R Wesso
Director: Civil Engineering Services
E-mail: rwesso@george.gov.za
Tel: +27 (0)44 801 9278

Reference number: Erf 464, GRDam Development
Date: 28 October 2020

Enquiries: L Mooiman
044 801 9353

ZUTARI
PO BOX 509
GEORGE
6530
Rudolf.Schroder@zutari.com

ATTENTION: MR. RUDOLF SCHRODER

ERF 464, GEORGE: REZIONING AND SUB-DIVISION (GARDEN ROUTE DAM DEVELOPMENT): AVAILABILITY OF MUNICIPAL CIVIL SERVICES

With reference to the proposed development, the following refers.

The municipality confirms that the proposed development is included in the general growth and development infrastructure planning for George Municipality. This pertains to water (raw water and potable), effluent, roads infrastructure and stormwater.

In line with general growth and demand, the new supporting bulk infrastructure must be constructed, and existing infrastructure upgraded where necessary to accommodate the services demand of all new development in George.

No development may connect to the municipal system unless the required bulk and link infrastructure is available. Specific standard development conditions are therefore stipulated during the municipal landuse application process and detailed in a services agreement between the George Municipality and the approved development. Unless the developer meets the requirements set out in the services agreement, the development will not be allowed to proceed.

It is to be noted that the George Municipality is in the process of extending the capacity at the Outeniqua Waste Water Treatment Works with final commissioning of the works anticipated in 2023. The George Municipality is also upgrading and rehabilitating various large and strategic sewer pump stations. The development will not be permitted to connect to the municipal sewer network until the necessary capacity is available. The phased implementation of the development may be taken into account if development is intended to be implemented over a period of time.

We trust the above information to be sufficient. Please do not hesitate to contact Lindsay Mooiman if any additional information is required.

Yours faithfully,

R Wesso
DIR: CIVIL ENGINEERING SERVICES

L Mooiman

REZONING AND DEVELOPMENT OF ERF 464

Engineering Services Report

George Municipality

Reference: 504255

Revision: 1

31 January 2020

aurecon

Bringing ideas to life

Document control record

Document prepared by:

Aurecon South Africa (Pty) Ltd
Reg No 1977/003711/07
Suite 201
2nd Floor
Bloemhof Building
65 York Street
George 6529
PO Box 509
George 6530
South Africa

T +27 44 874 2165
F +27 44 873 5843
E george@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title		Engineering Services Report				
Document ID		504255/1	**Project number**		504255	
File path		Document				
Client		George Municipality				
Client contact		D. Gelderbloem	**Client reference**		Erf 464	
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
0	19 July 2019	Engineering services report	Errol Witbooi	Marius Botha	-	Andre Keyser
1	31 January 2020	Engineering services report	Errol Witbooi	Marius Botha		Andre Keyser
Current revision		**1**				

Approval			
Author signature		Reviewer signature	
Name	Errol Witbooi	Name	Marius Botha
Title	Civil Technician	Title	Associate
Approver signature			
Name	Andre Keyser		
Title	Office Manager		

Contents

1 INTRODUCTION

1.1 Brief

George Municipality identified the need for the development of the Erf 464 into various development categories. The George area has seen a period of rapid growth in recent years which has had the effect that the demand for additional Tertiary education facilities with ancillary facilities as well as residential spaces and commercial properties has increased.

George Municipality is in the process of submitting an Environmental Authorization and Re-zoning Application for the proposed development of Erf 464.

1.2 General

The proposed development is situated opposite Madiba Drive towards the North-East of the George CBD and adjacent to the existing Garden Route Dam. A locality plan of the development area is given in Figure 1 below. The climate is moderate, with rainfall occurring mainly during autumn with the mean annual precipitation being in the order of 849mm. The temperature ranges from 18.2ºC in July to 27.6ºC in February.

Figure 1: Locality Plan

The proposed Site Development Plan is attached hereto. The development can be divided into the following broad categories:

A land use breakdown of the site is given in Table 1. The Site Development Plan for the proposed development is attached as Annexure A.

Table 1: Land use scheme Erf 464

Zoning	Land use Description	Extent (+/- ha)	% of Total (Approximated)
Community Zone I	Campus – University/Research institute/ Academy	13.66	12
Business Zone I	Waterfront commercial development	4.66	4
General Residential Zone VI	Hotel	1.55	1
General Residential Zone II	Medium density residential/Group housing	5.47	5
General Residential Zone IV	Apartments / Flats / Student Housing	4.84	4
Single Residential Zone VI	Free standing dwelling houses	5.76	5
Open Zone II	Recreational Spaces / Sport fields	7.57	6
Open Zone II	Parks / Natural Assets / Preservation Areas	67.90	57
Transport Zone II	Roads	7.60	6
TOTAL		**118.5 (ha)**	**100%**

2 BULK WATER SUPPLY SYSTEM

2.1 General Description

George is supplied with water mainly from the Garden Route Dam, but makes use of various other pumped sources such as from the Gwaiing River. The water is purified at the George WTP (Water Treatment Plant).

Water is supplied to all areas within George through a network of bulk water lines distributing water to and from each reservoir supply area.

The George Municipal Water Master Plan indicates that the proposed development falls within the George Main zone.

2.2 Proposed Water Demand for Development

Our calculations are based on the “Guidelines for Human Settlement Planning and Design”.

Existing network capacity as well as proposed upgrades in the vicinity of the site have been confirmed by the Municipality through the recent report done by GLS Consulting through their appointment by George Municipality, to draw up the Water and Sewer Master Plan for the Municipal area and to determine the effect of any form of development in the Municipal Area on the Water and Sewer Master Plan. The proposed development SDP (Site Development Plan) was submitted to GLS in order to determine whether the existing water network system has sufficient capacity.

According to GLS report, dated 14 June 2019, the existing WTP’s and network has insufficient capacity to accommodate the proposed development. (See GLS Report attached)

According to Table 9.14: Water Demand from “Guidelines for Human Settlement Planning and Design”, the following calculation was done to determine the Annual Average Daily Demand (AADD) for the various Land Uses:

Land use Description	Calculations	Annual Average Daily (AADD)
Campus – University/Research institute/ Academy	$\left(\frac{163920\ m^2}{100\ m^2}\right)\ x\ 600$	983520 ℓ/day
Waterfront commercial development	$\left(\frac{41500\ m^2}{100\ m^2}\right)\ x\ 650$	269750 ℓ/day
Hotel	$\left(\frac{46500\ m^2}{100\ m^2}\right)\ x\ 900$	418500 ℓ/day
Medium density residential/Group housing	191 erven x 600ℓ/erf/day	114600 ℓ/day
Student Housing	1000 erven x 500ℓ/erf/day	500000 ℓ/day
Apartments / Flats / Student Housing	1210 erven x 500ℓ/erf/day	605000 ℓ/day
Free standing dwelling houses	91 erven x 600ℓ/erf/day	54600 ℓ/day
Recreational Spaces / Sport fields	15 000ℓ/ha/day x 7,60ha	114000 ℓ/day
Parks / Natural Assets / Preservation Areas	-	0 ℓ/day
Roads	-	0 ℓ/day
	TOTAL AADD	**3 059 970** ℓ/day

This equates to 3060 equivalent erven and from the design codes, we expect to design for a peak factor of 4.

Peak Domestic Demand = 3 059 970 ℓ/d x 4.1
= 12 545 877 ℓ/d
= 145,2069 ℓ/s

Fire flow:

Such a development would fall into a moderate risk category and as such, the following would apply:

- 12 000 ℓ/min
- 6 hour design fire flow

With the supply spread over a wide area, according to the GLS Water Master Plan the existing reservoirs together with proposed upgrades will have sufficient storage capacity and capacity for fire flow conditions to accommodate this development.

2.3 Existing Services

The current site is undeveloped except for bulk infrastructure crossing the proposed development area. Currently two (2) existing 600 mm Ø raw water rising mains as well as 450 mm Ø treated effluent pipeline crosses the area. See attached Annexure B

2.4 Proposed Services

There is insufficient capacity in the existing network to accommodate the proposed development. According to the GLS report, accommodation of the proposed development requires the implementation of the following additions and adjustments to the existing water system (See GLS report attached Annexure C).

It is further recommended that water saving measures/devices are implemented during the design of each of the facilities

2.4.1 Bulk Items

Items required to alleviate existing problems in the bulk water system:

The item listed below for upgrading is currently under construction as confirmed by George Municipality: Civil Engineering Services (CES).

Master Plan Items	Description
	New 120 500 kℓ/day Reservoir @old WTP

Items required to upgrade the existing WTP in the future bulk water system:

Master Plan Items	Description
GMR_B01.06	New 7m x 500mmØ bulk connection to New WTP
GMR_B01.07	Upgrade existing New WTP PS (install pump only) @WTP
GMR_B01.01	Upgrade existing New WTP (phase 1a of 4), 10 000 kℓ/day module

The cost regarding the above-mentioned items were estimated at R 120 342 000.00 (Excl. VAT) as per the attached 14 June 2019 GLS report, more accurate estimates can be provided during the preliminary design stage of the required items as some of the abovementioned items are currently undergoing upgrading as part of the new Reservoir construction project.

2.4.2 External Reticulation items

Items required to accommodate the proposed development (including fire flow requirements) in the bulk water system:

Distribution mains

Master Plan Items	Description
GMR_02.02	New 335mmØ x 16m network reinforcement pipe
GMR_02.03	New 335mmØ x 447m network reinforcement pipe
GMR_F02.03	New 335mmØ x 437m network distribution pipe
GMR_F02.04	New 315mmØ x 52m network distribution pipe
GMR_F02.05	New 315mmØ x 327m network distribution pipe
GMR_F02.06	New 315mmØ x 791m network distribution pipe
GMR_F02.07	New 315mmØ x 282m network distribution pipe
GMR_F02.08	New 315mmØ x 169m network distribution pipe
GMR_F02.06	New 315mmØ x 73m network distribution pipe

The cost regarding the above-mentioned items were estimated at R 9 693 000.00 (Excl. VAT) as per the attached 14 June 2019 GLS report, more accurate estimates can be provided during the preliminary design stage of the proposed development.

Network mains

Master Plan Items	Description
GMR_F05.01	New 160mmØ x 783m network main pipe
GMR_F05.02	New 160mmØ x 1114m network main pipe
GMR_F05.03	New 160mmØ x 206m network main pipe
GMR_F06.01	New 160mmØ x 241m network main pipe
GMR_F06.02	New 160mmØ x 154m network main pipe

The cost regarding the above-mentioned items were estimated at R3 558 000.00 (Excl. VAT) as per the attached 14 June 2019 GLS report, more accurate estimates can be provided during the preliminary design stage of the required items. The items listed above will be verified during the preliminary design stage of the proposed development.

2.4.3 Internal Reticulation items

Items required to accommodate the proposed development (including fire flow requirements) facilities:

The internal water reticulation network will be connected at three (3) proposed external water connection points. The internal network will consist 160mmØ main distribution lines connecting to the external 315mmØ water mainlines.

The first 160mmØ connection point will be at Stander Street to a proposed 315mmØ waterline (GMR.F02.08-GMR.F02.09), which will connect to a proposed 355mmØ waterline (GMR.02.02-GMR02.03). The 335mmØ network reinforcement pipe (GMR.02.02-GMR02.03) is an upgrade requirement as per the GLS Report required to accommodate the development which will connect to a 450mmØ existing water main line in Van Kervel Street.

The second connection point will be in the vicinity Meyer street in the form of a proposed 160mmØ water pipe (GMR_F.06.01). The existing water line in Meyer Street will also be upgrade to a 160mmØ water pipe.

The third connection will be a 315mmØ (GMR.F.02.05) running from the development through the embankment of the culvert bridge (see drawing 504255-0000-DRG-CC-0005), connecting to a new proposed water line 160mmØ (GMR_F06.02) and 315mmØ (GMR_F02.04).

Proposed internal services: (see drawing 504255-0000-DRG-CC-0003)

- 4680m of 160mm dia PVC-u class 16 water pipe
- 2131m of 315mm dia PVC-u class 16 water pipe
- 463m of 355 mm dia PVC-u class 16 water pipe
- 12 No gate valves
- 13 No Fire hydrants.
- 25-40mm dia HDPE class 16 water house connections

3 BULK SEWAGE SYSTEM

3.1 Wastewater Treatment Works (WWTW)

George Municipality has more than one WWTW. The proposed development falls within the Glenwood Pump Station sub-drainage area which drains to the Outeniqua WWTW.

Wastewater generated from the proposed development will gravitate to the existing Glenwood PS as well as the proposed Erf 464 pump stations and pump sewage through rising mains and gravity pipelines to the Glenwood PS and from there into the existing system towards the Outeniqua Waste Water Treatment Works, where it will be treated. (See GLS report attached)

According to the GLS Sewer Master Plan for the Municipal area, insufficient capacity exists at the Outeniqua Waste Water Treatment Works. The Outeniqua WWTW is currently undergoing upgrades to increase its capacity as per attached GLS Report.

3.2 Wastewater Reticulation System

A wastewater reticulation system exists within the adjacent neighbourhoods to which the proposed development sewage will be conveyed.

This proposed development area requires two (2) new sewer pump stations due to the site topography and the 14 June 2019 GLS report. The pump stations are required to drain approximately 70% of the total development. (See GLS Figure 2) with the remainder able to gravitate. Sufficient emergency storage will be provided at the pump stations in order to mitigate events such as power outages, blockages and breakdowns.

The current site is undeveloped except for bulk infrastructure crossing the proposed development area. Currently two (2) existing 600 mm Ø raw water rising mains as well as 450 mm Ø treated effluent pipeline crosses the area. See attached Annexure B

3.3 Wastewater Flow Demand

Our calculations are based on the “Guidelines for Human Settlement Planning and Design”.

Existing network capacity as well as proposed upgrades in the vicinity of the site have been confirmed by the Municipality through the recent report done by GLS Consulting through their appointment by George Municipality to draw up the Water and Sewer Master Plan for the Municipal Area and to determine the effect of any form of development in the Municipal Area on the Water and Sewer Master Plan.

3.3.1 According to the guidelines, the expected average daily wastewater flow is as follows:

Income group	Average persons per Dwelling	No of Erven	Litres per Dwelling
Varies	4	2301	450

Based on the above, the Average Dry Weather Flow (ADWF) for the development categories would therefore be:

Q = 2301 x 450 ℓ/d

= 1 035 450 ℓ/d

= 1035.45 kℓ/d

ADWF = 1.03545 Mℓ/d

3.3.2 For the remaining of Land Uses, we can assume that 70% of the water demand as determined under item 2.2 will end up in sewer reticulation system:

Based on the above the ADWF for the remaining land uses would therefore be:

Q = (983 520 + 269 750 + 418 500 ℓ/day) x 0.70

= 1 170 239 ℓ/day

= 1 170.239 kℓ/day

ADWF = 1.170 Mℓ/day

3.3.3 The number of persons are:

The proposed development to be serviced is as follows:

2301 x 6

= 13 806 persons

The equates to peak factor of 1,80

This would lead to an expected Peak Dry Weather Flow (PDWF) as follows:

Q = (1 035 450 + 1 170 239 ℓ/day) x 1.80

= 3 970 240.2ℓ/day

= 3. 970Mℓ/day

PDWF = 45.952 ℓ/s

If an infiltration rate of 15% is used for the ingress of stormwater into the system, the Peak Wet Weather Flow (PWWF) is calculated as follows:

Q = 3 970 240.2 x 1.15

= 4 565 776.23 ℓ/d

= 4.565 Mℓ/d

PWWF = 52.844 ℓ/s

3.4 Proposed Services

There is insufficient capacity in the existing network to accommodate the proposed development. According to the GLS report, accommodation of the proposed development requires the implementation of the following additions and adjustments to the existing water system (See GLS report attached as Annexure C)

3.4.1 Sewer Bulk Items

Items required to alleviate existing problems in the bulk sewer system:

None.

Items required to accommodate the proposed development in future sewer system:

The item listed below for upgrading are currently under construction as confirmed by George Municipality: CES.

Master Plan Items	Description
OT_24.01a	Upgrade existing inlet works, flow diversion (Design Flow = 1 201 L/s)
OT_24.01b	Upgrade existing inlet works, gravity pipe (Design Flow = 333 L/s)
OT_24.01c	Upgrade Outeniqua WWTW, phase 1of 3 (Design Flow = 10 000 L/s)

The cost regarding the above-mentioned items were estimated at R 178 942 000.00 (Excl. VAT) as per the attached 14 June 2019 GLS report. The abovementioned items are currently undergoing upgrading and any additional requirements to these will be confirmed during the preliminary design stage of the proposed development.

3.4.2 Sewer Reticulation items

Items required to accommodate the proposed development in the future sewer system:

The proposed development will be internally reticulated by means of 160mmØ sewer main lines, whereby 70% of the development's generated sewer flow will gravitate towards two (2) proposed pump stations, Erf PS F1 (OT_F110.01) and Erf 464 PS F2 (OT_F110.01) as indicated in the GLS report. From the pump stations the raw sewage will be pumped through rising mains of 160mmØ until it reaches the high point from where it will gravitate to the existing Glenwood PS.

Future internal network

Master Plan Items	Description
OT_F110.01	New George Erf 464 PS F1 @ 26 L/s (Design flow = 26 L/s)
OT_F110.02	New 160mmØ x 693m rising main (Design flow = 26 L/s)
OT_F111.01	New George Erf 464 PS F2 @ 15 L/s (Design flow = 15 L/s)
OT_F111.02	New 160mmØ x 462m rising main (Design flow = 15 L/s)
OT_F112.01	New 160mmØ x 178m gravity pipe (Design flow = 28.4 L/s)
OT_F112.02	New 250mmØ x 380m gravity pipe (Design flow = 56.3 L/s)
OT_F113.01	New 160mmØ x 379m gravity pipe (Design flow = 21.5 L/s)
OT_F113.02	New 200mmØ x 85m gravity pipe (Design flow = 27.8 L/s)
OT_F114.00	New 160mmØ x 72m gravity pipe (Design flow = 1.4 L/s)
OT_F115.00	New 160mmØ x 178m gravity pipe (Design flow = 0.7 L/s)

The cost regarding the above-mentioned items were estimated at R 9 274 000.00 (Excl. VAT) as per the attached 14 June 2019 GLS report, more accurate estimates can be provided during the preliminary design stage of the proposed development.

Proposed internal services: (see drawing 504255-0000-DRG-CC-0002)

- 4078m of 160mm dia PVC-u gravity heavy duty sewer pipe
- 1155m of 160mm dia rising main
- 85m of 160mm dia PVC-u heavy duty sewer pipe
- 380m of 250mm dia PVC-u heavy duty sewer pipe
- 90 No Manholes.
- 110mm dia PVC-u house connection with end caps.

3.4.3 Pump station

Design consideration of pump stations:

The topography of the development is such that the utilisation of gravity sewers in some areas is not feasible. In certain areas however, a gravity sewer system can be utilised, but only at the expense of deep trench excavations. In such cases, both wastewater pumping and gravity flow sewers will be technically feasible. Therefore, the development requires two (2) pump stations that will be fenced off. The pump stations will pump wastewater from areas which cannot be served hydraulically by gravity sewers.

The design of the proposed sewer pump stations will conform to pump station design pump capacities. Each pump station will be designed to accommodate the flow rate that gravitates towards it. The pump stations will have variable speed pump sets to accommodate the varying nature of the incoming sewer flows.

A pump station consists of a sump to receive incoming sewage, and pumps that pump the sewage through a rising main to a waste water treatment work or into a downstream stilling chamber as well as emergency storage facilities.

"The Guidelines for Human Settlement Planning and Design, also known as the "Red Book" suggest that

The components of a pump station have its own design recommendations:"

Sump

The sump receives the sewage flow and acts as a storage vessel from where sewage is periodically pumped. The sump comprises an active volume and a relatively small internal emergency storage volume depending on the size of the sump but it is preferred that an extended emergency storage facility is built especially due to the sensitive nature of this development are. The active volume is defined by the operating levels of the sump.

Emergency Storage

The emergency storage capacity provides additional safety when the pumps fail, in that it provides time for the Municipalities maintenance operatives to make the necessary repairs as well as catering for normal power outages.

A minimum storage capacity that is equivalent to four to six hours' flow (George Municipality suggest 8 hours flow) at the design flow rate should be provided. The emergency storage will be provided outside the pump station.

Pumps

Pumps are used to transfer raw sewage from the sump to the required destination within the sewer system. Pumps are mechanical equipment that are chosen based on the hydraulic requirements they meet and the level of safety of the design. A pump station consists of duty pump and standby pump.

The pumps will be designed to operate under the full range of the projected system condition. The system design will prevent the pumps from operating for prolonged periods as per the manufacturer's recommendations.

The system will be designed in such a way that the pumps operate at a maximum of two duty cycles per hour during average flow conditions and not more than six cycles per hour during wet weather flow.

The pump tempo will be 25% more than the sewage design inflow to the pump station.

The suggested pumps for the pump station design will be the Vortex impellers.

Vortex impellers are proposed due to the fact that the impellers create a revolving mass of water which forms a whirlpool. A whirlpool is a funnel shaped opening created downward from the water surface. It is developed by water flowing out of a small opening in the bottom of a basin, in this instance the pump. Impellers creating this vortex are called vortex impellers. The benefit of a vortex over a channel impeller is the minimised risk of clogging. A Vortex impeller is also the better suited choice when the pumped liquid has the possibility of high sand content.

Pump Motor

The proposed motor shall comply with the requirements for electric motors and shall be suitable for both dry operation and permanent immersion.

Where pump motors are started direct-on-line and with an open discharge valve, the motor rating shall exceed the pump's shaft power required at maximum duty by not less than 30%. The margin required for other applications is 20%. Motors shall be provided with the same corrosion protection system as for the pumps.

Backup power

The pump stations should be provided with emergency mobile generator units, the amount of emergency storage allows for 8 hours downtime giving the maintenance teams enough time to connect mobile generators to allow the continued operation of the pump stations during prolonged interruptions to the power supply.

The suggestion of using mobile generators rather than having a permanent generator room is due to the fact that the emergency storage tank will have enough "downtime" capacity for normal power outages. Mobile generators can be stored at the Municipality's Maintenance facility in close proximity to the development where it can be better maintained.

The pump stations will also be given a telemetry system to control the operations of the pump stations and report any problems to the 24-hour emergency monitoring point, which will notify the relevant response team of any technical issues at the pump stations.

Pipework

The pipework configuration shall be similar to that shown on the typical drawings.

Isolation valves and check valves shall be horizontally mounted within horizontal pipework unless this is not feasible.

Pipe work shall preferably be mounted horizontally and supported approximately 500 mm above the floor level or shall be mounted and supported against a wall. Vertical pipework shall be mounted and supported against a wall, if required.

3.4.4 Conceptional Design Size.

The proposed development will require a 26 L/s and a 15 L/s pump station as per the attached 14 June 2019 GLS report.

Erf 464 PS F1 @ 26 L/s

PS F1: 26 L/s

Number of pumps: 2 vortex impeller sewage pumps – 1 duty – 1 standby

Pump tempo = ± 33 L/s

Pipe material = 160mmØ class 12

Sump size= ± 5m^3

Emergency Storage (8h storage) = ± 168 m^3

Area emergency storage = ± 10m x 10m

Pumping storage = ± 18 m^3

Erf 464 PS F2 @ 15 L/s

PS F2: 15 L/s

Number of pumps: 2 vortex impeller sewage pumps – 1 duty – 1 standby

Pump tempo = ± 19 L/s

Pipe material = 160mmØ class 12

Sump size=± 3 m^3

Emergency Storage (8h storage) =± 98 m^3

Area emergency storage =± 8.2m x 8.2m

Pumping storage = ± 9 m^3

4 STORMWATER

No bulk stormwater systems are required as the stormwater will be dispersed via a number of stormwater outlets into the existing natural watercourse. Accumulated stormwater will be dispersed by means of energy dissipating structures to minimize the effect of peak runoff downstream. Details regarding this is provided separately in the stormwater Management Plan as compiled by Aurecon dated 31 January 2020, as well as the Floodline determination done by Fraser Consulting Civil Engineering dated 14 January 2020.

Proposed internal services: (see drawing 504255-0000-DRG-CC-0004)

- 3790 of 450mm dia concrete stormwater pipe
- 54 No Manholes
- 26 No Catchpits
- 12 No Head walls

5 ACCESS ROAD

Access to the proposed development area during construction will be provided East from Stander Street. No upgrades to the existing road infrastructure is required at this point in time. This road will however be upgraded following construction of the internal roads.

The two (2) main access roads to the campus after construction will be North from Madiba Drive, whereby the design of the roads will be a combination of earthworks, filling and a bridge over the existing watercourse on site. The watercourse crossing might be a combination of culverts and earth fill, but this can only be confirmed during the design stage. See attached Annexure F for proposed detail regarding roads crossing the watercourses.

For other upgrades to the existing road infrastructure refer to the Traffic Impact Assessment (TIA) conducted by SMEC Consulting, dated 27 November 2019, (See SMEC report attached Annexure D).

Proposed internal services: (see drawing 504255-0000-DRG-CC-0004)

- There are approximately 45383m^2 of planned paved roads in the proposed development. Road widths vary from 4.5m – 7.4m wide with Barrier/Mountable kerb and channels on the lower side of the roadway and concrete channels at intersections.

6 SOLID WASTE

Refuse removal will be dealt with once a week as applicable to all the current residential areas in the George Municipal area.

Solid waste is based on an estimated 3.5 kg/person/day.

Therefore: (2301 units x 4 people per unit x 3.5 kg/day)

= 32 214 kg/day

= 32,214 tons/day

Volume = 32,214 t/d x 0.75

= 24,161 m^3/d

= 724,815 m^3/month

For all other land uses it can be assumed that approximately 12kg/100 m^2 of solid waste is generated per day.

Therefore: [(163 920 + 41 500 + 46 500)x 0.6 GLA] x 12kg/100 m^2

= 18 138.24 kg/day

= 18,138 tons/day

Volume = 18,138 t/d x 0.75

= 13,604 m^3/d

= 408,110 m^3/month

Total Volume of Solid Waste for Total Development = 724,815 m^3/month + 408,110 m^3/month

= 1 1325.925 m^3/month

Based on preliminary discussions with George Municipality the existing solid waste site will be able to accommodate the additional solid waste generated by the development.\

7 FLOODLINES

The proposed development is not being affected by a pre-determined floodline, but in certain areas is limited by portions of watercourse drainage lines and buffer zones adjacent to watercourse that drain into the larger system and Garden Route Dam. Refer Figure 2 below extracted from the Freshwater Habitat Assessment: Phase 1, done by Sharpe Environmental Services 31 January 2019 Below.

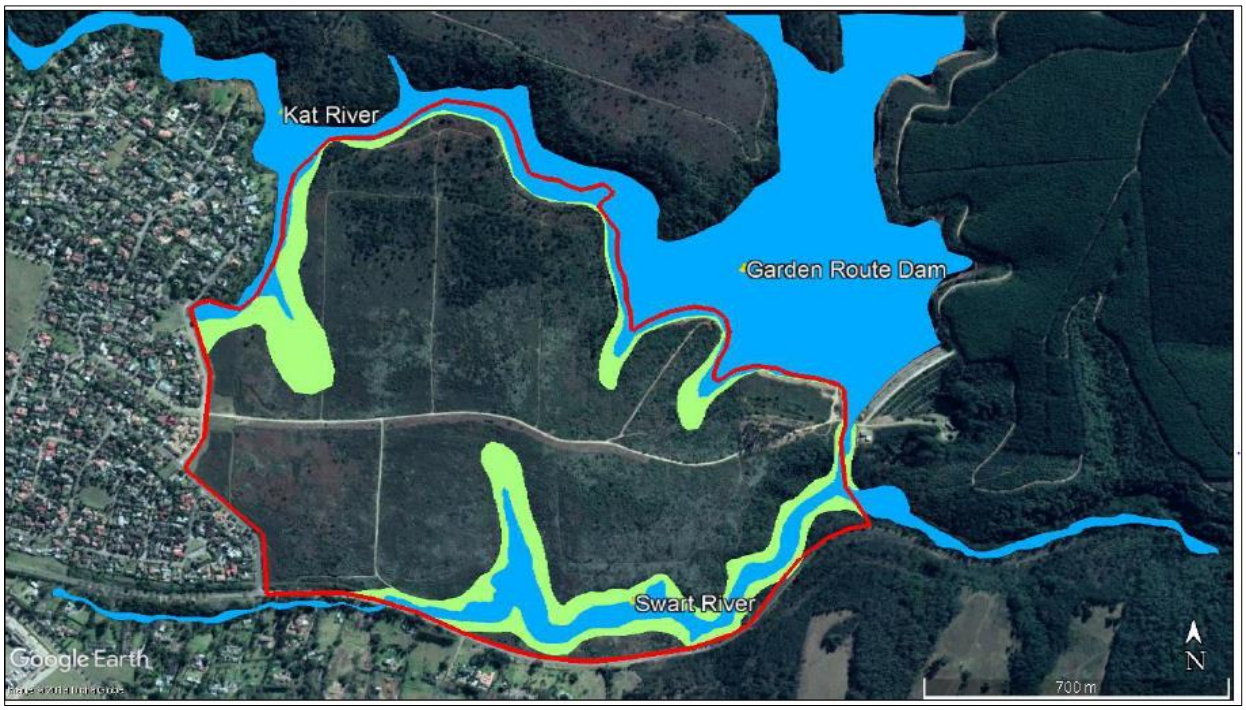


Figure2: Watercourse and Buffer Zones

Raising of the Garden Route Dam Spillway

The raising of the spillway for the Garden Route Dam has recently been completed which increased the capacity of the dam. The previous full supply level of the dam was on 180.30 m above sea level. The new full supply level of the dam is on 182.5 m above sea level. The new 1 in 200 year flood line is on contour 184 as indicated on the sub divisional layout plan of the proposed development. The proposed development is not planned in any areas that are within the floodlines.

Floodline Determination - Fraser Consulting Civil Engineers

Fraser Engineers cc were appointed on the 25th of November 2019 to determine the 50 year Recurrence Interval (RI) and 100 year RI floodlines for a tributary of the Swart River alongside the remainder of erf 464, George. The confluence of this tributary and the Swart River is 200m downstream of the Garden Route Dam Wall. The floodline as determined by Fraser Consulting Civil Engineers is illustrated in the image below. The proposed development is not planned in any areas that are within the floodlines. Please refer to the Floodline Determination report and drawing attahced to this report as Annexure E.

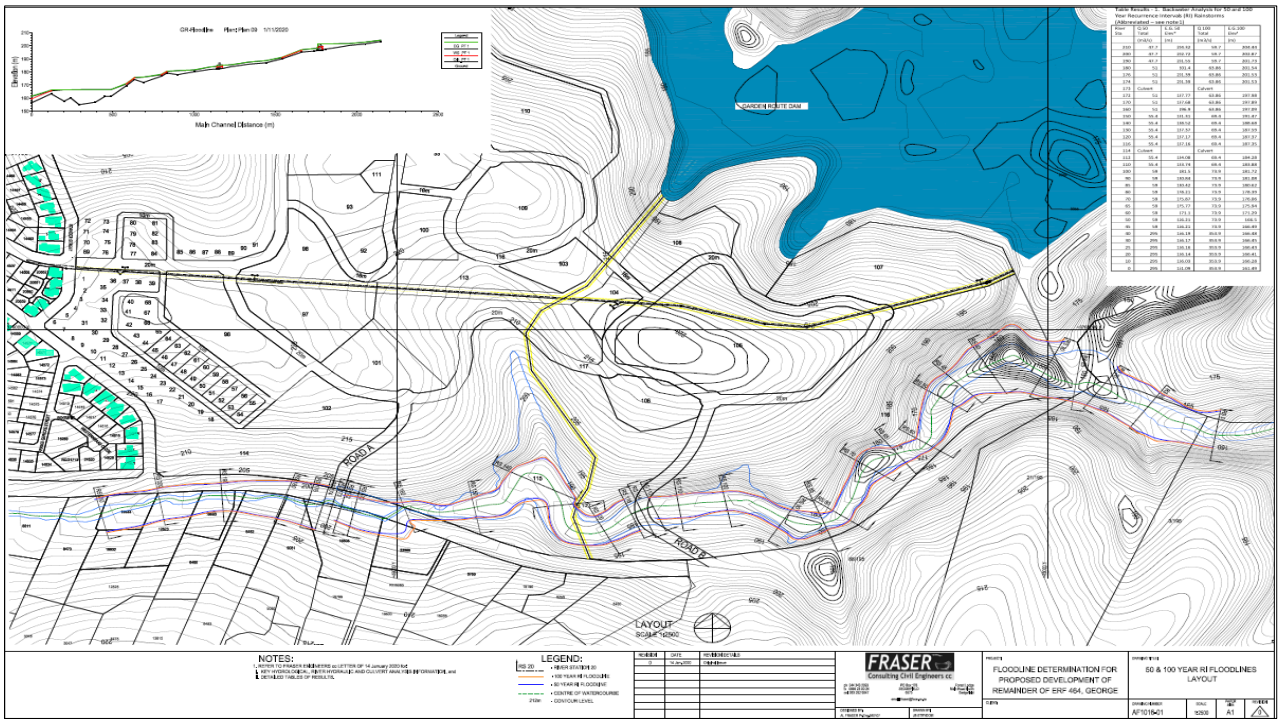


Figure3: Fraser consultant floodline

8 EXTRAORDINARY DEVELOPMENT CONDITIONS.

The general terrain and the underlying geology of this site appears to be suitable for general development. Some areas adjacent to natural drainage lines are quite steep and some terracing may be necessary.

