Transport Impact Assessment for the Proposed Bakubung Ledig Development

North West Province

January 2017

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Report Title:	**Transport Impact Assessment for the proposed Bakubung Ledig Development**
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	SANRAL
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Report Project nr:	**ITS 3641**
Date:	**January 2017**
Report Status:	**Draft**

Transport Impact Assessment for the proposed Bakubung Ledig Development

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Transport Impact Assessment for the proposed Bakubung Ledig Development

1. INTRODUCTION

It is planned to construct a mixed land use development in the Bakubung area. The proposed development is located on a portion of the Remaining Extent of the Farm Ledig 909, J.R., North West. The development is situated to the north of the R556, to the east of the existing Ledig township and to the west of Sun City. Refer to **Appendix A, Figure 1**.

2. LAND USE AND TRIP GENERATION

The proposed land uses and expected trip generation for the AM and PM peak hour is shown in the tables below. The development plan is attached in **Appendix A, Figure 2**.

Table 1: Land use and Expected Trip Generation for the AM Peak Hour

No	Land Use	Extent	Unit	Trip Rate	Adjuctment Factor (Vehicle Ownership)	Adjustment Factor (Internal Trips)	Directional Split		In (vph)	Out (vph)	Total Trips (vph)
							In (%)	Out (%)			
1	High Denisty Residential	6071	units	0.25	1	1	30%	70%	455	1062	1518
2	Shopping Centre	3084	m² GLA	2.5	0.4	1	65%	35%	20	11	31
3	Offices	3084	m² GLA	2.1	0.7	1	80%	20%	36	9	45
4	Hotel	400	rooms	0.5	0.7	1	60%	40%	84	56	140
5	Sportgrounds	5 000	seats	0.05	0.5	1	50%	50%	63	63	125
6	Municipal (Offices)	34450	m² GLA	2.1	0.7	0.4	80%	20%	162	41	203
7	Clinic	7250	m² GLA	6	0.2	0.2	60%	40%	10	7	17
8	Institution	11000	m² GLA	6	0.3	0.4	60%	40%	48	32	79
9	Public School	1500	pupils	0.75	0.2	0.4	80%	20%	72	18	90
Total									**950**	**1298**	**2248**

Table 2: Land use and Expected Trip Generation for the PM Peak Hour

No	Land Use	Extent	Unit	Trip Rate	Adjuctment Factor (Vehicle Ownership)	Adjustment Factor (Internal Trips)	Directional Split		In (vph)	Out (vph)	Total Trips (vph)
							In (%)	Out (%)			
1	High Denisty Residential	6071	units	0.25	1	1	75%	25%	1138	379	1518
2	Shopping Centre	3084	m² GLA	14.2	0.4	1	50%	50%	88	88	176
3	Offices	3084	m² GLA	2.1	0.7	1	20%	80%	9	36	45
4	Hotel	400	rooms	0.5	0.7	1	40%	60%	56	84	140
5	Sportgrounds	5 000	seats	0.06	0.5	1	90%	10%	135	15	150
6	Municipal (Offices)	34450	m² GLA	2.1	0.7	0.4	20%	80%	41	162	203
7	Clinic	7250	m² GLA	6	0.2	0.2	40%	60%	7	10	17
8	Institution	11000	m² GLA	6	0.3	0.4	40%	60%	32	48	79
9	Public School	1500	pupils	0.25	0.2	0.4	10%	90%	3	27	30
Total									**1508**	**850**	**2358**

Trip generation rates as specified in the COTO TMH 17 manual [1] were used for all land uses except for the residential units. The trip generation rate in COTO for residential units is expected to be too high due to the mixed-use nature of the development and the low car ownership of the

surrounding area,. Traffic counts and surveys at similar developments were done in the Johannesburg area and a trip rate of 0.25 vph/unit was derived from the data obtained, refer to **Appendix B**. It is expected that the trip rate for the residential units in the Bakubung development will be similar to the trip rate observed at the surveyed developments. A trip rate of 0.25 vph/unit was therefore used for the high density residential units. This trip rate includes public transport.

The proposed development is located in an area where very low vehicle ownership is expected. The trips generated by the proposed development, except for the residential units, were hence adjusted with the factors given in Table 3.2 of the COTO manual. Also, it is expected that approximately 60% of the trips generated by the municipal offices, institution and public school will be internal trips and that the clinic will generate approximately 80% internal trips, refer to **Tables 1** and **2**.

3. ROAD NETWORK

The roads surrounding the development is summarised in the table below. Refer to **Appendix A, Figure 3**.

Table 3: Surrounding Road Network

No	Road Name	Road Class	Description
1	R556	2	• Single carriage way with one lane per direction; • A sidewalk is located on the northern side of the road in the vicinity of the proposed development and on both sides of the road in the Ledig township development; • Under jurisdiction of SANRAL; • Serve as access road to the development.
2	R565	2	• Single carriage way with one lane per direction; • Under jurisdiction of SANRAL • North-south link between Ledig and Rustenburg
3	Internal Roads	4 and 5	• The Class 4 roads located in the development serve as connector roads between the R556 and the internal class 5 roads; • These internal roads serve as link roads between the proposed development and the existing Ledig township.

4. ACCESS

Three direct accesses to the development are proposed from the R556 and three indirect accesses from the west via the Ledig township. The National Guidelines for Road Access Management (RAM) in South Africa [2] recommends access spacing of 800m ± 10% for Class 2 roads. The access spacing provided at the proposed development does not comply with the RAM standards, however the access locations were approved in a meeting held with SANRAL refer to **Appendix A, Figure 3**.

The stopping sight distance is adequate as stopping sight distances of at least 200m in both directions are achieved, which exceeds the 130m minimum as specified in COTO TMH 16 [3].

5. TRAFFIC VOLUMES

5.1 EXISTING TRAFFIC VOLUMES

Traffic counts were done on 29 July 2016 during the AM and PM peak hours at intersections in close vicinity of the proposed development. Refer to **Appendix A, Figure 5.1** and **Figure 5.2** for the 2016 AM and PM peak hour traffic volumes respectively.

5.2 FUTURE BACKGROUND TRAFFIC VOLUMES

The 2016 traffic volumes were grown with 3% per annum to the 2021 horizon year. Refer to **Appendix A, Figure 6.1** and **Figure 6.2** for the expected 2021 AM and PM peak hour traffic volumes.

6. TRIP DISTRIBUTION AND TRIP ASSIGNMENT

Refer to **Appendix A, Figure 9, Figure 10.1** and **Figure 10.2** for the trip distribution and trip assignment.

7. CAPACITY ANALYSIS

The capacity analyses for the proposed development were conducted using the SIDRA 6.1 intersection analysis tool. The scenarios analysed and capacity analysis results can be seen in **Tables 4** and **5** below. The results indicated are the average levels of service of the intersection. Upgrades were proposed at intersections with unacceptable levels of service (LOS). Refer to **Section 9** for the proposed upgrades. The Sidra outputs can be seen in **Appendix C**.

Table 4: Capacity Analysis Results for the AM Peak Hour

		Intersection 1 R565 / R556	Intersection 2 R556 / Internal Rd 1	Intersection 3 R556 / Access 1	Intersection 4 R556 / Access 2	Intersection 5 R556 / Access 3	Intersection 6 R556 / Engen Access	Intersection 7 R556 / Sun City Access	Intersection 8 Internal Rd 1 / Internal Rd 2	Intersection 9 Internal Rd 2 / Internal Rd 3
Scenario 1: 2016 AM Peak Hour Traffic Demand with existing geometry	LOS	D	A	A	A	A	A	A	C	A
	Del	28	5	1	1	1	7	2	16	6
Refer to Fig 4 and 5.1	v/c	0.64	0.27	0.22	0.22	0.22	0.23	0.19	0.21	0.03
Scenario 2: 2021 AM Peak Hour Traffic Demand without upgraded geometry	LOS	D	A	A	A	A	A	A	C	A
	Del	34	5	1	1	1	8	2	16	6
Refer to Fig 4 and 6.1	v/c	0.74	0.38	0.25	0.25	0.25	0.32	0.23	0.24	0.04
Scenario 2U: 2021 AM Peak Hour Traffic Demand with upgraded geometry	LOS	A	A	A	A	A	A	A	C	A
	Del	7	5	1	1	1	8	2	16	6
Refer to Fig 7 and 8.1	v/c	0.28	0.38	0.25	0.25	0.25	0.32	0.23	0.24	0.04
Scenario 3: 2021 AM Peak Hour + Development Traffic Demand without upgraded geometry	LOS	A	F	B	A	B	F	A	C	A
	Del	8	>50	10	8	9	35	2	21	7
Refer to Fig 7 and 11.1	v/c	0.55	>1.5	0.62	0.56	0.66	1.57	0.45	0.64	0.11
Scenario 3U: 2021 AM Peak Hour + Development Traffic Demand with upgraded geometry	LOS	A	A	B	A	A	B	A	C	A
	Del	8	9	10	8	9	11	2	21	7
Refer to Fig 12 and 13.1	v/c	0.55	0.75	0.62	0.56	0.66	0.57	0.45	0.64	0.11

Table 5: Capacity Analysis Results for the PM Peak Hour

		Intersection 1 R565 / R556	Intersection 2 R556 / Internal Rd 1	Intersection 3 R556 / Access 1	Intersection 4 R556 / Access 2	Intersection 5 R556 / Access 3	Intersection 6 R556 / Engen Access	Intersection 7 R556 / Sun City Access	Intersection 8 Internal Rd 1 / Internal Rd 2	Intersection 9 Internal Rd 2 / Internal Rd 3
Scenario 1: 2016 PM Peak Hour Traffic Demand with existing geometry	LOS	E	A	A	A	A	A	A	B	A
	Del	45	5	1	1	1	8	4	13	6
Refer to Fig 4 and 5.2	v/c	0.95	0.34	0.27	0.27	0.27	0.48	0.25	0.21	0.04
Scenario 2: 2021 PM Peak Hour Traffic Demand without upgraded geometry	LOS	F	A	A	A	A	B	A	B	A
	Del	66	7	1	1	1	9	4	14	6
Refer to Fig 4 and 6.2	v/c	1.10	0.49	0.31	0.31	0.31	0.67	0.29	0.25	0.05
Scenario 2U: 2021 PM Peak Hour Traffic Demand with upgraded geometry	LOS	A	A	A	A	A	B	A	B	A
	Del	7	7	1	1	1	9	4	14	6
Refer to Fig 7 and 8.2	v/c	0.53	0.49	0.31	0.31	0.31	0.67	0.29	0.25	0.05
Scenario 3: 2021 PM Peak Hour + Development Traffic Demand without upgraded geometry	LOS	B	F	B	A	A	F	B	C	A
	Del	17	>50	13	8	9	>50	4	21	6
Refer to Fig 7 and 11.2	v/c	0.91	>1.5	0.88	0.66	0.77	>1.5	0.63	0.61	0.12
Scenario 3U: 2021 PM Peak Hour + Development Traffic Demand with upgraded geometry	LOS	B	A	B	A	A	B	B	C	A
	Del	17	8	13	8	9	12	4	21	6
Refer to Fig 12 and 13.2	v/c	0.91	0.74	0.88	0.66	0.77	0.80	0.63	0.61	0.12

8. UPGRADES

8.1 BACKGROUND TRAFFIC UPGRADES

The following upgrades were proposed in order to accommodate the 2021 background traffic on the surrounding road network. Refer to **Appendix A, Figure 7**.

Table 6: Upgrades Proposed for the 2021 Background Traffic (Scenario 2)

Intersection	Upgrade Required
Intersection 1: R556 / R565	Convert the all way stop to a two lane circulating roundabout, with an inner diameter of at least 30m

8.2 DEVELOPMENT TRAFFIC UPGRADES

The table below gives a summary of the proposed upgrades required in order to accommodate the development traffic on the road network. Refer to **Appendix A, Figure 12**

Table 7: Upgrades Proposed for the Development Traffic (Scenario 3)

Intersection	Upgrade Required
Intersection 2: R556 / Internal Road 1	Convert the priority stop controlled intersection to a two lane circulating roundabout, with an inner diameter of at least 30m
Intersection 3: R556 / Access 1	Construct a one lane roundabout, with an inner diameter of at least 30m, at the access to the development
Intersection 4: R556 / Access 2	Construct a one lane roundabout, with an inner diameter of at least 30m, at the access to the development
Intersection 5: R556 / Access 3	Construct a one lane roundabout, with an inner diameter of at least 30m, at the access to the development
Intersection 6: R556 / Engen Access	Convert the priority stop controlled intersection to a two lane circulating roundabout with an inner diameter of at least 30m

Intersection	Upgrade Required
Internal Development Roads	Construct all way stop controlled intersections at intersections where class 4 roads intersect; Construct priority stop control intersections at intersections where class 4 and class 5 roads intersect. Priority should be given to traffic on the class 4 road;
Educational Facilities	It is recommended to limit access for at least 500m from the R556 to the school

8.3 MOTIVATION FOR TRAFFIC CIRCLES ON THE R556

A traffic circle is an unconventional traffic control method on class 2 roads. Due to various factors, which will be elaborated on in this section, it is the preferred method in this study. A comparison of traffic signals versus traffic circles was done to motivate this preference over conventional traffic signals.

Area

The area, in which the proposed development is located, is rural with limited access to good road maintenance. Experience in similar areas has shown that there is a high theft and vandalism risk, and several examples exist where traffic signals have been completely removed due to continuous theft and vandalism. These intersections are then converted to four way stops, which has relative low capacity, and often results in drivers ignoring the stop sign.

Capacity and mobility

Traffic signals in general have higher capacity than traffic circles, but due to cable theft, a traffic signal in the area is expected to be non-operational a large percentage of the time. This in effect means that it will operate as four way stop, which has lower capacity than a traffic circle. Progression with traffic signals is better, but they need to be synchronised and it is expected that signal timing plans will not be maintained, removing the benefit for a large percentage of the time.

Considering the current traffic volumes plus additional development volumes, the design life of the single circulating lane traffic circles is at least 10 -15 years, and 15 – 20 years for the two

circulating lane traffic circles, where after it should be upgraded to traffic signalised intersections.

Road Safety

Traffic Circles:

- Fewer overall conflict points, no left turn conflicts and eliminates head on and right angle crashes.
- Reduces crash severities for all users, allow safer merges into circulating traffic, and provide more time for all users to detect and correct for their mistakes or the mistakes of others due to lower vehicles speeds.
- Can accommodate safe U-turn movements that would typically be performed in the area by taxis dropping people off near the development entrances and returning back to where they came from.
- Has the advantage that pedestrians must consider only one direction of conflicting traffic at a time.
- In general, they do present a risk to pedestrians, but due to lower speeds and if designed correctly, the risk and impact of crashes can be reduced.
- Needs to be well lit, with adequate road markings and road studs that indicate a traffic circle even at night.

Traffic Signals:

- With traffic signals the speed during green stages are higher and combined with a high risk of red light violations, serious conflicts can be created.
- Safer for pedestrians due to a protected stage, but considering theft and vandalism in the area, this would be non-operational a large percentage of the time.

