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 3 of 4

B O K A M O S O

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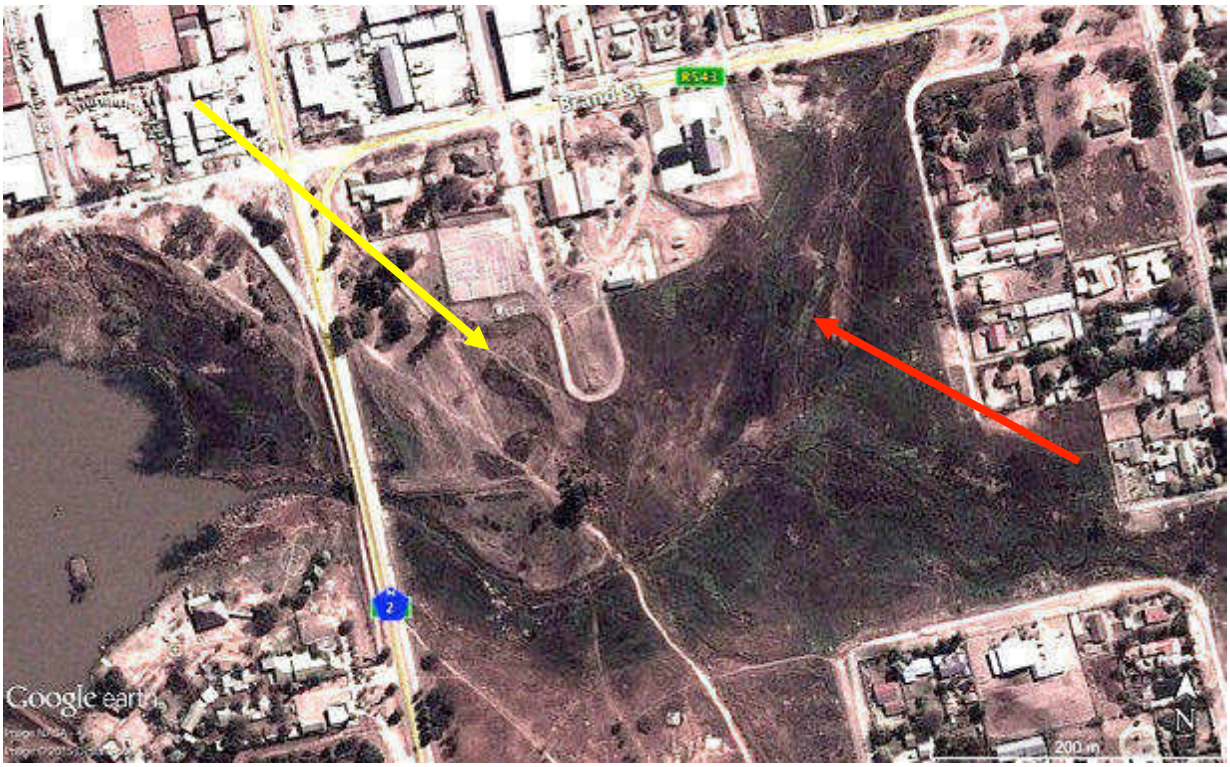

Figure 15 Google Earth image (2012/09/09) with the potential seepage areas (yellow arrow) very evident as artificial modifiers and again indicating a potential seepage wetland in the east (red arrow)

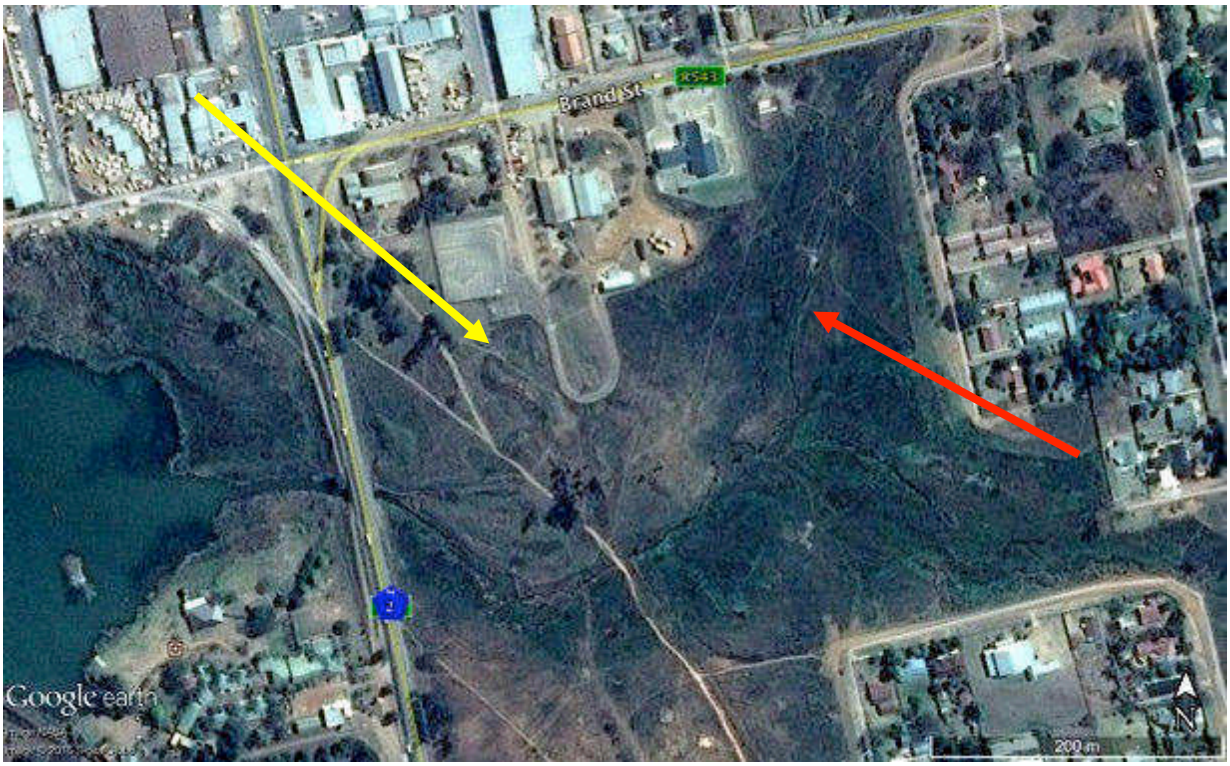

Figure 16 Google Earth image (2013/08/26) with the potential seepage areas (yellow arrow) very evident as artificial modifiers and again indicating a potential seepage wetland in the east (red arrow)

From **Figures 13** to **16** seasonal changes are evident in the expression of the possible seepage wetland in the east. Also, the possible seepage wetland in the west from **Figure 12** is very evident to have been altered through human activities.

7.1.2 Historical Land Use Changes and Impacts

The details of the historical land use changes on the site cannot be gleaned from the Google Earth images as the impacts precede the first available image. However, it is very evident that changes on the site occurred since 2003 in the form of additional paving and storm water runoff. Changes are also apparent in the stream channel over the image period as the channel appears more eroded in the recent images.

7.2 TERRAIN UNIT INDICATOR

From the contour data a topographic wetness index (TWI) (**Figure 17**) was generated for the site. The TWI provides a very accurate indication of water flow paths and areas of water accumulation that are often correlated with wetlands. This is a function of the topography of the site and ties in with the dominant water flow regime in the soils and the landscape (refer to previous section where the concept of these flows was elucidated). Areas in blue indicate concentration of water in flow paths with lighter shades of blue indicating areas of regular water flows in the soils and on the surface of the wetland / terrestrial zone interface.

From the TWI (**Figure 17**) it is very evident that the entire site is situated on convex topography (both plan and profile curvature) and as such have no areas associated with concentrations of surface runoff. The stream channel to the south is the only confirmed area of concentrated water accumulation and flow. The delineation of the wetland is addressed later in the report.

7.3 SOIL FORM AND SOIL WETNESS INDICATORS (SITE SURVEY)

The site survey revealed widespread and significant alterations to the soils and land surface. As an indication of the extent of the alterations and influences **Figures 18** to **33** provide photographs along a half-moon shaped transect from the western edge to the eastern edge of the site upslope of the stream channel. The captions are self-explanatory.

The main findings along the transect is that the landscape has been altered significantly through historical and more recent human activities. These activities have in most case led to additional soil material and rock being deposited on the land surface or to distinct excavations for urban related infrastructure. The areas that have been altered either show denuded vegetation (due to hard-setting and increased surface runoff) on convex local slopes or accumulation water in depressions with associated increases in vigour of plants and colonisation of plants that prefer wetter soil conditions. These plans are, for the largest part of the site, not true indicators of original wetland conditions.

A small section of darker soil, associated with a wetter patch of land and dolerite rock, was found in the eastern section of the site (**Figures 29** and **30**). This corresponds to the “marshy” area described in the geotechnical report. Although this section is wet more regularly it is not possible to indicate whether this is a historical (pre-human settlement) wetland as the higher clay content of the soils (compared to the rest of the site) would lead to perching of surface water with rapid colonisation of wetland plants. This area is at the foot of storm water accumulation from the existing structures upslope.

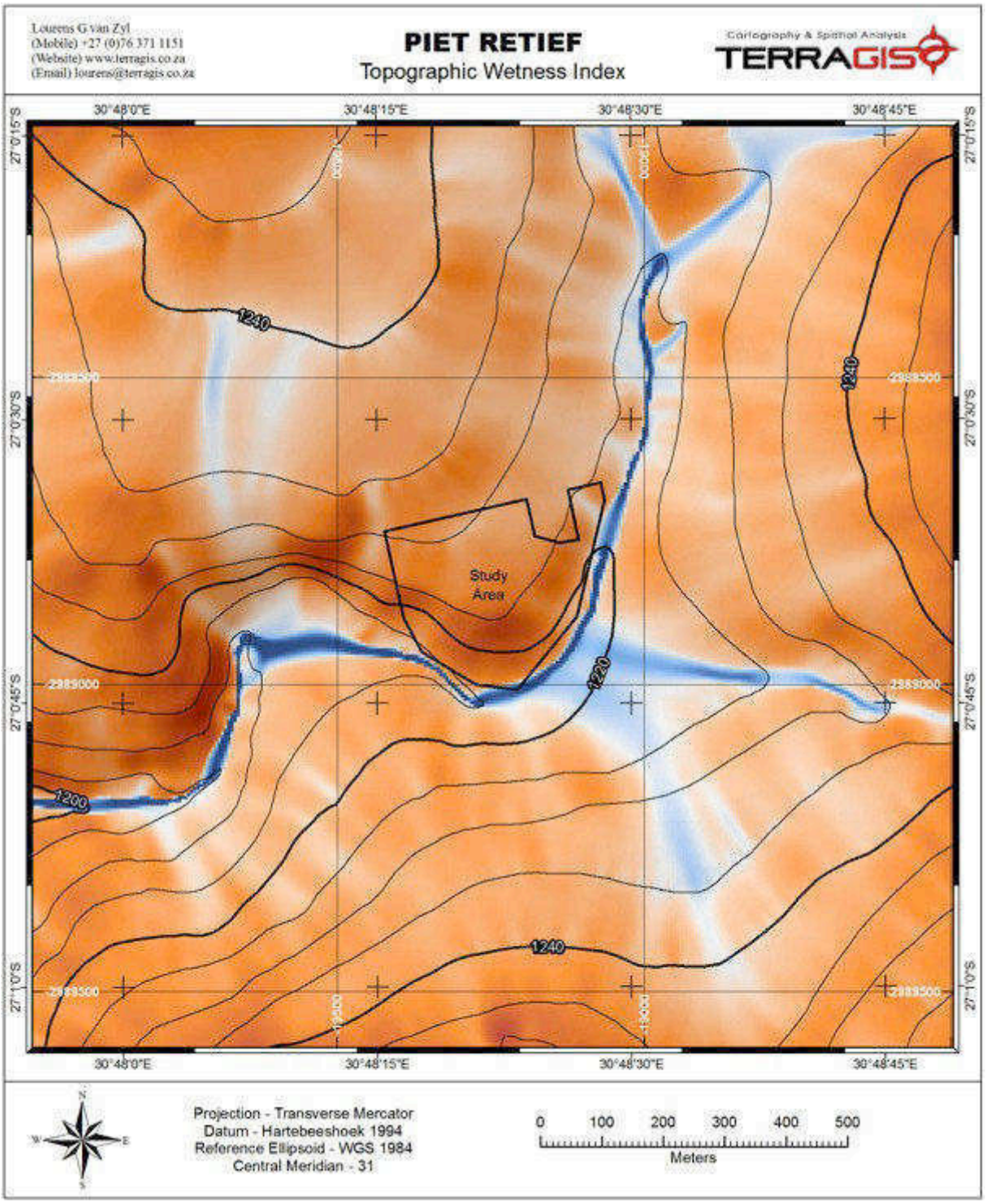

Figure 17 Topographic wetness index (TWI) of the survey site

Figure 18 Human impacts and altered landscape and vegetation on the western edge of the site

Figure 19 Human impacts and altered landscape and vegetation on the western edge of the site

Figure 20 Human impacts and altered landscape and vegetation on the western edge of the site – area erroneously identified during image interpretation as potential seepage wetland

Figure 21 Human impacts and altered landscape and vegetation on the western edge of the site near the stream – note the presence of a pipeline as well as soil disturbances

Figure 22 Human impacts in the form of a pipeline and historical earthworks on the southern boundary with the stream

Figure 23 Foreign soil material and soil disturbances on the south western edge of the site

Figure 24 Foreign soil material and soil disturbances on the south western edge of the site

Figure 25 Vegetation alterations initially (but erroneously) identified as potential seepage areas (yellow arrow)

Figure 26 Vegetation alterations to the south of the developments on the site

Figure 27 Foreign soil material and soil disturbances on the southern sections of the site

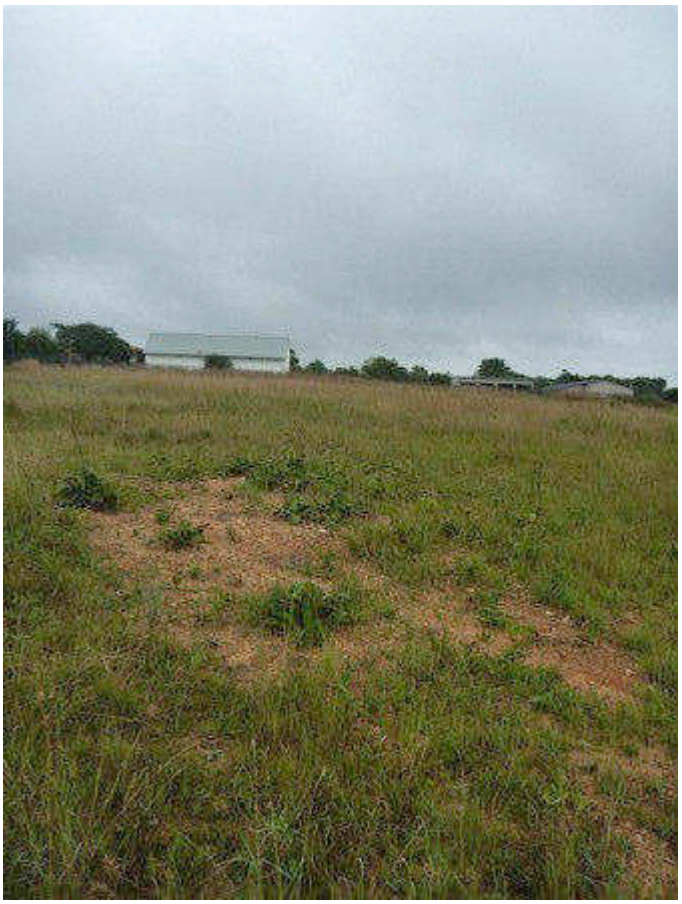

Figure 28 Foreign soil material and soil disturbances on the southern sections of the site

Figure 29 Vegetation alterations to the south of the developments on the site with evidence of regular surface wetness from plant species

Figure 30 Vegetation alterations to the southeast of the developments on the site with evidence of regular surface wetness from plant species

Figure 31 Vegetation and surface disturbances on the eastern section of the site

Figure 32 Vegetation and surface disturbances on the eastern section of the site with widely occurring rubbish and rubble

Figure 33 Altered stream channel (excavation and clearance)

The areas to the south and east of the drainage line exhibit large patches of potential seepage zones. Upon inspection these appeared to have some contribution of seepage water but the bulk of the water currently results from storm water runoff from paved areas upslope.

7.4 ARTIFICIAL MODIFIERS

The artificial modifiers have been discussed and elucidate in the previous sections.

8. WETLAND ASSESSMENT

8.1 PROPOSED DELINEATION AND BUFFER

From the investigation a wetland boundary, inclusive of storm water driven wetland areas, was determined **Figure 34**. It is difficult to assign a buffer to a wetland that has been impacted and that still receives significant contributions of water from storm water runoff from paved areas upslope. It is recommended that developments can encroach up to 30 from the drainage line and where the current developments are closer than that these areas should not be expanded. The above is proposed only in the event that adequate storm water planning and mitigation is conducted on site.

8.2 WETLAND CLASSIFICATION / TYPES

Based on the investigation two types of wetland areas are identified namely: 1) the areas associated with an impacted and eroded drainage feature and 2) a seepage/storm water outflow zone. As discussed earlier in the report it is not possible to indicate whether the latter zone is a natural seepage zone or a more recent development of storm water runoff increases and frequency.

8.3 WETLAND FUNCTIONALITY

The channelled valley bottom wetland / watercourse is fed predominantly from the catchment through overland flow with additions from storm water runoff from paved areas. The main contributor to the small impacted wetland patch on the site is storm water runoff from paved areas and structures upslope to the south. From the investigation it was not possible to identify any significant contributions of hillslope water or lateral flows to wetlands or the stream. This is a function of the convex slope of the site.

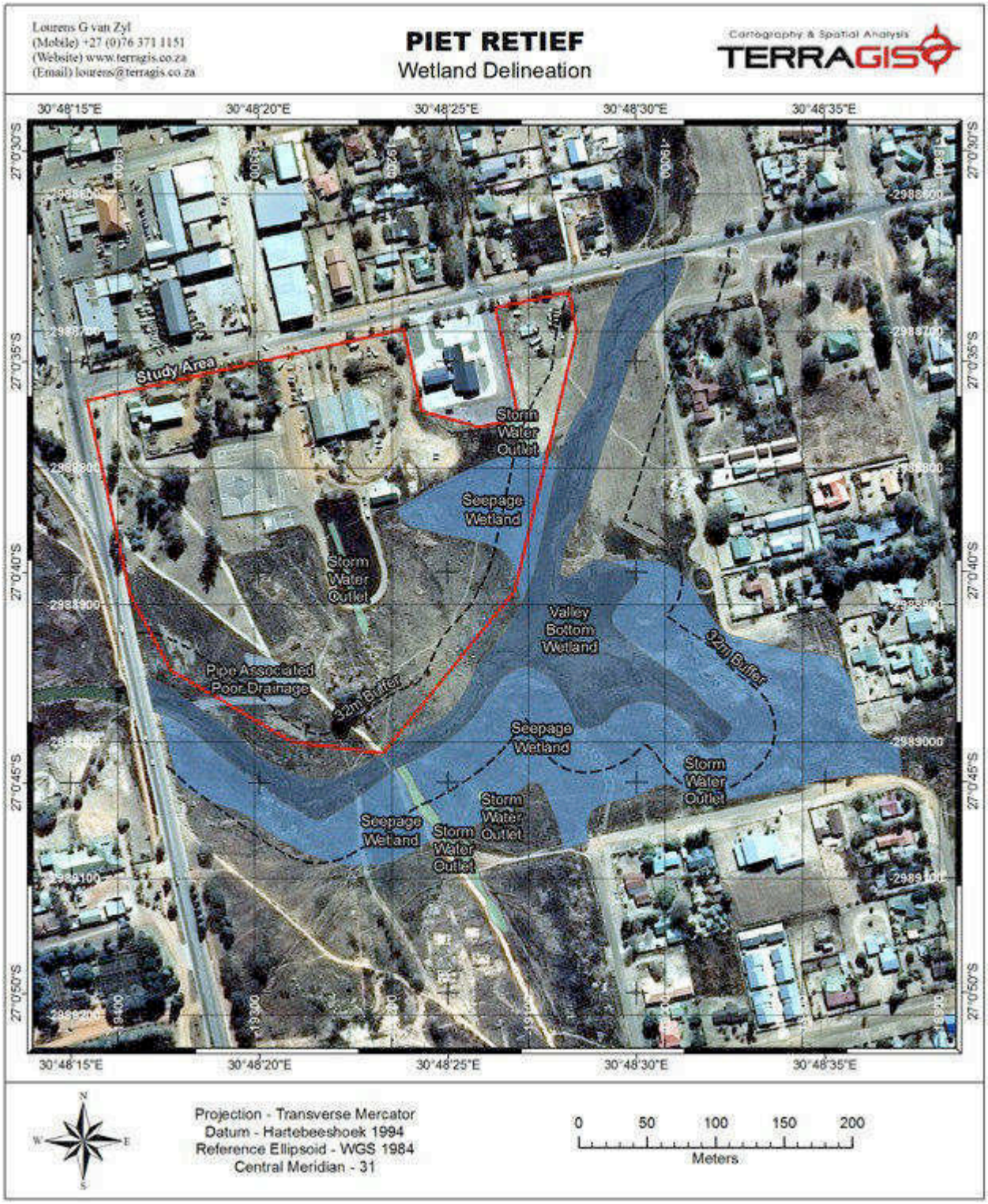

Figure 27 Proposed delineation for the investigation site

8.4 PRESENT ECOLOGICAL STATUS (PES) DETERMINATION

Hydrological Criteria:

- Flow modification: Large modification due to urban infrastructure in the catchment with significant erosion in the channel and on the banks. Score 2, Confidence 4.
- Permanent inundation: Permanent inundation was not part of the reference state and cannot be included as a new aspect. Inundation does take place in areas but this is due to significant human impacts in the form of alteration and rubble dumping. Score 2, Confidence 4.

Water Quality Criteria

- Water quality modification: Score 1, Confidence 4
- Sediment load modification: Score 1, Confidence 4

Hydraulic / Geomorphic Criteria

- Canalisation: Score 2, Confidence 4
- Topographic Alteration: Score 1, Confidence 4

Biological Criteria

- Terrestrial encroachment: Score 1, Confidence 3
- Indigenous vegetation removal: Score 2 (for most of the site), Confidence 4
- Invasive plant encroachment: Score 1 (for most of the site), Confidence 4
- Alien fauna: Score 2, Confidence 3
- Overutilisation of biota: Score 1, Confidence 4

Score

PES category D-E

From the data generated as well as the extent of the identified alterations the conclusion is that the wetland systems on the site have a PES rating of an D to an E. The potential for improvement is small as the storm water and water quality aspects have to be addressed outside of the wetland areas within the respective catchments.

9. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn from the investigation:

1. The entire site has undergone alterations in the form of varying intensity human activities.
2. The stream that forms the valley bottom section of the landscape is impacted in many areas through erosion and excavation. In addition, significant amounts of litter and invasive plants are evident throughout the channel.
3. A possible seepage wetland zone was identified at the foot of urban developments with storm water outflows. The specific soils found in this area indicate predominantly surface wetness and it is therefore concluded that the main contributor to wetland vegetation establishment is storm water emanating from the paved areas upslope.
4. The soils found in the small wetland area have high clay contents and this aspect precludes any significant volumes of water flowing laterally subsurface wise into the wetland. Dolerite intrusions in the general landscape often exhibit distinct weathering and zones of poor

drainage due to the localised effect of high clay content on water percolation, drainage and movement. From these aspects it is not possible to unequivocally assign the area as a seepage wetland. This area's possible recharge zone has been paved and it can therefore safely be assumed that the dominant hydrological functioning is one of surface water runoff from upslope areas during rainfall events.

5. During development of the site the construction activities should be limited to a distance of at least 30 m from the water course except if adequate storm water management and containments structures are constructed to minimise high energy flows into the stream channel.
6. The "seepage wetland" is situated immediately downslope of paved up sites and a buffer can therefore not be recommended. In this case the same recommendations as above regarding storm water management apply.

REFERENCES

Boehner, J., Koethe, R. Conrad, O., Gross, J., Ringeler, A., Selige, T. 2002: Soil Regionalisation by Means of Terrain Analysis and Process Parameterisation. In: Micheli, E., Nachtergaele, F., Montanarella, L. [Ed.]: Soil Classification 2001. European Soil Bureau, Research Report No. 7, EUR 20398 EN, Luxembourg. pp. 213-222.

Brady, N.C. and Weil, R.P. 1999. *The Nature and Properties of Soils*. Twelfth edition. Upper Saddle River, New Jersey: Prentice Hall.

Department of Water Affairs and Forestry (DWAF). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Hillel, D. 1982. Introduction to soil physics. Acedemic Press, INC. Harcourt Brace Javonovich, Publishers.

Jenny, H. 1941. Factors of soil formation. New York, NY, USA: McGraw-Hill Book Company, p 281

Land Type Survey Staff. (1972 – 2006). *Land Types of South Africa: Digital map (1:250 000 scale) and soil inventory databases*. ARC-Institute for Soil, Climate and Water, Pretoria.

MacVicar, C.N. et al. 1977. *Soil Classification. A binomial system for South Africa.* Sci. Bull. 390. Dep. Agric. Tech. Serv., Repub. S. Afr., Pretoria.

Soil Classification Working Group. 1991. Soil Classification. A taxonomic system for South Africa. *Mem. Agric. Nat. Resour. S.Afr.* No.15. Pretoria.

Wischmeier, W.H., C.B. Johnson and B.V. Cross. 1971. A Soil Erodibility Nomograph for Farm Land and Construction Sites. J. Soil Water Conserv. 26: 189 – 193.

Appendix D3:

Ecological Assessment

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Bokamoso:

Basic assessment Flora and Fauna Assessment

Portion 17 of the farm Vlakfontein 522KR; Piet Retief, Mpumalanga Province, South Africa

By

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Enviro-Insight CC was commissioned by Bokamoso to perform a basic assessment of fauna and flora for the proposed Portion of Portion 100 (Portion of Portion 1) of the farm Piet Retief Town and Townlands 149 HT; Mpumalanga Province, South Africa. This site falls entirely within the KaNgwane Montane Grassland regional vegetation unit (Figure 1; Mucina & Rutherford 2006). In addition, this vegetation type is the only vegetation unit in the immediately surrounding region. For the purposes of the study, any proposed developments should be compared against the new 2014 Environmental Impact Assessment Regulations, which drives much of the approach for this study.

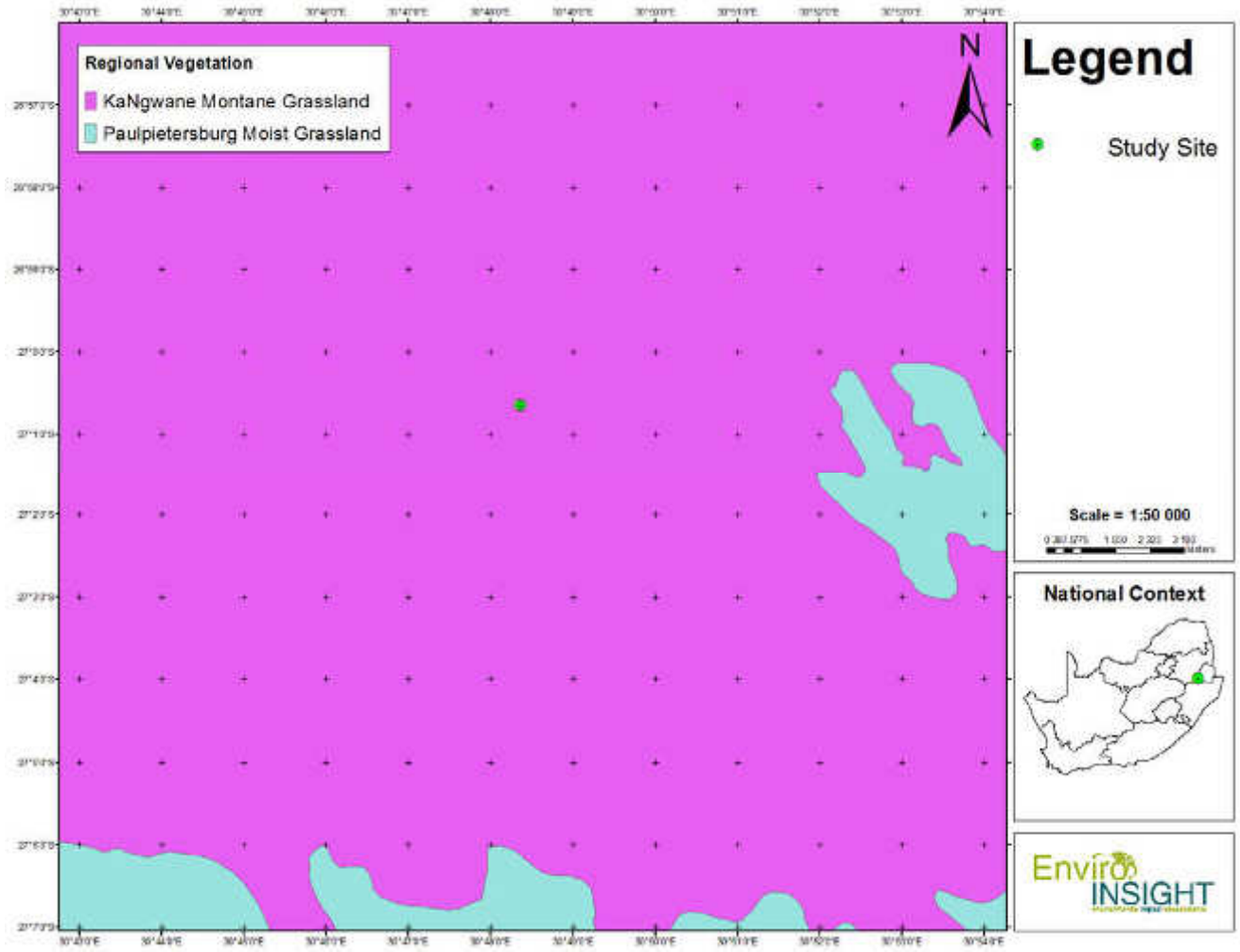


Figure 1: *The study area in relation to the regional vegetation type*

2 METHODS

2.1 FIELD SURVEY

A field survey was performed in March 2015 by a specialist zoologist/ ecologist where the botanical and the faunal aspects of the survey area were evaluated. This represented a wet season survey. During the field survey, the proposed development site was covered on foot and a series of georeferenced photographs were taken of the habitat attributes that would serve to drive the results and conclusions. The field survey focused on a Basic Assessment level classification of the fauna, flora, habitats as well as the potential presence of Red Data species (also referred to as Red-Listed species), which are species of conservation concern in South African (either classified as threatened by the IUCN (2014), protected by NEMBA (2014) or indeed other legislations applicable provincially or nationally). An analysis of the diversity and ecological integrity of the habitats present on site was also performed as well as the presence of indigenous vegetation with an extent of more than 1 hectare.

2.2 DESKTOP SURVEY

2.2.1 Literature study

As mentioned above, much of the approach for this survey is based upon the National and Mpumalanga Requirements for Biodiversity Assessments. The level of this study does not warrant intensive sampling but rather serves to combine the aspects of the regional vegetation unit (obtained from Mucina and Rutherford 2006) with the field study in order to formulate a series of recommendations. Many of the potential avifaunal triggers were referenced by the Southern Africa Bird Atlas Project (SABAP 2) and Hockey *et al.* (2005). Mammal information was referenced by Skinner and Chimimba (2005) while reptiles and amphibians were referenced from Bates *et al.* (2014) and Du Preez and Carruthers (2009) respectively. It must be stated that evaluation of species of concern was considered only AFTER the field study which served to identify the potential for occurrence. Therefore, all species identified under the above mentioned references were not necessarily analysed in detail. Plants were identified using Van Oudtshoorn (2004) and Van Wyk & Van Wyk (1997). Species nomenclature follows the aforementioned references throughout this document. The applicability of the information obtained from the literature sources was evaluated for the study area and the subsequent recommendations are to be used by the client (Bokamoso) in order to drive the development process in accordance with the relevant legislation.

2.2.2 GIS

Ground truthing and the use of recent satellite imagery were used to assist in the characterisation of the study area. The Mpumalanga C-Plan (2014) was also used in conjunction with ground truthing in order to verify the status of the site, which is shown in Figure 3.

3 RESULTS

3.1 DESCRIPTION OF STUDY AREA

The specialist tracks as well as the location of the georeferenced photos are shown as Figure 2. The georeferenced photographs served to assist in both the site characterisation as well as the sensitivity analysis. Although some areas were not able to be covered fully (e.g. the north-west corner of the site), transparent fencing into disturbed areas provided more than enough clarity for accurate descriptions to be made.

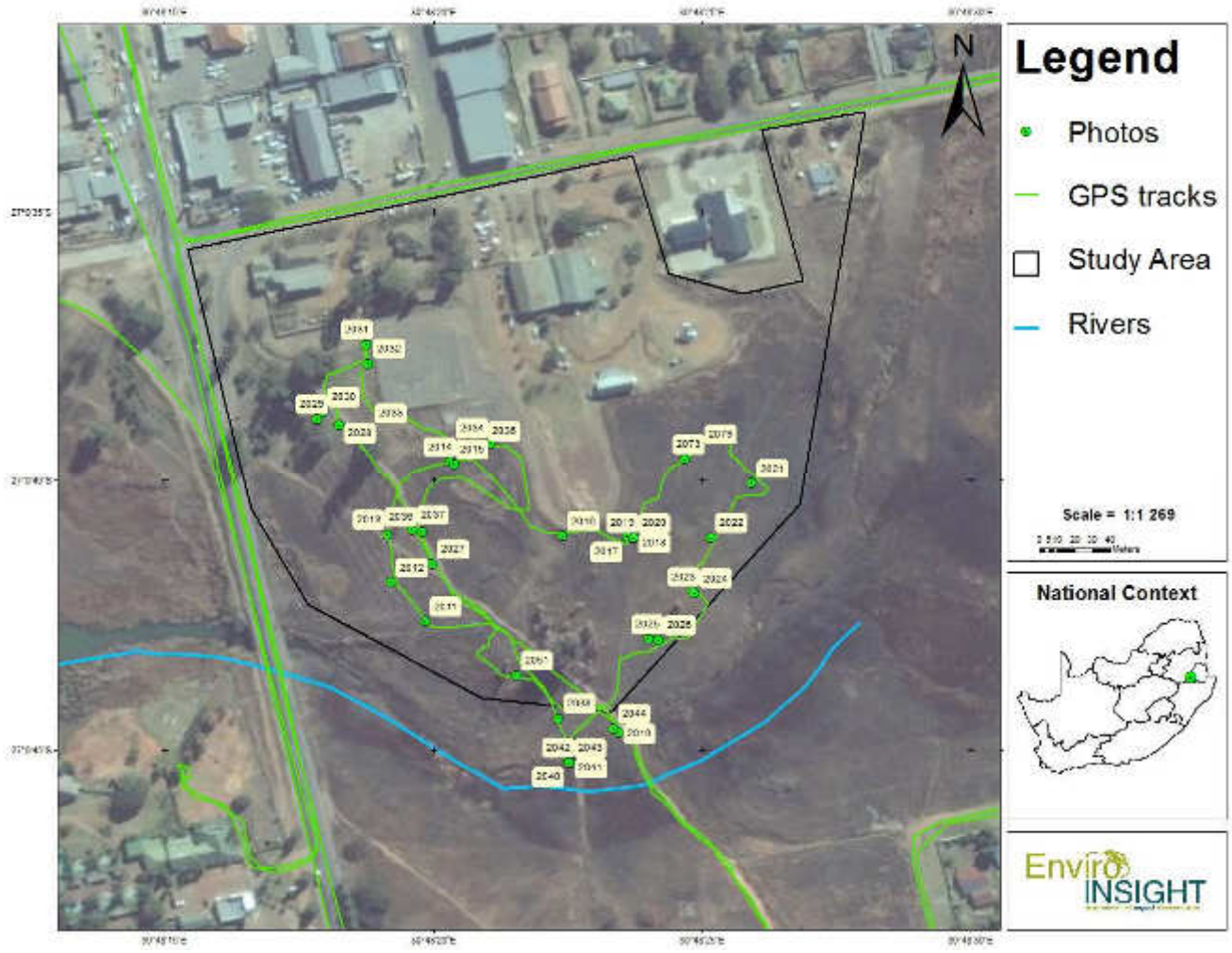


Figure 2: *Specialist coverage and location of georeferenced photographs taken in the field*

The study area was classified as falling entirely within the Vulnerable KaNgwane Montane Grassland regional vegetation unit which is under threat due to the low levels of protection afforded to the unit. It was evident from the ground-truthing (georeferenced photos provided in the Appendix) that much of the study area is not ecologically intact and is poorly connected to similar ecologically intact vegetation. The potential for Red Listed species is discussed below. In addition, the Mpumalanga C-Plan (2014) has classified the area as having "no natural habitat remaining".

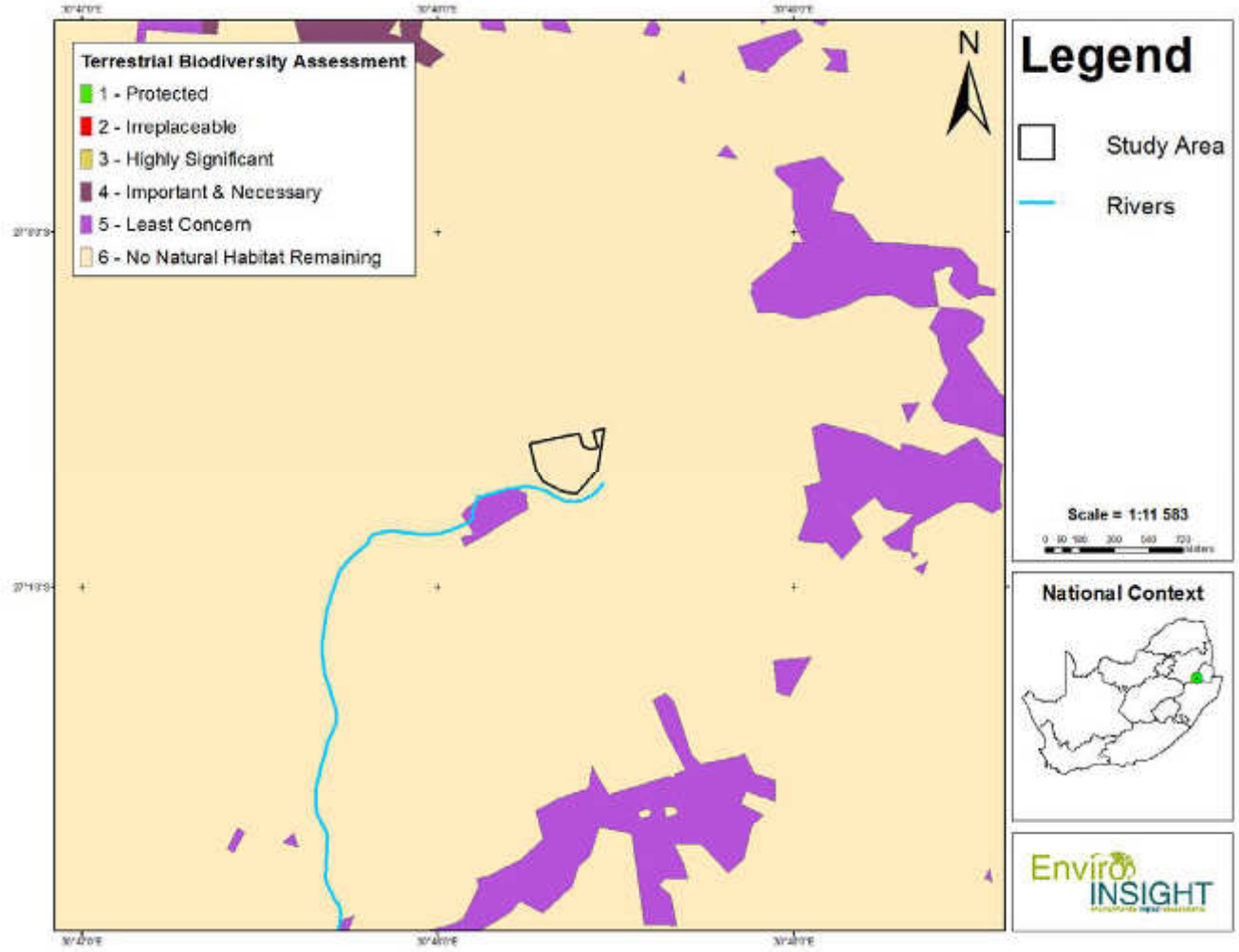


Figure 3: *Mpumalanga (2014) C-Plan showing the conservation plan status of the project footprint*

Significant current impacts (shown photographically in Table 1) were recorded on site, most of which related directly to the current use of the development footprint.

The most significant identified impacts on site included:

- The high densities of alien invasive / indigenous invasive species including are prevalent;
- The physical manipulation (mowing) of the grassland system;
- Adjacent road networks (fragmentation, noise and traffic effects);
- Fence related habitat fragmentation;
- Residential related presence of feral predators (cats and dogs); and
- Human density effects.

Photographic evidence of the current impacts on the site is shown in Table 1.

Table 1: *Examples of current impacts observed in the study area during the survey*

	
Physical mowing of grassland	Alien invasive plant species
	
Fence effects	Human (road) effects

The following section provides a description of each of the habitat types occurring within the study area.

3.2 HABITAT UNIT 1 – DISTURBED TRANSFORMED

This habitat type is characterised by building structures and development and is not considered o be ecologically functional in any way. Photographic evidence of this habitat type is shown as Figure 4.

Figure 4: *Photographic example of the Disturbed Transformed*

3.3 HABITAT UNIT 2- DISTURBED VEGETATED HABITAT

This habitat type was by far the most prevalent within the study area and although it shows an abundance of indigenous vegetation, it is no longer considered to be ecologically functional in any way. The habitat is characterised in a number of ways, specifically;

- Previous disturbance with secondary grass regrowth
- Cultivated lawn
- Alien invasive species

Despite the slight variations within the habitat, it is entirely classified as non-sensitive and no Red-Listed species are expected to occur. Historically, the habitat type was most likely subjected to unsupervised grazing practices, human activities and physical manipulation of the floristic structure. In regards to actual classification, this is shown by both the undifferentiated or monospecific floristic structure and low diversity of species composition.

The grass cover throughout Disturbed Vegetated habitat was significant, although the representative species were indicative of disturbance. Dominant and sub-dominant species included *Melinis repens*, *Pennisetum clandestinum* (or other lawn grasses), *Aristida congesta* subsp. *barbicolis*, *Cynodon dactylon*, *Sporobolus africanus*, *Heteropogon contortus*, *Hyparrhenia hirta* and fragments of *Cymbopogon sp.* Most of the species fell within the "Increaser" classification as described by Van Outshoorn (2004) showing low grazing value and high previous levels of disturbance, although some pockets of *Themeda triandra* were present (Decreaser).

A photographic example of the Disturbed Vegetated Habitat Type is shown as Figure 5.

Figure 5: *Photographic example of the Disturbed Vegetated Habitat Type*

3.4 HABITAT UNIT 3- STREAM AND STREAM BUFFER HABITAT TYPE

The Stream and Stream Buffer Habitat type mostly occurred outside of the project footprint, although the influence of the waterway and associated buffer on and within the study area warrants further discussion. In addition, it must be stated that formal wetland delineation was beyond the scope of this study which mostly sought to classify the flora fauna on a basic assessment level. The general classification of this habitat is required in order to subsequently relate its presence to potential Red-Listed faunal species.

Overall, this habitat type was divided into the following sub-categories:

- Flowing water (stream): This habitat appeared to flow from a north-easterly to south-westerly direction to the lowest point in the study area, terminating in what is now a large artificial permanent water body (see below). The stream habitat is considered to be in functional ecological condition, despite the evaluation from the C-Plan (Mpumalanga). Rock structure and good quality riparian vegetation persists throughout this habitat type.
- Stream buffer: This system consists of linear riparian vegetation buffering the open water streams draining into the large artificial wetland described below. The vegetation type shows intact vegetation which retains aspects of the previous ecological functionality of the system.
- Large artificial permanent wetland: This water body most likely was a functioning seasonal or semi-permanent wetland and through heavy excavation, has been converted into a permanent "dam like" water body. This habitat acts as a source for wetland birds and possibly aquatic mammals although it is considered to be of peripheral importance to the development as a whole.

A photographic example of the Stream/ Stream Buffer Habitat Type is shown as Figure 6.

Note: A formal wetland delineation has been carried out and further classiifcation was beyond the scope of this study, as per instructions.

3.5 FAUNAL SPECIES OF CONSERVATION CONCERN

Through the assessment of faunal characteristics of the site (habitat potential, evidence of the presence of faunal species etc.) as well as applying the basic assessment study performed in conjunction with the aforementioned faunal references, three faunal "trigger" species were identified and thus require further discussion. The species identified were based on a probability of occurrence (based on habitat potential and previous records) and are discussed below:

Water Rat *Dasymys incomtus* (Near Threatened)

The project footprint is intersected by a portion of intact stream drainage/stream buffer which shows a significant influence on the development area. Although water rats could be located within the site, the habitat observed is considered to be sub-optimal habitat for water rat (due to high levels of disturbance). It must be stated however that if the extension was to be developed without mitigation, the flow of the natural drainage line would be impeded significantly and riparian habitat could be eliminated. In light of this and by employing the precautionary principle (assuming that water rat is present in the area), it is concluded that simple mitigation measures could be employed by buffering the drainage line, so that free movement of animals can take place, thereby avoiding all direct impact and maintaining the existing integrity of the stream and stream buffer.

Spotted-neck otter *Lutra maculicollis* (IUCN Near Threatened)

It was apparent that some potentially suitable migratory/dispersal habitat persists on site, characterised by the linear stream and associated buffer. However, the area is mostly sub-optimal for spotted-neck otters which prefer deep, clear pools which support large populations of fish. The conclusion for the spotted-neck otter mirrors that of the water rat above which favours simple buffering rather than intensive studies on the presence of the species which may in fact prove inconclusive.

Figure 6: *Photographic example of the Stream/ Stream Buffer Habitat Type*

Striped Weasel *Poecilogale albinucha* (Data Deficient)

Although this species is a grassland resident and is known from the region, the sheer level of disturbance would be highly unlikely to support a viable population of striped weasels.

3.6 FLORAL SPECIES OF CONCERN

Based on the vegetation analysis and the observations made during the survey it is evident that the area currently does not show sound ecological functionality and no Red-Listed plant species were observed and none are expected.

4 DISCUSSION AND RECOMMENDATIONS

The Discussion and Recommendation section will be driven by the legislative minimum requirements and the level of the study commissioned by the client (Basic Assessment). The section will also be broken down into the various components of Fauna, Flora and Habitats.

4.1 FAUNA

Due to the low habitat potential for the regional "trigger" species of conservation concern, the suggested recommendations are purely precautionary. The legislative buffering should be kept intact in order to not restrict the movement of red-listed aquatic mammals such as water rats and spotted neck otters.

4.2 FLORA

The primary recommendations regarding the floral assemblage relates to the buffering of the Stream/ Stream Buffer habitat as a way to maintain corridor movement of birds and aquatic faunal species. In addition, avifauna use this habitat as a corridor for movement between upstream wetland habitats and the large impoundments downstream. Finally, alien/ invasive species located within the project footprint should be subjected to the appropriate eradication program as stipulated by the recommendations of the ROD and any relevant legislation.

4.3 HABITAT

Although no significant ecological triggers were identified on a habitat level, the presence of stream/ stream buffer habitat within the study area does represent an elevated sensitivity for the Habitat Type. This is due to the possible occurrence of the above mentioned wetland associated faunal species. Figure 7 shows the final delineation of the study area with the identifiable Stream/ Stream Buffer area illustrated in blue, denoting the **only** area of high sensitivity. The habitat sensitivity is therefore illustrated as Figure 8. Once more it is imperative to mention that the majority of this habitat type has been subjected to formal wetland delineation and botanically, falls outside the scope of this study (as instructed by the client).

