THE ROAD MAINTENANCE BACKLOG IN SOUTH AFRICA

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ABSTRACT

Commonly cited estimates of the road maintenance backlog in South Africa, including that used in the 2018 Draft Roads Policy for South Africa, quantified it at R197 billion in 2014. This paper interrogates the accuracy of this estimate by evaluating the extent to which national, provincial, and municipal road authorities are singularly and cumulatively affected by road maintenance backlogs as at 2017. The modelling suggests that rehabilitation backlogs are potentially as high as R135.4 billion for the paved road network and R281.2 billion for the gravel road network. Backlog estimates are also generated for gravel to surface upgrades and the contingent liability posed by unproclaimed roads. The discussion of these results addresses the implications for road investment policy, budget planning, and attempts to develop an integrated funding model.

1. INTRODUCTION

Like many countries, the infrastructure investment policy of South African road authorities is shaped by the severe budget constraints within the sector. The commonly accepted estimate, which was generated by the Committee of Transport Officials (COTO) (2014), is that the road maintenance backlog had grown to R197 billion in 2014. This estimate has been drawn on by several stakeholders, including the South African National Roads Agency (SANRAL) (2014; 2016), and was recently used as a reference point by the National Department of Transport (NDOT) (2018) in the *2018 Draft Roads Policy for South Africa*.

Through an updated evaluation of the extent to which national, provincial, and municipal road authorities are affected by road maintenance backlogs, this paper finds that the rehabilitation backlog as at 2017 may be as high as R135.4 billion for the paved road network and R281.2 billion for the gravel road network. This estimate greatly exceeds the currently reported figure and is sufficiently high to raise alarm. Gravel to surface upgrades are a cost-effective alternative to rehabilitating gravel roads, however, the estimated cost of this undertaking is R115.0 billion for high-volume gravel roads and R1.7 trillion for all proclaimed gravel roads. However, not all gravel, or even paved roads, will satisfy the criteria for maintenance once evaluated. It is also important that authorities are aware that unproclaimed roads pose a contingent liability between R105.5 billion and R461.7 billion, depending on the required remedial action.

These estimated road maintenance backlogs account for the capital expenditure required for rehabilitation to strengthen paved and gravel roads with a visual condition index (VCI) score of poor (< 30) and very poor (30-49), which is in line with the COTO (2014) methodology. Gravel to surface upgrades are considered based on Ross and Townshend's (2017) analysis of cost-effective surfaces for low-volume roads and their finding that, due to the relative labour intensity of sealed road maintenance compared to gravel road maintenance, and the low shadow price of labour in parts of South Africa where there is scope for surface upgrades, if a road is worth maintaining at all it is worth sealing. Unproclaimed roads are included in this study due to the NDOT's (2018) policy position that unproclaimed roads should be assigned to either a provincial or municipal road authority depending on the classification and significance of the road.

Section 2 provides an institutional overview of South Africa's road network, covering ownership profiles, road conditions, funding sources, and expenditure trends. The objective of this section is to scope the road maintenance backlogs and provide information on the authorities' funding arrangements to contextualise the subsequent analysis. Section 3 sets the parameters for the main factors that drive the road maintenance backlog and compares the applied network level approach to existing inter- and intra-authority studies. This information is used in Section 4 to extend the functionality of the National Treasury's (2018) Road Network Cost Model to estimate the functional and technical needs budgets, which estimate the cost to reduce the volume of roads in poor and very poor condition to 10.0% and 0.0%, respectively. The road maintenance backlog estimates are analysed in relation to current budgets and the 2018/19 Medium-term Expenditure Framework (MTEF). Section 5 concludes with the implications of this study for road investment policy, budget planning, and attempts to develop an integrated funding model.

2. INSTITUTIONAL OVERVIEW OF THE SOUTH AFRICAN ROAD NETWORK

Ownership of the South African road network is decentralised amongst the national, provincial, and municipal spheres of government. Municipalities include both the metropolitan and district municipalities. The responsible authority manages all planning, design, construction, operation, maintenance, and rehabilitation of roads under its control. The South African Local Government Association (2012) identified repeated discrepancies in road ownership data due to transfers between authorities, extensions of the network, proclamations, and inconsistencies in record keeping and reporting between departments. To ensure the accuracy of this study, the national and provincial ownership profiles in Table 1 reflect self-reported figures by SANRAL (2017) and the respective 2017 provincial Road Asset Management Plans (RAMP). The metropole data are based on SANRAL's (2016) statistics, while the district municipality profile was derived from the NDOT's (2017) RRAMS datasets as at September 2017.

