eastern and southern boundaries of the study area. The exotic invaders and weeds already encroached onto the riparian zone and some urgent intervention is required to prevent such weeds and invaders from destroying the open spaces associated with the watercourses of the province. The local authority does not have the capacity to maintain all the open spaces in the municipal area and the proposed development creates an ideal opportunity for the rehabilitation and long term management and maintenance of the riparian and wetland areas of the study area. It is suggested that a PPP be established for the rehabilitation, management and maintenance of the areas associated with the watercourse.
- The existing buildings on the study area are dilapidated and the applicant agreed to replace the social facilities, which were accommodated in such dilapidated structures, in new social facility to be developed by the applicant on another property already identified;
- The proposed new shopping mall will contribute to the social facilities in the area and all the residents of the town will benefit from the proposed services upgradings; and
- The proposed development will promote sustainable development if the above-mentioned inputs required from the applicant are implemented.

1.3.3 Proposed Zoning and Land-use

(Refer to Appendix C for Facility Illustrations)

The proposed zoning for the property is as follows:

The proposed zoning for the mall development is "Special" for shops, businesses, offices, places of refreshment, dry cleaners, motor dealerships, vehicle sales mart, vehicle sales showroom, workshops, as well as related uses subservient thereto.



LAND USE TABLE:

USE ZONE	NOTATION	ERF NUMBER	AREA (m²)	% OF TOWNSHIP	NUMBER OF ERVEN
Special		1	62,185	95.64%	1
Special		2	2,834	4.36%	1
TOTAL		1-2	65,019	100.00%	2

Figure 17: Proposed Land-Use

The proposed "special" zoning excludes residential units, residential buildings, places of worship and a public garage (including a filling station) that are normally associated with a Business 1 zoning.

The proposed development will entail the following:

The proposed height : Not exceed 2 storeys

FAR	:	The floor area ratio shall not exceed 0.6.
Coverage	:	Not exceed 60%
Parking	:	Parking shall be in accordance with provision Clause 19, Table E of the Piet Retief Town-planning Scheme, 1980.

Figure 18: Layout Map as Designed by Paragon Architects

Implications for the development:

- **Not significant**. The proposed development will be in line with the objectives of the Mkhondo Local Municipality Spatial Development Framework, 2010;
- The proposed new shopping facility will contribute to the social facilities in the area;
- Increased rates and taxes payable to the local authority;
- The development of new community services facilities on a portion of land identified by the local authority. The new facilities will replace the facilities in the north-western section of the study area, which will be demolished; and

- Rehabilitation of riparian area.

1.3.4 Qualitative Environment

(Refer to Figure 19 and Appendix G for Enlarged Figure)

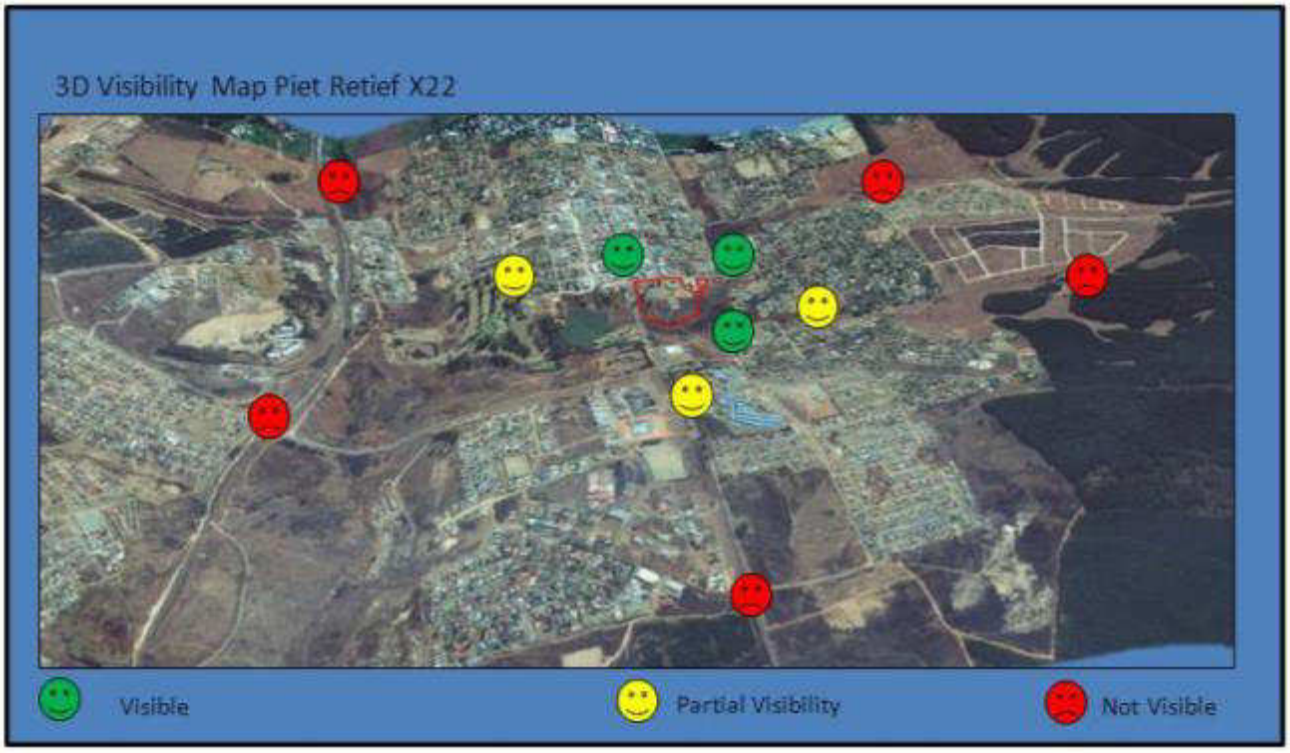


Figure 19: Visibility Map

- **Visual Aspects**

The following Visual Impact Assessment Criteria ***(Please refer to Table 2)*** have been used to determine the impact of the proposed development on the state of the environment – the significance is indicated by the respective colour coding for each of the impacts, being high, medium and low:

Table 2: Visual Impact Assessment Criteria

	IMPACT		
CRITERIA	**HIGH**	**MEDIUM**	**LOW**
Visibility	A prominent place	**A place with a loosely**	A place having little

	with an almost tangible theme or ambience.	**defined theme or ambience.**	or no ambience with which it can be associated.
Visual quality	A very attractive setting with great variation and interest – no clutter.	**A setting with some visual and aesthetic merit.**	A setting with no or little aesthetic value.
Compatibility with the surrounding landscape	Cannot accommodate proposed development without the development appearing totally out of place – not compatible with the existing theme.	**Can accommodate the proposed development without it looking completely out of place.**	The surrounding environment will ideally suit or match the proposed development.
Character	The site or surrounding area has a definite character/ sense of place.	**The site or surrounding environment has some character.**	The site or surrounding environment exhibits little or no character/ sense of place.
Visual Absorption Capacity	The ability of the landscape not to accept a proposed development because of a uniform texture, flat slope and limited vegetation cover.	**The ability of the landscape to less easily accepts visually a particular type of development because of less diverse landform, vegetation and texture**.	The ability of the landscape to easily accept visually a particular type of development because of its diverse landform, vegetation and texture.
View distance	If uninterrupted view distances to the site	If uninterrupted view distances to the site	**If uninterrupted view distances to the site are > 500 m and <**

	are > 5 km.	are < 5 km but > 1 km.	**1000 m.**
Critical Views	Views of the site seen by people from sensitive view sheds i.e. farms, nature areas, hiking trails etc.	Some views of the site from sensitive view sheds.	**A limited or partial view of the site from sensitive view sheds.**
Scale	A landscape with horizontal and vertical elements in high contrast to human scale.	**A landscape with some horizontal and vertical elements in some contrast to human scale.**	Where vertical variation is limited and most elements are related to the human & horizontal scale.

- The application site will be visible from the surrounding view sheds predominantly due to the study area's current topographical character, and the proposed size of the development. From the visual analysis it is clear that the existing property can be regarded as a place with a loosely defined theme or ambiance but a setting with minimal aesthetic value due to its current land-use (municipal purposes including storage facilities, offices, licensing department, vehicle testing grounds and structures used previously for the fire department);

- The CBD area has some "Sense of Place" and it also acts as a landmark/ gathering area in Piet Retief and the surrounding areas;

- The proposed development will not drastically impact on the views towards the study area from surrounding properties and from vehicles moving along the adjacent streets and the proposed structures are regarded as in line with a CBD development and the local authority planning; and the proposed new structure will without any doubt enhance the "Sense of Place" of the CBD area and it will assist in attracting more visitors to the CBD area. Furthermore, the study area is located in the road that forms part of the N2 national Road;

- The idea is to create structures and features in the CBD area that stand out and that are less easily accepted by the less diverse landform and structure, because

this characteristic will accentuate the CBD area even more. The landscaping to be implemented should be planned in such a way that it reduces the scale of the proposed new structure to a more human scale.

Implications for the development:

- The location of the study area is desirable in terms of accessibility and visibility from major roads; the proposed development will be highly visible from surrounding view sheds and this aspect can be contributed to the study area's topographical character and the proposed developable height of the development.

- Due to the surrounding developed landscape, it is anticipated that the proposed development will be accommodated from a visual perspective. From the tabulated assessment above it can be concluded that the proposed development will make a significant contribution towards the character and enhanced sense of place of the Piet Retief Central Business District. The surrounding developed urban landscape has a less diverse landform and texture but can still accommodate the proposed development from a visual perspective.

- The following measures are proposed to ensure that the proposed development is accommodated by the surrounding view sheds from a visual perspective:
    - The architectural styles, colours, textures and construction materials will determine the visual impact of the proposed development on the surrounding areas;
    - The proposed development will be seen from a distance and therefore the roofs should not reflect the sun or be covered with roofing materials that have bright colours;
    - Bokamoso is of the opinion that it would be possible to mitigate the anticipated visual impact through planning that takes the existing surrounding urban environment and aesthetical features of the site into consideration. The colour scheme for the proposed development must preferably blend in with the mosaic of colours from the surrounding urban environment;
    - Existing trees should be retained as far as possible, preferably only indigenous trees. The trees will soften the visual impact of the

proposed permanent structures and they will bring the scale of the vertical structures in some contrast to human scale;

- The landscaping to be installed as part of the proposed development must be chosen to assist with the creation and sustaining of a pleasant micro-climate, to act as visual screening and enhancement mechanism, to accentuate important focal points and movement and visual axis and to create a tranquil feeling;
- Landscaping should be done in concurrence with the building construction in order to create an instant visual enhancement of the development;
- Trees, shrubs and groundcovers that are prominent to the area and/or indigenous should preferably be used – landscaping that is in line with the natural vegetation of the area will not only help to reduce the visual impact of the development, but it will also create habitats for fauna and flora species;
- Where legally required, separate signage applications will also have to be submitted to the relevant authorities for approval;
- The lighting for the proposed development as well as all the billboards should be effectively designed so as not to spill unnecessary outward into the oncoming traffic, or into the yards of the neighbouring properties or open spaces;
- The exterior and interior lighting design should be sensitively designed to:
  - Prevent the lighting-up of the evening sky and the skyline;
  - Prevent any unnecessary spillage of lighting into the eyes of oncoming traffic;
  - Prevent the usage of flickering signage and advertising boards, especially where such boards will be visible from busy roads and surrounding residential areas; and
- It is recommended that movement activated lights are installed and that only some of the lights are on during the night in order to save energy. It is also recommended that the use of solar energy for external lighting and signage lighting be investigated.

- **Sense of Place**

The Sense of Place is a subjective feeling a person gets about a place by experiencing the place visually, physically, socially and emotionally. The "Sense of Place" of an area is one of the major contributors to the "Image of an area".

The image of an area consists of two main components, namely **place structure** and **sense of place.** These could be defined as the following:

- Place structure refers to the arrangement of the physical place making elements within a unique structure that can be easily legible and remembered; and
- The Sense of Place is the subjective meaning attached to a certain area by individuals or groups and is linked to its history, culture, activities, ambience and the emotions the place creates.

The study area can be regarded as a place with a loosely defined ambiance but a setting with minimal aesthetic value due to its current land-use (municipal purposes). The surrounding developed landscape- an urban area with views typically associated with central business districts has however some character and/or sense of place. The drainage feature and the open spaces associated with the drainage feature also contributes to the "Sense of Place" of the study area.

It is however anticipated that the proposed shopping centre development along the southern periphery of the CCBD of Piet Retief will significantly enhance the character and Sense of Place of the study area and if well planned and managed, it will also act as an attractive "Place Making Element" and "Southern Gateway" into the town of Piet Retief.

- **Pollution**

Noise Pollution

Some noise will be generated during the construction phase and such uneven construction associated noise may become a nuisance to the surrounding land owners, residents and businesses.

Noise generated during the operational phase will mainly be the noise generated by the increased traffic and noise generated by the proposed facilities and activities (i.e. air conditioners, placed of refreshment, compressors etc.) which is not anticipated to be a nuisance.

Implications for the development:

- It is anticipated that a certain amount of noise will be generated during the construction phase. The contractors should take care, and manage construction works to such an extent to comply with minimum ambient noise levels as defined in local, provincial, and National policies and frameworks. Construction activities must also be restricted to hours as specified in the National Building Regulations and if specific construction activities require that work continue after hours (i.e. the pouring of concrete slabs which cannot be interrupted), the surrounding residents must be notified of such potential disturbing activities;
- The contractor should notify the local/surrounding land-owners well in advance of any works that will generate noise (i.e. blasting operations);
- Construction site yards, workshops, concrete batching plants, and other noisy fixed facilities should be located well away from noise sensitive areas. All construction vehicles, plant and equipment are to be kept in good repair;
- Truck traffic should be routed away from noise sensitive areas, where possible;
- Blasting operations, if required are to be strictly controlled with regard to the size of explosive charge in order to minimize noise and air blast and timings of explosions. The number of blasts per day should be limited;
- Construction activities are to be contained to reasonable hours during the day. No construction should be allowed on weekends from 14h00 on Saturday afternoons to 06h00 the following Monday morning;
- Working hours during weekdays must be limited from 06h00 until 18h00;
- With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents and be kept informed of the nature and duration of intended activities; and
- As construction workers operate in a very noisy environment, it must be ensured that their working conditions comply with the requirements of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993). Where necessary ear protection gear should be worn.

Air/Dust Pollution

It is not foreseen that the proposed development would contribute significantly in terms of pollution by smoke, as it is a commercial development and not industrial land-use. It can however be expected that a certain amount of dust, will be generated due to earthmoving activities and construction works. One should note that the impact of dust pollution is short term, lasting for the duration of construction only.

Implications for the development:

- If dry and windy conditions occur during the construction phase, dust pollution could become a problem. The regular and effective damping of working areas must therefore be carried out on a continues basis, to ensure that the generation of dust due to involved construction works are kept under control.

1.3.5 Services

Lekwa Consulting Engineers (Pty) Ltd was appointed by Zarafusion (Pty) Ltd as the Civil Engineers for the proposed Shopping Centre. ***(Please refer to Figure 20 and Appendix D4 for a copy of the report)***

1.3.5.1 Water Supply

The Mkhondo Municipality is the authority (Water Services Authority) and provider (Water Services Provider) for Piet Retief and is responsible for the provisioning of water services within its area of jurisdiction.

The proposed development site is currently zoned as municipal and the existing rights for the property allows for 75% coverage of Municipal purposes. As the property forms part of an existing township, the existing network would have been designed/sized for these existing rights. There is an existing water connection which is currently being used by the land occupiers. The services engineer informed that according to the "Red Book" (Guidelines for the provision of Engineering Services and Amenities in Residents Township Developments) the annual average water demand is the same for Government and Municipal areas and Offices and Shops. The current water network and connection has sufficient capacity for the proposed shopping mall in Piet Retief.

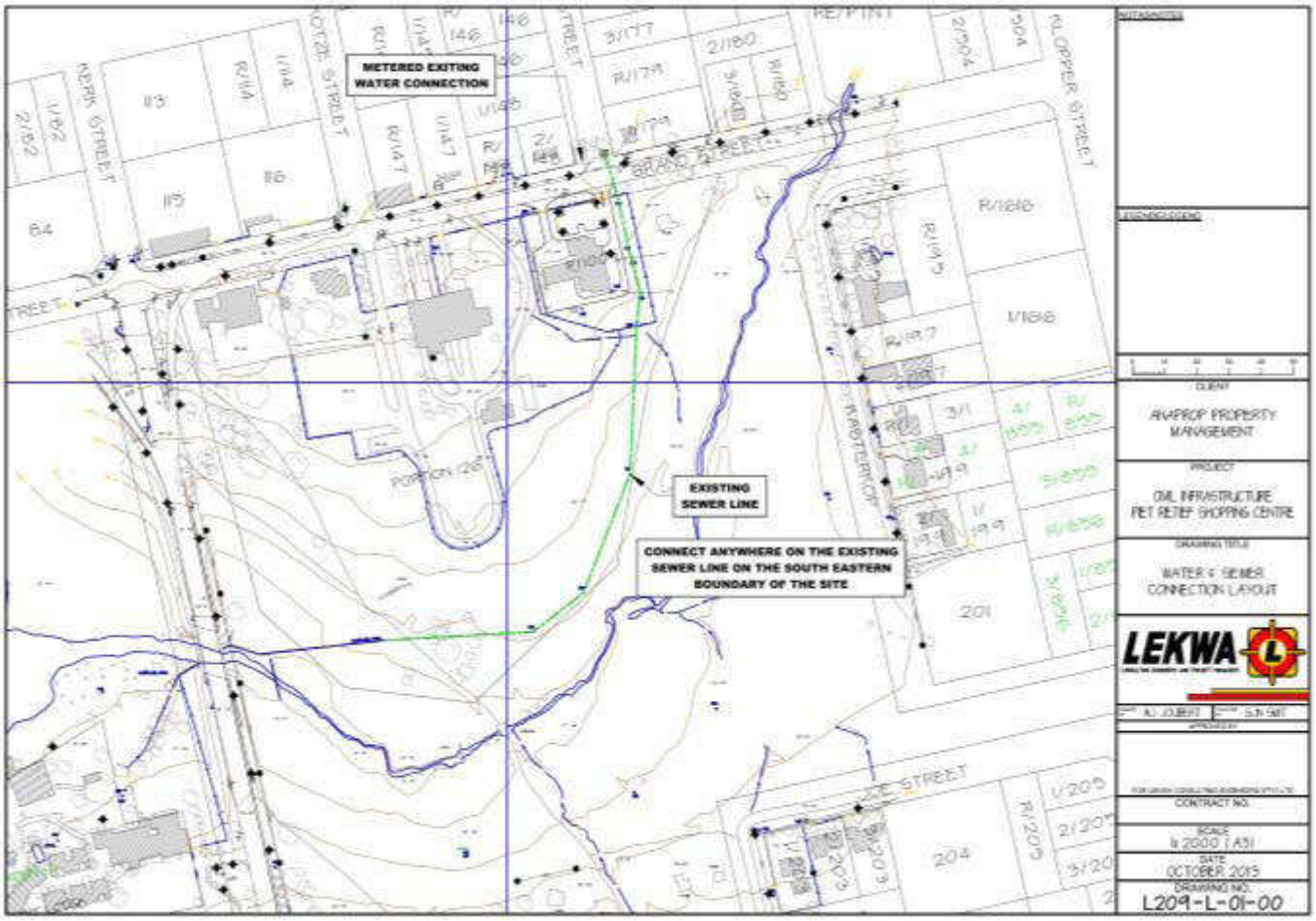


Figure 20: Services Map (Water and Sewer)

Internal Water Supply

In accordance with the "Red Book", the estimated water demand per shop/office is 400 litres per day / 100 m^2 of gross floor area. The instantaneous peak factor in the mains can be calculated by converting the proposed development to equivalent erven according to the design annual average demand. One equivalent erven has an annual average daily demand of 1000 litres. The peak factor is estimated to be about 4 but this can only be finalised once the final layout is set. Based on this peak factor, the estimated water demand for the proposed development of a shopping mall is 156 kℓ per day.

Implications for the development:

Not significant. Water supply is available for the proposed development.

1.3.5.2 Sewage

As mentioned earlier, Mkhondo Municipality is responsible for provision of water services within Piet Retief and its area of jurisdiction as they are the Water Service Authority (WSA) and the Water Services Provider (WSP) for Piet Retief.

There is an existing sewer connection which is currently being used by the land occupiers. As the property forms part of an existing township, the existing network would have been designed/sized for these existing rights. It is therefore anticipated that the current sewer network and connection has sufficient capacity for the proposed shopping mall in Piet Retief.

Internal sewer

Again, the "Red Book" is used for standards, and the estimated sewage outflow per unit (of any sort) is 80% of the water demand of the relevant unit. This also allows for 15% storm water infiltration rate.

A four meter wide Servitude line is planned to be constructed to the southern side of the development site, this proposed sewer line runs across the site form the eastern side to the western side of the development site (topography of the area will have to be considered during the design process and the viability of this option considered).

The estimated sewer flow for the proposed shopping mall is 6.6 ℓ/s. A 110mm sewer pipe installed at minimum 1:95 at 80% full flow will provide for sufficient capacity.

Implications for the development:
Not significant. Sewage services are available for the proposed development. Should any upgrade or extensions be done for the existing sewer line the topography of the area will have to be considered during the design process.

1.3.5.3 Storm Water

According to Lekwa Engineers, the storm water network of the development site must convey all surface storm water runoff (road and roof discharge) to the existing storm water network which serves the town of Piet Retief.

Due to the predisposition of the existing soils to erosion, it is crucial that effective storm water erosion control measures be implemented both during and following construction of the civil infrastructure.

Storm water from parking areas will be transferred to open channels which should be covered with steel grids. These channels will then convey the storm water to the municipal storm water networks with controlled discharge. The storm water from rooftops will be collected at a central point at each shop/unit or drained into the municipal network with a controlled discharge rate. No storm water attenuation is expected to form part of the storm water plan.

Implications for the development:

- Efficient scour protection and filtration systems will be required at all discharge points to maintain the integrity of the water quality flow and control the erosion protection at these points.

1.3.5.4 Solid Waste Removal

The local authority will be responsible for the solid waste removal. The waste will be disposed of at a registered landfill site and the landfill site has the capacity to accommodate the additional waste generated by the proposed development.

Implications for the development:

The local authority confirmed that there is an active dump fill site in Piet Retief and the developer needs to make the necessary arrangements. Removal will be twice a week.

1.3.5.5 Electricity

There is an existing electrical connection and the final size of this connection will be established as soon as the type of facilities in the mall is known. The Local Municipality confirmed that they are in the process of upgrading an electric main substation. The Local municipality also confirmed availability for electric services.

Implications for the development:

Not significant.

1.3.5.6 Road Access

(Please refer to Appendix D5)

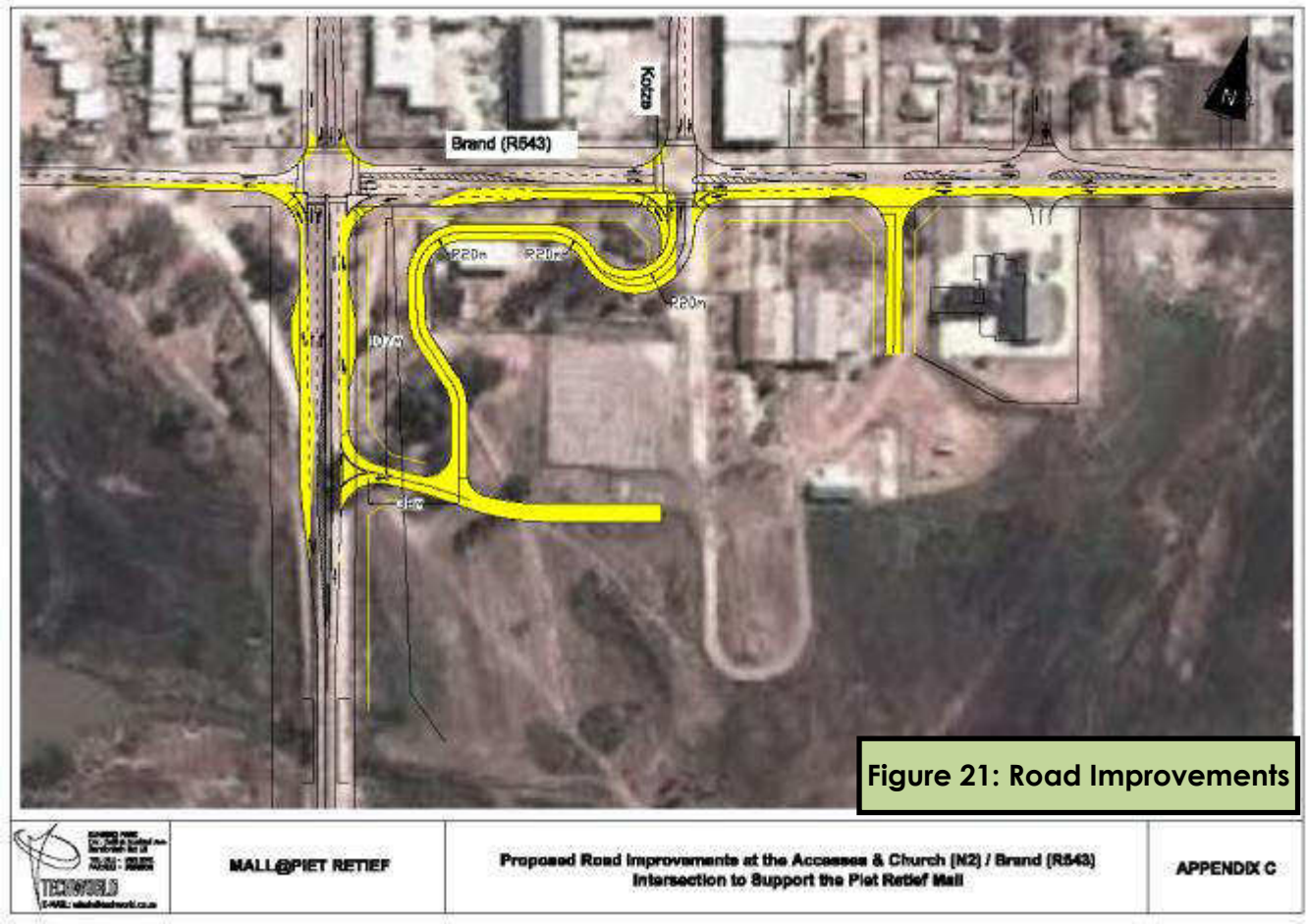


Figure 21: Road Improvements

Primary access to the proposed shopping mall is planned from Brand Street and a secondary access is planned in Church Street (this will be a marginal access, left-in and left-out).

2. APPLICABLE LEGISLATION AND GUIDELINES

2.1 Activities applied for in terms of NEMA

Apart from the fact that Zarafusion (Pty) Ltd has to apply for Town Planning Approval in terms of the Town planning and Townships Ordinance, 1986, it will also be necessary for the applicant to apply for Environmental Authorisation in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA).

In June 2010 the Minister of Environmental Affairs passed the Amended Environmental Impact Assessment Regulations[1] (The Regulations) in terms of Chapter 5 of the National Environmental Management Act, 1998[2] (NEMA). The Amended Regulations replaced the 2006 Environmental Impact Assessment (EIA) regulations, which were also promulgated in terms of the National Environment Management Act, 1998 (Act No. 107 of 1998). The new regulations came into effect on 18 June 2010 and, therefore, all new applications must be made in terms of the New NEMA regulations and not in terms of the 2006 EIA Regulations of the NEMA. The purpose of this process is to determine the possible negative and positive impacts of the proposed development on the surrounding environment and to provide measures for the mitigation of negative impacts and to enhance positive impacts.

Notice R. 544, R 545, & R 546 of the Amended Regulations list activities that indicate the process to be followed. The Activities listed in Notice No. Notice R. 544 & R 546 require that a Basic Assessment process be followed and the activities listed in Notice No. R 545 requires that the Scoping and EIA process be followed.

An application for Environmental Authorization for the proposed shopping mall was submitted to the approving authority, **Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) and an acknowledgement letter was received on 05/03/2014**. Bokamoso commenced with the public participation process immediately after the application has been submitted and has been included as part of this report**.** The application has been assigned the reference number **17/2/3/GS-239.**

Note: The Public Participation Section of this report (Section 3, Appendix F) supplies more detail regarding the entire public participation process that was followed.

In the environmental application process (to be compiled in terms of NEMA) the applicant is applying for the following listed activities.

Table 3: Listed activities in terms of Notice R. 544 & R. 546

Indicate the number and date of the	Activity No (s) (in terms of the	Describe each listed activity as per the detailed project description (and not as per wording of the relevant Government Notice)[4]:

[1] Environmental Impact Regulations, 2010
[2] Act No. 107 of 1998

relevant notice:	relevant notice) :	
R. 544, 18 June 2010	**Activity 9**	The construction of facilities or infrastructure exceeding 1000 meters in length for the bulk transportation of water, sewage or storm water – (i) With an internal diameter of 0,36 meters or more; or (ii) With a peak throughput of 120 liters per second or more; excluding where: a. Such facilities or infrastructure are for bulk transportation of water, sewage or storm water drainage inside a road reserve; or Where such construction will occur within urban areas but further than 32 meters from a watercourse, measured from the edge of the watercourse.
R. 544, 18 June 2010	**Activity 11**	The Construction of: (i) Canals; (ii) Channels; (iii) Bridges; (v) Weirs; (vi) Bulk storm water outlet structures; (x) Infrastructure or structures covering 50 square metres or more. Where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.
R. 544, 18 June 2010	**Activity 18**	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from: (i) a watercourse; but excluding were such infilling, depositing, dredging, excavation, removal or moving: (ii) is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or (iii) Occurs behind the development setback line

R. 544, 18 June 2010	**Activity 23**	The transformation of undeveloped, vacant land to- (iv) residential, retail, commercial, recreational, industrial or Institutional use inside an urban area, and where the total area to be transformed is 5 hectares or more, but less than 20 hectares, or (v) residential, retail, commercial, industrial or Institutional use outside an urban area and where the total area to be transformed is bigger than 1 hectare but less than 20 hectares;- Except where such transformation takes place for linear activities.
R. 544, 18 June 2010	**Activity 24**	The transformation of land bigger than 1000 square metres in size, to residential, retail, commercial, industrial or institutional use, where, at the time of the coming into effect of this schedule, such land was zoned as open space, conservation or had an equivalent zoning.

Please take note that the 2010 NEMA EIA Regulations were replaced by the Amended 2014 NEMA EIA Regulations on 4 December 2014, but due to the fact that the application was submitted in terms of the 2010 NEMA EIA Regulations, this application will be dealt with in terms of such Regulations. Once the Decision has been issued in terms of the 2010 NEMA EIA Regulations, such Decision will be regarded as a Decision issued in terms of the New 2014 EIA Regulations and all following procedures (i.e. Amendment Applications, Appeals etc. must be made/submitted in terms of the 2014 NEMA EIA Regulations. Refer to Chapter 8 – Transitional Arrangements and Commencement of the 2014 NEMA EIA Regulations).

Regulation 53 (3) of the 2014 NEMA EIA Regulations furthermore states "Where an application submitted in terms of the previous NEMA EIA Regulations, is pending in relation to the activity of which a component of the same activity was not identified under the previous NEMA Notices, but is now identified in terms of Section 24 (2) of the Act, the competent authority must dispense of such application in terms of the previous NEMA regulations and may authorise the activity identified in terms of Section 24 (2) as if it was applied for, on condition that all impacts of the newly identified activity and

requirements of these Regulations have also been considered and adequately assessed."

Section 24(2) Activities to be considered by MDEDET:

We perused the Amended 2014 NEMA EIA Regulations and decided to list the activities that will most probably be triggered in terms of such Regulations ***(Refer to the table below).*** *The activities identified are very similar to that activities applied for in terms of the 2010 NEMA EIA Regulations and we therefore feel confident that all the activities as listed have been assessed.*

Due to the fact that the 2014 Regulations are still new, we recommend that MDEDET rather dispense this application in terms of the 2010 NEMA EIA Regulations.

Table 4. 2014 Amended NEMA EIA Regulations: Listed Activities that will most probably be triggered:

Listing Notice 1:		
R.983	Activity 9	The development of infrastructure exceeding 1000 metres in length for the bulk transportation of water or storm water- (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of water or storm water or storm water drainage inside a road reserve; or (b) where such development will occur within an urban area.
	Activity 10	The development and related operation of infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of

		sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve; or (b) where such development will occur within an urban area.
	Activity 12	The development of- (i) canals exceeding 100 square metres in size; (ii) channels exceeding 100 square metres in size; (iii) bridges exceeding 100 square metres in size; (iv) dams, where the dam, including infrastructure and water surface area, exceeds 100 square metres in size; (v) weirs, where the weir, including infrastructure and water surface area, exceeds 100 square metres in size; (vi) bulk storm water outlet structures exceeding 100 square metres in size; (vii) marinas exceeding 100 square metres in size; (viii) jetties exceeding 100 square metres in size; (ix) slipways exceeding 100 square metres in size; (x) buildings exceeding 100 square metres in size; (xi) boardwalks exceeding 100 square metres in size; or (xii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; - excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area; or (ee) where such development occurs within existing roads or road reserves.
	Activity 19	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from-

		(i) a watercourse; (ii) the seashore; or (iii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater- but excluding where such infilling, depositing , dredging, excavation, removal or moving- (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; or (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies.
	Activity 27	The clearance of an area of 1 hectares or more, but less than 20 hectares of indigenous vegetation, except where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan

2.2 Relevant Legislations and Regulations

2.2.1 International Legislations and Regulations

Relevant International Conventions to which South Africa is party:

- Convention relative to the Preservation of Fauna and Flora in their natural state, 8 November 1993 (London);
- Convention on Biological Diversity, 1995

  (Provided, and added stimulus for a re-examining and harmonization of its activities relating to biodiversity conservation. This convention also allows for the in-situ and ex-situ propagation of gene material);
- Agenda 21 adopted at the United Nations Conference on Environment and Development (UNCED) in 1992.

  (An action plan and blueprint for sustainable development)

2.2.2 National Legislations and Regulations

- **National Environmental Management Act, 1998 (Act No. 107 of 1998) and the Environmental Impact Assessment Regulations**

The Environmental Impact Assessment (EIA) process followed is in compliance with the National Environmental Management Act: NEMA, 1998 (Act No. 107) of 1998), as amended and the Environmental Impact Assessment Regulations of 2010 (Government Notice No's R544, 545 & 546 of 2010). The proposed development involves 'listed activities', as defined by the NEMA, 1998. Listed activities are activities, which may potentially have detrimental impacts on the environment and therefore require environmental authorisation from the relevant authority, before such activities are implemented.

NEMA provide for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state and to provide for matters connected therewith.

This Act formulates a set of general principles to serve as guidelines for land development and it is desirable that:

- The law develops a framework for integrating good environmental management into all development activities;
- The law should promote certainty with regard to decision-making by organs of state on matters affecting the environment;
- The law should establish principles guiding the exercise of functions affecting the environment;
- The law should ensure that organs of state maintain the principles guiding the exercise of functions affecting the environment;
- The law should establish procedures and institutions to facilitate and promote co-operative government and inter-governmental relations;
- The law should establish procedures and institutions to facilitate and promote public participation in environmental governance; and
- The law should be enforced by the State and that the law should facilitate the enforcement of environmental laws by civil society.

Integrated Environmental Management

Integrated Environmental Management (IEM) is a philosophy, which prescribes a code of practice for ensuring that environmental considerations are fully integrated into all stages of the development process. This philosophy aims to achieve a desirable balance between conservation and development (Department of Environmental Affairs, 1992). The IEM guidelines intend endearing a pro-active approach to sourcing, collating and presenting information at a level that can be interpreted at all levels.

The Environmental Impact Assessment Regulations (EIA)

The Minister of Environmental Affairs, promulgated and passed in (April 2006) Environmental Impact Assessment Regulations (the new regulations) in terms of Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). When these regulations came into effect on 3 July 2006 they replaced the Environmental Impact Assessment Regulations that were promulgated in terms of the Environmental Conservation Act, 1989 (Act No. 73 of 1989) (ECA) in 1997, and introduced new provisions for EIAs.

The National Environmental Management Amendment Act, 2008 (Act 62 of 2008) (NEMAA), that was promulgated on 9 January 2009 (came into effect on 1 May 2009), made a number of significant amendments to the general provisions applicable to EIA's. On 2 August 2010 the Amended EIA Regulations came into effect and replaced the previous EIA Regulations that were promulgated on 21 April 2006.

Notice R. 544 R 545, & R 546 of the Amended Regulations list activities that indicate the process to be followed. The Activities listed in Notice No. Notice R. 544 & R 546 require that a Basic Assessment process be followed and the activities listed in Notice No. R 545 requires that the Scoping and EIA process be followed.

Please note that the NEMA EIA Regulations were amended on 4 December 2014 and came into effect on 8 December 2014. Table 4 lists the activities applicable for the 2014 Regulations.

Implications for the development:

Significant - The application for the proposed development consists only of activities listed under Notice **No. R544**, as applied for under the 2010 EIA Regulations**,** therefore a Basic Assessment Report will be submitted to the Mpumalanga Department of Economic Development, Environment and Tourism for consideration.

- **The National Water Act, 1998 (Act No. 36 of 1998)**

The purpose of this Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways that take into account, amongst other factors, the following:

- Meeting the basic human needs of present and future generations;
- Promoting equitable access to water;
- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Reducing and preventing pollution and degradation of water resources;
- Facilitating social and economic development; and
- Providing for the growing demand for water use.

In terms of Section 21 of the National Water Act, the developer must obtain water use licenses if the following activities are taking place:

a) Taking water from a resource;
b) Storing water;
c) Impeding or diverting the flow of water in a water course;
d) Engaging in a stream flow reduction activity contemplated in Section 36;
e) Engaging in a controlled activity identified as such in Section 37(1) or declared under Section 38(1)
f) Discharging waste or water containing waste into a water resource through a pipeline, canal, sewer, sea outfall or other conduit;
g) Disposing of waste in manner which may detrimentally impact on a water resource;
h) Disposing in any manner which contains waste from or which has been heated in any industrial or power generation process;
i) Altering the beds, banks, course or disposing of water found underground if it is necessary for the safety of people;

j) Removing, discharging, or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
k) Using water for recreational purposes.

The National Water Act (Section 144) also requires that (where applicable) the 1:50 and 1:100 year flood line be indicated on all the development drawings that are submitted for approval.

Implications for the development:

Significant - The proposed development is situated outside the 1:100 year floodline, according to the 1:100 year floodline delineation, and will therefore not be affected by any normal flood events. Furthermore, there is a drainage line outside the southern and eastern boundary of the proposed development site and the 32m buffer zone from the delineated wetland is within the study area. The proposed development will be within 500m of the delineated wetland.

- **National Environmental Management: Air Quality Act (Act No. 39 of 2004)**

The NEMA: Air Quality Act, 2004 serves to repeal the Atmospheric Pollution Prevention Act, 1965 (Act 45 f 1965). The Air Quality Act regulates air quality in order to protect the environment. It provides reasonable measures for the prevention of pollution and ecological degradation and for securing ecological sustainable development while promoting justification economic and social development.

The purpose of the Act is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air Quality management planning;
- Air Quality monitoring and information management;
- Air Quality management measures
- General Compliance and enforcement

Amongst other things, it is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa;
- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality;
- The reduction of risks to human health and the prevention of the degradation of air quality.