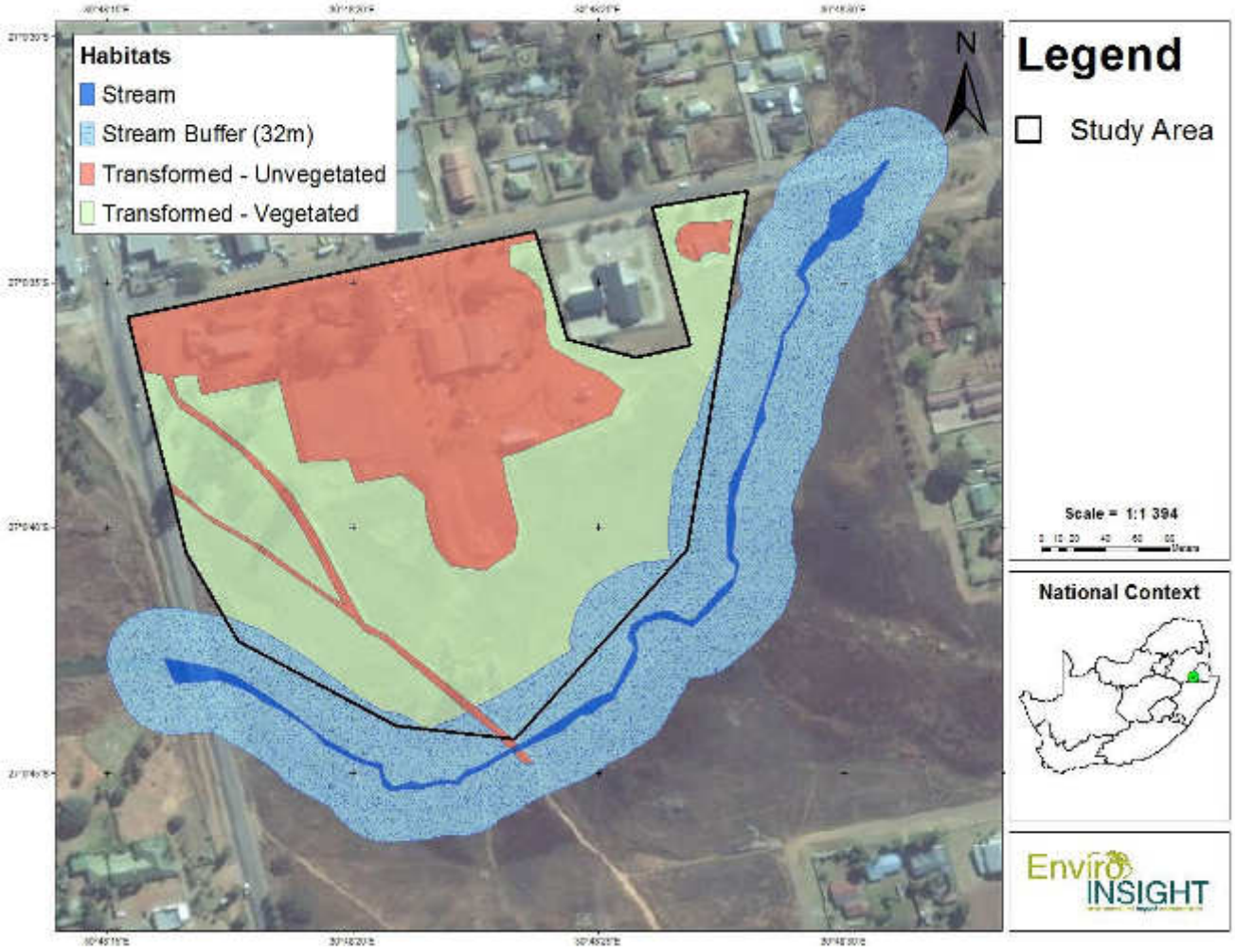


Figure 7: *Final Habitat Delineation of the designated study area*

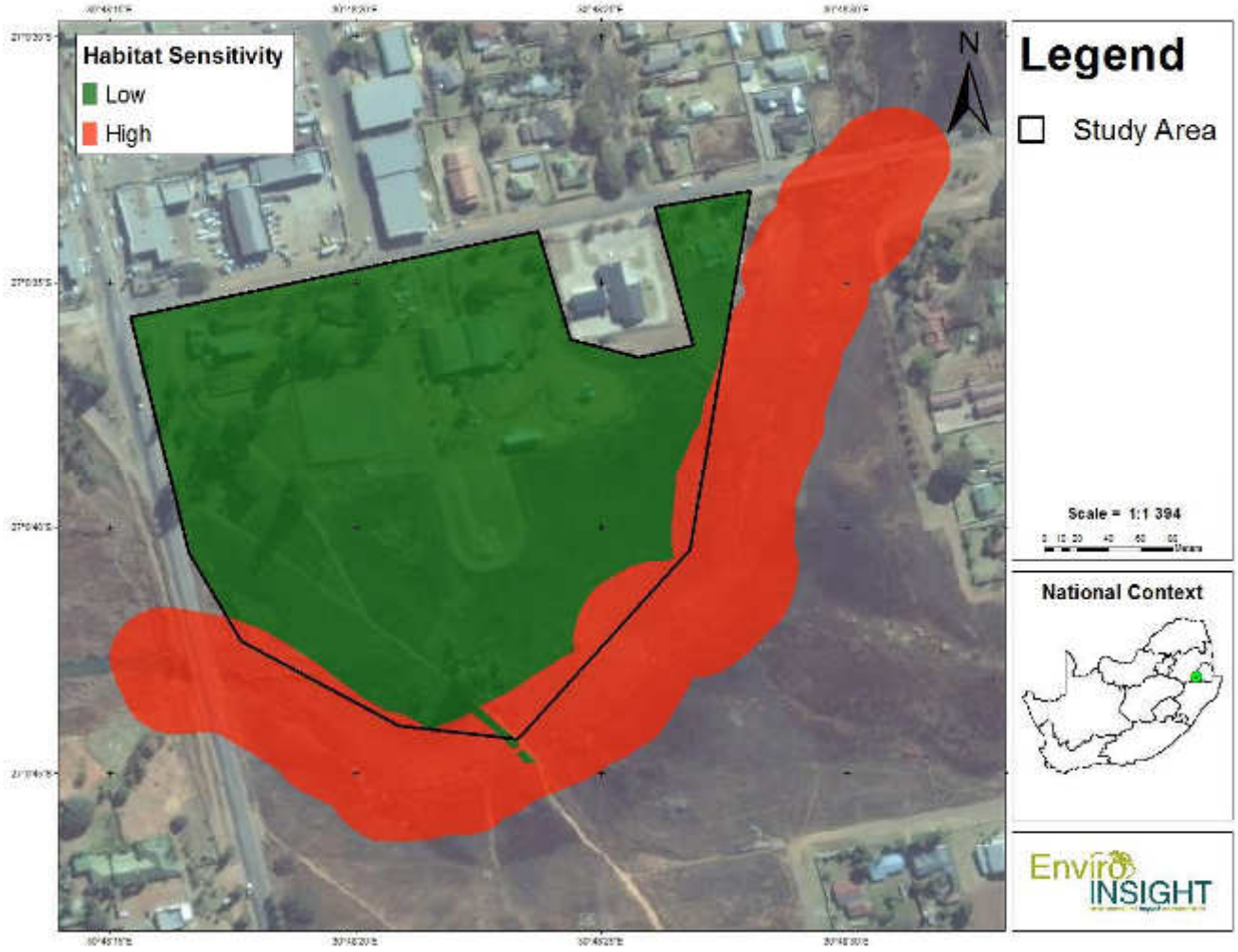


Figure 8: *Final Habitat Sensitivity of the designated study area*

4.4 ASSESSMENT OF THE PRESENCE OF INDIGENOUS VEGETATION HABITAT IN ACCORDANCE WITH THE LEGISLATION

In accordance with the new legislation concerning the presence of 1 Ha or more of continuous indigenous vegetation, a summary based upon the findings of the basic assessment level study is listed below.

- The assessment identified 1 Ha or more of continuous indigenous vegetation within the study area which triggers this portion of the 2014 regulations;
- Primary climax grass swards were all but absent;
- The indigenous vegetation on site was highly manipulated and disturbed; and
- Overall and from a floristic point of view, none of the identified indigenous vegetation is considered to be highly sensitive. According to the NEMA Regulations, Indigenous vegetation is refers "to vegetation consisting of indigenous plant species occurring naturally in an area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years". For the study area, disturbance is continuoius and on going.

5 REFERENCES

DU PREEZ, L.H. & CARRUTHERS, V. 2009. A complete guide to the frogs of southern Africa. Random House Struik, Cape Town.

FROGMAP 2015. The Southern African Frog Atlas Project (SAFAP, now FrogMAP). http://vmus.adu.org.za/

BATES, M.F., BRANCH, W.R., BAUER, A.M., BURGER, M., MARAIS, J., ALEXANDER, G.J. & DE VILLIERS, M.S. (EDS). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. Suricata 1. South African National Biodiversity Institute, Pretoria, South Africa.

HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (eds.) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.

IUCN. 2014. The IUCN red data list website. Available at www.iucnredlist.org (Visited April 2014).

MUCINA, L. AND RUTHERFORD, M.C. (Eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT. 2004 (act 10 of 2004): Publication of lists of critically endangered, endangered, vulnerable and protected species.

South African Bird Atlas Project (SABAP2). 2012. http://vmus.adu.org.za/

SANBI. 2014. Mpumalanga Biodiversity Conservation Plan (MBCP). URL: http://bgis.sanbi.org/MBCP/project.asp

SKINNER J.D. & CHIMIMBA, C.T. 2005. The Mammals of the Southern African Subregion (New Edition). Cambridge University Press. South Africa.

VAN OUDTSHOORN F. 2004. Gids tot die grasse van Suider-Afrika. Second Edition. Pretoria. Briza Publikasies

VAN WYK, B and VAN WYK, P. 1997. Field guide to trees of Southern Africa. Cape Town. Struik Publishers

6 APPENDIX

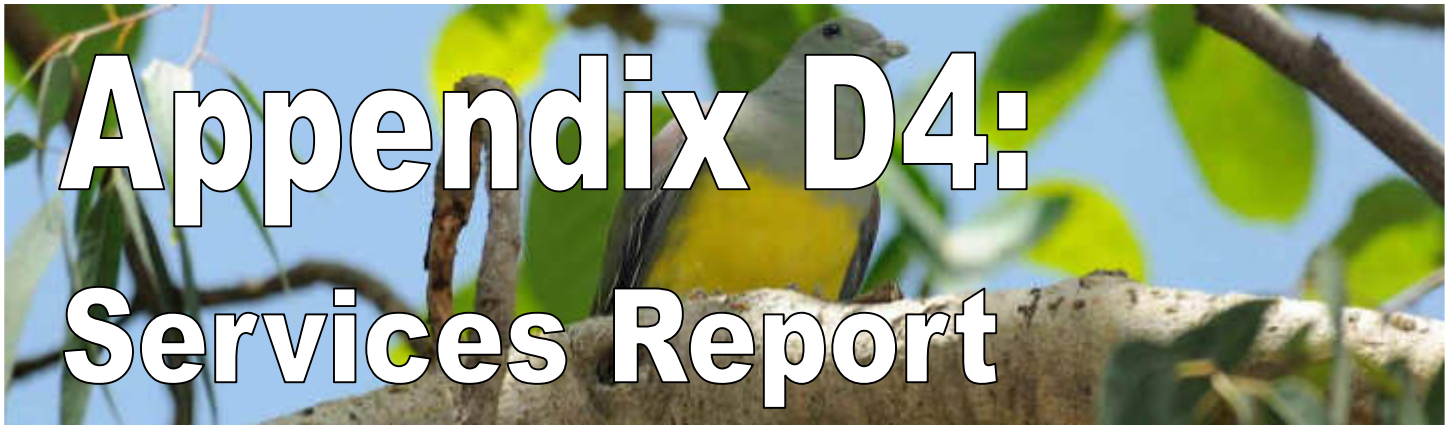
Appendix 1: *Georeferenced photographs taken during the fieldwork survey (shown in* ***Figure 2****)*

			
2059	2060	2061	2062
			
2063	2064	2065	2066
			
2067	2068	2069	2070

Mobile: [illegible]
Mobile: [illegible]
Email: [illegible]
Website: [illegible]

			
2071	2072	2073	2074
			
2075	2076	2077	2078
			
2080	2081	2082	2083
			
2084	2085	2086	2087
			
2088	2089	2090	2091

			
2092	2093	2094	2095
			
2096	2097	2098	



Appendix D4:
Services Report

ANAPROP PROPERTY MANAGEMENT

PRELIMINARY SERVICES REPORT
CIVIL INFRASTRUCTURE
PIET RETIEF SHOPPING CENTRE

NOVEMBER 2013

REPORT PREPARED FOR:

Anaprop Property Management
P.O. Box 569
Wierdapark
0149

Tel: +27 12 656 8957
Fax: +27 12 656 8959

PROJECT No.:

L209

PREPARED BY:

Lekwa Consulting Engineers (Pty) Ltd
PO Box 2779
ERMELO
2350

CONTACT:

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Fax: (017) 819-4017

e-Mail: lekwa@civilnet.co.za

Revision 01

CONTENT

1. INTRODUCTION

Messrs Anaprop (PTY) Ltd requested Lekwa Consulting Engineers (Pty) Ltd to prepare a Preliminary Engineering Services Report on the proposed Bulk Civil infrastructure for the Piet Retief shopping centre development.

The object of the Piet Retief shopping centre development is to establish a number of new commercial units. These rental units will be placed outside the 1:100 year floodline.

The purpose of this report is to provide the preliminary planning and criteria to which the civil services will be designed and constructed, and provide a working document, on which the services agreements can be formalised for the final approval of building plans.

2. LOCATION

The site is referred to as 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. The site is located on the corner of Brand Street and Kerk Street in the town of Piet Retief which is located within the Mkhondo Local Municipality area, which has jurisdiction within the Gert Sibande District Municipal area.

A locality map is attached as **Annexure 1**.

3. SITE DESCRIPTION

The site is situated on the west side of the N2 national road. This is an indication that the site is well suited for the proposed development of a shopping centre.

The site has a size of approximately *7,0254 Ha* but on this site a portion of the size 5 235 m^2 must be allocated for the town's local fire station. The proposed floor area will be approximately 39 000 m^2 and will be for retail/business purposes.

The site slopes from the eastern boundary to the western boundary.

4. CIVIL INFRASTRUCTURE

4.1 General

The Civil Infrastructure will be designed in accordance with the requirements of the:

- "Red Book" – Guidelines for the provision of Engineering Services and Amenities in Residents Township Developments"
- SABS 0400: National Building Regulations; and
- SABS 0252: Drainage and Water Supply

All contract documentation will be produced in accordance with the specification as set out in SABS 1200.

4.2 Geotechnical conditions

The Geotechnical considerations over the site have been dealt with in a separate report.

4.3 Hydraulic conditions

All commercial units will be developed above the 1:100 year floodline.

5. ACCESS AND ROAD WAYS

5.1 Design parameters

The design standards to be utilised in the design of streets in developments of this nature are those as set out in the "Red Book" – Guidelines for the provision of Engineering Services and Amenities in Residents Township Developments". All contract documentation will be produced in accordance with the specification as set out in SABS 1200. All streets will be designed above the 1: 10 year floodline level.

The access road ways are to be predominantly surfaced roads. Due to the type of development and the site conditions it is proposed that the design speed for all the traffic within the development to be 30 km/h. This reduces the allowable driving speed in the property thus reducing speed, along with creating safe environment for pedestrians.

It is intended that the design of the vertical alignment be flexible so that adjustments can be made to best suit the topography and any physical constraints found on site during the construction phase.

5.2 Access road

Access to the site will be from the Brand Street which intersects with the N2 national road or access can be obtained from the national road N2.

The access road way will be designed to have a crossfall and would have a permanent surface with the width of 6,0 m. The access road will have asphalt or paved surface determined by the material used in the parking area of the shopping centre.

The access road way will be designed for traffic comprising almost entirely passenger vehicles and light single axle heavy vehicles with a maximum loading of 9 tons per axle. The heaviest expected loading on the road network will be the construction traffic.

5.3 Residential roads

There will be no residential roads in this development site.

5.4 Existing roads

The only existing roads are those adjacent to the development site which will be used to gain access to the site. These are known as Brand Street and the national road N2 (Kerk Street).

6. STORMWATER DRAINAGE

6.1 Design parameters

The stormwater network of the development site must convey all surface stormwater run-off (both road and roof discharge) to the existing stormwater network serving the town of Piet Retief.

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

6.2 Road Stormwater

Stormwater on the parking area surface can be conveyed to open channels which can be covered by steel grids. These open channels can be built across the parking area to effectively catch all stormwater and these channels can be further used to convey the stormwater to the municipal stormwater network.

The stormwater can also be caught at collection points, and a network can be designed underneath the parking surface area to lead stormwater to the existing municipal stormwater networks.

These networks must be designed to create a controlled discharge into the existing municipal stormwater networks.

6.3 Roof Stormwater

All stormwater collected from roof runoff will be collected at a central point at each shop unit or drained into the design open channels. These structures can be constructed in such a manner as to lead the water into the municipal networks with a controlled discharge rate.

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.

6.4 Stormwater Attenuation

It is not anticipated that any stormwater attenuation will form part of the stormwater management of the proposed development.

7. WATER SUPPLY

Mkhondo Municipality is the Water Services Authority (WSA) and the Water Services Provider (WSP) for Piet Retief and is responsible for the provision of water services within its area of jurisdiction.

7.1 Existing services

An existing water connection is available and is currently being utilized by the present land occupiers.

The site is currently zoned as municipal and the existing rights allows for 75% coverage for Municipal purposes. As the property forms part

of an existing township, the existing network would have been designed/sized for these existing rights. According to the "Red Book" the annual average water demand for Government and Municipal is the same as for Offices and Shops. It is therefore foreseen that the current water network and connection should have sufficient capacity.

7.2 Design parameters

The estimated water demand per office or shop unit as per "Red book" is 400 litres per day / 100m^2 of gross floor area. The instantaneous peak factor in the mains of the development is determined by converting the type of development to "equivalent erven" according to the design annual average demand. The accepted basis for design is: one equivalent erven (ee) has an annual average daily demand of 1 000 litres.

The peak factors will be calculated based on the final layout of the development. The peak factor is expected to be around 4.

The water demand for this development is therefore estimated at 156 kℓ per day.

8. SEWAGE DISPOSAL

Mkhondo municipality is the Water Services Authority (WSA) and the Water Services Provider (WSP) for Piet Retief and is responsible for the provision of water services within its area of jurisdiction.

8.1 Existing services

An existing sewer connection is available and is currently being utilized by the present land occupiers.

As stated previously the property forms part of an existing township and the existing connections would have been designed/sized for these existing rights. It is therefore foreseen that the current sewer network and connection should have sufficient capacity.

8.2 Design parameters

The estimated sewage outflow per unit of any sort as per "Red Book" standards is estimated as 80% of the water demand of that specific unit. In addition a 15% Stormwater infiltration rate will be allowed for.

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

The sewer flow for this development is therefore estimated at 6,6 ℓ/s. An Ø110 mm sewer pipe installed at minimum 1:95 at 80% full flow will have sufficient capacity. The minimum pipe diameter should be determined taking this minimum requirement and the requirements of the National Building Regulations into consideration.

9. FIRE FIGHTING

All fire-fighting controls will be in accordance with the National Building Regulations as set out in the section for dealing with fire fighting and in accordance with "Red Book" standards

This proposed development will be considered as a High-risk area.

10. SOLID WASTE DISPOSAL

Mkhondo Municipality has a refuse removal service operating in the area. Mkhondo Municipality will be responsible for the removal and disposal of the solid waste generated by the proposed development.

11. ELECTRIC SUPPLY

An existing electrical connection is available and the final size of the connection will be determined by the type of facilities that will be accommodated in the centre.

At a later stage, when this information is available, will the size of the final connection be determined.

12. TELECOMMUNICATIONS

The supply of telecommunications will be the responsibility of Telkom and any upgrades required to deliver a service to the proposed development will be their responsibility.

The area of the proposed development is in a good mobile phone reception area.

13. CONCLUSION

The maintenance of all services on the property will be the responsibility of the land owners. The Mkhondo Municipality will have to agree to supply all services as discussed in this report.

All aspects of the design for both the bulk and internal services will generally be designed in accordance with the "Red Book" – Guidelines for Human Settlement planning and design and will be constructed in accordance with the requirements and specifications of SABS 1200.

As per the "Red Book" it is indicated that the water demand and sewerage flows for Retail/Business and Government/Municipal are the same. The development will be done with reduced floor area rights and therefore the water demand and sewerage flows will also reduce. As the existing water- and sewer networks would have been designed for the existing rights, it can be motivated that there will be sufficient capacity in the existing networks.

This report serves as preliminary planning for the civil infrastructure of proposed shopping centre development in Piet Retief and therefore some information and designs may change when the detail design commences.

Prior to the commencement of the detailed design stage the following information is required:

1. Specifications regarding the electric supply available to the development site currently must be discussed with representatives from Mkhondo Municipality and must be specified.

14. ANNEXURES

Annexure 1: Locality map

SOTIRALIS CONSULTING ENGINEERS (PTY) LTD
Consulting Civil and Structural Engineers

Ref: 3470 / 8.17 / 0076

31 March 2014

Mkhondo Local Municipality
Cnr. Market and De Wet Street
Piet Retief
2380

Att: Mr. Madubula Mabuza

MALL@PIET RETIEF: SEWERAGE DRAINAGE

Sotiralis Consulting Engineers (Pty) Ltd was appointed by Zarafusion (Pty) Ltd to administrate the design, monitoring and planning of the structural and civil engineering components for the proposed new Mall@Piet Retief shopping mall, situated on Portion 126 of Piet Retief town and Town lands 149HT.

As per the Guidelines for Human Settlement Planning and Design "RED BOOK" the estimated daily sewerage flow for the proposed new shopping mall development will be as follows:

LAND USE	COVERAGE	DAILY SEWERAGE FLOW (AS PER THE "RED BOOK")	ESTIMATED EXPECTED SEWERAGE FLOW
Special for Business (7.0254ha)	60%	400 litres per day / 100m² of gross floor area	168.61 Kℓ/day
TOTAL ESTIMATED DAILY WATER DEMEND			**168.61 Kℓ/day**

The current estimated daily sewerage flow, based on the existing land use rights of the property, can be summarized as follows (please refer to the attached document for a copy of the current, existing, land use rights of the property):

LAND USE	COVERAGE	DAILY SEWERAGE FLOW (AS PER THE "RED BOOK")	ESTIMATED CURRENT SEWERAGE FLOW
Municipal (7.0254ha)	75%	400 litres per day / 100m² of gross floor area	210.76 Kℓ/day
TOTAL ESTIMATED DAILY WATER DEMEND			**210.76 Kℓ/day**

As per the above it is evident that the estimated daily sewerage flow for the new proposed development will be less than the current allocated daily sewerage flow for the property as per the existing land use rights. We therefore foresee that the existing municipal outfall sewer pipeline and the existing municipal Sewerage Treatment Facility for the area should be sufficient to cater for sewerage flow from the proposed new development.

An existing municipal outfall sewer pipeline, of which the size is unknown at this stage, is located along the southern boundary of the proposed new development. According to the survey obtained from the site it seems that the capacity of this pipeline can be estimated as follows for different pipe sizes:

- 160mmØ Pipe : ± 20ℓ/s @ 80% Capacity
- 200mmØ Pipe : ± 60ℓ/s @ 80% Capacity
- 300mmØ Pipe : ± 128ℓ/s @ 80% Capacity

The sewerage network form the proposed new development will connect directly to this existing municipal outfall sewer pipeline.

We herewith request confirmation that the Mkhondo Local Municipality is in agreement with the above and that the sewer drainage network of the new Mall@Piet Retief development can connect directly to the existing municipal outfall sewer pipeline south of the proposed new development.

Due to the urgent nature of the requested feedback as per above, confirmation needs to be obtained by latest closing of business coming Friday, 04 April 2014. If no feedback has been received by the said date, it will be assumed that the Mkhondo Local Municipality is in agreement with the above.

You are welcome to contact us should you require any additional information.

Kind Regards

Kobus van Deventer
For and on behalf of
Sotiralis Consulting Engineers (Pty) Ltd

Tel: +27 12 991 0516
Fax: +27 12 991 0436

PO Box 1829
Faerie Glen
0043

MKHONDO MUNICIPALITY
MUNISIPALITEIT

All correspondence to be addressed to THE MUNICIPAL MANAGER

Alle korrespondensie moet gerig word aan DIE MUNISIPALE BESTUURDER

Navrae/Enquiries:
Bheki Bhengu

Verw./Ref.
Portion 100 (Ptn of Ptn 1) of Piet Retief Town and Townlands No. 149-HT

DEPARTMENT OF CORPORATE SERVICES: TOWN PLANNING, HUMAN SETTLEMENTS AND BUILDING CONTROL

A. **OWNER**

NAME: Mkhondo Municipality

B. **DETAILS OF STAND**

1. STAND NUMBER: Ptn 100 (Ptn of Ptn 1) of Piet Retief Town and Townlands No. 149-HT
2. PHYSICAL LOCATION: Brand Street
3. TOWN: Piet Retief
4. SUBURB: Piet Retief
5. EXTENTION: 0
6. AREA OF STAND: 7, 0254 Hectares

C. **DETAILS REGARDING DESTINATION AND CONDITIONS OF DEVELOPMENT OF: ZONING**

1. CONSENT USE: None
2. ZONING: Municipal
3. PRIMARY LAND USES:

Municipal Purposes

4. SECONDARY LAND USE (with consent)

Dwelling units, Residential buildings, Institutions, special uses, sports and recreation clubs

5. PROHIBITED USE:

Noxious industrial activities.

Shopping centre

Check if it can be done by consent

(017) 826 8100 (017) 826 3129/8102 23 Piet Retief 2380

6. PARKING REQUIREMENTS:

Adequate and paved parking, together with the necessary manoeuring area, shall be provided on the property for the Use Zones and uses to the satisfaction of the local authority.

7. FLOOR AREA RATIO (FAR): Residential buildings 1,2 and other buildings 2,1

8. HEIGHT ZONE: 0

9. COVERAGE: Dwelling houses 50%, Residential buildings 40%, and Other buildings 75%.

10. BUILDING LINES: 6 metres along street boundaries and 2 metres on other boundaries.

MR. B. EKI BHENGU
ADMIN CLERK TOWN PLANNING
MKHONDO MUNICIPALITY

15-11-2012
DATE

SOTIRALIS CONSULTING ENGINEERS (PTY) LTD
Consulting Civil and Structural Engineers

Ref: 3470 / 8.17 / 0077

31 March 2014

Mkhondo Local Municipality
Cnr. Market and De Wet Street
Piet Retief
2380

Att: Mr. Madubula Mabuza

MALL@PIET RETIEF: SOLID WASTE REMOVAL

Sotiralis Consulting Engineers (Pty) Ltd was appointed by Zarafusion (Pty) Ltd to administrate the design, monitoring and planning of the structural and civil engineering components for the proposed new Mall@Piet Retief shopping mall, situated on Portion 126 of Piet Retief town and Town lands 149HT.

Solid waste from the proposed new development will be collected on site and will be disposed of at the existing municipal landfill site.

We herewith request confirmation that the Mkhondo Local Municipality is in agreement with the above and that the solid waste of the new Mall@Piet Retief can be disposed of into the existing municipal landfill site.

Due to the urgent nature of the requested feedback as per above, confirmation needs to be obtained by latest closing of business coming Friday, 04 April 2014. If no feedback has been received by the said date, it will be assumed that the Mkhondo Local Municipality is in agreement with the above.

You are welcome to contact us should you require any additional information.

Kind Regards

Kobus van Deventer
For and on behalf of
Sotiralis Consulting Engineers (Pty) Ltd

Tel: +27 12 991 0516
Fax: +27 12 991 0436

PO Box 1829
Faerie Glen
0043

info@sotiralis.co.za

SOTIRALIS CONSULTING ENGINEERS (PTY) LTD
Consulting Civil and Structural Engineers

Ref: 3470 / 8.17 / 0075

31 March 2014

Mkhondo Local Municipality
Cnr. Market and De Wet Street
Piet Retief
2380

Att: Mr. Madubula Mabuza

MALL@PIET RETIEF: WATER SUPPLY

Sotiralis Consulting Engineers (Pty) Ltd was appointed by Zarafusion (Pty) Ltd to administrate the design, monitoring and planning of the structural and civil engineering components for the proposed new Mall@Piet Retief shopping mall, situated on Portion 126 of Piet Retief town and Town lands 149HT.

As per the Guidelines for Human Settlement Planning and Design "RED BOOK" the estimated daily water demand for the proposed new shopping mall development will be as follows:

LAND USE	COVERAGE	DAILY WATER DEMAND (AS PER THE "RED BOOK")	ESTIMATED EXPECTED WATER DEMEND
Special for Business (7.0254ha)	60%	400 litres per day / 100m² of gross floor area	168.61 Kℓ/day
TOTAL ESTIMATED DAILY WATER DEMEND			**168.61 Kℓ/day**

The current estimated daily water demand, based on the existing land use rights of the property, can be summarized as follows (please refer to the attached document for a copy of the current, existing, land use rights of the property):

LAND USE	COVERAGE	DAILY WATER DEMAND (AS PER THE "RED BOOK")	ESTIMATED CURRENT WATER DEMEND
Municipal (7.0254ha)	75%	400 litres per day / 100m² of gross floor area	210.76 Kℓ/day
TOTAL ESTIMATED DAILY WATER DEMEND			**210.76 Kℓ/day**

As per the above it is evident that the estimated daily water demand for the new proposed development will be less than the current allocated daily water supply for the property as per the existing land use rights. We therefore foresee that the existing municipal bulk water supply to the area should be sufficient to supply the new proposed development with potable water.

The existing water supply point to the property will be utilized for the water connection to the new shopping centre and will be upgraded to a 160mmØ water connection and bulk water meter.

We herewith request confirmation that the Mkhondo Local Municipality is in agreement with the above and that the water supply to the new Mall@Piet Retief development can be obtained from the existing municipal bulk water supply pipeline in the vicinity of the proposed new development.

Due to the urgent nature of the requested feedback as per above, confirmation needs to be obtained by latest closing of business coming Friday, 04 April 2014. If no feedback has been received by the said date, it will be assumed that the Mkhondo Local Municipality is in agreement with the above.

You are welcome to contact us should you require any additional information.

Kind Regards

Kobus van Deventer
For and on behalf of
Sotiralis Consulting Engineers (Pty) Ltd

Tel: +27 12 991 0516
Fax: +27 12 991 0436

PO Box 1829
Faerie Glen
0043

MKHONDO MUNICIPALITY
MUNISIPALITEIT

Alle korrespondensie moet gerig word aan DIE MUNISIPALE BESTUURDER

All correspondence to be addressed to THE MUNICIPAL MANAGER

Navrae/Enquiries:
Bheki Bhengu

Verw./Ref.
Portion 100 (Ptn of Ptn 1) of Piet Retief Town and Townlands No. 149-HT

DEPARTMENT OF CORPORATE SERVICES: TOWN PLANNING, HUMAN SETTLEMENTS AND BUILDING CONTROL

A. OWNER

NAME: Mkhondo Municipality

B. DETAILS OF STAND

1. STAND NUMBER: Ptn 100 (Ptn of Ptn 1) of Piet Retief Town and Townlands No. 149-HT

2. PHYSICAL LOCATION: Brand Street

3. TOWN: Piet Retief

4. SUBURB: Piet Retief

5. EXTENTION: 0

6. AREA OF STAND: 7, 0254 Hectares

C. DETAILS REGARDING DESTINATION AND CONDITIONS OF DEVELOPMENT OR ZONING

1. CONSENT USE: None

2. ZONING: Municipal

3. PRIMARY LAND USES:

Municipal Purposes

4. SECONDARY LAND USE (with consent)

Dwelling units, Residential buildings, Institutions, special uses, sports and recreation clubs

5. PROHIBITED USE:

Noxious industrial activities.

shopping centre

Check if it can be done by Consent

(017) 826 8100 (017) 826 3129/8102 23 Piet Retief 2380

6. PARKING REQUIREMENTS:

Adequate and paved parking, together with the necessary manoeuring area, shall be provided on the property for the Use Zones and uses to the satisfaction of the local authority.

7. FLOOR AREA RATIO (FAR): Residential buildings 1,2 and other buildings 2,1

8. HEIGHT ZONE: 0

9. COVERAGE: Dwelling houses 50%, Residential buildings 40%, and Other buildings 75%.

10. BUILDING LINES: 5 metres along street bounderies and 2 metres on other boundaries.

MR. BHEKI BHENGU
ADMIN CLERK TOWN PLANNING
MKHONDO MUNICIPALITY

15-11-2012
DATE

SOTIRALIS CONSULTING ENGINEERS (PTY) LTD
Consulting Civil and Structural Engineers

Ref: 3470 / 8.17 / 0074

24 March 2014

Mkhondo Local Municipality
Cnr. Market and De Wet Street
Piet Retief
2380

Att: Mr. Madubula Mabuza

MALL@PIET RETIEF: WATER DEMANDS AND SEWERAGE FLOWS

Sotiralis Consulting Engineers (Pty) Ltd was appointed by Zarafusion (Pty) Ltd to administrate the design, monitoring and planning of the structural and civil engineering components for the proposed new Mall@Piet Retief shopping mall, situated on Portion 126 of Piet Retief town and Town lands 149HT, and the proposed new Municipal structures on a Portion of Portion 123 of Piet Retief Town and Town lands 149HT.

The purpose of this letter is to give an indication to the local council of the expected estimated sewerage flows and water demands of the proposed new developments on the above mentioned properties. An indication will also be given on the estimated existing water demands and sewerage flows based on the current land uses.

The following is a summary of the estimated existing water demands and sewerage flows based on the current land uses:

PROPOSED DEVELOPMENT SITE	EXISTING LAND USE	EXISTING COVERAGE USES	DAILY WATER DEMAND & SEWERAGE FLOW	ESTIMATED EXISTING WATER DEMEND & SEWERAGE FLOW
ESTIMATED EXISTING DAILY WATER DEMAND				
Mall site	Municipal (7.0254ha)	75%	400 litres per day / 100m² of gross floor area	210.76 Kℓ/day
New Municipal Site	Public open Space	N/A	N/A	0.00 Kℓ/day
TOTAL ESTIMATED DAILY WATER DEMEND				**210.76 Kℓ/day**
ESTIMATED EXISTING DAILY SEWERAGE FLOWS				
Mall site	Municipal (7.0254ha)	75%	400 litres per day / 100m² of gross floor area	210.76 Kℓ/day
New Municipal Site	Public open Space	N/A	N/A	0.00 Kℓ/day
TOTAL ESTIMATED DAILY SEWERAGE FLOWS				**210.76 Kℓ/day**

An existing Municipal outfall sewer pipeline, of which the size is unknown at this stage, is located along the southern boundary of the proposed new development. According to the survey obtained from the site it seems that the capacity of this pipeline can be estimated as follows for different pipe sizes:

- 160mmØ Pipe : ± 20ℓ/s @ 80% Capacity
- 200mmØ Pipe : ± 60ℓ/s @ 80% Capacity
- 300mmØ Pipe : ± 128ℓ/s @ 80% Capacity

The following is a summary of the expected estimated water demands and sewerage flows for the proposed new developments:

PROPOSED DEVELOPMENT SITE	NEW LAND USE	COVERAGE	DAILY WATER DEMAND & SEWERAGE FLOW	ESTIMATED EXPECTED WATER DEMEND & SEWERAGE FLOW
ESTIMATED DAILY WATER DEMAND				
Mall site	Special for Business (7.0254ha)	60%	400 litres per day / 100m² of gross floor area	168.61 Kℓ/day
New Municipal Site	Municipal	Building Area: ±588m²	400 litres per day / 100m² of gross floor area	2.35 Kℓ/day
TOTAL ESTIMATED DAILY WATER DEMEND				**170.96 Kℓ/day**
ESTIMATED DAILY SEWERAGE FLOWS				
Mall site	Special for Business (7.0254ha)	60%	400 litres per day / 100m² of gross floor area	168.61 Kℓ/day
New Municipal Site	Municipal	Building Area: ±588m²	400 litres per day / 100m² of gross floor area	2.35 Kℓ/day
TOTAL ESTIMATED DAILY SEWERAGE FLOWS				**170.96 Kℓ/day**

All above calculations are based on the requirements as per the Guidelines for Human Settlement Planning and Design "RED BOOK".

You are welcome to contact us should you require any additional information.

Kind Regards

Kobus van Deventer
For and on behalf of
Sotiralis Consulting Engineers (Pty) Ltd

Tel: +27 12 991 0516
Fax: +27 12 991 0436

PO Box 1829
Faerie Glen
0043

info@sotiralis.co.za

MKHONDO MUNICIPALITY
MUNISIPALITEIT

Alle Korrespondensie moet gerig word aan
DIE MUNISIPALE BESTUURDER

All Correspondence to be addressed to
THE MUNICIPAL MANAGER

Enquiries: **MA.Jele**
Water and Sanitation Division

Date: 15 July 2015

Polla Scholtz
Mall@ reds
1st Floor
Cnr Rooi Huiskraal and Hendrick Verwoerd

Subject: CONFIRMATION OF SERVICES FOR THE MALL AND TRAFFIC DEPARTMENT OFFICES

The letter serves to confirm the availability of water, sewer and electricity services for the shopping mall and the traffic department that is to be constructed in eMkhondo (Piet Retief).

Water Services
The municipality do have the capacity to provide water to the two developments at a pressure of 3-5 bar.

Sewer Services
The development is responsible to upgrade the outfall sewer system through construction of holding or balance tank, approximately 500m3..

Electricity
The municipality is in a process of upgrading electric main substation, as a result the municipality do confirm availability of electric to the development.

NB:

Yours Sincerely

Mr. MJS. Mabuza
Acting Municipal Manager
Mkhondo Local Municipality

TEL: (017) 826 8100
P O Box 23 Piet Retief 2380

Fax: (017) 826 3129

STORMWATER MANAGEMENT LAYOUT (CONSTRUCTION PHASE)
SCALE 1:500

NOTES:

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS CODES.
2. ALL DIMENSIONS ARE IN METERS, UNLESS OTHERWISE INDICATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. ALL DIMENSIONS AND SETTING OUT POINTS MUST BE CHECKED AND APPROVED ON SITE BEFORE CONSTRUCTION COMMENCES.
5. FINAL POSITION OF EXISTING SERVICES TO BE CONFIRMED ON SITE BY CONTRACTOR.
6. ALL EXISTING SERVICES TO BE EXPOSED BY HAND EXCAVATION AND INVERT LEVELS TO BE PROVIDED TO THE ENGINEER IN WRITING BEFORE CONSTRUCTION COMMENCES.
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11. KERB INLET STRUCTURES (STEEL FRAME AND PRECAST COVERS), TO COMPLY WITH SCE STANDARD DRAWING SCE-SW001/002/003.
12. ALL STORMWATER JUNCTION BOX, MANHOLE AND COVER SLAB DETAILS TO COMPLY WITH SCE STANDARD DRAWING SCE-SW003/004/005/006/007.
13. ALL STORMWATER PIPE TRENCHES, BEDDING AND BACKFILLING TO COMPLY WITH SCE STANDARD DRAWING SCE-SW009.
14. MINIMUM FALL THROUGH ANY MANHOLE IS 80mm, UNLESS OTHERWISE INDICATED.
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16. CONTRACTOR TO COMPLY WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT (85 OF 1993), THE CONSTRUCTION REGULATIONS OF 2014 AND ALL RELEVANT REGULATIONS AS WELL AS THEIR AMENDMENTS.
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LEGEND:

- SW — PROPOSED STORMWATER LINE
- EXSW — EXISTING STORMWATER LINE
- MH — PROPOSED MANHOLE
- EXMH — EXISTING MANHOLE
- JB — PROPOSED JUNCTION BOX
- EXJB — EXISTING JUNCTION BOX
- JBMH — PROPOSED JUNCTION BOX WITH MANHOLE
- EXJBMH — EXISTING JUNCTION BOX WITH MANHOLE
- GI — PROPOSED GRID INLET
- EXGI — EXISTING GRID INLET
- LGI — PROPOSED LONG GRID INLET
- EXLGI — EXISTING LONG GRID INLET
- FI — PROPOSED FIELD INLET
- EXFI — EXISTING FIELD INLET
- KI — PROPOSED KERB INLET
- EXKI — EXISTING KERB INLET
- (0/0/0) — TRANSITION LENGTH UPSTREAM (US) / CATCHPIT LENGTH (CP) / TRANSITION LENGTH DOWNSTREAM (DS)
- FLOW DIRECTION OF STORMWATER
- 2% — PERCENTAGE AND DIRECTION OF ROAD SLOPE
- VAL — STORMWATER VALLEY LINE
- SUB — STORMWATER SUBSOIL LINE
- ERF BOUNDARY
- 100L — 1:100 YEAR FLOODLINE
- BENCHMARK
- SWXXX — STORMWATER SETTING OUT POINT
- PROPOSED BUILDING
- VEGETATION
- EARTH BERM

REFERENCE DRAWINGS:

3470-BM-L01	BENCHMARK LAYOUT PLAN

TYPICAL CROSS SECTION THROUGH TEMPORARY DRAINAGE CHANNEL
NOT TO SCALE

TYPICAL LONGSECTION THROUGH TEMPORARY DRAINAGE CHANNEL
NOT TO SCALE

ALL WORK TO SANS 1200

NO	DATE	DESCRIPTION	DESIGN	DRAWN
A	2014-11-14	FOR INFORMATION	KVD	SC

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admin@sotiralis.co.za FACSIMILE (012) 991 0436

CLIENT:
ANAPROP PROPERTY MANAGEMENT

PROJECT:
MALL@PIET RETIEF
PORTION 126
PIET RETIEF

DRAWING TITLE:
STORMWATER MANAGEMENT LAYOUT PLAN (CONSTRUCTION PHASE)

DATE:	SCALE:	DRAWN:
2014-11-13	AS SHOWN	S CHAMBERS
DESIGNED:	CHECKED:	REVISION NUMBER:
K VAN DEVENTER	S SOTIRALIS	A

DRAWING NUMBER: 3470-SW-L02
FOR: INFORMATION

STORMWATER LAYOUT
SCALE 1:500

NOTES:

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS CODES.
2. ALL DIMENSIONS ARE IN METERS, UNLESS OTHERWISE INDICATED.
3. DO NOT SCALE FROM THIS DRAWING.
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13. ALL STORMWATER PIPE TRENCHES, BEDDING AND BACKFILLING TO COMPLY WITH SCE STANDARD DRAWING SCE-SW009.
14. MINIMUM FALL THROUGH ANY MANHOLE IS 80mm, UNLESS OTHERWISE INDICATED.
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16. CONTRACTOR TO COMPLY WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT (85 OF 1993), THE CONSTRUCTION REGULATIONS OF 2014 AND ALL RELEVANT REGULATIONS AS WELL AS THEIR AMENDMENTS.
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- BENCHMARK
- SWXXX — STORMWATER SETTING OUT POINT
- PROPOSED BUILDING

REFERENCE DRAWINGS:

3470-BM-L01	BENCHMARK LAYOUT PLAN
3470-SW-LS01	STORMWATER LONGSECTIONS

ALL WORK TO SANS 1200

NO	DATE	DESCRIPTION	DESIGN	DRAWN
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admin@scline.co.za FACSIMILE (012) 991 0436

CLIENT:
ANAPROP PROPERTY MANAGEMENT

PROJECT:
MALL@PIET RETIEF
PORTION 126
PIET RETIEF

DRAWING TITLE:
STORMWATER LAYOUT PLAN

DATE:	SCALE:	DRAWN:
2014-11-07	AS SHOWN	S CHAMBERS
DESIGNED:	CHECKED:	REVISION NUMBER:
K VAN DEVENTER	S SOTIRALIS	A

DRAWING NUMBER: 3470-SW-L01 FOR: INFORMATION

Y +19 500
Y +19 400
Y +19 300
Y +19 200
Y +19 100
Y +19 000

X +2 988 700
X +2 988 800
X +2 988 900
X +2 989 000

BRAND STREET

KEWK STREET

MALL@PIET RETIEF
PORTION 126
PIET RETIEF

FUTURE
PHASE 2

32m BUFFER ZONE

4m SEWER SERVITUDE

WATERCOURSE

CONNECT TO EXISTING
MUNICIPAL SEWER NETWORK

110mm Ø uPVC CLASS 34

160mm Ø uPVC CLASS 34

MH

CE

EXMH

SEWER LAYOUT
SCALE 1:500

NOTES:

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12. ALL SEWER PIPE TRENCHES AND BEDDING TO COMPLY WITH SCE STANDARD DRAWING SCE-SE002.
13. SEWER HOUSE CONNECTION DETAILS AND HOUSE CONNECTION MARKER BLOCKS TO COMPLY WITH SCE STANDARD DETAIL DRAWING SCE-SE003.
14. MINIMUM FALL THROUGH ANY MANHOLE IS 80mm, UNLESS OTHERWISE INDICATED.
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- LH — PROPOSED LAMP HOLE
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- ERF BOUNDARY
- 100L — 1:100 YEAR FLOODLINE
- BENCHMARK
- SEXXX — SEWER SETTING OUT POINT
- PROPOSED BUILDING

REFERENCE DRAWINGS:

3470-BM-L01	BENCHMARK LAYOUT PLAN
3470-SE-LS01	SEWER LONGSECTIONS

ALL WORK TO SANS 1200

NO	DATE	DESCRIPTION	DESIGN	DRAWN
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SCE SOTIRALIS CONSULTING ENGINEERS (PTY) LTD
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CLIENT:
ANAPROP PROPERTY MANAGEMENT

PROJECT:
MALL@PIET RETIEF
PORTION 126
PIET RETIEF

DRAWING TITLE:
SEWER LAYOUT
PLAN OPTION A

DATE:	SCALE:	DRAWN:
2014-11-07	AS SHOWN	S CHAMBERS
DESIGNED:	CHECKED:	REVISION NUMBER:
K VAN DEVENTER	S SOTIRALIS	A

DRAWING NUMBER: 3470-SE-L01 FOR: INFORMATION

SEWER LAYOUT
SCALE 1:500

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- PROPOSED BUILDING

REFERENCE DRAWINGS:

3470-BM-L01	BENCHMARK LAYOUT PLAN
3470-SE-LS01	SEWER LONGSECTIONS

ALL WORK TO SANS 1200

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admin@sotiralis.co.za FACSIMILE (012) 991 0436

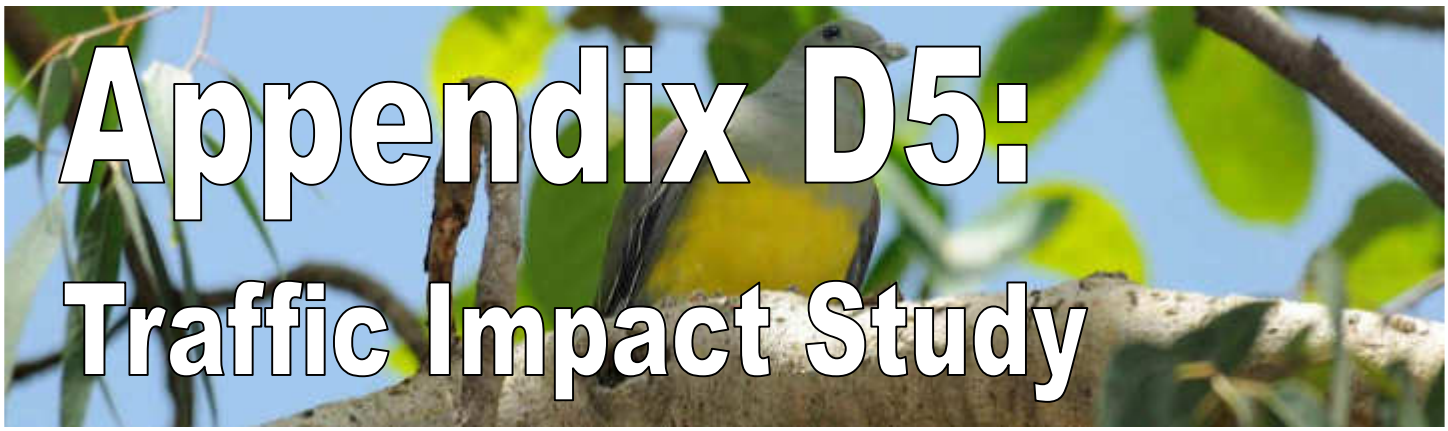
CLIENT:
ANAPROP PROPERTY MANAGEMENT

PROJECT:
MALL@PIET RETIEF
PORTION 126
PIET RETIEF

DRAWING TITLE:
SEWER LAYOUT
PLAN OPTION B

DATE:	SCALE:	DRAWN:
2014-11-07	AS SHOWN	S CHAMBERS
DESIGNED:	CHECKED:	REVISION NUMBER:
K VAN DEVENTER	S SOTIRALIS	A

DRAWING NUMBER: 3470-SE-L02 FOR: INFORMATION



Appendix D5:

Traffic Impact Study

TECHWORLD
consulting ENGINEERS

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<< Fax: +27 12 348 3587
<< Cell: +27 83 447 9961
<< Email: admin@techworld.co.za

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Cnr Glenmore & Glenwood Rd
Lynnwood Glen
South Africa

<< PO Box 12530
Hatfield
0028
South Africa

Traffic Engineering
Transportation Planning
Transport Economy
Project Management
Project Financing & Viability

TRAFFIC IMPACT STUDY

PIET RETIEF SHOPPING CENTRE

MKHONDO MUNICIPALITY, MPUMALANGA

November 2013

APPLICATION TO ROAD AUTHORITY

OUR REFERENCE	REP01/TW646/01Nov13
DATE	01 November 2013
AGENCY	Mkhondo Municipality
THE MANAGER	Municipal Manager
ADDRESS	PO Box 23, Piet Retief, 2380
FOR ATTENTION	Mr Absalom N. Mahlangu
SUBJECT	TRAFFIC IMPACT STUDY FOR NEW PIET RETIEF SHOPPING CENTRE

A new township is planned on Portion 126 (of Portion 100) of Piet Retief Town and Townlands 149-HT in the CBD of Piet Retief for commercial development ("Business 1") for a potential of 39,000 m^2 GLA that includes a shopping centre of maximum 25,000 m^2 GLA. The existing Municipal Buildings on the site will be relocated to a new site in Gerard Bohmer Road. Since the existing peak hour trip generation of the Municipal Buildings is negligible, the impact of the relocation was not addressed in this traffic impact study.

The primary access to the development is proposed from Brand Street opposite Kotze Street while a secondary access is proposed as a marginal access from Church Street (left-in and left-out).

No other large properties with existing undeveloped land use rights are known in the study area. An average to high traffic growth rate of 4.0% p.a. for the 5 year study period was assumed to account for growth in background traffic and any unknown latent land use rights.

The traffic impact study shows that the existing road network can accommodated the new development with relative ease. Mitigation measures are however required on the road network that provides access to the development and that borders the application site.

Improvements are recommended at the Church (N2) / Brand intersection (additional lanes and signalization), the Kotze / Brand intersection (additional lanes), the Church (N2) / Marginal Access intersection (additional lanes and widening to accommodate a physical curb median), and Church (N2) / Gerard Bohmer intersection (additional lanes and signalization).

The construction of taxi- / bus loading bays are also recommended along both sides of Church Street (N2) directly south of the intersection with Brand Street.

This comprehensive traffic impact study has determined the required mitigation measures for the township which are shown in *Figure 8: Required Road Improvements In Study Area.*

Your consideration and approval of this traffic impact study at your earliest convenience is hereby requested. Please do not hesitate to contact us (Pieter Kruger – 083 447 9961 / 012 348 0386) immediately for any discussions or enquiries.

