The SAICE Infrastructure Report Card for South Africa: 2006
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<th>Infrastructure</th>
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<tr>
<td><strong>Water</strong></td>
<td>D+ for DWAF infrastructure</td>
<td>Well maintained but ageing bulk infrastructure reaching end of useful life, and requires refurbishment or replacement. 43% of dams have safety problems and require urgent refurbishing. Serious concerns about funding.</td>
</tr>
<tr>
<td></td>
<td>C+ for major urban areas</td>
<td>South Africa is one of few nations where in most urban areas water can be drunk directly from the tap. Major, and ongoing, strides in provision of water and sanitation since 1994. However, erratic compliance with water quality requirements in most municipalities. Water wastage (leakage) is much too high. Shortage of skilled personnel.</td>
</tr>
<tr>
<td></td>
<td>D- for all other areas</td>
<td>Serious problems with management of many wastewater (sewage) treatment works. Wastewater leakage and spillage much too high, and frequent problems with on-site sanitation. Inadequate operation and maintenance capacity, and shortage of skilled personnel. Major urban areas grade is pulled down by Cape Town and Sebokeng.</td>
</tr>
<tr>
<td><strong>Sanitation (including wastewater)</strong></td>
<td>C- for major urban areas</td>
<td>Landfill sites in major urban centres well managed, but many municipalities, especially rural municipalities, have uncontrolled dumpsites with attendant health risks. More widespread waste avoidance and recycling initiatives required.</td>
</tr>
<tr>
<td></td>
<td>E for all other areas</td>
<td>Most in fair to very good condition, with recent strategic acquisitions in poorer shape. Increasing use of user-pays (tolling), but funding remains a challenge, especially given that key roads will soon require extensive refurbishing.</td>
</tr>
<tr>
<td><strong>Roads</strong></td>
<td>C for national roads</td>
<td>Generally inadequate funding and management systems leading to neglect of maintenance, combined with overloading, means that maintenance backlogs are growing. Less condition monitoring than in the past. Shortages of skilled personnel. Decisions have been taken to stop maintaining some roads.</td>
</tr>
<tr>
<td></td>
<td>D- for all other roads</td>
<td>World-class aviation infrastructure provider, strongly driven by the need to meet legislated requirements. Delays and inconvenience due to continuous expansion to meet growth exceeding 10% p.a. A profitable company, and no shortage of funding.</td>
</tr>
<tr>
<td><strong>Airports</strong></td>
<td>ACSA owned facilities only</td>
<td>Proper management practices on ageing infrastructure have extended its useful life. Increased investment and support underway to address increased demand. Further improvement expected as Transnet profitability improves.</td>
</tr>
<tr>
<td><strong>Ports</strong></td>
<td>Transnet owned facilities only</td>
<td>The iron ore and coal lines are world class and well maintained. Profitable. Where demand is approaching capacity, upgrading is programmed.</td>
</tr>
<tr>
<td><strong>Rail</strong></td>
<td>B for heavy haul freight lines</td>
<td>Condition declined in recent years due to maintenance backlogs and skills reduction. Traffic volumes are increasing, and upgrading urgently required. Improvement expected as Transnet profitability improves.</td>
</tr>
<tr>
<td></td>
<td>C for general freight lines being retained</td>
<td>Gradual deterioration due to inadequate maintenance funding, reducing skills base, and vandalism, with resulting increased safety risks. Refurbishment underway. Improvement expected with the transfer to Department of Transport.</td>
</tr>
<tr>
<td></td>
<td>E for uneconomical general freight lines</td>
<td>Demand is nearly reaching the limit of generating capacity. Shortfall will get worse, before improving around 2011 when new base-load stations commissioned. Eskom profitable, and no shortage of funding, but capital programme was delayed too long. Long and vulnerable transmission lines from Mpumalanga coalfields to urban centres. Risk of power cuts until the reserve increases.</td>
</tr>
<tr>
<td><strong>Electricity distribution</strong></td>
<td>C+ for Eskom’s generating &amp; bulk transmission capacity</td>
<td>Major, and ongoing, strides in provision of electricity since 1994 (this applies also to municipal distribution networks). State of (Eskom local distribution) infrastructure generally acceptable, but skills shortages.</td>
</tr>
<tr>
<td></td>
<td>C+ for Eskom’s local distribution networks</td>
<td>Inadequate operation and maintenance capacity, and shortage of skilled personnel. In many areas, ageing and/or overloaded infrastructure. Improvement not discernible. Grade pulled down by Johannesburg, although improvements also discernible there.</td>
</tr>
<tr>
<td></td>
<td>C- for municipal distribution networks in major urban areas</td>
<td>Same types of problems as in major urban areas, but significantly worse.</td>
</tr>
<tr>
<td></td>
<td>D+ for passenger lines</td>
<td>Improvement in some provinces, eg KZN and Limpopo, but deterioration in others, mainly due to inadequate maintenance funding, and inadequate skills and management systems. Revitalisation programme addresses some issues.</td>
</tr>
<tr>
<td><strong>Hospitals and clinics</strong></td>
<td>C for hospitals</td>
<td>Improvement in some provinces, eg KZN and Limpopo, but deterioration in others, mainly due to inadequate maintenance funding, and inadequate skills and management systems. Revitalisation programme addresses some issues.</td>
</tr>
</tbody>
</table>
About SAICE
The South African Institution of Civil Engineering (SAICE) represents the foremost body of professional expertise in water, sanitation, solid waste management, roads, rail, airports, harbours, stormwater and flood management, bridges and buildings - our infrastructure. Established in 1903, it is the largest of the engineering “learned societies”, with approximately 7000 members who enhance the welfare of humanity by advancing the science and profession of civil engineering.
The state of national infrastructure
An assessment by the South African Institution of Civil Engineering (SAICE) of the built environment infrastructure of South Africa

This report highlights the observations of the professionals responsible for the planning, construction, operation and maintenance of our nation's life-support system.