The Act describes various regulatory tools that should be developed to ensure the implementation and enforcement or air quality management plans. These include:

- Priority Areas, which are air pollution "hot spots"'
- Listed activities, which are 'problem' processes that require an Atmospheric Emission License;
- Controlled emitters, which includes the setting of emission standards for 'classes' of emitters, such as motor vehicles, incinerators, etc.
- Control of noise;
- Control of odours

Implications for the development:

Not Significant - It is not foreseen that the proposed development would contribute significantly in terms of smoke and noise as it is a commercial shopping mall development and not industrial. It can however be expected that a certain amount of dust will be generated with construction activities, due to earthmoving activities and demolition works. One should note that the impact of dust pollution is short term and lasting for the duration of construction only.

➢ The National Heritage Resources Act, 1999 (Act 25 of 1999) (NHRA)

The NHRA requires Heritage Resources Impact Assessments for various categories of development stipulated in Section 38 of the Act. It also provides for the grading of heritage resources and the implementation of a three-tier level of responsibilities and functions for heritage resources to be undertaken by the State, Provincial Authorities, depending on the grade of the heritage resource. The Act defines cultural significance, archaeological and paleontological sites and materials (section 35), historical sites and structures (section 34), and graves and burial sites (section 36) that fall under its jurisdiction. Archaeological sites and material are generally those resources

older than a hundred years, including gravestones and grave dressing. Procedures for managing graves and burial grounds are set out in Section 36 of the NHRA. Graves older than 100 years are legislated as archaeological sites and must be dealt with accordingly.

Section 38 of the NHRA makes provision for application by developers for permits before any heritage resource may be damaged or destroyed.

Implications for the development:

Not Significant - Due to the highly disturbed and totally transformed state of the study area, it was not deemed necessary to conduct a Heritage Impact Assessment in terms of the requirements as provided for in Section 38 of the NHRA, 1999. If any remains/cultural resources are exposed or uncovered during the construction phase, it should immediately be reported to the South African Heritage Resources Agency (SAHRA). Burial remains should not be disturbed or removed until inspected by an archaeologist.

- **The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)**

The Act provides for the control over the utilisation of Natural Agricultural resources of South Africa, in order to promote the conservation of soil, water sources and vegetation, as well as combating of weeds and invader plants and for matters connecting therewith.

Implications for the development:

Not Significant - According to a GIS desktop study, the study area has a medium agricultural potential and soils. Bokamoso are however of the opinion that as the development site is considered to be very small, developed and located within an urban environment, it would not be possible to utilise the site alternatively for the purpose of Agriculture.

- **National Environmental Management: Protected Areas Act, 2003 (Act No 57 of 2003)**

The purpose of this Act is to provide for the protection, conservation and management of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes, for the management of those areas in accordance to national norms and standards, as well as for the intergovernmental co-operation and public consultation in matters concerning protected areas. Protected areas are to be conserved for their biodiversity and ecological integrity.

Implications for the development:

Not Significant - From GIS desktop study it is evident that the application site is not located within any conservancy or protected area.

- **National Environmental Management: Waste Act, 2008 (Act 59 of 2008)**

The Waste Management Act which was finally Gazetted on 10 March 2009, is to give effect to the White Paper on Integrated Pollution and Waste Management and the National Waste Management Strategy (NWMS).

Purpose:

To reform the law regulating waste management in order to protect the health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development; to provide for institutional arrangements and planning matters; national norms and standards for regulating the management of waste by all spheres of government; to provide for specific waste management measures; to provide for the licensing and control of waste management activities; to provide for the remediation of contaminated land; to provide for the national waste information system; to provide for compliance and enforcement; and to provide for matters connected therewith.

Objectives:

- To ensure sound environmental management of waste;
- To provide for utilisation of environmentally-sound methods that maximise the utilisation of valuable resources and encourage resource conservation and

recovery;

- To reduce risk to human health and prevent the degradation of the environment through usage of mechanisms that promote the following:
    - Pollution prevention and cleaner production
    - Volume reduction at source
    - Recycling, recovery and re-use
- Set guidelines and targets for waste avoidance and volume reduction through source reduction and waste minimisation measures, including composting, recycling, re-use, recovery, green charcoal process, and others, before collection, treatment and disposal in appropriate and environmentally sound waste management facilities in accordance with this act;
- To ensure the proper segregation, collection, transportation, storage, treatment and disposal of waste through the formulation and adoption of the best environmental practice in ecological waste management;
- To promote national research and development programs for improved waste management and resource conservation techniques, more effective institutional arrangement and indigenous and improved methods of cleaner production, waste reduction, re-use, collection, treatment, separation and recovery;
- To encourage greater private sector participation in waste management;
- To encourage cooperation and self-regulation among waste generators through the application of market-based instruments;
- To institutionalize public participation in the development and implementation of national, provincial and local integrated, comprehensive, and ecological waste management programs;
- To strengthen the integration of ecological waste management and resource conservation and recovery topics into the academic curricula of formal and non-formal education in order to promote environmental awareness and action among the citizenry; and
- To control the export, import, transit, re-use, recovery, treatment and disposal of waste to ensure that all operations relating to export, import, transit, re-use, recovery, treatment and disposal will be undertaken in an environmentally sound manner.

Please note that the listed activities that will trigger a waste license application were amended on 29 November 2013.

Implications for the development:

Not significant - The construction and operation of the proposed development are not subjected to any activity as listed in Category A and B of NEMA: WA, 2008.

3 DETAILS OF THE PUBLIC PARTICIPATION PROCESS

(Refer to Appendix F for all public participation details)

The principles of the National Environmental Management Act, 1998 (Act No 107 of 1998) and the Environmental Impact Assessment Regulations, April 2006 govern many aspects of Environmental Impact Assessments, including Public Participation. These include provision of sufficient and transparent information on an ongoing basis to stakeholders to allow them to comment and ensuring the participation of previously disadvantaged people, women and youth.

Effective public involvement is an essential component of many decision-making structures, and effective community involvement is the only way in which the power given to communities can be used efficiently. The Public Participation Process is designed to provide sufficient and accessible information to interested and affected parties (I&AP's) in an objective manner to assist them to:

- Raise issues of concern and suggestions for enhanced benefits;
- Verify that their issues have been captured;
- Verify that their issues have been considered by the technical investigations; and
- Comment on the findings of the Basic Assessment Report.

In terms of the Guideline Document for Environmental Impact Assessment (EIA) Regulations promulgated in terms NEMA, stakeholders (I&AP's) were notified of the Environmental Evaluation Process through:

1) A site notice that was erected (at prominent points on and around the study area) on **19 March 2014** ***(refer to Appendix F1);***

2) A public notice was distributed in a 100m radius around the proposed site to all parties concerned **(Refer to Appendix F2);**

3) Notices regarding the project were **e-mailed to a list of interested and affected parties and the councillors** in the area that registered for other projects in the area **(Refer to Appendix F3)**;
4) An advertisement was placed in the **Excelsior Newspaper on 21 March 2014 (Refer to Appendix F4);**
5) A list of all persons, organisations and organs of state that were registered as interested and affected parties in relation to the application are attached in **Appendix F5;**
6) A summary of the issues raised by the interested and affected parties, are attached in **Appendix F6;**

4 LONGTERM SUSTAINABLILITY, NEED AND DESIRABILITY

4.1 NEED

Residential growth rates within the primary and secondary catchment is projected at 2.0% and 1.2%, respectively. These rates were used to get a projected figure of ±33164 households in 2015. Based on these demographics, possible market shares, gross leasable floor area, radius of primary trade area and travel time to centre, the proposed shopping mall classifies as a community centre or small regional centre.

The fact that the proposed shopping mall will satisfy the need for a variety of shopping facilities and is walking distance from a large portion of the development in Mkhondo and eThandakukhanya. The existing shopping centre to the north of Mkhondo is not classified as a community centre but rather a neighbourhood centre. This is due to the size of the centre, as the proposed development will have a gross leasable floor area of ±25000m^2 and this neighbourhood centre is only 3200m^2.

There is a need to upgrade and improve the CBD area of Piet Retief. The proposed shopping mall on the boundary of the CBD area will assist this need. In addition to that, the Mkhondo Local Municipality acknowledged the need for a regional or community shopping centre for the Mkhondo region by requesting proposals for the development of the study area.

4.2 DESIRABILITY

4.2.1 The Site

- The site available for development is ± 7 ha in extent and ample space is available for a shopping centre of 25000 m².
- The local and regional accessibility of the application site is exceptional. Direct access to the main road of Piet Retief will guarantee the popularity of the centre as a retail and business node.
- The proposed development is located south of the Piet Retief CBD and accordingly the application site is surrounded by mixed land uses such as:

    - Residential
    - Retail
    - Offices
    - Filling stations
    - Municipal land

The application is compatible with existing and future surrounding land uses.

- The site has a prominent location in Piet Retief and the proposed centre will enjoy high visibility from the main road.

- The site could be regarded as a high ranking site for a shopping centre as it meets all the basic requirements such as visibility, accessibility, trade area, traffic volumes and complementary facilities.

4.2.2 General

The application complies with modern principles and parameters for land development. The following of these principles are inter alia applicable to this case:

- ❖ The promotion and integration of the social, economic, institutional and physical aspects of land development;
- ❖ The promotion of integrated land development in rural and urban

areas in support of each other;

- To promote the availability of residential and employment opportunities in close proximity to or integrated with each other;
- The optimisation of existing resources including such resources relating to agriculture, land, minerals, bulk infrastructure, roads, transportation and social facilities;
- To discourage the phenomenon of urban sprawl and to contribute to the development of more compact towns and cities;
- To contribute to the correction of the historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure in excess of current needs; and
- Encourage environmentally sustainable land development practices and processes.

The CBD area of Piet Retief is characterised by a large number of pedestrians and informal trading on the sidewalks that contribute to the unstructured and neglected perspective of the DBC area. This leads to traffic congestions and also has an effect on the general amenity of the CBD. A shopping mall can accommodate mini-bus taxis with a new rank and thereby easing pressure of the current taxi rank in the CBD which currently contributes to the neglected representation of the CBD area.

The neighbourhood centre (Pick n Pay centre) is 2km from the southern CBD entrance and this is not convenient for pedestrians and commuters. The proposed shopping mall will be in close proximity, not only to Mkhondo, but also to the eThandakukhanya and Kempville townships. The unemployment aspect of these townships will also be addressed as the construction and operational phases will create a large number of employment opportunities. The existing municipal buildings and infrastructure are old and not suitable in terms of safety and functionality. These buildings will be demolished and a new testing ground and traffic centre will be constructed on another property.

Based on all these motivations and factors the proposed mall, and its functions and services, is definitely desirable in the town of Piet Retief. This application is in line with the town's needs and desirability and will have additional economic advantages such as optimising the use of land, optimal use of infrastructure and job creation. Economic development is one of the priorities of the central Government and all efforts in this regard should be welcomed and supported by the authorities.

4.3 Feasibility Study

Refer to Appendix D7 for the Feasibility Study compiled by Fernridge Consulting

Conclusions and recommendations made by Fernridge Consulting:

Conclusions

- The proposed shopping mall will cater for the upper and lower income households in Piet Retief and surrounding area.
- The site is rated as "Good" (74%) with good visibility, however good signage is required for motorists.
- Majority of local residents make use of public transport and should the proposed mall be constructed, which is much closer, they will save on transport costs.
- There are very little formal retail amenities within the secondary catchment.
- The closest formal retail centre with a great variety of shops and services is Ermelo, which is situated 113km from Piet Retief.

Recommendations

- Signage and visibility of the tenants at the proposed development will be of utmost importance in order to attract people, intercept passing trade, and generate support. Sufficient parking and functional layout are also very important.
- It is not necessary for the proposed shopping mall development to create major inflow, it just need to retain the primary and secondary catchment as the expenditure is currently flowing out to other towns, for instance Ermelo.
- The centre should host an attractive, well balanced mix of tenants incorporating a high percentage of national retailers and should not duplicate existing tenants. Relocations could be considered. New national tenants currently not present in the catchment must be introduced to the area. The tenant mix should be for all the market profiles.
- It should be a one-stop offer where the customer's needs (all purchases and services) are all met.
- An additional service at the proposed mall for pension/grant payout point.

5 IDENTIFIED ALTERNATIVES

5.1 No-Go Alternative

The "No-Go" option entails that the study area stays in its current state. If no development takes place, the open space erf will remain neglected and unmaintained and it will become an informal social gathering point, which often creates safety and security threats. Especially, with the old municipal buildings and testing grounds that will be moved as well. At present the site gives free access to pedestrians and it is used as a shortcut route from the north westerner of the site to the south of the site (see below). The unrestricted access to the site will also have an impact on the wetland system south of the proposed development site.

Based on the above, the "No-Go" option is not regarded as the preferred alternative for the study area.

5.2 Locality Alternatives

The study area is surrounded by existing and future land-uses that are in line with the proposed land-use and this proposed development together with other new developments in the area will contribute to the renewal and upliftment of the CBD area of Piet Retief and immediate surroundings. This upliftment project will also promote the optimum utilisation of services, it will prevent urban sprawl and it will create jobs in close proximity of existing residential areas and public transport facilities.

5.3 Land-use Alternative

5.3.1 Agricultural

The study area has medium agriculture potential. We are however of the opinion that the proposed development site is in the first instance too small to act as a viable and economical agricultural unit, the land is not zoned for agricultural purposes, the soils are very compacted and unfertile due to the loss of topsoil, buildings and infrastructure present on the site and it is situated within an urban area (directly south of the CBD) and agricultural activities are not regarded as compatible with CBD areas.

5.3.2 Residential

The option of a pure residential development with mixed densities was also considered. It was however decided that the commercial value of the study area (in terms of its strategic locality) is regarded as too high to sacrifice the land for a development that only comprise of residential uses. In addition the noise levels associated with the high traffic volumes of the N2 National Road and the activities within a CBD area are regarded as too high for a pure residential development. A person will rather purchase a residential property that is not associated with a business development in a more tranquil area, in line with the residential areas that surround the study area.

5.3.3 The Development of a Shopping Centre (The Preferred Option)

The proposed shopping mall development as described in this report is regarded as the preferred land-use for the study area and to follow are some of the most important benefits associated with this mixed use development:

- More rates and taxes payable to the involved local authority;
- Promote the optimisation of existing services;
- Upliftment of the CBD ;
- Urban renewal;
- Increased jobs;
- Job opportunities in close proximity of residential areas;
- Job opportunities in close proximity of public transport;

- Easy access;
- Maximum exposure;
- Development on already disturbed areas;
- Prevention of urban sprawl;
- Economical injection to the CBD;
- Upgrading of existing services and infrastructure;

5.3.4 Conservation Area

The application site is largely devoid of natural vegetation. According to the terrestrial biodiversity assessment as derived from the Mpumalanga Biodiversity Conservation Plan (MBCP 2007) the subject property is classified to have **no natural habitat remaining**, and is therefore according to the classification not deemed as sensitive.

The site is too small to act as habitat for fauna and flora species that are not adapted to the urban environment and it is subject to severe edge effects. It can furthermore not act as movement corridor or linkage for smaller faunal species as the surrounding area is residential townships and other developments.

5.4 Layout Alternatives

5.4.1 The Original Layout (Layout Alternative 1)

The original layout was done prior to the detailed site inspections, which included 1:100 year floodline delineation as well as a wetland assessment. The original layout was planned in such a way that parking and other section of the shopping mall is within the 1:100 year floodline and the 32m buffer zone of the wetland.

5.4.2 The Final Layout (Layout Alternative 2 – The Preferred Layout)

The final layout was done after the specialist studies, which took the traffic, geotechnical conditions, hydrology, the topography etc. into consideration, were conducted. The wetland buffer zone and 1:100 year floodline were however the major reason for change in the layout in the southern section of the study area. ***(Refer to Appendix C2 for Final Layout - The Preferred Layout)***

6 DESCRIPTION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.1 Environmental Impact Description, Environmental Management & Mitigation measures

The most significant anticipated environmental impacts associated with the development of the proposed application site are discussed in this section with reference to possible mitigation measures that will minimize negative impacts and enhance positive impacts.

6.1.1 Construction Related Impacts

BENEFICIAL IMPACTS

Socio-economic:

- **Creation of Job opportunities**

The proposed development would create job opportunities during the construction phase. The value that the jobs created by the construction industry should not be underestimated as it benefits lots of people that have no other work and further transfer skills.

- **Improved site security**

24 Hour security measures will already be implemented during the construction phase and no trucks will be allowed to overnight or stop on the site and the site will be closed so no more pedestrians will use this as a resting place or short cut route.

Bio-Physical Environment

- **Eradication of alien and invader plant species**

All alien and invasive species will be removed from the site prior to construction. This will limit the spreading of alien and invasive plant species and in turn, promote the growth indigenous plant species on the proposed site and ultimately, the surrounding area.

ADVERSE IMPACTS

Bio-Physical Environment

- **Geology and Soils**

- The site clearance and levelling will cause some additional exposed areas and could trigger some additional erosion and siltation, especially during rainy periods;
- Dust pollution;
- Degradation of soils;
- Unstable conditions;
- Dangerous excavations.

Proposed Mitigation measures

- Implementation of temporary storm water management measures as well as erosion control measures, during construction;
- Appointing of a geotechnical engineer to assist with foundation designs and other stability and geotechnical issues;
- Implementation of dust suppression measures during the construction phase;
- Clear marking of dangerous excavations.

- **Hydrology**

- More exposed areas and increased erosion and siltation and water pollution;
- Pollution/damaging of the wetland to the south and east of the study area;
- Construction during the rainy periods;
- Excavated materials (with levelling) that are stockpiled in wrong areas can interfere with the adjacent wetland/stream as it can cause sedimentation and water pollution.

Proposed Mitigation measures

- Implementation of temporary storm water management measures as well as erosion control measures, during construction;
- Fencing the site to ensure that the wetland to the south of the site is not influenced by construction activities;
- Schedule (where possible) construction associated with earthworks for the dryer winter months.

➢ **Climate**

- Should the construction phase be scheduled for the summer months, frequent rain could cause very wet conditions, which makes it difficult to build in and rehabilitate disturbed areas on site;
- These wet conditions often cause delays to building projects. The drainage of water away from the construction site into the surrounding open space areas could (if not planned and managed correctly) have an impact on the water quality of these water bodies.

Proposed mitigation measures

- It is recommended that the construction phase be scheduled for the winter months, especially activities such as the installation of services, foundations, excavations and road construction;
- It is also recommended that precautionary measures be taken in order to prevent the extensive loss of soil during rainstorms. Large exposed areas should be protected against erosion by matting or cladding;
- Measures should be implemented during the rainy season to channel storm water away from open excavations and foundations; and
- Construction workers and construction vehicles and machinery must stay out of the soggy areas during the wet periods. Barrier tape should be used to demarcate the areas that are drenched with water it should only be removed when the appointed Environmental Control Officer (ECO)/ Site supervisor/ project manager /main contractor regard the conditions as favorable.

➢ **Flora & Fauna**

The study area is not regarded as of any fauna and flora importance as the site is on a busy intersection just south of the Piet Retief CBD.

The proposed development could have the following impacts on the biological and ecological environments:

- The clearance of the site and the construction activties will result in the eradication of the existing vegetation on site;
- Destruction of the wetland habitat can lead to habitat loss;
- Increase in flow velocity around the development area in an already fragmented environment;
- Increase in surface drainage to accomodate infrastructure;
- Accidental introduction of exotics and invaders;
- The proposed development can result in an increase of hardened surfaces and subsequent storm water runoff. Any hardening in the surfaces will reduce the infiltration and ultimately reduce the yield of ground water that may be feeding into the wetland systems adjacent to the study area.

Proposed Mitigation measures

- All affected and exposed areas should be rehabilitated upon the completion of construction. In this regard, special reference is made to the use of indigenous vegetation as the first choice during landscaping;
- All areas affected by construction, which are to remain as open space areas, should be rehabilitated upon the completion of the construction phase of the development;
- The landscape architect should only specify the use of native and indigenous plant species in their plant design;
- Indigenous species and preferably endemic plant species should be encouraged within the development as this will promote habitat for birds and insects; and
- All exotic invader plant species on site should be eradicated.

➢ **<u>Veld fires may cause damage to infrastructure, vegetation and fauna</u>**

Construction workers could start uncontrolled fires, which could damage infrastructure on site and the adjacent open space areas.

Proposed mitigation measures

- One central cooking and fire area should be established on site. This should be located in a fire safe area where vegetation (especially Veld grass) has been removed;
- Cooking fires and smoking should strictly be limited to only this area. No smoking at the construction site should be permitted outside this area; and
- No fires or smoking should be allowed on windy days.

➢ **Areas where vegetation was not removed for construction are not rehabilitated**

Soils will be disturbed and exposed during the construction phase which may in turn cause environmental risks. The terrestrial biodiversity assessment that has been derived from the Mpumalanga Conservation Plan indicates that no natural habitats are present on site. The northern half of the site is in a developed state. Exposed areas should however be rehabilitated upon the completion of construction.

Proposed Mitigation measures

- All large and exposed areas should be rehabilitated immediately after construction has completed;
- Topsoil should be filled back directly during the installation of services; and
- All exposed and affected areas which are to remain as open space should be appropriately re-vegetated and/or landscaped to prevent erosion and/or the loss of valuable soil on site.

Air Pollution, Localised Vibration and Noise pollution

➢ **Nuisance to neighbours in terms of dust generation**

It can be expected that a certain amount of dust will be generated due to earthmoving activities and demolition works. One should take note that the impact of dust pollution is short-term and lasting for the duration of construction only.

Proposed Mitigation measures

- The application site must be damped on a regular basis with water during dry and windy conditions

➢ **Nuisance to neighbours in terms of noise generation, especially due to demolition works**

A certain amount of noise will be generated during the construction phase, which may definitely become a nuisance to the surrounding land owners, residents and businesses. One should note that although noise is generated during any normal construction operation, the development/construction of the new shopping mall is associated with demolition works. It is therefore anticipated that a considerable amount of noise will be generated, especially due to this.

Proposed Mitigation Measures

- It is anticipated that a certain amount of noise will be generated during the construction phase. The contractors should take care, and manage construction/demolition works to such an extent to comply to minimum ambient noise levels as defined in local, provincial, and National policies and frameworks;
- The contractor should liaise with local residents on how best to minimise impact.
- The local population should be kept informed of the nature and duration of intended activities;
- Construction yards, workshops, concrete batching plants and other noisy fixed facilities should be located well away from noise sensitive areas;
- All construction vehicles, plant and equipment are to be kept in good repair;
- Blasting operations (if required) are to be strictly controlled with regard to the size of explosive charges in order to minimise noise and air blast and timings of explosions;
- Construction activities should remain and take place during reasonable hours during the day and early evening. No construction should be allowed on weekends from 14h00 on Saturday afternoons to 06h00 the following Monday morning; and
- It must be ensured that the working conditions of construction workers comply with the requirements of the occupational Health and safety Act, 1993 (Act No 85 of 1993)

- **<u>Heavy vehicle traffic and noise increase on the local roads</u>**

Construction vehicles will have a negative impact on traffic volumes, road safety and noise levels during the construction period. Heavy construction vehicles will have an added negative impact on traffic flow during the peak hour traffic times.

Proposed Mitigation measures

- The Traffic Impact Study indicated that the developer should construct some upgrades to the local intersections/entrance to the proposed development area. It is recommended that these upgrades be implemented before major construction takes place on site. If the road upgrades cannot be scheduled early on in the construction program the developer should investigate the need to employ traffic officials to facilitate traffic flow at the intersections around the construction site;
- The heavy construction vehicles should avoid the local roads during peak traffic times and large deliveries should also be scheduled outside the peak traffic times;
- Signs should be erected in the vicinity of the site and on all major junctions that the construction vehicles will use; and
- The construction vehicles should obey all traffic rules and stay within the speed limits.

Visual Impact & Waste Management

- **If the site office and camp is not managed according to the EMP**

A construction site of this scale requires the establishment of construction infrastructure, such as a site office, material stockyards, and workshops. The area where the above facilities are to be erected should be located in an already disturbed part of the site.

Absence of proper sanitation facilities and good housekeeping could negatively impact the local community, surface/sub-surface hydrology and soils.

Proposed Mitigation measures

- Identify a central waste storage area and establish suitable containers skips for the different waste streams;
- The wind direction and the proximity to neighbouring properties should be taken into account, when a central waste storage area is established;
- Rubble and waste should be removed from the construction site on a weekly basis by a service provider;
- The contractor should communicate with other trades and businesses in the area to establish waste exchange and recycling possibilities;

- Rubble and waste should be removed to registered dumping sites as is acceptable to the local authorities; and
- Chemical toilets, one for every ten workers, should be erected close to the area where construction works are taking place.

- **Dumping of builder's rubble on site**

The dumping of builder's rubble on site may cause visual pollution. Dumping of waste in the open space areas south and east of the site could have a detrimental effect on the fauna, flora of the open space area. Builder's rubble can also pollute the hydrological system and soil of the open space area. It is therefore critical that no builder's rubble be dumped within the open space area or vacant land within the surrounding area.

Proposed Mitigation measures

- Identify a specific point for waste and rubble on site;
- The area should be located in an area that is already disturbed and which can be hidden from the surrounding residents to prevent visual pollution;
- All the rubble and waste materials should be transported and disposed at this central waste disposal site that should be established;
- Rubble should be removed from this area on a regular basis as to not cause a negative visual impact;
- Appropriate containers for different waste streams should be provided on site; and
- Barriers and screens should be erected around the waste storage area to mitigate and reduce its visual impact;

- **Vehicle maintenance on site could cause visual pollution**

Temporary maintenance and refuelling workshops may be required for construction vehicles. Soil and water pollution by oil, lubricants and fuel may occur at these facilities. The volume of lubricants and fuel expected to be on site should only cause localised pollution. However, any pollution of the soil and water is undesirable and should be prevented.

Proposed Mitigation measures

- One area in the site camp should be used for fuel or hazardous materials and lubricant storage;

- This area should be bunded to contain 1.5 times the storage volume of fuel and should have a concrete base;
- A working area should be established at the site camp with a concrete base on which all machinery repairs, vehicle services and such activities should take place; and
- After the construction works are completed this area should be rehabilitated and the soil quality should be restored.

- **Light Pollution**

Security and temporary lighting on site during the construction phase could have an adverse impact on the surrounding neighbours and driving conditions on the surrounding roads.

Proposed Mitigation measures

- Security lighting should be directed to the ground;
- Only the needed lighting should be installed;
- Lighting should not shine into the neighbouring properties or onto the surrounding roads and oncoming traffic; and
- The design, placement and arrangement of exterior lighting should take the sensitive night views into consideration.

- **Construction works could cause an adverse visual impact to the surrounding land owners/residents**

The infrastructure associated with the construction phase (Site camp and waste storage area) could cause an adverse visual impact.

Proposed Mitigation measures

- Waste and building material stockyards should at all times be cleaned and kept tidy;
- No litter, plastic package or cement bags should at any time be left on site. It is expected that the site be kept in a neat and tidy at all times. Waste items should be disposed off once a week by a contracted service provider;
- Screens should be erected to hide unsightly waste storage areas or any other temporary infrastructure that may cause an adverse visual impact; and

- Where possible, screens should be erected around the site, to mitigate the adverse visual impact that construction activities have on the surrounding urban environment.

Cultural & Historical

- **The potential occurrence of cultural and historical assets on site**

Archaeological sites/sites of cultural and historical importance can be disturbed and/or destroyed during construction works, if exposed.

Proposed Mitigation measures

- Archaeological sites that are exposed during construction work, should immediately be reported to a museum, preferably one at which an archaeologist are present, so that an investigation and evaluation of the findings can be made;
- It should be noted that in terms of the National Heritage Resources Act, 1999 (Act 25 of 1999), Section 35(4) no person may, without a permit issued by the responsible heritage resources authority, destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or paleontological site or material;
- Section 34 (1) also in addition states that no person may alter or demolish any structure or part of a structure, which is older than 60 years without a permit, issued by the relevant provincial heritage resources authority;
- If the remains of the old irrigation channel are older than 60 years, it will be necessary to obtain a demolition permit from SAHRA; and
- If it was found that the irrigation channel has some cultural and historical value, sections of the remains of the irrigation channel (if possible) should be incorporated as part of the shopping centre development. This will enhance the "Sense of Place".

Safety and Security

- **The following safety and security problems can arise during the construction phase**

- Reckless operators of construction vehicles can cause dangerous conditions on the nearby roads as well as on the construction site;
- Deep excavations without warning signs can pose a health and safety risk to the construction personnel on site, as well as the public/ surrounding residents/ pedestrians; and
- Possible crime initiated due to an influx of people that are associated with construction.

Proposed Mitigation measures

- Although regarded as a normal practice, it is important to erect proper signs indicating the operation of heavy vehicles in the vicinity of dangerous crossings and access roads;
- Dangerous excavations where construction is not actively taking place, should be properly marked and demarcated with orange safety barrier tape;
- Construction must be completed in the shortest possible time. No construction worker or relative may reside on the application site during the construction phase. All construction workers must leave the site at the end of the day's work. A security company must be appointed to secure the site, and to ensure a safe and controlled environment;
- No construction worker, friend or relative may reside on site. Only security personnel may be present on site after construction hours; and
- No construction worker should be allowed to enter any adjacent private property for any reason without written consent.

6.1.2 Operational Related Impacts

BENEFICIAL IMPACTS

Socio-Economic

- **Economical and Institutional:**

- This new centre will increase and expand the product and service range within the market and improve the overall quality thereof;

- The proposed shopping mall will attract larger volumes of customers from the Piet Retief and surrounding area and reduce leakage of purchase power from this market;
- More rates and taxes payable to the involved local authority;
- Promote the optimisation of existing services;
- Increased jobs;
- Job opportunities in close proximity of residential areas;
- Job opportunities in close proximity of public transport;
- Maximum exposure;
- Economical injection to the CBD;
- Prevention of urban sprawl; and
- The proposed expansion is in line with the planning frameworks for the area.

➢ **Social:**

- Upliftment of the CBD;
- Urban renewal;
- Increased jobs;
- Job opportunities in close proximity of residential areas;
- Job opportunities in close proximity of public transport;
- Easy access;
- Contribute to the upliftment of the Piet Retief CBD area and beautification of the prominent corner stand that is currently regarded as an eyesore and a security risk;
- The proposed mall will ensure a safe, secure and controlled environment;
- Upgrades to the surrounding road network will benefit the surrounding community;
- The proposed shopping mall will create a more attractive retail shopping development. It is anticipated that the proposed mall will enhance the "Sense of Place" of the study area and the surrounding urban environment.

➢ **Services (roads, water, sanitation, waste management, storm water management)** (Refer to Appendix D4 for a copy of the services report)

- Possible contributions for the upgrading of external services such as the external sewer network and the surrounding road network;

- The proposed new shopping mall will promote the optimal utilisation of services and infrastructure;
- If well planned and managed, the proposed new shopping facility will provide additional social facilities for usage by tourists and local residents.
- The proposed new development will contribute significantly to the increase of rates and taxes payable to the Mkhondo Local Authority.

Bio-Physical Environment:

- *Geology and Soils:*

- Prevention of any further erosion and siltation on and around the site.

- *Hydrology:*

- Protection of the adjacent wetland watercourse and the associated riparian zone.

- **Fauna and Flora:**

- Implementation of a weed control programme;
- Replacement of exotic species with indigenous species;
- Removal of exotic invaders;
- Development on already disturbed areas; and
- Create opportunity to introduce indigenous vegetation species on the site and to attract birds and insects.

The proposed development will create the opportunity to re-vegetate the site with indigenous vegetation. The exposed areas will be covered with paved surfaces or vegetation and will prevent any further erosion and siltation. The areas covered with vegetation will also improve the micro-climatic conditions of the site and its surroundings. It will also contribute to the aesthetical qualities of the study area.

It is also recommended that plant species that attract birds and insect species be introduced as part of the planting selection to be used for the development's gardens.

ADVERSE IMPACTS

Roads and Traffic

- The impact of additional vehicle traffic on the already busy roads due to traffic associated with development.

Proposed Mitigation measures:

- The appointed traffic engineers indicated that certain intersections and roads in the vicinity of the study area be upgraded, in order to accommodate the volume of traffic that are generated due to the proposed expansion. **(Please Refer to Appendix D5 for a copy of the Traffic Impact Assessment)**

Qualitative Environment

- **Lighting Pollution**

- The proposed development could cause a significant level of light pollution due to security and advertisement lighting. These lighting could easily glare into the surrounding environment, especially surrounding residences if not designed appropriately.

Proposed Mitigation measures:

- It is recommended that all the lighting on site be designed to point downwards and the lighting system should be designed not to cause glare, dispersal or unnecessary flickering.

- **Air pollution**

The development will generate additional traffic on the local roads that will contribute to the air pollution levels in the immediate area.

Proposed Mitigation measures:

- Air pollution levels will not exceed acceptable levels. No mitigation measures proposed.

- **Noise pollution**

Some additional noise will be generated during the operational phase of the proposed Shopping Centre due to:

- Increased Traffic on the surrounding roads; and
- Activities associated with the operation of the new facility (Air conditioning, compressors, places of refreshment etc.)

Proposed Mitigation measures:

- The design, placement and orientation of extractor fans for the ventilation of the buildings must take the noise impact aspect into consideration. Equipment with the best noise rating should be used. Roof mounted fans may further require attenuators and need to be screened from noise sensitive areas;
- High quality air conditioning equipment should be installed. Equipment with the best noise rating should be used;
- Where required, high quality refrigeration compressors should be installed. Equipment with the best noise rating should be used. Exterior installations should be acoustically encapsulated; and
- All mechanical equipment should be well maintained.

- **Visual Impact**

The site has a prominent location in Piet Retief and the proposed shopping mall will enjoy high visibility.

Proposed Mitigation measures:

- The architectural styles, colours and textures and construction materials will determine the visual impact of the proposed development on the surrounding areas;
- The proposed development will be seen from a distance. Roofs of the proposed shopping mall should therefore not be covered with bright colours.

Hydrology

- **Stormwater Management and the Protection of the adjacent Wetland**

Surface water run-off from the site has the potential to affect the surrounding open-space areas if not well managed.

Proposed Mitigation measures:

- Adequate storm water management must be incorporated in the design of the proposed development to ensure the effective management of surface water run-off from the site, and to prevent erosion and the associated sedimentation of the surrounding areas;
- The release points of storm water to the surrounding open space areas must be done carefully and the use of energy dissipation structures, reno mattresses and geo-textiles should be made to prevent erosion down the gradient of the discharge points;
- Sheet run-off from paved surfaces and access roads need to be curtailed;
- All areas which have been affected by construction, which are to remain as open space should be rehabilitated upon the completion of the construction phase;
- Discharge of storm water runoff from site should be limited to pre-design development peak flows and volumes;
- Where practical, retention and detention storage systems should be used to manage peak storm water flows within the on-site storm water management system;
- Uncontaminated storm water run-off from roofs, parking bays and the landscape should not be allowed to mix with process effluent, stored chemicals or storm water runoff from areas susceptible to chemical/petroleum based spills;
- Paved areas exposed to rainfall where dust, litter or spilled substances accumulate should be regularly cleaned using methods that prevent drainage or leaching of fluid into the surrounding environment. Gross pollutant (litter), oil and sand traps (appropriate to the site) are recommended at drain entry or discharge points. These traps require regular inspection and residue removal;
- First-flush water division for dusty outdoor areas should be considered to capture initial storm water run-off after any extended dry period.

6.2 Significance Description Methodology

The significance of Environmental Impacts was assessed in accordance with the following method:

Significance is the product of probability and severity. Probability describes the likelihood of the impact actually occurring, and is rated as follows:

- ❑ Improbable - Low possibility of impact to occur either, because of design or historic experience. Rating = 2
- ❑ Probable - Distinct possibility that impact will occur. Rating = 3
- ❑ Highly probable - Most likely that impact will occur. Rating = 4
- ❑ Definite - Impact will occur, in the case of adverse impacts regardless of any prevention measures. Rating = 5

The severity factor is calculated from the factors given to "intensity" and "duration". Intensity and duration factors are awarded to each impact, as described below.

The Intensity factor is awarded to each impact according to the following method:

Low intensity - natural and man-made functions not affected – Factor 1

Medium intensity - environment affected but natural and man-made functions and processes continue - Factor 2

High intensity	-	environment affected to the extent that natural or man-made functions are altered to the extent that it will temporarily or permanently cease or become dysfunctional - Factor 4

Duration is assessed and a factor awarded in accordance with the following:

Short term	-	<1 to 5 years - Factor 2
Medium term	-	5 to 15 years - Factor 3
Long term	-	impact will only cease after the operational life of the activity, either because of natural process or by human intervention - Factor 4.
Permanent	-	mitigation, either by natural process or By human intervention, will not occur in such a way or in such a time span that the impact can be considered transient - Factor 4.

The severity rating is obtained from calculating a severity factor, and comparing the severity factor to the rating in the table below. For example:

The Severity factor	=	Intensity factor X Duration factor
	=	2 x 3
	=	6

A Severity factor of six (6) equals a Severity Rating of Medium severity (Rating 3) as per table 16 below:

Table 5: Severity Ratings

RATING	FACTOR
Low Severity (Rating 2)	Calculated values 2 to 4
Medium Severity (Rating 3)	Calculated values 5 to 8
High Severity (Rating 4)	Calculated values 9 to 12
Very High severity (Rating 5)	Calculated values 13 to 16

Severity factors below 3 indicate no impact

A Significance Rating is calculated by multiplying the Severity Rating with the Probability Rating.

The significance rating should influence the development project as described below:

Low significance (calculated Significance Rating 4 to 6)

- Positive impact and negative impacts of low significance should have no influence on the proposed development project.

Medium significance (calculated Significance Rating >6 to 15)

- Positive impact:
  Should weigh towards a decision to continue
- Negative impact:
  Should be mitigated to a level where the impact would be of low significance before project can be approved.

High significance (calculated Significance Rating 16 and more)

- Positive impact:
  Should weigh towards a decision to continue, should be enhanced in final design.
- Negative impact:
  Should weigh towards a decision to terminate proposal, or mitigation should be performed to reduce significance to at least low significance rating.

6.3 Significance Assessment

Refer to **Table 6** for the Calculation and Result of the Significance Assessment of Impacts identified to be associated with the Proposed Development.