Kind Regards

Pieter Kruger for TECHWORLD

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

TABLE OF APPENDICES

TITLE PAGE OF REPORT

TITLE OF REPORT	Traffic Impact Study: New Piet Retief Shopping Centre, Mkhondo Municipality, Mpumalanga Province.
DESCRIPTION	This traffic impact study evaluates the traffic impact of a new community shopping centre in Piet Retief

DATE	STATUS OF REPORT
November 2013	Final Report
CLIENTS	**TOWN PLANNER**
SOUTHERN PALACE INVESTMENTS (Pty) Ltd t/a Anaprop Property Management Mr Yanni Anastasiadis Tel: +2712 656 8957 Fax: +2712 656 8959	NUPLAN DEVELOPMENT PLANNERS Martin Strydom Tel: +27 13 752 3422 Fax: +27 13 752 5795
PROJECT NUMBER	**REPORT NUMBER**
TW646	REP01/TW646/01Nov13
POSTAL ADDRESS	**PHYSICAL ADDRESS**
PO Box 12530 Hatfield, 0028 Tel: (012) 998 3541 Fax: (012) 993 5506	78 Glenmore Street C/O Glenmore & Glenwood Streets Lynnwood Glen Email: admin@techworld.co.za
PROJECT TEAM	**COPYRIGHT**
P Kruger, J Daling, MM Wilson	TECHWORLD

1 APPLICATION

Description of the application and property in terms of location, extent, current, and future usage

THE TYPE OF LAND USE APPLICATION IS THE FOLLOWING		
Type of Application	New township application for commercial development ("Business 1") in the CBD of Piet Retief for 39,000 m^2 GLA that includes a shopping centre of 25,000 m^2 GLA.	Refer to: *Figure 1: Locality Plan*
THE LOCATION OF THE SITE IN TERMS OF THE PROPERTY DESCRIPTION IS THE FOLLOWING		
Portion	Portion 126 (of Portion 100)	Refer to: *Appendix A: Site Layout Plan*
Farm	Piet Retief Town and Townlands 149-HT	
THE LOCATION OF THE SITE IN TERMS OF BORDERING AND/OR NEIGHBOURING ROADS ARE THE FOLLOWING		
Roads to the North	Brand Street (R543 East)	Directly bordering
Roads to the East	None	
Roads to the South	Gerard Bohmer Road	Not directly bordering
Roads to the West	Church Street (N2)	Directly bordering
THE SIZE AND/OR EXTENT OF THE SITE IS THE FOLLOWING		
Extent of Total Property	±6.50ha	
THE EXISTING ZONING IS THE FOLLOWING		
Zoning	"Municipal"	
THE EXISTING USAGE OF THE SITE IS THE FOLLOWING		
Usage	Municipal Buildings. The existing Municipal Buildings will be relocated to a new site in Gerard Bohmer Road near the Cemetery.	

THE REQUIRED ZONING AND EXTENT IS THE FOLLOWING		
Required Zoning (*refer to the Township Application for details on the development controls*)	"Business 1" - - FAR = 0.60 - Maximum Coverage = 80% - Maximum Height = 3 storeys - Parking = 2 bays / 100 m² GLA	
	The allowable floor area is thus 39,011.4 m² of which the shopping centre will be limited to a maximum GLA of 25,000 m². The following development scenario was subsequently investigated from a traffic perspective: Shopping Centre 25000 m² Motor Dealerships 3500 m² Offices 3500 m² Mini Storage 3500 m² Bulk Trade Centre 3500 m²	
THE STUDY AREA AND TOWNSHIP LAYOUT IS SHOWN ON THE ATTACHED PLANS		
Study Area		Refer to: *Figure 2: Study Area* *Appendix A: Site Layout Plan*

2 METHODOLOGY

The approach and methodology followed in the execution of this study is described in this section

THE FOLLOWING GENERAL APPROACH AND METHODOLOGY WAS UTILIZED	
Guidelines	Guidelines contained in SA Manual for Traffic Impact Studies PR93/635,1995
THE FOLLOWING TECHNICAL METHODOLOGY AND SOFTWARE WAS UTILIZED	

Traffic Impact Analysis Software	VISTRO 2.0	Refer to: *Figure 3: Traffic Model (VISTRO)*
Capacity and Operational Analysis Software	Latest HCM2010 methodology	
THE FOLLOWING CRITICAL PEAK HOURS WERE ANALYZED		
Critical Design Peak Hours	Weekday PM Peak Hour	
	Saturday AM Peak Hour	
THE STUDY PERIOD FOR THE DEVELOPMENT IS THE FOLLOWING		
Base Year (Existing Situation)	2013	
Study Period	5 years	
Horizon Year (Future Situation)	2018	2013 plus 5 years
THE FOLLOWING PLANNED ROAD NETWORK ALTERNATIVES WERE INVESTIGATED		
Network alternatives	None	
THE FOLLOWING SCENARIOS WERE ANALYZED		
Scenario 1	Existing 2013 peak hours.	Existing road network.
Scenario 2	Expected 2018 peak hours with growth in background traffic.	Existing road network.
Scenario 3	Expected 2018 peak hours with growth in background traffic and with full application.	Existing road network.
Scenario 4	Expected 2018 peak hours with growth in background traffic and with full application.	Required mitigation measures to support application.

THE FOLLOWING TRAFFIC AND OTHER REPORTS WERE TAKEN INTO ACCOUNT	
Available reports	*Feasibility Study Update, Retail Development, Piet Retief Mpumalanga, October 2013, FERNRIDGE, October 2013*

3 STUDY AREA AND NETWORK

This section describes the identification of an appropriate study area, and the characteristics of the network included in the study area.

3.1 LATENT DEVELOPMENT RIGHTS AND COMMITTED ROAD IMPROVEMENTS IN THE AREA

THE FOLLOWING LATENT (EXISTING AND UNDEVELOPED) LAND USE RIGHTS EXIST IN THE STUDY AREA		
Approved Land Use Rights	No other large properties with existing undeveloped land use rights (i.e. latent rights) are known in the study area.	Refer to: *Figure 1: Locality Plan*
Growth in Background Traffic	An average to high traffic growth rate of 4.0% p.a. for the 5 year study period was assumed to account for growth in background traffic and any unknown latent land use rights.	
THE FOLLOWING ROAD NETWORK IMPROVEMENTS ARE COMMITTED AND/OR PLANNED IN THE STUDY AREA		
Committed / Planned Road Improvements	None.	

3.2 STUDY AREA

THE STUDY AREA WAS DETERMINED BASED ON THE FOLLOWING

The Layout of The Current Road Network Influences the Required Study Area	Major roads such as Church (N2), Piet Retief (R543), and Brand (R543) will distribute traffic in north-south and east-west directions.	
The Expected Trip Distribution Influences the Required Study Area	The primary and secondary markets for the planned development were obtained from the Market Study by FERNRIDGE.	
The Extent of the Trip Generation Influences the Required Study Area	The expected primary (new) vehicle trip generation for the application is about 857 and 1612 vehicle trips during the Weekday PM and the Saturday AM peak hours, respectively.	
THE FOLLOWING INTERSECTIONS WERE INCLUDED IN THE STUDY AREA (THE EXISTING TYPE OF TRAFFIC CONTROL IS ALSO INDICATED)		
Intersection 1	Church (N2) / Theo Mocke	Two-way Stop
Intersection 2	Church (N2) / Smit	Traffic Signals
Intersection 3	Church (N2) / Piet Retief (R543)-Kruger	Traffic Signals
Intersection 4	Church (N2) / Retief	Traffic Signals
Intersection 5	Church (N2) / Brand (R543)	One-way Stop
Intersection 6	Church (N2) / Gerard Bohmer	Two-way Stop
Intersection 7	Kotze – Primary Access Piet Retief Mall / Brand (R543)	All-way Stop
Intersection 8	Pretorius / Brand (R543)	One-way Stop
Intersection 9	Von Brandis / Brand (R543)	All-way Stop
Intersection 10	Church (N2) / Secondary Access Piet Retief Mall	Planned One-way Stop
THE LAYOUT OF THE INTERSECTIONS IN THE STUDY AREA IS INDICATED SCHEMATICALLY ON THE ATTACHED FIGURE		

Existing Road Network		Refer to: *Figure 4: Existing Road Network and Lane Layout*

3.3 ROAD NETWORK DESCRIPTION

ROAD NETWORK PLANNING IN AREA		
Road Network Planning	*None*	
THE REGIONAL ACCESSIBILITY OF THE SITE IS PROVIDED BY THE FOLLOWING ROAD NETWORK		
N2 (Church Street), R543 West (Piet Retief Street), R543 East (Brand Street)	The N2 connects Piet Retief with Ermelo in the north and Pongola in the south, and also to Paulpietersburg in the south via the R33. The R543 WEST connects Piet Retief with Wakkerstroom in the west, while the R543 EAST connects Piet Retief with Swaziland in the west. The jurisdiction of SANRAL (by means of a national road declaration) starts / ends at Theo Mocke Street in the north and Kempville Street in the south.	Refer to: *Figure 1: Locality Plan*
THE LOCAL ACCESSIBILITY OF THE SITE IS PROVIDED BY THE FOLLOWING ROAD NETWORK		
Gerard Bohmer, Von Brandis, Pretorius, Kotze, Retief, Kruger, and Smit Streets	Traffic will also approach the development from the various residential areas along the following local streets; Gerard Bohmer, Von Brandis, Pretorius, Kotze, Retief, Kruger, and Smit Streets.	*Refer to:* *Figure 1: Locality Plan* *Figure 2: Study Area*
THE ROAD NETWORK THAT SERVES THE DEVELOPMENT HAS THE FOLLOWING CHARACTERISTICS		

N2 (Church Street), R543 West (Piet Retief Street), R543 East (Brand Street)	The N2 and R543 are classified as Class 2 Rural Distributors outside the Piet Retief urban area, but only comply with the design standards of Class 3 and Class 4 facilities in the urban area. These single carriageway roads are controlled with priority control as well as traffic signals at the high-volume intersections.	
Gerard Bohmer, Von Brandis, Pretorius, Kotze, Retief, Kruger, and Smit Streets	The functional classification of these streets are either Class 4 or Class 5 streets.	
3.4 ACCESS		
ACCESS TO THE DEVELOPMENT WILL BE OBTAINED FROM THE FOLLOWING STREETS		
Primary Access from Brand Street opposite Kotze Street	The primary access to the development is recommended from Brand Street opposite Kotze Street as the fourth approach of the Kotze / Brand Street T-junction approximately 150m from Church Street. The expected trip distribution and assignment shows that 55% of the visitors are expected to use the primary access during the weekday PM peak hour and 62% during the Saturday AM peak hour. Two inbound and two outbound lanes are required with a minimum throat length of about 35m.	Refer to: *Figure 2: Study Area*
Secondary Access 2 from Church Street (N2)	A secondary access to the development is recommended from Church Street approximately 150m south of Brand Street (R543). This will basically extend the current block-pattern of the CBD – of 150m between cross-streets – with one block distance of 150m towards the south.	Refer to: *Figure 2: Study Area*

	This access will only be a marginal access – left-in and left-out – and a physical curb island must be provided to prohibit any right-turn movements from/to Church Street at the access. The expected trip distribution and assignment shows that 45% of the visitors are expected to use the secondary access during the weekday PM peak hour and 38% during the Saturday AM peak hour. Two inbound lanes and two outbound lanes are required with a minimum throat length of about 35m.	
THE REQUIREMENTS FOR ACCESS CONTROL IS THE FOLLOWING:		
Access Control	Access control is not planned at this stage.	

4 EXISTING TRAFFIC CHARACTERISTICS

The existing traffic demand is described in this section.

TRAFFIC COUNTS WERE CONDUCTED DURING THE FOLLOWING PERIODS		
Weekday PM Peak Period	Friday 30/08/2013 Counting Period 12:00 to 18:00	Peak Hour 16:00 to 17:00
Saturday AM Peak Period	Saturday 31/08/2013 Counting Period 09:00 to 14:00	Peak Hour 12:15 to 13:15
THE EXISTING TRAFFIC DEMAND IS SHOWN SCHEMATICALLY ON THE ATTACHED FIGURES		

Peak Hour Traffic Demand		Refer to: *Figure 5: Weekday PM Peak Hour Traffic Demand* *Figure 6: Saturday AM Peak Hour Traffic Demand*
THE CURRENT TWO DIRECTIONAL PEAK HOUR FLOWS ON THE NETWORK ARE AS FOLLOWS (WEEK PM / SATURDAY AM)		
Church Street (N2)	South of Theo Mocke	±900 / ±770
	South of Piet Retief (R543)	±1160 / ±950
	South of Brand (R543)	±1360 / ±1150
	South of Gerard Bohmer	±680 / ±430
Piet Retief Street (R543)	West of Church Street (N2)	±260 / ±240
Brand Street (R543)	East of Church Street	±220 / ±80
	East of Von Brandis Street	±370 / ±170
Gerard Bohmer Street	West of Church Street	±540 / ±880
	East of Church Street	±330 / ±220
THE CURRENT AVERAGE PHF'S FOR THE INTERSECTIONS IN THE STUDY AREA ARE AS FOLLOWS (WEEK PM / SAT AM)		
PHF'S	WEEK PM / SAT AM	0.90 / 0.90

5 TRIP CHARACTERISTICS

The expected trip characteristics of the development are described in this section in terms of trip generation, trip distribution, modal split, and trip assignment.

5.1 TRIP GENERATION

THE EXPECTED TRIP GENERATION WAS BASED ON THE FOLLOWING		
Trip Generation	The trip generation was based on the South African Trip Generation Guidelines 2nd Edition RR92/228, 1995; enhanced with more recent information on trip generation. A high utilization of public transportation and non-motorised transport trips is expected which is supported by the low parking requirement of only 2 bays per 100 m² GLA. The average trip generation rates for shopping centres in urban areas (in South Africa) were thus reduced with 30% for application in Piet Retief; namely to 3.95 and 6.84 trips / 100 m² GLA during the weekday afternoon (PM) and Saturday morning (AM) peak hours respectively. Standard average trip rates were used for all the other auxiliary land uses on the site.	
THE APPLICATION IS EXPECTED TO GENERATE THE FOLLOWING TOTAL NUMBER OF PEAK HOUR TRIPS (SPLIT GIVEN)		
TOTAL TRIPS		Refer to: *Table 1: Expected Trip Generation*
Weekday PM Peak Hour	1203 (51% in / 49% out)	
Saturday AM Peak Hour	1954 (50% in / 50% out)	
PRIMARY TRIPS		
Weekday PM Peak Hour	857 (52% in / 48% out)	
Saturday AM Peak Hour	1612 (50% in / 50% out)	
BYPASS TRIPS		
Weekday PM Peak Hour	346 (50% in / 50% out)	
Saturday AM Peak Hour	342 (50% in / 50% out)	

IT IS EXPECTED THAT THE CURRENT APPLICATION WILL GENERATE THE FOLLOWING % BYPASS TRIPS DURING THE RESPECTIVE PEAK HOURS		
Bypass Trips	Bypass trips of 35% are expected during the weekday afternoon peak hour and 20% during the Saturday morning peak hour. The bypass trips were assumed to be attracted in proportion to the bypassing traffic; namely 85% from Church Street (N2) and 15% from Brand Street during the peak hours.	
IT IS EXPECTED THAT THE CURRENT APPLICATION WILL GENERATE THE FOLLOWING MULTIPLE PURPOSE AND PUBLIC TRANSPORTATION TRIPS DURING THE RESPECTIVE PEAK HOURS		
Multiple Purpose and Public Transportation Trips	All the vehicle trips generated by the new land uses will not be new trips in the study area since some of these trips will be shared between land uses and will also be attracted from other land uses in the study area. A large utilization of public transportation is also expected given the target market of the shopping centre. A reduction of 30% in the standard vehicle trip generation rates of only the shopping centre were however assumed for the analyses which is a conservative approach.	
DETAIL ON THE EXPECTED TRIP GENERATION ARE SHOWN IN THE ATTACHED TABLE		
Trip Generation Table		*Refer to:* *Table 1: Expected Trip Generation*

5.2 TRIP DISTRIBUTION

THE TRIP DISTRIBUTION WAS BASED ON THE FOLLOWING METHODOLOGY		
Method	Analogy Method	An assessment of the existing traffic flow pattern in the area was used as an adaptation of the Analogy Method
THE FOLLOWING PRIMARY TRIP DISTRIBUTION (%) IS EXPECTED		

Shopping Centre	Gerard Bohmer WEST	10%
	Church (N2) SOUTH	12%
	Gerard Bohmer EAST	4%
	Von Brandis SOUTH	6%
	Brand (R543 East) EAST	10%
	Von Brandis NORTH	7%
	Pretorius NORTH	7%
	Kotze NORTH	5%
	Retief EAST	1%
	Kruger EAST	1%
	Smit EAST	2%
	Bodorp EAST	2%
	Theo Mocke EAST	2%
	Church (N2) NORTH	8%
	Theo Mocke WEST	1%
	Bodorp WEST	4%
	Smit WEST	4%
	Kruger WEST	8%
	Retief WEST	1%
	Brand / Zuidend WEST	5%
THE FOLLOWING DISTRIBUTION OF TRIPS BETWEEN THE VARIOUS MARKETS IS EXPECTED		
Trip Distribution	External	32%
	North-Eastern Quadrant	25%
	South-Eastern Quadrant	10%
	North-Western Quadrant	15%
	Western Suburbs	18%

THE EXPECTED TRIP DISTRIBUTION IS SHOWN SCHEMATICALLY ON THE FOLLOWING FIGURE		
Trip Distribution		Refer to: *Figure 7: Primary Trip Distribution*

5.3 MODAL SPLIT

THE FOLLOWING MODAL SPLIT FOR PUBLIC TRANSPORT USAGE IS EXPECTED	
Modal Split	The average vehicle classification in the vicinity of the application site (i.e. centre of town) was 80% private light vehicles, 13% public transportation (bus and mini-bus taxi) vehicles, and 7% heavy commercial vehicles during the 6-hour survey period on a weekday afternoon. However in terms of modal split this translates into 43% private vehicle occupants, and 57% public transport passengers.
THE EXPECTED UTILIZATION OF PUBLIC TRANSPORT WARRANTS THE FOLLOWING ADJUSTMENTS	
Adjustments for public transport	The expected vehicle trip generation rates for the shopping centre were reduced with 30% to make provision for the use of public transportation (which also includes an adjustment for multiple purpose trips, and the rural nature of the study area).

5.4 TRIP ASSIGNMENT

THE TRIP ASSIGNMENT WAS BASED ON THE FOLLOWING METHODOLOGY	
Trip Assignment	Shortest travel time assignments taking into account the layout of the road network and the traffic control at key intersections.
THE ASSIGNED TRIPS FOR THE VARIOUS SCENARIOS ARE SHOWN SCHEMATICALLY IN THE FOLLOWING FIGURES	

Trip Assignment		Refer to: *Figure 5: Weekday PM Peak Hour Traffic Demand* *Figure 6: Saturday AM Peak Hour Traffic Demand*

6 CAPACITY AND OPERATIONAL ANALYSES

The capacity and operational analyses were subsequently done to determine the required road improvements for the various scenarios

THE FOLLOWING METHODOLOGY WAS UTILIZED		
Capacity and Operational Analyses	Methodology according to the 2010 Highway Capacity Manual (2010HCM)	
THE MEUSURES OF PERFORMANCE (MOE'S) ACCORDING TO THE HCM WERE UTILIZED		
The best service levels are A which indicates free flow conditions while F indicates congestion and jammed conditions	Total (Control) delay in seconds	
THE HCM2010 UTILIZES THE FOLLOWING LOS DELAY THRESHOLDS FOR SIGNALIZED AND UNSIGNALIZED INTERSECTIONS RESPECTIVELY		
The overall LOS and average delay are reported for the intersection except with priority control (stop on side road) where the critical side road LOS and delay is reported.	SIGNALIZED LOS A <10 LOS B >10 and <20 LOS C >20 and <35 LOS D >35 and <55 LOS E >55 and <80 LOS F >80	UNSIGNALIZED LOS A <10 LOS B >10 and <15 LOS C >15 and <25 LOS D >25 and <35 LOS E >35 and <50 LOS F >50

THE RESULTS OF THE CAPACITY AND OPERATIONAL ANALYSES ARE SUMMARIZED IN THE FOLLOWING TABLES		
Detailed Results		Refer to: *Table 2: Weekday PM Peak Hour: Results of Capacity and Operational Analyses* *Table 3: Saturday AM Peak Hour: Results of Capacity and Operational Analyses*
THE FOLLOWING RESULTS WERE OBTAINED FROM THE CAPACITY AND OPERATIONAL ANALYSES		
Intersection 1 Church (N2) / Theo Mocke	This two-way stop controlled intersection is already operating close to saturation during the critical peak hours (LOS F / LOS E – Scenario 1). The growth in background traffic will result in very poor operating conditions in future (LOS F / LOS F – Scenario 2). This situation will be exacerbated by the application. The construction of exclusive right-turn lanes on the southern (Church Street) and eastern approaches (Theo Mocke) in combination with the implementation of traffic signal control will ensure LOS B with the application in the design year (Scenario 4). The required mitigation measures are however not the responsibility of the applicant given that this intersection is already saturated and it is located a long distance from the application site.	
Intersection 2 Church (N2) / Smit	This traffic signal controlled intersection is expected to operate at good service levels (LOS C / LOS B) with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 3). No mitigation measures are required to support the application.	
Intersection 3 Church (N2) / Piet Retief (R543) – Kruger	This traffic signal controlled intersection is expected to operate at good service levels (LOS C / LOS C) with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 3). No mitigation measures are required to support the application.	

Intersection 4 Church (N2) / Retief	This traffic signal controlled intersection is expected to operate at good service levels (LOS D / LOS C) with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 3). No mitigation measures are required to support the application.
Intersection 5 Church (N2) / Brand (R543)	Long waiting times are already experienced at this one-way stop controlled intersection during the weekday PM peak hour (LOS F – Scenario1). This situation will deteriorate with the growth in background traffic and the application (Scenario 2 and Scenario 3). The reconfiguration of this intersection through limited construction works, changes in lane designation, and the implementation of traffic signal control will ensure LOS C and LOS B with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 4). These improvements are the responsibility of the applicant.
Intersection 6 Church (N2) / Gerard Bohmer	Long waiting times are already experienced at this two-way stop controlled intersection during the critical peak hours (LOS F – Scenario1). This situation will deteriorate with the growth in background traffic and the application (Scenario 2 and Scenario 3). The reconfiguration of this intersection through the construction of additional lanes on all the approaches, changes in lane designation, and the implementation of traffic signal control will ensure LOS C and LOS B with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 4). These improvements are the responsibility of the applicant.
Intersection 7 Kotze – Primary Access Piet Retief Mall / Brand (R543)	Traffic operations are expected to deteriorate at this all-way stop controlled intersection – which will also serve as the primary access to the application - with the growth in background traffic and the application. The reconfiguration of this intersection through the construction of additional lanes on all the approaches, and changes in lane designation, will ensure LOS B with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 4). All-way stop control (AWSC) will however suffice. These improvements are the responsibility of the applicant.

Intersection 8 Pretorius / Brand (R543)	This two-way stop controlled intersection is expected to operate at good service levels (LOS C) with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 3). No mitigation measures are required to support the application.
Intersection 9 Von Brandis / Brand (R543)	This all-way stop controlled intersection is expected to operate at good service levels (LOS C and LOS B) with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 3). No mitigation measures are required to support the application.
Intersection 10 Church (N2) / Secondary Access Piet Retief Mall	This proposed new one-way stop controlled intersection is expected to operate at reasonable service levels (LOS D) with the application during the weekday PM and Saturday AM peak hours in the design year (Scenario 4). The improvements are the responsibility of the applicant.

7 ROAD IMPROVEMENTS AND MITIGATION MEASURES

All the required road improvements on the road network, the subsequent apportionment of cost, and the required road improvements by the developer is discussed in this section.

7.1 REQUIRED ROAD IMPROVEMENTS BY APPLICANT TO SUPPORT THE APPLICATION

THE FOLLOWING ROAD IMPROVEMENTS BY THE APPLICANT ARE REQUIRED TO SUPPORT THE APPLICATION		
Intersection 5 Church (N2) / Brand (R543)	The reconfiguration of this intersection through limited construction works, changes in lane designation, and the implementation of traffic signal control is required.	Refer to: *Figure 8: Required Road Improvements In Study Area*

		Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall
Intersection 6 Church (N2) / Gerard Bohmer	The reconfiguration of this intersection through the construction of additional lanes on all the approaches, changes in lane designation, and the implementation of traffic signal control is required.	Refer to: *Figure 8: Required Road Improvements In Study Area* *Appendix D: Proposed Road Improvements at the Church (N2) / Gerard Bohmer Intersection to Support the Piet Retief Mall*
Intersection 7 Kotze – Primary Access Piet Retief Mall / Brand (R543)	The reconfiguration of this intersection through the construction of additional lanes on all the approaches, and changes in lane designation is required. All-way stop control (AWSC) will however suffice.	Refer to: *Figure 8: Required Road Improvements In Study Area* *Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall*
Intersection 10 Church (N2) / Secondary Access Piet Retief Mall	The construction of a left-turn deceleration lane of 45m / 45m (lane / taper) and a 2.5m wide physical median is required to prohibit any right-turn movements at this access.	Refer to: *Figure 8: Required Road Improvements In Study Area* *Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall*

7.2 REQUIRED ROAD RESERVE REQUIREMENTS BY THE APPLICANT TO SUPPORT THE APPLICATION

THE FOLLOWING LAND MUST BE PROVIDED BY THE APPLICANT TO SUPPORT THE APPLICATION		
Brand Street (R543) and Church Street (N2)	The applicant must provide the necessary land for the required widening of road reserves.	Refer to: *Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall*

8 PUBLIC TRANSPORT AND PEDESTRIANS REQUIREMENTS

This section describes requirements in terms of facilities for public transport and pedestrians (non-motorised forms of transport).

8.1 PUBLIC TRANSPORT BACKGROUND

THE FOLLOWING ASSESSMENT IS REQUIRED		
In terms of the National Land Transport Transition Act, Act 22 of 2000 (Section 29), it is also required to carry out a public transport assessment for all new developments. The assessment need to address aspects such as the number of new employment opportunities that will be created for public transport users, the expected travelling pattern of these users, as well as the impact it may have on the existing public transport network.		
THE ESTIMATED DEMAND FOR PUBLIC TRANSPORT USERS ARE THE FOLLOWING		
Full Application	In the absence of better information in this regard, the number of public transport users is estimated at about 2 per 100 m^2 GLA for the commercial bulk which translates to about 780 persons during the peak hours.	The expected public transport users can be transported with about 65 mini-bus taxi's in the peak hour (assuming an average occupancy of 12 persons).

		This is a conservative estimate since some of the public transport users will make use of bus transport.
THE FOLLOWING PUBLIC TRANSPORT FACILITIES ARE RECOMMENDED		
The objectives of the National Transport Policy (published by the Department of Transport in September 1996) are to limit walking distances for public transport users to less than 1 km in urban areas.		
Construction of Taxi- / Bus Loading Zones	The construction of taxi- / bus loading zones are recommended on both sides of the Church Street (N2) south of the intersection with Brand Street (R543). This position is recommended to enable pedestrians to cross Church Street (N2) at the signalized intersection with Brand Street.	Refer to: *Figure 8: Required Road Improvements In Study Area* *Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall*

8.2 PEDESTRIAN AND NMT FACILITIES

THE FOLLOWING PEDESTRIAN AND NMT FACILITIES ARE REQUIRED	
Pedestrian Sidewalks	To improve road safety and to separate vehicle and pedestrian traffic a 1.5m wide paved sidewalk must be provided along Brand Street (R543) and Church Street (N2) that borders the application site. Particular attention must be given to the movement of pedestrians between the taxi- / bus loading zone and the Shopping Centre.

9 PARKING REQUIREMENTS

This section describes the parking requirements of the site based on the relevant town planning scheme conditions

THE FOLLOWING NUMBER OF PARKING BAYS WILL BE PROVIDED ON THE SITE	
Parking Supply according to the Town Planning Scheme	The normal Town Planning Scheme requirements of two (2) parking bays per 100m^2 GLA will apply to the application site.

10 SITE DEVELOPMENT PLAN (SDP) ISSUES	***Internal circulation and parking issues which are important for the site development plan (SDP) are discussed in this section.***
A SITE DEVELOPMENT PLAN (SDP) IS AVAILABLE FOR THE DEVELOPMENT	
SDP	Only Concept
TRAFFIC ENGINEERING INPUT WILL BE PROVIDED FOR THE FINAL SDP	
Traffic engineering input	Affirmative
11 CONCLUSIONS AND RECOMMENDATIONS	***This section contains the conclusions and recommendations of the report.***

11.1 CONCLUSIONS

THE FOLLOWING IS CONCLUDED	
Application	New township application for commercial development ("Business 1") in the CBD of Piet Retief for 39,000 m^2 GLA that includes a shopping centre of 25,000 m^2 GLA.
Latent Rights and Growth in Background Traffic	No other large properties with existing undeveloped land use rights (i.e. latent rights) are known in the study area. An average to high traffic growth rate of 4.0% p.a. for the 5-year study period was assumed to account for growth in background traffic and any unknown latent land use rights.
ACCESS ARRANGEMENTS	
Primary Access from Brand Street opposite Kotze Street	The primary access to the development is recommended from Brand Street opposite Kotze Street as the fourth approach of the Kotze / Brand Street T-junction approximately 150m from Church Street.

	The expected trip distribution and assignment shows that 55% of the visitors are expected to use the primary access during the weekday PM peak hour and 62% during the Saturday AM peak hour. Two inbound and two outbound lanes are required with a minimum throat length of about 35m.	
Secondary Access 2 from Church Street (N2)	A secondary access to the development is recommended from Church Street approximately 150m south of Brand Street (R543). This will basically extend the current block-pattern of the CBD – of 150m between cross-streets – with one block distance of 150m towards the south. This access will only be a marginal access – left-in and left-out – and a physical curb island must be provided to prohibit any right-turn movements from/to Church Street at the access. The expected trip distribution and assignment shows that 45% of the visitors are expected to use the secondary access during the weekday PM peak hour and 38% during the Saturday AM peak hour. Two inbound lanes and two outbound lanes are required with a minimum throat length of about 35m.	
Expected Trip Generation	<u>TOTAL TRIPS</u> Weekday PM Peak Hour Saturday AM Peak Hour <u>PRIMARY TRIPS</u> Weekday PM Peak Hour Saturday AM Peak Hour <u>BYPASS TRIPS</u> Weekday PM Peak Hour Saturday AM Peak Hour	 1203 (51% in / 49% out) 1954 (50% in / 50% out) 857 (52% in / 48% out) 1612 (50% in / 50% out) 346 (50% in / 50% out) 342 (50% in / 50% out)
REQUIRED ROAD IMPROVEMENTS TO SUPPORT THE APPLICATION		
Intersection 5 Church (N2) / Brand (R543)	The reconfiguration of this intersection through limited construction works, changes in lane designation, and the implementation of traffic signal control is required.	

Intersection 6 Church (N2) / Gerard Bohmer	The reconfiguration of this intersection through the construction of additional lanes on all the approaches, changes in lane designation, and the implementation of traffic signal control is required.
Intersection 7 Kotze – Primary Access Piet Retief Mall / Brand (R543)	The reconfiguration of this intersection through the construction of additional lanes on all the approaches, and changes in lane designation is required. All-way stop control (AWSC) will however suffice.
Intersection 10 Church (N2) / Secondary Access Piet Retief Mall	The construction of a left-turn deceleration lane of 45m / 45m (lane / taper) and a 2.5m wide physical median is required to prohibit any right-turn movements at this access.
REQUIRED ROAD RESERVE FROM APPLICATION SITE	
Brand Street (R543) and Church Street (N2)	The applicant must provide the necessary land for the required widening of road reserves.
PUBLIC TRANSPORTATION AND NMT REQUIREMENTS	
Public Transport Facilities	The construction of taxi- / bus loading zones are recommended on both sides of the Church Street (N2) south of the intersection with Brand Street (R543). This position is recommended to enable pedestrians to cross Church Street (N2) at the signalized intersection with Brand Street.
Pedestrian and NMT facilities	To improve road safety and to separate vehicle and pedestrian traffic a 1.5m wide paved sidewalk must be provided along Brand Street (R543) and Church Street (N2) that borders the application site. Particular attention must be given to the movement of pedestrians between the taxi- / bus loading zone and the Shopping Centre.
Parking Supply according to the Town Planning Scheme	The normal Town Planning Scheme requirements of two (2) parking bays per 100m^2 GLA will apply to the application site.

11.2 RECOMMENDATIONS

THE FOLLOWING IS RECOMMENDED	
Requirements	It is recommended that the application be approved from a traffic engineering point of view subject to the required mitigation measures shown in *Figure 8, Appendix C, and Appendix D*.

TABLES

Table 1: Expected Trip Generation											
ITEM	LAND USE	EXTENT	UNITS	WEEKDAY PM PEAK HOUR				SATURDAY AM PEAK HOUR			
				TRIP RATE	TOTAL TRIPS	IN	OUT	TRIP RATE	TOTAL TRIPS	IN	OUT
1	Retail	25000	m^2 GLA	3.95	988	50%	50%	6.84	1711	50%	50%
2	Motor Dealerships	3500	m^2 GLA	2.30	81	50%	50%	2.20	77	45%	55%
3	Offices	3500	m^2 GLA	2.10	74	80%	20%	0.45	16	55%	45%
4	Mini Storage	3500	m^2 GLA	0.25	9	50%	50%	0.40	14	50%	50%
5	Bulk Trade Centre	3500	m^2 GLA	1.50	53	40%	60%	3.90	137	50%	50%
		39000	m^2 GLA		1203				1954		
A	Primary Trips			71%	857	446	412	82%	1612	803	809
B	Bypass Trips			29%	346	173	173	18%	342	171	171
C	Total Trips			100%	1203	618	585	100%	1954	974	980

TABLES

Table 1: Expected Trip Generation											
ITEM	LAND USE	EXTENT	UNITS	WEEKDAY PM PEAK HOUR				SATURDAY AM PEAK HOUR			
				TRIP RATE	TOTAL TRIPS	IN	OUT	TRIP RATE	TOTAL TRIPS	IN	OUT
Church Street (N2)	Primary Trips			28%	243	137	106	28%	456	246	210
	Bypass Trips			85%	294	147	147	85%	290	145	145
	Total Trips			45%	537	284	253	38%	746	391	355
Brand Street (R543)	Primary Trips			72%	614	310	304	72%	1152	554	598
	Bypass Trips			15%	52	26	26	15%	52	26	26
	Total Trips			55%	666	336	330	62%	1204	580	624

TABLES

Table 2: Weekday PM Peak Hour: Results of Capacity and Operational Analyses					
INTERSECTION	**(MOE)**	**1**	**2**	**3**	**4**
	Measure of Effectiveness	**Existing Situation**	**With Background Growth**	**With Application**	**With Application With Mitigation**
		2013	**2018**	**2018**	**2018**
Intersection 1 Church (N2) / Theo Mocke	Traffic Control	TWSC	TWSC	TWSC	TSC
	Worse Movement	SWBR	SWBR	SWBR	-
	V/C	0.234	0.780	1.344	0.531
	Delay	75.1	468.4	871.8	15.90
	LOS	F	F	F	B
Intersection 2 Church (N2) / Smit	Traffic Control	TSC	TSC	TSC	
	V/C	0.527	0.674	0.831	
	Delay	16.4	19.2	27.1	
	LOS	B	B	C	
Intersection 3 Church (N2) / Piet Retief (R543) - Kruger	Traffic Control	TSC	TSC	TSC	
	V/C	0.581	0.707	0.832	
	Delay	17.3	19.2	25.5	
	LOS	B	B	C	
Intersection 4 Church (N2) / Retief	Traffic Control	TSC	TSC	TSC	
	V/C	0.584	0.714	0.796	
	Delay	20.1	27.6	36.1	
	LOS	C	C	D	
Intersection 5 Church (N2) / Brand (R543)	Traffic Control	OWSC	OWSC	OWSC	TSC
	Worse Movement	WBR	WBT	WBR	-
	V/C	0.195	0.949	12.490	0.582
	Delay	67.0	236.4	5710.0	26.42
	LOS	F	F	F	C

TABLES

Table 2: Weekday PM Peak Hour: Results of Capacity and Operational Analyses					
INTERSECTION	**(MOE)**	**1**	**2**	**3**	**4**
	Measure of Effectiveness	**Existing Situation**	**With Background Growth**	**With Application**	**With Application With Mitigation**
		2013	**2018**	**2018**	**2018**
Intersection 6 Church (N2) / Gerard Bohmer	Traffic Control	TWSC	TWSC	TWSC	TSC
	Worse Movement	WBR	EBT	EBT	-
	V/C	7.467	2.024	4.547	0.708
	Delay	3447.7	10000.0	10000.0	24.88
	LOS	F	F	F	C
Intersection 7 Kotze – Primary Access Piet Retief Mall / Brand (R543)	Traffic Control	AWSC	AWSC	AWSC	AWSC
	Worse Movement	SBR	SBR	NBL	EBR
	V/C	-	-	-	-
	Delay	8.0	8.3	15.9	12.52
	LOS	A	A	C	B
Intersection 8 Pretorius / Brand (R543)	Traffic Control	TWSC	TWSC	TWSC	
	Worse Movement	NBR	NBR	NBR	
	V/C	0.000	0.000	0.000	
	Delay	11.7	12.7	16.5	
	LOS	B	B	C	
Intersection 9 Von Brandis / Brand (R543)	Traffic Control	AWSC	AWSC	AWSC	
	Worse Movement	EBT	EBT	EBT	
	V/C	-	-	-	
	Delay	10.1	11.9	17.1	
	LOS	B	B	C	
Intersection 10 Church (N2) / Secondary Access Piet Retief Mall	Traffic Control	NA	NA	NA	OWSC
	Worse Movement	NA	NA	NA	WBL
	V/C	NA	NA	NA	0.687
	Delay	NA	NA	NA	31.0
	LOS	NA	NA	NA	D

TABLES

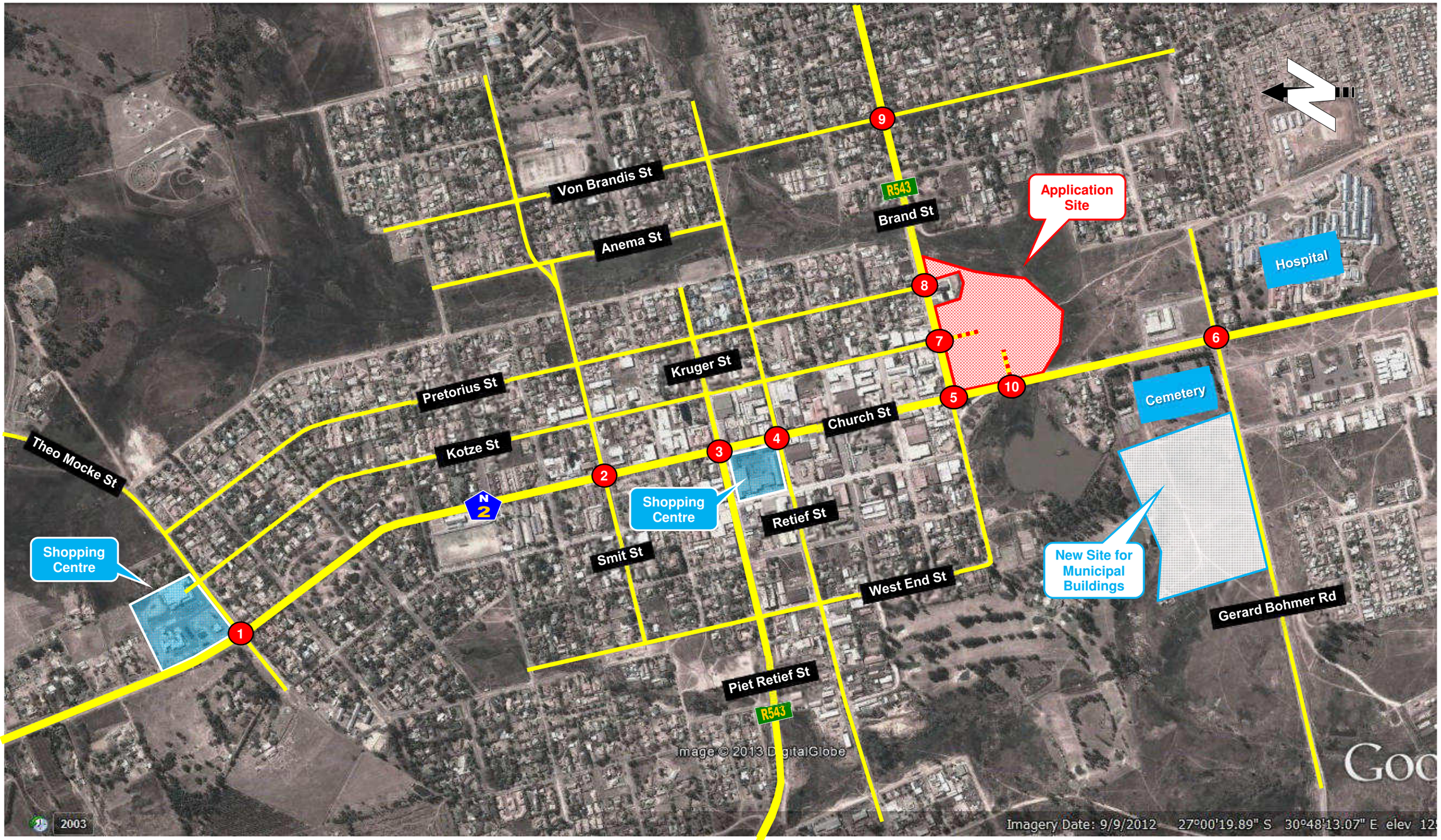
Table 3: Saturday AM Peak Hour: Results of Capacity and Operational Analyses					
INTERSECTION	**(MOE)**	**1**	**2**	**3**	**4**
	Measure of Effectiveness	**Existing Situation**	**With Background Growth**	**With Application**	**With Application With Mitigation**
		2013	**2018**	**2018**	**2018**
Intersection 1 Church (N2) / Theo Mocke	Traffic Control	TWSC	TWSC	TWSC	TSC
	Worse Movement	NEBR	SWBR	NEBR	
	V/C	0.011	0.143	0.638	0.573
	Delay	47.8	131.7	416.1	16.37
	LOS	E	F	F	B
Intersection 2 Church (N2) / Smit	Traffic Control	TSC	TSC	TSC	
	V/C	0.458	0.562	0.678	
	Delay	14.1	16.0	18.3	
	LOS	B	B	B	
Intersection 3 Church (N2) / Piet Retief (R543) - Kruger	Traffic Control	TSC	TSC	TSC	
	V/C	0.479	0.591	0.856	
	Delay	15.0	16.4	26.6	
	LOS	B	B	C	
Intersection 4 Church (N2) / Retief	Traffic Control	TSC	TSC	TSC	
	V/C	0.464	0.567	0.750	
	Delay	16.4	18.3	26.3	
	LOS	B	B	C	
Intersection 5 Church (N2) / Brand (R543)	Traffic Control	OWSC	OWSC	OWSC	TSC
	Worse Movement	WBR	WBR	WBR	
	V/C	0.019	0.040	15.776	0.522
	Delay	28.7	43.0	7028.6	13.67
	LOS	D	E	F	B

TABLES

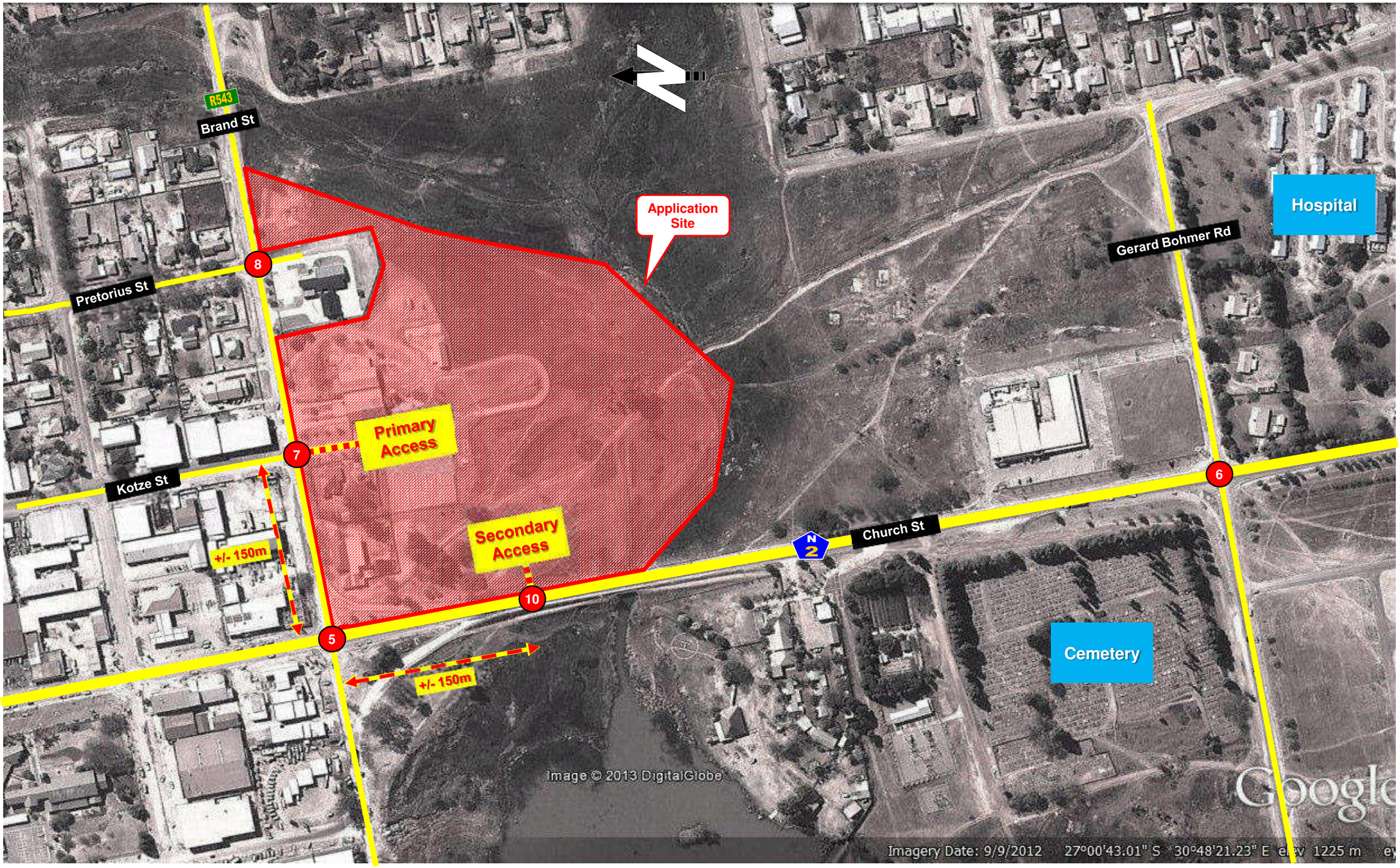
Table 3: Saturday AM Peak Hour: Results of Capacity and Operational Analyses					
INTERSECTION	**(MOE)**	**1**	**2**	**3**	**4**
	Measure of Effectiveness	**Existing Situation**	**With Background Growth**	**With Application**	**With Application With Mitigation**
		2013	**2018**	**2018**	**2018**
Intersection 6 Church (N2) / Gerard Bohmer	Traffic Control	TWSC	TWSC	TWSC	TSC
	Worse Movement	WBR	EBT	EBT	
	V/C	3.624	1.641	7.428	0.973
	Delay	1779.6	10000.0	10000.0	16.88
	LOS	F	F	F	B
Intersection 7 Kotze – Primary Access Piet Retief Mall / Brand (R543)	Traffic Control	AWSC	AWSC	AWSC	AWSC
	Worse Movement	SBR	SBR	NBL	
	V/C	-	-	-	-
	Delay	7.3	7.5	86.5	13.33
	LOS	A	A	F	B
Intersection 8 Pretorius / Brand (R543)	Traffic Control	TWSC	TWSC	TWSC	
	Worse Movement	SBT	SBT	SBR	
	V/C	0.000	0.000	0.328	
	Delay	11.3	12.0	23.3	
	LOS	B	B	C	
Intersection 9 Von Brandis / Brand (R543)	Traffic Control	AWSC	AWSC	AWSC	
	Worse Movement	NBT	NBT	EBT	
	V/C	-	-	-	
	Delay	8.1	8.5	11.3	
	LOS	A	A	B	
Intersection 10 Church (N2) / Secondary Access Piet Retief Mall	Traffic Control	NA	NA	NA	OWSC
	Worse Movement	NA	NA	NA	NBT
	V/C	NA	NA	NA	0.937
	Delay	NA	NA	NA	43.7
	LOS	NA	NA	NA	D