Excessive hard rock excavations are not suspected to be encountered in the area.

9 SUMMARY OF INTERNAL SERVICES

Detailed design of internal services will be conducted as soon as approval is obtained. All relevant drawings will be provided to George Municipality for approval prior to construction.

Below find a brief description of the services to be provided for the area.

9.1 Sewage

- 4078m of 160mm dia PVC-u gravity heavy duty sewer pipe
- 1155m of 160mm dia rising main
- 85m of 160mm dia PVC-u heavy duty sewer pipe
- 380m of 250mm dia PVC-u heavy duty sewer pipe
- 90 No Manholes.
- 110mm dia PVC-u house connection with end caps.

9.2 Water

- 4680m of 160mm dia PVC-u class 16 water pipe
- 2131m of 315mm dia PVC-u class 16 water pipe
- 463m of 355 mm dia PVC-u class 16 water pipe
- 12 No gate valves
- 13 No Fire hydrants.
- 25-40mm dia HDPE class 16 water house connections

9.3 Roads

- 45383m², paving roads. Road widths vary from 3.5m - 5.5m wide with Barrier/Mountable kerb and channels on the lower side of the roadway and concrete channels at intersections.

9.4 Stormwater

- 3790 of 450mm dia concrete stormwater pipe
- 54 No Manholes
- 26 No Catchpits
- 12 No Head walls

10 STANDARD OF ENGINEERING SERVICES TO PROVIDED

10.1 Sewer

- Pipe diameter: 160mm dia solid wall for main lines and 110mm solid wall for house connections. UPVC Class 34 or Ultracor Class 400 Heavy Duty (400 kPa).
- Precast concrete or Fibre cement shaft rings to be used for manholes.
- Erf connection ends 1m into the erf with a rodding eye.

10.2 Water

- Pipe diameter of 75 – 160 mm dia UPVC Class 9/12 pipes depending on residual pressure;
- Development will be serviced with a bulk water connection and a inspection chamber or water meter box; and
- Provision will be made for fire hydrants according to “Red Book” guidelines and GLS Report.

10.3 Roads and Stormwater

- The road width will be 4.5m minimum;
- All road surfaces will be either Cape seal, Asphalt or Paved surface;
- Sub-base and base materials will be imported;

- Sub-surface drainage, where applicable, will be installed;
- The underground piped stormwater drainage system will be minimum 375mm diameter;
- Barrier kerbs will be installed around bellmouths. Bellmouth's radius minimum 10m.
- All stormwater outlets will be provided with a sand trap of at least 300mm.

10.4 Design Criteria and Standards

10.4.1 Design criteria

The following documents will serves as a base for the detail design criteria and standards :

- Guidelines for Human Settlement Planning and Design ("Red Book"); and
- City of Cape Town Management of Urban Stormwater Impacts Policy – Version 1.1, 2009.

10.4.2 Construction specifications

All materials and workmanship shall comply with the specifications as set out in the South African National Standards for Civil Engineering (SANS).

10.4.3 Roads

The road system forms an integral part of the local area plan.

10.4.3.1 Design Criteria

The design criterion for roads is as follows:

- Road reserve widths will determine actual road width to be constructed.
- Design life of the roads is 20 years.
- Sub-grade CBR – 15 to 20.
- Sub-base CBR – 45min. (processed crushed stone)
- Base course CBR – 80min. (processed crushed stone)
- Surfacing - Asphalt, cape seal or paving
- Minimum road grade 0.475 % `
- Minimum road crossfall 2 %

10.4.4 Stormwater

The storm water system forms an integral part of the road and urban planning layout. The system rests on three legs, the minor system, the major system and an emergency system. The minor storms are catered for in the pipe system while the major storms are routed through a linked system of roads and public open spaces using attenuation techniques. The emergency system recognizes failure of the minor and major system by storms greater than provided for in major system or in the event of malfunction of the minor system by providing continuous overland flow routes to minimize flooding of residential areas.

10.4.4.1 Minimum design criteria for storm water system

The data to be used for the design of the system is as follows:

- Minor system: 2 year return period conveyed in an underground pipe system. Preferably the overland flow shall not exceed 200m.
- Major system: 50 year return period. The difference between the 2 year and 50 year to be conveyed in the road prism with depth not exceeding 150mm within the road reserve width.
- The minimum gradients for pipelines are designed to give a minimum velocity of 0.7m per second with the pipe flowing full.
- The maximum velocity used is 3.5m per second.
- Major storm water overflows are to be provided to convey the excess storm water from the streets into designated public open spaces.
- Storm water flow velocities in road ways will be kept as low as possible and related to the surface finish to prevent scour and erosion.
- Roads are to be graded to ensure free and continuous flow to the main storm water system and to prevent local ponds at intersections.

10.4.4.2 Pipelines

- Storm water pipes are generally 50D, 75D or 100D as required by the loading and installation conditions.
- Pipes are generally laid on Class C bed.
- The minimum cover on pipes is 0.80m within road reserves.
- The minimum pipe diameter is 375mm for longitudinal runs and catch pit

10.4.5 Sewers

The sewer drainage system forms an integral part of the sewage system. The drainage for the site is in different directions due to the topography of the site. Due to this, two (2) pump stations is required to pump the sewerage to the existing sewerage system adjacent to the site.

10.4.5.1 Minimum design criteria

The sewer drainage

- A conventional waterborne sewerage system will be provided with single connections to individual erven. The main sewer line will be constructed within roads reserves and/or midblock, site topography depending.
- Design parameters : Average daily flow - 500ℓ / erf / day
  : Peak factor – Harmon formula
  : Extraneous flow – 15 %
  : Minimum velocity – 0.7m per second
- Minimum cover to pipes : 0.80m within road reserves.
- Minimum pipe size : 110mm diameter for house connections
  : 160mm diameter for sewer mains
- Minimum gradients : 110mm diameter house connection 1:60
  : main lines at 80% capacity as follows:

Dwelling units	Grade
Less than 6	1:80
6 to 10	1:100
11 to 80	1:120
81 to 110	1:150
111 to 130	1:180

- House connection depth shall generally be 0.8m but at least be able to drain 60% of an erf.
- Maximum manhole spacing of 80m.

10.4.5.2 Pipelines

- Pipeline material for pipe sizes up to 160mm diameter:

  - uPVC Class 34 or Ultracor Class 400 Heavy Duty (400 kPa) complying with SABS
- Pipes are generally laid on Class C bedding.

10.4.5.3 Manholes

- Dolomite aggregate and low alkali sulphate resistant cement to SABS 471 shall be used for all concrete, mortar or screed.
- Manhole cover to be central over main pipe on downstream side.
- Manhole covers and frames to be Concrete or Fibre cement.

10.4.6 Water

10.4.6.1 Minimum design criteria

The design criteria generally as per the “Red Book” guidelines and specifically as follows :

- An average domestic consumption per day per erf dependent on landuse classification
- Peak factors for the development will be calculated in accordance with Figure 9.9 of the “Red Book”.
- Minimum pressures for the network are calculated for the fire flows of 30ℓ per second and peak demand at the point of lowest pressure under peak flow conditions.
- Valves to be placed such that a maximum of 4 valves need to be closed to isolate a section of pipeline.
- Valves to be spaced so that the length of main included in an isolated section does not exceed 600m.
- All valves to be installed at T-pieces where applicable and not within the road surface.
- Minimum cover to pipe to be 0.8m within road reserves.

10.4.6.1 Pipeline materials

- Network – uPVC Class 9/12, dia 75 – 160mm complying to SABS 966

- Erf connections – HDPE Class 12, JASWIC

We trust that we have provided sufficient information for your purposes and look forward to hearing from you shortly. Please do not hesitate to contact us if you should require any further information.

Annexures

Annexures A: Site Development plan (SDP)

NEW 1 IN 200 YEAR FLOOD LINE

GARDEN ROUTE DAM

PICNIC STREET

STUDENT DRIVE

HOSTEL STREET

ACADEMY STREET

SPORTS CIRCLE

HOTEL STREET

CAMPUS CIRCLE

WATERFRONT DRIVE

LECTURE CRESCENT

LIBRARY CRESCENT

ASSIGNMENT STREET

UNIVERSITY STREET

BEAN CRESCENT

HERSCHEL STREET

14452 PARK

14455 PARK

RE/21713 24820

RE/9083

3055

21195

88195

INSERT 1

SCALE 1 : 20 000

Portion A
(±118,5 Ha)

LOCALITY PLAN

SCALE 1 : 50 000

GEORGE CBD

GARDEN ROUTE DAM

APPLICATION FOR REZONING AND SUBDIVISION IN TERMS OF SECTION 15 OF THE GEORGE MUNICIPALITY LAND USE PLANNING BY-LAW, 2015

Application is being made for:

1. The subdivision of the Remainder of Erf 464, as shown on Insert 1, as follows:
   - 1.1.1 Portion A = ± 118.50 Ha
   - 1.1.2 Remainder
2. The rezoning of the above mentioned Portion A from Undetermined to a subdivisional area.
3. The subdivision of the above mentioned subdivisional area as shown on plan and set out in Table 1 below.
4. The permanent departure from the standard Zoning Scheme Provisions as set out in Chapter 8 of the George Integrated Zoning Scheme By-Law, 2017, in terms of parking requirements of "Business Premises" from 6 bays per 100m2 GLA to 4 bays per 100m2 GLA, and
5. Consent Use to permit a Conference Facility on the portion zoned as Community Zone 1, Boarding Houses on the respective portions zoned as General Residential Zone IV and Shops on the respective portions zoned as General Residential Zone VI as primary use

Remarks

1. The detail design of the development on the Waterfront business site will be dealt with as a separate task involving professional engineering and architectural input.
2. Architectural Guidelines will be drawn up to aesthetics of all development components.
3. All erven, other than the erven zoned Single Residential Zone 1, Open Space III and Transport Zone II will be subject to the approval of a site development plan prior to the submission of building plans.
4. A servitude 6 meter wide to be registered in favour of the George Municipality on the position of the two existing 600mm raw water rising mains and the 450mm treated effluent pipelines indicated on the layout as a black dashed line.
5. Current full supply level of dam is on 180.30 m above sea level. The full supply level of dam will be increased to 182.5 m above sea level when the raising of the dam wall is complete. The new 1 in 200 year flood line will be on contour 184,00m.
6. If buildings and structures are located within the high visual sensitive area (indicated on layout drawing) the highest point of all infrastructure should not exceed 5.5 meters.

SITUATED IN THE MUNICIPALITY AND ADMINISTRATIVE DISTRICT OF GEORGE

TABLE I

	Zoning	Land Use	Ptn No's	Number	Area (Ha)	%
	Community Zone 1	Campus - University / Research Institute / Academy	99-106	8	13.66	12%
	Business Zone 1	Waterfront Commercial Development	107	1	4.66	4%
	General Residential Zone VI	Hotel	108	1	1.55	1%
	General Residential Zone II	Medium Density Residential / Group Housing	96-98	3	5.47	5%
	General Residential Zone IV	Apartments / Flats / Student Housing	92-95	4	4.84	4%
	Single Residential Zone I	Free Standing Dwelling Houses	1-91	91	5.76	5%
	Open Space II	Recreational Spaces / Sports Fields	109-111	3	7.57	6%
	Open Space III	Parks / Natural Assets / Preservation Areas	112-116	5	67.90	57%
	Transport Zone II	Roads	117	1	7.6	6%
	Total			**117**	**119.01**	**100%**

aurecon
www.aurecongroup.com

Rudolf Schröder Pr. Pln, M.PRISA, MTRP
Integrated Human Settlement Development Consultant. Aurecon
T +27 44 8055455 M +27 833906963
Rudolf.Schroder@aurecongroup.com

CLIENT

GEORGE
THE CITY FOR ALL REASONS

REV	DATE	REVISION DETAILS	APPROVED
A	10/2019	PRELIMINARY	A. KEYSER
B	7/11/19	LAYOUT ACCORDING TO NEW BUFFERS	A. KEYSER

SCALE	SIZE
1:2500	A1

DRAWN

DESIGNED

REVIEWED

APPROVED DATE

PROJECT

PORTION OF THE REMAINDER OF ERF 464, GEORGE REZONING AND SUBDIVISION IN TERMS OF SECTION 15 OF THE GEORGE MINICIPALITY LAND USE PLANNING BY-LAWS, 2015

TITLE

SUBDIVISION PLAN

DRAWING NUMBER

PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
504255	-	0000	-	DRG	-	CC	-	0001	-	B

FLOODLINE CERTIFICATION

Portion of the Remainder of Erf 464 Rezoning and Subdivision: This is to certify that in terms of the provisions of the National Water Act. 1998 (Act 36 OF 1998) the land area on which the proposed Development as depicted on the Layout Plan, is subject to flooding which may occur with a frequency of once every 100 years , as indicated on the layout plan.

A. Fraser

Alastair Fraser Pr. Eng
Tel: 044 343 2093
Cell: 083 292 9047

LEGEND:

- VEGETATION BUFFERS
- WETLANDS BUFFERS
- RIPAIRIAN ZONE
- URBAN EDGE
- VISUAL IMPACT CONSTRAINTS
- RAW WATER RISING MAIN & PIPELINE
- HIGH VISUAL SENSITIVE AREA
- 50 YEAR FLOODLINE
- 100 YEAR FLOODLINE

25 0 50 100m
SCALE 1:2500

Annexures B: Existing and Proposed Services

GENERAL NOTES:

1. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH SANS 1200.

LEGEND

PROPOSED SERVICES :

- SEWER LINE
- SEWER MANHOLE
- WATER MAINS
- VALVE
- FIRE HYDRANT
- END CAP
- STORMWATER PIPE
- STORMWATER MANHOLE
- CATCH PIT
- HEADWALL
- 100 YEAR FLOOD LINE
- 50 YEAR FLOOD LINE
- PROPOSED 160mm RAISING MAIN
- MOUNTABLE KERB CK 7
- BARRIER KERB AND CHANNEL
- EDGE RESTRAINT

PROPOSED PUMPSTATION PS F2

PROPOSED PUMPSTATION PS F1

EXISTING GLENWOOD PUMPSTATION

TRANSFER MANHOLE

TRANSFER MANHOLE

CONNECT TO PROPOSED GMR-F02.03 355mm Ø WATER PIPE

CONNECT TO PROPOSED GMR-F06.02 160mm Ø WATER PIPE

CONNECT TO PROPOSED GMR-F13.00 160mm Ø WATER PIPE

PROPOSED 315mm Ø WATER PIPE

PROPOSED 355mm Ø WATER PIPE

INSERT A

SEE INSERT A

600mm Ø WATER PIPE

GARDEN ROUTE DAM

KWIKKIE STREET

BOKMAKIERIE STREET

STANDER ST

WESTERNRAAD CLOSE

ROAD A

ROAD B

+3760000 X

Plot Date: 3/17/2020 4:14:26 PM Office: ZAGBJ Filename: P:\PROJECTS\504255_ERF 464 GEORGE REZONING\5 DEL DESIGS CADD\DRAWINGS\REPORTS\504255-000JDR\5-CC-0001 - 0004 LAYOUTS.DWG

aurecon www.aurecongroup.com	CLIENT GEORGE MUNICIPALITY	

REV	DATE	REVISION DETAILS	APPROVED
A	16/1/2020	PRELIMINARY	A KEYSER

SCALE	1:2000
SIZE	A1
DRAWN	A. VAN WYK
DESIGNED	S. JOHNSON
REVIEWED	M. BOTHA

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED
DATE
AC KEYSER ECSA-200670108

PROJECT	ERF 464 GEORGE REZONING
TITLE	GENERAL SERVICES LAYOUT

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	504255	0000	DRG	CC	0001	A

PROPOSED PUMPSTATION PS F2

TRANSFER MANHOLE

TRANSFER MANHOLE

EXISTING GLENWOOD PUMPSTATION

PROPOSED PUMPSTATION PS F1

GARDEN ROUTE DAM

KWIKKIE STREET

BOKMAKIERIE STREET

STANDER ST

WESTERNRAAD CLOSE

ROAD A

ROAD B

600mm Ø WATER PIPE

+3760000 X

GENERAL NOTES:

1. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH SANS 1200.
2. MINIMUM PIPE SIZES 160mm DIAMETER FOR SEWER MAINS (EXCEPT WHERE SHOWN OTHERWISE) AND 110mm DIAMETER FOR ERF CONNECTIONS.
5. ALL SEWER PIPES TO BE ULTRACOR PVC-u CLASS 400KPa.
6. ALL CONNECTION POSITIONS AND LEVELS TO EXISTING SEWER LINES MANHOLES MUST BE VERIFIED ON SITE, BEFORE ANY CONSTRUCTION COMMENCES.

LEGEND

PROPOSED SERVICES :

- SEWER LINE
- SEWER MANHOLE
- PROPOSED 160mm RAISING MAIN
- 100 YEAR FLOOD LINE
- 50 YEAR FLOOD LINE

Plot Date: 31/1/2020 3:58:38 PM Office: ZAGRJ Filename: P:\PROJECTS\504255 ERF 464 GEORGE REZONING\5 DEL DESIGN\3 CAD\DRAWINGS\REPORTS\504255-0000-DRG-CC-0001 - 0004 LAYOUTS.DWG

aurecon
www.aurecongroup.com

CLIENT
GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
A	16/1/2020	PRELIMINARY	A KEYSER

SCALE	SIZE
1:2000	A1

PRELIMINARY
NOT FOR CONSTRUCTION

DRAWN
A. VAN WYK
DESIGNED
S. JOHNSON
REVIEWED
M. BOTHA

APPROVED
DATE
AC KEYSER ECSA-200670108

PROJECT	ERF 464 GEORGE REZONING
TITLE	SEWER LAYOUT

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	504255	0000	DRG	CC	0002	A

GENERAL NOTES:

1. ALL CONSTRUCTION MUST BE DONE ACCORDANCE WITH SANS 1200.
2. ALL WATER PIPES TO BE 160mm(EXCEPT WHERE SHOWN OTHERWISE) PVC-M - CLASS 12 .
3. ALL EXISTING CONNECTIONS, PIPE SIZE AND TYPE TO BE VERIFIED ON SITE BEFORE ANY CONSTRUCTION COMMENCES.
4. VALVES SHALL BE CONSTRUCTED ON CORNER OF SPLAYS.

LEGEND :

PROPOSED SERVICES :

- WATER MAINS
- VALVE
- FIRE HYDRANT
- END CAP
- 100 YEAR FLOOD LINE
- 50 YEAR FLOOD LINE

KWIKKIE STREET

BOKMAKIERIE STREET

STANDER ST

WESTERNRAAD CLOSE

ROAD A

ROAD B

GARDEN ROUTE DAM

CONNECT TO PROPOSED GMR-F02.03 355mm Ø WATER PIPE

CONNECT TO PROPOSED GMR-F06.02 160mm Ø WATER PIPE

600mm Ø WATER PIPE

+3760000 X

INSERT A

CONNECT TO PROPOSED GMR-F13.00 160mm Ø WATER PIPE

PROPOSED 315mm Ø WATER PIPE

PROPOSED 355mm Ø WATER PIPE

SEE INSERT A

Plot Date: 31/1/2020 4:09:21 PM Office: ZAGRJ Filename: P:\PROJECTS\504255 ERF 464 GEORGE REZONING\3.DEL\DES\03.CAD\DRAWINGS\REPORTS\504255-0000-DRG-CC-0001 - 0004 LAYOUTS.DWG

CLIENT	REV	DATE	REVISION DETAILS	APPROVED
GEORGE MUNICIPALITY	A	16/1/2020	PRELIMINARY	A KEYSER

SCALE	SIZE
1:2000	A1

DRAWN: A. VAN WYK
DESIGNED: S. JOHNSON
REVIEWED: M. BOTHA

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED
DATE
AC KEYSER ECSA-200670108

PROJECT	ERF 464 GEORGE REZONING
TITLE	WATER LAYOUT

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	504255	0000	DRG	CC	0003	A

aurecon
www.aurecongroup.com

GENERAL NOTES :

1. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH SANS 1200.

LEGEND :

PROPOSED SERVICES :

- STORMWATER PIPE
- STORMWATER MANHOLE
- CATCH PIT
- HEADWALL
- 100 YEAR FLOOD LINE
- 50 YEAR FLOOD LINE
- MOUNTABLE KERB CK 7
- BARRIER KERB AND CHANNEL
- EDGE RESTRAINT

KWIKKIE STREET

BOKMAKIERIE STREET

STANDER ST

WESTERNRAAD CLOSE

ROAD A

ROAD B

GARDEN ROUTE DAM

600mm Ø WATER PIPE

PROPOSED CULVERT SEE DRAWING 504255-0000-DRG-CC-0005 FOR DETAIL

PROPOSED CULVERT SEE DRAWING 504255-0000-DRG-CC-0005 FOR DETAIL

+3760000 X

Plot Date: 31/1/2020 3:45:37 PM Office: ZAGRJ Filename: P:\PROJECTS\504255_ERF 464 GEORGE REZONING\3.DEL DESIGN\CAD\DRAWINGS\REPORT\504255-0000-DRG-CC-0001 - 0004 LAYOUTS.DWG

aurecon
www.aurecongroup.com

CLIENT

GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
A	16/1/2020	PRELIMINARY	A KEYSER

SCALE	SIZE
1:2000	A1

DRAWN: A. VAN WYK

DESIGNED: S. JOHNSON

REVIEWED: M. BOTHA

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED

DATE

AC KEYSER ECSA-200670108

PROJECT: ERF 464 GEORGE REZONING

TITLE: ROADS AND STORMWATER LAYOUT

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	504255	0000	DRG	CC	0004	A

Annexures C: GLS Report

14 June 2019

Director: Civil and Technical Services
George Municipality
PO Box 19
GEORGE
6530

ATTENTION: Mr. Reggie Wesso

Dear Sir,

**WATER AND SEWER MASTER PLANS: PROPOSED TOWNSHIP DEVELOPMENT –
GEORGE ERF 464 (UNIVERSITY)**

The request by Aurecon (Mr. Marius Botha) regarding comments on the existing water and sewer system and conceptual design of infrastructure required to accommodate the proposed development, refers.

This report is a technical report indicating upgrades required in the water and sewer networks in the vicinity of the proposed development. The George Municipality engineering professional (yourself) will make a final decision on works to be implemented by the proposed development.

Water and sewer master plans are updated at three months intervals. The latest master plans used for this analysis were the March 2019 master plans.

GLS Consulting (Pty) Ltd
T +27 21 880 0388 | F +27 21 8800 389
13 Elektron Street, Techno Park, Stellenbosch, 7600 | PO Box 814, Stellenbosch, 7599
Reg no: **2007/003039/07**
www.gls.co.za

Directors: Z Mayet, JJ Streicher, HA Baartman, MS Mokgosi

1 WATER DISTRIBUTION NETWORK

1.1 Distribution Zone

The proposed development was taken into consideration in the water master plan as part of the Loerie Ext.1A and Loerie Ext.1B future development areas.

The master plan indicates that the proposed development falls in the George Main zone as shown in **Figure 1 (Water)** attached.

1.2 Revised Water Demand and Sewer Return Flows

The combined AADD for the proposed development, as used for the water distribution network analysis in the water master plan, was calculated as 650 kL/d.

The revised AADD, peak flow and fire flow for the proposed development used in this re-analysis of the water distribution network is 3 019 kL/d and was calculated as follows:

Zoning	Land use Description	FAR	Density (dwelling units per hectare)	Building square meters	Area (hectare)	Units		UWD		AADD (kL/d)
Community Zone I	Campus - University/Research institute/Academy	1.20	n.a.	205 320	17.11	2 053	100m² floor	0.50	kL/100m²/d	1 026.5
Business Zone I	Waterfront commercial development	3.00	n.a.	128 700	4.29	1 287	100m² floor	0.50	kL/100m²/d	643.5
General Residential Zone VI	Hotel	3.00	n.a.	35 700	1.19	357	100m² floor	0.50	kL/100m²/d	178.5
General Residential Zone II	Medium density residential / Group housing	n.a.	35	n.a.	4.89	171	unit	0.50	kL/unit/d	85.5
General Residential Zone IV	Apartments / Flats / Student Housing	1.00	n.a.	120 300	12.03	3008	unit	0.30	kL/unit/d	902.4
Single Residential Zone I	Free standing dwelling houses	n.a.	15	n.a.	8.7	129	unit	0.60	kL/unit/d	77.4
Open Space Zone III	Parks / Natural Assets / Preservation Areas	n.a.	n.a.	n.a.	48.8	48.8	ha	0	kL/ha/d	0.0
Open Space Zone II	Recreational Spaces / Sports fields	n.a.	n.a.	n.a.	10.5	10.5	ha	10	kL/ha/d	105.0
Open Space Zone IV	Nature reserve	n.a.	n.a.	n.a.	n.a.	0	ha	0	kL/ha/d	0.0
Transport Zone II	Roads	n.a.	n.a.	n.a.	10.9	10.9	ha	0	kL/ha/d	0.0
Total	**Total**				**118.41**					**3 018.8**

- Peak flow: Zone peak hour factor (3.0 x AADD) = 105 L/s
  Note: Higher peak flow factors might be applicable for internal networks.
- Fire flow for;
  - Moderate risk & High rise flats : 50 L/s (2 hydrant) @ ±15m minimum pressure
  - Small Business / Offices & Low rise flats : 20 L/s (1 hydrant) @ ±10m minimum pressure
  - Cluster housing > 30 units/ha : 20 L/s (1 hydrant) @ ±10m minimum pressure
  - Cluster housing ≤ 30 units/ha & Residential : 15 L/s (1 hydrant) @ ±10m minimum pressure

1.3 Accommodation of Proposed Development in the Existing Water System

Accommodation of the proposed development, with its revised AADD, requires implementation of the following additions and adjustments to the *existing* water system as indicated in **Figure 1 (Water)**:

1.3.1 Bulk Items

Items required to alleviate existing problems in the bulk water system:

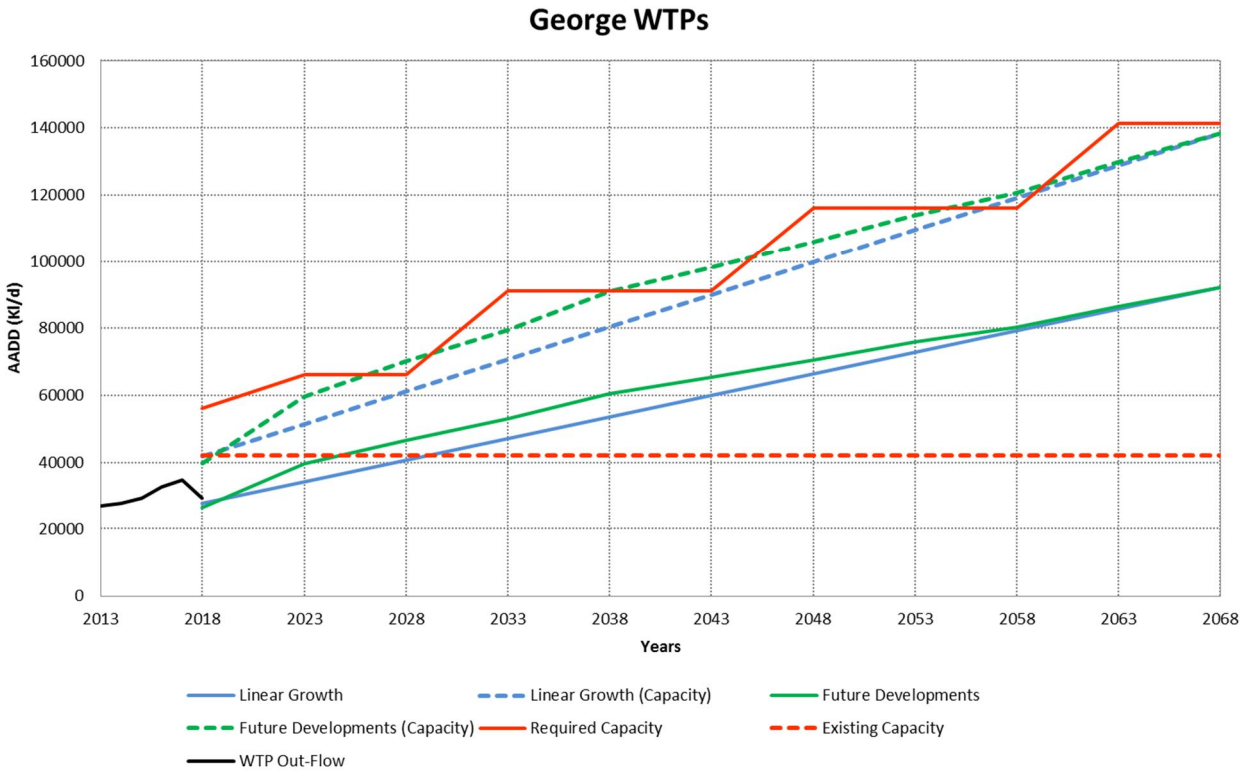
Upgrades currently under construction;

- New 12 500 kL Reservoir @ Old WTP

Items required to upgrade the existing WTP in the future bulk water system:

•	GMR_B01.06	New 7m x 500mmØ bulk connection to New WTP	R 201 000
•	GMR_B01.07	Upgrade existing New WTP PS (install pump only) @ WTP	R 1 191 000
•	GMR_B01.01	Upgrade existing New WTP (phase 1a of 4), 10 000 kL/d module	R 118 950 000
		Total	R 120 342 000

The following graph shows the Design Capacity of the George WTP's and Predicted Demands based on the phasing of Future Developments and Linear Growth.



1.3.2 Reticulation Items

Items required to accommodate the proposed development (including fire flow requirements):

Distribution mains;

• GMR_02.02	New 355 mmØ x 16 m network reinforcement pipe		R 156 000
• GMR_02.03	New 355 mmØ x 447 m network reinforcement pipe		R 2 353 000
• GMR_F02.03	New 315 mmØ x 437 m network distribution pipe		R 1 449 000
• GMR_F02.04	New 315 mmØ x 52 m network distribution pipe		R 220 000
• GMR_F02.05	New 315 mmØ x 327 m network distribution pipe		R 1 099 000
• GMR_F02.06	New 315 mmØ x 791 m network distribution pipe		R 2 580 000
• GMR_F02.07	New 315 mmØ x 282 m network distribution pipe		R 954 000
• GMR_F02.08	New 315 mmØ x 169 m network distribution pipe		R 595 000
• GMR_F02.09	New 315 mmØ x 73 m network distribution pipe		R 287 000
		Total	R 9 693 000

Network mains;

• GMR_F05.01	New 160 mmØ x 783 m network main pipe		R 1 097 000
• GMR_F05.02	New 160 mmØ x 1114 m network main pipe		R 1 545 000
• GMR_F05.03	New 160 mmØ x 206 m network main pipe		R 313 000
• GMR_F06.01	New 160 mmØ x 241 m network main pipe		R 361 000
• GMR_F06.02	New 160 mmØ x 154 m network main pipe		R 242 000
		Total	R 3 558 000

The proposed connection points (items GMR_F02.03 and GMR_F02.09) to the existing water distribution system are shown in **Figure 1 (Water)**.

Provision must be allowed for the following future connections;

- GMR_F08.01 New 160 mmØ connection for Kraaibosch 195/88 future development
- GMR_F13.00 2 x New 160 mmØ connections for Glenwood AH future development

1.4 Internal Reticulation

The internal network design on the property of the proposed development is beyond the scope of this report. However, the consulting engineer for the development should allow for the fire flow demand as listed in 1.2 above on the internal networks.

The following input pressures can be used for the design of the internal network at the proposed connection point, item PWT_F02.09 (see **Figure 1 (Water)**):

- Static EGL = 295.0 m a.s.l. (71.1 m)
- Residual EGL = 275.5 m a.s.l. (51.6 m)
- Fire Flow EGL = 273.5 m a.s.l. (49.6 m) (Moderate risk @ 50 L/s)
- Ground Level = 223.9 m a.s.l.

2 SEWER NETWORK

2.1 Drainage Area

The proposed development was taken into consideration in the sewer master plan as part of the Loerie Ext.1A and Loerie Ext.1B future development areas.

The master plan indicates that the proposed development falls in the following sub-drainage areas as shown in **Figure 2 (Sewer)** attached. This sub-drainage area drains to the Outeniqua WWTW.

- Future George Erf 464 PS F1
- Future George Erf 464 PS F2
- Existing Glenwood PS
- Existing Eden George PS

2.2 Revised Sewer Flow

The combined peak day dry weather flow (PDDWF) for the proposed development was originally calculated and used in the analysis of the sewer system in the master plan at 471 kL/d.

The revised PDDWF calculated for the proposed development and used in the re-analysis of the sewer system is 1 706 kL/d with an instantaneous peak dry weather flow (IPDWF) of 41 L/s. The design flow, or instantaneous peak wet weather flow (IPWWF), is 58 L/s.