Table 1: Ownership of the South African road network, 2017

Authority	Road distance (km)			Network split
	Paved	Gravel	Total	
SANRAL	22 197	0	22 197	*3.0%*
Provinces	48 945	173 732	222 677	*29.7%*
Metropolitan municipalities	51 682	14 461	66 143	*8.8%*
District municipalities	40 648	266 416	307 064	*40.9%*
Unproclaimed roads	Uncertain	Uncertain	131 919	*17.6%*
Total	**163 472**	**454 609**	**750 000**	***100%***

2.1 National roads

SANRAL's network has expanded through the absorption of provincial roads from 7 000 km in 1998 to 22 197 km in 2017 (SANRAL, 2017). Toll roads managed by SANRAL or through public-private partnerships accounted for 13.0% of SANRAL's network in 2017. The concessions last for 30-years, after which time the roads are returned to SANRAL free of charge in the specified condition. SANRAL funds the maintenance of directly managed toll roads through toll revenue and borrowings from capital markets. The remaining 87.0% of national roads are non-tolled and financed through transfers and subsidies from the national fiscus. Table 2 shows the national transfers to SANRAL for construction and maintenance of the non-tolled road network.

Table 2: National non-toll road capital transfers and subsidies

	Audited outcome			Estimate			
R billion	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**
Non-toll network	7.52	7.72	8.00	9.10	7.88	10.34	10.91
Coal haulage network	0.67	0.70	0.73	0.77	-	-	-
Other	-	0.17	0.60	1.25	1.80	2.69	1.84
Total	**8.18**	**8.59**	**9.33**	**11.12**	**9.68**	**13.03**	**12.75**

Although 76.0% of national roads are older than their theoretical 20-year design life, SANRAL has managed to effectively use its available funding to preserve the national road network in a good condition. Despite the proportion of roads with a VCI score of poor or very poor moving from 5.7% in 2016 to 11.0% in 2017, above the NDOT's (2006; 2018) performance indicator of 10.0%, the South African Institution of Civil Engineering (SAICE) (2017) scored national roads a "B" (fit for the future) in the 2017 Infrastructure Report Card. The fall in condition is explained in the SAICE scorecard by the inclusion of poor condition provincial roads within the national network. About 2 442 km of the paved national roads were in poor and very poor condition in 2017, which is only 222 km above the acceptable benchmark of 10.0%.

2.2 Provincial roads

The provincial road authorities managed 48 945 km of paved roads and 173 732 km of gravel roads in 2017. Table 3 provides the breakdown of these roads between provinces according to the information in their 2017 RAMPs.

Table 3: Provincial road networks, 2017

Authority	**Paved network (km)**	**Gravel network (km)**	**Total network (km)**
Eastern Cape	3 781	37 468	41 249
Free State	6 371	39 149	45 520
Gauteng	3 685	1 359	5 044
KwaZulu-Natal	8 128	24 505	32 633
Limpopo	5 974	14 286	20 260
Mpumalanga	5 459	8 396	13 855
North West	5 125	14 660	19 785
Northern Cape	3 602	23 747	27 349
Western Cape	6 820	10 162	16 982
Total	**48 945**	**173 732**	**222 677**

Table 4 lists the primary sources from which provinces fund road maintenance: equitable share allocations from the national fiscus; provincial own-revenues; and Provincial Road Maintenance Grant (PRMG). The Expanded Public Works Incentive Grant is another, albeit minor, source of funds. The PRMG is ring-fenced, with its use regulated by the

Division of Revenue Act, but the provinces exercise discretion over the amount of equitable share and own-revenues to allocate to road maintenance. The PRMG allocations are formulaically determined based on the extent of the provincial road network, traffic volumes, VCI, and climatic and topographic factors.

Table 4: Provincial road transport expenditure trends and estimates

R billion	Audited outcome			Estimate			
	2014/15	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**
Equitable share & own-revenues	11.12	11.79	12.64	13.17	12.58	13.09	TBC
PRMG: Roads maintenance	7.96	8.22	9.38	10.00	10.32	10.96	12.11
PRMG: Disaster relief	0.60	0.48	0.30	0.27	0.21	-	-
PRMG: Road network supporting electricity generation infrastructure	0.80	0.83	0.80	0.48	0.50	0.53	-
Total	**20.48**	**21.32**	**23.12**	**23.92**	**23.61**	**24.58**	

SAICE (2017) scored provincial paved roads a “D” (at risk of failure) in the 2017 Infrastructure Report Card. According to the road condition data presented in Table 5, which was taken from the provincial RAMPs, 15 728 km of provincial paved roads were in poor and very poor condition in 2017. This maintenance backlog is 10 834 km above the acceptable benchmark of 10.0%.

Provincial gravel roads were in a relatively worse condition, and hence scored an “E” (unfit for purpose) by SAICE (2017) in the 2017 Infrastructure Report Card. Table 5 indicates that 55.6% of the provincial gravel road network was in poor and very poor condition in 2017. This equates to a 96 703 km maintenance backlog on provincial gravel roads, which exceeds the acceptable limit of 10.0% by 79 330 km.

