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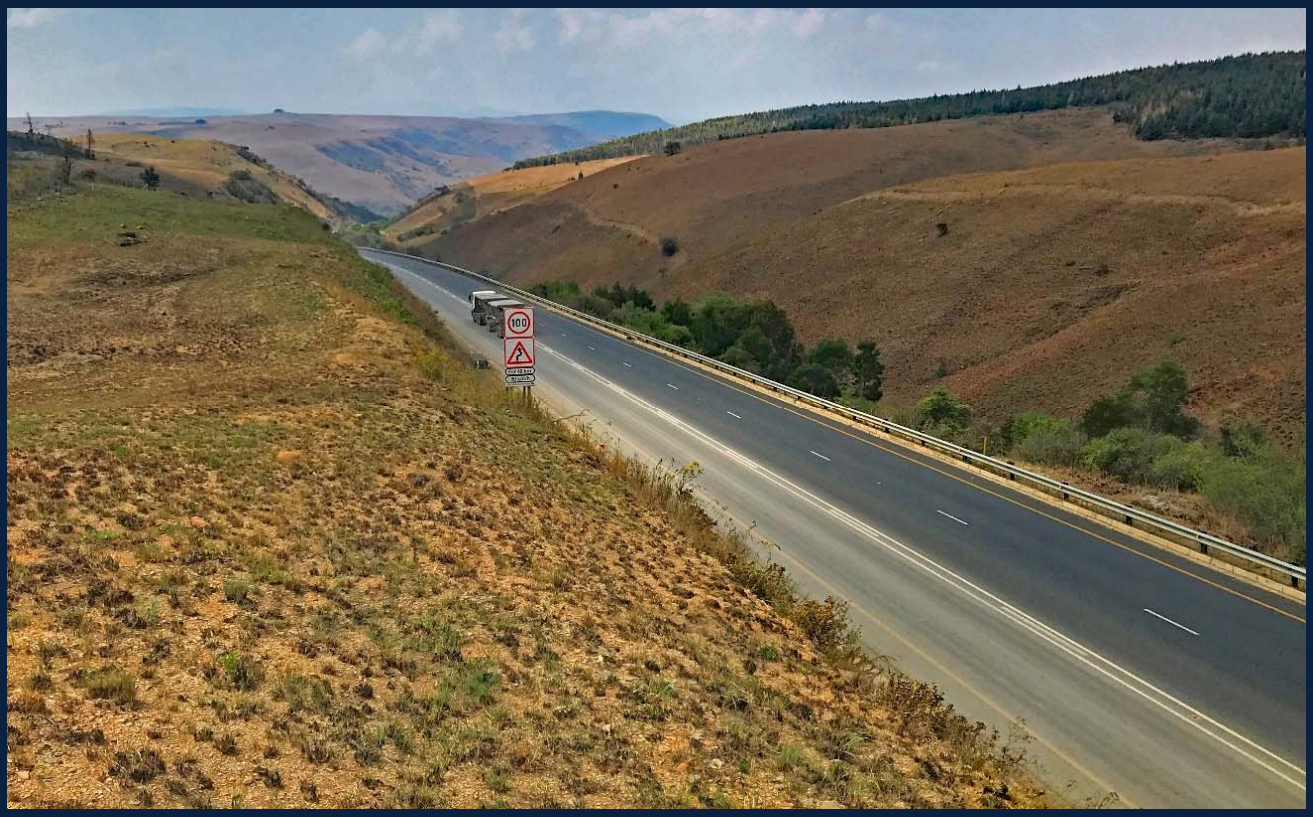

SMEC INTERNAL REF. **PE293**

Preliminary Design Report

N4-6Y (MDC Section 6N): Schoemanskloof

Volume 1 of 2

Reference No. TRAC/NEW-01/2018

Prepared for Trans African Concessions (TRAC)

22 October 2021

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Project number	PE293
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1 Introduction

1.1 Terms of Reference

In March 2019, SMEC South Africa (Pty) Ltd was appointed by Trans African Concessions (TRAC) for the Assessment and Preliminary Design (PD) of N4-6X (km 2,05 to km 3,18) and N4-6Y (km 2,56 and km 63,72) (MDC Section 6N) between Crossroads Interchange and the future Montrose Interchange via *Schoemanskloof* (excluding the interchanges), hereafter referred to as *Schoemanskloof*. The agreement number is TRAC/NEW-01/2018 of March 2019.

Schoemanskloof is situated in the Mpumalanga Province and illustrated with an orange line in Figure 1-1. The section of *Schoemanskloof* between Crossroads Interchange and the R36 (Bambi) intersection is hereafter referred to as *Section 1* and between the Bambi intersection and future Montrose Interchange as *Section 2*.

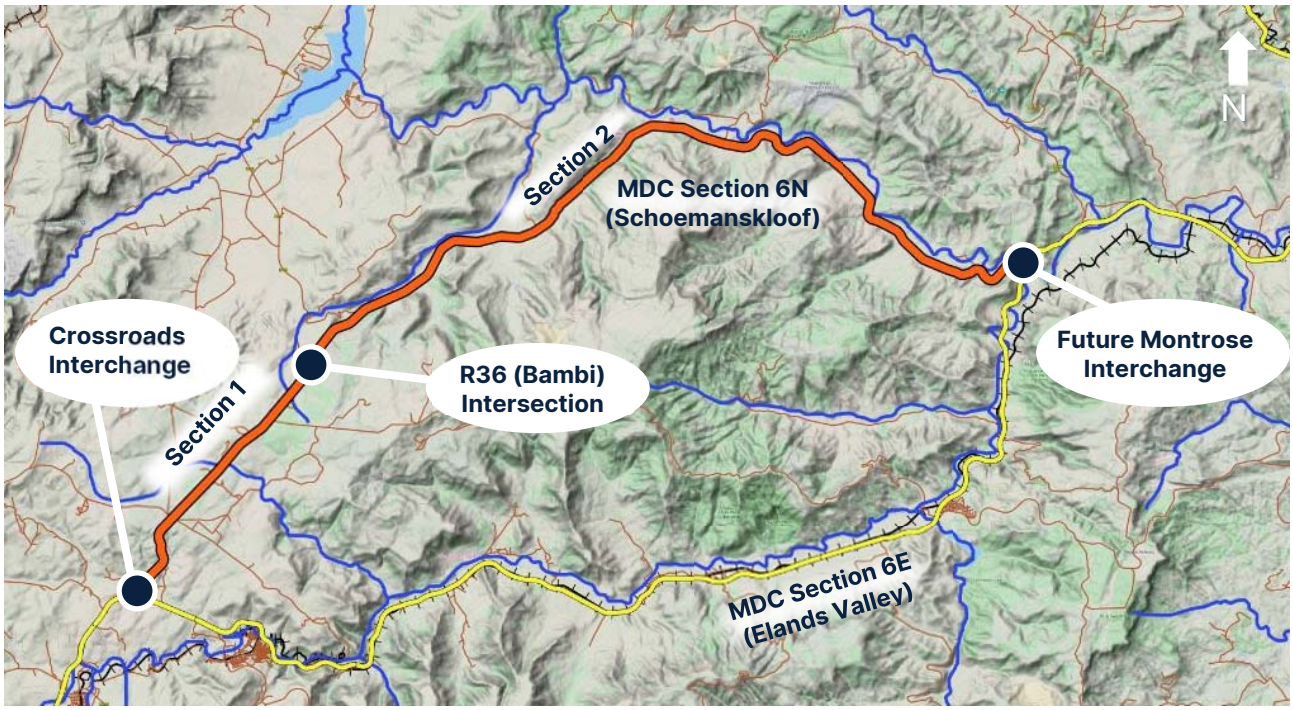

Figure 1-1: Locality Map for *Schoemanskloof*.

The Assessment- and PD phases of this project are based on the approved Upgrade Strategy Report of August 2019. The key principles agreed with TRAC and SANRAL on which the Preliminary Design is based on are highlighted in Section 1.2. This Preliminary Design report and corresponding Book of Drawings were submitted to SANRAL for approval on 30 July 2020.

In June 2020, SMEC was appointed to develop a high-level access management plan for *Schoemanskloof*. This access management plan was workshopped with SANRAL and TRAC and approved in principle by both parties. In November 2020, SMEC was appointed to develop the access management plan further into a Preliminary Design. The key principles of the high-level access management plan are highlighted in Section 1.3.

Both the abovementioned Preliminary Designs are discussed in this report. Supplementary information to this report is contained in the Book of Drawings, dated October 2021.

To date, the following studies and reports have been concluded:

a) Preliminary Design of the grade-separated Montrose Interchange, replacing the existing at-grade intersection where *Schoemanskloof* intersects with the N4-7X (Elands Valley), dated October 2019. Agreement number TRAC/NEW-01/2017.

b) Detailed Design and Tender Documentation of the grade-separated Montrose Interchange, replacing the existing at-grade intersection where *Schoemanskloof* intersects with the N4-7X (Elands Valley), dated May 2021. Agreement number TRAC/NEW-01/2017.

c) Upgrade Strategy Report for N4-6Y (MDC Section 6N): *Schoemanskloof*, dated August 2019.

d) Preliminary Design of N4-6X (km 2,05 to km 3,18) and N4-6Y (km 2,56 and km 63,72) (MDC Section 6N) between Crossroads Interchange and the future Montrose Interchange via *Schoemanskloof*.

- Volume 1: Preliminary Design Report, dated July 2020.
- Volume 2: Schedule of Quantities, dated December 2019.
- Book of Drawings, dated July 2020;
- Culvert and Bridge Reports, dated December 2019.

e) Initial and Detailed Pavement Assessment, dated February 2020.

f) High-level Access Management Plan, dated June 2020.

g) Detailed Design Site Investigation for the Schoemanskloof Upgrade, Maputo Development Corridor. Volume 1: Geotechnical Factual Report (GFR), dated August 2021 (Draft Report).

The following drawings are separately attached to this report in the Book of Drawing:

- Locality Plan and Contents – PE293-LOc01
- Key Plans – PE293-PKp01 to PKp03
- Layout Plans – PE293-PLy01 to PLy60
- Typical Road Cross-Sections – PE293-PCs01 to PCs02
- Curve Data Block Plans – PE293-PCd01 to PCd02
- Services Schedule – PE293-SSp01
- Bridge Width Schedule Plans – SMEC/PE293/BWS-01 to BWS-06
- General Arrangement Plans:

Drawing number	Drawing number
SMEC-PE293-C1077-01	SMEC-PE293-S3516-01
SMEC-PE293-S3501-01	SMEC-PE293-S3517-01
SMEC-PE293-S3502-01	SMEC-PE293-S3522-0
SMEC-PE293-B2064-01	SMEC-PE293-S3523-01
SMEC-PE293-B2065-01	SMEC-PE293-S3526-01
SMEC-PE293-S3504-01	SMEC-PE293-B2069-01
SMEC-PE293-S3509-01	SMEC-PE293-S3531-01
SMEC-PE293-B2067-01	

1.2 Key Principles from Approved Upgrade Strategy Report

The following points are extracts from the Upgrade Strategy Report of August 2019, which formed the basis of the preliminary design:

- The upgrade strategy refers to Annexure XVII of the Maputo Development Corridor Concession Contract and address capacity and safety issues. The length of the road under consideration is ± 62 km. According to the Concession Contract, *Schoemanskloof* would be upgraded by providing wider surfaced shoulders and additional 8 km passing / climbing lanes. There was an agreement between TRAC and SANRAL to convert / exchange the proposed wider shoulders area to additional passing / climbing lane area of ± 131 000 m^2.
- An additional 15,5 km of passing lanes are proposed in the eastbound direction and 22,5 km in the westbound direction. This amounts to an additional proposed surfaced width of ± 132 000 m^2, which is in line with the recommendations of the Concession Contract. The length and spacing of the passing lanes are based on the results from the Highway Capacity Manual (HCM) analysis and VISSIM traffic simulation. All affected bridges and major culverts should be widened / lengthened to accommodate the proposed widening.
- The proposed Ramp C on-ramp onto *Schoemanskloof* will run parallel to the new alignment and therefore function as a passing lane on *Schoemanskloof*. This passing lane will form part of the Montrose interchange project and is therefore excluded from the Upgrade Strategy of *Schoemanskloof*.
- SANRAL agrees with the principles of the Upgrade Strategy as contained in the *Schoemanskloof* Upgrade Strategy Report.

1.3 Key Principles from Approved High-Level Access Management Plan

This section describes the process followed to develop the approved high-level access management plan on which this Preliminary Design is based on. The high-level access management plan can be made available on request.

1.3.1 Private Accesses

Currently there are ± 130 private accesses along *Schoemanskloof* gaining direct access to the roadway. For these accesses no turning lanes are available and vehicles must stop within a lane to wait for a gap in oncoming traffic in order to turn. This creates unsafe situations for road users. The safety of existing accesses, and especially the turning movements were one of the main concerns raised by landowners during the public engagement sessions. In the approved high-level access management plan, the number of access points could be reduced to 24 intersections by utilising formal and informal gravel roads to provide access to properties along the route.

1.3.2 Process Followed

An iterative process was followed to develop the high-level access management plan. The process is summarised below in three iterative steps.

a) **First Iteration**

A site visit and desktop study were conducted by the project design team to determine the possible locations for intersections in order to consolidate existing accesses and properties, to improve the safety and mobility along *Schoemanskloof*. These positions were assessed for sight distances and other safety concerns and adjusted accordingly. During the first iteration process consultations were had with the General Manager of Joubert and Sons as they own the most properties along *Schoemanskloof*. The first iteration process is summarised in Figure 1-2.

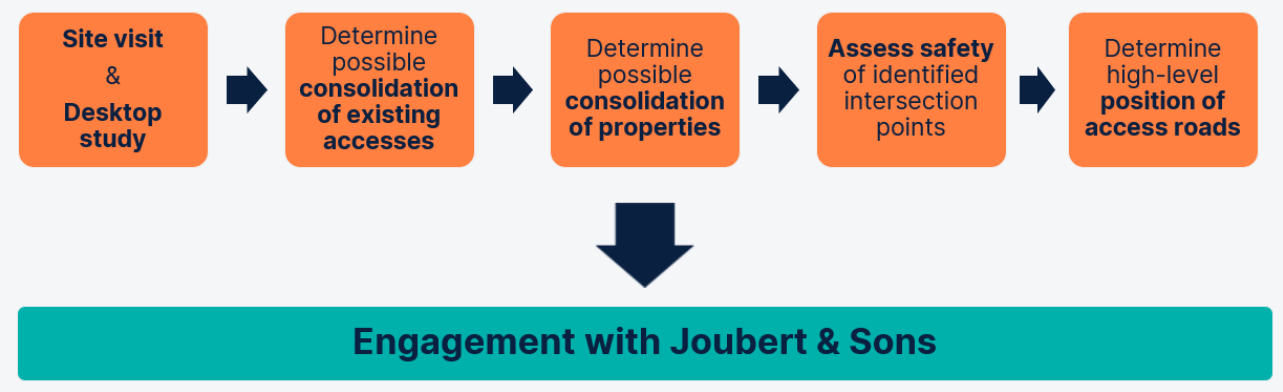

Figure 1-2: First iteration.

b) Second Iteration

During the second iteration process a high-level cost estimate were developed and the proposed intersection positions workshopped with TRAC and SANRAL. It was decided to use a phased implementation approach and categorise the implementation of the proposed intersections according to priority. The prioritising of the proposed intersections is described in the next section. A detailed investigation was then conducted, and the proposed access management plan presented to the I&APs during the public engagement sessions held 12 and 13 February 2021. The second iteration process is summarised in Figure 1-3.

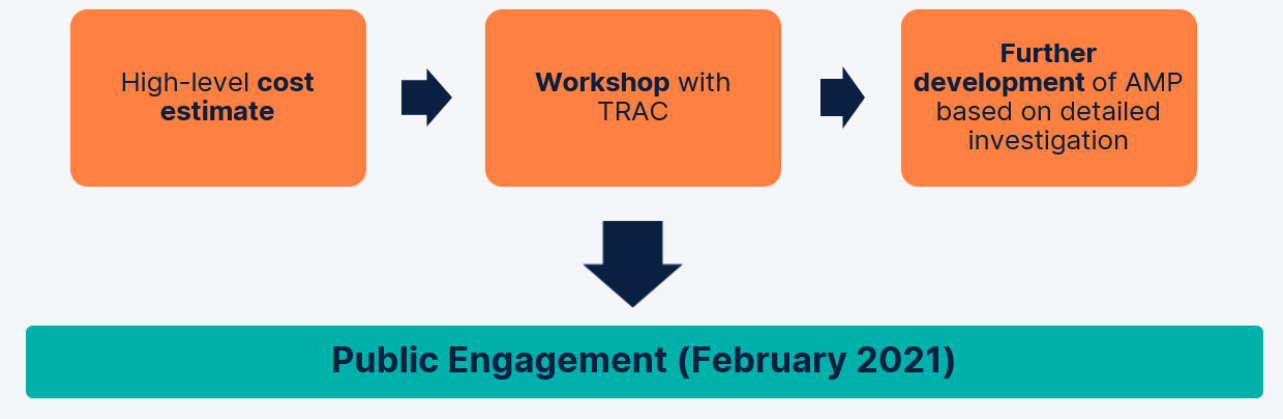

Figure 1-3: Second iteration.

c) Third Iteration

For the final iteration the feedback received from the public engagement sessions were incorporated in the proposed access management plan, where possible. In addition to the public engagement sessions, the design team held individual appointments, on-line calls and email correspondence with the landowners as requested. The third iteration process are summarised in Figure 1-4.

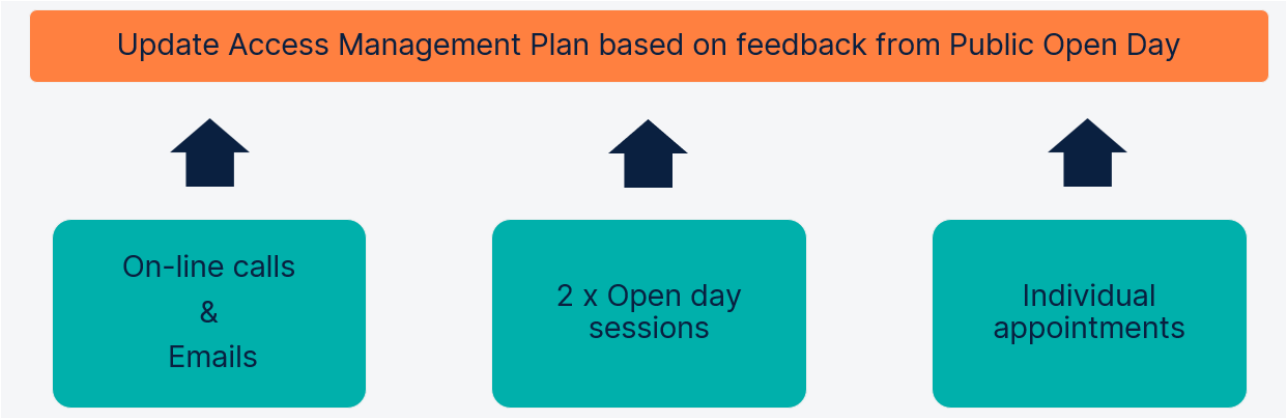

Figure 1-4: Third iteration.

1.3.3 Prioritising of Intersections

Access management along *Schoemanskloof* is outside the scope of the Concession Contract between TRAC and SANRAL. Due to limited funds available from TRAC, it was decided to use a phase implementation approach and prioritise the proposed intersections to establish which intersections will benefit the project and road user the most in terms of safety and effectiveness. The following criteria were identified for each of the proposed intersections and used as the basis for prioritisation:

- Number of existing accesses consolidated per intersection.
- Number of properties served per intersection.

Three priority levels were used for the classification of the proposed intersections, namely high-, medium- and low priority. Currently there are four main intersections along *Schoemanskloof* namely, Goedewil-, Elandshoogte-, R36 (Bambi)- and Weltevreden intersections. The upgrading of these intersections is already part of the planned road upgrade. So, to fully utilise these intersections as part of the access management plan, only gravel access roads must be constructed additionally. For this reason, these four intersections were also classified as high priority intersections.

The 24 proposed intersections are divided as follow in the different priority categories (also refer to Figure 1-5 for a visual representation):

- Four major road intersections classified as high priority.
- Six high priority intersections.
- Five medium priority intersections.
- Nine low priority intersections.

Figure 1-5: Prioritisation of intersections.

The high-level access management plan was workshopped with TRAC and SANRAL and approved by both parties. The Preliminary Design will include the design of all 24 proposed intersections, after which only certain intersections will be developed further into detail design and in the end constructed, depending on available funding.

2 Existing Road Infrastructure

This section discusses the existing road infrastructure of *Schoemanskloof*.

2.1 Topographical Survey

The topographical- and structural survey and mapping was concluded between February and November 2019 and conformed to the TMH11 requirements. The following additional items were supplied by the surveyors:

- High quality orthophotos along *Schoemanskloof*.
- High-density point clouds of all major structures. These point clouds were used as input to the preliminary structural designs where the supplied as-built drawings and / or survey had inaccuracies or omissions.
- Completed drainage schedule of all culverts along *Schoemanskloof*.
- Culvert photo book with photographs at each in- and outlet structure.

Additional Lidar Survey will be undertaken along Section 1 before end 2021 as this section of road was under construction during the initial topographical survey.

2.2 General

Schoemanskloof is a two-lane road ("*two-lane facility*") situated in rolling to mountainous terrain, with occasional passing / climbing lanes along the route. The existing lengths of *two-lane facilities* and sections with passing / climbing lanes ("*three-lane facility*") are tabulated in Table 2-1. This is applicable between km 3,0 and km 62,05 (tie-in to the future Montrose Interchange). The topography is generally downhill in the eastbound direction towards Mbombela.

Table 2-1: Existing road length per cross-section category.

Road cross-section category	Length (km): Eastbound	Length (km): Westbound	Total Length
Two-lane facilities	51,0	46,9	± 98 km
Three-lane facilities	8,0	12,2	± 20 km

2.3 Existing Road Cross-Section

2.3.1 Concession Contract: Year 2 to Year 4

The cross-sections illustrated below are as proposed in Annexure XVIII of the Maputo Development Corridor Concession Contract. The following lane configurations are described:

a) *Two-lane facility*: Total surfaced width of 10 m.

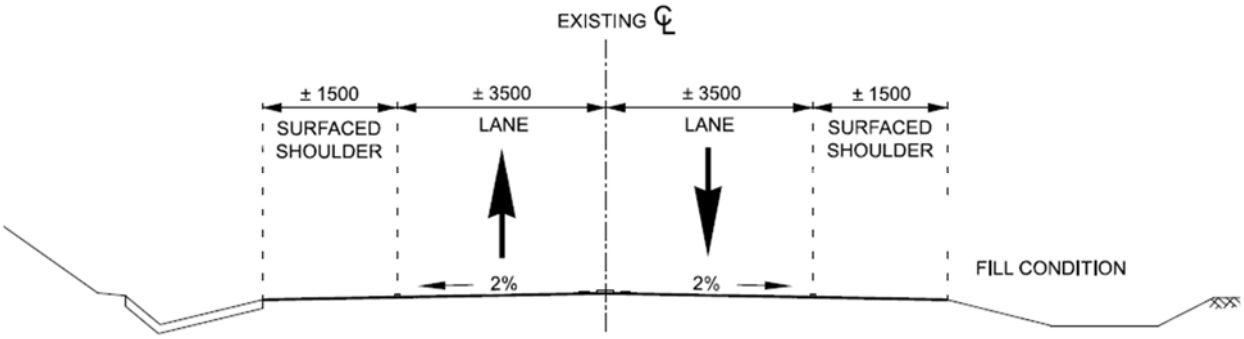

Figure 2-1: *Two-lane facility* (based on Concession Contract).

b) *Three-lane facility*: Total surfaced width of 13 m.

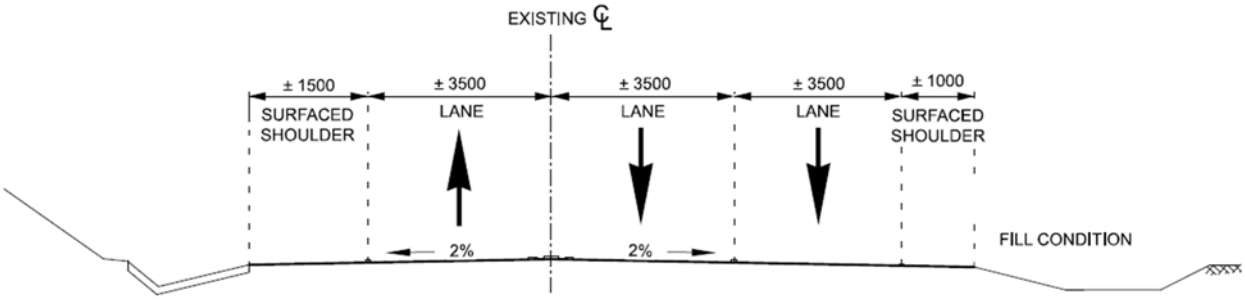

Figure 2-2: *Three-lane facility* (based on Concession Contract).

2.3.2 Status Quo Conditions

Currently, a three-line painted median configuration is used on the road, which measures ± 450 mm wide. The existing lane widths are consistent with the typical cross-sections provided in Section 2.3.1. The existing three-line painted median results in the existing surfaced shoulders being less than the mentioned 1,0 m or 1,5 m.

2.3.3 Edge Drops

During the pavement rehabilitation of 2014, the level of asphalt surfacing was raised, resulting in a difference in level between the road surfacing and gravel shoulders. The rehabilitation strategies of 2012 and 2014 are illustrated schematically in Figure 2-3 and an example of a typical edge drop observed on site, in Photograph 2-1.

The existing surfacing width of 2012 was reinstated, and an asphalt transition was created to tie into the asphalt surfacing level of 2014. This resulted in the mentioned level difference between the asphalt surfacing and gravel shoulder.

This asphalt transition also resulted in reduced road width and narrower available width for surfaced shoulders.