FIGURES

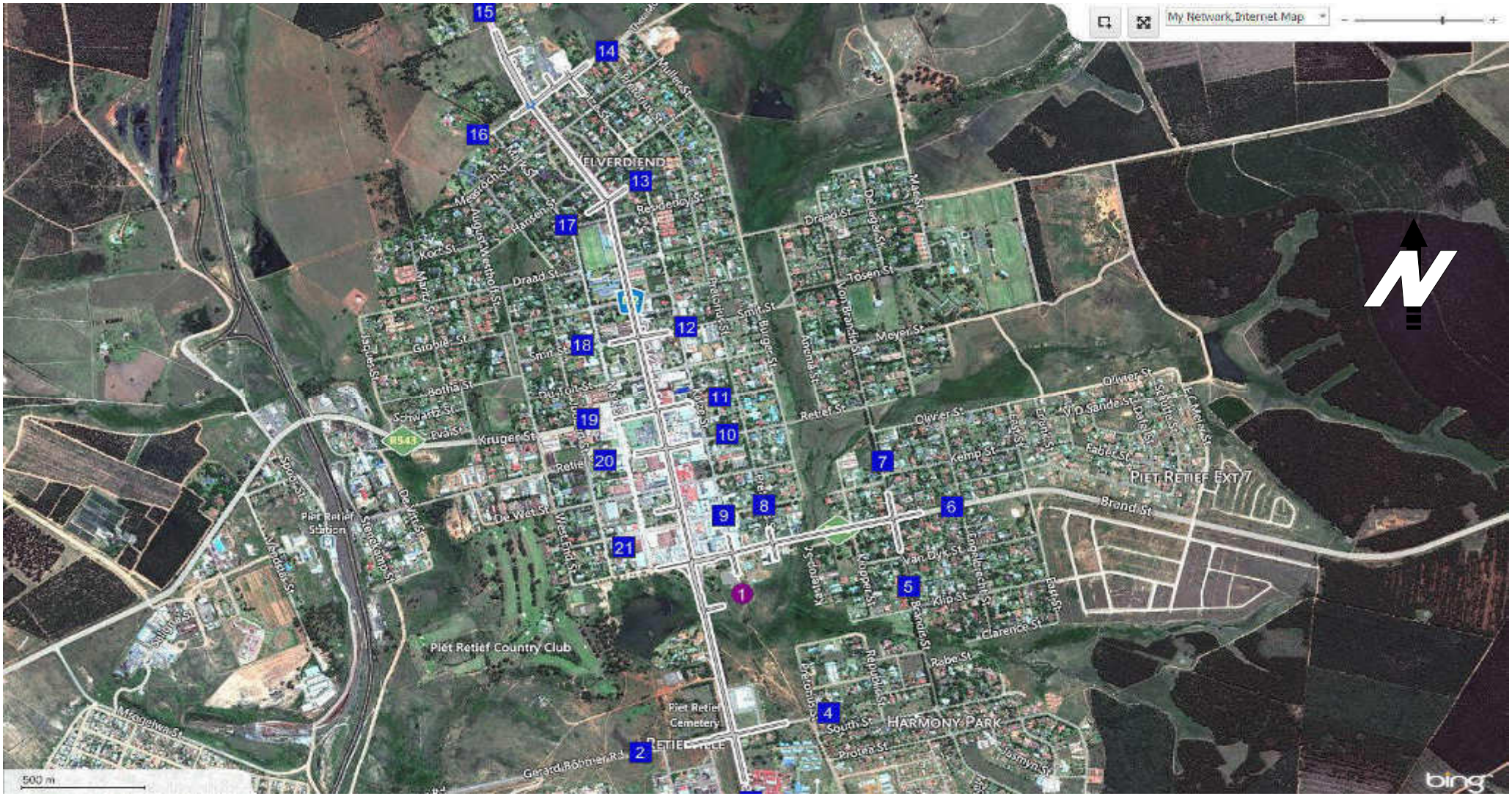
FIGURES



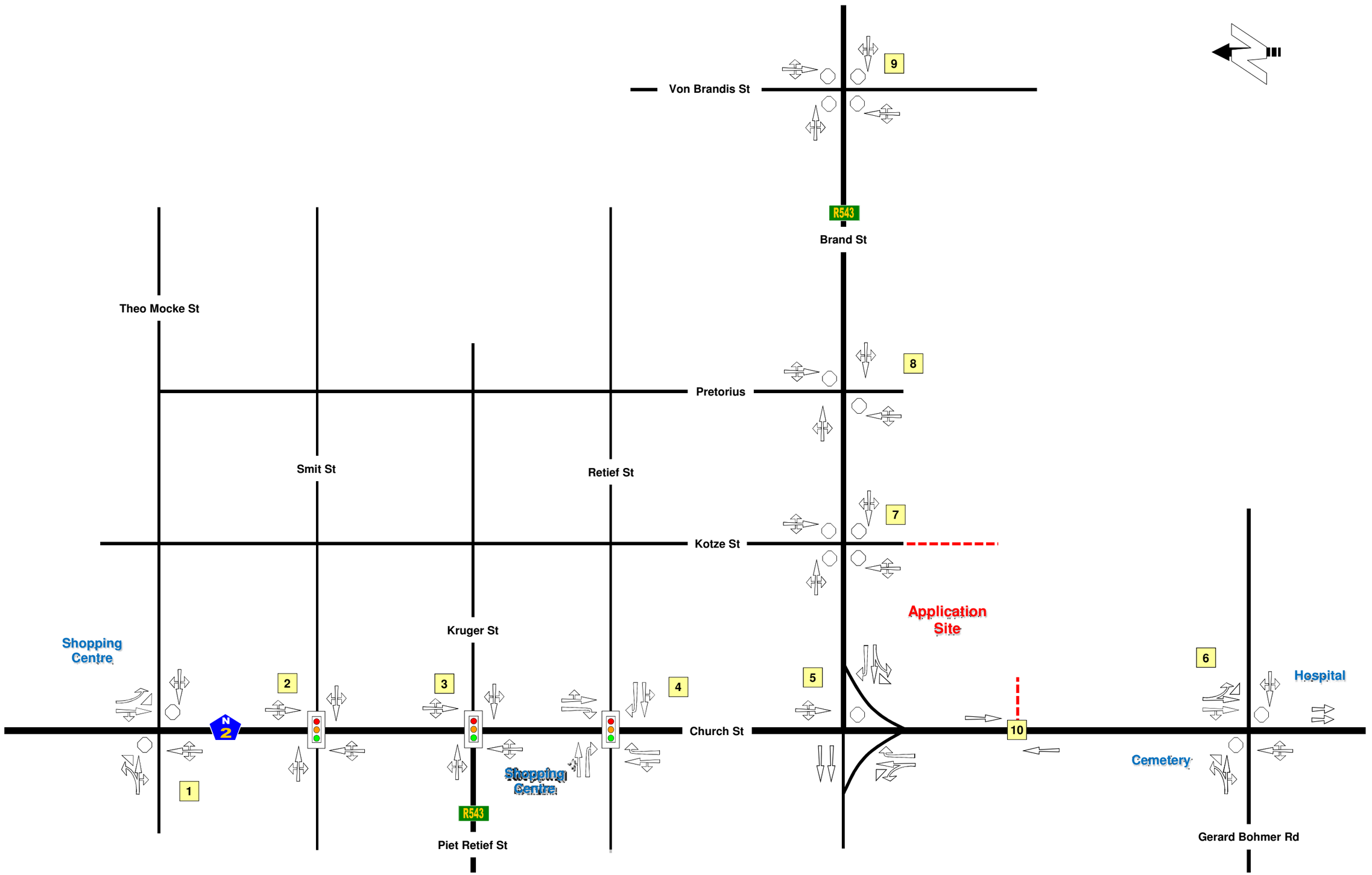
	MALL@PIET RETIEF	**Locality Plan**	**FIGURE 1**



	MALL@PIET RETIEF	**Study Area**	**FIGURE 2**

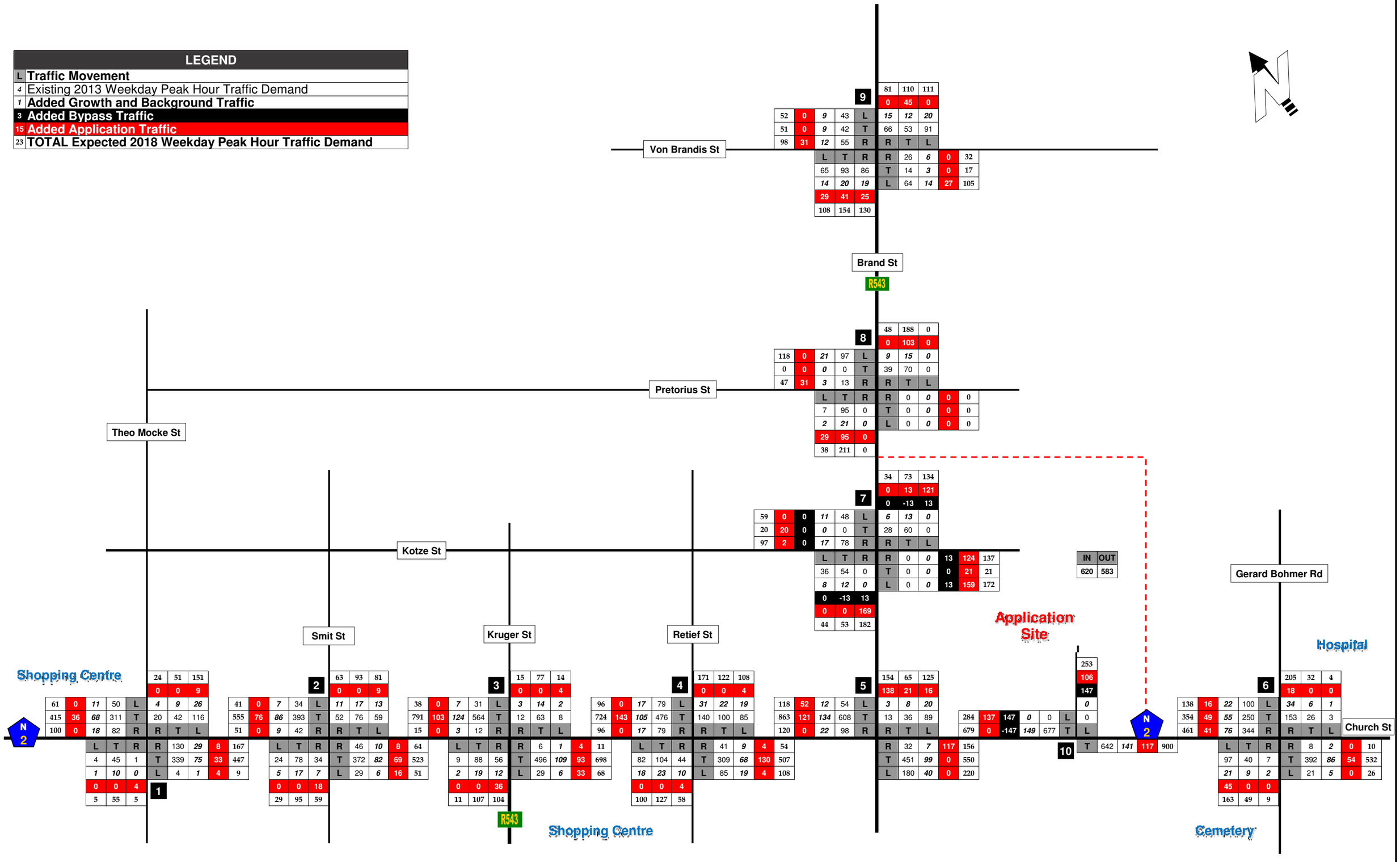


	MALL@PIET RETIEF	**Traffic Model (VISTRO)**	**FIGURE 3**



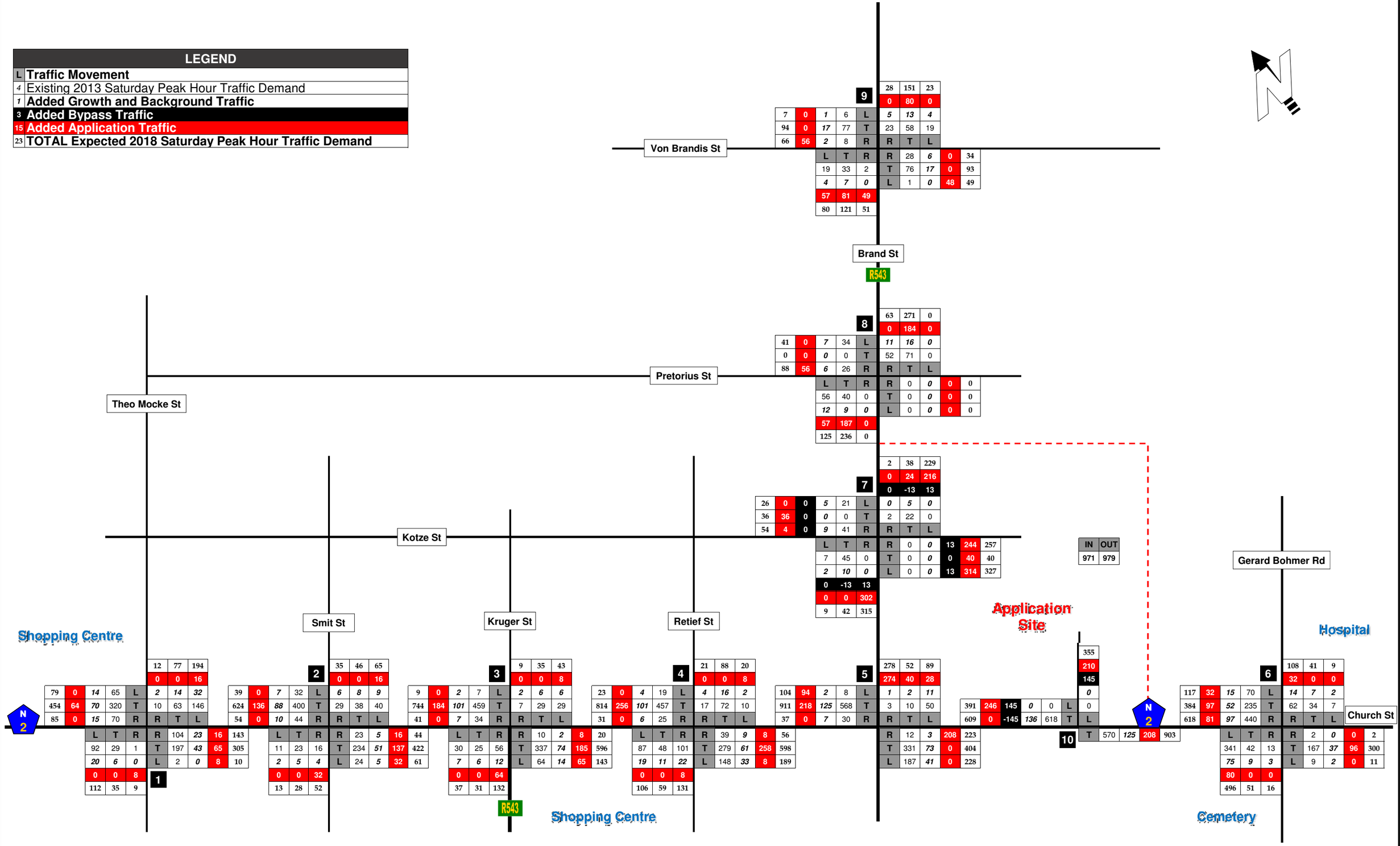
	MALL@PIET RETIEF	Existing Road Network and Lane Layout	FIGURE 4

LEGEND	
L	Traffic Movement
4	Existing 2013 Weekday Peak Hour Traffic Demand
1	Added Growth and Background Traffic
3	Added Bypass Traffic
15	Added Application Traffic
23	TOTAL Expected 2018 Weekday Peak Hour Traffic Demand



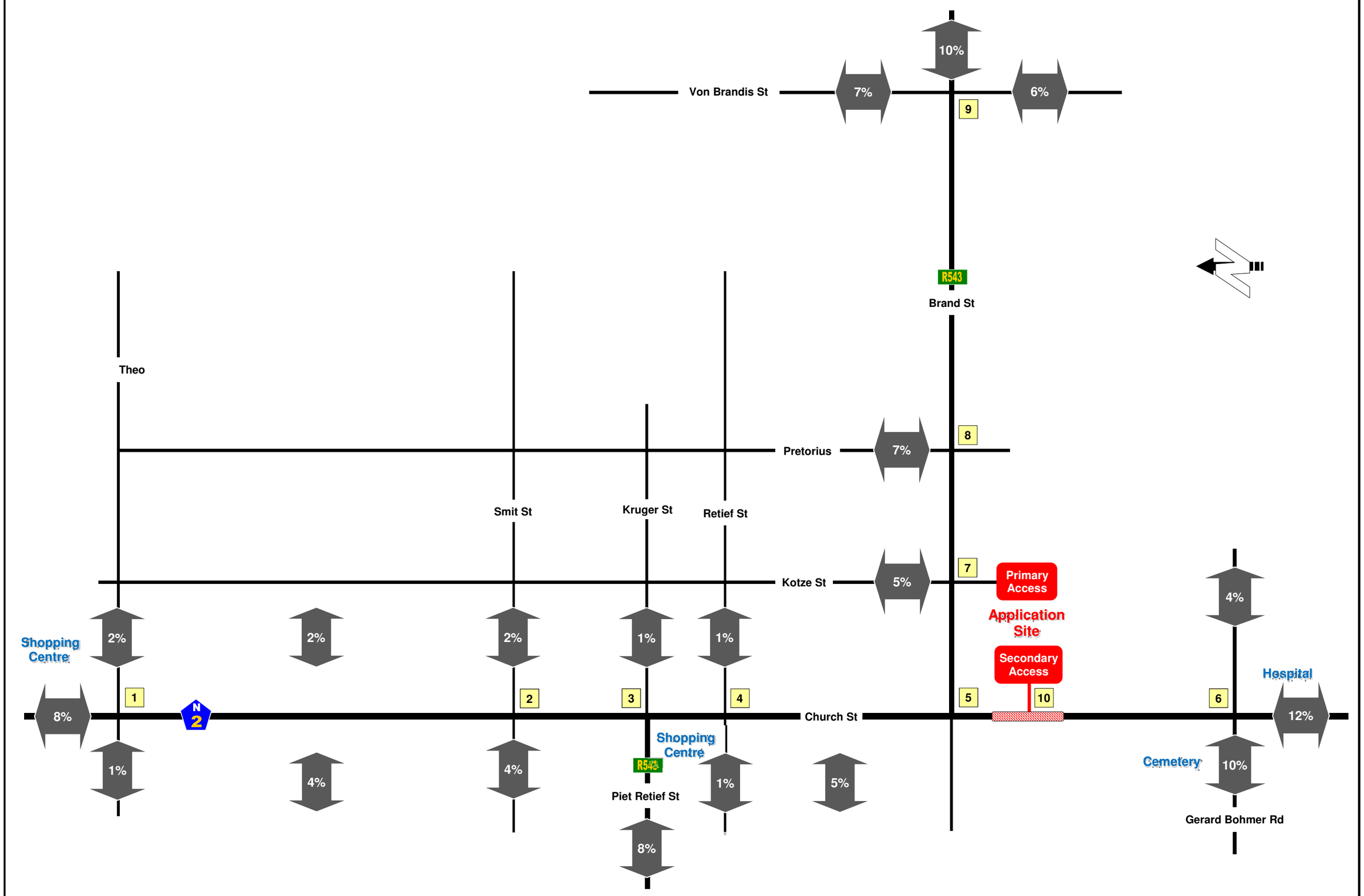
TECHWORLD	MALL@PIET RETIEF	Weekday PM Peak Hour Traffic Demand	FIGURE 5

LEGEND	
L	Traffic Movement
4	Existing 2013 Saturday Peak Hour Traffic Demand
1	Added Growth and Background Traffic
3	Added Bypass Traffic
15	Added Application Traffic
23	TOTAL Expected 2018 Saturday Peak Hour Traffic Demand



TECHWORLD	MALL@PIET RETIEF	Saturday AM Peak Hour Traffic Demand

FIGURE 6



	MALL@PIET RETIEF	Primary Trip Distribution	FIGURE 7

LEGEND

- Existing Road Network and Lane Layout
- Required Road Improvements by Applicant
- Required Road Improvements by Others
- *60*/**60** Lane Length / ***Taper Length***

Von Brandis St

9

R543

Brand St

Theo Mocke St

Smit St

Retief St

Pretorius

8

45/45

Kotze St

7

Primary Access

Application Site

45/45

Shopping Centre

1

2

3

4

5

Kruger St

N2

Secondary Access

10

45/45

45/45

6

45/45

Hospital

60/60

Shopping Centre

R543

Piet Retief St

60/60

±100m

60/60

60/60

60/60

Cemetery

45/45

Gerard Bohmer Rd

Bus / Taxi Loading Zone

	MALL@PIET RETIEF	Required Road Improvements in Study Area	FIGURE 8

APPENDICES

APPENDICES

Appendix A: Site Layout Plan: Portion 126

Appendix B: Concept SDP Mall@Piet Retief

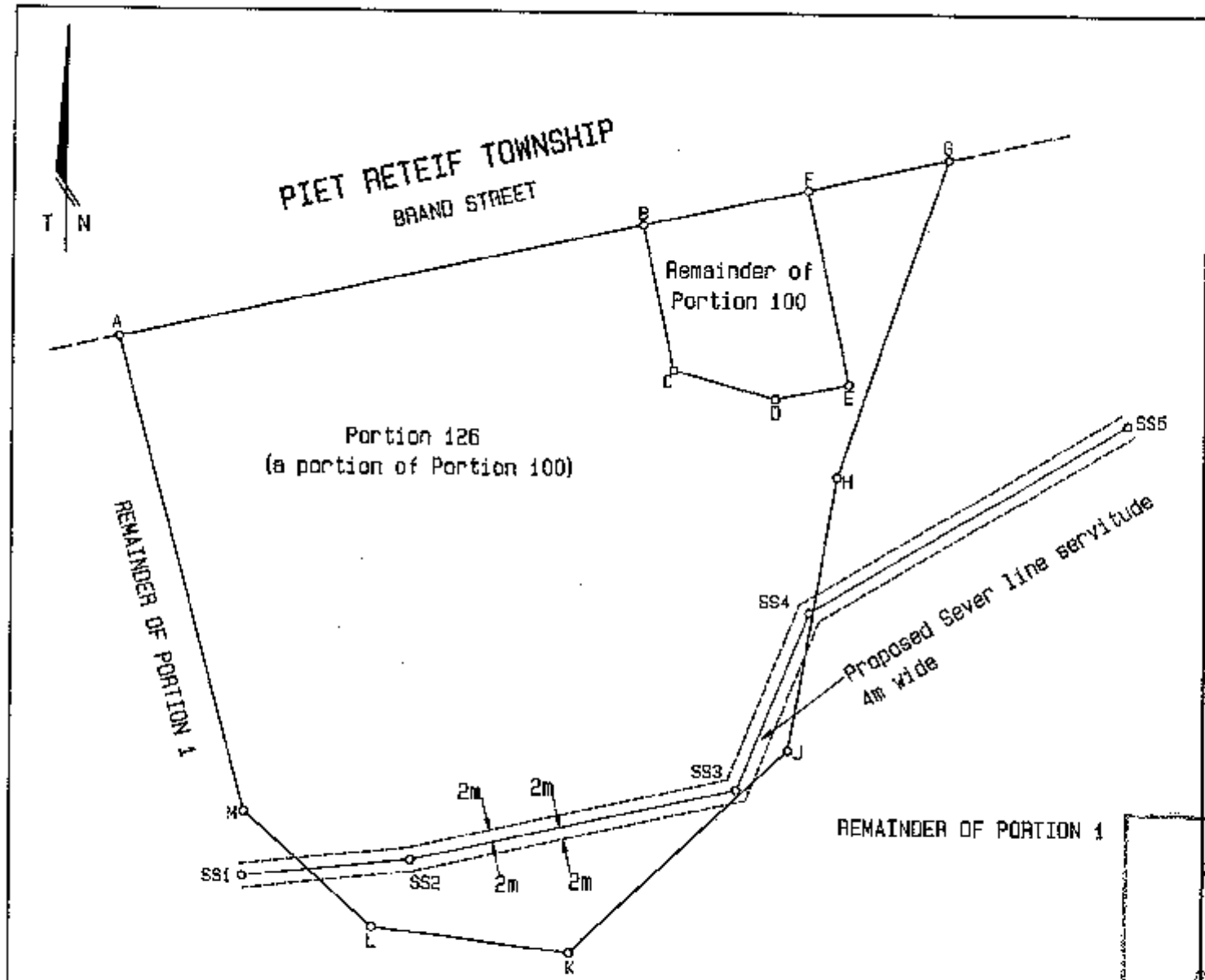
Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall

Appendix D: Proposed Road Improvements at the Church (N2) / Gerard Bohmer Intersection to Support the Piet Retief Mall

Appendix E: Traffic Counts

APPENDICES

Appendix A: Site Layout Plan



PIET RETIEF TOWN & TOWNLANDS No. 149-HT

SKETCH PLAN
in terms Ordinance 20/1986

Subdivision of Portion 126
(a portion of Portion 100)
of the farm
Piet Retief Town & Townlands No. 149-HT
Province of Mpumalanga

REED & PARTNERS/VENNOTE
PROFESSIONAL LAND SURVEYORS
PROFESSIONELE LANDMETERS

OWNER / EIENAAR : P. REED & GENOTE INC. REG NO. 84/08478/21

Joubertstr, 100
PO Box/Posbus 132
ERMELO , 2350

Tel. : (017) 8112348
Fax. : (017) 8197841
e-mail : rperm@hagaweb.co.za

Layout / Sketch plan approved in terms of Section 18 of Ordinance 20/1986.

MKHONDO MUNICIPALITY
2013 -06- 27
MUNICIPALITY
DATEX PUSBUS 23

MUNICIPAL MANAGER

Date June 2013
Scale 1: 500

J. VAN WYK (PLS 0675)

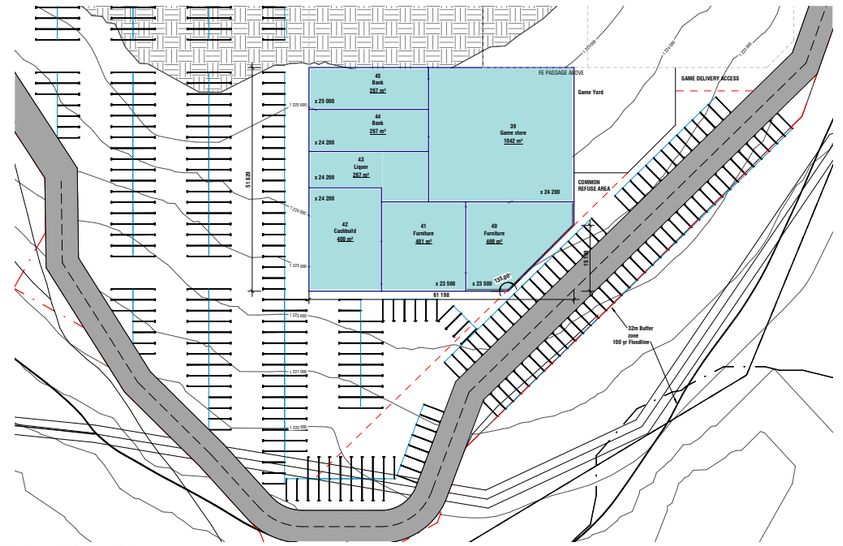
REFERENCE NO.	VERWYSINGS NO.	DRWG NO.	TEK NO.
C:\DAT\DAT2013\P266-10\PTN126SP.dwg		1	

APPENDICES

Appendix B: Concept SDP Mall@Piet Retief

00 Ground Floor (Option D)

SCALE: 1 : 500



-01 Level (Option D)

SCALE: 1 : 500

PARKING CALCULATION - RETAIL

Gross Rentable Area =	26192 m²
Assignable Area (80% of Gross Rentable Area) =	20954 m²

Total Parking Bays Required		Less Taxi Credits	Bays in Hand
Parking @ 6 Bays per 100m² =	1257,216 Bays	1057,216 Bays	-528,216 Bays
Parking @ 5 Bays per 100m² =	1047,68 Bays	847,68 Bays	-318,68 Bays
Parking @ 4 Bays per 100m² =	838,144 Bays	638,144 Bays	-109,144 Bays
Total Taxi Bays Provided =	25 Bays		
Parking Bay Credits at 8 Bays per Taxi =	200 Bays		
Total Parking Bays Provided =	529 Bays	(Includes Tenant Parking Area)	

Parking Schedule

SCALE: 1 : 100

ACTUAL PARKING RATIO IS 3.48/100 (X/100=729/20954)

Area Schedule (Rentable Option D)				
Area	**Level**	**Name**	**Number**	**Area Retail Type**
1042 m²	-01 Level (Option D)	Game store	39	Tenant
400 m²	-01 Level (Option D)	Furniture	40	Tenant
401 m²	-01 Level (Option D)	Furniture	41	Tenant
400 m²	-01 Level (Option D)	Cashbuild	42	Tenant
267 m²	-01 Level (Option D)	Liquor	43	Tenant
267 m²	-01 Level (Option D)	Bank	44	Tenant
267 m²	-01 Level (Option D)	Bank	45	Tenant
3044 m²				
3044 m²	TOTAL GLA LEVEL -01			
924 m²	00 Ground Floor (Option D)	Area	27	Future Extension
924 m²				
2504 m²	00 Ground Floor (Option D)	Edgars	1	Tenant
3201 m²	00 Ground Floor (Option D)	Spar and Pharmacy	2	Tenant
100 m²	00 Ground Floor (Option D)	Dodo's	4	Tenant
704 m²	00 Ground Floor (Option D)	Mr Price	5	Tenant
284 m²	00 Ground Floor (Option D)	Exact	7	Tenant
323 m²	00 Ground Floor (Option D)	Cape Union Mart	8	Tenant
280 m²	00 Ground Floor (Option D)	Pep Home	15	Tenant
406 m²	00 Ground Floor (Option D)	Shops	17	Tenant
450 m²	00 Ground Floor (Option D)	Identity	9	Tenant
3201 m²	00 Ground Floor (Option D)	Shoprite	10	Tenant
1606 m²	00 Ground Floor (Option D)	Truworths	24	Tenant
3001 m²	00 Ground Floor (Option D)	Game	28	Tenant
250 m²	00 Ground Floor (Option D)	Tops	46	Tenant
150 m²	00 Ground Floor (Option D)	Shopr Liquor	47	Tenant
450 m²	00 Ground Floor (Option D)	Pep	48	Tenant
40 m²	00 Ground Floor (Option D)	Pep cell	49	Tenant
290 m²	00 Ground Floor (Option D)	Dunns	50	Tenant
515 m²	00 Ground Floor (Option D)	Ackermans	51	Tenant
50 m²	00 Ground Floor (Option D)	Am Swiss	52	Tenant
734 m²	00 Ground Floor (Option D)	Clicks	53	Tenant
180 m²	00 Ground Floor (Option D)	John Craig	54	Tenant
224 m²	00 Ground Floor (Option D)	Shoe City	55	Tenant
170 m²	00 Ground Floor (Option D)	Sheet Street	56	Tenant
45 m²	00 Ground Floor (Option D)	Shop	57	Tenant
72 m²	00 Ground Floor (Option D)	Drimac	58	Tenant
402 m²	00 Ground Floor (Option D)	Foschini	59	Tenant
65 m²	00 Ground Floor (Option D)	Area	60	Tenant
180 m²	00 Ground Floor (Option D)	Hungry lion	61	Tenant
220 m²	00 Ground Floor (Option D)	Totalsports	62	Tenant
180 m²	00 Ground Floor (Option D)	Sport Scene	63	Tenant
139 m²	00 Ground Floor (Option D)	Shop	64	Tenant
115 m²	00 Ground Floor (Option D)	Shop	65	Tenant
101 m²	00 Ground Floor (Option D)	Shop	66	Tenant
32 m²	00 Ground Floor (Option D)	Shop	67	Tenant
30 m²	00 Ground Floor (Option D)	Shop	68	Tenant
403 m²	00 Ground Floor (Option D)	CB STORES	69	Tenant
273 m²	00 Ground Floor (Option D)	Shop	70	Tenant
52 m²	00 Ground Floor (Option D)	Shop	71	Tenant
406 m²	00 Ground Floor (Option D)	Shop	72	Tenant
138 m²	00 Ground Floor (Option D)	Food	73	Tenant
127 m²	00 Ground Floor (Option D)	Food	74	Tenant
77 m²	00 Ground Floor (Option D)	Food	75	Tenant
44 m²	00 Ground Floor (Option D)	Food	76	Tenant
22215 m²				
23139 m²	TOTAL GLA GROUND FLOOR LEVEL			
26183 m²	TOTAL GLA BOTH LEVELS			

PARAGON GROUP
PARAGON ARCHITECTS
PARAGON INTERFACE
HUB ARCHITECTS
PARAGON ARQUITETURA

PARAGON ARCHITECTS

9th Floor, 15 Alice Lane, Sandown, Sandton, Tel 011 482 3781, Fax 011 482 3784, info@paragon.co.za

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REV	DATE	DRAWN	DESCRIPTION
A	131010	MB	FOR INFORMATION
B	131011	MB	Issue for information
C	131022	MB	Issue for information

Mall@Piet Retief

FOR

Anaprop Property Management

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

Design Option D

SCALE: As indicated

PROJECT	STAGE / SERIES / SIZE	REVISION
PAX_138	D001-07-A0	C

INFO	COUNCIL	TENDER	CONSTRUCTION

DATE: 2013.09.12 DRAWN BY: MB

ACTS OF PARLIAMENT
All Contractors shall ensure that, before any work is put in hand, they comply with all the necessary Acts of Parliament of the Republic of South Africa.

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2013/10/22 03:47:12 PM

APPENDICES

Appendix C: Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall

SUNBIRD PARK
Cnr. Delfi & Sunbird Ave
Garsfontein Ext 15
TEL:012 - 998 3541
FAX:012 - 9935506
TECHWORLD
E-MAIL: admin@techworld.co.za

MALL@PIET RETIEF

Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall

APPENDIX C

APPENDICES

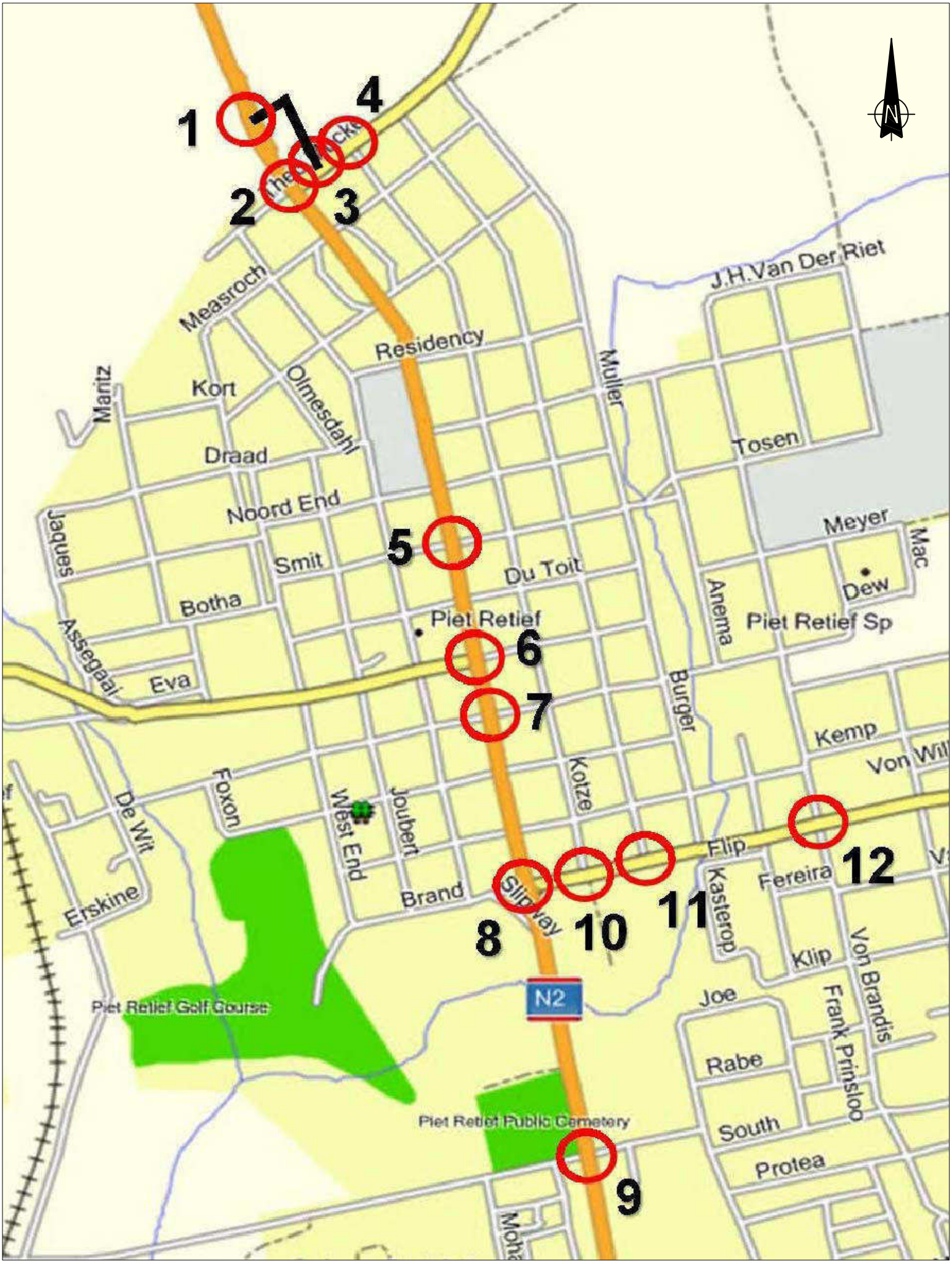
Appendix D: Proposed Road Improvements at the Church (N2) / Gerard Bohmer Intersection to Support the Piet Retief Mall

SUNBIRD PARK
Cnr, Delft & Sunbird Ave
Garsfontein Ext 15
TEL:012 - 998 3541
FAX:012 - 9935506
TECHWORLD
E-MAIL: admin@techworld.co.za

MALL@PIET RETIEF	Proposed Road Improvements at the Church (N2) / Gerard Bohmer Intersection to Support the Piet Retief Mall	APPENDIX D

APPENDICES

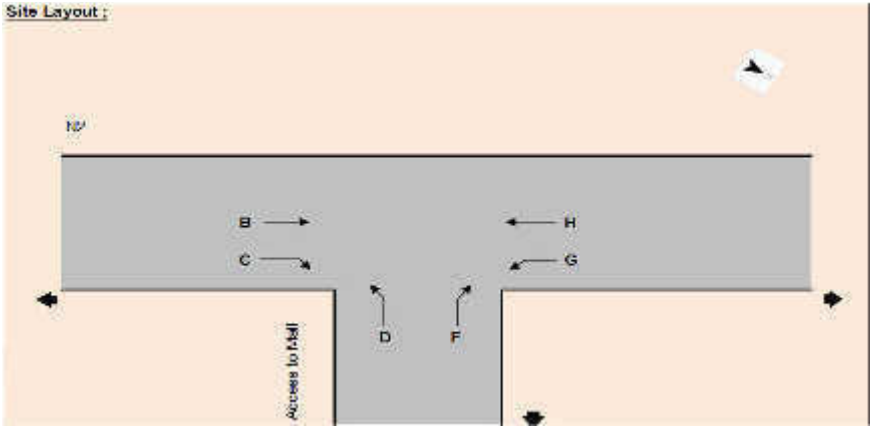
Appendix E: Traffic Counts



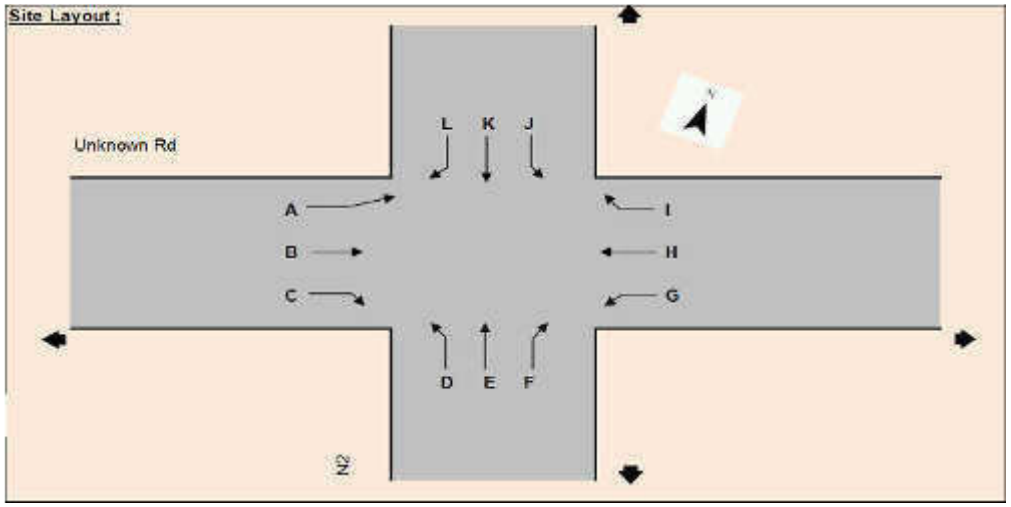
Trafsol

PROJECT:	FIGURE:	Nr.
PIET RETIEF TRAFFIC SURVEY	TRAFFIC SURVEY LOCATIONS	FIGURE 01

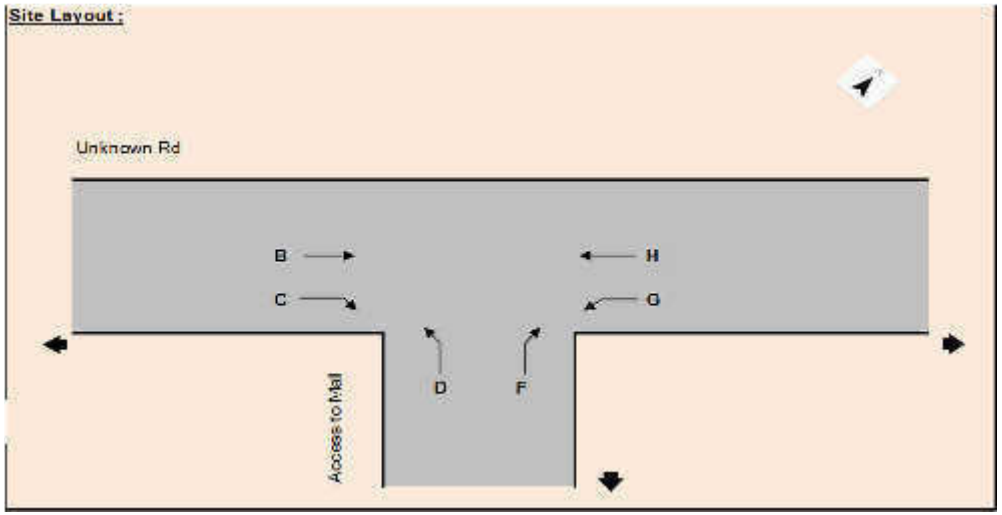
Site Layout :



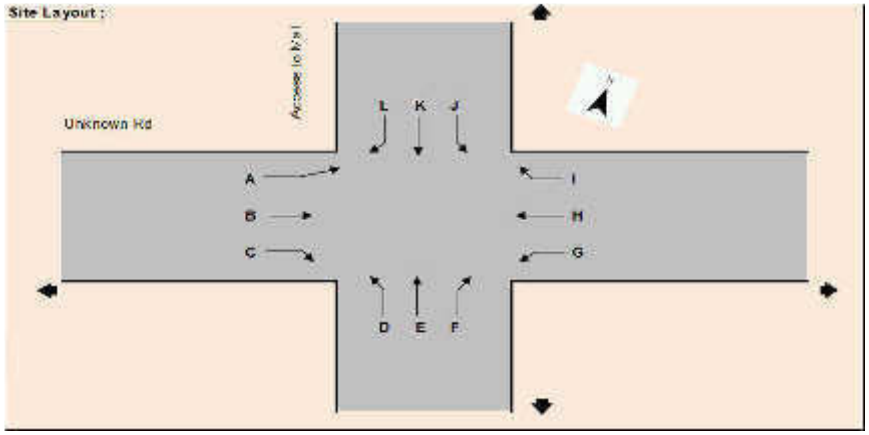
Time Period		TOTAL VEHICLES						
Start	End	H	G	F	D	C	B	Total
12:00	12:15	71	16	28	25	38	29	**207**
12:15	12:30	101	5	10	8	16	56	**196**
12:30	12:45	78	12	21	17	16	53	**197**
12:45	13:00	66	17	24	21	25	59	**212**
13:00	13:15	172	13	23	14	28	132	**382**
13:15	13:30	97	5	9	7	8	113	**239**
13:30	*13:45*	*90*	*10*	*11*	*8*	*16*	*90*	***225***
13:45	*14:00*	*97*	*8*	*24*	*15*	*32*	*80*	***256***
14:00	*14:15*	*126*	*17*	*28*	*16*	*31*	*92*	***310***
14:15	*14:30*	*95*	*28*	*17*	*20*	*36*	*61*	***257***
14:30	14:45	92	22	28	22	27	85	**276**
14:45	15:00	84	12	28	19	38	78	**259**
15:00	15:15	105	20	29	17	27	70	**268**
15:15	15:30	108	8	19	17	21	85	**258**
15:30	15:45	73	10	30	20	35	52	**220**
15:45	16:00	60	17	24	16	21	39	**177**
16:00	16:15	82	20	31	17	24	55	**229**
16:15	16:30	129	16	20	16	33	69	**283**
16:30	16:45	80	23	38	19	24	71	**255**
16:45	17:00	92	13	27	17	36	64	**249**
17:00	17:15	98	14	30	16	34	79	**271**
17:15	17:30	94	16	28	17	31	51	**237**
17:30	17:45	47	18	31	19	37	68	**220**
17:45	18:00	76	23	29	9	24	31	**192**
TOTAL		**2213**	**363**	**587**	**392**	**658**	**1662**	**5875**



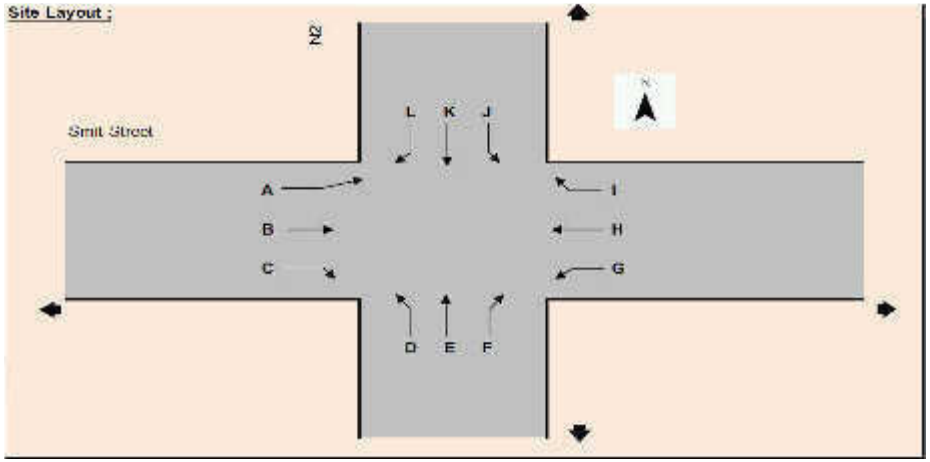
Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	17	70	0	3	21	26	23	43	1	0	14	0	**218**
12:15	12:30	13	80	0	5	11	23	27	50	0	0	16	0	**225**
12:30	12:45	17	66	0	5	21	24	26	38	1	2	10	1	**211**
12:45	13:00	9	64	0	3	15	20	25	54	0	1	16	0	**207**
13:00	13:15	26	140	0	6	20	38	48	99	0	1	13	6	**397**
13:15	13:30	17	74	0	7	12	31	35	79	0	0	8	3	**266**
13:30	*13:45*	*15*	*70*	*0*	*4*	*12*	*30*	*32*	*72*	*0*	*0*	*6*	*2*	***243***
13:45	*14:00*	*20*	*79*	*0*	*4*	*9*	*22*	*30*	*76*	*0*	*0*	*13*	*1*	***254***
14:00	*14:15*	*25*	*103*	*0*	*8*	*10*	*24*	*23*	*78*	*1*	*0*	*18*	*1*	***291***
14:15	*14:30*	*24*	*76*	*1*	*9*	*9*	*19*	*34*	*61*	*0*	*1*	*14*	*1*	***249***
14:30	14:45	18	80	0	6	16	25	20	59	1	0	12	2	**239**
14:45	15:00	22	72	0	6	6	23	33	74	0	0	13	4	**253**
15:00	15:15	22	87	0	6	10	22	23	63	0	0	7	0	**240**
15:15	15:30	21	92	0	2	8	30	35	72	0	1	18	1	**280**
15:30	15:45	14	62	0	6	6	23	34	53	0	0	9	2	**209**
15:45	16:00	8	51	0	4	7	26	27	49	0	0	7	0	**179**
16:00	16:15	17	71	0	3	9	30	32	59	0	0	11	1	**233**
16:15	16:30	28	102	0	4	13	40	34	69	1	0	9	2	**302**
16:30	16:45	16	66	0	7	4	23	33	54	1	1	17	1	**223**
16:45	17:00	21	72	0	6	16	23	31	57	2	0	8	0	**236**
17:00	17:15	13	80	0	7	11	29	36	70	0	0	14	1	**261**
17:15	17:30	21	71	0	9	7	27	39	48	0	4	12	2	**240**
17:30	17:45	5	52	0	7	13	27	31	67	0	0	12	1	**215**
17:45	18:00	12	56	0	7	6	34	17	38	1	1	9	0	**181**
TOTAL		**421**	**1836**	**1**	**134**	**272**	**639**	**728**	**1482**	**9**	**12**	**286**	**32**	**5852**



Time Period		TOTAL VEHICLES						
Start	End	H	G	F	D	C	B	Total
12:00	12:15	36	10	15	12	0	35	**108**
12:15	12:30	33	26	8	13	11	31	**122**
12:30	12:45	21	27	19	25	6	31	**129**
12:45	13:00	25	30	19	26	12	19	**131**
13:00	13:15	27	34	17	18	14	47	**157**
13:15	13:30	34	22	23	13	12	27	**131**
13:30	*13:45*	*30*	*16*	*16*	*15*	*14*	*30*	***121***
13:45	*14:00*	*37*	*13*	*9*	*13*	*12*	*26*	***110***
14:00	*14:15*	*34*	*20*	*18*	*17*	*20*	*24*	***133***
14:15	*14:30*	*29*	*12*	*18*	*19*	*17*	*19*	***114***
14:30	14:45	27	11	21	20	12	26	**117**
14:45	15:00	17	38	14	17	15	21	**122**
15:00	15:15	30	13	18	15	14	20	**110**
15:15	15:30	34	31	13	26	16	27	**147**
15:30	15:45	23	37	14	11	10	21	**116**
15:45	16:00	27	24	18	14	12	19	**114**
16:00	16:15	18	36	17	28	14	25	**138**
16:15	16:30	28	30	25	16	14	32	**145**
16:30	16:45	29	38	18	26	13	16	**140**
16:45	17:00	30	25	23	28	14	22	**142**
17:00	17:15	34	37	22	29	10	25	**157**
17:15	17:30	30	40	23	21	17	20	**151**
17:30	17:45	22	30	27	20	20	20	**139**
17:45	18:00	21	22	22	18	16	25	**124**
TOTAL		**676**	**622**	**437**	**460**	**315**	**608**	**3118**