Table 5: Provincial paved and gravel road conditions, 2017

Authority	**Very poor**		**Poor**		**Fair**		**Good**		**Very good**	
	Paved	Gravel	Paved	Gravel	Paved	Gravel	Paved	Gravel	Paved	Gravel
Eastern Cape	*6.0%*	*30.0%*	*35.7%*	*35.0%*	*36.3%*	*25.0%*	*21.8%*	*8.0%*	*0.2%*	*2.0%*
Free State	*33.0%*	*11.0%*	*33.0%*	*23.0%*	*27.0%*	*24.0%*	*6.0%*	*23.0%*	*1.0%*	*19.0%*
Gauteng	*0.8%*	*0.0%*	*9.3%*	*33.0%*	*33.5%*	*65.8%*	*26.3%*	*1.2%*	*30.1%*	*0.0%*
KwaZulu-Natal	*7.0%*	*3.7%*	*29.0%*	*53.2%*	*34.0%*	*40.1%*	*16.0%*	*2.7%*	*14.0%*	*0.2%*
Limpopo	*2.5%*	*35.0%*	*10.6%*	*50.0%*	*18.0%*	*15.0%*	*26.8%*	*0.0%*	*42.1%*	*0.0%*
Mpumalanga	*6.0%*	*0.0%*	*28.0%*	*61.0%*	*35.0%*	*32.0%*	*21.0%*	*7.0%*	*10.0%*	*0.0%*
North West	*39.6%*	*93.0%*	*11.5%*	*7.0%*	*15.6%*	*0.0%*	*21.2%*	*0.0%*	*12.0%*	*0.0%*
Northern Cape	*1.0%*	*2.0%*	*13.0%*	*33.0%*	*32.0%*	*51.0%*	*32.0%*	*11.0%*	*22.0%*	*3.0%*
Western Cape	*2.0%*	*4.6%*	*11.0%*	*38.8%*	*29.0%*	*45.5%*	*36.0%*	*9.3%*	*22.0%*	*1.8%*
Total	***11.5%***	***21.1%***	***20.7%***	***34.5%***	***28.6%***	***29.3%***	***22.3%***	***9.9%***	***16.9%***	***5.2%***

2.3 Municipal roads

The distribution of district municipality roads between provincial regions is shown in Table 6. Road transport expenditure by municipalities, shown in Table 7, is funded from a combination of the local government equitable share, municipal own-revenues, EPWP Integrated Grant for municipalities, Municipal Infrastructure Grant, and Public Transport Infrastructure and Systems Grant. Municipalities exercise discretion over the amount of equitable share and own-revenues allocated to road maintenance.

Table 6: Location of district municipality roads, 2017

Provincial region	Paved roads	Gravel roads	Total roads
Eastern Cape	*5.5%*	*13.3%*	*11.8%*
Free State	*8.7%*	*4.1%*	*5.0%*
Gauteng	*18.3%*	*1.4%*	*4.7%*
KwaZulu-Natal	*14.3%*	*12.0%*	*12.5%*
Limpopo	*4.8%*	*26.4%*	*22.2%*
Mpumalanga	*15.3%*	*10.6%*	*11.5%*
North West	*13.5%*	*24.8%*	*22.6%*
Northern Cape	*6.7%*	*6.1%*	*6.2%*
Western Cape	*12.9%*	*1.3%*	*3.5%*

Table 7: Municipal road transport expenditure

R billion	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Metropolitan municipalities	8.56	8.01	9.18	10.15	11.53	12.45	16.78
Local municipalities	4.76	5.50	6.84	6.83	7.51	8.50	12.20
Total	**13.32**	**13.51**	**16.02**	**16.98**	**19.04**	**20.95**	**28.98**

The availability of municipal road data has historically been a challenge, as attested by COTO (2014) and SAICE (2017). The paved and gravel road condition data for the metropoles is based on the 2013 data used by COTO (2014), with the exception that Johannesburg's paved road condition profile was updated with using the Johannesburg Roads Agency's (2017) 2017 statistics. Considering that some of the metropole VCI samples are from 2004, COTO (2014) acknowledge that the network conditions are likely to have deteriorated. The district municipality paved and gravel road condition data is sourced from the NDOT's (2017) 2017 RRAMS dataset, which covers 40 of the 44 district municipalities.

SAICE (2017) scored paved metropole roads "C-" (satisfactory for now) and paved municipal roads "D-" (at risk of failure) in the 2017 Infrastructure Report Card. According to the condition profiles in Table 8, 5 117 km of metropole and 9 065 km of district municipality paved roads were in poor and very poor condition in 2017. This metropole backlog is within the acceptable benchmark of 10.0%, while the district municipality backlog exceeds this limit by 5 000 km.

SAICE (2017) scored gravel roads "E" (unfit for purpose) in the 2017 Infrastructure Report Card, which is reflected by the high proportion of deteriorated gravel roads in Table 8. These profiles indicate that 1 229 km of metropole and 242 439 km of district municipality gravel roads were in poor and very poor condition in 2017. The metropole backlog is within the benchmark of 10.0%, while the district municipality backlog exceeds the 10.0% limit by 215 797 km.