Table 6: Calculation and Result of the Significance Assessment of Impacts Identified to be Associated with the Proposed Development

Impact	Probability Rating	Severity Rating		Severity Factor	Severity Rating	Significance Rating- prior to mitigation and after mitigation *(Note proposed mitigation measures are supplied in EMP and in Item 5 above – no mitigation required for beneficial impacts)*
		Intensity	Duration			
THE CONSTRUCTION PHASE						
BENEFICIAL IMPACTS (Note: Not necessary to mitigate because the impact are positive)						
Socio-Economic						
Creation of Employment opportunities	4	4	2	8	3	**12 Medium**
Improved site security	5	2	3	6	3	**15 Medium**
Flora						
The eradication of exotic invaders and weeds on the subject property	5	4	2	8	3	**15 Medium**
ADVERSE IMPACTS						
Geology and Soils						

The site clearance and levelling will cause some additional exposed areas and could trigger some additional erosion and siltation, especially during rainy periods	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Dust pollution	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Degradation of soils	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Unstable conditions	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Dangerous excavations	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Surface & Sub-surface Hydrology						
More exposed areas and increased erosion, siltation and water pollution	3 2	2 2	2 2	4 4	2 2	**6 Low** **4 Low**
Removal/damaging of the adjacent wetland, south of the study area	3 2	2 1	4 2	4 2	4 2	**12 Medium** **4 Low**
Construction during the rainy periods	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Excavated materials that are stockpiled in wrong areas can interfere with the natural drainage, cause sedimentation and water pollution	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Climate						

Should the construction be phased for the summer months, frequent rain could cause very wet conditions, which makes it difficult to build in in and rehabilitate disturbed areas on the site	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
The wet conditions often cause delays to building projects. The drainage of water away from the construction site into the surrounding open space areas could (if not planned and managed correctly) have an impact on the water quality of these water bodies	4 2	2 2	2 2	4 4	2 2	**8 Medium** **4 Low**
Flora and Fauna						
The clearance of the site and the construction activities will result in the eradication of the existing vegetation on site	4 2	2 2	4 4	8 8	2 3	**8 Medium** **6 Medium**
Accidental introduction of exotics and invaders	2 2	1 1	4 2	4 2	2 2	**4 Low** **4 Low**
Veld fires may cause damage to infrastructure, vegetation and fauna	2 2	1 1	2 2	2 2	2 2	**4 Low** **4 Low**
Areas where vegetation cleared for construction are not properly rehabilitated	4 2	2 1	4 2	8 2	3 2	**12 Medium** **4 Low**
Destruction of the wetland habitat can lead to habitat loss	4 2	2 1	4 2	8 2	3 2	**12 Medium** **4 Low**
Increase in flow velocity around the development area in already fragmented environment	4 2	2 1	4 4	8 4	3 2	**12 Medium** **4 Low**
Increase in surface drainage to accommodate infrastructure and structures	4 2	2 1	4 4	8 4	3 2	**13 Medium** **4 Low**
Air pollution, Localized vibration & noise pollution						

Nuisance to neighbours in terms of dust generation.	4 2	2 1	2 2	4 2	2 2	**8 Medium** **4 Low**
Nuisance to neighbours in terms of noise generation during construction	4 2	2 1	2 2	4 2	2 2	**8 Medium** **4 Low**
Heavy vehicle traffic and noise increase on the local roads	4 2	2 1	2 2	4 2	2 2	**8 Medium** **4 Low**
Visual Impact & Waste Management						
If the site office and camp, and associated waste are not managed according to the EMP	4 2	2 1	2 2	4 2	2 2	**8 Medium** **4 Low**
Builder's rubble is dumped during the construction phase on site.	4 2	2 1	2 2	4 2	2 2	**8 Medium** **4 Low**
Vehicle maintenance on site could cause visual pollution	2 2	2 1	2 2	4 2	2 2	**4 Low** **4 Low**
Lighting pollution	3 2	2 1	2 2	4 2	2 2	**6 Low** **4 Low**
Construction works could have an adverse visual impact on the surrounding residents and landowners	4 2	2 1	2 2	4 2	2 2	**8 Medium** **4 Low**
Cultural & Historical						
The occurrence of cultural and historical assets on the proposed development site	2 2	2 1	4 2	8 2	3 2	**6 Low** **4 Low**
Safety and Security						
The following safety and security problems are likely to occur during the construction phase: • Reckless operators of construction vehicles can cause dangerous conditions on the subject property and surrounding roads; • If ground works, especially deep excavations are not properly marked or demarcated for safety	3 2	2 1	2 2	4 2	2 2	**6 Low** **4 Low**

reasons; and • Possible crime initiated by construction workers/ friends/relatives during the construction phase						

OPERATIONAL PHASE						
BENEFICIAL IMPACTS (Note: Not necessary to mitigate because the impact are positive)						
Socio-Economic						
Economical and Institutional						
The proposed new centre will increase and expand the product and service range within the market and will improve the overall quality thereof.	5	2	4	8	3	**15 Medium**
The new mall will attract larger volumes of customers form the area and reduce leakage of purchase power from the market.	5	2	4	8	3	**15 Medium**
More rates and taxes payable to the local authority	5	4	4	16	5	**25 High**
Promote the optimum utilisation of services	5	4	4	16	5	**25 High**
Increased jobs	4	2	4	8	3	**12 Medium**
Job opportunities in close proximity of residential areas	5	2	4	8	3	**15 Medium**
Job opportunities in close proximity of public transport	5	2	4	8	3	**15 medium**
Maximum exposure	5	4	4	16	5	**25 High**
Economical injection to the town	4	2	4	8	3	**12 Medium**
Prevention of urban sprawl	4	2	4	8	3	**12 Medium**
The proposed expansion is in line with the planning frameworks for the area	5	2	4	8	3	**15 Medium**
Social						
Upliftment of the CBD	4	2	4	8	3	**12 Medium**
Urban renewal	4	2	4	8	3	**12 Medium**
Increased jobs	4	2	4	8	3	**12 Medium**

Job opportunities in close proximity of residential areas	4	2	4	8	3	**12 Medium**
Job opportunities in close proximity of public transport	4	2	4	8	3	**12 Medium**
Contribute to the upliftment of the Piet Retief CBD area and the beautification of the prominent corner stand that is currently regarded as an eye sore and safety risk	4	2	4	8	3	**12 Medium**
The proposed mall will ensure a safe, secure and controlled environment	4	2	4	8	3	**12 Medium**
Upgrades to the surrounding road network will benefit the surrounding community	5	4	4	16	5	**25 High**
The proposed new shopping mall will create a more attractive retail shopping development. It is anticipated that the proposed centre will enhance the "Sense of Place" of the study area and the surrounding environment	4	2	4	8	3	**12 Medium**
Services, Roads and Traffic						
Possible contributions for the upgrading of external services such as the external sewer network, the surrounding road network and the water purification works (which is currently being upgraded, but some funds are required to successfully complete the upgrading of the municipal water supply system)	4	4	4	16	5	**20 High**
The proposed new centre will promote the optimum utilisation of services	4	4	4	16	5	**20 High**
Bio-Physical Environment						
Geology and Soils						
Prevention of any further erosion and siltation	2	2	4	8	3	**6 Low**
Hydrology						
Protection of the adjacent wetland	4	2	4	8	3	**12 Medium**

Fauna and Flora						
Implementation of a weed control programme	2	2	4	8	3	**6 Low**
Replacement of exotic species with indigenous species	4	2	4	8	3	**12 Medium**
Removal of exotic invaders	2	2	4	8	3	**6 Low**
Development of the already disturbed areas	4	4	4	16	5	**20 High**
Create the opportunity to introduce indigenous vegetation species to the site and to attract birds and insects	2	2	4	8	3	**6 Low**
ADVERSE IMPACTS						
Roads & Traffic						
The impact of additional vehicular traffic on already busy roads due to traffic associated with the development	4 2	4 2	4 4	16 8	5 3	**20 High** **6 Low**
Qualitative Environment, Pollution & Visual Impact						
Light pollution	4 2	4 2	4 4	16 8	5 3	**20 High** **6 Low**
Air Pollution	2 2	2 1	4 4	8 4	3 2	**6 Low** **4 Low**
Noise Pollution	2 2	2 1	4 4	8 4	3 2	**6 Low** **4 Low**
Visual Impact	4 2	4 2	4 4	16 8	5 3	**20 High** **6 Low**
Hydrology						
Storm water management and the protection of the adjacent wetland	4 2	2 1	4 4	8 4	3 2	**12 Medium** **4 Low**

6.4 Discussion of Significance Assessment

Thirty-two (32) beneficial and thirty-four (34) adverse impacts are associated with the proposed development.

Twenty-four (24) of the anticipated beneficial impacts are socio-economic and institutional related and eight (8) bio-physical related. Of the thirty-four (34) adverse impacts, nineteen (19) are bio-physical related and fifteen (15) are socio-economical and institutional related.

Of the thirty-four (34) anticipated adverse impacts that are associated with the construction and operation of the proposed development, three (3) of the impacts have a high significance rating, but such ratings were successfully reduced to low impacts with low significance ratings through the application of suitable mitigation measures.

The above results can mainly be ascribed to the current developed and transformed state of the study area, and its immediate surrounding environment (Piet Retief CBD). In addition to this, no geotechnical condition exists, to such an extent, of not allowing the proposed development of a shopping mall to proceed.

Twenty-eight (28) of the thirty-four (34) adverse impacts relate to the construction phase alone. Thus, almost 83% of all the adverse impacts, associated with the development of the shopping centre, are of a short term in nature, lasting for construction only and can be successfully mitigated.

The significance assessment furthermore indicates that twenty-nine (29) of the beneficial impacts are related to the operational phase of the shopping mall and twenty-two (22) of these impacts are related to the socio-economical and institutional environments. This means that the socio-economical and institutional environmental will benefit significantly from the proposed development of a shopping mall.

In light of the above, it can be provisionally concluded that, no "fatal flaw" adverse impacts or impacts that cannot be adequately mitigated, are anticipated to be associated with the proposed new shopping centre. This is subjected to the condition that all recommended mitigation measures as stipulated in the Environmental Management Plan **(EMP)** and as supplied in this report, be adhered to, in order to mitigate the adverse impacts and to achieve the maximum gain from the identified beneficial impacts. ***(Refer to Appendix E1 for the attached report).***

7 INPUTS AND RECOMMENDATIONS BY SPECIALISTS

All the inputs and recommendations made by the various specialists were taken into consideration and such inputs have been summarized in this report. Furthermore, the recommendations made by the specialists were included as part of the EMP.

The various specialist reports are included as Appendix D of this BAR.

8 ENVIRONMENTAL MANAGEMENT PLAN (containing the aspects contemplated in regulation 33)

Please refer to Appendix E1 for the attached Environmental Management Plan (EMP)

9 ASSUMPTIONS, UNCERTAINCIES AND GAPS IN KNOWLEDGE

The following assumptions and gaps in knowledge are implicit in this Basic Assessment Report (BAR)

9.1 Assumptions:

- The primary assumption underpinning this BAR and the individual specialist studies upon which this BAR is based is that all information received from the applicant, professional consultants, and other stakeholders including registered I & AP's are correct and valid at the time of the study;
- The significance of impacts was not underestimated. The specialist assessed impacts under the worse-case scenario situation.

10 ENVIRONMENTAL IMPACT STATEMENT

Environmental Impact Statement that summarizes the impacts that the proposed development may have on the environment after the management and mitigation of impacts that have been taken into account.

The major impacts that are likely to occur during the construction and operational phases are the following:

10.1 The Physical and Biological Environment:

Construction Phase

- The natural environment will be affected by construction related activities- site clearance, bulk earthworks etc. The study area is on the other hand in a developed and transformed state with no important or significant faunal or floral species present;

- The study area is affected by a 1:100 year floodline but this is incorporated in determining the final layout. A stream/wetland habitat is present to the south and east of the site. The 32m buffer zone traverses the boundary of the site. It is also recommended that the layout of the proposed shopping mall be re-evaluated to ensure that the wetland and associated buffer zone is not impacted. It must however be noted that runoff from the proposed development site has the potential to affect the surrounding open space areas if adequate stormwater management measures are not implemented;

- The site occurs at a medium slope towards the adjacent wetland. Levelling and its associated materials, as well as surface runoff, should be managed to avoid pollution of the wetland;

- Valuable topsoil may be lost during the construction process. The loss of topsoil can be minimised through the storage of topsoil in stockpiles on site and the re-use thereof within the landscape component of the development;

- Some vegetative coverage will be lost and areas will be exposed. Such areas will be subject to erosion and siltation. The terrestrial biodiversity assessment as derived from the Mpumalanga Conservation Plan however indicates that no natural habitats or sensitive faunal or floral species are present on site.

Operational Phase

- Some vegetative coverage will be permanently lost to accommodate the hard surfaces and structures associated with the proposed development;
- Increased storm water volumes due to an increase in impermeable surfaces.

10.2 The Socio-economic Environment

Construction Phase

- Nuisance to neighbours due to dust pollution that are associated with construction activities;
- Nuisance to neighbours due to noise that is generated by construction activities;
- Nuisance to neighbours due to the undesirable visual impact that is associated with construction activities;
- Damage to local roads by heavy vehicles; and
- Heath, safety and security problems that is likely to occur during construction of the proposed mall.

Operational Phase

- Increased traffic volumes;
- Possible noise pollution and visual pollution caused by the signage, interior lighting, security lighting, exterior lighting, transformers, air conditioners, places of refreshments etc.

Finding

None of the adverse impacts that were identified are regarded as impacts that cannot be mitigated to acceptable levels and therefore it is our opinion that there are no

"fatal flaws" associated with the proposed development of the shopping mall in Piet Retief.

11 CONCLUSION AND RECOMMENDATIONS:

As mentioned throughout the report, the subject property is in a developed and transformed state with buildings and infrastructure already present and no significant or sensitive faunal or floral habitats. In addition the proposed layout is not affected by the 1:100 year floodline even though the site is subject to the 1:100 year floodline.

The geotechnical engineers furthermore indicated that no geotechnical condition exist to the extent of not allowing the proposed development to proceed. The involved geotechnical engineers subsequently indicated that certain measures are recommended to ensure a safe and sound development.

The significance assessment of the impacts that is associated with the development of the shopping mall indicates that almost 83% of the anticipated adverse impacts are of a short term nature lasting for the construction phase only. In addition, it is important that one should take cognizance of the fact that the significance of these impacts is predominantly low to medium, with high mitigation levels.

The significance assessment further indicated that a great number of beneficial impacts are associated with the development of the proposed mall. These impacts are generally of a socio-economic nature with medium to high significance ratings.

The need, desirability and sustainability of the proposed shopping mall have been well motivated in this report, and based on the findings of the involved town and regional planners and market research specialists, the development of the new shopping mall will be economically and socially viable. Some of the key findings that have been made include:

- The local residents need to visit neighbouring towns for the purpose of shopping (food, furniture, appliances etc.) and services. The proposed mall will reduce this outflow and rather manage the flow within the local market;

- The proposed development will increase the rates and taxes payable to the local authority;
- The proposed development will contribute significantly to the upgrading of the existing external services and roads;
- The proposed development will be in line with the existing and future land-uses of the area.

Opinion and Recommendations by EAP:

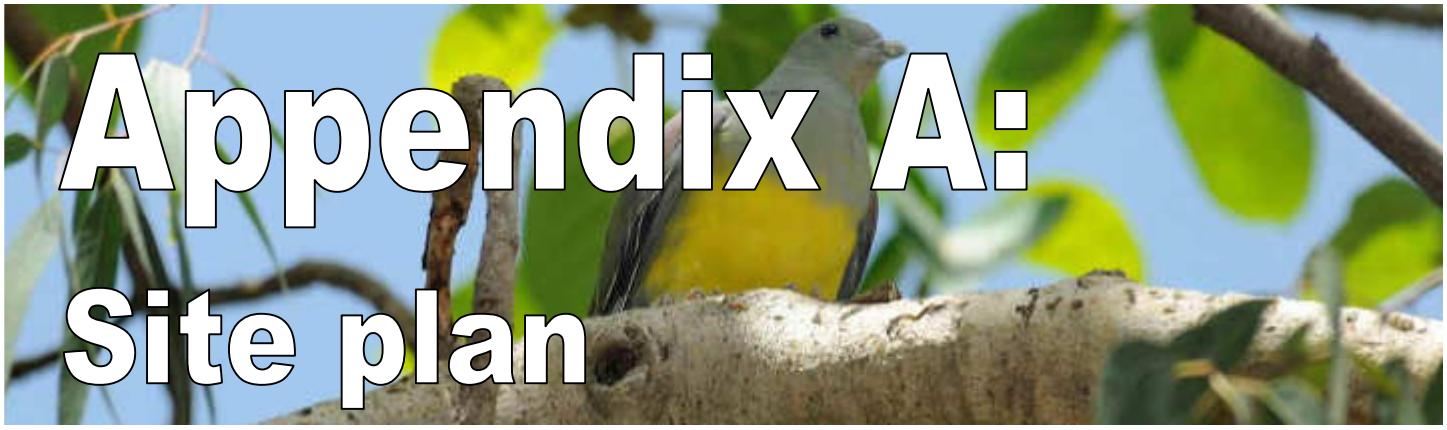
It is believed that both beneficial and adverse impacts were thoroughly assessed, and the needs and benefits have been assessed so as to give the proposed shopping mall development the go-ahead. As a result Bokamoso is of the opinion that the proposed Shopping Mall will have a significant long-term beneficial socio-economic impact on the subject property and its immediate surroundings.

It is therefore recommended by Bokamoso that the proposed development be approved, subjected to the implementation of appropriate mitigation measures as stipulated in this report and the Environmental Management Plan (EMP), to achieve maximum advantage from the beneficial impacts and the sufficient mitigation of adverse impacts.

It is recommended that, based on the findings of the BAR and supplemental specialist information that:

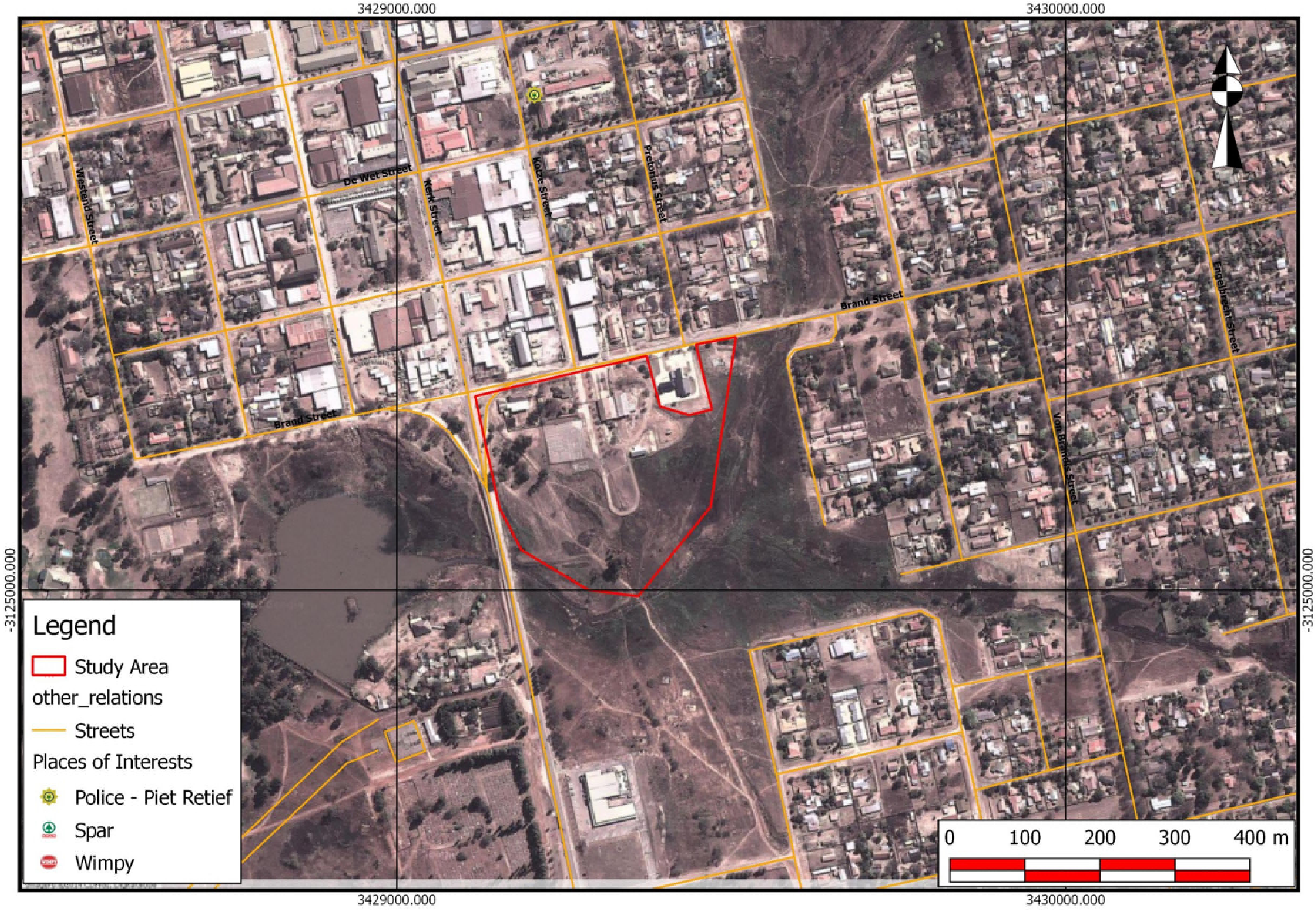
- Should the proposed Piet Retief x 22 Shopping Mall obtain the necessary environmental authorisation, an Environmental Management Plan (EMP) must be implemented for the construction and operational phases of the development. The EMP, as attached to this document, should be made part of the contractual documents of the contractors;
- The construction of all structures, roads and services must be in accordance with the specifications of the Geotechnical Investigation;
- The design and implementation of the infrastructure and services are to be done in accordance with engineering specifications so as to comply with the requirements, regulations and standards of the local controlling authority;

- It is recommended that DWS be approached regarding the applicability of Section 21 of the National Water Act. Even though the seepage wetland in the north-eastern section of the study area is regarded as a man-made watercourse/ wetland, DWS will most probably require that a License application be submitted for the removal of the wetland and for the proposed development within 500m from a wetland;
- Runoff from the proposed development site has the potential to affect the surrounding open space areas. It is therefore recommended that adequate storm water management be incorporated in the design of the proposed development in order to prevent erosion and the associated sedimentation of the surrounding areas. All areas affected by construction which are to remain as open space areas should be rehabilitated upon the completion of the construction phase of the development; and
- Signage/advertising board signage should comply with the relevant by-laws, regulations and standards of the local authority.



Appendix A:

Site plan


3429000.000
3430000.000
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-3125000.000
3429000.000
3430000.000
Wrisland Street
De Wet Street
Kerk Street
Koze Street
Pretorius Street
Brand Street
Brand Street
Von Brandis Street
Engelbrecht Street
Legend
Study Area
other_relations
Streets
Places of Interests
Police - Piet Retief
Spar
Wimpy
0
100
200
300
400 m

Appendix B:

Photographs


19 03 2014 12:31


19 03 2014 12:31

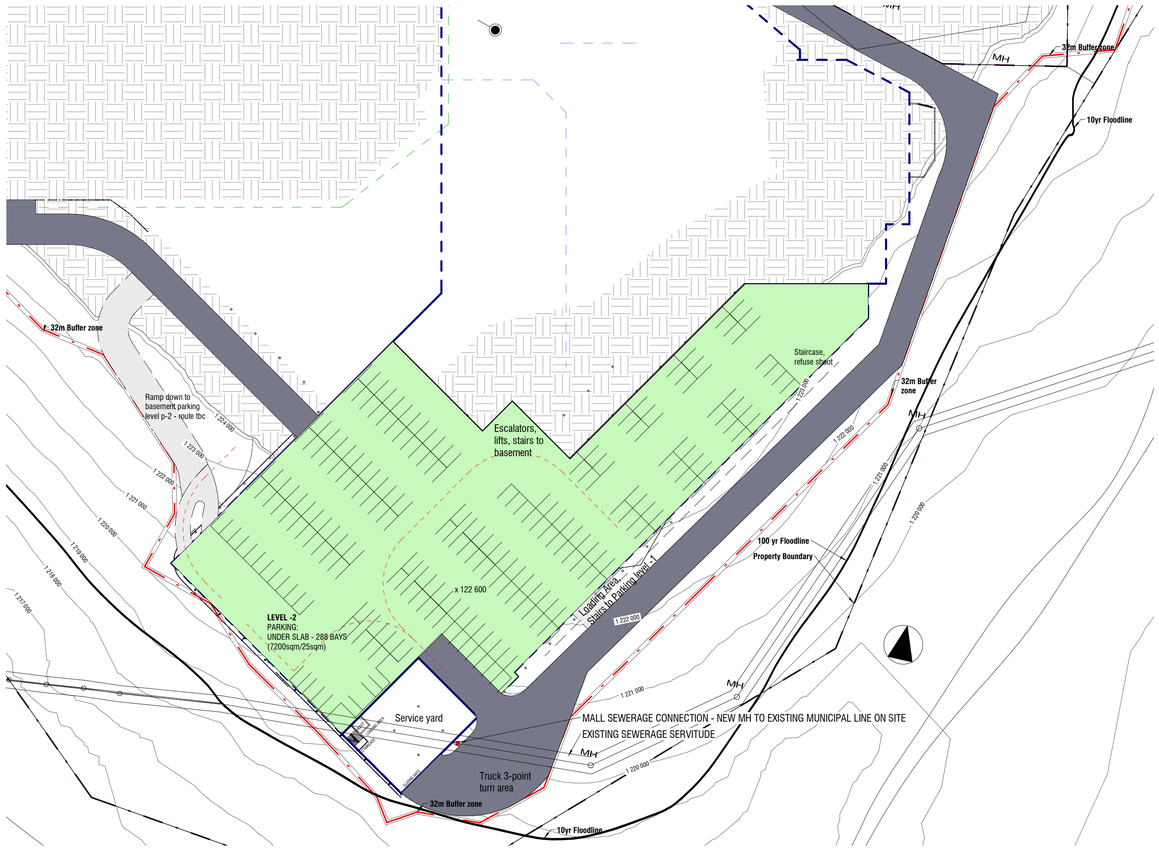

19 03 2014 12:31

Appendix C:

Facility Illustration

Appendix C1:

The Original Layout



-02 Parking Level 1 750

SCALE: 1 : 750

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REV	DATE	DRAWN	DESCRIPTION
A	140318	JM	Issue for information
B	140324	MB	Issue for Information

Mall@Piet Retief

FOR

Anaprop Property Management

Portion 126, Piet Retief Town & Townlands 149HT, Mpumalanga

-02 Parking Level Leasing Plan

SCALE: 1 : 750

PROJECT	STAGE / SERIES / SIZE	REVISION
PAX_138	D004-07-A1	B

INFO	COUNCIL	TENDER	CONSTRUCTION

DATE: 2013.08.12 DRAWN BY: Author

ACTS OF PARLIAMENT
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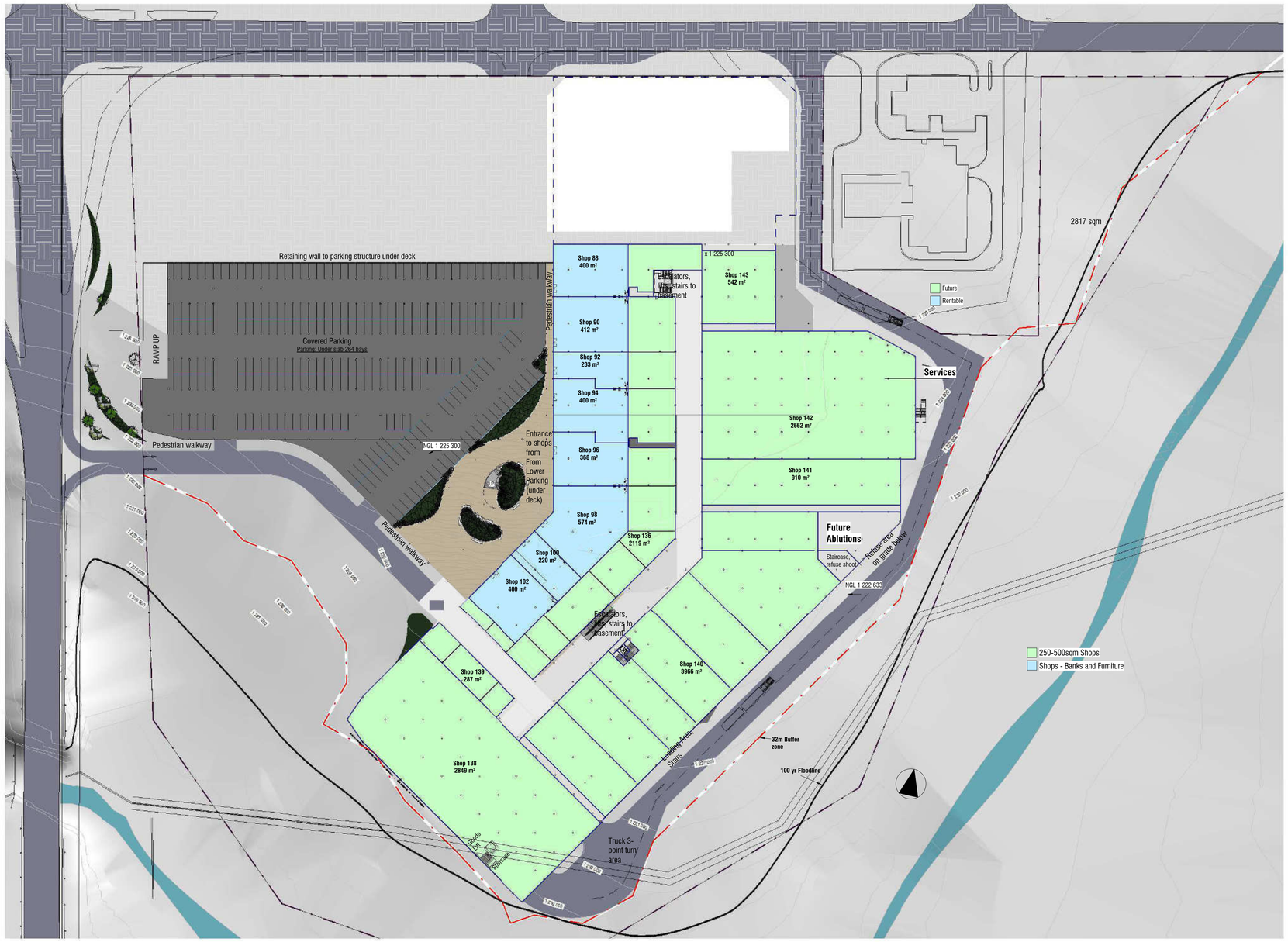
C:\Revit files\140324_PA-0138-R1 Piet Retief Mall_mel_2014.rvt
2014/03/24 02:14:52 PM



C -01 Level Leasing complete 1 750

SCALE: 1 : 750

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REV	DATE	DRAWN	DESCRIPTION
A	140324	MB	Issue for Information

Mall@Piet Retief

FOR

Anaprop Property Management

Portion 126, Piet Retief Town & Townlands 149HT, Mpumalanga

Lvl -1 Leasing Layout Complete

SCALE: 1 : 750

PROJECT	STAGE / SERIES / SIZE	REVISION
PAX_138	D004-08-A1	A

INFO	COUNCIL	TENDER	CONSTRUCTION

DATE: 2013.08.12
DRAWN BY: MB

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2014/03/24 02:14:55 PM

C 00 Ground Floor Leasing complete 1 750

SCALE: 1 : 750

Area Schedule Complete		
Number	Area	Level
136	2119 m²	-01 Level
138	2849 m²	-01 Level
139	287 m²	-01 Level
140	3966 m²	-01 Level
141	910 m²	-01 Level
142	2662 m²	-01 Level
143	542 m²	-01 Level
88	400 m²	-01 Level
90	412 m²	-01 Level
92	233 m²	-01 Level
94	400 m²	-01 Level
102	400 m²	-01 Level
98	574 m²	-01 Level
96	368 m²	-01 Level
-01 Level: 14	16122 m²	
22	2644 m²	00 GF
26	402 m²	00 GF
40	2822 m²	00 GF
14	3195 m²	00 GF
97	250 m²	00 GF
28	1408 m²	00 GF
30	699 m²	00 GF
54	161 m²	00 GF
70	225 m²	00 GF
48	88 m²	00 GF
56	176 m²	00 GF
58	175 m²	00 GF
60	179 m²	00 GF
18	280 m²	00 GF
24	1001 m²	00 GF
42	268 m²	00 GF
52	155 m²	00 GF
16	180 m²	00 GF
78	264 m²	00 GF
32	212 m²	00 GF
12	71 m²	00 GF
6	484 m²	00 GF
2	36 m²	00 GF
68	300 m²	00 GF
44	514 m²	00 GF
36	681 m²	00 GF
82	64 m²	00 GF
84	112 m²	00 GF
86	83 m²	00 GF
80	219 m²	00 GF
4	400 m²	00 GF
74	36 m²	00 GF
66	280 m²	00 GF
64	190 m²	00 GF
62	212 m²	00 GF
135	257 m²	00 GF
8	50 m²	00 GF
20	255 m²	00 GF
38	250 m²	00 GF
76	111 m²	00 GF
34	212 m²	00 GF
46	103 m²	00 GF
50	104 m²	00 GF
75	31 m²	00 GF
00 GF: 44	19841 m²	
Grand total: 58	35963 m²	

PARKING CALCULATION - RETAIL

Gross Rentable Area =		36000 m²	
Assignable Area (80% of Gross Rentable Area) =		28800 m²	
Total Parking Bays Required		Less Taxi Credits	Bays in Hand
Parking @ 6 Bays per 100m² =	1728 Bays	1728 Bays	-228 Bays
Parking @ 5 Bays per 100m² =	1440 Bays	1440 Bays	60 Bays
Parking @ 4 Bays per 100m² =	1152 Bays	1152 Bays	348 Bays
Total Taxi Bays Provided =	**0 Bays**		
Parking Bay Credits at 8 Bays per Taxi =	0 Bays		
Total Parking Bays Provided =	**1500 Bays**		

Parking requirements for Future Rentable area: 36000sqm GLA
@4/100 - 1120 bays required (1500 provided)

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REV	DATE	DRAWN	DESCRIPTION
A	140324	MB	Issue for Information

Mall@Piet Retief

FOR

Anaprop Property Management

Portion 126, Piet Retief Town & Townlands 149HT, Mpumalanga

00GF Leasing Layout Complete

SCALE: As indicated

PROJECT	STAGE / SERIES / SIZE	REVISION
PAX_138	D004-09-A1	A

INFO | COUNCIL | TENDER | CONSTRUCTION

DATE: 2013.08.12 DRAWN BY: MB

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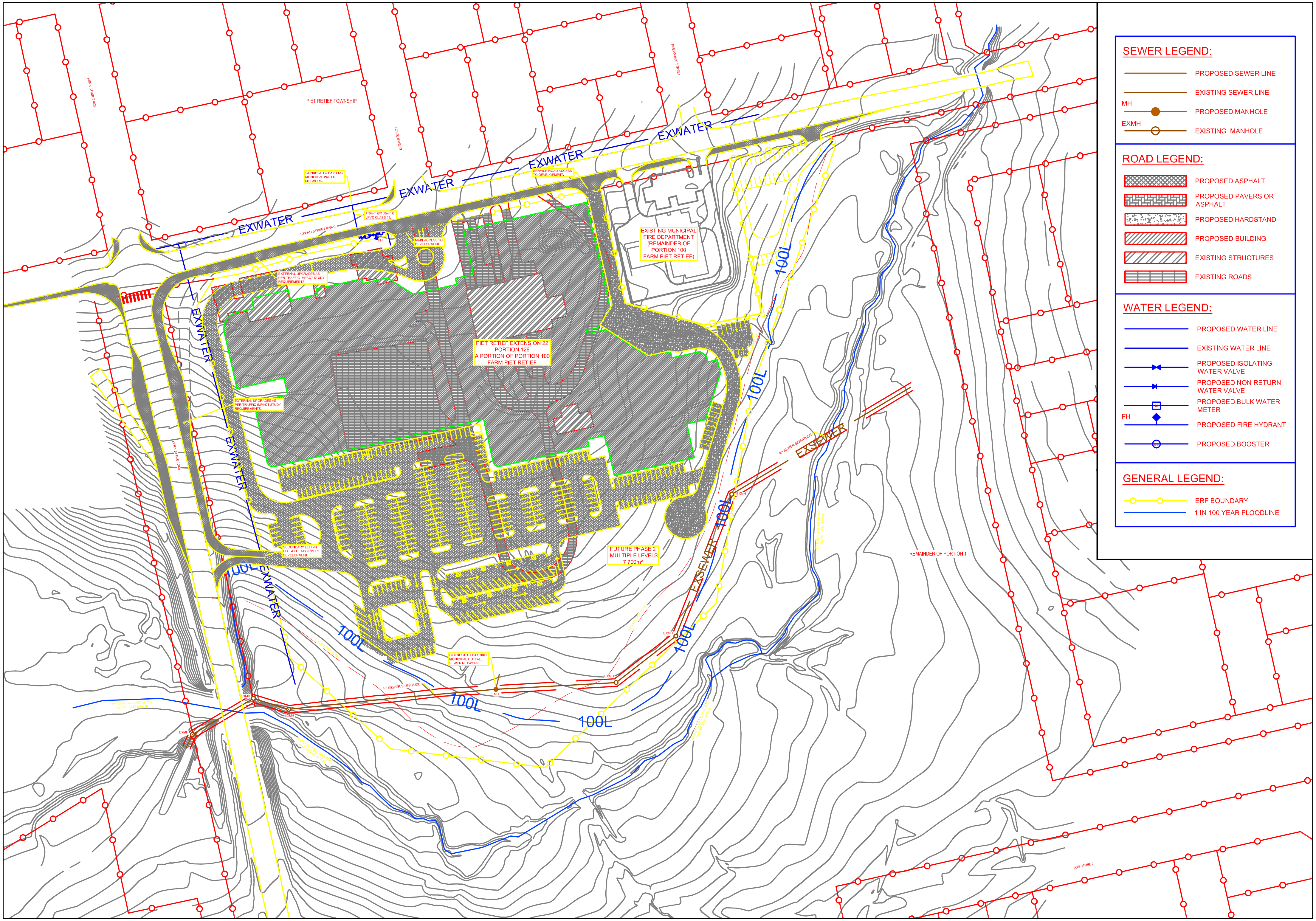
Appendix C2:

Final Layout – The Preferred Layout


EXISTING
100L
EXISTING
100L
EXISTING
100L
GENERAL LEGEND
WATER LEGEND
ROAD LEGEND
SEWER LEGEND


PIET RETIEF EXTENSION 22
PORTION 126
A PORTION OF PORTION 100
FARM PIET RETIEF
EXISTING MUNICIPAL FIRE DEPARTMENT (REMAINDER OF PORTION 100 FARM PIET RETIEF)
FUTURE PHASE 2
MULTIPLE LEVELS
7 700m²
MAIN ACCESS TO DEVELOPMENT.
SERVICE ROAD ACCESS TO DEVELOPMENT.
SECONDARY LEFT-IN LEFT-OUT ACCESS TO DEVELOPMENT.
EXTERNAL UPGRADES AS PER TRAFFIC IMPACT STUDY REQUIREMENTS.
EXTERNAL UPGRADES AS PER TRAFFIC IMPACT STUDY REQUIREMENTS.
CONNECT TO EXISTING MUNICIPAL WATER NETWORK.
CONNECT TO EXISTING MUNICIPAL OUTFALL SEWER NETWORK.
110mm Ø/160mm Ø uPVC CLASS 12.
4m SEWER SERVITUDE
4m SEWER SERVITUDE
NATURAL WATERCOURSE KLIPMESSELSPRUIT
KERK STREET (N2)
BRAND STREET (R543)
KOTZE STREET
PRETORIUS STREET
PIET RETIEF TOWNSHIP
REMAINDER OF PORTION 1
JOE STREET
EXWATER
EXSEWER
100L
EXMH
MH
FH
SEWER LEGEND:
PROPOSED SEWER LINE
EXISTING SEWER LINE
MH
PROPOSED MANHOLE
EXMH
EXISTING MANHOLE
ROAD LEGEND:
PROPOSED ASPHALT
PROPOSED PAVERS OR ASPHALT
PROPOSED HARDSTAND
PROPOSED BUILDING
EXISTING STRUCTURES
EXISTING ROADS
WATER LEGEND:
PROPOSED WATER LINE
EXISTING WATER LINE
PROPOSED ISOLATING WATER VALVE
PROPOSED NON RETURN WATER VALVE
PROPOSED BULK WATER METER
FH
PROPOSED FIRE HYDRANT
PROPOSED BOOSTER
GENERAL LEGEND:
ERF BOUNDARY
1 IN 100 YEAR FLOODLINE

Appendix D:

Specialist Reports

Appendix D1:

Geotechnical Report

Soilkraft cc

Reg no CK 96/08031/23

PO Box 73478
Lynnwood Ridge
0040
Tel: 012-9910426
Fax: 012-9912555
Email: izak@soilkraft.co.za

GEOTECHNICAL CONDITIONS ON A PORTION OF PORTION 100 (A PORTION OF PORTION 1) OF PIET RETIEF TOWN & TOWNLANDS 149 HT, MPUMALANGA: A REPORT FOR THE PROPOSED ESTABLISHMENT OF A NEW SHOPPING MALL

1 INTRODUCTION

- *Appointment*: It is envisaged to establish a new shopping mall on a portion of portion one of Piet Retief Town and Townlands 149 HT in Piet Retief, Mpumalanga. To this end Soilkraft cc was appointed by K. Anastasiadis on behalf of Zarafusion (Pty) Ltd to undertake a geotechnical investigation on the property. The purpose of the investigation was to:

    - identify possible relevant geotechnical constraints
    - make certain recommendations regarding the founding of structures
    - identify other factors that could possibly influence the future development of the area

- *Reporting*: Two printed and bound copies and the original of the report are supplied to the client. An electronic copy of the entire report is also supplied to enable the client to adjust the site plans to a scale convenient to him and to provide additional copies of the report, should it be required. All printed drawings in the hard copies are in A3 or A4 format, and serve for illustrative purposes only.
- *Project Restrictions*: At the time of the investigation the majority of the site was occupied by existing infrastructure and buildings. Limited access was available for trial hole excavation. In addition, a layout for the proposed mall had not been finalised and as a result, the site was investigated as a whole, rather than investigating a specific layout.