1. Message from SAICE

In 1994 the democratic South African government evaluated the imbalance in access to infrastructure -- our basic social life support systems -- that characterised the nation, and embarked on an ambitious plan to put matters right by addressing the backlog. For example, the government invested in providing potable water to 15 million people previously not served by formal supply infrastructure. Other infrastructure provided, such as sanitation and road infrastructure, has further improved the quality of life of the people of South Africa. Acting on its mandate, the government is continuing to invest at a rapid pace in infrastructure for previously disadvantaged communities.

However, once the infrastructure is built and commissioned, it needs to be looked after. After it has been built, people and governments appear to take notice of infrastructure only when it fails. The media often cover only the bad news stories, ignoring the good work that is ongoing.

Nonetheless, South Africa has failed to invest sufficiently in maintaining and renewing this infrastructure. We have for too long suffered from a "patch and make good" culture; extending the metaphor, it must be realised that "a stitch in time saves nine". That is, timely repair of worn and damaged infrastructure saves money in the long run. A repair postponed could cost three or four times as much to repair a year later and, if left long enough, the damage will be such that repair is no longer possible, but the element of infrastructure has to be replaced. Infrastructure that is overloaded will also fail sooner, even if it is properly maintained.

There is an old saying that someone pays for maintenance whether it is done or not. Failure of infrastructure services has negative consequences for all who depend on them. Health and safety are compromised (for example when people drink untreated contaminated water), manufacturing businesses lose production, equipment is damaged (for example corrugated and potholed roads damage vehicles), and people are inconvenienced.

This report on the state of the nation's built infrastructure is the first of its kind in South Africa, the first to "grade" the state of the built infrastructure in selected sectors, and to set out the results in a "report card" format. It is hoped that it will be possible to update and reissue the report card at periodic intervals, so that trends in the state of infrastructure can be identified.

This report has been compiled by a panel of experts drawn from the various fields of civil engineering expertise across SAICE's membership, and with the assistance of experts in related fields. SAICE feels that if government is aware of the profession's opinion on where maintenance or replacement is most needed, such as where infrastructure is ageing or approaching obsolescence, better informed decisions can be made. This thinking is in line with government's National Infrastructure Maintenance Strategy, recently approved by Cabinet.

The answers to many of the issues posed in this report are neither easy nor simple, which underlines how great the need is for more public understanding and education about the serious decisions that must be taken concerning our infrastructure.

The report is issued to a wide audience of stakeholders, including politicians, civil servants, local authorities, and trade, regulatory and consumer bodies, as well as the media.

2. South Africa's built environment infrastructure

This report deals with "built environment infrastructure", that is, buildings and engineering infrastructure -- that part of a nation's capital stock that produces services that are consumed by members of households (e.g. hospital services, water, sanitation and electricity) or facilitate economic production or serve as inputs to production (e.g. electricity, roads and ports).
Only infrastructure that is in the ownership of the public sector (including state-owned enterprises such as Eskom and Transnet) is considered.

This infrastructure is a public asset. All South Africans have a stake in its upkeep and operation, and all share in the expense of its construction and maintenance.

Sometimes, those who most use the infrastructure have to pay for it through service charges -- for example payment for electricity and water which has been consumed, hospital fees, road tolls, and airport taxes that are built into airline ticket prices. But because infrastructure affects all by supporting the economy and providing fundamental community services, the public usually bears a portion of the cost through general taxation (including property assessment rates and rentals paid in lieu thereof). Sometimes sections of the public bear a proportion of the cost that is disproportionately large compared with the usage they make of the infrastructure -- for example those who pay for water services at a rate into which is built provision for them to subsidise free basic water services to others.

The reasons for the lower of the grades given in this report are numerous, and varied in nature. For example only:

- accommodation needs in the nation as a whole, but, more importantly, population movements across the nation, together with new household formation is faster than population growth;
- a long history of neglect of maintenance of infrastructure;
- the hugely successful rollout of new infrastructure, but generally without concomitant growth in the resources (principally skills and budgets) allocated to looking after the infrastructure;
- an overall skills shortage, especially of engineers and artisans, and a slow rate of new entry to the profession;
- institutional changes (for example in local government); and
- a number of unsustainable investments that have been made.

Government should not change its focus from providing the new infrastructure to address backlogs from the past. The challenge is to do this and at the same time also maintain both old and new infrastructure, and upgrade or replace infrastructure that is overloaded or has become obsolescent.

Infrastructure, well maintained, underpins quality of life and economic development. If maintenance is inadequate, social and economic growth in South Africa will be impeded -- something that just cannot be afforded.

3. Skills

Engineering skills, from professionals through to technicians and artisans, are in short supply in South Africa. Many public sector institutions, each responsible for tens of millions of Rand of infrastructure, have little or no in-house engineering expertise. For example, a recent comprehensive survey by SAICE showed that 79 of the 231 local municipalities had no civil engineers, technologists or technicians. Vacancies then existed in local government for at least 1000 civil engineers, technologists and technicians, and the position has not improved since. Shortages in provincial and central government, and in most state-owned enterprises, are no less acute.

Civil engineering infrastructure is inextricably linked with the social and economic health of nations. South Africa is heavily disadvantaged in comparison to almost all other than the least developed nations. Below are given the numbers of people per engineer in a number of nations. Also, in parentheses for each, is the number of people per medical doctor - in all except South Africa, either the number of people per engineer is of the same order as the number of people per medical doctor, or they have more engineers than doctors (in China, more than four times as many).