Table 8: Municipal paved and gravel road conditions, 2017

Authority	Surface	Very poor	Poor	Fair	Good	Very good
Metropolitan municipalities	*Paved*	*2.5%*	*7.4%*	*18.5%*	*38.5%*	*32.9%*
District municipalities		*6.9%*	*15.4%*	*39.3%*	*33.9%*	*4.5%*
Metropolitan municipalities	*Gravel*	*1.3%*	*7.2%*	*2.8%*	*88.5%*	*0.2%*
District municipalities		*41.3%*	*49.7%*	*7.1%*	*1.5%*	*0.4%*

2.4 Unproclaimed roads

There are also 131 919 km of unproclaimed roads that have not been formally classified as the responsibility of any sphere of government. This means that authorities are not able

to legally spend public funds on these roads, and thus they are in a very poor condition unless privately maintained (National Treasury, 2011). The assignment of these roads is at the discretion of the NDOT (2018), whose policy position is that unproclaimed roads be assigned to provincial or municipal authorities depending on the classification and significance of the road. These roads therefore pose a significant contingent liability to the sub-national road authorities.

3. ESTIMATION METHODOLOGY AND KEY COST DRIVERS

The methodology to estimate the road maintenance backlog is informed by developing country and World Bank practices (2005), TRH 22 (1994), and the COTO study (2014). An aggregate cost matrix is produced based on specific road categories. Each of the 372 723 km of roads in poor and very poor condition fall within one of 48 road categories, which are determined according to 11 variables: ownership status (proclaimed or unproclaimed); road surface (paved or gravel); traffic volume (low, medium, or high); topographic conditions (flat or steep terrain); and climate zone (dry or wet climate). An average cost in Rand/km to rehabilitate poor and very poor condition roads is assigned to each road category according to the local conditions. The aggregate backlog cost is then simply the matrix product of the total km of poor and very poor condition roads in each category and the cost to rehabilitate each such km.

The following sub-sections disaggregate the poor and very poor condition roads between the road categories and set the parameters for their respective average rehabilitation costs.

3.1 Specified road works

TRH 22 is used by the South African road authorities to guide the classification of roads into maintenance categories. The condition index trigger method is a network level tool to group roads into specific maintenance categories once the condition index for that road, in this case VCI, falls below a specified limit. The applied practice is that segments of roads with a poor or very poor VCI are classified as deteriorated assets (i.e. a maintenance backlog) and trigger major rehabilitation. It is assumed that poor and very poor condition roads can be recovered through rehabilitation and do not require reconstruction.

Although gravel to surface upgrades require a large capital outlay, a life cycle cost analysis by Ross and Townshend (2017) demonstrated that surface upgrades are the most cost-effective method to manage deteriorated gravel roads. Moreover, the relative labour intensity of sealed road maintenance compared to gravel road maintenance, and the low shadow price of labour in parts of South Africa where there is scope for road surface upgrades, supports the proposition that, in South Africa under current economic and institutional conditions, all heavily deteriorated gravel roads worth maintaining should be sealed.

3.2 Road maintenance backlog volumes

Table 9 displays the road maintenance backlog statistics as at 2017. The main categories are: the volume of paved and gravel roads in poor and very poor condition, expressed as a total volume (technical needs backlog) and the volume above the acceptable benchmark of 10.0% (functional backlog); high-volume proclaimed gravel roads; and the total volume of gravel roads, from which the unproclaimed network can be disaggregated.

Table 9: The volume of road maintenance backlogs, 2017

	Volume of roads (km)					
	Functional backlog		Technical needs backlog		Gravel to surface	
Authority	**Paved**	**Gravel**	**Paved**	**Gravel**	**High-vol**	**All**
National	222	N/A	2 442	N/A	N/A	N/A
Provincial	10 834	79 330	15 728	96 703	13 506	173 732
Metropolitan municipalities	0	0	5 117	1 229	1 157	14 461
District municipalities	5 000	215 797	9 065	242 439	7 992	266 416
Unproclaimed	N/A	N/A	N/A	N/A	N/A	131 919
Total	**16 056**	**295 127**	**32 352**	**340 371**	**22 655**	**586 528**

3.3 Road work costs

Rehabilitation and upgrade costs are sensitive to traffic volumes, as the bearing capacity of a road determines its cross-section, pavement structure, and surface type. COTO (2014) applied a uniform rehabilitation cost to national and provincial paved roads. However, while provinces manage some roads with similarly high Average Annual Daily Traffic (AADT) to national roads, the variation in AADT is higher on provincial roads than on national roads. In 2013 there were roughly 4 times more low-volume (AADT < 500) provincial paved roads in poor and very poor condition than high-volume (AADT > 5 001) provincial paved roads (COTO, 2014). Accordingly, Table 10 shows that in 2017 30.0% and 26.0% of paved provincial roads had AADT less than 500 and 2 000 vehicles, respectively. Given that the cost to rehabilitate a high-volume paved road can be approximately double a medium-volume paved road, it is important that the road maintenance backlog estimate reflects the network's traffic profile.

Table 10 disaggregates the provincial paved and gravel roads into three traffic categories: low-volume; medium-volume; and high-volume. The AADT thresholds, which are different for paved and gravel roads, are based on the reporting style of the RAMPs and traffic categories used by the National Treasury (2018). The average was applied to the provinces with missing data and variations in the reported AADT categories required some approximations.