2 AVAILABLE INFORMATION

The following sources of information were consulted:

- 1 : 50 000 scale topographical map, Kemp 2730BB Piet Retief, published in 1989
- 1 : 250 000 geological map, Vryheid 2730, published in 1988

- 1 : 250 000 geological map, Mbabane 2630, published in 1986
- The document *Geotechnical Conditions on Portions 16 and 17 of the Farm Welgekozen 514-IT : A Report for the Development of the Proposed Thandekile Township*, compiled by Soilkraft cc on behalf of Welgekozen 514-IT Filling Station cc and issued on 23 July 2002.
- The document *Geotechnical conditions on the remainder of portion 17, portion 18 and the proposed portion of portion 53 (including the reserve of Theo Mocke Street) of the farm Welgekozen 514-IT: A report for the establishment of the N2 Woodhill Shopping Centre*, compiled by Soilkraft cc on behalf of Dr H Joubert and issued on 17 April 2006
- The document *Geotechnical conditions on portion 14 of the farm Welgekozen 514-IT: a report for the proposed township establishment of Thandekile Extension four*, compiled by Soilkraft cc on behalf of Tech IQ Consulting Engineers on 25 March 2013
- The document *Geotechnical conditions on portion 15 of the farm Welgekozen 514-IT: a report for the proposed township establishment of Thandekile Extension three*, compiled by Soilkraft cc on behalf of Tech IQ Consulting Engineers on 27 March 2013

3 SITE DESCRIPTION

3.1 Site Location

The study area investigated is located on a portion of portion 1 of Piet Retief Town and Townlands 149 HT in Piet Retief, Mpumalanga. The property is just over seven hectares in size, while the proposed shopping centre itself is to be approximately 25000m^2 in size.

The study area is located on the south eastern quadrant of the intersection between Church Street (N2) and Brand Street (R543). These roads form the western and northern boundaries of the site, respectively. The east of the site is bordered by vacant land, where a stream is also found. The same stream continues along the perimeter of the site, forming the southern border also. The site can be accessed on foot from any direction, but vehicular traffic is limited and in the case of the existing facilities, access is also controlled.

Refer to the attached Figure 1 : Locality Plan.

3.2 Topography and Drainage

The study area is located between altitudes of 1215m and 1233m above mean sea level. As it is located in the bend of a water course, the site dips in an eastern, southern and western direction in the eastern, southern and western parts of the site, respectively. The natural gradient of the site has been modified, though, as earth works and imported materials have been used at the existing facilities to create more level landscapes. This will be discussed in more detail later in the report. As a result of

the earthworks, gradients across the site are highly variable. Areas along the northern boundary of the site are generally flat (2%), while other localised areas on the periphery of landscaped areas exceed 12%.

Drainage of the study area presumably takes place by means of sheet was and infiltration. Excess surface runoff is destined to drain in accordance with the prevailing gradient and is most likely to drain into the stream on the southern and eastern periphery of the study area. No natural erosion channels were found on site, though some storm water outlet channels (i.e. trenches) were found to have been eroded by concentrated water discharge.

3.3 Vegetation

Regional vegetation had largely been removed from the site when the existing facilities were established. The remainder of the property was largely covered by short, wild grass and scattered clusters of eucalyptus trees.

3.4 Climate and Weather Conditions

The property is located in an area with an approximate Weinert N-value of 1,5 and a Thornthwaite Moisture Index close to zero. Climatically the area may thus be described as sub-humid. This signifies that chemical weathering of rock material will dominate over mechanical weathering, resulting in the formation of active clays where suitable bedrock materials are encountered. Minerals such as amphiboles, pyroxenes and olivine are particularly susceptible to chemical weathering; however mechanical weathering may not be entirely disregarded, especially where brittle bedrock materials are encountered.

The area receives summer rainfall at a mean annual precipitation of 892mm, generally in the form of thunderstorms, but prolonged periods of soft rain are common. The average maximum summer temperature of approximately 26,1°C occurs in December. Winters are cold to very cold and the presence of morning frost is common.

4 EXISTING FACILITIES

As referred to in previous section, the majority of the study area was already occupied by existing facilities at the time of the investigation. The north eastern most portion of the site played host to two dated residences which had been converted apparently to offices or commercial buildings. The majority of the site, however, was occupied by the Mkhondo Municipal and traffic department. The facility included a weigh bridge and licensing department, including testing grounds with a short examination circuit. Near the north eastern corner of the site, a small area (estimated at 4900m^2) was used to host the local fire brigade.

In terms of services, it is anticipated that all municipal services (i.e. sewerage, electricity and water reticulation) are available to the existing facilities on the site.

Site conditions are illustrated on the attached Photo 1 : Site Conditions.

5 SITE INVESTIGATION

5.1 Trial Holes

For the purposes of the survey ten trial holes were excavated across the study area. The trial holes were excavated on 4 September 2013 with the aid of a Case 580 Super R backhoe, supplied by Mkhondo Plant Hire.

The placement of trial holes was affected by the existing facilities and as a result, the number of trial holes excavated in the northern half of the site is less than would have been ideal. Safe and acceptable positions for trial hole excavation was pointed out by representatives of the local municipality and the location of the trial holes were recorded with a handheld GPS using the WGS84 reference system, and are recorded on trial hole log sheets.

The trial holes were inspected and profiled by a professional engineering geologist according to the guidelines of SAICE and SAIEG[Reference 9.1]. For the benefit of the non-geotechnical reader, these guidelines are summarised in the attached Table 1 : Soil Profiling Parameters. The profiles of the trial holes may be found in Addendum A to this report. The profile descriptions as per the test pits reflect the impressions created by the pedological conditions and may sometimes be in slight variance with the results of the soil tests.

The positions of trial holes are depicted in Figure 2.

5.2 Materials Tests

Soil samples were retrieved from trial holes and delivered to the commercial geotechnical laboratory facilities of Geostrada in Pretoria. Geostrada is a SANAS accredited laboratory. Soil tests included the following:

- *Foundation Indicator Tests:* Foundation indicator samples were tested to determine the general geotechnical properties of the in situ materials.
- *Soil Chemistry:* Soil chemistry tests consisted of soil paste pH and conductivity determinations. The soil chemistry/corrossivity is assessed to determine whether in situ soils are corrosive towards buried steel objects (e.g. utilities, services, anchoring poles, etc.).

- *Consolidation Tests:* Undisturbed soil samples were retrieved for consolidation tests. The consolidation tests were performed to assess the materials' susceptibility to settle under loading.

TABLE 1 : SOIL PROFILING PARAMETERS

CONSISTENCY : GRANULAR SOILS

SPT N	GRAVELS & SANDS Generally free draining soils		DRY DENSITY (kg/m^3)
<4	Very loose	Crumbles very easily when scraped with geological pick. Requires power tools for	<1450
4-10	Loose	Small resistance to penetration by sharp pick point. requires many blows by pick point	1450-1600
10-30	Medium dense	Considerable resistance to penetration by sharp pick point.	1600-1750
30-50	Dense	Very high resistance to penetration by sharp pick point. Requires many blows by pick point for excavation.	1750-1925
>50	Very dense	High resistance to repeated blows of geological pick. Requires power tools for excavation.	>1925

CONSISTENCY : COHESIVE SOILS

SPT N	SILTS & CLAYS and combinations with SANDS. Generally slow draining soils		UCS (kPa)
<2	Very soft	Pick point easlily pushed in 100mm. Easily moulded by fingers.	<50
2-4	Soft	Pick point easlily pushed in 30mm to 40mm. Moulded by fingers with some pressure.	50-125
4-8	Firm	Pick point penetrates to 10mm. Very difficult to mould with fingers.	125-250
8-15	Stiff	Slight indentation by pick point. Cannot be moulded by fingers. Penetrated by thumb nail.	250-500
15-30	Very stiff	Slight indentation by blow of pick point. Requires power tools for excavation.	500-1000

SOIL TYPE

SOIL TYPE	PARTICLE SIZE(mm)
Clay	<0,002
Silt	0,002-0,06
Sand	0,06-2,0
Gravel	2,0-60,0
Cobbles	60,0-200,0
Boulders	>200,0

MOISTURE CONDITION

Dry	No water detectable
Slightly moist	Water just discernable
Moist	Water easily discernable
Very moist	Water can be squeezed out
Wet	Generally below water table

COLOUR

Speckled	Very small patches of colour <2mm
Mottled	Irregular patches of colour 2-6mm
Blotched	Large irregular patches 6-20mm
Banded	Approximately parallel bands of varying colours
Streaked	Randomly orientated streaks of colour
Stained	Local colour variations : Associated with discontinuity surfaces

SOIL STRUCTURE

Intact	No structure present.
Fissured	Presence of discontinuities, possibly cemented.
Slickensided	Very smooth, glossy, often striated discontinuity planes.
Shattered	Presence of open fissures. Soil break into gravel size blocks.
Micro shattered	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs.
Residual structures	Residual bedding, laminations, foliations etc.

ORIGIN

Transported	Alluvium, hillwash, talus etc.
Residual	Weathered from parent rock, eg residual granite
Pedocretes	Ferricrete, silcrete, calcrete etc.

DEGREE OF CEMENTATION OF PEDOCRETES

TERM	DESCRIPTION	UCS (MPa)
Very weakly cemented	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1-0,5
Weakly cemented	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrate to a friable state.	0,5-2,0
Cemented	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2,0-5,0
Strongly cemented	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5,0-10,0
Very strongly cemented	Hand-held specimen can be broken by single firm blow of hammer head. Similar appearance to concrete.	10,0-25

- *California Bearing Ratio:* California Bearing Ratio (CBR) tests were extracted and tested to determine the quality of in situ soil materials encountered. The aim of this is to determine whether in situ materials can be considered for the construction of layer works or whether it can be used in cut and fill earthworks operations.

The results of the soil test results are summarised in the attached Table 2 : Results of Soil Tests. The original results are included in Addendum B.

6 DISCUSSION

6.1 Geology

According to the regional geological map of the area, the site is located on medium to coarse grained biotite granite, porphyritic biotite granite or coarse grained hornblende granite. The materials are associated with Mozaan or Nsuze Groups of the Pongola Sequence.

While no bedrock was encountered in trial holes, residual materials confirmed the presence of granitic materials across the majority of the site. In addition, two trial holes (i.e. trial holes one and five) appeared to contain residual dolerite materials. This is possible, as erratically distributed dolerite dykes occur in the region.

The regional geology is indicated on the attached Figure 3 : Regional Geology.

6.2 Groundwater

- *Perched Water*: No seepage or perched water was encountered in trial holes during the investigation. It must be considered, though, that the investigation was conducted at the time of year when shallow groundwater is least prominent. Considering that the site lies in the bend of a water course – and considering conditions encountered in trial hole five – it is anticipated that the soil profile may see an abundance of moisture in the profile on a seasonal basis. In addition, marshy conditions and surface seepage may occur in areas close to the stream, It is important to realise that perched water or seepage water is a seasonal phenomenon in is likely to be most pronounced at the end of the rainy season when shallow groundwater has accumulated in the soil profile.
- *Permanent Water*: Vegter[Reference 9.2] indicates the probability for drilling successfully for water in the area to be less than 40% and the probability that such a borehole will yield more than 2l/s is between 30% and 40%. Groundwater is expected to occur at depths less than ten metres in pores, fractures and disintegrated rock restricted to a zone directly below ground water level.

6.3 Soil Profile

Before discussing the geotechnical properties of the site, the materials encountered in trial holes need to be discussed. The following materials were encountered:

- *Made Ground / Fill*: Imported materials were encountered in trial holes one, two, three, nine and ten. For the most part the fill consisted on mixed soils with foreign objects such as steel rods, bricks, etc. In trial holes three and four, however, the fill material appeared to consist of imported slate or baked materials. It was initially considered that this material could be in situ bedrock; however observations along terraces on site suggest that the slate is in fact imported and was used in earth works. The bottom of the slate fill could not be reached as the material induced refusal of excavation before being fully penetrated. The slate materials were also noted to protrude terraced faces immediately north of trial hole ten and adjacent to trial hole five. Due to the inconsistent nature of the fill materials, no material samples were taken.
- *Colluvium 1*: The first colluvial material identified in trial holes occupied between 200mm and 800mm of the vertical profile and occurred in trial holes one, four and six through eight. In general the colluvial material had dark brown colour, a dense consistency and an intact structure, while it occasionally contained ferricrete nodules. The colluvial materials also appeared to have been used to cover some of the imported slate-rich fill. Such an instance was encountered in trial hole three, where the material also hosted a 500mm diameter termite nest. Test results suggest that the colluvium is not expansive, despite large active clay content. The material had active clay content of 51% and a plasticity index of 15%. A grading modulus of 0,56 was calculated for this material and a PRA classification of A-6 was awarded.
- *Colluvium 2*: The second colluvial horizon was unearthed in trial holes one and five and was closely associated with dolerite materials. The horizon was of a limited thickness, though, spanning between 200mm and 300mm of the vertical profile. The horizon had light grey or black colour and slickensided or shattered structures were noted, indicating that the material is likely active with regard to soil heave. Finally, the horizon's consistency ranged from very soft to firm and is expected to be moisture dependent. No material test samples were retrieved due to the limited occurrence of the material.
- *Residual Dolerite*: Residual dolerite was only encountered on two occasions (i.e. trial holes one and five). In trial hole one the material was described as brown yellow speckled black silty sand with a medium dense consistency and intact structure. The material was at least 1000mm in thickness, but the bottom of the horizon was not reached. In contradiction to this, the residual materials in trial hole five were far more decomposed and were described as orange brown blotched grey, very soft, intact clayey silt, which also spanned 1000mm without encountering the base of the horizon. On both occasions the residual materials contained corestones; however, corestones were larger and more abundant in trial hole five, ultimately inducing refusal of excavation. A sample of each of the residual soil were collected and analysed. Test results proved that the material is indeed somewhat peculiar, largely due to the range of values recorded for its

plasticity index. While a minimum plasticity index of 17% was recorded, a very high maximum plasticity index of 64% was recorded. This value was confirmed by re-tests in the laboratory. The active clay contents of the material ranged from 25% to 70%, indicating that the material has the potential to be moderately to very highly expansive. The samples were classified as A-7-5 or A-7-6 by the PRA classification and grading moduli ranged from 0,16 to 0,89.

- *Residual Granite*: The most common material encountered in trial holes was the residual granite. The horizon showed some variation, mostly due to varying mica content in the residual material. This variation can most likely be ascribed to slight segregation in the original magma parent material. This ultimately results in higher silt and clay contents in zones which were richer in mica. Nevertheless, the residual granite was generally characterised by a distinctive orange colour, with shades of orange brown or orange pink and discolourations of grey, white and black. In general the horizon had a loose to medium dense consistency with an intact structure. Quartz gravel or quartz veins were noted on limited occasions and were the remnants which remained after the plagioclase and feldspar minerals comprising the granite bedrock had been weathered. Laboratory analyses indicate that in most instances the residual granite borders between a low and moderate affinity to heave. The samples revealed active clay contents between 28% and 42%, with associated plasticity indices between 12% and 21%. The results further revealed that the material had grading moduli between 0,47 and 1,29 and PRA classifications included A-7-5 and A-7-6. Consolidation tests also confirmed that the material is susceptible to compression, even at relatively small loads.

6.4 Geotechnical Zoning

When discussing the geotechnical zoning of the area, the following must be considered:

- *Properties of Heave*: Material test results indicated that the residual dolerite soils have the potential to be moderately to very highly expansive. The peculiar properties noted in this material's samples suggest that it best be treated cautiously. As far as the residual granite is concerned, this material, too, mostly bordered between a low and moderate expansiveness, with only one sample being convincingly tested as moderately expansive. This has far reaching implications for the project at hand, as the residual granite made up thick horizons of the soil profile and any assumptions regarding the borderline expansiveness could lead to significant underestimation or overestimation of soil heave. In this instance, however, a conservative approach is adopted. Soil heave was calculated using the method proposed by van der Merwe[Reference 9.3], as per RAFT software compiled by the CSIR. Heave calculated for each zone will be discussed in subsequent sections.
- *Properties of Settlement*: The results of the consolidation settlement indicate both samples to be in an over-consolidated state. The pre-consolidation pressure for sample 3/8913 is estimated at 250kPa and for sample 3/8916, it is estimated at 100kPa. The over-consolidation factor of sample 3/8913 is 13,9 while the same value for sample 3/8916 is 9,8. Both factors are considered to be

very high. Both these factors as well as the high pre-consolidation pressures are indications of the fact that substantial volumes of historical overlying material had been removed from the site. Limited settlement due to foundation induced stresses is thus expected, but this can only be quantified once more detail of foundations design is available.

- *Fill*: Fill materials encountered around existing facilities on the site are considered to be problematic. Little is known about the origins or age of the fill materials; however, it was clear that the materials are not uniform in composition, origin or compaction and would therefore affect future structures adversely.

Based on the discussion above, the site can be divided into the following zones:

- *Geotechnical Zone I:* **P_{Fill}/S1/H1**: This zone includes trial holes two, three, nine and ten and encompasses the majority of the developed site. The full extent and soil properties could not be assessed due to the existing infrastructure; however based on the information obtained from limited trial holes in this zone, it is clear that problematic fill materials prevail. These materials were imported – presumably a number of decades ago – to level the site. While the fill could not be penetrated in trial hole three, adjacent trial holes suggest that the fill is underlain by residual granite. Taking the horizon thicknesses and soil properties into account, it is expected that settlement of up to 20mm may occur, while up to 15mm unrestrained heave is anticipated as a precautionary measure.
- *Geotechnical Zone II*: **P_{Fill}//H-H1**: As with the preceding zone, this zone is classified based on limited trial hole information. Nevertheless, surficial problematic fill materials were encountered in this zone, along with (occasionally moderately expansive) residual dolerite. As a precautionary measure, unrestrained heave of up to 15mm is anticipated in this zone. This zone includes trial holes one and four. Dolerite outcrop was encountered adjacent to trial hole one.
- *Geotechnical Zone III*: **H3/P_{Marsh}**: This zone includes only trial hole five and soil heave of up to 65mm was calculated for the profile. In addition, it is expected that this zone – and possibly its immediate surroundings – will make for very marshy conditions on a seasonal basis. Such conditions were already encountered during the investigation (during the region's dry season) and are expected to become more prevalent during the wet season.
- *Geotechnical Zone IV*: **S1/H1**: This final zone includes the majority of the undeveloped site which is devoid of fill materials. Trial holes six, seven and eight fall within this zone. Settlement of up to 20mm is anticipated in this zone and as before, 15mm unrestrained heave is anticipated as a precautionary measure.

6.5 Conditions of Excavation

Conditions of excavation can be best summarised at the hand of the SANS 1200 guidelines. Based on the said guidelines, conditions of excavation can be summarised as follows:

- *Made Ground*: For the most part, imported or fill materials were excavatible by backhoe. This excludes the fill encountered in trial holes three and four which consisted of slate or baked shale. First impression when excavating through this material was that it comprised an outlier of slate bedrock; however, observations in the immediate surroundings suggest that this material, too, was imported to elevate the natural ground level. As this particular fill material could not be penetrated it is not know exactly how thick it is or what lies between the fill and in situ soils. Based on the immediate surroundings, it is estimated that the slate fill may be as thick as 1500mm.
- *Colluvium 1*: This colluvial material proved to be excavatible by backhoe with moderate effort. No major impediments were encountered in this horizon apart from its general dense consistency.
- *Colluvium 2*: The second colluvial soil was encountered in close proximity to residual dolerite soils. The material was notably more cohesive that other materials (excluding residual dolerite) and in it moisture state (i.e. moist to very moist) the horizon made for conditions of clayey excavation. Conditions of wet excavation are also expected on a seasonal basis. In trial hole five excavation was severely impeded by the occurrence of dolerite corestones in the colluvium. The corestones were up to 600mm in diameter).
- *Residual Dolerite*: Residual dolerite materials made for variable conditions of excavation. In trial hole one the material had a medium dense consistency and consisted of a granular soil; however in trial hole five the material was soft and cohesive, resulting in clayey excavation. Regardless of this, the horizon contained corestones in both instances. The corestones ranged in diameter from 400mm to 1000mm and in trial hole five, induced refusal of excavation.
- *Residual Granite*: The residual granite proved excavatible by backhoe in all trial holes without inducing refusal of excavation on any occasion. The horizon occasionally contained corestones; however, these were generally limited in size and seldom exceeded a diameter of 400mm. That being stated, the presence of larger corestones cannot be discounted.
- *Bedrock*: No competent bedrock was encountered in any of the trial holes excavated on site. Apparent dolerite outcrop was encountered immediately adjacent to trial hole one.
- *Excavation Stability*: All excavation proved stable during inspection; however it is expected that excavations may be adversely affected by water ingress, especially in areas along lower-lying parts of the site.
- *Seepage Water*: Cognisance must be taken of expected water ingress along lower lying parts of the site.

6.6 Soil Corrossivity

When discussing soil corrossivity, it is important to consider the guidelines as proposed by Evans[Reference 9.4]. The corrossivity of a soil towards buried, exposed, metallic surfaces depends on the following properties of a material:

- Electrical conductivity
- Chemical properties
- Ability of the soil to support sulphate reducing bacteria
- Heterogeneity

The tests carried out for the compilation of this report must be considered indicative of the soil conditions only. The pH of a soil gives an indication of potential acid related problems. Should the soil pH be less than 6,0 corrosion may take place and should the pH be less than 4,50, the problem of corrosion may be serious. If the conductivity of the soil is less than 0,1mS/cm, corrossivity is generally not a problem. However, the corrosion potential of the soil increases with an increase in conductivity. Should the conductivity of the soil exceed 0,5mS/cm, the soil can be regarded as very corrosive.

Samples of the in situ soils were extracted and tested to determine their corrosive nature. The results revealed the following:

- *Soil Acidity:* Soil paste mixtures revealed pH levels between 6,48 and 8,61. These values are indicative of generally non-corrosive conditions, as far as acidity is concerned.
- *Soil Conductivity:* The conductivity tests showed a significant range in results. The paste sample had soil conductivity values between 0,0206S/m and 0,1049S/m. This range of reading indicates mildly corrosive to extremely corrosive soils.
- *Heterogeneity of the Soil*: Electrochemical cells may exist between the residual dolerite and residual granite materials due to the different rates of oxygen diffusion of the soils along this boundary. As such, precautionary measures may be required if metal objects (e.g. services and utilities) are installed at these depths.
- *Waterlogged Conditions*: Waterlogged conditions were encountered and are expected to be more prominent in the vicinity of trial hole five.

6.7 Seismicity

Kijko[Reference 9.5] indicates the annual probability for an earthquake with intensity of 4,3 on the Modified Mercalli Scale to occur in the area to be less than 10^0 and with an intensity of 7,5 the probability is 10^{-4}. A 10% probability exists that an earthquake with Peak Ground Acceleration of 0,15g to 0,17g may take place once in 50 years.

To put the above information into perspective, Table 3 : Earthquake and Magnitude and Intensity, is attached to this report.

6.8 Material Utilisation

Three samples of in situ soil materials were sourced to determine the material quality for potential use in construction (i.e. layer works and earth platforms). The results revealed the following:

- *Colluvium:* The colluvial material failed to achieve a COLTO rating. The material not only had a slightly elevated plasticity index (i.e. 15%), but it was characterised by fairly poor CBR values and achieved a maximum CBR value of 23% at 100% Mod AASHTO density.
- *Residual Granite:* Two samples of the residual granite were tested and the results were mixed. The first sample also failed to achieve a COLTO rating. As with the colluvial sample, this sample had a slightly elevated plasticity index (i.e. 16%) and achieved relatively poor CBR values. The second sample was classified as G8 (COLTO) and achieved a maximum CBR of 24% at 100% Mod AASHTO density.

6.9 Other Considerations

- *Historic Monuments*: There are no historic monuments on the site.
- *Dolomite Stability*: The site is not subject to instabilities due to the presence of dolomite.
- *Undermining*: The area is not subject to undermining.
- *Cemetery Sites*: No cemeteries or graves were encountered during the investigation. Taking the guidelines of Fischer[Reference 9.6] into account, the property is not suitable to be developed as a cemetery site.

7 CONCLUSIONS

The following must be taken into account:

- *Geology*: The study area appears to be located on a deeply weathered granitic profile associated with the Pongola Sequence. In addition, residual dolerite materials were encountered. No competent bedrock was found in any trial holes.
- *Soil Profile*: Profiles on site are variable. While large parts of the site are underlain by imported fill materials, residual granite dominated in situ soils. Residual dolerite and colluvial soils were also found in lesser abundance.
- *Groundwater*: Seepage water and very moist to wet soil profiles are expected to occur in lower lying areas on a seasonal basis. Marshy conditions and surface seepage may also occur adjacent to the water course on a seasonal basis.
- *Founding Conditions:* Founding conditions across the site vary and are complicated by the occurrence of problematic fill materials. A slightly conservative approach is adopted as far as soil

heave is concerned. The site was divided into four zones, namely **P_{Fill}/S1/H1**, **P_{Fill}/H-H1**, **H2/P_{Marsh}** and **S1/H1**.

- *Excavation Potential*: In situ soil materials generally proved excavatible by backhoe, with only dolerite corestones inducing refusal of excavation. Imported fill materials containing slate proved to be very difficult to excavate and induced refusal of excavation. Finally, conditions of wet and/or clayey excavation may occur in lower lying areas and where residual dolerite occurs.
- *Soil Corrossivity*: Conditions of mildly corrosive to very corrosive soils prevail on site due to elevated soil conductivity properties. Oxidation by seepage water further contributes to conditions of corrosion.
- *Material Utilisation*: In situ materials performed fairly poorly under testing. One sample was classified as G8 (COLTO), while remaining samples failed to achieve a classification.
- *Historic Monuments:* There are no historic monuments on the site.
- *Cemetery Sites:* No cemeteries or graves were encountered during the investigation. The property is not suitable to be developed as a cemetery site.
- *Dolomite Stability*: The site is not subject to instabilities due to the presence of dolomite.
- *Undermining*: The area is not subject to undermining.
- *Seismicity*: The annual probability for an earthquake with intensity of 4,3 on the Modified Mercalli Scale to occur in the area to be less than 10^0 and with an intensity of 7,5 the probability is 10^{-4}. A 10% probability exists that an earthquake with Peak Ground Acceleration of 0,15g to 0,17g may take place once in 50 years.

8 RECOMMENDATIONS

8.1 Preliminary Proposals for Founding and Construction

No structural information was available at the time of reporting and as such, recommendations given here are done so in good faith and as a general guideline only. It is assumed that high point loads may be present due to load bearing columns. The initial indication of a minimum pre-consolidation pressure of 100kPa indicates that little settlement will take place if this figure is not exceeded, but it may increase after that, depending on the dimensions, shape and stresses associated with the foundation.

Considering the nature of the proposed project, it is generally recommended that mass earthworks be undertaken on this terrain to create construction terraces and import suitable soil replacement platforms for construction. If this approach is adopted, the following applies:

- *Geotechnical Zone I:* **P_{Fill}/S1/H1**: It is recommended that all fill materials in this zone be removed and founding be done on in situ materials. In order to accommodate conditions and settlement and heave discussed, it is recommended that founding be done by means of reinforced strip footings capable of accommodating up to 20mm settlement and up to 15mm

unrestrained heave. The floor slabs shall be fabric reinforced and the superstructure shall contain lightly reinforced masonry. Finally, articulation joints may be considered if required by engineering design.

- *Geotechnical Zone II*: **P_{Fill}/H-H1**: The recommendations given for Zone I apply to this zone as well and foundations must be capable of accommodating up to 15mm unrestrained heave. However, in addition, areas of bedrock outcrop must be anticipated. If competent bedrock is identified at suitable depths, such bedrock may be considered for founding, provided it is approved by a competent person.
- *Geotechnical Zone III*: **H3**/**P_{Marsh}**: This area is not suitable for development in its current state. The zone can be reclaimed for development by means of a carefully designed earthworks program and will most likely also require the installation of a network of sub-surface drains to route and discharge profile moisture. Construction in this zone will be dictated by the reclamation design and cannot be commented upon further.
- *Geotechnical Zone IV*: **S1**/**H1**: Construction in this final zone can be done as described for Zone I above.

Site drainage must be planned carefully to ensure that surface run off water does not drain towards structures. All surface water should be channelled away from structures and no surface water accumulation should be allowed within 1,5m of structures.

The anticipated soil movements, soil zoning and proposed foundation precautions are summarised in the attached Table 4 : Foundation Design, Building Procedures and Precautionary Measures and illustrated in Figure 4.

8.2 Conditions of Excavation

Considering the conditions of excavation encountered, the following is recommended:

- *Fill Materials*: The majority of fill materials can be considered excavatible by backhoe. Materials consisting of slate will require additional measure to permit excavation. The use of pneumatic equipment may be necessary to break the rock fragment down, or alternatively the use of an excavator may be considered. It is also recommended that conditions underlying this fill be assessed once it has been removed to ensure that the underlying materials comply with the findings of this report.
- *Colluvium 1*: It is recommended that any method of machine excavation be considered for colluvial materials. Hand excavation may be considered, but will prove difficult.
- *Colluvium 2*: Provision must be made for clayey and potentially wet excavation of this colluvial material. In addition, the presence of corestones must be anticipated. Such corestones would most likely be best addressed by an excavator, as opposed to a backhoe. Hand excavation is not recommended.

- *Residual Dolerite*: While the residual dolerite varies somewhat in properties, it is advisable that this material be excavated with the aid of an excavator to effectively address the inclusion of corestones which could not be excavated by backhoe. The residual dolerite is also likely to make for conditions of clayey excavation in the vicinity of trial hole five. Hand excavation is not recommended.
- *Residual Granite*: Residual granite materials can be considered excavatible by mechanical means as easy to moderately difficult excavation. While no *large* corestones were encountered in the residual granite, the occurrence of such corestones cannot be discounted. In the instance where such corestones do occur, an excavator would be better suited for excavation. Large to very large corestones may also require the use of pneumatic equipment or small scale blasting for removal.
- *General*: A minimum proven depth of excavation by backhoe was established at 1100mm; however in general excavations into residual granite can maintain of depth of at least 2000mm with relative ease.
- *Excavation Stability*: The safety of all persons working in or near open excavations must be ensured. Particular caution must be paid in areas where very clayey or wet conditions occur.
- *Movement of Construction and Excavation Equipment*: It must be considered that lower lying areas of the site adjacent to the water course are likely to be treacherous during the wet season. It is likely that track-mounted equipment would be best suited to move in these areas.

8.3 Soil Corrossivity

Mildly corrosive to extremely corrosive soils prevail on site; hence it is recommended that precautionary steps be taken to protect buried and exposed steel objects (e.g. services, utilities, anchoring poles, etc.). The use of protective coating may be considered. Where piping is involved, the use of PVC piping may be considered.

8.4 Groundwater

Cognisance must be taken of the expected marshy conditions and possible surface seepage along the lower lying areas of the site. In order to remedy such conditions it is recommended that a network of sub-surface drains be installed to discard the moisture. Alternatively bulk earth works can be manipulated to reclaim the saturated land. Considering the preliminary layouts which indicate that lower lying areas will largely be used for parking, the latter option would most likely be the most suitable.

8.5 Material Utilisation

In situ soil materials are of relatively poor quality and should at best be considered for earth fill. Residual dolerite materials should not be considered for any earthworks application. All remaining

materials used for the construction of layer works should be imported from commercial (or other) sources.

8.6 Additional Work

It is strongly recommended that the area occupied by existing buildings be investigated in more detail once the buildings are not in use or demolished. Such additional work should focus on the following important factors:

- The distribution of imported materials must be identified so as to determine where imported materials are present and where in situ materials begin. Simultaneously the vertical thickness of the fill materials must be determined. It is recommended that provision be made for excavation with an excavator and not a backhoe when additional work is undertaken. This is largely due to the fact that the backhoe failed to penetrate the imported baked shale materials encountered during this investigation. Once the fill materials have been penetrated, it is pivotal that the underlying materials be investigated to determine/ensure that they comply with the findings of this report.
- The distribution of dolerite bedrock associated with the apparent outcrop adjacent to trial hole one must be identified. It would also be advisable to determine the distribution of the dolerite and residual dolerite materials on the north eastern parts of the site in order to increase the accuracy of the geotechnical zoning plan provided in this report.
- It is recommended that the marshy area in the vicinity of trial hole five (and adjacent areas) be investigated by a wetlands specialist to determine the full extent of the marsh that may occur on a seasonal basis.

9 SOURCES OF REFERENCE

9.1 SAIEG-AEG-SAICE: *Guidelines for Soil and Rock Logging* – Proceedings of the 1990 Geoterminology Workshop.

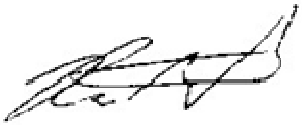
9.2 Vegter JR: *An Explanation of a Set of National Ground Water Maps*, published by the Water Research Commission, in August 1995.

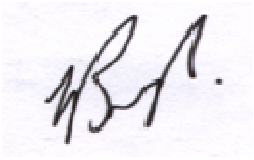
9.3 Van der Merwe DH: *Prediction of Heave from the Plasticity Index and Per cent Fraction of Soil*, published in The Civil Engineer in South Africa, Vol 6, No 6, pages 103 to 107, published in June 1964.

9.4 Evans UR: *The Corrosion and Oxidation of Metals*, published by Edward Arnold in 1971.

9.5 Kijko A *et al.* : *Probabilistic Peak Ground Acceleration and Spectral Seismic Hazard Maps for South Africa*, Report 2003-0053 by the Council for Geoscience.

9.6 Fischer GJ: *The Selection of Cemetery Sites in South Africa*, published by the Council of Geoscience.





IJ Breytenbach (Pr. Sci. Nat.)

4 October 2013

For Soilkraft cc

FJ Breytenbach (Pr. Eng.)

FIGURE 2

LEGEND

TP1 TEST PITS

FOR ILLUSTRATIVE PURPOSES ONLY

SOILKRAFT

POSBUS 73478
LYNWOOD RIF
0040
TEL : (012) 991-0426
FAX: (012) 991-2555
SEL: 082 570-2767
EPOS: admin@soilkraft.co.za

PO BOX 73478
LYNWOOD RIDGE
0040
TEL: (012) 991-0426
FAX: (012) 991-2555
CELL: 082 577-6215
EMAIL: izak@soilkraft.co.za

TAAK: JOB NAME:	A Portion of Portion 100 (a Portion of Portion 1) of the farm Piet Retief Town and Townlands 149-HT (to be known as Portion 126)
KLIËNT: CLIENT:	Zarafusion (Pty) Ltd
TEKENING NO: DRAWING NO:	Site Layout
DATUM: DATE:	24 September 2013

FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

ZONE	GEOTECHNICAL CLASS	% OF TOTAL AREA	ESTIMATED SOIL MOVEMENT	SOIL PROFILE	DEVELOPMENT POTENTIAL	CONSTRUCTION TYPE	FOUNDATION DESIGN	ASSOCIATED PROBLEMS
I	P_{Fill} /S1/H1	45,0	Up to and exceeding 20mm settlement and up to 15mm unrestrained heave	Problematic fill underlain by residual granite	Intermediate	Modified	Reinforced strip footings	Corrosive soils Problematic fill Difficult excavation (fill)
II	P_{Fill} /H-H1	15,9	Up to 15mm unrestrained heave	Problematic fill underlain by residual dolerite	Intermediate	Modified	Reinforced strip footings	Corrosive soils Corestones Bedrock outcrop Problematic fill
III	H3/P_{Marsh}	3,2	Up to 30mm unrestrained heave	Colluvium overlying residual dolerite	Not suitable	N/A	N/A	Corrosive soils Corestones Marshes
IV	S1/H1	35,9	Up to and exceeding 20mm settlement and up to 15mm unrestrained heave	Limited soil cover overlying residual granite	Intermediate	Modified	Reinforced strip footings	Corrosive soils

FIGURE 4

LEGEND

TP1 TEST PITS

INFERRED BOUNDARY

FOR ILLUSTRATIVE PURPOSES ONLY

SOILKRAFT

POSBUS 73478
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0040
TEL: (012) 991-0426
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EMAIL: izak@soilkraft.co.za

TAAK: / JOB NAME: A Portion of Portion 100 (a Portion of Portion 1) of the farm Piet Retief Town and Townlands 149-HT (to be known as Portion 126)

KLIËNT: / CLIENT: Zarafusion (Pty) Ltd

TEKENING NO: / DRAWING NO: Geotechnical Zoning

DATUM: / DATE: 7 October 2013

REPORT ON THE FOUNDATION INVESTIGATION CARRIED OUT FOR THE PROPOSED NEW PIET RETIEF MALL MPUMALANGA PROVINCE

Prepared for:

Sotirales Consulting Engineers (Pty) Ltd

On behalf of:

Zarafusion (Pty) Ltd t/a Piet Retief

Report by:

Geo Simplicity Geotechnical Engineering (Pty) Ltd
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Ref: G082-PVS-R01
September 2014

REPORT ON THE FOUNDATION INVESTIGATION CARRIED OUT FOR THE PROPOSED NEW PIET RETIEF MALL, MPUMALANGA PROVINCE

INDEX

REPORT ON THE FOUNDATION INVESTIGATION CARRIED OUT FOR THE PROPOSED NEW PIET RETIEF MALL, MPUMALANGA PROVINCE

1. INTRODUCTION

This report presents the results of the foundation investigation carried out for the proposed new Piet Retief Shopping Mall, to be situated at the intersection of Kerk and Brand Streets in Piet Retief, Mpumalanga Province.