China 130 (593); USA 389 (361); UK 311 (492); Germany 217 (291); Australia 455 (414); South Africa 3166 (1493)

Whereas Western Europe, North America, India and China have between 130 and 450 people per engineer, only one of every 3200 South Africans is an engineer, a ten- to twenty-fold disadvantage.
**Water**

- **D+** for DNAF infrastructure
- **C+** for major urban areas
- **D-** for all other areas

**Sanitation (including wastewater)**

- **C+** for major urban areas
- **D-** for all other areas

**Solid waste management**

- **C-** for major urban areas
- **D** for all other areas

**Roads**

- **C** for national roads
- **D-** for all other roads

**Airports**

- B ACSA owned facilities only
- C+ Transnet owned facilities only

**Electricity distribution**

- **C+** for Eskom’s generating & bulk transmission capacity
- **C-** for Eskom’s local distribution networks
- **D-** for municipal distribution networks in major urban areas
- **D-** for municipal distribution networks in all other areas

**Hospitals and clinics**

- **C** for hospitals
- **D+** for clinics

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### 4. The SAICE report card

SAICE investigated nine of the built environment infrastructure sectors, viz water (including water resources and water supply), sanitation and wastewater, solid waste management, roads, airports, ports (harbours), railways, electricity generation and distribution, and hospitals and clinics. Sectors not investigated include transport as in rolling stock and the operation of road and rail services, housing, schools, stormwater and flood management, and the natural environment. SAICE has also in respect of some of the sectors confined its attention to the most significant of the infrastructure only.

For example in respect of airports, it investigated only the airports owned and operated by the Airports Company South Africa (ACSA), and in respect of harbours, only those owned by Transnet – whereas smaller airports and harbours are owned by others (including municipalities).

It is hoped that comparable reports will be issued at intervals in the future, and also that the range of sectors covered can gradually be widened.

As noted above, subsequent reports will refer back to previous reports, such as this one, and will draw attention to trends, asking if the situation is improving, staying the same, or getting worse.

In compiling this report, SAICE has not undertaken primary research, but has relied upon investigations and findings reported to it by its members, as selected and analysed on its behalf by its panel of experts.

### 5. Grading the built environment infrastructure

SAICE assigned letter-of-the-alphabet grades to six categories of public sector infrastructure. Each category was evaluated on the basis of condition and performance, and capacity versus need.

The grades can be interpreted as follows:

- A = very good
- B = good
- C = fair
- D = poor
- E = very poor.

Caution needs to be exercised in interpreting the report card table adjacent. The single symbols for each sector (e.g. water) hide huge variations in the condition and performance of the infrastructure within each sector. Water quality, for example, is excellent in the metropolitan areas (although there are invariably problems of ensuring reliable supply at all times, and water losses are often unacceptably high), but water quality in many more rural areas, including small towns, is frequently below the standards laid down.

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Finally, an overall grade for built environment infrastructure as a whole:

**Overall Grade**

- **D+**

Although South Africa’s built environment infrastructure varies from very good, even world class in parts, to the relatively poor overall grade reflects extensive maintenance and refurbishment backlogs. Those backlogs are caused primarily by funding and skills shortages.
6. The infrastructure graded - discussion

6.1 Water and sanitation

Water and sanitation infrastructure (including wastewater infrastructure) consists in the first instance of the infrastructure for the abstraction and supply of water, and its treatment. Responsibility for capturing the water in dams, and its bulk conveyance closer to the places where it is needed, lies with the national Department of Water Affairs and Forestry (DWAF). This is certainly so in respect of major schemes – but responsibility for abstraction of groundwater, often the major supply to smaller centres, is more diverse.

In the second instance, responsibility for treatment of water, its distribution, and for dealing with sanitation, is allocated to the statutory water services authorities (all are municipalities, or combinations of municipalities) and the water boards. (Arrangements differ from place to place. In many areas, the water boards are responsible for treatment of both water and wastewater, and are also in some or other way supportive of community water supply and sanitation in rural areas. The water services authorities are then responsible for water supply storage and distribution, and are also usually responsible for all aspects of sanitation and wastewater. In some cases, however, water boards are involved in some of these municipal-type activities, sometimes under contract to the municipality.)

Another major user of water is irrigation – the infrastructure for this is not dealt with in this report.

6.1.1 Covering firstly the responsibility of DWAF:

DWAF is responsible for the management of the nation’s water resources and the provision of raw water in bulk through water resource infrastructure to various institutions and direct consumers. The DWAF water resources and bulk supply infrastructure comprises dams, weirs, canals, pumpstations, pipelines, siphons and tunnels. No figure for the replacement cost of this could be obtained.

DWAF has reasonably up-to-date records of the location and capacity of assets, and of their maintenance history. However records of condition vary -- DWAF has chosen to focus its infrastructure asset management attention on the most strategic elements of infrastructure.

In particular, DWAF has in recent years focused on the condition and management of its dams. The National Water Act makes DWAF responsible for ensuring that measures are taken to improve the safety of its dams. However, DWAF is currently unable to comply, because it does not have sufficient funds. Many of the dams have reached a state where further postponement of necessary maintenance and refurbishment will result in serious cost escalations as their condition deteriorates. This is further compounded by the fact that DWAF inherited a large number of ex-homeland dams which had not been operated and maintained properly, and which require urgent attention.

Some 150 of DWAF’s 350 dams have significant dam safety shortcomings. Priority rankings have been allocated, and the remediation (i.e. refurbishment) programme is starting during the 2006/2007 financial year.