2.3 Accommodation of the Proposed Development in the Existing Sewer System

Accommodation of the proposed development, with the revised PDDWF, requires implementation of the following additions and adjustments to the *existing* sewer system as indicated in **Figure 2 (Sewer)**:

2.3.1 Sewer Bulk Items

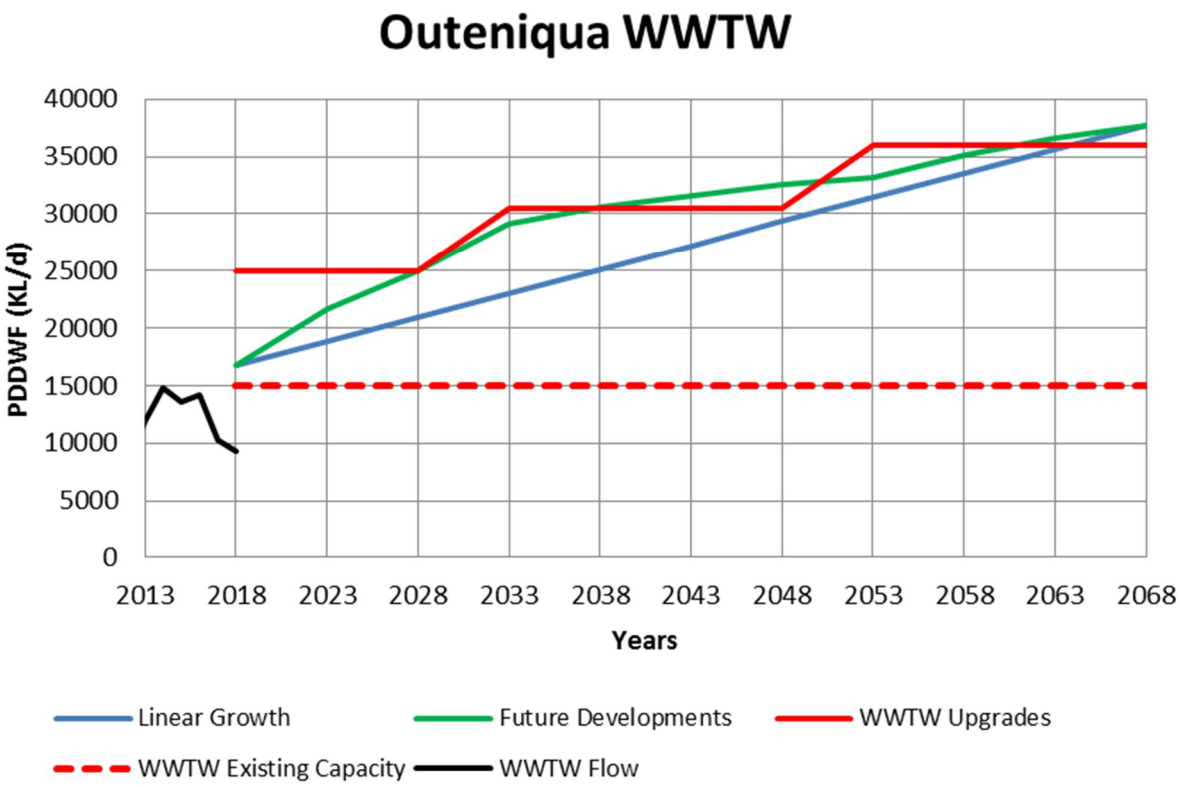
Items required to alleviate existing deficiencies in the bulk sewer system:

- None

Items required to accommodate the proposed development in the future sewer system:

•	OT_24.01a	Upgrade existing inlet works, flow diversion (Design Flow = 1 201 L/s)	R 1 410 000
•	OT_24.01b	Upgrade existing inlet works, gravity pipe (Design Flow = 337 L/s)	R 191 000
•	OT_24.01c	Upgrade Outeniqua WWTW, phase 1 of 3 (Design Flow = 10 000 kL/d)	R 177 341 000
		Total	R 178 942 000

The following graph shows the Design Capacity of the Outeniqua WWTW, the Average Flow, and Predicted Flow based on the phasing of Future Developments and Linear Growth.



2.3.2 Sewer Reticulation Items

The proposed connection points to the existing sewer system are shown in **Figure 2 (Sewer)**.

In **Figure 2 (Sewer)** pipes in future development areas are indicated schematically.

<u>Items required to accommodate the proposed development in the future sewer system:</u>

Future internal network

•	OT_F110.01	New George Erf 464 PS F1 @ 26 L/s (Design flow = 26 L/s)	R 2 869 000
•	OT_F110.02	New 160 mmØ x 693 m rising main (Design flow = 26 L/s)	R 882 000
•	OT_F111.01	New George Erf 464 PS F2 @ 15 L/s (Design flow = 15 L/s)	R 2 429 000
•	OT_F111.02	New 125 mmØ x 462 m rising main (Design flow = 15 L/s)	R 477 000
•	OT_F112.01	New 160 mmØ x 178 m gravity pipe (Design flow = 28.4 L/s)	R 344 000
•	OT_F112.02	New 250 mmØ x 380 m gravity pipe (Design flow = 56.3 L/s)	R 874 000
•	OT_F113.01	New 160 mmØ x 379 m gravity pipe (Design flow = 21.5 L/s)	R 671 000
•	OT_F113.02	New 200 mmØ x 85 m gravity pipe (Design flow = 27.8 L/s)	R 212 000
•	OT_F114.00	New 160 mmØ x 72 m gravity pipe (Design flow = 1.4 L/s)	R 172 000
•	OT_F115.00	New 160 mmØ x 178 m gravity pipe (Design flow = 0.7 L/s)	R 344 000
		Total	R 9 274 000

Items required to alleviate deficiencies in the existing sewer system:

• OT_01.01	Upgrade Eden George PS from 123.0 L/s to 129.8 (Design flow = 129.8 L/s)	R 2 632 000
• OT_65.00	Upgrade 200 mmØ x 8 m gravity pipe to 400 mmØ (Design flow = 82.2 L/s)	R 181 000
• OT_02.01	Upgrade Glenwood PS from 30.0 L/s to 82.2 (Design flow = 82.2 L/s)	R 1 966 000
• OT_72.00	Upgrade 500 mmØ x 12 m gravity pipe to 600 mmØ (Design flow = 225.5 L/s)	R 303 000
• OT_03.01	Upgrade Meul PS from 242.0 L/s to 404.7 (Design flow = 404.7 L/s)	R 5 465 000
• OT_03.02	Upgrade 450 mmØ x 483 m rising main to 710 mmØ (Design flow = 404.7 L/s)	R 7 789 000
• OT_09.01	Upgrade 700 mmØ x 18 m gravity pipe to 1050 mmØ (Design flow = 409.9 L/s)	R 846 000
• OT_09.02	Upgrade 700 mmØ x 26 m gravity pipe to 1050 mmØ (Design flow = 410.4 L/s)	R 969 000
• OT_09.04	Upgrade 700 mmØ x 160 m gravity pipe to 825 mmØ (Design flow = 414.1 L/s)	R 2 148 000
• OT_09.03	Upgrade 600 mmØ x 14 m gravity pipe to 900 mmØ (Design flow = 425.7 L/s)	R 588 000
• OT_10.01	Upgrade Schaapkop PS from 380.0 L/s to 491.3 (Design flow = 491.3 L/s)	R 6 336 000
• OT_10.02	Upgrade 500 mmØ x 154 m rising main to 710 mmØ (Design flow = 491.3 L/s)	R 3 089 000
• OT_10.03	Upgrade 999 mmØ x 315 m gravity pipe to 1050 mmØ (Design flow = 491.6 L/s)	R 0
• OT_10.04	Upgrade 999 mmØ x 32 m gravity pipe to 1050 mmØ (Design flow = 667.5 L/s)	R 0
• OT_10.05	Upgrade 999 mmØ x 8 m gravity pipe to 1050 mmØ (Design flow = 1200.9 L/s)	R 0
	Total	R 32 312 000

The above Design Flows (or IPWWF) and resulting pipe sizes were calculated taking into account future developments upstream of the proposed development.

As the Design Flow already accommodates stormwater ingress, the pipes can be designed to flow 100% full with the Design Flows provided above.

3 BULK CONTRIBUTIONS AND COSTING OF REQUIRED WORKS

GLS hereby confirms that any contributions of the developer to the required construction of infrastructure and/or the upgrading of existing infrastructure, whether it be in the form of a capital contribution or in the form of constructing sections of new infrastructure, is a matter to be discussed and agreed upon between the developer and the George LM.

All costs shown in this report are year 2018/19 Rand value **estimates** and **include** 50% surcharge for P&Gs, contingencies, fees and a regional factor but **exclude** VAT.

Yours sincerely,

_____

Per: Dr BF Loubser
GLS Consulting

(Report done by: JJ van der Merwe)

REQUEST FROM CONSULTANT TO GLS

From: Marius Botha [mailto:Marius.Botha@aurecongroup.com]
Sent: 16 May 2019 15:59
To: Jurie van der Merwe <jurie@gls.co.za>; Flip du Plessis <flip@gls.co.za>
Cc: Rudolf Schröder <Rudolf.Schroder@aurecongroup.com>
Subject: Erf 464 George- Rezoning and Subdivision for George University : Bulk Sewer and Water Infrastructure

Middag Jurie/Flip,

Die aangehegde voorgestelde ontwikkelingsplan verwys. Die terrein is aanliggend tot die Tuinroete Dam by George.

Ons benodig asb. 'n kwotasie so gou moontlik rakende die bevestiging van bestaande dienste kapasiteit asook tydlyn vir die verslag se voltooiing.

Die tabel hier onder wys die sonerings wat voor aansoek gedoen sal word asook die ontwikkelings beperkings en potensiële aantal eenhede.

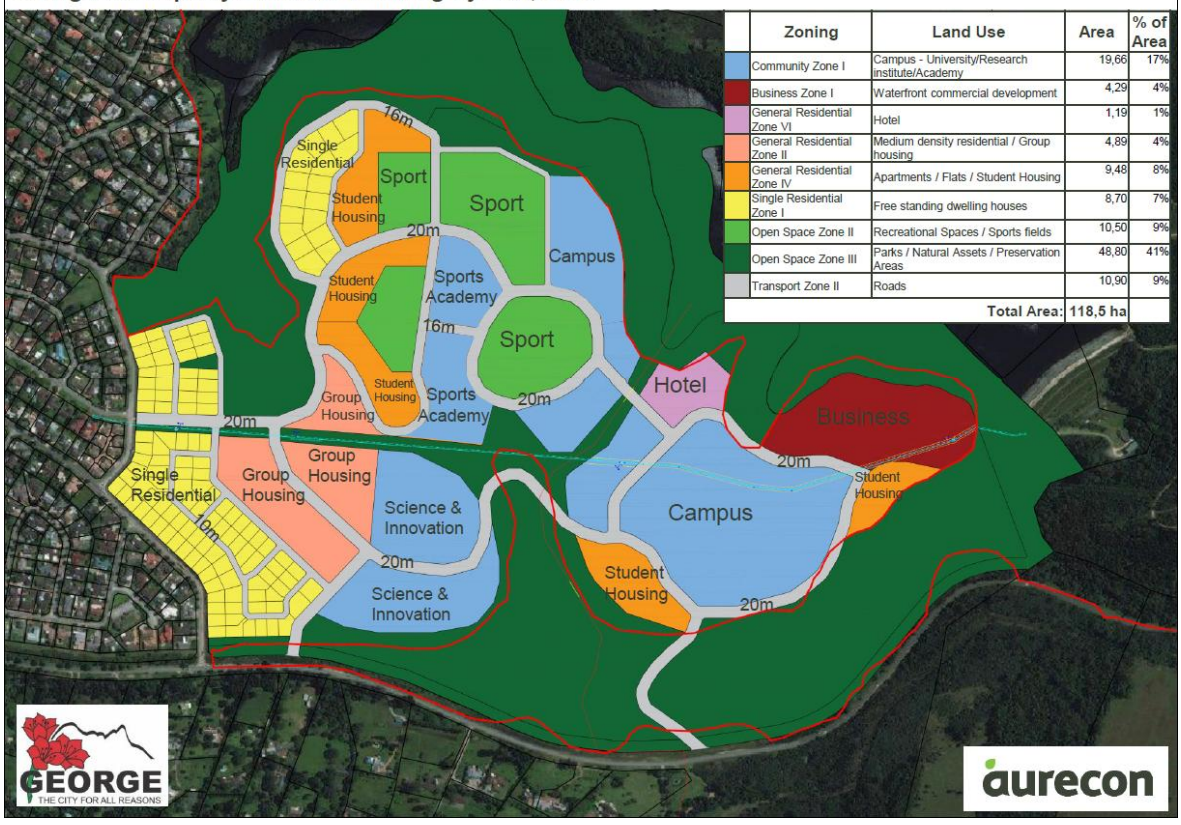
Zoning	Land use Description	Primary Use	Minimum erf size in m²	FAR	Density (dwelling units per hectare)	Building square meters	number of dwelling units	Area	% of Area
Community Zone I	Campus - University/Research institute/Academy	Place of instruction	na	1,2	na	205345,04	na	17,11	14%
Business Zone I	Waterfront commercial development	Business premises	na	1	na	42885,67	na	4,29	4%
General Residential Zone VI	Hotel	Hotel	na	1	na	11853,24	na	1,19	1%
General Residential Zone II	Medium density residential / Group housing	Group Housing	na	N/A	35	na	171	4,89	4%
General Residential Zone IV	Apartments / Flats / Student Housing	Flats	na	1		120301,13	3008	12,03	10%
Single Residential Zone I	Free standing dwelling houses	Dwelling house	600	N/A	1 dwelling per erf		129	8,70	7%
Open Space Zone III	Parks / Natural Assets / Preservation Areas	Public open space	na	na	na	na	na	48,80	41%
Open Space Zone II	Recreational Spaces / Sports fields	Private open space	na	na	na	na	na	10,50	9%
Open Space Zone IV	Nature reserve	Nature reserve	na	na	na	na	na		
Transport Zone II	Roads	Public Street	na	na	na	na	na	10,90	9%

Skakel gerus indien daar enige vrae is.

Groete,

Marius Botha PrTech Eng, BTech Eng (Civil)
Associate, Land Development Services, Aurecon
T +27 44 8055446 **F** +27 86 6009396 **M** +27 72 3861043
Marius.Botha@aurecongroup.com
Suite 201, 2nd Floor, Bloemhof Building, 65 York Street, George South Africa 6529
PO Box 509, George 6530
aurecongroup.com

Rezoning and Subdivision of a Portion of the Remainder of Erf 464, George, in terms of Section 15 of the George Municipality Land Use Planning By-Law, 2015.



	Zoning	Land Use	Area	% of Area
	Community Zone I	Campus - University/Research institute/Academy	19,66	17%
	Business Zone I	Waterfront commercial development	4,29	4%
	General Residential Zone VI	Hotel	1,19	1%
	General Residential Zone II	Medium density residential / Group housing	4,89	4%
	General Residential Zone IV	Apartments / Flats / Student Housing	9,48	8%
	Single Residential Zone I	Free standing dwelling houses	8,70	7%
	Open Space Zone II	Recreational Spaces / Sports fields	10,50	9%
	Open Space Zone III	Parks / Natural Assets / Preservation Areas	48,80	41%
	Transport Zone II	Roads	10,90	9%
		Total Area:	**118,5 ha**	

0 125 250 375 500 m

Scale 1:25000

Legend:

Proposed Master Plan

- Existing
- Proposed Bulk
- Proposed Retic
- Abandoned
- Investigate
- Future Main
- Future Schematic

Future development areas

- Future Developments Areas
- Developable Area

FIGURE 1

Required Works:
George Erf 464 (University)
Future George Water System
2019-03

Eden George PS
OT_01.01

George Erf 464 PS F2
OT_F111.01

George Erf 464 PS F1
OT_F110.01

Glenwood PS
OT_02.01

Saasveld PS

Welgelegen

Kraaibosch PS

Meul PS
OT_03.01

Blue Mountain PS 2

Blue Mountain PS 1

Parkdene PS 1

Parkdene PS 2

Parkdene PS 3

Thembalethu PS 1

Thembalethu PS A

Thembalethu PS B

Thembalethu PS 2

Thembalethu PS 5

Tamsui PS

Schaapkop PS

Rosedale PS 2

Rosedale PS 1

Pacaltsdorp Ext.3A PS

Outeniqua WWTP

0 100 200 300 400 m

Scale 1:20000

Legend:

Proposed Master Plan

- Existing
- Proposed
- Proposed (Investigate first)
- Abandoned
- Investigate
- Future Main
- Future Schematic

Pipes

- Gravity Mains
- Rising main

Future development areas

- Future Developments Areas
- Developable Area

GEORGE
THE CITY FOR ALL REASONS

FIGURE 2

Required Works:
George Erf 464 (University)
Future George Sewer System
2019-03

Annexures D: SMEC TIA Report

SMEC South Africa

Member of the Surbana Jurong Group

GEORGE

THE CITY FOR ALL REASONS

George Municipality

Traffic Impact Assessment for the Proposed George Campus

Date 27 November 2019 Ref. C1736

65 Riebeek Street, Cape Town, 8001 Tel: 031 277 6600 emile.jordaan@smec.com

DOCUMENT CONTROL

Project Name:	Traffic Impact Assessment for the Proposed George Campus
Project Number:	C1736
Report for:	George Municipality

REVISIONS

Revision #	Date	Change Overview	Prepared by	Reviewed by
0	2019/10/04	Draft for Review	EB Jordaan, PEng	J Engelbrecht, PrEng
1	2019/10/18	Final	EB Jordaan, PEng	W Annandale, PrEng
2	2019/11/27	Revised access spacing	EB Jordaan, PEng	W Annandale, PrEng

APPROVAL

Approver Name:	W Annandale, PrEng	**Approver Position:**	Office Manager, Roads & Highways
Approver Signature:		**Date:**	2019/11/27

SMEC COMPANY DETAILS

Prepared by:	SMEC South Africa	
	Address:	65 Riebeek Street, Cape Town, 8001, South Africa
	Telephone:	+27 (0) 21 417 2900
	Contact Person:	Emile Jordaan
	Email Address:	emile.jordaan@smec.com
	www.smec.com	

TABLE OF CONTENTS

PAGE(S)

TABLE INDEX

PAGE(S)

FIGURE INDEX

PAGE(S)

1. DEVELOPMENT PARTICULARS

SMEC South Africa (Pty) Ltd was appointed by George Municipality to conduct a Traffic Impact Assessment for the proposed George Campus Development. The site is bound by the Garden Route Dam to the north and Madiba Drive to the south. Refer to Figure 1.

Figure 1 Locality Plan (source: Google)

The site measures approximately 118 hectares in extent. The anticipated composition of the development is a Campus catering for 8 000 students, a Waterfront commercial development of 129 300 square metres Gross Lettable Area (GLA), and a Hotel of 34 500 square metres GLA (assumed to be 345 rooms). The Campus component will include residential units for 303 lecturers and 3 009 students.

For the purpose of this TIA it was assumed that the development will be 50% implemented over 5 years by 2024, and 100% within 10 years by 2029.

2. STUDY AREA

The study area is an area from which transportation elements are selected for the TIA. Such transport elements are selected as follows:

- Site accesses;
- Minimum of two intersections on the road where access is proposed; and
- All roads in sensitive areas.

Taking the above into consideration, the following primary study area and associated transportation elements have been selected for assessment (Refer to Figure 2):

- Stander Street & Site Access 1 (opposite Arthur Bleksley Street);
- Saasveld Road (West) & Site Access 2; and
- Saasveld Road & Site Access 3, opposite Road 1.

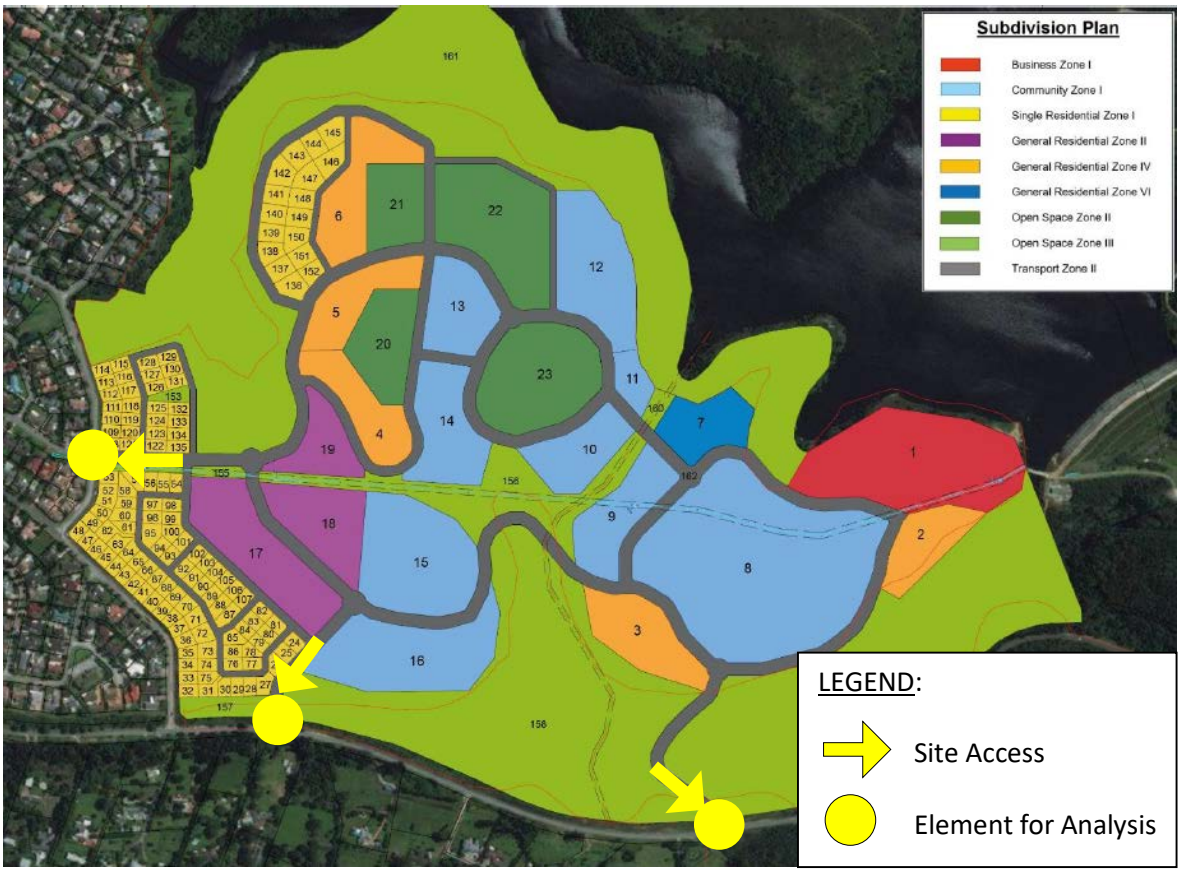


Figure 2 Primary Study Area (source: Aurecon)

Based on the type and extent of development, the following secondary study area and associated transportation elements have been selected for assessment (Refer to Figure 3):

- N9 Knysna Street & Saasveld Road intersection;
- N9 Knysna Street & Road 1; and
- Saasveld Road & Meyer Street.

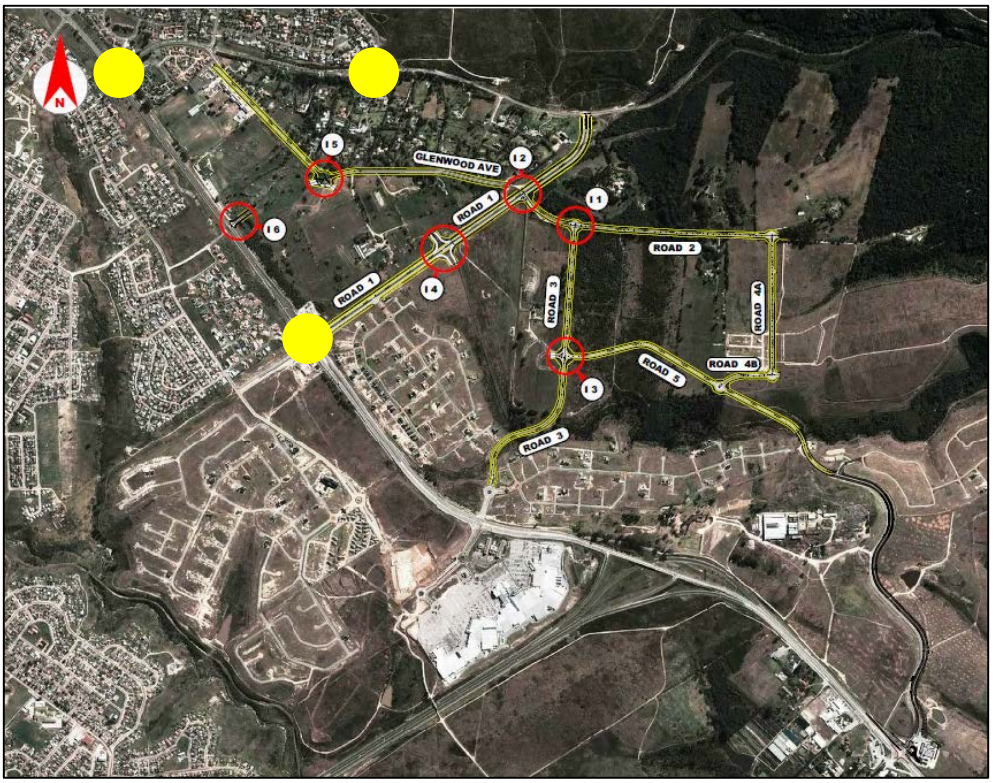


Figure 3 Secondary Study Area (source: Google)

3. BACKGROUND INFORMATION

3.1 Existing Roads

National Route N9 is a Class 2 Major Arterial under the jurisdiction of the South African National Road Agency Limited. In the vicinity of Saasveld Road it comprises of two lanes per direction. It experiences moderate traffic flows during peak hours, and operates at an acceptable Level of Service.

Saasveld Road is a Class 3 Minor Arterial, extending from Eden George to the north of Wilderness and Hoekwil. The road comprises of one lane per direction in the vicinity of the subject site. It experiences low traffic flows during peak hours, and operates at an acceptable Level of Service.

Meyer Street is a Class 4 Urban Collector, serving the suburb of Eden, George. The road comprises of one lane per direction in the vicinity of the subject site. It experiences low traffic flows during peak hours, and operates at an acceptable Level of Service.

Kraaibosch Way is a Class 4 Urban Collector, designed to predominantly serve the Kraaibosch development. The will comprises of one lane per direction. It experiences low traffic flows during peak hours, and operates at an acceptable Level of Service.

3.2 Public Transport Facilities

George is currently served by three phases of the George Integrated Public Transport Network (George IPTN). As Kraaibosch and George Campus is rolled out, it is anticipated that these developments will be well served by an extended Phase 1 of the George IPTN. Refer to Figure 4.

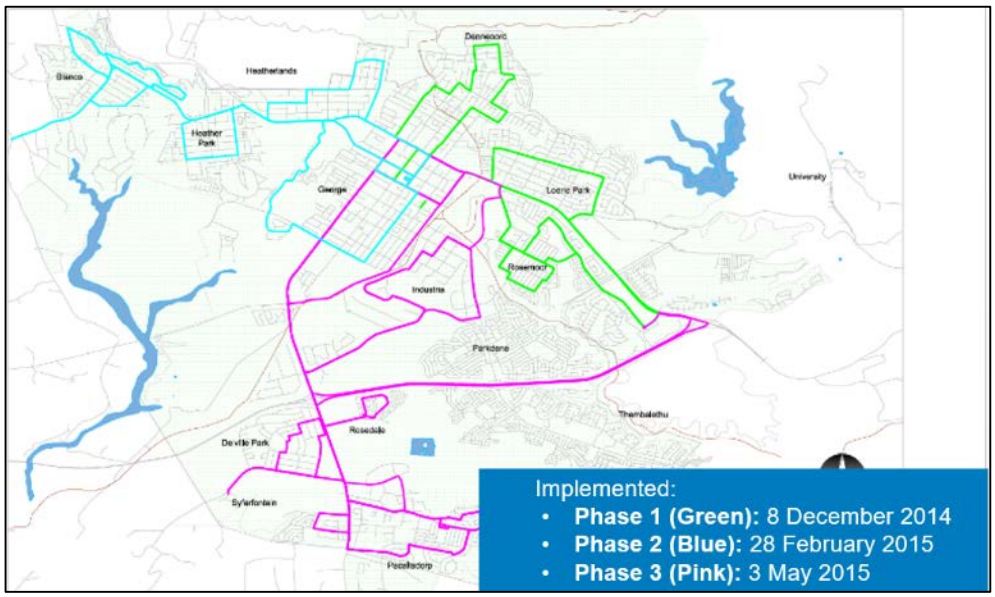


Figure 4 Public Transport Facilities (source: George Municipality)

3.3 Non-Motorized Transport Facilities

The George Campus design focuses on pedestrian accessibility and mobility, providing green corridors linking all components of the development. Refer to Figure 5.

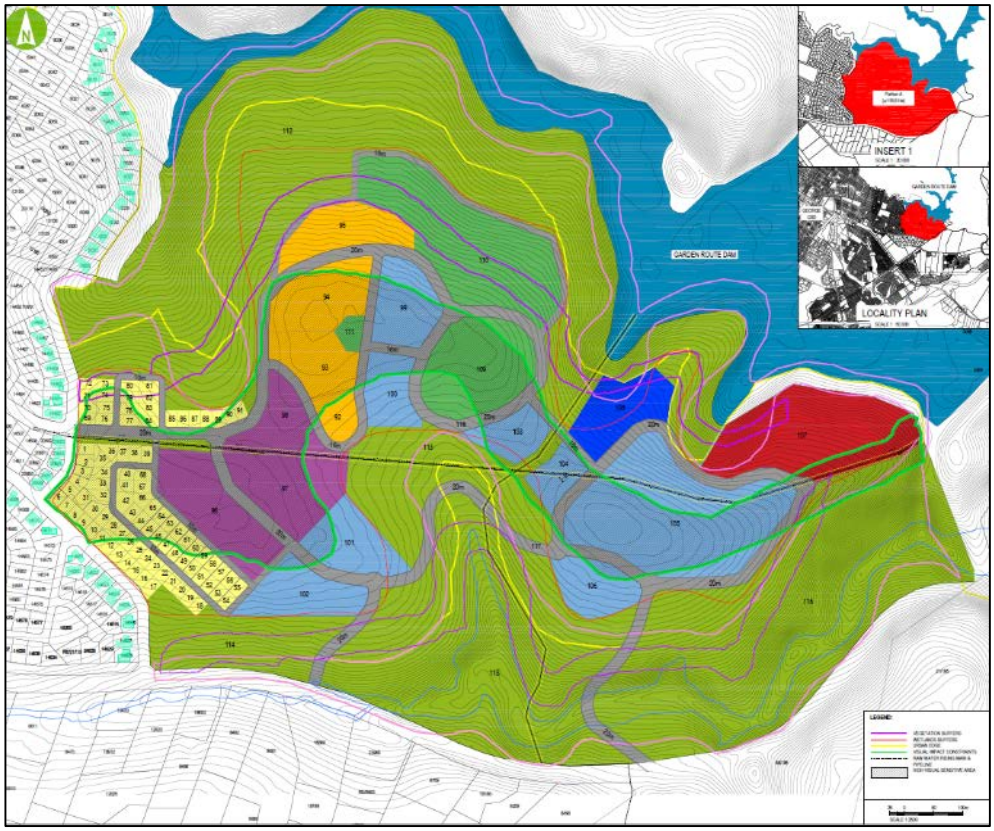


Figure 5 NMT Facilities (source: Aurecon)

3.4 Planned Changes to Transportation Facilities

It is proposed that an extended Phase 1 of the George IPTN serve the George Campus, with the provision of bus stops within the Campus grounds.

3.5 Site Access

The site will be served by three accesses, as follows:

- Access 1 along Stander Street (opposite Arthur Bleksley Street);
- Access 2 along Saasveld Road (between Meyer Street & Access 3); and
- Access 3 along Saasveld Road (opposite Road 1).

