Perspectives on the future of waste management in South African protected areas

Technical report

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EXECUTIVE SUMMARY

Effective waste management is increasingly critical to the ecological integrity, operational sustainability, and public credibility of protected areas in South Africa. This report explores perspectives on the future of waste management in national parks, with the aim of understanding key challenges and opportunities across alternative future scenarios and identifying pathways toward more responsible waste management in protected areas.

The study adopted an exploratory case study design focusing on waste management in South African national parks. A qualitative research approach, underpinned by the *Seven Questions Method*, was used to explore alternative future trajectories for waste management in protected areas. Data were generated through a review of protected area management plans, field-based observations across a range of national parks, and semi-structured interviews with key stakeholders. A futures-thinking framework was applied to assess how current practices and institutional dynamics may influence divergent future trajectories, including a worst-case scenario of increasing environmental risk and a more optimistic "Blue Skies" scenario characterised by integration, circularity, and proactive waste management.

The findings reveal a consistent disconnect between high-level conservation aspirations and the operational reality of waste management. While acceptable levels of cleanliness are often maintained in national parks, waste management remains marginal within strategic planning, uneven in implementation across parks, and constrained by limited institutional capacity and leadership prioritisation. Infrastructure effectiveness varies widely, separation at source is at an early and fragmented stage, and specific vulnerabilities (such as poorly maintained infrastructure and public roads traversing parks) undermine cleanliness outcomes. At the same time, examples of good practice and stakeholder perspectives demonstrate that a more sustainable future is both plausible and achievable.

The report concludes that the future of waste management in South African protected areas will be shaped primarily by governance decisions made in the present. By repositioning waste management as a core conservation function and acting on targeted strategic recommendations, protected area authorities can actively steer the system away from a worst-case trajectory and toward a resilient "Blue Skies" future that supports pollution prevention, conservation, responsible tourism, and long-term sustainability.

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Acronyms and abbreviations

BAT:	Best Available Technology
BPEO:	Best Practicable Environmental Option
CSIR:	Council for Scientific and Industrial Research
DEFF:	Department of Environment, Forestry and Fisheries
DFFE:	Department of Forestry, Fisheries and Environment
EE:	Environmental Education
EIA:	Environmental Impact Assessment
EPR:	Extended Producer Responsibility
EPWP:	Extended Public Works Programme
FNAS-REC:	Faculty of Natural and Agricultural Sciences Research Ethics Committee
GBVF:	Gender-Based Violence and Femicide
GDP:	Gross Domestic Product
GNR:	Government Notice Regulation
GO-Science:	Government Office for Science
ha:	Hectares
IUCN:	International Union for Conservation of Nature
IWMP:	Integrated Waste Management Plan
km:	Kilometres
MoU:	Memorandum of Understanding
MPA:	Marine Protected Area
MSc:	Master of Science
NEMA:	National Environmental Management Act
NEM:BA:	National Environmental Management: Biodiversity Act
NEM:PAA:	National Environmental Management: Protected Areas Act
NEM:WA:	National Environmental Management: Waste Act
NP:	National Park
NWMS:	National Waste Management Strategy
NWU:	North-West University
PA:	Protected Area
PoE:	Portfolio of Evidence
PRO:	Producer Responsibility Organisations
RDI:	Research Development and Innovation
SANParks:	South African National Parks
SAWIS:	South African Waste Information System
SKA:	Square Kilometre Array
SMME:	Small, Medium and Micro Enterprise
SPSS:	Statistical Package for the Social Sciences
SWM:	Solid Waste Management
TA:	Thematic Analysis
TPB:	Theory of Planned Behaviour

UK:	United Kingdom
UNEP:	United Nations Environment Programme
UNEP-WCMC:	United Nations Environment Programme World Conservation Monitoring Centre
UNESCO:	United Nations Educational, Scientific and Cultural Organization
UNWTO:	United Nations World Tourism Organisation
WDF:	Waste Disposal Facility
WRIU:	Waste RDI Roadmap Implementation Unit
WTTC:	World Travel and Tourism Council

1 Introduction

This report is submitted to the Department of Science, Technology and Innovation, as a deliverable on a targeted research grant project on perspectives on the future of waste management in South African protected areas. This work contributes to addressing the current gap in research related to waste management in protected areas across the country.

1.1 Background and problem statement

Protected areas play a critical role in conserving biodiversity and sustaining ecosystem services (Solomon *et al*., 2013; Mitchell *et al*., 2018; Przydatek, 2019; Palfrey *et al*., 2020). However, these areas are increasingly expected to generate tourism revenue and deliver associated community benefits, which places additional development pressure on already vulnerable environments (Sandbrook *et al*., 2019; Lindsey *et al*., 2020). One important concern arising from increased development and activity within protected areas is the effective management of waste (Steg and Vlek, 2009; Belsoy *et al*., 2012; Rodríguez-Rodríguez, 2012; Lawhon *et al*., 2018; Sandham *et al*., 2020).

The negative impacts of waste on protected areas are well documented and include water and soil pollution, odours, increased fire hazards, aesthetic degradation, and adverse effects on animal health and behaviour (Ragazz *et al.,* 2014; Przydatek, 2019). In addition to the environmental and social implications for protected areas and adjacent communities, waste mismanagement has been shown to negatively affect visitor experience. Morrison-Saunders *et al*. (2019), Lawhon *et al.* (2018), and Mateer (2020) all found that responsible waste management is among the highest-ranked eco-tourism expectations within protected areas. Poor waste management practices frequently contribute to negative outcomes for neighbouring communities as well (Przydatek, 2019).

Responsible waste management in protected areas is essential to ensure the continued protection of these regions and to minimise negative impacts on their sensitive environments. In the South African context, the National Environmental Management: Protected Areas Act (57 of 2003) aims to *"promote the sustainable utilisation of protected areas for the benefit of people, in a manner that would preserve the ecological character of such areas*", while the National Environmental Management: Waste Act (59 of 2008) seeks to *"prevent pollution and ecological degradation".* In addition, one of the expected outcomes of the 2020 South African National Waste Management Strategy (DEFF, 2020) is that *"all South Africans live in clean communities with waste services that are well managed and financially sustainable".*

Despite the environmental and social imperatives of responsible waste management in protected areas, there is limited published research on this topic, both internationally and in South Africa. No published research specifically addresses the intersection of waste management and futures thinking or future projections within South African protected areas.

Futures thinking offers valuable tools for anticipating the future of waste management in and around protected areas by enabling the identification of potential environmental challenges and opportunities. Through the exploration of various scenarios and their implications, proactive strategies can be developed to support sustainable waste management practices that safeguard the

ecological integrity of these regions. The aim of the proposed research is therefore to explore future perspectives on waste management in South African protected areas through selected case studies (i.e., national parks). Ultimately, the project seeks to provide recommendations and guidelines to improve waste management in these protected areas as well as in the surrounding communities.

1.2 Aims and objectives

The aim of the research is to explore the future of waste management in South African national parks. The objectives include:

1. Exploring perspectives on the future of waste management in national parks in South Africa;
2. Understanding the challenges and opportunities regarding waste management in national parks based on future scenarios; and
3. Providing recommendations for improvement towards responsible waste management in protected areas.

1.3 Scope of the project

This study examines the future of waste management in South African national parks, applying a case study approach in which all twenty national parks managed by South African National Parks (SANParks) during the 2024/2025 period were included in the research sample. Together, these parks encompass approximately 3,751,113 hectares (over 3% of South Africa's total land area) and represent a diverse range of protected area contexts. Meerkat National Park was not formally included, as it does not host ecotourism activities and therefore falls outside the focus of this study.

The findings are informed by a combination of stakeholder perspectives and direct observations of waste management practices and infrastructure at each park. Within this scope, the research explores expectations for the future of waste management, identifies emerging challenges and opportunities under various future scenarios, and provides recommendations aimed at supporting responsible and sustainable waste management across protected areas.

2 Literature review

The purpose of this literature review is to contextualise the research project by examining existing studies on waste management in protected areas, with a focus on South Africa. Globally, research on waste management within protected areas is limited. Notable studies include the *Leave No Trace Center for Outdoor Ethics'* exploration of visitor attitudes and behaviours toward waste disposal in U.S. national parks, highlighting the need for sustainable waste practices in these environments (Marion *et al*., 2016). Similarly, Przydatek (2020) reviewed waste management in selected national parks, emphasising the challenges posed by inappropriate waste disposal methods, such as landfilling and combustion, which threaten the ecological integrity of these areas.

In the South African context, research on waste management in protected areas is even more limited. Notably, the majority of research on waste management in South African protected areas has been published by the project team from North-West University (NWU), South Africa since the early 2020s (Roos, Alberts, Retief, and Cilliers).

Roos *et al.* (2021) applied the Theory of Planned Behaviour (TPB) to understand waste management behaviour in private nature reserves, providing insight into the psychological and behavioural drivers influencing waste management practices. An MSc student from NWU extended this approach by applying TPB to tourism-related waste behaviour in marine protected areas, specifically the Aliwal Shoal (Harper *et al.,* 2022). Roos *et al*. (2022) further investigated the challenges and opportunities for sustainable solid waste management in private nature reserves, underscoring the limitations of existing waste management practices. Roos *et al.* (2023) synthesised principles toward responsible waste management in South African protected areas, distilling existing legislation, guidelines, and best practices to propose key principles aimed at achieving responsible waste management. Most recently, Roos *et al*. (2025) evaluated protected area management plans to establish the extent to which waste management is provided for in *"Towards responsible waste management in protected areas: An evaluation of South African national parks management plans".* Some unpublished research by the research group (not included in this literature review) include: *"Exploring Solid Waste Management (SWM) Behaviour in Etosha National Park, Namibia"* and *"Exploring plastic waste management practices surrounding the Agulhas National Park: The case of Struisbaai Harbour".*

It should be emphasised that the literature review for this study is based on a limited number of publications, with a significant portion authored by members of the project team themselves. This highlights the scarcity of research on waste management in protected areas within the South African context, reinforcing the need for further academic inquiry. Given this limitation, the purpose of the literature review is not to provide an exhaustive analysis of all available literature on the topic but rather to contextualise the research within the existing body of work.

The literature review explores waste management within South African protected areas, examining current practices, challenges, and strategies for improvement. The review first considers the current state of waste management in protected areas, identifying legislative frameworks, policies, and management strategies in place. It then examines challenges such as waste generation by tourists and staff, inadequate infrastructure, and enforcement limitations. The section ends with an introduction to the Seven Questions Method from the *Futures Toolkit: Tools for Futures Thinking and Foresight Across UK Government*. This method provides a systematic approach to analysing the complexities of waste management by framing key issues through forward-looking questions.

2.1 The unique context of protected areas

The environment is described by Arihilam and Arihilam (2019:54) as *"a biological, physical, social, economic, and cultural habitat in which living beings maintain their relationships throughout their lives and in their mutual interaction".* The importance of the interactions between living organisms and their environment cannot be overstated (Arihilam & Arihilam, 2019). However, these interactions often lead to unintended environmental harm. As the global population grows, resource consumption increases, leading to greater exploitation and production of natural resources. This in turn results in higher levels of waste generation, emissions, pollution, and contributes significantly to climate change (Kanivets *et al*., 2023). Anthropogenic activities not only pose risks to human and animal health but also threaten biodiversity conservation, resulting in environmental degradation, ecological depletion, and economic losses (Chen *et al*., 2014; Harris, 2010). The impact of human activities on the

environment is a complex and multifaceted issue that requires a holistic approach to minimize its negative effects. According to Kanivets *et al.* (2023), addressing this challenge involves reducing harmful emissions, controlling pollution, and improving waste management practices. Through better understanding and management of these activities, sustainable development can be achieved.

Vulnerable areas, in particular, are especially sensitive to anthropogenic pressures. To aid in the conservation of environmental, ecological, and cultural resources, a key strategy has been the establishment of protected areas (PAs) through legislation (IUCN, 2016). PAs restrict certain human activities to mitigate biodiversity loss, promote sustainable development, and conserve ecosystems. The International Union for Conservation of Nature (IUCN, 2016) formally defines PAs as *"a clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."* In addition to their environmental role, PAs provide additional benefits, including clean air and water, reduced risk of natural disasters and climate change, and opportunities for economic growth and recreation.

However, simply designating an area as a PA is not sufficient to ensure its success. Each PA is unique, with distinct functions, resource uses, land ownership, and management authorities. Consequently, PAs face a range of challenges, including poaching, inadequate resources, land development pressures, poor governance, and human intrusion (Nyaupane *et al*., 2020). These challenges must be addressed to support sustainable development within these areas. PAs often have multiple, sometimes conflicting, goals, as noted by Borrini-Feyerabend and Hill (2015), making it essential to find a balance between conservation and development efforts. Management paradigms for PAs have evolved significantly since the establishment of the first formal PA in the United States, Yellowstone National Park, in 1872 (Nyaupane *et al*., 2020). By 1971, the global number of PAs had grown to 20,054, and by 2020, this number increased to 258,608 (IUCN, 2020). As of November 2024, there were 303,309 PAs worldwide, covering approximately five million square kilometres (UNEP-WCMC & IUCN, 2024).

As previously mentioned, PAs contribute to economic and recreational opportunities through tourism, which has seen rapid growth in recent years (Manzoor *et al*., 2019; Ocheni *et al.,* 2020; Qin *et al*., 2018). According to the World Travel and Tourism Council (WTTC, 2023), tourism contributed approximately 7.6% to global GDP in 2022. This contribution is even more significant in countries that rely heavily on tourism for economic support. This trend is particularly evident in many African countries. Tourism contributes 4.3% to Africa's overall GDP, with notable variation across the continent. For instance, the Seychelles sees a high tourism contribution of 62.1%, while the Democratic Republic of Congo only contributes 1.6% (UNWTO, 2023). However, it should be noted that data was unavailable for several countries, including Djibouti, Equatorial Guinea, Eritrea, Guinea-Bissau, Liberia, Mauritania, Somalia, and South Sudan.

Tourists tend to frequent protected areas (Bushell & Bricker, 2017), of which some activities may be detrimental to the environment. With the increase in tourist flows, there is also an increase in deforestation and pollution, the overconsumption of resources, and of particular concern to this study, the generation of waste (Belsoy *et al*., 2012). The generation of waste by tourists, as stated by Przydatek (2019) and Steg and Vlek (2009), is one of the greatest threats to the sustainability of PAs.

Waste places significant pressure on the waste management facilities and services of tourist destinations. Not only does waste cause direct pollution through the contamination of air, water, and soil, but it causes visual or aesthetic impacts as well (Dileep, 2007). The ecotourism experiences of visitors are also influenced by pollution, as cited by Kimaro *et al.* (2015:124), Roos *et al.* (2021:39), and Zajchowski *et al*. (2019:3).

Although the ultimate purpose of a PA is to conserve an area, the success of these conservation efforts relies heavily on the area's effective management (Bhammar *et al.,* 2021; Bushell & Bricker, 2017). Understanding waste management practices in protected areas are, therefore, crucial.

2.2 Waste management in protected areas

Waste management within protected areas (PAs) is a critical aspect of environmental conservation and protection. As highlighted earlier, waste generation is often an inevitable by-product of tourism activities, which are central to the sustainability of many PAs. The environmental degradation caused by waste, especially in these sensitive areas, has been extensively documented by various authors (Dunjić *et al*., 2017; Harper *et al*., 2022; Mihai, 2013; Morrison-Saunders *et al*., 2019; Przydatek, 2019; Roos *et a*l., 2022; Steg & Vlek, 2009). Ineffective waste management not only exacerbates the ecological impact on biodiversity and ecosystems but also diminishes the aesthetic and recreational value of these areas, threatening their long-term sustainability.

Given the vulnerability of PAs, the effective and sustainable management of waste is a top priority. Waste management within these areas generally falls under the jurisdiction of the governing body responsible for the area, which typically operates under the legal framework of the region or country. This framework defines the regulations, responsibilities, and strategies for managing waste in a way that minimises environmental harm (Przydatek, 2019).

Despite the recognition of waste's degrading effects, traditional methods of waste management, such as landfilling, inadequate waste treatment, and waste mixing, remain commonplace, especially in developing countries (Dunjić *et al.,* 2017). These methods, which have long been entrenched due to financial constraints, insufficient infrastructure, and limited technical expertise, often fail to mitigate the adverse environmental impacts associated with waste in PAs. The need for alternative, more effective waste management methods is pressing. Approaches based on concepts such as the "zero waste" philosophy and the "waste hierarchy" (which prioritise waste prevention, reduction, reuse, and recycling) are essential for improving the efficiency and environmental integrity of waste management systems in PAs. These alternative strategies not only reduce the amount of waste generated but also foster a culture of sustainability and environmental responsibility among both staff and visitors.

2.3 Current waste management practices and challenges in South African protected areas

South African protected areas, including national parks and game reserves, face considerable challenges related to waste management. These areas, often located in remote environments, have limited infrastructure to handle the waste generated by increasing numbers of tourists and staff (Leung *et al*., 2018). According to Roos *et al*. (2022), the lack of proper waste disposal systems, such as recycling facilities or waste segregation practices, is a major issue in many South African parks. Moreover, poorly managed waste can lead to environmental degradation, threatening biodiversity and the integrity of ecosystems.

The legislative framework for waste management in South Africa includes the National Environmental Management: Waste Act (NEMWA) of 2008, which outlines the responsibilities of various stakeholders, including government bodies, municipalities, and private entities (Republic of South Africa, 2008). However, the implementation of these policies in protected areas often faces constraints such as limited resources, inadequate enforcement, and a lack of capacity within park management teams (Roos *et al*., 2023).

The primary challenges related to waste management in protected areas stem from several factors. One major issue is the high volume of waste generated by tourists, including single-use plastics and food packaging, which contribute significantly to littering (Pratt, 2021). Waste management practices are often reactive rather than proactive, with many parks struggling to cope with the influx of waste during peak tourist seasons. Furthermore, remote locations often lack the necessary infrastructure to support efficient waste disposal, recycling, and treatment systems (Roos *et al*., 2023).

Moreover, enforcement mechanisms for waste management are typically weak. The absence of effective monitoring systems means that the regulations around waste disposal are not always adhered to, and park authorities often lack the manpower to effectively enforce these rules (Roos *et al*., 2022). This is compounded by a general lack of awareness and commitment among visitors and park staff regarding the importance of waste reduction and responsible disposal (Du Plessis *et al*., 2012).

2.4 The impacts of waste on protected areas

As previously noted, waste is an unavoidable by-product of human activity that has significant direct and indirect effects on the environment and surrounding communities. The following sections highlight the impacts of waste on protected areas (PAs) in South Africa.

2.4.1 The impacts of waste on the receiving environment and biodiversity

Waste negatively impacts PA ecosystems in numerous ways, threatening conservation and preservation efforts and disrupting ecosystem balance. Water, air, and soil pollution are often linked to improper waste management. Waste decomposition, particularly from indiscriminate dumping, is a significant source of environmental pollution.

Liquid leachate produced from decomposing waste poses a threat to local surface and groundwater systems (Alam & Ahmade, 2013; Ololade et al., 2019). In South African PAs, this can lead to the contamination of water sources, creating water shortages and diminishing water quality (Leung *et al.,* 2018). Such effects can be especially harmful in arid regions like the Karoo or parts of the Western Cape (Aljaradin & Persson, 2012). Polluted water can alter the salinity and siltation of aquatic ecosystems, which can harm both fauna and flora within PAs (Belsoy, 2012). Wildlife may also be negatively impacted by ingesting polluted water.

Littering, a pervasive issue in South African tourist destinations such as Kruger National Park and Table Mountain National Park, exacerbates water and soil pollution. Litter not only affects soil and water nutrient composition but also endangers wildlife. It releases harmful gases into the air and can spread disease (Kariminia *et al*., 2013; Rodríguez-Rodríguez, 2012). Waste is often dispersed throughout PAs, with wildlife mistaking it for food. This not only degrades their natural habitat but also affects feeding grounds and could result in population declines in some species. Waste also impacts the climate, further disrupting PA ecosystems.

The uncontrolled disposal of waste contributes significantly to environmental pollution. Improper waste disposal releases excess gases into the atmosphere, such as methane, a potent greenhouse gas produced through anaerobic decomposition (Alam & Ahmade, 2013). Other gases like CO_2, CH_4, and N_2O are also released during improper waste disposal (Ackerman, 2012). Additionally, incineration and open burning produce harmful emissions, including SO2, N2O, HCl, CO, CO2, dioxins, and furans (Vergara & Tchobanoglous, 2012). Climate change, exacerbated by these emissions, affects temperature and precipitation patterns in South African PAs, disrupting ecosystems and habitats (Aljaradin & Persson, 2012).

Vegetation in PAs plays a crucial role in mitigating climate change by absorbing carbon. However, waste can lead to the degradation of vegetation, worsening climate change effects (Mansourian *et al*., 2009). Climate change, driven in part by increased waste, can force wildlife in South African PAs to move in search of more suitable conditions, leading to shifts in species composition and potentially jeopardizing habitats ill-prepared for these changes (Mansourian *et al.,* 2009).