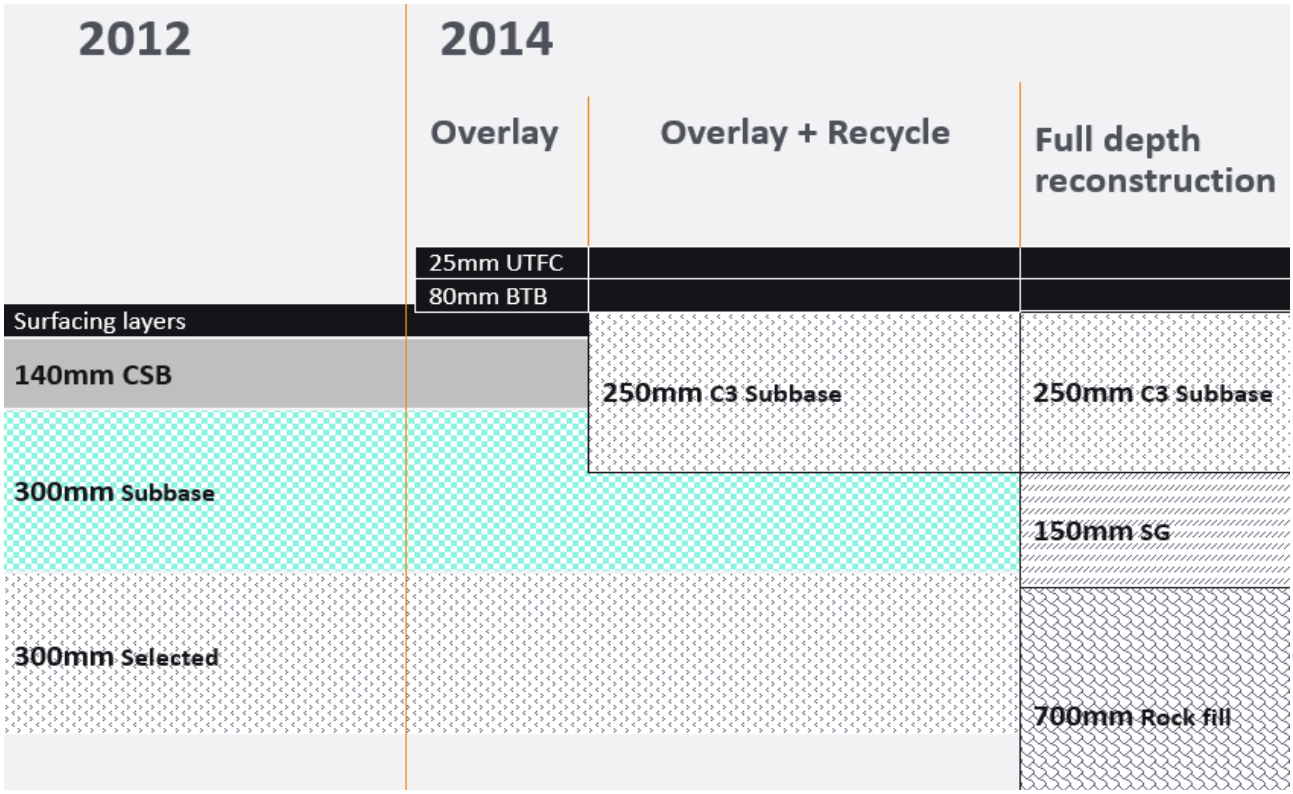

Figure 2-3: **Schematic illustration of pavement rehabilitation strategy of 2012 and 2014.**

Photograph 2-1: **Edge drop along *Schoemanskloof*.**

2.4 Position of Road Crown

2.4.1 *Two-lane Facility*

In cases where a *two-lane facility* is applicable along *Schoemanskloof*, the road crown is generally situated in the centre of the surfaced road width and coinciding with the median lane markings.

2.4.2 *Three-lane Facility*

In cases where a *three-lane facility* is applicable along *Schoemanskloof*, the road crown remains in the centre of the surfaced width and is typically situated in the centre of the fast lane. This results in the wheel tracks of a vehicle driving in the fast lane to straddle the road crown.

2.5 Deep Cuttings

Deep cuttings (deeper than 3 m) along the route where widening is proposed are tabulated in Table 2-2, together with the existing batter slopes. It is proposed that these batter slopes be analysed for slope stability and material sourcing during detail design. The existing batter slopes were accepted as stated below for the purpose of quantity calculation for the preliminary design report.

Table 2-2: Position of affected deep cuttings.

Number	Start chainage (km)	End chainage (km)	Existing side slope
1	18,400	18,900	± 1:1
2	20,740	21,000	± 1:1,5
3	24,200	24,400	± 1:1
4	26,240	26,460	± 1:1,3
5	32,400	32,900	± 1:2
6	37,260	37,300	± 1:1,7
7	42,000	42,120	± 1:1,5
8	42,280	42,380	± 1:2
9	50,500	50,600	± 1:2
10	60,500	60,600	± 1:2

2.6 Gravel Shoulders

Gravel shoulders are typically present along *Schoemanskloof*, with the exception at high fill- or cut conditions. Photograph 2-2 illustrates typical observed gravel shoulder conditions. There are generally a level difference between the level of the gravel shoulder and asphalt surfacing as a result of previous road rehabilitation actions.

Photograph 2-2: Typical gravel shoulders along *Schoemanskloof*.

The proposed upgrading / rehabilitation of the gravel shoulders is discussed in more detail in Section 4.

2.7 Design and Posted Speed

The design and posted speed of the road can be classified as follows:

a) Section 1: Crossroads interchange to R36 (Bambi) intersection
   - Design speed: 80 km/h;
   - Posted speed: 120 km/h;

b) Section 2: R36 (Bambi) intersection to future Montrose interchange
   - Design speed: 80 km/h;
   - Posted speed: 100 km/h, with localized speed reduction warning signs at sub-standard horizontal curves.

2.8 Intersections

Table 2-3 provides a list of the more significant roads intersecting *Schoemanskloof*.

Table 2-3: Intersecting roads with *Schoemanskloof*.

Major intersecting road	km-distance	Spacing (km)	Remark
N4-6X (MDC Section 5B)	km 2,56	-	Crossroads interchange (excluded from the scope of works for this project).
Road 796 Goedewil (Left)	km 7,09	4,53 km	At-grade surfaced intersection with no turning lanes. Situated on a straight section of the road.
Road 792 Elandshoogte (Right)	km 14,57	7,48 km	At-grade surfaced intersection with no turning lanes. Situated on a straight section of the road.
P8/1 (R36) Mashishing (Left) and Bambi Country Lodge (Right)	km 18,09	3,52 km	At-grade intersection with designated left- and right turn lanes. Situated on a straight section of the road.
Weltevreden Provincial Road (Left)	km 44,07	25,98 km	At-grade surfaced intersection with no turning lanes. Situated on the inside of a curve with a radius of ± 1 315 m.
N4-7X (MDC Section 6E) and access to the Joubert & Sons warehouse.	km 63,70	19,63 km	Planned Montrose interchange. Refer to Section 4.5 for a description of the planned interchange. (Excluded from the scope of works for this project).

From the above it follows that:

- All the intersection spacings mentioned in the table above conforms to the intersection spacing requirement stipulated in SANRAL's geometric design guideline.
- The Weltevreden Provincial Road intersection is situated in the inside of a horizontal curve with a radius of ± 1 315 m. This conforms to a design speed of 90 km/h. Refer to Section 4 for a description of the upgrade proposal for this intersection.

2.9 Private Accesses

There are numerous attraction points / destinations obtaining direct access from *Schoemanskloof* as well as numerous farm and private property accesses. TRAC provided a list of accesses approved in 2003. This list was updated with information from the topographical survey mapping and georeferenced aerial photographs. The consolidated list of all existing accesses along *Schoemanskloof* can be seen in Appendix A.

A total number of ± 130 existing private accesses have been identified along *Schoemanskloof*. These accesses are often located at unsafe locations for the following reasons:

- Insufficient spacing. Several accesses are situated next to one another. The spacing are tabulated in Appendix A.
- From site visits and on-site measurements, insufficient intersection sight distances to safely enter the N4 were observed;
- No protected right-turning lanes to safely enter private access roads. This safety concern was continuously raised by property owners during the public participation engagement sessions;

- Relatively high speed of vehicles travelling along *Schoemanskloof* and relatively high traffic volumes

The items listed above were also highlighted by the owners during the public participation open days held on,

- 29 and 30 November 2019 &
- 12 and 13 February 2021.

Refer to Section 10 for more information regarding the public open days.

2.10 Rest Stops

Two rest stops are situated along *Schoemanskloof* at the following locations:

- Eastbound between km 35,110 (entrance) and km 35,170 (exit);
- Westbound between km 34,660 (entrance) and km 34,610 (exit), known as “Old Joe the Stone”.

These rest stops will be unaffected by the proposed road upgrades.

3 Physiographic and Land Use

3.1 Topography

The westbound carriageway of *Schoemanskloof* follows a general uphill grade with localised downhills as a result of the rolling / mountainous terrain, and vice-versa for the eastbound carriageway. Due to the challenging terrain, deep cuts, high fills and in some instances high cliffs are present along the route. In addition, from ± km 40,4 onwards, the Crocodile River is situated to the north of the *Schoemanskloof* road and often meanders in close proximity to the road.

Maximum longitudinal gradients of are typically in excess of 6-8% as a result of the steep terrain.

3.2 Climate

The site is located on the escarpment between the highveld and the lowveld, which is characterized by warm to hot daily temperatures throughout the year. The average high temperature ranges from 23°C in June to 29°C in January. Corresponding average low temperatures are 6°C and 19°C, respectively.

The mean annual precipitation recorded is 870 mm on average, with an average of 100 rain days per year.

3.3 Geography

Defined major water courses along the route are the Crocodile River and its tributaries. The Crocodile River meanders near the eastbound carriageway of *Schoemanskloof* from km 40,4 onwards. The Crocodile River tributaries include:

- Blaauwboschkraal Tributary
- Zondagskraal River
- Mooiplaats River
- Buffelspoortspruit Tributary
- Sterkspruit and its tributaries
- Crocodile River Tributary
- Devil's Creek

Vegetation along the route comprises mainly agricultural land, small trees, shrubs, and grasslands. Larger trees can be found closer to the banks of the rivers.

3.4 Land Use

The land use along *Schoemanskloof* mainly includes commercial and agricultural activities. The commercial activities include (but not limited to) guest houses, holiday resorts, shops and wedding venues. The agricultural activities within *Schoemanskloof* have been intensifying over recent years and is expected to continue growing.

3.5 Geology

Most of the site is underlain by sedimentary and igneous extrusive rocks of the Pretoria Group, Transvaal Supergroup. Notably a section of the eastern part of the alignment is underlain by dolomitic bedrock. This section and adjacent areas may be underlain by dolomitic rock at depths of less than 100 m. Sections of the site are also underlain by igneous intrusive rocks and quaternary deposits of alluvium and scree. Refer to the geological map on the next page for more information.

Legend for Figure 3-1:

	Name:	**Type of rock / Sequence / Group / Sub-group / Formation**
•	Vsi:	Sedimentary and Volcanic Rock / Vaalian / Pretoria / Silverton / Lydenburg Member
•	Vsm:	Sedimentary and Volcanic Rock / Vaalian / Pretoria/Silverton / Machadodorp Member
•	Vsb:	Sedimentary and Volcanic Rock / Vaalian / Pretoria / Silverton / Boven Member
•	Vdw	Sedimentary and Volcanic Rock / Vaalian / Pretoria / Dwaalheuwel
•	Vt:	Sedimentary and Volcanic Rock / Vaalian / Pretoria / Timeball Hill / Klaaperkop Member
•	Vmd:	Sedimentary and Volcanic Rock / Vaalian / Chuniespoort / Malmani
•	Vdi:	Intrusive Rock / Vaalian
•	Q:	Sedimentary and Volcanic Rock / Quaternary

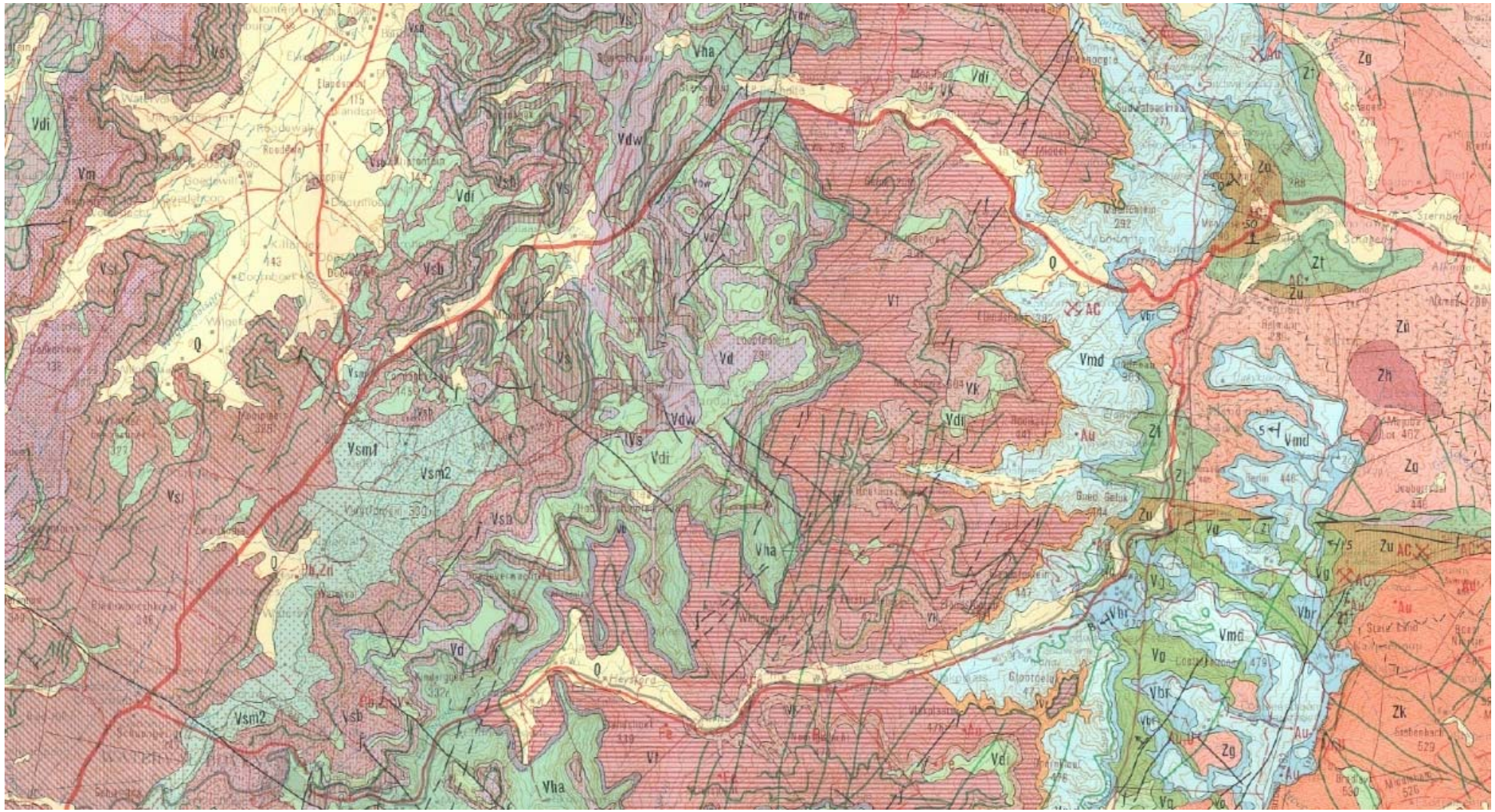

Figure 3-1: Geological Map for *Schoemanskloof*.

4 Proposed Road Upgrading

4.1 Upgrading of Main N4

In accordance with Annexure XVIII of the concession contract and following discussions with TRAC, it was decided to retain the existing horizontal alignment (with the exception of three cases), vertical alignment, position of the road crown and superelevations of *Schoemanskloof* road. The proposed horizontal alignment deviations are discussed in more detail in Section 4.1.4. Longitudinal drawings of the road are excluded from the preliminary design drawings book as the existing vertical alignment is retained. A summary of the vertical alignment is tabulated in Appendix B.

The road can broadly be divided into two cross-section categories, namely a *two-lane facility* and a *three-lane facility*. The lengths of the different road categories before and after adding the proposed additional passing / climbing lanes are tabulated in Table 4-1. The percentage of the road with passing / climbing lanes for the existing and upgraded scenarios are provided in Table 4-2.

Table 4-1: Road length per cross-section category after road upgrade.

Road cross-section category	Length (km): Eastbound	Length (km): Westbound	Total length
Existing two-lane facility	34,3	24,1	± 58 km
Existing three-lane facility	8,0	12,2	± 20 km
New three-lane facility	16,7	22,7	± 39 km

Table 4-2: Percentage of road consisting of a *three-lane* facility.

Description	Percentage of road with passing / climbing lanes	
	Existing scenario	Upgraded scenario
Eastbound	14 %	42 %
Westbound	21 %	59 %
Combined	17 %	50 %

The total area of additional surfacing amounts to ± 139 300 m^2, including the end of taper recovery areas and the upgrading of the 4 major intersections mentioned in Section 2.8 (but excluding the proposed intersections part of the access management plan).

4.1.1 Proposed Road Cross-Section

4.1.1.1 Schoemanskloof

The proposed road cross-sections for *Schoemanskloof* have been approved by TRAC and SANRAL and are illustrated in Figure 4-1 Figure 4-3 on the next page.

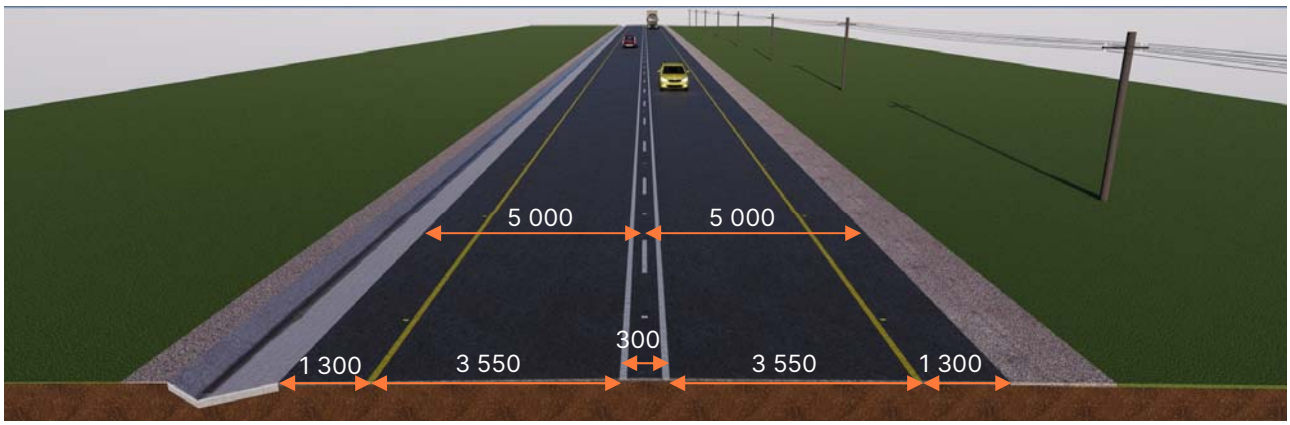

Figure 4-1: **Proposed *two-lane facility*.**

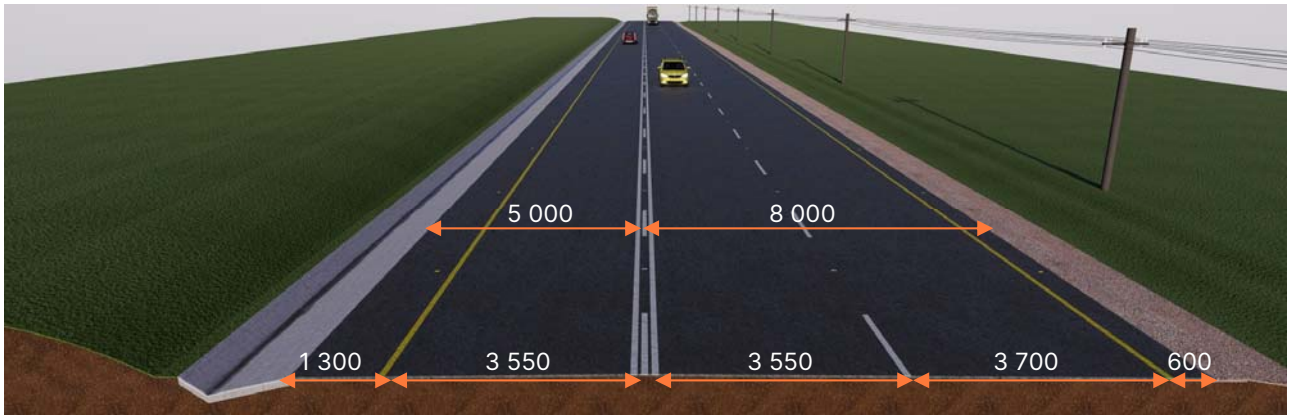

Figure 4-2: **Proposed *three-lane facility*.**

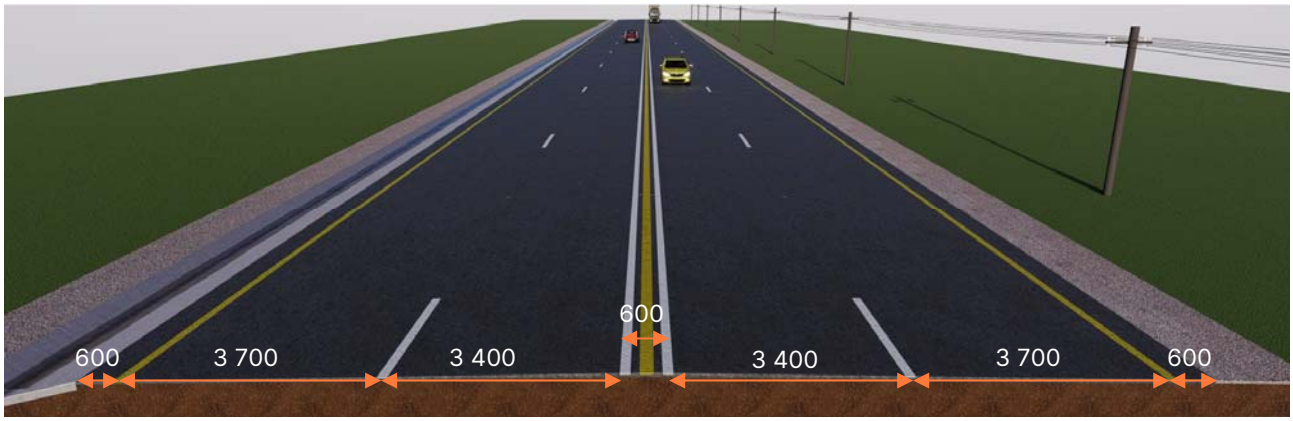

Figure 4-3: **Proposed *undivided dual carriageway**.**

*The *"undivided dual carriageway"* cross-section will not be implemented as a stand-alone cross-section and only applies to cases where *two-lane facilities* with passing / climbing lanes overlap in opposing directions.

New lane configurations are proposed to allow for a more visible painted median, especially where an *undivided dual carriageway* section is present. The wider painted median with a milled-out rumble strip in the centre will discourage drivers to illegally overtake on these sections. The line markings of the proposed lane configurations tie up for the three proposed cross-section types as illustrated above. The implementation of the painted median is described in more detail in the following section.

4.1.1.2 Painted Median

Two different types of painted median configuration are proposed for implementation on the road, i.e. 300 mm wide painted three-line system and a 600 mm wide painted median with milled out rumble strips in the centre. Both types of painted median conform to the South African Road Traffic Sign Manual (SARTSM) and are described as follows:

a) *Two-lane*- or *three-lane facilities*

A 300 mm wide three-line painted median are proposed for implementation on *two-lane* and *three-lane facilities* along *Schoemanskloof* (refer to Figure 4-4 for an illustration). This configuration simplifies indication through painted line markings of the following scenarios, as illustrated in Figure 4-5:

- Sections where overtaking can be safely performed;
- Sections where no overtaking is allowed;
- Sections where no crossing is allowed.

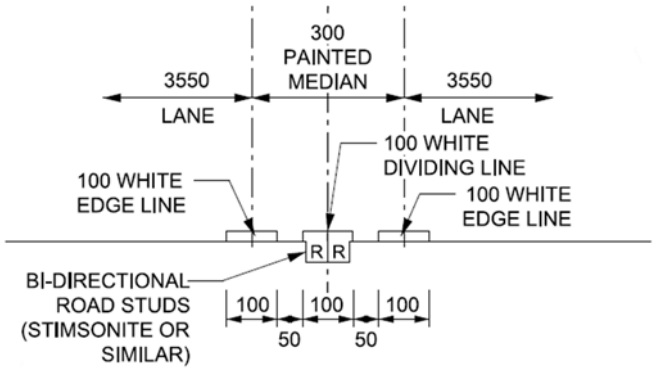

Figure 4-4: 300 mm wide painted three-line system.

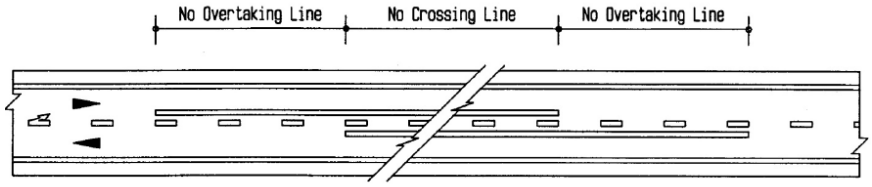

Figure 4-5: Extract from SARTSM Volume 4 – Three-line system.

b) Undivided *four-lane facility*

For an *undivided four-lane facility*, no overtaking will be allowed in oncoming traffic lanes and therefore a wide visible painted median is proposed as illustrated in Figure 4-6.

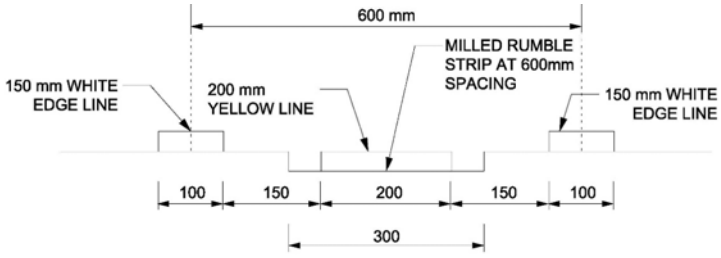

Figure 4-6: Dimensions of 600 mm wide painted median.