Table 10: Traffic volumes and distributions on provincial roads, 2017

	AADT Category					
	Low-volume		Medium-volume		High-volume	
	Gravel	Paved	Gravel	Paved	Gravel	Paved
Authority	**0 - 249**	**0 - 499**	**250 - 499**	**500 - 1 999**	**> 500**	**> 2 000**
Eastern Cape	*60.0%*	*39.0%*	*20.0%*	*43.0%*	*20.0%*	*18.0%*
Free State	*96.0%*	*35.0%*	*2.0%*	*15.0%*	*2.0%*	*50.0%*
Gauteng	*70.0%*	*5.0%*	*22.0%*	*18.0%*	*8.0%*	*77.0%*
KwaZulu-Natal	*84.0%*	*15.0%*	*8.0%*	*20.0%*	*8.0%*	*65.0%*
Limpopo	*84.0%*	*30.0%*	*8.0%*	*26.0%*	*8.0%*	*44.0%*
Mpumalanga	*84.0%*	*30.0%*	*8.0%*	*44.0%*	*8.0%*	*26.0%*
North West	*93.0%*	*33.0%*	*5.0%*	*34.0%*	*2.0%*	*33.0%*
Northern Cape	*95.0%*	*61.0%*	*1.0%*	*10.0%*	*4.0%*	*29.0%*
Western Cape	*93.0%*	*36.0%*	*6.0%*	*29.0%*	*1.0%*	*35.0%*
Total	***84.0%***	***30.0%***	***8.0%***	***26.0%***	***8.0%***	***44.0%***

Fitting these traffic data to the volume of paved and gravel road maintenance backlogs in Table 9 generates the profile of poor and very condition roads in Tables 11 and 12. The RRAMS data provide aggregated traffic statistics for district municipality paved and gravel roads: 95.4% low-volume; 3.2% medium-volume; and 1.4% high-volume. National roads

are assumed to be high volume, and in the absence of data the provincial average was applied to metropolitan roads.

Table 11: Distribution of poor and very poor condition paved roads, 2017

	Functional backlog (km)			Technical needs backlog (km)		
	AADT category			AADT category		
Authority	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
National roads	0	0	222	0	0	2 442
Provincial roads						
Eastern Cape	467	515	216	615	678	284
Free State	1 249	535	1 784	1 472	631	2 102
Gauteng	0	1	3	19	67	287
KwaZulu-Natal	317	423	1 374	439	585	1 902
Limpopo	56	48	81	235	203	344
Mpumalanga	393	576	341	557	817	483
North West	695	716	695	864	890	864
Northern Cape	88	14	42	308	50	146
Western Cape	74	59	72	319	257	310
Metropolitan municipalities	0	0	0	1 535	1 330	2 252
District municipalities	4 750	200	50	8 612	363	90
Total	**8 089**	**3 087**	**4 880**	**14 975**	**5 871**	**11 506**

Table 12: Distribution of poor and very poor condition gravel roads, 2017

	Functional backlog (km)			Technical needs backlog (km)		
	AADT category			AADT category		
Authority	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
National roads	N/A	N/A	N/A	N/A	N/A	N/A
Provincial roads						
Eastern Cape	12 364	4 121	4 121	14 613	4 871	4 871
Free State	9 020	188	188	12 778	266	266
Gauteng	219	69	25	314	99	36
KwaZulu-Natal	9 654	919	919	11 712	1 115	1 115
Limpopo	9 000	857	857	10 200	971	971
Mpumalanga	3 597	343	343	4 302	410	410
North West	12 270	660	264	13 634	733	293
Northern Cape	5 640	59	237	7 896	83	332
Western Cape	3 157	204	34	4 102	265	44
Metropolitan municipalities	0	0	0	1 033	98	98
District municipalities	205 007	8 632	2 158	230 317	9 698	2 424
Total	**269 928**	**16 052**	**9 146**	**310 901**	**18 609**	**10 860**

Standard rehabilitation and upgrade costs are provided in Table 13 for paved and gravel roads in these traffic categories, assuming flat topography and relatively dry conditions. The higher cost to rehabilitate roads with more traffic is due to factors such as wider cross sections, deeper layer works, and thicker surfaces. The unit costs are from the National Treasury's (2018) Road Network Cost Model, which used a first principles approach to determine competitive rates for categories of road works on different road surfaces with varying traffic volumes. The unit costs were cross-checked against available tender information, interrogated by industry bodies and three experienced pavement engineers, and sent to the provincial road authorities for comment.

The cost to rehabilitate national roads was sourced from the maintenance backlog study by COTO (2014) as their cost for SANRAL's roads was based on calculations of average actual costs considering traffic, climate, and terrain. Annual roadwork inflation was used to convert the 2013 cost for national roads into 2017 terms (Statistics South Africa, 2018).