2.4.2 The impacts of waste on health and the receiving communities

Waste can have detrimental effects on the health of communities and individuals, especially those living near waste management facilities or in areas lacking effective waste management systems (Alam & Ahmade, 2013). In South Africa, such communities, often in proximity to PAs, are at greater risk. According to Mateu-Sbert *et al.* (2013), the negative impacts of waste are more severe for residents compared to tourists, who typically stay for shorter periods.

Health risks may be either direct or indirect. Direct risks involve individuals handling waste, such as waste workers and waste pickers, who are often exposed to hazardous materials (Alam & Ahmade, 2013). These individuals are rarely protected from direct contact with waste, which can pose serious health risks (Vergara & Tchobanoglous, 2012). Indirect risks arise from disease transmission linked to

poorly managed waste. Mismanagement, such as the mixing of waste streams or the use of open dumping sites, can result in various health problems (Alam & Ahmade, 2013:167).

2.4.3 Aesthetic and economic impacts of waste

South African PAs are critical to the country's tourism industry, which relies on the aesthetic appeal of natural environments (Hatton, 2002). Waste detracts from the attractiveness of these areas, negatively affecting the visitor experience. The beauty of a PA is essential for attracting tourists, and improper waste management can severely impact this attraction (Arbulú *et al*., 2015). Waste management sites and landfills within or near PAs can also spoil the natural landscape, potentially deterring visitors. This not only affects the environment but also the local economy.

The presence of waste affects the functioning and structure of ecosystems within PAs, reducing their ability to provide essential ecosystem services. This, in turn, may lower the economic value of tourist destinations (Arabi & Nahman, 2020). Research shows that a variety of factors influence a tourist's decision to visit a destination (Arabi & Nahman, 2020; de Araújo & Costa, 2006; Krelling *et al.,* 2017). Inefficient waste management can detract from the overall visitor experience and, consequently, reduce tourism revenue. A study by Leggett *et al*. (2014) found that tourists are willing to spend more and travel further to visit cleaner, more attractive environments. Reduced tourism, combined with the high costs of environmental clean-up, can significantly lower revenue for local economies (Krelling *et al*., 2017; Przydatek, 2019).

To mitigate these negative impacts, effective waste management systems must be established. Legal frameworks and policies play a crucial role in ensuring compliance with waste management regulations and minimising the harmful effects of waste on South African PAs.

2.5 The legal framework for waste management in South African protected areas

South Africa has a comprehensive legal framework for waste management that includes various laws, regulations, and policies aimed at regulating waste generation, handling, and disposal. Key pieces of legislation relevant to the management of waste in PAs include the Constitution of South Africa, the National Environmental Management Act (NEMA), the National Environmental Management: Waste Act (NEM:WA), the National Environmental Management: Protected Areas Act (NEM:PAA), and the National Environmental Management: Biodiversity Act (NEM:BA). These laws collectively address the need for responsible waste management within protected areas, ensuring that activities do not harm the environment or the species and ecosystems that these areas are designed to protect.

2.5.1 Constitutional Mandate for Environmental Protection

Section 24 of the Constitution of South Africa (1996) establishes the fundamental right to an environment that is not harmful to health or well-being and mandates the protection of the environment for the benefit of current and future generations. This constitutional provision serves as the foundation for all environmental legislation in the country, including waste management laws. It emphasises the importance of promoting conservation, securing ecologically sustainable

development, and preventing ecological degradation, which is directly relevant to waste management practices in protected areas.

2.5.2 National Environmental Management Act (NEMA) and the Duty of Care

The National Environmental Management Act (NEMA) of 1998 provides the overarching framework for environmental management in South Africa. Section 2 of NEMA sets out a range of guiding principles for environmental governance, including the precautionary principle and the duty of care to avoid environmental degradation. These principles apply to all sectors, including waste management. In the context of protected areas, NEMA emphasises cooperative governance and requires environmental authorities and stakeholders to cooperate in managing activities that may cause harm to ecosystems. The Act forms the basis for many of the regulations that govern waste management, ensuring that activities in protected areas do not compromise biodiversity and ecosystem integrity.

2.5.3 National Environmental Management: Waste Act (NEM:WA)

The National Environmental Management: Waste Act No. 59 of 2008 (NEM:WA) is the primary legislation governing waste management in South Africa. It provides a comprehensive framework for managing waste in a manner that minimises pollution and promotes the reduction, reuse, and recycling of waste. The Act is particularly relevant in protected areas as it mandates the minimisation of waste generation, prioritising alternatives to landfilling and encouraging sustainable practices in waste management.

The National Norms and Standards for Disposal of Waste to Landfill (GNR.636 of 2013) provide requirements for waste disposal practices, ensuring that only waste that meets specific environmental criteria is accepted at disposal sites. In the case of protected areas, where the impact of waste is particularly sensitive, the regulations emphasise the need for waste diversion from landfills, recycling, and energy recovery options.

The Act's provisions for waste management licensing ensure that waste disposal activities within protected areas are closely monitored and regulated. Certain waste management activities (GNR. 921 of November 2013) in protected areas such as, but not limited to, the construction of waste disposal sites or the treatment of hazardous waste, require a waste management license. This helps to mitigate the potential environmental risks posed by waste to sensitive ecosystems in protected areas. These waste management activities are subject to stringent licensing processes, including environmental impact assessments (EIAs), which evaluate the potential environmental impacts of waste disposal.

Furthermore, norms and standards regulating the storage of waste (GNR. 926 of November 2013); sorting, shredding, grinding, crushing of waste (GNR. 1093 of October 2017); composting of organic waste (GNR. 561 of June 2021) are equally applicable in protected areas.

2.5.4 National Environmental Management: Protected Areas Act (NEM:PAA)

The National Environmental Management: Protected Areas Act (NEM:PAA) No. 57 of 2003 focuses on the management and conservation of South Africa's protected areas, including national parks, nature reserves, and marine protected areas. The Act provides the legal framework for the establishment, management, and regulation of these areas, ensuring that activities within them are aligned with conservation goals. The Act mandates that all activities in protected areas (which may include waste disposal) must not interfere with the ecological integrity of these areas. Waste management activities within protected areas are therefore subject to strict regulatory oversight to avoid harm to biodiversity and natural resources.

The NEM:PAA mandates that all protected areas must have a management plan to ensure the effective management and conservation of biodiversity. These management plans outline objectives, strategies, and actions required to maintain ecological integrity while addressing human activities within these areas. In terms of waste management, protected area management plans may contribute by:

- Setting guidelines for waste prevention, minimisation, and disposal to mitigate environmental impacts.
- Ensuring compliance with national and provincial waste management regulations, such as the National Environmental Management: Waste Act (NEM:WA).
- Establishing infrastructure and operational frameworks for sustainable waste handling, including waste collection, recycling, and disposal strategies.
- Providing a foundation for monitoring and enforcement mechanisms to prevent illegal dumping and pollution within protected areas.
- Promoting responsible tourism practices by incorporating waste management guidelines for visitors and concessionaires operating within the park.

Despite their importance, challenges remain in effectively integrating waste management into these plans, often due to resource constraints, lack of enforcement, or limited awareness among stakeholders (refer to Section 5.1).

2.5.5 National Environmental Management: Biodiversity Act (NEM:BA)

The National Environmental Management: Biodiversity Act (NEM:BA) of 2004 complements the waste management regulations by focusing on the conservation of biodiversity and the protection of species and ecosystems, including those within protected areas. This Act mandates the prevention of activities that could negatively affect biodiversity, such as pollution caused by waste. In practice, it intersects with waste management laws to ensure that waste management practices in protected areas align with conservation objectives.

2.6 Proposed principles towards responsible waste management in South African protected areas

Roos *et al.* (2023) have proposed principles towards achieving responsible waste management in South African protected areas. These principles are distilled from and based on existing legislation, guidelines and best practices applicable to environmental management, waste management and protected areas management. The principles are framed around the South African environmental management principles, and specifically contextualised for waste management in protected areas, based on legislation, guidelines and best practices from the literature. Six key principles are synthesised, which aim to achieve responsible waste management in protected areas through: (1) protection of ecosystems and biodiversity; (2) prevention and remediation of pollution; (3) implementation of the waste management hierarchy; (4) provision of effective waste services and infrastructure; (5) promotion of participation and building of partnerships; and (6) contribution to wellbeing, livelihoods and capacity. These principles provide a first step towards the development of detailed guidance on dealing with waste management in South African protected areas and may have relevance in other countries.

Principle 1: Protection of ecosystems and biodiversity

Principle 1 emphasises the importance of protecting ecosystems and biodiversity within protected areas to ensure they continue providing benefits for current and future generations (Brownlie & Treweek, 2018). Waste management should aim for no net loss to biodiversity by avoiding harm to sensitive species, habitats, and ecosystems (Brownlie & Treweek, 2018). To minimize negative impacts, waste infrastructure should be placed outside of sensitive areas while remaining accessible to tourists (Rodríguez-Rodríguez, 2018; Lai *et al*., 2018). The location of waste management facilities must consider ecological sensitivity and connectivity to prevent adverse effects on biodiversity (Lai, *et al.,* 2018). Negative impacts must be mitigated to preserve ecosystems within protected areas (Roos *et al*., 2022; World Bank, 2021c).

Principle 2: Prevention and remediation of pollution

Principle 2 focuses on preventing and remediating pollution from mismanaged waste in protected areas. Waste impacts must be mitigated throughout the entire management cycle, especially for new developments (Brownlie & Treweek, 2018). South African studies show waste management is often overlooked in Environmental Impact Assessments (Claassens *et al*., 2022; Sandham *et al*., 2020). Waste management should prevent littering and illegal dumping by providing adequate infrastructure (Wade & Eagles, 2003). Infrastructure must be well-located and of high quality to avoid leaks (World Bank, 2021c). Zero-tolerance policies, such as "leave no trace" programmes in U.S. parks, may not work in South Africa due to remote locations (Lawhon *et al*., 2018; Przydatek, 2019; Roos *et al.,* 2022). If waste disposal is necessary, it must be done responsibly, and degraded areas should be rehabilitated (USAID, 2018; RSA, 2014). Waste management should also mitigate greenhouse gas emissions (Gross *et al*., 2016).

Principle 3: Implementation of the waste management hierarchy

The waste management hierarchy is at the heart of South African waste-related legislation and strategy. Principle 3 advocates for the implementation of the waste management hierarchy, where waste is viewed as a resource. The hierarchy prioritises waste avoidance, followed by reduction, reuse,

recycling, recovery, treatment, and disposal (DEFF, 2020). Research on the environmental performance of tourism facilities in protected areas highlights key practices like waste separation at source, recycling, composting, and cooperation with recycling firms (Alberts *et al*., 2022; Erdogan & Tosun, 2009).

Waste separation at source is crucial for implementing the hierarchy, requiring infrastructure like recycling bins and awareness campaigns (Dunjić *et al*., 2017). Once separated, waste should remain segregated during collection and transportation, which can be challenging in South Africa, especially in private nature reserves (Roos *et al.,* 2022). Supporting local businesses and involving communities in waste management is important for gaining their support in conservation areas (Bennett & Dearden, 2014; Dri *et al*., 2018; World Bank, 2021a). However, remote protected areas may face challenges with transporting waste to recycling facilities, leading to higher costs and carbon emissions (Gross *et al*., 2016). The reuse, recycling, and recovery of waste should only be pursued if it is more environmentally beneficial than disposal, and a life cycle approach should be followed when planning waste management (RSA, 2008; DEFF, 2020).

Principle 4: Provision of effective waste services and infrastructure

In many remote protected areas in South Africa, municipal waste management services are unavailable due to location and resource limitations (Roos *et al.,* 2022). As a result, management authorities must establish their own waste services, potentially through private partnerships, and ensure proper resource allocation for waste management (Cointreau, 2001).

Principle 4 highlights that waste services must comply with legal requirements for storage, collection, transportation, and disposal, with documented evidence of compliance, though the unique context of protected areas can complicate this. Infrastructure may include bins, waste separation facilities, composting, transfer stations, and incinerators, but challenges such as animal access and the suitability of certain practices for local conditions need consideration (Roos *et al*., 2022). Large areas, like Kruger National Park, face difficulties with centralized services, and visitor behaviour impacts waste management effectiveness (Principle 3). The affordability of waste services is also important. Services should be cost-effective while meeting environmental standards and legal requirements, aiming for the Best Practicable Environmental Option (BPEO) and Best Available Technology (BAT) (Cointreau, 2001). To cover costs, user fees, such as entrance fees or taxes, may be needed, but these funds should be earmarked specifically for waste management (Crofts *et al*., 2020).

Principle 5: Promotion of participation and building of partnerships

Building sustainable partnerships and promoting meaningful participation in waste management decision-making is crucial for addressing the needs, expectations, and values of stakeholders (Cointreau, 2001). The National Waste Management Strategy (NWMS) emphasises community participation (DEFF, 2020). Consulting widely, including using traditional and indigenous knowledge, helps design waste management systems that are culturally and environmentally appropriate (Mwangi & Thuo, 2014). Indigenous knowledge can identify local materials and methods for waste management, such as composting plants or recycling practices suited to the local context. Principle 5 emphasises that early engagement with stakeholders ensures the appropriateness and acceptability of waste management practices and increases community support for conservation efforts.

Principle 6: Contribution to wellbeing, livelihoods and capacity

Principle 6 focuses on the contribution of waste management to wellbeing, livelihoods and capacity. Waste management in protected areas should aim to prevent negative impacts on surrounding communities' wellbeing, promote community upliftment, and create job opportunities through waste-related initiatives (Cointreau, 2001). The circular economy approach in South Africa focuses on integrating local communities and the informal waste sector into formal waste management systems to support livelihoods (DEFF, 2020). However, challenges such as inadequate infrastructure and the remote location of protected areas need to be addressed for these opportunities to be realized (Roos *et al*., 2022).

Skills, capacity, and education are crucial for effective waste management (Rodríguez-Rodríguez, 2012). There is a need to develop competencies through education, awareness, and knowledge-sharing to improve waste management practices and create business opportunities (Appleton, 2016; DEFF, 2020).

In Section 5.1, the protected areas management plans of national parks are reviewed against these six key principles.

2.7 Future perspectives on waste management in South African protected areas

The research aimed to explore *future perspectives* on waste management in South African protected areas by using case studies (selected protected areas, i.e. national parks). The project ultimately aimed to provide recommendations and guidelines for improved waste management in South African protected areas, as well as surrounding communities. Futures thinking can provide valuable insights into the future of waste management in and around protected areas by helping us anticipate and plan for potential environmental challenges and opportunities. By considering various scenarios and their implications, we can develop proactive strategies to ensure sustainable waste disposal practices that safeguard the ecological integrity of these protected regions.

2.7.1 Foresight and futures thinking methodologies

Foresight methodologies are essential tools for anticipating future challenges and opportunities, particularly in environmental and waste management contexts. These approaches enable stakeholders to proactively address potential scenarios, ensuring the most suitable outcomes for protected areas. Various methods exist for exploring future possibilities, each with unique strengths.

Environmental scanning, for example, involves systematically collecting data from diverse sources—such as news articles, academic papers, and expert interviews—to identify emerging trends and potential disruptions (Reality Pathing, 2021). This method helps in recognising external factors that could impact waste management strategies in protected areas. Similarly, horizon scanning focuses on identifying and monitoring potential threats and opportunities by analysing current and emerging issues across multiple domains (ICSU, 2016). This technique supports early detection of environmental changes that may necessitate adjustments in waste management practices.

Another widely used approach is scenario planning, which involves developing detailed narratives about different future contexts based on varying assumptions and drivers of change (Chermack, 2011). The Delphi method is a structured technique used for futures predictions and scenario building, often applied to complex, uncertain, or ambiguous issues (Dalkey & Helmer, 1963). It is a systematic process that relies on a panel of experts to gather informed opinions on a specific topic. The Delphi method involves multiple rounds of surveys or questionnaires, with feedback provided after each round. The goal is to reach a consensus or at least a clearer understanding of future developments by leveraging the expertise and insights of participants.

The *Seven Questions Method*, as outlined in the UK Government's Futures Toolkit, is another valuable method for exploring the future of waste management in protected areas (UK Government, 2019). The method was considered to be suitable for exploring the future of waste management in South African protected areas as it provides a structured framework for identifying key trends, uncertainties, and potential scenarios. This method encourages a holistic approach by considering both environmental and socio-economic factors, which is crucial for waste management in these unique areas. Given the complex interplay between tourism, local communities, regulatory requirements, and environmental protection in protected areas, the Seven Questions Method enables stakeholders to anticipate a range of possible futures and develop proactive strategies. Moreover, it promotes inclusive participation, helping to integrate local knowledge into decision-making processes, which is essential for the successful implementation of waste management practices in these areas.

2.7.2 The Seven Questions Method from the Futures Toolkit: Tools for Futures Thinking and Foresight Across UK Government

The *Seven Questions* method, initially developed for military strategic planning, has evolved over time to serve various sectors, including environmental policy development. Originally known as the "Combat Estimate", this framework was designed to guide military commanders in formulating effective plans under challenging conditions (Foresight Projects, 2018). Its adaptability has led to its adoption in diverse fields requiring structured decision-making processes. In the context of environmental policy, the Government Office for Science (GO-Science) in the UK incorporated the Seven Questions method into its *Futures Toolkit*, aimed at assisting policymakers in developing robust strategies amidst uncertain futures by providing tools such as horizon scanning and the Delphi method (Foresight Projects, 2018). The Seven Questions technique, as outlined in the toolkit, is particularly effective for engaging stakeholders and extracting strategic insights, especially from senior leaders. It facilitates the identification of key drivers in policy areas, offering a structured approach to understanding complex issues. This method encourages comprehensive analysis through a series of probing questions that cover various aspects of change, uncertainty, and strategy.

2.7.3 The Seven Questions

The Seven Questions Method begins with an open invitation to the contributor to discuss what they see as the key factors shaping the future of a given topic, followed by a set of questions that serve as "triggers" to delve deeper into their thoughts (Figure1). The interviewer should provide the time frame, for instance*, "imagine/reflect on the future of waste management in the next 25 years (or by 2050)"*.

Figure 1. Overview of the Seven Questions Method (adapted from the UK Government's Futures Toolkit)

The first question, the "Clairvoyant" or “Time-traveller” question, encourages the participant to imagine what they would want to know from a clairvoyant or time-traveller about the future of the subject in question. This question invites reflections on critical issues and uncertainties. It sets the stage for further exploration of what the future might hold. The second question focuses on an optimistic but realistic outcome. The participant is asked to imagine how things could develop positively, if all goes well, and what signs would indicate success. This scenario helps identify potential pathways for success and what conditions would need to be in place for these outcomes to occur.

Next, the "Pessimistic outcome" question (Q3) considers the opposite scenario: what could go wrong and how the situation could deteriorate. This question provides valuable insights into risks, challenges, and potential threats, helping participants think through worst-case scenarios and the factors that could lead to undesirable outcomes. The fourth question turns the focus to the internal situation. It asks the participant to reflect on the current culture, organisation, systems, and resources and how these would need to change to achieve the optimistic outcome. This allows for a more grounded understanding of what internal factors, such as organisational culture, capacity, and resources, need to be addressed to succeed in achieving the desired future.

The "Looking back" question encourages a retrospective view, asking participants to consider the factors that have shaped the current situation. This question allows participants to analyse the past and understand the influences that have brought the issue to its present state, providing context for future planning. The sixth question, "Looking forward," prompts participants to think about the decisions that need to be made in the near term to achieve the desired long-term outcome. This question bridges the present and future, helping to identify actionable steps and decisions that can move the issue in the right direction. Finally, the "Epitaph" question asks participants to imagine they have a mandate free of constraints and ask what additional actions they would take to ensure a successful future. This question allows for creative thinking and inspires the identification of bold or unconventional actions that could significantly impact the future trajectory of the issue.

Overall, the Seven Questions Method is a powerful tool for exploring diverse future scenarios and fostering deep reflection on the forces and decisions that will shape the future (Foresight and Futures

Studies, 2021). For the purposes of this research, the questions were contextualised for waste management in South African national parks.

Once the interview responses are gathered using the Seven Questions Method, the next step is to synthesise the insights into different future scenarios. These scenarios are typically framed around a range of possibilities, from the most optimistic to the most pessimistic, and include a more realistic middle ground. For example, responses to the "Optimistic outcome" and "Pessimistic outcome" questions may provide a basis for constructing two extreme scenarios: a "blue skies" scenario (best-case future) and a "doom and gloom" scenario (worst-case future). These scenarios reflect the potential for success or failure, based on the factors identified during the interview. The "Looking forward" question, which focuses on decisions needed to reach a long-term goal, helps to bridge these extreme scenarios by shaping a more balanced or "glass half-full" scenario, which represents a realistic and achievable future, taking into account both opportunities and challenges. By combining insights from all seven questions, the interview responses contribute to building a range of plausible futures, providing a valuable framework for strategic decision-making and planning.

3 Context of the case study

This project employed an exploratory case study design, focusing on South African *national parks* within the broader context of protected areas. The International Union for Conservation of Nature (IUCN) defines a protected area as *"A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values"* (Dudley, 2008). Protected areas are categorised into six management categories: Category I (Strict Nature Reserve), Category II (National Park), Category III (Natural Monument or Feature), Category IV (Habitat/Species Management Area), Category V (Protected Landscape/Seascape), and Category VI (Protected Area with Sustainable Use of Natural Resources).