4.1.1.3 Gravel Shoulders

a) New gravel shoulders

In cases where passing / climbing lanes are proposed, i.e. where the road is widened, gravel shoulders will be implemented in all cases where the road is in fill. The following scenarios are applicable:

- 2,4 m wide gravel shoulders where the road is in fill of up to 3 m and without a guardrail.
- 2,7 m wide gravel shoulders where the road is in fill of higher than 3 m and with a guardrail. A guardrail will be implemented in this case, which will result in an effective functional gravel shoulder width of 1,9 m.

The outer edge development of the road upgrade is illustrated in Figure 4-7.

In cases where steep longitudinal slopes or superelevation is applicable, a 300 mm wide edge beam will be constructed between the gravel shoulder and edge of surfacing to prevent erosion.

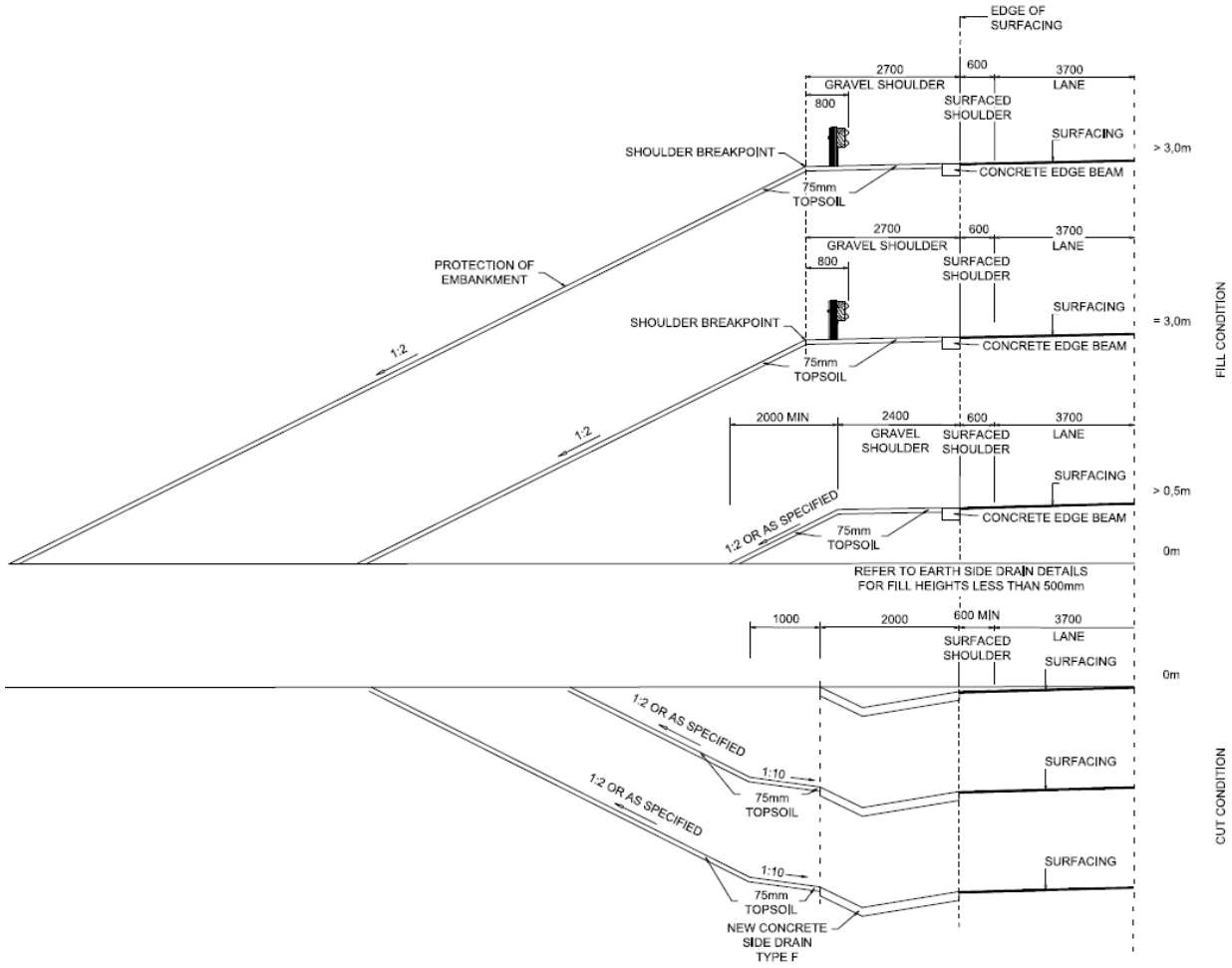

Figure 4-7: Outer edge development where the road is widened.

b) Existing gravel shoulders

The existing gravel shoulders for the remainder of the road will be rehabilitated where feasible. The length of existing gravel shoulders to be rehabilitated adds up to ± 30% of the length of the road, or ± 38 km in length. The following will be applicable:

- Cut conditions: The existing outer edge development will be unchanged and a tapered step between the surfacing and the concrete side drain will still be present.
- Fill conditions: The gravel shoulder will be reconstructed to the existing width of the gravel shoulder and to the same level as the road surfacing. This will eliminate the vertical step between the existing gravel shoulder and the road surfacing.
- In cases where the road is in high fill and where guardrails are present, the existing gravel shoulder will remain unchanged.

4.1.1.4 Batter Slopes

The following are applicable to batter slopes along *Schoemanskloof*:

- The existing batter slopes where no widening is taking place will remain unchanged.
- Shallow cuts and all fill batters will be implemented at slopes of 1:2 on all road widenings.
- In deep cut scenarios (deeper than 3 m), the existing batter slopes will be reinstated where warranted, based on batter stability. Cut slopes will be investigated in more detail during the detail design phase. Refer to Section 2.5 for a list of deep cuttings and existing batter slopes.

4.1.2 Posted Speed

The posted speeds described in Section 2.7 will be reimplemented as instructed by SANRAL.

Additional warning signs at areas which requires reduced speeds will be implemented along the road where applicable.

4.1.3 Geometric Standards Adopted

The minimum geometric design standards, as specified in Table 2.3.2 and 2.3.3 of the Amended Annexure III of the Concession Contract, and the resultant geometric design standards attained are indicated in the Table 4-3. The minimum standards specified correlate with the standards mentioned in SANRAL's geometric design guidelines.

Table 4-3: *Schoemanskloof* geometric design standards.

Description	Minimum standard specified	Standard achieved	
		Section 1	Section 2
Design speed for Section 6N during the expansion period (single carriageway road in rolling to mountainous terrain).	90 km/h	80 km/h	80 km/h
Radius for 7% maximum super-elevation for single carriageway road.	240 m (80 km/h) and 400 m (100 km/h)	237 m min (80 km/h) e_{max} = 8%	425 m min (100 km/h) e_{max} = 8%

Description	Minimum standard specified	Standard achieved	
		Section 1	Section 2
Crossfall. **- For vertical grades > 1,0 %.** **- For vertical grades < 1,0 % over lengths > 500 m.**	2% 3%	Achieved	Achieved
Maximum grades. **- Desirable** **- Absolute maximum**	6% 8,5%	7,13 %	8,51 %
Minimum grades.	0,5 %	0,02 %	0,11 %
Vertical alignment K-values. **For crest curves (based on an object height of 0,6 m).**	33 (80 km/h) to 60 (100 km/h)	33 (80 km/h)	31 (80 km/h)
For sag curves (based on comfort).	25 (100 km/h) to 36 (120 km/h)	25 (100 km/h)	24 (100 km/h)
Minimum lengths of vertical curves.	150 m	105 m	52 m
Minimum spacing between major intersections.	600 m	> 600 m	> 600 m

4.1.4 Horizontal Alignment Deviations

In cases where passing / climbing lanes are proposed, but the topography is difficult to navigate, it is proposed to widen the road to one side only, in order to reduce construction costs. This can only be achieved where the road geometry allows, i.e. between horizontal curves where the super elevation can accommodate / terminate the off-centre road crown position. In these cases, some of the lanes will be in reverse camber, similar to existing scenarios on the road.

4.1.4.1 ± km 36,900 to ± km 42,400

The topography over this stretch of road generally slopes upwards from south to north. This results in deep to very deep cuttings typically being present along the westbound carriageway and fills along the eastbound carriageway.

At the following positions along the westbound carriageway deep cuts (> 3 m) are present:

- 37,260 to 37,740
- 38,240 to 38,440
- 39,120 to 39,220
- 40,000 to 40,180
- 40,360 to 40,580
- 41,240 to 41,420

By widening into these cuttings, the slope stability might be compromised, and daylighting of the batter slopes becomes very long, resulting in unnecessary expropriation and construction cost.

For the abovementioned reasons, it is proposed that the road be widened only to the north for this stretch of road, with the following exceptions (refer to the legend listed after Figure 4-9):

Both of the following road re-alignments are proposed to accommodate concerns raised by landowners during the public open days of November 2019 and February 2021 (refer to Section 10 for more information).

a) Horizontal bends between ± km 37,000 and ± km 37,600: It is proposed to widen the N4 to the south between the two horizontal bends illustrated in Figure 4-8 to reduce the expropriation needed for Sterkspruit No. 296-JT Remainder of Portion 45. A retaining wall or similar (illustrated in yellow on Figure 4-8) is proposed along the new northern batter to retain the fill within the existing N4 road reserve.

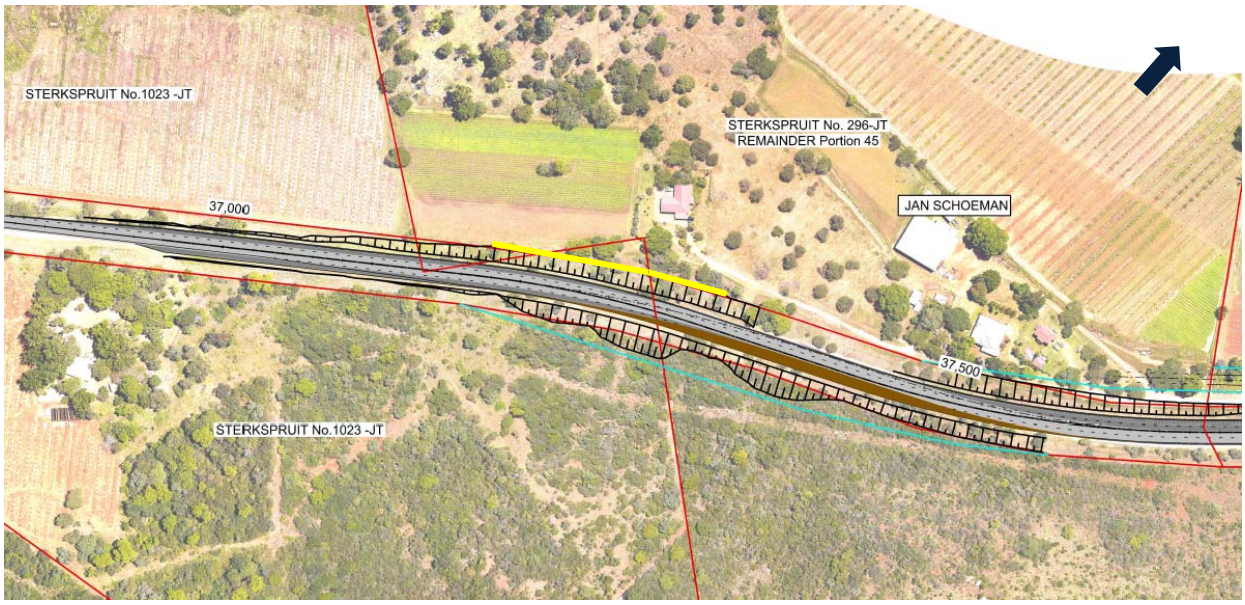

Figure 4-8: Road layout between ± km 37,00 and ± km 37,600.

b) Horizontal bends between ± km 38,500 and ± km 39,500: It is proposed to widen the N4 to the south between the two horizontal bends illustrated in Figure 4-9 to reduce the expropriation needed for Sterkspruit No. 296-JT Remainder of Portion 64.

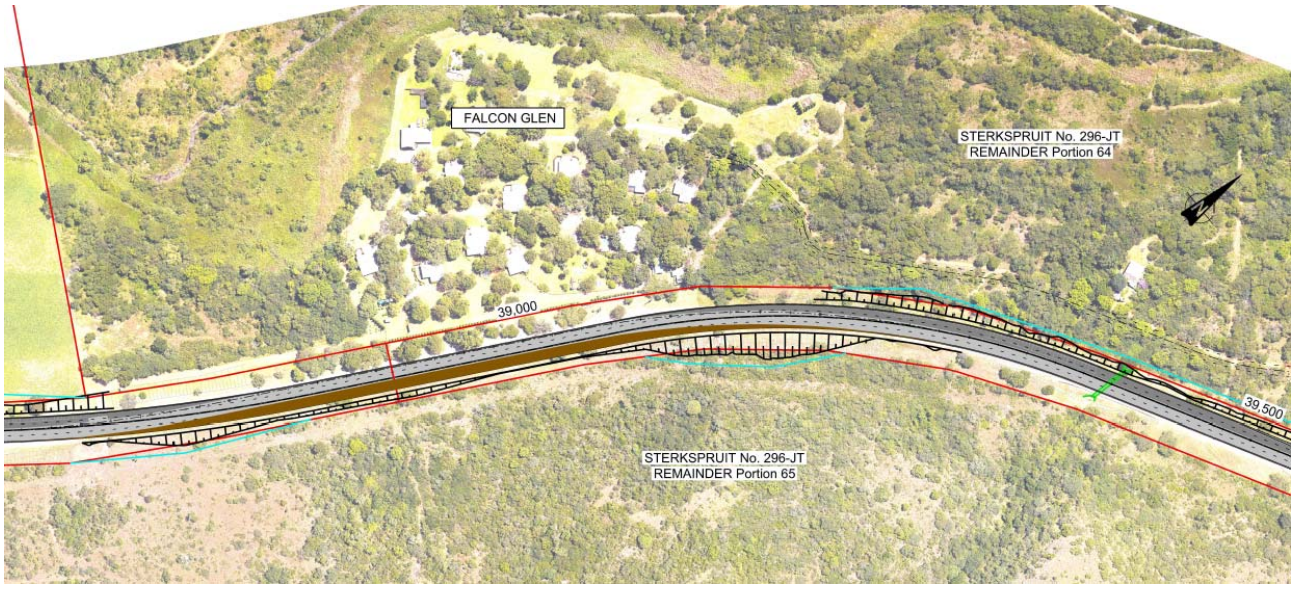

Figure 4-9: Road layout between ± km 38,500 and ± km 39,500.

The following legend applies to Figure 4-8 and Figure 4-9:

- Light grey hatching: Existing road surfacing.
- Dark grey hatching: Proposed road widening.
- Brown hatching: Proposed road widening to the south to reduce effect on adjacent property.
- Red lines: Cadastral boundaries and existing N4 road reserve.
- Light blue lines: Additional road reserve required to accommodate road widening.
- Yellow line: Proposed retaining wall or similar.

4.1.4.2 Weltevreden Intersection to ± km 46,000

It is proposed that the centreline of the road is shifted to the south so that widening of the road along this stretch of road is only to the southern side. This has the following advantages:

- An increase of the horizontal curve radius from ± 1 315 m to ± 1 693 m, improving sight distance along the horizontal curve through the Weltevreden intersection, which is situated on the inside of the curve.
- Proposed widening affecting mostly only the relocation of street lighting on the southern side of the road (refer to Section 8 for more detail). Localised poles on the northern side of the road at the Weltevreden Road bell mouths will also need relocation.
- The northern acceleration and deceleration tapers of the VIVA petrol station remains unchanged. The VIVA petrol station is situated ± 730 m to the east of the Weltevreden road intersection.
- Structures S3522 and S3523 only requires extension to the south.
- The least number of established trees will be affected by the construction works.
- The traffic camera situated along the eastbound carriageway at ± km 44,6 is unaffected.

Additional road reserve will be required on the southern side of the road across from VIVA fuel station (remainder of Portion 69 of Farm Rietvly No. 295-JT).

Refer to Section 8 for other services to be relocated.

4.1.4.3 Horizontal Curve at Entrance to Poplar Creek

A preliminary investigation was done to determine the feasibility to improve the geometry and safety of the horizontal curve (radius of 289,7 m) at the entrance to Poplar Creek (± km 60,880). The safety of this stretch of road was raised by the interested and affected parties (I&AP) during the public open days of November 2019 and February 2021. Two options were investigated as summarized in Table 4-4 and illustrated in Figure 4-10.

Table 4-4: Summary of design standards to improve the horizontal curve past Poplar Creek.

Design speed	Radius	Description
80 km/h	289,7 m	Status quo (Grey)
100 km/h	394,0 m	Green
120 km/h	676,0 m	Orange

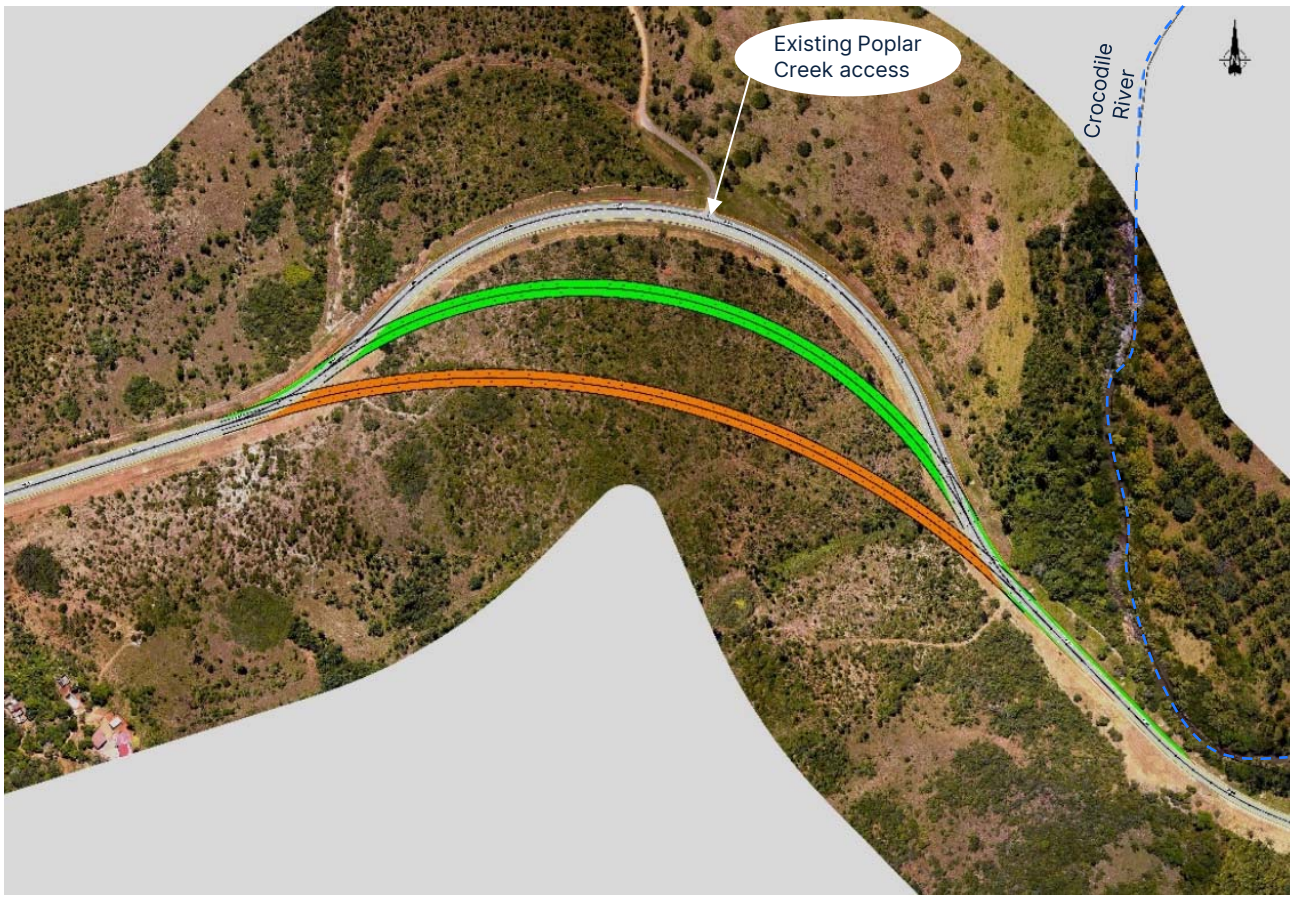

Figure 4-10: Proposed geometric improvements to the horizontal curve past Poplar Creek.

The horizontal curve with a design speed of 120 km/h were further developed. The high-level vertical alignment of the proposed re-alignment is illustrated in Figure 4-11 and the corresponding layout in Figure 4-12. To obtain a maximum vertical grade of 8,5%, a part of the existing N4 will have to be re-constructed as illustrated by the yellow hatching in Figure 4-12.

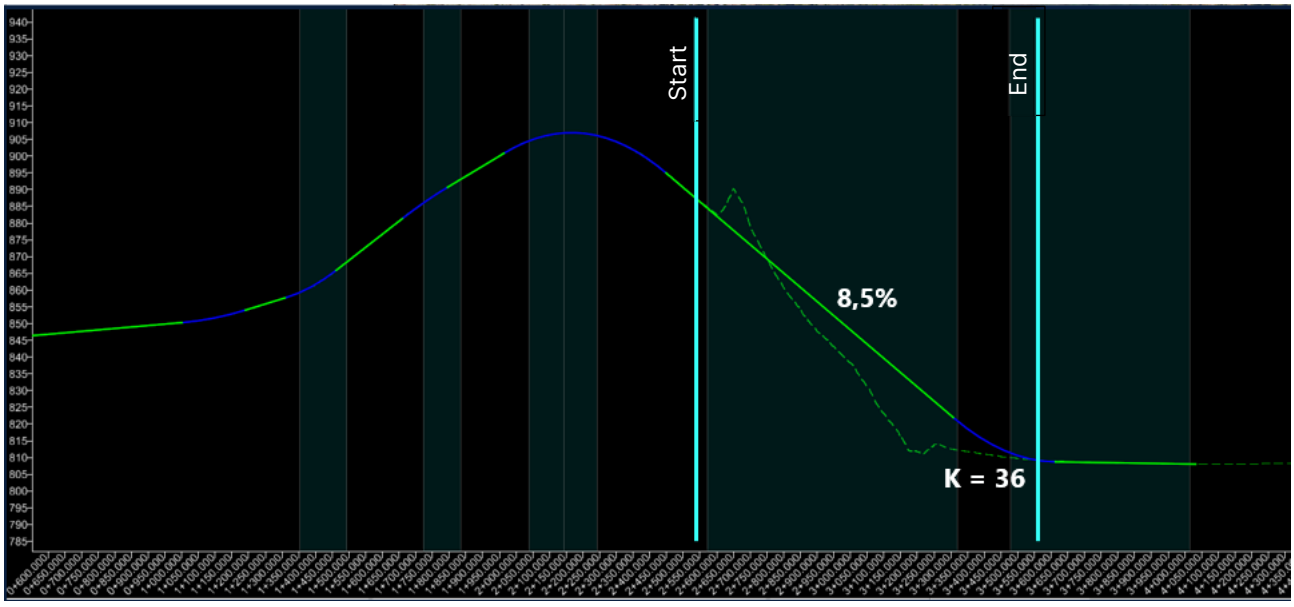

Figure 4-11: Vertical alignment of proposed re-alignment of N4 (120 km/h designs speed).

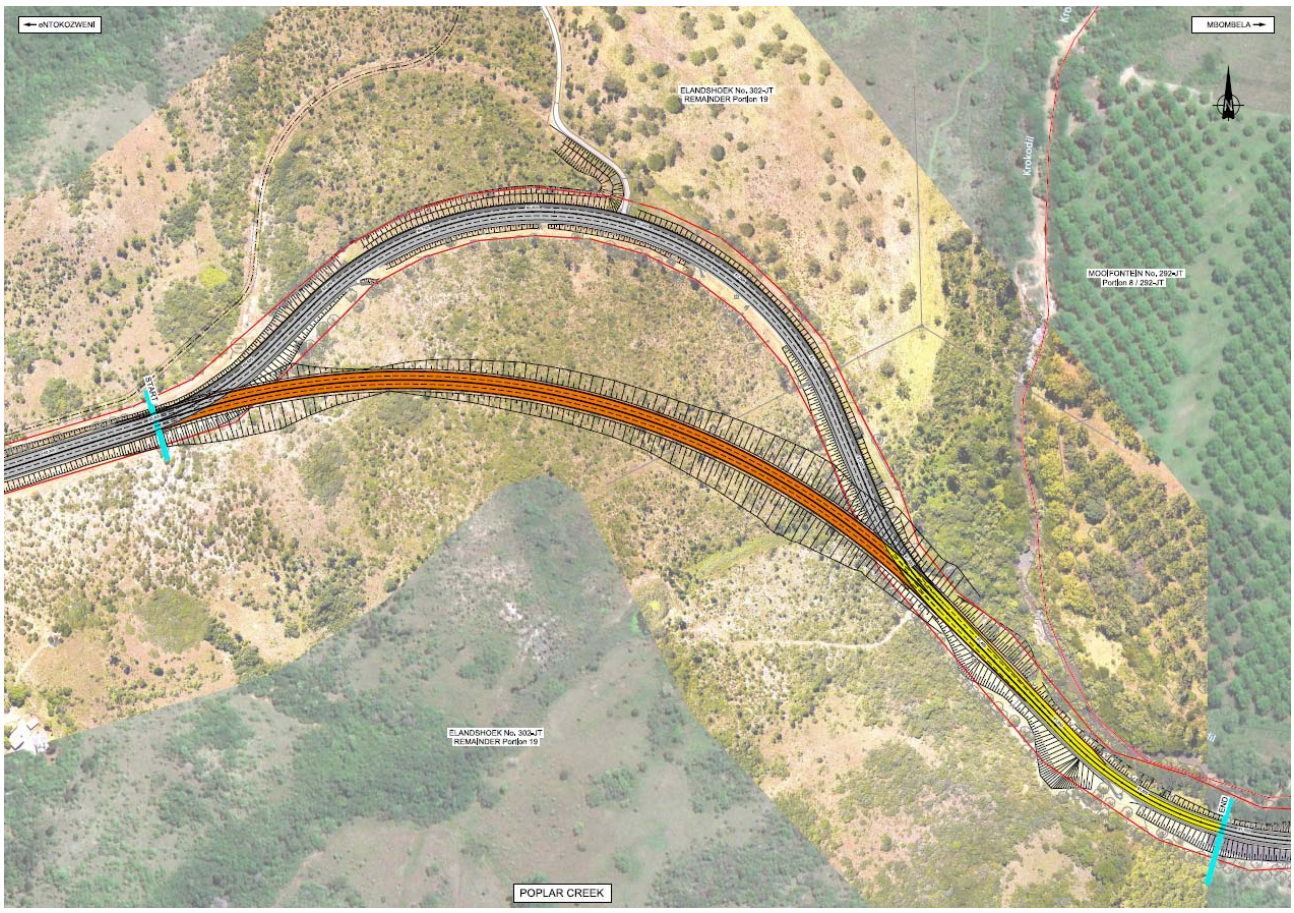

Figure 4-12: Layout of the proposed re-alignment of the horizontal curve part Poplar Creek.