DWAF will have to spend significant amounts to bring the rest of its bulk infrastructure, i.e. other than dams, up to an acceptable standard. In particular, infrastructure built in the 1960s and 1970s needs major refurbishment, or might even have to be replaced. For example, a canal’s design lifetime takes into account that major (refurbishment) work will be required after 25 to 30 years. Given the size of the elements of infrastructure that DWAF owns, failure of any element would have significant impact. Specific examples currently of concern to DWAF include a canal and pump station to Sasol at Secunda, a canal and siphon to a major agricultural scheme in the Free State, and a pipeline to one of the metropolitan municipalities. In all cases, regular maintenance has been undertaken, but certain portions of the infrastructure have reached the end of their useful life and now require refurbishment or replacement.

DWAF is doing what it can to address its maintenance needs. It has in some instances sought partners who have a strong interest in ensuring the
reliability of water supply to themselves, and have the resources to assist significantly. A good example is the instance mentioned above of the supply to Secunda. The cost of the pump station refurbishment or replacement will be borne by Sasol, with DWAF retaining the responsibility for the canal refurbishment.

In summary, the key determinant of the state of DWAF water resources and bulk supply infrastructure is the size of the available budget. DWAF has identified its most strategic infrastructure, and is prioritising the maintenance needs of that infrastructure, while doing what it can to address the needs of the remainder.

6.1.2 Then covering the responsibility of the water services authorities and water boards:

South Africa is one of the few nations in the world where in most urban areas water can safely be drunk directly from a tap. The CSIR has estimated that the current replacement cost of the water services infrastructure that is the responsibility of the 170 water services authorities is at least R120 billion, and that the current replacement cost of the water services infrastructure that is the responsibility of the 15 water boards is of the order of R60 billion. At least a quarter (by current replacement cost) of that infrastructure has been constructed since 1994. This constitutes an enormous amount of water services infrastructure that is in place and is (or should be) delivering services, and has to be operated and maintained. A stringent timetable has been set for the eradication of the backlogs in provision of basic services (8.2 million people (2.1 million households) lack a basic water supply, and 15.3 million people (3.8 million households) lack basic sanitation). In terms of the timetable, all households will by 2008 have access to a functioning basic water supply, and to a functioning basic sanitation facility by 2010. From this it can be inferred that there will within the near future be a steep increase in the amount of water services infrastructure that will have to be operated and maintained.

DWAF has for some time expressed concern as to how well water services infrastructure is (or is not) delivering a service. Every ministerial budget speech of recent years has raised the issue of non-delivery due to failing infrastructure. For example, in her 2005 budget speech, the Minister stated that the monitoring of service quality by her department shows “how important it is to manage infrastructure effectively. Last year, I reported that water supply to 37% of households was interrupted for more than a day during the previous year -- mainly for technical reasons, rather than for non-payment. …. This year, we focussed on the quality of drinking water, and I regret to say that 63% of municipalities could not confirm that they met the Drinking Water Quality guidelines. [Also] there are serious problems in the management of wastewater treatment works – even in metro municipalities such as Cape Town. An acute example is Emfuleni, in Gauteng where, repeatedly, untreated sewage has been discharged into the Vaal River”.

A 2006 survey of water services authorities, to estimate their compliance with drinking water quality regulations (i.e. with SABS 241-2001), revealed that only 72% were compliant. However, the more urban water services authorities are, in respect of drinking water quality (as they are in respect of most other indicators of water services infrastructure operation and maintenance adequacy), more likely to be delivering satisfactory services. Most non-metro water services authorities are failing in their compliance with the compulsory national standards for the quality of potable water, and in many instances this failure in regulatory governance is resulting in the provision of drinking water of unacceptably poor quality.

Leakage of already treated water is a major problem. Leakage data from water reticulation systems operated by thirty South African water services providers were in 2004 compared with international norms. Of the thirty, just over half (16) reported higher leakage ratios than the average calculated by the International Water Association for 27 supply systems in 19 countries. Seven of these 16 reported leakage ratios double or more than double the international average.
A nationwide sanitation sustainability audit in 2004/2005 to ascertain the functionality of sanitation projects completed since 1994 revealed that 28% of households' sanitation facilities have failed or are in the process of failing, and only 53% of municipalities have adequate operations and maintenance capacity.

Monitoring of effluent quality from wastewater (sewage) treatment works of local municipalities in the Free State revealed extensive non-compliance of wastewater effluent quality -- for example, 45% failure on bacteriological indicators. The main reasons for non-compliance in the Free State include: operational inefficiency, equipment shortcomings, lack of skills, inadequate monitoring equipment, and lack of proper chemical dosing equipment.

In order to understand the extent of challenges faced by the small and medium municipal sector, a study of 51 wastewater treatment works was undertaken in 2005/2006. This found that "immediate intervention" is required at approximately 30% of the works in order to avoid crisis situations such as an outbreak of waterborne diseases. In the short to medium term, intervention would be required at more than 66% of the works. The majority of micro, small and medium size wastewater treatment works in South Africa do not comply with the regulatory standards. The study stated that the main problem does not seem to be the need for additional or upgraded plant infrastructure or the need for additional funding. The main challenge is that the available plant infrastructure and equipment are not well operated and/or sufficiently maintained.

To summarise, South Africa has some very adequate water supply and sanitation infrastructure and service delivery, but also has an increasing proportion of deteriorating infrastructure together with poor and often unacceptable quality services. Similarly, while some water services institutions have exemplary practices in place in respect of many of the aspects of infrastructure management, gross shortfalls in management policies and practice exist in many others. Between these two extremes, a wide range of capacity and competence can be found.

6.2 Solid waste management

Prior to 1992, the national legislation on solid waste management lacked a supporting framework of acceptable standards. In that year, the "Minimum requirements for waste management" were published, and became enforceable on municipalities. The approach of these requirements is to apply graded minimum requirements to waste management facilities, based on their potential for environmental pollution. This approach, which is recognised to be among international best practice, has been instrumental in improving waste management practices in South Africa.