National parks (Category II) are defined by the IUCN as *"Large natural or near-natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities"* (Dudley, 2008).
This research specifically examines national parks managed by South African National Parks (SANParks), the organisation responsible for managing the national parks of South Africa. SANParks operates a network of 21 national parks[1] (Figure 2), which play a crucial role in conserving South Africa's rich biodiversity and offer various eco-tourism opportunities.

[1] Namaqua National Park and Namaqua National Park Marine Protected Areas are deemed to be two different national parks, but mapped as one park in Figure 2, and dealt with under one section below.

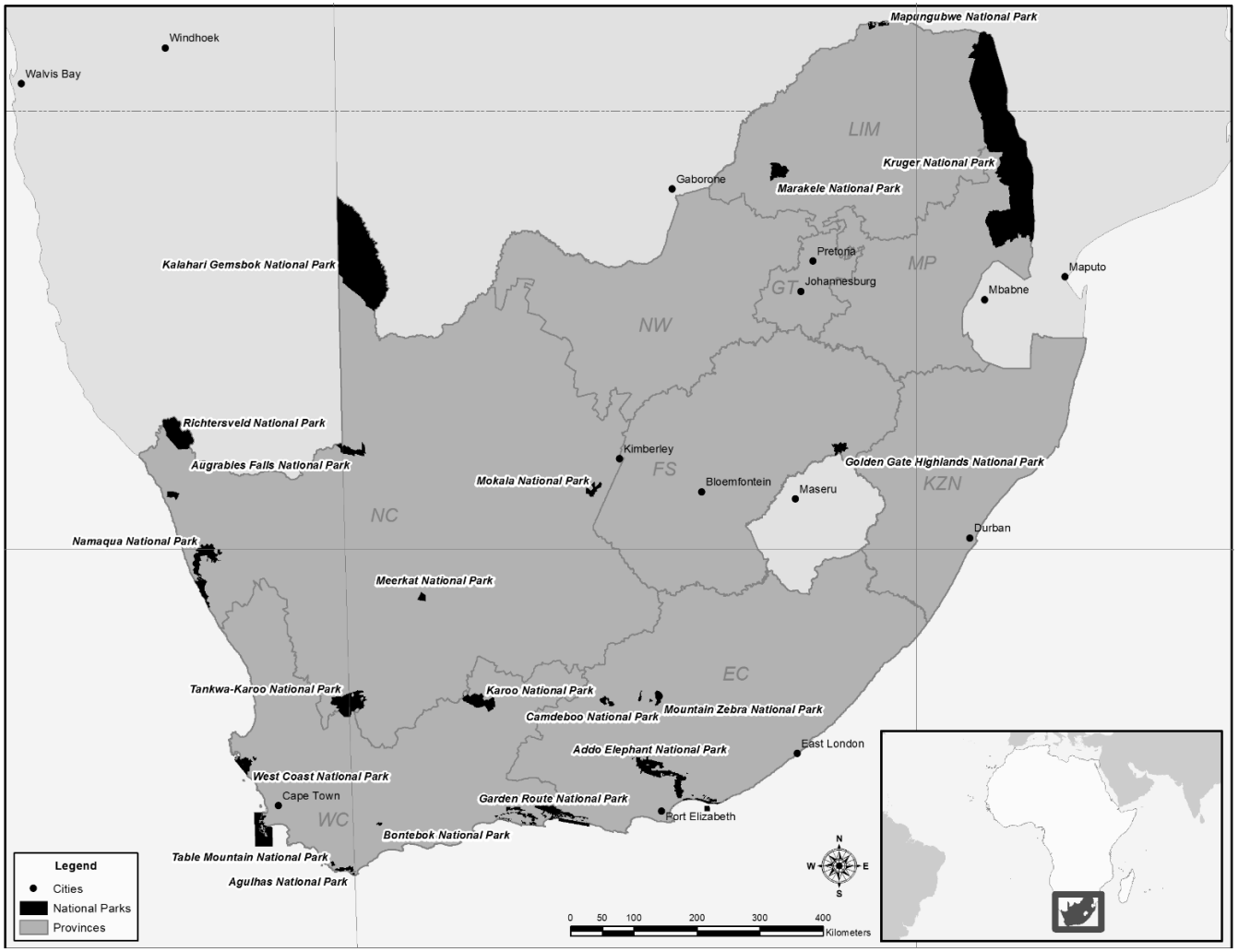

Figure 2. Map of national parks in South Africa managed by SANPARKS

3.1 Description of national parks included in the study

Table 1 and the Section 3.1.1 to 3.1.20 below provide a brief overview of the twenty national parks included in the research. Detailed information of each of these national parks can be found in their approved management plans, and are not repeated in this report. The sections reflect on tourism facilities and accommodation capacity, since these would influence the waste that is generated in each park.

Table 1 provides a summary of the national parks included in the project with their location (also see Figure 2), accommodation/tourism facilities and -capacity, as well as some key features of each park. The sub-sections below provide further detail as background information.

3.1.1 Addo Elephant National Park

Addo Elephant National Park is the third largest national park in South Africa, and located in the Eastern Cape. The park is situated in the Eastern Cape Province, with the administrative office of the park about 75 km north of Port Elizabeth (Figure 2). The park stretches from the semi-arid plains around Darlington Dam, south and east over the Zuurberg Mountain range and into the Sundays River Valley. From here, although occasionally interrupted by state and private land, the park extends south to the Sundays River mouth and then east along the coast to the Bushman's River mouth.

3.1.2 Agulhas National Park

The park lies about 260 km south east of Cape Town and 37 km south south-west of Bredasdorp (Figure 2), situated on the Agulhas Plain in the Overberg region of the Western Cape Province. It extends approximately 45 km along the coast, from Pearly Beach in the west to L'Agulhas in the east and extends between one and 25 km inland from the coastline.

3.1.3 Augrabies Falls National Park

Augrabies Falls National Park is located in the Northern Cape, approximately 120 km west of Upington and 40 km west of Kakamas, along the southern edge of the Kalahari Desert and the eastern border of Namibia (Figure 2). It was initially proclaimed to conserve a small area of geological interest around the Augrabies Falls, which is the largest waterfall on the Orange River.

3.1.4 Bontebok National Park

Bontebok National Park is situated in the Western Cape, about 220 km from Cape Town and eight km from Swellendam (Figure 2). It is situated on the coastal plateau between the Langeberg Mountain range (5 km away) and the Indian Ocean (50 km away). The park presents an attractive stop over point for travellers following the Garden Route, being situated close to Swellendam, and around halfway between Cape Town and George.

Table 1. South African national parks with as summary of their location (province), accommodation facilities, tourist/bed capacity and key features/tourism focus.

National Park	Province	Accommodation Facilities	Total Units & Sites (Beds/Guests)	Key Features & Tourism Focus
Addo Elephant National Park	Eastern Cape	Addo Rest Camp, Kabouga, Langebos Huts (Woody Cape), Matyholweni Rest Camp, Narina Bush Camp, Nyathi Rest Camp, Spekboom Tented Rest Camp	93 units and 37 camp sites. Boasts occupancy rates higher than the organisational average.	Third largest national park in South Africa. Matyholweni rest camp is a notable example of community partnership.
Agulhas National Park	Western Cape	Agulhas rest camp, Bergplaas guest house, Lagoon house guest house, Rhenosterkop	20 accommodation units with 68 beds capacity.	Includes the Agulhas Marine Protected Area (MPA).
Augrabies Falls National Park	Northern Cape	Augrabies camp, Gorge	Total: 438 beds person capacity. Includes a total of 60 chalets/cottages and 50 camp sites.	Initially proclaimed to conserve a small area of geological interest around the Augrabies Falls and has since expanded.
Bontebok National Park	Western Cape	Lang Elsie's Kraal Rest Camp	156 beds person capacity. Includes 14 chalets (36 beds) and 20 camp sites.	A day visitor facility at 'die Stroom' on the banks of the Breede River has braai facilities. The facility can be used for functions.
Camdeboo National Park	Eastern Cape	Lakeview tented camp, Nqweba camp site	98 beds person capacity. Includes four 2-bed tents and 15 camp sites.	Virtually surrounds the historic town of Graaff-Reinet. Known for "The Valley of Desolation". Divided by the R75 and N9 roads into an eastern and western section.
Garden Route National Park	Spans two provinces	Knysna Lakes Section, Nature's Valley Rest Camp, Storms River	Knysna Lakes Section 32 beds; Nature's Valley Rest Camp 65 camp sites, ten 2-bed	The Garden Route is a popular holiday destination

National Park	Province	Accommodation Facilities	Total Units & Sites (Beds/Guests)	Key Features & Tourism Focus
	(Eastern Cape and Western Cape)	Mouth Rest Camp, Wilderness Ebb-and-Flow (North & South)	forest huts, two 2-bed chalets; Storms River Mouth 910 beds; Wilderness Ebb-and-Flow North 420 beds; South 540 beds.	during summer and winter months. The park has well-established tourism nodes in Wilderness and Tsitsikamma
Golden Gate Highlands National Park	Free State	Golden Gate Hotel & Chalets, Highlands Mountain Retreat, Glen Reenen Rest Camp, Basotho Cultural Village, Noord Brabant farmhouse, Rhebok hut	426 in accommodation units and 180 persons camping. (Includes hotel rooms, rondawels, chalets, cottages, guesthouse, and 30 camp sites).	Tourism has become well established in the park and is in line with SANParks' approach to offer a range of products focusing primarily on the self-catering range.
Karoo National Park	Western Cape	Main rest camp (Stolzhoek), Grantham facility, Embizweni (remote facility), Afsaal (rustic cottage)	350 guests per night. 37 Cape Dutch style units (148 persons capacity). 24 camping and caravan sites (144 persons capacity). Grantham facility can sleep up to 50 people.	Forms part of the Great Karoo within the semi-arid Nama-Karoo environment.
Kgalagadi Transfrontier Park	Northern Cape	Twee Rivieren, Nossob, Mata Mata (Rest Camps); Kieliekrankie, Kalahari tented camp, Grootkolk, Gharagab, Bitterpan, Urikaruus (Wilderness Camps)	277 in accommodation units and 534 persons camping. Total Units: 106 units and 89 campsites.	The western border is the international boundary with Namibia. One of SANParks' top performing and financially sustainable parks.
Kruger National Park	Spans two provinces (Mpumalanga and Limpopo)	12 main rest camps, 5 bushveld camps, 2 bush lodges, 4 satellite camps, Skukuza Safari Lodge, 7 contracted and community-operated game lodges	9,131 guests per night. (Includes 4,243 SANParks beds and 3,840 campsite guests and 1,048 beds by concessionaires).	Biggest national park in SA and offers the most complex range of accommodation and tourism facilities. Top performing and financially sustainable park.
Mapungubwe National Park	Limpopo	Leokwe Camp, Limpopo Forest Camp, Mazhou Camping Site, Tshugulu Lodge, Vhembe Camp	76 in 32 accommodation units, and 60 persons in 10 camp sites.	A World Heritage Site.

National Park	Province	Accommodation Facilities	Total Units & Sites (Beds/Guests)	Key Features & Tourism Focus
Marakele National Park	Limpopo	Bontle rest camp, Tlopi Tented camp, Motswere Guest Cottage, Education centre	317 overnight guests. Bontle (31 camp sites, 9 safari tents); Tlopi (9 safari tents); Motswere (one 8-sleeper guest house); Education centre (sleeps 50–70).	Located approximately 15km from Thabazimbi.
Meerkat National Park	Northern Cape	Not applicable	No accommodation available.	Site of the Square Kilometre Array (SKA) core site.
Mokala National Park	Northern Cape	Mosu Lodge, Lilydale rest camp, Haak-en-Steek cottage, Kameeldoring/Dinokeng tree top cottages, Stofdam bird hide, Motswedi camp site, Mofele education centre	Up to 121 overnight guests in tourism facilities (plus 60 in education centre).	Located at the interface of the Nama-Karoo and Savanna Biomes.
Mountain Zebra National Park	Eastern Cape	Main rest camp, mountain cottages, historic guesthouse	Up to 248 overnight guests (20 family cottages, 25 campsites, two mountain cottages and a historic guesthouse).	Established to save the endangered Cape mountain zebra. The park has a formal conference venue that can accommodate 40 people.
Namaqua National Park	Northern Cape	Skilpad, Luiperdskloof, Groenriver coastal	Up to 320 overnight guests. (Includes four 2-bed chalets, one 6-bed cottage, and 51 camp sites).	Known for its annual flower displays.
Richtersveld National Park	Northern Cape	Sendelingsdrif, Tatasberg, Gannakouriep (Wilderness camps); Camp sites: De Hoop, Kokerboomkloof, Potjiespram, Richtersberg	Up to 380 overnight guests (33 fixed beds, 336 camping capacity). 18 units (10 chalets, 8 wilderness units). Total Campsites: 44 sites across the park.	Managed in collaboration with the local Nama community.
Table Mountain National Park	Western Cape	Olifants Bos Guest House (Cape Point), Slangkop tents, Smitswinkel tents, Overseers Mountain cottage	Approximately 70 beds. (Includes 1 x 6-sleeper guesthouse, 24 x 2-sleeper tents, 1 x 16-sleeper cottage).	Natural World Heritage Site. Primarily a day-visitor park, with an estimated 4 million visitors per year.

National Park	Province	Accommodation Facilities	Total Units & Sites (Beds/Guests)	Key Features & Tourism Focus
Tankwa Karoo National Park	Western Cape and Northern Cape	Tankwa Karoo Rest Camp (includes De Zyfer and Pauls Hoek cottages), Elandsberg Rest Camp	Up to 100 overnight guests in 29 units (units/cottages/guesthouses) and 8 camping sites.	Provides a migration corridor for succulent plants in this region.
West Coast National Park	Western Cape	West Coast Rest Camp (Stleytler House Cottage; Abrahamskraal Cottage; Van Breda Cottage; Jo-annes Beach Cottage A/B)	Up to24 guests in 5 guest cottages	Very popular destination for day visitors, especially during the festive season (Preekstoel picnic site).

3.1.5 Camdeboo National Park

The Camdeboo National Park is situated in the Eastern Cape Province, approximately 250 km north of Gqeberha (Port Elizabeth). It virtually surrounds the historic town of Graaff-Reinet, often referred to as the "Gem of the Karoo", lies at the junction of the R63 to Murraysburg, the N9 to Middelburg/ Aberdeen and the R75 to Gqeberha (Figure 2). The park is effectively divided by the R75 and N9 roads into an eastern section of ±8,022 ha and a western section of ±11,030 ha.

The park offers various activities such as "The Valley of Desolation" which is the natural structure of piled dolerite columns towering over a deep rocky cleft. The Nqweba Dam attracts a wide variety of water birds and game viewing. Various walks and hikes are offered and a 4x4 route which leads to the top of the mountain provides views of the landscapes.

3.1.6 Garden Route National Park

The Garden Route National Park extends over roughly 150 kilometres between Wilderness (west) and Tsitsikamma (east) and over 40 kilometres north to south between the Outeniqua and Tsitsikamma mountains, along the Indian ocean coastline (Figure 2). The park spans two provinces, two district and four local municipal boundaries, within a fragmented and multi-use landscape including urban, forestry, conservation and agricultural land uses. The Garden Route is a popular holiday destination during summer and winter months. The park has well-established tourism nodes in Wilderness and Tsitsikamma.

3.1.7 Golden Gate Highlands National Park

The Golden Gate National Park is situated in the north-eastern Free State and extends between the towns of Clarens (20 km) and Phuthaditjhaba (40 km) (Figure 2) on the R712 provincial road that meanders through the middle of the park. It lies in the foothills of the Maloti Mountains in the Rooiberg range. Other nearby towns are Bethlehem (60 km), Fouriesburg (50 km), Kestell (60 km) and Harrismith (75 km). To the south the park borders on Lesotho.

Tourism has become well established in the park and is in line with SANParks' approach to offer a range of products focusing primarily on the self-catering range. There are a wide variety of overnighting options to choose from. These include the Golden Gate Hotel and Chalets, as well as several smaller rest camps, including the popular Highlands Mountain Retreat with wooden cabins nestled in the steep slopes at high altitude, and Glen Reenen with a variety of chalet types and camping. Further east there is the Basotho Cultural Village where quaint chalets have been designed to bring in the Basotho cultural elements. Finally, there is the Noord Brabant farmhouse and the Rhebok hut offering a basic overnight cabin for the hikers on this trail.

3.1.8 Karoo National Park

The Karoo National Park is situated against the Nuweveld Mountain range, 3 km northwest of Beaufort West, in the Western Cape Province (Figure 2). It forms part of the Great Karoo, South Africa's largest

ecosystem, covering 35% of South Africa's land area. The park falls within the Central Karoo District of the semi-arid Nama-Karoo environment

The park has one rest camp, which is situated at Stolzhoek approximately 6 km from the N1, and includes accommodation and camping facilities. Additional accommodation is available at the Grantham facility, which is mainly used for environmental education e.g. Kids in Parks, and can sleep up to 50 people. There are also two remote overnight facilities available, one on the Embizweni 4x4 route, and Afsaal, a rustic shepherd's cottage.

3.1.9 Kgalagadi Transfrontier Park

The Kgalagadi Transfortier Park situated in the Northern Cape Province. The western border is the international boundary with Namibia and the eastern border along the Nossob River is the international boundary with Botswana (Figure 2), where it adjoins the Gemsbok National Park (GNP). The closest town is Askham (72 km from Twee Rivieren), while Upington is located 250 km to the south. The park is one of SANParks' top performing and financially sustainable parks and includes three rest camps and six wilderness camps, with a total of 106 accommodation units and 89 campsites available. The park has a total beds person capacity of 277 in its accommodation units and 534 persons camping.

3.1.10 Kruger National Park

The Kruger National Park is located across two South African provinces in the northeast: Mpumalanga and Limpopo, stretching northwards from the Crocodile River up to the Limpopo River, bordering Zimbabwe and Mozambique (Figure 2).

The Kruger National Park is the biggest national park in South Africa, covering an area of 19,623 km^2. Kruger has 12 main rest camps, 5 bushveld camps, 2 bush lodges and 4 satellite camps. The park further boasts seven game lodges operated by contracted concessionaires, providing for the full-service luxury market. There are five game lodges operated on community owned and contracted land providing 392 beds. The Skukuza Safari Lodge provides accommodation for 250 guests. The park overnight guest capacity therefore totals 9,131 guests per night.

3.1.11 Mapungubwe National Park

Mapungubwe National Park is located on the border between South Africa, Zimbabwe and Botswana. It is located in the Limpopo Province on the South African side of the confluence between the Shashe and Limpopo Rivers (Figure 2). The Limpopo River forms the northern boundary and the R572 and R521 Provincial tar roads form the southern and western boundaries respectively.

Tourism has become well established in the park and is in line with SANParks' approach to offer a range of products focus primarily on the self-catering range. There are currently five small camps varying from a lodge, cottages at Leokwe rest camp, Limpopo Forest camp to the more rustic Vhembe camp and Mazhou campsite.

3.1.12 Marakele National Park

Marakele National Park is situated in the Limpopo Province, roughly 15 km northeast of Thabazimbi (Figure 2). The park lies on the extreme south-western quadrant of the Waterberg massif and its adjoining lowlands to the west. The Kwaggasvlakte section of the park is currently disconnected from the main area of the park by the D928 provincial Hoopdal road.

3.1.13 Meerkat National Park

The Square Kilometre Array (SKA) core site of Meerkat National Park is located in the Northern Cape Province. It is approximately 650 km from Cape Town, 900 km from Johannesburg and 90 km from Carnarvon (Figure 2). Access to the site is via a provincial tar road. The site consists of the 'core' area (SKA core) and three spiral arms.

There is no accommodation available in the park. As Meerkat NP is at an early stage in its development, it is anticipated that the park zoning will be significantly updated in future iterations. Meerkat National Park were, therefore, not visited to observe tourism infrastructure and related waste management infrastructure.

3.1.14 Mokala National Park

The park is located in the Northern Cape Province, 80 km south-west of Kimberley, and west of the Kimberley-Cape Town N12 road (Figure 2). The park has a range of tourism accommodation facilities and can cater for small conferences of up to 40 people at Mosu, however these are seldom used, due to the lack of adequate accommodation to cater for conference guests.

3.1.15 Mountain Zebra National Park

Mountain Zebra National Park is situated in the Eastern Cape, on the northern slopes of the Bankberg mountain range in the Cape Midlands. It is situated on the R61 road, 12 km from Cradock on the road to Graaff-Reinet, and is 262 km from Port Elizabeth (Figure 2). The park accommodation includes a total of 20 family cottages, 25 campsites, two mountain cottages and a historic guesthouse. It has a formal conference venue that can accommodate up to 40 people.

3.1.16 Namaqua National Park

The park is situated in the Namaqualand region of the Northern Cape Province of South Africa, and stretches from the Groen- and Spoegriviere on the Atlantic Ocean to just west of the town Kamieskroon, which is 495 km north of Cape Town (Figure 2). The park can accommodate a total of 320 overnight guests.