Table 13: Standard road rehabilitation and upgrade costs per km, 2017

Maintenance activity	Low-volume	Medium-volume	High-volume	National roads
Rehabilitation of a paved road	R2 100 000	R3 680 000	R6 300 000	R8 939 792
Rehabilitation of a gravel road	R800 000	R840 000	R1 010 000	N/A
Gravel to surface upgrade	R3 500 000	R4 030 000	R6 410 000	N/A

The gravel to surface upgrade costs reported by provinces helps to explain the reporting and costing challenges within the sector, which are partly due to the absence of effective regulation by the NDOT (National Treasury, 2018). The unit cost for gravel to surface upgrades reported in the 2017 RAMPs ranged from R347 200 per km in North West province to R11.2 million and R11.4 million per km in Limpopo and Mpumalanga provinces, respectively. These varied cost estimates, which are distinct from COTO's (2014) 2014 estimate of R6 million per km, partly stem from a shift within under-resourced road authorities to overcapitalise in low-volume roads. In addition to being inefficient, this trend has served to distort the reported backlog estimates.

3.4 Environmental factors

The main environmental factors that affect road rehabilitation and upgrade costs are moisture and gradient. High moisture, scoring more than 20 on Thornthwaite's Moisture Index, requires measures such as additional subsoil drains or a layer of rock fill to stabilise the road foundation. The added measures for roads with gradients steeper than 8.0% include paved side drains and segmented block paving or concrete to cope with the steep gradient. Table 14 details the extra cost associated with road works under these conditions, over-and-above the standard unit costs presented in Table 13.

Table 14: Climate and topographic cost escalation factors, 2017

Region and activity	Low-volume road	Medium-volume road	High-volume road
High moisture region			
Gravel road rehabilitation	*25.0%*	*25.0%*	*69.7%*
Paved road rehabilitation	*20.0%*	*20.0%*	*20.0%*
Gravel to surface upgrade	*60.0%*	*60.0%*	*49.0%*
Steep road gradient			
Gravel road rehabilitation	*50.0%*	*50.0%*	*67.3%*
Paved road rehabilitation	*35.0%*	*30.0%*	*30.0%*
Gravel to surface upgrade	*58.0%*	*50.4%*	*31.8%*

In terms of the length of roads affected by these conditions, approximately 6.0% of land area in South Africa averages more than 1 000 mm of rainfall per year (Council for Geoscience. 2011). Most of this area is in Mpumalanga and along the KwaZulu-Natal coastline. The Mpumalanga Department of Public Works, Roads and Transport's (2016) road inventory shows that 36.9% of the province's road network is affected by a wet climate. This proportion is applied to district municipality roads in Mpumalanga, as well as the road networks in KwaZulu-Natal. With more than 60 mountain ranges across South Africa and relatively low road densities in these areas, it is difficult to estimate the volume of roads affected by steep gradients. While this factor will impact the road maintenance backlog, it is excluded in this study due to the high uncertainty.

4. ROAD MAINTENANCE BACKLOG RESULTS

The road maintenance backlog estimates, measured as the cost to rehabilitate roads in poor and very poor condition, are presented according to administrative classes: national; provincial; metropolitan; district municipality; and unproclaimed roads. The two scenarios considered are a functional backlog that estimates the cost to lower the volume of roads in poor and very poor condition to 10.0%, and a technical needs backlog that estimates the cost to lower the volume of roads in poor and very poor condition to zero.

Figure 1 shows the estimated maintenance backlog for paved roads as at 2017. The functional backlog and technical needs backlog are R61.2 billion and R135.4 billion, respectively. While provinces are responsible for 29.9% of the total paved road network, the extensive deterioration of their networks means that they account for 78.1% of the functional backlog and 51.3% of the technical needs backlog.