It was in 1992 estimated that as many as 1600 unpermitted municipally-owned solid waste dumps existed across South Africa. By the end of the nineties, at least 400 controlled landfills had achieved compliance with the "minimum requirements", and had as a consequence been approved (i.e. granted permits to operate) by the national Department of Environmental Affairs and Tourism.

The metropolitan municipalities and some district municipalities have committed significant funding to upgrade existing landfill sites and to develop new sites (including sites for the disposal of hazardous waste such as medical waste), and also to upgrade and equip solid waste collection vehicle fleets. Other initiatives include obtaining carbon credits for methane combustion, composting of garden waste, leachate treatment, and the establishment of recycling buy-back centres.

In contrast, in the majority of municipalities, especially those in the more rural areas, illegal dumping, littering and scavenging continue to occur on largely uncontrolled dumpsites, with attendant health risks. Similarly, maintenance of fleet and plant items is often poor outside the major urban centres.

Other national initiatives on solid waste management have promoted the principles of waste avoidance, minimisation and recycling. Successful waste minimisation strategies could significantly reduce the ballooning waste management costs, and contain environmental pollution.
Whereas the above refers only to solid waste management that is the responsibility of municipalities, other sources of solid waste include mining waste and specific industrial wastes. Disposal of this waste can present a severe problem.

6.3 Roads

In 2002, provincial and national roads totalled of the order of 370 000 km in length, and municipal roads 170 000 km – a grand total of 540 000 km. At the one end of the scale are freeways carrying in excess of 120 000 vehicles per 24 hours, and at the other are the roads in deep rural environments which may carry traffic volumes of less than 50 vehicles per day. The greater portion of the provincial road system is unpaved – some of this has been badly neglected, and is in very poor condition.

The South African National Roads Agency Ltd (SANRAL), a company wholly owned by the South African government, as represented by the Ministry of Transport, is responsible for national roads. The SANRAL road network, which is valued at approximately R50 billion, carries over 70% of the national road freight.

Starting with a network of 7200 kilometres in 1998, over the last few years SANRAL has taken over several thousand kilometres of key strategic roads from some provincial departments. It is now responsible for approximately 16 000 km which is expected to increase to 20 000 by early 2008 with concomitant increases in maintenance demands. A portion of its road system (small in proportion to the total road system of the nation) has been concessioned. Although much of the original network is in fair to good condition, the recently incorporated sections are in poorer condition. A serious concern, moreover, is that 72% of the national road network is nearing the end of its design life, placing the health of the entire national network at risk.

Funding is a continuous challenge. The current replacement cost of all the road infrastructure in the ownership of provincial governments has not been rigorously calculated, but it is estimated to be in the order of R200 billion. That in the ownership of municipalities has been estimated in the same way to be in excess of R60 billion.

The most common cause of the failure of paved (usually bituminous) road surfaces is neglect – neglect of routine maintenance, and neglect to repair damage without delay. Neglect of surface damage or of cracking leads to water penetration of the underlying layers, and consequent erosion followed by loss of portion of the paved surface (with the formation of “potholes”). Another common cause is overloading – for example, a road might, for economic reasons, be designed in the expectation that heavy traffic will be infrequent, but the use by heavy vehicles of the road thereafter increases significantly, with damage following as a consequence. The DBSA noted that severe overloading by heavy vehicles “has led to major structural damage on certain haulage routes”.

If road maintenance is delayed, the cost of repairs and rehabilitation increases exponentially. According to SANRAL, a delay in road maintenance of 3 to 5 years increases the required repair costs by between 6 and 18 times. Also, because of the subsequent decrease in riding quality, the vehicle operating cost of roads could easily double, with the associated ripple effect on the economy.

The DBSA noted in 2006 that indications are that the national road network and the road network of Gauteng province remain in a stable condition. However the condition of the remainder of the provincial road network continues generally to decline. The main reason for this has been insufficient funding in the past. Even though in recent years funding by provinces of their road systems has started to increase, the challenges of increases in traffic volumes, increased heavy vehicle usage, ageing network condition and climatic conditions all continue to adversely affect the quality of the network.

Study of the visual condition information available shows that almost all if not all provinces suffered a steady decline in road condition until the end of the 1990s, since which time some have managed to hold (even if tenuously) or even slightly improve the condition of the paved road network. However it is clear that, given budget
shortages, conscious decisions have been taken to not maintain selected roads, or to maintain them minimally. Hence the available budget has preferentially been given to the strategically more significant roads, while the proportions of the lower order of roads in “poor” or “very poor” condition have climbed.

The national Department of Transport noted that all provincial roads authorities used to carry out annual “visual condition index” studies, but during the 10 years prior to 2002 “more than half” of them curbed or stopped doing the surveys. This is a “disturbing factor” – some provinces have very little quality information on which to base managerial performance evaluation and need-identification processes. It seems that this could be one of the primary causes for the poor condition of the provincial road networks in general. More effective road management systems would offer the opportunity to prioritise spending more effectively, and would hopefully promote sustained cycles of preventative maintenance which have been largely absent in many provinces.

Very little consolidated information is available on the condition of roads in municipalities. However the pavement management system records of the paved roads (i.e. not gravelled roads) of a substantial proportion of the municipalities in the Western Cape were surveyed during 2004. It was found inter alia that:

- 8% of the network has deteriorated "mainly due to the lack of maintenance", to the extent that the roads need to be reconstructed – at a cost of R750 million;
- the cost of the resurfacing backlog that has accumulated is R500 million; and
- catching up on these backlogs over five years would require a sixfold increase in current budgets.