The traffic accommodation cost to reconstruct the existing N4 will be high and possibly disruptive to traffic as the eastern part of the existing N4 reconstruction is straddled by the Crocodile River to the north and high cliffs to the south. For the construction cost estimate for the 120 km/h design speed option, passing lanes in both directions were allowed for. The cost of the planned passing lane as part of the Preliminary Design was subtracted from the cost to achieve the "delta" construction cost estimate. The delta construction cost is estimated at ± R 16,8 M.

Due to the excessively high construction cost to upgrade this horizontal curve, the upgrade does not form part of this preliminary design report. Safety improvement to the Poplar Creek access was assessed in the high-level access management study and the relocation of the access is proposed. Refer to Section 4.2 for more detail.

4.1.5 Opening and Closing of Passing / Climbing Lane Tapers

The opening and closing tapers are based on the standards mentioned in Table 4-5 and conforms to SANRAL design guidelines.

Table 4-5: Design standards adopted for tapers.

Description	Design standard based on SANRAL typical drawings
Opening taper	Taper length: 120 m
Closing taper	Taper rate: 1:40
Recovery area	Length equal to the following stopping sight distances: Section 1 (posted speed of 120 km/h): 250 m Section 2 (posted speed of 100 km/h): 185 m

The following were considered in the positioning of the tapers:

- Climbing / passing lanes are proposed in positions where truck speeds cannot be retained at 80 km/h as a result of vertical inclines. This is based on the speed profile as contained in the Upgrade Strategy Report of August 2019.
- The opening and closing tapers of passing lanes are positioned where a driver has sufficient stopping sight distance, i.e. outside of a horizontal curve, after a vertical crest curve.
- The position of closing tapers along opposite carriageways are not located at the same position on the roadway.
- Tapers do not coincide with access positions and recovery areas are extended past access positions.

4.2 Upgrading of Intersections

The proposed upgrading of the intersections is based on the approved high-level access management plan for *Schoemanskloof*. The key principles on which this Preliminary Design is based on is highlighted in Section 1.3.

4.2.1 Intersection Layout Configurations

a) Typical Farm Access

The proposed intersections will be upgraded to the SANRAL approved farm access intersection layout, allowing a 30 m long dedicated right-turning lane as well as acceleration and deceleration tapers. The crossroads will be stop controlled. The intersection layout configuration is illustrated in Figure 4-13. This is applicable to all intersections accept the R36 (Bambi) intersection, which is classified as a provincial road.

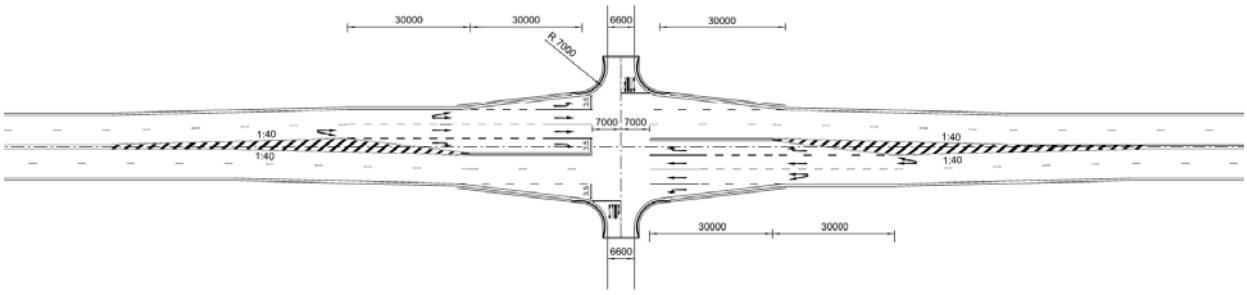

Figure 4-13: Typical access intersection layout.

b) Provincial Road Intersection

The existing R36 (P8/1) Bambi intersection, situated at km 18,09, is a 4-way intersection, with the R36 turning off to the north and the entrance to the Bambi Country Lodge situated to the south. The existing intersection layout with the R36 conforms to the SANRAL typical intersection, with sheltered right turning lanes on the Class 1 road. The intersection configuration will be reinstated

4.2.2 Positions of Proposed Intersections

The proposed intersections are numbered, and the intersection positions are indicated inTable 4-7. The table is colour coded as follows:

- Red highlighting: High priority intersections.
- Grey highlighting: Major intersections already included in the original Preliminary Design. These intersections are also classified as high priority.
- Yellow highlighting: Medium priority intersections.

- Green highlighting: Low priority intersections.

4.2.3 Intersection Spacing

The intersection spacing is listed in Table 4-7 and conforms to the minimum requirement of 600 m spacing between major intersections according to SANRAL's geometric design guidelines for a Class 2 Rural Major Arterial Road.

4.2.4 Intersection Sight Distance

The minimum intersection sight distances achieved when measuring the available intersection sight distance along the horizontal and vertical alignment respectively, are listed in Table 4-7. To measure the available sight distances along the vertical alignment, a driver eye height of 1,05 m was used and an object height of 1,3 m. The available horizontal intersection sight distances were measured from the stop line and restricted to the shoulder breakpoint of the road.

The intersection sight distance standards for SANRAL and AASHTO are listed in

Table 4-6. Most of the available intersection sight distances complies with the higher SANRAL standard for 120 km/h. The intersection sight distances not conforming to this standard are discussed in more detail below.

Table 4-6: Intersection sight distance standards.

Guideline document	Intersection sight distance for 100 km/h design speed	Intersection sight distance for 120 km/h design speed
SANRAL Geometric Design Guidelines	300 m	360 m
AASHTO, 2018	210 m	255 m

a) **Intersection No. 8 Mooiplaats, km 26,555**: The intersection sight distance is limited to the left as a result of the existing vertical alignment of the N4. The chainage, km 26,555, was optimally selected taking into consideration the property owner utilising the intersection to travel to the opposite side of his properties split by the N4. This access position is also situated between horizontal curves, and therefore cannot be shifted as the horizontal sight distance will be compromised.

b) **Intersection No. 16 Uncle John, km 42,406:** The intersection sight distance is limited to the right as a result of the existing vertical alignment of the N4. This intersection cannot be shifted more to the left, as the horizontal curve before the proposed intersection will then limit the available sight distance.

c) **Intersection No. 18 Shop J&S Bottle store, km 48,726**: An existing informal access is currently present on the road at this position. The upgrade of this intersection was included in the original Preliminary Design on request of SANRAL and can also be used to provide access to five surrounding properties should the access management plan be implemented. The intersection sight distance to both sides of the intersection is limited by the existing horizontal alignment. It is proposed to cut wide earth drains on the inside of both horizontal curves to increase the available sight distance when looking to both directions.

d) **Intersection No. 21 Die Rots / Kingfisher (Left), km 53,910:** An existing access point is currently present on the road providing access to Die Rots and Kingfisher guest houses on opposite sides of the N4. At the current access point the horizontal intersection sight distance to the right is substandard due to the horizontal bend. It is proposed to shift the access point further to the left to increase the available sight distance. The horizontal shift to the left, is however limited due to high fills and deep cuts along the N4.

Table 4-7: Summary of proposed intersections along *Schoemanskloof*.

Int. no.	Description	km-distance of centre line	Priority	Spacing between intersections	No. properties served	No. existing accesses replaced	Length of formal road required	Length of informal road required	Lowest intersection sight distance achieved
1	First	4,310	Low	-	5	5	0,771 km	1,458 km	> 350 m
2	Goedewil	7,105	High	2,769 m	6	3	1,851 km	-	> 350 m
3	Sappi	10,275	Low	3,196 m	3	5	0,650 km	-	> 350 m
4	Elandshoogte	14,570	High	4,293 m	10	8	4,814 km	0,709 km	> 350 m
5	R36 (Bambi)	18,094	High	3,524 m	5	5	1,513 km	-	>300 m
6	Kevin Gray	21,610	Low	3,518 m	4	2	0,674 km	0,265 km	> 350 m
7	Game Farm	23,886	High	2,276 m	16	14	3,221 km	0,103 km	> 350 m
8	Mooiplaats	26,555	High	2,669 m	7	6	0,873 km	3,181 km	335 m (Vertical)
9	Indabushe	29,921	Medium	3,366 m	4	7	1,054 km	0,836 km	> 350 m
10	Drakenzicht	31,120	Low	1,199 m	7	5	1,810 km	-	> 350 m
11	Start of J&S properties	36,603	Low	5,756 m	3	7	0,022 km	1,572 km	> 350 m
12	Martinique	37,849	Low	969 m	3	3	0,183 km	0,066 km	> 350 m
13	Falcon Glen	39,827	High	1,982 m	6	8	0,164 km	0,139 km	> 350 m
14	A-frame house / Deon Terblanche	40,810	Medium	1,016 m	6	3	0,737 km	-	> 350 m
15	Old Joe's Kaia	41,627	High	784 m	4	4	0,827 km	0,226 km	> 350 m
16	Rietvly	42,404	Low	745 m	5	4	0,141 km	0,051 km	311 m (Vertical)
17	Weltevreden	44,076	High	1,704 m	8	6	5,072 km	0,259 km	> 350 m
18	J&S bottle store	48,726	High	4,650 m	5	7	1,113 km	0,057 km	240 m (Horizontal)

Int. no.	Description	km-distance of centre line	Priority	Spacing between intersections	No. properties served	No. existing accesses replaced	Length of formal road required	Length of informal road required	Lowest intersection sight distance achieved
19	J&S shooting range	49,831	Medium	1,105 m	6	6	1,529 km	-	> 350 m
20	J&S Padstal	51,875	Medium	2,044 m	3	5	1,804 km	-	> 350 m
21	Die Rots / Kingfisher	53,909	Low	2,035 m	5	4	0,838 km	0,064 km	266 m (Horizontal)
22	Croc Grove	55,512	High	1,602 m	7	5	0,615 km	1,465 km	> 350 m
23	Mashobotho Trust	57,366	Low	1,854 m	2	4	-	0,032 km	> 350 m
24	Poplar Creek	59,582	Medium	2,204 m	5	2	0,869 km	0,906 km	> 350 m
	TOTALS				**135**	**128**	**31,145 km**	**11,389 km**	

4.2.5 Gravel Access Roads

With the implementation of the access management plan, direct access points to the N4 will be closed off and formal gravel access roads will be utilized within a 16 m wide road reserve to reinstate access across adjacent properties to the proposed intersections along Schoemanskloof. Access to all properties currently gaining access to *Schoemanskloof* will be reinstated. Informal gravel access roads will also be utilised to reinstate access from existing internal gravel roads to the proposed formal gravel access roads. The informal access roads will solely be used by the property owner.

Both the formal and informal gravel access roads will be 6,6 m wide and the formal gravel access roads will be situated within a 16 m wide road reserve situated outside of the existing N4 road reserve. Additional land will have to be acquired for the formal gravel access roads. The typical cross-section for the gravel access roads are illustrated in Figure 4-14.

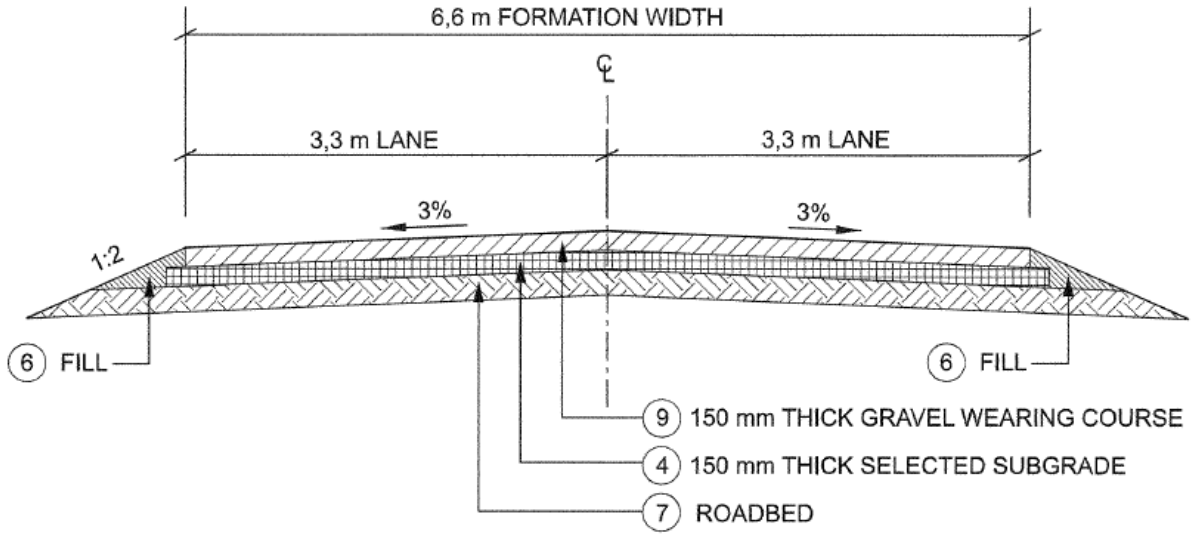

Figure 4-14: Typical cross-section of proposed gravel access road.

4.3 Sound Barriers

The section of *Schoemanskloof* between km 36,900 and km 42,100 has private properties situated near the road. During liaison with the owners and during the public participation open days, the owners were concerned about the noise pollution caused by the road, especially with further encroachment. The implementation of a noise barrier or similar is under consideration by TRAC.

4.4 Road Reserve Width

The current road reserve width of the N4 is ± 40 m, but varying. Localised widening of the road reserve will be required where the upgraded road prism extends up to or beyond the existing road reserve as a result of the proposed road widening. Additional road reserve will also be required for the formal access roads situated within a 16 m road reserve adjacent and outside of the existing N4 road reserve.

4.5 Planned Montrose Interchange

As part of contract TRAC/NEW-01/2017, SMEC was appointed by TRAC for the design of the proposed Montrose Interchange to replace the existing at-grade intersection of *Schoemanskloof* with N4 Section 7X (MDC Section 6E, also known as Elands Valley).

An interim and ultimate scheme of the interchange were proposed and both were accepted by TRAC and SANRAL. The interim scheme is currently in the Construction stage and the ultimate scheme is reserved for future planning. In summary, the project consists of the following:

- A grade-separated interchange that will accommodate free-flow movements for all movements with two new bridges over N4-7X (Elands Valley). The portion of *Schoemanskloof* between km 62 049 and MDC Section 6E will be realigned.
- The existing Crocodile River bridge B1577 will be upgraded to allow two lanes in the eastbound direction and three lanes in the westbound direction across the bridge.
- New access point to Martin's Haven and the Joubert & Sons warehouse will be provided via an upgraded existing farm access. The access point will be an at-grade intersection and link to the existing *Schoemanskloof* road, functioning as an access road to these properties.

Ramp A (from Mbombela to *Schoemanskloof*) will consist of two lanes in the westbound direction. The second lane will be approximately 1,2 km in length and function as the first passing lane on *Schoemanskloof*. This passing lane forms part of the Montrose Interchange project and is therefore excluded from the *Schoemanskloof* road upgrade.

4.6 Safety Improvements and Considerations

The following road safety improvements form part of the *Schoemanskloof* road upgrade:

- Existing passing / climbing lane tapers often opens and closes inside horizontal curves or on the crest of vertical curves. In order to provide sufficient stopping sight distance, the closing and opening of tapers are positioned outside horizontal curves and past vertical crests.
- The radius through the Weltevreden Road intersection are increased to allow for improved intersection sight distance and overall safety. Furhermore, this access will be widened to include a protected right turn lane, which has previously been requested by the Farmers' Association.
- Wide gravel shoulders are implemented along sections where the road is widened and in fill. This creates an area for a vehicle to safely pull off the road and out of the way of traffic.
- Existing gravel shoulders will be rehabilitated where possible to eliminate the level difference between the existing road surfacing and gravel shoulders as a result of previous rehabilitation actions.
- Warning signs will be implemented in areas where the design speed of the road is lower than the posted speed and practical, i.e. along sharp bends and areas such as De Beersnek and Patatanek.
- Road markings to be repainted according to standard and to conform to the geometry of the road, i.e. no overtaking in locations where there are perceived passing opportunities.
- As part of the Upgrade Strategy phase of the project, accident data between January 2016 and March 2019 were plotted along the centreline of the road and grouped into clusters. New passing / climbing lanes coincide with most of these accident clusters which should improve the safety along these sections.
- A 300 mm wide painted median will be implemented for *two-lane* and *three-lane facilities*. A 600 mm wide painted median with a yellow centreline and rumble strips will be implemented for an *undivided four-lane* scenario to discourage drivers to overtake.
- From site observations, it was observed that guardrails often stop too short. In these cases where fills are higher than 3 m, the guardrails will be extended.
- Passing lane lengths along *Schoemanskloof* are increased from 17% to 50% and significantly improving the LOS for the road.

- The main concern raised during both sets of Public Open Day sessions was the safety of private accesses. The proposed access management plan reduces the number of direct access points along *Schoemanskloof* from approximately 130 accesses to 24 intersections. The proposed intersections will have protected turning lanes as well as acceleration and deceleration tapers. This will significantly improve the abovementioned safety concern and create a much safer road for travellers and landowners along the route. Access management along the route will, however, have a phased implementation. Only prioritised intersections will be constructed as part of the road upgrade construction.
- Sight distances will be improved along the route where feasible by creating wider cuttings to improve the line of sight along horizontal curves.
- It is proposed that the access point to Poplar Creek be repositioned to a safer location as part of the access management proposal. Improvements to the horizontal curve at Poplar Creek are currently being considered by TRAC and SANRAL.

5 Stormwater Drainage Infrastructure

5.1 Hydrology

The average rainfall for the area is approximately 870 mm per annum.

Catchment slopes are moderate to steep, with vegetation cover consisting mainly of pine plantations, dense bush and agricultural land. Moderate stormwater run-off can therefore be expected.

The Rational Method was utilized, where necessary, in the calculation of stormwater run- off for minor stormwater culverts.

5.2 Existing Minor Drainage

The existing minor stormwater drainage infrastructure along the route consists of surface drainage and cross drainage culverts. The surface drainage consists mainly of concrete lined side drains, kerb and channel combination drains, side inlets as well as down pipes. Minor cross drainage culverts are mainly single or multiple 600 mm and 900 mm diameter pipe culverts, with a few larger pipe and box culverts with a maximum diameter or height of 1 800 mm.

From recent site visits it was observed that for some cross drainage culverts the culvert sizes change along the length of the crossing, possibly coinciding with road widenings of the past. An example is illustrated in Figure 5-1. It was decided by TRAC to rectify these situations where possible.

Figure 5-1: Example of culvert sizes and shape differ at single crossing position (± km 50,220).

Existing culverts classified as minor culverts according to SANRAL's latest standards but has a structure number assigned to them under previous standards will be declassified. These culverts will be extended by precast units where practical and feasible.

Subsurface drainage infrastructure is also expected to form part of the minor stormwater drainage system; particularly on the sections of road with concrete lined side drains. However, the existence and condition of the existing subsurface drains has to be confirmed.

5.3 Proposed Drainage Infrastructure

The existing concrete lined side drains along both sides of the road that will be affected by road widenings, will be replaced with new concrete lined side drains, where required. In addition, where the road widening necessitates side drains, new concrete lined side drains will be provided.

All new concrete lined side drains will be provided with subsurface drains underneath, whilst berms on top of cuttings will be provided where necessary.

All affected kerb and channel combination drains, side inlets and down pipes will be removed where the road is widened. Limited lengths of concrete lined side drains on top of high fills, with side inlets and down pipes, will be constructed mainly at the bridges with parapets as well as where required due to expected erosion of the fill slopes.

The existing minor cross drainage culverts will be extended to either the north or south where road widenings occur.

Affected culverts underneath accesses will be replaced with new concrete culverts and several farm accesses with concrete drifts will be reinstated. The culvert underneath the farm access at km 35,780 on the southern side of the road will be replaced with a concrete drift at the farm access in order to adequately convey stormwater run-off to the major culvert at km 35,860.

The cross-drainage system between km 45,640 and km 45,700, including the culvert underneath the farm access at km 45,665, requires further investigation during the detail design stage in order to confirm if the system is sufficient to manage the anticipated stormwater run-off along this section of road.

New inlet- or outlet structures will also be provided to accommodate culvert extensions or replacements. Where minor drainage culverts are lengthened to one side, clearing and grubbing may also be required at the inlet- or outlet structure being retained in order to ensure functionality of the culvert.

Concentrated stormwater flow across the gravel access roads will be managed by means of concrete drifts and concrete causeways.

6 Major Structures

6.1 General

Schoemanskloof crosses numerous streams and watercourses. As previously mentioned, the route traverses rolling to mountainous terrain with topography that generally drains towards the east. The Crocodile River meanders just north of the road. As a consequence, the watercourses generally flow from south to north.

An additional 16,7 km of eastbound passing / climbing lanes and 22,7 km of westbound passing / climbing lanes are proposed. Where possible, the start and end of passing / climbing lanes are positioned to avoid lengthening / widening of the major structures. In cases where this cannot be avoided, the affected major structures shall be lengthened / widened to accommodate the proposed road upgrade. The affected major structures are summarised in Table 6-1. Bridge Width Schedules (BWS) have been compiled in SANRAL's format and is included in the Book of Drawings, i.e. drawing no.'s. PE293-BWS01 to PE293-BWS06.

Table 6-1: List of structures affected by the upgrade of *Schoemanskloof*.

Structure no.	km	Type	Name
C1077	3,603	Major Culvert	Blaauwboschkraal Tributary
S3501	16,500	Major Culvert	River / Stream Culvert
S3502	18,240	Major Culvert	River / Stream Culvert
B2064	23,468	Bridge	Zondagskraal River Bridge
B2065	25,178	Bridge	Mooiplaats River Bridge
S3504	27,283	Major Culvert	Agricultural Underpass*
S3509	32,137	Major Culvert	Buffelskloofspruit Tributary
B2067	35,425	Bridge	Sterkspruit Bridge
S3514	36,706	Major Culvert	Agricultural Underpass
S3516	37,950	Major Culvert	Sterkspruit Tributary 1
S3517	39,397	Major Culvert	Sterkspruit Tributary 2
S3522	45,026	Major Culvert	Crocodile River Tributary 1
S3523	45,258	Major Culvert	Geluk Agricultural Underpass
S3526	49,583	Major Culvert	River / Stream Culvert
B2069	51,149	Bridge	Devil's Creek River Bridge
S3531	61,251	Major Culvert	Crocodile River Tributary 2

* Primarily a drainage culvert. Also functions as an agricultural underpass.

Only structures which are affected by the widening of the road will have rehabilitation works carried out, which was identified in the most recent bridge and culvert inspections.

6.2 Hydrologic and Hydraulic Conditions

Schoemanskloof is classified as a Class 2 Rural Major Arterial road. All existing major drainage culverts were originally designed for a 20-year flood return period as prescribed in the Concession Contract. Following the introduction of the SANRAL Code of Procedures (2002) and Drainage Manual (latest version 2013), the hydraulic requirements for major culverts subsequently changed. It was therefore necessary to check if the existing major culverts comply with the present SANRAL requirements.

The required design return periods and corresponding peak discharges were first established. For each culvert, the design discharge for a reference 20-year return period, Q_{20}, was used in combination with Figure 8.2 of the Drainage Manual (Figure 6-1) to estimate the applicable design return period. Relevant hydraulic and hydrological information was obtained from as-built drawings. For culverts C1077, S3504 and S3509 no as-built drawings were available and such information was estimated using recognised methods and formulas. Culvert S3523 was originally designed as an agricultural underpass for which no hydraulic information was required.

For each of the four affected bridge structures, the peak discharge for a reference 20-year return period, Q_{20}, was obtained from the as-built drawings.

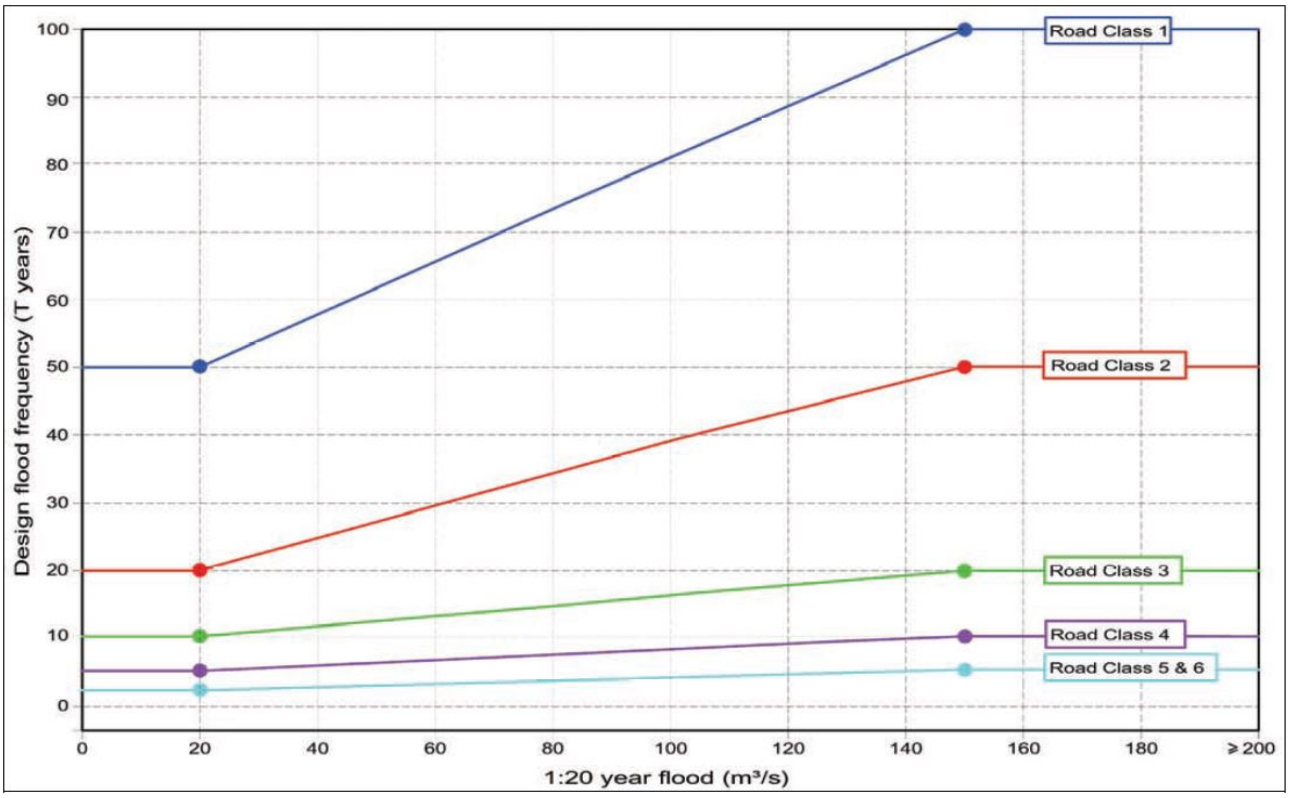

Figure 6-1: Design flood frequency (Figure 8.2, SANRAL Drainage Manual, 2013).