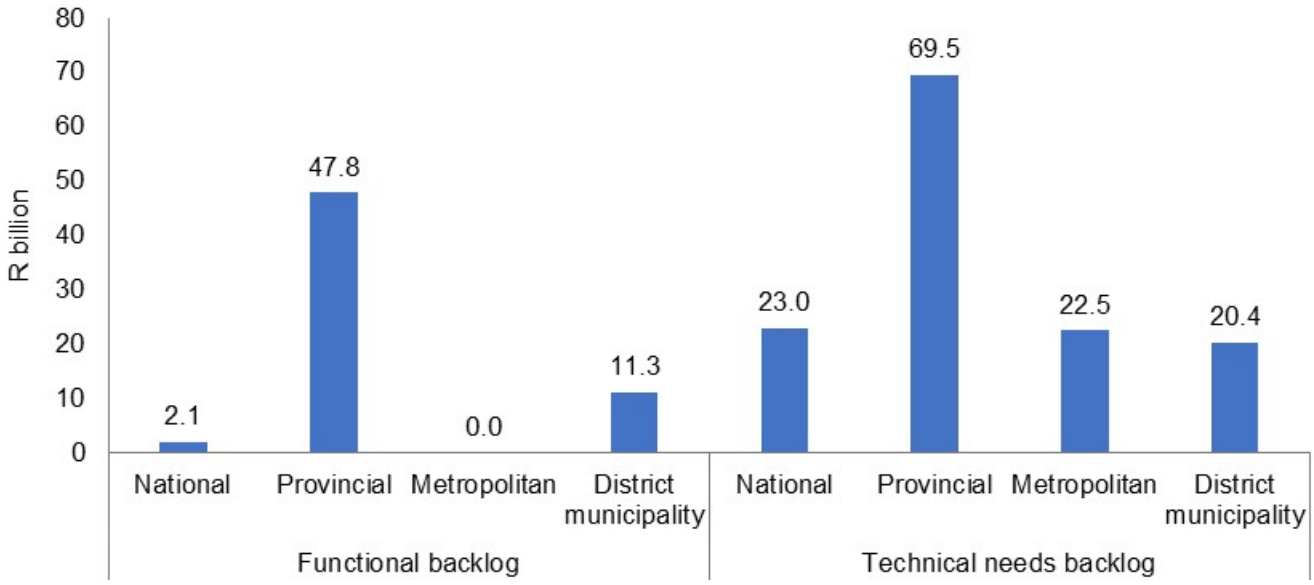

Figure 1: Maintenance backlog for paved roads, 2017

The estimated maintenance backlogs on the national and municipal paved road networks are more manageable, with the functional backlogs amounting to 5.9% of SANRAL's MTEF non-toll road funding and 39.0% of the 2017/18 municipal road transport expenditure. However, the functional and technical needs backlogs for provincial paved roads are 138.0% and 200.7% of the PRMG MTEF allocation, respectively. The PRMG accounts for about half of provincial road maintenance expenditure, with the funds primarily used for routine and periodic maintenance. Hence, limited resources are available to rehabilitate the provincial paved road network unless the PRMG is significantly grown over the medium to long term or provinces allocate a much larger proportion of own funds to road maintenance – ideally a combination of both measures.

Figure 2 shows the maintenance backlog for gravel roads. The functional backlog is estimated at R243.7 billion, while the technical needs backlog is at R281.2 billion. The funding pressures on provincial and municipal road authorities notably worsen when these backlogs in gravel road maintenance are combined with those for paved roads. The cumulative functional and technical needs backlogs for provinces respectively escalate to 330.4% and 435.2% of the MTEF PRMG allocation. Municipalities now appear highly distressed, with their functional and technical needs backlogs at 650.1% and 838.2% of 2017/18 municipal road transport expenditure, respectively.

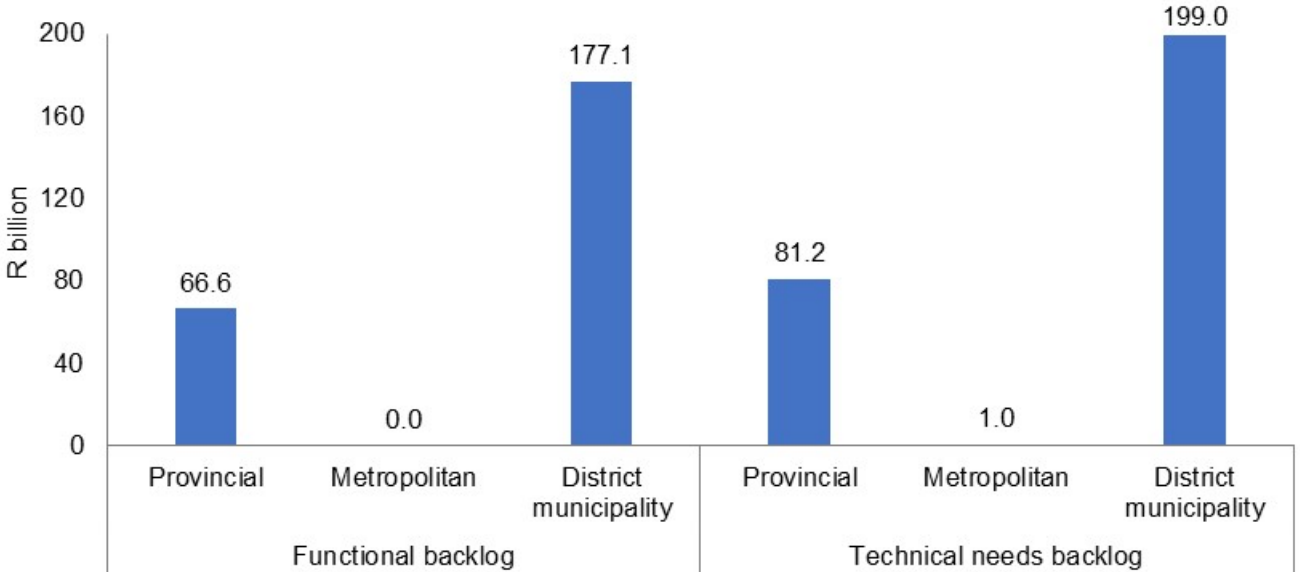

Figure 2: Maintenance backlog for gravel roads, 2017

Figure 3 shows the estimated costs to upgrade high-volume gravel roads (AADT > 500), all proclaimed gravel roads, and unproclaimed roads. Gravel to surface upgrades for high-volume roads is estimated to cost R115.0 billion, which although a sizeable capital outlay is more cost-effective than their continued maintenance as gravel roads. Most of these upgrade costs fall to provinces. The estimated cost to seal all proclaimed gravel roads is R1.7 trillion. Unproclaimed roads have been ear-marked in this study for upgrade rather than rehabilitation as many years of maintenance neglect likely necessitate reconstruction, in which case Ross and Townshend (2017) show that light seals are more cost-effective. The unproclaimed road network poses a R461.7 billion contingent liability to road authorities, which may rise depending on conditions.