The investigation was carried out at the request of Mr Gerrit Borman, of Messrs Sotirales Consulting Engineers (Pty) Ltd on behalf of the Client, Messrs Zarafusion (Pty) Ltd, t/a Piet Retief.

Permission to proceed with the foundation investigation was granted via email and the fieldwork was carried out on 29 May 2014. The samples for laboratory testing were handed over to Messrs Roadlab (Pty) Ltd the next day for physical and chemical testing.

2. DESK STUDY OF EXISTING INFORMATION

The following existing information was studied to determine the expected in-situ geotechnical conditions and to plan our foundation investigation:

- The 1:250 000 Vryheid 2530 geological map.
- The geotechnical report compiled by Soilcraft, ref: 2013/J056/ZAR, dated 04 October 2013.

3. PURPOSE OF INVESTIGATION

The purpose of the foundation investigation is to:

- Identify any potential problematic soils which may influence the pile type and design.
- Determine the design parameters for pile design purposes, bearing the potential different pile types applicable to the in-situ soils conditions in mind.
- Provide our recommendations with regards to the most cost effective pile type and design for the site under consideration.

4. METHOD OF INVESTIGATION

4.1 *Digging of test holes, soil profiling and DPSH in-situ testing*

Initially, the fieldwork was planned to be carried out once the bulk earthworks had been completed, allowing complete and unhindered access to investigate representatively across the site.

Unfortunately, programme restraints resulted in the fieldwork to be carried out prior to the site being evacuated and test positions were placed as such to accommodate the existing activities and services.

Based on the piled foundations anticipated for the more heavily loaded column loads of the shopping centre, together with the fairly shallow expected bedrock occurrence below NGL, test holes by means of a Sumitomo SH 200-3 21t traxcavator combined with Dynamic Probe Super Heavy (DPSH) testing were earmarked to assist in providing information with regards to pile design parameters.

In addition, the test holes provided factual confirmation of the occurrence (level) of, and inflow rate of groundwater seepage, which intern is required to establish appropriate pile types.

DPSH testing provides indicative side shear parameters for pile design purposes and refusal of the standard 60° probe generally confirms competent resistance for side shear and end bearing capacities of piles, where applicable.

In total, 4No traxcavator test holes were dug where access was granted and 6No DPSH tests were carried out between test hole positions where test pitting was impossible. In addition, DPSH test results are used to provide in-situ soil consistencies with depth below test hole elevations.

Unfortunately, the abundant scattered occurrence of fill and residual obstructions (boulders, builders rubble and residual corestones, respectively) prevented DPSH cones to be advanced to representative refusal depths, with the bulk of DPSH tests refusing atop these obstructions.

The traxcavator test hole and DPSH test positions' locality plan, together with the soil profiles and DPSH test results are attached hereto in Appendix A, B and C, respectively.

4.2 *Sampling and laboratory testing*

A total number of eight (8No) representative disturbed samples were taken of the in-situ material for laboratory testing.

The following laboratory testing was requested:

- 8No x Foundation indicator tests.
- 8No x Chemical soil aggressiveness tests which comprised of pH and conductivity testing.

The reason for carrying out these tests specifically is described below:

- Foundation indicator testing: To provide basic classification of the in-situ soils in terms of potential expansiveness and/or heave which should be borne in mind in pile designs.
- Chemical soil aggressiveness testing: To determine the proneness of the in-situ material to corrosivity with specific reference to structural concrete for foundations (shallow and piled) as well as underground services (stormwater, water reticulation and sewer pipes and electrical cables).

The laboratory test results are attached hereto in Appendix D.

5 GEOLOGY AND GENERALIZED SOIL PROFILE

5.1 *Geology*

According to the 1:250 000 Vryheid 2530 geological map the site is underlain by medium to coarse grained biotite granite, porphyritic biotite granite or coarse grained hornblende granite of the Pongola Sequence.

Reworked residual, residual granite and granite bedrock was encountered in ¾ of the test holes dug.

In addition, residual diabase, generally associated with granite occurrence, was encountered in the last test hole, TH04, dug on site.

5.2 *Generalized soil profile*

A generalized soil profile was not encountered on site.

From a macro point of view, two distinct soil profiles were encountered and can be summarized as follows:

Fill, alluvium and pebblemarker transported, granite soil/rock profile - Test holes TH01, TH02 & TH03

Depth to (m):	Layer thickness (m):	Description:
1,6 (TH01 only)	1,6	Slightly moist, olive and orange-brown, blotched olive-black, medium dense with intermittent loose to medium dense and dense zones in profile, massive, medium grained silty and clayey SAND with fine to coarse grained gravel, cobbles, boulders and builders rubble (concrete blocks and existing foundations, bricks and UPVC pipes) in profile. Fill.
TH01: 2,2 TH02: 0,5 TH03: 0,6	TH01: 0,8 TH02: 0,4 TH03: 1,4	Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine grained gravel (TH01, TH02 & TH03), cobbles and boulders up to 0,8m in diameter (TH03 only) in profile. Alluvium transported.
0,7 (TH02 only)	0,2	Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine to coarse grained gravel (pebbles) in profile. Pebblemarker transported.
TH01:3,4 TH02: 4,5 TH03: NE	TH01: 1,2 TH02: 3,8 TH03: NA	Moist to very moist, dark orange-brown, mottled and streaked olive-black, firm to stiff (TH01), firm to stiff up to 1,8m becoming soft with intermittent soft to firm zones in profile with depth (TH02), slightly ferruginous and micro-shattered, clayey SILT. Reworked residual granite.
TH01: 3,6 + TH02: 5,0 + TH03: 2,0	TH01: 0,2 + TH02: 0,5 + TH03: 1,4	Moisture content varying between moist to very moist, dark olive-orange (TH01 & TH02), dark yellow-orange (TH03 only) streaked black, medium dense to dense (TH01 & TH03), very dense bordering highly to completely weathered, very soft rock (TH02), relic jointed (TH01 & TH02), massive and friable (TH03 only), fine grained silty micaceous SAND. Residual granite.
Below 2,0m (TH03 only)	Unknown	Dark yellow-orange, streaked black, highly to completely weathered, massive, presumably very closely spaced stained jointed, SOFT ROCK and possibly harder with highly weathered, soft to medium hard rock corestones in profile. Granite.

Alluvium transported, pedogenic, diabase soil profile - Test holes TH04 only

Depth to (m):	Layer thickness (m):	Description:
0,6	0,6	Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine grained gravel, cobbles and boulders (up to 1m in diameter) in profile. Alluvium transported.
1,2	0,6	Moist to very moist, dark yellow and olive-brown, speckled and mottled black (ferricrete nodules), medium dense, ferruginized, fine grained silty slightly clayey SAND with frequently scattered completely weathered ferricrete nodules in profile. Pedogenic.
1,8	0,6	Very moist to wet, dark olive-grey and orange-brown, very soft to soft, shattered and slightly micro-shattered, silty slightly sandy CLAY with abundant scattered, unweathered very hard rock cobbles and boulders (up to 1,5m in diameter) in profile. Reworked residual diabase.
2,3	0,5	Moist to very moist, dark orange-brown, mottled and blotched olive-grey, very soft to soft, slightly ferruginous and slightly micro-shattered, clayey SILT. Reworked residual diabase.
3,0	0,7	Very moist to wet, dark olive and yellow-orange, very soft, relic jointed, sandy SILT, with abundant scattered, unweathered very hard rock cobbles and boulders (up to 1,5m in diameter) in profile. Residual diabase.
3,9	0,9	Wet, dark olive and yellow-orange, medium dense to dense with intermittent loose to medium dense zones in profile, medium to coarse grained silty sand with frequent scattered highly to completely weathered and unweathered to slightly weathered, very soft to soft rock and very hard to extremely hard rock, cobble and boulder size corestones (150mm to 1m in diameter) in profile. Residual diabase.
3,9 +	Unknown	Wet, dark olive and yellow-orange, medium dense to dense with intermittent loose to medium dense zones in profile, medium to coarse grained silty sand with abundant scattered highly to completely weathered and unweathered to slightly weathered, very soft to soft rock and very hard to extremely hard rock, cobble and boulder size corestones (150mm to 1m in diameter) in profile. Residual diabase.

NE = Not encountered

Refusal of the Sumitomo SH 200-3 21t traxcavator occurred in $^{2}/_{4}$ of the test holes dug, whilst difficult advance through bouldary material was noted in an additional test hole.

Refusal of the machine occurred in test hole TH03 at 2,0m below NGL on highly to completely weathered, soft rock and possibly harder bedrock, granite and in test hole TH04 at 3,9m below NGL on an abundant occurrence of cobble and boulder size diabase corestones. Difficult advance was noted in test hole TH01 from NGL to 1,6m below NGL within cobbles, boulders and builders rubble, fill material.

Groundwater seepage was generally not encountered. However, very slight groundwater seepage was noted below 3m in test hole TH04 which resulted in the test hole sidewalls to become unstable and the bottom of the test hole to be completely saturated.

The test holes were thoroughly backfilled immediately after profiling was completed.

6. DISCUSSION AND RECOMMENDATIONS

6.1 *General*

According to the 1:250 000 Vryheid 2530 geological map the site is underlain by medium to coarse grained biotite granite, porphyritic biotite granite or coarse grained hornblende granite of the Pongola Sequence.

Reworked residual, residual granite and granite bedrock was encountered in ¾ of the test holes dug.

In addition, residual diabase, generally associated with granite occurrence, was encountered in the last test hole, TH04, dug on site.

6.2 *Problem soil considerations*

6.2.1 *Collapse potential*

A collapsible grain structure was not noted during the soil profiling of these soils nor was it observed in any of the other soils encountered.

Therefore, no problems insofar collapsibility are expected to occur on site.

6.2.2 *Compressibility and settlement*

When considering the behaviour in terms of compressibility and potential settlement of the in-situ soils with regards to conventional shallow foundation design (pad and/or strip foundations), the following criteria needs to be considered:

- The cut/fill scenario below the structural footprint.
- The anticipated load cases of the proposed structures. The following load cases were provided for analysis purposes:

  Type 1 - Parking area: 850kN
  Type 2 - Ground floor: 150kN
  Type 3 - Level 1: 1250kN
  Type 4 - Level 2: 2300kN

- The influence of the in-situ moisture content on the in-situ allowable bearing capacity of the different soil layers.

- The soil consistencies -and structure of the in-situ soils with depth in terms of allowable bearing capacity and settlement tolerances.

The final bulk earthworks level/s within the shopping centre footprint were not finalized at time of reporting. Nevertheless, with specific reference to the higher loadcases (type 1, 3 & 4), time related settlement in excess of acceptable tolerances (>20mm) are expected to occur, should conventional foundations be placed atop or within the fill, transported, reworked residual and residual soils encountered on site, pending the final footing dimensions and ad hoc geotechnical conditions at founding depth.

6.2.3 *Potential Expansiveness*

According to Van der Merwe (1964), the reworked residual granite and residual diabase soils are prone to be potentially expansive, with representative laboratory test result indicating a "Low to Medium" activity, insofar potential heave is concerned.

However, Van der Merwe's method assumes a complete "dry to wet" cycle to occur in order for heave to take place. We believe that the probability of these soils to undergo the above significant moisture fluctuation is low, especially with depth and below the shopping centre footprint. Therefore, we recommend that the maximum heave for surface beds be limited to 10mm for design purposes.

According to our calculations, all column foundations will still be in a nett compression state.

Therefore, column foundations, albeit shallow, raft (soil and/or concrete raft) or piled foundations do not require special precautionary measures to accommodate potential heave.

6.3 *Groundwater*

Groundwater seepage was generally not encountered. However, very slight groundwater seepage was noted below 3m in test hole TH04 which resulted in the test hole sidewalls to become unstable and the bottom of the test hole to be completely saturated.

It must be noted that the fieldwork was conducted towards the middle of the dry season (29 May 2014) and that groundwater seepage is therefore possible to occur on site, during the rainy season, possibly in the form of a perched water table, especially below soils with competent in-situ soil consistencies and/or at the soil/bedrock interface.

Therefore, we suggest that proper surface run-off and subsurface groundwater drainage form part of the permanent works.

An elevated structural building platform, in the form of an engineered fill, should be considered to provide the above.

Insofar piled foundations is concerned, we strongly suggest allowance should be made for the forming of piles under water with associated sidewall collapse, as suggested under clause 5.8 of this report.

6.4 *Excavatibility*

Excavatability of the in-situ material encountered in the test holes, vary significantly across the site.

Transported and fill boulders, as well as builders rubble are expected to be encountered across the site where manmade fill platforms have been constructed in the past. Cobble and boulder size corestones (between 150mm and up to 1,5m in diameter) have been encountered within the reworked residual diabase, as well in the residual diabase and granite soils (test holes TH03 & TH04).

The following table, Table 1: Excavatibility, summarizes the different classes of excavation to be expected and allowed for in the bulk earthworks, in accordance with SANS 1200D: Earthworks.

	Depth range in test holes (m)				
TH/DPSH position	Soft excavation (m)	Intermediate excavation (m)	Hard excavation (m)	Boulder A (>40% of excavation volume)	Boulder B (<40% of excavation volume) (m)
TH01	1,6 - 3,6 +	NE	NE	0 - 1,6	NE
TH02	0 - 5,0 +	NE	NE	NE	NE
TH03	0 - 0,6	NE	2,0 +	1,6 - 2,0	NE
TH04	0,6 - 1,2	NE	NE	0 - 0,6	NE
	1,8 - 2,3			1,2 - 1,8	
				2,3 - 3,9 +	
DPSH 4	Possible	Possible	Possible	Below NGL	Possible
DPSH 5	3,9	Possible	3,9 +	Possible	Possible
DPSH 6	0,9 - 2,4	Possible	2,1 +	0 - 0,9; 2,1 +	Possible
DPSH 7	Possible	Possible	Possible	NGL +	Possible
DPSH 8	0 - 0,9	Possible	Possible	0,9 +	Possible
DPSH 9	0 - 1,5	Possible	Possible	1,5 +	Possible

Note: NE = Not encountered in test holes

Insofar piling is concerned, we believe that significant problems associated with conventional auger drilling will be experienced, should conventional Auger Concrete Cast In-Situ (ACIS) piles be considered and the in-situ obstructions are not removed prior to the piling operations.

Piling Contractors should bear this in mind when considering the optimum pile type for this project.

Should it appear that the bulk of the bouldary and manmade builders rubble obstructions be removed prior to constructing piling platforms, we strongly suggest that the more modern European auger piling rigs should only be considered for this project. Rigs with a minimum torque of 18 tonne metre and greater/stronger should be considered. However, allowance should still be made for the handling or dealing with these obstructions, should they be encountered.

In addition, various coring and specialized drilling tools should be allowed for to form pile holes and to handle these obstructions during the piling operations.

Straddling of piles across obstructions should be considered, should it not be possible to remove all obstructions.

We believe that Driven Concrete Cast In-Situ (DCIS) and Odex Percussion Drillled Concrete Cast In-Situ (ODEX) piles will be more effective from an installation and costing point of view, should the in-situ obstructions not be removed prior to the piling operations. Oscillator Concrete Cast In-situ (OCIS) piles can also be considered. However, these piles may proof to be more costly and will result in a prolonged piling programme duration.

6.5 *Slope stability*

The sidewalls of all the test holes up to the first occurrence of a fairly high degree of saturation and/or ground water seepage appeared to be completely safe and stable.

However, sidewalls do become unstable where a combined high in-situ moisture content and poor soil consistency exist within profile and we believe that severe sidewall collapse will occur, once pile holes are formed below the first occurrence of a perched water table, should it be encountered.

Therefore, allowance should be made for temporary casings.

No problems are foreseen within shallow excavations insofar slope stability is concerned. However, the status quo can change drastically if water is to be encountered in these excavations, albeit in the form of a shallower perched water table, damaged water pipe or poor surface water run-off which may accidently be draining into excavations during construction.

Therefore, excavation sides deeper than, say 1,5m, must either be battered back to 1:1,5 or shored; allowing safe working conditions for workers in excavations.

6.6 *Soil aggressiveness and corrosivity*

The pH and conductivity of soil is generally determined to get an indication of the potential corrosiveness of the soil. The pH of a soil gives an indication of the acidity of the soil. As a general guideline Evans [6.8] notes that corrosion may take place in soil with a pH of less than 6 and that should the pH be less than 4.5, the problem may be serious. It should however be borne in mind that a low pH value is not necessarily an indication of serious corrosiveness as the pH of the surrounding soil will generally start to rise as soon as corrosion starts.

Should one view the pH values only of the 8No samples tested (pH ranges between 7,73 and 8,92), then the soils classifies as generally not being corrosive.

However, corrosion is an electrochemical process whereby metals are changed and electrical energy is released. The conductivity of the soil therefore has a profound influence on the rate of corrosion of buried metallic objects. Duligal [6.9] provides the following table for evaluation of the conductivity of soil:

Soil conductivity (S/m)	Corrosion classification
More than 0,05	Extremely corrosive
0,025 - 0,05	Very corrosive
0,02 - 0,025	Corrosive
0,01 - 0,02	Mildly corrosive
Less than 0,01	Not generally corrosive

The soil corrosion classification can be summarized as follows:

Soil layer	Soil conductivity (S/m)	Corrosion classification
Fill	0,018	Mildly corrosive
Alluvium transported	0,009	Not generally corrosive
Pedogenic soils	0,028	Corrosive to very corrosive
Reworked and residual granite	Between 0,010 and 0,033	Not generally corrosive to very corrosive
Reworked and residual diabase	Between 0,045 and 0,068	Very to extremely corrosive

Therefore, we suggest that a "very severe" exposure condition should be followed for this site in order to prevent services to corrode with time.

Therefore, subsurface services should be treated/sleeved to prevent possible damages due to corrosion.

According to SANS 1200G: Concrete (Structural), concrete used for foundations of structures within potentially aggressive soils should have the following minimum concrete cover and maximum water:cement ratio's:

Exposure conditions	Specified strength of concrete (MPa)					Minimum cover for various exposure conditions (mm)
	20	25	30	40	50	
Mild	20	20	15	15	15	
Moderate	40	40	30	25	20	
Severe	NA	50	40	40	35	
Very severe	NA	NA	75	60	50	

Type of structures	Exposure conditions			
	Mild	Moderate	Severe	Very severe
Thin sections, reinforced piles, all sections with less than 25mm cover to reinforcement	*	0.53	0.48	0.4
Moderate sections, retaining walls, piers, beams	*	*	0.53	0.43
Exterior portions of mass concrete	*	*	0.53	0.43
Concrete slabs laid on ground	*	0.53	0.48	*
Concrete protected from the weather, inside buildings, or in ground below frost level	*	*	*	*
* In these cases the ratio will be based on strength for workability required				

The soil aggressiveness and corrosivity laboratory test results are included in Appendix E.

6.7 *Proposed founding and piling considerations*

The following column load cases have been provided, namely:

- Type 1 - Parking area: 850kN
- Type 2 - Ground floor: 150kN
- Type 3 - Level 1: 1250kN
- Type 4 - Level 2: 2300kN

Conventional shallow foundations should be considered for the Type 2 column load case. An engineered fill mattress or soil raft may be required in this case, pending on the exact site location in relation to the ad hoc geotechnical conditions at these positions.

Insofar the remainder of the loadcases are concerned, we believe that a piled foundation solution should preferably adopted.

When consider the method of piling, special consideration must be given to the significant occurrence of the fill obstructions, granite and diabase corestone occurrence. Reference should be made to the soil profiles, DPSH test results and in this regard.

Fill obstructions in the form of cobbles, boulders and builders rubble are expected to occur across the site when one considers the obstructions encountered in test hole TH01 and DPSH tests DPSH 7, 8, 9 specifically, and possibly 6 as well.

Cobble and boulder size granite and diabase corestones were encountered in test holes TH03 and TH04, and are expected to occur across the site as noted during the DPSH testing (see Table 1 in clause 6.2.2).

Therefore, Auger Concrete Cast In-Situ (ACIS) piles should only be considered, should these obstructions be removed during the bulk earthworks operations and we strongly suggest that the more modern European auger piling rigs should only be considered in this case. Rigs with a minimum torque of 18 tonne metre and greater/stronger should be considered. However, allowance should still be made for the handling or dealing with these obstructions. However, significant programme delays with associated costs will be the result should auger piling be attempted on site, should the ad hoc bouldary and builders rubble status remains unchanged.

In view of the high probability of corestone and obstruction occurrence, Continuous Flight Auger Concrete Cast In-Situ (CFA) piles should not be considered at all for this project.

In addition, groundwater seepage with associated sidewall collapse are likely to occur, especially at the first occurrence of dense and/or bedrock material. Allowance should therefore be made in the piling operations for the effective installation and, in the case of ACIS, Driven Concrete Cast In-Situ (DCIS) and Oscillator Concrete Cast In-Situ (OCIS) piles, extraction of temporary casings. Permanent casings are generally employed in the case of Odex Percussion Drilled Concrete Cast In-Situ (ODEX) piles and should be allowed for in this project.

In addition, allowance should be made to place concrete under water by means of tremie concreting, should DCIS piles not be considered.

Bearing the bouldary and builders rubble profile encountered on site in mind, DCIS piles should take preference, should these obstructions not be removed during the bulk earthworks operations. ODEX and OCIS piles may be considered for the same reason. However, in our experience both these (ODEX and OCIS) pile types are considerably more expensive than DCIS piles, should one consider the in-situ soil conditions.

For budget purposes and taking the aforementioned into account, we suggest that the following should be considered for the various pile types:

	ACIS			DCIS			OCIS			ODEX		
WL (kN)	Dia (mm)	CL (m)	DL (m)	Dia (mm)	CL (m)	DL (m)	Dia (mm)	CL (m)	DL (m)	Dia (mm)	CL (m)	DL (m)
850	600,0	8,0	10,5	520	5,0	5,0	1000	8,0	9,5	600	8,0	10,5
1250	600,0	8,0	11,5	610	5,0	5,0	1000	8,0	10,0	600	8,0	11,5
2300	750,0	8,0	13,0	750	5,0	5,0	1000	8,0	12,0	2 x 600	8,0	11,0

Note:

1 Dia = Pile diameter (mm)

2 CL = Anticipated casing installation depth (m)

3 DL = Drilled/advance length (m)

4 30MPA tremie concrete should be allowed for.

5 Allowance should be made for 0,6% pile reinforcing to be installed over the full concrete shaft length.

We strongly recommend that confirmation test holes with a traxcavator, capable of reaching a minimum depth of 5m below platform level be dug and inspected, prior to final founding decision making.

All foundations and pile designs should be inspected and verified prior to placement of any reinforcing and concrete by a competent person, and we confirm our availability in this regard, should it be requested.

We trust that you find the above in order. Should you wish to discuss the above in any further detail, please do not hesitate to contact the undersigned.

Yours faithfully,

P F van Straten

7 REFERENCES

7.1 JENNINGS, J.E, BRINK, A.B.A & WILLIAMS, A.A.B. Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa. Trans. S Afr. Inst. Civ. Engrs. Vol. 15, No. 1, 1973, pp3 to 12.

7.2 JENNINGS, J.E & KNIGHT, K. A Guide to the Construction on, or with Materials Exhibiting Additional Settlement due to Collapse. 6th Regional Conference for Africa on Soil Mechanics & Foundation Engineering. Durban, South Africa, September 1975.

7.3 SCHWARTZ, K. (1985): Problem Soils in South Africa - State of the Art: Collapsible Soils. The Civil Engineer in South Africa, Volume 27, No. 7. July 1985.

7.4 VAN DER MERWE, D.H. The prediction of Heave from the Plasticity Index and the Percentage Clay Fraction. The Civil Engineer in South Africa. Vol. 6, No. 6, 1964.

7.5 COLLINS, L.E. (1953). A Preliminary Theory for the Design of Underreamed Piles, in relation to the Leeuhof Clays of the Orange Free State. Proceedings of the S.A. Institution of Civil Engineers.

7.6 TOMLINSON M.J. Pile Design and Construction Practice. Fourth Edition.

7.7 SOUTH AFRICAN INSTITUTE OF CIVIL ENGINEERS. Code of Practice: Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction. Joint structural division, 1995, Johannesburg.

7.8 EVANS, U R. The Corrosion and Oxidation of Metals: Scientific principles and practical applications. Edward Arnold (Publishers) Ltd. 1977.

7.9 DULIGAL E. Significance of Soil Resistivity on Corrosivity. Unpublished report compiled for Africon. 1996.

APPENDIX A:

TEST HOLE AND DPSH TEST POSITIONS

LOCALITY MAP

TESTHOLE & DPSH POSITIONS

LEGEND:

TH 1	TESTHOLE NUMBER & POSITION
	TEST HOLE DEPTH, m
	TEST HOLE REFUSAL DEPTH, m
	GROUNDWATER SEEPAGE, m
DPSH 5	DYNAMIC PROBE SUPER HEAVY TEST NUMBER & POSITION
	DPSH TEST REFUSAL, m

TESTHOLE DATA:

TESTHOLE	TH 1	TH 2	TH 3	TH 4
	3.60 m	5.00 m	2.10 m	3.90 m
	NOT ENCOUNTERED		2.10 m	3.90 m
	NOT ENCOUNTERED			3.90 m

DPSH DATA:

DPSH No.	DPSH 4	DPSH 5	DPSH 6	DPSH 7	DPSH 8	DPSH 9
	0.90 / 3.0 m	4.20 m	2.40 m	< 0.30 m	1.20 m	1.80 m

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Fax: +27 86 658 0641
geosimplicity@gmail.com

PROJECT:

FIGURE 1:
FOUNDATION INVESTIGATION TO PIET RETIEF MALL.
MPUMALANGA PROVINCE.

REVISIONS:	DATE:
01 DPSH & DATA & PROJECT NAME	29-SEPTEMBER-2014
	DRAWING No: G082-DRW01-REV.01
	REVISION No: 01

APPENDIX B:

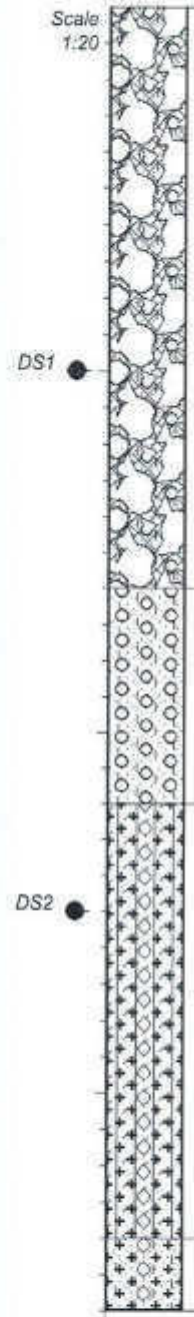
SOIL PROFILES

Geo Simplicity Geotechnical Engineering (Pty) Ltd

Zarafusion (Pty) Ltd t/a Piet Retief
Foundation Investigation to the Proposed
Piet Retief Shopping Mall

HOLE No: TH 01
Sheet 1 of 1

JOB NUMBER: G082



0.00

Slightly moist, olive and orange-brown, blotched olive-black, medium dense with intermittent loose to medium dense and dense zones in profile, massive, medium grained silty and clayey SAND with fine to coarse grained gravel, cobbles, boulders and builders rubble (concrete blocks and existing foundations, bricks and UPVC pipes) in profile. Fill.

1.60

Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine grained gravel in profile. Alluvium transported.

2.20

Moist to very moist, dark orange-brown, mottled and blotched olive-grey, soft to firm, slightly ferruginous and micro-shattered, clayey SILT. Reworked residual granite.

3.40

Very moist, dark olive-orange, streaked black, medium dense to dense, relic jointed, fine grained silty micaceous SAND. Residual granite.

3.60

NOTES

1) No groundwater seepage encountered in test hole.

2) Maximum reach of Sumitomo SH 200-3 Excavator - no refusal encountered. However, difficult to advance through obstructions encountered up to 1,6m below NGL.

3) Test hole sidewalls appear to be completely stable throughout the soil profiling process with no sidewall collapse to report.

4) Disturbed sample DS1 at 1m for Foundation Indicator, pH and Conductivity.
Disturbed sample DS2 at 2,5m for Foundation Indicator, pH and Conductivity.

CONTRACTOR : PW Mouton cc
MACHINE : Sumitomo SH 200-3 Excavator
DRILLED BY : N/A
PROFILED BY : PF van Straten

INCLINATION : Vertical
DIAM : Trench
DATE : 29/05/14
DATE : 29/05/14

ELEVATION : 1235m
X-COORD : S 27°00'37,3"
Y-COORD : E 30°48'16,8"

HOLE No: TH 01

TYPE SET BY : T Schulz
SETUP FILE : STANDARD.SET

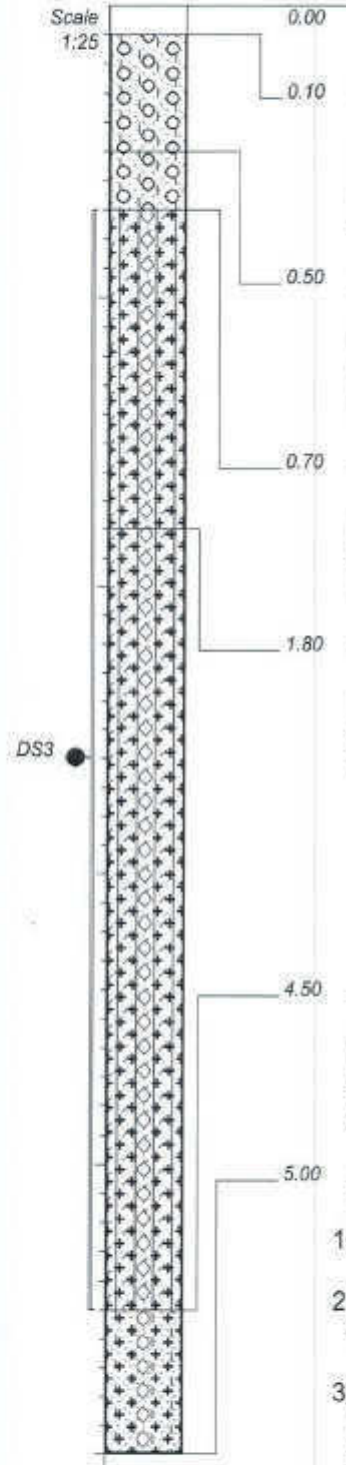
DATE : 30/09/2014 08:27
TEXT : ..PLOT\G082SoilProfile.TXT

Geo Simplicity Geotechnical Engineering (Pty) Ltd

Zarafusion (Pty) Ltd t/a Piet Retief
Foundation Investigation to the Proposed
Piet Retief Shopping Mall

HOLE No: TH 02
Sheet 1 of 1

JOB NUMBER: G082



0.00 — Lawn.

0.10 — Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine grained gravel in profile. Alluvium transported.

0.50 — Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine to coarse grained gravel (pebbles) in profile. Pebblemarker transported.

0.70 — Moist to very moist, dark orange-brown, mottled and streaked olive-black, firm to stiff, slightly ferruginous and micro-shattered, clayey SILT. Reworked residual granite.

1.80 — Moist to very moist, dark orange-brown, mottled and streaked olive-black, soft with intermittent soft to firm zones in profile, slightly ferruginous and micro-shattered, clayey SILT. Reworked residual granite.

4.50 — Very moist, dark olive-orange, streaked black, very dense bordering highly to completely weathered, very soft rock, relic jointed, fine grained silty micaceous SAND. Residual granite.

5.00

NOTES

1) No groundwater seepage encountered in test hole.

2) Maximum reach of Sumitomo SH 200-3 Excavator - no refusal encountered.

3) Test hole sidewalls appear to be fairly stable throughout the soil profiling process. However, sidewall collapse anticpated, should excavation sides be left open for prolonged periods of time due to the combined high in-situ moisture content and poor soil consistency encountered in profile.

4) Disturbed sample DS3 mix at 0,7--4,5m for Foundation Indicator, pH and Conductivity.

CONTRACTOR : PW Mouton cc
MACHINE : Sumitomo SH 200-3 Excavator
DRILLED BY : N/A
PROFILED BY : PF van Straten

INCLINATION : Vertical
DIAM : Trench
DATE : 29/05/14
DATE : 29/05/14

ELEVATION : 1233m
X-COORD : S 27°00'38,9"
Y-COORD : E 30°48'18,6"

HOLE No: TH 02

TYPE SET BY : T Schulz
SETUP FILE : STANDARD.SET

DATE : 30/09/2014 08:27
TEXT : ..PLOT\G082SoilProfile.TXT

Geo Simplicity Geotechnical Engineering (Pty) Ltd

Zarafusion (Pty) Ltd t/a Piet Retief
Foundation Investigation to the Proposed
Piet Retief Shopping Mall

HOLE No: TH 03
Sheet 1 of 1

JOB NUMBER: G082

0.00 – 0.60

Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine grained gravel, cobbles and boulders (up to 0,8m in diameter) in profile. Alluvium transported.

0.60 – 2.00

Moist to very moist, dark yellow-orange, streaked black, medium dense to dense, massive and friable, fine grained silty SAND, Residual granite. Note: Abundantly scaterred, highly to completely weathered, very soft to medium hard rock corestones in a dense to very dense, medium to coarse grained silty SAND, residual granite matrix encountered from 0,6m to 2,0m below NGL in the Western face of the testhole.

2.00 +

Dark yellow-orange, streaked black, highly to completely weathered, massive, presumably very closely spaced stained jointed, SOFT ROCK and possibly harder with highly weathered, soft to medium hard rock corestones in profile. Granite.

NOTES

1) No groundwater seepage encountered in test hole.

2) Refusal of Sumitomo SH 200-3 Excavator at 2.0m on soft rock and possibly harder granite.

3) Test hole sidewalls appear to be completely stable throughout the soil profiling process with no sidewall collapse to report.

CONTRACTOR : PW Mouton cc
MACHINE : Sumitomo SH 200-3 Excavator
DRILLED BY : N/A
PROFILED BY : PF van Straten

TYPE SET BY : T Schulz
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : Trench
DATE : 29/05/14
DATE : 29/05/14

DATE : 30/09/2014 08:27
TEXT : ..PLOT\G082SoilProfile.TXT

ELEVATION : 1228m
X-COORD : S27°00'41,1"
Y-COORD : E30°48'22,5"

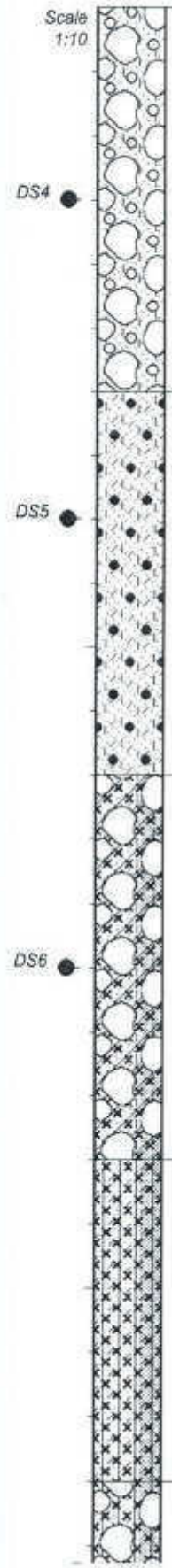
HOLE No: TH 03

Geo Simplicity Geotechnical Engineering (Pty) Ltd

Zarafusion (Pty) Ltd t/a Piet Retief
Foundation Investigation to the Proposed
Piet Retief Shopping Mall

HOLE No: TH 04
Sheet 1 of 2

JOB NUMBER: G082



0.00

Moist, dark olive-black, speckled black, dense, massive, fine to medium grained silty SAND with abundant scattered fine grained gravel, cobbles and boulders (up to 1m in diameter) in profile. Alluvium transported.

0.60

Moist to very moist, dark yellow and olive-brown, speckled and mottled black (ferricrete nodules), medium dense, ferruginized, fine grained silty slightly clayey SAND with frequently scattered completely weathered ferricrete nodules in profile. Pedogenic.

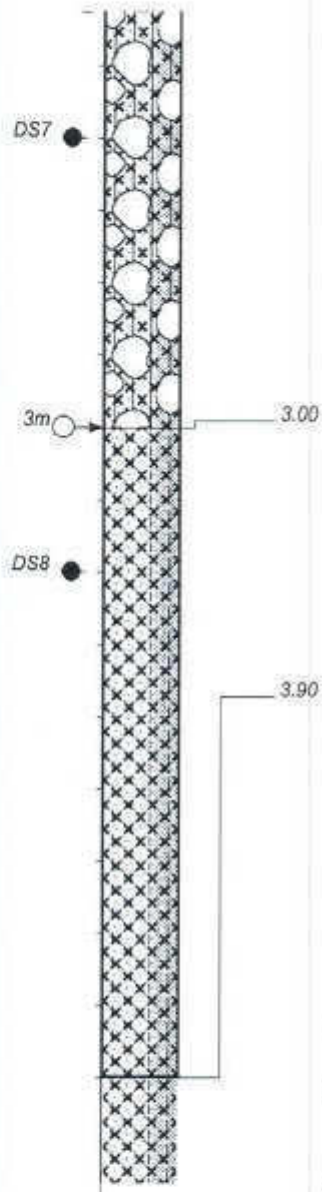
1.20

Very moist to wet, dark olive-grey and orange-brown, very soft to soft, shattered and slightly micro-shattered, silty slightly sandy CLAY with abundant scattered, unweathered very hard rock cobbles and boulders (up to 1,5m in diameter) in profile. Reworked residual diabase.

1.80

Moist to very moist, dark orange-brown, mottled and blotched olive-grey, very soft to soft, slightly ferruginous and slightly micro-shattered, clayey SILT. Reworked residual diabase.

2.30



Very moist to wet, dark olive and yellow-orange, very soft, relic jointed, sandy SILT, with abundant scattered, unweathered very hard rock cobbles and boulders (up to 1,5m in diameter) in profile. Residual diabase.

Wet, dark olive and yellow-orange, medium dense to dense with intermittent loose to medium dense zones in profile, medium to coarse grained silty sand with frequent scattered highly to completely weathered and unweathered to slightly weathered, very soft to soft rock and very hard to extremely hard rock, cobble and boulder size corestones (150mm to 1m in diameter) in profile. Residual diabase.

Wet, dark olive and yellow-orange, medium dense to dense with intermittent loose to medium dense zones in profile, medium to coarse grained silty sand with abundant scattered highly to completely weathered and unweathered to slightly weathered, very soft to soft rock and very hard to extremely hard rock, cobble and boulder size corestones (150mm to 1m in diameter) in profile. Residual diabase.

NOTES

1) Very slight groundwater seepage at 3m encountered in test hole.

2) Bottom of test hole noted to be completely saturated but no water standing, even at 40 minutes after digging.

3) Refusal of Sumitomo SH 200-3 Excavator on very hard to extremely hard rock corestones at 3.9m below natural ground level.

4) Test hole sidewalls becoming unstable below 2,5m.

5) Disturbed sample DS4 at 0,3m for Foundation Indicator.
Disturbed sample DS5 at 0,8m for Foundation Indicator, pH and Conductivity.
Disturbed sample DS6 at 1,5m for Foundation Indicator, pH and Conductivity.
Disturbed sample DS7 at 2,6m for Foundation Indicator, pH and Conductivity.
Disturbed sample DS8 at 3,2m for Foundation Indicator, pH and Conductivity.