In summary, the key factor pertinent to the state of roads infrastructure is the size of the maintenance budget. In some jurisdictions, current budgets are sufficient to prevent further deterioration of the more strategic roads, or even improve them, but in others they are not. Funding for the lower order of roads, and the state of these roads, is in general decline. Overall, the maintenance backlog is increasing.

6.4 Airports

Of the 35 million annual passenger movements in South Africa, approximately 85% occur at just four airports: Johannesburg (17 million), Cape Town (7 million), Durban (4 million) and Port Elizabeth (1.5 million). Passenger growth over the past five years averaged nearly 10% annually (amongst the highest in the world) and is projected to continue at these levels for the next five years.

Secondary airports are the concurrent responsibility of provincial and municipal governments. The private sector owns a number of secondary airports. However the major airports are the responsibility of the Airports Company South Africa (ACSA), which owns and operates South Africa’s nine principal airports, including the international airports at Johannesburg, Cape Town and Durban. It also has a 35-year concession to operate the airport at Pilanesberg.

ACSA, which commenced operation in 1995, was one of the first state-owned enterprises to be commercialised. It is owned by the South African government, as represented by the Ministry of Transport (73%), the Public Investment Corporation (20%), empowerment investors and staff share trusts. The company is profitable.

ACSA is at each of its airports responsible for the property as a whole, and in particular for the runways, terminals and some of the hangars and technical areas (most hangars and technical areas are owned by the airlines). ACA is not responsible for navigational aids and air traffic control.

The current replacement cost of ACSA infrastructure exceeds R 9.5 billion. The company has in the last five years invested R 3.6 billion in capital infrastructure, and has programmed to invest an additional R 15 billion in the next five-year period, much of it at OR Tambo International (Johannesburg).

Budgets for infrastructure management are reported to be very close to the optimum. ACSA has a more or less adequate technical staff resource at all levels, competent enough to manage its infrastructure.
However ACSA agrees that it does not meet its target service levels during peak periods (International Civil Aviation Organisation level of service C for the 30th peak hour) for international travel at OR Tambo and for domestic travel at Cape Town.

ACSA’s infrastructure management policy is based on the understanding that the most economical way to retain the value of the infrastructure is to maintain regularly, and to optimise replacement periods. Specific elements of infrastructure, being those elements most closely associated with aircraft and passenger safety, receive the highest priority.

Thus instrument landing systems, runway approach lights and runway ground lighting enjoy the highest priority, and are maintained in such a way as to meet the statutory safety and reliability assurance requirements of the International Civil Aviation Organisation. The next highest priority infrastructure elements include security, emergency lighting within terminals, baggage handling and lifts and air bridges. Statutory requirements rule here also, in particular those of the (South African) Civil Aviation Authority, the (USA) Federal Aviation Authority with respect to security, and those of the Occupational Health and Safety Act. All ACSA airports have standby generators of sufficient capacity to meet the power needs of these highest priority elements. Performance in these areas is comparable with the best internationally.

ACSA also pays close attention to the condition of runways and aprons. The company runs a sophisticated pavement management system, kept up-to-date by weekly visual inspections, recording of all work done, and annual assessments of remaining useful life.

In summary, the key factor pertinent to the state of ACSA’s infrastructure has been its strong financial state, and in particular its ability over the years to budget adequately for maintenance and replacement. Statutory requirements for safety and reliability have been strong incentives.

6.5 Ports

Secondary harbours are variously the responsibility of the private sector, municipalities and others. However the seven commercial ports are owned by Transnet (since 1989 a state-owned enterprise and wholly owned by the South African government as represented by the Ministry of Public Enterprises), through its business units (divisions) the National Ports Authority (NPA) and SA Port Operations (SAPO). The NPA is responsible for the ports and their infrastructure, including the berths, port buildings, tug and pilot services, navigable areas (therefore including services such as dredging) and aids to navigation. SAPO is responsible for the ports and their infrastructure, including the berths, port buildings, tug and pilot services, navigable areas (therefore including services such as dredging) and aids to navigation. SAPO is responsible for equipment such as straddle carriers, cranes and conveyor belts, and terminals (such as grain elevators) and their equipment. Figures of replacement cost are not available.

The financial state of Transnet has been highly material to the state of its infrastructure and that of its business units. Transnet has been posting substantial losses ever since it inherited massive accumulated losses at the time of its creation. The turnaround strategy, involving amongst other measures restructuring the balance sheet, disposing of non-core assets, renegotiating contracts with key customers, and enhancing the quality of infrastructure, is making a difference. Transnet returned to profitability in 2004/2005, and is managing to progressively reduce its heavy debt.

There is a new emphasis in NPA and SAPO (and indeed in all other Transnet business units) on infrastructure, both on capital investment to grow the business, and on repair and replacement of existing infrastructure. Even though much of the infrastructure, including port infrastructure, has been ageing, it is maintained in an operationally serviceable condition. There is a strict regime of condition monitoring of all infrastructure -- this information is utilised by maintenance staff to repair faults and to schedule planned maintenance interventions – also the information is utilised for audit and long-term planning.

The new emphasis has manifested in recently increased support to a number of existing programmes for maintenance (and upgrading and replacement). Emphasis is now on improving the condition of strategic infrastructure and on expanding its
capacity to meet demand. The seven port engineers are obliged to inspect their infrastructure annually, and report to NPA. In the most recent such inspection, only one port scored less than "good", and the reasons for its current rating of "adequate" are specifically being addressed. NPA has laid down a maintenance policy, and each port puts together its own maintenance programme, unique to its environment, within the guidelines set out in the policy. SAPO has similar measures in place for its infrastructure.