The resultant peak flood discharges were then compared with the hydraulic capacity of the culverts. Capacities were calculated using survey, as-built drawings and site inspection information. In cases where a major culvert or bridge had insufficient capacity for a flood with a return period corresponding to a Class 2 road, it was tested against that corresponding to a Class 3 (Rural Minor Arterial) road. According to the Drainage Manual, a structure with a hydraulic capacity satisfying the requirements of a road one class below the road's actual classification can be considered acceptable. If the structure is found to be totally hydraulically inadequate, it should be replaced or upgraded to accommodate the correct floods for the actual class of road.

In terms of Section 8.3 of the Drainage Manual, the following requirements apply for the hydraulic capacity of drainage structures:

- For Q_T: The minimum required freeboard is satisfied for the given design peak discharge, and
- For Q_{2T}: The design flood level does not overtop the road shoulder break point.

6.2.1 Hydraulic Analysis of Bridges

The findings of the hydraulic analysis for the bridge structures affected by widenings are summarised in Table 6-2.

Table 6-2: Hydraulic information for bridges affected by widenings.

Bridge no., km	Road class	Effective catchment area (km^2)	20-Year flood Q20 (m^3/s)	Design return period T (years)	Design flood QT (m^3/s)	Road flooded ? (Y/N)	Design return period 2T (years)	Design flood Q2T (m^3/s)	Road flooded ? (Y/N)
B2064, 23,468	2	24,1	128,0	45	162,0	N	90	192,0	N
B2065, 25,178	2	23,0	135,0	45	172,0	N	90	202,0	N
B2067, 35,425	2 3	31,2 31,2	156,7 156,7	50 20	205,0 156,7	Y N	100 40	241,0 193,1	Y Y*
B2069, 51,149	2	40,8	184,7	50	241,5	N	100	284,1	N

6.2.2 Hydraulic Recommendations for Bridges B2064, B2065 and B2069

The above shows that the bridges B2064, B2065 and B2069 have adequate capacity for the hydraulic requirements of a Class 2 Major Arterial Road. In terms of the Drainage Manual, *the bridge can be considered acceptable and does not require upgrading or replacement*.

Additionally, the calculated effective catchment area and estimated flood discharges were found to correlate closely with the as-built information.

At Bridge B2065 it is further recommended that siltation at both the inlet and outlet of the bridge be removed to the level of the existing floor slab. Siltation prevention measures should also be considered during detailed design.

6.2.3 Hydraulic Recommendations for Bridge B2067

* Bridge B2067, was found to have insufficient capacity for a Class 2 road. The hydraulic capacity was therefore checked for the requirement of a Class 3 road with the following findings:

- For QT = 20 years, the bridge has sufficient capacity. Though a negative freeboard is expected, it is only 100 mm above the deck soffit. The hydraulic capacity is regarded acceptable, since floodwaters will not overtop the shoulder break point.
- For Q2T = 40 years, the hydraulic capacity of the bridge will be exceeded. An estimated 36 m^3/s of overflow will drain to nearby structures B2068 (2 x 4,5 x 3,6 m box culvert at km 35,856) and S3513 (3,1 x 3,1 m box culvert at km 36,150). Further detailed analysis is required to establish the combined capacity of these structures. A property access at km 35,780 may obstruct flow between these structures and cause the road to flood at that point. Adequate drainage solutions at this point should be provided for during detailed design.
- There is evidence of canalization upstream of the bridge which extends well outside of the road reserve. This canalization will potentially increase bridge capacity because of a higher approach velocity upstream of the bridge. Further detailed analysis is required to confirm the effect of upstream canalisation. The combined capacity of adjacent culverts will avoid road overtopping for the Class 3 Q2T flood.

According to the Drainage Manual guidelines, structures that have hydraulic capacity that satisfy the requirements of class of road one below the specified class of road may be considered acceptable. Only structures which are totally hydraulically inadequate should be replaced or upgraded to accommodate the correct floods for the current class of road.

Based on the above, Bridge B2067 can be considered acceptable and does not require upgrading or replacement.

6.2.4 Hydraulic Analysis of Culverts

The findings of the hydraulic analysis for the culvert structures affected by widenings are summarised in Table 6-3.

Table 6-3 Notes:

1. Maximum capacity for a Class 2 road is a flood with a 35-year return period.
2. Sufficient capacity for a Class 3 road.
3. Berm / gabions to be constructed at new southern inlet (FGL = 1 225,050 m) to prevent floodwater overflowing into the roadway.
4. Hydraulic capacity is based on the combined capacity of S3516 and the adjacent minor culvert at km 37,925 (H = 2,1 m, W = 1,8 m).
5. Maximum capacity for a Class 2 road is a flood with a 27,5-year return period.
6. Sufficient capacity for a Class 3 road.
7. Hydraulic capacity is based on the combined capacity of S3522 and nearby culvert S3523.
8. Maximum capacity for a Class 2 road before overflowing to S3523 is a flood with a 15-year return period.
9. Sufficient combined capacity with S3523 to accommodate a flood with a 40-year return period.
10. Overflow towards S3523 during a Q_{2T} flood event for a Class 2 road.
11. Combined capacity of S3522 and S3523 is sufficient for a Class 3 road.
12. Culvert is primarily an agricultural underpass but will help drain overflow from S3522 for floods with a return period $\geq$ 15-years (Class 2 road).

    Sufficient combined capacity with S3522 to accommodate a 40-year flood.

6.2.5 Hydraulic Recommendations for Culverts

During the hydraulic analysis, effective catchments and peak flood discharges were determined and compared with the as-built information. In both instances, the evaluated results correlated closely with the as-built information.

All culverts were found to have adequate hydraulic capacity for the requirements of a road one class below the road's actual classification (i.e. for a Class 3 road). In terms of the Drainage Manual, all structures are considered acceptable and do not require replacement or upgrading.

Table 6-3: Hydraulic information for the affected major culverts.

			CLASS 2 ROAD						CLASS 3 ROAD						
Structure no., km	Effective catchment area (km²)	20 year flood (m³/s)	Return period T (years)	Design flood QT (m³/s)	Road flooded? (Y/N)	Return period 2T (years)	Design flood Q2T (m³/s)	Road flooded? (Y/N)	Return period T (years)	Design flood QT (m³/s)	Road flooded? (Y/N)	Return period 2T (years)	Design flood Q2T (m³/s)	Road flooded? (Y/N)	Comment
C1077, 3,603	5,35	39,3	25	42,3	**N**	50	51,2	**N**	-	-	-	-	-	-	-
S3501, 16,500	5,90	40,5	25	43,6	**N**	50	53,7	**Y**	12,5	33,6	N	25	43,6	**N**	*1
S3502, 18,240	2,00	22,2	20	22,2	**N**	40	27,3	**N**	-	-	-	-	-	-	-
S3504, 27,283	1,20	18,1	20	18,1	**N**	40	22,2	**N**	-	-	-	-	-	-	*2
S3509, 32,137	1,20	16,1	20	16,1	**N**	40	19,8	**N**	-	-	-	-	-	-	-
S3514, 36,706	0,65	5,85	20	5,85	**N**	40	7,2	**N**	-	-	-	-	-	-	-
S3516, 37,950	8,30	50,3	27,5	55,8	**N**	55	67,5	**Y**	12,5	42,5	N	25	54,0	**N**	*3
S3517, 39,397	0,80	9,4	20	9,4	**N**	40	11,6	**N**	-	-	-	-	-	-	-
S3522, 45,026	11,30	106,0	40	130,4	**N**	80	155,1	**Y**	15,0	96,0	N	30	120,0	**N**	*4
S3523, 45,258	-	-	40	34,0	**N**	80	59,0	**Y**	15,0	0,0	N	30	24,0	**N**	*5
S3526 49,583	0,96	13,9	20	13,9	N	40	17,1	**Y**	10	10,6	N	20	13,9	**N**	*6
S3531, 61,251	4,00	38,1	25	41,1	**N**	50	49,8	**N**	-	-	-	-	-	-	-

6.3 Major Culverts affected by Road Widening

Preliminary design has been carried out at all twelve of the major culverts affected by the proposed road widenings. The existing structures were evaluated using information from record drawings (where available), survey, inspection records and from on-site verifications carried out by SMEC during October 2019.

In general, culvert extensions of between 3 m and 10 m are required to accommodate the proposed widenings. The proposed structural solutions and actual extensions required at the major culverts affected are tabulated below in Table 6-4.

Where culvert extensions are proposed, they will match the existing structure and will be doweled into the existing structure to ensure continuity.

Table 6-4: Proposed structural solutions for affected major culverts.

Structure no., km	Extension details		Final length (m)	Comment
	Side (N/S)	Length (m)		
C1077, 3,603	N	6,68	19,69	Provide gabions / scour protection at outlet embankments.
S3501, 16,500	S	3,44	24,63	Normal culvert extension.
S3502, 18,240	N	10,94	48,19	Normal culvert extension.
S3504, 27,283	S	3,22	20,15	Berm to be constructed at new inlet (FGL = 1 225,050 m) to prevent floodwater overflowing into the roadway.
S3509, 32,137	N & S	N: 8,39 S: 6,52	36,02	Normal culvert extension.
S3514, 36,706	N & S	N: 2,82 S: 2,29	20,84	Normal culvert extension.
S3516, 37,950	N	6,20	26,63	Normal culvert extension.
S3517, 39,397	N	8,53	28,55	Replace and install additional concrete-filled gabion mattresses at inlet.
S3522, 45,026	S	10,12	25,49	Invert slab will sit below natural ground level (NGL) at new inlet. Drop inlet and apron slab required at new inlet.
S3523, 45,258	S	5,65	24,39	Normal culvert extension.
S3526, 49,583	N	4,40	21,12	Provide gabions at outlet embankments to channel the flow in the direction of the existing downstream channel within the road reserve.
S3531, 61,251	-	-	24,90	Existing length sufficient to accommodate northern road widening. Gabion wall required behind outlet headwall to retain widened road embankment.

6.3.1 Summary of Findings and Recommendations for Major Culvert Works

- All culverts are considered hydraulically acceptable as they satisfy the requirements of a Class 3 Minor Arterial road; one class below the actual classification of *Schoemanskloof* (Class 2 Major Arterial).
- Cast in-situ extensions are proposed for nine culverts to accommodate the road widenings.
- Culvert S3531 does not require extending. Instead, a gabion wall is proposed to retain the widened road embankment behind its outlet headwall.
- Culvert S3514 at km 36,706 will need to be extended approximately 2,5 m on either side to accommodate the tapering geometry of the proposed access. The alternative option would be to extend the existing headwall height and reduce the gravel shoulders from 2,7 m wide to approximately 1,2 m wide over the culvert.
- None of the culverts require urgent repairs / rehabilitation. Notable remedial activities identified by a 2018 and 2019 SMEC inspections include:
  - C1077: Outlet scour repairs.
  - S3502: Mass concrete fill to possible undermining of foundation fill at large crack in base of wall.
  - S3509: Cell displacement / settlement requires concrete fill to invert and footings.
  - S3517: Inlet scour repairs and improvements.
  - Further details and drawings of the rehabilitation measures will be set out during detailed design.
- All culvert extensions will be founded on rockfill foundations encased in geotextile.
- During construction, all excavations should be inspected by a competent person to verify the findings and recommendations of this report.

6.4 B2064: Zondagskraal River Bridge km 23,468

6.4.1 Description of the Existing Structure

Bridge B2064 is located at km 23,468 and carries *Schoemanskloof* over the Zondagskraal River. The deck has an overall length of 20,12 m and consists of three simply supported solid reinforced concrete slabs. The substructure consists of wall-type piers and closed-wall abutments with wingwalls. The original date of construction is unknown. In 2000, the bridge was widened towards the south. The original deck was replaced, and the abutments and piers received mass concrete extensions. New wingwalls were also constructed on the side of the widening. An elevation and longitudinal section of the existing bridge are shown in Figure 6-2 and Figure 6-3 respectively. Details of the existing bridge are summarised in Table 6-5.

Figure 6-2: North elevation of existing bridge B2064.

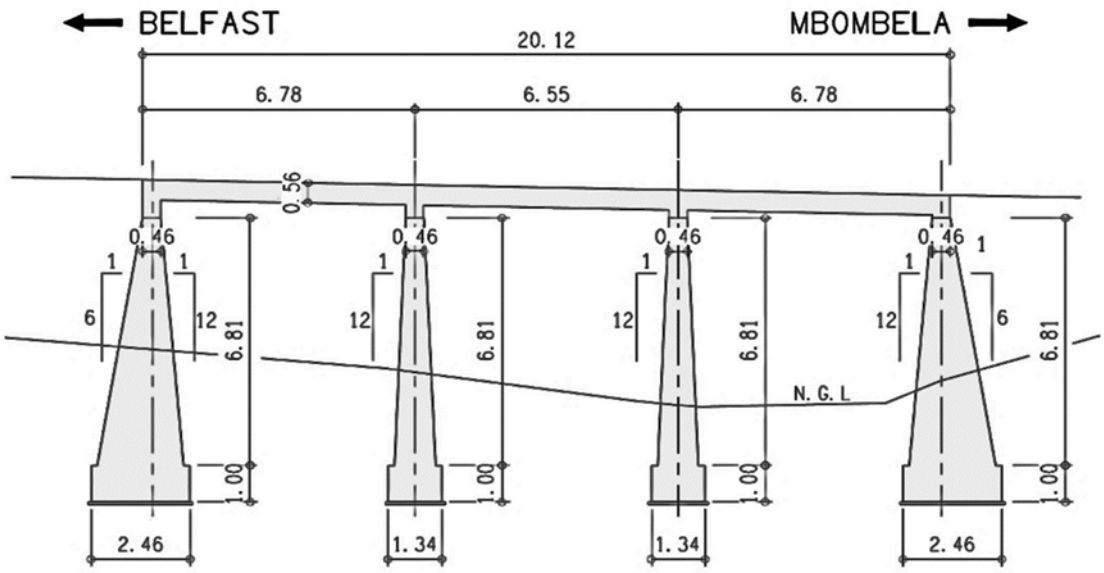

Figure 6-3: Longitudinal section of existing bridge B2064.

Table 6-5: Details of existing Bridge B2064.

Bridge no.	B2064
Name:	Zondagskraal river bridge.
Type:	Road over river.
Year of construction:	2000 (Widening).
Length:	20,12 m
Width between parapets:	12,40 m
No. of spans	3
Balustrades:	Precast new jersey barriers. In-situ end blocks.
Bearings:	Simply supported on 3-layers roofing felt.
Expansion joints:	Asphaltic-plug (thorma) joints.
Design loads:	NA, NB36 & NC 30 x 5 x 40, TMH7 Parts 1, 2 & 3 (Amended 1988).
Deck type:	3 x Solid reinforced concrete slabs.
Maximum deck depth:	0,56 m
Skew:	None
Crossfall:	± 2% From crown on deck.
Vertical grade:	± 2% Fall towards east.
Horizontal curvature:	None (straight).
Substructure:	Closed-wall abutments with wingwalls, wall-type piers.
Foundations:	Spread footings.

6.4.2 Proposed Widening Solution

As part of the upgrades to *Schoemanskloof*, an additional westbound lane will be provided over bridge B2064. To accommodate this, it is proposed that the bridge be widened along its southern edge using reinforced concrete.

Widening of the deck will entail demolition of the existing parapet, preparation of the existing deck edge, doweling into it, and casting the extension. The proposed deck section is shown in Figure 6-4. As shown, the existing camber will be continued onto the widened deck. If necessary, the soffit of the widening can be inclined to ensure a minimum deck depth is achieved.

Moreover, additional reinforcement will be provided to the existing deck edge to manage the load introduced by the widened deck. This effect is somewhat counteracted by the relieving effect caused by the removal of the existing parapet. Since the deck is simply supported with relatively short spans, differential creep and shrinkage will be negligible and the use of a second-stage longitudinal deck pour strip is unwarranted.

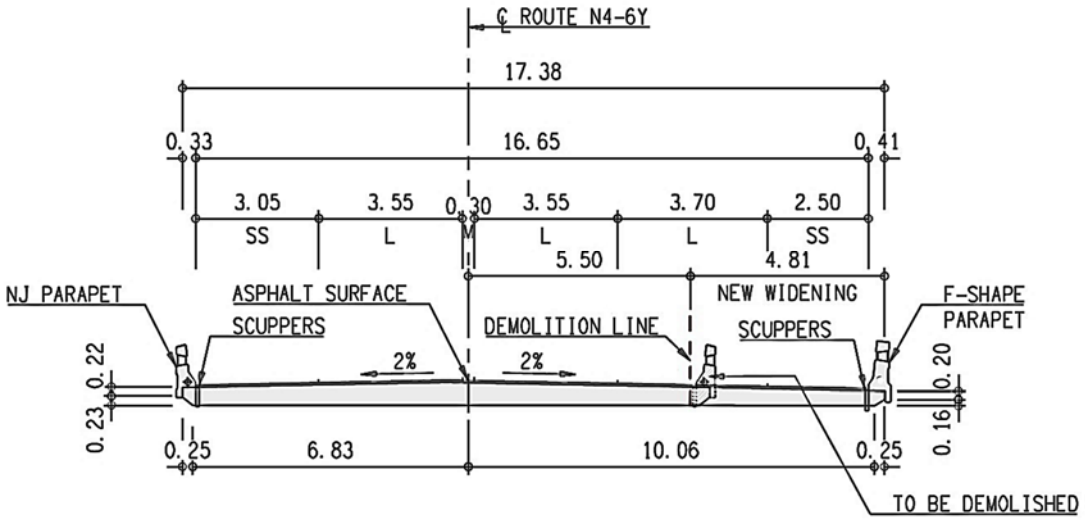

Figure 6-4: Proposed deck section on B2064.

The substructure will be widened by doweling into and extending the existing pier and abutments. Additionally, reinforced concrete wingwalls will be constructed on the widened side of the bridge. All new works will have the same form as the existing substructure. Where possible, existing wingwalls will be maintained and buried under the widened road fill. However, local demolition of existing concrete may be required to accommodate the extensions. Differential settlement can be minimised by founding onto hard rock material, to match the existing bridge founding.

6.5 B2065: Mooiplaats River Bridge at km 25,178

6.5.1 Description of the Existing Structure

Bridge B2065 is located at km 25,178 and carries *Schoemanskloof* over the Mooiplaats River. The deck has an overall length of 20,17 m and consists of three simply supported solid reinforced concrete slabs. The substructure consists of wall-type piers and closed-wall abutments with wingwalls. It is supported throughout on a 455 mm thick solid reinforced concrete raft foundation. The original date of construction is unknown. In 2000, the bridge was widened towards the south. The deck received a reinforced concrete overlay to suit the road's vertical alignment while the substructure received mass concrete extensions. New wingwalls were also constructed on the side of the widening. An elevation and longitudinal section of the existing bridge are shown in Figure 6-5 and Figure 6-6 respectively. Details of the existing bridge are summarised in Table 6-6 on the next page.

Figure 6-5: **North elevation of existing bridge B2065.**

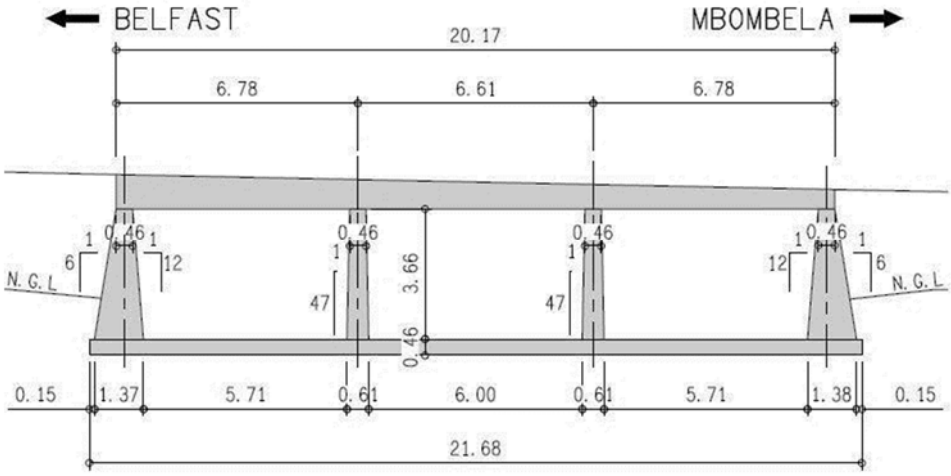

Figure 6-6: **Longitudinal section of existing bridge B2065.**

Table 6-6: **Details of existing bridge B2065.**

Bridge no.	B2065
Name:	Mooiplaats river bridge.
Type:	Road over river.
Year of construction:	2000 (Widening).
Length:	20,17 m
Width between parapets:	12,40 m
No. of spans	3
Balustrades:	Precast new jersey barriers. In-situ end blocks.
Bearings:	Simply supported on 3-layers roofing felt.
Expansion joints:	Asphaltic-plug (thorma) joints.
Design loads:	NA, NB36 & NC 30 x 5 x 40, TMH7 Parts 1, 2 & 3 (Amended 1988).

Bridge no.	B2065
Deck type:	3 x Solid reinforced concrete slabs.
Maximum deck depth:	0,88 m (incl. overlay).
Skew:	None.
Crossfall:	± 2% From crown on deck.
Vertical grade:	± 1% Fall towards east.
Horizontal curvature:	None (straight).
Substructure:	Closed-wall abutments with wingwalls, wall-type piers.
Foundations:	0,455 m thick solid reinforced concrete raft.

6.5.2 Proposed Widening Solution

As part of the upgrade to *Schoemanskloof*, an additional westbound lane will be provided over bridge B2065. To accommodate this, it is proposed that the bridge be widened along its southern edge using reinforced concrete.

Widening of the deck will entail demolition of the existing parapet, preparation of the existing deck edge, doweling into it, and casting the extension. The proposed deck section is shown in Figure 6-7. As shown, the existing camber will be continued onto the widened deck. If necessary, the soffit of the widening can be inclined to ensure a minimum deck depth is achieved.

Moreover, additional reinforcement will be provided to the existing deck edge to manage the load introduced by the widened deck. This effect is somewhat counteracted by the relieving effect caused by the removal of the existing parapet. Since the deck is simply supported with relatively short spans, differential creep and shrinkage will be negligible and the use of a second-stage longitudinal deck pour strip is unwarranted.

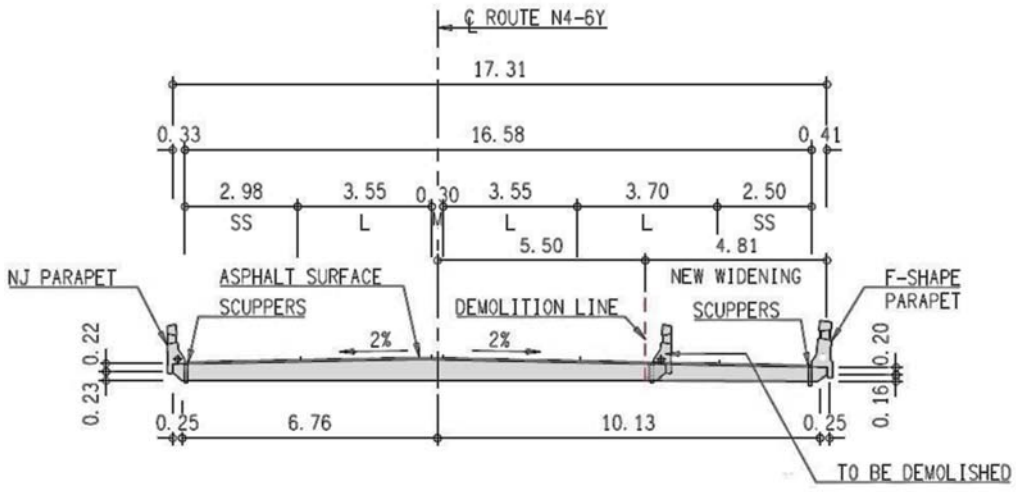

Figure 6-7: Proposed deck section on B2065.

The substructure will be widened by doweling into and extending the existing piers, abutments and concrete raft. Additionally, reinforced concrete wingwalls will be constructed on the widened side of the bridge. All new works will have the same form as the existing substructure. Where possible, existing wingwalls will be maintained and buried under the widened road fill. However, local demolition of existing concrete may be required to accommodate the extensions. Differential settlement can be minimised by placing compacted rockfill underneath the geotextile-wrapped rockfill foundations proposed.

6.6 B2067: Sterkspruit River Bridge at km 35,425

6.6.1 Description of the Existing Structure

Bridge B2067 is located at km 35,425 and carries *Schoemanskloof* over the Sterkspruit River. The deck has an overall length of 33,13 m and consists of six simply supported solid reinforced concrete slabs. The substructure consists of wall-type piers and closed-wall abutments with wingwalls. All supports rest on 450 mm thick footings interconnected with a 300 mm solid reinforced concrete raft foundation. The original date of construction is unknown. In 2000, the bridge was widened towards the south. New wingwalls were constructed and the parapets and end blocks were replaced on both edges. An elevation and longitudinal section of the existing bridge are shown in Figure 6-8 and Figure 6-9 respectively. Details of the existing bridge are summarised in Table 6-7.