Security

At a traffic circle, one does not have to stop, especially at night, which will result in a lower risk of hijackings in this rural area.

Maintenance

Traffic signals require signal hardware or equipment (e.g. signal timing plan maintenance), whereas traffic circles may require landscape maintenance.

Aesthetics

Traffic circles have aesthetic advantages over traffic signals. It provides the opportunity for landscaping and attractive centrepieces to enhance the community. Considering the high tourism activity in the area, traffic circles would specifically be beneficial for their aesthetic properties.

Space

Although traffic circles require more space at the intersection itself than other intersection treatments, they often require less queue storage space on intersection approaches.

Cost

The cost to construct a traffic signal will be approximately R600 000, depending on the proximity of power. In addition turning lanes will have to be constructed of approximately R420 000 per lane. A single circulating traffic circle with minimum inner diameter of 20m will cost approximately R2 000 000, and a two circulating lane traffic circle with and minimum inner diameter of 25m in the vicinity of R3 500 000, subject to location of power for provision of street lights. Estimating 2-3 turning lane requirements for a traffic signal, the construct cost of the two control methods are similar.

9. PUBLIC TRANSPORT AND NON-MOTORISED TRANSPORT

The Ledig township is well served with public transport facilities. Lay-bys are located on both sides of the R556 and are used by buses and mini-bus taxis. A pedestrian crossing is located at intersection 2. A pedestrian sidewalk is located on the northern side of the R556 between the Ledig township and Engen garage. Sidewalks are provided on both sides of the R556 in the Ledig township, enabling pedestrians to safely walk to and from the public transport lay-bys.

9.1 PUBLIC TRANSPORT AND NMT UPGRADES

The following upgrades were proposed in order to accommodate the public transport and non-motorised transport users.

External Upgrades

- Construct public transport lay-bys on R556 within 500m of the proposed development accesses. The lay-bys should be constructed downstream of the intersections;

- Construct sidewalks of at least 1.5m, but preferably 2m wide on the southern side of the R556. These sidewalks should be constructed along the whole southern part of the R556 abutted by the proposed development.

Internal Upgrades

- A pedestrian walkway of at least 1.5m should be provided on all internal roads;
- Provision should be made for a public transport lay-by at the access to the school.

10. CONCLUSIONS AND RECOMMENDATIONS

A mixed land use development is proposed in the Bakubung area. The development is situated to the north of the R556, to the east of the existing Ledig township and to the west of Sun City.

- It is expected that the development will generate 2248vph during the AM peak hour and 2358vph during the PM peak hour;
- It is proposed to construct three traffic circle controlled accesses from the R556 to the development;
- Upgrades to traffic circle control at the R556/R565 intersection is proposed in order to accommodate the background traffic as well as at the R556/Internal Rd 1 and R556/Engen Access intersections in order to accommodate the 2021 background and development traffic;
- Public transport facilities should be constructed on the R556, downstream of the proposed development accesses;
- Sidewalks are proposed on the southern part of the R556 leading to the public transport lay-bys;
- Given that the proposed upgrades are in place, it can be recommended that the development should be considered favourably from a traffic engineering point of view.

11. REFERENCES

[1] Committee of Transport Officials (COTO) Technical Methods for Highways (TMH 17) Volume 1, *South African Trip Data Manual,* September 2012.

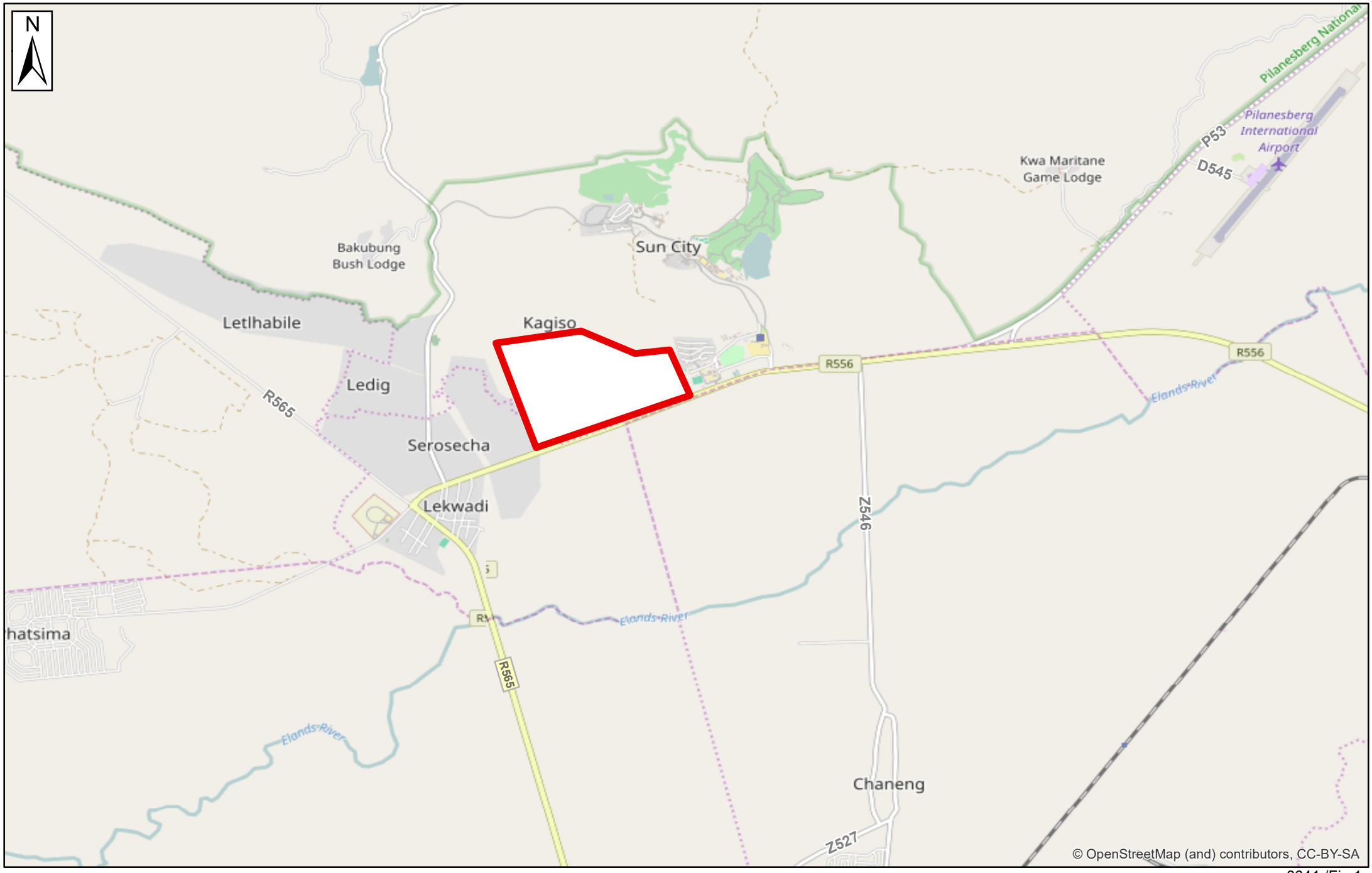
[2] National Guidelines for Road Access Management in South Africa (RAM), October 2005

[3] Committee of Transport Officials (COTO) Technical Methods for Highways (TMH 16) Volume 2, *South African Traffic Impact and Site Traffic Assessment Standards and Requirements Manual*, August 2012.

APPENDIX A

Figures

List of Figures



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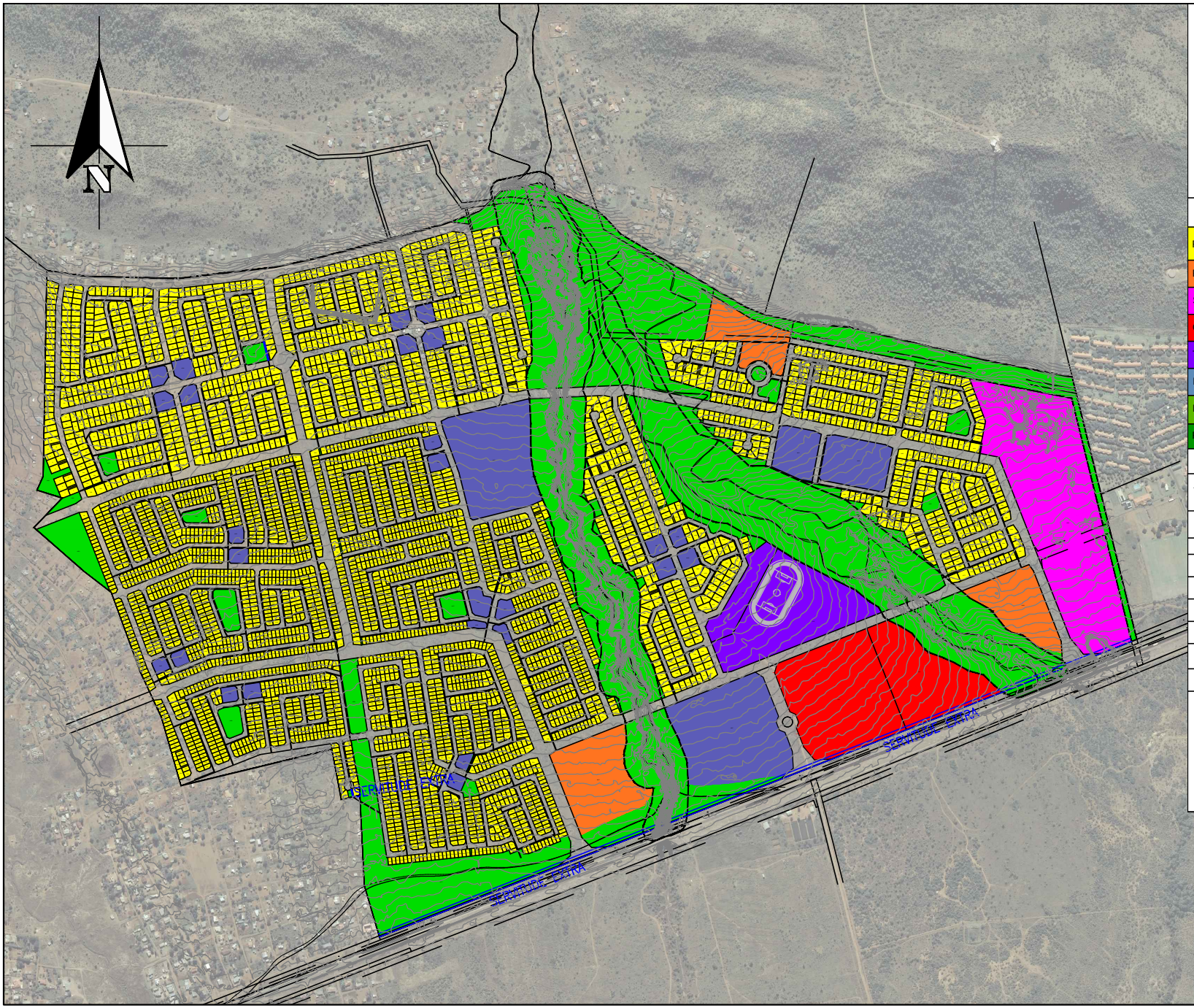
PROJECT:	FIGURE:	NO:
BAKUBUNG LEDIG DEVELOPMENT	LOCALITY MAP	1



PROPOSED TOWNSHIP ESTABLISHMENT:

A Portion of the Remaining Extent of the Farm Ledig 909, J.R., North West Province

LAND USE	NUMBER	ERF NO.	AREA (ha)	%
Residential 6	4604	1 -4604	131.08	36.34%
Residential 30	4	4605-4608	10.058	1%
Special	1	4609	14.39	5%
Commercial	2	4610	12 334.84	2%
Tourism	2	4611, 4612	7.99	2%
Business	30	4613-4635, 4637-4643	21.74	6%
Parks	39	4644-4682	81.02	3%
Roads			81.84	22.76%
Total	4682		361	100

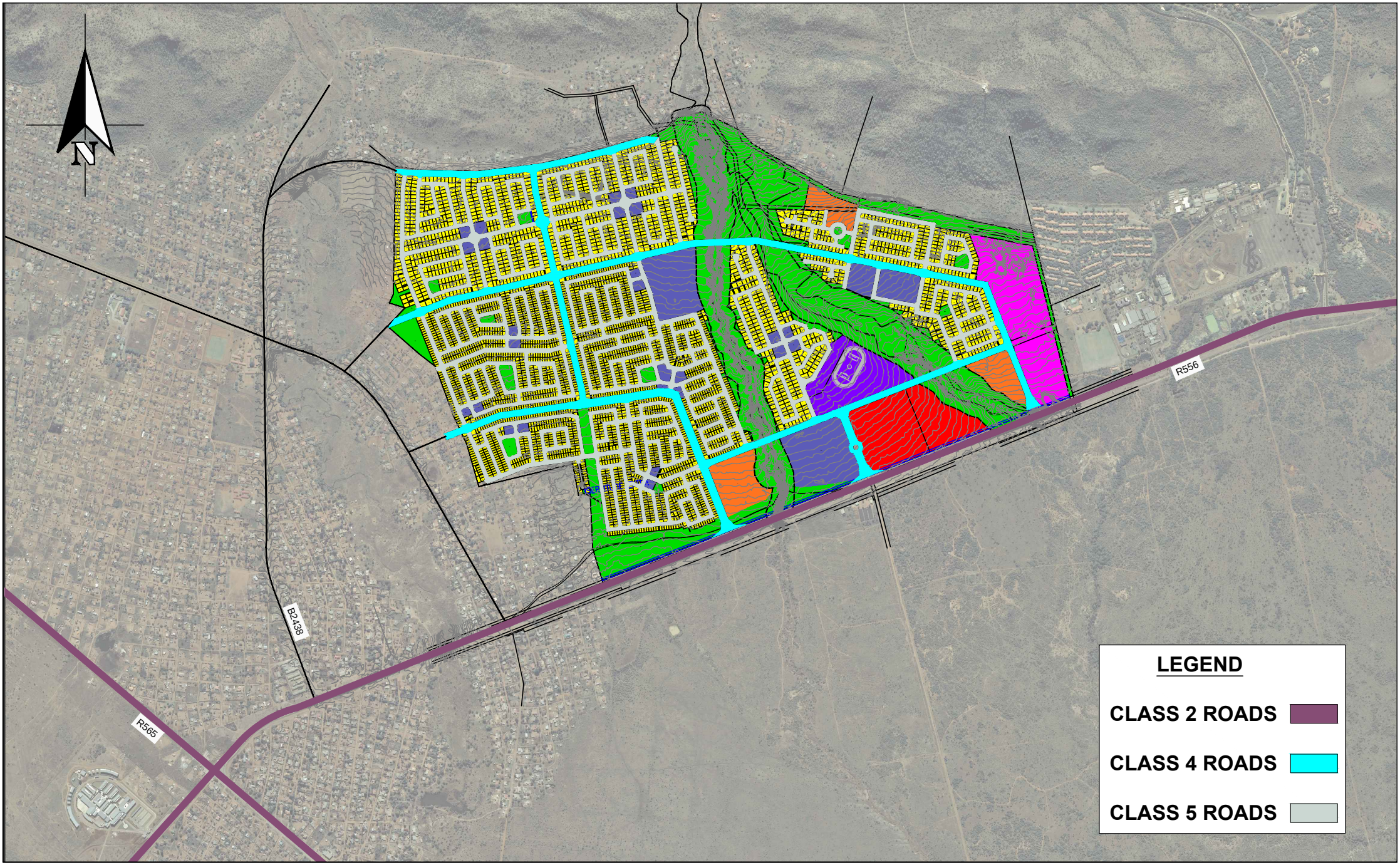
LAYOUT PLAN

	NAME:	SIGNATURE:
DESIGNED:	Wilhelm Rost	
DRAWN:	Yolande Scheepers	
CHECKED:	Wilhelm Rost	
SCALE:	1:2 500	
DATE:	2016/08/17	
DRAWING No.:	TE166_Ledig_Rev3	