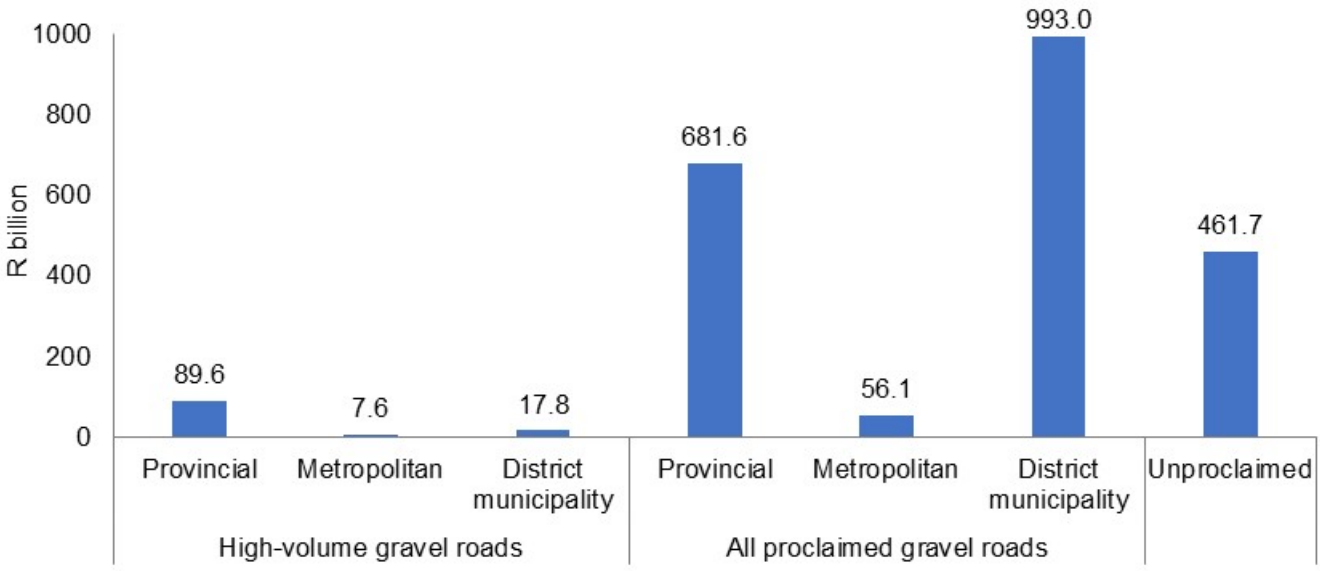

Figure 3: Gravel to surface backlogs, 2017

5. CONCLUSION

The estimated road maintenance backlogs are immense, particularly within the provincial and municipal networks. These authorities have historically under-funded road maintenance on the grounds that other needs, such as education, are more pressing (National Treasury, 2018). The consequences are provincial and municipal road rehabilitation backlogs that amount to more than 6 and 8 times what provinces and municipalities respectively spent on road maintenance in 2017/18. The magnitude of these backlogs means they are unlikely to be addressed through national transfers and subsidies, especially given the National Treasury's commitment to fiscal consolidation, which in the continued absence of notable economic growth must be primarily realised through savings and efficiencies in departmental expenditure. In fact, the 2018 MTEF PRMG allocation received a parliamentary approved haircut (National Treasury, 2018b).

The NDOT (2018) and SANRAL (2017), among other stakeholders, are exploring alternative funding sources to help finance the backlog in road maintenance. While a well-designed version of the NDOT's integrated funding model would help to relieve some of the funding pressures, it is unlikely to alleviate the funding constraints completely or sooner than the medium to long term. Firstly, it is unrealistic from a finance and resource perspective to alleviate a R416.6 billion maintenance backlog over a relatively short time horizon. In fact, several road authorities note in their RAMPs that neither they, the consulting engineers, nor the contractors are at present suitably equipped to handle the large capital injections required to address the maintenance backlogs over the short term. Secondly, the NDOT's (2018) policy position that provinces and municipalities should absorb unproclaimed roads within their networks may exacerbate the road maintenance backlog by between R105.5 billion to R461.7 billion. Lastly, many of the proposed and available funding mechanisms are not uniformly applicable across the road authorities, so either some authorities (most likely rural municipalities) must remain under-funded or complex ring-fencing and inter-governmental revenue sharing agreements are required.

One of the obvious implications for road investment policy is that authorities are now forced to prioritise their road maintenance schedules. Within this context of severely limited resources, it is vital that authorities allocate their budgets towards roads that protect citizen's constitutional basic access rights and maximise potential economic growth. Without effective prioritisation, it is possible that one or even both objectives may be severely harmed. Authorities can also use prioritisation tools to identify and unproclaim unproductive roads, thus minimizing maintenance demand and limiting the contingent liability posed by unproclaimed roads.

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