Figure 6-8: South elevation of existing bridge B2067.

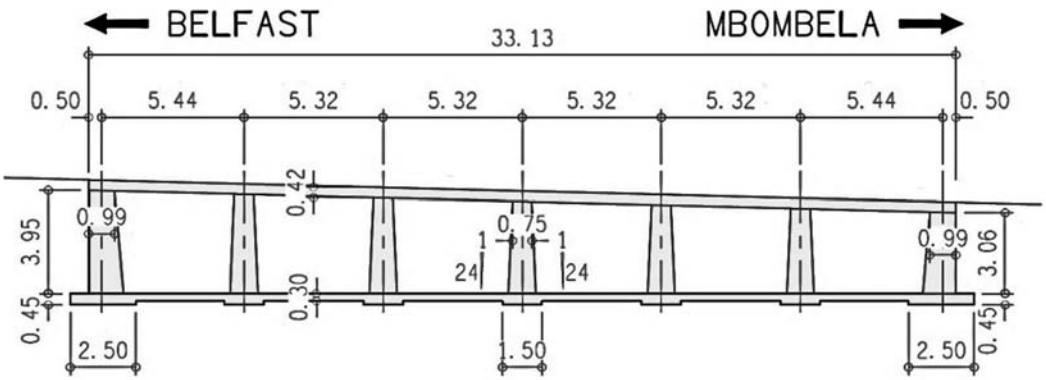

Figure 6-9: Longitudinal section of existing bridge B2067.

Table 6-7: Details of existing bridge B2067.

Bridge no.	B2067
Name:	Sterkspruit River Bridge.
Type:	Road over river
Year of construction:	2000 (Widening)
Length:	30,13 m
Width between parapets:	12,40 m
No. of spans	6
Balustrades:	Precast new jersey barriers. In-situ end blocks.
Bearings:	Simply supported on 3-layers roofing felt.
Expansion joints:	Asphaltic-plug (thorma) joint.
Design loads:	NA, NB36 & NC 30 x 5 x 40, TMH7 Parts 1, 2 & 3 (Amended 1988).
Deck type:	6 x Solid reinforced concrete slabs.
Maximum deck depth:	0,43 m
Skew:	52°
Crossfall:	± 2% From crown on deck.
Vertical grade:	± 3% Fall towards east.
Horizontal curvature:	None (straight).
Substructure:	Closed-wall abutments with wingwalls, Wall-type piers.
Foundations:	0,450 m spread footings interconnected by a 0,300 m solid reinforced concrete raft.

6.6.2 Proposed Widening Solution

As part of the upgrade to *Schoemanskloof*, an additional westbound lane will be provided over bridge B2067. To accommodate this, it is proposed that the bridge be widened along its southern edge using reinforced concrete.

Widening of the deck will entail demolition of the existing parapet, preparation of the existing deck edge, doweling into it, and casting the extension. The existing and proposed deck sections are shown in Figure 6-10. As shown, the existing camber will be continued onto the widened deck. If necessary, the soffit of the widening can be inclined to ensure a minimum deck depth is achieved. The load effects on the deck of widening, including creep and shrinkage will be dealt with as described for Bridge B2065.

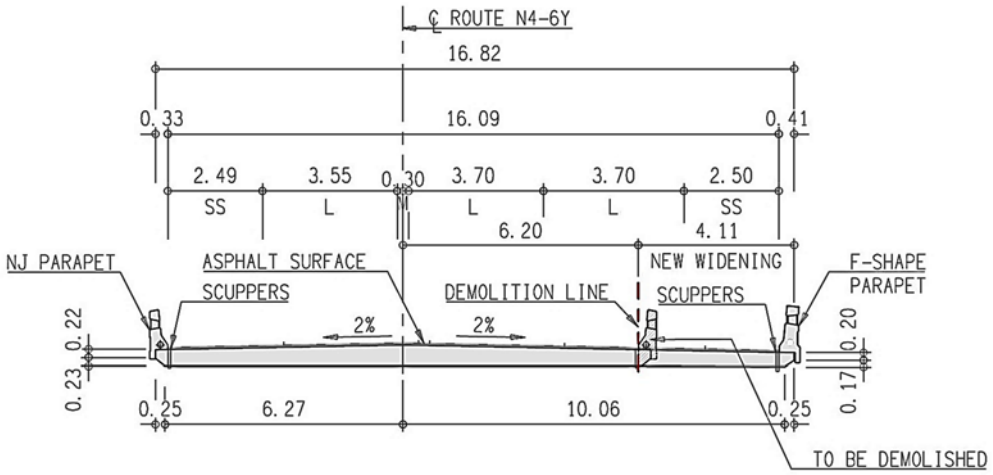

Figure 6-10: Proposed deck section on B2067.

The substructure will be widened by doweling into and extending the existing piers, abutments and concrete raft as described for Bridge B2065. Differential settlement can be minimised by placing compacted rockfill underneath the geotextile-wrapped rockfill foundations proposed.

6.7 B2069: Devil's Creek Stream Bridge at km 51,149

6.7.1 Description of the Existing Structure

Bridge B2069 is located at km 51,149 and carries *Schoemanskloof* over the Devil's Creek stream. It was built in 2000 as a replacement for a single span bridge in the same location. The bridge consists of a three-span reinforced concrete continuous cellular structure. The inlet and outlet consist of reinforced concrete headwalls, wingwalls and apron slabs with cut-off walls. The structure is founded throughout on rockfill and the approach embankments are protected with gabion mattresses. An elevation and longitudinal section of the existing bridge are shown in Figure 6-11 and Figure 6-12 respectively. Details of the existing bridge are summarised in Table 6-8.

Figure 6-11: South elevation of existing bridge B2069.

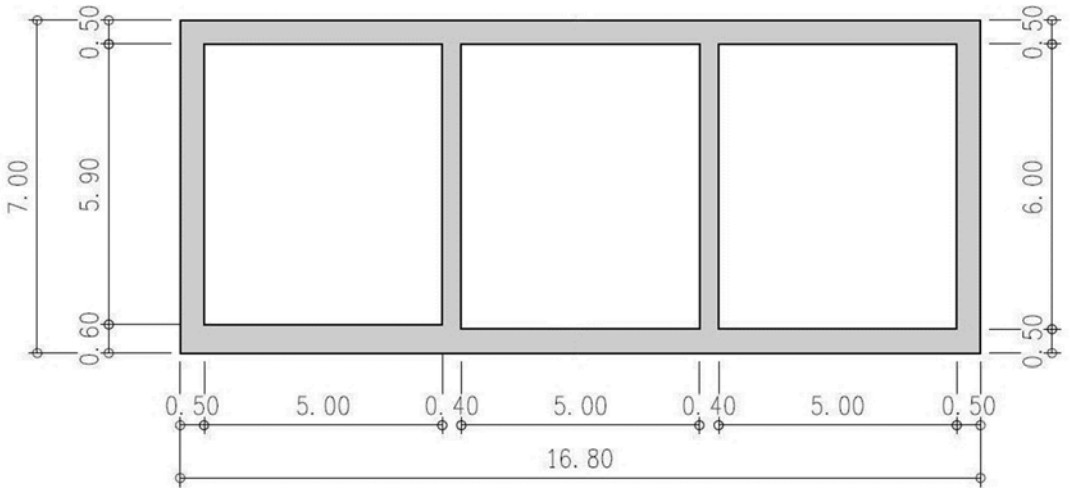

Figure 6-12: Longitudinal section of existing bridge B2069.

Table 6-8: Details of existing bridge B2069.

Bridge no.	B2069
Name:	Devil's Creek river bridge.
Type:	Road over river.
Year of construction:	2000
Structural form:	Reinforced concrete continuous cellular structure.
No. of spans	3
Length along road:	16,800 m
Cell length:	20,000 m
Inlet / Outlet structure:	Reinforced concrete headwalls, wingwalls and apron slabs with cut-off walls.
Erosion protection:	Gabion mattresses on approach embankments.
Foundations:	Founded throughout on rockfill.
Balustrades:	Guardrails on overlying road.
Bearings:	None
Expansion joints:	None
Design loads:	NA, NB36 & NC 30 x 5 x 40, TMH7 Parts 1, 2 & 3 (Amended 1988).
Top slab thickness:	0,500 m
Invert slab thickness:	Span 1: 0,6 m Span 2 & 3: 0,5 m
Invert slope:	0,5 %
Skew:	None

6.7.2 Proposed Widening Solution

As part of the upgrades to *Schoemanskloof*, an additional lane will be provided in each direction over Bridge B2069. To accommodate this, it is proposed that the bridge be extended along both edges using reinforced concrete.

The structure will be widened by doweling into the existing cell edges and casting the extensions. Additionally, new reinforced concrete inlet and outlet structures will be constructed. New works will adopt the same form as the existing structure. A section through the widened structure is shown in Figure 6-13. Where possible, existing wingwalls and headwalls will be maintained and buried under the widened road fill. However, local demolition of existing concrete may be required to accommodate the extensions. Differential settlement can be minimised by placing compacted rockfill underneath the geotextile-wrapped rockfill foundations proposed.

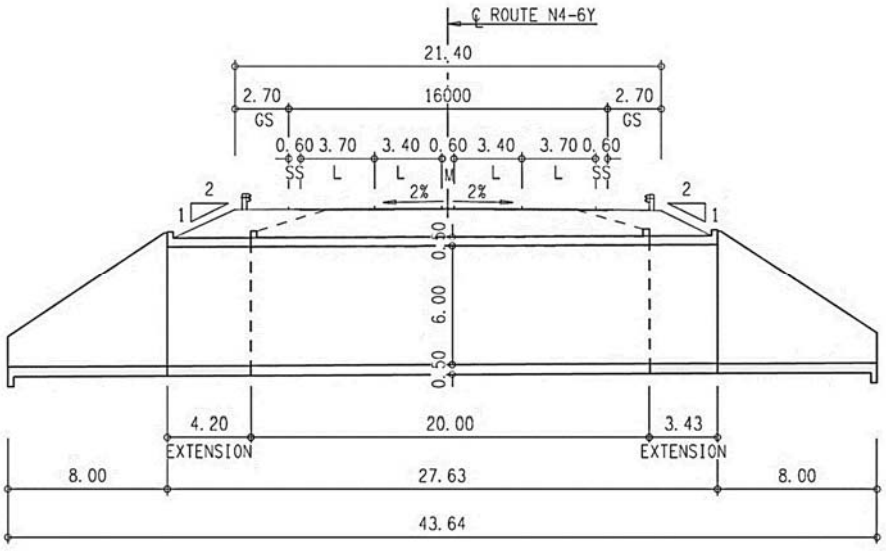

Figure 6-13: B2069 – Extended Cellular Section.

6.8 Bridge Repairs required at Bridges to be Widened

6.8.1 Bridges' Condition Assessed

The bridges were most recently inspected by Mr. Barry Schlebusch of KBK Engineers (Pty) Ltd in October 2018. During a site visit in November 2019, Messrs Roger Dickson and Johan Bisschoff of SMEC made supplementary observations of the condition of the structures. These investigations identified no urgently required repair work. However, noteworthy repair items are listed below:

6.8.2 Bridge Repairs required at B2064

- Significant shear cracks in both the original (northern) wingwalls must be sealed, and
- The asphaltic-plug joint at the west abutment requires replacement within the next five years. However, all deck joints will be replaced during the proposed widening of the bridge.

6.8.3 Bridge Repairs required at B2065

- Cracks in the deck soffit as well as significant cracks in the wingwalls require sealing,
- Steel end plates to the anchor rods of the precast parapets must be repainted,
- Joint sealant between parapet units must be replaced, and
- The asphaltic-plug joint at the west abutment requires replacement. However, all deck joints will be replaced during the proposed widening of the bridge.

6.8.4 Bridge Repairs required at B2067

- Gabions / erosion protection is required at the approach embankments,
- Spalls in the abutment wingwalls and parapets require repairing,
- Cracks in the piers and abutments require sealing,
- Exposed tie rods in the existing substructure extensions must be cut back, and
- The asphaltic-plug joint at the east abutment requires replacement. However, all deck joints will be replaced during the proposed widening of the bridge.

6.8.5 Bridge Repairs required at B2069

- Cracks in the abutments, wingwalls, headwalls and deck soffit require sealing, and
- The irrigation pipe passing through the westernmost span is leaking and spraying onto the abutment and deck. This should be repaired.

6.9 Foundation Conditions

A preliminary foundation investigation comprising a series of trial pits was carried out in October 2019 by SMEC. A summary of the foundation conditions encountered is provided in Table 6-9 below. A preliminary geotechnical investigation report was submitted to TRAC in February 2020.

Table 6-9: Foundation conditions at the affected bridges and major culverts.

Structure no.	Chainage	Foundation conditions
C1077	3,603	Hand dug trial pits refused on boulders at 0,7 m. Water at 0,3 m.
S3501	16,500	Soft sandy clay to 2,6 m. Rockfill (cobbles and boulders) in mesh observed to 2,2 m (likely existing foundations). Water at 0,7 m.
S3502	18,240	Soft / firm sandy clay to 2,6 m. Medium dense sand and gravel thereafter. Water at 1,0 m.
B2064	23,468	Cobbles and boulders observed up to 2,7 m. Refusal on boulders. Water up to 0,4 m.
B2065	25,178	Cobbles and boulders up to 2,3 m. Refusal on boulders. No water.
S3504	27,283	Medium dense clayey sand to 1,5 m. Very soft rock thereafter. No water.
S3509	32,137	North – sand fill to 1,0 m. Clayey sand / sandy clay with boulders thereafter. South – boulders up to 2,3 m. Refusal on boulders. No water.
B2067	35,425	Boulders up to 2,1 m. Refusal on boulders. Water at 0,4 m.
S3514	36,706	Loose to medium dense clayey sand to 2,8 m, overlain in T2 by gravelly sand fill.
S3516	37,950	North – Sand fill up to 1,5 m. Cobbles and boulders up to 2,4 m. Refusal on boulders. No water. South – Cobbles and boulders up to 2,0 m. Refusal on boulders. No water.
S3517	39,397	North – Medium dense sand with some boulders up to 2,6 m. Refusal in one pit on boulders. No water. South – Hand dug pit: Foundations sitting on boulders. Gabions along the edge of the apron slab. Refusal on boulders at 1,1 m. No water.

Structure no.	Chainage	Foundation conditions
S3522	45,026	North – Medium dense sandy gravel with some cobbles and boulders up to 2,7 m. Pits unstable. No water. South – Cobbles and boulders to 2,5 m. Refusal on boulders. No water.
S3523	45,258	Hand dug pits: stiff sandy clay to 1,5 m. No water.
S3526	49,583	Stiff clay to 1,5 m, medium dense clayey sand thereafter. No water.
B2069	51,149	North – cobbles and boulders rockfill up to 2,2 m (within mesh with geofabric above and below). Soft / firm sandy clay thereafter. Water up to ground level. South – cobbles and boulders up to 1,5 m. Refusal on boulders at 1,5 m.
S3531	61,251	Boulders fill up to 1,1 m. Loose and strongly cemented ferricrete thereafter. Refusal on ferricrete. No water.

6.9.1 Foundation Recommendations

For the relatively low bearing pressures anticipated for the culvert foundations and the three bridges which have concrete raft-type spread footing foundations, it is possible to adopt rockfill foundations (similar to those observed within several trial pits), utilising the hard rock cobbles and boulders in abundance along the route. To prevent transportation of the rockfill and excessive build-up of fines, the rockfill should be encased with geotextile and mesh.

For culvert C1077 and the four bridges, it is recommended that a drilling investigation be undertaken due to the following limitations of the preliminary foundation investigation:

- Water entering the test pit such that the material could not properly be assessed, combined with the presence of large boulders, prohibited excavation to the depth needed (rock at depths of approximately 7 – 8 m per as-builts where boreholes where previously drilled - only at two bridges); and
- Inadequate depth to confirm depth to hard material and settlement prediction.

It should be noted that the information and recommendations given in this report are based on point data i.e. trial pits. It is therefore possible that inconsistencies from what has been reported here may be observed during construction, where positions were not explicitly investigated. For the scale of the bridge structures to be widened, the limited point data provided insufficient information to confirm settlement predications and consistency of founding solutions.

Additional drilling investigation has been recommended by SMEC due to limitations of test pit information. However, SMEC acknowledges TRAC's requirement that no further borehole drilling for geotechnical investigation be done during the preliminary design phase, which is a risk which the Client acknowledged accepting. This requirement is based on adopting the founding method shown on the existing structure record drawings: rock fill to over-excavated foundations and placing spread footing foundations on ground-improved, encapsulated rock fill.

Although deep test pits were suggested by TRAC, the geotechnical engineer's recommendation is that deep excavation of test pits with a large excavator must be avoided at the proposed widening locations. This is because the alluvial conglomerate material of boulders and fine materials (with shallow water present) would be substantially disturbed in that process. Deep excavations would risk the stability of the material already supporting the existing structure, as well as disturbing the stability / equilibrium of the alluvial material on which the proposed widening will be founded. Therefore, the foundation design has to be based on the very limited test pit and borehole information available from the record drawings of the existing structures, and the shallow test pit information from the preliminary foundation investigation.

In order to accurately determine the depth to hard material and the settlement risk potential, additional borehole drilling would need to be carried out. If the Client seeks to minimise the risk of variation as part of construction, additional borehole drilling would need to be done during the detail design or construction stage.

It is imperative that a Competent Person inspects all excavations to ensure that conditions at variance with those predicted are exposed and accommodated in the structural design and to undertake reinterpretation of the facts supplied in this report where necessary.

7 Pavement Design and Material Usage

7.1 Historic Construction Information

The existing road is a two-lane facility with occasional passing lanes. According to as-built data from SMEC's archives, the following pavement rehabilitation actions were carried out in 2013 / 2014 from the R36 (Bambi) intersection (km 18,09) up to the at-grade intersection of *Schoemanskloof* with Elandsvalley (Montrose: km 63,72):

- 25 mm Ultra-Thin Friction Course constructed using A-P1 modified binder with 13,2 mm maximum aggregate size, full length of project road),
- 80 mm BTB (A-P1) Base layer (full length of project road),
- 250 mm Cement in-situ stabilised gravel subbase (C3) (selected sections of the project road),
- Two localised sections of full-depth pavement repair; comprising 700 mm rock fill, 150 mm selected layer covered with the above-mentioned pavement layers.

Recent mill and replace actions were carried out along localised sections of the road on areas directed by TRAC to repair performance defects.

The first 18 kilometres of *Schoemanskloof* (Section 1) was recently rehabilitated by TRAC. This section does not form part of SMEC's rehabilitation investigation and is therefore not covered in this report.

7.2 Traffic Data

Traffic data was obtained from TRAC for the years 2014 to 2020 taken at the Crossroads and Montrose counting stations. The following should be noted with regards to the position of the counting stations:

- Crossroads: The counting station is located at the start of N4-6Y at km 2,1;
- Montrose: The counting station is located at the end of N4-6Y at km 62,8;

This was supplemented with detailed hourly counts taken at the Machado Toll Plaza situated along N4-5X (km 56,43), which leads up to the *Schoemanskloof* route.

Higher heavy vehicle volumes were observed at the Montrose counting station than at Crossroads. This is most probably due to additional heavy vehicles joining *Schoemanskloof* from the R36 (Mashishing) route, which joins *Schoemanskloof* at the Bambi intersection (km 18,09).

7.2.1 Traffic Growth Rate

In recent years there have been various construction activities along both *Schoemanskloof* and Elandsvalley. This significantly affected the traffic usage of the two roads and resulted in high variability of the historical year-to-year traffic volumes along the two routes. Consequently, yielding highly variable traffic growth rates on these roads.

Traffic volumes through the Machado Toll Plaza were used to determine a more realistic growth rate for a sensitivity analysis.

The traffic growth rate through the Machado Toll Plaza was calculated by taking the average growth rate from 2015 to 2018 as shown in Table 7-1 on the next page. The growth rates in South Africa's GDP over this period are also indicated in the table. From the table the high variance in the yearly traffic growth rates is evident. The annual GDP is below 1,5%. According to Treasury's 2019 budget review; the forecasted GDP for 2019 to 2021 is between 5% and 6%.

Table 7-1: Historical growth rates at Machado Toll Plaza.

Year	Eastbound Total (veh)	Westbound Total (veh)	Total traffic (veh)	Yearly traffic growth	Real GDP growth*
2015	5225	5045	10270	11,09%	1,3%
2016	5264	4979	10243	-0,26%	0,6%
2017	5355	5155	10510	2,61%	1,3%
2018	5381	5238	10619	1,04%	0,7% (E)
			Average	**3,62%**	
* 2019 Budget Review (www.treasury.gov.za). (E) estimated.					

Based on the above a traffic growth rate of 3,6% was selected.

7.2.2 Design Traffic

The historical traffic data was used to conduct a sensitivity analysis in order to determine the design traffic for the road. It is based on the assumption that construction will start in 2020. The projected traffic volumes (year 2020) are shown in Table 7-2.

Table 7-2: Projected traffic volumes (2020).

AADT *Schoemanskloof* - 2020			
Road section		**Section 1 Crossroads to Bambi**	**Section 2 Bambi to Montrose**
Eastbound	Light	2994	3001
	Heavy	304	789
	Total	3298	3790
Westbound	Light	2753	2893
	Heavy	250	659
	Total	3003	3553
Total	Light	5747	5894
	Heavy	554	1448
	Total	6301	7343

An E80 per heavy vehicle factor of 3,3 was selected for this study. This is in line with the E80 / HV factors seen from the data for Farrefontein CTO station (3046) located near the Machado Toll Plaza. The analysis period was taken as 6 years i.e. from 2022 to 2028, up to the end of the Concession Contract.

The results of the sensitivity analysis are provided in Table 7-3. The expected design traffic over the remaining concession period (including the required additional 8 million E80s in the slow lanes at the end of the concession period), varies around 15 million to 17 million E80s.

Table 7-3: Summary of traffic sensitivity analysis.

Design traffic*	Estimated design traffic (million E80s)
Structural capacity	13 – 14
Traffic class (TRH4)	ES30

* SAPEM, Section 10

7.2.3 Visual Condition of Existing Carriageway

A detailed visual assessment of the road was carried out in October 2019 and repeated in November 2020. Visible defects were recorded along the road according to the degree rating as per TMH91. The road was found to be in a generally good to very good visual condition with localised poor sections. Longitudinal cracks occurred frequently along almost the whole length of the road. Isolated areas of patching were found along the route as well as crocodile cracks with pumping. Rutting, bleeding and transverse cracks were found to be minimal and of limited occurrence.

The surfacing along the route is a UTFC overlay that is generally in good to very good visual condition, no stripping or stone loss were observed. The typical condition of *Schoemanskloof* is shown in Figure 7-1.

General condition of UTFC	Longitudinal cracks

Figure 7-1: Typical visual condition of *Schoemanskloof*.

7.2.4 Assessment of Existing Pavement Condition

A detailed assessment on the condition of the existing pavement structure and repair options is dealt with in a separate report. However, the proposed outcome of the investigation is summarised in the section below.

7.3 Road Pavement Design

7.3.1 Existing Carriageway

A pavement assessment study was concluded in February 2020 by SMEC. Refer to "Draft Pavement Assessment Report dated February 2020" which could be supplied upon request. This report details the condition assessment of the existing pavement structure of Section 2 of *Schoemanskloof* (R36 (Bambi) intersection to future Montrose interchange) as well as the in-situ conditions of the proposed widenings.

Based on recent evaluations of the existing road, the existing UTFC surfacing has reached the end of its optimal design life and is proposed to be milled and replaced with a 45 surfacing. Limited rehabilitation of the existing road is required where high deflections and localised failures occurred. The following actions are recommended on these poor sections:

- Mill out existing 25 mm UTFC and 80 mm BTB,

[1] *TMH9: Pavement Management Systems: Standard Visual Assessment Manual for Flexible Pavements. 1992.*

- In-situ cement stabilise the existing sub-base to a 250 mm C3 layer,
- Reconstruct the 80 mm BTB base,
- Followed by a 45 mm asphalt surfacing on top of BTB base.

7.3.2 New Passing Lanes

Passing lanes will be constructed at different positions over the length of the road. According to the traffic analysis for this scenario, design traffic of 11 to 15 million E80s is recommended. The road is a Category A road with design traffic in the lower ES30 traffic class. Based on past experience, and relatively poor sub-grade conditions the following pavement structure is recommended for the newly built widened areas:

- 45 mm Asphalt surfacing,
- 150 mm G1 crushed stone base,
- 300 mm C3 cement stabilised subbase,
- 200 mm G7 natural gravel upper selected (stabilised with cement),
- 150 mm G9 natural gravel lower selected,
- 150 mm G9 (or better) in-situ roadbed (where applicable) / fill.

7.4 Materials Investigation

Test pits were excavated at 400 m intervals along the sections to be widened, where accessible with a TLB, to determine the in-situ conditions. Test results from the samples taken are summarised in the Draft Pavement Assessment Report, dated February 2020.

The purpose of the test pits was to confirm the in-situ material properties on the proposed sections to be widened and determine to what extent the material could be re-used in the pavement structure. The test pits were excavated to depths ranging from 1 m to 3 m deep using a TLB.

The main observations from the materials test data can be summarized as follows:

- The majority (69%) of the materials tested were classified as G10 quality material. This was mainly due to high PI and low CBR classification of the material. With limited occurrence of G6 to G9 material, with proportions of less than 10% for each quality class.
- The plasticity index (PI) of the materials varied from non-plastic to 37 with an average of 14. Material with a PI larger than 12 is classified as a G10 material.
- The linear shrinkage (LS) varied from 0 to 35 with an average of 7. The liquid limit (LL) varied from 0 to 80 with an average of 39. Material is regarded as potentially expansive when the liquid limit exceeds 30 and the linear shrinkage exceeds 8.
- The percentage swell varied from 0 to 27 with an average of 1.
- The grading modulus (GM) varied between 0,07 and 3 with an average of 1,1 which indicates a finer grained material.

Potentially expansive material was identified along the route which is a cause for concern.

7.5 Construction Materials

7.5.1 Hard Rock Quarries

Material investigations were undertaken at three potential quarries during 2021 (tabulated in Table 7-4). The investigations comprised the rotary coring of fourteen (14) boreholes at a cluster of three potential quarries.

Table 7-4: Summary of potential quarries.