TOWNSCAPE PLANNING SOLUTIONS
5 Dahlia St
Potchefstroom
2531
Tel : 082 662 1105
Fax : 018 290 8014

its (PTY) LTD Engineers

PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	DEVELOPMENT PLAN	2



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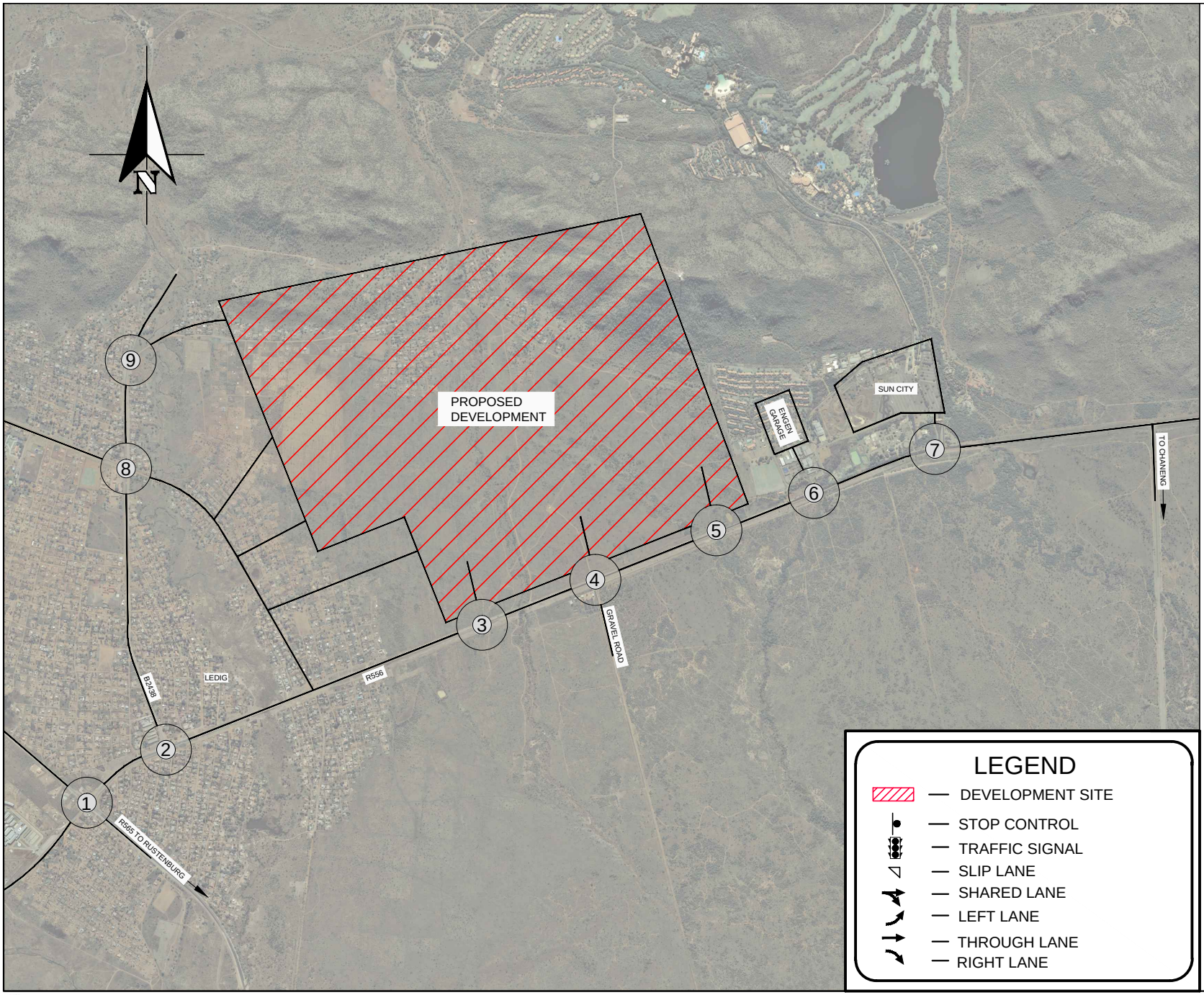
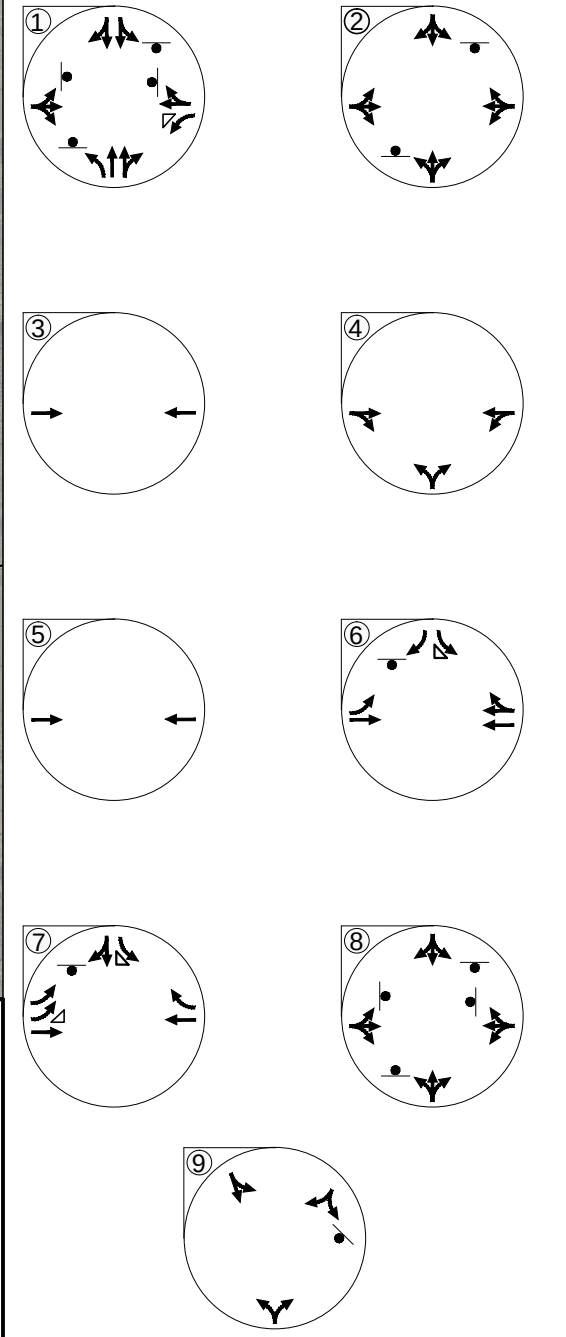
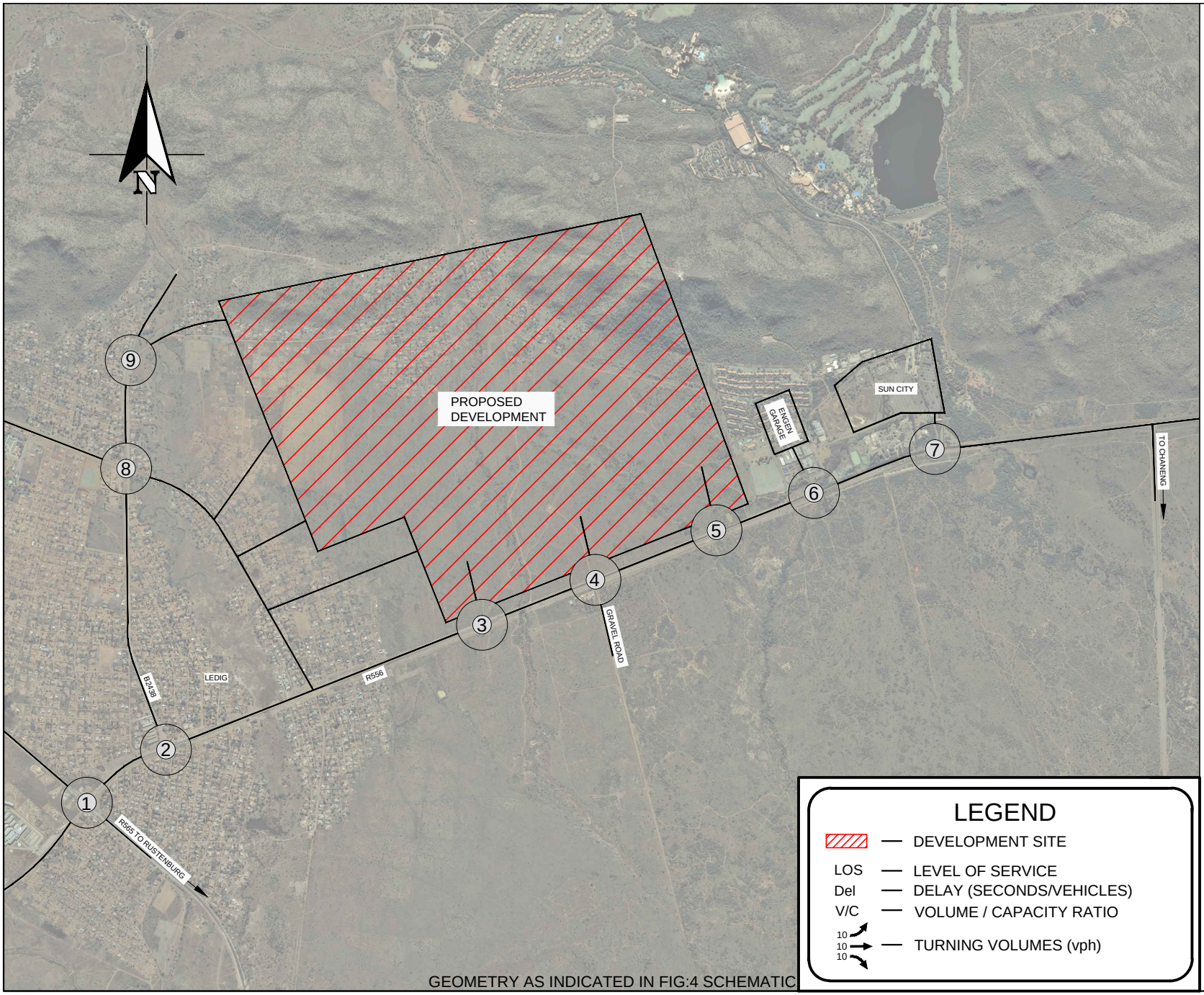
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	ROAD HIERARCHY PLAN	3

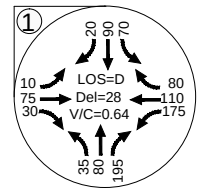


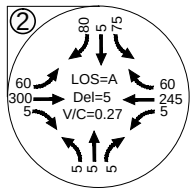


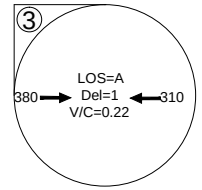
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	EXISTING INTERSECTION GEOMETRY AND CONTROL	4

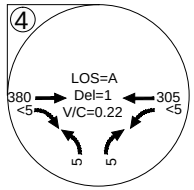


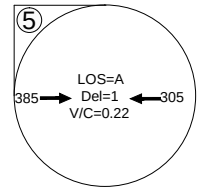
GEOMETRY AS INDICATED IN FIG:4 SCHEMATIC

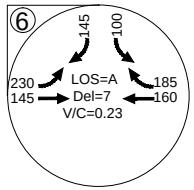


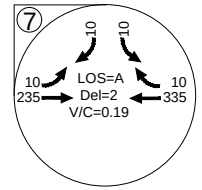


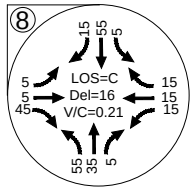


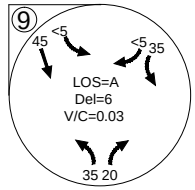












LEGEND

- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

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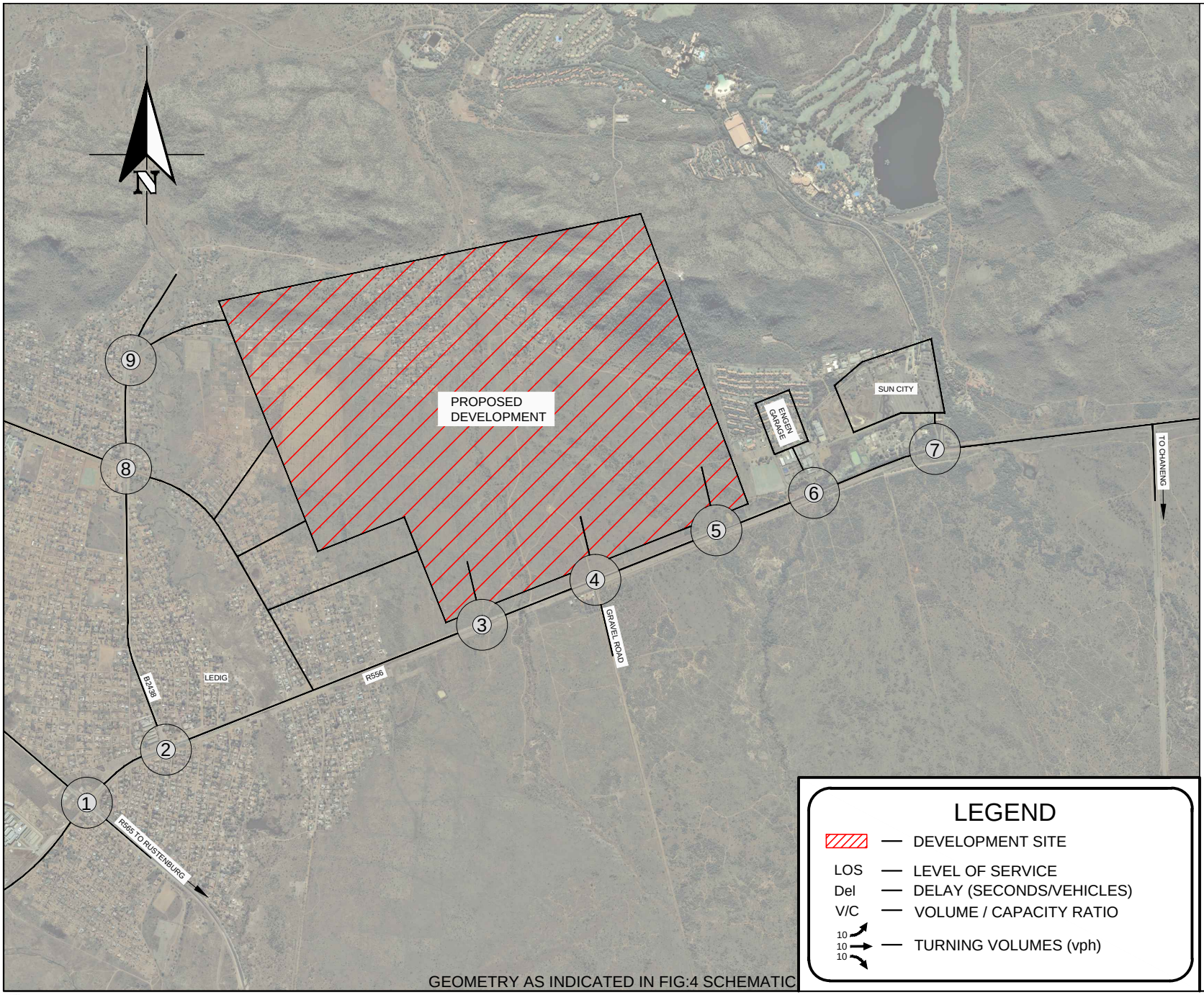
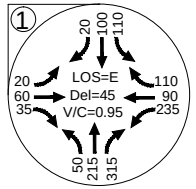
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2016 AM PEAK HOUR TRAFFIC VOLUMES WITH EXISTING GEOMETRY AND CAPACITY ANALYSIS RESULTS	5.1