3.1.17 Richtersveld National Park

The park is situated within the Northern Cape Province approximately 90 km northeast of Alexander Bay (Figure 2), with the Orange River forming the north / north-eastern boundary which is also the border between South Africa and Namibia.

There are various small camps along the Orange River. The largest of these is Sendelingsdrift. There are wilderness camps at Tatasberg and Gannakouriep, and the four day Venstervalle Hiking Trail can be undertaken from Hakiesdoring Wilderness Camp. Furthermore, there are four camp sites across the park: De Hoop, Kokerboomkloof, Potjiespram and Richtersberg.

3.1.18 Table Mountain National Park

Table Mountain National Park is located on the Cape Peninsula, the south-western extremity of Africa. It stretches from Signal Hill in the north to Cape Point in the south and includes Table Mountain, a national monument and one of the New Seven Wonders of the World (Figure 2).

The Park has many access points, but there are only four sites currently charging visitors a conservation fee for access with the number of visitors accessing the Park being formally counted at these sites. Whilst Cape Point and Table Mountain cableway are currently the most visited attractions with over 850,000 visitors each per year, the Boulder penguin colony also has high visitation with over 650,000 visitors per year. From visitor surveys conducted by the Park, it is estimated that the number of non-paying visitors to the non-gated area of the park is more than 1.5 million per annum, contributing to an estimated 4 million visitors to TMNP each year. Accommodation includes Olifants Bos Guest House, as well as Slangkop and Smitswinkel tents and Overseers Mountain cottage.

3.1.19 Tankwa Karoo National Park

The Tankwa Karoo National Park is situated in the northern section of the Tanqua Karoo approximately 140 km north of Ceres, 100 km south of Calvinia, 120 km west of Sutherland and 25 km south-west of Middelpos (Figure 2) The park is bounded by the Cedarberg Mountains in the west, the Roggeveld escarpment to the east and the Klein Roggeveld Mountains to the south-east. Two public roads leading from Ceres to Calvinia and Middelpos (the R355 and P2250) cut through the park. The park falls across the two provinces of the Western Cape Province and the Northern Cape Province of South Africa. The Tankwa Karoo National Park has been recognised as important in the face of climate change as it provides a migration corridor for succulent plants in this region. Accommodation is available in Tankwa Karoo Rest Camp and Elandsberg Rest Camp.

3.1.20 West Coast National Park

The West Coast National Park is situated approximately 100km northwest of Cape Town on the Atlantic seaboard in the Western Cape Province (Figure 2). The park stretches from Yzerfontein in the south to Langebaan in the north and from the Atlantic Ocean in the west (with approximately 30 km of coastline) across the West Coast road (R27) towards Hopefield in the east. West Coast Rest Camp has five guest cottages sleeping a total of 24 guests.

3.2 Overview of waste management services at South African national parks

Table 2 provides a brief overview of waste management based on three different park "clusters". The information was obtained from SANPARKS as part of its *Draft Action Plan to Tackle Problem Plastics in National Parks* (November 2024). Further refinements and elaborations to this information are made in Section 5 of this report as part of the results of this research.

Cluster 1: Parks with Access to Municipal Waste Services

Cluster 1 consists of eight national parks (Karoo, Agulhas, Bontebok, Camdeboo, Knysna, Namaqua, Table Mountain and West Coast) that have access to municipal waste services. These parks benefit from regular waste collection and disposal services provided by local municipalities. This arrangement ensures that waste generated within the parks is efficiently collected and removed, reducing the environmental impact of waste accumulation.

Cluster 2: Parks without Municipal Waste Services, where SANParks Transports Waste to an Outside Landfill Site

Cluster 2 includes four national parks (Addo Elephant, Mapungubwe, Marakele and Mountain Zebra) that do not have access to municipal waste services. In these parks, SANParks is responsible for the transportation of waste to external landfill sites. This process can be more complex and costly due to the distance and logistical challenges involved in moving waste out of the parks. These parks are mostly located in more remote areas where municipal services are either unavailable or impractical, requiring SANParks to handle the waste management independently.

Cluster 3: Parks with Onsite Waste Processing, Typically Through Open Burning

Cluster 3 comprises eight national parks (Tsitsikamma, Kruger, Augrabies, Kgalagadi, Richtersveld, Golden Gate, Tankwa Karoo, Mokala) where there is some degree of onsite waste processing, most commonly through open burning. In these parks, waste is often burned in open pits or controlled areas as a means of disposal. While this method may help reduce waste volumes, it can have environmental implications, including air pollution and the release of harmful chemicals. The practice of open burning is often a necessity in parks where waste removal options are limited or impractical, but it highlights the need for alternative waste processing solutions to mitigate negative environmental impacts.

Table 2. Park clusters based on approaches to waste management, and key actions required for an integrated approach to waste management (Source: Draft Action Plan to Tackle Problem Plastics in National Parks, dated November 2024)

Park Clusters	Park	Waste Separation	Key actions
Cluster 1 Parks with access to municipal waste services	Karoo	No	***Short term (2024-2025)*** 1. Confirm that all waste disposal facilities (WDFs)* are registered. 2. Determine if there are buy back-centres, recycling facilities, SMMEs, or formal or informal waste pickers associated with the WDF. 3. Implement separation at source inside parks, to increase the quality of the recyclables, and measures to divert food waste away from landfills. 4. Monitor quantities of waste generated. 5. Work with suppliers and concessionaires to remove problematic plastics and other identified items from the supply chain or prevent them from leaking out of the waste stream. 6. Conduct awareness campaigns around conscious consumption to reduce waste. 7. Identify and rehabilitate all dis-used waste sites inside Parks. ***Medium Term (2026-2029)*** 8. Agreements with municipalities to formally divert recyclables and food waste out of landfill. 9. Reduction of waste to landfill by 50% ***Long Term (2030)*** 10. Zero waste to landfill
	Agulhas	Yes	
	Bontebok	No	
	Camdeboo	No	
	Knysna	No	
	Namaqua	No	
	Table Mountain	Yes (some sites)	
	West Coast	No	
Cluster 2 Parks without municipal waste services, where SANParks transports waste to an outside landfill site	Addo Elephant	Yes	***Short term* (2024-2025)** 1. Confirm that all WDFs are registered 2. Determine if there are buy back-centres, recycling facilities or formal or informal waste pickers associated with each site. 3. Implement separation at source inside parks. 4. Measure and characterise waste. 5. Work with suppliers and concessionaires to remove problematic plastics and other identified items from the supply chain.
	Mapungubwe	No	
	Marakele	No	

Park Clusters	Park	Waste Separation	Key actions
	Mountain Zebra	No	6. Conduct awareness campaigns with target audiences around conscious consumption to reduce waste generated and increase recycling efforts. 7. Identify and rehabilitate all dis-used waste sites inside Parks ***Medium Term (2026-2029)*** 8. Agreements with buy back centres, extended producer responsibility companies, SMMEs to find alternatives for recyclables, food waste, and other items that can be reused and repurposed. 9. Reduction of waste to landfill by 50% ***Long Term (2030)*** 10. Zero waste to landfill
Cluster 3 Parks where there is a degree of onsite processing of waste	Tsitsikamma	No	***Short term (2024-2025)*** 1. Confirm that all waste sites inside Parks are registered and submitting data to SAWIS 2. Ensure burning is fully complaint with NEMWA, if not commission work to look at alternatives to burning. 3. Determine if there are buy back-centres, recycling facilities or formal or informal waste pickers located in the vicinity 4. Implement separation at source inside parks. 5. Measure and characterise waste generated 6. Work with suppliers and concessionaires to remove problematic plastics and other identified items from the supply chain. 7. Identify and rehabilitate all dis-used waste sites inside Parks ***Medium Term (2026-2029)*** 7. Agreements with buy back centres, extended producer responsibility companies, SMMEs to divert recyclables, food waste, and other items that can be reused and repurposed away from burning. 8. Reduction of waste to landfill by 50% ***Long Term (2030)*** 9. Zero waste to landfill
	Kruger	Yes (at some sites, or at sorting facility)	
	Augrabies	Yes	
	Kgalagadi	No	
	Richtersveld	No	
	Golden Gate	No	
	Tankwa Karoo	No	
	Mokala	Yes (but being burned)	

3.3 Waste related policies, plans and procedures of South African national parks

There are currently no approved waste-specific policies, plans or procedures for any of the South African national parks. In the absence of such specific policies, plans or procedures, protected areas management plans emerge as a pragmatic instrument for managing waste in South African national parks. Furthermore, it is acknowledged that SANParks is in the process of developing an integrated waste management strategy, with related waste management plans/programmes for its national parks.

Protected areas management plans are comprehensive documents developed in terms of the South African National Environmental Management: Protected Areas Act (57 of 2003) (NEM: PAA) to guide the administration and operation of these areas. They outline the goals, strategies, and actions necessary to maintain and enhance the ecological, cultural, and recreational value of protected areas.

According to Goosen and Blackmore (2019), protected area management plans have developed over 150 years of conservation history, evolving to fulfil three primary functions. Firstly, they ensure that protected areas are managed effectively, aligning with the purposes for which they were established. Secondly, they provide a consistent framework for management actions, ensuring continuity as management transitions between different authorities or managers. Thirdly, these plans serve as a transparent mechanism for the public, demonstrating that protected areas are being managed in their best interests and those of future generations.

Despite the critical role of protected area management plans in conservation, there has been limited research on their implementation and effectiveness in the South African context (Goosen and Blackmore, 2019). Existing studies primarily focus on biodiversity conservation and cultural heritage management practices (for instance: Goodman, 2003; Taru *et al*., 2013) leaving a significant gap in understanding how these plans are effectively implemented to achieve other areas of management. Furthermore, there is a notable lack of published research evaluating management plans in the context of responsible waste management within protected areas.

Section 5.1 provides an analysis of the extent to which waste management is addressed in protected areas management plans. In the absence of specific legal requirements, other criteria or established best practice principles for waste management in national parks, the evaluation uses the principles proposed by Roos et al. (2023) in their paper “Proposing principles towards responsible waste management in South African protected areas” (See Section 2.6). These principles are aligned with environmental management principles set out in South African environmental law and the objectives of waste-related legislation, and have been contextualised for protected areas based on the objectives of protected areas and biodiversity legislation. Additionally, principles, guidelines and good and/or best practices proposed for the management of waste, biodiversity, ecotourism and protected areas by internationally recognised agencies were considered (see Roos *et al*., 2023 for further detail). Thus, inclusion of these principles in management plans would provide for compliance with waste-related legal requirements as well as best practice.

The above principles, although only published in 2023, and not legally required to be incorporated into the management plans, are still considered useful as a means of evaluation. Consideration of the

adoption of the principles within current management plans provides an overview of the status quo regarding waste management considerations within management plans and provides an initial step towards determining to what extent current practice is aligned with published best practice. Recommendations may thus be made as to how management actions and interventions can better align with the proposed waste management principles and thus inform future management plans. The same principles will also allow evaluation of the extent to which future integrated waste management plans adhere to best practice principles for waste management in protected areas and will, therefore, determine whether these IWMPs improve waste management in South Africa's national parks.

4 Methodology

Section 4 of this report provides a brief overview of the data collection methodology followed for the purposes of this research. The research design and approach are discussed, followed by the methods of data collection and analysis, as well as research ethics.

4.1 Research design and approach

As mentioned earlier, this research adopted an exploratory case study design, focusing on waste management in South African national parks. A case study design enables the use of multiple research tools to thoroughly investigate the phenomenon in question (Ridder, 2017). The case study method involves examining a real-life, contemporary, bounded, or multi-bounded system through detailed, in-depth data collection from multiple sources, leading to a case description and identification of key themes (Creswell & Creswell, 2018). Exploratory studies are necessary when there is limited knowledge about a topic which is important to explore (Swedberg, 2020). A description of the national parks included in this study is provided in the sub-sections to Section 3.1.

A qualitative research approach, underpinned by the *Seven Questions Method* (see Section 2.7.2 and 2.7.3), was adopted to explore the future of waste management in South African protected areas (in this case – national parks). A qualitative approach was chosen since it provides a rich and nuanced understanding of the research question. The qualitative methods allowed for the exploration of individual perspectives and in-depth insights.

4.2 Case study selection

The aim of this project was to explore the future of waste management within the South African protected areas context. National parks (see Section 3) were selected as the primary case study to address this aim, given their ecological sensitivity, complex operational environments, and diverse waste generation profiles.

- National parks were selected for inclusion in the study based on the following criteria:
- The case study area had to be a national park located in South Africa.
- The national park had to involve multiple stakeholder groups in waste generation, including tourists, staff, and service providers.

- The case study area had to support significant tourism activities that generate measurable quantities of waste and allow for meaningful engagement during the research period.
- The national park had to employ a sufficient number of staff with active roles in waste generation or management.
- The management authority of the case study area had to grant permission for the research and be willing to participate.

Based on these criteria, all twenty national parks managed by South African National Parks (SANParks) (see Table 1) were purposively selected as suitable case studies. Purposive case selection is widely recognised as an appropriate approach in qualitative and applied environmental research, particularly where the objective is to investigate information-rich cases that are directly relevant to the research aims rather than to achieve statistical representativeness (Patton, 2015; Creswell & Poth, 2018). Meerkat National Park was excluded from site visit activities, as it does not currently have tourism infrastructure or visitor facilities.

Within each selected national park, a further site-level sampling approach was applied. Due to time, logistical, and cost constraints, it was not feasible to visit every accommodation facility, camp, picnic site, and public-use area within each park. Instead, a purposive sampling strategy was employed to obtain a representative overview of waste management practices and infrastructure. Site visits typically included one or more accommodation nodes (such as rest camps, campsites, or lodges), as well as key public areas including receptions, picnic sites, viewpoints, and day visitor facilities.

This approach is consistent with established practice in field-based environmental and conservation research, where access limitations, large spatial extents, and resource constraints necessitate selective site sampling to assess system-level performance (Yin, 2018; Babbie, 2020). While this method does not capture every site-specific variation, it enables the identification of dominant waste management strategies, infrastructure typologies, and operational patterns within each park. The findings should therefore be interpreted as indicative of overall park-level conditions rather than as a comprehensive inventory of all facilities.

4.3 Data collection

Data was gathered by means of document review, observations and interviews. The sub-sections below elaborate on these methods of data collection.

4.3.1 Document review

To determine the extent to which proposed principles towards responsible waste management in South African protected areas (see Section 2.6) has been addressed, the management plans of the 20 national parks were systematically reviewed to assess their provisions for waste management. The review focused on identifying references to terms such as "*waste", "waste management", "litter", "littering", "refuse", "garbage".* Using a data mining approach, these terms were searched for within the entire management plan, which included introductory and descriptive text, as well as the contents of specific management programmes [presented in a table which contains objectives, sub-objectives, actions, responsibility and Portfolio of Evidence (PoE)].

Each section or reference related to waste management was evaluated against the six principles of responsible waste management outlined in Section 2.6. For each principle, the extent of inclusion in the management plans was categorised being addressed (A) indicated (green); partially addressed (B) (yellow); or not addressed (C) (red).

4.3.2 Observations

Observations were conducted during on-site visits to national parks. During the site visits, a comprehensive assessment of waste management practices was conducted through direct observations and the collection of additional data from relevant personnel. The focus was on several key aspects related to waste management in these sensitive environments:

- Extent of visible pollution/waste in or around the protected area,
- Availability of waste-related infrastructure in the protected area (disposal bins, separation bins),
- Extent to which waste is diverted from landfill (through reduction, re-use, recycling, recovery) (include as interview question as well);
- Types of programmes/initiatives related to waste management in/around the nature reserve (include as interview question as well); and
- Approximate types and quantities of waste generated and disposed of (Note!!! The research does not include any waste characterisation studies).

A flexible, unstructured approach was followed during fieldwork observations. This approach is often used in studies where observations help to supplement other data by adding more context (Yin, 2018). Since there were no specific predefined criteria, the observations allowed for an open-ended exploration of waste management behaviours in a natural setting. No formal tools or checklists were used, but field notes helped identify themes and patterns in how waste was managed in national parks. This provided a deeper, context-specific understanding of observed behaviours.

While the absence of formal tools could raise concerns about reliability, the observations were not meant to be exhaustive but rather to complement questionnaire and interview data. The goal was to capture waste management infrastructure and practices as they naturally occurred, recognising the variations across different areas of the park. This helped add another layer of context to the self-reported (interview and survey) data, making it possible to better understand how waste is handled in everyday situations.

Extent of Visible Pollution/Waste (cleanliness): The first priority was to evaluate the extent of visible pollution and waste both within the protected area and its surrounding vicinity. This included noting litter along pathways, at visitor facilities, or near water bodies, as well as any environmental damage caused by waste accumulation. The observations helped determine the severity and the areas most impacted by waste, which required immediate intervention.

Availability and Condition of Waste-Related Infrastructure: The second area of focus was the availability of waste-related infrastructure within the protected area. This included waste bins, waste

separation/recycling stations, composting facilities, and other infrastructure that facilitated proper waste disposal and management. The accessibility and effectiveness of these systems were assessed, with attention to whether they were well-maintained and sufficient to meet the needs of visitors, staff, and wildlife protection efforts.

Waste Diversion Practices: Another critical aspect of the site visit was evaluating the extent to which waste was diverted from landfill. Observations were made regarding waste minimization practices, such as efforts in waste reduction, re-use, recycling, and recovery programs within the protected areas. This included noting the presence of dedicated recycling bins or composting systems and any initiatives aimed at reducing waste generation.

Waste Management Programmes/Initiatives: The site visits also sought to identify any specific programmes or initiatives related to waste management operating in or around the national park. This could involve educational programmes for visitors, collaborations with local communities, or partnerships with waste management organisations.

The evaluation of observations employed a three-point categorical assessment scale to systematically record and compare observations across national parks. The scale comprised three categories: A, indicating good performance; B, indicating moderate performance or partial evidence; and C, indicating poor performance or limited evidence. This classification system was applied consistently across all assessment criteria, including visible pollution, waste-related infrastructure, waste separation and diversion practices, and the condition and suitability of waste receptacles. An A rating was assigned where clear and consistent evidence demonstrated that waste management practices were effectively implemented and generally aligned with expected standards for protected areas. This included situations where infrastructure was readily available, well maintained, and appropriately designed to minimise environmental impacts and human–wildlife interactions. A B rating was used where some evidence of implementation was observed, but where gaps, inconsistencies, or limitations were evident. These cases reflected partial compliance or uneven performance across facilities or visitor areas. A C rating was assigned where little or no evidence of effective waste management practices was observed, or where deficiencies were sufficiently pronounced to pose potential risks to environmental integrity, visitor experience, or wildlife.

The use of a three-point categorical scale enabled a structured yet flexible assessment of qualitative, observation-based data. While the scale did not attempt to quantify waste management performance in precise numerical terms, it provided a transparent and replicable framework for comparing conditions across diverse park contexts. This approach acknowledged the inherently interpretive nature of observational data while enhancing consistency and reducing subjectivity through clearly defined rating criteria.

These findings can offer perspectives on potential improvements or innovations needed in the future, such as the introduction of more sustainable practices (e.g., zero-waste initiatives or more advanced recycling systems) to align with future waste management trends in national parks.

4.3.3 Interviews

Park managers and other roleplayers involved in environmental- and solid waste management functions from selected national parks were targeted to participate in interviews. A total of 48 participants were invited to participate in the research.

Prior to the interviews, all participants were provided with background information on the purpose, scope, and objectives of the study. Participants were informed of what participation would entail, including the voluntary nature of their involvement and their right to withdraw at any stage. Informed consent was obtained from all interviewees before the commencement of the interviews.

Interviews were conducted based on the Seven-Questions method proposed in the *Futures Toolkit: Tools for Futures Thinking and Foresight Across UK Government* (UK Government Office for Science, 2017) (See Section 2.7 for background). The questions were contextualised to address the future of waste management in protected areas:

1. What would you identify as the critical issue for the future of waste management your protected area?
2. If things went well, being optimistic but realistic, talk about your desired future for the management of waste in your protected area?
3. In the worst possible world, what are your greatest fears for achieving your desired future for waste management in the protected area?
4. Looking forward, what needs to change (internal and external factors) if the outcomes for your desired future waste management in the protected area are to be realised?
5. Looking back, what would you identify as the significant events that produced the current state of waste management in your protected area?
6. Looking forward, what are considered priority actions that need to be implemented soon/ immediately to achieve your desired future for waste management in the protected area?
7. If you had absolute authority and could do anything without constraints, is there anything else you would do to change waste management in the protected area?

All interviews were audio-recorded with the permission of participants and subsequently transcribed verbatim. The transcripts were analysed using thematic analysis to identify recurring themes, patterns, and insights relevant to the future of waste management in protected areas.

4.4 Data analysis

Data from on-site observations and semi-structured interviews were analysed using thematic analysis (TA), a widely used technique for qualitative data analysis (Terry et al., 2017). An inductive approach to thematic analysis was adopted, allowing themes to emerge directly from the data rather than being imposed by pre-existing theoretical frameworks.