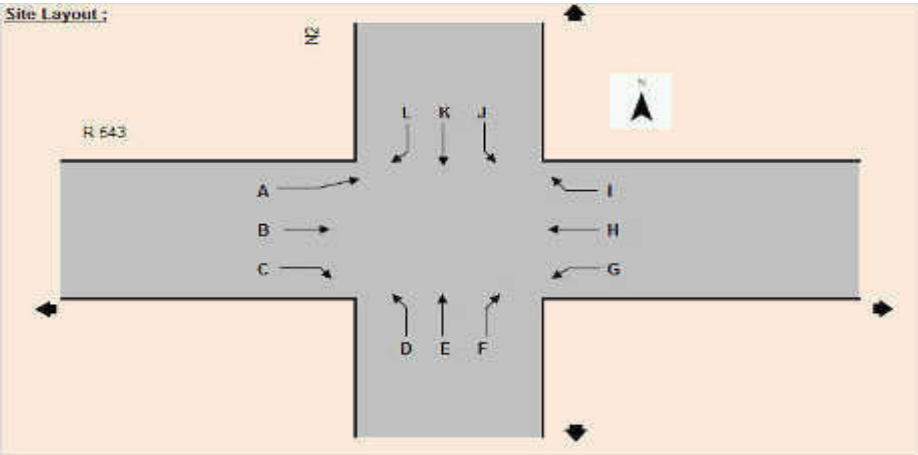


Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	9	16	18	9	20	12	5	13	6	7	37	4	**156**
12:15	12:30	18	14	27	22	20	13	3	21	4	13	28	5	**188**
12:30	12:45	29	25	30	22	4	16	1	18	4	5	40	1	**195**
12:45	13:00	16	20	32	18	7	15	6	21	8	11	39	1	**194**
13:00	13:15	18	21	20	18	33	21	4	13	10	18	43	4	**223**
13:15	13:30	16	16	22	31	17	19	1	18	6	12	26	9	**193**
13:30	*13:45*	*14*	*18*	*28*	*32*	*23*	*17*	*1*	*13*	*7*	*12*	*24*	*4*	***193***
13:45	*14:00*	*10*	*18*	*30*	*40*	*23*	*19*	*2*	*11*	*5*	*13*	*39*	*4*	***214***
14:00	*14:15*	*16*	*23*	*32*	*34*	*14*	*20*	*1*	*18*	*14*	*17*	*20*	*4*	***213***
14:15	*14:30*	*16*	*23*	*35*	*33*	*14*	*14*	*0*	*17*	*6*	*22*	*30*	*8*	***218***
14:30	14:45	15	16	20	41	10	24	0	16	13	25	27	5	**212**
14:45	15:00	12	17	32	27	12	16	1	13	12	14	15	5	**176**
15:00	15:15	12	15	23	21	10	21	2	18	12	13	23	9	**179**
15:15	15:30	22	18	14	15	10	29	5	20	11	18	33	9	**204**
15:30	15:45	11	20	36	36	10	19	5	24	10	19	10	5	**205**
15:45	16:00	12	16	21	40	10	29	2	20	9	17	17	7	**200**
16:00	16:15	18	23	57	47	12	25	2	21	9	13	27	6	**260**
16:15	16:30	27	21	26	41	13	24	4	24	6	12	19	13	**230**
16:30	16:45	15	22	50	60	7	24	4	21	7	20	31	4	**265**
16:45	17:00	21	24	33	35	7	22	2	26	8	25	26	7	**236**
17:00	17:15	21	28	40	30	10	23	5	27	4	25	32	6	**251**
17:15	17:30	20	23	23	30	9	29	3	22	8	18	28	5	**218**
17:30	17:45	22	20	22	25	7	30	7	22	11	30	4	8	**208**
17:45	18:00	25	25	18	32	9	23	6	17	7	6	27	6	**201**
TOTAL		**415**	**482**	**689**	**739**	**311**	**504**	**72**	**454**	**197**	**385**	**645**	**139**	**5032**

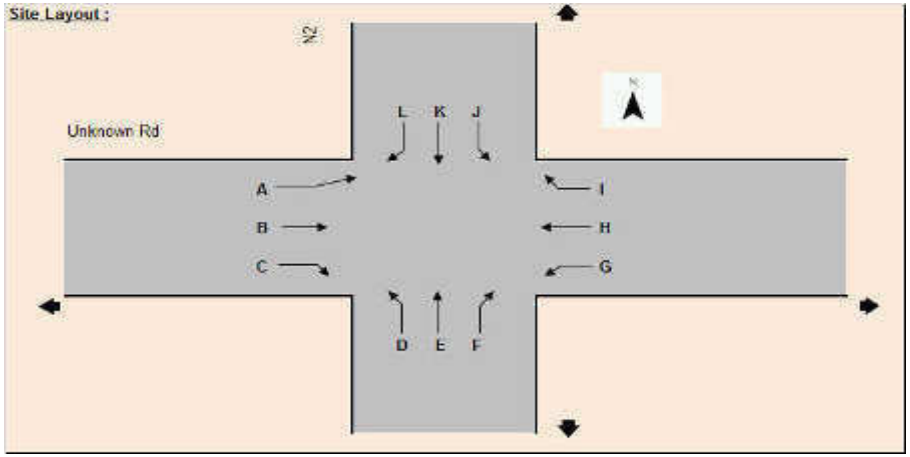


Time Period		Total vehicles												
Start	**End**	**L**	**K**	**J**	**I**	**H**	**G**	**F**	**E**	**D**	**C**	**B**	**A**	**Total**
12:00	12:15	10	80	8	6	17	9	9	58	3	9	19	4	**232**
12:15	12:30	11	93	5	9	23	8	10	67	4	8	15	4	**257**
12:30	12:45	13	85	5	7	23	9	6	70	7	7	24	3	**259**
12:45	13:00	10	81	8	5	18	11	4	62	6	8	33	3	**249**
13:00	13:15	11	94	13	10	28	9	13	59	4	10	22	8	**281**
13:15	13:30	5	90	5	10	27	9	8	66	15	6	18	4	**263**
13:30	*13:45*	*13*	*133*	*19*	*14*	*33*	*9*	*12*	*67*	*4*	*8*	*23*	*3*	***338***
13:45	*14:00*	*12*	*80*	*5*	*14*	*16*	*10*	*15*	*67*	*6*	*10*	*20*	*6*	***261***
14:00	*14:15*	*12*	*115*	*8*	*7*	*15*	*7*	*4*	*80*	*10*	*10*	*21*	*4*	***293***
14:15	*14:30*	*6*	*99*	*6*	*12*	*19*	*11*	*13*	*80*	*10*	*6*	*18*	*3*	***283***
14:30	14:45	6	97	5	12	22	11	10	85	13	11	23	6	**301**
14:45	15:00	9	84	19	11	23	13	8	100	4	7	17	3	**298**
15:00	15:15	13	102	19	13	22	14	12	91	6	7	23	4	**326**
15:15	15:30	12	83	16	14	19	9	16	100	9	9	29	6	**322**
15:30	15:45	13	80	17	11	23	11	8	92	12	9	21	5	**302**
15:45	16:00	10	111	14	10	24	18	15	92	10	6	16	6	**332**
16:00	16:15	9	94	10	8	20	19	13	95	8	9	15	7	**307**
16:15	16:30	9	100	8	13	18	13	11	92	6	9	19	3	**301**
16:30	16:45	11	104	6	17	17	17	11	99	6	10	20	6	**324**
16:45	17:00	13	95	10	14	21	10	11	86	9	6	24	8	**307**
17:00	17:15	12	93	11	14	23	9	10	87	8	5	18	9	**299**
17:15	17:30	12	77	5	8	24	19	10	78	5	9	29	6	**282**
17:30	17:45	6	85	5	13	20	19	12	83	8	7	25	5	**288**
17:45	18:00	12	83	8	14	20	16	11	102	10	5	19	3	**303**
TOTAL		**250**	**2238**	**235**	**266**	**515**	**290**	**252**	**1958**	**183**	**191**	**511**	**119**	**7008**

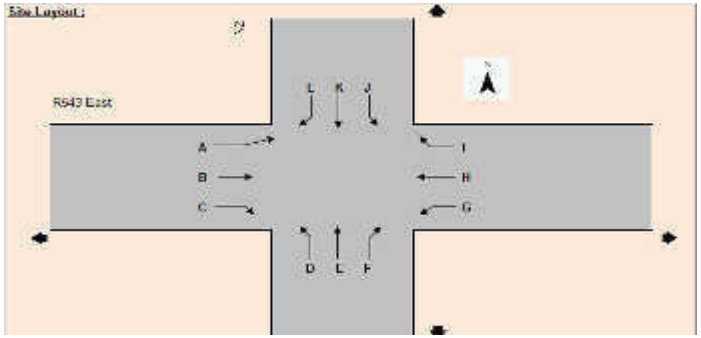
Site Layout ;



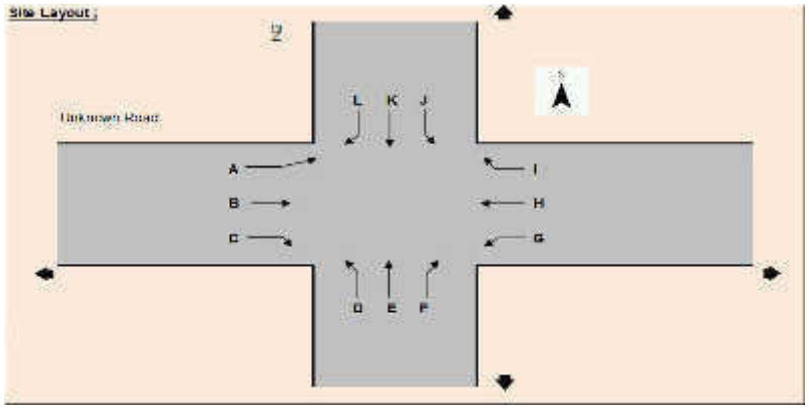
Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	1	119	5	1	13	1	3	103	8	6	14	1	**275**
12:15	12:30	3	115	2	4	6	1	2	98	5	7	27	2	**272**
12:30	12:45	4	126	2	2	12	1	1	96	18	5	22	2	**291**
12:45	13:00	2	112	5	3	24	3	2	107	10	5	24	6	**303**
13:00	13:15	1	112	7	4	14	0	3	93	12	13	22	2	**283**
13:15	13:30	3	120	3	2	11	4	0	110	8	10	19	0	**290**
13:30	*13:45*	*1*	*115*	*11*	*5*	*16*	*4*	*5*	*131*	*10*	*10*	*30*	*2*	***340***
13:45	*14:00*	*2*	*141*	*3*	*7*	*30*	*2*	*2*	*92*	*14*	*12*	*18*	*2*	***325***
14:00	*14:15*	*4*	*97*	*7*	*2*	*19*	*5*	*1*	*130*	*19*	*17*	*20*	*3*	***324***
14:15	*14:30*	*1*	*94*	*6*	*6*	*13*	*3*	*3*	*146*	*8*	*23*	*18*	*1*	***322***
14:30	14:45	1	118	8	5	18	1	2	121	18	12	26	2	**332**
14:45	15:00	2	117	6	2	16	0	6	134	11	8	16	1	**319**
15:00	15:15	4	129	5	3	18	0	2	110	7	12	22	3	**315**
15:15	15:30	2	118	5	2	12	2	1	126	8	11	37	2	**326**
15:30	15:45	2	133	5	8	9	4	1	116	13	16	29	3	**339**
15:45	16:00	2	117	2	3	15	2	3	130	7	13	25	4	**323**
16:00	16:15	3	134	6	2	13	3	1	133	6	14	21	2	**338**
16:15	16:30	3	149	7	1	14	3	1	117	9	17	21	1	**343**
16:30	16:45	3	150	10	5	20	0	3	121	8	10	23	4	**357**
16:45	17:00	3	131	8	4	16	2	1	125	6	15	23	2	**336**
17:00	17:15	1	112	7	7	15	2	1	111	10	20	35	4	**325**
17:15	17:30	2	117	5	3	13	4	2	123	7	11	39	1	**327**
17:30	17:45	2	108	3	1	18	0	1	133	3	14	20	1	**304**
17:45	18:00	1	127	2	2	9	4	1	127	5	13	27	0	**318**
TOTAL		**53**	**2911**	**130**	**84**	**364**	**51**	**48**	**2833**	**230**	**294**	**578**	**51**	**7627**



Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	14	109	12	33	25	20	4	68	23	4	18	12	**342**
12:15	12:30	13	107	13	32	29	18	6	61	23	5	18	12	**337**
12:30	12:45	15	111	16	35	28	20	6	67	22	5	18	13	**356**
12:45	13:00	21	93	10	29	26	28	8	78	26	7	34	12	**372**
13:00	13:15	20	99	11	27	35	23	5	70	29	10	41	11	**381**
13:15	13:30	20	101	15	23	33	24	16	80	33	6	45	15	**411**
13:30	*13:45*	*19*	*99*	*15*	*35*	*37*	*15*	*9*	*84*	*25*	*8*	*20*	*27*	***393***
13:45	*14:00*	*25*	*118*	*16*	*34*	*69*	*20*	*21*	*45*	*29*	*6*	*39*	*29*	***451***
14:00	*14:15*	*24*	*86*	*16*	*30*	*19*	*28*	*13*	*102*	*24*	*10*	*25*	*18*	***395***
14:15	*14:30*	*23*	*90*	*16*	*33*	*14*	*26*	*11*	*102*	*23*	*10*	*25*	*22*	***395***
14:30	14:45	21	102	16	36	25	29	16	84	38	12	33	22	**434**
14:45	15:00	19	93	14	31	27	15	3	97	35	10	38	22	**404**
15:00	15:15	27	101	19	44	18	21	9	67	36	9	27	8	**386**
15:15	15:30	11	113	19	34	25	34	10	90	22	10	17	11	**396**
15:30	15:45	24	116	13	32	23	20	15	82	28	13	38	18	**422**
15:45	16:00	14	114	11	45	28	23	14	80	30	9	17	15	**400**
16:00	16:15	26	117	9	38	21	15	17	82	27	14	20	20	**406**
16:15	16:30	20	121	28	26	24	23	12	81	16	6	38	20	**415**
16:30	16:45	17	122	23	36	34	25	7	75	22	14	22	21	**418**
16:45	17:00	16	116	19	40	21	22	5	71	20	10	24	21	**385**
17:00	17:15	8	112	9	35	27	20	9	72	32	12	29	16	**381**
17:15	17:30	11	107	17	41	23	18	7	78	12	14	18	14	**360**
17:30	17:45	10	99	13	29	21	11	10	93	16	13	15	16	**346**
17:45	18:00	12	126	13	38	14	12	6	84	20	5	17	11	**358**
TOTAL		**430**	**2572**	**363**	**816**	**646**	**510**	**239**	**1893**	**611**	**222**	**636**	**406**	**9344**

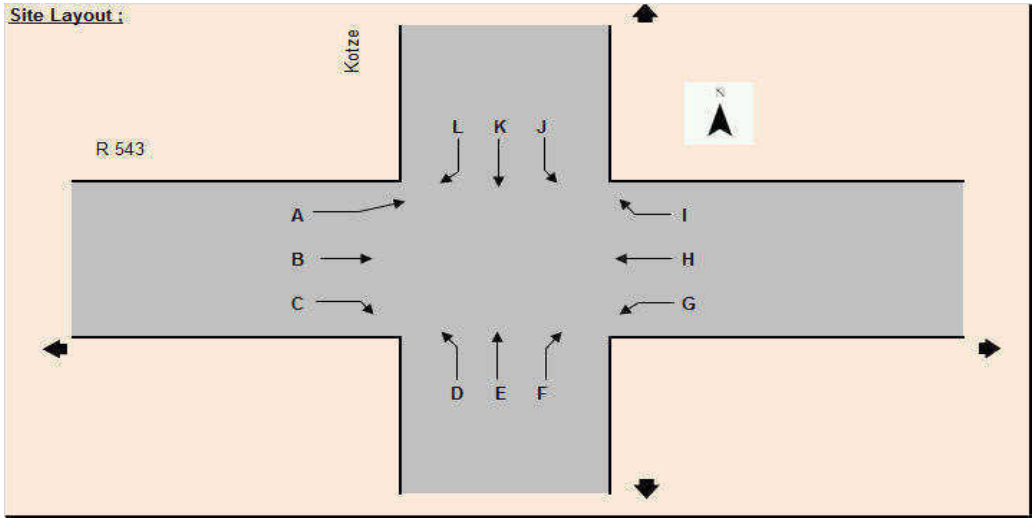


Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	17	116	10	4	6	21	5	107	49	0	0	0	**335**
12:15	12:30	19	129	18	3	2	19	10	112	36	0	0	0	**348**
12:30	12:45	17	128	14	1	4	18	10	114	41	0	0	0	**347**
12:45	13:00	16	131	16	3	2	19	5	107	55	0	0	0	**354**
13:00	13:15	18	135	13	5	5	16	12	110	40	0	0	0	**354**
13:15	13:30	22	132	18	4	4	15	11	130	54	0	0	0	**390**
13:30	*13:45*	*21*	*150*	*19*	*5*	*3*	*20*	*8*	*129*	*37*	*0*	*0*	*0*	***392***
13:45	*14:00*	*22*	*144*	*14*	*3*	*10*	*27*	*8*	*112*	*30*	*0*	*0*	*0*	***370***
14:00	*14:15*	*19*	*137*	*15*	*3*	*6*	*20*	*7*	*130*	*26*	*0*	*0*	*0*	***363***
14:15	*14:30*	*18*	*139*	*7*	*2*	*9*	*24*	*8*	*132*	*27*	*0*	*0*	*0*	***366***
14:30	14:45	16	128	10	2	4	19	6	127	48	0	0	0	**360**
14:45	15:00	28	135	12	2	6	21	4	128	44	0	0	0	**380**
15:00	15:15	23	150	9	3	6	23	6	119	44	0	0	0	**383**
15:15	15:30	21	160	9	4	6	19	4	119	49	0	0	0	**391**
15:30	15:45	23	147	10	5	3	19	2	134	47	0	0	0	**390**
15:45	16:00	23	147	8	6	3	21	5	126	51	0	0	0	**390**
16:00	16:15	24	159	6	4	2	15	5	126	47	0	0	0	**388**
16:15	16:30	28	161	7	3	3	17	1	113	35	0	0	0	**368**
16:30	16:45	25	157	14	1	7	19	3	98	50	0	0	0	**374**
16:45	17:00	21	131	7	5	4	18	3	114	48	0	0	0	**351**
17:00	17:15	18	146	12	5	5	20	7	102	56	0	0	0	**371**
17:15	17:30	19	151	13	6	3	15	5	101	51	0	0	0	**364**
17:30	17:45	20	159	16	3	6	15	11	104	48	0	0	0	**382**
17:45	18:00	17	148	12	5	3	17	5	118	45	0	0	0	**370**
TOTAL		**495**	**3420**	**289**	**87**	**112**	**457**	**151**	**2812**	**1058**	**0**	**0**	**0**	**8881**



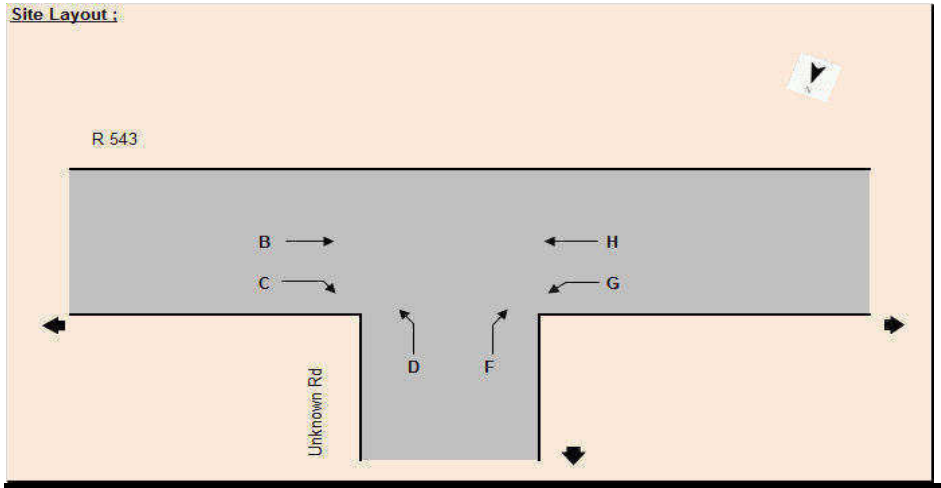
Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	58	41	15	22	6	1	0	59	6	1	8	2	**219**
12:15	12:30	68	42	14	22	7	5	1	78	5	3	7	7	**259**
12:30	12:45	72	34	16	27	5	3	2	85	2	1	8	10	**265**
12:45	13:00	75	38	18	24	8	2	5	93	14	3	4	12	**296**
13:00	13:15	80	44	22	24	6	4	6	93	5	1	2	16	**303**
13:15	13:30	73	41	20	22	4	5	3	102	6	2	3	13	**294**
13:30	*13:45*	*76*	*52*	*18*	*33*	*6*	*2*	*2*	*103*	*9*	*3*	*10*	*14*	***328***
13:45	*14:00*	*76*	*50*	*21*	*30*	*8*	*3*	*5*	*100*	*5*	*3*	*2*	*18*	***321***
14:00	*14:15*	*61*	*42*	*23*	*34*	*6*	*3*	*4*	*101*	*4*	*3*	*10*	*14*	***305***
14:15	*14:30*	*95*	*70*	*23*	*32*	*6*	*3*	*5*	*96*	*17*	*6*	*7*	*12*	***372***
14:30	14:45	84	68	29	21	17	6	3	73	7	4	13	16	**341**
14:45	15:00	101	82	22	19	8	2	2	94	2	3	11	10	**356**
15:00	15:15	101	84	22	27	10	5	2	59	2	1	8	15	**336**
15:15	15:30	90	62	23	13	8	2	4	70	2	4	9	9	**296**
15:30	15:45	90	64	39	13	11	1	2	59	5	2	9	14	**309**
15:45	16:00	92	66	16	24	9	4	1	55	4	0	8	14	**293**
16:00	16:15	112	93	17	20	4	0	3	42	4	1	14	5	**315**
16:15	16:30	111	79	32	13	9	2	0	54	7	4	10	12	**333**
16:30	16:45	57	38	19	6	7	0	3	19	1	0	6	7	**163**
16:45	17:00	64	40	32	13	6	1	2	18	9	2	10	9	**206**
17:00	17:15	62	42	30	16	2	1	1	33	8	4	10	4	**213**
17:15	17:30	58	39	30	16	5	0	0	33	5	1	6	11	**204**
17:30	17:45	54	32	27	8	6	0	0	45	5	4	5	5	**191**
17:45	18:00	34	34	20	10	3	0	0	40	1	2	6	6	**156**
TOTAL		**1844**	**1277**	**548**	**489**	**167**	**55**	**56**	**1604**	**135**	**58**	**186**	**255**	**6674**

Site Layout :

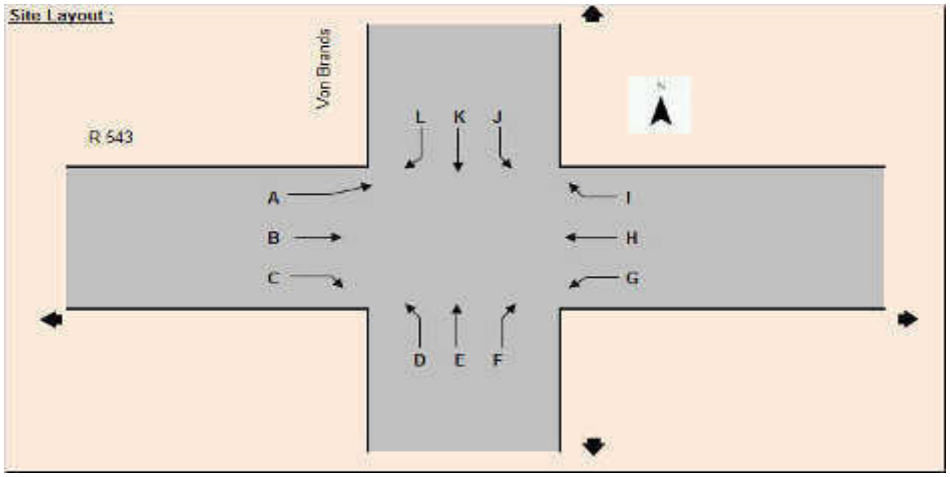


Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	9	0	2	5	13	0	0	0	0	0	6	7	**42**
12:15	12:30	10	0	3	7	14	0	0	0	0	0	14	14	**62**
12:30	12:45	12	0	5	8	2	0	0	0	0	0	10	11	**48**
12:45	13:00	13	0	4	4	7	0	0	0	0	0	9	12	**49**
13:00	13:15	13	0	2	5	4	0	0	0	0	0	10	9	**43**
13:15	13:30	14	0	6	9	3	0	0	0	0	0	12	11	**55**
13:30	*13:45*	*19*	*0*	*6*	*8*	*7*	*0*	*0*	*0*	*0*	*0*	*7*	*14*	***61***
13:45	*14:00*	*15*	*0*	*7*	*7*	*17*	*0*	*0*	*0*	*0*	*0*	*7*	*13*	***66***
14:00	*14:15*	*23*	*0*	*3*	*7*	*2*	*0*	*0*	*0*	*0*	*0*	*10*	*16*	***61***
14:15	*14:30*	*13*	*0*	*8*	*5*	*20*	*0*	*0*	*0*	*0*	*0*	*14*	*15*	***75***
14:30	14:45	14	0	7	4	8	0	0	0	0	0	6	12	**51**
14:45	15:00	9	0	5	7	15	0	0	0	0	0	7	13	**56**
15:00	15:15	16	0	7	8	16	0	0	0	0	0	5	14	**66**
15:15	15:30	17	0	6	10	7	0	0	0	0	0	4	9	**53**
15:30	15:45	16	0	6	6	6	0	0	0	0	0	3	15	**52**
15:45	16:00	17	0	3	9	6	0	0	0	0	0	4	12	**51**
16:00	16:15	15	0	5	5	3	0	0	0	0	0	3	9	**40**
16:15	16:30	18	0	5	9	2	0	0	0	0	0	2	11	**47**
16:30	16:45	17	0	5	8	3	0	0	0	0	0	5	3	**41**
16:45	17:00	16	0	4	6	4	0	0	0	0	0	4	13	**47**
17:00	17:15	20	0	6	6	3	0	0	0	0	0	5	9	**49**
17:15	17:30	16	0	5	9	3	0	0	0	0	0	6	12	**51**
17:30	17:45	13	0	4	8	6	0	0	0	0	0	11	11	**53**
17:45	18:00	15	0	7	6	4	0	0	0	0	0	7	13	**52**
TOTAL		**360**	**0**	**121**	**166**	**175**	**0**	**0**	**0**	**0**	**0**	**171**	**278**	**1271**

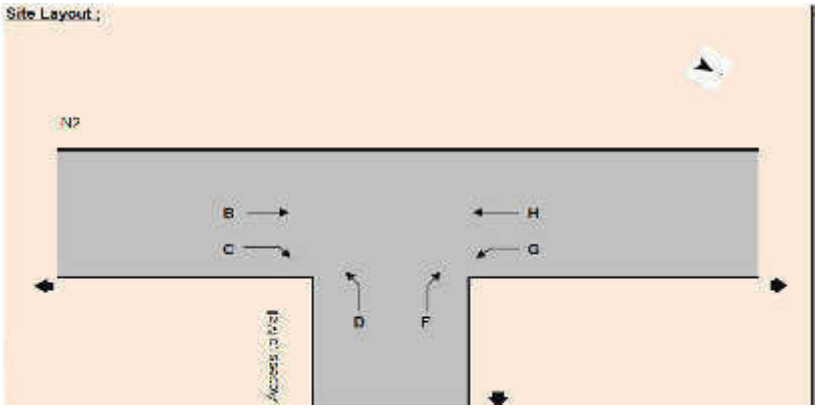
Site Layout :



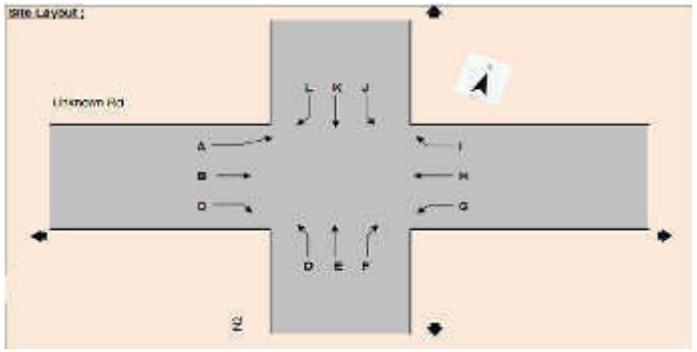
		TOTAL VEHICLES						
Start	**End**	**H**	**G**	**F**	**D**	**C**	**B**	**Total**
12:00	12:15	10	2	2	23	6	16	**59**
12:15	12:30	15	2	3	22	6	18	**66**
12:30	12:45	10	4	6	24	10	6	**60**
12:45	13:00	17	3	2	27	9	10	**68**
13:00	13:15	11	5	3	27	5	5	**56**
13:15	13:30	12	2	5	22	4	12	**57**
13:30	*13:45*	*17*	*2*	*6*	*19*	*5*	*11*	***60***
13:45	*14:00*	*16*	*2*	*2*	*23*	*5*	*23*	***71***
14:00	*14:15*	*15*	*3*	*3*	*22*	*8*	*5*	***56***
14:15	*14:30*	*15*	*2*	*6*	*26*	*7*	*19*	***75***
14:30	14:45	17	4	5	22	8	6	**62**
14:45	15:00	17	1	4	23	2	17	**64**
15:00	15:15	15	2	4	23	7	20	**71**
15:15	15:30	15	5	3	23	7	15	**68**
15:30	15:45	13	2	6	26	6	5	**58**
15:45	16:00	14	2	5	23	10	11	**65**
16:00	16:15	13	2	2	24	9	6	**56**
16:15	16:30	13	2	3	25	4	9	**56**
16:30	16:45	15	1	2	23	2	10	**53**
16:45	17:00	14	2	6	25	4	5	**56**
17:00	17:15	15	3	7	25	6	1	**57**
17:15	17:30	16	4	5	26	10	8	**69**
17:30	17:45	16	2	2	31	2	12	**65**
17:45	18:00	17	2	5	29	2	6	**61**
TOTAL		**348**	**61**	**97**	**583**	**144**	**256**	**1489**



Time Period		Total vehicles												
Start	End	L	K	J	I	H	G	F	E	D	C	B	A	Total
12:00	12:15	3	1	1	12	11	16	1	0	10	19	15	6	**95**
12:15	12:30	2	3	4	17	11	21	4	1	10	22	11	5	**111**
12:30	12:45	11	5	9	25	10	15	5	1	8	24	15	8	**136**
12:45	13:00	6	1	6	14	14	13	8	4	12	16	15	19	**128**
13:00	13:15	5	4	11	11	12	15	3	3	7	19	14	9	**113**
13:15	13:30	8	6	14	21	16	13	6	5	10	24	12	17	**152**
13:30	*13:45*	*9*	*12*	*16*	*26*	*10*	*16*	*6*	*2*	*7*	*17*	*11*	*15*	***147***
13:45	*14:00*	*9*	*11*	*18*	*21*	*9*	*13*	*5*	*3*	*10*	*18*	*13*	*15*	***145***
14:00	*14:15*	*12*	*10*	*12*	*27*	*9*	*12*	*7*	*4*	*8*	*16*	*20*	*16*	***153***
14:15	*14:30*	*1*	*11*	*4*	*16*	*16*	*16*	*9*	*5*	*6*	*15*	*19*	*12*	***130***
14:30	14:45	5	10	11	25	12	20	3	5	7	25	25	11	**159**
14:45	15:00	8	11	15	17	15	12	10	4	11	19	30	10	**162**
15:00	15:15	9	14	10	15	11	23	9	2	8	27	18	14	**160**
15:15	15:30	10	15	9	23	10	14	6	7	11	25	16	15	**161**
15:30	15:45	13	12	15	23	10	12	5	6	9	21	19	19	**164**
15:45	16:00	9	15	16	13	11	9	7	4	8	20	15	19	**146**
16:00	16:15	5	14	11	24	14	19	5	3	14	28	24	21	**182**
16:15	16:30	15	13	8	16	15	27	10	4	16	17	22	20	**183**
16:30	16:45	17	9	13	14	13	26	2	6	17	13	22	16	**168**
16:45	17:00	18	6	11	12	11	19	9	1	17	28	25	8	**165**
17:00	17:15	12	5	9	28	10	26	6	6	15	26	29	25	**197**
17:15	17:30	14	4	11	11	18	23	5	2	12	24	14	17	**155**
17:30	17:45	13	11	9	11	13	17	9	3	9	16	20	15	**146**
17:45	18:00	10	9	11	13	16	23	11	1	10	19	14	7	**144**
TOTAL		**224**	**212**	**254**	**435**	**297**	**420**	**151**	**82**	**252**	**498**	**438**	**339**	**3602**

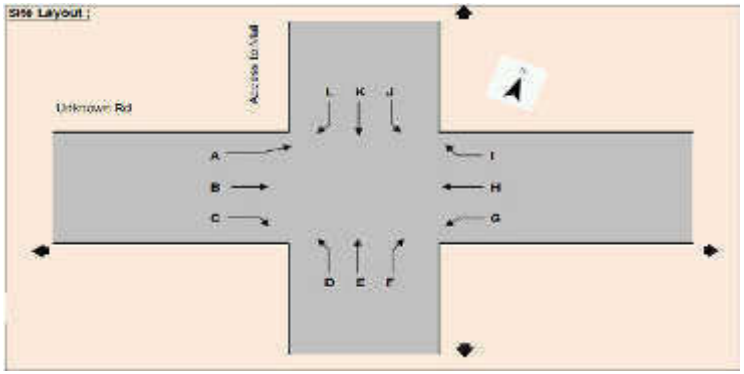


Time Period		Total vehicles						
Start	End	B	C	D	F	G	H	Total
09:00	09:15	20	11	23	18	16	25	**113**
09:15	09:30	26	15	15	16	6	17	**95**
09:30	09:45	14	35	20	12	21	15	**117**
09:45	10:00	15	34	11	17	10	45	**132**
10:00	10:15	17	30	18	10	11	45	**131**
10:15	10:30	35	25	15	13	10	61	**159**
10:30	*10:45*	*69*	*20*	*12*	*17*	*8*	*59*	***185***
10:45	*11:00*	*41*	*19*	*10*	*16*	*7*	*95*	***188***
11:00	*11:15*	*62*	*33*	*24*	*33*	*8*	*66*	***226***
11:15	*11:30*	*50*	*23*	*12*	*12*	*8*	*60*	***165***
11:30	11:45	63	18	16	17	6	104	**224**
11:45	12:00	49	24	17	19	19	93	**221**
12:00	12:15	50	20	24	15	8	64	**181**
12:15	12:30	54	25	11	21	16	73	**200**
12:30	12:45	59	20	13	22	10	128	**252**
12:45	13:00	52	19	12	18	7	101	**209**
13:00	13:15	49	10	5	7	7	74	**152**
13:15	13:30	58	11	6	8	7	76	**166**
13:30	13:45	36	11	11	15	9	71	**153**
13:45	14:00	61	8	15	20	8	60	**172**
TOTAL		**880**	**411**	**290**	**326**	**202**	**1332**	**3441**

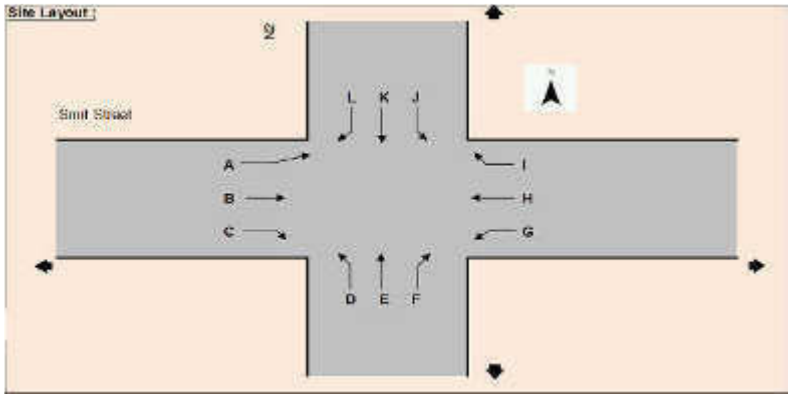


Time Period		Total vehicles												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
09:00	09:15	13	2	3	1	11	11	4	2	1	23	26	2	**99**
09:15	09:30	15	9	1	2	17	7	12	2	3	13	16	4	**101**
09:30	09:45	11	6	4	1	30	13	7	5	5	13	21	2	**118**
09:45	10:00	13	4	5	0	36	21	5	3	2	6	41	4	**140**
10:00	10:15	14	3	2	4	30	21	12	4	1	9	43	5	**148**
10:15	10:30	16	8	4	2	33	25	19	12	1	3	61	2	**186**
10:30	*10:45*	*26*	*13*	*0*	*1*	*75*	*14*	*22*	*7*	*1*	*6*	*63*	*7*	***235***
10:45	*11:00*	*18*	*4*	*1*	*1*	*47*	*20*	*20*	*4*	*1*	*15*	*83*	*8*	***222***
11:00	*11:15*	*24*	*10*	*0*	*1*	*61*	*19*	*23*	*4*	*6*	*13*	*65*	*19*	***245***
11:15	*11:30*	*23*	*10*	*0*	*0*	*50*	*30*	*17*	*5*	*6*	*9*	*51*	*10*	***211***
11:30	11:45	28	42	0	0	61	29	13	5	7	46	67	13	**311**
11:45	12:00	30	17	0	1	43	37	18	7	3	8	77	21	**262**
12:00	12:15	25	12	1	0	49	21	22	10	7	16	61	15	**239**
12:15	12:30	27	10	0	1	48	21	22	6	3	10	59	17	**224**
12:30	12:45	23	8	0	0	63	26	71	21	4	27	117	27	**387**
12:45	13:00	25	5	0	0	37	32	50	18	3	17	81	21	**289**
13:00	13:15	17	6	0	1	49	25	3	18	0	11	63	5	**198**
13:15	13:30	18	9	1	1	48	20	21	14	1	16	71	3	**223**
13:30	13:45	23	7	0	0	12	26	16	4	1	12	69	3	**173**
13:45	14:00	22	5	1	0	63	27	25	10	2	13	65	4	**237**
TOTAL		**411**	**190**	**23**	**17**	**863**	**445**	**402**	**161**	**58**	**286**	**1200**	**192**	**4248**

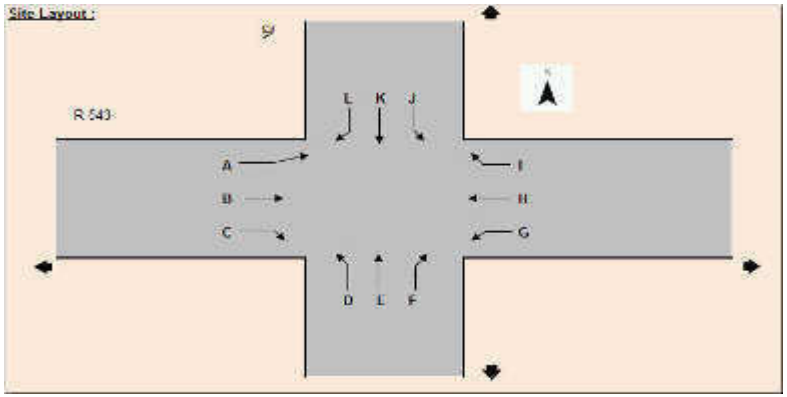
Time Period		Total vehicles						
Start	End	B	C	D	F	G	H	Total
09:00	09:15	5	2	6	1	1	5	**20**
09:15	09:30	8	10	4	2	2	8	**34**
09:30	09:45	11	14	10	2	0	7	**44**
09:45	10:00	10	12	14	2	1	15	**54**
10:00	10:15	13	13	9	7	3	13	**58**
10:15	10:30	19	16	16	2	3	14	**70**
10:30	*10:45*	*18*	*12*	*18*	*4*	*2*	*16*	***70***
10:45	*11:00*	*13*	*14*	*17*	*4*	*4*	*15*	***67***
11:00	*11:15*	*15*	*15*	*11*	*2*	*0*	*27*	***70***
11:15	*11:30*	*22*	*11*	*10*	*16*	*4*	*16*	***79***
11:30	11:45	9	25	10	7	3	6	**60**
11:45	12:00	7	12	10	7	3	18	**57**
12:00	12:15	10	12	19	2	6	20	**69**
12:15	12:30	2	10	25	12	2	15	**66**
12:30	12:45	11	1	62	0	2	15	**91**
12:45	13:00	15	7	30	6	6	25	**89**
13:00	13:15	5	11	15	3	11	6	**51**
13:15	13:30	10	12	5	3	3	6	**39**
13:30	13:45	3	3	10	5	0	12	**33**
13:45	14:00	20	20	25	5	3	20	**93**
TOTAL		**226**	**232**	**326**	**92**	**59**	**279**	**1214**



Time Period		Total vehicles												
Start	**End**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**Total**
09:00	09:15	7	9	16	9	6	5	5	28	11	6	11	7	**120**
09:15	09:30	11	5	10	5	6	4	8	13	8	7	8	4	**89**
09:30	09:45	7	9	11	4	3	0	2	17	7	10	6	8	**84**
09:45	10:00	2	7	9	4	8	1	1	13	9	4	9	8	**75**
10:00	10:15	11	7	10	5	6	1	3	7	8	11	16	7	**92**
10:15	10:30	2	12	9	5	3	1	3	16	12	7	11	17	**98**
10:30	*10:45*	*5*	*15*	*9*	*9*	*4*	*1*	*2*	*15*	*7*	*5*	*12*	*3*	***87***
10:45	*11:00*	*5*	*11*	*14*	*8*	*9*	*5*	*1*	*15*	*8*	*7*	*17*	*12*	***112***
11:00	*11:15*	*8*	*6*	*19*	*11*	*7*	*0*	*1*	*8*	*9*	*9*	*15*	*10*	***103***
11:15	*11:30*	*10*	*8*	*10*	*1*	*11*	*2*	*0*	*16*	*10*	*9*	*11*	*5*	***93***
11:30	11:45	11	14	11	9	14	3	5	7	6	6	10	5	**101**
11:45	12:00	61	6	13	11	2	1	1	11	9	8	13	14	**150**
12:00	12:15	12	12	14	8	5	6	2	12	4	3	10	7	**95**
12:15	12:30	6	13	13	8	6	1	3	16	13	8	10	11	**108**
12:30	12:45	7	13	11	5	11	0	3	10	4	3	9	7	**83**
12:45	13:00	5	14	13	7	7	1	1	11	7	5	8	10	**89**
13:00	13:15	5	11	4	5	11	1	3	49	0	4	3	5	**101**
13:15	13:30	5	18	11	1	6	3	2	10	11	7	14	11	**99**
13:30	13:45	7	18	20	16	8	0	1	10	9	5	9	7	**110**
13:45	14:00	15	36	12	17	0	0	0	4	6	2	7	2	**101**
TOTAL		**202**	**244**	**239**	**148**	**133**	**36**	**47**	**288**	**158**	**126**	**209**	**160**	**1990**



Time Period		Total vehicles												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
09:00	09:15	2	4	2	4	28	5	7	4	2	2	57	1	**118**
09:15	09:30	5	7	2	2	43	6	5	5	4	7	51	1	**138**
09:30	09:45	4	8	2	0	40	4	10	4	2	5	64	5	**148**
09:45	10:00	5	8	2	2	33	3	4	3	4	7	80	2	**153**
10:00	10:15	2	10	1	0	57	5	13	5	5	10	89	1	**198**
10:15	10:30	5	7	3	5	55	7	12	6	6	15	96	5	**222**
10:30	*10:45*	*2*	*9*	*3*	*6*	*86*	*8*	*17*	*9*	*5*	*6*	*97*	*2*	***250***
10:45	*11:00*	*2*	*4*	*5*	*1*	*58*	*6*	*11*	*9*	*12*	*3*	*100*	*1*	***212***
11:00	*11:15*	*5*	*10*	*2*	*4*	*76*	*6*	*10*	*13*	*11*	*7*	*103*	*5*	***252***
11:15	*11:30*	*3*	*7*	*2*	*6*	*73*	*8*	*8*	*14*	*9*	*7*	*87*	*6*	***230***
11:30	11:45	3	11	2	7	76	10	10	8	5	9	96	1	**238**
11:45	12:00	2	11	3	5	65	2	10	8	6	11	82	6	**211**
12:00	12:15	4	11	5	5	77	4	10	8	8	9	78	6	**225**
12:15	12:30	5	5	6	8	57	4	7	10	6	6	78	7	**199**
12:30	12:45	1	8	5	7	60	8	13	11	6	12	110	12	**253**
12:45	13:00	2	8	1	5	56	4	13	9	9	9	104	19	**239**
13:00	13:15	3	2	4	4	61	7	7	8	8	5	108	6	**223**
13:15	13:30	1	2	4	3	70	9	5	3	14	7	82	3	**203**
13:30	13:45	2	6	4	2	84	6	7	5	17	11	82	3	**229**
13:45	14:00	2	4	3	2	74	11	9	2	3	6	85	4	**205**
TOTAL		**60**	**142**	**61**	**78**	**1229**	**123**	**188**	**144**	**142**	**154**	**1729**	**96**	**4146**



Time Period		Total vehicles												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
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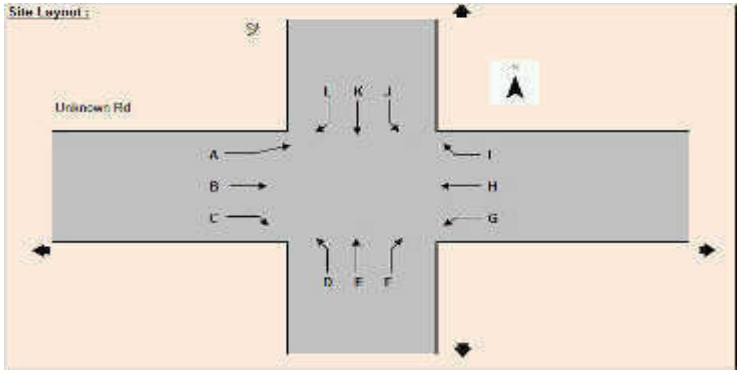
09:15	09:30	6	2	7	3	31	1	5	2	2	0	62	3	**124**
09:30	09:45	5	4	14	2	58	3	1	3	1	2	91	5	**189**
09:45	10:00	3	2	9	3	50	2	2	2	1	1	75	3	**153**
10:00	10:15	8	4	14	8	64	3	2	5	1	2	98	2	**211**
10:15	10:30	8	3	15	9	72	3	5	5	2	4	104	7	**237**
10:30	*10:45*	*9*	*8*	*15*	*12*	*85*	*5*	*2*	*5*	*3*	*5*	*104*	*4*	***257***
10:45	*11:00*	*9*	*6*	*11*	*16*	*65*	*5*	*2*	*3*	*1*	*2*	*111*	*12*	***243***
11:00	*11:15*	*14*	*6*	*12*	*18*	*62*	*4*	*4*	*4*	*1*	*1*	*111*	*8*	***245***
11:15	*11:30*	*11*	*7*	*22*	*22*	*102*	*5*	*6*	*7*	*4*	*3*	*86*	*14*	***289***
11:30	11:45	11	4	26	17	86	3	3	6	3	5	105	9	**278**
11:45	12:00	9	10	13	17	84	1	6	6	3	3	112	10	**274**
12:00	12:15	10	9	15	22	74	6	5	8	1	3	103	9	**265**
12:15	12:30	9	7	16	17	89	3	9	2	2	2	85	8	**249**
12:30	12:45	9	6	16	13	83	1	5	10	1	1	115	9	**269**
12:45	13:00	6	5	12	16	84	2	4	9	2	2	127	8	**277**
13:00	13:15	6	7	12	18	81	4	11	8	2	2	132	9	**292**
13:15	13:30	10	5	10	6	81	3	2	6	2	4	102	7	**238**
13:30	13:45	8	6	10	14	101	4	3	1	2	2	92	9	**252**
13:45	14:00	8	4	18	14	102	1	4	0	3	1	90	7	**252**
TOTAL		**163**	**109**	**272**	**253**	**1494**	**63**	**82**	**94**	**38**	**46**	**1951**	**145**	**4710**



Time Period		Total vehicles												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
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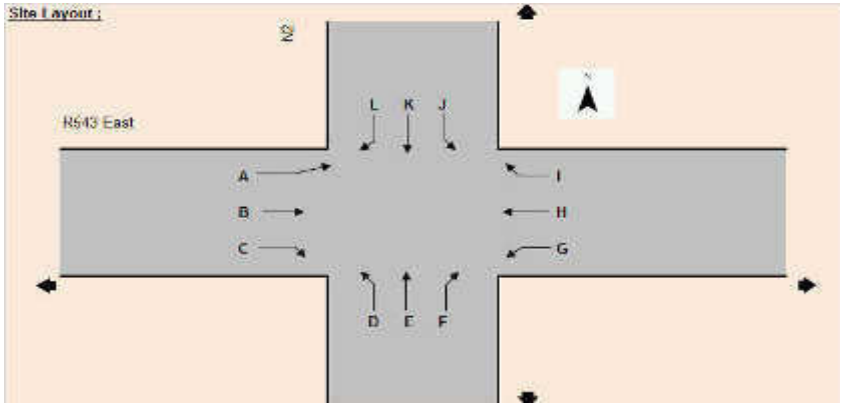
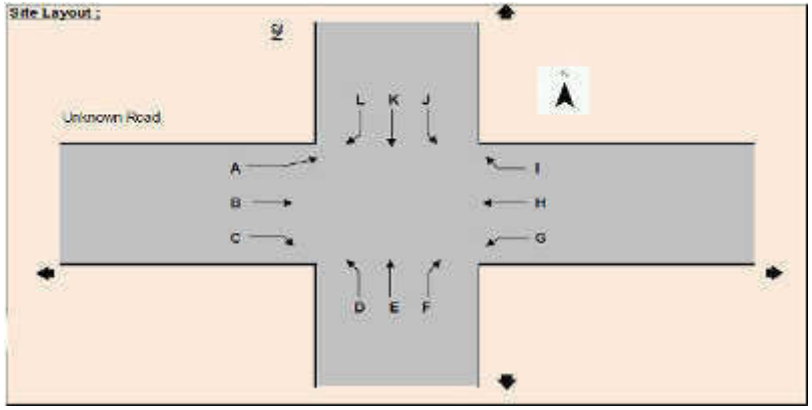
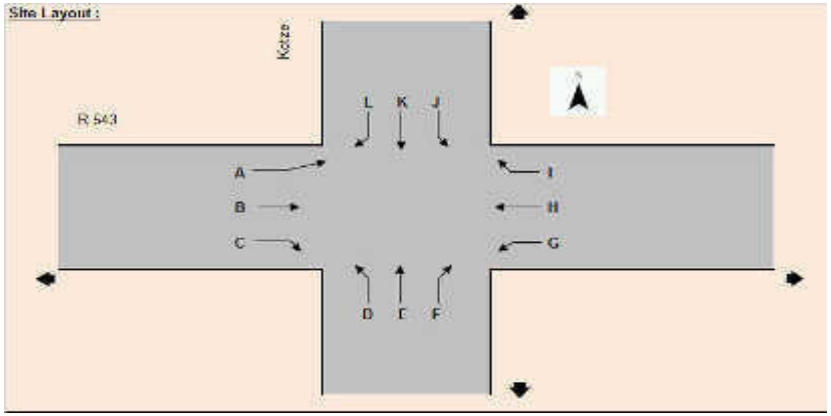
09:15	09:30	5	11	0	12	54	6	1	14	1	1	64	2	**171**
09:30	09:45	4	4	0	17	61	8	1	10	2	0	72	2	**181**
09:45	10:00	8	10	0	18	53	18	1	18	4	0	66	4	**200**
10:00	10:15	4	14	5	28	50	10	3	21	2	2	60	2	**201**
10:15	10:30	2	27	12	14	64	9	3	20	8	4	95	2	**260**
10:30	*10:45*	*8*	*15*	*17*	*14*	*70*	*34*	*5*	*11*	*8*	*3*	*97*	*5*	***287***
10:45	*11:00*	*9*	*12*	*14*	*15*	*74*	*25*	*3*	*14*	*3*	*6*	*97*	*3*	***275***
11:00	*11:15*	*2*	*11*	*16*	*35*	*81*	*5*	*3*	*27*	*2*	*3*	*95*	*11*	***291***
11:15	*11:30*	*17*	*16*	*12*	*17*	*74*	*4*	*8*	*9*	*5*	*1*	*96*	*5*	***264***
11:30	11:45	5	15	5	14	65	1	3	8	4	2	93	2	**217**
11:45	12:00	22	16	23	29	67	13	8	18	10	6	76	7	**295**
12:00	12:15	20	18	22	6	60	8	6	27	4	4	64	7	**246**
12:15	12:30	30	12	34	48	70	17	2	39	6	3	87	7	**355**
12:30	12:45	22	12	26	32	71	8	3	18	3	9	76	7	**287**
12:45	13:00	17	13	23	29	35	8	1	8	4	2	94	3	**237**
13:00	13:15	18	11	18	39	53	6	4	7	4	5	100	8	**273**
13:15	13:30	27	23	31	4	66	17	3	17	1	7	98	3	**297**
13:30	13:45	24	4	35	30	79	5	1	10	5	7	90	3	**293**
13:45	14:00	25	16	42	63	39	9	4	23	6	4	94	8	**333**
TOTAL		**271**	**269**	**335**	**479**	**1220**	**217**	**65**	**324**	**83**	**70**	**1652**	**92**	**5077**