To summarise, the key factor pertinent to the state of the infrastructure of Transnet and its business units has been its financial state. Inadequate budgets rather than wilful neglect or inadequate skills and experience have been the main underlying cause of infrastructure deterioration, ageing and obsolescence, where these are experienced.

### 6.6 Rail network

The responsibility for nearly all of the approximately 20 000 km rail network lies with Spoornet, a division of Transnet, a state-owned enterprise wholly owned by the South African government as represented by the Ministry of Public Enterprises. The smaller part of the network, all of it in the larger urban areas, is owned by the South African Rail Commuter Corporation (SARCC), a division of the national Department of Transport. Each is able, by arrangement, to travel on the lines of the other.

The rail network infrastructure comprises track, electrical power distribution network, communications and signalling system, and structures such as bridges, tunnels, mastpoles, pipe culverts, fencing etc.

The above does not include the rolling stock. For the sake of completeness, however, operation of services on the railway network, and responsibility for the rolling stock (locomotives, carriages, wagons, and so on), is split between passenger transport operations (suburban and long distance) and freight transport operations. All of the passenger transport responsibility is in the process of being transferred to the Department of Transport. Whereas income-generating opportunity is limited, operations are subsidised by the Department of Transport. Freight transport operations, on the other hand, falling within the ambit of the Department of Public Enterprises, are not subsidised. In order therefore to ensure sustainability, the freight carriage operator, Spoornet, is forced to aim for reasonable levels of profitability, by either reducing cost or by increasing income.

Returning to the topic of the rail network infrastructure: In order to describe the state of this infrastructure, it is convenient to separately consider the heavy haul freight lines, the general freight lines, a category of general freight lines regarded as uneconomical, and the passenger lines. The first three of these are owned by Spoornet, and the last, the passenger lines, are those owned by SARCC.

The first category is the heavy haul freight lines, comprising two lines, generally known as the Iron Ore Line and the Coal Line. The Iron Ore line, running between Sishen and the port of Saldanha Bay, although also used for transporting small volumes of general freight, is primarily used for transporting iron ore for export. The Coal Line, running between Broodsnyersplaas (in the coalfields of the Witbank area) and the port of Richards Bay, is used for general freight transport (especially timber, domestic coal, cement, minerals, paper etc.). However the primary commodity transported on this line is export grade coal. Thanks to the revenue generated on these lines, large sums of money have been available to maintain a high standard of infrastructure. These lines compare favourably with many of the world class heavy haul lines in respect of infrastructure complexity and condition. Spoornet has programmed to invest R6 billion over the next five years in upgrading these lines in order to convey higher tonnages.

The second category of freight lines comprises those of the general freight lines, operation on which is more or less breaking even financially. Higher volumes of traffic are predicted, and there is consequently a need for extensive rehabilitation and upgrading of infrastructure (e.g. to carry heavier or longer trains) and rolling stock (locomotives and wagons) to increase throughput. In order to do this, challenges will have to be overcome.

Due to income limitations, insufficient money has been spent on
maintenance, and ongoing rationalisation based on changing business models has contributed to the reduction in skills base. Infrastructure condition has as a result declined. Spoornet has programmed to invest R5 billion over the next five years in order to refurbish this part of the rail network, and improve its condition. (Funding for upgrading is separate from this.)

The third category of freight lines is made up of an extensive network of uneconomical lines. The shift of freight from rail to road has accelerated the demise of these lines. Due to the low income generated on these lines, infrastructure is maintained to a minimum safety and environmental compliance standard, and running speeds are reduced significantly in order to mitigate safety risks. These lines are not seen as part of Spoornet’s core business and are currently in the process of being concessioned, sold or removed. Some have already been closed.

The fourth category of lines comprises the passenger lines under the jurisdiction of the SARCC. These lines have also suffered from indifferent maintenance focus due to the dual usage and shared responsibilities in the past. The general condition of these lines has deteriorated gradually, and a diminishing skills base, poor rolling stock handling and condition as well as limited funding over the past few years have contributed significantly to the decline in infrastructure condition and increased safety risks.

Furthermore, services on these lines are also affected by high levels of theft and vandalism. R1,5 billion is programmed for investment in this part of the network over the next five years, in order to refurbish and improve its condition.

6.7 Electricity

6.7.1 Covering firstly electricity generation and bulk transmission:

During the 1980s and 1990s, because Eskom generated more electricity than South Africa needed, some of the power stations were mothballed. The planning and construction of new generation capacity has not kept pace with growth in demand since. Given that existing generating capacity is approximately 40 000 MW, peak demand already exceeding 35 000 MW leaves little in reserve.

Moreover it is necessary from time to time that capacity be taken out of service for maintenance reasons. Should there then be a major generation or transmission grid failure, power cuts would be inevitable. While the return to service over the next two years of mothballed power stations will provide some relief, growth of the South African economy, even at levels below the anticipated rate of 4% per annum, will place increasing pressure on capacity between now and 2011, when the first of the new base-load stations will come on-stream. It will thereafter take some more years before a reserve has been built adequate to enable shutdowns for regular maintenance.

Over 90% of electricity is generated by coal-fired power stations, most of them in Mpumalanga. However the demand is greatest in Gauteng and in the coastal cities of Durban, Cape Town and Port Elizabeth, at a distance from the generating source, and thus at risk from transmission failure. Thus the interruptions to supply in Cape Town early in 2006 were directly attributable to problems with the Eskom high-voltage transmission lines from the power stations in Mpumalanga and with the supply from the Koeberg power station in Cape Town.