4.4.1 Thematic analysis of interview responses and observational data

Thematic analysis was applied as it is compatible with a range of theoretical frameworks and research designs (Braun & Clarke, 2012) and enables the systematic identification and interpretation of patterns and themes within qualitative data. The inductive nature of the analysis ensured that findings were grounded in participants' experiences and observations, thereby enhancing the exploratory focus of the study. This approach also facilitated the examination of large volumes of qualitative data in a structured and manageable manner.

The analysis began with the researcher immersing themselves in the data to develop familiarity with the content. Through this process, codes were generated inductively from the data. Coding referred to the process of representing participants' perceptions and their influence on the phenomenon under investigation (Williams & Moser, 2019). Codes took the form of descriptive labels, such as words or phrases, which were assigned to relevant segments of textual or observational data. These codes enabled the categorisation of similar concepts, themes, or ideas within the dataset, supporting a systematic and transparent analysis. Given these characteristics, inductive thematic analysis was considered an appropriate method for analysing the interview and observational data.

Two primary coding approaches are commonly recognised in qualitative research: a priori (deductive) coding, where codes are established prior to analysis, and emergent (inductive) coding, where codes are derived directly from the data (Blair, 2015; Stemler, 2001). This study employed emergent, inductive coding, which was conducted manually without the use of computer-assisted qualitative data analysis software. Based on the resulting codes, themes and patterns were identified and interpreted in relation to the research questions. In particular, insights into the opportunities and challenges associated with waste management in South African national parks were derived from the semi-structured interviews and on-site observations. Consistent with Stemler (2001), inferences drawn from the thematic analysis were also used to support the validation of findings obtained through other data collection methods. Accordingly, the results from the questionnaires were compared with the interview and observational data.

To further structure the analysis, frequency tables were developed to quantify the prevalence of specific themes across the dataset. These tables provided a numerical representation of the qualitative findings, indicating how frequently particular themes emerged within the interviews and observations. Organising the data in this manner assisted in identifying dominant and recurring issues related to waste management in South African national parks.

4.4.2 Scenario development: Different futures of waste management in national parks

In addition to thematic analysis, interview responses associated with the *Seven Questions Method* were used to develop three distinct scenarios describing potential futures for waste management in protected areas. These scenarios were constructed to explore a range of plausible outcomes, informed by current conditions, stakeholder perspectives, and emerging challenges.

The three scenarios developed were as follows:

Optimistic (Blue Skies) Scenario: This scenario outlined a future in which waste management in protected areas was highly effective, characterised by well-implemented policies, strong enforcement mechanisms, high levels of compliance, and active participation from all stakeholders. Innovative waste reduction strategies and sustainable tourism practices formed the foundation of this scenario.

Realistic (Glass Half) Scenario: This scenario represented a middle-ground future in which some progress in waste management had been achieved, but notable challenges persisted. While policies and enforcement mechanisms were moderately effective, limitations such as constrained resources, inconsistent compliance, and stakeholder conflicts continued to impede full success.

Pessimistic (Doom and Gloom) Scenario: This scenario depicted a future in which waste management in protected areas had deteriorated, marked by widespread non-compliance, ineffective enforcement, and increasing environmental degradation. Poor waste disposal practices and a lack of stakeholder cooperation intensified the challenges, posing significant risks to conservation outcomes.

By developing these scenarios, the study provided a structured framework for considering multiple potential futures for waste management in South African national parks. This approach supported the identification of risks, opportunities, and strategic decision points, thereby assisting conservation managers, policymakers, and decision-makers in developing informed and proactive waste management strategies.

4.5 Ethical considerations

This study applied for ethics approval through the Faculty of Natural and Agricultural Sciences Research Ethics Committee (FNAS-REC) (ethics number: NWU-01253-24-A9). The guideline of the FNAS-REC was adhered to, to ensure that the study was ethically conducted. A research ethics permit from SANPARKS Scientific Services (SS1399) was obtained prior to conducting the research.

Before participation, all individuals received a detailed explanation of the study's purpose, objectives, and procedures, after which informed consent was obtained. This consent was provided either in writing or verbally, depending on the interview format. No questions of a sensitive nature were posed during interviews. Interview questions were limited to the scope of the research, i.e. future perspective of waste management in South African national parks.

The confidentiality and anonymity of participants were maintained. All responses were anonymised (i.e. Participant 1, Participant 2, etc.), and no personally identifiable information was included in any published or presented material. Data were securely stored and accessible only to the researcher to safeguard participants' privacy. Participation in the study was entirely voluntary, and individuals retained the right to withdraw at any time without consequences or explanations required.

5 Results

Section 5 presents the results of this study. Section 5.1 provides the results of the review of protected areas management plans against the proposed principles for responsible waste management (See Section 2.6 for background). Section 5.2 presents the results of on-site observations, which mainly focused on waste management infrastructure in each of the national parks, while Section 5.3 provides the results of interviews. Section 5.4 outlines the future waste management scenarios, and finally, Section 5.5 provides an integrated discussion towards bridging policy, practice, and future pathways.

5.1 Protected areas management plans addressing waste management

Table 3 provides the results of the evaluation of the 20 national parks' management plans against the six principles proposed for responsible waste management in protected areas (See Section 2.6). These results were published in the IUCN PARKS[2] Journal in 2025.

Most of the management plans made some reference to waste management, although this was limited. Five of the 20 management plans did not address waste management at all in any of its programmes, but did make reference to "no littering" and "disposal of waste in bins" as part of the internal park rules, which were appended to the management plans. Similarly, some of the management plans highlighted "littering", "waste disposal" and "poor waste management practices" as threats in the descriptive, narrative sections of the management plans but did not incorporate any actions to address these threats in any of the programmes of the management plans. The best performing management plan was that of the Kruger National Park which mentioned "waste" 16 times and addressed four of the principles, and partially addressed one other.

The extent to which each of the principles were provided for in the 20 protected area management plans reviewed are addressed per principle in the sub-sections below.

[2] These results have been published in IUCN PARKS journal. See ROOS, C., ALBERTS, R. C., RETIEF, F. P., CILLIERS, D. P., MOOLMAN, H. J. AND BOND, A. 2025. Towards Responsible Waste Management in Protected Areas: An Evaluation of South African National Parks Management Plans. Parks Vol 31.1 May 2025. https://parksjournal.com/wp-content/uploads/2025/05/31.1_8_Roos-et-al-1.pdf

Table 3. Extent to which proposed principles for responsible waste management is provided for in the protected areas management plans of 20 South African national parks

Park management plans	Principle 1 Protection of ecosystems and biodiversity	Principle 2 Prevention and remediation of pollution	Principle 3 Implementation of the waste management hierarchy	Principle 4 Provision of effective waste services and infrastructure	Principle 5 Promotion of participation and building of partnerships	Principle 6 Contribution to wellbeing, livelihoods and capacity
Addo Elephant National Park	C	C	C	B	C	C
Agulhas National Park	C	C	A	B	C	C
Augrabies Falls National Park	C	C	A	A	B	C
Bontebok National Park	C	C	C	C	C	C
Camdeboo National Park	C	C	C	C	C	C
Garden Route National Park	C	A	A	B	C	C
Golden Gate Highlands National Park	C	C	A	A	C	B
Karoo National Park	C	C	C	A	C	C
Kgalagadi Transfrontier Park	C	C	C	B	C	C
Kruger National Park	C	B	A	A	A	A
Mapungubwe National Park	A	C	A	A	C	C
Marakele National Park	C	C	C	C	C	C
Meerkat National Park	C	C	C	C	C	C
Mokala National Park	C	C	C	B	C	C
Mountain Zebra National Park	C	C	C	B	C	C
Namaqua National Park	C	C	A	B	C	C
Richtersveld National Park	C	C	C	B	C	C
Table Mountain National Park	C	C	C	C	C	C
Tankwa Karoo National Park	C	B	C	C	C	C
West Coast National Park	C	B	C	C	C	C

5.1.1 Principle 1: Protection of ecosystems and biodiversity

Principle 1 emphasises the conservation of ecosystems and biodiversity within protected areas to ensure they provide services, value, and benefits for current and future generations. This principle underscores the importance of achieving no net loss to biodiversity through effective waste management practices that avoid damage to unique, endemic, threatened, or declining species, habitats, and ecosystems (Roos *et al.,* 2023).

Of the 20 national parks (Table 3) only Mapungubwe National Park, addressed (A) Principle 1 in the context of managing human-wildlife conflicts through its Human-Wildlife Conflict Programme. This programme provides for *"monitoring the implementation and effectiveness of an integrated waste management plan to minimise human-wildlife conflict issues"* (SANParks, 2019: 104). By reducing human-wildlife conflicts through effective waste management, this action indirectly supports the protection of biodiversity and ecosystem services. At the time of the research, it could not be established whether an IWMP has been developed and implemented.

The fact that only one out of twenty national parks have addressed Principle 1 highlights a significant gap in the consideration of waste management measures towards protection of ecosystems and biodiversity.

5.1.2 Principle 2: Prevention and remediation of pollution

Four of the 20 protected area management plans have addressed (A) or partially addressed (B) Principle 2 (Table 3). This principle aims at the prevention, minimisation, mitigation and remediation of pollution. *"Lack of proper waste management"* (SANParks, 2020b: 42) and "*litter, illegal dumping and ineffective waste management"* (SANParks, 2020b: 43) are highlighted in the Garden Route National Park management plan as threats to the vital attributes of the park. The Environmental Management Programme of the management plan includes a specific sub-objective "*To ensure responsible waste management in the park"*. This is achieved through actions such as *"reviewing and assessing current waste management practices to ensure waste is handled responsibly"*, which supports the prevention of pollution.

"Pollution from refuse" is highlighted as a threat to the park's vital attributes in the Kruger National Park management plan (SANParks, 2018a: 43). The descriptive, narrative section of the Freshwater Ecosystem Programme mentions *that "in 2007 a groundwater monitoring programme was established with the aim to optimise and determine the most effective monitoring station density, as well as early warning monitoring as part of abstraction, sanitation and waste disposal management and protection of the groundwater resource"* (SANParks, 2018a: 111). This provides partially for Principle 2, which focuses on pollution prevention and remediation. However, no further mention of waste-related monitoring is made in action plans of any of the programmes of the management plan.

The management plans of Tankwa Karoo and West Coast National Parks mention waste management in the narrative section of its Environmental Management Programme. The section

reads as follows: *"Special emphasis must be placed on water use, energy efficiency and waste management focusing on the following:*

- *Identification of environmental aspects and significant environmental impacts.*
- *Identification of relevant legislative and regulatory requirements.*
- *Identification of priorities, appropriate environmental objectives and targets.*
- *Establish a structured process to implement policy, achieve objectives and meet targets.*
- *Plan, control, monitor and review implementation for continuous improvement*. (SANParks, 2014b: 62, SANParks, 2013c:50)

These provisions partially align with Principle 2 focusing on the minimisation of impacts and the prevention of pollution. No specific mention is, however, made of waste management in the Environmental Management Programme objectives or actions.

Lastly, the narrative section of the Management Programme for the Langebaan Ramsar site included in the West Coast National Park management plan (SANParks, 2013c: 96 – 102) highlights the duty to *"Ensure all waste and sewage discharges within the Lagoon and catchment of the aquifers are appropriately licensed (Lead Agency: Saldanha Bay Municipality, Priority: High)"*. This duty aligns with Principle 2, which aims at pollution prevention, however, no further actions are allocated in the management plan to address this duty.

5.1.3 Principle 3: Implementation of the waste management hierarchy

Principle 3 was most frequently provided for in the evaluated management programmes. Seven of the 20 management plans have addressed (A) the implementation of the waste management hierarchy (Table 3).

The management plans of several national parks include provisions for waste management within their Responsible Tourism Programmes, emphasising *waste minimisation and recycling* as part of their planned actions. The Responsible Tourism Programme of Agulhas, Augrabies Falls, Golden Gate Highlands, Kruger, Mapungubwe, and Namaqua National Parks have sub-objectives to *"use local resources sustainably, avoid waste and over-consumption"* with actions to *"set appropriate targets for reduction or recycling of waste produced" and/or to "minimise waste and recycle where possible"*, aligning with Principle 3 of the waste management hierarchy. Apart from the Kruger National Park, none of the other parks' management plans provided for any specific, measurable minimisation targets or key performance indicators. The Kruger's Infrastructure Programme sets an objective *"to reduce solid waste in the park with 30% in the next 7 years"* through the implementation of plastic container and packaging reduction programmes and establishing memoranda of understanding (MoUs) with recycling companies (SANParks, 2018a: 163). This is the only management plan that provides specific actions, with measurable objectives related to waste reduction.

The management plans of Agulhas, Augrabies Falls, Golden Gate Highlands, Kruger, and Mapungubwe National Parks list *"increased recycling of waste"* as part of the portfolio of evidence (PoE) of their Climate Change Programmes towards implementing measures to reduce carbon footprint over time. However, none of these management plans provide any specific actions,

objectives or key performance indicators for quantities of waste reduced, recycled or recovered. Additionally, some of the parks have unique provisions aimed towards the implementation of the waste management hierarchy, or elements thereof. The Climate Change Programme of the Kruger National Park management plan aims to *"facilitate and encourage appropriate lifestyle choices of both staff and tourists in order to manage behaviour (e.g., waste management, recycling)"* (SANParks, 2018a: 179). This is the only management plan with the objective of managing human behaviour to achieve waste reduction. The importance of addressing waste reduction, reuse and recycling through human behaviour is well-documented (for example: Gilli *et al*., 2018; Harper *et al*., 2022). The Kruger National Park management plan suggests *information sessions* and *reports* as a mechanism to influence waste management behaviour. Strydom (2018) suggests that changing behaviour through information-sharing may not be sufficient on its own, and that it may need to be combined with other mechanisms focusing on convenience, perceived behavioural control, and addressing entrenched behaviour or habits.

The Augrabies Falls National Park management plan mentions the importance of performing a *"lifecycle assessment of waste to determine reuse and recycling options and to manage and coordinate the vehicle fleet"* in the narrative section of the plan (SANParks, 2024: 119). However, these suggestions are not formally incorporated as actions within the Climate Change Programme.

The management plan of the Garden Route National Park highlights the importance of "*waste reduction and resource-efficient designs and approaches*" in all upgrades, redesigns, and new activities (SANParks, 2020b: 93). This emphasises the importance of providing for waste management considerations in environmental impact assessment (EIA) processes for developments in protected areas, as highlighted by Claassens *et al.* (2022). Finally, the Namaqua National Park management plan (SANParks, 2023b) mentions waste management infrastructure to *"minimise waste"* as part of the narrative section of its Infrastructure Programme but does not elaborate on it in the action plan of this programme.

Despite the frequent inclusion of Principle 3 provisions in the evaluated management plans, many of these provisions lack specific targets or key performance indicators for waste reduction or recycling. Furthermore, many sections of text in the narrative parts of the management plans are not translated into concrete objectives and actions (as part of programmes), risking that these measures will not be effectively addressed.

5.1.4 Principle 4: Provision of effective waste services and infrastructure

Principle 4, which advocates for the provision of effective waste services and infrastructure, was also frequently provided for in the management plans, with five of the management plans addressing (A) and eight of the management plans partially addressing (B) this principle (Table 3).

The Infrastructure Programmes of the management plans of Augrabies, Golden Gate Highlands, Kruger, and Mapungubwe National Parks provide for a specific sub-objective *"To ensure that all solid waste site infrastructure in the park is maintained and upgraded to a desired state*". This sub-objective has specific actions, namely:

- *Compile an inventory of all infrastructures in the park and determine the extent of maintenance required; and*
- *Implement an annual maintenance plan.*

The management plans of Addo Elephant, Agulhas, Garden Route, Karoo, Kgalagadi, Mokala, Mountain Zebra, Namaqua and Richtersveld National Parks partially provide for Principle 4. The narrative sections of the Infrastructure Programmes of these management plans provide for *"touching the earth lightly"* principles, which also refers to the provision of sufficient waste management infrastructure. The management plan, however, does not elaborate on the type of waste management infrastructure and services required to adhere to this principle, and it is not integrated into objectives or actions of any management programmes.

Unique requirements in terms of waste management services and infrastructure are provided for in the management plans of Karoo National Park (SANParks, 2017a) and Garden Route National Park (SANParks, 2020b). The Environmental Management Programme of the Karoo National Park (under the sub-objective: *To manage and reduce the impacts of park activities on the vital attributes*) provides for an action *to "co-ordinate and implement effective waste management (solid and fluids)*" (SANParks, 2017a: 97). Details are not provided, but the management plan refers to *"Waste Management Policies".* Terrestrial Ecosystems Management Programme of the Garden Route National Park management plan outlines "*appropriate infrastructure designs and effective waste disposal"* as a evidence (PoE) of a sub-objective on managing human wildlife interface in and around the park. No further detailed actions related to waste infrastructure designs or effective waste disposal is mentioned.

More detailed management actions, with allocation of budget, time frames and responsible persons would be required to ensure that waste management infrastructure and services are effectively implemented in these parks.

5.1.5 Principle 5: Promotion of participation and building of partnerships

Objectives and actions towards the achievement of Principle 5, focusing on the promotion of participation and building of partnerships, were poorly addressed in the management plans evaluated. Only one management plan (Kruger National Park) addressed this principle (A), while another management plan (Augrabies Falls National Park) partially addressed it (B) (Table 3).

The Integrated Land Use and Regional Planning and Management Programme of the Kruger National Park includes a sub-objective to promote responsible natural resource management and restoration of land*,* with the action to *"develop guidelines, criteria and programmes to support co-operative waste management programmes within adjacent communities…"* (SANParks, 2018a: 86). Furthermore, the Kruger management plan's Infrastructure Programme outlines an action to *"develop an MoU with recyclable companies to purchase all recyclable products"* (SANParks, 2018a: 163) towards achieving their waste reduction target of 30% over the next 7 years. These provisions are aligned with Principle 5, which promotes the participation and building of partnerships towards addressing waste management and waste-related issues.

Although it is not formally provided for in any of the park management programmes, the Augrabies Falls National Park management plan partially addresses Principle 5 (Table 2). The narrative part of the management plan mentions that *"Various organisations, forums and agencies such as the Park Forum, Kakamas Water-users Association, South African Nama Development Agency and the Kai! Garib Environmental Forum, are operating within the landscape. The park is either part of, or actively engaging these organisations, in information sharing, supporting cultural initiatives, capacitating and improving effectiveness of waste and sanitation management in the local municipal area…..This allows the park to collaborate with and support efforts of the various governmental and non-governmental partners in the region to achieve integrated implementation of activities and responses to the various impacts on a regional scale"* (SANParks, 2024: 71). Such collaborations and engagements align with Principle 5, which advocates for the promotion of participation and building of partnerships. Waste-related partnerships and collaborations should, however, be formally integrated into the Stakeholder Engagement Programme and/or Communications Programme of the management plan.

5.1.6 Principle 6: Contribution to wellbeing, livelihoods and capacity

Lastly, Principle 6 acknowledges the contribution that responsible waste management could make towards wellbeing, livelihoods and capacity building. This principle is poorly provided for in the management plans of national parks, with Principle 6 being addressed (A) in only one management plan (Kruger National Park) and partially addressed (B) in another management plan (Golden Gate Highlands National Park) (Table 3). The Integrated Land Use and Regional Planning Programme of the Kruger National Park has a sub-objective to *promote responsible natural resource management and restoration of land.* This sub-objective includes an action to develop guidelines, criteria and programmes to support co-operative waste management programmes within adjacent communities**,** *"including linkages to environmental education and feasible socio-economic development initiatives"* (SANParks, 2018a: 86). Environmental education programmes could contribute to capacity building towards waste management, while the development of socio-economic development initiatives may lead to skills development, job creation and contribution towards livelihoods and wellbeing in these surrounding communities.

Finally, the Golden Gate Highlands National Park management plan's Socio-economic Transformation Programme (in its narrative section) states that *"Several programmes are implemented throughout SANParks to contribute to the development of local communities, including waste management, social legacy, the Extended Public Works Programme (EPWP), environmental protection, infrastructure development, the wildlife economy and green and blue economy."* (SANParks, 2020c: 105). No further details or actions within the waste management context are, however, provided in the management plan.

5.2 Observation results

Table 4 provides a comprehensive summary of the national parks visited between 2024 and 2025, together with the specific observation points assessed during each site visit. With the exception of Meerkat National Park, which does not have tourism facilities or associated waste management infrastructure, all national parks included in the study were visited during the data collection period.

Within each park, observations were undertaken at a wide range of tourism and operational infrastructure, including rest camps, wilderness camps, guest cottages, camping areas, picnic sites, viewpoints, bird hides, day visitor areas, interpretation centres, swimming pools, reception areas, access gates, and major internal road networks. This approach enabled the assessment of waste management practices across areas with varying levels of visitor intensity and operational complexity.

Due to time, logistical, and cost constraints, it was not feasible to visit every accommodation facility, camp, picnic site, and public area within each national park assessed. Instead, a purposive sampling approach was applied to provide a representative overview of waste management practices and infrastructure at a park level. Site selection prioritised a mix of high-use public areas (such as receptions, picnic sites, viewpoints, and day visitor facilities) and one or more accommodation nodes (including rest camps, campsites, or lodges), depending on park size and accessibility. This approach was designed to capture the dominant waste management strategies, infrastructure typologies, and operational practices in use within each park, rather than to document every individual facility. While site-specific variations may therefore not be fully reflected, the sampled locations were sufficient to identify systemic strengths, limitations, and patterns in waste management performance. The findings should accordingly be interpreted as indicative of overall park-level conditions rather than as a comprehensive inventory of all facilities.