Description	Co-ordinates		Approximate km distance
Quarry	Latitude	Longitude	
Existing quarry (EQ)	25,439091	30,469062	32,0
Quarry 10	25,441787	30,463804	31,2
Quarry 11	25,440790	30,464296	31,2

The rock quality at the existing quarry (EQ) was found to be unsuitable for development as the vertical and lateral extend of the hard quartzite outcrop proved to be limited and no testing was undertaken on the samples recovered from the borehole.

Various laboratory tests were carried out on the cylindrical core samples obtained from the boreholes at Quarry 10 and Quarry 11. The results indicates that the quartzite is not suitable to be used as G1 to G3 quality material, but it is suitable to be used as G4 quality material. It is foreseen that the establishment of a multi-stage crusher to produce the material will be required. The sourcing of material from these sites will be investigated further in the Detail Design phase of the project. The G1 quality material will be hauled from designated stockpile at the planned Montrose interchange which is produced under the Montrose project.

7.5.2 Borrow Sources (Cutting and Borrow Pits)

Test pits were excavated on each of the five (5) potential borrow pits and cuttings using a TLB. Road indicator, foundation indicator, moisture / density relationship and California Bearing Ration (CBR) tests were undertaken on disturbed soil samples recovered from the cutting and borrow pits. Table 7-5 summarises the five potential borrow pits.

Table 7-5: Summary of potential borrow pits.

Description	Co-ordinates		Approximate km distance
Borrow pits	Latitude	Longitude	
Borrow pit 2	25,439091	30,469062	44,4
Borrow pit 7	25,441787	30,463804	61,2
Existing borrow pit 10	25,440790	30,464296	3,60
Borrow pit 10	25,443011	30,462788	31,2
Borrow pit 11	25,440338	30,465030	31,2

From the test results received, G6 – G9 quality material was found in the cuttings and borrow pits. This material will be used in the lower pavement layers and fill where feasible.

7.5.3 Other Sources of Material

Aggregate for bituminous surfacing and concrete will be obtained from commercial sources. However, if the quality of the material in the rock quarry is suitable, these aggregates could be produced on site.

Water for construction purposes could be obtained from the local authorities. Water in streams and dams is not available without the necessary DWAF water permits. Negotiations can be held with local landowners who do not use their full quota to supply the contractor.

The approximate quantity of material required for this project can be summarized as follows (Excluding concrete works):

Table 7-6: Approximate quantities required for the *Schoemanskloof* upgrade.

Description	Quantities
Surfacing: • Area of existing surfacing: - Section 1 - Section 2	 ± 185 030 m^2 ± 459 550 m^2
• Surface area of proposed widening:	± 168 650 m^2
• Additional widening to bench up to lane line:	± 78 100 m^2
150 mm G1 Base:	± 39 000 m^3
300 mm Subbase	± 80 500 m^3
200mm Upper- and 150 mm upper and lower selected	± 133 000 m^3
150 mm gravel shoulder:	± 26 000 m^3
150mm gravel wearing course	± 43 000 m^3
Fill	± 292 500 m^3
Cut	± 422 500 m^3

8 Services Affected

8.1 General

Forming part of the scope of this project is the requirement to relocate or protect existing services that may be affected by the proposed road widenings along *Schoemanskloof*.

These identified services have roadway clearances that need to be adhered to, both horizontally and vertically. Thus, the focus of service relocation / protection will be on the sections of the roadway where there are proposed widenings or alignment changes that deviate from the existing roadway geometry.

In addition to clearance requirements, the placement of services from the edge of roadway is also important, to ensure that these services are offset a safe distance from the edge of roadway to mitigate the risk to public safety. The potential risk is a result of the proximity of objects to the roadway and the frequency of incidences as a result of colliding with these objects alongside the roadway edge. The further away the object is from the roadway, the less likely it is for motorists to collide with these objects.

All known services along the route are summarized on the shifting of services schedule, drawing no. PE293-SSs01. The following is a brief summary of affected services.

8.2 Electrical and Lighting Services

8.2.1 Identified Existing Electrical and Lighting Services

Along *Schoemanskloof*, there are existing electrical services located above ground and these services were identifiable from recent survey data, aerial photography and site inspections. These services either cross over *Schoemanskloof* or span alongside the roadway within the road reserve for varied lengths, via overhead line power structures. The following services were identified:

- There are underground electrical cables and flashing amber signs located near Joubert & Sons' farm stall and Falls Fish Farm.
- There is an existing lighting installation within the road reserve that will be affected by the road widening. This lighting installation is located at the Viva Petrol Port from km 43,800 to km 45,820 along *Schoemanskloof*. This lighting installation was implemented by the stakeholders of the Viva Petrol Port to light the entrance to the Petrol Port and the associated turning lanes.

8.2.2 Identified Stakeholders of Existing Electrical and Lighting Services

The main stakeholders of the existing electrical and lighting services who are impacted by the proposed road widenings are:

- SANRAL SOC LTD;
- TRAC;
- ESKOM;
- TELKOM;
- LIQUID TELECOM;
- Viva Petrol Port;
- Joubert & Sons; and
- Martins Funeral Parlour (outside the scope of this project).

There may be minor stakeholders or individuals that may be affected as a result of the relocation / protection of these services.

8.2.3 Proposed Relocation / Protection of Existing Electrical and Lighting Services

Where existing lighting installations are impacted by the proposed road widenings, it shall be necessary to evaluate the impact the road widening has on the existing lighting levels. This shall determine if the existing lighting installation shall provide lighting levels compliant to SANS lighting standards and SANRAL SOC Ltd lighting requirements for the widened road sections. Thus, it may be necessary to upgrade the existing lighting installations affected through the provision of additional light poles and luminaires, to provide compliant lighting levels for the widened road section that the existing lighting installation currently lights.

The affected electrical and lighting systems identified are listed in Table 8-1.

Table 8-1: Existing electrical and lighting services affected by project.

Item no.	Description of service	Chainage	Owner	Remarks
E01	O/H Power Line	28,060	ESKOM	Crossing over roadway, vertical clearance of service over *Schoemanskloof* to be confirmed.
E02	O/H Power Line	32,020	ESKOM	Crossing over roadway, vertical clearance of service over *Schoemanskloof* to be confirmed.
E03	O/H Power Line	37,270	ESKOM	Crossing over roadway, vertical clearance of service over *Schoemanskloof* to be confirmed.
E04	O/H Power Line	39,055	ESKOM	Existing transformer affected by northern widening. Relocation of service shall be necessary.
E05	Street Lighting	43,800 - 45,820	VIVA Petrol Port	Streetlight poles are to be relocated with additional light poles to provide compliant lighting along *Schoemanskloof* approaching VIVA petrol port entrances.
E06	O/H Power Line	61,115	ESKOM	Crossing over roadway, vertical clearance of service over *Schoemanskloof* to be confirmed.
E07	Flashing Amber Signage	TBC	TRAC	Electrical reticulation and signage may require relocation, and protection during construction.
E08	Flashing Amber Signage	TBC	TRAC	Electrical reticulation and signage may require relocation, and protection during construction.
E09	Street Lighting	TBC	Martins Funeral Parlour	Streetlight poles may require relocation and may require additional light poles to provide compliant lighting along *Schoemanskloof* approaching facility (outside the scope of this project).

8.2.4 Proposed Electrical and Lighting Works

The basis of the electrical and lighting works is the relocation of services, and that these services remain compliant to the applicable standards and requirements. There is no new installation works foreseen.

8.2.5 Design Standards and Requirements

The relocation works of the affected electrical and lighting systems shall adhere to the applicable SANS standards and stakeholder requirements:

- SANS 10098-1: Public lighting Part 1: The lighting of public thoroughfares;
- SANS 10098-2: Public lighting Part 2: Lighting of certain specific areas of street and highways;
- SANS 10142-1: Code of Practice for the Wiring of Premises-Part 1: Low Voltage Installations; and
- Stakeholder standards and requirements.

8.3 Telecommunication

8.3.1 Identified Existing Telecommunication Services

Along *Schoemanskloof*, there are existing telecommunication services located above ground and underground and these services were identifiable from recent survey data. These services either cross over or beneath *Schoemanskloof* or run alongside the roadway within the road reserve for varied lengths.

8.3.2 Identified Stakeholders of Existing Telecommunication Services

The main stakeholders of the existing telecommunication services who are impacted by the proposed road widenings are:

- SANRAL SOC LTD;
- TRAC;
- TELKOM; and
- LIQUID TELECOM.

There may be minor stakeholders or individuals that may be affected as a result of the relocation of these services.

8.3.3 Proposed Relocation / Protection of Existing Telecommunication Services

Where existing underground services may be impacted by the works, these services shall be confirmed on site for position and depth of service and shall be either relocated or protected prior the commencement of any works over these services.

It is the intention to notify the respective stakeholders of the service that may be potentially impacted by the works. The service agreements between SANRAL SOC Ltd or TRAC and the service stakeholder shall dictate the persons responsible for relocating or protecting the services and the associated costs thereof.

The affected telecommunication systems identified are listed in Table 8-2.

Table 8-2: Existing telecommunication services affected by project.

Item no.	Description of service	Chainage	Owner	Remarks
T01	Underground Optical Cable	9,388	Liquid Telecom	Optical cable crosses *Schoemanskloof*. Service to be protected during construction, may require relocation.
T02-T03	Underground Optical Cable	14,560 - 14,580	Liquid Telecom	Optical cable crosses access road. Service to be protected during construction, may require relocation.

Item no.	Description of service	Chainage	Owner	Remarks
T04-T05	Underground Optical Cable	18,085 - 18,105	Liquid Telecom	Optical cable crosses access road. Service to be protected during construction, may require relocation.
T06	Underground Optical Cable	18,128	Liquid Telecom	Optical cable crosses *Schoemanskloof*. Service to be protected during construction, may require relocation.
T07-T08	Underground Optical Cable	23,440 - 23,500	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T09	Underground Optical Cable	28,438	Liquid Telecom	Optical cable crosses *Schoemanskloof*. Service to be protected during construction, may require relocation.
T10-T11	Underground Optical Cable	32,600 - 32,940	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*. Affected by northern widening. May require relocation or protection of service during construction.
T12-T13	Underground Optical Cable	35,410 - 35,460	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T14-T15	Underground Optical Cable	35,850 - 38,870	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T16-T17	Underground Optical Cable	41,020 - 41,620	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*. Affected by northern widening. May require relocation or protection of service during construction.
T18-T19	Underground Optical Cable	45,000 - 45,050	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T20-T21	Underground Optical Cable	45,240 - 45,280	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T22-T23	Underground Optical Cable	48,020 - 48,160	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*. Affected by northern widening. May require relocation or protection of service during construction.
T24-T25	Underground Optical Cable	51,140 - 51,165	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T26-T27	Underground Optical Cable	51,880 - 51,920	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*, on culvert. Protection of service might be necessary.
T28-T29	Underground Optical Cable	60,520 - 60,620	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*. Affected by northern widening. May require relocation or protection of service during construction.

Item no.	Description of service	Chainage	Owner	Remarks
T30-T31	Underground Optical Cable	61,460 - 61,600	Liquid Telecom	Optical cable runs parallel and to the north of *Schoemanskloof*. Affected by northern widening. May require relocation or protection of service during construction.
T32-T33	Overhead Telecom Line	13,920 - 14,000	Telkom	Overhead line runs parallel and to the south of *Schoemanskloof*. Affected by southern widening. May require relocation to maintain horizontal clearance.
T34-T35	Overhead Telecom Line	14,560 - 17,100	Telkom	Overhead line runs parallel and to the south of *Schoemanskloof*. Affected by southern widening. May require relocation to maintain horizontal clearance.
T36	Overhead Telecom Line	39,088	Telkom	Overhead line crosses *Schoemanskloof*. Nearby pole affected by northern widening, may require relocation to maintain horizontal clearance.
T37-T38	Overhead Telecom Line	44,000 - 44,600	Telkom	Overhead line runs parallel and to the south of *Schoemanskloof*. Affected by southern widening. May require relocation to maintain horizontal clearance.
T39	Overhead Telecom Line	44,272	Telkom	Overhead line crosses *Schoemanskloof*. Nearby pole affected by southern widening, may require relocation to maintain horizontal clearance.
T40	Overhead Telecom Line	44,600	Telkom	Overhead line crosses *Schoemanskloof*. Nearby pole affected by southern widening, may require relocation to maintain horizontal clearance.
T41	Overhead Telecom Line	48,595	Telkom	Overhead line crosses *Schoemanskloof*. Nearby pole affected by northern widening, may require relocation to maintain horizontal clearance.

8.3.4 Design Standards and Requirements

The relocation works of the affected telecommunication systems shall adhere to the applicable SANS standards and stakeholder requirements.

8.4 Entrance Gates

The entrance gate to Wolwekrans Eco Lodge will be affected by the proposed upgrade of *Schoemanskloof*. Other relocation of gates will be identified during the detail design.

8.5 Private Services

Numerous private services were identified during recent site visits. These private services often cross underneath *Schoemanskloof* by means of culverts. These services will require relocation / protection during construction works.

9 Ancillary Works

9.1 Road Signs

New road signs will be required to conform to the SADC Road Traffic Signs Manual. All single pole road signs on this project will be replaced. The remainder of road signs are currently being maintained by TRAC and will be re-used where applicable.

9.2 Road Markings

All road markings will be designed according to the SADC Road Traffic Signs Manual standard and according to the road cross-sections as documented in Section 4.1.1.

a) Section 1

New road markings were painted on Section 1 as part of the recent rehabilitation of this section of the road. For sections where road widenings are proposed, road markings will be implemented according to the relevant cross-section and tied back to the existing road markings.

b) Section 2

The road markings along this section of road will be implemented according to the relevant cross-section.

9.3 Guardrails

a) Road widenings

Existing guardrails along the road sections being widened will be dismantled and stored for re-use. All guardrail poles and reflectors will be replaced.

b) Remainder of road

The guardrails for the remainder of the road will remain intact.

9.4 Road Reserve Fencing

Approximately 12,8 km of new 6-strand stock-proof road reserve fencing is required to demarcate the new road reserve due to widening of the N4 and approximately 31,2 km to demarcate the road reserve for the formal gravel access roads. The existing fence will be removed and stockpiled at a designated TRAC storage yard.

10 Environmental Considerations

10.1 EIA Process

At the time of writing, the Environmental Impact Assessment (EIA) application process had already commenced in the form of a Basic Assessment Report and Process (BAR). The following relevant authorities have been contacted:

- Department of Forestry, Fisheries and the Environment (DFFE);
- The Mpumalanga Department of Agriculture, Rural Development, Land and Environmental Affairs;
- Inkomati-Usuthu Catchment Management Agency (IUCMA)
- Mbombela Local Municipality;
- Ehlanzeni District Municipality.

The Public Participation Process commenced with identifying and notifying all potential Interested and Affected Parties (I&AP's) of the proposed project.

It must be noted that at that stage, the proposed project was not only the upgrades to the *Schoemanskloof* Road, but it also included the proposed Montrose Interchange project. The Montrose Interchange was proposed to replace the existing T-junction between the *Schoemanskloof* Road (R539) and the N4 Route passing Ngodwana. The Montrose Interchange project was initially advertised and opportunity for registering as an I&AP commenced on **13 September 2019**. The EIA process for the Montrose Interchange was completed in December 2020, and an Environmental Authorisation was granted for the project by the DFFE on 21 April 2021.

Soon after this initial notification and registration period for the Montrose Interchange, the Proponent opted to include the proposed upgrades to the *Schoemanskloof* Road as part of the environmental assessments and approval process. This was done on **15 November 2019** where newspaper advertisements in The Lowvelder / Die Laevelder and The Star were also published, Background Information Documents (BIDs) and Comment Forms were again provided as a basic source of information which were handed-out along the *Schoemanskloof* Route, whilst Site Notices were again displayed along the *Schoemanskloof* Road.

This prompted a need by the *Schoemanskloof* Farmers Association (who registered as I&AP) to allow Open Days to be held at the *Schoemanskloof* Farmers Association Hall during their Annual General Meeting and social gathering on Saturday, 30 November 2019 – a day which was already set aside by most individuals of the *Schoemanskloof*. To ensure additional opportunity for all to participate at the Open Days, The EAP decided to hold the Open Days on **29 & 30 November 2019**.

The decision to keep the Montrose Interchange and the *Schoemanskloof* Road upgrades as one application was decided against by the Proponent since the Montrose Interchange commencement of construction needed to be started ahead of the upgrades to the *Schoemanskloof* Road (should the two projects have been granted). The Montrose Interchange environmental assessment and public participation then went on its own course where Registered I&APs were provided opportunity to comment on the draft Scoping Report (on 22 September – 23 October 2020) and later the draft EIA Report (13 November – 14 December 2020).

All comments raised during the initial project communication (Montrose Interchange only), the combination of the two projects (*Schoemanskloof* upgrades and Montrose Interchange) and after the first set of Open Days are included in the draft BAR document for I&AP review and possible further comments.

On **3 February 2021** all registered I&APs (all of whom registered for the Montrose Interchange project and *Schoemanskloof* Road Upgrades project) were communicated to via e-mail. The communication outlined proposed changes to the original proposed upgrades to the *Schoemanskloof* Road, namely that of upgrading existing intersections along the route and consolidating numerous existing accesses to fewer intersections with associated access roads into properties. The communication also provided details of the second set of Open Days to be held on **12 & 13 February 2021** at the *Schoemanskloof* Farmers Hall.

On **16 February 2021** all registered I&APs – including additional individuals who wanted to be registered after attending the second set of Open Days, were communicated to via e-mail. The communication clarified that all comments in regard to the proposed consolidated intersections with access roads (or any other comments in regard to the proposed *Schoemanskloof* upgrades for that matter) need to be communicated by **28 February 2021**. These comments, as explained during the second set of Open Days, were required to inform the next revision of route upgrade designs.

The comments received during and after the second set of Open Days required responses drafted as a joint effort between TRAC, SMEC and the EAP due to the fact that most of the comments and concerns raised were in regard to technical, engineering or similar nature. A draft Issues and Responses Report as well as formal response letters to some landowners and the *Schoemanskloof* Farmer's Association have been drafted and will be included in the draft BAR for comment.

10.2 Specialist Studies

The following required specialist studies have been identified:

- Ecological (Flora and Fauna);
- Aquatic (SASS-5 monitoring, diatoms, riparian vegetation, etc);
- Wetland identifications and delineations; and
- Heritage Impact Assessment.

10.2.1 Ecological

The study consisted of a literature – and desktop review to provide regional context, while a site visit was done on 12 & 13 January 2020 to provide local context. During the site visit eleven plots were surveyed, and remote images captured of the area. During November 2020, an additional two sites associated with existing river crossing were assessed. In May 2021 an additional 15 surveys were done in areas where proposed access roads are to be constructed.

It was determined that the sections to be upgraded transects two threatened regional vegetation units, namely Lydenburg Montane Grassland within the Grassland Biome and Legogote Sour Bushveld within the Savanna Biome of South Africa, vulnerable and endangered respectively. The remaining natural vegetation contain national and provincial protected plants, for which permits are required for their destruction.

Due to the presence of existing road infrastructure and small footprint of the total upgrade sections (upgrade and access roads = 40 ha of which half represent pristine, primary vegetation), it is not expected that the development will have a significant impact on fauna in the area. However, the upgrade does provide an opportunity to improve the permeability of the road infrastructure to allow the movement of small to medium animals and herpetofauna to and from the Crocodile River, a source of water in the area. The proposed upgrade of the two existing river crossing will contribute significantly to improve the permeability of the landscape, especially for ground dwelling organisms during the time of flooding.

Due to the fact that the proposed upgrade will contribute less than 1% to transformation of the remaining natural vegetation and therefore habitat in the broader landscape, this development cannot be considered a no-go.

10.2.2 Aquatic

Aquatic assessments were undertaken 13 – 15 January 2020, 12th November 2020, and between 19 – 21 April 2021. These assessments determined that the road and bridge infrastructure upgrades would impact on the associated aquatic resource areas. The latest draft Aquatic Resources report focussed on riparian areas, river(s), stream(s) and drainage areas affected by the proposed activities and will be incorporated into the draft BAR for review and comment. The wetlands affected by the proposed activities are addressed in a separate report.

The Present Ecological Status (PES) for the aquatic resources scored in the middle to low ranges as the impacted reaches of the rivers, streams (perennial/non-perennial) and/or drainage lines are moderately to considerably

modified and impacted on by surrounding agricultural and recreational activities/facilities, but to a greater extent by existing roads and crossings. The Ecological Importance and Sensitivity (EIS) falls in the high range and has functionality in respect of moderating water quality and supporting intolerant fish species and sensitive aquatic macroinvertebrates. Rehabilitation will be required to enhance the ecological function of riparian areas affected by the road and bridge upgrades. The nature of the drainage lines / non-perennial streams limited the extent to which they could be studied, and has been assessed majorly on habitat integrity, current impacts, and reference conditions. The Zondagskraal, Sterkspruit, Junglespruit and Devil's Creek rivers / streams under study were considered to be highly sensitive rivers, more specifically in respect of flow, water quality and biodiversity.

For this reason, from an aquatic point of view it can be supported that the road and bridge infrastructure upgrades may proceed on condition that the required buffers are adhered to, and the resource drivers preserved. Only activities as authorised by the Environmental Authorisation and / or Water Use License should be permitted to take place. The rehabilitation of affected sections of the aquatic resources are vital to recover the required ecological function. The resource drivers must be enhanced or sustained as part of the rehabilitation of the affected areas. In respect of the construction phase, it is important to ensure that the required erosion protection measures linked to the crossing sections and areas in proximity of the riparian / drainage areas / be carefully designed and installed.

10.2.3 Wetlands Assessments

The Wetlands Assessments concluded that seven (7) natural wetland units and one (1) artificial wetland unit as well as five (5) artificial dams and four (4) drainages could be recorded that could be affected by the proposed upgrades of the road infrastructure.

Concluded from the results of the assessments, the project can be supported, should all mitigation measures be implemented and monitored against to ensure compliance and protection of aquatic resources.

10.2.4 Water Use Licence Application (WULA)

The EAP is completing a WULA with the Inkomati-Usuthu Catchment Management Agency (IUCMA) for affecting existing waterflows, riverbanks and beds as well as abstraction of water for construction activities.

10.2.5 Heritage Impact Assessment

In field and desktop assessments towards completing a Heritage Impact Assessment (HIA) were conducted 23 January 2021 and 17 to 21 May 2021 for the proposed Schoemanskloof road upgrades. The aim of the study is to survey the proposed development footprint to identify cultural heritage sites, document, and assess their importance within local, provincial and national context. It serves to assess the impact of the proposed project on non-renewable heritage resources, and to submit appropriate recommendations with regard to the responsible cultural resources management measures that might be required to assist the developer in managing the discovered heritage resources in a responsible manner. It is also conducted to protect, preserve and develop such resources within the framework provided by the National Heritage Resources Act of 1999 (Act No 25 of 1999).

During the survey, Iron Age sites, burial sites and historical features were recorded. General site conditions and features on sites were recorded by means of photographs, GPS locations and site descriptions. Possible impacts were identified and mitigation measures have been proposed in the HIA report. The South African Heritage Resources Agency (SAHRA) as a commenting authority under section 38(8) of the National Heritage Resources Act require all environmental documents, compiled in support of an Environmental Authorisation application as defined by NEMA EIA Regulations section 40 (1) and (2), to be submitted to SAHRA for commenting. Upon submission to SAHRA the project will be automatically given a case number as reference. As such the draft BAR and its appendices inclusive of the HIA Report and EMPr will be submitted to SAHRA for review and comment.

Nine features related to the built environment were recorded. Features range from rectangular stone-built structures to bridges and modern ruins that are of no heritage significance.

Nineteen features were recorded with stone packed walls and Iron Age Artefacts. Due to dense vegetation accessibility and visibility was limited in many of these areas. The greater area is known for extensive stone walled settlements and these finds concur with previous finds.

Four burial sites were recorded during the study characterized by both stone packed informal graves as well as gravestones with inscriptions in formal cemeteries. Graves are always of high social significance and due to the dense vegetation and the fact that graves can occur anywhere across the landscape more graves can be expected in the area.

The anticipated impact of the project is medium to high prior to mitigation. With the implementation of the mitigation measures proposed in the HIA report and draft BAR and associated EMPr, the impacts can be mitigated to an acceptable level. No additional impacts are expected after the construction phase.

11 Further Investigation Required

The following additional investigations are required for detail design stage:

- Further geotechnical investigation (drilling) for major structures;
- Further investigation will be required to determine if the cuttings can be used for selected layers.
- An EIA study is in progress comprising a basic assessment, public participation process, Inkomati-Usuthu Catchment Management Agency (IUCMA) water license applications and environmental management plan. The following specialist studies will be required:
  - Ecological (Flora and Fauna);
  - Aquatic (SASS-5 monitoring, diatoms, riparian vegetation, wetland delineations);
  - Heritage Impact Assessment.
  - A palaeontological assessment for *Schoemanskloof* will be considered after recommendations has been received from the South African Heritage Resource Agency (SAHRA).

12 Preliminary Construction Estimate

The schedule of quantities is provided in Volume 2 of the report. The construction estimate has been calculated to be approximately R 666 million (excluding 15% VAT). Escalated construction rates from previous projects were used to estimate the construction value for *Schoemanskloof*. A summary of the schedules is indicated in Table 12-1.

Table 12-1: Summary of construction estimate.

Description	Amount	
Total Schedule A: Roadworks	± R	639 000 000
Total Schedule B: Structures	± R	26 000 000
Total Schedule C: Electrical	± R	660 000
Total preliminary construction cost – August 2022 (excluding VAT)	**± R**	**665 660 000**

13 Conclusions and Recommendations

From the report, the following conclusions and recommendations are made:

- The proposed upgrade of *Schoemanskloof* (additional of passing / climbing lanes and the implementation of access management) is feasible from a technical engineering and safety perspective and will greatly improve the overall Level of Service and safety of the road.
- It is recommended that this report be distributed to the Implementing Authority for approval.
- The following issues are of importance:
  - Timeous acquisition of portions of land as identified in the design drawings and the property reports submitted to SANRAL. SANRAL should indicate if all land affected by the implementation of the access management should be acquired now or also as a phased approached, as and when needed.
  - Timeous acquisition of borrow pits, IUCMA water licenses and environmental authorisation.
  - Agreement with service owners for relocation and / or protection of services affected by the design.
- Timeous review and approval of the Preliminary Design is required, as this affects the Detail Design and Contract Documentation phases of the project. Construction Procurement is scheduled for February 2022.
- The preliminary construction estimate has been calculated to be ± R 666 million (excluding 15% VAT). This estimate excludes any rehabilitation cost of Section 1 of the existing road.