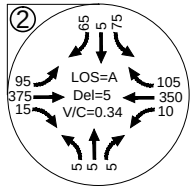


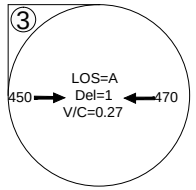
GEOMETRY AS INDICATED IN FIG:4 SCHEMATIC

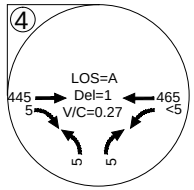
LEGEND

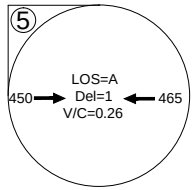
- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

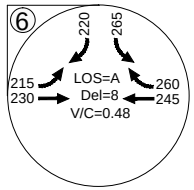


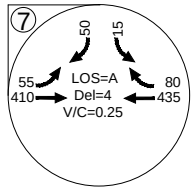


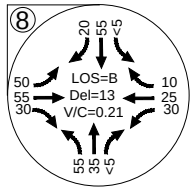


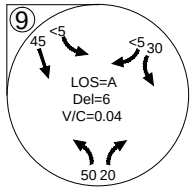






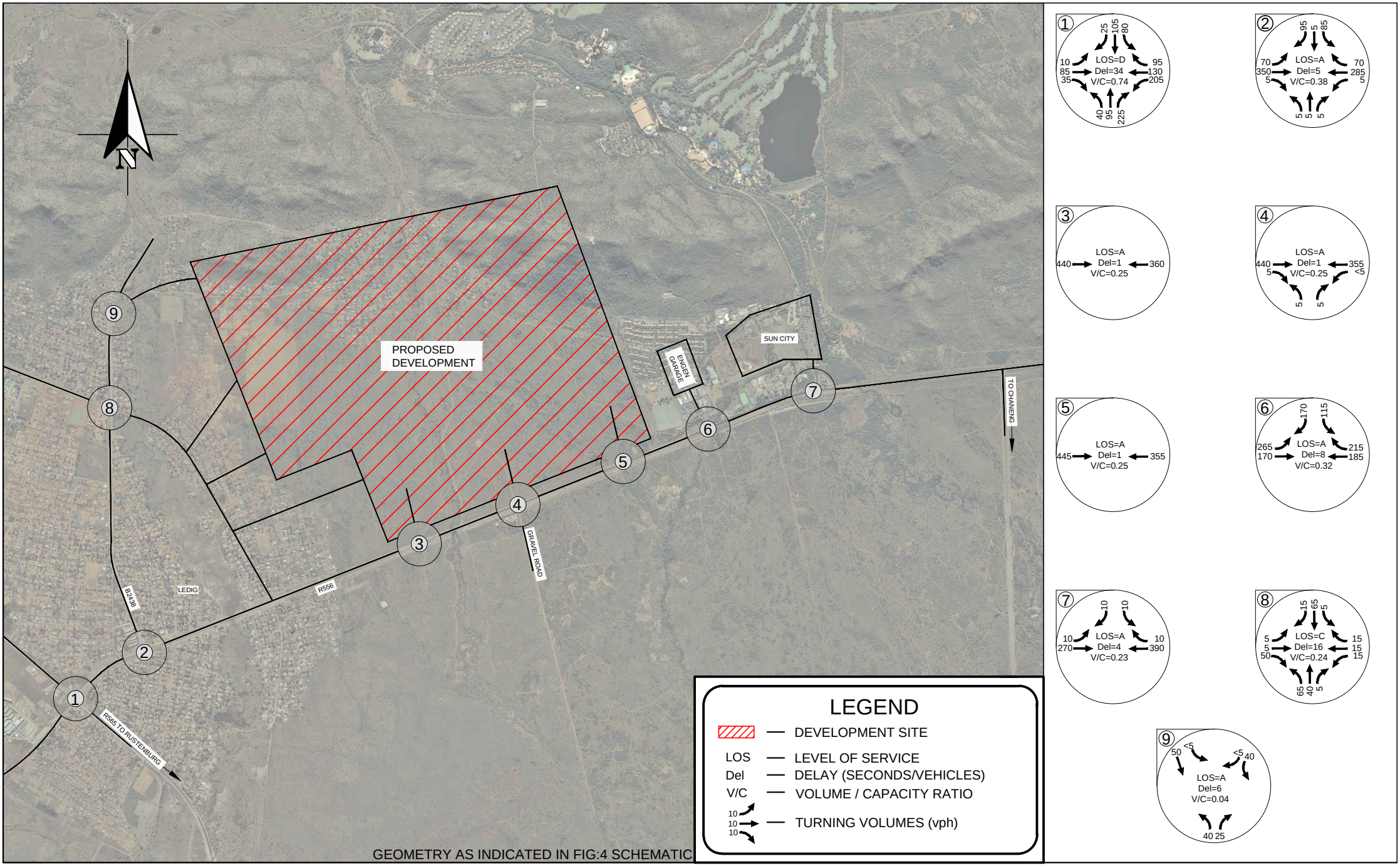




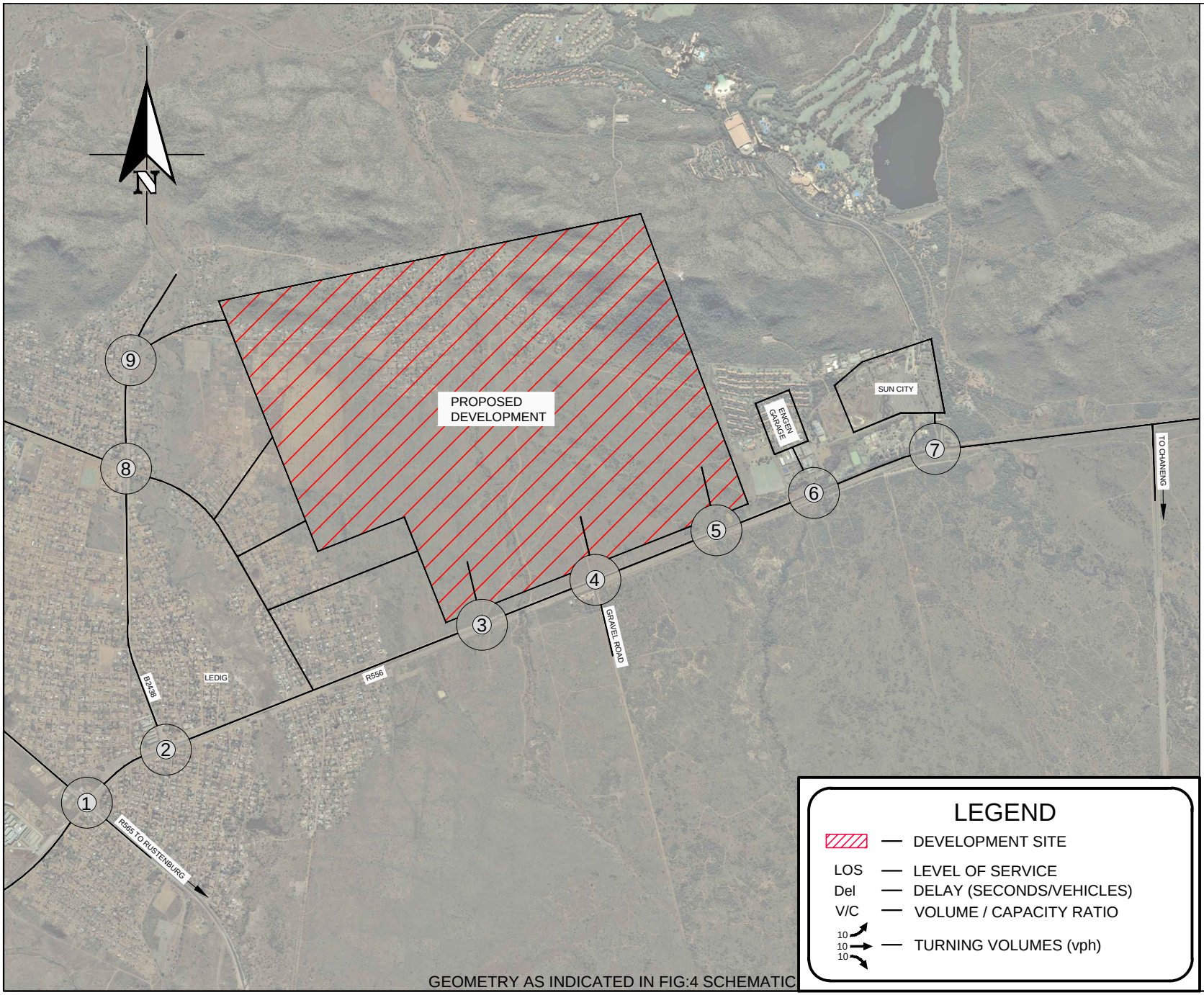


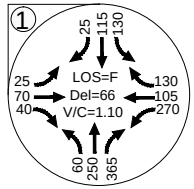
Engineers

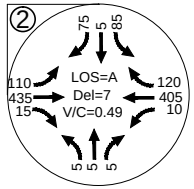
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2016 PM PEAK HOUR TRAFFIC VOLUMES WITH EXISTING GEOMETRY AND CAPACITY ANALYSIS RESULTS	5.2

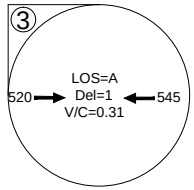


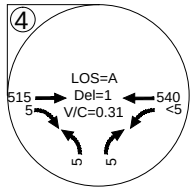
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 AM PEAK HOUR TRAFFIC VOLUMES WITH EXISTING GEOMETRY AND CAPACITY ANALYSIS RESULTS	6.1