Time Period		TOTAL VEHICLES												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
09:00	09:15	0	0	0	19	52	2	5	2	1	0	79	5	**165**
09:15	09:30	0	0	0	26	69	7	10	4	0	0	108	7	**231**
09:30	09:45	0	0	0	30	76	4	15	3	0	1	105	5	**239**
09:45	10:00	0	0	0	27	100	6	10	3	1	0	128	11	**286**
10:00	10:15	0	0	0	32	91	7	16	1	0	0	125	11	**283**
10:15	10:30	0	0	0	20	70	8	18	2	0	0	139	14	**271**
10:30	*10:45*	*0*	*0*	*0*	*35*	*92*	*7*	*23*	*4*	*3*	*4*	*150*	*15*	***333***
10:45	*11:00*	*0*	*0*	*0*	*31*	*104*	*5*	*21*	*3*	*0*	*3*	*133*	*16*	***316***
11:00	*11:15*	*0*	*0*	*0*	*38*	*118*	*7*	*26*	*7*	*0*	*2*	*144*	*11*	***353***
11:15	*11:30*	*0*	*0*	*0*	*43*	*89*	*30*	*7*	*2*	*4*	*4*	*125*	*13*	***317***
11:30	11:45	0	0	0	46	111	7	15	3	3	4	154	10	**353**
11:45	12:00	0	0	0	50	82	32	11	0	0	4	110	2	**291**
12:00	12:15	0	0	0	37	90	2	11	1	2	3	155	11	**312**
12:15	12:30	0	0	0	46	91	4	9	5	1	4	135	12	**307**
12:30	12:45	0	0	0	46	87	1	2	1	1	1	119	3	**261**
12:45	13:00	0	0	1	45	78	4	23	3	1	2	155	7	**319**
13:00	13:15	0	0	0	50	75	3	16	1	0	1	159	8	**313**
13:15	13:30	0	0	0	39	117	5	15	1	3	3	94	5	**282**
13:30	13:45	0	0	0	37	81	2	6	0	2	3	108	9	**248**
13:45	14:00	0	0	0	41	102	8	9	1	0	3	132	9	**305**
TOTAL		**0**	**0**	**1**	**738**	**1775**	**151**	**268**	**47**	**22**	**42**	**2557**	**184**	**5785**



Time Period		TOTAL VEHICLES												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
09:00	09:15	33	2	1	1	6	1	1	0	3	7	23	25	**103**
09:15	09:30	61	2	0	0	10	0	0	2	5	7	36	41	**164**
09:30	09:45	53	8	1	2	14	1	2	1	11	7	59	56	**215**
09:45	10:00	47	2	2	1	21	0	1	11	9	11	43	46	**194**
10:00	10:15	67	4	1	1	5	1	1	5	21	9	45	60	**220**
10:15	10:30	83	1	0	1	11	0	0	12	21	10	57	57	**253**
10:30	*10:45*	*88*	*2*	*2*	*3*	*23*	*0*	*1*	*10*	*21*	*11*	*74*	*76*	***311***
10:45	*11:00*	*70*	*6*	*1*	*3*	*28*	*0*	*2*	*1*	*22*	*11*	*62*	*66*	***272***
11:00	*11:15*	*63*	*3*	*0*	*3*	*32*	*2*	*1*	*5*	*20*	*13*	*74*	*69*	***285***
11:15	*11:30*	*128*	*5*	*2*	*3*	*27*	*1*	*1*	*8*	*14*	*16*	*61*	*91*	***357***
11:30	11:45	76	8	2	8	33	0	2	14	14	10	76	73	**316**
11:45	12:00	108	13	5	4	64	0	1	9	22	11	61	65	**363**
12:00	12:15	71	4	3	3	61	0	2	10	17	15	67	84	**337**
12:15	12:30	76	11	5	1	57	1	1	7	20	14	59	92	**344**
12:30	12:45	100	13	2	2	47	0	1	9	16	13	66	83	**352**
12:45	13:00	94	6	3	6	32	1	3	11	12	21	48	142	**379**
13:00	13:15	71	12	3	0	31	0	2	7	14	22	62	123	**347**
13:15	13:30	73	10	6	4	27	2	3	13	15	20	84	98	**355**
13:30	13:45	73	6	1	2	47	3	3	8	20	13	68	89	**333**
13:45	14:00	75	9	2	5	48	1	1	3	8	7	67	88	**314**
TOTAL		**1510**	**127**	**42**	**53**	**624**	**14**	**29**	**146**	**305**	**248**	**1192**	**1524**	**5814**



Time Period		Total vehicles						
Start	End	A	B	H	I	J	L	Total
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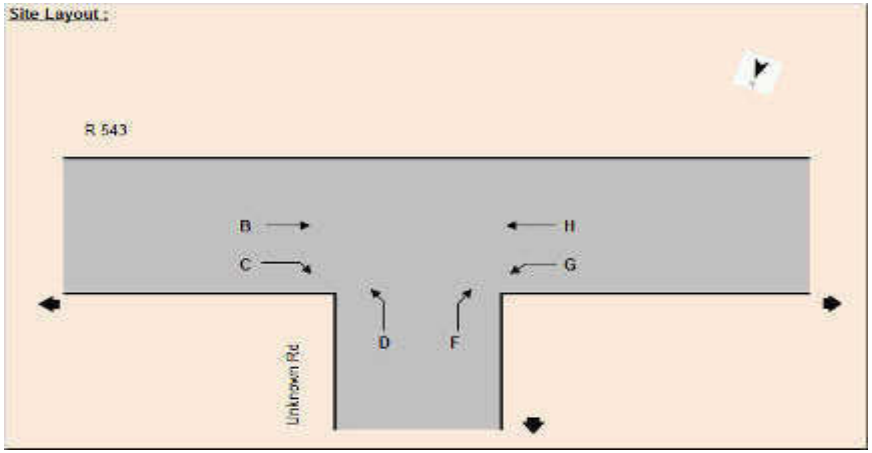
09:15	09:30	1	12	2	1	2	3	**21**
09:30	09:45	1	15	7	0	0	5	**28**
09:45	10:00	1	12	6	0	1	6	**26**
10:00	10:15	2	11	12	0	1	6	**32**
10:15	10:30	1	14	11	0	2	7	**35**
10:30	*10:45*	*3*	*13*	*12*	*3*	*9*	*8*	***48***
10:45	*11:00*	*1*	*11*	*10*	*9*	*4*	*20*	***55***
11:00	*11:15*	*2*	*12*	*11*	*2*	*2*	*9*	***38***
11:15	*11:30*	*10*	*11*	*7*	*7*	*5*	*10*	***50***
11:30	11:45	3	10	12	2	4	35	**66**
11:45	12:00	2	13	2	0	3	1	**21**
12:00	12:15	3	12	13	0	5	7	**40**
12:15	12:30	1	11	5	1	4	8	**30**
12:30	12:45	4	10	1	1	7	20	**43**
12:45	13:00	0	9	11	0	4	8	**32**
13:00	13:15	2	15	5	0	6	5	**33**
13:15	13:30	1	6	3	0	4	7	**21**
13:30	13:45	1	11	2	0	2	5	**21**
13:45	14:00	2	10	4	0	1	1	**18**
TOTAL		**42**	**229**	**138**	**26**	**67**	**173**	**675**



Time Period		Total vehicles						
Start	End	G	H	F	B	C	D	Total
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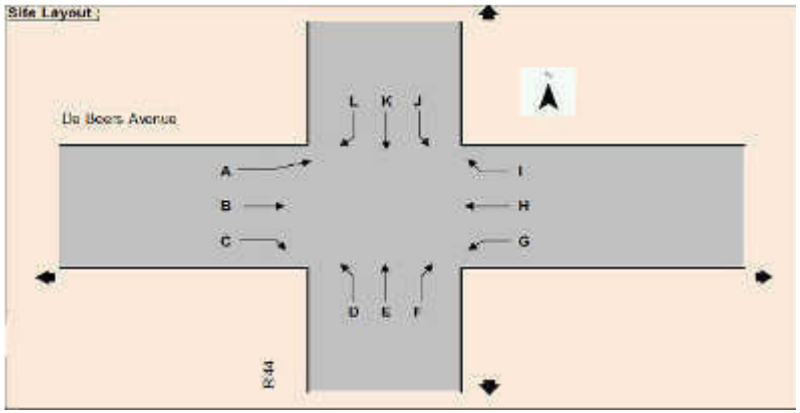
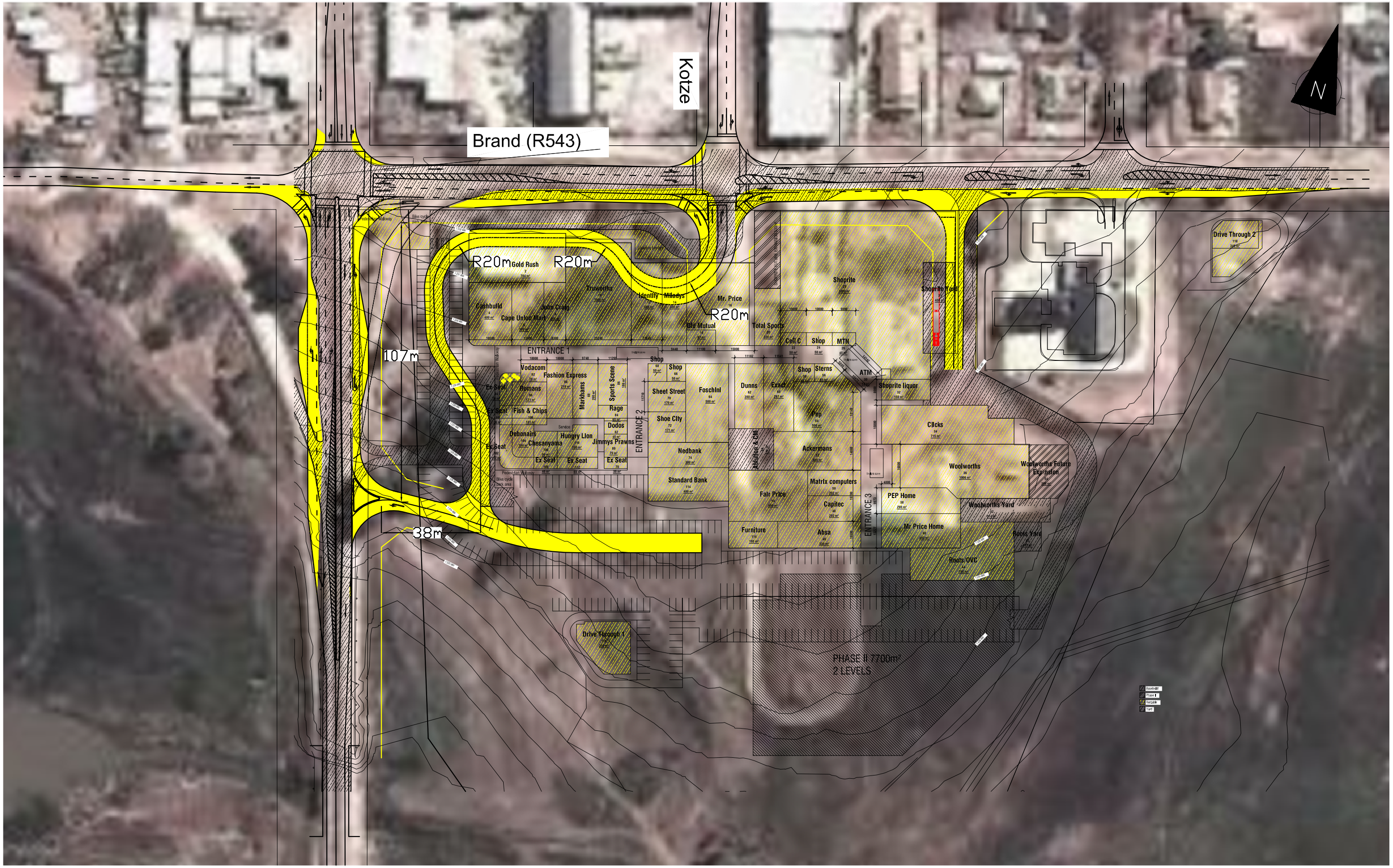
09:15	09:30	8	18	9	8	5	3	**51**
09:30	09:45	8	6	9	11	6	6	**46**
09:45	10:00	4	13	6	7	5	3	**38**
10:00	10:15	6	18	4	10	8	1	**47**
10:15	10:30	11	12	3	10	11	6	**53**
10:30	*10:45*	*6*	*11*	*4*	*18*	*7*	*5*	***51***
10:45	*11:00*	*9*	*12*	*5*	*15*	*5*	*5*	***51***
11:00	*11:15*	*7*	*16*	*7*	*15*	*4*	*8*	***57***
11:15	*11:30*	*6*	*7*	*5*	*14*	*5*	*3*	***40***
11:30	11:45	6	12	5	8	10	5	**46**
11:45	12:00	8	11	7	8	12	6	**52**
12:00	12:15	16	11	2	10	10	15	**64**
12:15	12:30	13	6	5	10	10	9	**53**
12:30	12:45	15	5	9	19	13	9	**70**
12:45	13:00	19	19	6	17	19	8	**88**
13:00	13:15	9	10	6	25	10	8	**68**
13:15	13:30	24	12	8	15	8	8	**75**
13:30	13:45	21	9	9	9	8	7	**63**
13:45	14:00	12	11	5	14	9	8	**59**
TOTAL		**214**	**229**	**121**	**254**	**172**	**127**	**1117**



Time Period		TOTAL VEHICLES												
Start	End	A	B	C	D	E	F	G	H	I	J	K	L	Total
09:00	09:15	8	10	1	1	19	6	8	14	2	3	16	5	**93**
09:15	09:30	7	7	0	2	28	8	10	12	1	1	33	2	**111**
09:30	09:45	2	8	2	0	2	6	3	9	1	0	0	3	**36**
09:45	10:00	4	3	1	0	20	5	5	16	3	0	19	4	**80**
10:00	10:15	3	15	0	2	17	12	4	18	4	0	33	4	**112**
10:15	10:30	3	10	0	1	23	11	4	19	5	1	30	3	**110**
10:30	*10:45*	*2*	*4*	*5*	*0*	*9*	*3*	*3*	*14*	*7*	*1*	*21*	*3*	***72***
10:45	*11:00*	*5*	*10*	*0*	*1*	*26*	*11*	*5*	*23*	*9*	*3*	*38*	*1*	***132***
11:00	*11:15*	*0*	*6*	*1*	*0*	*18*	*4*	*3*	*2*	*4*	*0*	*17*	*4*	***59***
11:15	*11:30*	*8*	*8*	*1*	*0*	*22*	*10*	*1*	*18*	*3*	*0*	*19*	*2*	***92***
11:30	11:45	8	13	1	1	21	0	2	8	3	0	1	2	**60**
11:45	12:00	5	14	2	0	26	6	6	6	5	1	24	2	**97**
12:00	12:15	2	5	1	1	7	5	3	10	1	2	17	2	**56**
12:15	12:30	7	11	0	0	18	5	5	8	8	3	12	2	**79**
12:30	12:45	3	12	1	0	12	11	6	7	5	3	24	0	**84**
12:45	13:00	6	4	1	1	26	7	3	20	6	0	19	1	**94**
13:00	13:15	3	6	0	0	20	5	5	23	4	0	22	5	**93**
13:15	13:30	3	3	0	0	16	7	1	13	5	0	12	1	**61**
13:30	13:45	2	5	0	2	6	2	1	11	1	1	6	1	**38**
13:45	14:00	5	10	0	3	34	8	3	14	2	2	19	4	**104**
TOTAL		**86**	**164**	**17**	**15**	**370**	**132**	**81**	**265**	**79**	**21**	**382**	**51**	**1663**



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E-MAIL: admin@techworld.co.za

MALL@PIET RETIEF

Proposed Road Improvements at the Accesses & Church (N2) / Brand (R543) Intersection to Support the Piet Retief Mall

APPENDIX C

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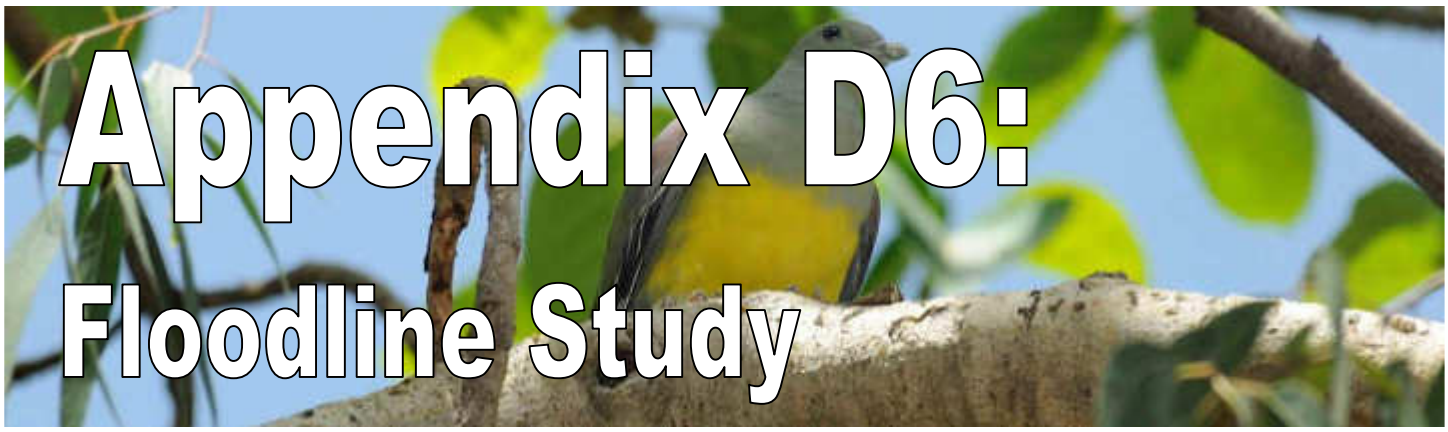
APPENDIX C



Appendix D6:

Floodline Study

Anaprop Property Management

PROJECT:
Development of Portions 100 & 123 PIET RETIEF TOWN
(Townland 149 HT)

Report on the Delineation of the 1:100 Year Floodlines

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DELINEATION OF THE 1:100 YEAR FLOODLINES FOR DEVELOPMENT OF PORTIONS 100 & 123 – PIET RETIEF TOWN

CONTENTS

LIST OF ABBREVIATIONS

APP	Approved professional person
DWA	Department of Water Affairs
EPP	Emergency preparedness plan
FSL	Full supply level
HRU	Hydrological Research Unit
K	Regional coefficient
MAP	Mean annual precipitation
MAR	Mean annual run-off
MSL	Mean sea level
NOC	Non-overspill crest
NWA	National Water Act, Act 36 of 1998
OMM	Operation and maintenance manual
PMF	Probable maximum flood
PMP	Probable maximum precipitation
RDD	Recommended design discharge
RDF	Recommended design flood
RI	Recurrence interval
RL	Reduced level
RMF	Regional maximum flood
SANCOLD	South African Committee on Large Dams
SCS	Soil Conservation Service
SED	Safety evaluation discharge
SEF	Safety evaluation flood

DELINEATION OF THE 1:100 YEAR FLOODLINES FOR DEVELOPMENT OF PORTIONS 100 & 123 – PIET RETIEF TOWN

SECTION 1: INTRODUCTION

A floodline analysis was required to determine the position of the 1 in 100 year floodlines for the developments to take place on portions 100 and 123 in the town of Piet Retief in the Mpumalanga Province. Both sites are situated near the Klipmesselspruit (Townland 149 HT).

The analysis starts at approximately latitude **27° 00' 31,1"** and longitude **30° 48' 32,4"** (Cross-section RS100) and ends at latitude **27° 00' 50,8"** and longitude **30° 47' 54,4"** (Cross-section RS85) – WGS84.

The specific area which was analyzed during this investigation will be affected by accumulated flood waters in the Klipmesselspruit and associate tributaries.

The determination / analysis of the post-development 1:100 year floodlines were carried out by PG Consulting Engineers on behalf of Lekwa Consulting Engineers & Project Managers.

SECTION 2: HYDROLOGY AND SUMMARY OF FLOW DIMENSIONS

a) Methods used for Calculations

Methods that were used to calculate the different run-off peaks with variance in return periods are summarised below (a deterministic method with two different implementations were used and compared against an empirical method). The empirical method was furthermore utilized to calculate the RMF peaks.

a) Rational method - Implementation 1: Based on the regional DDF-equations representing the HRU 1/78 DDF-relationships ("Op ter Noort & Stephenson" - 1982)

b) Rational method - Implementation 2: Based on DWA's implementation

c) Empirical Method (TR137) – Regional maximum floods based on "Francou-Rodier" K-values ("Kovacs" - 1988) - Commonly used by DWAF for catchments >10km²

NB! It was specifically decided on the above mentioned rational implementations as they provide for the incorporation of post-development site specific conditions.

b) Catchment Parameters

Two (2) seperate catchments were identified in the study for the hydrology calculations in order to determine the expected flood peaks, referred to as Catchments A and B (Refer to ortho images below).

Homogeneous catchment characteristics for the different catchments were used for calculation purposes as obtained from appropriate 1:50 000 topographical maps, 1:10 000 ortho photos as well as GISap software data. The main catchment characteristics are summarized below.

The specific sub-catchments are part of quaternary catchment W51D (Assegaai River). The mean annual precipitation (MAP) for the polygon grid covering the total tributary catchment area, based on the GISap software, is given as **887mm**.

Catchment A (Upper catchment)

Catchment area (km²)	**14,818km²**
Vertical difference in height of catchment (m)	**98m**
Flow length of longest watercourse (km)	**5 250m**
Average slope of catchment (10/85)	**1,87%**
Catchment run-off coefficients applied (post-development)	
Q_{50}	**0,426**
Q_{100}	**0,504**
Time of concentration (Tc)	**1,10 hrs**

Catchment A&B (Combined total catchments)

Catchment area (km²)	**17,733km²**
Vertical difference in height of catchment (m)	**104m**
Flow length of longest watercourse (km)	**5 610m**
Average slope of catchment (10/85)	**1,85%**
Catchment run-off coefficients applied (post-development)	
Q_{50}	**0,426**
Q_{100}	**0,504**
Time of concentration (Tc)	**1,16 hrs**

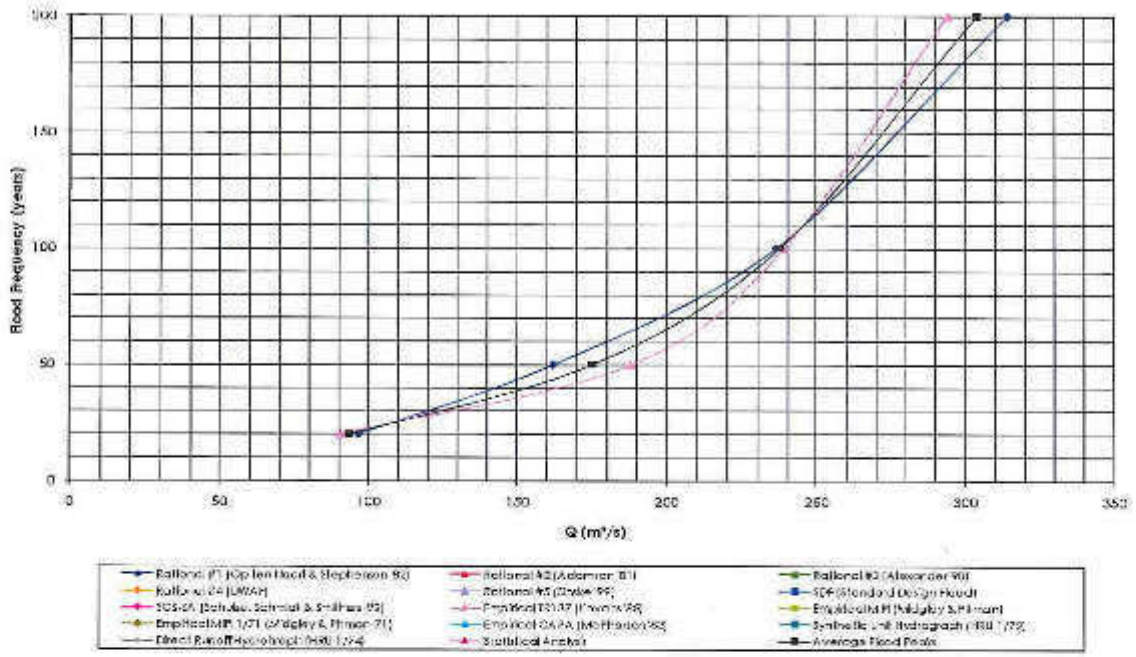
NB! Provision was made for urbanization conditions (i.e. 30% of total catchment size) and area reduction factors were applied as the catchments exceed 10km².

c) Summary of Hydrology

Following the final hydrology calculations, it was found that the post-development flood peak values derived by the rational method implementation (1) had compared favourably with the values calculated utilizing the empirical TR137 method.

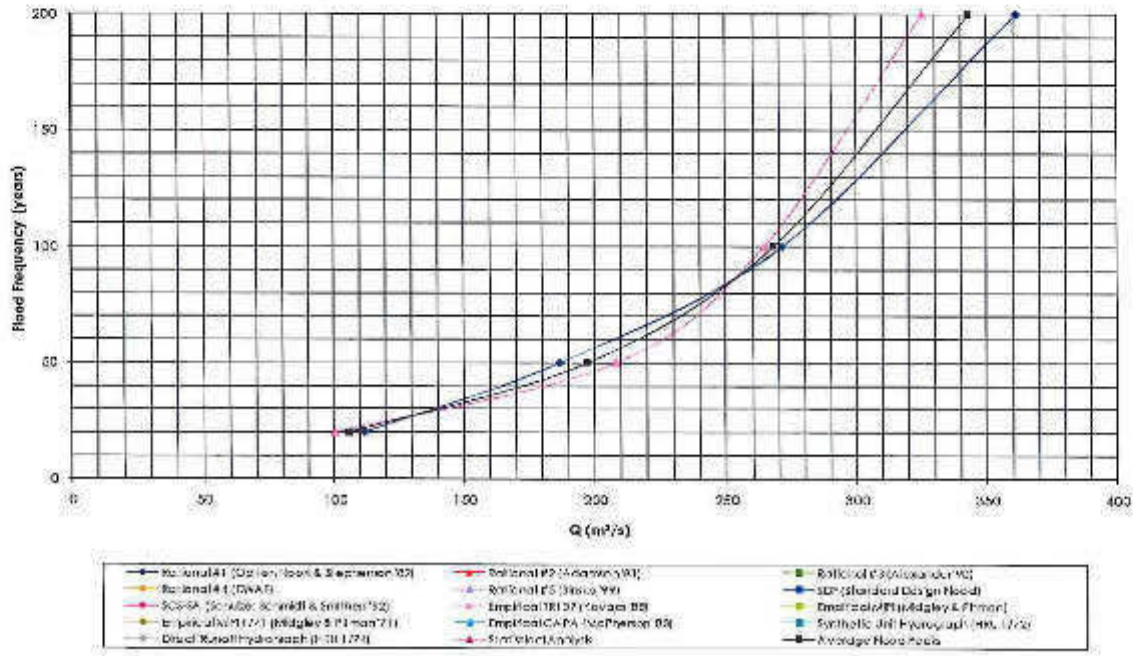
As some disparities were found between the two rational implementations applied (refer to the tables below), it was decided to rather follow a conservative approach by using the average of the two closest corresponding methods applied. The rational method implementation (2) values were therefore omitted. The following parameter sets, as tabled, were derived.

DERIVED FLOOD PEAKS WITH DIFFERENT INTERVALS - Upper Catchment 14.818km²



Flood peaks derived for catchment A (Upper Catchment)			
Values in m³/s	Q_{20}	Q_{50}	Q_{100}
Rational (a) – Op ten Noort & Stephenson '82	96.5	161.9	236.0
Rational (b) – DWA	125.2	165.4	206.6
Empirical – (TR137) K_e - region 5,2	90.5	188.3	238.9
Average of all above	**104.1**	**171.9**	**227.2**

DERIVED FLOOD PEAKS WITH DIFFERENT INTERVALS - Combined Catchments 17.733km²



Flood peaks derived for catchments A&B (Combined catchments)			
Values in m^3/s	Q_{20}	Q_{50}	Q_{100}
Rational (a) – Op ten Noort & Stophenson '82	111.0	186.3	271.3
Rational (b) – DWA	142.6	187.6	233.4
Empirical – (TR '37) K_e - region 5,2	100.1	208.2	264.2
Average of all above	**117.9**	**194.0**	**256.3**

d) Recommended Flood Peaks for the Floodline Computations of the different stream flow sections

The recommended flood peaks adopted for the analysis, were hydrologically balanced between the two catchments, in order to determine the floodlines for each of the following streamflow sections.

Klipmesselspruit - Section RS100 to RS95

Regional maximum flood (RMF) – calculated for K_e - region 5,2: 453m^3/s
Probable maximum flood (PMF) – graphically forecasted: 1 297m^3/s
Q_{100} used for floodlines determination: **237m^3/s**

Klipmesselspruit - Section RS95 to RS85

Regional maximum flood (RMF) – calculated for K_e - region 5,2: 500m^3/s
Probable maximum flood (PMF) – graphically forecasted: 1 434m^3/s
Q_{100} used for floodlines determination: **268m^3/s**

(See calculations, attached as Appendix A)

e) Floodlines Computations

For the computation of the different floodlines, the HEC-RAS (Version 4.1) computer analysis software was used.

Initially sixteen (16) cross-sections were generated from the contour drawings provided. For the purpose of the floodline delineation, additional cross-sections were generated by interpolation. The sections, after interpolation, are approximately 25 meters apart (Refer to 3D schematic and layout drawings attached).

f) Assumptions

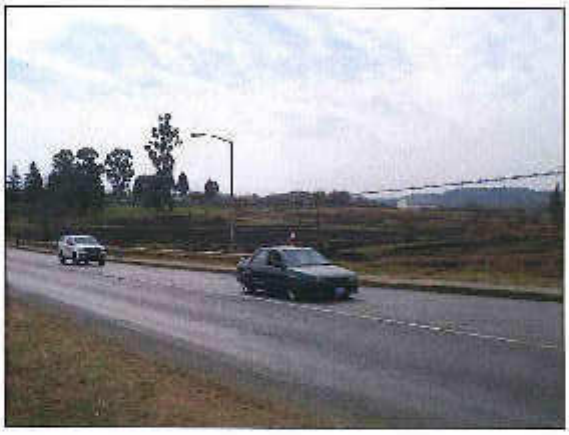
a) All the above calculations were based on Manning's formula using an n-value (roughness coefficient) of 0,035 for the watercourse canal flow as well as the overbank flow sections as there are no significant differences to be found. This value represents the present scenario at the watercourse in question (i.e. clean, winding, with no significant pools and shoals, and relative undefined bank conditions with short to medium pasture covering).

b) The following "s" – value was adapted for the section boundary condition in the model; Section RS100 to RS85 – 0,01723 m/m (1,72%).

c) All the computations were based on "steady flow stage" conditions with a "subcritical flow regime" due to the retention effects caused by the road bridge as well as the dam / weir.

d) The main road bridge, crossing the Klipmesselspruit, was assumed to have an effective opening of 16m x 6m as measured from the contour layout drawing provided.

e) The dam wall (weir) dimensions incorporated in the analysis were based on an effective overflow width of 84m with a total available freeboard of 1,85m.



The photos above are showing the actual stream flow conditions at the sites analyzed.

g) Results

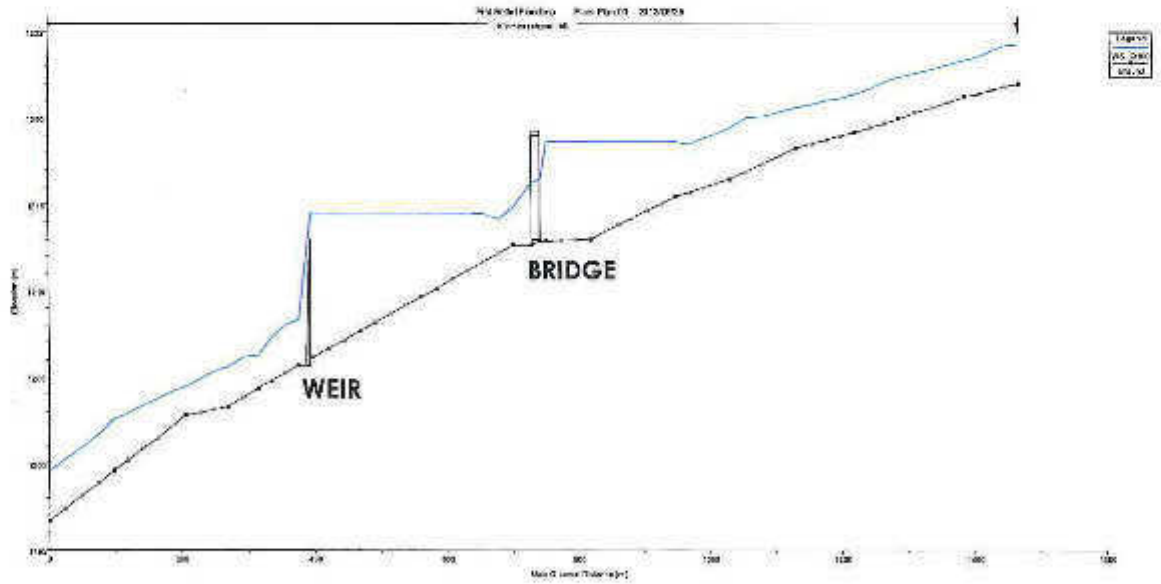
The following tables give a summary of the flow data of the expected 1:100 year flood peak which were calculated for the specific stream flow sections, derived at each of the major cross-sections;

Klipmesselspruit (Section RS100 to RS85) – 1:100 year flood				
Cross-sections (see drawing)	Q_{100}-value (m^3/s)	Max. flow velocity (m/s)	Max. flow depth (m)	Section top width (m)
RS100	237	4.17	2.30 (1224.30)	48
RS99	237	3.60	2.10 (1223.35)	60
RS98	237	2.94	2.40 (1222.40)	97
RS97	237	3.13	2.23 (1221.43)	89
RS96	237	2.47	2.34 (1220.64)	109

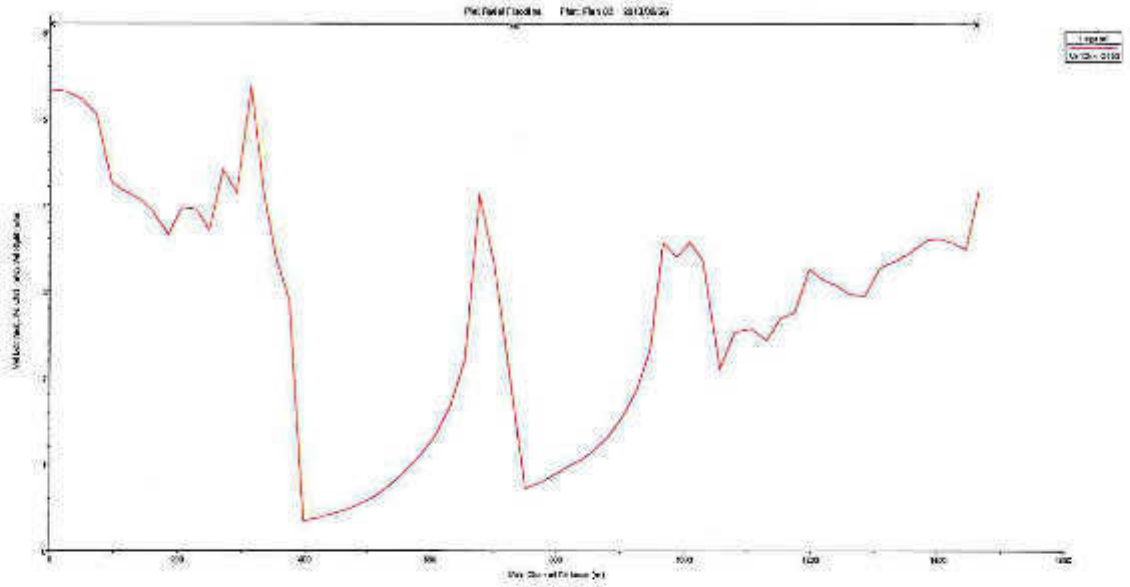
RS95	268	3.29	2.90 (1219.40)	78
RS94	268	2.92	2.79 (1218.29)	90
RS93	268	1.02	5.26 (1218.26)	110
RS92	268	0.75	5.35 (1218.26)	149
RS91	268	3.28	2.08 (1214.78)	77
WEIR	**268**	**2.19**	**1.46 (1214.46)**	**84**
RS90	268	2.76	2.58 (1208.29)	69
RS89	268	5.30	1.80 (1206.20)	47
RS88	268	4.30	2.23 (1205.53)	70
RS87	268	3.85	1.62 (1204.42)	73
RS86	268	4.17	2.89 (1202.49)	52
RS85	268	5.18	2.82 (1199.52)	45

NB! Corresponding high flow actual contour levels indicated in brackets, in the tables. The section top flow width is rounded up to the nearest meter.

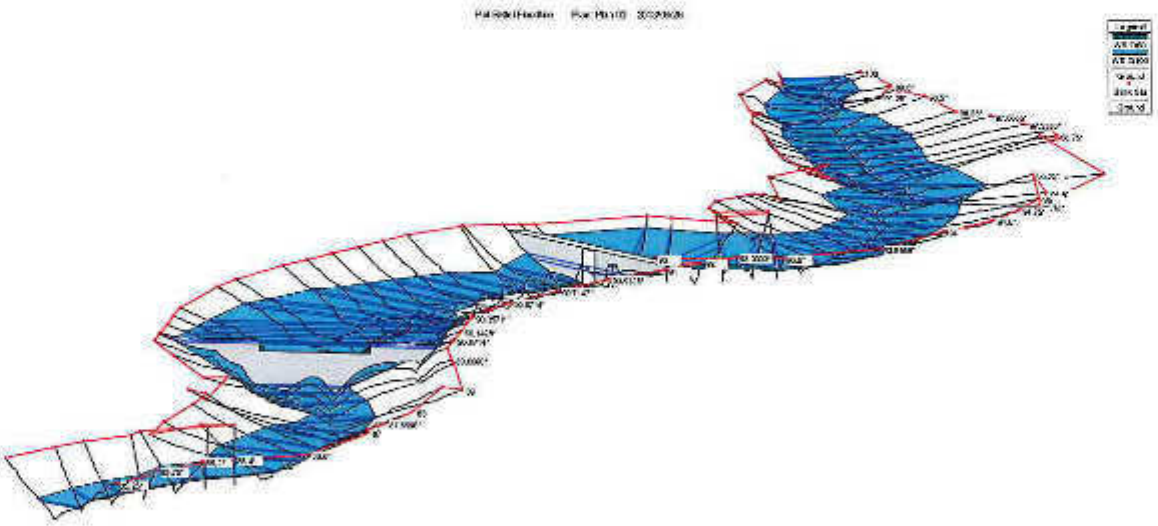
The following graph illustrates the expected water level to be generated by the 1:100 year flood peak over the stream flow section (Klipmesselspruit).



Graph on next page illustrates the expected variances in the flow velocities of the Klipmesselspruit stream flow section, during the 1:100 year recurrence intervals (Flow from right to left).



Following is a 3D schematic illustration of the high water level, during the expected 1:100 year flood peak.



(See calculations attached as Appendix A, and cross-sections attached as Appendix B).

h) XY Co-ordinates of the 1:100 Year Floodlines for reference (WGS84) Lo31°

The following tables give the exact XY co-ordinates of the 1:100 year floodlines as determined, for both the left and right banks of the applicable section of the Klipmesselspruit analyzed, with reference to each of the major cross-sections (refer to

attached drawings). These co-ordinates can be utilized by a professional surveyor to set out the different floodlines.

1:100 Year Floodlines					
Left bank			Right bank		
Cross-section	X	Y	Cross-section	X	Y
RS100	2 988 621	18 969	RS100	2 988 618	19 017
RS99	2 988 686	19 009	RS99	2 988 670	19 067
RS98	2 988 785	19 008	RS98	2 988 755	19 101
RS97	2 988 844	19 031	RS97	2 988 819	19 116
RS96	2 988 937	19 032	RS96	2 988 895	19 134
RS95	2 989 009	19 098	RS95	2 988 956	19 159
RS94	2 989 074	19 189	RS94	2 988 975	19 221
RS93	2 989 061	19 336	RS93	2 988 954	19 284
RS92	2 989 050	19 350	RS92	2 988 897	19 381
RS91	2 988 986	19 410	RS91	2 988 908	19 426
RS90	2 989 132	19 649	RS90	2 989 082	19 711
RS89	2 989 173	19 704	RS89	2 989 134	19 734
RS88	2 989 205	19 729	RS88	2 989 151	19 777
RS87	2 989 233	19 793	RS87	2 989 165	19 826
RS86	2 989 232	19 899	RS86	2 989 179	19 886
RS85	2 989 217	19 986	RS85	2 989 171	19 988

SECTION 3: CONCLUSIONS

- For the analysis of the 1:100 year floodlines, cross-sections were generated from 0,5m-interval contours which were provided by Lekwa Consulting Engineers (Pty) Ltd. The 0,5m-interval contours are based on a recent survey conducted for the development area by Reed & Partners Professional Land Surveyors.

- The floodlines derived from the analysis are indicated on attached (A3) drawings PB-13-286-FL01 & PB-13-286-FL02. Appendix C. An electronic file with the floodlines and grid layers will be e-mailed.

- During final analysis the retention effects caused by the main road bridge as well as the dam wall / weir were incorporated.

- NB! It is important to note that any foreign / manmade obstacles (i.e. ponds, access walkways etc) in the watercourse may result in the alteration of the present specified floodline.

- It is hereby **certified** that the floodlines indicated on the attached contour layout drawings, along the watercourse with a catchment area exceeding one square kilometre, represent the maximum flood level likely to be reached on an average every 100 years, by floodwater in the watercourse.