The primary purpose of the on-site observations was to assess the status, distribution, and condition of waste management infrastructure, as well as observable waste management practices. Particular attention was given to the availability and placement of waste receptacles, waste separation practices, signage, cleanliness of facilities, evidence of littering or illegal dumping, and the interaction between visitors and waste infrastructure (see Section 4.3.2). These observations complemented the interview data by providing contextual, site-specific evidence of how waste management systems were implemented and maintained on the ground.

Table 5 presents a summary of on-site observations related to waste management practices across the national parks. As explained in Section 4.3.2, the observations focused on the cleanliness of the park (presence and extent of visible pollution) and measures to prevent loss of containment of waste, the availability and condition of waste-related infrastructure, waste separation and diversion practices, the use of animal-proof waste receptacles, and the (observed) existence of waste management programmes or initiatives. As explained in Section 4.3.2, the evaluation employed a three-point categorical scale, where A indicated good performance, B indicated moderate performance or partial evidence, and C indicated poor performance or limited evidence. This approach enabled a comparative assessment of waste management practices across parks, while acknowledging the observational nature of the data. More detailed discussion and illustrative examples of waste management infrastructure are provided in the park-specific sub-sections of Section 5.2, where observed practices and infrastructure are described in greater detail.

Table 4. Parks visited (2024 – 2025) and observation points.

Date	Park(s)	Observation points
4 – 9 Feb 2024	Kruger National Park	Pretoriuskop
18 – 24 Mar 2024	Kruger National Park	Skukuza, Berg-en-Dal, Malelane, Olifants, Orpen, Satara, Afsaal picnic site, Tamboti, Muzandzeni picnic site, N'wanetsi picnic site, Nhlanguleni picnic site, Skukuza Day Visitor's area, Timbavati picnic site, Tshokwane picnic site
28 Mar – 2 Apr 2024	Mapungubwe National Park	Leokwe Camp, Limpopo Forest Camp, Mazhou Camp, Tree Top Boardwalk, Bird hide, Confluence Lookout and Picnic Area, Day Visitors Area, Interpretive Centre
10 – 14 Jun 2024	Golden Gate Highlands National Park	Glen Reenen Rest Camp, Golden Gate Hotel and Chalets, Basotho Cultural village, Meriting picnic site, Wilgehof EE Centre, main roads through park, vulture hide
15 – 17 Jun 2024	Mountain Zebra National Park	Main rest camp, mountain cottages, historic guesthouse, camping, picnic area, lookout
17 – 19 Jun 2024	Addo Elephant National Park	Addo Rest Camp, picnic areas, Spekboom Hide, viewpoints, lookout points.
19 – 21 Jun 2024	Natures Valley	Storms Rivier Mouth Rest Camp
5 – 7 Jul 2024	Kruger National Park	Punda Maria, Sirheni, Shingwedzi, Mopani, Letaba, Babalala picnic site, Mooiplaas picnic site, Punda Maria picnic site,
12 Aug 2024	Kruger National Park	Talamati, Makhadzi picnic site,
1 – 6 Sep 2024	Marakele National Park	Bontle rest camp, Tlopi tented camp, Educational centre, Tsetsebe picnic site
18 – 19 Sep 2024	Table Mountain National Park	Smitswinkel accommodation
19 – 20 Sep 2024	West Coast National Park	Jo-Annes Beach cottage, Atlantic lookout, Geelbek picnic site, Langebaan entrance gate, Preekstoel picnic site, Seeberg bird hide, Seeberg viewpoint, Tsaarsbank picnic site
20 – 21 Sep 2024	Agulhas National Park	Agulhas Rest Camp, Rasperspunt, Southern tip monument and boardwalk, unmarked fishing spots
21 – 22 Sep 2024	Bontebok National Park	Lang Elsieskraal camp, Die Stroom picnic site, Fishing area and viewing deck, reception area

Date	Park(s)	Observation points
23 – 24 Sep 2024	Karoo National Park	Karoo Rest camp (camping, reception, chalets, swimming pool), Bulkraal picnic area, Doornhoek lookout, Doornhoek picnic area, Interpretive centre
24 – 26 Sep 2024	Tankwa-Karoo National Park	Elandsberg Wilderness camp, Langkloof camping, Perdekloof camping
28 – 30 Sep 2024	Mokala National Park	Lillydale Rest Camp, Motswedi camp site, Kameeldoring picnic site, Motopi picnic area, Interpretation Centre, lookout, bird hide
16 – 21 Dec 2024	Kruger National Park	Tamboti, Crocodile Bridge, Lower Sabie
30 Mar – 6 Apr 2025	Kruger National Park	Bataleur, Biyamiti, picnic sites, Nkuhlu picnic site,
17 – 22 Jun 2025	Kgalagadi National Park	Nossob, Twee Rivieren, Mata Mata Auchterlonie picnic site, Dikbaardskolk picnic site, Kamqua picnic site Lijersdraai picnic site, Melkvlei picnic site
28 – 29 Jun 2025	Augrabies National Park	Augrabies Falls Rest Camp, picnic site, swimming pool
29 June– 2 Jul 2025	Namaqua National Park	Namaqua Rest Camp, Koeroebees Cultural Picnic Area,
2 – 5 Jul 2025	Richtersveld National Park	De Hoop, Sendelingsdrif campsite,
3 – 6 Nov 2025	Garden Route National Park	Wilderness (Ebb and flow), Tarentaal Day Visitors Area, Woodville Indigenous Forest, Goudveld Indigenous Forest, Ysterhoutrug picnic site, King Edward VII Big tree picnic site, Diepwalle Rest Camp, Grootdraai picnic site, Velbroeksdraai picnic site, Spitskop lookout, Valley of Ferns picnic site, Natures Valley Rest Camp: De Vasselot,
6 – 7 Nov 2025	Camdeboo National Park	Lakeview tented camp, Mpunzi picnic site, Valley of Desolation, Ribbokberg picnic site

Table 5. Observed waste management practices and waste management infrastructure.

National Park	Cleanliness/ measures to prevent loss of containment	Availability of Waste Bins	Condition of Waste Bins	Animal-Proof Infrastructure	Availability of Waste Separation Bins	Waste Diversion/ Prevention Practices	Waste Management Programmes / Initiatives
Addo Elephant National Park	B	A	B	B	C	B	B
Agulhas National Park	C	B	B	C	C	C	C
Augrabies Falls National Park	A	A	A	A	B	B	B
Bontebok National Park	A	A	B	C	B	B	B
Camdeboo National Park	A	A	A	A	C	C	B
Garden Route National Park	B	A	B	B	C	B	B
Golden Gate Highlands National Park	C	B	B	B/C	C	B	C
Karoo National Park	A	A	A	B	B	B	B
Kgalagadi Transfrontier Park	A	A	A	C	C	A	B
Kruger National Park	B	A	B	B	B	B	A
Mapungubwe National Park	A	B	B/C	B	C	C	C
Marakele National Park	A	A	B	B	C	B	B
Mokala National Park	A	A	A	A	B	B	B
Mountain Zebra National Park	B	A	A	A	C	B	B
Namaqua National Park	A	B	B	B	C	B	B
Richtersveld National Park	A	B	A	B	C	B	B
Table Mountain National Park	A	B	A	A	A	A	B
Tankwa Karoo National Park	A	B	A	A	B	A	B
West Coast National Park	B	A	B	C	C	B	B

5.2.1 Addo Elephant National Park

The waste management system at Addo Elephant National Park demonstrates an overall acceptable standard. In high-use visitor areas, such as the Addo Rest Camp (chalets, camping area, Day Visitor Area), and along routes to popular attractions like bird hides, waste bins are generally well designed, enclosed, and thoughtfully integrated into the surrounding environment. Most of the bins are animal proof, however, instances of animals (monkeys) interacting with these bins highlight the ongoing challenge of managing waste in a wildlife-rich setting. In some cases, animal-proof bins within camping areas were not consistently used as intended (for example, lids left open or not properly secured), which reduced their effectiveness and allowed animal access (Figure 4b).

Within and around chalet areas, the presence of multiple bin types, varying in size, design, and level of animal resistance, introduces additional complexity (Figure 3a-c).

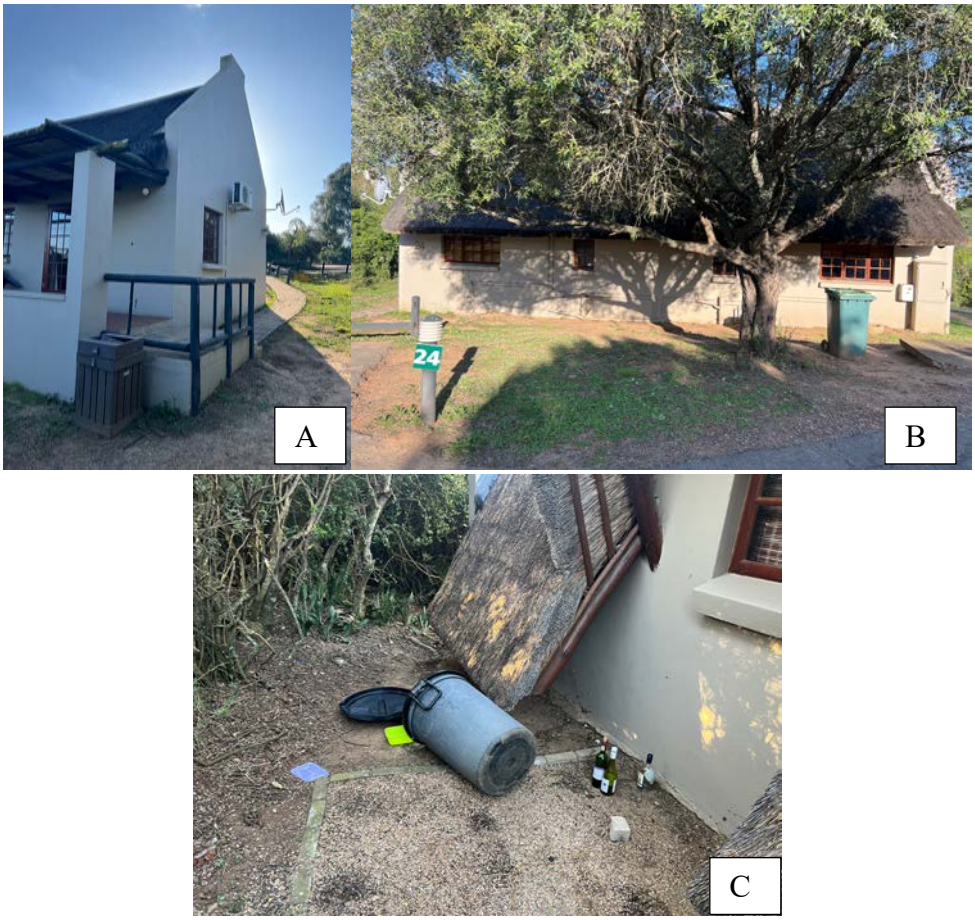

Figure 3. Different types of waste bins available at chalets in Addo Rest Camp.

Beyond the main visitor zones, waste infrastructure is more varied and practical in nature. Large wheelie bins at access gates (Figure 5b) and simpler, improvised bins at lookout/viewpoints point to different priorities based on location, expected waste volumes, and available resources. Alongside these containment measures, the park also makes deliberate use of waste prevention strategies. Clear and direct signage in certain areas (i.e. some picnic sites) promotes a pack-in, pack-

out approach and reinforces anti-littering rules (Figure 6a), encouraging visitors to take responsibility for their waste.

Figure 4. Animal-proof bins in camping area (a) with misused bins being ineffective in preventing animal access (b).

Figure 5. Waste bins at bird hide (a), entrance gate (b) and lookout point (c).

Figure 6. No bin signage at picnic site (a) and no littering signage at bird hide (b).

As indicated in Table 5, *cleanliness and measures to prevent loss of containment* are assessed as B. Public-use areas, including day visitor facilities and the bird hide, appeared generally well maintained, with bins that are tidy and minimal visible litter. However, this standard is compromised by isolated containment failures, most notably an overturned bin outside a chalet that has resulted in waste spillage (Figure 3c) and some incidences of scattered litter in the camping area. These incidents (albeit isolated) indicates gaps in containment measures.

Availability of waste bins is rated A. Waste bins are widely and consistently provided across the park, including at the main gate, camping and accommodation areas, day visitor areas, bird hides, and designated viewpoints. While this ensures that visitors have frequent access to disposal points, the observations suggests that the overall number of bins, as well as the variety of bin types and locations (especially at the chalets in the main camp), may be greater than necessary. This level of provision can complicate waste management operations and increase the risk of misuse, particularly in wildlife-sensitive areas. Areas where bins are deliberately absent, such as the picnic site, are clearly supported by explanatory signage and demonstrate that reduced bin provision can be effective when paired with strong waste prevention messaging. As such, although bin availability is high and justifies an A rating, there is a clear opportunity to rationalise, standardise, and reduce bin numbers and types without negatively affecting cleanliness or visitor compliance (especially if waste separation infrastructure is considered in the future).

Availability of bins for waste separation receives a C. Evidence of waste separation infrastructure is limited. Only the southern gate features two differently coloured wheelie bins (black and green), which may indicate a degree of separation. In contrast, other bin locations consist of single bins without visible colour differentiation, compartmentalisation, or signage to guide users in separating waste streams.

Condition of waste bins is evaluated as B. Many of the animal-proof bins are in good condition and appear structurally sound. However, this is offset by the presence of lower-quality or poorly maintained units, including an overturned bin at the chalet and a cut-open oil drum (Figure 5c) (without any animal access prevention measures) used as a bin at a viewpoint. These inconsistencies point to variable standards in bin quality, durability, and maintenance.

Animal-proofing is rated B. While most of the bins are animal proof and designed to reduce wildlife access, observations show a monkey actively interacting with a bin (Figure 4b) and instances of bins being overturned. Moreover, bins at lookout points did not have any animal prevention measures (Figure 5c). These observations indicate that the current infrastructure does not consistently prevent animal interference.

Waste diversion and prevention practices achieve a rating of B. The prominently displayed "Why are there no bins?" signage at the picnic site (Figure 6a) clearly communicates a pack-in, pack-out policy. This measure represents a strong and effective waste prevention strategy, reducing on-site waste generation and encouraging responsible visitor behaviour. These types of "leave no trace" or "pack-in, pack-out" initiatives could be rolled out to other areas in the park.

Visible *waste management programmes or initiatives* are assessed as B. Clear enforcement and deterrence measures are evident through *"No littering"* signage (Figure 6b), and the no-bin policy itself constitutes a visible management initiative. However, there is limited visual evidence of active waste separation and recycling programmes or broader waste management initiatives beyond litter prevention and enforcement.

5.2.2 Agulhas National Park

Agulhas National Park occupies a geographically and ecologically significant position at the southernmost point of the African continent where the Atlantic and Indian Oceans converge. Coastal zones like Agulhas are globally recognised for their rich biodiversity, high ecological value, and vulnerability to human impacts, including tourism and waste generation. Effective waste management in coastal protected areas is, therefore, not merely a visitor service function but a core conservation requirement. Without appropriate infrastructure and strategies, improperly managed waste can rapidly become terrestrial litter and marine debris, degrading ecosystems, harming wildlife, and undermining conservation objectives. Herrera-Franco *et al*. (2024) emphasise that integrated waste management is essential in coastal zones to mitigate pollution, protect ecosystems, and support sustainability goals in these sensitive environments.

The current assessment (Table 5) indicates that, while some aspects of waste management in Agulhas National Park are functional, particularly within accommodation areas, the overall system is undermined by significant shortcomings in public and coastal zones.

Within the Agulhas Rest Camp, waste management practices demonstrate a relatively high level of control. Waste is predominantly collected through bins located inside individual accommodation units, which effectively limits exposure to wind, wildlife, and scavenging. This approach contributes positively to overall cleanliness within the camp area and reflects a degree of proactive risk management. As a result, cleanliness within accommodation areas can be regarded as acceptable to good, although this is not consistently replicated elsewhere. The exception to this system is the guesthouse (Figure 7a) , which relies on an external standard black utility bin, introducing a minor vulnerability to environmental exposure (Figure 7b).

Figure 7. Black bin outside of guest house (a) and plastic waste on the perimeter of the guest house area close to the coastline (b).

In contrast, *cleanliness and measures to prevent loss of containment* in public- and coastal areas is assessed as poor (C). Observations at popular tourist sites such as Rasperpunt, the Southern Tip Monument, and fishing locations revealed overflowing bins, scattered plastic waste, and litter accumulation along paths and near coastal features (Figure 8 a-e, Figure 9 a&b).

Figure 8. Open bins and loss of containment of waste at Rasperspunt.

With regard to the *availability of waste bins*, the park performs at an acceptable level (B). Waste receptacles are present at major visitor nodes and activity areas, indicating an awareness of visitor needs. However, the bins provided are generally insufficient for peak visitor volumes, contributing to frequent overflow and associated cleanliness issues (Figure 8a,c,d).

Figure 9. Open bins (a) and waste disposed next to bins (b) at Southern Tip boardwalk.

The *condition and design of waste bins*, however, is rated as moderate (B). The bins used in public areas are basic black plastic containers mounted on wooden poles and, critically, lack lids. In a high-wind coastal environment, this represents a fundamental design failure. The absence of lids allows waste to be easily blown into surrounding environments and onto adjacent beaches, creating a clear pathway for the generation of marine debris.

Animal-proofing measures are assessed as poor (C). While large mammals are not a significant concern at Agulhas, the open-top bins allow unrestricted access by birds and small mammals. This not only increases litter dispersion but also raises concerns related to animal habituation and hygiene.

Similarly, the park's performance in terms of *waste separation and recycling infrastructure* is also poor (C). No bins for separated waste streams were observed in public areas, nor was there any signage promoting recycling or responsible disposal practices. All waste is co-disposed, limiting opportunities for waste separation at source, diversion and increasing the volume of material destined for landfill. In line with this, *waste diversion and prevention practices*, such as "pack-it-out" messaging (see Section 5.2.1), visitor education initiatives, or strategies aimed at reducing waste generation, are largely absent and are therefore rated poor (C). This represents a missed opportunity, particularly in sensitive coastal areas where prevention is often more effective than cleanup.

Finally, no visible *waste management programmes or initiatives*, such as recycling schemes, coastal litter mitigation efforts, or targeted management responses for high-risk sites, were identified during the assessment. Consequently, this criterion is also rated poor (C).

In summary, while Agulhas National Park demonstrates elements of functional waste management within accommodation areas, the broader system, particularly in public and coastal zones, is and area for future improvement.

5.2.3 Augrabies Falls National Park

Augrabies Falls National Park operates within an arid landscape characterised by high temperatures, low rainfall, and a dense concentration of habituated wildlife, particularly baboons and monkeys. Within this context, the park's waste management infrastructure reflects a deliberate and largely effective response to known risks, particularly those associated with animal scavenging.

A strength of waste management at Augrabies Falls National Park is the consistent use of *animal-proof waste containment*, which is assessed as good (A). Heavy-duty baboon-proof bins are the standard across the Main Rest Camp, day visitor areas, and along boardwalks leading to the falls (Figure 10 a-d). These bins are purpose-built, typically constructed from thick timber slats with weight-operated or latched openings (Figure 10a&b), or black refuse bins fitted with steel arm/locking mechanisms (Figure 10c&d) designed to prevent access by baboons and monkeys. This design significantly reduces human-wildlife conflict, prevents waste dispersal, and keeps refuse visually unobtrusive, thereby maintaining both ecological integrity and aesthetic quality.

Figure 10. Animal-proof bins in public areas at Augrabies Falls National Park.

In terms of *cleanliness and mechanisms to prevent loss of containment of waste*, the park also performs well (A). Primary visitor nodes, including boardwalks and viewing platforms, were observed to be largely free of litter, with minimal evidence of overflowing bins. This suggests a well-maintained and frequent waste collection schedule, which is particularly important in the park's hot climate where odours can rapidly attract scavenging animals and insects, and cause a nuisance to visitors.

The *availability of waste bins* is similarly rated as good (A). Waste receptacles are well distributed throughout high-traffic areas, rest camps, and along the main waterfall viewing routes. Strategic placement at viewing decks and along boardwalks is especially important given the steep gorge and the practical impossibility of retrieving waste once it enters the river system below. The *condition of waste bins* is assessed as good (A). The bins were generally in a good condition and demonstrated durability.

With respect to *waste separation at source*, the infrastructure presents a more mixed picture and is therefore assessed as acceptable (B). Bins for separating recyclables and non-recyclables are available at some guest interface points, particularly within the main rest camp and selected visitor nodes (Figure 10a&b). However, these separation bins are interspersed with standard black refuse bins designed for mixed waste (Figure 10c&d), which can reduce the overall effectiveness and visibility of recycling efforts at the point of disposal. Research indicates that when users are presented with a clear and convenient choice between general waste and recycling bins, they are more likely to use the separation bins, particularly when these are positioned prominently and minimise additional effort (Soon, 2024). The inconsistent placement of separation infrastructure alongside mixed-waste bins at Augrabies may, therefore, limit the full behavioural benefits that could be achieved through more uniform and intentional bin design and placement. Importantly, waste separation is more consistently implemented at back-of-house and operational facilities (Figure 11a&b), where recyclables are reportedly sorted prior to disposal or collection.