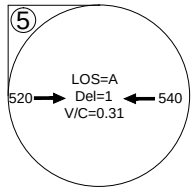


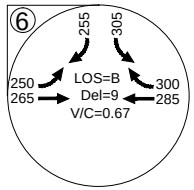


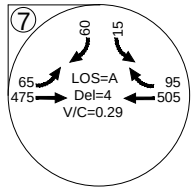


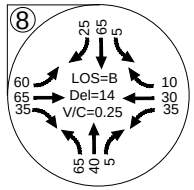


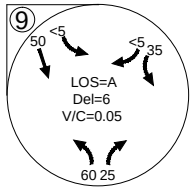










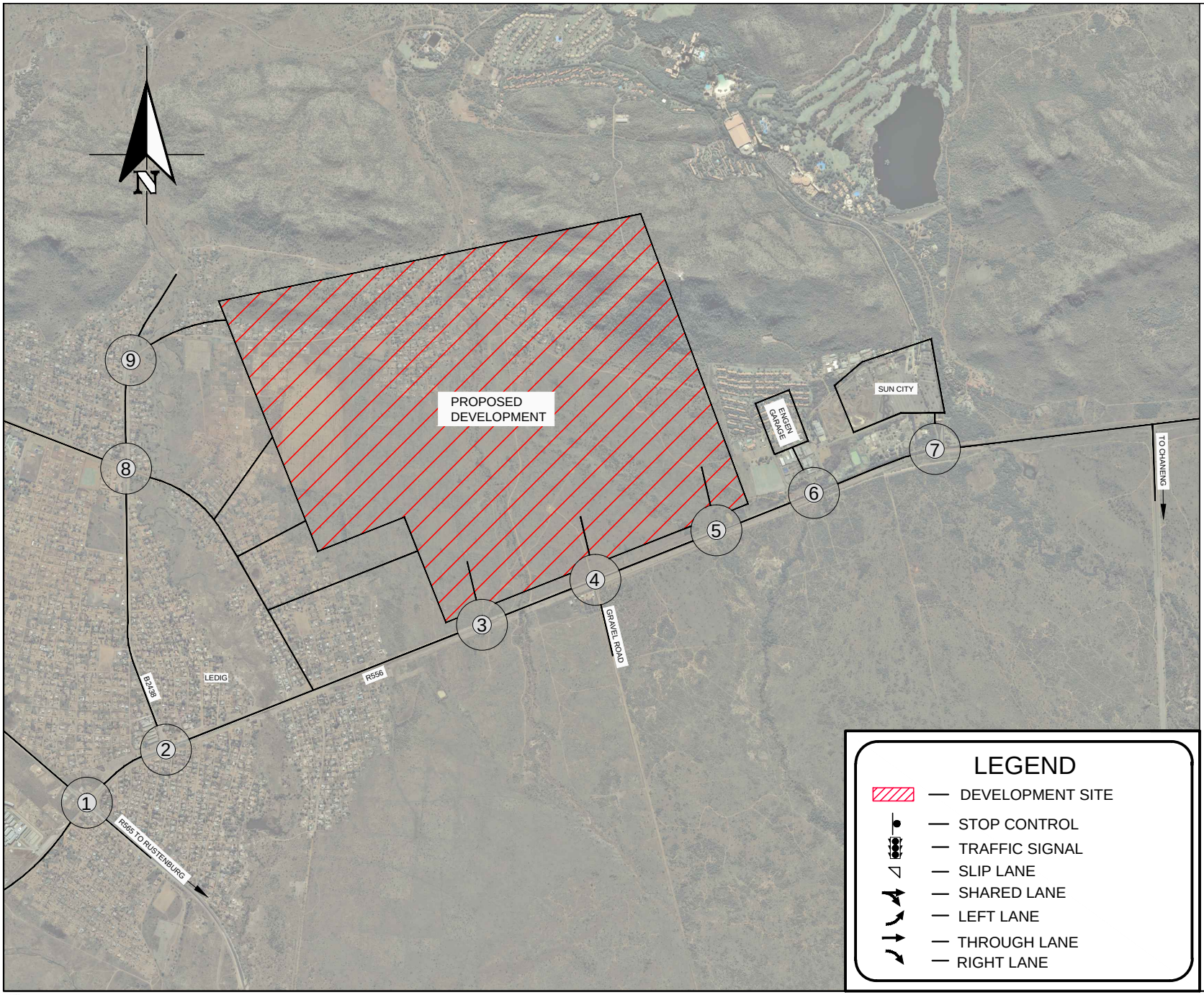


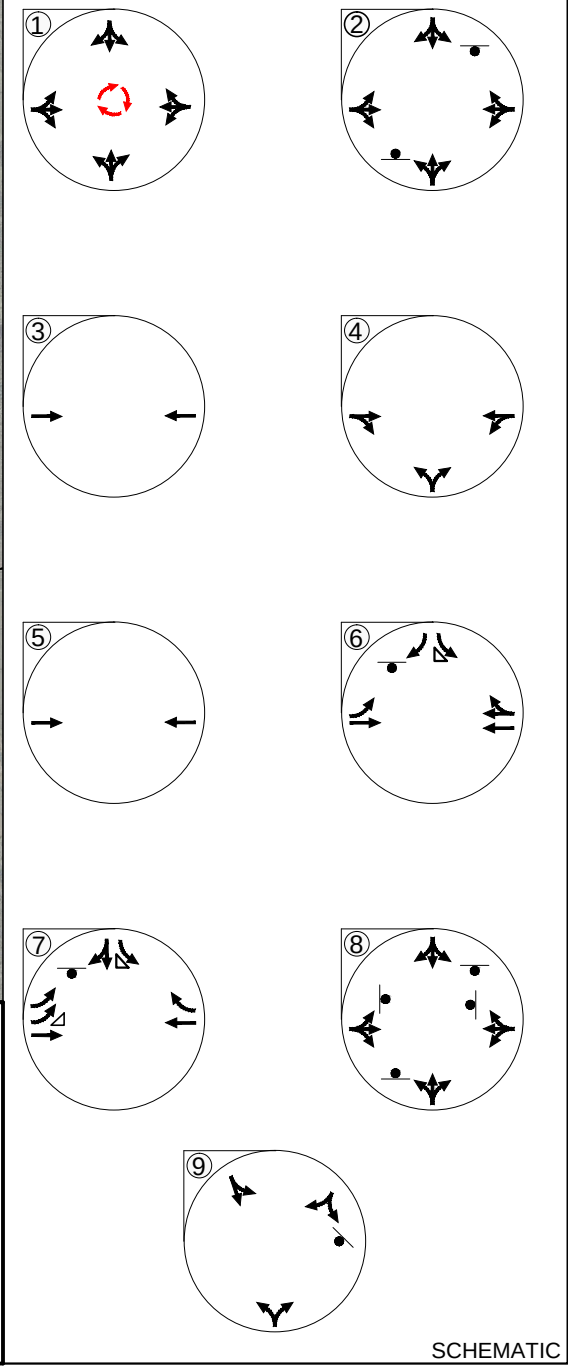
LEGEND

- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

its (PTY) LTD Engineers

PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 PM PEAK HOUR TRAFFIC VOLUMES WITH EXISTING GEOMETRY AND CAPACITY ANALYSIS RESULTS	6.2





LEGEND

- DEVELOPMENT SITE
- STOP CONTROL
- TRAFFIC SIGNAL
- SLIP LANE
- SHARED LANE
- LEFT LANE
- THROUGH LANE
- RIGHT LANE

SCHEMATIC

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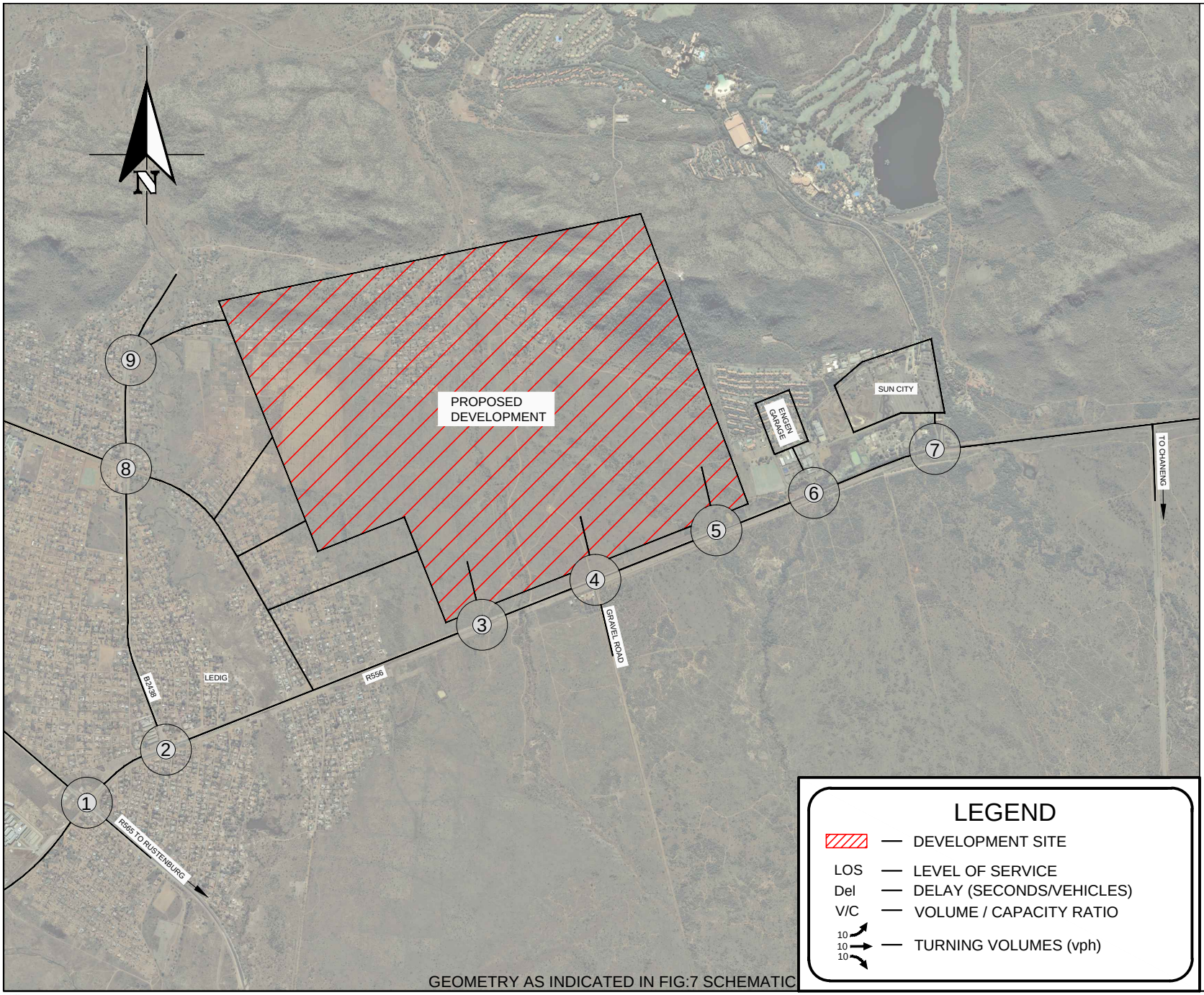
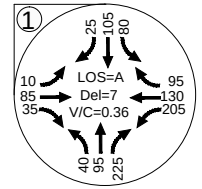
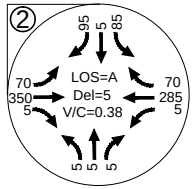
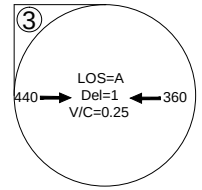
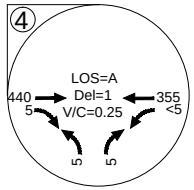
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	PROPOSED INTERSECTION GEOMETRY AND CONTROL FOR THE 2021 BACKGROUND TRAFFIC	7

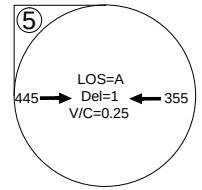


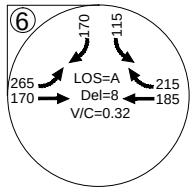


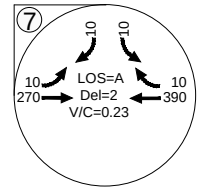


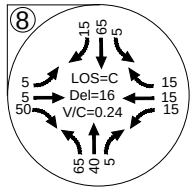


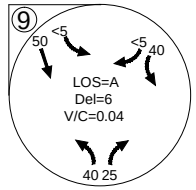












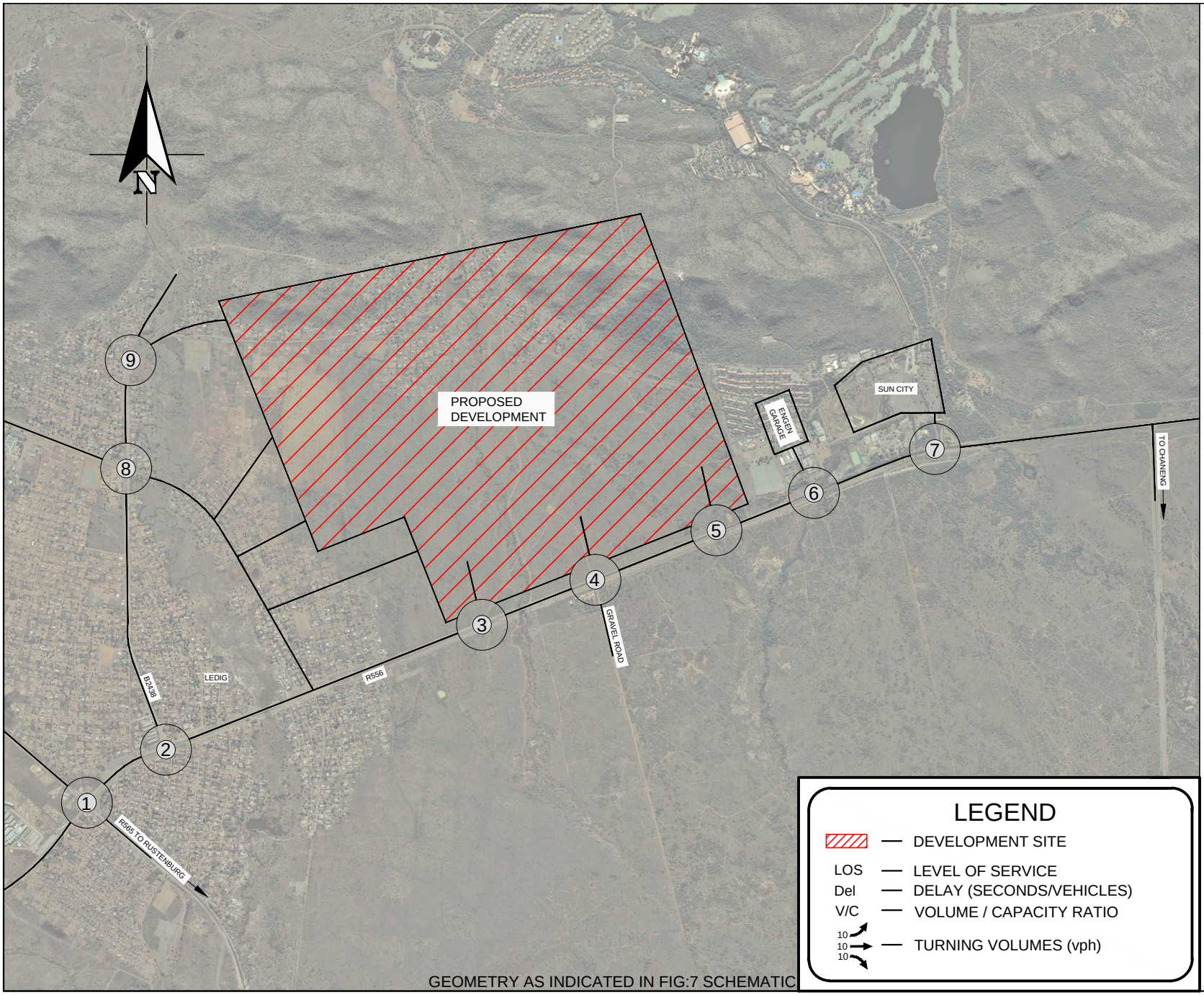
LEGEND

- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

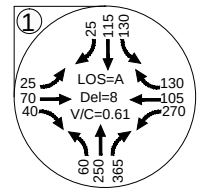
GEOMETRY AS INDICATED IN FIG:7 SCHEMATIC

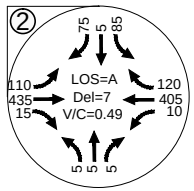
its (PTY) LTD Engineers

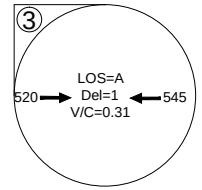
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 AM PEAK HOUR TRAFFIC VOLUMES WITH UPGRADED GEOMETRY AND CAPACITY ANALYSIS RESULTS	8.1

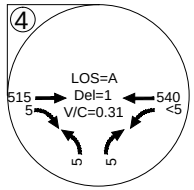


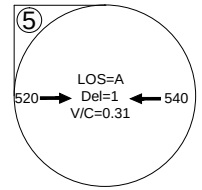
GEOMETRY AS INDICATED IN FIG:7 SCHEMATIC