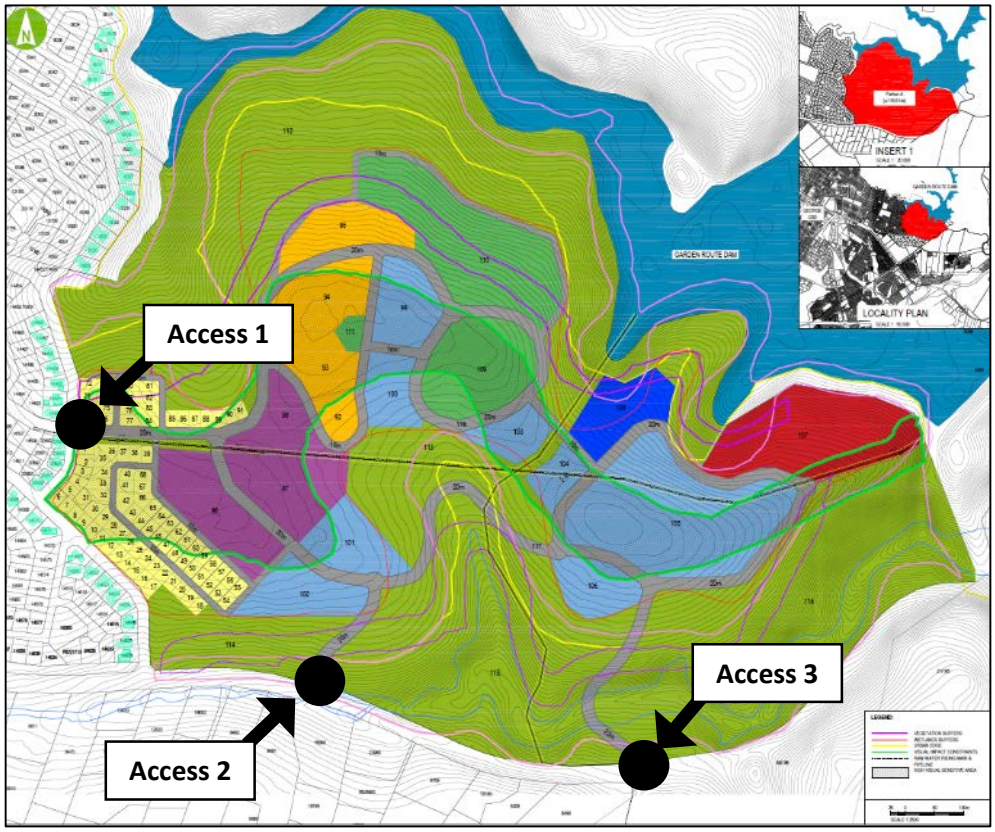


Figure 6 Site Access (source: Aurecon)

The access spacing requirements were derived from the COTO TMH 16 Volume 2. This requires a 600 metre access spacing (± 20%) along Class 3 roads within Urban Areas.

With the locations of Meyer Street and Access 3 being fixed, it would be preferred to locate Access 2 midway between Meyer Street and Access 3. This was, however, not achievable, due to environmental constraints limiting the possible access locations.

Taking into consideration the proposed junction control being roundabouts, it would be deemed appropriate to accept a reduced intersection spacing on either side of Access 2. The attainable access spacing along Saasveld Road is 300 metres between Meyer Street and Access 2, and 600 metres between Access 2 and Access 3.

4. OTHER PLANNING AUTHORITIES

N9 Knysna Street falls under the jurisdiction of the South African National Roads Agency Limited (SANRAL), and Saasveld Road under the Western Cape Department of Transport. As such, these Authorities would need to be included in the approval process.

5. TRAFFIC DEMAND ESTIMATION

5.1 Assessment Year

The traffic assessment will be undertaken for a 2024 and 2029 design year. A linear build-out of the development has been assumed, as set out in Table 1.

Table 1 Development Phasing (Cumulative)

Phase	Year	Assumed Build-Out	University (students)	Housing (units)	Commercial (sqm GLA)	Hotel (rooms)
Phase 1	2024	50%	4 000	1 652	64 650	173
Phase 2	2029	100%	8 000	3 303	129 300	345

5.2 Assessment Hour

The traffic assessment must be undertaken for the hours during which the combined effect of background and development traffic will result in the highest traffic demand. Taking into consideration the planned mixed use development, it is deemed appropriate for the Weekday AM and PM Peak Hours to be analysed.

5.3 Background Traffic Demand Estimation

5.3.1 Traffic Counts

Manual classified intersection traffic counts were undertaken as part of this project assignment. Details of the traffic survey are provided below:

- Date counted July 2019
- Day of the week Normal Weekdays
- Day class Normal
- Congestion levels Low
- Enumerator SMEC

5.4 Peak Hour

A common peak hour was identified for the intersections under discussion, as follows:

- Weekday AM Peak Hour 07h00 - 08h00
- Weekday AM Peak Hour 16h15 – 17h15

5.5 Traffic Growth

A traffic growth rate is applied to background traffic in order to determine the anticipated increase in Base Year traffic by a predefined Design Year.

The COTO TMH 17 South African Trip Data Manual dated September 2012 provides typical growth rates to be used for growth areas based on the existing/anticipated rate of growth. Refer to Table 2.

Table 2 Typical Growth Rates

DEVELOPMENT AREA	GROWTH RATE
Low Growth Areas	0% - 3%
Average Growth Areas	3% - 4%
Above Average Growth Areas	4% - 6%
Fast Growing Ares	6% - 8%
Exceptionally High Growth Areas	> 8%

Taking into consideration the location of the subject site, a compounded traffic growth rate of 2.0% was applied to the 2019 Base Year Traffic in order to derive 2024 and 2029 Design Year traffic flows.

Taking into consideration the close proximity of the other development parcels forming part of the Kraaibosch development, it was deemed appropriate to only apply a growth rate to N9 Knysna Street traffic.

5.6 Existing exercised land-use rights

Where a development has existing land-use rights that have been exercised and where a growth rate is applied, the trip generation of the exercised rights must be estimated and subtracted from the traffic counts before any growth is applied.

No existing exercised land-use rights apply to this development.

5.7 Trip Generation by Other Developments

Other developments as well as future potential development in the area must be taken into account in the estimation of future background traffic. The following developments have been taken into account:

5.7.1 Kraaibosch Development

The Roads Master Plan for the Kraaibosch Development dated September 2018 includes several land parcels and development land therein.

The location of each development is shown in Figure 7.

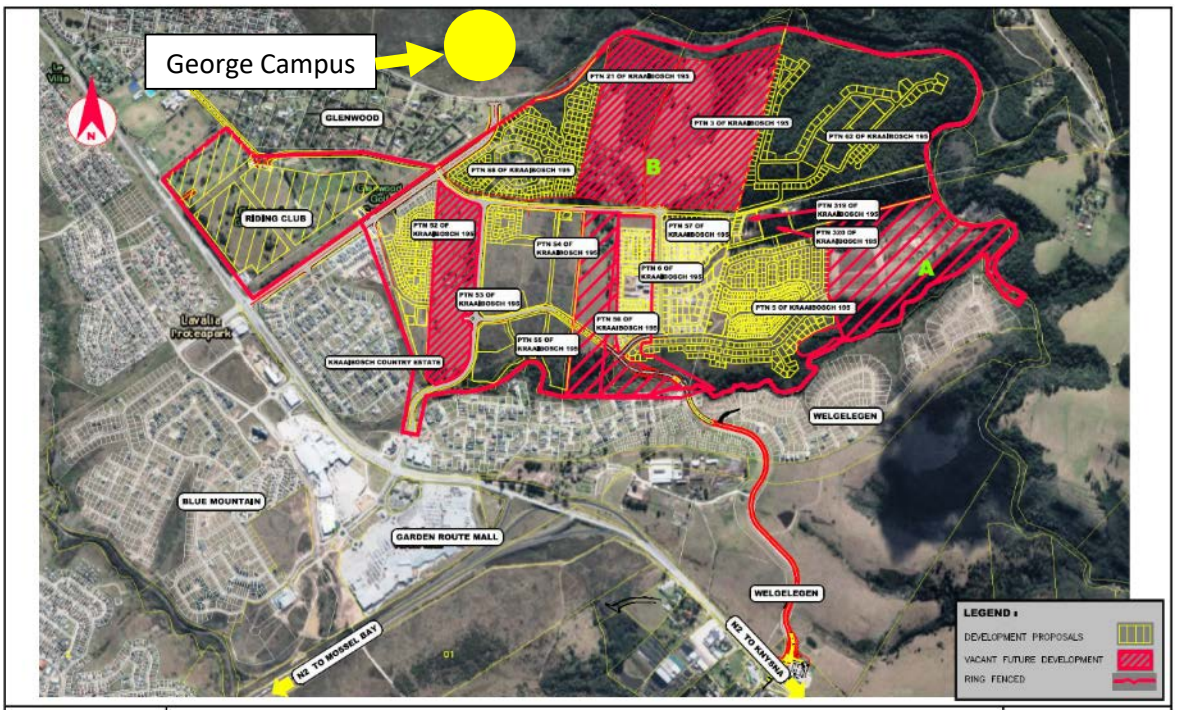


Figure 7 Other Developments (source SMEC)

The trip generation potential of the other developments is set out in Table 3.

Table 3 Other Development Trip Generation

PORTION	PROPOSED DEVELOPMENT	TRIP RATE	IN / OUT SPLIT		TRIPS GENERATED		TOTAL
			IN	OUT	IN	OUT	
195/62	43 High Income Units	1.5	25%	75%	37	110	146
	5.2 ha Group Housing Units @ 55 du/ha	1.1	25%	75%	78	234	312
195/3	30.5 ha Retirement Units @ 20du/ha	0.15	25%	75%	23	69	92
195/88	144 Group Housing Units	1.1	25%	75%	40	119	159
	124 High Income Units	1.5	25%	75%	46	140	186
195/21	20 ha High Income Units @ 15du/ha	1.5	25%	75%	112	338	450
195/54 & 55	8.76 ha Retirement @ 35 du/ha	0.15	35%	65%	16	30	46
	2.27 ha Group Housing units @ 55 du/ha	1.1	25%	75%	35	104	138
	1.60 ha Flats @ 55du/ha	1.1	25%	75%	24	73	97
	2.76 ha Suburban Medical Centre	7/100m^2	55%	45%	1061	868	1929
	6.05 ha Private Hospital (50% coverage)	2.4/100m^2	55%	45%	399	327	726
	1.54 ha Shopping Centre	224.5 GLA$^{-0.34}$ / 100m^2	50%	50%	653	653	1306
195/52	171 Retirement Units	0.15	35%	65%	9	17	26
	13 Retirement Units	0.15	35%	65%	1	1	2
	1.43 ha Group Housing Units @ 15 du/ha	1.1	25%	75%	6	18	24
	0.36 ha Sport/Recreation	40/ha	50%	50%	7	7	14
195/5	156 Group Housing Units	1.1	25%	75%	43	129	172
	0.75 ha Community Orientated Uses	40/ha	50%	50%	15	15	30
	289 Retirement Units	0.15	25%	75%	11	32	43
	40 High Income Units	1.5	25%	75%	15	45	60
195/6 & 57	343 Retirement Units	0.15	25%	75%	13	39	52
195/1	124 Group Housing units	1.1	25%	75%	34	102	136
195/56	14.00 ha Vacant land @ 15 du/ha	1.1	25%	75%	58	173	231
195/53	13.60 ha Vacant land @ 15du/ha	1.1	25%	75%	56	168	224
Riding Club	6.04 ha Sport/Recreation/Education	40/ha	50%	50%	121	121	242
	7.75 ha Community Orientated Uses	40/ha	50%	50%	155	155	310
	9.86 ha Group Housing @ 15 du/ha	1.1	25%	75%	41	122	163
195/319	5 High Income units	1.5	25%	75%	2	6	8
	0.74 ha Group Housing @ 60du/ha	1.1	25%	75%	12	37	49
195/320	5 High Income units	1.5	25%	75%	2	6	8
	0.75 ha Group Housing @ 60du/ha	1.1	25%	75%	13	38	50
Section A	18.60 ha Vacant land @ 15du/ha	1.1	25%	75%	77	230	307
						TOTAL	7738

The anticipated trip generation for the other developments totals to 7 738 private vehicle trips during the Weekday AM Peak Hour.

With reference to the Kraaibosch Roads Master Plan and Cost Apportionment (Revision 4) dated September 2018, it is not feasible to analyse the operational analysis of the infrastructure until the site development plans have reached a certain level of finality. As such, this development impact is not considered as part of the current project assignment.

5.8 Trip Generation

Trip generation rates are measured in units of trip ends, with either an origin or a destination at the development. It is the sum of traffic to or from a development.

The Trip Generation Rates for the planned land use types were obtained from the COTO TMH 17 South African Trip Data Manual dated September 2012.

The trip generation potential of Phase 1 of the George Campus is shown in Table 4.

Table 4 Trip Generation – Phase 1

Land Use	Unit	Trip Generation Rate		Total Trips			
				AM		PM	
		AM	PM	In	Out	In	Out
Hotel (rooms)	173	0.5	0.5	52	35	48	39
University (students)	4 000	0.2	0.2	640	160	240	560
Shopping Centre (sqm GLA)	64 650	0.6	3.0	330	178	1438	1438
Total				1 022	372	1 725	2 037
				1 394		3 762	

Based on the size of the Phase 1 retail component, a site-specific size adjustment factor of 1.308 applies.

The trip generation potential of Phase 2 of the George Campus is shown in Table 5.

Table 5 Trip Generation – Phase 2

Land Use	Unit	Trip Generation Rate		Total Trips			
				AM		PM	
		AM	PM	In	Out	In	Out
Hotel (rooms)	345	0.5	0.5	104	69	95	78
University (students)	8 000	0.2	0.2	1 280	320	480	1 120
Shopping Centre (sqm GLA)	129 300	0.6	3.0	584	314	2 546	2 546
Total				1 968	703	3 121	3 743
				2 671		6 864	

Based on the size of the Phase 2 retail component, a site-specific size adjustment factor of 1.158 applies.

It is anticipated that Phase 1 of the planned development would generate 1 394 and 3 762 new vehicular trips during the Weekday AM and PM Peak Hours respectively, and with Phase 2 it would generate a total of 2 671 and 6 864 new vehicular trips during the Weekday AM and PM Peak Hours respectively.

5.9 Trip Reduction Factors

For the purpose of this study, the below trip reduction factors from the George Campus were applied, subject to approval by George Municipality. Particular note should be taken of the Retail component, which is specifically designed for the needs of the Campus. As such, it was deemed appropriate to assess this component of the development serving very low car ownership. Trip reduction factors for transit and mixed use were applied to the remainder of the development components. Refer to Table 6.

Table 6 Trip Reduction Factor

Land Use	Adjustment				
	Mixed Use	Car Ownership		Transit Corridors	Factor
		Low	Very Low		
University	20%			15%	0.68
Hotel, Residential	20%			15%	0.68
Shopping Centre	10%		60%	15%	0.31

Taking into consideration the trip reduction factors being applied, the revised vehicular trip generation potential for Phase 1 is shown in Table 7.

Table 7 Revised Vehicular Trip Generation – Phase 1

Land Use	Unit	Trip Generation Rate		Total Trips			
				AM		PM	
		AM	PM	In	Out	In	Out
Hotel (rooms)	173	0.5	0.5	35	24	32	26
University (students)	4 000	0.2	0.2	435	109	163	381
Shopping Centre (sqm GLA)	64 650	0.6	3.0	101	54	440	440
Total				571	187	635	847
				758		1 483	

Similarly, the revised vehicular trip generation potential for Phase 2 is shown in Table 8.

Table 8 Revised Vehicular Trip Generation – Phase 2

Land Use	Unit	Trip Generation Rate		Total Trips			
				AM		PM	
		AM	PM	In	Out	In	Out
Hotel (rooms)	345	0.5	0.5	70	47	65	53
University (students)	8 000	0.2	0.2	870	218	326	762
Shopping Centre (sqm GLA)	129 300	0.6	3.0	179	96	779	779
Total				1 119	361	1 170	1 593
				1 480		2 763	

It is anticipated that Phase 1 of the planned development would generate 758 and 1 483 new vehicular trips during the Weekday AM and PM Peak Hours respectively, and with Phase 2 it would generate a total of 1 480 and 2 763 new vehicular trips during the Weekday AM and PM Peak Hours respectively.

5.10 Trip Types

For the purpose of this study, it is assumed that all trips associated with the proposed development are classified as primary trips, therefore new trips on the surrounding road network.

6. TRIP DISTRIBUTION AND ASSIGNMENT

6.1 Trip Distribution – Internal

The location and extent of individual land use parcels within the development will define the access to be used in serving those components. With this in mind, the anticipated internal trip distribution is shown in Table 9.

Table 9 Internal Trip Distribution

Component	Access 1	Access 2	Access 3
University	40%	30%	30%
Hotel		100%	
Retail	10%	40%	50%

6.2 Trip Distribution – External

Trip distribution was estimated manually, based on the principles of the gravity model and with knowledge of local conditions. Refer to Table 10.

Table 10 External Trip Distribution

Direction	Destination	Route	Distribution
SW	George CBD	N9 Knysna Street	40%
W	George CBD	Stander Street	10%
W	George Bodorp	Stander Street	20%
S	Rosemore	Kraaibosch Way	20%
E	N2	N9 Knysna Street	10%

Based on the trip generation potential of the subject site, development trip distribution summary is set out in Table 11.

Table 11 Development Trip Distribution

Direction	Route	Percent	AM In	AM Out	PM In	PM Out
SW	N9 Knysna Street	40%	448	144	468	637
W	Stander Street	30%	336	108	351	478
S	Kraaibosch Way	20%	224	72	234	319
E	N9 Knysna Street	10%	112	36	117	159
Total		100%	1119	361	1170	1593

6.3 Traffic Assignment

Traffic assignment involves determining the percentage of traffic that will use specific routes in the network. The traffic assignment is made with consideration to logical routings, available roadway capacity, right-turn movements, travel times and other factors. Refer to Figure 8.

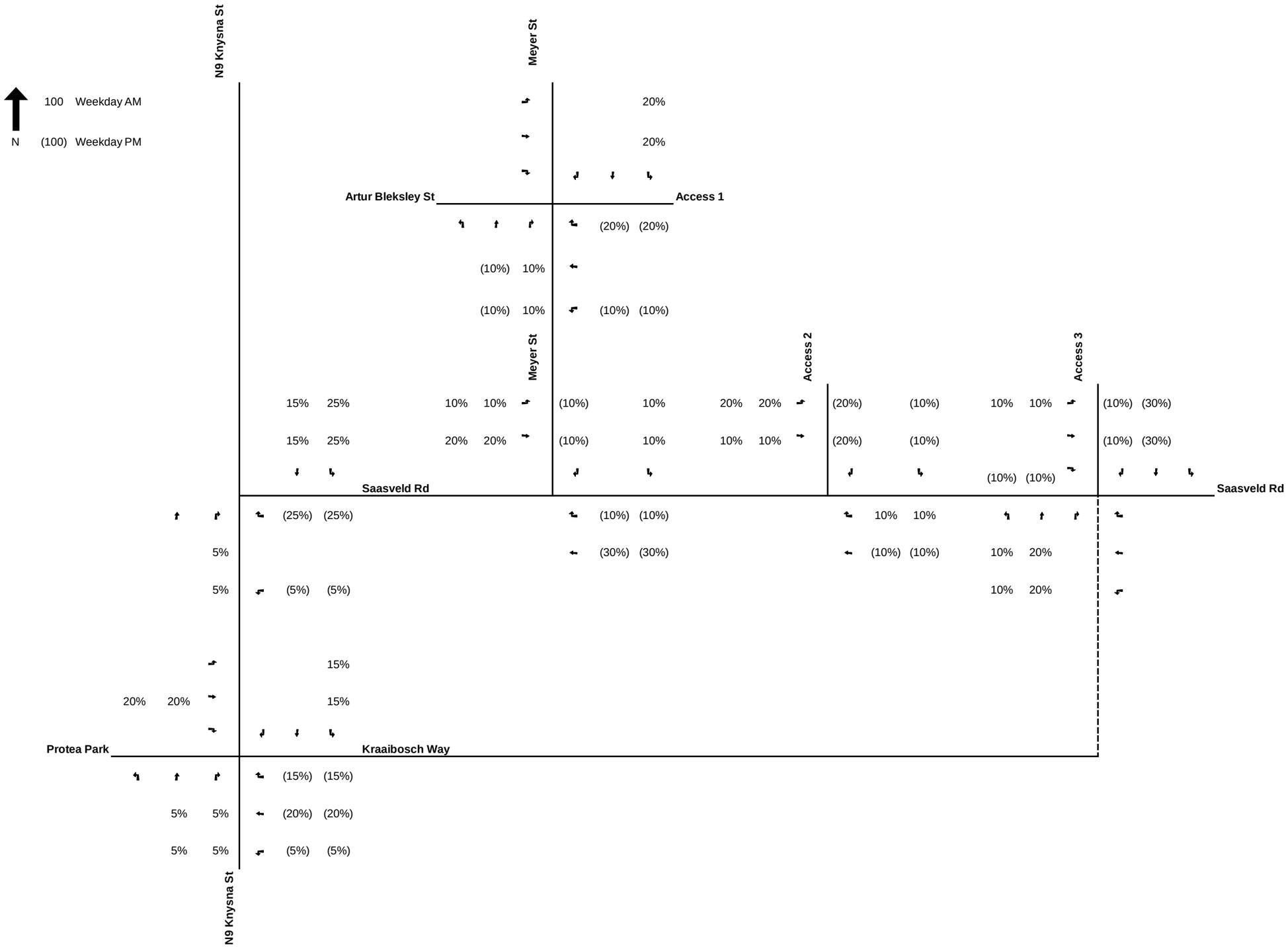


Figure 8 Traffic Assignment

7. TOTAL TRAFFIC DEMAND

7.1 Figures

The following information on traffic demand is provided for each horizon year and peak hour that is assessed:

- Figure 9 2019 Base Year Traffic;
- Figure 10 Phase 1 Development Trips;
- Figure 11 Phase 1+2 Development Trips;
- Figure 12 2024 Design Year + Phase 1 Development Trips: and
- Figure 13 2029 Planning Year + Phase 1+2 Development Trips.