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Zarafusion (Pty) Ltd t/a Piet Retief
Foundation Investigation to the Proposed
Piet Retief Shopping Mall

LEGEND
Sheet 1 of 1

JOB NUMBER: G082

BOULDERS	{SA01}
GRAVEL	{SA02}
SAND	{SA04}
SANDY	{SA05}
SILT	{SA06}
SILTY	{SA07}
CLAY	{SA08}
CLAYEY	{SA09}
GRANITE	{SA17}{SA44}
DIABASE	{SA18}{SA41}
FERRICRETE NODULES	{SA24}
RUBBLE	{SA31}
FILL	{SA32}
CRUSHED ROCK	{SA33}
DISTURBED SAMPLE	{SA38}
WATER SEEPAGE/water strike	{CH50}

Name ●

15.5○→

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY : T Schulz
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 30/09/2014 08:27
TEXT : ..PLOT\G082SoilProfile.TXT

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

APPENDIX C:

DPSH TEST RESULTS

PENETROMETER RESULTS			MAKARIOS GEOTECHNICAL CONTRACTORS (082 896 8481)					
Job No			REMARKS:					
Project	Piet Retief							
Site								
Date	29/05/2014							
Done by	Neer							
DEPTH	**7A**	**7B**	**8**	**5**	**6**	**4A**	**4B**	**9**
0,3	130	134	38	64	99	99	97	36
0,6			46	40	35	93	22	43
0,9			49	17	19	120	15	69
1,2			130	16	13		7	80
1,5				14	15		13	94
1,8				13	17		19	100
2,1				12	49		21	
2,4				12	100		59	
2,7				11			72	
3				18			100	
3,3				22				
3,6				40				
3,9				62				
4,2				100				
4,5								
4,8								
5,1								
5,4								
5,7								
6								
6,3								
6,6								
6,9								
7,2								
7,5								
7,8								
8,1								
8,4								
8,7								
9								
9,3								
9,6								
9,9								
10,2								
Redrive								
0,3				2				
0,6				2				

APPENDIX D:

LABORATORY TEST RESULTS

ROADLAB
Civil Engineering Materials Laboratory
(PTY) LTD
Established 1965

HEAD OFFICE
207 Rietfontein Rd Primrose Germiston 1401
P O Box 1476 Germiston 1400
Tel: 011 828 0279 Fax: 011 828 0273
E-mail: info@roadlab.co.za
www.roadlab.co.za

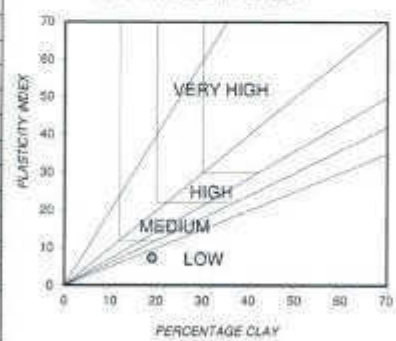
OUR REF : 92/GE0013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH01 : DS1
LAYER : 1.0m
SAMPLE No. : S2667
SAMPLE DESCRIPTION : Light Brown Ferricrete Gravel & Quartz

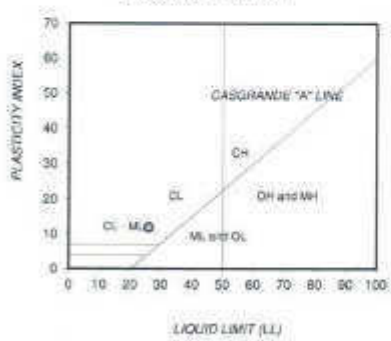
FOUNDATION INDICATOR RESULTS

Weighted PI		7.44
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	96
	26.5	96
	19.0	94
	13.2	93
	4.75	87
	2.000	77
	0.425	62
	0.250	52
	0.150	40
	0.075	28
	0.050	25
	0.005	23
	0.002	19
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	15.0
	0.425 - 0.250	10.0
	0.250 - 0.150	12.0
	0.150 - 0.075	12.0
	< 0.075	36.4
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		4.0
Shrinkage Product		372.0
Grading Coefficient		16.5
Grading modulus		1.33
Atter-berg Limits	Liquid Limit	26
	Plasticity Index	12
	Linear Shrinkage	6
Unified Soil Classification		SC
U.S. Highway Classification		A-2-6(0)
pH - Value		N/A
Conductivity mS/cm		N/A

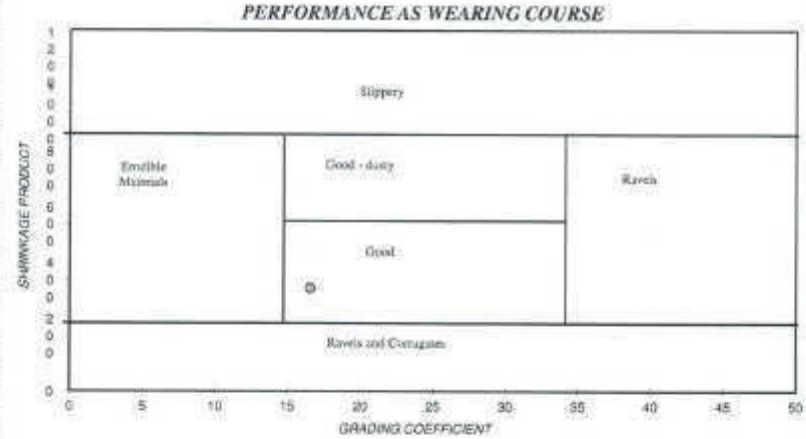
POTENTIAL EXPANSION



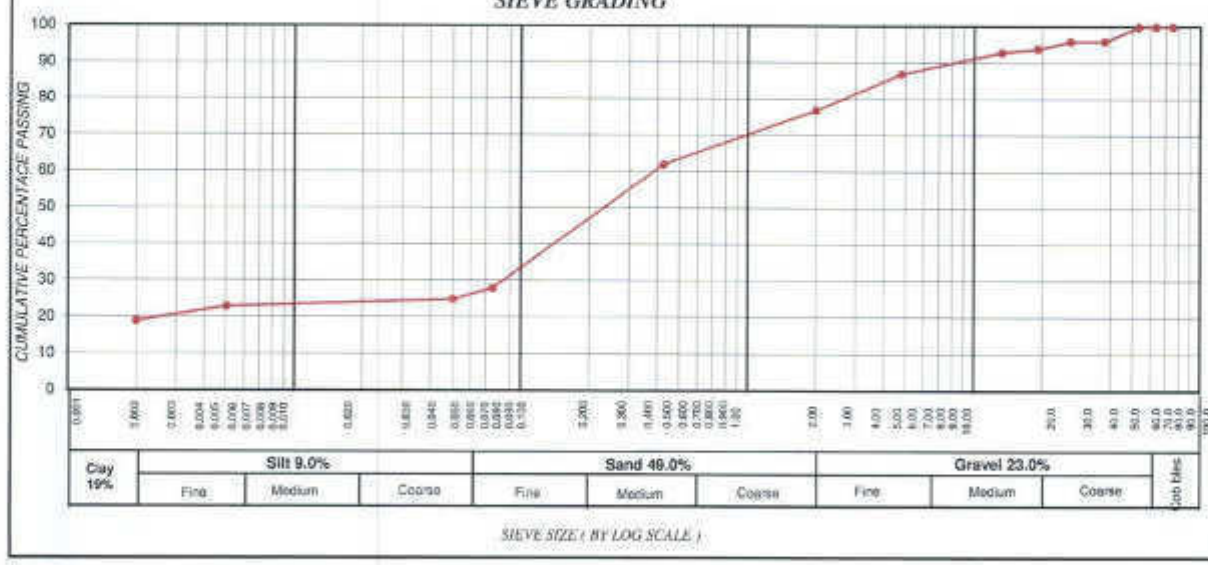
PLASTICITY CHART



PERFORMANCE AS WEARING COURSE



SIEVE GRADING



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Established 1965

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Tel: 011 828 0279 Fax: 011 828 0273
E-mail: info@roadlab.co.za
www.roadlab.co.za

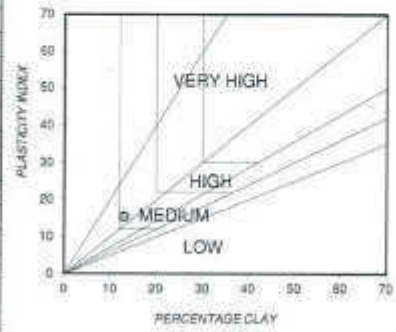
OUR REF : 92/GEO013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH01 : DS2
LAYER : 2.5m
SAMPLE No. : S2668
SAMPLE DESCRIPTION : Light Yellow Orange Ferricrete

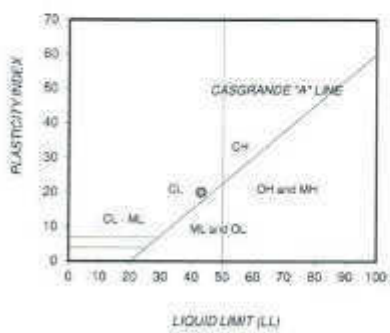
FOUNDATION INDICATOR RESULTS

Weighted PI		**15.4**
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	99
	4.75	92
	2.000	84
	0.425	77
	0.250	57
	0.150	40
	0.075	18
	0.050	16
	0.005	15
	0.002	13
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	7.0
	0.425 - 0.250	20.0
	0.250 - 0.150	17.0
	0.150 - 0.075	22.0
	< 0.075	21.4
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		672.2
Grading Coefficient		14.7
Grading modulus		1.21
Atterberg Limits	Liquid Limit	43
	Plasticity Index	20
	Linear Shrinkage	8.73
Unified Soil Classification		SC
U.S. Highway Classification		A-2-7(1)
pH - Value		N/A
Conductivity mS/cm		N/A

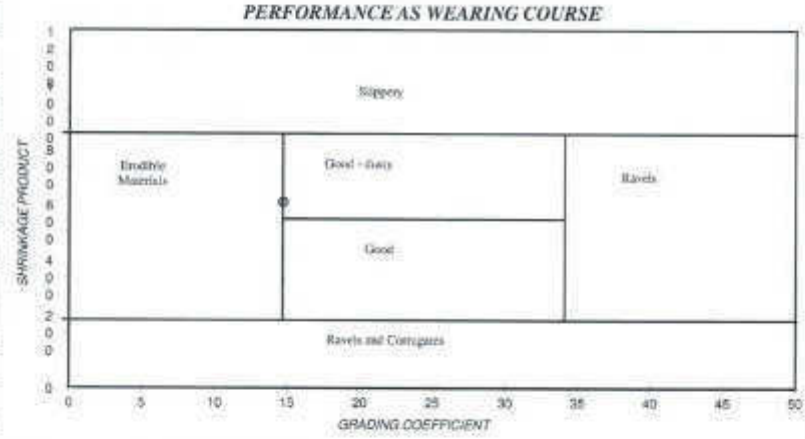
POTENTIAL EXPANSION



PLASTICITY CHART



PERFORMANCE AS WEARING COURSE



SIEVE GRADING

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E-mail: info@roadlab.co.za
www.roadlab.co.za

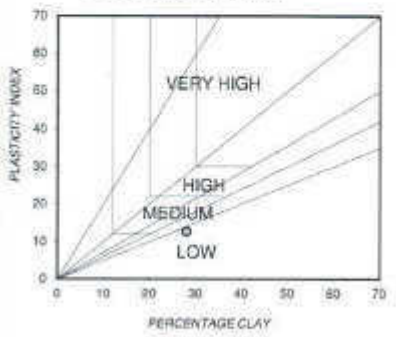
OUR REF : 92/GEO013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH02 : DS3
LAYER : Mix 0.7m TO 4.5m
SAMPLE No. : S2669
SAMPLE DESCRIPTION : Light Red Orange Ferricrete & Quartz

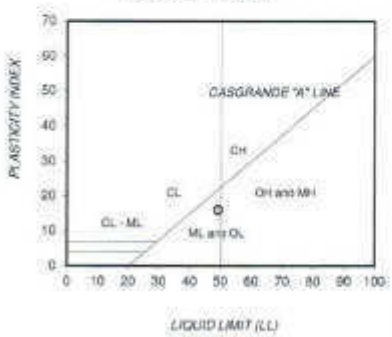
FOUNDATION INDICATOR RESULTS

Weighted PI		12.64
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	99
	13.2	98
	4.75	94
	2.000	88
	0.425	79
	0.250	67
	0.150	55
	0.075	42
	0.050	38
	0.005	34
	0.002	28
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	9.0
	0.425 - 0.250	12.0
	0.250 - 0.150	12.0
	0.150 - 0.075	13.0
	< 0.075	47.7
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		594.9
Grading Coefficient		11.3
Grading modulus		0.91
Atterberg Limits	Liquid Limit	49
	Plasticity Index	16
	Linear Shrinkage	7.53
Unified Soil Classification		SC
U.S. Highway Classification		A-6(4)
pH - Value		N/A
Conductivity mS/cm		N/A

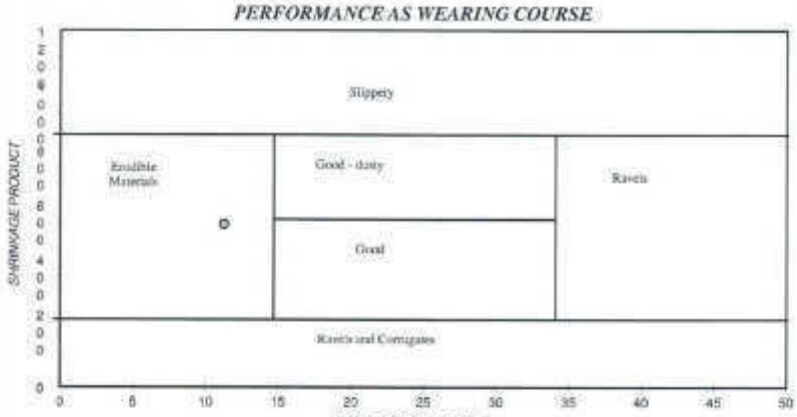
POTENTIAL EXPANSION



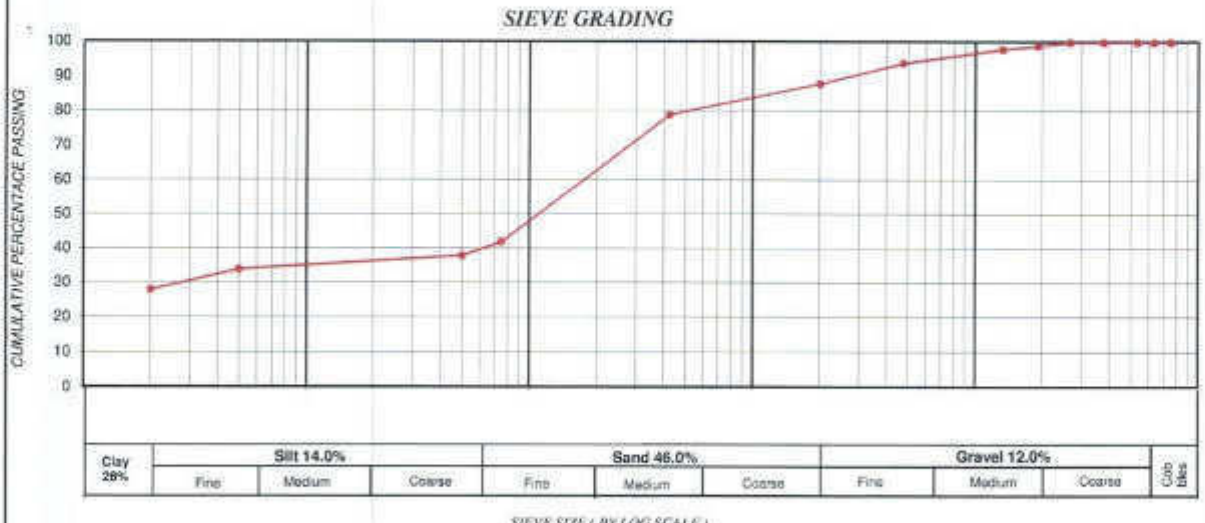
PLASTICITY CHART



PERFORMANCE AS WEARING COURSE



SIEVE GRADING



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Established 1965

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E-mail: info@roadlab.co.za
www.roadlab.co.za

OUR REF : 92/GEO013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH04 : DS4
LAYER : 0.3m
SAMPLE No. : S2670
SAMPLE DESCRIPTION : Dark Brown Ferricrete Gravel

FOUNDATION INDICATOR RESULTS

Weighted PI	**4.2**

Sieve analysis Cumulative percentage passing (mm)

75.0	100
63.0	100
53.0	100
37.5	90
26.5	83
19.0	73
13.2	71
4.75	59
2.000	44
0.425	30
0.250	25
0.150	20
0.075	14
0.050	12
0.005	10
0.002	8

Soil Mortar Analysis % < 2.00mm

2.000 - 0.425	14.0
0.425 - 0.250	5.0
0.250 - 0.150	5.0
0.150 - 0.075	6.0
< 0.075	31.8

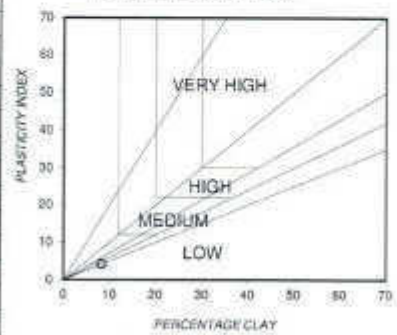
Effective size	0.005
Uniformity Coefficient	22.8
Curvature Coefficient	7.4
Oversize Index	10.0
Shrinkage Product	205.8
Grading Coefficient	23.0
Grading modulus	2.12

Atterberg Limits

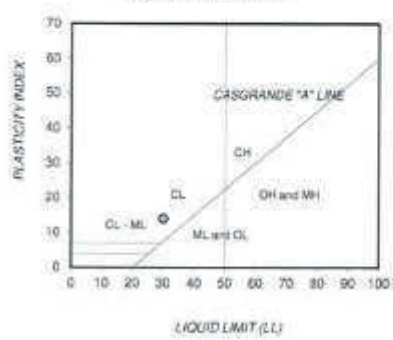
Liquid Limit	30
Plasticity Index	14
Linear Shrinkage	6.86

Unified Soil Classification	SC
U.S. Highway Classification	A-2-6(0)
pH - Value	N/A
Conductivity mS/cm	N/A

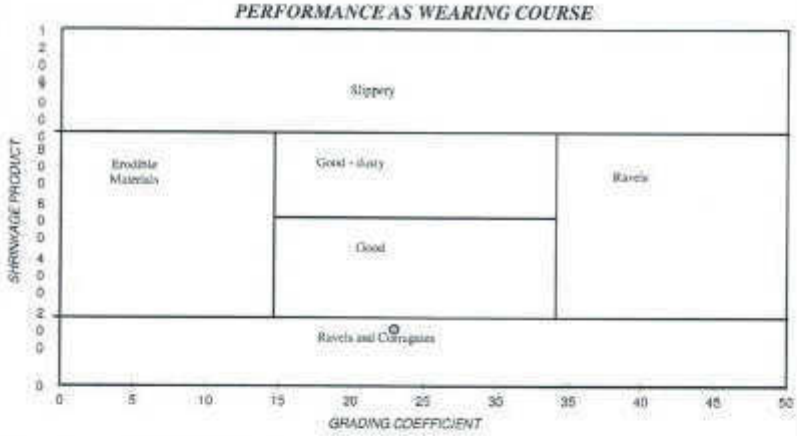
POTENTIAL EXPANSION



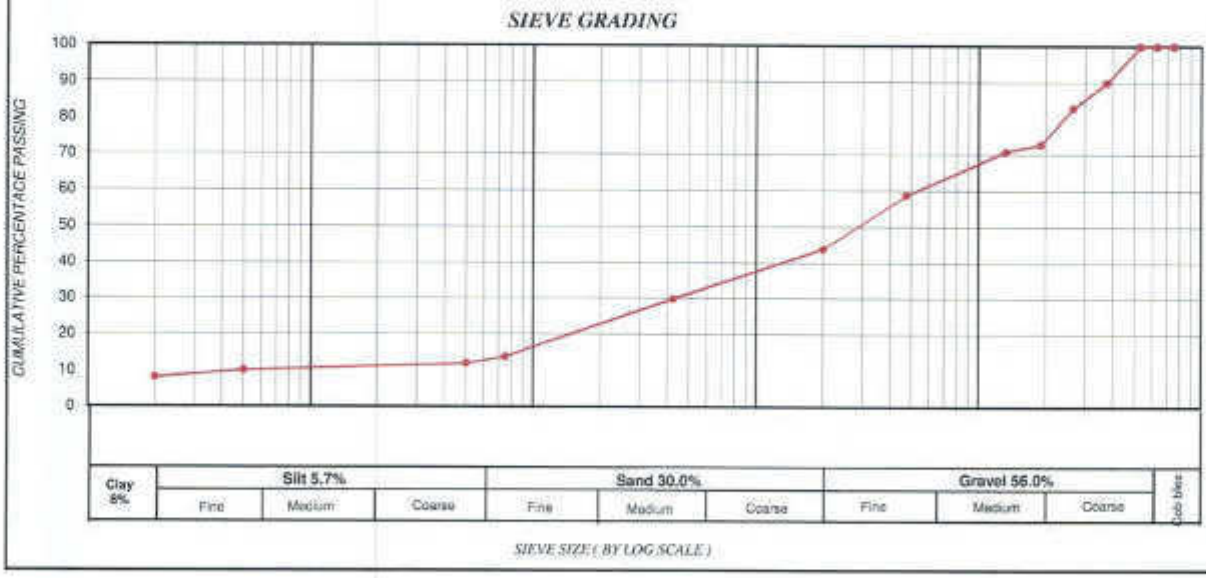
PLASTICITY CHART



PERFORMANCE AS WEARING COURSE



SIEVE GRADING



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E-mail: info@roadlab.co.za
www.roadlab.co.za

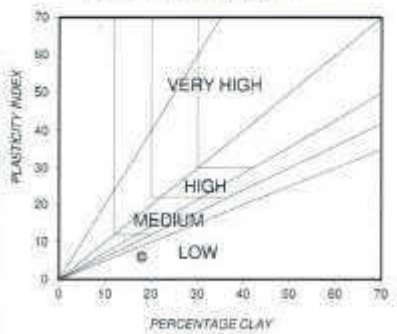
OUR REF : 92/GE0013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH04 : DS5
LAYER : 0.8m
SAMPLE No. : S2671
SAMPLE DESCRIPTION : Dark Yellow Ferricrete

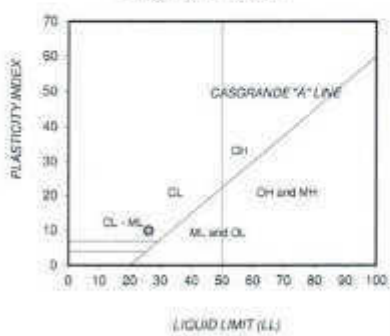
FOUNDATION INDICATOR RESULTS

Weighted PI		6
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	93
	2.000	79
	0.425	60
	0.250	50
	0.150	40
	0.075	27
	0.050	24
	0.005	21
	0.002	18
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	19.0
	0.425 - 0.250	10.0
	0.250 - 0.150	10.0
	0.150 - 0.075	13.0
	< 0.075	34.2
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		259.8
Grading Coefficient		19.5
Grading modulus		1.34
Atter-berg Limits	Liquid Limit	26
	Plasticity Index	10
	Linear Shrinkage	4.33
Unified Soil Classification		SC
U.S. Highway Classification		A-2-4(0)
pH - Value		N/A
Conductivity mS/cm		N/A

POTENTIAL EXPANSION



PLASTICITY CHART



PERFORMANCE AS WEARING COURSE

SIEVE GRADING

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E-mail: info@roadlab.co.za
www.roadlab.co.za

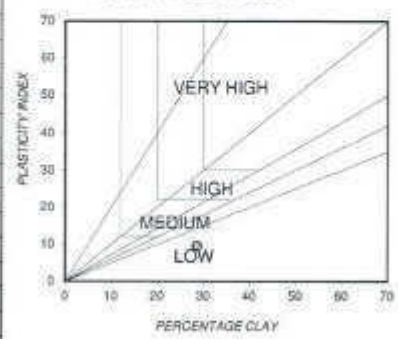
OUR REF : 92/GE0013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH04 : DS6
LAYER : 1.5m
SAMPLE No. : S2672
SAMPLE DESCRIPTION : Light Yellow Ferricrete

FOUNDATION INDICATOR RESULTS

Weighted PI		9.5
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	99
	2.000	98
	0.425	95
	0.250	80
	0.150	63
	0.075	44
	0.050	37
	0.005	33
	0.002	29
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	3.0
	0.425 - 0.250	15.0
	0.250 - 0.150	17.0
	0.150 - 0.075	19.0
	< 0.075	44.9
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		430.4
Grading Coefficient		2.0
Grading modulus		0.63
Atterberg Limits	Liquid Limit	30
	Plasticity Index	10
	Linear Shrinkage	4.53
Unified Soil Classification		SC
U.S. Highway Classification		A-4(1)
pH - Value		N/A
Conductivity mS/cm		N/A

POTENTIAL EXPANSION



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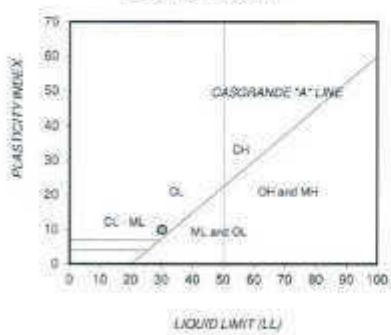
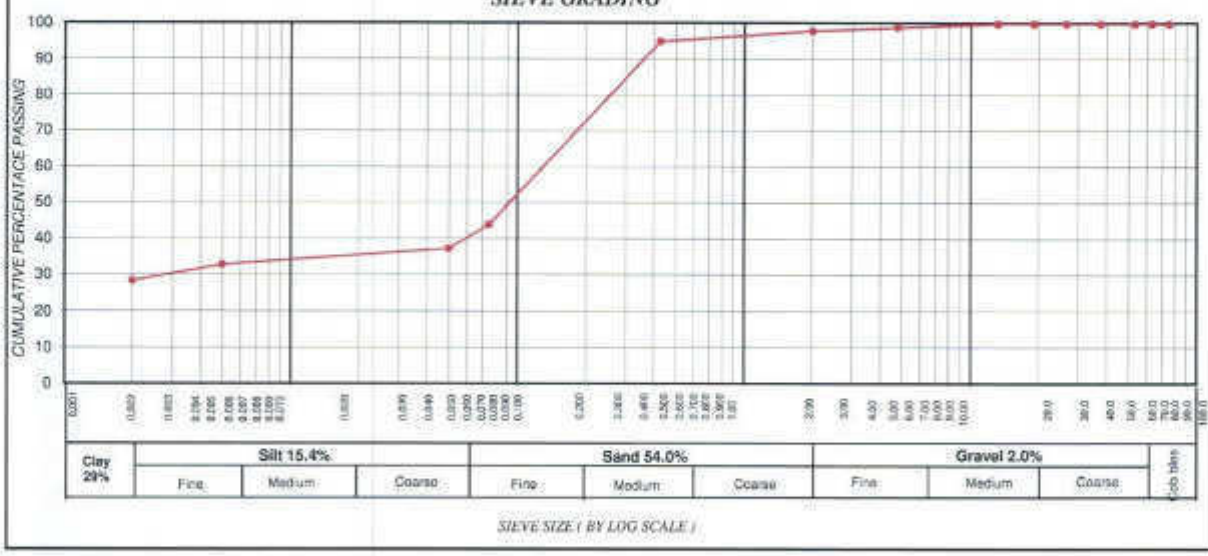


PERFORMANCE AS WEARING COURSE

SIEVE GRADING



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E-mail: info@roadlab.co.za
www.roadlab.co.za

OUR REF : 92/GEO013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH04 : DS7
LAYER : 2.6m
SAMPLE No. : S2673
SAMPLE DESCRIPTION : Light Yellow Ferricrete

FOUNDATION INDICATOR RESULTS

Weighted PI	**13.5**

Sieve analysis Cumulative percentage passing (mm)

75.0	100
63.0	100
53.0	100
37.5	100
26.5	100
19.0	100
13.2	100
4.75	99
2.000	97
0.425	90
0.250	74
0.150	57
0.075	37
0.050	32
0.005	27
0.002	20

Soil Mortar Analysis % < 2.00mm

2.000 - 0.425	7.0
0.425 - 0.250	16.0
0.250 - 0.150	17.0
0.150 - 0.075	20.0
< 0.075	38.1

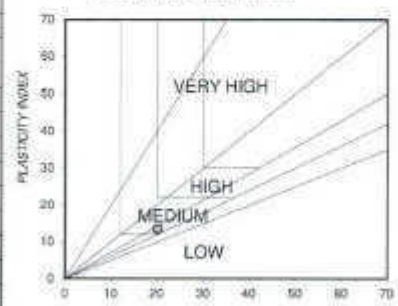
Effective size	0.005
Uniformity Coefficient	22.8
Curvature Coefficient	7.4
Oversize Index	0.0
Shrinkage Product	635.4
Grading Coefficient	3.0
Grading modulus	0.76

Atter-berg Limits

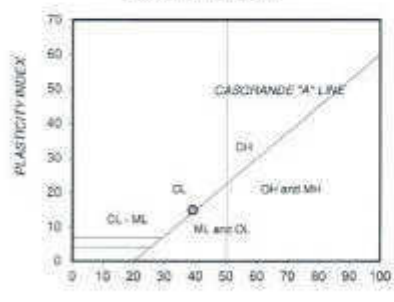
Liquid Limit	39
Plasticity Index	15
Linear Shrinkage	7.06

Unified Soil Classification	SC
U.S. Highway Classification	A-6(1)
pH - Value	N/A
Conductivity mS/cm	N/A

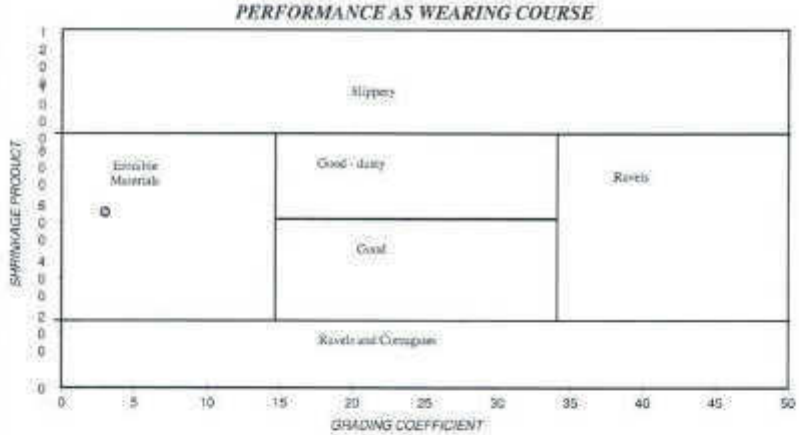
POTENTIAL EXPANSION



PLASTICITY CHART



PERFORMANCE AS WEARING COURSE



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E-mail: info@roadlab.co.za
www.roadlab.co.za

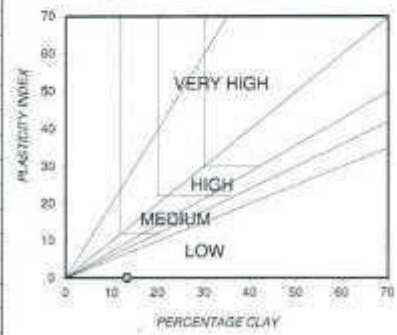
OUR REF : 92/GEO013-18/0001/14
CLIENT : Geo Simplicity
SITE : Proposed Shopping Mall, Piet Retief

DATE REPORTED : 30-May-14
CHAINAGE : TH04 : DS8
LAYER : 3.2m
SAMPLE No. : S2674
SAMPLE DESCRIPTION : Light Yellow Ferricrete & Dolerite

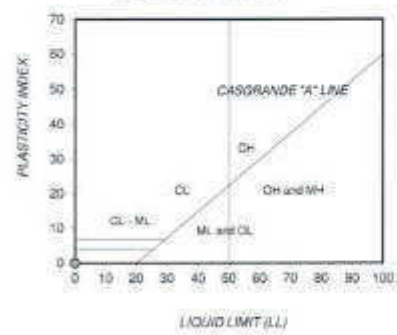
FOUNDATION INDICATOR RESULTS

Weighted PI		**0**
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	95
	19.0	94
	13.2	89
	4.75	85
	2.000	75
	0.425	50
	0.250	40
	0.150	31
	0.075	20
	0.050	18
	0.005	16
	0.002	13
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	25.0
	0.425 - 0.250	10.0
	0.250 - 0.150	9.0
	0.150 - 0.075	11.0
	< 0.075	26.7
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		56.5
Grading Coefficient		17.0
Grading modulus		1.55
Atter-berg Limits	Liquid Limit	0
	Plasticity Index	SP
	Linear Shrinkage	1.13
Unified Soil Classification		SC
U.S. Highway Classification		A-2-4(0)
pH - Value		N/A
Conductivity mS/cm		N/A

POTENTIAL EXPANSION

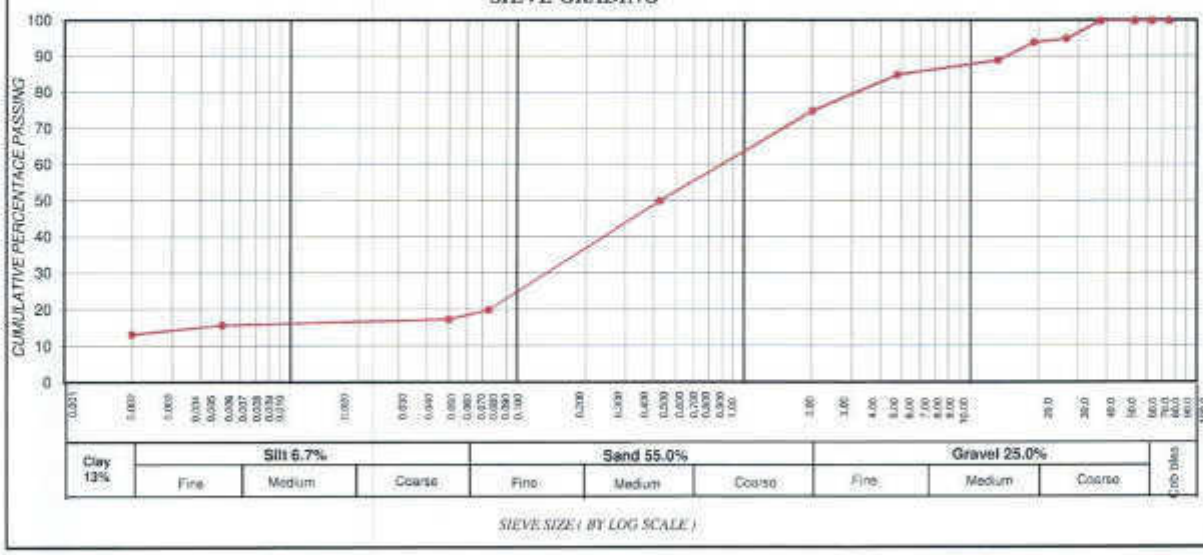


PLASTICITY CHART



PERFORMANCE AS WEARING COURSE

SIEVE GRADING



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www.roadlab.co.za

92/GEO013-18/0001/14

2014/06/17

Geo Simplicity Engineering (Pty) Ltd
1 Killoran Place
Bedfordview
2007

ATTENTION: Mr. P van Straten

Test Report : **PROPOSED SHOPPING MALL, PIET RETIEF - pH & CONDUCTIVITY TEST RESULTS**

Clients Marking: None
Sample Number: S2667-S2674
Sample delivered to: Roadlab

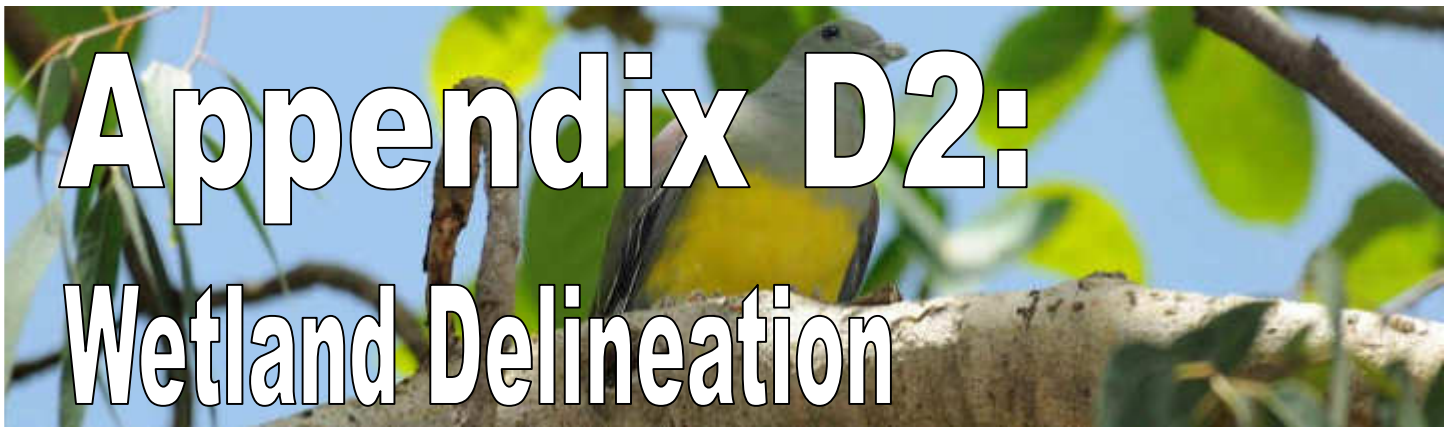
Date Sampled: 2014/05/30
Date Received: 2014/05/30

Sample Number	Layer / Road :	Temperature (°C) : Conductivity	Conductivity (ms/m)	Temperature (°C) : pH	pH Value
S2667	TH01 : DS1 : 1.0m	25.0	18.02	25.0	7.99
S2668	TH01 : DS2 : 2.5m	25.0	9.66	25.0	7.86
S2669	TH02 : DS3 : Mix 0.7m & 4.5m	25.0	32.90	25.0	8.92
S2670	TH04 : DS4 : 0.3m	25.0	8.73	25.0	7.83
S2671	TH04 : DS5 : 0.8m	25.0	28.40	25.0	8.16
S2672	TH04 : DS6 : 1.5m	25.0	67.50	25.0	7.92
S2673	TH04 : DS7 : 2.6m	25.0	61.70	25.0	7.73
S2674	TH04 : DS8 : 3.2m	25.0	44.60	25.0	7.88

Kind Regards

TECHNICAL SIGNATORY
Mr L. Kruger / D. Juckers / N. Herbst

Remarks :
The samples were subjected to analysis according to TMH 1
The results reported relate only to the sample tested
Further use of the above information is not the responsibility or liability of Roadlab
Documents may only be reproduced or published in their full context
Compiled By : Linda van Niekerk



Appendix D2:

Wetland Delineation

REPORT

WETLAND DELINEATION AND MANAGEMENT REPORT:

A PORTION OF PORTION 100 OF THE FARM PIET RETIEF TOWN AND TOWNLANDS 149 HT, MPUMALANGA PROVINCE

6th January, 2015

Compiled by:

J.H. van der Waals
(PhD Soil Science, Pr.Sci.Nat.)
Registered with the South African Council for Natural Scientific Professions
(Registration number: 400106/08)
Member of:
Soil Science Society of South Africa (SSSSA)
Accredited member of:
South African Soil Surveyors Organisation (SASSO)

Declaration

I, Johan Hilgard van der Waals, 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 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS

TABLE OF CONTENTS

WETLAND DELINEATION AND MANAGEMENT REPORT: A PORTION OF PORTION 100 OF THE FARM PIET RETIEF TOWN AND TOWNLANDS 149 HT, MPUMALANGA PROVINCE

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Terra Soil Science was appointed by **Bokamoso** to conduct a wetland delineation and wetland management report for the proposed Piet Retief X22 development on a portion of Portion 100 of the Farm Piet Retief Town and Townlands 149 HT in the Mpumalanga Province.