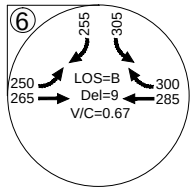


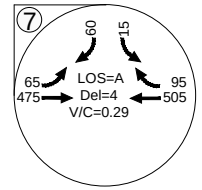


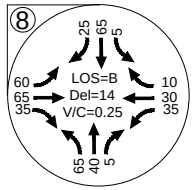


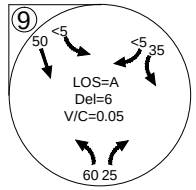










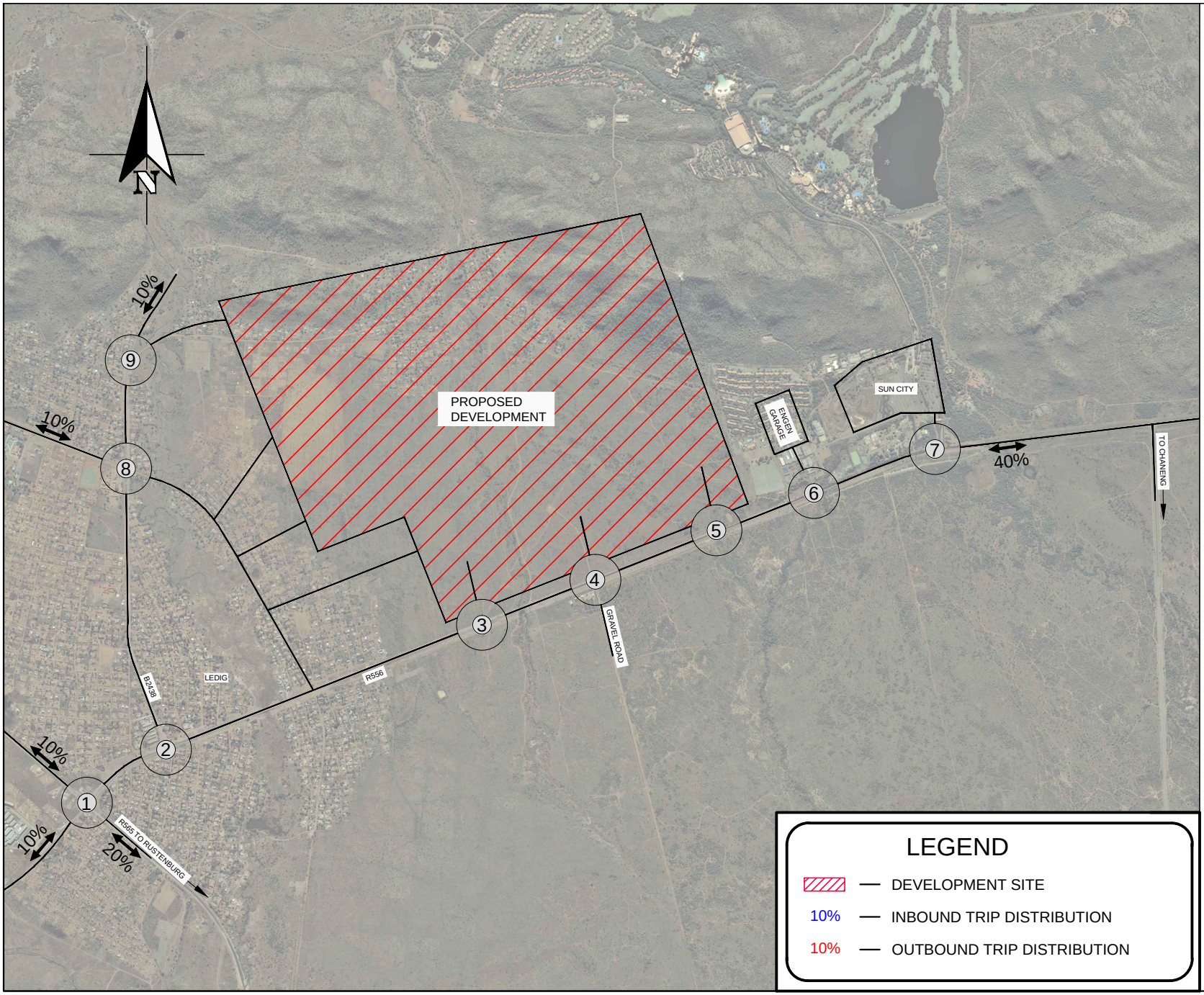


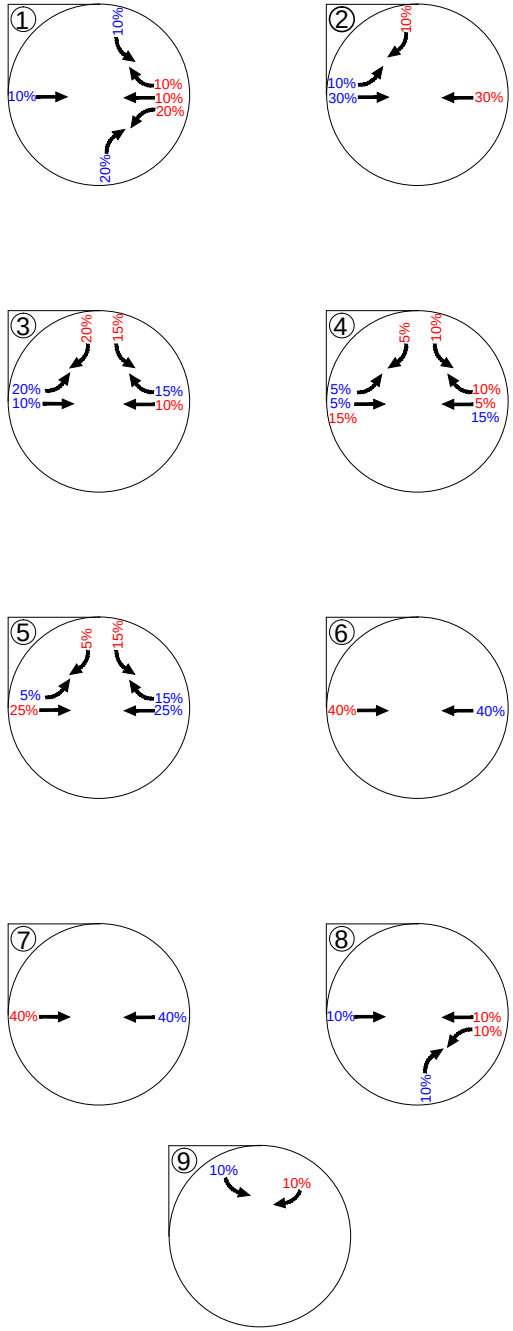
LEGEND

- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

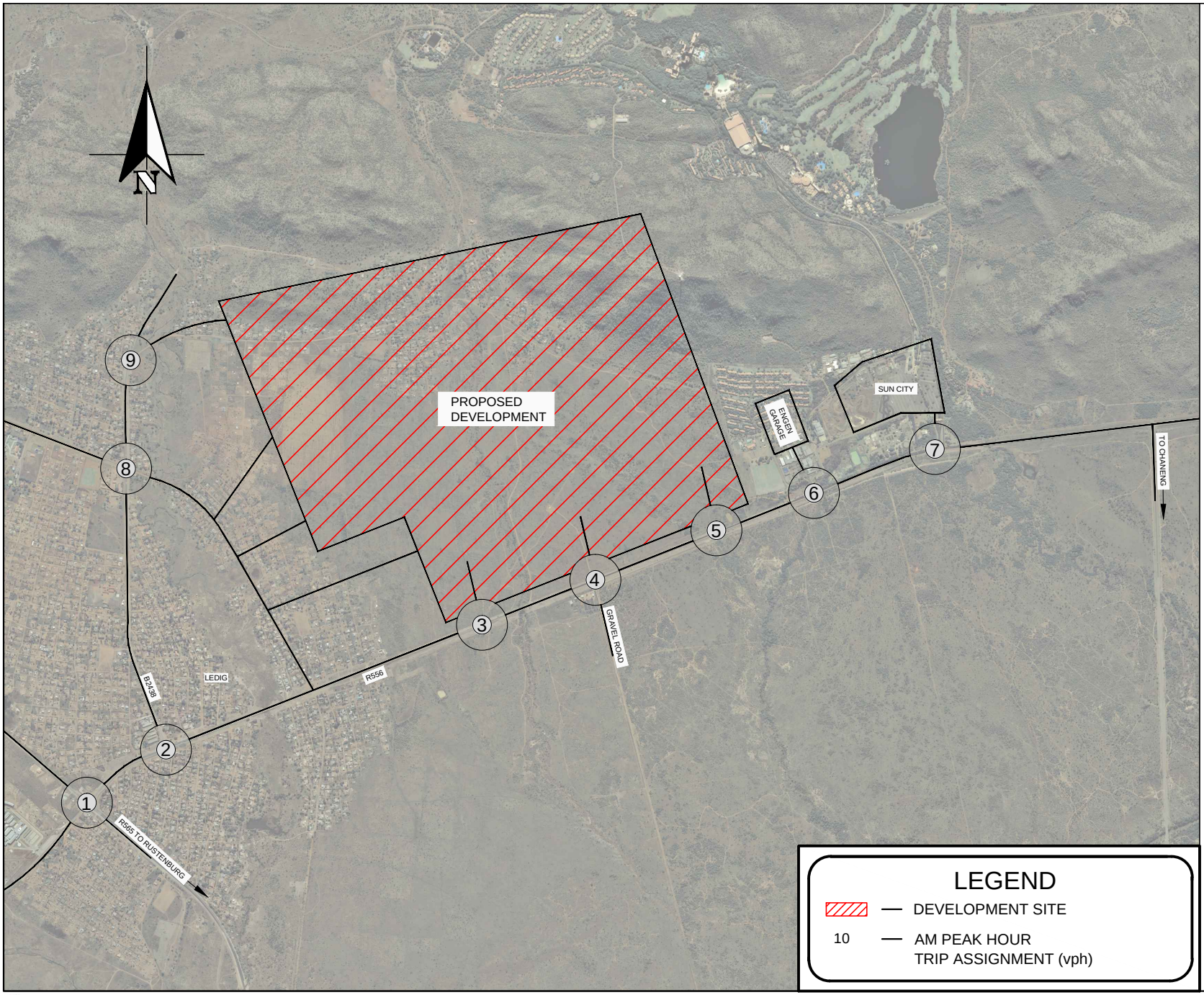
its (PTY) LTD Engineers

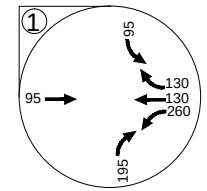
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 PM PEAK HOUR TRAFFIC VOLUMES WITH UPGRADED GEOMETRY AND CAPACITY ANALYSIS RESULTS	8.2

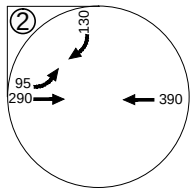


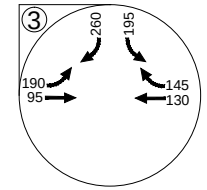


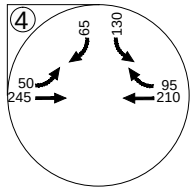
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	TRIP DISTRIBUTION	9

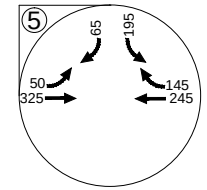


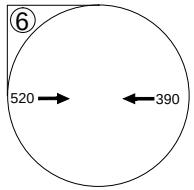


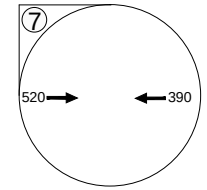


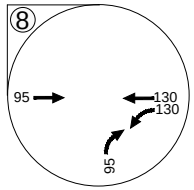


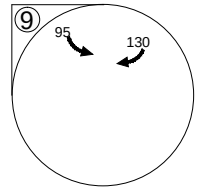












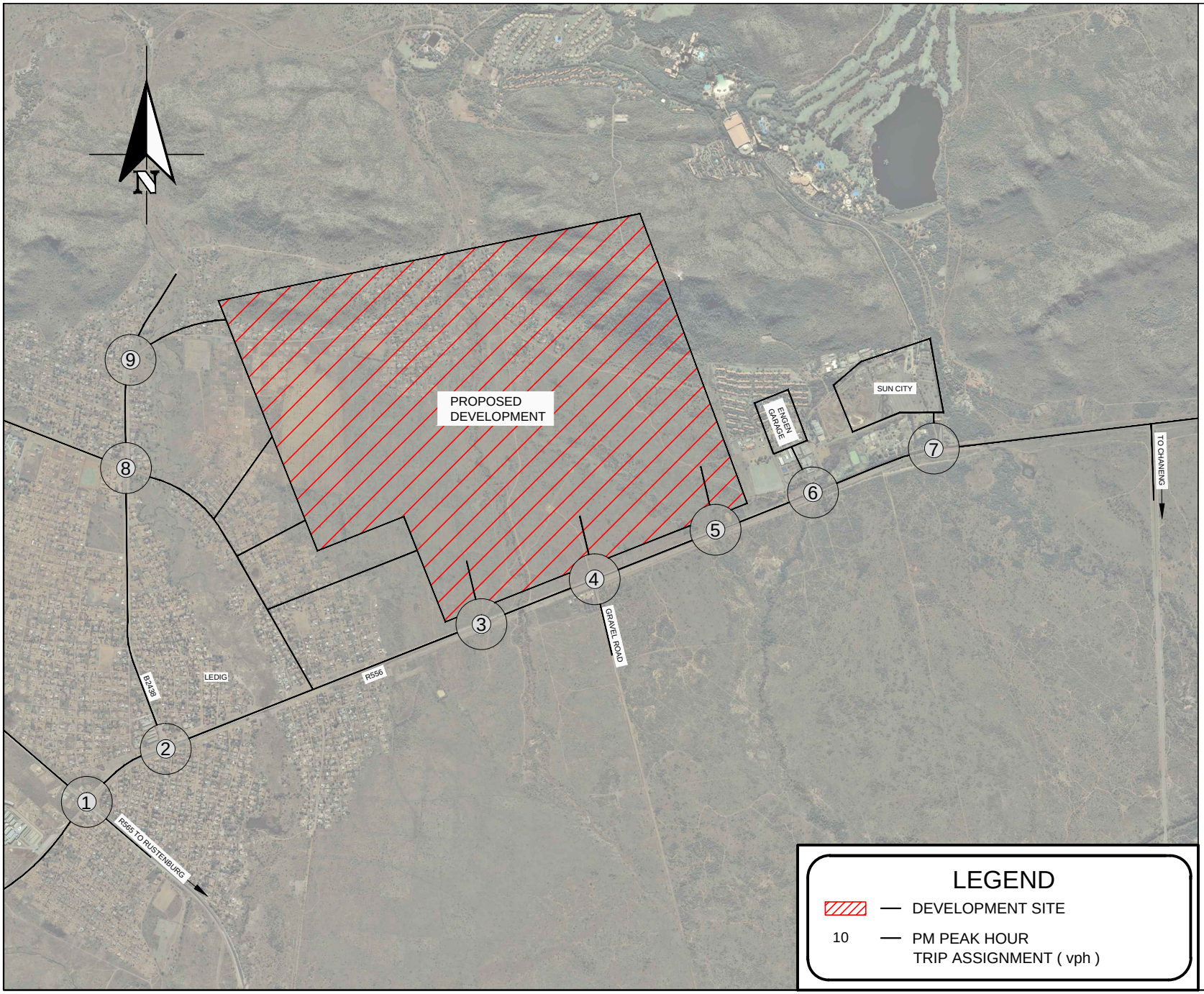
LEGEND

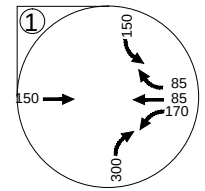
DEVELOPMENT SITE

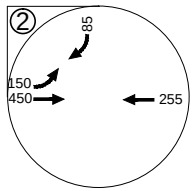
10 — AM PEAK HOUR TRIP ASSIGNMENT (vph)

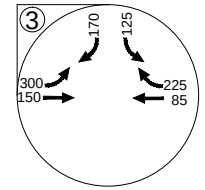
its (PTY) LTD Engineers

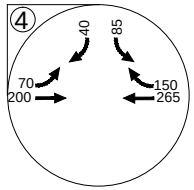
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	AM PEAK HOUR TRIP ASSIGNMENT	10.1