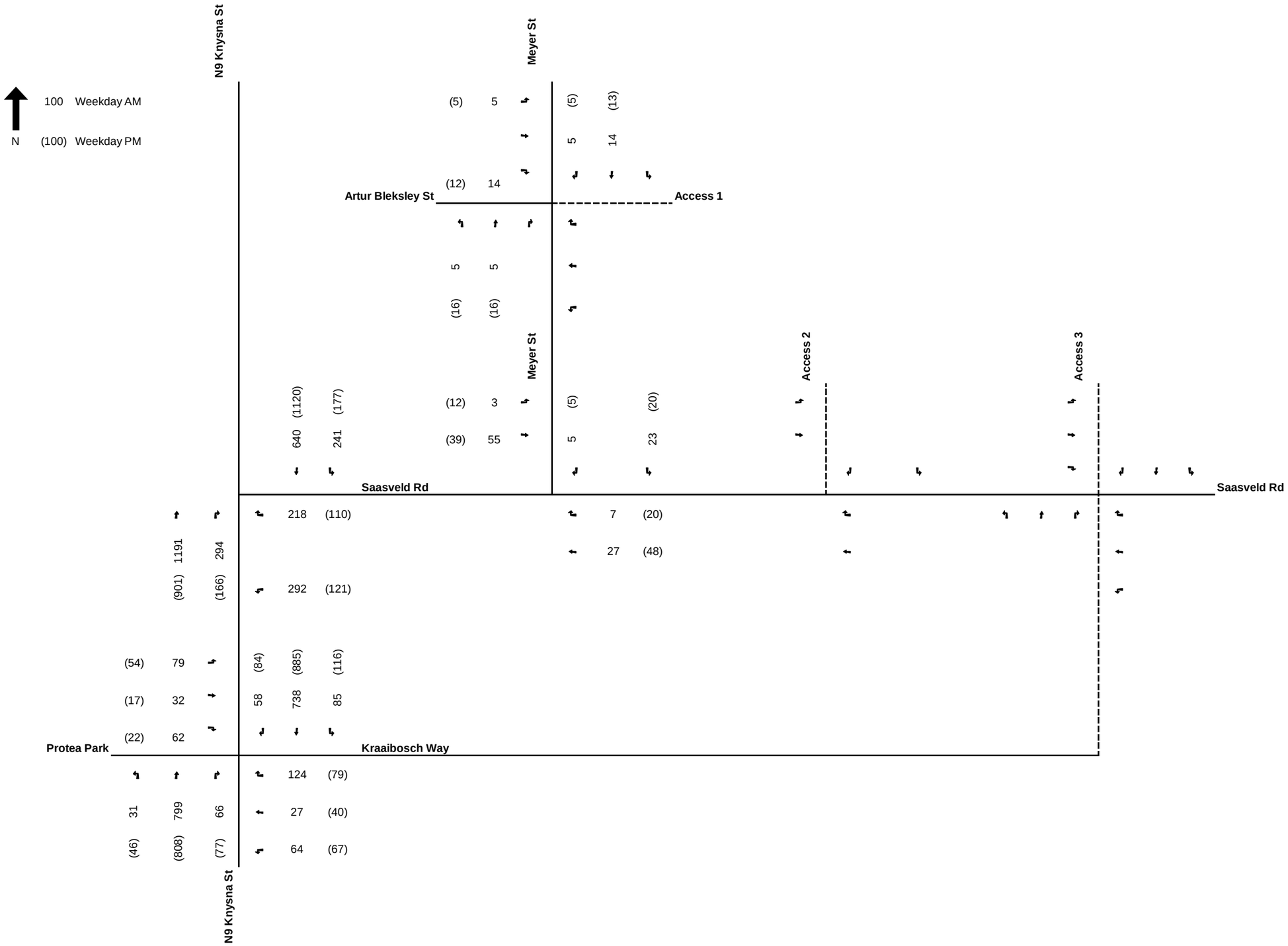


Figure 9 2018 Base Year Traffic

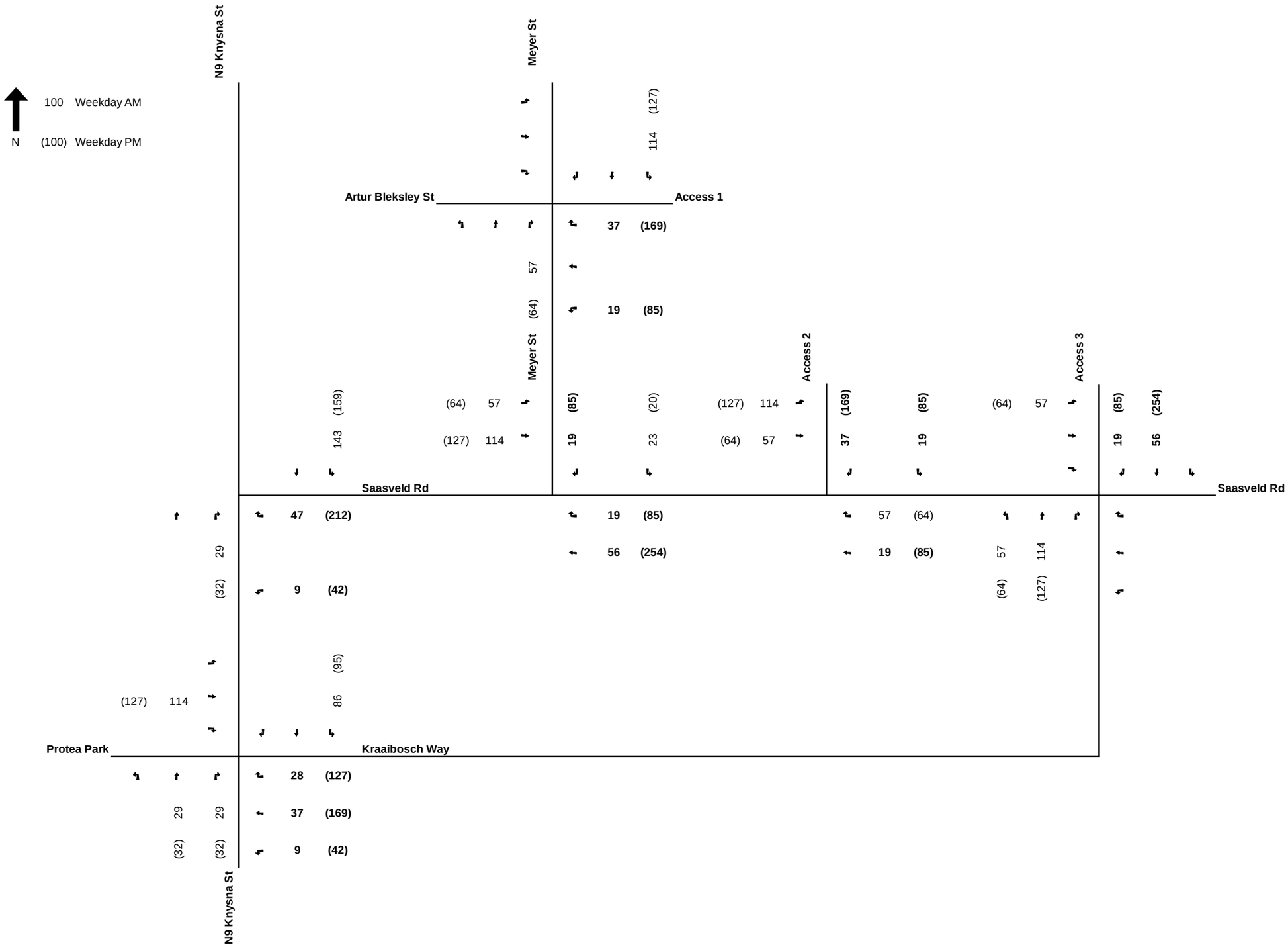


Figure 10 Phase 1 Development Trips

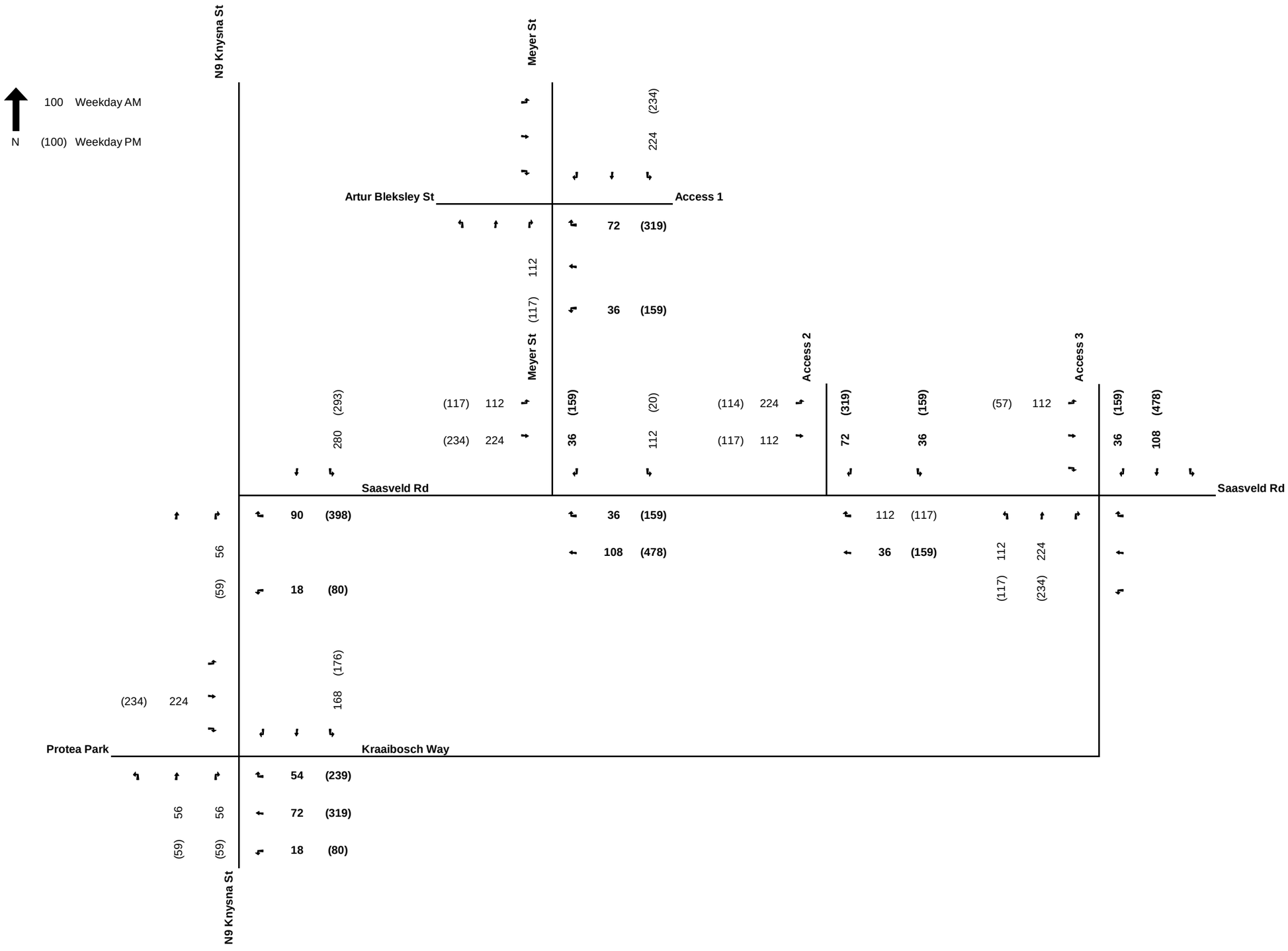


Figure 11 Phase 1+2 Development Trips

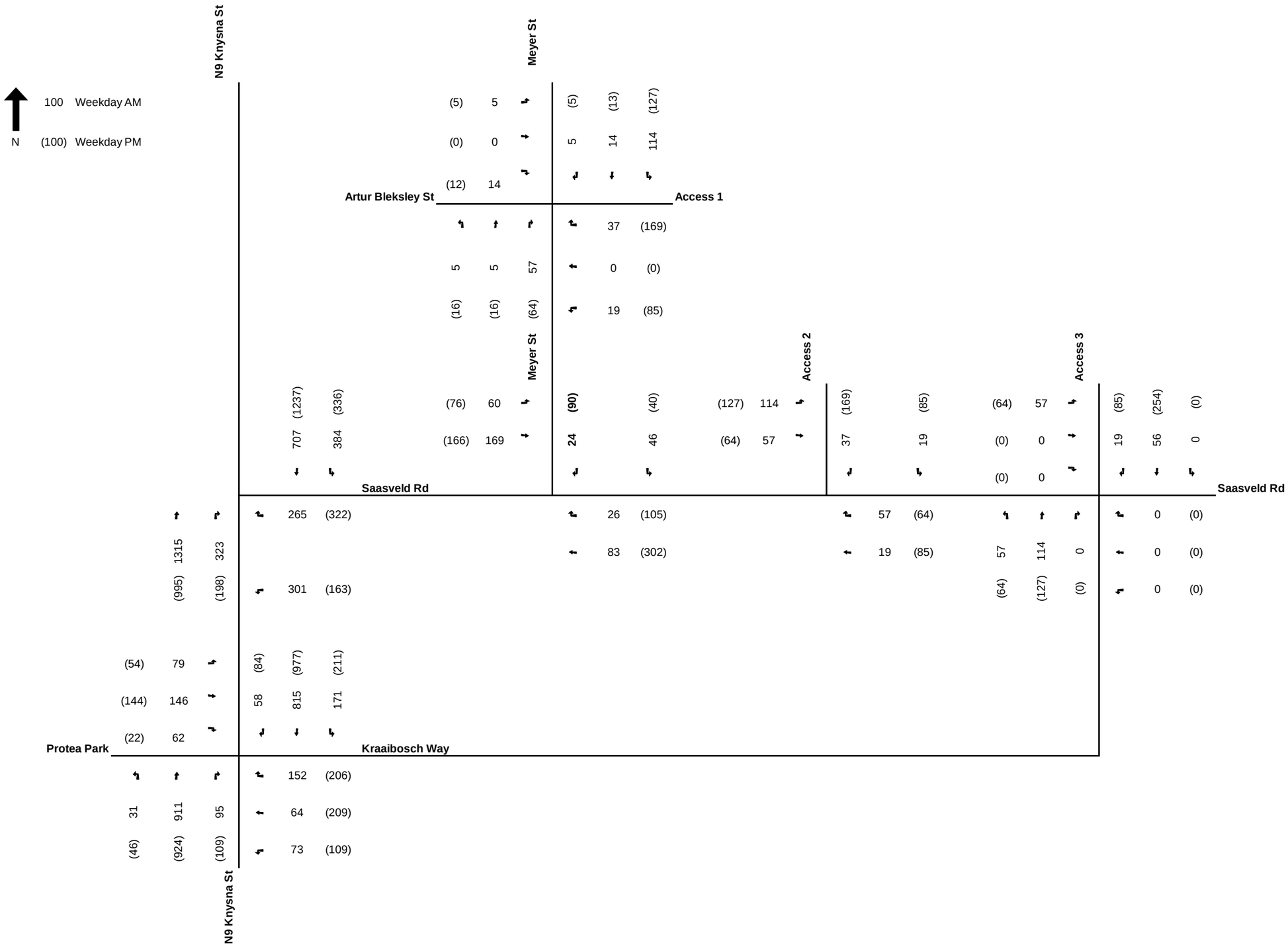


Figure 12 2025 Design Year + Phase 1 Development Trips

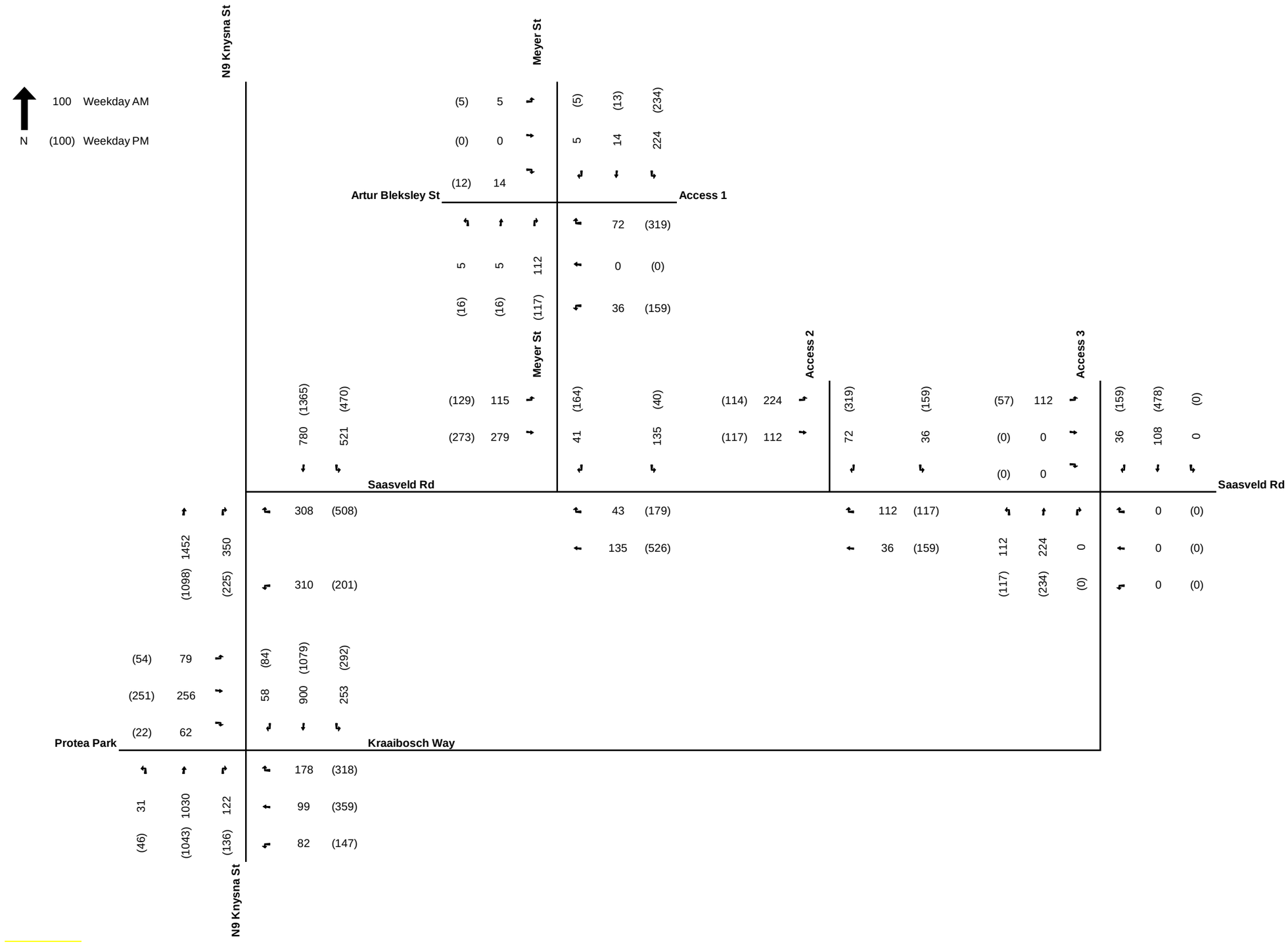


Figure 13 2035 Planning Year + Phase 1+2 Development Trips

8. TRAFFIC IMPACT ASSESSMENT SCENARIOS

The following scenarios were analysed as part of the Traffic Impact Assessment:

- 2019 Base Year Traffic;
- 2024 Design Year + Phase 1 Development Trips;
- 2029 Planning Year + Phase 1+2 Development Trips; and
- 2029 Planning Year + Phase 1+2 Development Trips + Other Development Trips.

The following sub-sections set out the analysis findings.

8.1 Intersection of N9 Knysna Street and Saasveld Road

The intersection of N9 Knysna Street and Saasveld Road is a signalised T-junction. The north approach has a short left-turn slip-lane plus two through lanes, the east approach has a left-turn lane plus a right-turn lane, and the south approach has two through lanes plus a short right-turn lane. Refer to Figure 14.

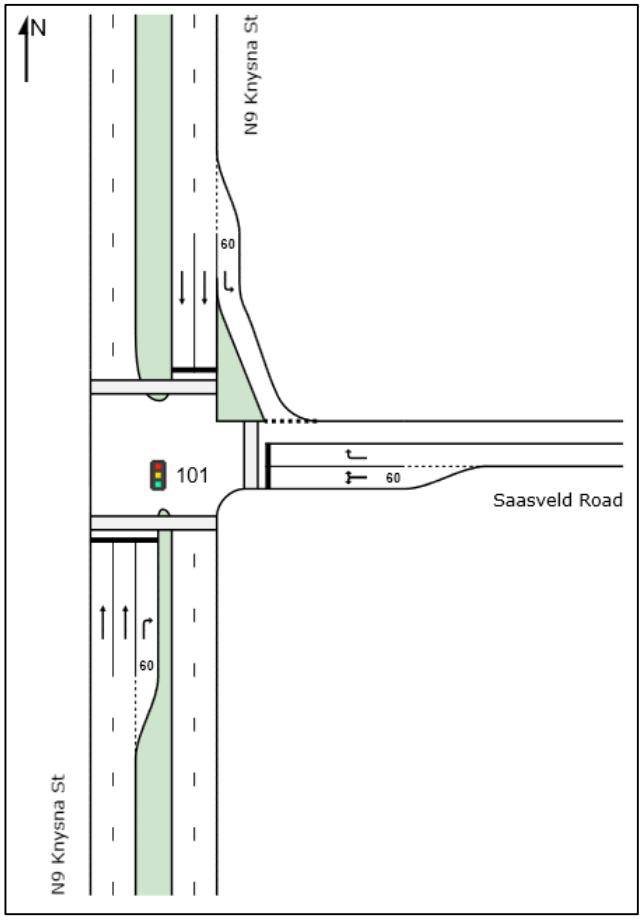


Figure 14 Layout: N9 Knysna Street & Saasveld Road

2019 Base Year Traffic

Taking into consideration the 2019 Base Year traffic flows, the intersection currently operates at Level of Service B during both the Weekday AM and PM Peak Hours, with an average delay of approximately 12 seconds.

2024 Design Year + Phase 1 Development Trips

Taking into consideration the 2024 Design Year plus Phase 1 Development traffic flows, the intersection will continue to operate at Level of Service B during both the Weekday AM and PM Peak Hours, with an average delay of approximately 13 seconds.

2029 Planning Year + Phase 1+2 Development Trips

Taking into consideration the 2029 Design Year plus Phase 1+2 Development traffic flows, the intersection will operate at Level of Service B and C during the Weekday AM and PM Peak Hours, with an average delay of approximately 13 and 22 seconds respectively.

It is concluded that the existing intersection configuration would be suitable to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service by a 2029 Planning Year.

2029 Planning Year + Phase 1+2 Development Trips + Other Development Trips

It is recommended that further intersection analysis be undertaken with consideration of the intersection capacity requirements of the full Kraaibosch Development.

8.2 Intersection of N9 Knysna Street and Kraaibosch Road

The intersection of N9 Knysna Street and Kraaibosch Road is a signalised four-leg intersection. The north approach has a short left-turn slip-lane plus two through lanes plus two short right-turn lanes, the east approach has a short left-turn slip-lane plus two through lanes plus a right-turn lane, the south approach has a short left-turn slip-lane plus two through lanes plus two short right-turn lanes, and the west approach has a short left-turn slip-lane plus two through lanes plus a right-turn lane. Refer to Figure 15.

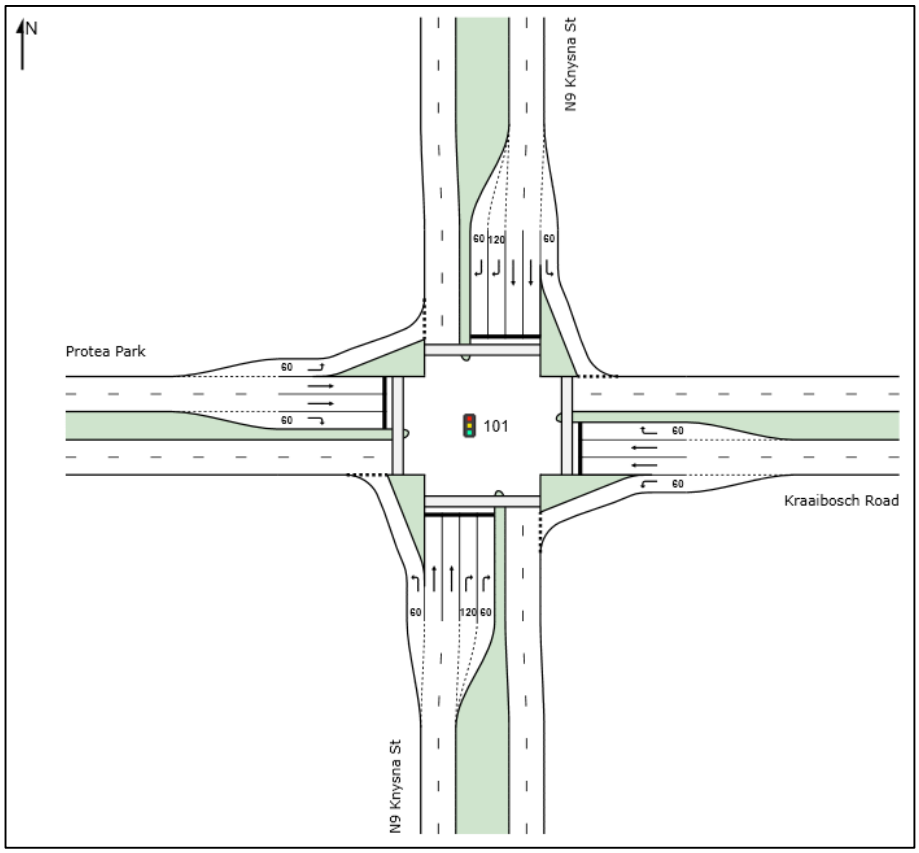


Figure 15 Layout: N9 Knysna Street & Kraaibosch Road

2019 Base Year Traffic

Taking into consideration the 2019 Base Year traffic flows, the intersection currently operates at Level of Service B during both the Weekday AM and PM Peak Hours, with an average delay of approximately 19 seconds.

2024 Design Year + Phase 1 Development Trips

Taking into consideration the 2024 Design Year plus Phase 1 Development traffic flows, the intersection will operate at Level of Service B and C during the Weekday AM and PM Peak Hours, with an average delay of approximately 19 and 23 seconds respectively.

2029 Planning Year + Phase 1+2 Development Trips

Taking into consideration the 2029 Design Year plus Phase 1+2 Development traffic flows, the intersection will operate at Level of Service C during both the Weekday AM and PM Peak Hours, with an average delay of approximately 29 seconds.

It is concluded that the existing intersection configuration would be suitable to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service by a 2029 Planning Year.

2029 Planning Year + Phase 1+2 Development Trips + Other Development Trips

It is recommended that further intersection analysis be undertaken with consideration of the intersection capacity requirements of the full Kraaibosch Development.

8.3 Intersection of Saasveld Road and Meyer Road

The intersection of Saasveld Road and Meyer Road is a priority-controlled T-junction, with Meyer Road being under stop control. The north approach has one lane serving left- and right-turn movements, the east approach has a single lane serving through and right-turn movements, and the west approach has a single lane serving left-turn and through movements. Refer to Figure 16.

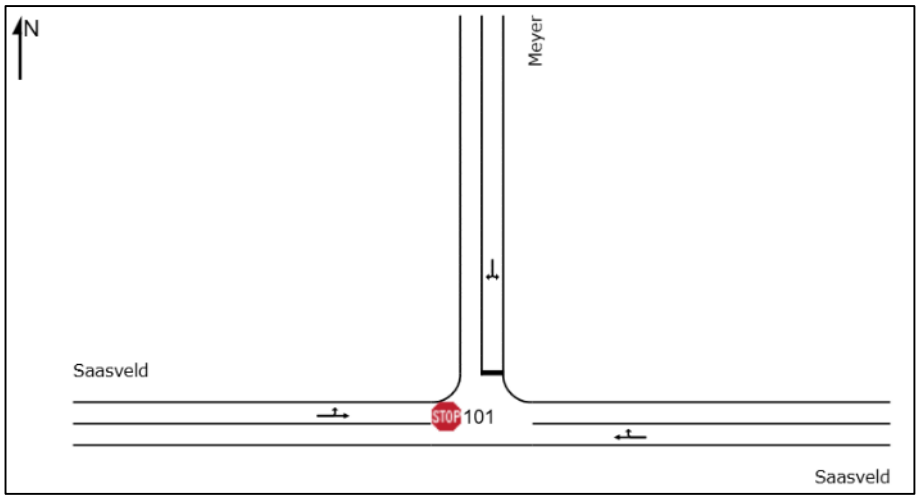


Figure 16 Layout: Saasveld Road & Meyer Road

2019 Base Year Traffic

Taking into consideration the 2019 Base Year traffic flows, the critical movements under stop control currently operate at Level of Service A during both the Weekday AM and PM Peak Hours, with an average delay of approximately 8 seconds.

2024 Design Year + Phase 1 Development Trips

Taking into consideration the 2024 Design Year plus Phase 1 Development traffic flows, the critical movements under stop control will continue to operate at Level of Service A during both the Weekday AM and PM Peak Hours, with an average delay of approximately 9 seconds.

2029 Planning Year + Phase 1+2 Development Trips

Taking into consideration the 2029 Design Year plus Phase 1+2 Development traffic flows, the intersection will operate at Level of Service F during both the Weekday AM and PM Peak Hours, with significant delays being experienced.

It is our submission that intersection upgrades would be required at this point in time, in order to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service. It is proposed to convert the intersection into a roundabout with one circulation lane. Refer to Figure 17.

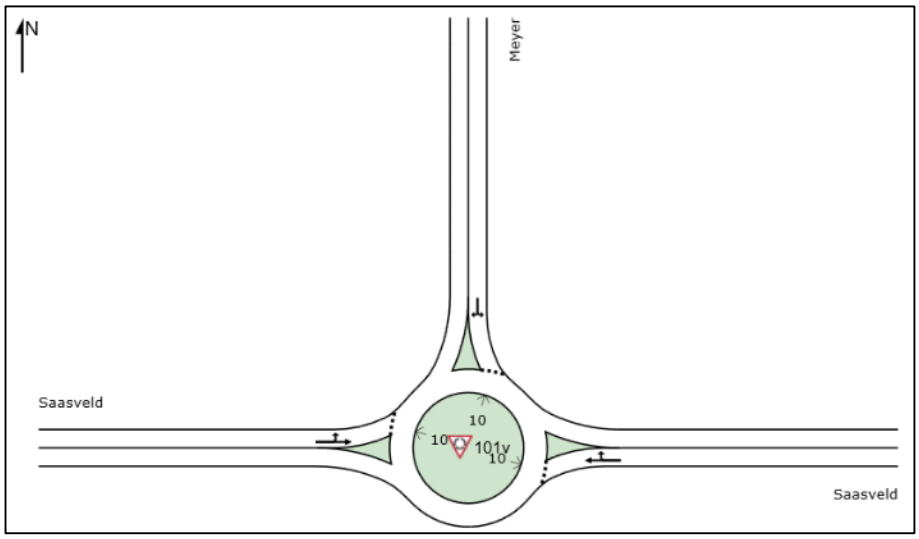


Figure 17 Proposed Layout: Saasveld Road & Meyer Road

Taking into consideration the conversion of the intersection to a roundabout, the critical movements under yield control will operate at Level of Service B during both the Weekday AM and PM Peak Hours, with an average delay of approximately 10 seconds

It is concluded that the proposed intersection configuration would be suitable to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service by a 2029 Planning Year.

8.4 Access 1 and Meyer Road

Access 1 and Meyer Road is planned as a roundabout with one circulating lane. Refer to Figure 18.

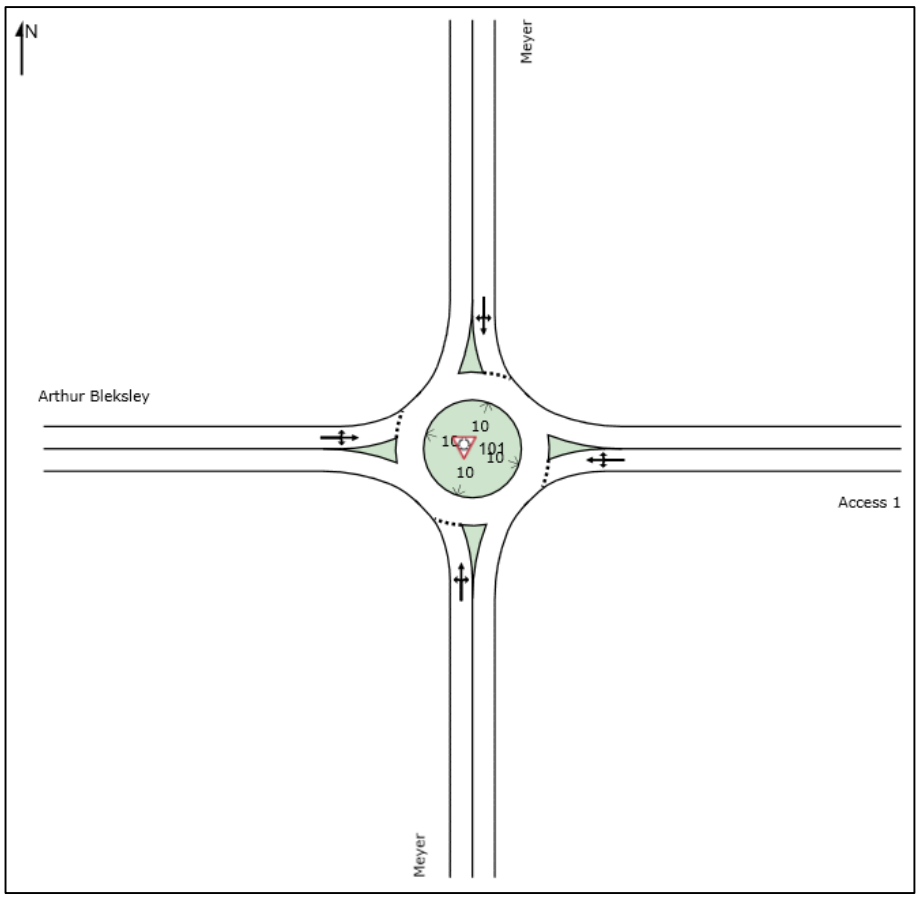


Figure 18 Layout: Access 1 & Meyer Road

2029 Planning Year + Phase 1+2 Development Trips

Taking into consideration the 2029 Design Year plus Phase 1+2 Development traffic flows, the intersection will operate at Level of Service A and B during the Weekday AM and PM Peak Hours, with an average delay of 9 and 10 seconds respectively.

It is concluded that the proposed access configuration would be suitable to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service by a 2029 Planning Year.

8.5 Access 2 and Saasveld Road

Access 2 and Saasveld Road is planned as a roundabout with one circulating lane. Refer to Figure 19.

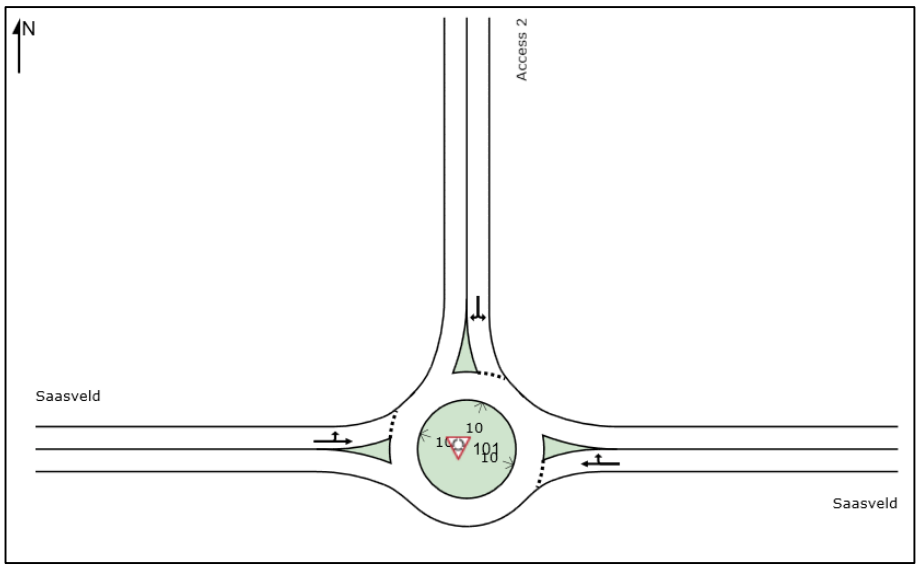


Figure 19 Layout: Access 2 & Saasveld Road

2029 Planning Year + Phase 1+2 Development Trips

Taking into consideration the 2029 Design Year plus Phase 1+2 Development traffic flows, the intersection will operate at Level of Service A and B during the Weekday AM and PM Peak Hours, with an average delay of 9 and 10 seconds respectively.

It is concluded that the proposed access configuration would be suitable to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service by a 2029 Planning Year.

8.6 Access 3 and Saasveld Road / Kraaibosch Road

Access 3 and Saasveld Road / Kraaibosch Road is planned as a roundabout with one circulating lane. Refer to Figure 20.

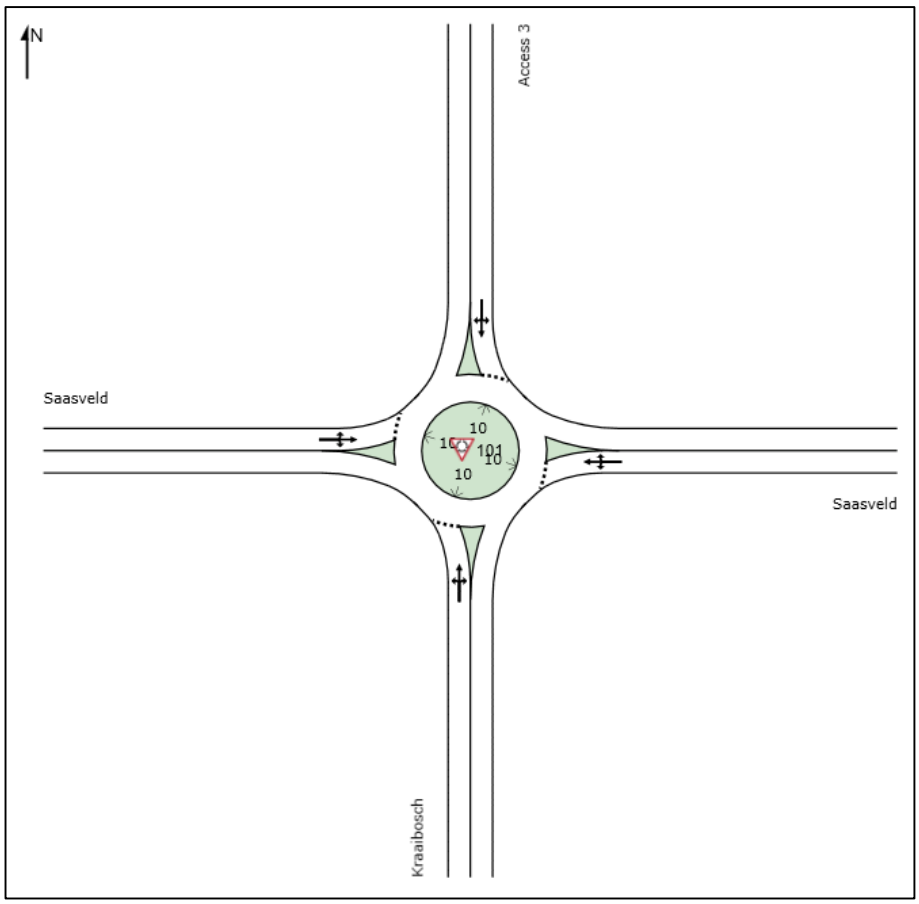


Figure 20 Layout: Access 1 & Meyer Road

2029 Planning Year + Phase 1+2 Development Trips

Taking into consideration the 2029 Design Year plus Phase 1+2 Development traffic flows, the intersection will operate at Level of Service A and B during the Weekday AM and PM Peak Hours, with an average delay of 9 and 12 seconds respectively.

It is concluded that the proposed access configuration would be suitable to accommodate the anticipated Phase 1+2 Development traffic flows at an acceptable Level of Service by a 2029 Planning Year.

8.7 Analysis Summary

A summary of the analysis outputs is provided in Table 12.

Table 12 Analysis Summary (AM / PM)

Scenario	2019 Base Year	2024 Design Year + Phase 1	2029 Design Year + Phase 1+2	2029 Design Year + Phase 1+2 With Upgrades
N9 Knysna Street & Saasveld Road	B / B	B / B	B / C	-
N9 Knysna Street & Kraaibosch Road	B / B	B / C	C / C	-
Saasveld Road & Meyer Road	A / A	A / A	F / F	B / B
Access 1 & Meyer Road	-	-	-	A / B
Access 2 & Saasveld Road	-	-	-	A / B
Access 3 & Saasveld Road / Kraaibosch Road	-	-	-	A / B

9. PROPOSED IMPROVEMENTS

The following transport improvements are proposed as part of the planned development:

2024 Design Year:

- N/A.

2029 Planning Year:

- Convert the Saasveld Road & Meyer Road intersection to a roundabout with one circulating lane.

10. SITE TRAFFIC ASSESSMENT

A Site Traffic Assessment did not form part of this project assignment.

11. CONCLUSIONS AND RECOMMENDATIONS

SMEC South Africa (Pty) Ltd was appointed by George Municipality to conduct a Traffic Impact Assessment for the proposed George Campus Development. The site is bound by the Garden Route Dam to the north and Madiba Drive to the south. Refer to Figure 1.

The site measures approximately 118 hectares in extent. The anticipated composition of the development is a Campus catering for 8 000 students, a Waterfront commercial development of 129 300 square metres Gross Lettable Area (GLA), and a Hotel of 34 500 square metres GLA (assumed to be 345 rooms). The Campus component will include residential units for 303 lecturers and 3 009 students.

For the purpose of this TIA it was assumed that the development will be 50% implemented over 5 years by 2024, and 100% within 10 years by 2029It is anticipated that the development will be 100% implemented over 20 years by 2035, with 80% being built out within 10 years by 2025.

George is currently served by three phases of the Geoarge Integrated Public Transport Network (George IPTN). As Kraaibosch and George Campus is rolled out, it is anticipated that these developments will be well served by an extended Phase 1 of the George IPTN. Refer to Figure 4.

The site will be served by three accesses, as follows:

- Access 1 along Stander Street (opposite Arthur Bleksley Street);
- Access 2 along Saasveld Road (300 metres east of Meyer Street); and
- Access 3 along Saasveld Road (600 metres east of Access 2, and opposite Road 1).

The George Campus design focuses on pedestrian accessibility and mobility, providing green corridors linking all components of the development.

It is anticipated that Phase 1 of the planned development would generate 758 and 1 483 new vehicular trips during the Weekday AM and PM Peak Hours respectively, and with Phase 2 it would generate a total of 1 480 and 2 763 new vehicular trips during the Weekday AM and PM Peak Hours respectively.

The following transport improvements are proposed as part of the planned development:

<u>2024 Design Year</u>:

- N/A.

<u>2029 Planning Year</u>:

- Convert the Saasveld Road & Meyer Road intersection to a roundabout with one circulating lane.

This Traffic Impact Assessment is supported form a Traffic Engineering point of view, provided that the recommended improvements be implemented in line with appropriate design standards.