1.2 AIM OF THIS REPORT

The aim of this report is to provide a wetland delineation and management report for the Piet Retief X22 development site within the context of specific soil, topography and geology conditions.

1.3 DISCLAIMER

This report was generated under the regulations of NEMA (National Environmental Management Act) that guides the appointment of specialists. The essence of the regulations are 1) independence, 2) specialisation and 3) duty to the regulator. The independent specialist has, in accordance with the regulations, a duty to the competent authority to disclose all matters related to the specific investigation should he be requested to do such (refer to declaration above).

It is accepted that this report can be submitted for peer review (as the regulations also allow for such). However, the intention of this report is not to function as one of several attempts by applicants to obtain favourable delineation outcomes. Rather, the report is aimed at addressing specific site conditions in the context of current legislation, guidelines and best practice with the ultimate aim of ensuring the conservation and adequate management of the water resource on the specific site.

Due to the specific legal liabilities wetland specialists face when conducting wetland delineations and assessments this author reserves the right to, in the event that this report becomes part of a delineation comparison exercise between specialists, submit the report to the competent authorities, without entering into protracted correspondence with the client, as an independent report.

1.4 METHODOLOGY

The report was generated through:

1. The collection and presentation of baseline land type and topographic data for the site;

2. The thorough consideration of the statutory context of wetlands and the process of wetland delineation;
3. The identification of water related landscape parameters (conceptual and real) for the site;
4. Aerial photograph interpretation of the site;
5. Assessment of historical impacts and changes on the site through the accessing of various historical aerial photographs and topographic maps;
6. Focused soil and site survey in terms of soil properties as well as drainage feature properties; and
7. Presentation of the findings of the various components of the investigation.

2. SITE LOCALITY AND DESCRIPTION

2.1 SURVEY AREA BOUNDARY

The site lies between 27° 00' 32'' and 27° 00' 44'' south and 30° 48' 14'' and 30° 48' 29'' east in the town of Piet Retief (**Figure 1**).

2.2 LAND TYPE DATA

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

The proposed Piet Retief X22 falls into the **Ba54** land type (Land Type Survey Staff, 1972 - 2006) with **Figure 2** providing the land type distribution for the site. **Ba** land types denote areas with dominantly plinthic catena where red soils occur frequently. Following on the field survey it is evident that the land type data (**Ba54**) caters for an area with very variable geology whereas the specific site consists of granite and occasional dolerite. Additionally, the survey site has been influenced by human activities. A dedicated discussion of the specific site conditions will be provided later in the report.

2.3 TOPOGRAPHY

The topography of the site and catchment is undulating to hilly. The bulk of the area around the site has been influenced by human activities and developments. The contour map for the site is provided in **Figure 3**. From the contour data a digital elevation model (DEM) (**Figure 4**) was generated. This data was used to generate pertinent aspects related to the wetland distribution for the site as discussed later in the report.

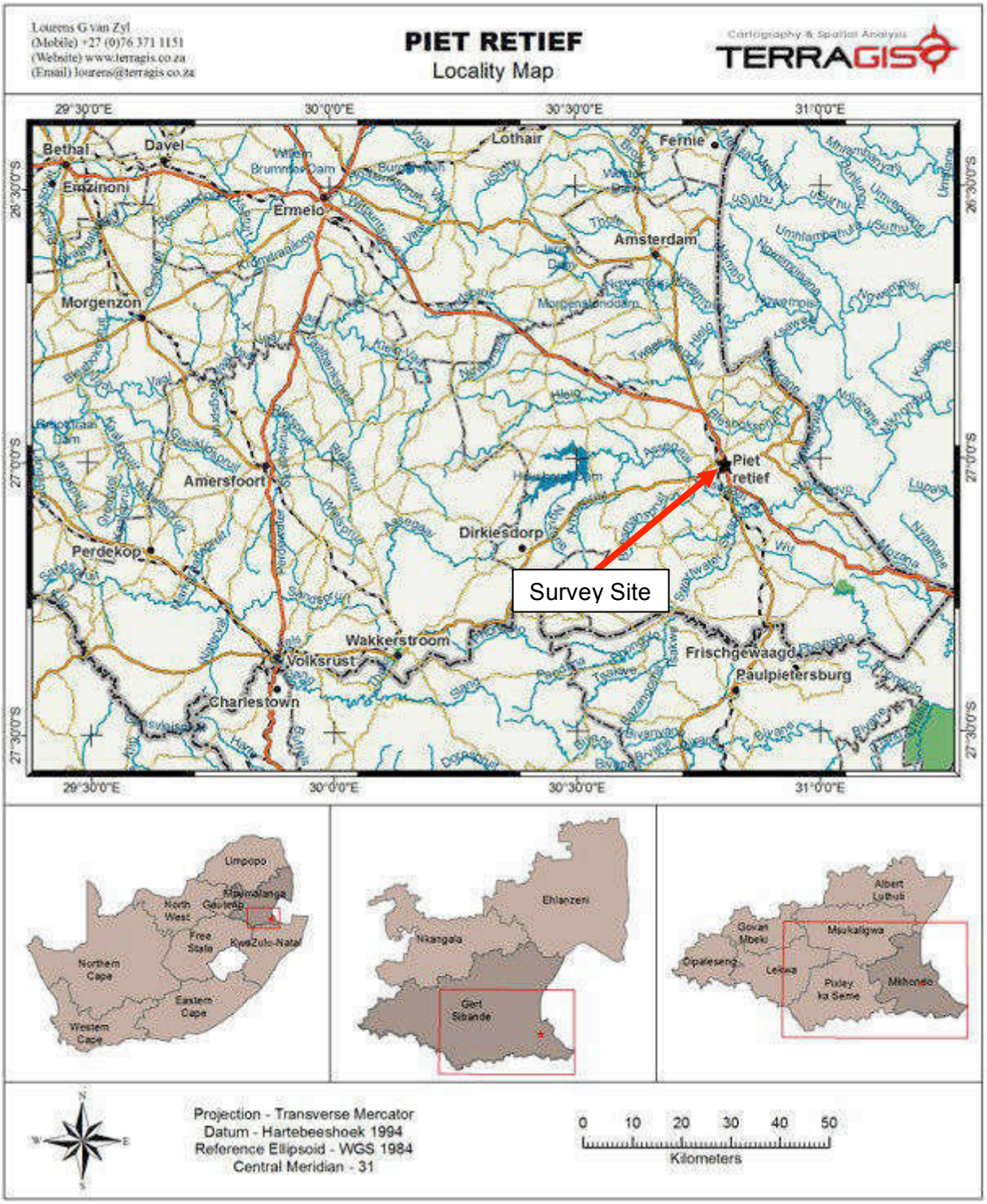


Figure 1 Locality of the survey site

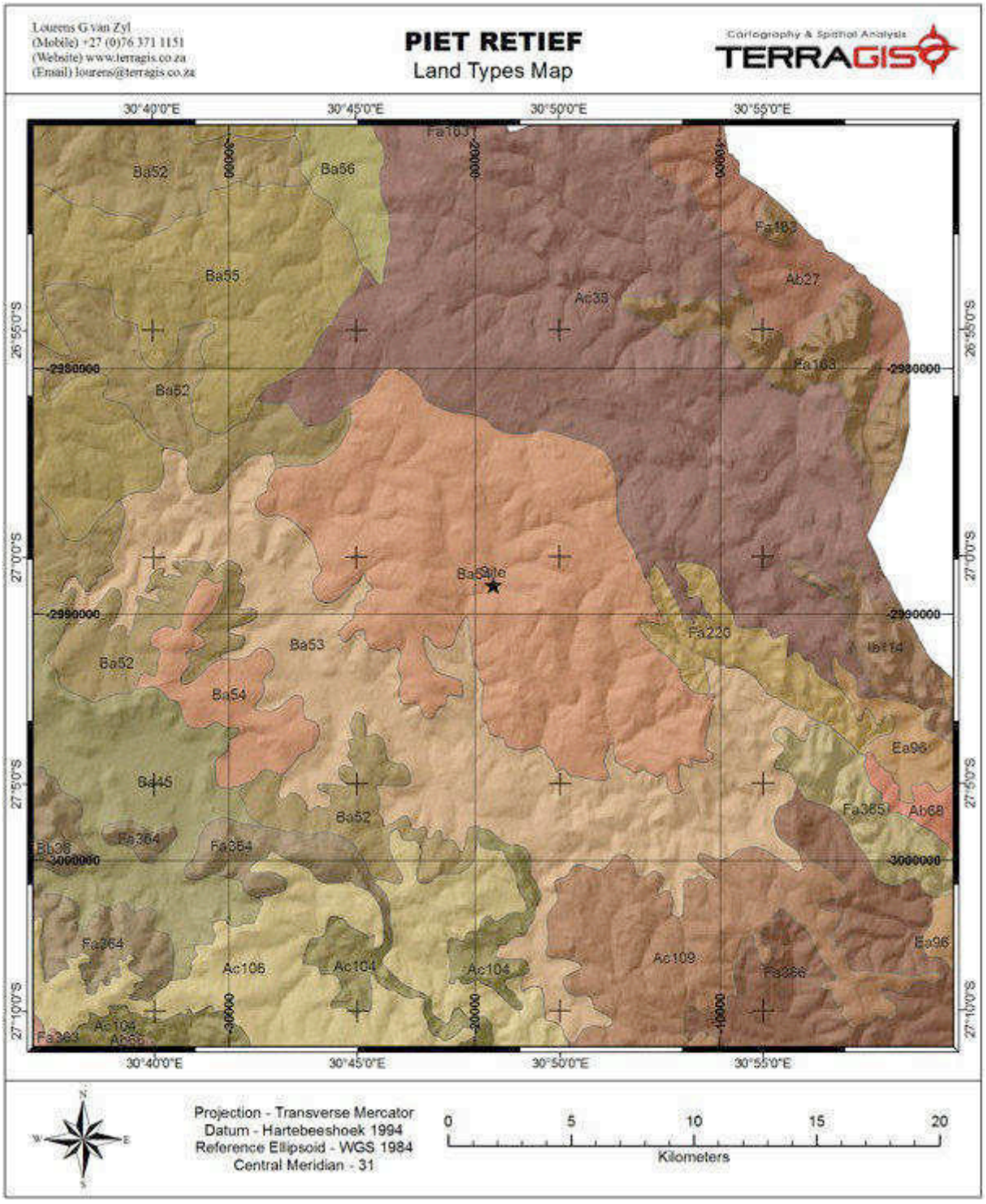


Figure 2 Land type map of the survey site and surrounding area

Figure 3 Contours of the survey area superimposed on an aerial photograph

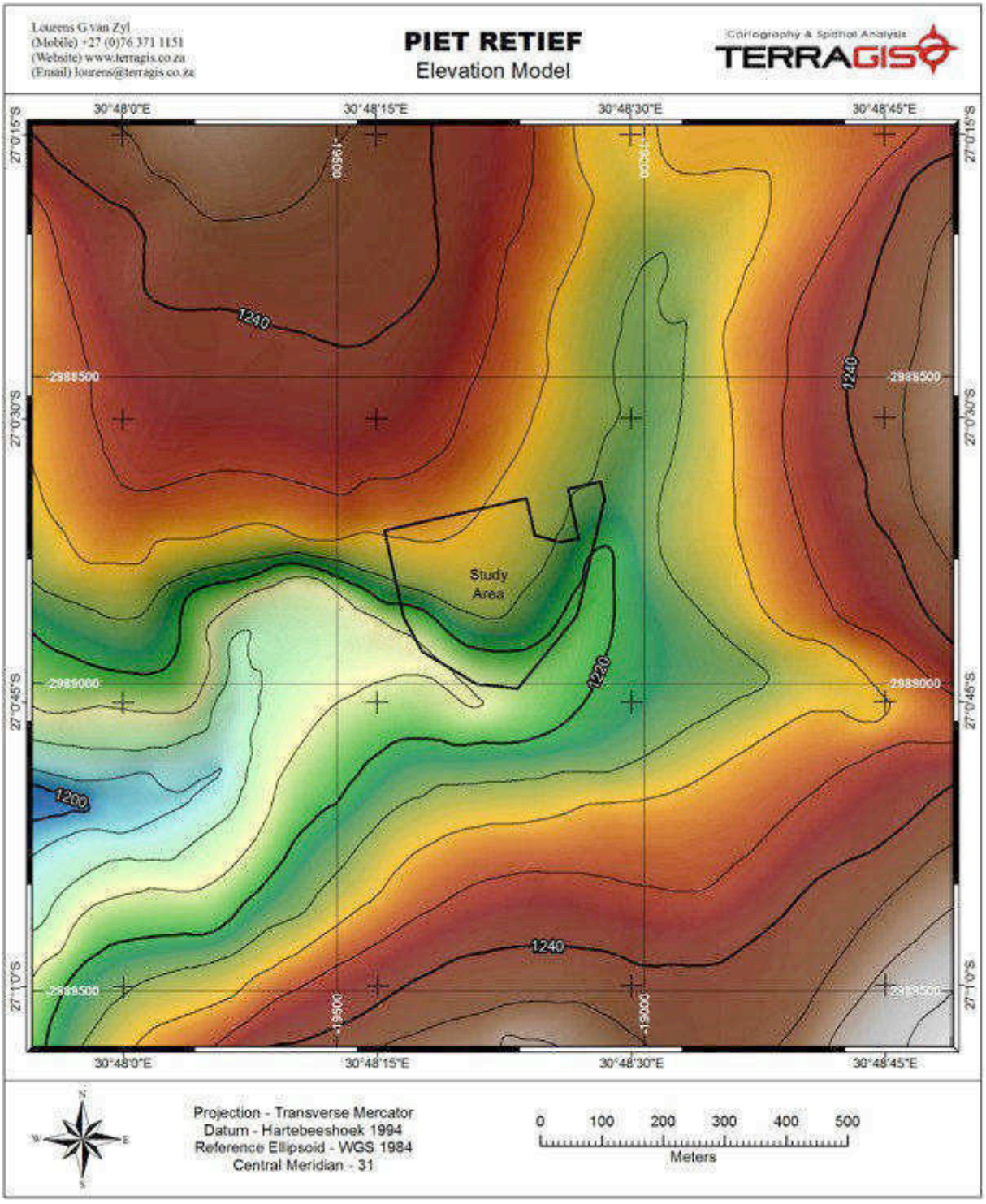


Figure 4 DEM of the survey site

3. PROBLEM STATEMENT

The delineation of wetlands in areas with complex geological features, such as a mixture of igneous (mafic), sedimentary and metamorphic rock, is highly challenging. The difficulty arises from the fact that the different rock formations lead to the formation of entirely different soil profiles, with some of the rocks forming soils with more pronounced signs of hydromorphism even if hydrological processes are similar. The delineation exercise is often further hampered by various human activities that influence natural vegetation characteristics. This investigation will focus on the delineation of the wetland features based on landscape hydrological properties as well as soil hydromorphy and inferred hillslope processes in such a complex environment.

4. STATUTORY CONTEXT

The following is a brief summary of the statutory context of wetland delineation and assessment. Where necessary, additional comment is provided on problematic aspects or aspects that, according to this author, require specific emphasis.

4.1 WETLAND DEFINITION

Wetlands are defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

4.2 WATERCOURSE DEFINITION

"Catchment" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

"…, in relation to a watercourse or watercourses or part of a watercourse, means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points;"

"Watercourse" is defined, in terms of the National Water Act (Act no 36 of 1998) (NWA), as:

> "*(a)* a river or spring;
> *(b)* a natural channel in which water flows regularly or intermittently;
> *(c)* a wetland, lake or dam into which, or from which, water flows; and
> *(d)* any collection of water which the Minister may, by notice in the *Gazette*, declare to be a water course,
> and a reference to a watercourse includes, where relevant, its bed and banks;"

4.3 THE WETLAND DELINEATION GUIDELINES

In 2005 the Department of Water Affairs and Forestry published a manual entitled "A practical field procedure for identification and delineation of wetland and riparian areas" (DWAF, 2005). The "…manual describes field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries." The definition of a wetland in the guidelines is that of the NWA and it states that wetlands must have one or more of the following attributes:

- "**Wetland (hydromorphic) soils** that display characteristics resulting from prolonged saturation"
- "The presence, at least occasionally, of **water loving plants (hydrophytes)**"
- "A **high water table** that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil."

The guidelines further list four indicators to be used for the finding of the outer edge of a wetland. These are:

- Terrain Unit Indicator. The terrain unit indicator does not only identify valley bottom wetlands but also wetlands on steep and mild slopes in crest, midslope and footslope positions.
- Soil Form Indicator. A number of soil forms (as defined by MacVicar et al., 1991) are listed as indicative of permanent, seasonal and temporary wetland zones.
- Soil Wetness Indicator. Certain soil colours and mottles are indicated as colours of wet soils. The guidelines stipulate that this is the primary indicator for wetland soils. (Refer to the guidelines for a detailed description of the colour indicators.) In essence, the reduction and removal of Fe in the form of "bleaching" and the accumulation of Fe in the form of mottles are the two main criteria for the identification of soils that are periodically or permanently wet.
- Vegetation Indicator. This is a key component of the definition of a wetland in the NWA. It often happens though that vegetation is disturbed and the guidelines therefore place greater emphasis on the soil form and soil wetness indicators as these are more permanent whereas vegetation communities are dynamic and react rapidly to external factors such as climate and human activities.

The main emphasis of the guidelines is therefore the use soils (soil form and wetness) as the criteria for the delineation of wetlands. The applicability of these guidelines in the context of the survey site will be discussed in further detail later in the report.

Due to numerous problems with the delineation of wetlands there are a plethora of courses being presented to teach wetland practitioners and laymen the required techniques. Most of the courses and practitioners focus on ecological or vegetation characteristics of landscapes and soil characteristics are often interpreted incorrectly due to a lacking soil science background of these practitioners. As such this author regularly presents, in conjunction with a colleague (Prof. Cornie van Huysteen) from the University of the Free Sate, a course on the aspects related to soil classification and wetland delineation.

4.4 THE RESOURCE DIRECTED MEASURES FOR PROTECTION OF WATER RESOURCES

The following are specific quotes from the different sections of the "Resource Directed Measures for Protection of Water Resources." as published by DWAF (1999).

4.4.1 The Resource Directed Measures for Protection of Water Resources: Volume 4: Wetland Ecosystems.

From the Introduction:

"This set of documents on Resource Directed Measures (RDM) for protection of water resources, issued in September 1999 in Version 1.0, presents the procedures to be followed in undertaking **preliminary determinations of the class, Reserve and resource quality objectives for water resources**, as specified in sections 14 and 17 of the South African National Water Act (Act 36 of 1998).

The development of procedures to determine RDM was initiated by the Department of Water Affairs and Forestry in July 1997. Phase 3 of this project will end in March 2000. Additional refinement and development of the procedures, and development of the full water resource classification system, will continue in Phase 4, until such time as the detailed procedures and full classification system are ready for publication in the Government Gazette.

It should be noted that until the final RDM procedures are published in the Gazette, and prescribed according to section 12 of the National Water Act, all determinations of RDM, whether at the rapid, the intermediate or the comprehensive level, will be considered to be preliminary determinations."

4.4.2 The Resource Directed Measures for Protection of Water Resources: Generic Section "A" for Specialist Manuals – Water Resource Protection Policy Implementation Process

"Step 3: Determine the reference conditions of each resource unit"

"What are reference conditions?"

"The determination of reference conditions is a very important aspect of the overall Reserve determination methodology. Reference conditions describe the natural unimpacted characteristics of a water resource. Reference conditions quantitatively describe the ecoregional type, specific to a particular water resource."

4.4.3 The Resource Directed Measures for Protection of Water Resources: Appendix W1 (Ecoregional Typing for Wetland Ecosystems)

Artificial modifiers are explained namely:

"Many wetlands are man-made, while others have been modified from a natural state to some degree by the activities of humans. Since the nature of these alterations often greatly influences the character of such habitats, the inclusion of modifying terms to accommodate human influence is important. In addition, many human modifications, such as dam walls and drainage ditches, are visible in aerial photographs and can be easily mapped. The following Artificial Modifiers are defined and can be used singly or in combination wherever they apply to wetlands:

Farmed: the soil surface has been physically altered for crop production, but hydrophytes will become re-established if farming is discontinued

Artificial: substrates placed by humans, using either natural materials such as dredge spoils or synthetic materials such as concrete. Jetties and breakwaters are examples of Non-vegetated Artificial habitats

Excavated: habitat lies within an excavated basin or channel

Diked/Impounded: created or modified by an artificial barrier which obstructs the inflow or outflow of water

Partially Drained: the water level has been artificially lowered, usually by means of ditches, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes."

4.4.4 The Resource Directed Measures for Protection of Water Resources: Appendix W4 IER (Floodplain Wetlands) Present Ecological Status (PES) Method

In Appendix W4 the methodology is provided for the determination of the present ecological status (PES) of a palustrine wetland.

The present ecological state (PES) of the wetland was determined according to the method described in "APPENDIX W4: IER (FLOODPLAIN WETLANDS) PRESENT ECOLOGICAL STATUS (PES) METHOD" of the "Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems" as published by DWAF (1999). However, the PES methodology already forms an adaptation from the methodology to assess palustrine wetlands. Hillslope seepage wetlands have a range of different drivers and as such some modification of the criteria has been made by this author to accommodate the specific hydropedology drivers of hillslope seepage wetlands.

The criteria as described in Appendix 4 is provided below with the relevant modification or comment provided as well.

The summarised tasks in the PES methodology are (for detailed descriptions refer to the relevant documentation):

1. Conduct a literature review (review of available literature and maps) on the following:
    a. Determine types of development and land use (in the catchment in question).
    b. Gather hydrological data to determine the degree to which the flow regime has been modified (with the "virgin flow regime" as baseline). The emphasis is predominantly on surface hydrology and hydrology of surface water features as well as the land uses, such as agriculture and forestry, that lead to flow modifications. Important Note: The hydropedology of landscapes is not explicitly mentioned in the RDM documentation and this author will make a case for its consideration as probably the most important component of investigating headwater systems and seepage wetlands and areas.
    c. Assessment of the water quality as is documented in catchment study reports and water quality databases.
    d. Investigate erosion and sedimentation parameters that address aspects such as bank erosion and bed modification. Important Note: The emphasis in the RDM documentation is again on river and stream systems with little mention of erosion of headwater and seepage zone systems. Again a case will be made for the emphasis of such information generation.
    e. Description of exotic species (flora and fauna) in the specific catchment in question.
2. Conduct and aerial photographic assessment in terms of the parameters listed above.
3. Conduct a site visit and make use of local knowledge.
4. Assess the criteria and generate preliminary PES scores.
5. Generation of report.

Table 1 presents the scoresheet with criteria for the assessment of habitat integrity of palustrine wetlands (as provided in the RDM documentation).

Table 1 "Table W4-1: Scoresheet with criteria for assessing Habitat Integrity of Palustrine Wetlands (adapted from Kleynhans 1996)"

Criteria and attributes	**Relevance**	**Score**	**Confidence**
Hydrologic			
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.		
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.		
Water Quality			
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland		
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use		

	practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.		
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.		
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railwaylines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.		
Biota			
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant speciesdue to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.		
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.		
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).		
Alien fauna	Presence of alien fauna affecting faunal community structure.		
Overutilisation of biota	Overgrazing, Over-fishing, etc		
TOTAL MEAN			

Scoring guidelines per attribute:

natural, unmodified = 5; Largely natural = 4, Moderately modified = 3; largely modified = 2; seriously modified = 1; Critically modified = 0.

Relative confidence of score:

Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1.

Important Note: The present ecological state (PES) determination is, as discussed earlier in the report, based on criteria originally generated for palustrine and floodplain wetlands. Seepage wetlands very rarely have the same degree of saturation or free water and consequently often do not have permanent wetland zones. These wetlands are therefore often characterised by seasonal or temporary properties and as such a standard PES approach is flawed. The existing criteria is provided below as is a comment on the applicability as well as proposed improvements.

Criteria

Hydrological Criteria

- "Flow modification: Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland." Comment: Although the description is wide it is very evident that seepage or hillslope wetlands do not become inundated but rather are fed by hillslope return flow processes. The main criterion should therefore be the surface and subsurface hydrological linkages expressed as a degree of alteration in terms of the surface, hydropedology and groundwater hydrology.
- "Permanent inundation: Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota." Comment: Mostly not applicable to hillslope seepage wetlands.

Water Quality Criteria

- "Water quality modification: From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland." Comment: Water quality in this context applies generally but cognisance should be taken of seepage water quality that can be natural but significantly different to exposed water bodies. The main reason for this being the highly complex nature of many redox processes within the hillslope.
- "Sediment load modification: Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats." Comment: This is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences.

Hydraulic / Geomorphic Criteria

- "Canalisation: Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects shoud be elucidated and contextualised.
- "Topographic Alteration: Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railwaylines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects shoud be elucidated and contextualised.

Biological Criteria

- "Terrestrial encroachment: Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from

wetland to terrestrial habitat and loss of wetland functions." Comment: Again this is a very relevant concept but on hillslopes should be linked to erosivity of the soils as well as the specific land use influences. This concept does however not address the influences on the hydropedology of the hillslope. These aspects shoud be elucidated and contextualised.

- "Indigenous vegetation removal: Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion."
- "Invasive plant encroachment: Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading)."
- "Alien fauna: Presence of alien fauna affecting faunal community structure."
- "Overutilisation of biota: Overgrazing, Over-fishing, etc."

Scoring Guidelines
Scoring guidelines per attribute:
Natural, unmodified = 5
Largely natural = 4
Moderately modified = 3
Largely modified = 2
Seriously modified = 1
Critically modified = 0

Relative confidence of score:
Very high confidence = 4
High confidence = 3
Moderate confidence = 2
Marginal/low confidence = 1

4.4.5 The Resource Directed Measures for Protection of Water Resources: Appendix W5 IER (Floodplain Wetlands) Determining the Ecological Importance and Sensitivity (EIS) and the Ecological Management Class (EMC)

In Appendix W5 the methodology is provided for the determination of the ecological importance and sensitivity (EIS) and ecological management class (EMC) of floodplain wetlands.

"Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC)." Please refer to the specific document for more detailed information.

The following primary determinants are listed as determining the EIS:

1. Rare and endangered species

2. Populations of unique species
3. Species / taxon richness
4. Diversity of habitat types or features
5. Migration route / breeding and feeding site for wetland species
6. Sensitivity to changes in the natural hydrological regime
7. Sensitivity to water quality changes
8. Flood storage, energy dissipation and particulate / element removal

The following modifying determinants are listed as determining the EIS:

1. Protected status
2. Ecological integrity

4.5 SUMMARY AND PROPOSED APPROACH

When working in environments where the landscape and land use changes are significant (such as urban and mining environments) it is important to answer the following critical questions regarding the assessment and management planning for wetlands:

1. What is the reference condition?
2. What is the difference between the reference condition and the current condition and how big is this difference from a hydrological driver perspective?
3. What are the hydrological drivers (as a function of geology, topography, rainfall and soils) and what are the relative contributions of these drivers to the functioning of the wetland system?
4. What is the intended or planned land use in the wetland as well as terrestrial area and how will these developments impact on the hydrology of the landscape and wetlands?
5. How can the intended land use be plied to secure the best possible hydrological functioning of the landscape in terms of storm water attenuation, erosion mitigation and water quality?

The key to the generation of adequate information lies in the approach that is to be followed. In the next section an explanation about and motivation in favour of will be provided for a hydropedology assessment approach. Due to the detailed nature of the information that can be generated through such an approach it is motivated that all wetland assessments be conducted with the requirements of criminal law in mind. The main reason for this is the fact that many well-meaning administrative exercises often yield not tangible results due to the gap in terms of information that is required should there be a compliance process followed.

To Summarise:

During wetland assessments and delineations it is important to provide a perspective on assessment tools, the original or reference state of the wetland, the assessment process and outcome as well as the intended or possible state of the wetland and site post

development. Urban and mining developments are good examples of cases where surrounding developments and land use changes have significant effects on wetland integrity and water quality emanating from the site.

5 CHALLENGES REGARDING WETLAND DELINEATION IN COMPLEX GEOLOGICAL ENVIRONMENTS

In order to discuss the procedures followed and the results of the wetland identification exercise it is necessary at the outset to provide some theoretical background on soil forming processes, soil wetness indicators, water movement in soils and topographical sequences of soil forms (catena).

5.1 PEDOGENESIS

Pedogenesis is the process of soil formation. Soil formation is a function of five (5) factors namely (Jenny, 1941(:

- Parent material;
- Climate;
- Topography;
- Living Organisms; and
- Time.

These factors interact to lead to a range of different soil forming processes that ultimately determine the specific soil formed in a specific location. Central to all soil forming processes is water and all the reactions (physical and chemical) associated with it. The physical processes include water movement onto, into, through and out of a soil unit. The movement can be vertically downwards, lateral or vertically upwards through capillary forces and evapotranspiration. The chemical processes are numerous and include dissolution, precipitation (of salts or other elements) and alteration through pH and reduction and oxidation (redox) changes. In many cases the reactions are promoted through the presence of organic material that is broken down through aerobic or anaerobic respiration by microorganisms. Both these processes alter the redox conditions of the soil and influence the oxidation state of elements such as Fe and Mn. Under reducing conditions Fe and Mn are reduced and become more mobile in the soil environment. Oxidizing conditions, in turn, lead to the precipitation of Fe and Mn and therefore lead to their immobilization. The dynamics of Fe and Mn in soil, their zones of depletion through mobilization and accumulation through precipitation, play an important role in the identification of the dominant water regime of a soil and could therefore be used to identify wetlands and wetland conditions.

5.2 WATER MOVEMENT IN THE SOIL PROFILE

In a specific soil profile, water can move upwards (through capillary movement), horizontally (owing to matric suction) and downwards under the influence of gravity.

The following needs to be highlighted in order to discuss water movement in soil:

- Capillary rise refers to the process where water rises from a deeper lying section of the soil profile to the soil surface or to a section closer to the soil surface. Soil pores can be regarded as miniature tubes. Water rises into these tubes owing to the adhesion (adsorption) of water molecules onto solid mineral surfaces and the surface tension of water.

  The height of the rise is inversely proportional to the radius of the soil pore and the density of the liquid (water). It is also directly proportional to the liquid's surface tension and the degree of its adhesive attraction. In a soil-water system the following simplified equation can be used to calculate this rise:

  $$\text{Height} = 0.15/\text{radius}$$

  Usually the eventual height of rise is greater in fine textured soil, but the rate of flow may be slower (Brady and Weil, 1999; Hillel, 1983).

- Matric potential or suction refers to the attraction of water to solid surfaces. Matric potential is operational in unsaturated soil above the water table while pressure potential refers to water in saturated soil or below the water table. Matric potential is always expressed as a negative value and pressure potential as a positive value.

  Matric potential influences soil moisture retention and soil water movement. Differences in the matric potential of adjoining zones of a soil results in the movement of water from the moist zone (high state of energy) to the dry zone (low state of energy) or from large pores to small pores.

  The maximum amount of water that a soil profile can hold before leaching occurs is called the field capacity of the soil. At a point of water saturation, a soil exhibits an energy state of 0 $J.kg^{-1}$. Field capacity usually falls within a range of -15 to -30 $J.kg^{-1}$ with fine textured soils storing larger amounts of water (Brady and Weil, 1999; Hillel, 1983).

- Gravity acts on water in the soil profile in the same way as it acts on any other body; it attracts towards earth's centre. The gravitational potential of soil water can be expressed as:

  $$\text{Gravitational potential} = \text{Gravity} \times \text{Height}$$

Following heavy rainfall, gravity plays an important part in the removal of excess water from the upper horizons of the soil profile and recharging groundwater sources below.

Excess water, or water subject to leaching, is the amount of water that falls between soil saturation (0 $J.kg^{-1}$) or oversaturation (> 0 $J.kg^{-1}$), in the case of heavy rainfall resulting in a pressure potential, and field capacity (-15 to -30 $J.kg^{-1}$). This amount of water differs according to soil type, structure and texture (Brady and Weil, 1999; Hillel, 1983).

- Under some conditions, at least part of the soil profile may be saturated with water, resulting in so-called saturated flow of water. The lower portions of poorly drained soils are often saturated, as are well-drained soils above stratified (layers differing in soil texture) or impermeable layers after rainfall.

  The quantity of water that flows through a saturated column of soil can be calculated using Darcy's law:

  $$Q = Ksat.A.\Delta P/L$$

  Where Q represents the quantity of water per unit time, Ksat is the saturated hydraulic conductivity, A is the cross sectional area of the column through which the water flows, ΔP is the hydrostatic pressure difference from the top to the bottom of the column, and L is the length of the column.

  Saturated flow of water does not only occur downwards, but also horizontally and upwards. Horizontal and upward flows are not quite as rapid as downward flow. The latter is aided by gravity (Brady and Weil, 1999; Hillel, 1983).

- Mostly, water movement in soil is ascribed to the unsaturated flow of water. This is a much more complex scenario than water flow under saturated conditions. Under unsaturated conditions only the fine micropores are filled with water whereas the macropores are filled with air. The water content, and the force with which water molecules are held by soil surfaces, can also vary considerably. The latter makes it difficult to assess the rate and direction of water flow. The driving force behind unsaturated water flow is matric potential. Water movement will be from a moist to a drier zone (Brady and Weil, 1999; Hillel, 1983).

The following processes influence the amount of water to be leached from a soil profile:

- Infiltration is the process by which water enters the soil pores and becomes soil water. The rate at which water can enter the soil is termed infiltration tempo and is calculated as follows:

  $$I = Q/A.t$$

  Where I represents infiltration tempo ($m.s^{-1}$), Q is the volume quantity of infiltrating water (m^3), A is the area of the soil surface exposed to infiltration (m^2), and t is time (s).

If the soil is quite dry when exposed to water, the macropores will be open to conduct water into the soil profile. Soils that exhibit a high 2:1 clay content (swelling-shrinking clays) will exhibit a high rate of infiltration initially. However, as infiltration proceeds, the macropores will become saturated and cracks, caused by dried out 2:1 clay, will swell and close, thus leading to a decline in infiltration (Brady and Weil, 1999; Hillel, 1983).

- Percolation is the process by which water moves downward in the soil profile. Saturated and unsaturated water flow is involved in the process of percolation, while the rate of percolation is determined by the hydraulic conductivity of the soil.

  During a rain storm, especially the down pouring of heavy rain, water movement near the soil surface mainly occurs in the form of saturated flow in response to gravity. A sharp boundary, referred to as the wetting front, usually appears between the wet soil and the underlying dry soil. At the wetting front, water is moving into the underlying soil in response to both matric and gravitational potential. During light rain, water movement at the soil surface may be ascribed to unsaturated flow (Brady and Weil, 1999; Hillel, 1983).

  The fact that water percolates through the soil profile by unsaturated flow has certain ramifications when an abrupt change in soil texture occurs (Brady and Weil, 1999; Hillel, 1983). A layer of course sand, underlying a fine textured soil, will impede downward movement of water. The macropores of the coarse textured sand offer less attraction to the water molecules than the macropores of the fine textured soil. When the unsaturated wetting front reaches the coarse sand, the matric potential is lower in the sand than in the overlying material. Water always moves from a higher to a lower state of energy. The water can, therefore, not move into the coarse textured sand. Eventually, the downward moving water will accumulate above the sand layer and nearly saturate the fine textured soil. Once this occurs, the water will be held so loosely that gravitational forces will be able to drag the water into the sand layer (Brady and Weil, 1999; Hillel, 1983).

  A coarse layer of sand in an otherwise fine textured soil profile will also inhibit the rise of water by capillary movement (Brady and Weil, 1999; Hillel, 1983).

Field observations and laboratory based analysis can aid in assessing the soil-water relations of an area. The South African soil classification system (Soil Classification Working Group, 1991.) comments on certain field observable characteristics that shed light on water movement in soil. The more important of these are:

- Soil horizons that show clear signs of leaching such as the E-horizon – an horizon where predominantly lateral water movement has led to the mobilisation and transport of sesquioxide minerals and the removal of clay material;
- Soil horizons that show clear signs of a fluctuating water table where Fe and Mn mottles, amongst other characteristics, indicate alternating conditions of reduction and oxidation (soft plinthic B-horizon);

- Soil horizons where grey colouration (Fe reduction and redox depletion), in an otherwise yellowish or reddish matrix, indicate saturated (or close to saturated) water flow for at least three months of the year (Unconsolidated/Unspecified material with signs of wetness);
- Soil horizons that are uniform in colouration and indicative of well-drained and aerated (oxidising) conditions (e.g. yellow brown apedal B-horizon).

5.3 WATER MOVEMENT IN THE LANDSCAPE

Water movement in a landscape is a combination of the different flow paths in the soils and geological materials. The movement of water in these materials is dominantly subject to gravity and as such it will follow the path of least resistance towards the lowest point. In the landscape there are a number of factors determining the paths along which this water moves. **Figure 5** provides a simplified schematic representation of an idealised landscape (in "profile curvature". The total precipitation (rainfall) on the landscape from the crest to the lowest part or valley bottom is taken as 100 %. Most geohydrologists agree that total recharge, the water that seeps into the underlying geological strata, is less than 4 % of total precipitation for most geological settings. Surface runoff varies considerably according to rainfall intensity and distribution, plant cover and soil characteristics but is taken as a realistic 6 % of total precipitation for our idealised landscape. The total for surface runoff and recharge is therefore calculated as 10 % of total precipitation. If evapotranspiration (from plants as well as the soil surface) is taken as a very high 30 % of total precipitation it leaves 60 % of the total that has to move through the soil and/or geological strata from higher lying to lower lying areas. In the event of an average rainfall of 750 mm per year it results in 450 mm per year having to move laterally through the soil and geological strata. In a landscape there is an accumulation of water down the slope as water from higher lying areas flow to lower lying areas.