SECTION 4: LIST OF APPENDICES

Appendix A:	Hydrology and hydraulic calculations spreadsheets
Appendix B:	Cross-sections with 1:100 year flow depths indicated with "blue" lines (scales adjusted to fit pages)
Appendix C:	Floodlines (indicated on layout drawings attached (reauced to fit A3)
Appendix D:	Floodline certificate

SECTION 5: REFERENCES

a) Alexander WJR (1990)
Flood hydrology for Southern Africa, SANCOLD

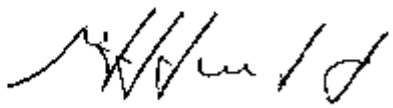
b) HRU (1972)
Design flood determination in South Africa, HRU Report 1/72, Wits University

c) Kovacs Z (1988)
Regional maximum flood peaks in Southern Africa, Z Kovacs, Technical Report TR137, Department of Water Affairs and Forestry

d) Midgley DC & Pitman WV (1978)
A depth-duration-frequency diagram for point rainfall in Southern Africa, HRU Report 1/78, Wits University

e) Op ten Noort & Stephenson (1982)
Regional DDF-equations representing the HRU 1/78 DDF-relationships

Compiled by:



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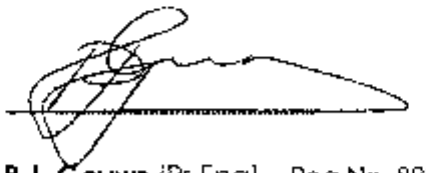

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APPENDIX A

Appendix A1

Piet Retief Town - Portions 100, 123 & 126 (Upper catchment)

CALCULATION OF (RMF) REGIONAL MAXIMUM FLOOD AND THE RECOMMENDED (SEF) SAFETY EVALUATION FLOOD

(TR 137 "DWAF" KOVACS - BASED ON THE FRANCOU-RODIER MODEL)

EMPIRICAL METHOD

Ke - determined value if applicable	0.0	Ke - value if determine otherwise "0"
Ke - envelope value	5.2	2.8 / 3.4 / 4 / 4.6 / 5 / 5.2 / 5.4 / 5.6
Watersurface at FSL (ha.)	N/A	In hectare
Areal catchment area (sq. km.)	14.818	Smaller than 10 use other method
Is the dam in the Southwest-Cape (Y/N) ?	N	Important for region 5

Zone	Transition zone
RMF	**452.5**
Q200	294.1
Q100	238.9
Q50	188.3
Q20*	90.5
RDF	**188.3**
** RMF - <>	384.9
** RMF + <>	532.0

PMF (Gratic)	**1297.1**
PMF (K-max)	**625.4**
PMF (Avg)	**961.2**
Q175	280.3
Q150	266.5
Q125	252.7
Q75	221.2
Q25	110.1

	Recommended SEF
PMF based	192.2
RMF based	384.9
Average SEF	**288.6**
SEF (Cat. I) < 10km² – Q175	N/A

Appendix A2

Piet Retief Town - Portions 100, 123 & 126 (Combined catchments)

CALCULATION OF (RMF) REGIONAL MAXIMUM FLOOD AND THE RECOMMENDED (SEF) SAFETY EVALUATION FLOOD

(TR 137 "DWAF" KOVACS - BASED ON THE FRANCOU-RODIER MODEL)

EMPIRICAL METHOD

Ce - determined value if applicable	0.0	Ke - value if determine otherwise "0"
Ke - envelope value	5.2	2.8 / 3.4 / 4 / 4.6 / 5 / 5.2 / 5.4 / 5.6
Watersurface of LS. (ha.)	N/A	In hectare
Areal catchment area (sq. km.)	17.73	Smaller than 10 use other methods
Is the dam in the Southwest-Cape (Y/N) ?	N	Important for region 5

Zone	Transition zone
RMF	**500.4**
Q200	325.3
Q100	264.2
Q50	208.2
Q20*	130.1
RDF	**208.2**
** RMF - <>	421.1
** RMF + <>	594.6

PMF (Gratic)	**1434.3**
PMF (K-max)	**706.6**
PMF (Avg)	**1070.5**
Q175	310.0
Q150	294.7
Q125	279.5
Q75	244.6
Q25	121.7

	Recommended SEF
PMF based	914.1
RMF based	421.1
Average SEF	**317.6**
SEF (Cat. I) < 10km² = Q175	N/A

RATIONAL METHOD # 1

Based on the Regional DDF-Equations representing the HRU 1/78 DDF-relationships (Op ten Noort & Stephenson, 1982)

PROJECT	Piet Retief Development Ptn 100 & 123 (Upper catchment)

CATCHMENT CHARACTERISTICS

Catchment Area	Total (A)	14.818	km²
Areal Weighting Factors: x + y + z = 1			
x (Rural)	y (Urban)	z (Lakes)	
0.70	0.30		

Effective (Ae)	14.8180	km²
Dolomitic (Ad)		km²
Ratio of Ad / A		%
Channelised Flow (Y/N)		Y
Overland Flow (Y/N)		N

Longest Watercourse (L)	5.230	km
Height Difference (H 10/85)	78	m
Mean Slope (S)	1.87	%
Mean Annual Rainfall (MAP)	687	mm
Time of Concentration (Tc)	1.10	hour
	66.1	min

Inland (Y/N)	Y
Coastal (Y/N)	N

C1

Steepness %		%A	Factor	Avg
10/85 Slope	< 1			
	1 - 3	100	0.05	0.050
	3 - 10			
	10 - 30			
	30 - 50			
	> 50			
Total %		100	Cs	0.050

Soil Permeability	%A	Factor	Avg
Very Permeable			
Permeable	5	0.08	0.004
Semi-Permeable	90	0.16	0.144
Impermeable	5	0.26	0.013
Total %	100	Cp	0.161
Total C1 Value		0.271	

Vegetation	%A	Factor	Avg
Forest Plantation	55	0.04	0.022
Dense Bush, Wood			
Thin Bush			
Cultivated Land	40	0.11	0.044
Grassland			
Bare Surface	5	0.28	0.014
Total %	100	Cv	0.080

C2

Urban for T < 21 Years

Occupation	%A	Factor	AVG
Lawns, Parks	10		0.015
Sandy flat < 2%			
Sandy 2 - 7%			
Sandy steep > 7%			
Heavy soil flat < 2%	10	0.150	0.015
Heavy soil 2 - 7%			
Heavy soil > 7%			
Residential	40		0.160
Single family area	40	0.400	0.160
Apartment dwelling			
Industrial	30		0.195
Light areas	30	0.650	0.195
Heavy areas			
Business	10		0.085
Downtown	10	0.850	0.085
Neighbourhood			
Streets	10	0.850	0.085
Total %	100		0.540

Urban for T21 to 50 Years

Occupation	%A	Factor	Avg
Lawns	10	0.450	0.045
Other	90	0.500	0.610
Total %	100		0.655

Urban for T > 50 Years

All included	100	1.000	1.000
Total C2 for T < 21			0.540
Total C2 for T21 - 50			0.655
Total C2 for T > 50			1.000

Surface Condition Factor (f)	0.35

STORM RAINFALL

Flood Frequency in Years	STORM DURATION (AS MULTIPLES OF Tc) IN HOURS											
	0.5	Tc (h) =	0.55	1.0	Tc (h) =	1.10	2.0	Tc (h) =	2.20	3.0	Tc (h) =	3.30
	D (mm)	ARF	I (mm/h)	D (mm)	ARF	I (mm/h)	D (mm)	ARF	I (mm/h)	D (mm)	ARF	I (mm/h)
2	31	0.970	55.49	35	0.985	35.17	46	1.000	20.94	52	1.000	15.84
5	41	0.970	72.97	52	0.985	46.27	61	1.000	27.57	65	1.000	19.79
10	51	0.970	89.83	64	0.985	56.29	75	1.000	33.74	81	1.000	24.37
20	63	0.970	110.60	78	0.985	70.17	92	1.000	41.76	99	1.000	30.00
50	83	0.970	145.49	105	0.985	92.36	121	1.000	55.00	130	1.000	39.49
100	102	0.970	179.24	127	0.985	113.71	149	1.000	67.72	161	1.000	48.62
200	125	0.970	220.67	157	0.985	140.33	184	1.000	83.37	190	1.000	57.56
PMF	405	0.970	713.28	506	0.985	452.71	594	1.000	269.56	640	1.000	193.57

RUN-OFF COEFFICIENT

Flood Frequency (Years)		2	5	10	20	50	100	200	PMF*
Rural	C1	0.102	0.112	0.122	0.134	0.165	0.204	0.244	0.590
Urban	C2	0.162	0.166	0.179	0.197	0.237	0.300	0.300	0.300
Combined	C	0.264	0.290	0.300	0.334	0.425	0.504	0.544	0.890
C1 adjusted for Ad									
Final adjusted C		0.264	0.290	0.300	0.334	0.426	0.504	0.544	0.890

* PMF = Cs + Cp max + Cv max

PEAK DISCHARGE

Flood Frequency (Years)		2	5	10	20	50	100	200	PMF*
Q (m³/s)	0.5 Tc	60.25	84.15	111.01	152.13	255.23	371.92	494.92	2616.17
	1.0 Tc	38.22	53.38	70.43	96.62	161.92	235.95	313.99	1659.74
	2.0 Tc	22.76	31.29	41.94	57.47	96.42	140.51	186.98	985.36
	3.0 Tc	16.34	22.93	30.11	41.57	69.24	100.99	154.26	709.60

FLOOD VOLUMES

Flood Frequency (Years)		2	5	10	20	50	100	200	PMF*
V (m³)	0.5 Tc	350 271	500 384	660 171	904 545	1 517 790	2 211 457	2 943 099	15 557 256
	1.0 Tc	227 294	317 458	418 795	578 942	962 907	1 404 116	1 667 155	9 469 870
	2.0 Tc	135 231	189 040	249 364	341 779	573 402	835 540	1 111 575	5 877 421
	3.0 Tc	97 196	136 729	179 371	245 415	411 723	599 936	798 975	4 230 245

RATIONAL METHOD # 1

Based on the Regional DDF-Equations representing the HRU 1/78 DDF-relationships (Op ten Noord & Stephenson, 1982)

PROJECT: **Piet Retief Development Ptn 100 & 123 (Total catchment)**

CATCHMENT CHARACTERISTICS

Catchment Area	Total (A)	17.733 km²	Effective (Ae)	17.320	km²	Longest Watercourse (L)	5.610	km
Areal Weighting Factors: x+y+z = 1			Determ. (Ad)		km²	Height Difference (H) "10/85"	104	m
x (Rural)	y (Urban)	z (Lakes)	Ratio Ae / A		%	Mean Slope (S)	1.85	%
0.70	0.30		Channelled Flow (Y/N)		Y	Mean Annual Rainfall (MAR)	667	mm
			Overland Flow (Y/N)		N	Time of Concentration (Tc)	1.76	hour
							59.7	min

Inland (Y/N)	Y
Coastal (Y/N)	N

C1

Steepness %		%A	Factor	Avg	Soil Permeability	%A	Factor	Avg
10 pct Slope	< 1				Very Permeable			
	1 - 3	100	0.05	0.050	Permeable	5	0.09	0.004
	3 - 10				Semi Permeable	90	0.16	0.144
	10 - 30				Impermeable	5	0.26	0.013
	30 - 50							
	> 50				Total %	100	Cp	0.161
Total %		100	Cr	0.200	Total C1 Value		0.291	

Vegetation	%A	Factor	Avg
Forest Plantation	55	0.04	0.022
Dense Bush, Wood			
Thin Bush			
Cultivated Land	10	0.11	0.044
Grassland			
Bare Surface	5	0.28	0.014
Total %	100	Cv	0.081

C2

Urban for T = 21 Years			
Occupation	%A	Factor	Avg
Lawns, Parks	10		0.015
Sandy flat < 2%			
Sandy 2 - 7%			
Sandy steep > 7%	10	0.150	0.015
Heavy soil flat < 2%			
Heavy soil 2 - 7%			
Heavy soil > 7%			
Residential	40		0.160
Single family urban	40	0.400	0.160
Apartment dwelling			
Industrial	30		0.195
Light areas	30	0.650	0.195
Heavy areas			
Business	10		0.085
Downtown	10	0.850	0.085
Neighborhood			
Streets	10	0.850	0.085
Total %	100		0.540

Urban for T 21 to 50 Years			
Occupation	%A	Factor	Avg
Lawns	10	0.450	0.045
Other	90	0.900	0.810
Total %	100		0.855

Urban for T > 50 Years			
All Included	100	1.000	1.000

Total C2 for T < 21	0.540
Total C2 for T 21 - 50	0.855
Total C2 for T > 50	1.000

Surface Condition Factor (F)	0.55

STORM RAINFALL

Flood frequency in Years	STORM DURATION (AS MULTIPLES OF tc) IN HOURS											
	0.5 tc (h) =		0.8	1.0 tc (h) =		1.5	2.0 tc (h) =		2.5	3.0 tc (h) =		3.4
	D (mm)	ARF	I (mm/h)	D (mm)	ARF	I (mm/h)	D (mm)	ARF	I (mm/h)	D (mm)	ARF	I (mm/h)
2	32	0.970	51.00	40	0.985	39.91	47	1.000	20.06	50	1.000	14.39
5	42	0.970	79.58	52	0.985	44.30	61	1.000	25.40	66	1.000	20.95
10	52	0.970	66.87	65	0.985	54.79	76	1.000	32.50	81	1.000	23.30
20	64	0.970	106.95	80	0.985	67.45	91	1.000	40.05	100	1.000	28.69
50	84	0.970	140.78	105	0.985	88.77	122	1.000	52.66	132	1.000	37.77
100	104	0.970	173.30	129	0.985	109.32	151	1.000	64.85	162	1.000	46.50
200	128	0.970	213.39	159	0.985	134.58	186	1.000	79.84	200	1.000	57.25
PMF	415	0.970	690.02	513	0.985	435.20	600	1.000	256.19	645	1.000	184.12

RUN-OFF COEFFICIENT

Flood frequency (Years)		2	5	10	20	50	100	200	PMF*
Rural	C1	0.102	0.112	0.122	0.136	0.157	0.204	0.241	0.895
Urban	C2	0.162	0.168	0.178	0.197	0.257	0.300	0.392	0.920
Combined	C	0.564	0.280	0.503	0.334	0.476	0.504	0.544	0.890
C1 adjusted for Ad									
Final adjusted C		0.294	0.350	0.420	0.494	0.424	0.504	0.544	0.895

* PMF = Cr + Cmax + Cr 0.10

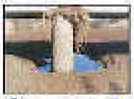
PEAK DISCHARGE

Flood Frequency (Years)		2	5	10	20	50	100	200	PMF*
Q (m³/s)	0.5 hr	69.72	97.57	128.46	176.00	248.36	430.39	572.74	3027.46
	1.0 hr	43.97	61.41	81.02	111.03	156.28	271.45	361.22	1909.62
	2.0 hr	26.09	36.43	48.06	65.87	110.51	161.03	214.29	1132.75
	3.0 hr	18.70	26.12	34.46	47.23	79.24	115.46	153.65	812.27

FLOOD VOLUMES

Flood Frequency (Years)		2	5	10	20	50	100	200	PMF*
V (m³)	0.5 hr	487 479	681 012	896 064	1 226 885	1 553 358	2 700 620	3 593 774	18 926 881
	1.0 hr	278 915	385 344	505 386	696 726	1 168 903	1 703 285	2 266 693	12 981 342
	2.0 hr	163 667	228 618	301 696	413 329	693 443	1 010 461	1 344 642	7 106 641
	3.0 hr	117 361	163 922	216 250	296 364	497 219	724 530	964 134	5 096 459

Utility Programs for Drainage
Flood calculations



Sinotech

Project name:	Flordline Analysis (Upper Catchment)
Analysed by:	MJ Joubert
Name of river:	Klipmeatelspruit
Description of site:	Piet Retief Town - Portions 100 & 123
Filename:	C:\Documents and Settings\Francois\My Documents\LEK\Piet Retief\Hydrology upper.fld
Date:	26 August 2013

Flood Frequency Analysis: Rational Method

Project	= Flordline analysis (upper catchment)
Analysed by	= MJ Joubert
Name of river	= Klipmeatelspruit
Description of site	= Piet Retief Town - Portions 100 & 123
Date	= 2013/08/26
Area of catchment	= [illegible] km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAP)	= [illegible] mm
Length of longest watercourse	= [illegible] km
Flow of water	= Defined water course
Height difference along 10-85 slope	= [illegible] m
Rainfall region	= Inland
Area distribution	= Rural: 70 %, Urban: 30 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	0	Houses	40	City centre	10
Sandy, steep (>7%)	0	Flats	0	Suburban	0
Heavy soil, flat (<2%)	10	Light industry	10	Streets	30
Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	0	Very permeable	0	Thick bush & forests	[illegible]
Flat area	100	Permeable	[illegible]	Light bush & cultivated land	40
Hilly	0	Semi-permeable	90	Grasslands	0
Steep areas	0	Impermeable	[illegible]	Bare	[illegible]

Average slope	= 0.00[illegible] m/m
Time of concentration	= [illegible] min
Run-off factor	
Rural - C1	= 0.[illegible]
Urban - C2	= 0.[illegible]
Lakes - C3	= 0.000
Combined - C	= 0.[illegible]

The HRU, Report 2/78, Depth-Duration-Frequency diagram was used to determine the point rainfall.

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m³/s)
1:2	0.92	45.6	27.2	45.3	0.75	33.1	54.77
1:5	0.92	55.2	27.1	54.4	0.68	34.2	76.16
1:10	0.92	65.8	26.3	68.2	0.88	35.5	99.20
1:20	0.92	66.3	[illegible]	83.6	0.90	36.4	139.33
1:50	0.92	112.2	96.1	107.6	0.95	37.5	161.41
1:100	0.92	128.1	98.7	128.9	1.00	39.7	208.63

Run-off coefficient percentage includes adjustment correction factors (Ft) for steep and impermeable catchments

Calculated using Utility Programs for Drainage 1.1.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name:	Floodline Analysis (Combined Catchments)
Analysed by:	MP Joubert
Name of river:	Klipmeerdspruit
Description of site:	Piet Retief Town - Portions 108 & 123
Filename:	C:\Documents and Settings\Francois\My Documents\LEC\Piet Retief\Hydrology\ otnf.fld
Date:	26 August 2013

Fri 16:26 Aug 30 2013 Page 1

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Flood Frequency Analysis: Rational Method

Project                                 - Floodline Analysis (Combined Catchments)
Analysed by                             - MP Joubert
Name of river                           - Klipmeerdspruit
Description of site                     - Piet Retief Town - Portions 108 & 123
Date                                    - 2013/08/26
Area of catchment                       - 33.3333 km²
Lakes/dam area                          - 0.0 %
Mean annual rainfall (MAR)              - 865.00 mm
Length of longest watercourse           - 8.03 km
Flow of water                           - Radial water drains
Height difference along longest slope   - 104.0 m
Rainfall region                         - Transv
Area distribution                       - Rural: 70 %,  Urban: 30 %,  Lakes: 0 %

Catchment description - Urban area (%)
Terrain                                 Residential and Industry suitable
Sandy, flat (<3%)           0           Bungs                   40  City centre         30
Sandy, steep (>7%)          0           Flats                   0   Suburbs             5
Loamy soil, flat (<3%)      10          Light Industry          20  Streets             20
Loamy soil, steep (>7%)     0           Heavy Industry          0   Mixed-use flood     0

Catchment description - Rural area (%)
Terrain slopes                          Permeability                Vegetation
Lakes and pans              0           Very permeable          0   Thick bush & forests        80
Flat areas                  100         Permeable               0   Light bush & cultivated land 45
Hilly                       0           Semi-permeable          90  Grasslands                  0
Steep areas                 0           Impermeable             5   Barren                      0
-------------------------------------------------------------------------------------------------
Average slope                           = 0.02072 m/m
Time of concentration                   = 1.34 h
Run-off factor
Rural - C1                              = 0.321
Urban - C2                              = 0.590
Lakes - C3                              = 0.300
Combined - C                            = 0.397
Use NOMO, Report 2/78, South Peninsa Frequency diagram you used to determine the point rainfall.

-------------------------------------------------------------------------------------------------
Return    Time of      Point       ARF     Average      Factor      Runoff      Peak
Period    Concentratio rainfall            intensity    F1          coefficient flow
(years)   Coverd       (mm)        (%)     (mm/h)                   (%)         (m³/s)
-------------------------------------------------------------------------------------------------
1:2       1.34         41.2        97.3    30.8         0.78        33.1        62.76
1:5       1.34         50.1        92.4    52.2         0.88        34.2        87.65
1:10      1.34         55.0        88.4    48.3         0.85        38.3        103.15
1:20      1.34         61.0        84.3    59.6         0.90        35.4        143.86
1:50      1.34         113.9       80.6    101.4        0.95        37.5        387.59
1:100     1.34         160.2       86.6    138.6        1.00        39.7        755.43
Run-off coefficient percentage includes adjustment saturation factors (F1) for steep and impervious
catchments

Calculated using Utility Programs for Drainage 1.1.0

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Plan: Plan 03 Klipmesselspruit AB RS: 100 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1224.80	Element			
Vel Head (m)	0.75	Wt. n-Val.		0.035	
W.S. Elev (m)	1224.05	Reach Len. (m)	20.50	20.50	20.50
Crit W.S. (m)	1224.20	Flow Area (m2)		45.60	
E.G. Slope (m/m)	0.017934	Area (m2)		45.60	
Q Total (m3/s)	175.00	Flow (m3/s)		175.00	
Top Width (m)	43.55	Top Width (m)		43.55	
Vel Total (m/s)	3.84	Avg. Vel. (m/s)		3.84	
Max Chl Dpth (m)	2.05	Hydr. Depth (m)		1.05	
Conv. Total (m3/s)	1333.0	Conv. (m3/s)		1333.0	
Length Wtd. (m)	20.50	Wetted Per. (m)		44.09	
Min Ch El (m)	1222.00	Shear (N/m2)		174.91	
Alpha	1.00	Stream Power (N/m s)		671.27	
Frctn Loss (m)		Cum Volume (1000 m3)		201.31	
C & E Loss (m)		Cum SA (1000 m2)		124.54	

Plan: Plan 03 Klipmesselspruit AB RS: 100 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1225.19	Element			
Vel Head (m)	0.89	Wt. n-Val.		0.035	
W.S. Elev (m)	1224.30	Reach Len. (m)	20.50	20.50	20.50
Crit W.S. (m)	1224.49	Flow Area (m2)		56.56	
E.G. Slope (m/m)	0.017234	Area (m2)		56.56	
Q Total (m3/s)	237.00	Flow (m3/s)		237.00	
Top Width (m)	47.97	Top Width (m)		47.97	
Vel Total (m/s)	4.17	Avg. Vel. (m/s)		4.17	
Max Chl Dpth (m)	2.30	Hydr. Depth (m)		1.19	
Conv. Total (m3/s)	1805.3	Conv. (m3/s)		1805.3	
Length Wtd. (m)	20.50	Wetted Per. (m)		48.54	
Min Ch El (m)	1222.00	Shear (N/m2)		197.98	
Alpha	1.00	Stream Power (N/m s)		825.19	
Frctn Loss (m)		Cum Volume (1000 m3)		247.44	
C & E Loss (m)		Cum SA (1000 m2)		137.86	

Plan: Plan 03 Klipmesselspruit AB RS: 99 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1223.66	Element			
Vel Head (m)	0.44	Wt. n-Val.		0.035	
W.S. Elev (m)	1223.24	Reach Len. (m)	25.00	25.00	25.00
Crit W.S. (m)	1223.18	Flow Area (m2)		59.43	
E.G. Slope (m/m)	0.010527	Area (m2)		59.43	
Q Total (m3/s)	175.00	Flow (m3/s)		175.00	
Top Width (m)	58.67	Top Width (m)		58.67	
Vel Total (m/s)	2.94	Avg. Vel. (m/s)		2.94	
Max Chl Dpth (m)	1.99	Hydr. Depth (m)		1.01	
Conv. Total (m3/s)	1705.6	Conv. (m3/s)		1705.6	
Length Wtd. (m)	25.00	Wetted Per. (m)		59.02	
Min Ch El (m)	1221.25	Shear (N/m2)		103.94	
Alpha	1.00	Stream Power (N/m s)		306.10	
Frctn Loss (m)	0.25	Cum Volume (1000 m3)		197.01	
C & E Loss (m)	0.31	Cum SA (1000 m2)		120.30	

Plan: Plan 03 Klipmesselspruit AB RS: 98 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1224.01	Element			
Vel Head (m)	0.66	Wt. n-Val.		0.035	
W.S. Elev (m)	1223.35	Reach Len. (m)	25.00	25.00	25.00
Crit W.S. (m)	1223.42	Flow Area (m2)		65.83	
E.G. Slope (m/m)	0.014125	Area (m2)		65.83	
Q Total (m3/s)	237.00	Flow (m3/s)		237.00	

Plan: Plan 03 Klipmesselspruit AB RS: 99 Profile: Q100 (Continued)

Top Width (m)	59.93	Top Width (m)			59.93
Vel Total (m/s)	3.60	Avg. Vel. (m/s)			3.60
Max Chl Dpth (m)	2.10	Hydr. Depth (m)			1.10
Conv. Total (m3/s)	1994.1	Conv. (m3/s)			1994.1
Length Wtd. (m)	25.00	Wetted Per. (m)			60.31
Min Ch El (m)	1221.25	Shear (N/m2)			151.21
Alpha	1.00	Stream Power (N/m s)			544.87
Frctn Loss (m)	0.28	Cum Volume (1000 m3)			242.08
C & E Loss (m)	0.00	Cum SA (1000 m2)			133.16

Plan: Plan 03 Klipmesselspruit AB RS: 98 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1222.60	Element			
Vel Head (m)	0.37	Wt. n-Val.		0.035	
W.S. Elev (m)	1222.23	Reach Len. (m)	21.67	21.67	21.67
Crit W.S. (m)	1222.22	Flow Area (m2)		64.71	
E.G. Slope (m/m)	0.013792	Area (m2)		64.71	
Q Total (m3/s)	175.00	Flow (m3/s)		175.00	
Top Width (m)	89.10	Top Width (m)		89.10	
Vel Total (m/s)	2.70	Avg. Vel. (m/s)		2.70	
Max Chl Dpth (m)	2.23	Hydr. Depth (m)		0.73	
Conv. Total (m3/s)	1490.1	Conv. (m3/s)		1490.1	
Length Wtd. (m)	21.67	Wetted Per. (m)		89.44	
Min Ch El (m)	1220.00	Shear (N/m2)		97.86	
Alpha	1.00	Stream Power (N/m s)		264.64	
Frctn Loss (m)	0.30	Cum Volume (1000 m3)		190.51	
C & E Loss (m)	0.00	Cum SA (1000 m2)		112.94	

Plan: Plan 03 Klipmesselspruit AB RS: 98 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1222.84	Element			
Vel Head (m)	0.44	Wt. n-Val.		0.035	
W.S. Elev (m)	1222.40	Reach Len. (m)	21.67	21.67	21.67
Crit W.S. (m)	1222.40	Flow Area (m2)		80.64	
E.G. Slope (m/m)	0.013641	Area (m2)		80.64	
Q Total (m3/s)	237.00	Flow (m3/s)		237.00	
Top Width (m)	96.67	Top Width (m)		96.67	
Vel Total (m/s)	2.94	Avg. Vel. (m/s)		2.94	
Max Chl Dpth (m)	2.40	Hydr. Depth (m)		0.83	
Conv. Total (m3/s)	2036.7	Conv. (m3/s)		2036.7	
Length Wtd. (m)	21.67	Wetted Per. (m)		97.02	
Min Ch El (m)	1220.00	Shear (N/m2)		110.37	
Alpha	1.00	Stream Power (N/m s)		324.38	
Frctn Loss (m)		Cum Volume (1000 m3)		234.96	
C & E Loss (m)		Cum SA (1000 m2)		126.52	

Plan: Plan 03 Klipmesselspruit AB RS: 97 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1221.68	Element			
Vel Head (m)	0.33	Wt. n-Val.		0.035	
W.S. Elev (m)	1221.35	Reach Len. (m)	22.25	22.25	22.25
Crit W.S. (m)	1221.29	Flow Area (m2)		68.32	
E.G. Slope (m/m)	0.010762	Area (m2)		68.32	
Q Total (m3/s)	175.00	Flow (m3/s)		175.00	
Top Width (m)	84.80	Top Width (m)		84.80	
Vel Total (m/s)	2.56	Avg. Vel. (m/s)		2.56	
Max Chl Dpth (m)	2.15	Hydr. Depth (m)		0.81	
Conv. Total (m3/s)	1686.9	Conv. (m3/s)		1686.9	
Length Wtd. (m)	22.25	Wetted Per. (m)		85.05	
Min Ch El (m)	1218.20	Shear (N/m2)		84.78	

Plan: Plan 03 Klipmesselspruit AB RS: 97 Profile: Q50 (Continued)

Alpha	1.00	Stream Power (N/m s)	217.14
Frctn Loss (m)	0.24	Cum Volume (1000 m3)	186.35
C & E Loss (m)	0.00	Cum SA (1000 m2)	107.41

Plan: Plan 03 Klipmesselspruit AB RS: 97 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1221.93	Element			
Vel Head (m)	0.50	Wt. n-Val.		0.035	
W.S. Elev (m)	1221.43	Reach Len. (m)	22.25	22.25	22.25
Crit W.S. (m)	1221.47	Flow Area (m2)		75.66	
E.G. Slope (m/m)	0.014771	Area (m2)		75.66	
Q Total (m3/s)	237.00	Flow (m3/s)		237.00	
Top Width (m)	88.06	Top Width (m)		88.06	
Vel Total (m/s)	3.13	Avg. Vel. (m/s)		3.13	
Max Chl Dpth (m)	2.20	Hydr. Depth (m)		0.86	
Conv. Total (m3/s)	1950.0	Conv. (m3/s)		1950.0	
Length Wtd. (m)	22.25	Wetted Per. (m)		89.32	
Min Ch El (m)	1219.20	Shear (N/m2)		124.10	
Alpha	1.00	Stream Power (N/m s)		388.72	
Frctn Loss (m)	0.32	Cum Volume (1000 m3)		229.87	
C & E Loss (m)	0.00	Cum SA (1000 m2)		119.52	

Plan: Plan 03 Klipmesselspruit AB RS: 98 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1220.72	Element			
Vel Head (m)	0.26	Wt. n-Val.		0.035	
W.S. Elev (m)	1220.46	Reach Len. (m)	25.00	25.00	25.00
Crit W.S. (m)		Flow Area (m2)		77.14	
E.G. Slope (m/m)	0.008623	Area (m2)		77.14	
Q Total (m3/s)	175.00	Flow (m3/s)		175.00	
Top Width (m)	97.21	Top Width (m)		97.21	
Vel Total (m/s)	2.27	Avg. Vel. (m/s)		2.27	
Max Chl Dpth (m)	2.16	Hydr. Depth (m)		0.79	
Conv. Total (m3/s)	1884.5	Conv. (m3/s)		1884.5	
Length Wtd. (m)	25.00	Wetted Per. (m)		97.56	
Min Ch El (m)	1218.30	Shear (N/m2)		66.86	
Alpha	1.00	Stream Power (N/m s)		151.89	
Frctn Loss (m)	0.22	Cum Volume (1000 m3)		180.10	
C & E Loss (m)	0.00	Cum SA (1000 m2)		99.48	

Plan: Plan 03 Klipmesselspruit AB RS: 98 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1220.95	Element			
Vel Head (m)	0.31	Wt. n-Val.		0.036	
W.S. Elev (m)	1220.64	Reach Len. (m)	25.00	25.00	25.00
Crit W.S. (m)		Flow Area (m2)		96.04	
E.G. Slope (m/m)	0.008623	Area (m2)		96.04	
Q Total (m3/s)	237.00	Flow (m3/s)		237.00	
Top Width (m)	108.56	Top Width (m)		108.56	
Vel Total (m/s)	2.47	Avg. Vel. (m/s)		2.47	
Max Chl Dpth (m)	2.34	Hydr. Depth (m)		0.88	
Conv. Total (m3/s)	2523.2	Conv. (m3/s)		2523.2	
Length Wtd. (m)	25.00	Wetted Per. (m)		108.92	
Min Ch El (m)	1218.30	Shear (N/m2)		76.29	
Alpha	1.00	Stream Power (N/m s)		188.25	
Frctn Loss (m)	0.22	Cum Volume (1000 m3)		222.47	
C & E Loss (m)	0.00	Cum SA (1000 m2)		119.99	

Plan: Plan 03 Klipmesselsprult AB RS: 95 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1219.64	Element			
Vel Head (m)	0.50	Wt. n-Val.		0.035	
W.S. Elev (m)	1219.14	Reach Len. (m)	21.00	21.00	21.00
Crit W.S. (m)	1219.14	Flow Area (m2)		63.14	
E.G. Slope (m/m)	0.012845	Area (m2)		63.14	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	66.36	Top Width (m)		66.36	
Vel Total (m/s)	3.12	Avg. Vel. (m/s)		3.12	
Max Chl Dpth (m)	2.64	Hydr. Depth (m)		0.95	
Conv. Total (m3/s)	1738.2	Conv. (m3/s)		1738.2	
Length Wtd. (m)	21.00	Wetted Per. (m)		66.76	
Min Ch El (m)	1216.50	Shear (N/m2)		119.13	
Alpha	1.00	Stream Power (N/m s)		371.69	
Frctn Loss (m)	0.27	Cum Volume (1000 m3)		173.02	
C & E Loss (m)	0.00	Cum SA (1000 m2)		90.77	

Plan: Plan 03 Klipmesselsprult AB RS: 95 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1219.95	Element			
Vel Head (m)	0.55	Wt. n-Val.		0.035	
W.S. Elev (m)	1219.40	Reach Len. (m)	21.00	21.00	21.00
Crit W.S. (m)	1219.40	Flow Area (m2)		81.45	
E.G. Slope (m/m)	0.012395	Area (m2)		81.45	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	77.02	Top Width (m)		77.02	
Vel Total (m/s)	3.29	Avg. Vel. (m/s)		3.29	
Max Chl Dpth (m)	2.90	Hydr. Depth (m)		1.06	
Conv. Total (m3/s)	2407.2	Conv. (m3/s)		2407.2	
Length Wtd. (m)	21.00	Wetted Per. (m)		77.43	
Min Ch El (m)	1216.50	Shear (N/m2)		127.87	
Alpha	1.00	Stream Power (N/m s)		420.70	
Frctn Loss (m)	0.26	Cum Volume (1000 m3)		213.32	
C & E Loss (m)	0.00	Cum SA (1000 m2)		100.99	

Plan: Plan 03 Klipmesselsprult AB RS: 94 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1218.43	Element			
Vel Head (m)	0.46	Wt. n-Val.		0.035	
W.S. Elev (m)	1217.96	Reach Len. (m)	21.50	21.50	21.50
Crit W.S. (m)	1217.96	Flow Area (m2)		65.36	
E.G. Slope (m/m)	0.013266	Area (m2)		65.36	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	74.24	Top Width (m)		74.24	
Vel Total (m/s)	3.01	Avg. Vel. (m/s)		3.01	
Max Chl Dpth (m)	2.48	Hydr. Depth (m)		0.88	
Conv. Total (m3/s)	1710.4	Conv. (m3/s)		1710.4	
Length Wtd. (m)	21.50	Wetted Per. (m)		74.57	
Min Ch El (m)	1215.50	Shear (N/m2)		114.03	
Alpha	1.00	Stream Power (N/m s)		343.70	
Frctn Loss (m)	0.31	Cum Volume (1000 m3)		167.75	
C & E Loss (m)	0.02	Cum SA (1000 m2)		84.92	

Plan: Plan 03 Klipmesselsprult AB RS: 94 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1218.72	Element			
Vel Head (m)	0.43	Wt. n-Val.		0.035	
W.S. Elev (m)	1218.29	Reach Len. (m)	21.50	21.50	21.50
Crit W.S. (m)	1218.22	Flow Area (m2)		91.80	
E.G. Slope (m/m)	0.010085	Area (m2)		91.80	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	

Plan: Par 03 Klipmosselspruit AB RS: 94 Profile: Q100 (Continued)

Top Width (m)	89.10	Top Width (m)		89.10
Vel Total (m/s)	2.92	Avg. Vel. (m/s)		2.92
Max Chl Dpth (m)	2.79	Hydr. Depth (m)		1.93
Conv. Total (m3/s)	2668.7	Conv. (m3/s)		2668.7
Length Wtd. (m)	21.50	Wetted Per. (m)		89.41
Min Ch El (m)	1215.50	Shear (N/m2)		101.50
Alpha	1.00	Stream Power (N/m s)		296.34
Frctn Loss (m)	0.14	Cum Volume (1000 m3)		206.57
C & E Loss (m)	0.05	Cum SA (1000 m2)		94.28

Plan: Plan 03 Klipmosselspruit AB RS: 93 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1217.35	Element			
Vel Head (m)	0.07	Wt. n-Val.		0.035	
W.S. Elev (m)	1217.28	Reach Len. (m)	22.33	22.33	22.33
Crit W.S. (m)		Flow Area (m2)		166.59	
E.G. Slope (m/m)	0.000746	Area (m2)		166.59	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	88.71	Top Width (m)		88.71	
Vel Total (m/s)	1.18	Avg. Vel. (m/s)		1.18	
Max Chl Dpth (m)	4.26	Hydr. Depth (m)		1.88	
Conv. Total (m3/s)	7201.0	Conv. (m3/s)		7201.0	
Length Wtd. (m)	22.33	Wetted Per. (m)		89.52	
Min Ch El (m)	1213.00	Sheer (N/m2)		13.66	
Alpha	1.00	Stream Power (N/m s)		16.15	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)		155.11	
C & E Loss (m)	0.00	Cum SA (1000 m2)		74.61	

Plan: Plan 03 Klipmosselspruit AB RS: 93 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1218.31	Element			
Vel Head (m)	0.05	Wt. n-Val.		0.035	
W.S. Elev (m)	1218.26	Reach Len. (m)	22.33	22.33	22.33
Crit W.S. (m)		Flow Area (m2)		262.45	
E.G. Slope (m/m)	0.000401	Area (m2)		262.45	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	109.22	Top Width (m)		109.22	
Vel Total (m/s)	1.02	Avg. Vel. (m/s)		1.02	
Max Chl Dpth (m)	5.26	Hydr. Depth (m)		2.40	
Conv. Total (m3/s)	13376.4	Conv. (m3/s)		13376.4	
Length Wtd. (m)	22.33	Wetted Per. (m)		110.15	
Min Ch El (m)	1213.00	Shear (N/m2)		9.38	
Alpha	1.00	Stream Power (N/m s)		9.56	
Frctn Loss (m)	0.01	Cum Volume (1000 m3)		180.33	
C & E Loss (m)	0.00	Cum SA (1000 m2)		80.94	

Plan: Plan 03 Klipmosselspruit AB RS: 92 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1217.30	Element			
Vel Head (m)	0.04	Wt. n-Val.		0.035	
W.S. Elev (m)	1217.26	Reach Len. (m)	50.00	50.00	50.00
Crit W.S. (m)	1216.85	Flow Area (m2)		217.18	
E.G. Slope (m/m)	0.000520	Area (m2)		217.18	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	130.89	Top Width (m)		130.86	
Vel Total (m/s)	0.91	Avg. Vel. (m/s)		0.91	
Max Chl Dpth (m)	4.36	Hydr. Depth (m)		1.66	
Conv. Total (m3/s)	8638.2	Conv. (m3/s)		8638.2	
Length Wtd. (m)	50.00	Wetted Per. (m)		132.22	
Min Ch El (m)	1212.90	Shear (N/m2)		8.38	

Plan: Plan 03 Klipmesselspruit AB RS: 92 Profile: Q50 (Continued)

Alpha	1.00	Stream Power (N/m s)	7.60
Frctn Loss (m)		Cum Volume (1000 m3)	142.32
C & E Loss (m)		Cum SA (1000 m2)	67.30

Plan: Plan 03 Klipmesselspruit AB RS: 92 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1216.28	Element			
Vel Head (m)	0.03	Wt. n-Val.		0.035	
W.S. Elev (m)	1216.26	Reach Len. (m)	50.00	50.00	50.00
Crit W.S. (m)	1216.09	Flow Area (m2)		357.56	
E.G. Slope (m/m)	0.000217	Area (m2)		357.56	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	148.93	Top Width (m)		148.93	
Vel Total (m/s)	0.75	Avg. Vel. (m/s)		0.75	
Max Chl Dpth (m)	5.35	Hydr. Depth (m)		2.40	
Conv. Total (m3/s)	18199.8	Conv. (m3/s)		18199.8	
Length Wtd. (m)	50.00	Wetted Per. (m)		150.39	
Min Ch El (m)	1212.90	Shear (N/m2)		3.06	
Alpha	1.00	Stream Power (N/m s)		3.79	
Frctn Loss (m)		Cum Volume (1000 m3)		162.61	
C & E Loss (m)		Cum SA (1000 m2)		72.16	

Plan: Plan 03 Klipmesselspruit AB RS: 91 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1215.02	Element			
Vel Head (m)	0.47	Wt. n-Val.		0.035	
W.S. Elev (m)	1214.55	Reach Len. (m)	23.29	23.29	23.29
Crit W.S. (m)	1214.56	Flow Area (m2)		65.18	
E.G. Slope (m/m)	0.012901	Area (m2)		65.18	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	72.24	Top Width (m)		72.24	
Vel Total (m/s)	3.02	Avg. Vel. (m/s)		3.02	
Max Chl Dpth (m)	1.85	Hydr. Depth (m)		0.90	
Conv. Total (m3/s)	1734.4	Conv. (m3/s)		1734.4	
Length Wtd. (m)	23.29	Wetted Per. (m)		72.52	
Min Ch El (m)	1212.70	Shear (N/m2)		113.71	
Alpha	1.00	Stream Power (N/m s)		343.67	
Frctn Loss (m)	0.30	Cum Volume (1000 m3)		135.26	
C & E Loss (m)	0.00	Cum SA (1000 m2)		62.23	

Plan: Plan 03 Klipmesselspruit AB RS: 91 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1215.33	Element			
Vel Head (m)	0.55	Wt. n-Val.		0.035	
W.S. Elev (m)	1214.78	Reach Len. (m)	23.29	23.29	23.29
Crit W.S. (m)	1214.78	Flow Area (m2)		81.75	
E.G. Slope (m/m)	0.012176	Area (m2)		81.75	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	76.77	Top Width (m)		76.77	
Vel Total (m/s)	3.28	Avg. Vel. (m/s)		3.28	
Max Chl Dpth (m)	2.08	Hydr. Depth (m)		1.06	
Conv. Total (m3/s)	2428.7	Conv. (m3/s)		2428.7	
Length Wtd. (m)	23.29	Wetted Per. (m)		77.10	
Min Ch El (m)	1212.70	Shear (N/m2)		126.60	
Alpha	1.00	Stream Power (N/m s)		415.03	
Frctn Loss (m)	0.28	Cum Volume (1000 m3)		151.82	
C & E Loss (m)	0.00	Cum SA (1000 m2)		66.52	

Plan: Plan 03 Klipmesselspruit AB RS: 90 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1208.35	Element			
Vel Head (m)	0.29	Wt. n-Val.		0.035	
W.S. Elev (m)	1208.06	Reach Len. (m)	20.00	20.00	20.00
Crit W.S. (m)		Flow Area (m2)		82.39	
E.G. Slope (m/m)	0.005099	Area (m2)		82.39	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	64.06	Top Width (m)		64.06	
Vel Total (m/s)	2.39	Avg. Vel. (m/s)		2.39	
Max Chl Dpth (m)	2.36	Hydr. Depth (m)		1.29	
Conv. Total (m3/s)	2758.7	Conv. (m3/s)		2758.7	
Length Wtd. (m)	20.00	Wetted Per. (m)		64.94	
Min Ch El (m)	1205.70	Shear (N/m2)		63.44	
Alpha	1.00	Stream Power (N/m s)		151.70	
Frctn Loss (m)	0.15	Cum Volume (1000 m3)		19.54	
C & E Loss (m)	0.02	Cum SA (1000 m2)		20.35	

Plan: Plan 03 Klipmesselspruit AB RS: 90 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1208.67	Element			
Vel Head (m)	0.39	Wt. n-Val.		0.035	
W.S. Elev (m)	1208.28	Reach Len. (m)	20.00	20.00	20.00
Crit W.S. (m)		Flow Area (m2)		97.24	
E.G. Slope (m/m)	0.005999	Area (m2)		97.24	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	69.00	Top Width (m)		69.00	
Vel Total (m/s)	2.76	Avg. Vel. (m/s)		2.76	
Max Chl Dpth (m)	2.58	Hydr. Depth (m)		1.41	
Conv. Total (m3/s)	3460.0	Conv. (m3/s)		3460.0	
Length Wtd. (m)	20.00	Wetted Per. (m)		68.97	
Min Ch El (m)	1205.70	Shear (N/m2)		81.76	
Alpha	1.00	Stream Power (N/m s)		225.34	
Frctn Loss (m)	0.16	Cum Volume (1000 m3)		24.59	
C & E Loss (m)	0.02	Cum SA (1000 m2)		22.61	

Plan: Plan 03 Klipmesselspruit AB RS: 89 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1207.25	Element			
Vel Head (m)	1.32	Wt. n-Val.		0.035	
W.S. Elev (m)	1205.94	Reach Len. (m)	22.50	22.50	22.50
Crit W.S. (m)	1206.35	Flow Area (m2)		38.73	
E.G. Slope (m/m)	0.035109	Area (m2)		38.73	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	41.67	Top Width (m)		41.67	
Vel Total (m/s)	5.09	Avg. Vel. (m/s)		5.09	
Max Chl Dpth (m)	1.53	Hydr. Depth (m)		0.93	
Conv. Total (m3/s)	1051.4	Conv. (m3/s)		1051.4	
Length Wtd. (m)	22.50	Wetted Per. (m)		41.81	
Min Ch El (m)	1204.40	Shear (N/m2)		318.88	
Alpha	1.00	Stream Power (N/m s)		1622.06	
Frctn Loss (m)	0.53	Cum Volume (1000 m3)		15.97	
C & E Loss (m)	0.06	Cum SA (1000 m2)		16.67	

Plan: Plan 03 Klipmesselspruit AB RS: 89 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1207.63	Element			
Vel Head (m)	1.43	Wt. n-Val.		0.035	
W.S. Elev (m)	1206.20	Reach Len. (m)	22.50	22.50	22.50
Crit W.S. (m)	1206.66	Flow Area (m2)		50.53	
E.G. Slope (m/m)	0.031210	Area (m2)		50.53	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	

Plan: Plan 03 Klipmesselsprult AB RS: 89 Profile: Q100 (Continued)

Top Width (m)	46.75	Top Width (m)		46.75
Vel Total (m/s)	5.30	Avg. Vel. (m/s)		5.30
Max Ch Depth (m)	1.80	Hydr. Depth (m)		1.08
Conv. Total (m3/s)	1517.0	Conv. (m3/s)		1517.0
Length Wtd. (m)	22.50	Wetted Per. (m)		46.92
Min Ch El (m)	1204.40	Shear (N/m2)		329.61
Alpha	1.00	Stream Power (N/m s)		1745.04
Frctn Loss (m)	0.48	Cum Volume (1000 m3)		20.14
C & E Loss (m)	0.06	Cum SA (1000 m2)		18.65

Plan: Plan 03 Klipmesselsprult AB RS: 88 Profile: Q50

E.G. Elev (m)	1206.14	Element	Left OB	Channel	Right OB
Vel Head (m)	0.80	Wt. n-Val.		0.035	
W.S. Elev (m)	1205.33	Reach Len. (m)	21.33	21.33	21.33
Crit W.S. (m)	1205.57	Flow Area (m2)		49.59	
E.G. Slope (m/m)	0.026791	Area (m2)		49.59	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	62.91	Top Width (m)		62.91	
Vel Total (m/s)	3.97	Avg. Vel. (m/s)		3.97	
Max Ch Dpth (m)	2.03	Hydr. Depth (m)		0.79	
Conv. Total (m3/s)	1203.6	Conv. (m3/s)		1203.6	
Length Wtd. (m)	21.33	Wetted Per. (m)		63.33	
Min Ch El (m)	1203.30	Shear (N/m2)		205.71	
Alpha	1.00	Stream Power (N/m s)		817.23	
Frctn Loss (m)	0.42	Cum Volume (1000 m3)		13.66	
C & E Loss (m)	0.02	Cum SA (1000 m2)		14.20	

Plan: Plan 03 Klipmesselsprult AB RS: 88 Profile: Q100

E.G. Elev (m)	1206.47	Element	Left OB	Channel	Right OB
Vel Head (m)	0.94	Wt. n-Val.		0.035	
W.S. Elev (m)	1205.53	Reach Len. (m)	21.33	21.33	21.33
Crit W.S. (m)	1205.79	Flow Area (m2)		62.38	
E.G. Slope (m/m)	0.026245	Area (m2)		62.38	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	69.34	Top Width (m)		69.34	
Vel Total (m/s)	4.30	Avg. Vel. (m/s)		4.30	
Max Ch Dpth (m)	2.23	Hydr. Depth (m)		0.90	
Conv. Total (m3/s)	1654.3	Conv. (m3/s)		1654.3	
Length Wtd. (m)	21.33	Wetted Per. (m)		69.77	
Min Ch El (m)	1203.30	Shear (N/m2)		230.13	
Alpha	1.00	Stream Power (N/m s)		988.63	
Frctn Loss (m)	0.46	Cum Volume (1000 m3)		17.33	
C & E Loss (m)	0.02	Cum SA (1000 m2)		15.96	

Plan: Plan 03 Klipmesselsprult AB RS: 87 Profile: Q50

E.G. Elev (m)	1204.86	Element	Left OB	Channel	Right OB
Vel Head (m)	0.83	Wt. n-Val.		0.035	
W.S. Elev (m)	1204.23	Reach Len. (m)	21.80	21.80	21.80
Crit W.S. (m)	1204.36	Flow Area (m2)		56.13	
E.G. Slope (m/m)	0.019003	Area (m2)		56.13	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	66.34	Top Width (m)		66.34	
Vel Total (m/s)	3.51	Avg. Vel. (m/s)		3.51	
Max Ch Dpth (m)	1.43	Hydr. Depth (m)		0.85	
Conv. Total (m3/s)	1429.1	Conv. (m3/s)		1429.1	
Length Wtd. (m)	21.80	Wetted Per. (m)		66.72	
Min Ch El (m)	1202.80	Shear (N/m2)		156.77	

Plan: Plan 03 Klipmesseisprult AB RS: 87 Profile: Q50 (Continued)

Alpha	1.00	Stream Power (N/m s)	650.25
Frctn Loss (m)	0.42	Cum Volume (1000 m3)	10.02
C & E Loss (m)	0.01	Cum SA (1000 m2)	5.94

Plan: Plan 03 Klipmesseisprult AB RS: 87 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1205.18	Element			
Vel Head (m)	0.75	Wt. n-Val.		0.035	
W.S. Elev (m)	1204.42	Reach Len. (m)	21.80	21.80	21.80
Crit W.S. (m)	1204.59	Flow Area (m2)		69.63	
E.G. Slope (m/m)	0.016391	Area (m2)		69.63	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	72.80	Top Width (m)		72.80	
Vel Total (m/s)	3.85	Avg. Vel. (m/s)		3.85	
Max Chl Dpth (m)	1.62	Hydr. Depth (m)		0.96	
Conv. Total (m3/s)	1924.4	Conv. (m3/s)		1924.4	
Length Wtd. (m)	21.80	Wetted Per. (m)		73.19	
Min Ch El (m)	1202.80	Shear (N/m2)		180.93	
Alpha	1.00	Stream Power (N/m s)		696.35	
Frctn Loss (m)	0.41	Cum Volume (1000 m3)		12.82	
C & E Loss (m)	0.00	Cum SA (1000 m2)		11.27	

Plan: Plan 03 Klipmesseleprult AB RS: 86 Profile: Q50

			Left OB	Channel	Right OB
E.G. Elev (m)	1202.98	Element			
Vel Head (m)	0.80	Wt. n-Val.		0.035	
W.S. Elev (m)	1202.19	Reach Len. (m)	24.50	24.50	24.50
Crit W.S. (m)	1202.34	Flow Area (m2)		49.81	
E.G. Slope (m/m)	0.016832	Area (m2)		49.81	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	44.85	Top Width (m)		44.85	
Vel Total (m/s)	3.96	Avg. Vel. (m/s)		3.96	
Max Chl Dpth (m)	2.59	Hydr. Depth (m)		1.11	
Conv. Total (m3/s)	1518.4	Conv. (m3/s)		1518.4	
Length Wtd. (m)	24.50	Wetted Per. (m)		45.19	
Min Ch El (m)	1199.60	Shear (N/m2)		181.92	
Alpha	1.00	Stream Power (N/m s)		719.53	
Frctn Loss (m)	0.37	Cum Volume (1000 m3)		4.13	
C & E Loss (m)	0.00	Cum SA (1000 m2)		3.91	

Plan: Plan 03 Klipmesseisprult AB RS: 86 Profile: Q100

			Left OB	Channel	Right OB
E.G. Elev (m)	1203.37	Element			
Vel Head (m)	0.98	Wt. n-Val.		0.035	
W.S. Elev (m)	1202.49	Reach Len. (m)	24.50	24.50	24.50
Crit W.S. (m)	1202.67	Flow Area (m2)		64.33	
E.G. Slope (m/m)	0.015979	Area (m2)		64.33	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	51.55	Top Width (m)		51.55	
Vel Total (m/s)	4.17	Avg. Vel. (m/s)		4.17	
Max Chl Dpth (m)	2.89	Hydr. Depth (m)		1.25	
Conv. Total (m3/s)	2120.1	Conv. (m3/s)		2120.1	
Length Wtd. (m)	24.50	Wetted Per. (m)		51.92	
Min Ch El (m)	1199.60	Shear (N/m2)		194.13	
Alpha	1.00	Stream Power (N/m s)		808.77	
Frctn Loss (m)	0.35	Cum Volume (1000 m3)		5.33	
C & E Loss (m)	0.00	Cum SA (1000 m2)		4.49	

Plan: Plan 03 Klipmosselspruit AB RS: 65 Profile: Q50

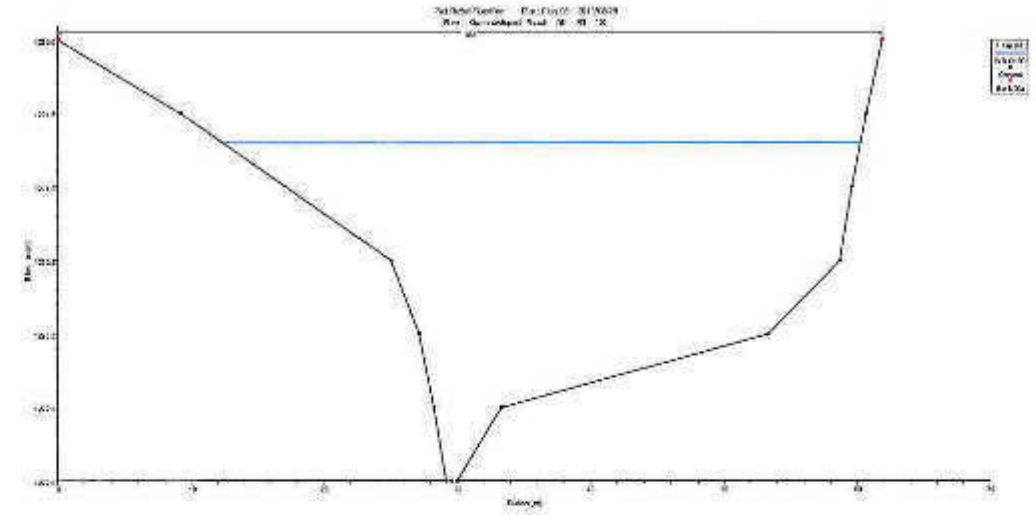
			Left OB	Channel	Right OB
E.G. Elev (m)	1200.46	Element			
Vel Head (m)	1.21	Wt. n-Val.		0.035	
W.S. Elev (m)	1199.25	Reach Len. (m)			
Crit W.S. (m)	1199.63	Flow Area (m2)		40.47	
E.G. Slope (m/m)	0.027469	Area (m2)		40.47	
Q Total (m3/s)	197.00	Flow (m3/s)		197.00	
Top Width (m)	35.46	Top Width (m)		35.46	
Vel Total (m/s)	4.87	Avg. Vel. (m/s)		4.87	
Max Ch Dpth (m)	2.55	Hydr. Depth (m)		1.05	
Conv. Total (m3/s)	1168.6	Conv. (m3/s)		1168.6	
Length Wtd. (m)		Wetted Per. (m)		38.63	
Min Ch El (m)	1196.70	Shear (N/m2)		283.74	
Alpha	1.00	Stream Power (N/m s)		1386.58	
Frctn Loss (m)	0.67	Cum Volume (1000 m3)			
C & E Loss (m)	0.00	Cum SA (1000 m2)			