Annexure A

List of Accesses along Schoemanskloof

Table A-1 contains a list of accesses approved in 2003 along *Schoemanskloof* based on information received from TRAC, topographical survey and aerial photographs.

Table A-1: List of accesses along the *Schoemanskloof*.

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
1	3,52	South	Farm	Unknown	-	Informal gravel access road
2	3,66	South	Farm	Unknown	0,14	Informal gravel access road (staggered)
3	3,72	North	Farm	Unknown	0,06	Informal gravel access road (staggered)
	4,30	North	Farm	Yes	0,58	No longer in use
4	4,46	South	Farm	Unknown	0,16	Informal gravel access road
5	4,50	North	Farm	No	0,04	Informal gravel access road
6	4,50	South	Farm	Yes	0,00	Informal gravel access road
7	5,84	South	Farm	Unknown	1,34	Informal gravel access road
8	6,75	North	Farm	No	0,92	Informal gravel access road
9	7,40	South	Farm	Yes	0,65	Informal gravel access road
10	8,08	South	Farm	Yes	0,68	Informal gravel access road
11	8,16	North	Farm	Unknown	0,08	Informal gravel access road
12	8,22	North	Farm	Yes	0,06	Informal gravel access road
13	9,08	South	Farm	Yes	0,86	Informal gravel access road
14	10,28	North	Farm	Yes	1,20	Informal gravel access road
15	10,28	South	Farm	Yes	0,00	Informal gravel access road
16	10,90	North	Farm	Yes	0,62	Informal gravel access road
17	10,90	South	Farm	Yes	0,00	Informal gravel access road
18	11,50	South	Farm	No	0,60	Informal gravel access road
	12,40	South	Farm	No	0,90	No longer in use

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
19	13,35	North	Farm	No	0,95	Informal gravel access road
20	13,35	South	Farm	No	0,00	Informal gravel access road
21	13,84	South	Farm	No	0,49	Informal gravel access road
22	15,00	North	Farm	Yes	1,16	No longer in use
23	15,64	North	Farm	Yes	0,64	Informal gravel access road
24	15,64	South	Farm	Yes	0,00	Informal gravel access road
25	16,30	North	Farm	No	0,67	Informal gravel access road
26	17,42	North	Farm	No	1,12	Informal gravel access road
27	18,10	South	Farm (Bambi Country Lodge)	Yes	0,68	Entrance to Bambi Country Lodge (southern leg of the Bambi intersection)
28	18,32	South	Farm	No	0,22	Informal gravel access road
	18,35	North	Farm	No	0,03	No longer in use
	21,44	South	Farm	Yes	3,09	No longer in use
29	21,44	North	Farm	Yes	0,00	Informal gravel access road
30	22,10	South	Farm	No	0,66	Informal gravel access road
	23,40	North	Farm	Yes	1,30	No longer in use
	23,40	South	Farm	Yes	0,00	No longer in use
31	23,50	South	Farm	Yes	0,10	Informal gravel access road
32	23,90	North	Farm	Yes	0,40	Informal gravel access road
33	23,90	South	Farm	Yes	0,00	Informal gravel access road
34	24,18	North	Farm	Unknown	0,28	Informal gravel access road
35	25,10	North	Farm	Yes	0,92	Informal gravel access road
36	25,10	South	Farm	Yes	0,00	Informal gravel access road
37	25,36	North	Farm	No	0,26	Informal gravel access road

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
38	25,36	South	Farm	No	0,00	Informal gravel access road
39	25,75	South	Farm	Yes	0,39	Informal gravel access road
40	26,20	South	Farm	Unknown	0,45	Informal gravel access road
41	26,87	South	Farm	No	0,67	Informal gravel access road
	26,87	North	Farm	No	0,00	No longer in use
42	27,70	South	Farm	No	0,83	Informal gravel access road
43	27,70	North	Farm	No	0,00	Informal gravel access road
44	28,57	South	Farm	No	0,87	Informal gravel access road
45	28,65	North	Farm	No	0,07	Informal gravel access road
46	29,42	North	Farm	Yes	0,78	Informal gravel access road
47	29,42	South	Farm	Yes	0,00	Informal gravel access road
48	29,80	South	Farm	Yes	0,38	Informal gravel access road
49	29,92	North	Farm	Yes	0,12	Informal gravel access road
50	30,02	North	Farm	Yes	0,10	Informal gravel access road
51	30,15	North	Farm	Unknown	0,13	Informal gravel access road
52	30,78	North	Farm	Yes	0,63	Informal gravel access road
53	31,12	North	Farm	Yes	0,34	Informal gravel access road
54	31,12	South	Farm	Yes	0,00	Informal gravel access road
55	32,17	North	Farm (Dunanis Adventure)	No	1,05	Informal gravel access road
56	32,86	North	Farm	No	0,69	Informal gravel access road
57	34,610 (out) 34,660 (in)	South	Rest stop	Yes	1,75	Old Joe rest stop for vehicles travelling West

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
58	35,110 (in) 35,170 (out)	North	Rest stop	Yes	0,45	Rest stop for vehicles travelling East
59	35,35	North	Farm	Yes	0,18	Informal gravel access road
60	35,35	South	Farm	Yes	0,00	Informal gravel access road
61	35,78	South	Farm	Yes	0,43	Informal gravel access road
	36,60	North	Farm	No	0,82	No longer in use
62	36,62	South	Farm	Yes	0,02	Informal gravel access road
63	36,97	North	Farm	No	0,35	Informal gravel access road
64	36,97	South	Farm	Yes	0,00	Informal gravel access road
65	37,86	North	Farm	Yes	0,89	Informal gravel access road
66	37,86	South	Farm	Yes	0,00	Informal gravel access road
67	38,02	North	Farm	Unknown	0,16	Informal gravel access road
	38,70	South	Farm	Yes	0,68	No longer in use
68	38,70	North	Farm (Falcon Glen Estates)	Yes	0,00	Informal gravel access road to Falcon Glen Resort
	39,82	South	Farm	Yes	1,12	No longer in use
69	39,82	North	Farm	Yes	0,00	Informal gravel access road
	40,60	North	Farm	No	0,78	No longer in use
70	40,92	North	Farm	No	0,32	Informal gravel access road
71	40,92	South	Fitzgerald's Pub & Grill	Yes	0,00	Informal gravel access road
72	41,47	North	Old Joe's Kaia	Yes	0,55	Informal gravel access road
73	41,48	South	Farm	Yes	0,01	Informal gravel access road
74	41,62	North	Farm	Yes	0,14	Informal gravel access road

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
75	41,62	South	Farm	Yes	0,00	Informal gravel access road
76	41,72	South	Farm	No	0,10	Informal gravel access road
77	41,74	North	Farm	No	0,02	Informal gravel access road
	42,20	South	Farm	Yes	0,46	No longer in use
78	42,25	North	Farm	Yes	0,05	Informal gravel access road
79	42,40	South	Farm	Yes	0,15	Informal gravel access road
80	42,40	North	Farm	Yes	0,00	Informal gravel access road
81	42,97	North	Farm	No	0,57	Informal gravel access road
82	42,97	South	Farm	No	0,00	Informal gravel access road
83	43,08	North	Farm	No	0,11	Informal gravel access road
84	43,08	South	Farm	No	0,00	Informal gravel access road
85	43,39	North	Farm	Unknown	0,31	Informal gravel access road
86	43,78	North	Farm	Yes	0,39	Informal gravel access road
87	43,82	South	Farm	Yes	0,04	Informal gravel access road
88	44,05	South	Farm	Yes	0,23	Informal gravel access road (southern leg of the Weltevreden intersection)
89	44,32	North	Farm	Unknown	0,27	Informal gravel access road
90	44,34	North	Farm	Yes	0,02	Informal gravel access road
91	44,60	South	Farm	Yes	0,26	Informal gravel access road
92	44,60	North	St Paul Chalets	Yes	0,00	Informal gravel access road
93	45,29	South	Farm	Yes	0,69	Informal gravel access road
94	45,31	North	St Paul Chalets	Yes	0,02	Informal gravel access road
95	45,66	South	Farm	Unknown	0,35	Informal gravel access road
96	46,63	South	Farm	Yes	0,97	Informal gravel access road

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
97	46,63	North	Farm	No	0,00	Informal gravel access road
98	47,60	North	Farm (Mooiland)	No	0,97	Informal gravel access road
99	48,23	North	Farm (Loxley)	Yes	0,63	Informal gravel access road
100	48,30	South	Farm	No	0,07	Informal gravel access road
101	48,72	North	Farm	Yes	0,42	Informal gravel access road
102	48,72	South	Business	Yes	0,00	Informal gravel access road
103	49,56	North	Farm	Yes	0,84	Informal gravel access road
104	49,56	South	Farm	Yes	0,00	Informal gravel access road
105	49,83	North	Farm	Yes	0,27	Informal gravel access road
106	50,46	North	Farm	No	0,63	Informal gravel access road
107	50,46	South	Farm	No	0,00	Informal gravel access road
108	51,88	North	Farm	Yes	1,42	Informal gravel access road
109	51,88	South	Farm (Joubert & Sons)	Yes	0,00	Informal gravel access road (± 100 m wide access)
	52,40	North	Farm	Yes	0,52	No longer in use
110	52,40	South	Farm	Yes	0,00	Informal gravel access road
111	52,76	North	Farm	No	0,36	Informal gravel access road
112	52,76	South	Farm	No	0,00	Informal gravel access road
113	53,95	North	Farm	No	1,19	Informal gravel access road
114	53,95	South	Farm	Yes	0,00	Informal gravel access road
115	54,24	South	Farm	Unknown	0,29	Informal gravel access road
116	54,87	North	Farm (Croc Grove Farm)	Yes	0,63	Informal gravel access road (surfaced bell mouths)
117	55,28	North	Farm	Yes	0,41	Informal gravel access road
118	55,28	South	Farm	Yes	0,00	Informal gravel access road

Access no.	km-distance	Position	Type of access	Approved Yes / No	Spacing (km)	Description
	55,60	North	Farm	No	0,32	No longer in use
	55,60	South	Farm	No	0,00	No longer in use
119	56,06	North	Farm	No	0,46	Informal gravel access road
120	56,06	South	Farm	No	0,00	Informal gravel access road
121	56,36	North	Farm	Yes	0,30	Informal gravel access road
122	56,36	South	Farm	Yes	0,00	Informal gravel access road
	57,15	North	Farm	Yes	0,79	No longer in use
	57,15	South	Farm	Yes	0,00	No longer in use
123	57,47	North	Farm	Yes	0,32	Informal gravel access road
124	57,47	South	Farm	Yes	0,00	Informal gravel access road
	57,60	North	Farm	No	0,13	No longer in use
125	58,48	South	Farm	Yes	0,88	Informal gravel access road
126	58,55	North	Farm	Yes	0,07	Informal gravel access road
127	58,55	South	Farm	No	0,00	Informal gravel access road
	59,60	North	Farm	No	1,05	No longer in use
128	59,62	South	Farm	No	0,02	Informal gravel access road
	59,90	South	Farm	No	0,28	No longer in use
129	60,88	North	Poplar Creek	Yes	0,98	Surfaced access road with no turning lanes
130	61,34	South	Farm	Yes	0,46	Informal gravel access road

Annexure B

Existing Vertical Alignment of Schoemanskloof

The existing vertical alignment of the road will remain unchanged. The table below indicates a preliminary vertical alignment through the existing road.

Table B-1: Preliminary vertical alignment of existing ground (on crown line).

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
3000	3314	313,960	-0,02%	-	Linear
3314	3779	464,628	-	65	Parabola
3779	5565	1786,357	7,13%	-	Linear
5565	5775	210,000	-	-102	Parabola
5775	5905	130,000	-	-39	Parabola
5905	6046	141,194	1,75%	-	Linear
6046	6240	194,233	-	46	Parabola
6240	6333	92,270	5,96%	-	Linear
6333	6759	426,602	-	-49	Parabola
6759	7505	746,234	-2,80%	-	Linear
7505	7710	204,136	-	151	Parabola
7710	8242	532,808	-1,45%	-	Linear
8242	8449	206,725	-	82	Parabola
8449	8737	287,874	1,08%	-	Linear
8737	8947	210,235	-	-404	Parabola
8947	9376	428,437	0,56%	-	Linear
9376	9697	321,045	-	-50	Parabola
9697	9803	106,610	5,96%	-	Linear
9803	9991	188,012	-	269	Parabola
9991	10433	441,783	-5,17%	-	Linear
10433	10644	210,725	-	100	Parabola
10644	11005	360,989	-3,06%	-	Linear
11005	11262	257,339	-	54	Parabola
11262	11290	27,732	1,70%	-	Linear
11290	11558	267,772	-	69	Parabola
11558	11606	48,774	5,59%	-	Linear
11606	11881	274,536	-	-93	Parabola
11881	12064	183,243	2,64%	-	Linear
12064	12329	264,380	-	78	Parabola
12329	12981	652,821	6,03%	-	Linear
12981	13340	358,600	-	-52	Parabola
13340	13614	274,422	-0,87%	-	Linear

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
13614	13853	238,227	-	106	Parabola
13853	13942	89,282	1,40%	-	Linear
13942	14062	120,000	-	-37	Parabola
14062	14167	105,000	-	-29	Parabola
14167	14841	673,578	-5,50%	-	Linear
14841	15111	270,000	-	120	Parabola
15111	15115	3,958	-3,20%		Linear
15115	15205	90,046	-	50	Parabola
15205	15561	356,178	-1,44%	-	Linear
15561	15713	152,205	-	171	Parabola
15713	15869	156,083	-0,55%	-	Linear
15869	16051	182,000	-	-43	Parabola
16051	16383	331,820	-4,74%	-	Linear
16383	16677	294,399	-	25	Parabola
16677	16894	216,431	7,03%	-	Linear
16894	17333	439,190	-	-33	Parabola
17333	17398	65,105	-6,30%	-	Linear
17398	17590	191,927	-	26	Parabola
17590	17616	26,385	1,11%	-	Linear
17616	17887	270,404	-	-33	Parabola
17887	18054	167,630	-7,09%	-	Linear
18054	18308	253,190	-	33	Parabola
18308	18382	74,586	-0,06%	-	Linear
18382	18644	262,309	-	-34	Parabola
18644	20440	1795,533	-7,13%	-	Linear
20440	20745	305,008	-	53	Parabola
20745	20802	57,456	-1,37%	-	Linear
20802	21026	223,245	-	-43	Parabola
21026	21104	78,172	-6,57%	-	Linear
21104	21352	248,511	-	126	Parabola
21352	21716	363,652	-4,59%	-	Linear
21716	21995	278,756	-	-117	Parabola
21995	22197	202,718	-7,00%	-	Linear
22197	22346	148,459	-	38	Parabola
22346	22468	122,558	-3,07%	-	Linear

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
22468	22607	138,945	-	-59	Parabola
22607	22715	107,518	-5,42%	-	Linear
22715	22909	193,777	-	48	Parabola
22909	22975	66,062	-1,40%	-	Linear
22975	23195	219,924	-	-70	Parabola
23195	23321	126,004	-4,53%	-	Linear
23321	23493	172,302	-	70	Parabola
23493	23708	215,425	-2,07%	-	Linear
23708	23833	124,199	-	55	Parabola
23833	23885	52,301	0,20%	-	Linear
23885	24015	129,786	-	-34	Parabola
24015	24040	25,736	-3,60%	-	Linear
24040	24173	133,021	-	46	Parabola
24173	24639	465,197	-0,74%	-	Linear
24639	24783	144,753	-	-37	Parabola
24783	25049	265,209	-4,65%	-	Linear
25049	25186	137,302	-	39	Parabola
25186	25418	232,009	-1,13%	-	Linear
25418	25560	142,209	-	43	Parabola
25560	25612	52,305	2,20%	-	Linear
25612	25797	184,757	-	-49	Parabola
25797	26080	283,126	-1,60%	-	Linear
26080	26239	158,805	-	227	Parabola
26239	26349	110,033	-0,89%	-	Linear
26349	26759	409,560	-	-99	Parabola
26759	26970	211,532	-5,03%	-	Linear
26970	27140	170,110	-	352	Parabola
27140	27442	302,069	-4,54%	-	Linear
27442	27647	204,257	-	68	Parabola
27647	28445	798,175	-1,54%	-	Linear
28445	28606	161,012	-	60	Parabola
28606	28714	108,072	-1,14%	-	Linear
28714	28848	133,871	-	-54	Parabola
28848	29026	177,693	-1,34%	-	Linear
29026	29200	174,321	-	-109	Parabola

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
29200	29270	69,756	-2,94%	-	Linear
29270	29392	122,524	-	-82	Parabola
29392	29422	29,766	-4,40%	-	Linear
29422	29556	133,891	-	35	Parabola
29556	29674	118,527	-0,60%	-	Linear
29674	29766	91,751	-	-142	Parabola
29766	30101	334,901	-1,25%	-	Linear
30101	30201	100,436	-	104	Parabola
30201	30280	78,497	-0,28%	-	Linear
30280	30452	171,661	-	32	Parabola
30452	30933	481,384	5,08%	-	Linear
30933	31081	148,228	-	70	Parabola
31081	31648	566,483	-7,20%	-	Linear
31648	31928	280,159		-34	Parabola
31928	32004	76,408	-1,04%	-	Linear
32004	32218	213,488	-	26	Parabola
32218	32276	58,056	7,17%	-	Linear
32276	32745	469,532	-	-33	Parabola
32745	35179	2433,299	-7,06%	-	Linear
35179	35474	295,086	-	64	Parabola
35474	35711	237,133	-2,45%	-	Linear
35711	35890	179,546	-	400	Parabola
35890	36117	227,066	-2,00%	-	Linear
36117	36258	140,290	-	41	Parabola
36258	36278	20,007	1,40%	-	Linear
36278	36415	137,566	-	-51	Parabola
36415	36488	73,072	-1,30%	-	Linear
36488	36642	153,692	-	168	Parabola
36642	36835	193,196	-0,36%	-	Linear
36835	36964	128,991	-	-75	Parabola
36964	37003	39,205	-2,08%	-	Linear
37003	37129	125,377	-	55	Parabola
37129	37161	32,214	0,20%	-	Linear
37161	37394	232,760	-	-33	Parabola
37394	37421	26,916	-6,85%	-	Linear

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
37421	37571	150,176	-	126	Parabola
37571	37707	135,766	-5,66%	-	Linear
37707	37857	150,322	-	38	Parabola
37857	37966	108,808	-1,71%	-	Linear
37966	38050	83,890	-	-71	Parabola
38050	38102	52,024	-2,90%	-	Linear
38102	38228	126,393		25	Parabola
38228	38272	43,562	2,20%	-	Linear
38272	38527	254,960	-	-32	Parabola
38527	38737	210,219	-5,80%	-	Linear
38737	38901	164,475	-	26	Parabola
38901	38923	21,885	0,50%	-	Linear
38923	39083	159,610	-	-33	Parabola
39083	39206	122,698	-4,31%	-	Linear
39206	39332	126,538	-	53	Parabola
39332	39368	36,194	-1,90%	-	Linear
39368	39503	134,760	-	-63	Parabola
39503	39632	128,545	-4,06%	-	Linear
39632	39774	142,194	-	31	Parabola
39774	39805	31,153	0,50%	-	Linear
39805	39937	131,975	-	-43	Parabola
39937	40262	324,740	-2,54%	-	Linear
40262	40390	128,340	-	41	Parabola
40390	40454	63,565	0,59%	-	Linear
40454	40567	113,632	-	-163	Parabola
40567	40673	106,008	-0,11%	-	Linear
40673	40840	167,000	-	67	Parabola
40840	40996	156,166	2,37%	-	Linear
40996	41338	341,650	-	-63	Parabola
41338	41632	293,799	-3,05%	-	Linear
41632	41806	174,218	-	-50	Parabola
41806	41854	48,471	-6,53%	-	Linear
41854	41970	115,862	-	41	Parabola
41970	42138	167,447	-3,71%	-	Linear
42138	42287	149,620	-	34	Parabola

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
42287	42418	130,854	0,69%	-	Linear
42418	42569	150,329	-	42	Parabola
42569	42573	4,190	4,30%	-	Linear
42573	42908	335,660	-	-33	Parabola
42908	42941	32,908	-5,90%	-	Linear
42941	43209	267,202	-	25	Parabola
43209	43240	31,533	4,79%	-	Linear
43240	43460	219,663	-	-33	Parabola
43460	43489	29,366	-1,87%	-	Linear
43489	43642	152,876	-	25	Parabola
43642	43664	21,772	4,20%	-	Linear
43664	43813	149,363	-	-31	Parabola
43813	44024	210,651	-0,57%	-	Linear
44024	44185	161,155	-	-68	Parabola
44185	44348	163,471	-2,94%	-	Linear
44348	44561	213,095	-	-80	Parabola
44561	44650	88,125	-5,61%	-	Linear
44650	44868	218,131	-	51	Parabola
44868	45101	233,611	-1,33%	-	Linear
45101	45172	70,496	-	74	Parabola
45172	46005	832,870	-0,38%	-	Linear
46005	46164	159,787	-	-49	Parabola
46164	46166	1,488	-3,60%	-	Linear
46166	46309	143,441	-	51	Parabola
46309	46381	71,315	-0,82%	-	Linear
46381	46556	175,586	-	44	Parabola
46556	46681	124,871	3,17%	-	Linear
46681	46889	207,726	-	-38	Parabola
46889	46965	76,289	-2,30%	-	Linear
46965	47102	136,959	-	-61	Parabola
47102	47124	21,601	-4,55%	-	Linear
47124	47289	165,543	-	73	Parabola
47289	47656	366,698	-2,28%	-	Linear
47656	47708	52,368	-		Parabola
47708	47841	132,764	0,22%	-	Linear

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
47841	48104	262,703	-	-331	Parabola
48104	48121	16,722	-0,58%	-	Linear
48121	48209	88,248	-	140	Parabola
48209	48262	52,999	0,01%	-	Linear
48262	48407	145,322	-	43	Parabola
48407	48434	26,933	3,40%	-	Linear
48434	48591	156,638	-	-41	Parabola
48591	48803	211,803	-0,39%	-	Linear
48803	48926	123,900	-	-79	Parabola
48926	49032	105,741	-1,96%	-	Linear
49032	49064	31,486	-		Parabola
49064	49119	55,762	-1,57%	-	Linear
49119	49373	253,929	-	-202	Parabola
49373	49474	101,046	-2,83%	-	Linear
49474	49654	179,622	-	87	Parabola
49654	50107	453,334	-0,76%	-	Linear
50107	50188	80,685	-	-85	Parabola
50188	50233	45,374	-1,71%	-	Linear
50233	50404	170,474	-	80	Parabola
50404	50406	2,277	0,42%	-	Linear
50406	50524	117,364	-	24	Parabola
50524	50666	142,437	5,31%	-	Linear
50666	51028	362,289	-	-33	Parabola
51028	51077	48,649	-5,67%	-	Linear
51077	51227	150,066	-	25	Parabola
51227	51240	12,782	0,33%	-	Linear
51240	51386	145,888	-	56	Parabola
51386	51394	8,093	2,94%	-	Linear
51394	51596	201,985	-	-242	Parabola
51596	51740	144,618	2,10%	-	Linear
51740	52070	329,434	-	-302	Parabola
52070	52207	137,325	1,01%	-	Linear
52207	52321	114,375	-	352	Parabola
52321	52363	41,982	1,34%	-	Linear
52363	52546	182,256	-	-168	Parabola

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
52546	52610	64,753	0,25%	-	Linear
52610	52794	183,442	-	50	Parabola
52794	52935	141,595	3,92%	-	Linear
52935	53258	322,826	-	-32	Parabola
53258	53524	265,808	-6,17%	-	Linear
53524	53639	115,256	-	-134	Parabola
53639	53925	285,195	-7,00%	-	Linear
53925	54120	195,714	-	34	Parabola
54120	54355	234,554	-1,27%	-	Linear
54355	54611	255,851	-	521	Parabola
54611	54791	179,846	-0,78%	-	Linear
54791	55020	229,872	-	134	Parabola
55020	55243	222,474	0,93%	-	Linear
55243	55511	267,905	-	-147	Parabola
55511	55912	401,144	-0,89%	-	Linear
55912	56086	174,156	-	69	Parabola
56086	56109	22,859	1,60%	-	Linear
56109	56246	136,992	-	-158	Parabola
56246	56375	128,699	0,77%	-	Linear
56375	56583	208,194	-	-443	Parabola
56583	56996	413,338	0,30%	-	Linear
56996	57180	184,000	-	-267	Parabola
57180	57589	408,611	-0,39%	-	Linear
57589	57710	120,868	-	-66	Parabola
57710	57907	197,755	-2,22%	-	Linear
57907	58080	172,963	-	51	Parabola
58080	58264	184,105	1,17%	-	Linear
58264	58371	107,000	-	-348	Parabola
58371	58852	480,429	0,86%	-	Linear
58852	59052	199,790	-	92	Parabola
59052	59166	113,961	3,03%	-	Linear
59166	59323	157,100	-	33	Parabola
59323	59499	176,030	7,79%	-	Linear
59499	59657	158,685	-	-94	Parabola
59657	59815	157,615	6,11%	-	Linear

Vertical alignment					
Start chainage (m)	End chainage (m)	Length (m)	Slope (%)	K-value	Description
59815	60312	496,976	-	-34	Parabola
60312	61172	859,787	-8,51%	-	Linear
61172	61355	182,778	-	26	Parabola
61355	61467	112,162	-1,48%	-	Linear
61467	61693	225,925	-	181	Parabola
61693	61851	158,765	-0,23%	-	Linear
61851	62288	436,966	-	1044	Parabola
62288	62440	151,332	0,19%	-	Linear
62440	62677	237,237	-	69	Parabola
62677	62711	34,337	3,60%	-	Linear
62711	62836	124,701	-	-34	Parabola
62836	62902	66,315	-0,02%	-	Linear
62902	62985	82,944	-	126	Parabola
62985	63093	107,785	0,61%	-	Linear
63093	63254	161,032	-	-33	Parabola
63254	63396	142,290	-4,27%	-	Linear
63396	63672	275,167	-	43	Parabola
63672	63706	34,902	2,10%	-	Linear

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