6.7.2 Then covering electricity distribution:

The distribution of electricity is in some areas the responsibility of Eskom (a state-owned enterprise wholly owned by the South African government as represented by the Ministry of Public Enterprises), and in others the responsibility of municipalities. (The formation of the regional electricity distributors (REDs) will in due course change this.) Municipalities supply around 53% of customers, but account for a smaller proportion, around 43%, of national sales of electricity. That Eskom supplies a minority of customers but more than half of the electricity sold is explained in that Eskom supplies some very major consumers of electricity, such as Spoornet and most of the mines.
The replacement cost of distribution infrastructure was in 2004 estimated by the National Energy Regulator (NERSA) to be of the order of R84 billion. One third (R29 billion) belongs to Eskom and the remainder (R55 billion) to municipalities. The comments that follow refer only to municipal distribution systems.

NERSA reported that there is no comprehensive national database on the condition and age of the distribution infrastructure. Nonetheless, much is known about the condition of many distribution systems, and general remarks can be inferred from that knowledge, and also from the reports from time to time of electricity supply interruptions. The most publicised of these in the last couple of years have been those plaguing Johannesburg. The planned maintenance and refurbishment programmes in this city came to a standstill in the late 1990s, when the municipality was in financial crisis, with consequent deterioration of equipment, growth in loading without correlating network upgrades, "band aid" repairs rather than the required refurbishment or replacement, and – no less important – the exodus of key staff. The municipality has however turned the corner financially, and the electricity infrastructure backlog is being tackled energetically.

Mention must also be made of the impact that NERSA is beginning to have. Some of its initiatives in working together with municipalities (for example on the East Rand) that do not comply with their licence conditions are bearing fruit in terms of improved practices.

Returning to municipal electricity distribution systems in general, NERSA and others have reported that:

- Much equipment is ageing, its unreliability is increasing as is the cost of its repair, and it needs to be replaced.
- Much equipment is overloaded, due to unplanned-for development in its area.
- Municipalities often do not have the capacity to spend the funds they have at their disposal.
- Decisions (including procurement decisions) are made by officials who do not have the necessary technical knowledge.
- Some municipalities are not appropriately staffed to comply with Occupational Health and Safety Act requirements.
- Few municipalities have adequate programmes of planned or preventative maintenance.
- Few municipalities have infrastructure asset databases, many rely on their corporate memory for their maintenance strategy, few have contingency arrangements, and many lack adequate stocks of suitable spare parts.
- Insufficient provision has been made for refurbishment of networks. Practice has in many cases been to rely on the overdesign of the past, but that capacity has now been eroded.

To summarise: it is of course in recognition of this that the concept of the REDs has been formulated, and is now government policy. Responsibility for operation and maintenance will be taken away from those municipalities which are unable to adequately discharge that responsibility. Implementation is awaited.

6.8 Hospitals and clinics

Provincial governments are responsible for all public sector hospitals and clinics. (With the exception that some clinics are still in the process of being transferred from municipal to provincial ownership.)

The CSIR has estimated that the current replacement cost of all hospitals and clinics exceeds R100 billion. International norms suggest that on average at least 4% of the replacement cost should be spent per annum on maintenance – provided that the facilities are in good condition, and regular maintenance has been done in the past. This level of expenditure would include provision for planned maintenance (including legislated maintenance, such as on lifts or fire equipment) and unplanned work (such as minor repairs). However, provincial governments generally budget for much less than this.

Where facilities are not in good condition, percentages larger than the 4% minimum need to be spent – for example where, due to lack of preventative maintenance in the past, major repair and rehabilitation is now
required. Because of insufficient budgets and for other reasons given below, the maintenance backlog in some provinces is escalating.

With a few exceptions, provincial governments have not done formal broad-based audits of the state (i.e. condition) of their health facilities. Particularly lacking are overviews of state and performance trends. The last nation-wide survey of health facilities needs was undertaken about 10 years ago, and a new survey is long overdue.

Investigations undertaken by the CSIR on behalf of provincial governments indicate that a lack of maintenance is in many instances hampering health and education service delivery. For example, the condition of much hospital mechanical and electrical equipment has deteriorated, which is leading to unacceptably high rates of equipment failure in service. An especially stark consequence of maintenance not being addressed is the loss of service life (i.e. a shortening of the lives of the facilities, and hence the need for them to be replaced sooner).

The four principal causes of the ongoing failure of some provinces to catch up on maintenance backlogs and to run a preventative maintenance programme are:

- Emphasis being laid on capital works to construct new facilities, but inadequate measures to maintain these once they are built.
- New facilities often not designed for low maintenance, and also sometimes poorly built.
- Inadequate maintenance budgets, because maintenance budgets are not condition-based, and maintenance does not in the planning and budgeting process receive the level of priority that it deserves.
- Inadequate skills (especially technical skills) and experience to plan and implement appropriate maintenance programmes.

The shortage of skills in the provincial government departments responsible for commissioning and controlling facilities is in many instances manifesting in delays in planning and initiating work, in underestimation of the budgets required, in poor selection of consultants and contractors, and in poor supervision of work. In some provinces, difficulties also arise between the institutions responsible for maintenance (often the provincial Departments of Works) and the client institutions (the Departments of Health).

National Treasury has established the "Hospital Revitalisation Fund", a capital grant programme for the upgrading of hospitals and the building of new ones. The revitalisation process does require provinces to include budget provision for hospital facilities maintenance, but the budget level that has been set is too low. Nevertheless the programme has succeeded in improving much hospital infrastructure where other programmes have failed. The reasons for its success are principally that it is a dedicated fund and that it is monitored by National Treasury and the national Department of Health.

To summarise: thanks to good programme planning and targeted investment, health facilities in some provinces have improved over the last 10 years (for example KwaZulu-Natal and Limpopo), while there is strong evidence to suggest that their condition is deteriorating in others.