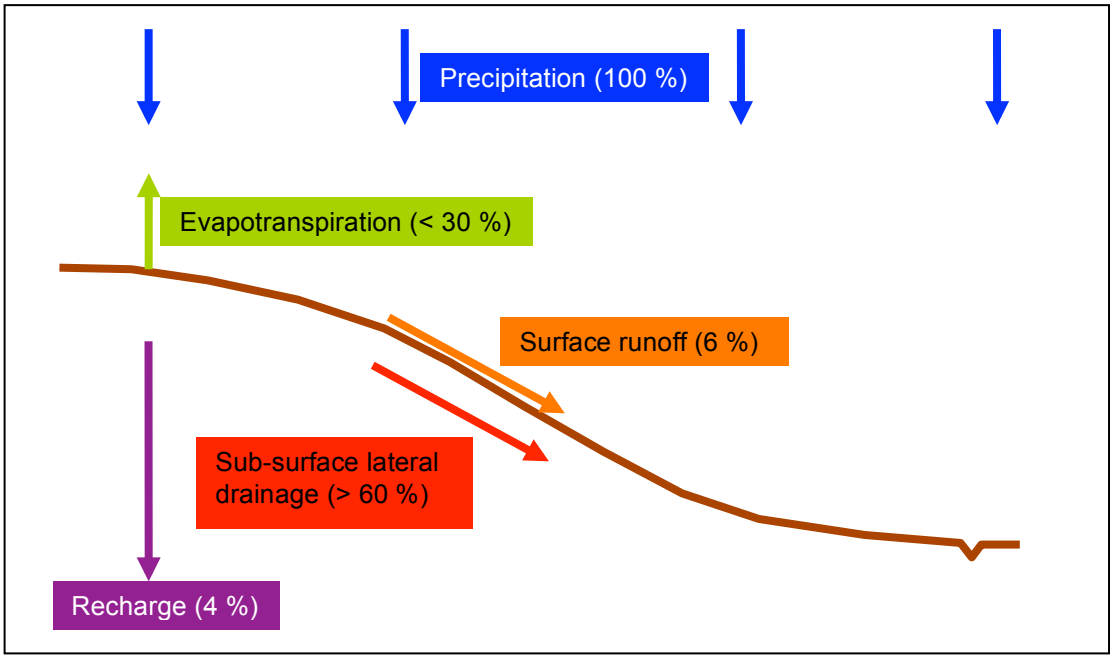


Figure 5 Idealised landscape with assumed quantities of water moving through the landscape expressed as a percentage of total precipitation (100 %).

To illustrate: If the assumption is made that the area of interest is 100 m wide it follows that the first 100 m from the crest downwards has 4 500 m^3 (or 4 500 000 litres) of water moving laterally through the soil (100 m X 100 m X 0.45 m) per rain season. The next section of 100 m down the slope has its own 4 500 m^3 of water as well as the added 4 500 m^3 from the upslope section to contend with, therefore 9 000 m^3. The next section has 13 500 m^3 to contend with and the following one 18 000 m^3. It is therefore clear that, the longer the slope, the larger the volume of water that will move laterally through the soil profile.

Flow paths through soil and geological strata, referred to as “interflow” or “hillslope water”, are very varied and often complex due to difficulty in measurement and identification. The difficulty in identification stems more from the challenges related to the physical determination of these in soil profile pits, soil auger samples and core drilling samples for geological strata. The identification of the morphological signs of water movement in permeable materials or along planes of weakness (cracks and seams) is a well-established science and the expression is mostly referred to as “redox morphology”. In terms of the flow paths of water large variation exists but these can be grouped into a few simple categories. **Figure 6** provides a schematic representation of the different flow regimes that are usually encountered. The main types of water flow can be grouped as 1) recharge (vertically downwards) of groundwater; 2) lateral flow of water through the landscape along the hillslope (interflow or hillslope water); 3) return flow water that intercepts the soil/landscape surface; and 4) surface runoff. Significant variation exists with these flow paths and numerous combinations are often found. The main wetland types associated with the flow paths are: a) valley bottom wetlands (fed by groundwater, hillslope processes, surface runoff, and/or in-stream water); b) hillslope seepage wetlands (fed by interflow water and/or return flow water); and wetlands associated with surface runoff, ponding and surface ingress of water anywhere in the landscape.

Amongst other factors, the thickness of the soil profile at a specific point will influence the intensity of the physical and chemical reactions taking place in that soil. **Figure 7** illustrates the difference between a dominantly thick and a dominantly thin soil profile. If all factors are kept the same except for the soil profile thickness it can be assumed with confidence that the chemical and physical reactions associated with water in the landscape will be much more intense for the thin soil profile than for the thick soil profile. Stated differently: The volume of water moving through the soil per surface area of an imaginary plane perpendicular to the direction of water flow is much higher for the thin soil profile than for the thick soil profile. This aspect has a significant influence on the expression of redox morphology in different landscapes of varying soil/geology/climate composition.

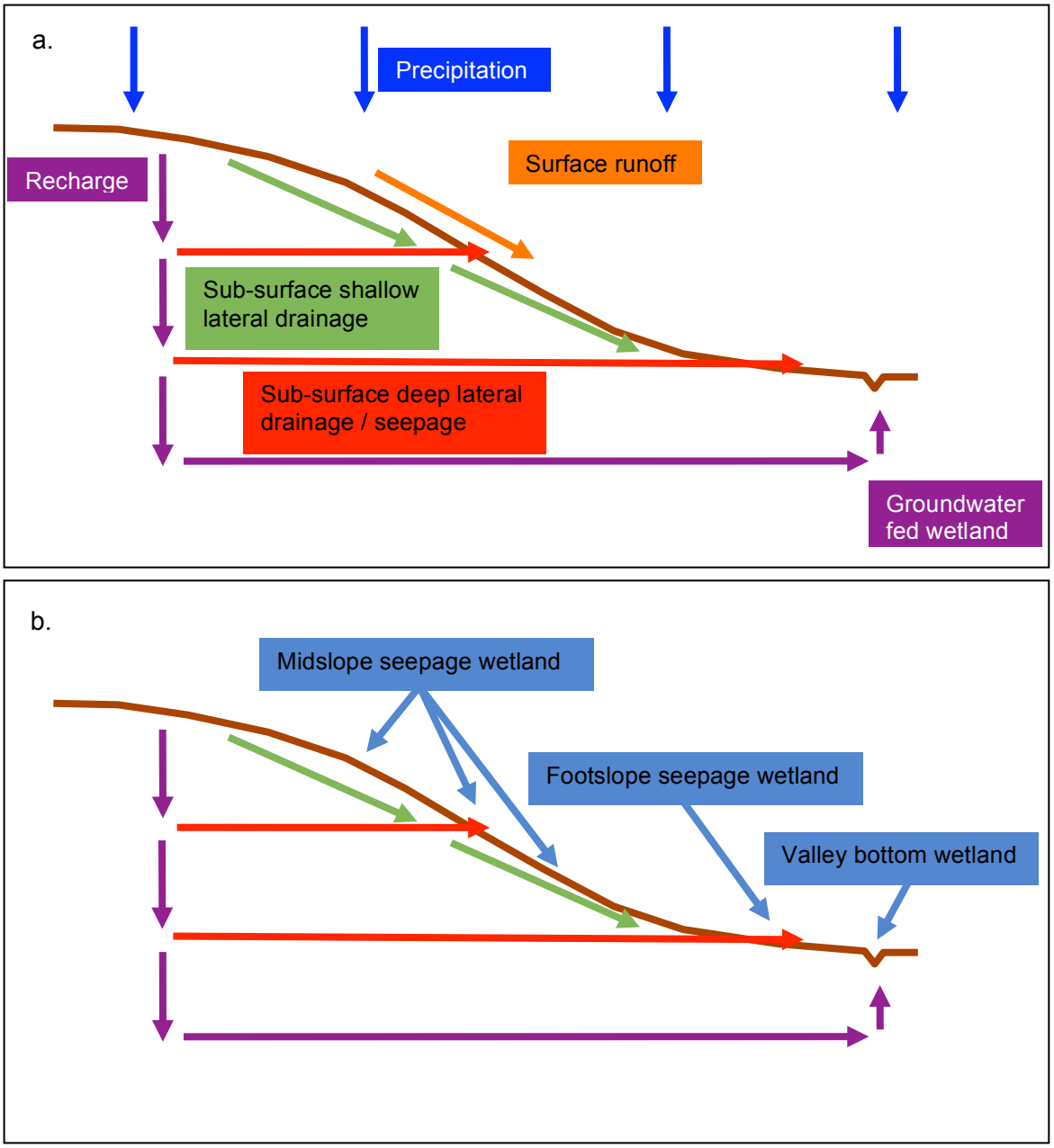


Figure 6 Different flow paths of water through a landscape (a) and typical wetland types associated with the water regime (b)

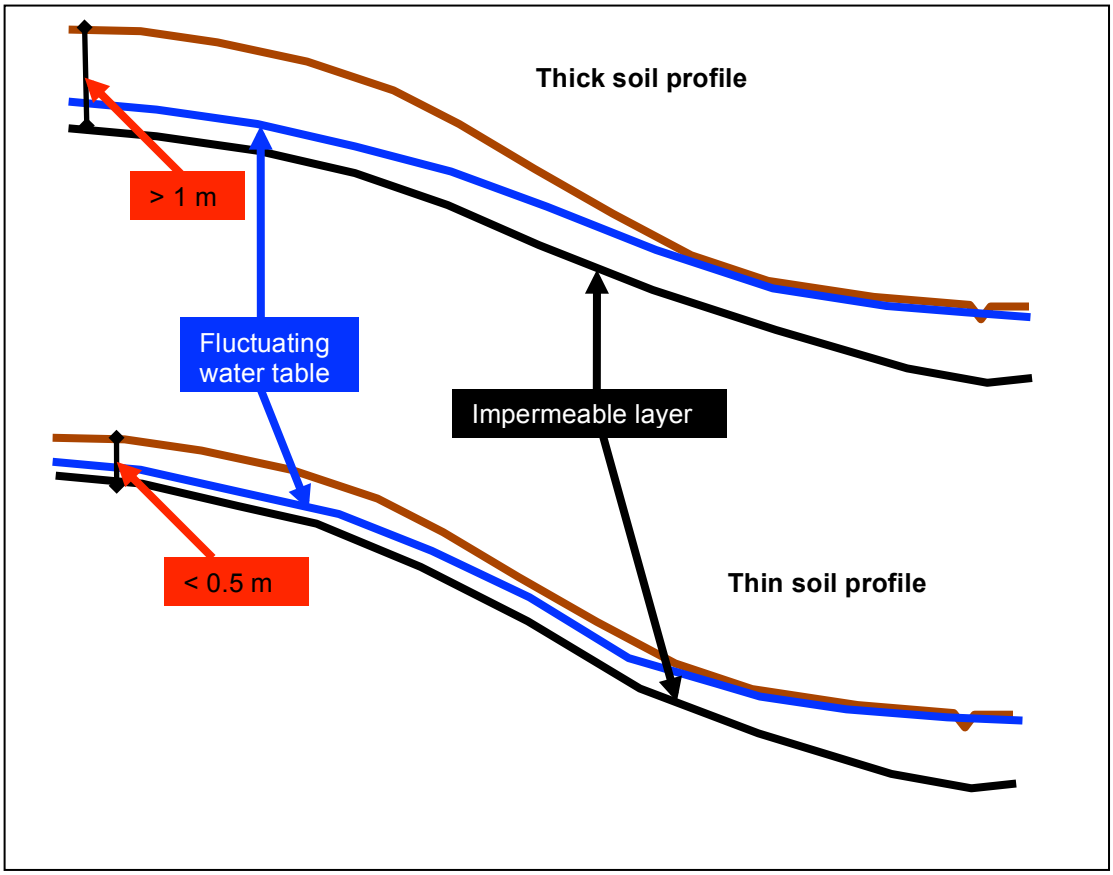


Figure 7 The difference in water flow between a dominantly thick and dominantly thin soil profile.

5.4 THE CATENA CONCEPT

Here it is important to take note of the "catena" concept. This concept is one of a topographic sequence of soils in a homogenous geological setting where the water movement and presence in the soils determine the specific characteristics of the soils from the top to the bottom of the topography. **Figure 8** illustrates an idealised topographical sequence of soils in a catena for a quartz rich parent material. Soils at the top of the topographical sequence are typically red in colour (Hutton and Bainsvlei soil forms) and systematically grade to yellow further down the slope (Avalon soil form). As the volume of water that moves through the soil increases, typically in midslope areas, periodic saturated conditions are experienced and consequently Fe is reduced and removed in the laterally flowing water. In the event that the soils in the midslope positions are relatively sandy the resultant soil colour will be bleached or white due to the colour dominance of the sand quartz particles. The soils in these positions are typically of the Longlands and Kroonstad forms. Further down the slope there is an accumulation of clays and leaching products from higher lying soils and this leads to typical illuvial and clay rich horizons. Due to the regular presence of water the dominant conditions are anaerobic and reducing and the soils exhibit grey colours often with bright yellow and grey mottles (Katspruit soil form). In the event that there is a large depositional environment with prolonged saturation soils of the Champagne form may develop (typical peat land). Variations on this sequence (as is often found on the Mpumalanga Highveld) may include

the presence of hard plinthic materials instead of soft plinthite with a consequent increase in the occurrence of bleached soil profiles. Extreme examples of such landscapes are discussed below.

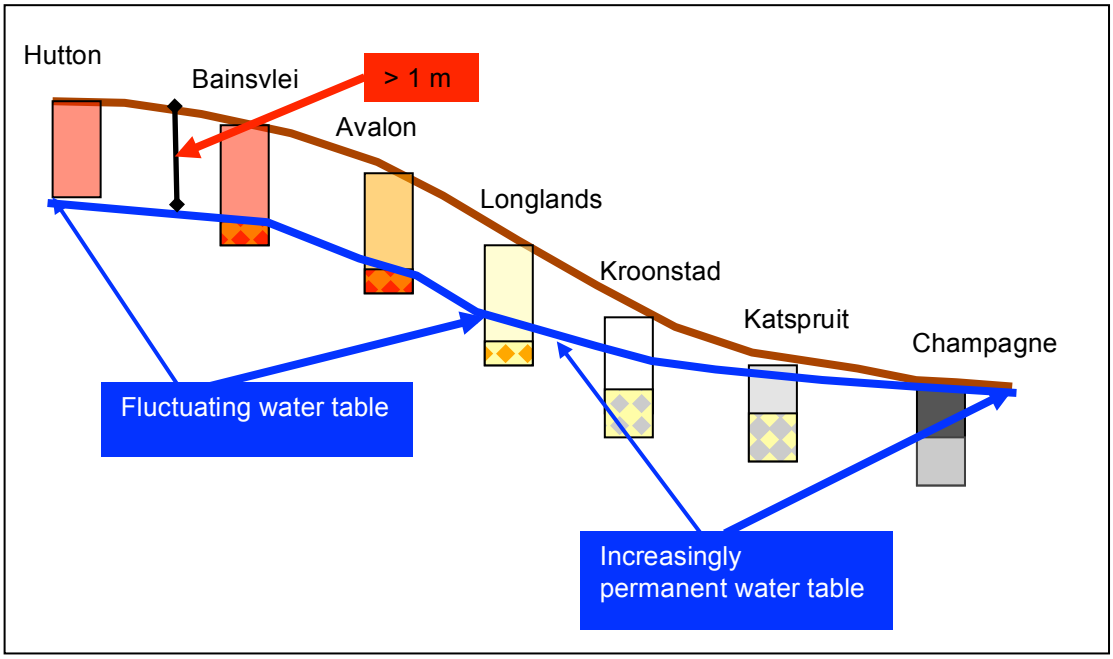


Figure 8 Idealised catena on a quartz rich parent material.

5.5 THE BA54 LAND TYPE CATENA CHALLENGE

The **Ba54** land type description (Land Type Survey Staff, 1972 - 2006) indicates a range of soils within the landscape. For the specific survey area the geology has been reported to be granite in the western half with dolerite in the eastern section – all overlain by colluvial soil material (Geotechnical Report by Soilkraft cc – copy undated). Granite and dolerite differ in the characteristics of their weathering products with granite yielding sandier soils that exhibit bleaching and mottling more readily that the clayey soils derived from dolerite. The higher clay content soils also have lower water conductance and often have pH levels above 7 (refer to next section). Additionally, the colluvial material is often a mix of the residual rock material and therefore can have widely varying expression of hydromorphism – even at similar levels and durations of saturation.

5.6 REDOX MORPHOLOGY IN ALKALINE SOILS

Wetland delineation is a very challenging exercise in areas dominated by alkaline soils such as lime containing and/or vertic/melanic soils. This is mainly due to the almost complete absence of Fe-mottles in the soils that grade from the terrestrial to the wetland areas. There are a number of reasons that will be explained in more detail below.

In order to illustrate the stability and distribution of Fe minerals in soils the figure provided below (**Figure 9**) was copied from page 124 of a book entitled “Soil Chemistry” by Bohn, et al., (1990).

The essence is that when reduction and oxidation reactions of Fe (in this case) are considered in soils both the electron activity (driver of reducing conditions) and pH have to be considered as they are intimately linked and dependent on each other. Suffice to say that for redox and mineral stability purposes they are indicated on the same graph. From Figure 4.6 (**Figure 9**) it is clear that as the Eh decreases (increasing reducing conditions) the dominant Fe species in solution changes from Fe^{3+} (insoluble and forming brightly coloured minerals) to Fe^{2+} (soluble and essentially colourless). Once pH is included in the observation it is clear that distinct Fe minerals come into play. Applying the decreasing Eh values to Fe minerals at high pH it is clear that the dominant Fe mineral under oxidizing conditions is FeOOH (Goethite – predominantly yellow). As the conditions become more reducing the equilibrium shifts to $FeCO_3$ (Siderite – white) and thereafter to FeS_2 (Pyrite). Whereas goethite has a distinct colour in soil, siderite and pyrite are less conspicuous in small quantities. It follows therefore that Fe minerals are much less visible in high pH reduced soils than in oxidised soils. In addition, vertic and melanic soils are dark coloured and it is therefore also clear that this dark colour will mask the presence of the above mentioned Fe minerals.

Another factor related to pH is the degree of reduction that is required to reduce Fe from its oxidised to its reduced state. From the graph it is clear that there is a steep decreasing gradient as the pH of the soil increases. This implies that much more intensive reducing conditions are required for the same degree of Fe reduction when high pH conditions (as those experienced in vertic and melanic soils) are compared to low pH conditions.

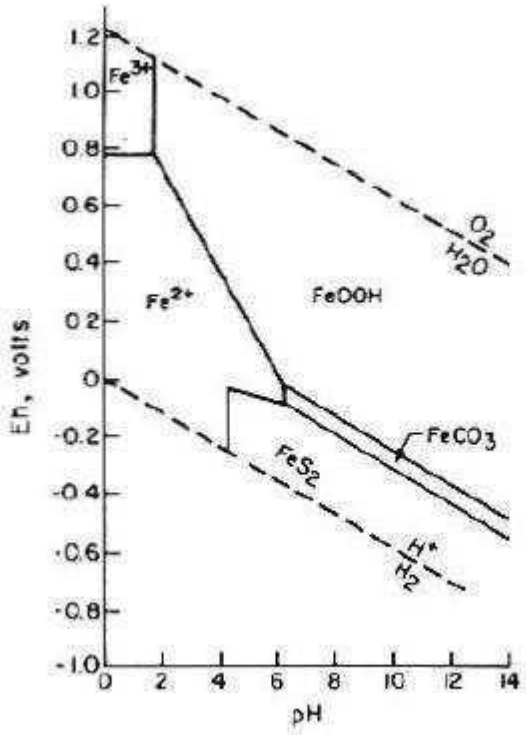


FIGURE 4.6. The *Eh*–pH diagram of various iron ions and compounds.

Figure 9 Eh pH diagram as sourced from Bohn, et al., (1990) p124

The situation becomes even more complex as other intermediate Fe minerals (blue green rusts) come into play. The essence of the presence of blue-green rusts is that they are tints that occur extensively in poorly drained and poorly aerated soils such as G-horizons under vertic and/or melanic A-horizons. These minerals are not stable and often disappear within a few minutes of exposure to the atmosphere. They in all probability form some of the most important Fe phases in vertic soils but disappear rapidly. Before they disappear it is also evident that these minerals are visible against a grey matrix but poorly visible against a black or dark background.

In essence therefore, a number of factors, including degree of reduction, soil pH and dominant Fe minerals, conspire against the use of Fe indicators in vertic, melanic and lime containing soils for the delineation of wetlands. There is no quick solution to this problem and delineators should use as many other indicators of wetland conditions in such soils as they can.

One word of caution: The wetland delineation guidelines (DWAF, 2005) indicate the Rensburg and Willowbrook soil forms as occurring in the permanent wetland zone. This is somewhat erroneous. Although these can occur in permanent wetland zones their formation is dependent on distinct cycling between wet and dry seasons. The development of 2:1 clays (found in these soils) depends on the accumulation of weathering products and clays in lower lying landscape positions. These clays are, depending on a range of factors, either swelling or non-swelling and their formation requires a distinct time (seasonally) where evaporation exceeds precipitation, with consequent drying of the soil, to lead to a concentration of bases (Ca and Mg). These clay minerals (such as smectite) often express themselves in the form of distinct cracks in Vertic soils. From this discussion it follows that the Rensburg and Willowbrook soils could only have formed in conditions that resemble a **seasonal wetland**. Drainage lines on the site can, if dominated by Rensburg or Willowbrook soils, therefore not be classified as permanent wetlands unless there are other characteristics indicating conditions of permanent saturation.

5.7 Implications for Wetland Delineation and Application of the Guidelines

The main implication for the delineation of wetlands and the application of the guidelines is the fact that highly variable conditions occur in the specific land type. One set of indicators of hydromorphism cannot be used as many of the clayey soils do not exhibit mottling or grey colours. The opposite is true for the sandy soils where a very large proportion of them will indicate signs of Fe removal. But this, as explained earlier is a function of slightly acid pH and a low Fe reserve. A delineation exercise is therefore a complex process with a very distinct possibility of not elucidating the hydrological parameters need for the making of informed decision regarding the impact of the development on the wetland.

5.8 Implications for Wetland Conservation in Urban Environments

Whether an area is designated a wetland or not loses some of its relevance once drastic influences on landscape hydrology are considered. If wetlands are merely the expression of water in a landscape due to proximity to the land surface (viz. the 50 cm mottle criterion in the delineation

guidelines) it follows that potentially large proportions of the water moving in the landscape could fall outside of this sphere – as discussed in detail above. **Figures 10** and **11** provide schematic representations (as contrasted with **Figure 6**) of water dynamics in urban environments with distinct excavations and surface sealing activities respectively.

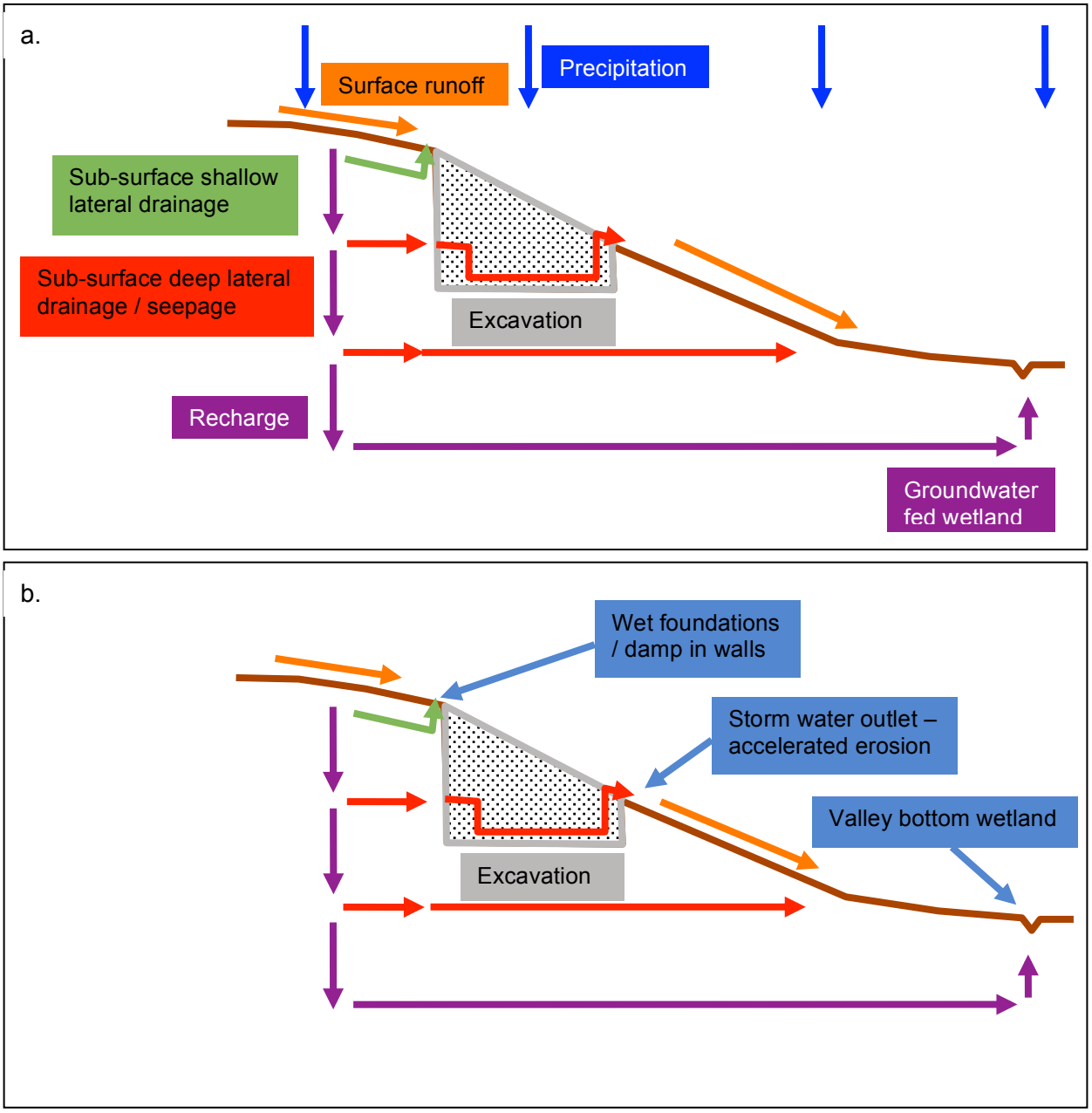


Figure 10 Different flow paths of water through a landscape with an excavated foundation (a) and typical wetland types associated with the altered water regime (b)

Through the excavation of pits (**Figure 10**) for the construction of foundations for infrastructure or basements for buildings the shallow lateral flow paths in the landscape are severed. As discussed above these flow paths can account for up to 60 % of the volume of water entering the landscape in the form of precipitation. These severed flow paths often lead to the ponding of water upslope from the structure with a subsequent damp problem developing in buildings. Euphemistically we

have coined the term “wet basement syndrome” (WBS) to describe the type of problem experienced extensively on certain landscapes. A different impact is experienced once the surface of the land is sealed through paving (roads and parking areas) and the construction of buildings (in this case the roof provides the seal) (**Figure 11**). In this case the recharge of water into the soil and weathered rock experienced naturally is altered to an accumulation and concentration of water on the surface with a subsequent rapid flowing downslope. The current approach is to channel this water into storm water structures and to release it in the nearest low-lying position in the landscape. These positions invariable correlate with drainage features and the result is accelerated erosion of such features due to a drastically altered peak flow regime.

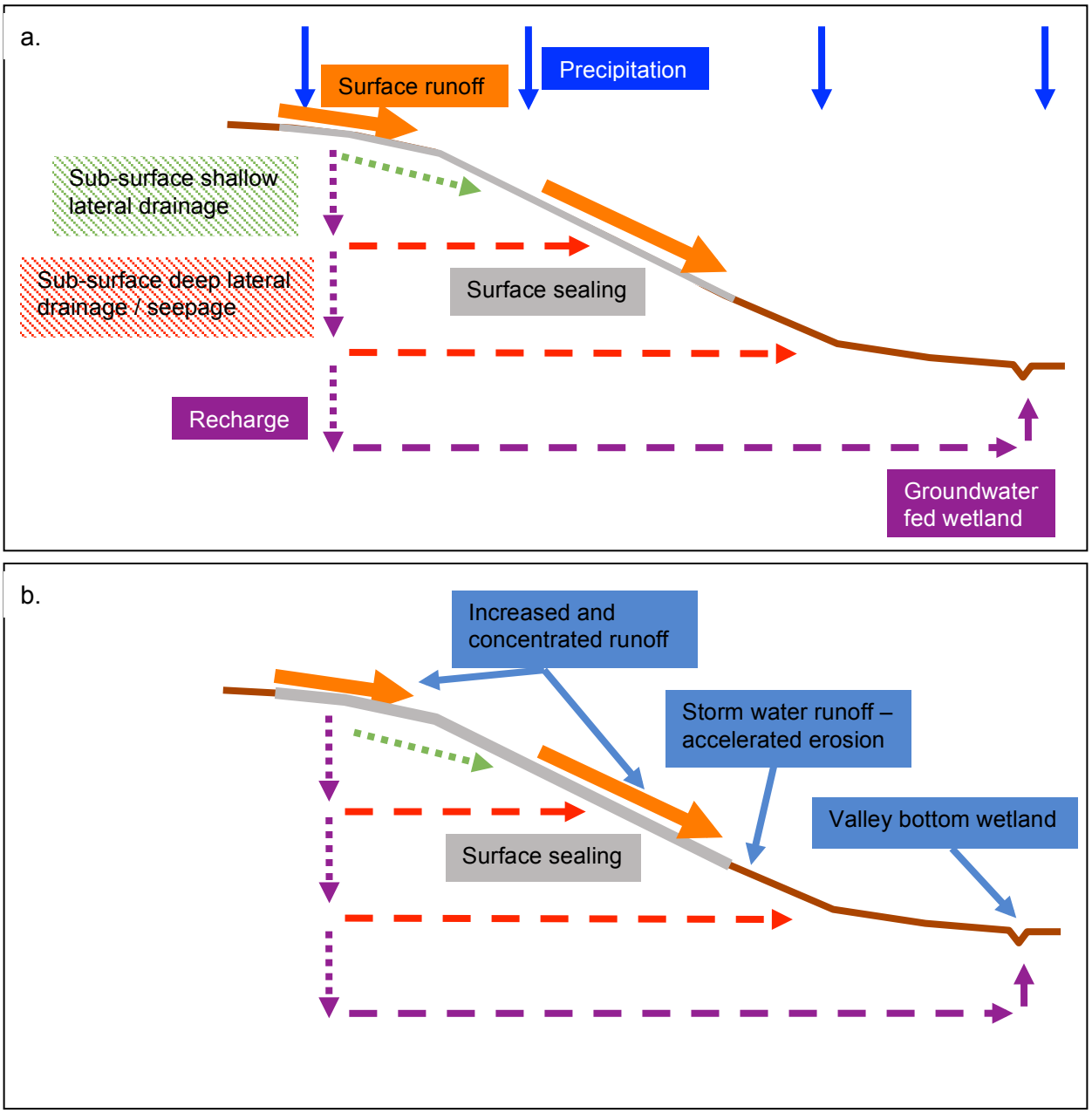


Figure 11 Different flow paths of water through a landscape with surface sealing (buildings and paving) (a) and typical wetland types associated with the altered water regime (b)

The result of the above changes in landscape hydrology is the drastic alteration of flow dynamics and water volume spikes through wetlands. This leads to wetlands that become wetter and that experience vastly increased erosion pressures.

All the above aspects are complicated by variable geology in an area where the hydrological pathways could vary significantly. Later in the report specific reference will be made to the hydropedology of the site linked to the expected impacts of a pipeline development.

6. METHOD OF WETLAND INVESTIGATION AND DELINEATION

The wetlands on the site were investigated and assessed on the basis of the wetland indicators as described in the wetland delineation guidelines (DWAF, 2005).

6.1. AERIAL PHOTOGRAPH INTERPRETATION

An aerial photograph interpretation exercise was conducted through the use of Google Earth images and historical aerial photographs of the site. This data was used to obtain an indication of the extent of the wetlands on the site as well as to provide an indication of the artificial modifiers evident on the site and in the catchment.

6.2 TERRAIN UNIT INDICATOR

Detailed contours of the site (filtered to 2 m intervals for the purpose of map production) were used to provide an indication of drainage depressions and drainage lines. From this data the terrain unit indicator was deduced.

6.3 SOIL FORM AND SOIL WETNESS INDICATORS

The soil form and wetness indicators were assessed on the site through a dedicated soil survey within the context of the description of the Ba54 land type description as provided in sections 5.5 and 5.6. The site was traversed on foot and soils were augured and described where rock and rubble did not impede the soil auger. The areas covered by granite and dolerite were identified even though the colluvial material exhibited a large degree of variation.

Historical impacts were identified as the impacts on the soils are very distinct. Soil characteristics could therefore be used to provide a good indication of the historical impacts on the grounds of a forensic approach. In areas where soil impacts are limited the standard approach in terms of identification of soil form and soil wetness indicators was used.

6.4 VEGETATION INDICATOR

Due to the extent of the historical impacts as well as soil disturbances a dedicated vegetation survey for the purpose of wetland delineation was not conducted. Vegetation parameters were noted and these are addressed in the report where relevant.

6.5 ARTIFICIAL MODIFIERS

Artificial modifiers of the landscape and wetland area were identified during the different components of the investigation and are addressed in the context of the wetland delineation.

7. SITE SURVEY RESULTS AND DISCUSSION

7.1 AERIAL PHOTOGRAPH INTERPRETATION

7.1.1 Potential Wetlands

From the aerial photograph interpretation that was based on several historical Google Earth images, the most likely wetland areas were identified. Apart from the drainage feature on the southern boundary of the site a few potential seepage wetland areas were identified. **Figure 12** indicates a partial coverage the satellite image and exhibits signatures that may be interpreted as seepage wetland areas. From the little information that is evident from the image these areas appear as if they may be the product of human activity. **Figures 13** to **16** indicate changes to 2013.

Figure 12 Google Earth image (2003/10/02) indicating potential seepage areas (yellow arrows)

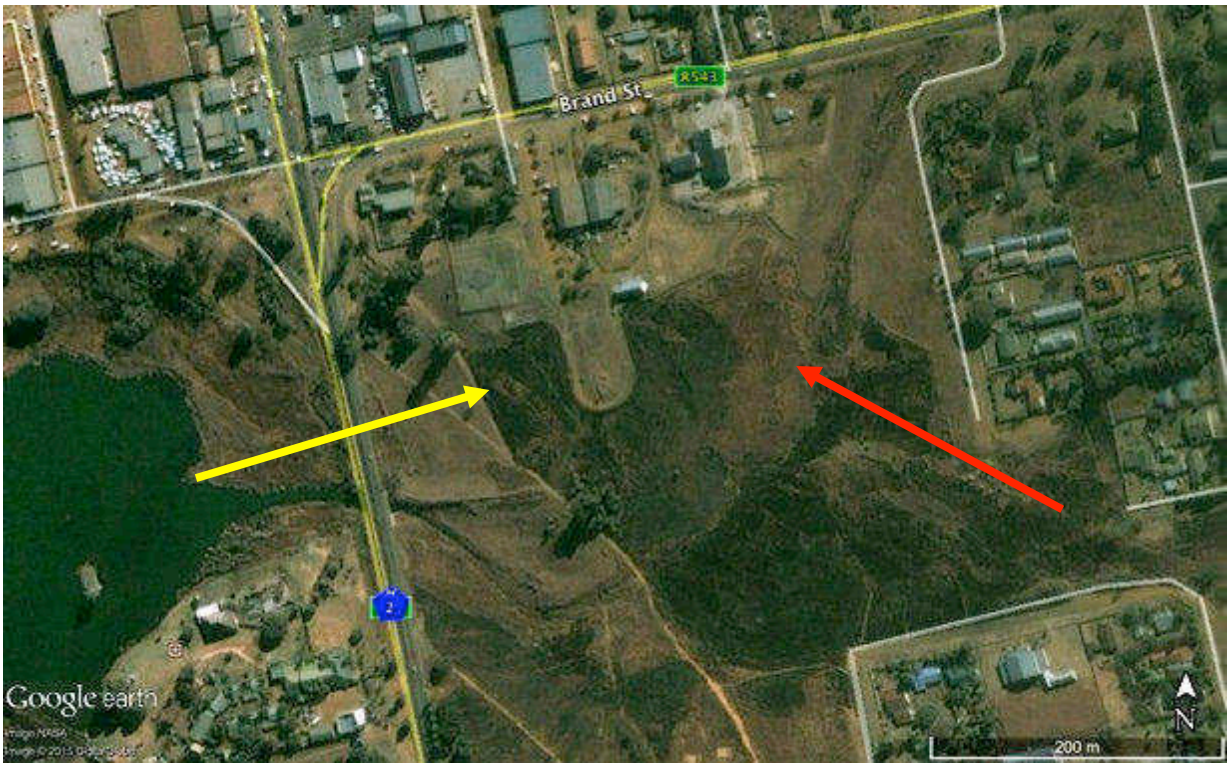


Figure 13 Google Earth image (2010/06/18) with the potential seepage areas (yellow arrow) very evident as artificial modifiers and indicating a potential seepage wetland in the east (red arrow)

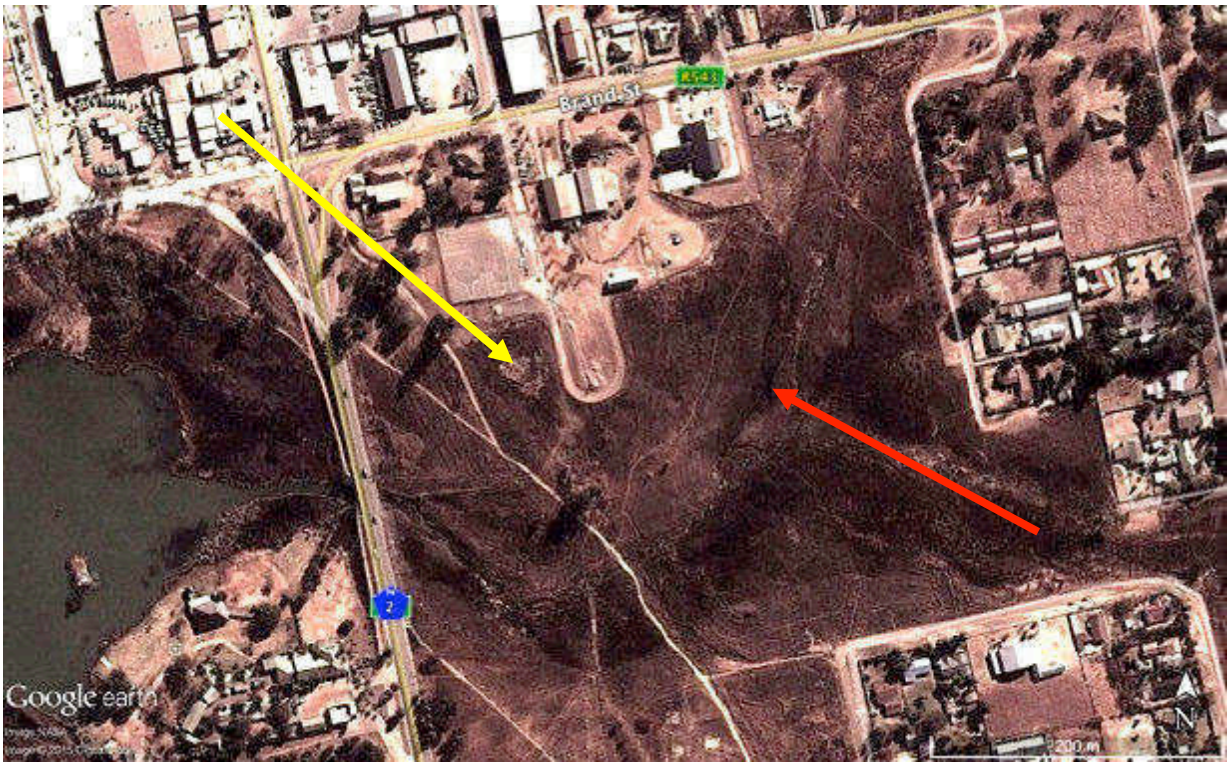


Figure 14 Google Earth image (2011/07/20) with the potential seepage areas (yellow arrow) very evident as artificial modifiers and without signs of a potential seepage wetland in the east (red arrow)