ANNEXURE A: TRAFFIC SURVEY DATA

N9 Knysna & Saasveld — **2019**

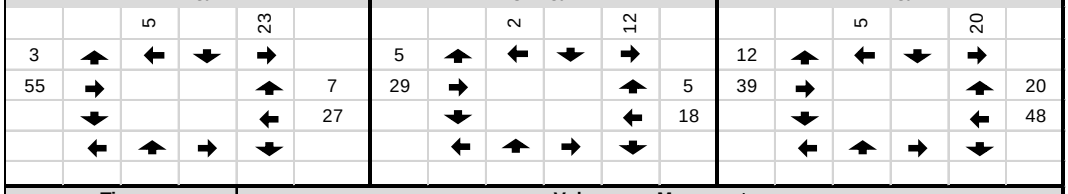
Weekday Counts

AM Peak						Off Peak						PM Peak					
		218		292				67		75				110		121	
241	↑	←	↓	→		156	↑	←	↓	→		177	↑	←	↓	→	
640	→			↑	294	1058	→			↑	119	1120	→			↑	166
	↓			←	1191		↓			←	1018		↓			←	901
	←	↑	→	↓			←	↑	→	↓			←	↑	→	↓	

Time		Volume per Movement												
		South			East			North			West			Hourly
From	To	1	2	3	4	5	6	7	8	9	10	11	12	
05:00	05:15													
05:15	05:30													
05:30	05:45													
05:45	06:00													
06:00	06:15	0	0	0	0	25	2	5	0	5	5	17	0	59
06:15	06:30	0	0	0	0	40	4	6	0	3	0	23	0	135
06:30	06:45	0	0	0	0	63	5	13	0	11	11	57	0	295
06:45	07:00	0	0	0	0	163	63	21	0	44	50	78	0	714
07:00	07:15	0	0	0	0	473	158	82	0	69	112	121	0	1 670
07:15	07:30	0	0	0	0	243	50	81	0	20	54	125	0	2 167
07:30	07:45	0	0	0	0	268	47	73	0	85	39	193	0	2 712
07:45	08:00	0	0	0	0	207	39	56	0	44	36	201	0	**2 876**
08:00	08:15	0	0	0	0	234	37	39	0	36	34	159	0	2 400
08:15	08:30	0	0	0	0	155	37	26	0	18	23	178	0	2 264
08:30	08:45	0	0	0	0	148	16	19	0	31	33	148	0	1 954
08:45	09:00	0	0	0	0	175	16	12	0	21	14	160	0	1 769
09:00	09:15	0	0	0	0	171	22	27	0	11	22	136	0	1 619
09:15	09:30	0	0	0	0	173	14	14	0	13	14	221	0	1 631
09:30	09:45	0	0	0	0	223	17	17	0	9	26	181	0	1 709
09:45	10:00	0	0	0	0	175	20	14	0	15	24	195	0	1 754
10:00	10:15	0	0	0	0	198	15	20	0	35	42	263	0	1 938
10:15	10:30	0	0	0	0	196	17	11	0	17	24	247	0	2 001
10:30	10:45	0	0	0	0	235	16	31	0	5	13	189	0	2 017
10:45	11:00	0	0	0	0	215	22	19	0	16	15	216	0	2 077
11:00	11:15	0	0	0	0	226	19	26	0	18	43	400	0	2 236
11:15	11:30	0	0	0	0	252	20	15	0	8	8	25	0	2 052
11:30	11:45	0	0	0	0	241	23	17	0	22	57	366	0	2 289
11:45	12:00	0	0	0	0	238	24	12	0	15	22	199	0	2 296
12:00	12:15	0	0	0	0	265	24	18	0	3	29	222	0	2 125
12:15	12:30	0	0	0	0	274	48	28	0	27	48	271	0	**2 493**
12:30	12:45	0	0	0	0	245	24	42	0	13	35	194	0	2 320
12:45	13:00	0	0	0	0	276	42	35	0	20	38	251	0	2 472
13:00	13:15	0	0	0	0	229	35	29	0	23	34	198	0	2 459
13:15	13:30	0	0	0	0	262	55	6	0	24	50	275	0	2 435
13:30	13:45	0	0	0	0	135	27	42	0	64	50	229	0	2 429
13:45	14:00	0	0	0	0	323	57	18	0	6	50	196	0	2 417
14:00	14:15	0	0	0	0	254	41	72	0	63	37	214	0	2 550
14:15	14:30	0	0	0	0	230	25	39	0	34	42	259	0	2 507
14:30	14:45	0	0	0	0	220	35	49	0	31	52	275	0	2 622
14:45	15:00	0	0	0	0	250	43	26	0	23	50	307	0	2 671
15:00	15:15	0	0	0	0	257	28	48	0	27	34	200	0	2 584
15:15	15:30	0	0	0	0	177	22	16	0	5	29	262	0	2 466
15:30	15:45	0	0	0	0	188	30	33	0	47	39	185	0	2 326
15:45	16:00	0	0	0	0	252	43	45	0	44	37	243	0	2 291
16:00	16:15	0	0	0	0	291	27	47	0	35	24	156	0	2 277
16:15	16:30	0	0	0	0	196	27	21	0	39	62	328	0	2 439
16:30	16:45	0	0	0	0	221	44	37	0	23	39	240	0	2 521
16:45	17:00	0	0	0	0	248	45	40	0	27	43	283	0	2 543
17:00	17:15	0	0	0	0	236	50	23	0	21	33	269	0	**2 595**
17:15	17:30	0	0	0	0	242	41	31	0	40	49	269	0	2 594
17:30	17:45	0	0	0	0	227	34	41	0	44	44	159	0	2 539
17:45	18:00	0	0	0	0	158	35	20	0	35	33	168	0	2 302
18:00	18:15													1 670
18:15	18:30													998

Saasveld & Meyer — 2019

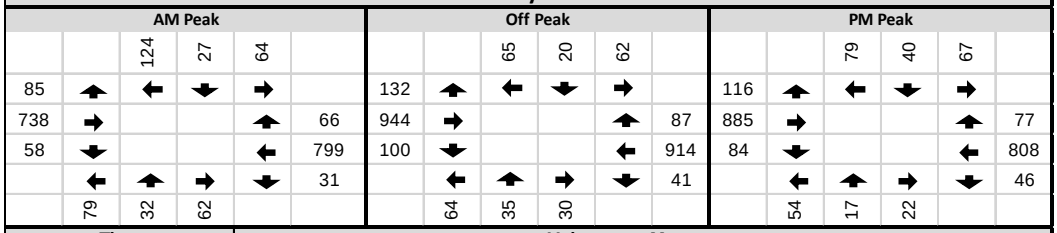
Weekday Counts



Time		Volume per Movement												
		South			East			North			West			Hourly
From	To	1	2	3	4	5	6	7	8	9	10	11	12	
05:00	05:15													
05:15	05:30													
05:30	05:45													
05:45	06:00													
06:00	06:15	0	0	0	0	2	1	0	0	1	0	0	0	4
06:15	06:30	0	0	0	0	1	0	0	0	0	0	1	0	6
06:30	06:45	0	0	0	0	3	1	1	0	1	0	2	0	14
06:45	07:00	0	0	0	0	5	2	3	0	3	0	7	0	34
07:00	07:15	0	0	0	0	11	3	7	0	3	2	13	0	69
07:15	07:30	0	0	0	0	6	2	5	0	1	0	6	0	87
07:30	07:45	0	0	0	0	3	2	5	0	0	0	18	0	107
07:45	08:00	0	0	0	0	5	1	7	0	1	1	16	0	118
08:00	08:15	0	0	0	0	13	2	6	0	3	2	15	0	**120**
08:15	08:30	0	0	0	0	9	3	3	0	1	0	3	0	119
08:30	08:45	0	0	0	0	6	1	3	0	2	0	11	0	114
08:45	09:00	0	0	0	0	2	0	4	0	2	1	9	0	101
09:00	09:15	0	0	0	0	2	4	4	0	1	1	0	0	72
09:15	09:30	0	0	0	0	8	2	1	0	0	1	1	0	66
09:30	09:45	0	0	0	0	5	1	2	0	0	1	2	0	54
09:45	10:00	0	0	0	0	6	0	3	0	0	1	5	0	51
10:00	10:15	0	0	0	0	2	2	7	0	0	1	11	0	62
10:15	10:30	0	0	0	0	5	4	1	0	0	0	3	0	62
10:30	10:45	0	0	0	0	2	0	4	0	0	0	6	0	63
10:45	11:00	0	0	0	0	2	2	4	0	0	0	5	0	61
11:00	11:15	0	0	0	0	3	4	3	0	1	0	3	0	52
11:15	11:30	0	0	0	0	6	2	3	0	2	0	7	0	59
11:30	11:45	0	0	0	0	6	2	5	0	0	1	4	0	65
11:45	12:00	0	0	0	0	0	3	1	0	0	0	2	0	58
12:00	12:15	0	0	0	0	1	2	7	0	1	0	2	0	57
12:15	12:30	0	0	0	0	3	0	1	0	1	2	4	0	48
12:30	12:45	0	0	0	0	1	3	2	0	2	1	3	0	42
12:45	13:00	0	0	0	0	5	4	4	0	0	1	3	0	53
13:00	13:15	0	0	0	0	3	2	2	0	0	1	4	0	52
13:15	13:30	0	0	0	0	4	1	4	0	0	1	7	0	58
13:30	13:45	0	0	0	0	4	1	2	0	1	3	6	0	63
13:45	14:00	0	0	0	0	7	1	4	0	1	0	12	0	**71**
14:00	14:15	0	0	0	0	7	6	4	0	2	3	6	0	87
14:15	14:30	0	0	0	0	4	3	3	0	0	1	11	0	92
14:30	14:45	0	0	0	0	2	0	1	0	4	1	4	0	87
14:45	15:00	0	0	0	0	2	2	4	0	1	1	5	0	77
15:00	15:15	0	0	0	0	7	2	4	0	3	3	4	0	72
15:15	15:30	0	0	0	0	4	3	2	0	2	2	4	0	67
15:30	15:45	0	0	0	0	4	3	5	0	2	1	6	0	76
15:45	16:00	0	0	0	0	7	2	5	0	0	1	11	0	87
16:00	16:15	0	0	0	0	8	2	3	0	0	5	6	0	88
16:15	16:30	0	0	0	0	19	7	6	0	1	2	9	0	115
16:30	16:45	0	0	0	0	10	3	5	0	2	3	7	0	124
16:45	17:00	0	0	0	0	11	8	6	0	2	2	17	0	**144**
17:00	17:15	0	0	0	0	5	0	5	0	3	3	5	0	141
17:15	17:30	0	0	0	0	6	6	2	0	1	0	5	0	117
17:30	17:45	0	0	0	0	3	1	8	0	0	0	13	0	112
17:45	18:00	0	0	0	0	0	2	1	0	0	1	4	0	74
18:00	18:15													53
18:15	18:30													33

N9 Knysna & Kraaibosch — 2019

Weekday Counts



Time		Volume per Movement												
From	To	South			East			North			West			Hourly
		1	2	3	4	5	6	7	8	9	10	11	12	
05:00	05:15													
05:15	05:30													
05:30	05:45													
05:45	06:00													
06:00	06:15	1	0	1	3	17	4	2	0	2	2	19	0	51
06:15	06:30	1	2	14	2	45	5	6	5	5	2	28	3	169
06:30	06:45	6	5	12	6	65	9	4	3	10	6	42	2	339
06:45	07:00	33	9	9	8	135	11	3	6	30	6	75	10	674
07:00	07:15	22	9	15	6	238	13	16	10	37	7	131	10	1 137
07:15	07:30	20	6	21	10	226	9	16	5	46	23	191	12	1 604
07:30	07:45	18	8	17	6	187	19	14	7	21	38	237	20	2 026
07:45	08:00	19	9	9	9	148	25	18	5	20	17	179	16	**2 165**
08:00	08:15	11	6	6	5	155	14	11	5	23	17	166	17	2 087
08:15	08:30	17	6	11	6	170	14	11	2	29	15	170	12	1 965
08:30	08:45	12	3	12	6	132	11	18	8	30	29	162	11	1 807
08:45	09:00	5	5	4	5	100	5	6	7	18	22	145	19	1 674
09:00	09:15	13	3	14	6	136	13	11	4	14	14	157	20	1 643
09:15	09:30	19	6	6	4	128	13	10	9	20	14	154	20	1 583
09:30	09:45	13	6	7	6	152	16	11	5	26	19	185	19	1 614
09:45	10:00	20	5	5	3	171	25	22	5	23	38	229	34	1 853
10:00	10:15	9	1	11	3	144	16	22	1	14	19	175	15	1 878
10:15	10:30	8	5	11	9	203	13	19	8	28	24	207	34	2 044
10:30	10:45	14	8	10	13	192	13	15	9	28	19	217	23	2 140
10:45	11:00	31	6	8	12	263	25	31	11	42	43	229	31	2 292
11:00	11:15	8	2	1	3	132	13	11	1	6	15	109	10	2 173
11:15	11:30	8	3	3	9	119	8	15	6	9	22	115	16	1 937
11:30	11:45	16	7	7	3	145	16	9	1	11	13	125	6	1 735
11:45	12:00	16	18	11	11	276	21	16	4	21	49	395	49	1 890
12:00	12:15	5	6	6	7	173	18	15	5	11	33	147	11	2 016
12:15	12:30	29	6	5	12	309	30	15	7	25	22	215	24	2 382
12:30	12:45	14	5	8	11	156	18	16	4	8	28	187	16	**2 494**
12:45	13:00	9	4	2	4	254	30	19	9	18	27	209	25	2 217
13:00	13:15	17	7	7	9	199	12	15	10	14	30	172	28	2 300
13:15	13:30	28	7	7	8	228	19	20	6	12	29	243	25	2 233
13:30	13:45	16	3	7	8	220	20	14	4	13	28	146	11	2 252
13:45	14:00	16	8	6	4	225	22	8	3	19	18	183	17	2 171
14:00	14:15	24	8	7	12	204	16	7	7	29	20	208	25	2 218
14:15	14:30	19	2	7	10	192	13	10	8	16	25	228	27	2 143
14:30	14:45	30	2	7	11	221	32	12	5	35	43	289	41	2 381
14:45	15:00	15	5	7	6	192	19	6	4	17	18	143	13	2 297
15:00	15:15	14	9	12	2	188	19	11	5	25	23	224	41	2 303
15:15	15:30	6	4	7	11	194	23	13	5	22	22	175	21	2 249
15:30	15:45	16	1	5	5	173	23	4	1	16	13	176	18	1 972
15:45	16:00	11	10	7	11	201	18	9	4	25	23	188	17	2 051
16:00	16:15	17	4	3	15	247	23	16	12	22	41	254	22	2 154
16:15	16:30	12	5	6	8	138	11	15	5	13	19	169	8	2 060
16:30	16:45	15	6	6	14	211	20	22	12	21	26	215	23	2 200
16:45	17:00	10	2	7	9	212	23	14	11	23	30	247	31	**2 295**
17:00	17:15	8	9	17	19	181	16	13	5	13	31	209	17	2 157
17:15	17:30	5	3	10	6	97	10	6	4	5	6	87	11	1 998
17:30	17:45	32	5	27	29	296	32	26	1	32	32	312	30	2 261
17:45	18:00	14	1	5	5	137	15	4	0	11	22	131	8	1 995
18:00	18:15													1 457
18:15	18:30													1 207

ANNEXURE B: DETAILED SIDRA OUTPUTS

Intersection of N9 Knysna Street & Saasveld Road

2019 Base Year

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
2	T1	1254	3.0	0.566	7.1	LOS A	8.5	60.7	0.72	0.64	0.72	53.7
3	R2	309	3.0	0.594	13.9	LOS B	3.8	27.1	0.91	0.81	0.93	47.7
Approach		1563	3.0	0.594	8.4	LOS A	8.5	60.7	0.76	0.67	0.77	52.4
East: Saasveld Road												
4	L2	307	3.0	0.681	22.8	LOS C	6.1	43.8	0.97	0.87	1.09	42.7
6	R2	229	3.0	0.509	21.1	LOS C	4.2	29.9	0.92	0.80	0.92	43.6
Approach		537	3.0	0.681	22.1	LOS C	6.1	43.8	0.95	0.84	1.02	43.1
North: N9 Knysna St												
7	L2	254	3.0	0.210	7.5	LOS A	1.2	8.8	0.45	0.67	0.45	52.6
8	T1	674	3.0	0.639	15.7	LOS B	6.3	45.5	0.94	0.82	1.01	47.7
Approach		927	3.0	0.639	13.4	LOS B	6.3	45.5	0.81	0.78	0.85	49.0
All Vehicles		3027	3.0	0.681	12.4	LOS B	8.5	60.7	0.81	0.73	0.84	49.5

PM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
2	T1	948	3.0	0.351	4.5	LOS A	5.4	38.7	0.50	0.43	0.50	55.9
3	R2	175	3.0	0.394	13.4	LOS B	1.8	13.2	0.82	0.77	0.82	48.0
Approach		1123	3.0	0.394	5.9	LOS A	5.4	38.7	0.55	0.49	0.55	54.5
East: Saasveld Road												
4	L2	127	3.0	0.397	27.1	LOS C	3.0	21.3	0.94	0.77	0.94	40.7
6	R2	116	3.0	0.361	27.0	LOS C	2.7	19.2	0.93	0.77	0.93	40.8
Approach		243	3.0	0.397	27.1	LOS C	3.0	21.3	0.94	0.77	0.94	40.7
North: N9 Knysna St												
7	L2	186	3.0	0.139	6.9	LOS A	0.8	5.8	0.33	0.64	0.33	53.0
8	T1	1179	3.0	0.666	12.9	LOS B	11.9	85.2	0.86	0.76	0.86	49.5
Approach		1365	3.0	0.666	12.1	LOS B	11.9	85.2	0.79	0.74	0.79	50.0
All Vehicles		2732	3.0	0.666	10.9	LOS B	11.9	85.2	0.70	0.64	0.70	50.7

2024 Design Year + Phase 1 Development

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
2	T1	1384	3.0	0.625	7.4	LOS A	9.8	70.2	0.76	0.67	0.76	53.5
3	R2	340	3.0	0.672	15.0	LOS B	4.4	31.6	0.95	0.85	1.05	47.0
Approach		1724	3.0	0.672	8.9	LOS A	9.8	70.2	0.80	0.71	0.82	52.1
East: Saasveld Road												
4	L2	317	3.0	0.702	23.1	LOS C	6.4	45.8	0.97	0.89	1.13	42.6
6	R2	279	3.0	0.618	21.9	LOS C	5.3	38.2	0.95	0.84	1.01	43.2
Approach		596	3.0	0.702	22.6	LOS C	6.4	45.8	0.96	0.86	1.07	42.9
North: N9 Knysna St												
7	L2	404	3.0	0.333	7.7	LOS A	2.1	15.2	0.49	0.69	0.49	52.4
8	T1	744	3.0	0.706	16.7	LOS B	7.4	52.8	0.96	0.88	1.10	47.1
Approach		1148	3.0	0.706	13.5	LOS B	7.4	52.8	0.80	0.81	0.88	48.8
All Vehicles		3468	3.0	0.706	12.8	LOS B	9.8	70.2	0.82	0.77	0.88	49.2

PM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
2	T1	1047	3.0	0.401	5.2	LOS A	6.5	46.6	0.54	0.47	0.54	55.3
3	R2	208	3.0	0.500	15.0	LOS B	2.5	17.8	0.90	0.79	0.90	47.0
Approach		1256	3.0	0.500	6.8	LOS A	6.5	46.6	0.60	0.53	0.60	53.7
East: Saasveld Road												
4	L2	172	3.0	0.707	28.9	LOS C	6.5	46.6	0.99	0.88	1.14	39.9
6	R2	339	3.0	0.707	28.9	LOS C	6.5	46.6	0.99	0.88	1.14	39.9
Approach		511	3.0	0.707	28.9	LOS C	6.5	46.6	0.99	0.88	1.14	39.9
North: N9 Knysna St												
7	L2	354	3.0	0.264	7.2	LOS A	1.7	12.4	0.38	0.66	0.38	52.8
8	T1	1302	3.0	0.772	16.7	LOS B	15.4	110.7	0.93	0.89	1.05	47.1
Approach		1656	3.0	0.772	14.7	LOS B	15.4	110.7	0.81	0.84	0.90	48.2
All Vehicles		3422	3.0	0.772	13.9	LOS B	15.4	110.7	0.76	0.73	0.83	48.5

2029 Planning Year + Phase 1+2 Development

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
2	T1	1528	3.0	0.690	8.2	LOS A	11.7	83.9	0.80	0.73	0.82	52.9
3	R2	368	3.0	0.748	16.5	LOS B	5.1	36.7	0.98	0.90	1.19	46.1
Approach		1897	3.0	0.748	9.8	LOS A	11.7	83.9	0.84	0.76	0.89	51.4
East: Saasveld Road												
4	L2	326	3.0	0.723	23.5	LOS C	6.7	47.9	0.98	0.90	1.16	42.4
6	R2	324	3.0	0.719	23.5	LOS C	6.6	47.5	0.98	0.90	1.15	42.5
Approach		651	3.0	0.723	23.5	LOS C	6.7	47.9	0.98	0.90	1.16	42.4
North: N9 Knysna St												
7	L2	548	3.0	0.448	8.1	LOS A	3.2	23.2	0.54	0.71	0.54	52.1
8	T1	821	3.0	0.779	18.5	LOS B	8.7	62.5	0.99	0.96	1.24	46.0
Approach		1369	3.0	0.779	14.3	LOS B	8.7	62.5	0.81	0.86	0.96	48.3
All Vehicles		3917	3.0	0.779	13.7	LOS B	11.7	83.9	0.85	0.82	0.96	48.6

PM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
2	T1	1156	3.0	0.414	6.7	LOS A	10.4	74.4	0.50	0.45	0.50	54.1
3	R2	237	3.0	0.613	24.3	LOS C	5.5	39.5	0.97	0.84	1.02	42.0
Approach		1393	3.0	0.613	9.7	LOS A	10.4	74.4	0.58	0.51	0.59	51.5
East: Saasveld Road												
4	L2	212	3.0	0.876	48.1	LOS D	16.8	120.8	1.00	0.99	1.33	33.0
6	R2	535	3.0	0.876	48.1	LOS D	16.8	120.8	1.00	0.99	1.33	33.0
Approach		746	3.0	0.876	48.1	LOS D	16.8	120.8	1.00	0.99	1.33	33.0
North: N9 Knysna St												
7	L2	495	3.0	0.363	8.2	LOS A	4.5	32.5	0.41	0.68	0.41	52.2
8	T1	1437	3.0	0.861	27.4	LOS C	33.9	243.3	0.90	0.93	1.07	41.4
Approach		1932	3.0	0.861	22.5	LOS C	33.9	243.3	0.77	0.87	0.90	43.7
All Vehicles		4071	3.0	0.876	22.8	LOS C	33.9	243.3	0.75	0.77	0.87	43.4

Intersection of N9 Knysna Street & Kraaibosch Road

2019 Base Year AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
1	L2	33	3.0	0.023	6.1	LOS A	0.1	0.7	0.17	0.58	0.17	53.6
2	T1	841	3.0	0.558	19.7	LOS B	11.7	83.8	0.86	0.74	0.86	45.4
3	R2	69	3.0	0.088	17.1	LOS B	0.6	4.5	0.74	0.69	0.74	46.2
Approach		943	3.0	0.558	19.0	LOS B	11.7	83.8	0.82	0.73	0.82	45.7
East: Kraaibosch Road												
4	L2	67	3.0	0.058	8.3	LOS A	0.6	4.3	0.36	0.63	0.36	52.0
5	T1	28	3.0	0.039	26.4	LOS C	0.4	2.9	0.86	0.60	0.86	42.0
6	R2	131	3.0	0.294	24.8	LOS C	3.4	24.4	0.83	0.74	0.83	42.3
Approach		226	3.0	0.294	20.1	LOS C	3.4	24.4	0.70	0.69	0.70	44.7
North: N9 Knysna St												
7	L2	89	3.0	0.060	6.1	LOS A	0.3	2.0	0.17	0.59	0.17	53.6
8	T1	777	3.0	0.516	19.3	LOS B	10.6	75.9	0.84	0.72	0.84	45.7
9	R2	61	3.0	0.084	17.4	LOS B	0.5	3.9	0.76	0.69	0.76	46.0
Approach		927	3.0	0.516	17.9	LOS B	10.6	75.9	0.77	0.71	0.77	46.3
West: Protea Park												
10	L2	83	3.0	0.085	8.9	LOS A	0.8	6.0	0.40	0.64	0.40	51.6
11	T1	34	3.0	0.051	26.6	LOS C	0.5	3.5	0.86	0.61	0.86	41.9
12	R2	65	3.0	0.419	41.0	LOS D	2.3	16.4	0.99	0.75	0.99	35.7
Approach		182	3.0	0.419	23.7	LOS C	2.3	16.4	0.69	0.68	0.69	42.9
All Vehicles		2279	3.0	0.558	19.0	LOS B	11.7	83.8	0.78	0.71	0.78	45.6

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
1	L2	48	3.0	0.035	6.1	LOS A	0.2	1.2	0.13	0.58	0.13	53.7
2	T1	851	3.0	0.370	15.1	LOS B	12.8	91.7	0.61	0.54	0.61	48.2
3	R2	81	3.0	0.107	15.7	LOS B	0.8	6.0	0.57	0.67	0.57	47.1
Approach		980	3.0	0.370	14.7	LOS B	12.8	91.7	0.58	0.55	0.58	48.3
East: Kraaibosch Road												
4	L2	71	3.0	0.064	7.9	LOS A	0.7	5.2	0.26	0.61	0.26	52.4
5	T1	42	3.0	0.065	42.9	LOS D	1.0	7.0	0.88	0.63	0.88	35.4
6	R2	83	3.0	0.240	41.9	LOS D	3.7	26.5	0.86	0.73	0.86	35.4
Approach		196	3.0	0.240	29.9	LOS C	3.7	26.5	0.65	0.67	0.65	40.0
North: N9 Knysna St												
7	L2	122	3.0	0.082	6.0	LOS A	0.4	2.8	0.12	0.58	0.12	53.7
8	T1	932	3.0	0.405	15.4	LOS B	14.3	102.9	0.63	0.55	0.63	47.9
9	R2	88	3.0	0.114	15.3	LOS B	0.9	6.6	0.55	0.66	0.55	47.3
Approach		1142	3.0	0.405	14.4	LOS B	14.3	102.9	0.57	0.56	0.57	48.5
West: Protea Park												
10	L2	57	3.0	0.057	8.1	LOS A	0.6	4.4	0.27	0.61	0.27	52.2
11	T1	18	3.0	0.030	42.6	LOS D	0.4	2.9	0.87	0.60	0.87	35.5
12	R2	23	3.0	0.233	62.8	LOS E	1.3	9.1	0.99	0.71	0.99	29.5
Approach		98	3.0	0.233	27.3	LOS C	1.3	9.1	0.55	0.63	0.55	41.2
All Vehicles		2416	3.0	0.405	16.3	LOS B	14.3	102.9	0.58	0.57	0.58	47.3

2024 Design Year + Phase 1 Development AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
1	L2	33	3.0	0.023	6.2	LOS A	0.1	0.8	0.18	0.58	0.18	53.5
2	T1	959	3.0	0.637	20.4	LOS C	13.8	99.1	0.89	0.77	0.89	45.0
3	R2	100	3.0	0.135	17.6	LOS B	0.9	6.5	0.77	0.70	0.77	45.9
Approach		1092	3.0	0.637	19.7	LOS B	13.8	99.1	0.86	0.76	0.86	45.3
East: Kraaibosch Road												
4	L2	77	3.0	0.068	8.6	LOS A	0.7	5.2	0.38	0.64	0.38	51.8
5	T1	67	3.0	0.093	26.9	LOS C	1.0	7.1	0.87	0.64	0.87	41.8
6	R2	160	3.0	0.406	25.4	LOS C	4.2	30.5	0.88	0.77	0.88	42.0
Approach		304	3.0	0.406	21.5	LOS C	4.2	30.5	0.75	0.70	0.75	44.1
North: N9 Knysna St												
7	L2	180	3.0	0.129	6.6	LOS A	0.9	6.5	0.24	0.61	0.24	53.3
8	T1	858	3.0	0.570	19.8	LOS B	12.0	85.9	0.86	0.74	0.86	45.4
9	R2	61	3.0	0.090	18.0	LOS B	0.5	3.9	0.79	0.69	0.79	45.7
Approach		1099	3.0	0.570	17.5	LOS B	12.0	85.9	0.75	0.72	0.75	46.5
West: Protea Park												
10	L2	83	3.0	0.091	10.0	LOS A	1.0	7.0	0.44	0.66	0.44	50.8
11	T1	154	3.0	0.234	27.9	LOS C	2.3	16.8	0.90	0.69	0.90	41.3
12	R2	65	3.0	0.419	41.0	LOS D	2.3	16.4	0.99	0.75	0.99	35.7
Approach		302	3.0	0.419	25.8	LOS C	2.3	16.8	0.79	0.70	0.79	42.0
All Vehicles		2797	3.0	0.637	19.7	LOS B	13.8	99.1	0.80	0.73	0.80	45.3

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
1	L2	48	3.0	0.035	6.6	LOS A	0.2	1.8	0.23	0.60	0.23	53.3
2	T1	973	3.0	0.734	24.6	LOS C	15.6	112.0	0.95	0.86	1.01	42.8
3	R2	115	3.0	0.186	20.8	LOS C	1.1	8.2	0.88	0.73	0.88	44.2
Approach		1136	3.0	0.734	23.5	LOS C	15.6	112.0	0.91	0.84	0.96	43.3
East: Kraaibosch Road												
4	L2	115	3.0	0.102	9.3	LOS A	1.2	8.9	0.42	0.66	0.42	51.3
5	T1	220	3.0	0.304	28.2	LOS C	3.4	24.4	0.92	0.72	0.92	41.2
6	R2	217	3.0	0.451	23.2	LOS C	5.4	38.9	0.87	0.78	0.87	43.1
Approach		552	3.0	0.451	22.3	LOS C	5.4	38.9	0.79	0.73	0.79	43.7
North: N9 Knysna St												
7	L2	222	3.0	0.157	6.6	LOS A	1.2	8.3	0.24	0.61	0.24	53.3
8	T1	1028	3.0	0.792	26.9	LOS C	18.0	129.1	0.97	0.93	1.09	41.7
9	R2	88	3.0	0.142	20.3	LOS C	0.9	6.3	0.85	0.71	0.85	44.4
Approach		1339	3.0	0.792	23.1	LOS C	18.0	129.1	0.84	0.86	0.94	43.4
West: Protea Park												
10	L2	57	3.0	0.065	10.8	LOS B	0.7	5.1	0.48	0.65	0.48	50.3
11	T1	152	3.0	0.231	27.9	LOS C	2.3	16.6	0.90	0.69	0.90	41.3
12	R2	23	3.0	0.099	35.8	LOS D	0.7	5.2	0.91	0.70	0.91	37.6
Approach		232	3.0	0.231	24.5	LOS C	2.3	16.6	0.80	0.68	0.80	42.8
All Vehicles		3258	3.0	0.792	23.2	LOS C	18.0	129.1	0.85	0.82	0.91	43.4

2029 Planning Year + Phase 1+2 Development AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
1	L2	33	3.0	0.023	6.2	LOS A	0.1	0.8	0.18	0.58	0.18	53.5
2	T1	1084	3.0	0.722	21.9	LOS C	16.7	119.6	0.93	0.83	0.96	44.2
3	R2	128	3.0	0.185	18.4	LOS B	1.2	8.5	0.81	0.72	0.81	45.5
Approach		1245	3.0	0.722	21.2	LOS C	16.7	119.6	0.89	0.81	0.92	44.5
East: Kraaibosch Road												
4	L2	86	3.0	0.078	9.3	LOS A	0.9	6.6	0.41	0.65	0.41	51.3
5	T1	104	3.0	0.144	27.2	LOS C	1.6	11.1	0.88	0.66	0.88	41.6
6	R2	187	3.0	0.531	26.1	LOS C	5.1	36.3	0.93	0.78	0.93	41.7
Approach		378	3.0	0.531	22.6	LOS C	5.1	36.3	0.80	0.72	0.80	43.5
North: N9 Knysna St												
7	L2	266	3.0	0.199	7.1	LOS A	1.8	12.6	0.30	0.64	0.30	52.9
8	T1	947	3.0	0.629	20.3	LOS C	13.6	97.5	0.89	0.77	0.89	45.1
9	R2	61	3.0	0.096	18.7	LOS B	0.5	3.9	0.82	0.70	0.82	45.3
Approach		1275	3.0	0.629	17.5	LOS B	13.6	97.5	0.76	0.74	0.76	46.5
West: Protea Park												
10	L2	83	3.0	0.096	11.3	LOS B	1.1	8.0	0.51	0.67	0.51	49.9
11	T1	269	3.0	0.411	29.0	LOS C	4.3	30.7	0.94	0.75	0.94	40.8
12	R2	65	3.0	0.419	41.0	LOS D	2.3	16.4	0.99	0.75	0.99	35.7
Approach		418	3.0	0.419	27.3	LOS C	4.3	30.7	0.86	0.73	0.86	41.4
All Vehicles		3316	3.0	0.722	20.7	LOS C	16.7	119.6	0.83	0.76	0.84	44.7

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: N9 Knysna St												
1	L2	48	3.0	0.036	7.1	LOS A	0.4	2.7	0.23	0.60	0.23	53.0
2	T1	1098	3.0	0.717	28.8	LOS C	23.4	168.0	0.91	0.81	0.91	40.8
3	R2	143	3.0	0.322	28.4	LOS C	2.0	14.5	0.92	0.75	0.92	40.5
Approach		1289	3.0	0.717	28.0	LOS C	23.4	168.0	0.89	0.79	0.89	41.1
East: Kraaibosch Road												
4	L2	155	3.0	0.147	12.4	LOS B	2.8	20.1	0.46	0.68	0.46	49.2
5	T1	378	3.0	0.560	42.7	LOS D	8.7	62.6	0.97	0.79	0.97	35.4
6	R2	335	3.0	0.608	28.9	LOS C	11.6	83.5	0.90	0.82	0.90	40.4
Approach		867	3.0	0.608	32.0	LOS C	11.6	83.5	0.85	0.78	0.85	39.2
North: N9 Knysna St												
7	L2	307	3.0	0.219	7.3	LOS A	2.7	19.2	0.27	0.63	0.27	52.8
8	T1	1136	3.0	0.818	33.5	LOS C	30.0	215.1	0.93	0.89	1.02	38.8
9	R2	88	3.0	0.186	26.0	LOS C	1.2	8.8	0.85	0.72	0.85	41.5
Approach		1532	3.0	0.818	27.8	LOS C	30.0	215.1	0.80	0.83	0.86	41.2
West: Protea Park												
10	L2	57	3.0	0.076	14.8	LOS B	1.1	8.2	0.52	0.67	0.52	47.8
11	T1	264	3.0	0.432	41.9	LOS D	6.0	42.9	0.95	0.76	0.95	35.7
12	R2	23	3.0	0.064	40.7	LOS D	0.9	6.6	0.84	0.70	0.84	35.8
Approach		344	3.0	0.432	37.3	LOS D	6.0	42.9	0.87	0.74	0.87	37.3
All Vehicles		4033	3.0	0.818	29.6	LOS C	30.0	215.1	0.84	0.80	0.87	40.4