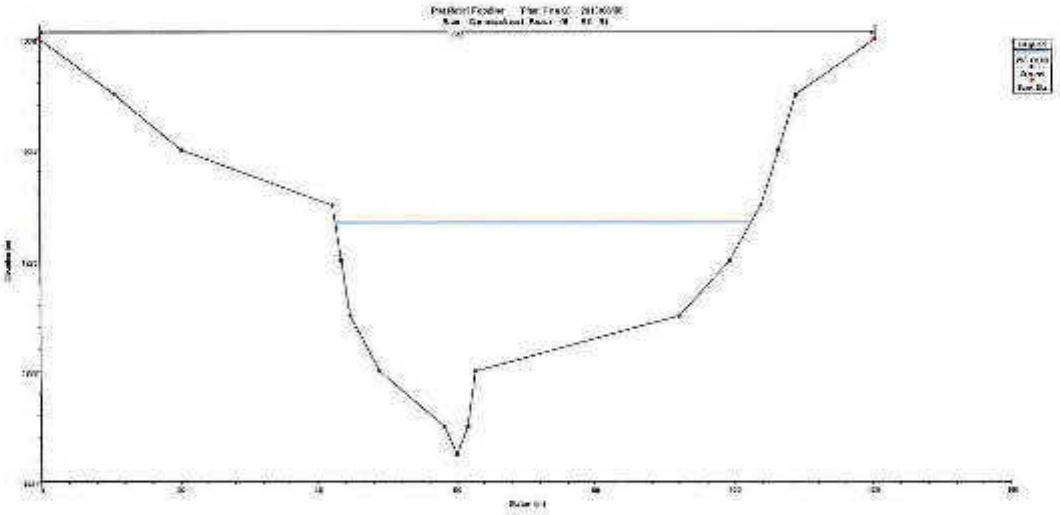
Plan: Plan 03 Klipmosselspruit AB RS: 65 Profile: Q100

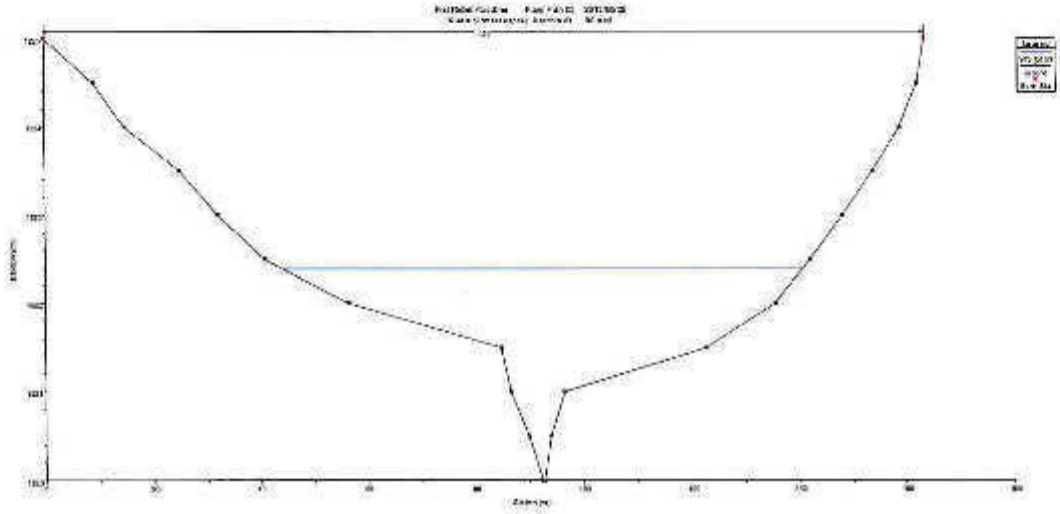
			Left OB	Channel	Right OB
E.G. Elev (m)	1200.89	Element			
Vel Head (m)	1.37	Wt. n-Val.		0.035	
W.S. Elev (m)	1199.52	Reach Len. (m)			
Crit W.S. (m)	1199.93	Flow Area (m2)		51.74	
E.G. Slope (m/m)	0.027077	Area (m2)		51.74	
Q Total (m3/s)	268.00	Flow (m3/s)		268.00	
Top Width (m)	44.33	Top Width (m)		44.33	
Vel Total (m/s)	5.18	Avg. Vel. (m/s)		5.18	
Max Ch Dpth (m)	2.82	Hydr. Depth (m)		1.17	
Conv. Total (m3/s)	1626.7	Conv. (m3/s)		1626.7	
Length Wtd. (m)		Wetted Per. (m)		44.74	
Min Ch El (m)	1196.70	Shear (N/m2)		307.08	
Alpha	1.00	Stream Power (N/m s)		1590.34	
Frctn Loss (m)	0.68	Cum Volume (1000 m3)			
C & E Loss (m)	0.00	Cum SA (1000 m2)			

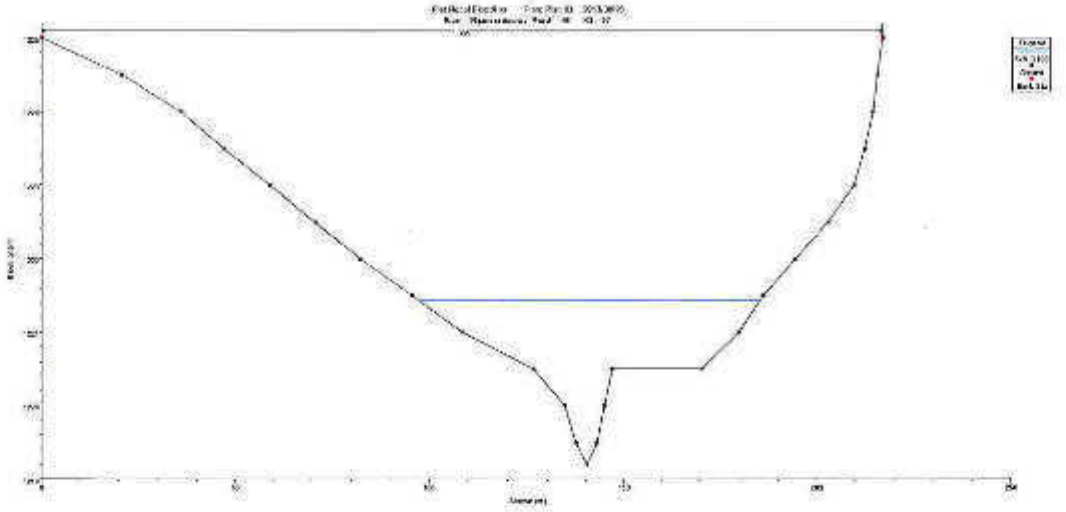
APPENDIX B

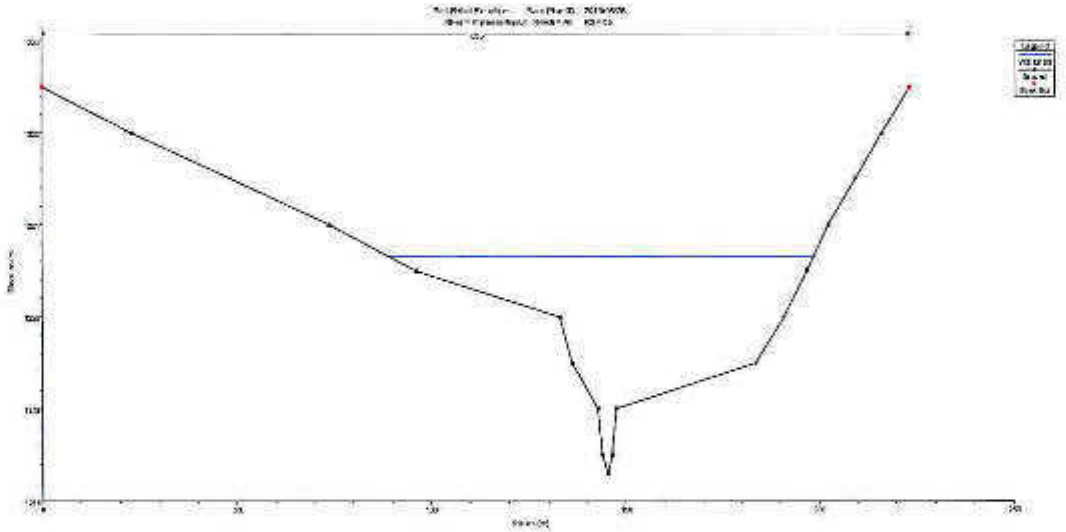
APPENDIX B: MAJOR CROSS-SECTIONS OF THE KLIPMESSELSPRUIT (RS100 – RS85)

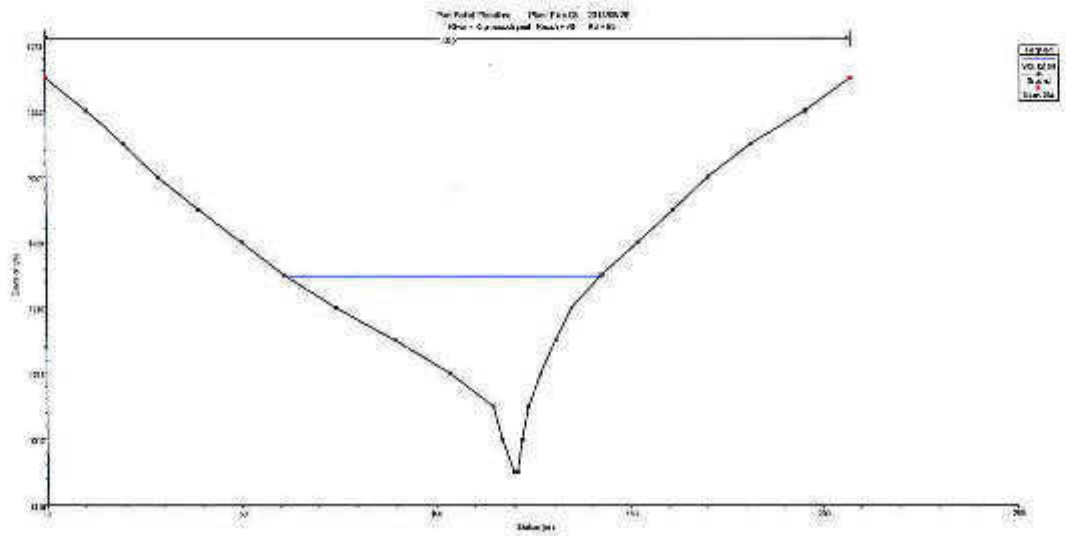


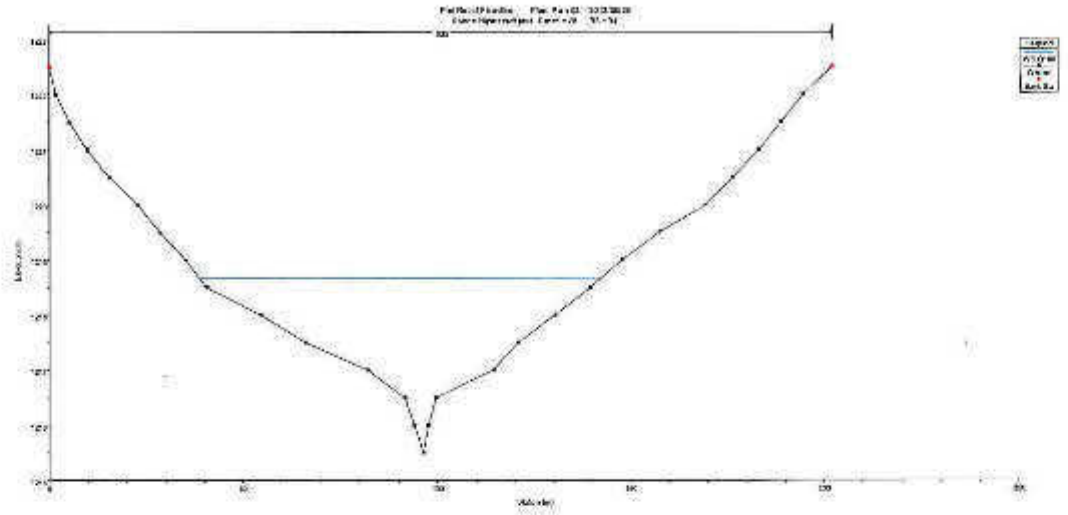


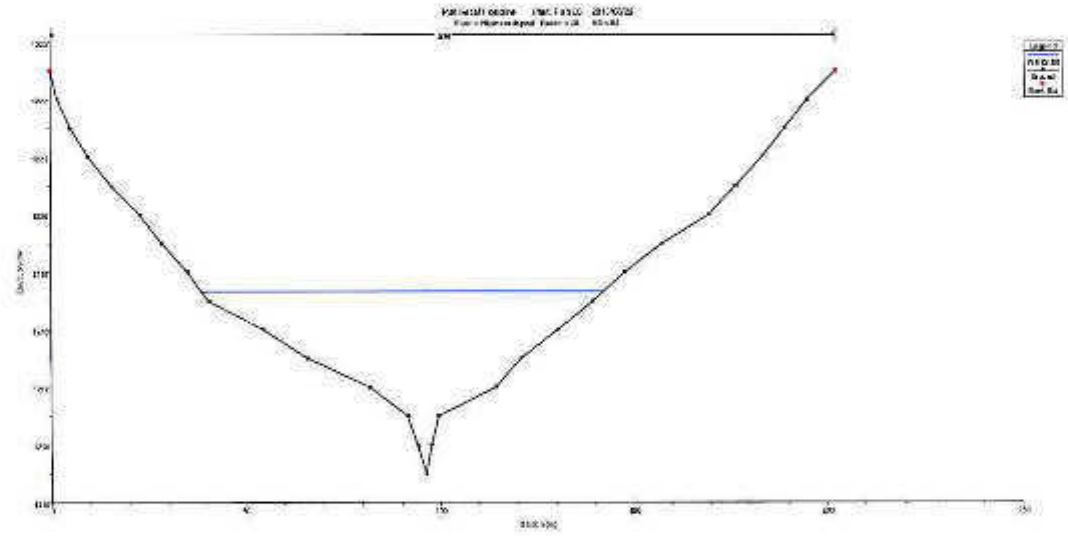


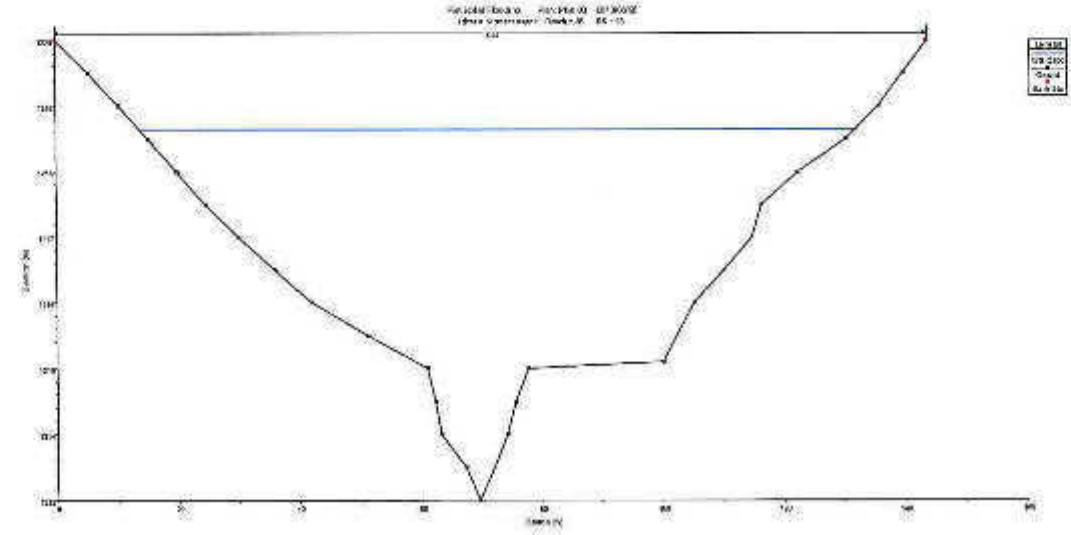


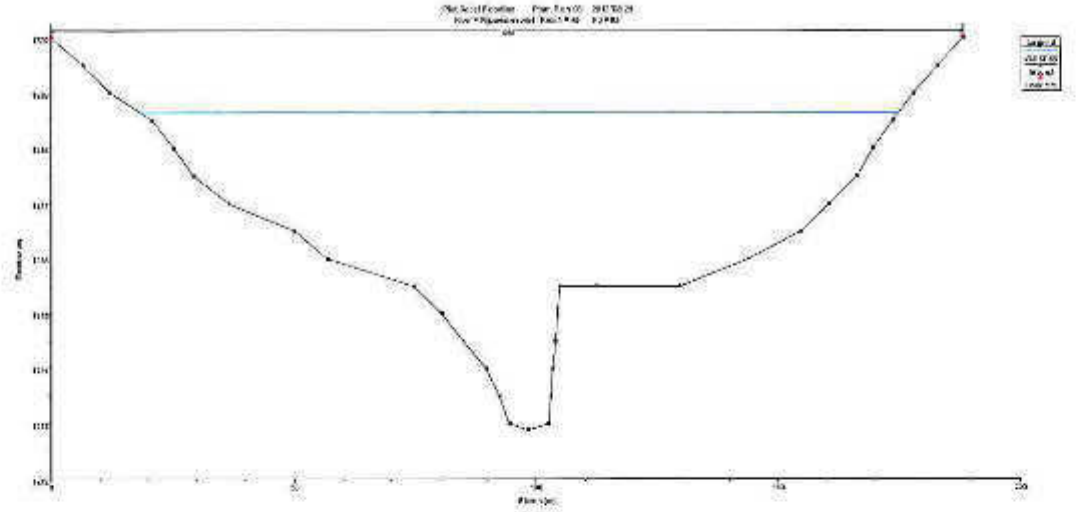


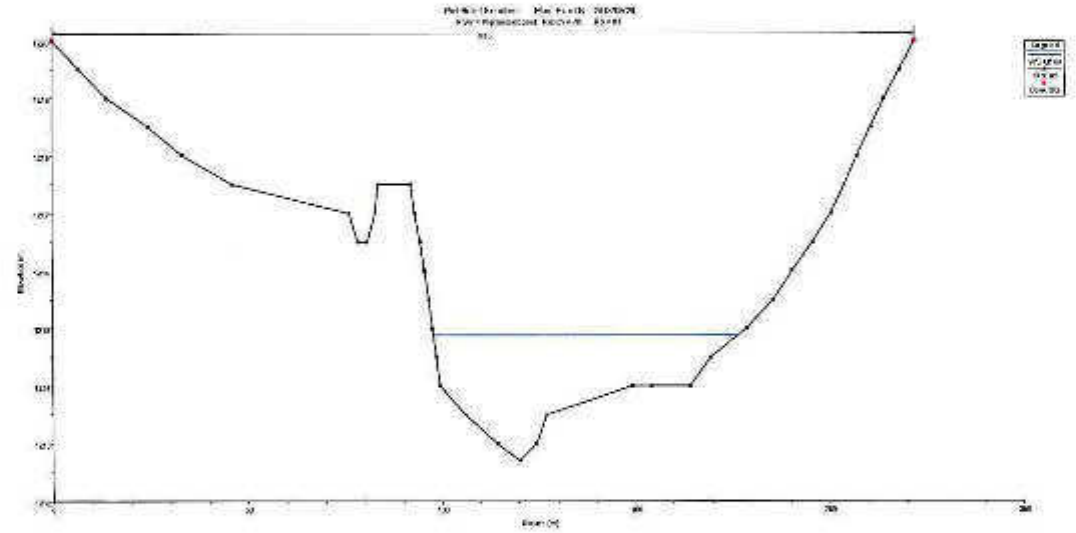


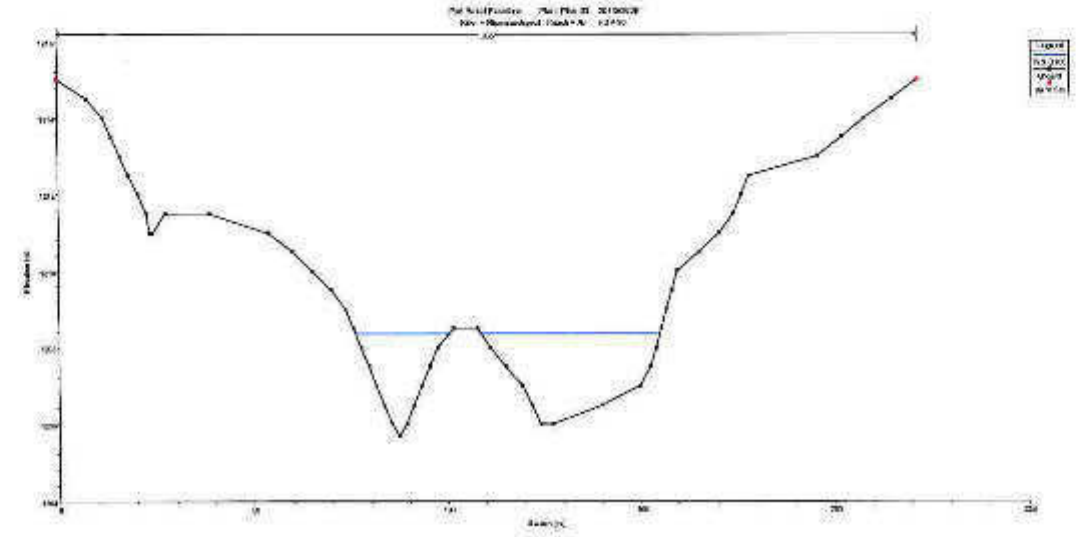


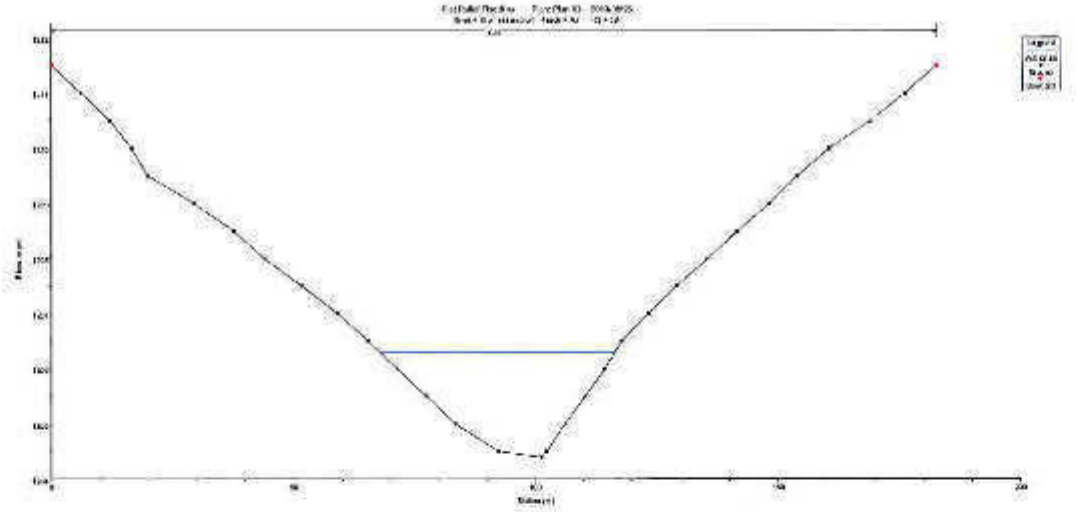


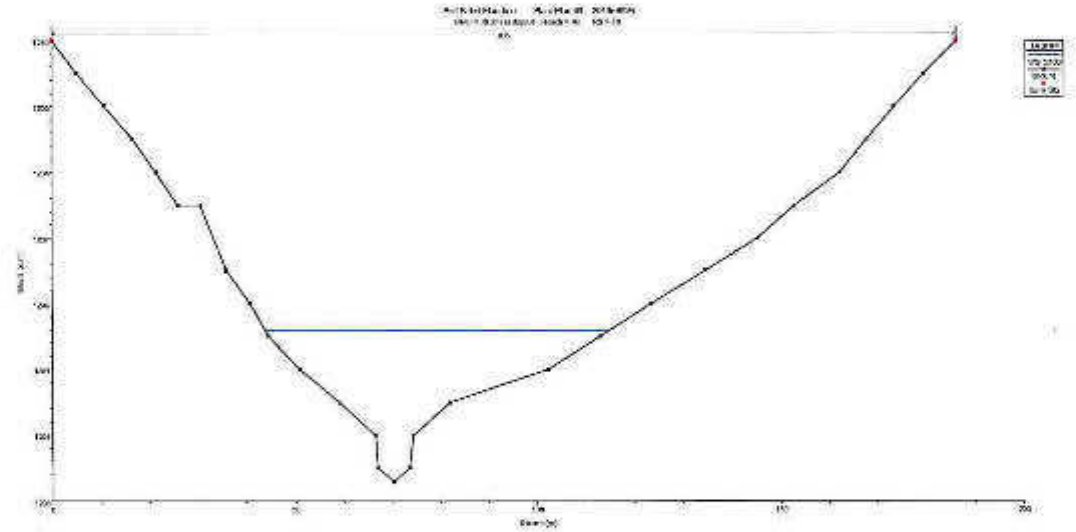


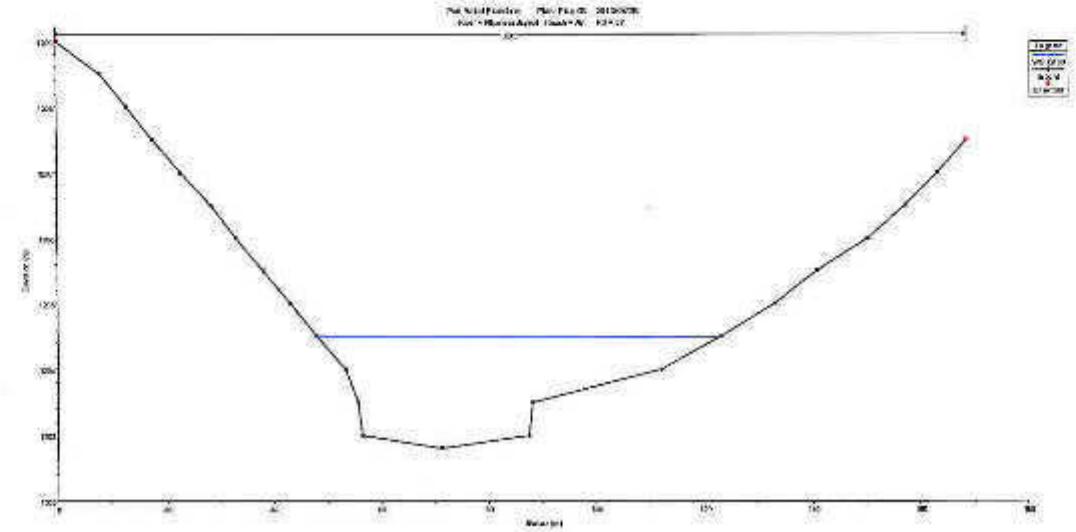


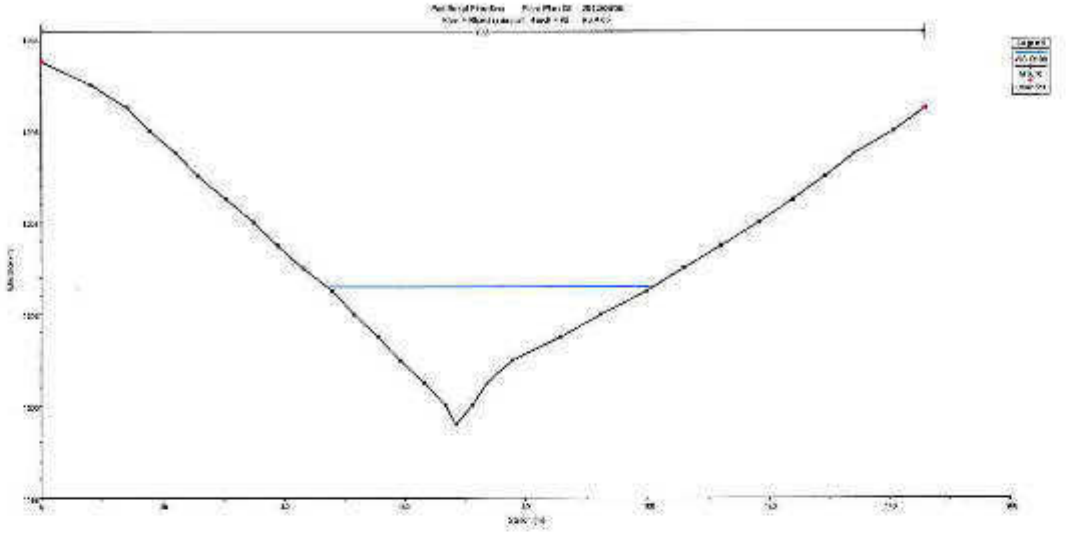


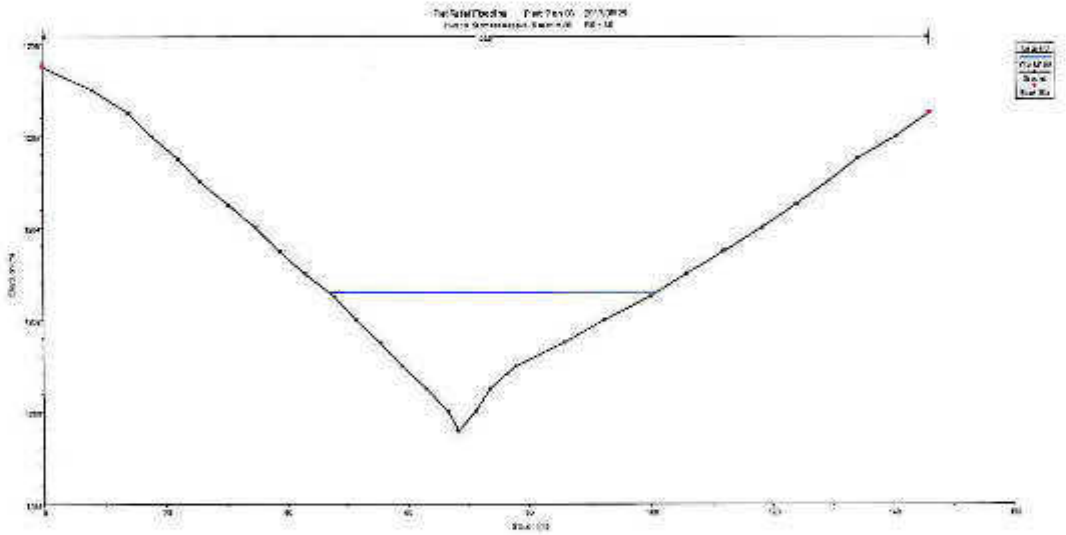












APPENDIX C

GENERAL NOTES:

REVISIONS

Nr	Date	Remarks	Checked

Client:

Anaprop Property Management

Consultants

PG CONSULTING

LEKWA

Project Title:

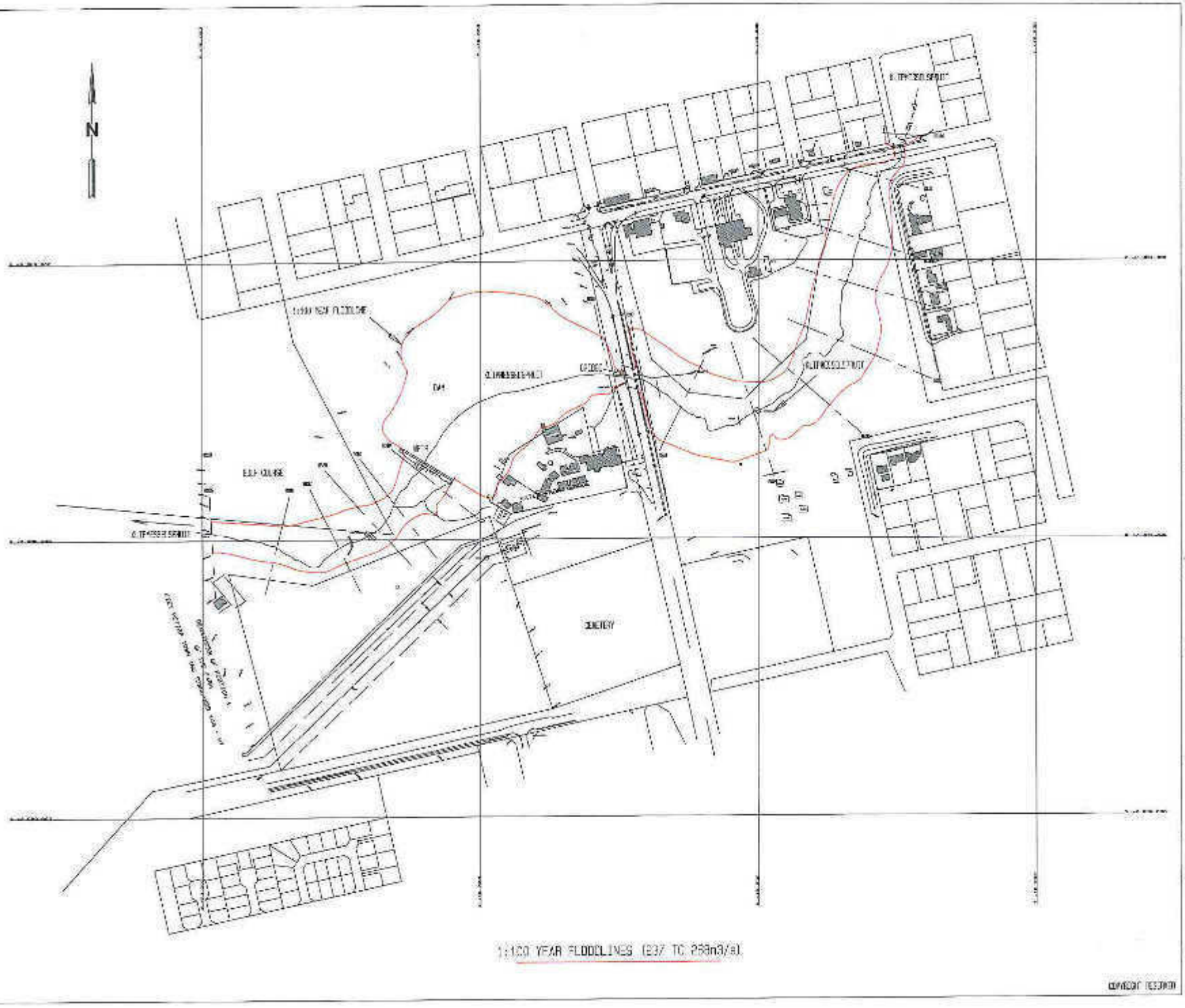
PROPOSED DEVELOPMENT
PORTIONS 100 & 129
PIET RETIEF TOWN LAND 149 HT

Drawing Title:

CERTIFIED 1:100 YEAR FLOODLINES

Surveyed	Drawn	Checked / Certified
MF JOUBERT Tech	M LOUBSER Tech	PJ BOOYS Pr Eng
Scale: 1 : 1000 (A0)	Date: 23/08/2019	Plot Size: A0

Project No	Drawing No	Rev
PG/13/280/PIET	FL01	A



GENERAL NOTES:

No	Date	Description	Checked
		REVISIONS	

Client:
Anaprop Property Management

Consultants:
PG CONSULTING
LEKWA

Project Title:
PROPOSED DEVELOPMENT
PORTIONS 130 & 123
PIET RETIEF TOWN (TOWNLAND 149 HT)

Drawing Title:
CERTIFIED 1:100 YEAR FLOODLINES

Designed	Drawn	Checked / Certified
MF JOUBERT Tech	MF JOUBERT Tech	PJ BOSHOFF Pr Eng
Scale	Date	Plot Size
1 : 1000 (A3)	23/08/2013	A3

Project No.	Drawing No.	Rev
PD/13/280/PIET	F_02	A

APPENDIX D

PG Consulting Engineers (Pty) Ltd.
Reg Nr. 2012/039090/07
VAT No. 4260861278

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P.O. Box 11770, Bendor Park, 0713
Rentco Office No.16, 11 Pierre Street,
Bendor, Polokwane, 0699
GPS: S'23'53'41,2" E'29'28'46,4"
Website: www.pgconsulting.co.za

Offices also at: Polokwane | Pretoria | Nelspruit

PG CONSULTING
WATERTIGHT ENGINEERING

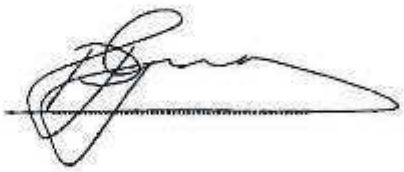
PROJECT

DELINEATION OF THE 1:100 YEAR FLOODLINES FOR DEVELOPMENT PURPOSES AT PORTIONS 100, 123 & 126 – PIET RETIEF TOWN (TOWNLAND 149 HT)

DISTRICT OF GERT SIBANDE – MPUMALANGA PROVINCE

FLOODLINE CERTIFICATE:

I HEREBY CERTIFY, IN MY CAPACITY AS PROFESSIONAL ENGINEER, THAT IN TERMS OF THE SPECIFICATIONS LAID DOWN BY CLAUSE 144 OF THE NATIONAL WATER ACT (ACT 36 OF 1998), THE FLOODLINES INDICATED ON THE ATTACED LAYOUT DRAWING REPRESENT THE MAXIMUM FLOOD LEVELS LIKELY TO BE REACHED ON AN EVERY 100 YEARS BY FLOODWATERS IN THE SPECIFIC WATERCOURSE ANALYZED (SECTION RS100 TO RS85 OF THE KLIPMESSELSPRUIT – TRIBUTARY OF ASSEGAAI RIVER).



NAME: **P.J. Gouws (Pr Eng)**
REG NO: **880061**
DATE: **26 August 2013**

Appendix D7:

Feasibility Report

PLEASE NOTE: This is an objective, independent market report with the sole aim of limiting risk for our client and to optimize development potential. Similarly, Fernridge cannot be held responsible for the failure or under performance of any development, as many other aspects, apart from demographic potential, determine the ultimate success or failure of a scheme.

Department: Development

Feasibility Study Update:

Piet Retief, Mpumalanga
Retail Development

October 2013

Important Notes:

1. This report is Confidential as it contains Data, Information and Intellectual Property of Fernridge Consulting (Limited Distribution)
2. This report was done to determine the viability of a shopping centre. Any tenant recommendations made in this report are anecdotal and not substantiated through primary research. Retailers must do their own research.

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Table of Content

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Orientation

Piet Retief is placed in context of the larger area in order to provide a regional overview/understanding of the area.

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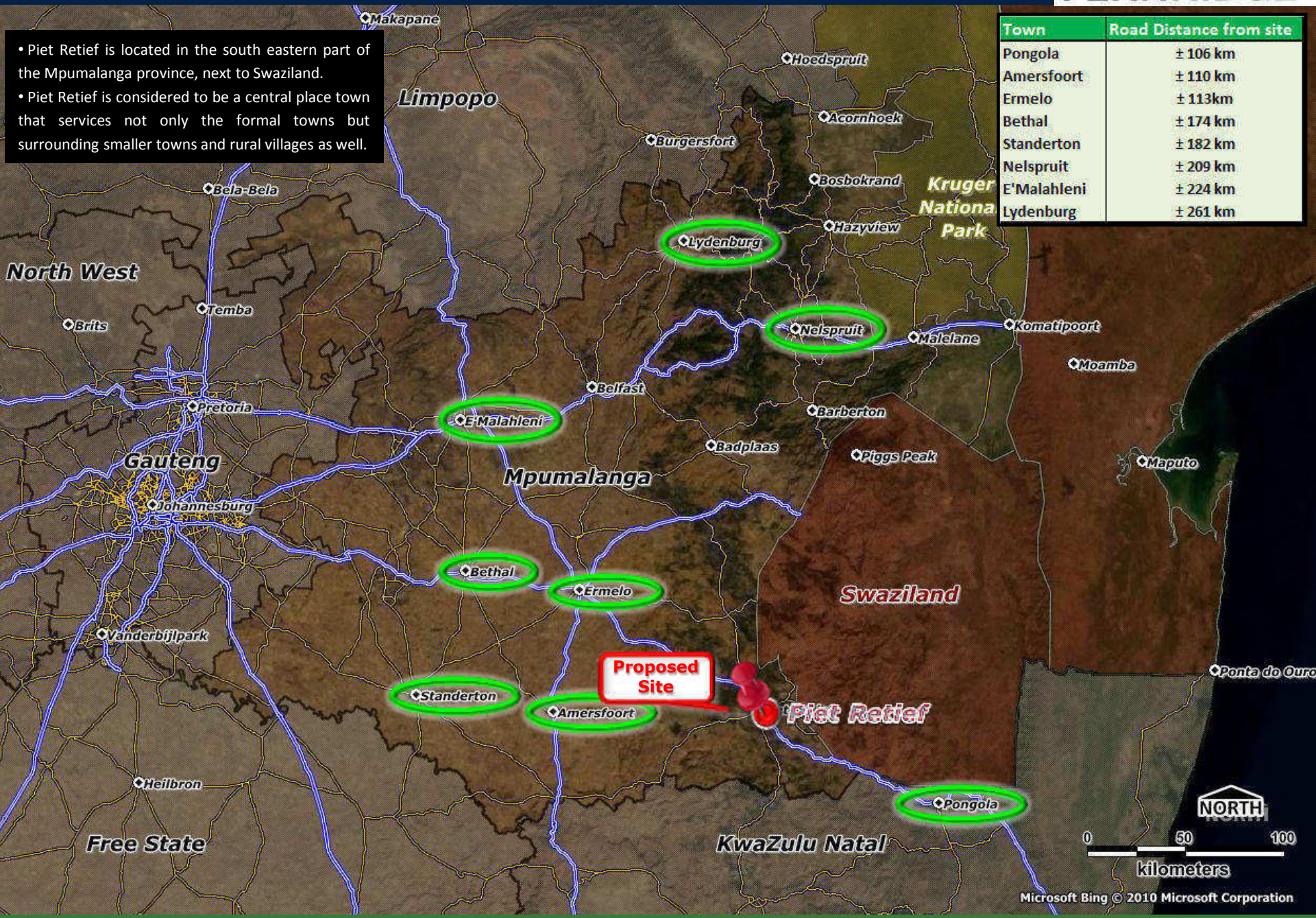
- Piet Retief is located in the south eastern part of the Mpumalanga province, next to Swaziland.
- Piet Retief is considered to be a central place town that services not only the formal towns but surrounding smaller towns and rural villages as well.

Town	Road Distance from site
Pongola	± 106 km
Amersfoort	± 110 km
Ermelo	± 113km
Bethal	± 174 km
Standerton	± 182 km
Nelspruit	± 209 km
E'Malahleni	± 224 km
Lydenburg	± 261 km



Town Orientation

Source: 2012 Aerial Photography & Oct'13 Fieldwork

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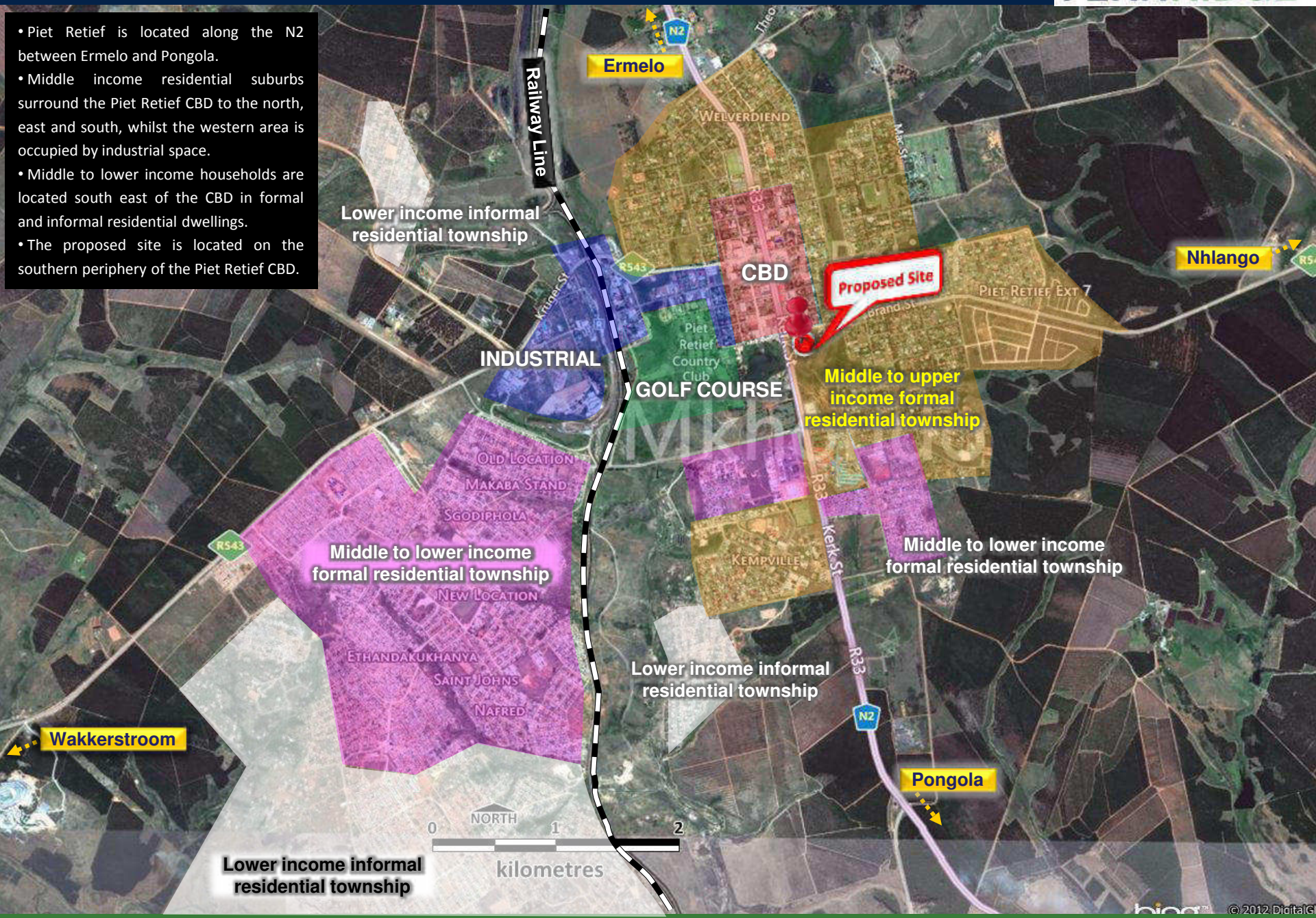
- Piet Retief is located along the N2 between Ermelo and Pongola.
- Middle income residential suburbs surround the Piet Retief CBD to the north, east and south, whilst the western area is occupied by industrial space.
- Middle to lower income households are located south east of the CBD in formal and informal residential dwellings.
- The proposed site is located on the southern periphery of the Piet Retief CBD.



Catchment Areas

A primary and secondary catchment area are delineated after taking the physical and psychological boundaries, existing retail, road infrastructure, etc. into consideration.

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Catchment Area

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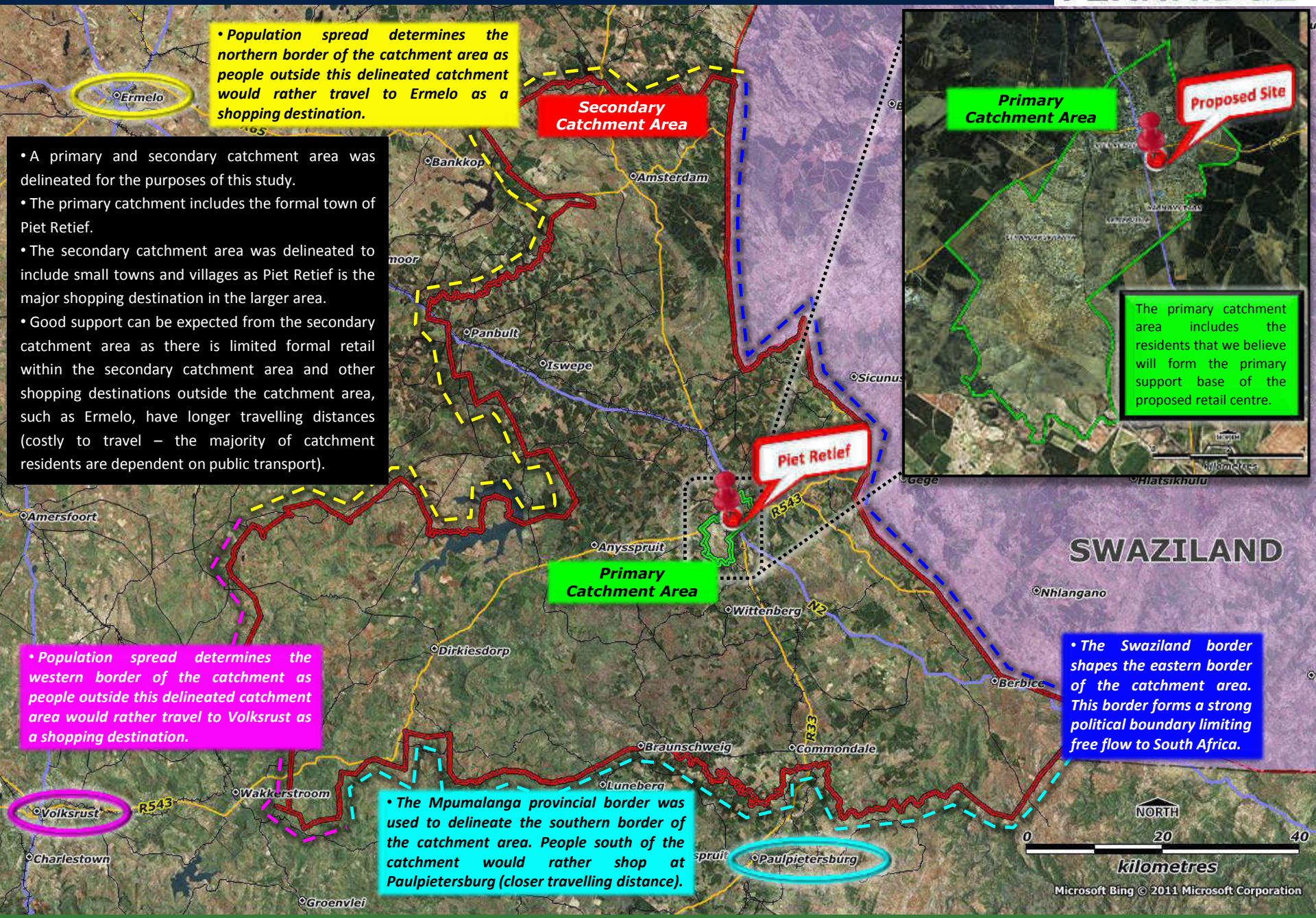

The Site

Site dynamics is a crucial element that needs to be assessed. A poor site could jeopardise the development.

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Site Dynamics

Source: Oct'13 Fieldwork

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- The proposed site is located on the corner of the N2 and Brand Street.
- The N2 is a busy road and experiences high traffic volumes throughout the day.
- Visibility from this road is very good – residents and passing trade will have a high awareness of the centre.
- The site is located just south of the main retail activity currently present in Piet Retief (CBD).
- Many of the secondary catchment residents travel via the N2 Rd to access the CBD.
- The site is ideally located to intercept this market en route to the CBD.
- It is important that the proposed centre caters for all market segments (lower, middle and upper income).

Please Note: The formal taxi rank is currently under construction and accordingly the majority of taxis now stop in Mark St.

Source: Oct'13 Fieldwork

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1

2