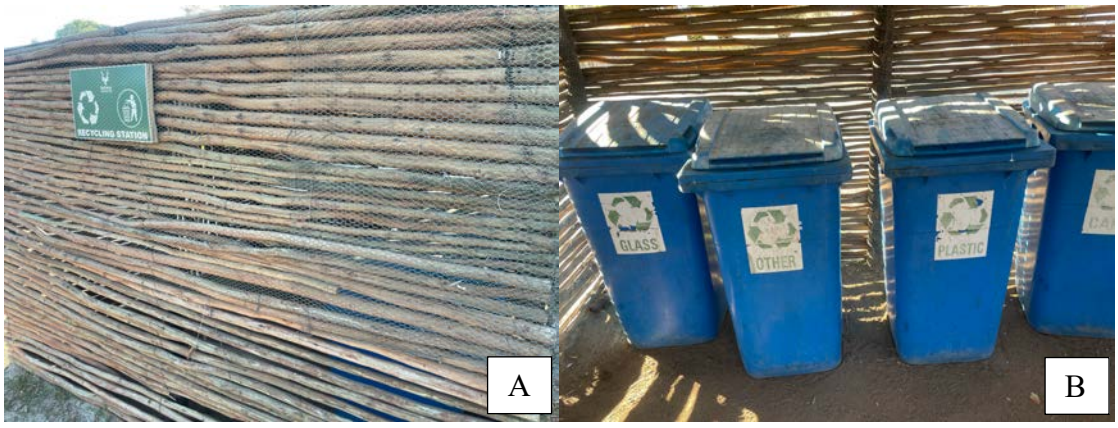

Figure 11. Recycling station where waste is sorted into glass, plastic, carboard and other waste streams prior to disposal.

Waste diversion and prevention practices are rated as acceptable (B). While containment and maintenance are strong, broader behavioural interventions, such as enhanced anti-littering

campaigns, visitor education beyond trail signage, and expanded recycling messaging at key visitor hubs, could be strengthened to further encourage waste-minimising behaviours. Finally, *waste management programmes and initiatives* are rated as acceptable (B). The prominence of wildlife-proofing infrastructure and systematic servicing reflects a clear management strategy, yet the visibility of broader sustainability programmes (such as comprehensive recycling campaigns or visitor education initiatives beyond trail messaging) is less pronounced.

In summary, Augrabies Falls National Park demonstrates a strong and context-appropriate waste management system, particularly in relation to animal-proofing, cleanliness, and infrastructure design. Future improvements would most productively focus on expanding visitor-visible recycling and waste reduction initiatives to complement an already robust containment-focused system.

5.2.4 Bontebok National Park

Located along the banks of the Breede River, Bontebok National Park operates within a sensitive riparian environment where strong winds and proximity to the river heighten the risks associated with poorly contained waste. Waste management seems to be most effective within Lang Elsie's Kraal Rest Camp, where both chalets (Figure 12a) and camping areas (Figure 12b) are well supplied with standard black refuse bins that are sufficient in number and maintained in good functional condition. *Cleanliness* in the rest camp is consistently high and assessed as good (A), reflecting regular servicing and effective housekeeping. The *availability of waste bins* in these areas is considered to be good (A).

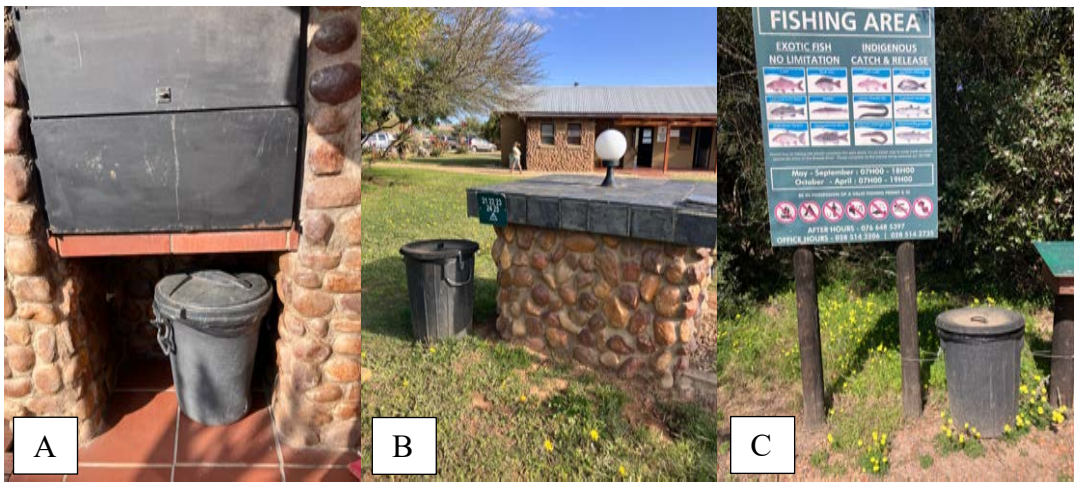

Figure 12. Black refuse bins at the chalets (a) and camping area (b) of Lang Elsie's Kraal Rest Camp, and at the fishing area outside of the camp.

Conditions were less robust at the Die Stroom picnic site, where several deficiencies were observed. Although waste bins were generally available (Figure 13 a), some bins were observed without lids (Figure 13b), while others were missing entirely and replaced only by unsecured black refuse bags (Figure 13c). In this exposed riverside setting, the *condition of waste bins* is therefore assessed as acceptable (B) overall, with localised infrastructure failures significantly increasing the risk of loss of containment. The absence of secure lids and frames also lowers the level of *animal proofing* in these

areas, which is rated as poor (C), where open bins remain vulnerable to scavenging and wind dispersal. Despite these infrastructural shortcomings at Die Stroom, overall site cleanliness remained high during observations, supported by what appears to be a diligent manual cleaning schedule by park staff.

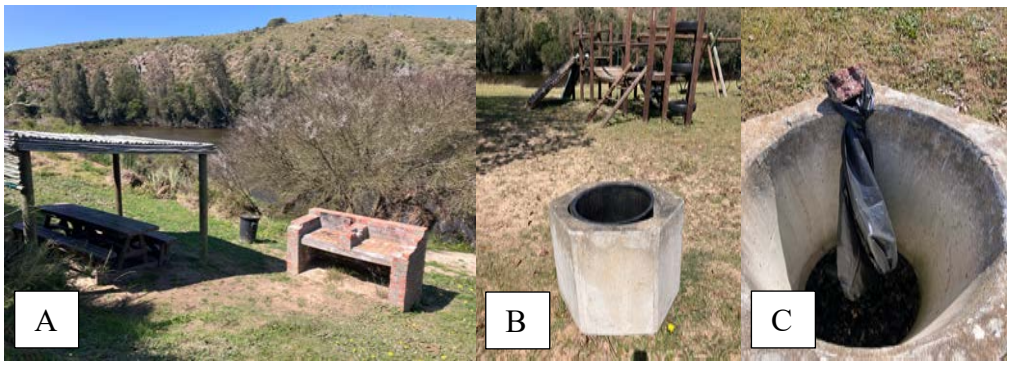

Figure 13. Bins at Die Stroom picnic area, with some bins being placed close to the edge of the river (a), having missing lids (b) or being entirely absent (c).

Waste separation at Bontebok National Park is supported through the provision of "recycling stations" at several key visitor interface points, notably within the Lang Elsie's Kraal Rest Camp, at the Die Stroom picnic site, and at the reception complex; however, the overall effectiveness of this system is uneven. At Lang Elsie's Kraal, a recycling station is available within the camping area (Figure 14a), indicating an institutional commitment to waste diversion at source, yet deficiencies in clear, durable labelling limit its usability and may contribute to the co-disposal of recyclable and non-recyclable materials, particularly for chalet guests for whom the station is less conveniently located. A similar challenge is evident at the Die Stroom picnic site, where a recycling station is present but poorly labelled (Figure 14b), reducing the likelihood of accurate waste sorting by day visitors. While a centralised recycling facility is also located at the reception area (Figure 14c), its positioning is somewhat misaligned with waste generation patterns (it may capture limited waste generated during visitor transit and arrival). Collectively, these factors constrain the effectiveness of waste separation at source and suggest that, despite the presence of recycling infrastructure, improvements in signage clarity, bin placement, and alignment with visitor movement patterns are necessary to fully realise the park's waste diversion objectives. As a result, the *availability of bins for waste separation* is rated as acceptable (B), as infrastructure exists but is not optimally designed to encourage consistent guest participation.

Figure 14. Waste separation ("recycling") stations at Lang Elsie's Kraal Rest Camp (a), Die Stroom picnic site (b) and Bontebok National Park reception area (c).

Waste diversion and prevention practices at the park are assessed as *acceptable* (B). The presence of recycling stations at the rest camp, picnic site, and reception demonstrates an active attempt to divert waste from landfill; however, inconsistent placement, poor signage, and limited convenience for guests reduce overall effectiveness. Similarly, *waste management programmes and initiatives* are rated as acceptable (B), as the foundational elements of a recycling programme are in place but require improved signage, better integration across visitor areas, and more consistent containment solutions to fully support the park's efforts towards waste diversion in the future.

5.2.5 Camdeboo National Park

Waste infrastructure across Camdeboo National Park is well organised and appropriately distributed between accommodation areas and day-visitor sites, contributing to a consistently high level of *cleanliness*, which is assessed as good (A). At the Lakeview Tented Camp, each unit is provided with a dedicated external refuse bin (Figure 15). These bins are designed to be animal-proof, an important feature given the activity of birds and small mammals (especially monkeys) in the area. This system ensures that guest-generated waste remains securely contained at source, reducing the risk of littering and human-wildlife conflict.

Figure 15. Animal-proof bins at Lakeview Tented Camp.

At the Mpunzi picnic site (Figure 16a), the park employs a more utilitarian yet effective waste containment strategy. Upcycled oil drums mounted on poles are used as refuse bins, providing sufficient capacity for picnic groups. These drums are fitted with lids to prevent windblown litter and animal access. The *condition of these bins* is generally good (A). Similar infrastructure is used at the Valley of Desolation, where lidded drum bins are positioned to accommodate high visitor volumes at viewing points (Figure 16b). The *availability of waste bins* across the park is therefore assessed as good (A), with ample provision at all major visitor nodes. The Valley of Desolation also benefits from "No Littering" signage (Figure 16c). While signage plays a positive role in influencing visitor behaviour, formal waste *diversion initiatives* are not the primary focus of the system (B).

Figure 16. Waste bins at Mpunzi picnic site (a) and the Valley of Desolation Lookout Point (b), supported by a "no littering" sign (c).

With respect to *animal proofing*, the park performs well (A). The use of animal-resistant bins at Lakeview Tented Camp and securely lidded drums at picnic and viewpoint areas provides effective protection against wildlife access.

In contrast, *waste separation and recycling infrastructure* is assessed as poor (C). During observations, there was no clear evidence of dedicated guest-facing bins for separating recyclables from general waste. While general refuse bins are plentiful and well managed, the absence of visible recycling or separation facilities at accommodation areas and public sites indicates that *waste diversion* is not actively promoted at the point of disposal (C).

5.2.6 Garden Route National Park

The Garden Route National Park is a complex, multi-node protected area comprising several distinct sections, including Storms River Mouth Rest Camp (Tsitsikamma area), the Wilderness Section (centred around Ebb and Flow Rest Camp), the Knysna Lakes Section, and Nature's Valley (De Vasselot Rest Camp). These core nodes are connected by an extensive network of picnic sites, nature trails, viewpoints, and day-visitor facilities distributed across forest, estuarine, and coastal landscapes. Because the park is embedded within a developed urban and municipal context and supports high volumes of both overnight and day visitors, waste management infrastructure must function across a wide range of environmental conditions, visitor densities, and access constraints. This spatial complexity results in varying levels of containment, servicing, and effectiveness between rest camps and more exposed public-use areas.

Waste management within the park generally follows a tiered pattern linked to the level of control and supervision. In primary rest camps such as Wilderness Ebb-and-Flow (Figure 17a-d) and Storms River Mouth (Figure 22a-e) rest camps, waste containment systems are typically robust and well maintained. Overnight accommodation units often make use of individual or closely clustered bins, which reduces the likelihood of littering and limits access by wildlife. These areas are serviced regularly, contributing to an overall level of *cleanliness* that can be considered acceptable (B) to good, particularly within managed accommodation areas.

At Storms River Mouth Rest Camp, waste management is currently influenced by the construction of the new restaurant facility. During site observations, the temporary restaurant and food service area were associated with an overflowing refuse bin (Figure 24), indicating that existing waste provision may be insufficient to accommodate the concentrated demand created by interim facilities. While this appears to be a temporary condition linked to construction activities, it nonetheless presents an elevated risk of littering, wildlife attraction, and windblown waste in a high-use coastal setting.

Figure 17. Black refuse bins at Wilderness Ebb and Flow Rest Camp in the camping area (a), communal camp kitchen (b), chalets (c) and Tartentaal Day Visitors Area (d).

A significant limitation across Garden Route National Park is the availability of infrastructure for *waste separation at source,* which is assessed as poor (C). While isolated examples of recycling or separation facilities do exist, these are limited in number, inconsistently applied, and generally not located at the primary points of waste generation. Guest-facing waste separation infrastructure was observed at only a few locations, notably within the Wilderness Ebb and Flow camping area (Figure 18a&b), the Tarentaal Day Visitor Area at Ebb and Flow (Figure 18c), and at the reception complex of Nature's Valley De Vasselot Rest Camp (Figure 18c). Even at these sites, separation facilities are not comprehensively integrated into all public-use areas, and their visibility and accessibility for visitors remain limited.

Figure 18. Waste separation efforts at Wilderness Ebb and Flow Rest Camp (a) (in open bins), with waste being mixed (b); and waste separation bins at Tarentaal Day Visitors Area in Ebb and Flow Rest Camp (c). Waste separation bins at Natures Valley De Vasselot Rest Camp's reception area (d).

Across the majority of picnic sites, viewpoints, trails, and accommodation precincts, visitors are provided predominantly with single-stream general waste bins, resulting in the co-mingling of recyclables and non-recyclables. Waste infrastructure at picnic sites and viewpoints were, generally, more variable in both design and effectiveness, reflecting site-specific management decisions. Different types of bins are used across the park's picnic sites: open wooden bins are present at Grootdraai, Velbroeksdraai, and Valley of Ferns picnic sites (Figure 20a-c); animal-proof bins are provided at higher-profile or wildlife-sensitive locations such as the King Edward VII Big Tree and Spitskop Lookout (Figure 20d&e); while concrete bins are installed at Ysterhoutrug picnic site (Figure 20f). While this diversity allows for context-specific responses, open wooden bins in particular offer limited protection against wind, rain, and scavenging birds, increasing the risk of loss of containment in forest and riverine environments. As a result, the *condition of waste bins* across the park is assessed as acceptable (B), with notable variability between sites.

Figure 19. Picnic sites at Woodville Indigenous Forest and Millwood/Goudveld do not have any bins, encouraging guests to take waste with them.

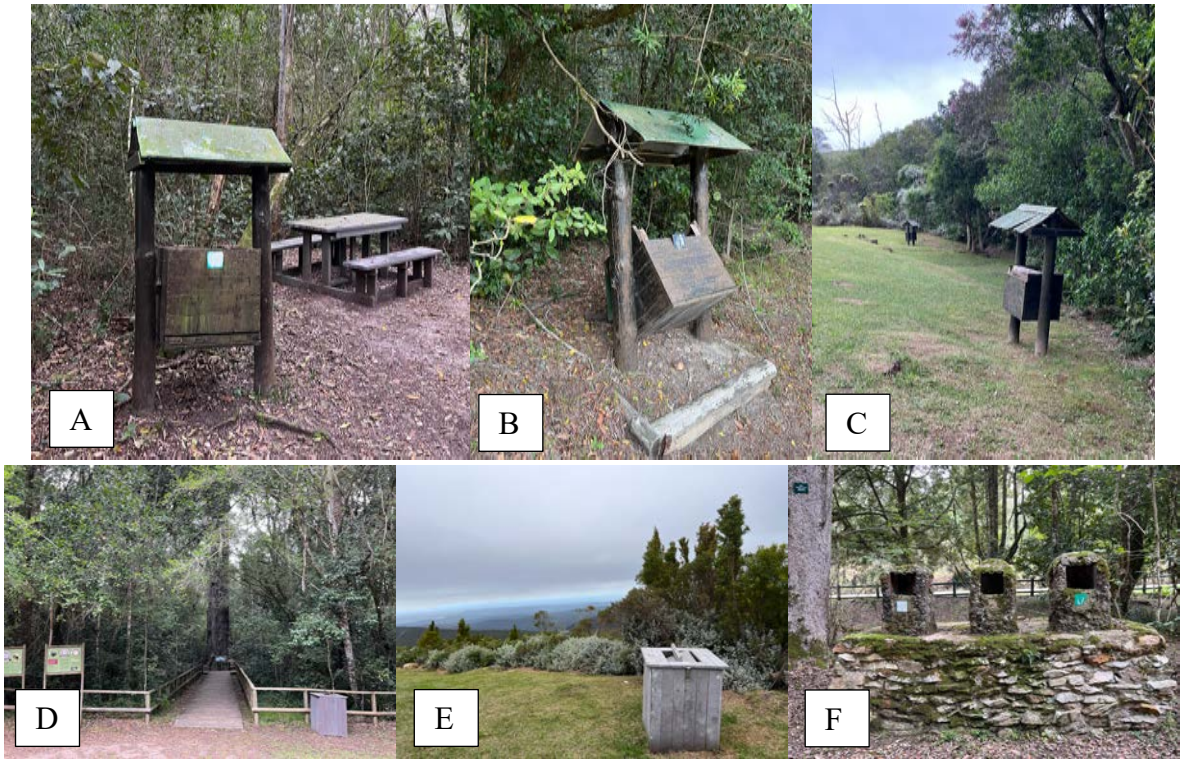

Figure 20. Different bin types at picnic sites. Open wooden bins at Grootdraai (a), Velbroeksdraai (b) and Valley of Ferns (c) picnic sites; animal-proof bins at King Edward VII big tree (d) and Spitskop Lookout (e), and concrete bins at Ysterhoutrug picnic site (f).

The *availability of waste bins* throughout Garden Route National Park is generally good (A), with bins provided at most formal picnic areas, trailheads, viewpoints, and rest camps. However, the park also deliberately applies intentional no-waste-disposal policies at certain sensitive or remote picnic sites, including Woodville Indigenous Forest and the Millwood/Goudveld area (Figure 19). At these locations, visitors are expected to carry out all waste they generate. This approach reduces infrastructure intrusion in ecologically sensitive forest environments and limits long-term maintenance demands, but it relies heavily on visitor compliance and effective communication.

Figure 21. Wooden bins at Diepwalle Rest Camp in the Knysna Section of Garden Route National Park. Although bins are designed to prevent animal access, several bins (a and b) were in a poor condition.

Animal-proofing of waste infrastructure across the park is uneven and therefore rated as acceptable (B). Some picnic sites and viewpoints are equipped with animal-resistant bins. Along the De Vasselot hiking trail, modern monkey-proof bins have been installed (Figure 26), providing effective containment in an area of high primate activity and demonstrating an appropriate response to wildlife-related waste risks. However, many of animal-proof bins in the park are in a poor condition (Figure 21a&b), while others, particularly those with open wooden or standard utility bins, remain vulnerable to scavenging by birds and small mammals. This variability increases the likelihood of litter dispersal where bins are not adequately secured.

Waste diversion and prevention practices are assessed as acceptable (B). The use of no-waste-disposal policies at selected sites (Figure 19) represents a proactive prevention strategy, and "no littering" or low-impact messaging is present in some areas. However, the absence of widespread, visible recycling options and consistent educational signage limits the overall effectiveness of these measures.

Finally, *waste management programmes and initiatives* within park are rated as acceptable (B). Internal municipal and SANParks waste systems are clearly operational and support regular servicing of high-use areas, but their objectives and outcomes are not always visible to visitors. Greater consistency in bin design, clearer communication at no-disposal sites, and expanded at-source separation infrastructure would strengthen alignment between operational practice and the park's conservation mandate.

Figure 22. Animal-proof bins at the Storms River Mouth Rest Camp in Garden Route National Park. Bins are provided at the camp sites (a), communal ablution/kitchen area (b), chalets (c) and chalet braai areas (d), as well as huts (e).