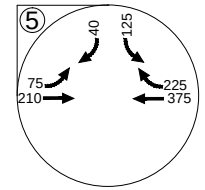


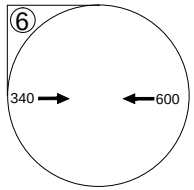


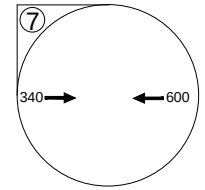


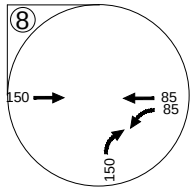


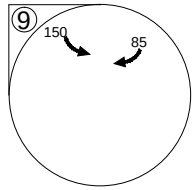












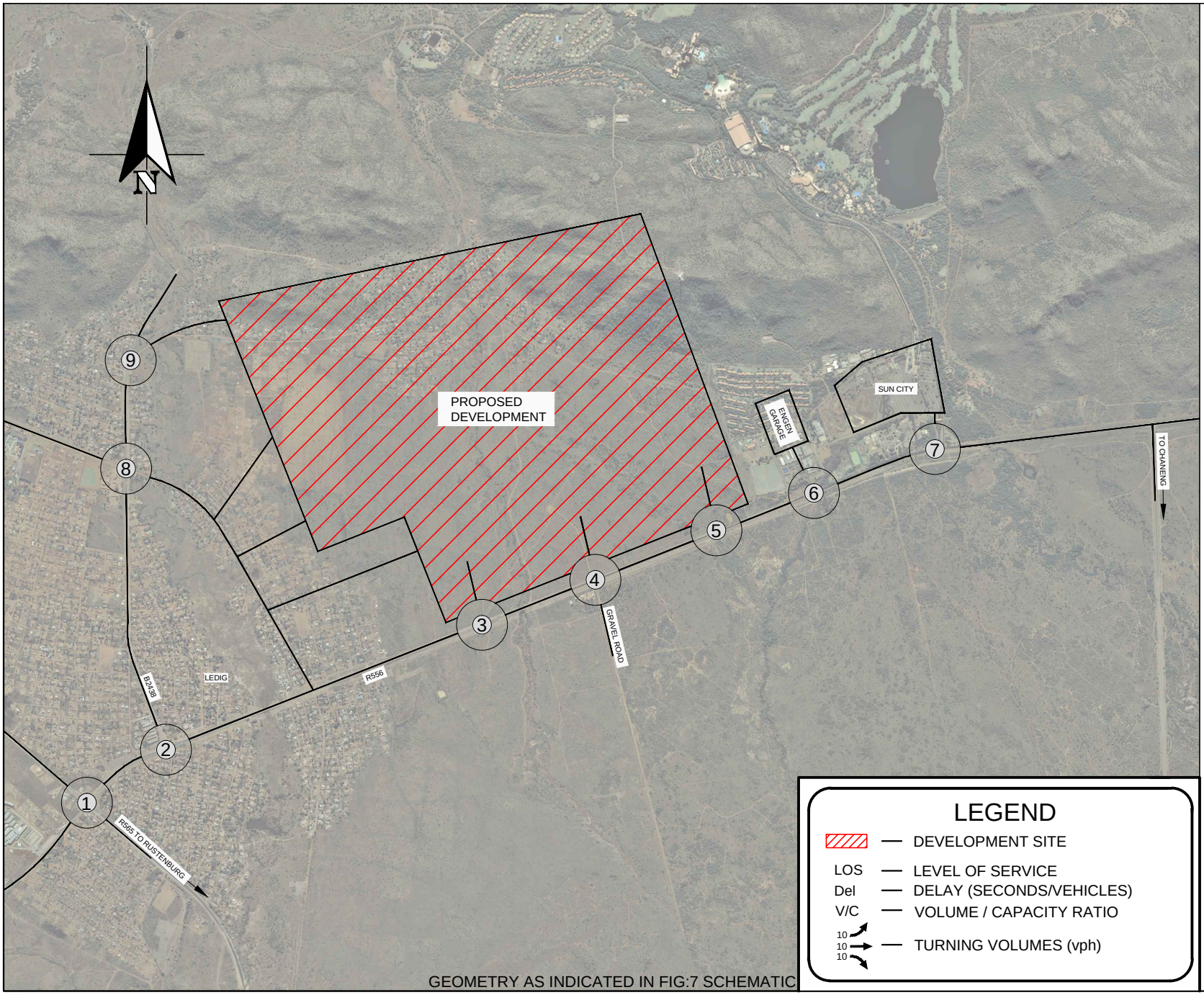
LEGEND

DEVELOPMENT SITE

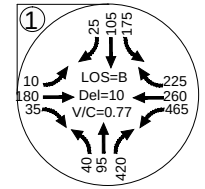
10 — PM PEAK HOUR TRIP ASSIGNMENT (vph)

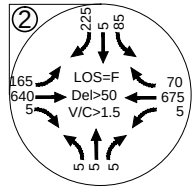
its (PTY) LTD Engineers

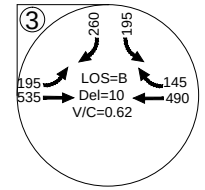
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	PM PEAK HOUR TRIP ASSIGNMENT	10.2

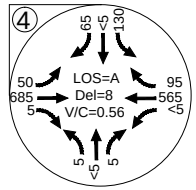


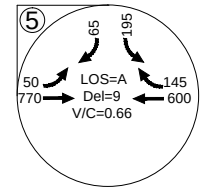
GEOMETRY AS INDICATED IN FIG:7 SCHEMATIC

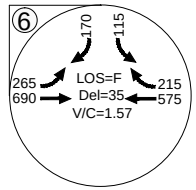


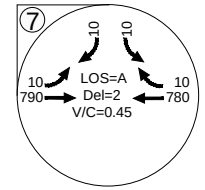


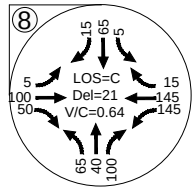


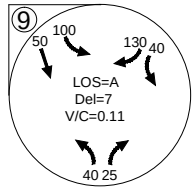










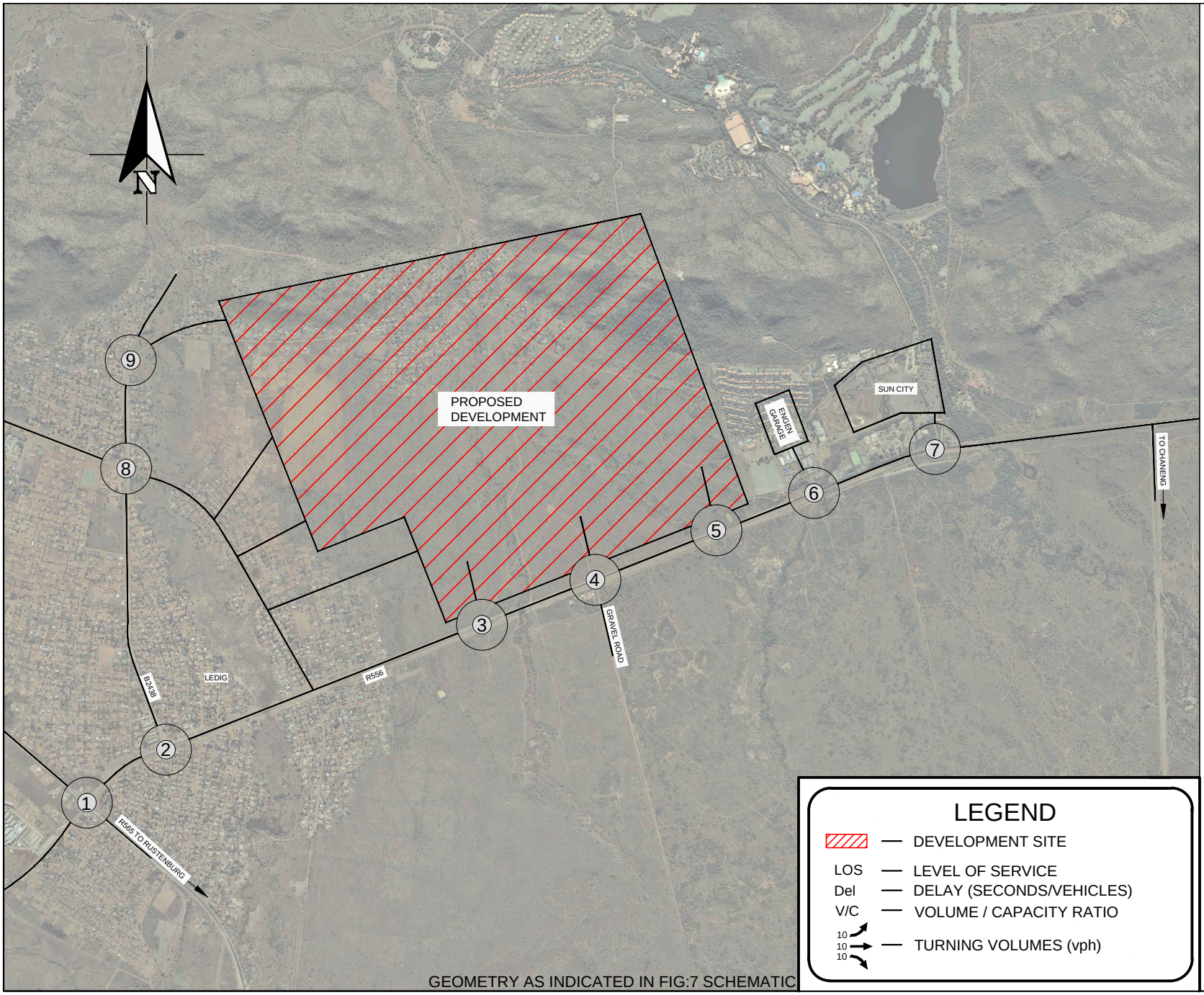


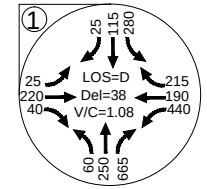
LEGEND

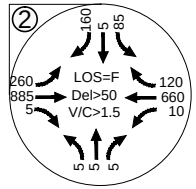
- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

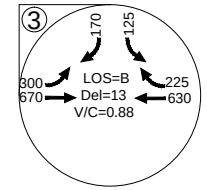
its (PTY) LTD Engineers

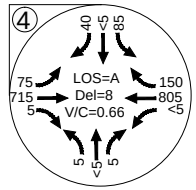
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 AM PEAK HOUR + DEVELOPMENT TRAFFIC VOLUMES WITHOUT UPGRADED GEOMETRY AND CAPACITY ANALYSIS RESULTS	11.1