Intersection of Saasveld Road & Meyer Road

2019 Base Year AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	28	3.0	0.052	0.0	LOS A	0.0	0.2	0.02	0.13	0.02	58.8
6	R2	7	3.0	0.052	5.7	LOS A	0.0	0.2	0.02	0.13	0.02	56.5
Approach		36	3.0	0.052	1.2	NA	0.0	0.2	0.02	0.13	0.02	58.3
North: Meyer												
7	L2	24	3.0	0.149	8.4	LOS A	0.0	0.0	0.00	1.00	0.00	51.7
9	R2	5	3.0	0.149	8.0	LOS A	0.0	0.0	0.00	1.00	0.00	51.2
Approach		29	3.0	0.149	8.3	LOS A	0.0	0.0	0.00	1.00	0.00	51.6
West: Saasveld												
10	L2	3	3.0	0.032	5.6	LOS A	0.0	0.0	0.00	0.03	0.00	57.9
11	T1	58	3.0	0.032	0.0	LOS A	0.0	0.0	0.00	0.03	0.00	59.7
Approach		61	3.0	0.032	0.3	NA	0.0	0.0	0.00	0.03	0.00	59.6
All Vehicles		126	3.0	0.149	2.4	NA	0.0	0.2	0.00	0.29	0.00	57.2

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	51	3.0	0.134	0.0	LOS A	0.1	1.0	0.05	0.18	0.05	58.3
6	R2	21	3.0	0.134	5.7	LOS A	0.1	1.0	0.05	0.18	0.05	56.0
Approach		72	3.0	0.134	1.7	NA	0.1	1.0	0.05	0.18	0.05	57.6
North: Meyer												
7	L2	21	3.0	0.134	8.3	LOS A	0.0	0.0	0.00	1.00	0.00	51.7
9	R2	5	3.0	0.134	8.0	LOS A	0.0	0.0	0.00	1.00	0.00	51.2
Approach		26	3.0	0.134	8.2	LOS A	0.0	0.0	0.00	1.00	0.00	51.6
West: Saasveld												
10	L2	13	3.0	0.028	5.6	LOS A	0.0	0.0	0.00	0.14	0.00	57.0
11	T1	41	3.0	0.028	0.0	LOS A	0.0	0.0	0.00	0.14	0.00	58.7
Approach		54	3.0	0.028	1.3	NA	0.0	0.0	0.00	0.14	0.00	58.3
All Vehicles		152	3.0	0.134	2.7	NA	0.1	1.0	0.02	0.31	0.02	56.7

2024 Design Year + Phase 1 Development

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	87	3.0	0.163	0.0	LOS A	0.1	0.6	0.05	0.15	0.05	58.5
6	R2	27	3.0	0.163	6.5	LOS A	0.1	0.6	0.05	0.15	0.05	56.2
Approach		115	3.0	0.163	1.5	NA	0.1	0.6	0.05	0.15	0.05	57.9
North: Meyer												
7	L2	48	3.0	0.333	8.7	LOS A	0.0	0.1	0.00	1.00	0.00	51.8
9	R2	25	3.0	0.333	8.8	LOS A	0.0	0.1	0.00	1.00	0.00	51.3
Approach		74	3.0	0.333	8.8	LOS A	0.0	0.1	0.00	1.00	0.00	51.6
West: Saasveld												
10	L2	63	3.0	0.128	5.6	LOS A	0.0	0.0	0.00	0.16	0.00	56.9
11	T1	178	3.0	0.128	0.0	LOS A	0.0	0.0	0.00	0.16	0.00	58.6
Approach		241	3.0	0.128	1.5	NA	0.0	0.0	0.00	0.16	0.00	58.1
All Vehicles		429	3.0	0.333	2.7	NA	0.1	0.6	0.01	0.30	0.01	56.8

PM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	318	3.0	0.635	0.1	LOS A	1.4	9.9	0.23	0.18	0.25	57.6
6	R2	111	3.0	0.635	9.6	LOS A	1.4	9.9	0.23	0.18	0.25	55.4
Approach		428	3.0	0.635	2.5	NA	1.4	9.9	0.23	0.18	0.25	57.0
North: Meyer												
7	L2	42	3.0	0.658	8.9	LOS A	0.2	1.3	0.00	1.00	0.00	51.9
9	R2	95	3.0	0.658	9.1	LOS A	0.2	1.3	0.00	1.00	0.00	51.4
Approach		137	3.0	0.658	9.0	LOS A	0.2	1.3	0.00	1.00	0.00	51.5
West: Saasveld												
10	L2	80	3.0	0.135	5.6	LOS A	0.0	0.0	0.00	0.19	0.00	56.6
11	T1	175	3.0	0.135	0.0	LOS A	0.0	0.0	0.00	0.19	0.00	58.3
Approach		255	3.0	0.135	1.8	NA	0.0	0.0	0.00	0.19	0.00	57.8
All Vehicles		820	3.0	0.658	3.4	NA	1.4	9.9	0.12	0.32	0.13	56.2

2029 Planning Year + Phase 1+2 Development

AM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	142	3.0	0.256	0.0	LOS A	0.1	0.5	0.04	0.15	0.05	58.2
6	R2	45	3.0	0.256	7.9	LOS A	0.1	0.5	0.04	0.15	0.05	55.9
Approach		187	3.0	0.256	1.9	NA	0.1	0.5	0.04	0.15	0.05	57.6
North: Meyer												
7	L2	142	3.0	0.817	26.2	LOS D	0.4	2.6	1.00	1.10	1.44	39.4
9	R2	43	3.0	0.817	52.0	LOS F	0.4	2.6	1.00	1.10	1.44	39.1
Approach		185	3.0	0.817	32.2	LOS D	0.4	2.6	1.00	1.10	1.44	39.3
West: Saasveld												
10	L2	121	3.0	0.220	5.6	LOS A	0.0	0.0	0.00	0.17	0.00	56.7
11	T1	294	3.0	0.220	0.0	LOS A	0.0	0.0	0.00	0.17	0.00	58.4
Approach		415	3.0	0.220	1.7	NA	0.0	0.0	0.00	0.17	0.00	57.9
All Vehicles		787	3.0	0.817	8.9	NA	0.4	2.6	0.24	0.39	0.35	52.0

PM Peak Hour

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	554	3.0	1.046	42.5	LOS E	28.5	204.5	1.00	0.46	4.71	30.3
6	R2	188	3.0	1.046	106.8	LOS F	28.5	204.5	1.00	0.46	4.71	29.6
Approach		742	3.0	1.046	58.9	NA	28.5	204.5	1.00	0.46	4.71	30.1
North: Meyer												
7	L2	42	3.0	1.564	521.9	LOS F	51.7	371.4	1.00	4.72	20.06	5.8
9	R2	173	3.0	1.564	557.8	LOS F	51.7	371.4	1.00	4.72	20.06	5.8
Approach		215	3.0	1.564	550.8	LOS F	51.7	371.4	1.00	4.72	20.06	5.8
West: Saasveld												
10	L2	136	3.0	0.225	5.6	LOS A	0.0	0.0	0.00	0.19	0.00	56.6
11	T1	287	3.0	0.225	0.0	LOS A	0.0	0.0	0.00	0.19	0.00	58.2
Approach		423	3.0	0.225	1.8	NA	0.0	0.0	0.00	0.19	0.00	57.7
All Vehicles		1380	3.0	1.564	117.9	NA	51.7	371.4	0.69	1.04	5.65	19.9

2029 Planning Year + Phase 1+2 Development + Upgrades

AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	142	3.0	0.146	4.9	LOS A	1.0	7.0	0.21	0.51	0.21	53.6
6	R2	45	3.0	0.146	8.2	LOS A	1.0	7.0	0.21	0.51	0.21	53.2
Approach		187	3.0	0.146	5.7	LOS A	1.0	7.0	0.21	0.51	0.21	53.5
North: Meyer												
7	L2	142	3.0	0.206	7.1	LOS A	1.3	9.0	0.55	0.67	0.55	51.7
9	R2	43	3.0	0.206	10.3	LOS B	1.3	9.0	0.55	0.67	0.55	52.1
Approach		185	3.0	0.206	7.8	LOS A	1.3	9.0	0.55	0.67	0.55	51.7
West: Saasveld												
10	L2	121	3.0	0.308	5.0	LOS A	2.2	16.0	0.23	0.48	0.23	53.3
11	T1	294	3.0	0.308	5.0	LOS A	2.2	16.0	0.23	0.48	0.23	54.1
Approach		415	3.0	0.308	5.0	LOS A	2.2	16.0	0.23	0.48	0.23	53.9
All Vehicles		787	3.0	0.308	5.8	LOS A	2.2	16.0	0.30	0.53	0.30	53.3

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	554	3.0	0.680	7.0	LOS A	7.8	55.8	0.77	0.65	0.77	51.8
6	R2	188	3.0	0.680	10.3	LOS B	7.8	55.8	0.77	0.65	0.77	51.4
Approach		742	3.0	0.680	7.8	LOS A	7.8	55.8	0.77	0.65	0.77	51.7
North: Meyer												
7	L2	42	3.0	0.245	7.1	LOS A	1.6	11.7	0.60	0.71	0.60	50.4
9	R2	173	3.0	0.245	10.3	LOS B	1.6	11.7	0.60	0.71	0.60	50.8
Approach		215	3.0	0.245	9.7	LOS A	1.6	11.7	0.60	0.71	0.60	50.7
West: Saasveld												
10	L2	136	3.0	0.416	6.5	LOS A	3.4	24.7	0.60	0.61	0.60	52.1
11	T1	287	3.0	0.416	6.5	LOS A	3.4	24.7	0.60	0.61	0.60	52.8
Approach		423	3.0	0.416	6.5	LOS A	3.4	24.7	0.60	0.61	0.60	52.6
All Vehicles		1380	3.0	0.680	7.7	LOS A	7.8	55.8	0.69	0.65	0.69	51.8

Access 1 & Meyer Road

2029 Planning Year + Phase 1+2 Development AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Meyer												
1	L2	5	3.0	0.111	5.2	LOS A	0.6	4.0	0.25	0.62	0.25	51.2
2	T1	5	3.0	0.111	5.2	LOS A	0.6	4.0	0.25	0.62	0.25	52.0
3	R2	118	3.0	0.111	8.4	LOS A	0.6	4.0	0.25	0.62	0.25	51.6
Approach		128	3.0	0.111	8.1	LOS A	0.6	4.0	0.25	0.62	0.25	51.6
East: Access 1												
4	L2	38	3.0	0.093	4.9	LOS A	0.5	3.4	0.15	0.60	0.15	52.1
5	T1	5	3.0	0.093	4.8	LOS A	0.5	3.4	0.15	0.60	0.15	52.9
6	R2	76	3.0	0.093	8.1	LOS A	0.5	3.4	0.15	0.60	0.15	52.6
Approach		119	3.0	0.093	6.9	LOS A	0.5	3.4	0.15	0.60	0.15	52.4
North: Meyer												
7	L2	236	3.0	0.230	5.6	LOS A	1.3	9.3	0.35	0.56	0.35	52.9
8	T1	15	3.0	0.230	5.6	LOS A	1.3	9.3	0.35	0.56	0.35	53.7
9	R2	5	3.0	0.230	8.8	LOS A	1.3	9.3	0.35	0.56	0.35	53.3
Approach		256	3.0	0.230	5.7	LOS A	1.3	9.3	0.35	0.56	0.35	52.9
West: Arthur Bleksley												
10	L2	5	3.0	0.025	5.8	LOS A	0.1	0.8	0.36	0.59	0.36	51.7
11	T1	5	3.0	0.025	5.7	LOS A	0.1	0.8	0.36	0.59	0.36	52.5
12	R2	15	3.0	0.025	9.0	LOS A	0.1	0.8	0.36	0.59	0.36	52.1
Approach		25	3.0	0.025	7.6	LOS A	0.1	0.8	0.36	0.59	0.36	52.1
All Vehicles		528	3.0	0.230	6.7	LOS A	1.3	9.3	0.28	0.59	0.28	52.5

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Meyer												
1	L2	17	3.0	0.174	7.0	LOS A	0.9	6.6	0.52	0.71	0.52	50.5
2	T1	17	3.0	0.174	6.9	LOS A	0.9	6.6	0.52	0.71	0.52	51.3
3	R2	123	3.0	0.174	10.1	LOS B	0.9	6.6	0.52	0.71	0.52	50.9
Approach		157	3.0	0.174	9.5	LOS A	0.9	6.6	0.52	0.71	0.52	50.9
East: Access 1												
4	L2	167	3.0	0.356	4.9	LOS A	2.4	17.4	0.17	0.59	0.17	52.0
5	T1	5	3.0	0.356	4.8	LOS A	2.4	17.4	0.17	0.59	0.17	52.8
6	R2	336	3.0	0.356	8.1	LOS A	2.4	17.4	0.17	0.59	0.17	52.4
Approach		508	3.0	0.356	7.0	LOS A	2.4	17.4	0.17	0.59	0.17	52.3
North: Meyer												
7	L2	246	3.0	0.240	5.7	LOS A	1.4	10.4	0.38	0.57	0.38	52.8
8	T1	14	3.0	0.240	5.6	LOS A	1.4	10.4	0.38	0.57	0.38	53.7
9	R2	5	3.0	0.240	8.8	LOS A	1.4	10.4	0.38	0.57	0.38	53.3
Approach		265	3.0	0.240	5.7	LOS A	1.4	10.4	0.38	0.57	0.38	52.9
West: Arthur Bleksley												
10	L2	5	3.0	0.028	7.5	LOS A	0.1	1.0	0.55	0.66	0.55	50.7
11	T1	5	3.0	0.028	7.4	LOS A	0.1	1.0	0.55	0.66	0.55	51.5
12	R2	13	3.0	0.028	10.7	LOS B	0.1	1.0	0.55	0.66	0.55	51.1
Approach		23	3.0	0.028	9.2	LOS A	0.1	1.0	0.55	0.66	0.55	51.1
All Vehicles		954	3.0	0.356	7.1	LOS A	2.4	17.4	0.30	0.61	0.30	52.2

Access 2 & Saasveld Road

2029 Planning Year + Phase 1+2 Development AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	38	3.0	0.131	5.1	LOS A	0.7	5.0	0.24	0.60	0.24	52.4
6	R2	118	3.0	0.131	8.3	LOS A	0.7	5.0	0.24	0.60	0.24	52.0
Approach		156	3.0	0.131	7.5	LOS A	0.7	5.0	0.24	0.60	0.24	52.1
North: Access 2												
7	L2	38	3.0	0.104	5.4	LOS A	0.5	3.9	0.31	0.61	0.31	51.6
9	R2	76	3.0	0.104	8.6	LOS A	0.5	3.9	0.31	0.61	0.31	52.1
Approach		114	3.0	0.104	7.5	LOS A	0.5	3.9	0.31	0.61	0.31	51.9
West: Saasveld												
10	L2	236	3.0	0.302	5.5	LOS A	1.9	13.4	0.35	0.54	0.35	52.9
11	T1	118	3.0	0.302	5.5	LOS A	1.9	13.4	0.35	0.54	0.35	53.7
Approach		354	3.0	0.302	5.5	LOS A	1.9	13.4	0.35	0.54	0.35	53.2
All Vehicles		623	3.0	0.302	6.4	LOS A	1.9	13.4	0.31	0.57	0.31	52.7

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Saasveld												
5	T1	167	3.0	0.326	7.2	LOS A	2.0	14.6	0.60	0.72	0.60	51.8
6	R2	123	3.0	0.326	10.4	LOS B	2.0	14.6	0.60	0.72	0.60	51.5
Approach		291	3.0	0.326	8.6	LOS A	2.0	14.6	0.60	0.72	0.60	51.7
North: Access 2												
7	L2	167	3.0	0.424	5.7	LOS A	3.1	22.3	0.42	0.62	0.42	51.3
9	R2	336	3.0	0.424	8.8	LOS A	3.1	22.3	0.42	0.62	0.42	51.8
Approach		503	3.0	0.424	7.8	LOS A	3.1	22.3	0.42	0.62	0.42	51.6
West: Saasveld												
10	L2	120	3.0	0.217	5.5	LOS A	1.3	9.6	0.36	0.53	0.36	52.8
11	T1	123	3.0	0.217	5.4	LOS A	1.3	9.6	0.36	0.53	0.36	53.7
Approach		243	3.0	0.217	5.5	LOS A	1.3	9.6	0.36	0.53	0.36	53.3
All Vehicles		1037	3.0	0.424	7.5	LOS A	3.1	22.3	0.45	0.63	0.45	52.0

Access 3 & Saasveld Road / Kraaibosch Road

2029 Planning Year + Phase 1+2 Development AM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kraaibosch												
1	L2	118	3.0	0.269	5.0	LOS A	1.6	11.2	0.20	0.49	0.20	53.3
2	T1	236	3.0	0.269	4.9	LOS A	1.6	11.2	0.20	0.49	0.20	54.2
3	R2	5	3.0	0.269	8.2	LOS A	1.6	11.2	0.20	0.49	0.20	53.8
Approach		359	3.0	0.269	5.0	LOS A	1.6	11.2	0.20	0.49	0.20	53.9
East: Saasveld												
4	L2	5	3.0	0.015	5.5	LOS A	0.1	0.5	0.31	0.55	0.31	52.3
5	T1	5	3.0	0.015	5.5	LOS A	0.1	0.5	0.31	0.55	0.31	53.1
6	R2	5	3.0	0.015	8.7	LOS A	0.1	0.5	0.31	0.55	0.31	52.8
Approach		16	3.0	0.015	6.6	LOS A	0.1	0.5	0.31	0.55	0.31	52.7
North: Access 3												
7	L2	5	3.0	0.112	4.8	LOS A	0.6	4.3	0.09	0.52	0.09	53.2
8	T1	114	3.0	0.112	4.7	LOS A	0.6	4.3	0.09	0.52	0.09	54.0
9	R2	38	3.0	0.112	8.0	LOS A	0.6	4.3	0.09	0.52	0.09	53.6
Approach		157	3.0	0.112	5.5	LOS A	0.6	4.3	0.09	0.52	0.09	53.9
West: Saasveld												
10	L2	118	3.0	0.131	6.2	LOS A	0.7	4.8	0.43	0.61	0.43	52.6
11	T1	5	3.0	0.131	6.2	LOS A	0.7	4.8	0.43	0.61	0.43	53.5
12	R2	5	3.0	0.131	9.4	LOS A	0.7	4.8	0.43	0.61	0.43	53.1
Approach		128	3.0	0.131	6.4	LOS A	0.7	4.8	0.43	0.61	0.43	52.7
All Vehicles		660	3.0	0.269	5.4	LOS A	1.6	11.2	0.22	0.52	0.22	53.6

PM Peak Hour

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kraaibosch												
1	L2	123	3.0	0.345	6.0	LOS A	2.1	15.3	0.44	0.58	0.44	52.5
2	T1	246	3.0	0.345	6.0	LOS A	2.1	15.3	0.44	0.58	0.44	53.4
3	R2	5	3.0	0.345	9.2	LOS A	2.1	15.3	0.44	0.58	0.44	53.0
Approach		375	3.0	0.345	6.0	LOS A	2.1	15.3	0.44	0.58	0.44	53.1
East: Saasveld												
4	L2	5	3.0	0.023	9.1	LOS A	0.1	0.8	0.64	0.68	0.64	50.1
5	T1	5	3.0	0.023	9.0	LOS A	0.1	0.8	0.64	0.68	0.64	50.8
6	R2	5	3.0	0.023	12.2	LOS B	0.1	0.8	0.64	0.68	0.64	50.5
Approach		16	3.0	0.023	10.1	LOS B	0.1	0.8	0.64	0.68	0.64	50.4
North: Access 3												
7	L2	5	3.0	0.441	4.8	LOS A	3.5	25.2	0.13	0.52	0.13	53.0
8	T1	503	3.0	0.441	4.8	LOS A	3.5	25.2	0.13	0.52	0.13	53.9
9	R2	167	3.0	0.441	8.0	LOS A	3.5	25.2	0.13	0.52	0.13	53.5
Approach		676	3.0	0.441	5.6	LOS A	3.5	25.2	0.13	0.52	0.13	53.8
West: Saasveld												
10	L2	60	3.0	0.074	6.2	LOS A	0.4	2.7	0.45	0.60	0.45	52.5
11	T1	5	3.0	0.074	6.1	LOS A	0.4	2.7	0.45	0.60	0.45	53.3
12	R2	5	3.0	0.074	9.4	LOS A	0.4	2.7	0.45	0.60	0.45	53.0
Approach		71	3.0	0.074	6.4	LOS A	0.4	2.7	0.45	0.60	0.45	52.6
All Vehicles		1137	3.0	0.441	5.8	LOS A	3.5	25.2	0.26	0.54	0.26	53.4

Annexures E: Fraser Consultant Report

Tel: 044 343 2093
Email: afraser@telkomsa.net
Mobile: 083 292 9047
Fax: 086 623 0024

FRASER
Consulting Civil Engineers cc

Forest Lodge, Main Road North
PO Box 178, Sedgefield, 6573

Our ref: AF1016 Date: 14 January 2020

Aurecon
Suite 201
2nd floor Bloemhof Building
65 York Street
George 6529
PO Box 509
George 6530
Tel: 044 874 2165
Email: george@aurecongroup.com
Att: Ms Sinako Johnson (Sinako.Johnson@aurecongroup.com)

Dear Sirs

Floodline Determination for Proposed Development of Remainder of erf 464, George

Fraser Engineers cc were appointed on the 25th of November 2019 to determine the 50 year Recurrence Interval (RI) and 100 year RI floodlines for a tributary of the Swart River alongside the remainder of erf 464, George. The confluence of this tributary and the Swart River is 200m downstream of the Garden Route Dam Wall.

Generally we place our floodline calculation notes on our drawings; however in this instance we have appended this information to this letter. This is to allow a single A1 paper size drawing to represent the floodlines.

The key hydrological, river hydraulic and culvert analysis information is attached as Appendix A to this letter. This acts as extended notes to floodline drawing AF1016-1

Drawing AF1016-1 contains a table listing the river stations (positions), as well as the 50 year RI and 100 year RI flood flows and floodline levels. More detailed tables are attached as Appendix B to this letter.

We have calculated preliminary sizes for the box culverts required at the two road crossings to the proposed development. These are presented within Appendix A of this letter. The culvert sizing may be affected by the embankment design. Fraser Engineers would like to review these recommendations during the preliminary design of the roadways.

Please call for any further information.

Yours faithfully,

Alastair Fraser Pr. Eng

Attached:

Appendix A	Key Hydrological, River Hydraulic and Culvert Analysis Information
Appendix B	Results of Backwater Analyses for 10, 20, 50 and 100 Year Recurrence Intervals (RIs) Rainstorms
Drawing	AF1016-rev 0: 50 Year and 100 Year RI Floodlines (A1 paper size, loose)

References

Aurecon (2018). Project Document Contract T/ING/025/2018 for Raising of Garden Route Dam Spillway and Associated Works. Prepared by Aurecon for the George Municipality. Aurecon, PO box 509, George, 6530.

CCT (2009). City of Cape Town. Floodplains and River Corridor Management Policy v2.1. Catchment, Stormwater and River Management Branch, Roads and Stormwater Department, City of Cape Town.

SANRAL (2007). Drainage Manual. Published by the South African National Roads Agency Limited; PO Box 415, Pretoria, 0001. www.nra.co.za: ISBN 1-86844-328-0.

US Army (2016). HEC-RAS River Analysis System. Users Manual v5.0. www.hec.usace.army.mil .
MAPPING: 1: 50 000 topographical maps 3322 CD and DC; 1: 10 000 orthomaps 3322 CD 25 and DC 21.

Appendix A Key Hydrological, River Hydraulic and Culvert Analysis Information

Project AF1016 –Floodline Determination for Proposed Development of Remainder of erf 464 George.

Notes for Floodline Drawing AF1016-01

1. TABLE OF RAINGAUGES CLOSE TO CATCHMENT AREA

Ref	Name	Lat	Long	MAP (mm)	Altitude	Years of record	One Day Design rainfalls (mm) for RI (years)			
		(deg) (min)	(deg) (min)		(m amsl)		10y	20y	50y	100y
28338 W	George	33 57	22 26	911	216	93	127	156	199	236
29058	Saasveld	33.57	22.28	849	174	49	129	158	201	239
							128	157	200	237

Rainfall Information sourced from SANRAL (2009)

2. TABLE OF FLOOD ANALYSIS INFORMATION

Catchment Area	2.015 km^2
Land Usage	Urban residential erven 500 to 3000 m2, schools, peri-urban small- holdings, light business, parks and minor bush forest
Soil Classifications	Hydrological Soil Classification: B/C (Moderate Stormwater Potential)
Time of Concentration	73 minutes (1.25 hours)
Flood Flow Estimates: (m^3/s) (at study area outfall) (m3/s) (downstream of GR Dam Wall)	

	10 Year RI	20 Year RI	50 Year RI	100 Year RI
SCS	30.6 m3/s	42 m3/s	59 m3/s	73.9 m3/s
Aurecon (2018)	144 m3/s	182 m3/s	236 m3/s	280 m3/s

3. TABLE OF MANNING'S n VALUES FOR THE RIVER AND FLOODPLAIN.

Position in Floodplain:	Left hand bank	Watercourse	Right hand bank
	0.12	0.09	0.12

4. The survey used was an aerial survey and large tolerances are required to the thick vegetation cover.

5. Consideration from the City of Cape Town Floodplain and River Management Policy (2009):

   a. It is far more cost effective in the long term to develop in areas where the threat of flooding is infrequent and the severity of flooding is minimal as opposed to the retrospective implementation of flood mitigation works which would generally be very costly and sometimes prone to catastrophic failure when flood flows exceed the design flow of infrastructure.

   b. In determining catchment runoff the foreseeable ultimate development scenario for the catchment must be used.

   c. The flood levels must be based upon theoretical energy levels as opposed to water surface levels.

   d. Any structure built within the floodplain (ablutions and clubhouse) should be designed to withstand the forces and effects of flowing floodwaters, including scour of foundations, debris forces and buoyancy forces.

6. Note that the 100 year flood line is likely to be exceeded during the infinite course of time. We recommend that infrastructure close to the floodlines have raised floor levels to assist with the possibilities of climate change.

7. The position of the floodline on the ground should be based upon elevation data rather than the approximate position indicated on the drawing.

8. CULVERT ANALYSIS

Road Classification	Class 4. As precaution used higher Class 5 for analysis
Design Principle (from SANRAL (2007)	Refer to SANRAL (2007). Select design RI from 20 year RI flow rate and class of road: design for 10 year RI allowing for 300mm of freeboard from water surface to soffit of culvert.
Road A culvert :	Size: 1 no. x 3.6 m wide x 3 m high; IL 196.85 m amsl; Soffit level 199.85 m amsl; Road deck level (kerbs, etc): 201.25 m amsl
Road B culvert :	Size: 1 no. x 4 m wide x 3 m high; IL 182.6 m amsl; Soffit level 185.6 m amsl; Road deck level (kerbs, etc): 187.0 m amsl
	Please contact Fraser Engineers for assistance in selecting the final sizes for detail design considering possibilities of blockages.

Appendix B Results of Backwater Analyses for 10, 20, 50 and 100 Year Recurrence Intervals (RIs) Rainstorms

Table Results - A. Backwater Analysis for 10 year Recurrence Interval (RI) Rainstorms

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev*	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
	(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	Channel
210	24.8	203.3	203.8	203.79	203.97	0.087517	2	15.37	45.17	0.93
200	24.8	201.4	202.47	201.98	202.5	0.006043	0.89	40.36	54.49	0.28
190	24.8	200.2	200.74	200.74	200.95	0.102362	2.35	13.63	33.78	1.02
180	26.5	198.23	199.7		199.72	0.003802	0.88	49.07	51.2	0.23
176	26.5	197.5	199.67		199.68	0.000345	0.52	85.31	58.12	0.11
174	26.5	196.85	199.67	197.38	199.68	0.000098	0.33	113.45	60.13	0.06
173	Culvert									
172	26.5	196.3	197.24		197.29	0.004728	1.1	31.64	44.14	0.36
170	26.5	195.92	197.18		197.2	0.004235	0.84	46.94	50.14	0.24
160	26.5	195.15	196.37	195.97	196.46	0.026253	1.43	20.69	26.21	0.54
150	28.7	190.15	190.69	190.69	190.93	0.103251	2.16	13.26	28.01	1
140	28.7	187	188.22	187.62	188.24	0.005075	0.66	43.58	57.34	0.24
130	28.7	185.9	186.48	186.48	186.72	0.103577	2.14	13.39	28.78	1
120	28.7	183.9	185.4		185.43	0.003713	0.75	38.48	34.82	0.22
116	28.7	182.6	185.38	183.27	185.38	0.000357	0.34	86.01	44.4	0.08
114	Culvert									
112	28.7	182.2	183.54		183.58	0.006127	0.9	31.81	29.8	0.28
110	28.7	181.95	183.23	182.66	183.28	0.009071	0.98	29.3	32.73	0.33
100	30.6	180.1	180.82	180.82	181.08	0.099833	2.29	13.34	25.15	1.01
90	30.6	178	180.25		180.27	0.001339	0.56	54.62	35.05	0.14
85	30.6	179	179.75		179.97	0.054457	2.1	15.56	24.59	0.79
80	30.6	176.8	177.5	177.5	177.78	0.09954	2.31	13.22	24.53	1.01
70	30.6	172	175.43		175.43	0.000136	0.28	121.78	49.4	0.05
65	30.6	174.2	175.14	175.13	175.38	0.091978	2.15	14.23	27.86	0.96
60	30.6	169.5	170.37	170.37	170.65	0.096997	2.35	13.04	23.25	1
50	30.6	161.3	165.54		165.55	0.000075	0.23	155.54	55.8	0.04
45	30.6	161.2	165.54		165.54	0.00007	0.23	157.09	54.75	0.04
40	174.6	156.8	165.53		165.54	0.000133	0.51	466.99	90.82	0.06
30	174.6	155	165.52		165.53	0.000071	0.36	588.99	105.8	0.04
25	174.6	160.2	165.51		165.52	0.000304	0.5	381.15	112.81	0.08
20	174.6	157.6	165.5		165.51	0.000078	0.37	577.06	115.92	0.04
10	174.6	163.3	164.93	164.93	165.44	0.085817	3.63	60.26	64.01	1.07
0	174.6	156.4	159.97	158.55	160.11	0.006309	1.99	126.83	59.64	0.34

* The Energy Grade (EG) elevation determines the floodline

Table Results - B. Backwater Analysis for 20 year Recurrence Interval (RI) Rainstorms

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev*	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
	(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	Channel
210	34	203.3	203.92	203.88	204.1	0.066611	2.04	21.48	51.95	0.84
200	34	201.4	202.64	202.08	202.67	0.006283	1	49.53	57.44	0.29
190	34	200.2	200.85	200.85	201.1	0.095275	2.57	17.56	37.23	1.02
180	36.2	198.23	200.37		200.38	0.001375	0.68	86.86	60.83	0.15
176	36.2	197.5	200.36		200.36	0.000213	0.49	128.33	67.64	0.09
174	36.2	196.85	200.36	197.49	200.36	0.000079	0.34	158.35	70.63	0.06
173	Culvert									
172	36.2	196.3	197.45		197.5	0.004235	1.19	40.91	46.79	0.35
170	36.2	195.92	197.39		197.41	0.004281	0.93	57.71	52.66	0.25
160	36.2	195.15	196.55	196.11	196.66	0.027186	1.62	25.56	28.7	0.56
150	39.4	190.15	190.81	190.81	191.09	0.097815	2.37	16.66	29.53	1.01
140	39.4	187	188.39	187.73	188.41	0.005192	0.74	53.57	60.73	0.25
130	39.4	185.9	186.6	186.6	186.88	0.097996	2.34	16.83	30.41	1
120	39.4	183.9	186.08		186.1	0.001576	0.63	64.85	42.8	0.15
116	39.4	182.6	186.06	183.4	186.07	0.000274	0.35	118.58	50.63	0.07
114	Culvert									
112	39.4	182.2	183.75		183.8	0.006616	1.03	38.35	31.27	0.3
110	39.4	181.95	183.43	182.8	183.49	0.00937	1.1	35.97	34.77	0.34
100	42	180.1	180.95	180.95	181.27	0.094843	2.48	16.91	27.25	1.01
90	42	178	180.5		180.52	0.001589	0.67	63.36	37.02	0.16
85	42	179	179.88	179.8	180.17	0.057326	2.41	18.9	25.88	0.83
80	42	176.8	177.64	177.64	177.96	0.094145	2.53	16.58	25.74	1.01
70	42	172	175.61		175.62	0.000207	0.36	131.29	50.91	0.06
65	42	174.2	175.25	175.25	175.55	0.095092	2.41	17.39	29.3	1
60	42	169.5	170.51	170.51	170.85	0.091572	2.56	16.38	24.47	1
50	42	161.3	165.83		165.84	0.000107	0.29	172.11	58.37	0.05
45	42	161.2	165.83		165.83	0.000102	0.28	173.29	57.3	0.04
40	224	156.8	165.81		165.82	0.000192	0.63	493.14	94.49	0.07
30	224	155	165.8		165.81	0.000103	0.44	619.21	110	0.05
25	224	160.2	165.78		165.8	0.000399	0.6	412.58	115.97	0.09
20	224	157.6	165.78		165.79	0.000111	0.45	609.27	119.14	0.05
10	224	163.3	165.13	165.13	165.7	0.078416	3.86	73.91	67.5	1.05
0	224	156.4	160.39	158.83	160.54	0.006312	2.14	152.14	62.77	0.35

* The Energy Grade (EG) elevation determines the floodline

Table Results - C. Backwater Analysis for 50 year Recurrence Interval (RI) Rainstorms

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev*	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
	(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	Channel
210	47.7	203.3	204.21		204.32	0.027203	1.69	37.74	60.2	0.57
200	47.7	201.4	202.66		202.72	0.011462	1.37	50.85	57.86	0.39
190	47.7	200.2	201.48		201.55	0.012602	1.47	45.94	50.68	0.42
180	51	198.23	201.39		201.4	0.000519	0.54	155.84	74.12	0.1
176	51	197.5	201.39		201.39	0.000119	0.45	204.68	80.25	0.07
174	51	196.85	201.39	197.64	201.39	0.000055	0.34	237.93	84.01	0.05
173	Culvert									
172	51	196.3	197.71		197.77	0.003903	1.31	53.58	50.19	0.35
170	51	195.92	197.65		197.68	0.004406	1.06	72.16	55.85	0.26
160	51	195.15	196.77	196.29	196.9	0.028481	1.85	32.21	31.78	0.59
150	55.4	190.15	190.96	190.96	191.31	0.091964	2.59	21.38	31.53	1.01
140	55.4	187	188.47		188.52	0.007734	0.94	59	62.49	0.31
130	55.4	185.9	187.27		187.37	0.014697	1.37	40.35	39.01	0.43
120	55.4	183.9	187.16		187.17	0.000567	0.52	117	54.1	0.1
116	55.4	182.6	187.15	183.57	187.16	0.000161	0.34	179.71	61.53	0.06
114	Culvert									
112	55.4	182.2	184.01		184.08	0.007273	1.18	46.83	33.13	0.32
110	55.4	181.95	183.67	182.97	183.74	0.01002	1.25	44.45	37.21	0.36
100	59	180.1	181.15	181.12	181.5	0.081466	2.62	22.49	29.76	0.96
90	59	178	180.8		180.84	0.001872	0.81	75.18	39.52	0.17
85	59	179	180.05	179.99	180.42	0.061959	2.8	23.18	27.43	0.89
80	59	176.8	177.82	177.82	178.21	0.08712	2.77	21.33	27.35	1
70	59	172	175.86		175.87	0.000318	0.47	143.93	52.86	0.08
65	59	174.2	175.41	175.41	175.77	0.091692	2.66	22.16	31.36	1.01
60	59	169.5	170.69	170.69	171.1	0.0875	2.83	20.88	26.03	1.01
50	59	161.3	166.21		166.21	0.000152	0.36	194.57	61.68	0.06
45	59	161.2	166.2		166.21	0.000145	0.36	195.25	60.58	0.05
40	295	156.8	166.17		166.19	0.000281	0.79	528.19	99.2	0.08
30	295	155	166.16		166.17	0.000152	0.55	659.64	115.38	0.06
25	295	160.2	166.13		166.16	0.000528	0.73	453.99	120.01	0.11
20	295	157.6	166.13		166.14	0.000162	0.56	651.69	123.26	0.06
10	295	163.3	165.38	165.38	166.03	0.074351	4.19	90.75	70.25	1.05
0	295	156.4	160.91	159.19	161.09	0.006303	2.34	185.89	66.53	0.36

* The Energy Grade (EG) elevation determines the floodline

Table Results - D. Backwater Analysis for 100 year Recurrence Interval (RI) Rainstorms

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev*	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
	(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	Channel
210	59.7	203.3	204.33		204.44	0.025942	1.79	44.85	62.52	0.57
200	59.7	201.4	202.8		202.87	0.011505	1.48	59.36	60.45	0.4
190	59.7	200.2	201.65		201.73	0.012116	1.57	54.67	53.69	0.42
180	63.86	198.23	201.53		201.54	0.000678	0.64	166.26	75.93	0.11
176	63.86	197.5	201.52		201.53	0.000161	0.54	215.71	81.75	0.09
174	63.86	196.85	201.52	197.76	201.53	0.000076	0.41	249.46	85.78	0.06
173	Culvert									
172	63.86	196.3	197.9		197.98	0.003743	1.4	63.78	52.76	0.35
170	63.86	195.92	197.86		197.89	0.004492	1.15	83.64	58.27	0.27
160	63.86	195.15	196.93	196.43	197.09	0.029263	2	37.56	34.05	0.61
150	69.4	190.15	191.08	191.08	191.47	0.08872	2.75	25.21	33.04	1.01
140	69.4	187	188.63		188.68	0.007738	1.01	68.85	65.57	0.31
130	69.4	185.9	187.49		187.59	0.013015	1.41	49.07	41.39	0.41
120	69.4	183.9	187.35		187.37	0.000704	0.61	127.48	56.56	0.11
116	69.4	182.6	187.34	183.7	187.35	0.000212	0.4	191.4	63.4	0.06
114	Culvert									
112	69.4	182.2	184.19		184.28	0.008213	1.32	52.77	34.88	0.34
110	69.4	181.95	183.77		183.88	0.012198	1.43	48.55	38.33	0.41
100	73.9	180.1	181.44		181.72	0.046983	2.33	31.78	33.3	0.76
90	73.9	178	181.04		181.08	0.00207	0.91	84.69	41.42	0.19
85	73.9	179	180.17	180.13	180.62	0.063954	3.08	26.76	28.64	0.92
80	73.9	176.8	177.95	177.95	178.39	0.085013	2.95	25.02	28.54	1.01
70	73.9	172	176.05		176.06	0.000415	0.55	153.96	54.35	0.09
65	73.9	174.2	175.54	175.54	175.94	0.08751	2.81	26.27	33.03	1.01
60	73.9	169.5	170.83	170.83	171.29	0.082173	3	24.64	27.13	1
50	73.9	161.3	166.49		166.5	0.000188	0.42	212.58	64.22	0.06
45	73.9	161.2	166.49		166.49	0.000181	0.42	212.85	63.08	0.06
40	353.9	156.8	166.44		166.48	0.000357	0.9	556	102.78	0.1
30	353.9	155	166.43		166.45	0.000194	0.63	691.67	119.47	0.07
25	353.9	160.2	166.4		166.43	0.000625	0.82	486.39	123.07	0.12
20	353.9	157.6	166.39		166.41	0.000205	0.64	684.84	126.38	0.07
10	353.9	163.3	165.55	165.55	166.28	0.07403	4.47	102.87	72.17	1.06
0	353.9	156.4	161.29	159.45	161.49	0.006301	2.47	212.16	69.32	0.36

* The Energy Grade (EG) elevation determines the floodline

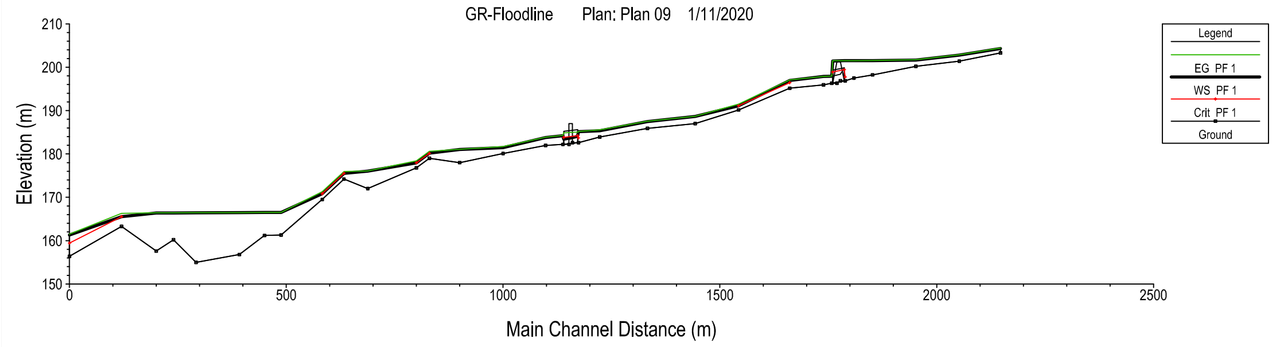


Table Results - 1. Backwater Analysis for 50 and 100 Year Recurrence Intervals (RI) Rainstorms (Abbreviated – see note 1)

River Sta	Q 50 Total	E.G. 50 Elev*	Q 100 Total	E.G. 100 Elev*
	(m3/s)	(m)	(m3/s)	(m)
210	47.7	204.32	59.7	204.44
200	47.7	202.72	59.7	202.87
190	47.7	201.55	59.7	201.73
180	51	201.4	63.86	201.54
176	51	201.39	63.86	201.53
174	51	201.39	63.86	201.53
173	Culvert		Culvert	
172	51	197.77	63.86	197.98
170	51	197.68	63.86	197.89
160	51	196.9	63.86	197.09
150	55.4	191.31	69.4	191.47
140	55.4	188.52	69.4	188.68
130	55.4	187.37	69.4	187.59
120	55.4	187.17	69.4	187.37
116	55.4	187.16	69.4	187.35
114	Culvert		Culvert	
112	55.4	184.08	69.4	184.28
110	55.4	183.74	69.4	183.88
100	59	181.5	73.9	181.72
90	59	180.84	73.9	181.08
85	59	180.42	73.9	180.62
80	59	178.21	73.9	178.39
70	59	175.87	73.9	176.06
65	59	175.77	73.9	175.94
60	59	171.1	73.9	171.29
50	59	166.21	73.9	166.5
45	59	166.21	73.9	166.49
40	295	166.19	353.9	166.48
30	295	166.17	353.9	166.45
25	295	166.16	353.9	166.43
20	295	166.14	353.9	166.41
10	295	166.03	353.9	166.28
0	295	161.09	353.9	161.49

GARDEN ROUTE DAM

ROAD A

ROAD B

LAYOUT
SCALE 1:2500

NOTES:

1. REFER TO FRASER ENGINEERS cc LETTER OF 14 January 2020 for:
   i. KEY HYDROLOGICAL, RIVER HYDRAULIC AND CULVERT ANALYSIS INFORMATION, and
   ii. DETAILED TABLES OF RESULTS.

LEGEND:

- RS 20 - RIVER STATION 20
- 100 YEAR RI FLOODLINE
- 50 YEAR RI FLOODLINE
- CENTRE OF WATERCOURSE
- 212m - CONTOUR LEVEL

REVISION	DATE	REVISION DETAILS
0	14 Jan. 2020	Original Issue

FRASER
Consulting Civil Engineers cc
ph 044 343 2093
fx 0866 23 00 24
cell 083 292 9047
PO Box 178
SEDGEFIELD
6573
Forest Lodge
Main Road North
Sedgefield
email: fraser@fcce.co.za

DESIGNED BY: AL FRASER Pr.Eng.940107
DRAWN BY: JB STRYDOM

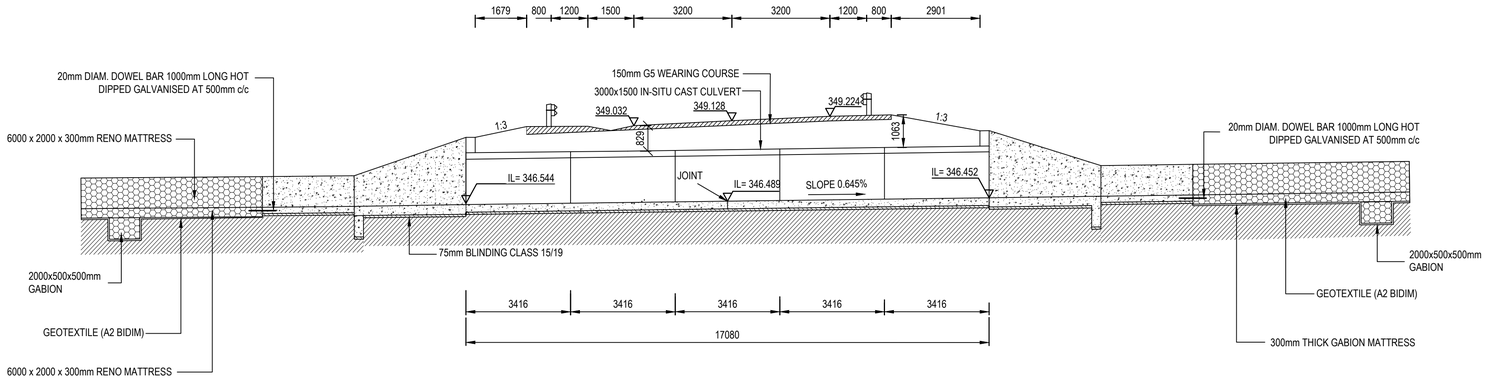
PROJECT: FLOODLINE DETERMINATION FOR PROPOSED DEVELOPMENT OF REMAINDER OF ERF 464, GEORGE

CLIENT:

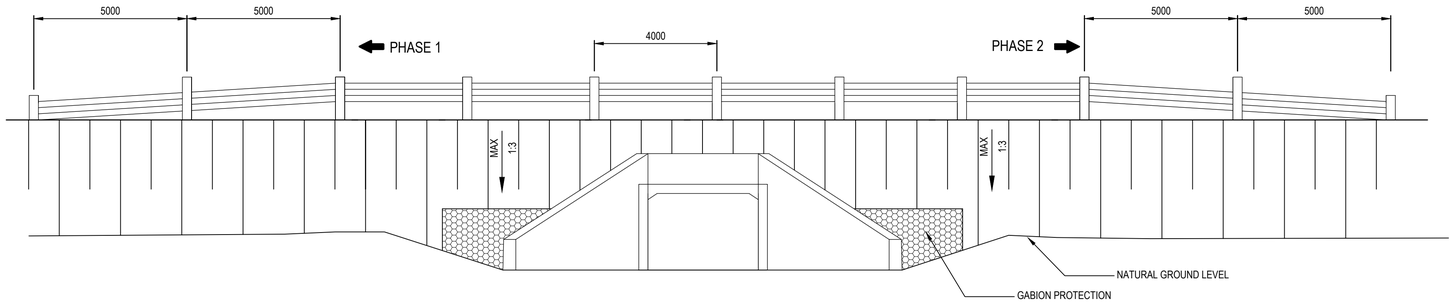
DRAWING TITLE: 50 & 100 YEAR RI FLOODLINES LAYOUT

DRAWING NUMBER	SCALE	PAPER SIZE	REVISION
AF1016-01	1:2500	A1	0

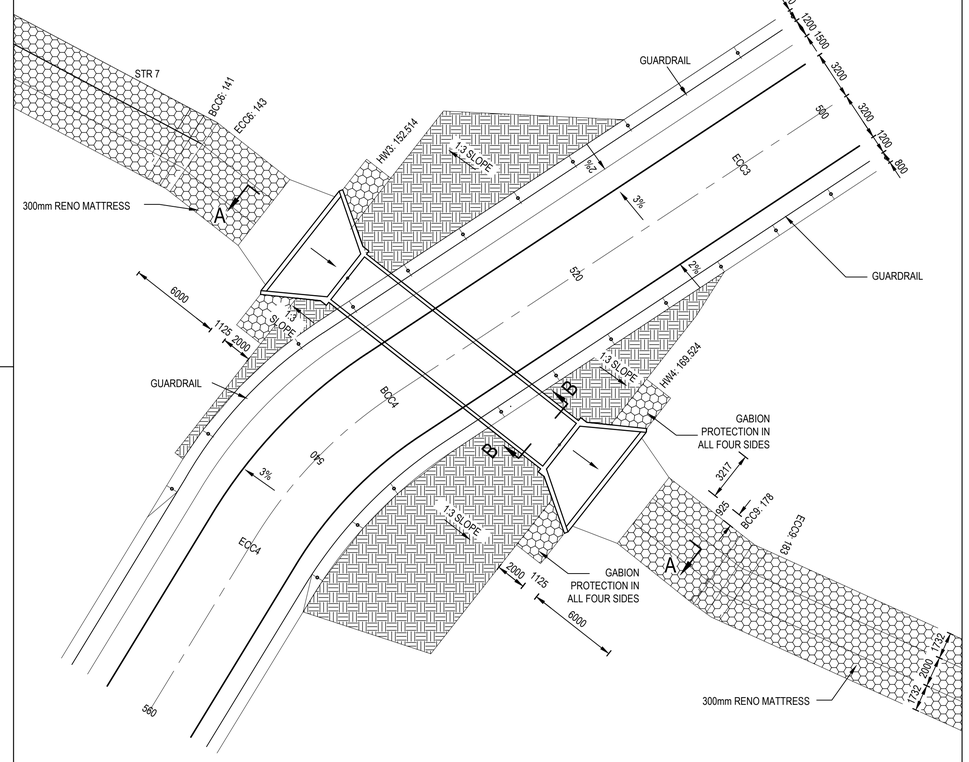
Annexures F: Culvert Bridge



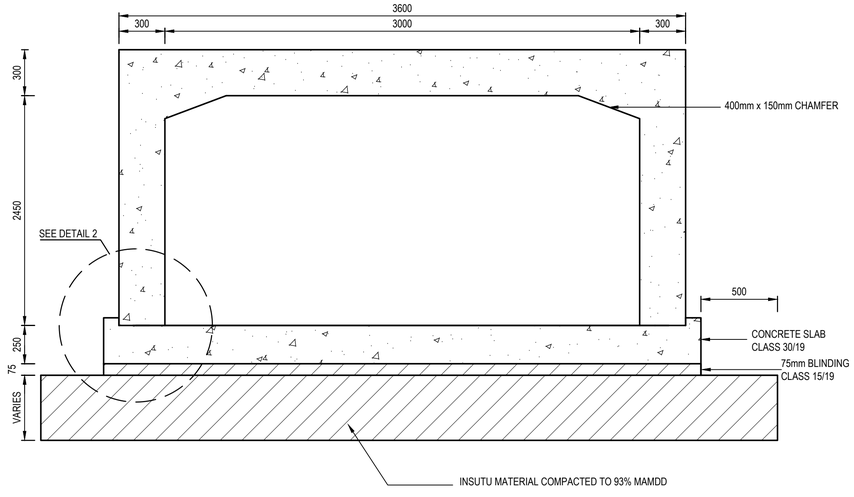
SECTION A-A
SCALE 1:100



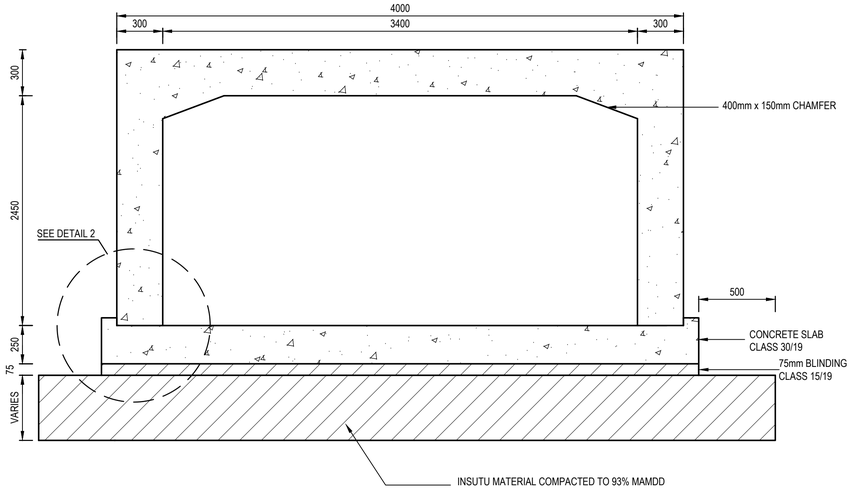
FRONT ELEVATION
NTS



FRONT ELEVATION
SCALE 1:200



ROAD A -SECTION B - B
SCALE 1:20



ROAD B -SECTION B - B
SCALE 1:20

aurecon
www.aurecongroup.com

CLIENT
GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
A	16/1/2020	PRELIMINARY	A KEYSER

SCALE	SIZE
1:2000	A1

DRAWN
A. VAN WYK
DESIGNED
S. JOHNSON
REVIEWED
M. BOTHA

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED
DATE
AC KEYSER ECSA-200670108

PROJECT	ERF 464 GEORGE REZONING
TITLE	ROAD A & B CULVERT ROAD BRIDGE DETAILS

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	504255	0000	DRG	CC	0005	A

Filename: P:\PROJECTS\504255 ERF 464 GEORGE REZONING\DEL DES\03 CAD\DRAWINGS\REPORT\504255-0000-DRG-CC-0005-A - CULVERT BRIDGE.DWG
Plot Date: 31/1/2020 3:25:39 PM Office:

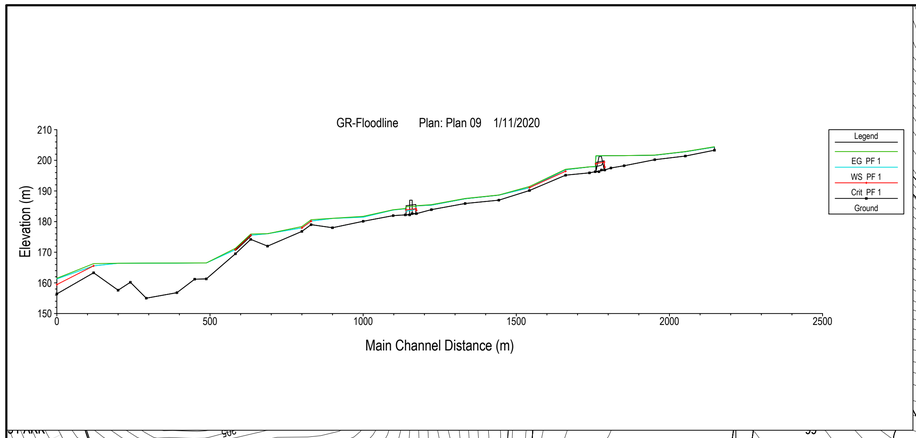


Table Results - 1. Backwater Analysis for 50 and 100 Year Recurrence Intervals (RI) Rainstorms (Abbreviated – see note 1)

River Sta	Q 50 Total (m3/s)	E.G. 50 Elev* (m)	Q 100 Total (m3/s)	E.G. 100 Elev* (m)
210	47.7	204.32	59.7	204.44
200	47.7	202.72	59.7	202.87
190	47.7	201.55	59.7	201.73
180	51	201.4	63.86	201.54
176	51	201.39	63.86	201.53
174	51	201.39	63.86	201.53
173	Culvert		Culvert	
172	51	197.77	63.86	197.98
170	51	197.68	63.86	197.89
160	51	196.9	63.86	197.09
150	55.4	191.31	69.4	191.47
140	55.4	188.52	69.4	188.68
130	55.4	187.37	69.4	187.59
120	55.4	187.17	69.4	187.37
116	55.4	187.16	69.4	187.35
114	Culvert		Culvert	
112	55.4	184.08	69.4	184.28
110	55.4	183.74	69.4	183.88
100	59	181.5	73.9	181.72
90	59	180.84	73.9	181.08
85	59	180.42	73.9	180.62
80	59	178.21	73.9	178.39
70	59	175.87	73.9	176.06
65	59	175.77	73.9	175.94
60	59	171.1	73.9	171.29
50	59	166.21	73.9	166.5
45	59	166.21	73.9	166.49
40	295	166.19	353.9	166.48
30	295	166.17	353.9	166.45
25	295	166.16	353.9	166.43
20	295	166.14	353.9	166.41
10	295	166.03	353.9	166.28
0	295	161.09	353.9	161.49

GARDEN ROUTE DAM

STANDER STREET

FRIKKIE GERICKE STREET

BOOMPIE

WESTERNROAD CLOSE

ROAD A

ROAD B

+3760000 X

+45000 Y

LEGEND:
- RS 20 - RIVER STATION 20
- 100 YEAR RI FLOODLINE
- 50 YEAR RI FLOODLINE
- CENTRE OF WATERCOURSE
- 212m - CONTOUR LEVEL

Plot Date: 31/1/2020 3:38:33 PM Offset: ZAGRJ Filename: P:\PROJECTS\504255 ERF 464 GEORGE REZONING\5 DEL DES\03 CAD\DRAWINGS\REPORT\504255-0000DRG-CC-0006.DWG

aurecon
www.aurecongroup.com

CLIENT: GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
A	16/1/2020	PRELIMINARY	A KEYSER

SCALE	1:2500
SIZE	A1
DRAWN	A. VAN WYK
DESIGNED	S. JOHNSON
REVIEWED	M. BOTHA

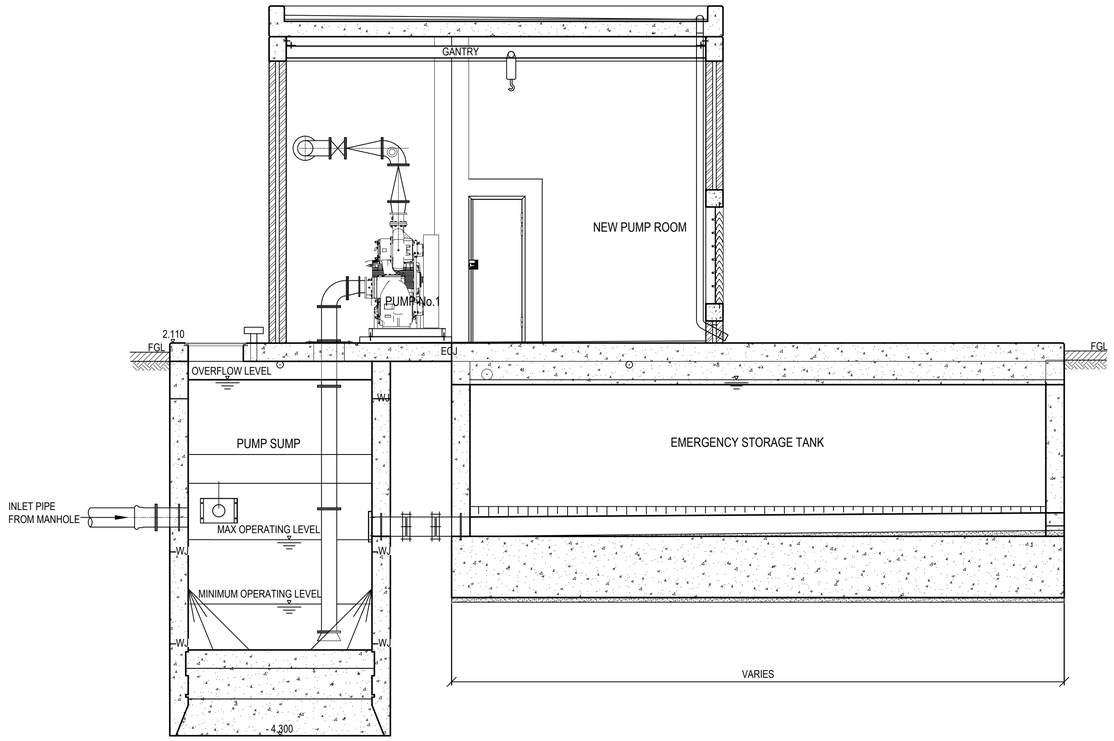
PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED
DATE
AC KEYSER ECSA-200670108

PROJECT	ERF 464 GEORGE REZONING
TITLE	50 & 100 YEAR RI FLOODLINES

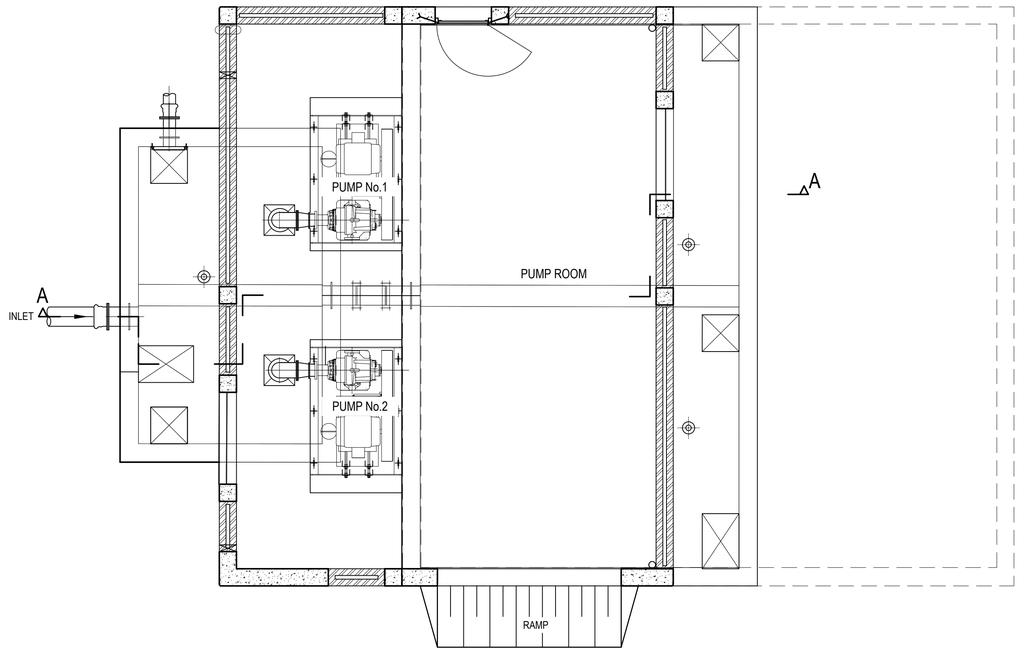
DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	504255	0000	DRG	CC	0006	A

Annexures G: Pump station



SECTION A-A

SCALE 1:50



SECTIONAL PLAN VIEW

SCALE 1:50

GENERAL NOTES:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF THE PIPE WORK, VALVES, FITTINGS, SUPPORTS, ETC. PIPE WORK DETAILS AND LAYOUTS ARE FOR INFORMATION PURPOSES ONLY.
2. ALL PIPE WORK SHALL BE MANUFACTURED FROM 304L STAINLESS STEEL AND TREATED IN ACCORDANCE WITH SYSTEM 1 OF SPEC T/HP.
3. ALL FLANGES TO BE DRILLED IN ACCORDANCE WITH SANS 1123 TABLE 1000/3.
4. PIPE AND VALVES SUPPORTS ONLY SHOWN SCHEMATICALLY.
5. ALL CONSTRUCTION DONE IN ACCORDANCE WITH SANS 1200.
6. 280mm x 280mm CONCRETE BEAM AND COLUMNS REINFORCED WITH Y12 SPACED AT 200mm c/c AROUND ALL DOORS AND LOUVERS.
7. PAVING, GRAVEL LAYERS AND/OR FINISHED GROUND LEVEL TO FREE DRAIN TO NATURAL WATER COURSE.
8. GANTRY TO BE SUPPLIED AND INSTALLED UNDER MECHANICAL CONTRACT. CONTRACTOR TO ARRANGE LOAD TEST CERTIFICATE. ALL FITTINGS AND EQUIPMENT SIZES TO BE VERIFIED TO CARRY THE REQUIRED LOADS PRIOR TO ORDERING AND/OR INSTALLATION OF EQUIPMENT.
9. CRAWLER AND HOIST EQUIPMENT TO BE INSTALLED BY MECHANICAL CONTRACTOR.
   LOAD TEST CERTIFICATE TO BE SUPPLIED BY MECHANICAL CONTRACTOR.

aurecon
www.aurecongroup.com

CLIE

GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
A	30/1/2020	PRELIMINARY	AC KEYSER

SCALE	SIZE
1:50	A1

PRELIMINARY
NOT FOR CONSTRUCTION

DRAWN	APPROVED
A VAN WYK	DATE
DESIGNED	
E WITBOOI	
REVIEWED	AC KEYSER ECSA-200670108
M BOTHA	

PROJECT

ERF 464 GEORGE REZONING

TITLE

PUMPSTATION LAYOUT

DRAWING NUMBER

PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
504255	-	0000	-	DRG	-	CC	-	0007	-	A

Document prepared by

Aurecon South Africa (Pty) Ltd
Reg No 1977/003711/07

Suite 201
2nd Floor
Bloemhof Building
65 York Street
George 6529

PO Box 509
George 6530
South Africa

T +27 44 874 2165
F +27 44 873 5843
E george@aurecongroup.com
W aurecongroup.com

aurecon

Bringing ideas to life

Aurecon offices are located in:
Angola, Australia, Botswana, China, Ghana, Hong Kong, Indonesia, Kenya, Lesotho, Macau, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Qatar, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.