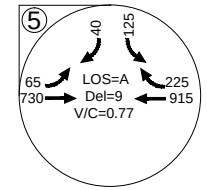


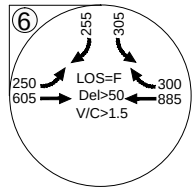


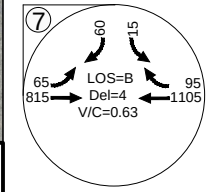


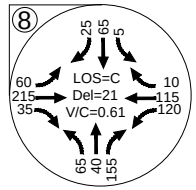


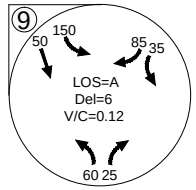




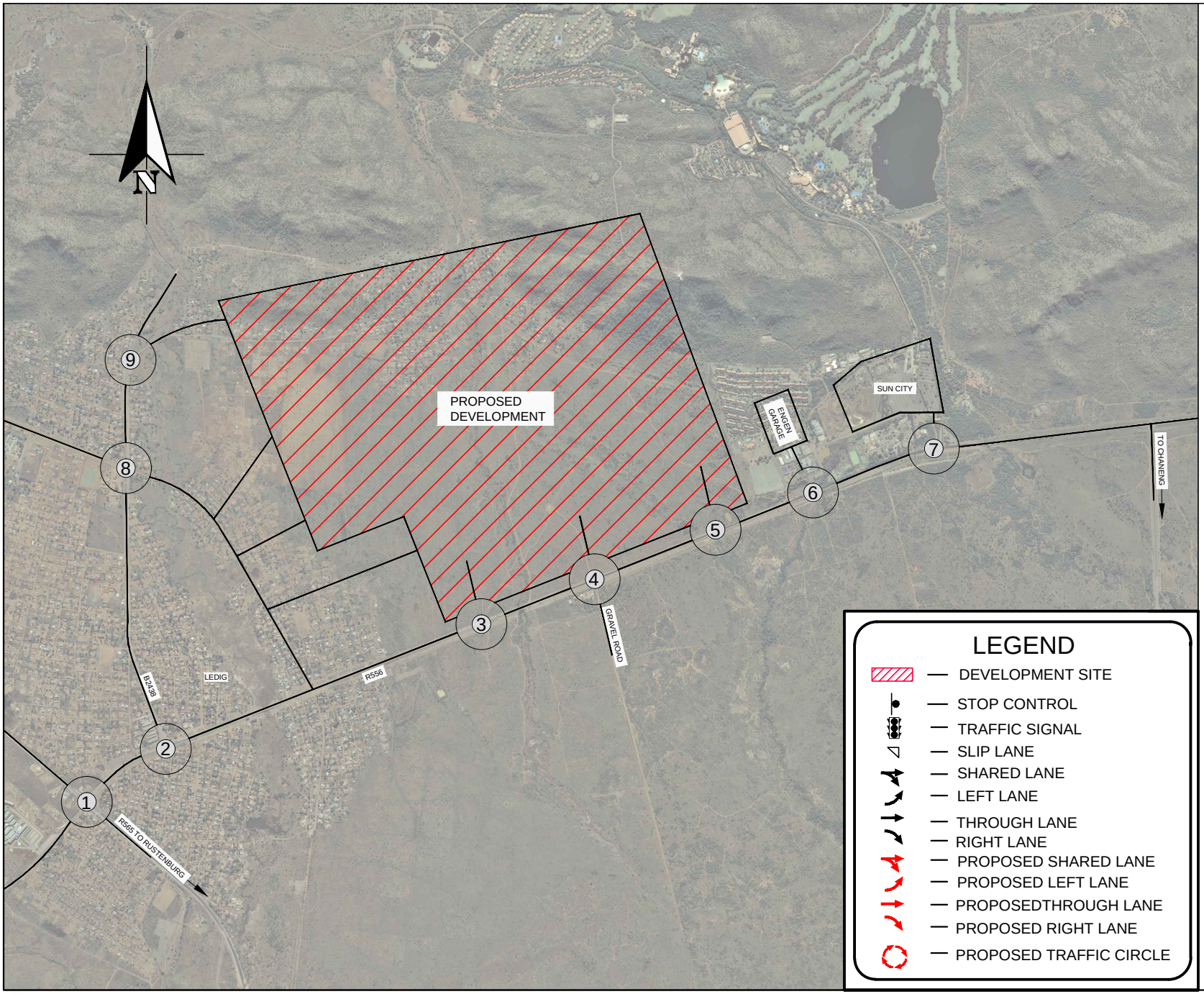






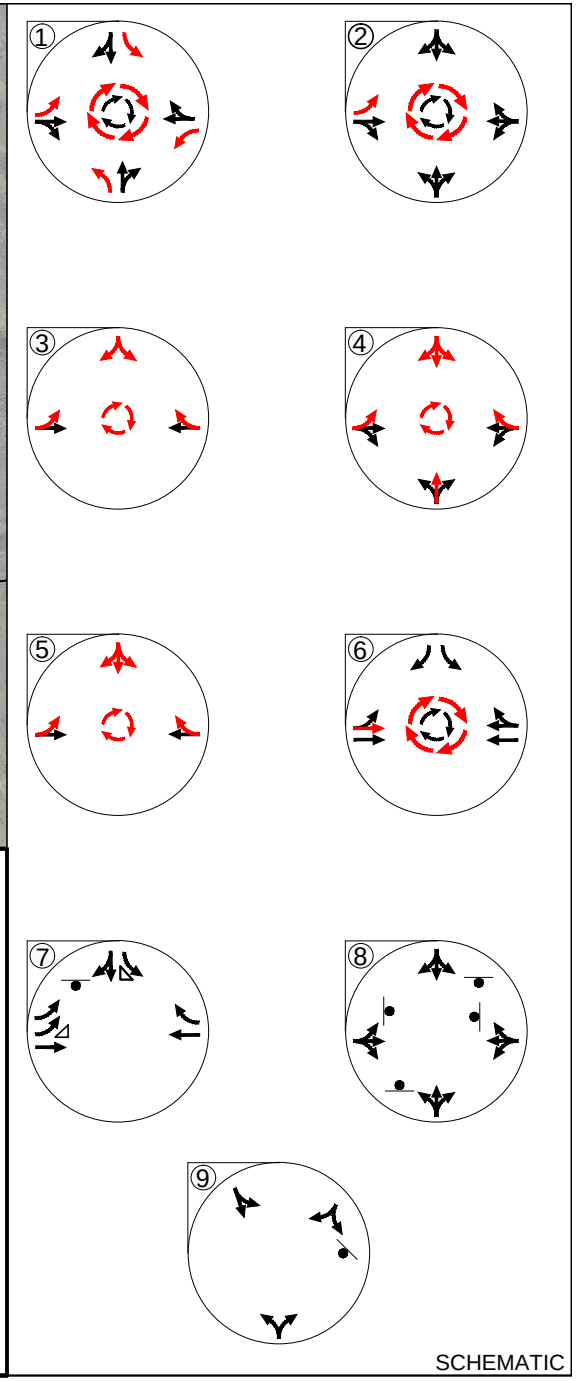


PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 PM PEAK HOUR + DEVELOPMENT TRAFFIC VOLUMES WITHOUT UPGRADED GEOMETRY AND CAPACITY ANALYSIS RESULTS	11.2



LEGEND

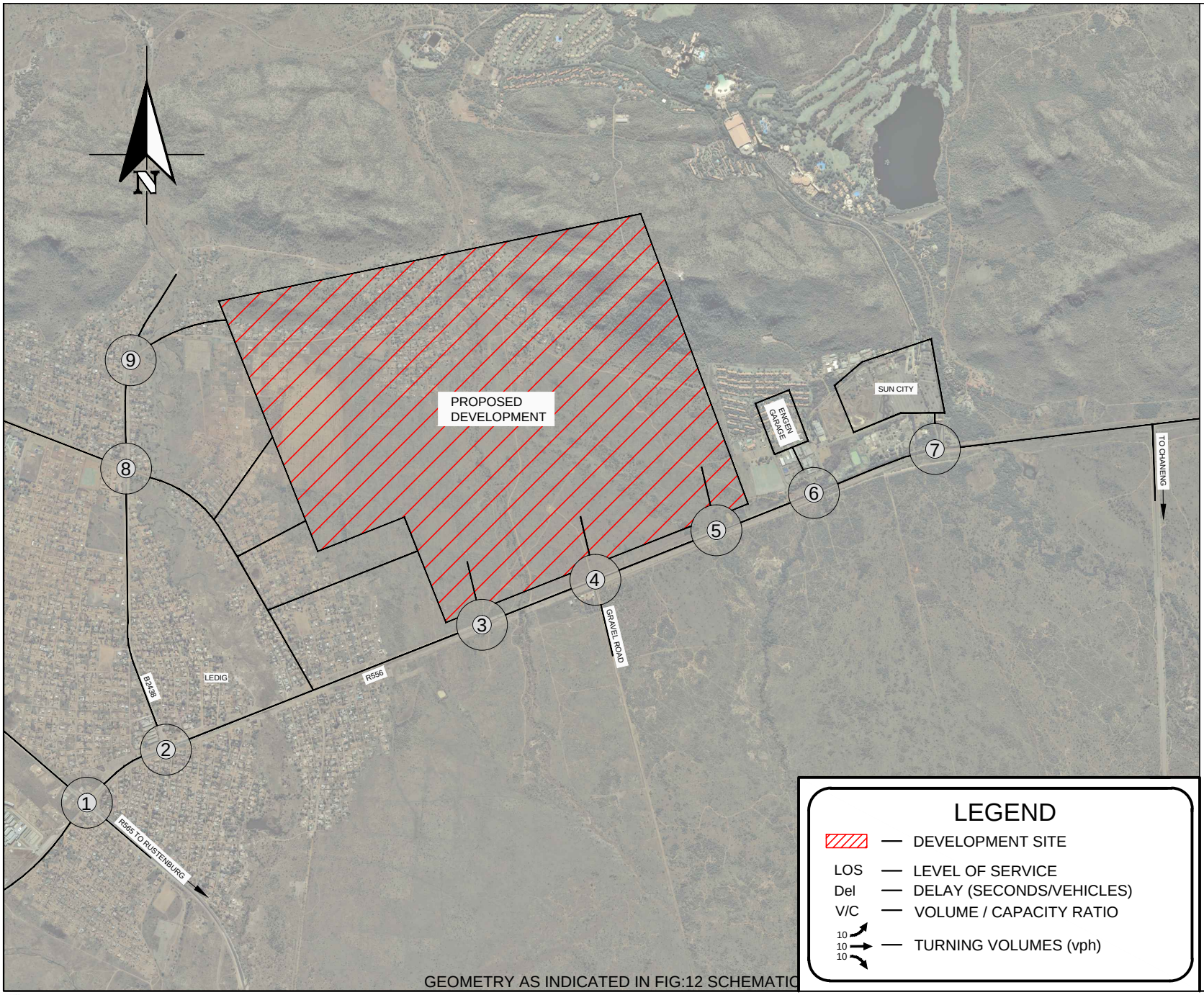
- DEVELOPMENT SITE
- STOP CONTROL
- TRAFFIC SIGNAL
- SLIP LANE
- SHARED LANE
- LEFT LANE
- THROUGH LANE
- RIGHT LANE
- PROPOSED SHARED LANE
- PROPOSED LEFT LANE
- PROPOSEDTHROUGH LANE
- PROPOSED RIGHT LANE
- PROPOSED TRAFFIC CIRCLE

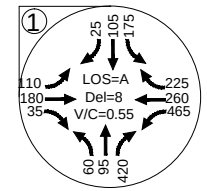


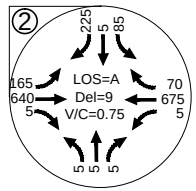
SCHEMATIC

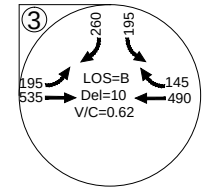
its (PTY) LTD Engineers

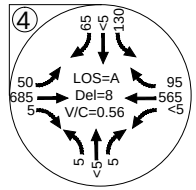
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	PROPOSED INTERSECTION GEOMETRY AND CONTROL FOR THE DEVELOPMENT TRAFFIC	12

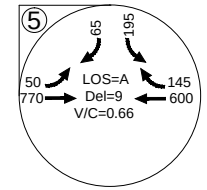


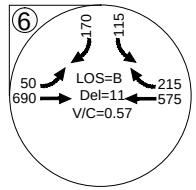


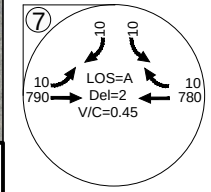


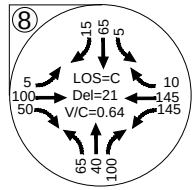


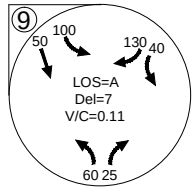












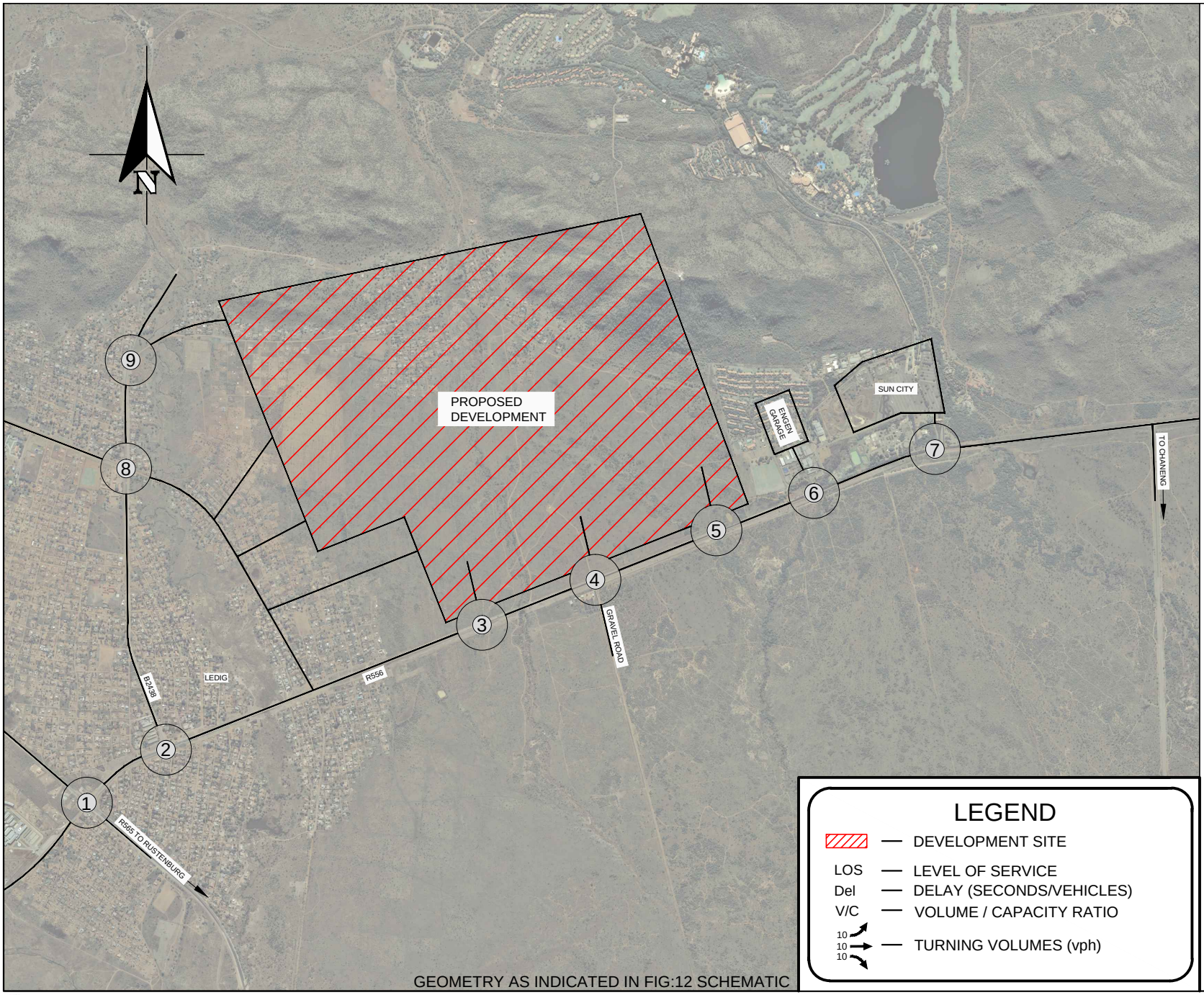
LEGEND

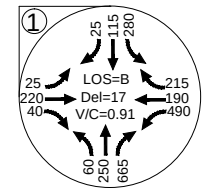
- DEVELOPMENT SITE
- LOS — LEVEL OF SERVICE
- Del — DELAY (SECONDS/VEHICLES)
- V/C — VOLUME / CAPACITY RATIO
- 10 / 10 / 10 — TURNING VOLUMES (vph)

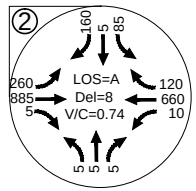
GEOMETRY AS INDICATED IN FIG:12 SCHEMATIC

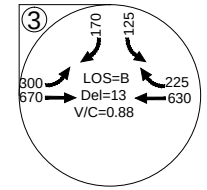
its (PTY) LTD Engineers

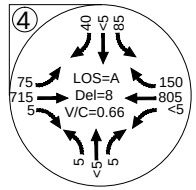
PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 AM PEAK HOUR + DEVELOPMENT TRAFFIC VOLUMES WITH UPGRADED GEOMETRY AND CAPACITY ANALYSIS RESULTS	13.1

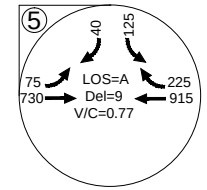


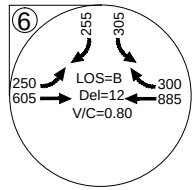


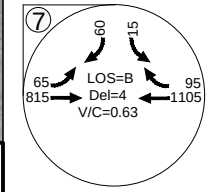


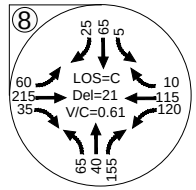


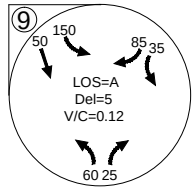












PROJECT:	FIGURE:	NUMBER:
BAKUBUNG - LEDIG DEVELOPMENT	2021 PM PEAK HOUR + DEVELOPMENT TRAFFIC VOLUMES WITH UPGRADED GEOMETRY AND CAPACITY ANALYSIS RESULTS	13.2

APPENDIX B

JRA Correspondence

a world class African city

City of Johannesburg
Johannesburg Roads Agency

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2001

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17/8/P14
P.Peska

GOBA
PO Box 180
SUNNINGHILL
2157

Date: 19 February 2013

Fax no: (011) 807 8535

Attention: Mr A. Brislin

Sir,

PROPOSED TRIP GENERATION FOR LOW INCOME CHARTERED HOUSING DEVELOPMENTS IN PROTEA GLEN:

To confirm the meeting held at the offices of the JRA on 19 February 2013. The following is agreed:

The proposed vehicular trip generation of **0.178 (AM Peak Hour)** and **0.167 (PM Peak Hour) trips per residential unit**, as well as the proposed modal split, is based on actual traffic counts/surveys conducted in the existing residential townships of Protea Glen Extensions 1,2,3,4,11 and 12. This trip generation also takes into consideration schools, Residential 3 developments as well as the typical small businesses found in township.
The trip rates are in line with those of other similar developments measured within the boundaries of COJ.
As a factor of safety, the Traffic Engineering Department will support a trip generation of **0.25** for this type of development. The proposed modal split is also supported.

Large Industrial, Business and Commercial developments that do not fall within a typical residential township must still be measured separately.

Yours faithfully

Peter Peska
Senior Engineer: Traffic Engineering and analysis

Appendix C

Sidra Outputs