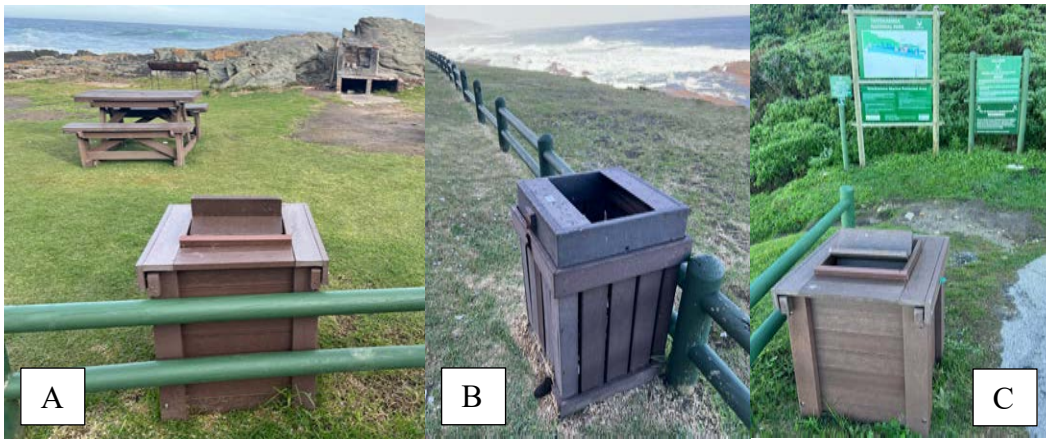

Figure 23. Animal-proof bins at the Storms River Mouth Rest Camp in public use areas, including the Day Visitor site (a), walkways next to the beach (b) and hiking trails (c).

Figure 24. Waste storage at the temporary restaurant with bin overflowing.

Figure 25. Animal-proof bins in camping area (a) and at chalets and cabins (b) in Natures Valley De Vasselot Rest Camp.

Figure 26. Modern monkey-proof bins at the hiking trail adjacent to Nature's Valley De Vasselot Rest Camp.

5.2.7 Golden Gate Highlands National Park

Golden Gate Highlands National Park faces unique waste management challenges due to the public provincial road that bisects the park. This accessibility, while beneficial for tourism, creates a high-pressure environment (Table 5) for waste containment and litter control across its vast landscape.

The waste management landscape at Golden Gate Highlands National Park is marked by a contrast between its structured visitor nodes and its more vulnerable roadside corridors. Overall *cleanliness* across the park is assessed as poor (C), primarily due to the frequent occurrence of illegal dumping and littering along the main road that traverses the park (Figure 28 a-d). These transit routes are particularly susceptible to loss of containment, resulting in visible waste accumulation. The prevalence of roadside litter suggests that current monitoring, enforcement, and waste collection frequencies along these corridors may be insufficient to keep pace with public behaviour and traffic volumes.

In terms of *availability of waste bins*, the park performs at an acceptable level (B). Established rest camps, picnic areas, and viewing points are generally equipped with bins that are reasonably well distributed and functional (Figure 27a-g). However, spacing and coverage along the main road and roadside stopping points appear inadequate, which likely contributes to improper disposal practices and illegal dumping in these areas.

The *condition of waste bins* across the park is likewise assessed as acceptable (B). Most bins observed are structurally sound and serviceable, though there is noticeable variation in design, age, and robustness. This inconsistency affects both aesthetics and functionality, particularly in exposed areas where older or open-top bins are more vulnerable to environmental conditions.

Figure 27. Bins in Glen Reenen Rest Camp camping area (a) and play area (b) next to the camp, Meriting picnic site (c), the Basotho Cultural Village (d), Golden Gate Hotel and Chalets (e), Vulture Hide (f) and Wilgenhof Educational Centre (g).

Figure 28. Loss of containment of waste at Gladstone Lookout point (a), littering/illegal dumping next to the main road traversing the park (b&c). Waste bin overflowing at Basotho Cultural Village (d).

With regard to *animal-proofing*, the park demonstrates mixed performance, resulting in a rating between acceptable and poor (B/C). Some bins are fitted with lids secured by metal arms, an intentional design to deter primates and opportunistic scavengers (Figure 27 a-c). These units represent a positive step toward reducing wildlife access to refuse. However, this standard is not applied consistently across the park, and open-top bins remain common along roadsides and in certain public-use areas (Figure 28c&d). In these locations, waste is readily accessible to wildlife and vulnerable to wind dispersal, increasing the risk of litter spread.

A significant limitation within Golden Gate Highlands National Park is the absence of *waste separation infrastructure,* which is rated as poor (C). There is no evidence of at-source separation facilities for visitors anywhere within the park. All refuse, ranging from recyclables to organic waste, is disposed of as mixed waste, reinforcing a single-stream disposal system. This lack of separation options substantially restricts opportunities for waste diversion and is misaligned with contemporary conservation and sustainability principles.

The park does demonstrate some commitment to *waste prevention practices*, which are assessed as acceptable (B). “No Littering” and “Keep Golden Gate Clean” signage (Figure 29a-d) is widely deployed throughout visitor areas and along key routes, serving as a behavioural prompt for responsible disposal. However, these preventative messages are not supported by complementary infrastructure, such as recycling bins or targeted education initiatives, limiting their overall effectiveness.

Figure 29. No littering signage in Golden Gate Highlands National Park at Zuluhoek Lookout Point (a) and Drakensberg Viewpoint (b). “Keep Golden Gate Clean” signage next to the main road (c) and at the Meriting picnic site (d).

Finally, *waste management programmes and initiatives* visible to the public are assessed as poor (C). Beyond basic bin provision and signage, there is limited evidence of active waste reduction, recycling, or public-facing sustainability programmes within the park.

5.2.8 Karoo National Park

Karoo National Park, located within the ecologically sensitive semi-arid environment of the Great Karoo, demonstrates a well-organised approach to waste management. Waste bins are readily available at all major visitor areas, resulting in a good (A) rating for *availability*. Standard black refuse bins with secure lids are provided throughout the Karoo Rest Camp, including chalet and camping areas, as well as at the Bulkraal picnic site (Figure 30a-c). During site observations, these bins were found to be well distributed, sufficient in number, and able to accommodate visitor use. Their

generally good physical condition further supports a good (A) rating for *bin condition*, with no signs of persistent overflow or damage.

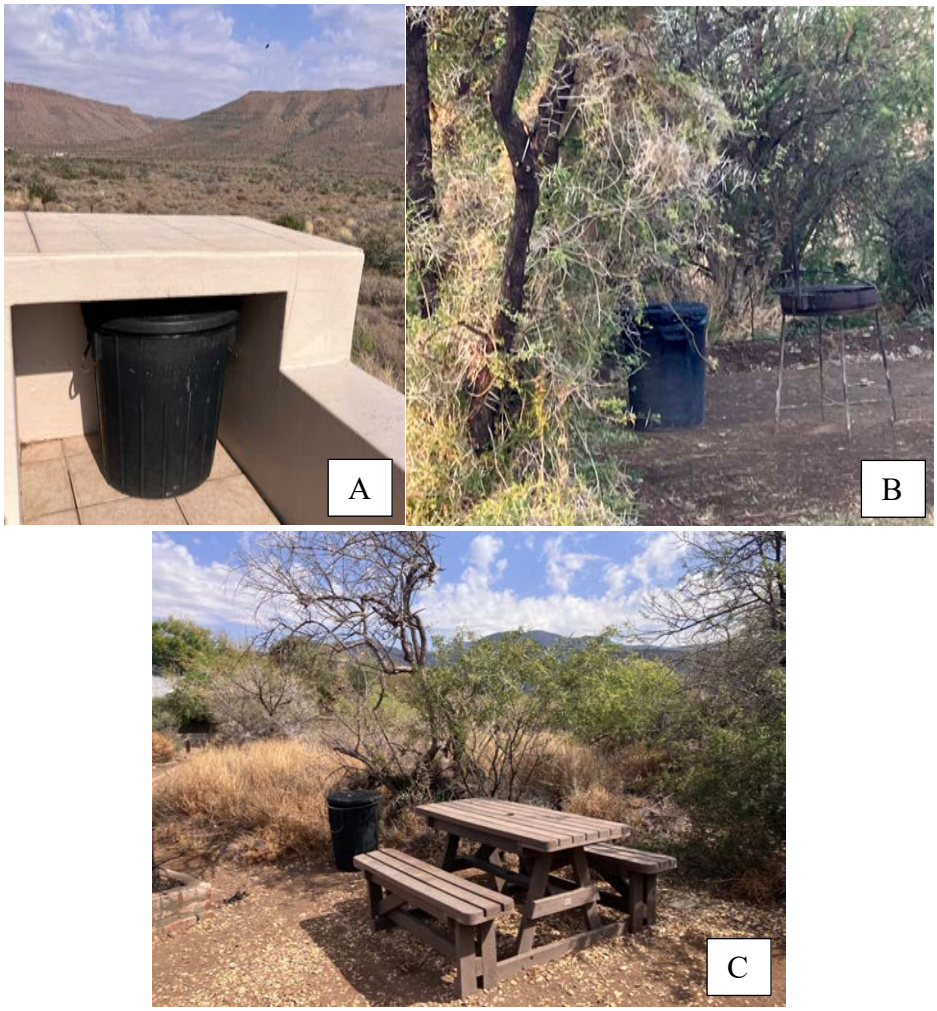

Figure 30. Black refuse bins at the Karoo Rest Camp chalets (a) and camping area (b), as well as the Bulkraal picnic area.

In areas where wildlife activity is more concentrated, the park has taken additional precautions by installing animal-proof waste bins. These are located at the Doornhoek Lookout Point and picnic area (Figure 31a&b), the Interpretive Centre, and the swimming pool within the main rest camp (Figure 31c&d). These heavier-duty or small-opening bins were well maintained and effectively limited access by scavenging animals. Their placement shows clear awareness of where human-wildlife interactions are most likely to occur and reflects a proactive management approach. While the bins in these areas are animal proof, the fact that main camp and Bulkraal picnic area has no animal proof bins, justifies a B-rating (acceptable).

Figure 31. Animal proof bins at Doornhoek Lookout Point (a) and Doornhoek picnic area (b), as well as the Interpretive Centre (c) and the swimming pool (d) at Karoo Rest Camp.

Overall *cleanliness* within visitor-accessible areas of Karoo National Park remained high and was therefore rated as good (A). Most areas, including the rest camp, accommodation zones, and key visitor facilities, were free of visible litter, illegal dumping, or unmanaged waste. However, a small amount of scattered litter (primarily plastic food packaging) was observed at the Doornhoek picnic area. While limited in extent and localised, this suggests that higher-use picnic sites may require more frequent monitoring or targeted visitor messaging to prevent litter accumulation. Importantly, the observed waste did not indicate systemic management failures and appeared to be an isolated issue rather than a widespread condition. No waste-related impacts were observed in more remote sections of the park. Although waste infrastructure is largely absent from these areas, restricted access and low visitor volumes appear to effectively limit waste generation.

Karoo National Park has made visible progress in promoting *waste separation at source*. Recycling stations for waste separations are available at the Rest Camp reception (Figure 32a) and within the campsites (Figure 32b), allowing visitors to separate plastics, cans, and glass. This component of the

system was rated as acceptable (B). While the infrastructure is well designed and clearly functional, its availability is currently limited to key accommodation nodes and does not yet extend to picnic sites or viewpoints.

Figure 32. Waste separation bins at the Karoo Rest Camp reception (a) and camp sites (b).

Waste diversion and prevention practices were assessed as acceptable (B). Although waste separation at source is clearly supported, more visible waste-reduction messaging, such as signage encouraging visitors to minimise waste or carry refuse with them, could further strengthen prevention efforts. *Waste management programmes/initiatives* are rated as moderate (B). The consistent quality of waste infrastructure, combined with the presence of multi-stream waste separation stations, points to an active and well-managed waste programme within the park. Opportunities remain to build on this by expanding recycling infrastructure to additional visitor nodes and increasing visitor awareness around waste minimisation.

Overall, the park's approach supports both visitor use and environmental protection, and provides a solid basis for continued improvement.

5.2.9 Kgalagadi Transfrontier Park

Kgalagadi Transfrontier Park operates under waste management constraints shaped by extreme remoteness, low infrastructure density, and a sensitive desert ecosystem. In response, the park has adopted a pragmatic and prevention-focused waste management philosophy that combines conventional waste collection in major rest camps with a strict "pack-it-in, pack-it-out" approach across much of the park's interior.

Waste infrastructure is deliberately concentrated in the park's three main rest camps: Twee Rivieren, Nossob, and Mata Mata, where visitor use is highest. The *availability of waste bins* within these camps was rated as good (A). In Twee Rivieren, refuse bins are widely distributed across chalets, the swimming pool, camping areas, and day visitor facilities (Figure 33). Mata Mata follows a similar approach, with bins consistently placed at key activity nodes such as the shop, pool,

chalets, and campsite (Figure 35). In Nossob, waste infrastructure is more restrained. While the camping area makes use of both standard black refuse bins and large wheelie bins (Figure 34), chalets are equipped only with internal bins. This minimalist approach appears intentional and likely serves to reduce windblown litter and limit scavenger activity in the open desert environment. Across all three camps, waste bins were observed to be in generally good condition, supporting a good (A) rating for *bin condition*.

Cleanliness throughout the park was assessed as good (A). The combination of concentrated waste infrastructure in rest camps and the absence of bins in interior areas has proven highly effective in maintaining a tidy environment. No significant litter accumulation or unmanaged waste was observed at picnic sites, roadsides, or visitor facilities. This outcome highlights the success of the park's waste prevention strategy rather than reliance on extensive infrastructure, which would be logistically difficult to maintain in such a remote setting.

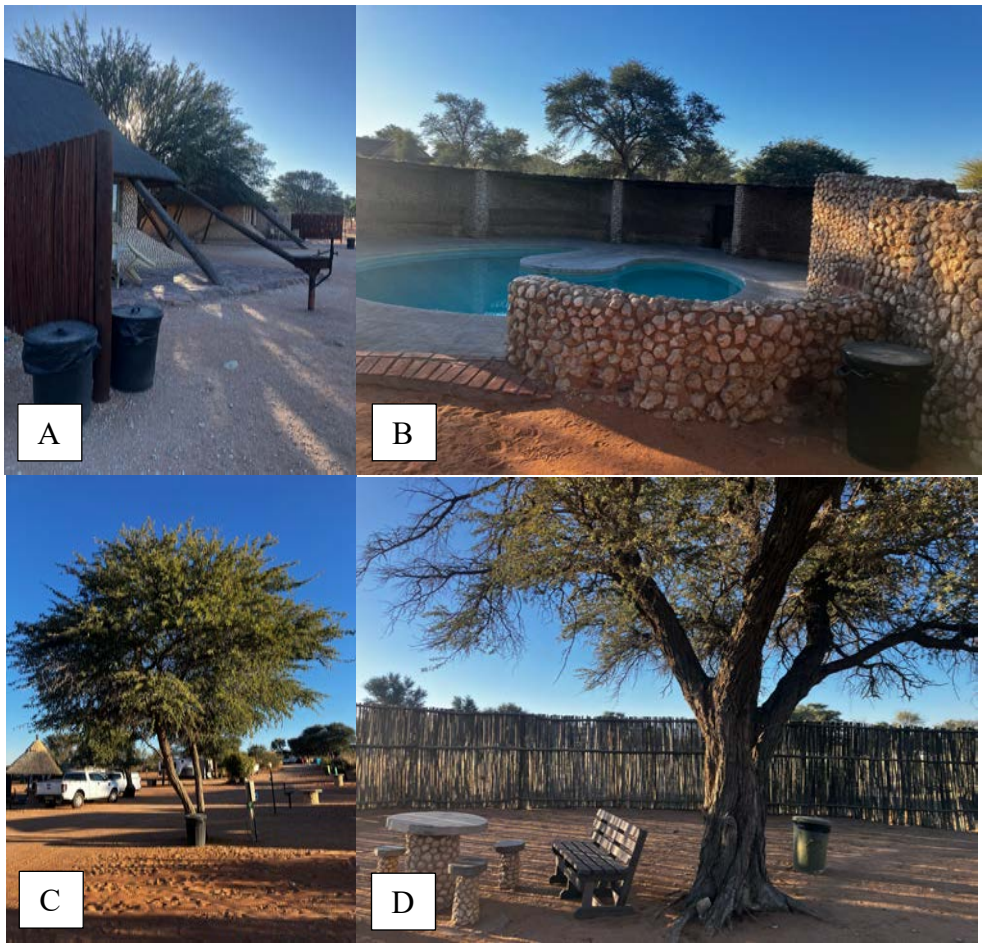

Figure 33. Refuse bins at the Tweeriveren Rest Camp chalets (a), swimming pool (b), camping area (c) and Day Visitors Area (d).

Figure 34. Black refuse bins (a) and wheelie bins (b) in Nossob Rest Camp camping area.

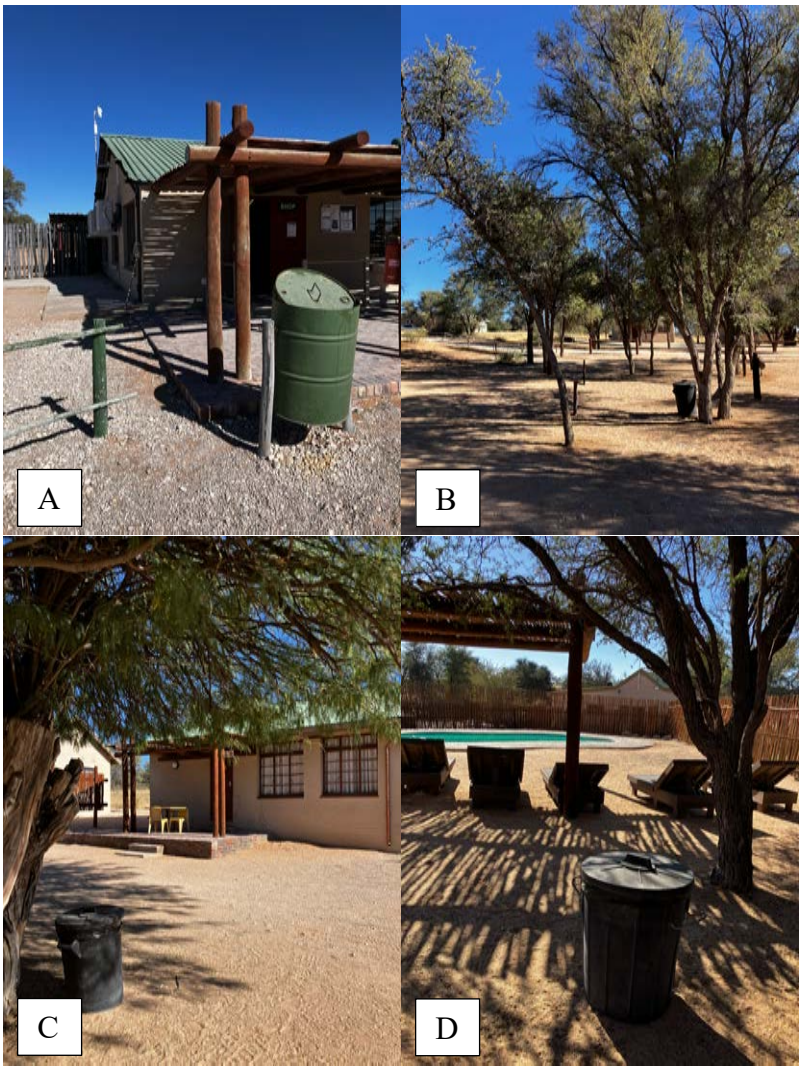

Figure 35. Refuse bins at Mata Mata Rest Camp shop (a), camping area (b), chalets (c) and swimming pool (d).

The absence of specialised *animal-proof bins* represents a notable limitation. No animal-resistant waste containers were observed anywhere in the park, resulting in a poor (C) rating for animal-proofing. While most bins are fitted with lids that provide basic containment, this may not be sufficient in a landscape inhabited by opportunistic scavengers. The park's reliance on controlled bin placement and prevention policies partially mitigates this risk, but the lack of dedicated animal-proof infrastructure remains a vulnerability.

One of the strongest aspects of Kgalagadi's waste management system is its proactive and clearly communicated waste prevention policy. All interior picnic sites are intentionally bin-free, providing only essential amenities such as braai facilities, tables and toilets. This approach is supported by an extensive network of signage at picnic sites such as Dikbaardskolk, Kamqua, Lijersdraai, and Melkvlei (Figure 37 a-c), as well as targeted reminders in bathroom facilities at Auchterlonie picnic site (Figure 37d). Visitors are consistently instructed to retain their waste and dispose of it at the next major rest camp. This strategy has been highly effective and was rated as good (A) for *waste diversion and prevention practices*. By removing disposal options in remote areas, the park minimises the risk of waste accumulation, reduces the need for frequent waste collection, and limits disturbance to wildlife in areas where management presence is minimal.

Waste separation at source is very limited within Kgalagadi Transfrontier Park and was rated as poor (C). Waste separation facilities for glass and plastic were observed only in the chalet area of Twee Rivieren (Figure 36 a&b), with no separation infrastructure available in Nossob, Mata Mata, or other camping areas. As a result, the majority of the park operates on a single-stream waste disposal system. While this limitation is understandable given the park's remoteness and logistical challenges, it nonetheless constrains opportunities for broader waste diversion.

Figure 36. Waste separation bins for glass (a) and plastic (b) at Tweerivieren Rest Camp chalet area.

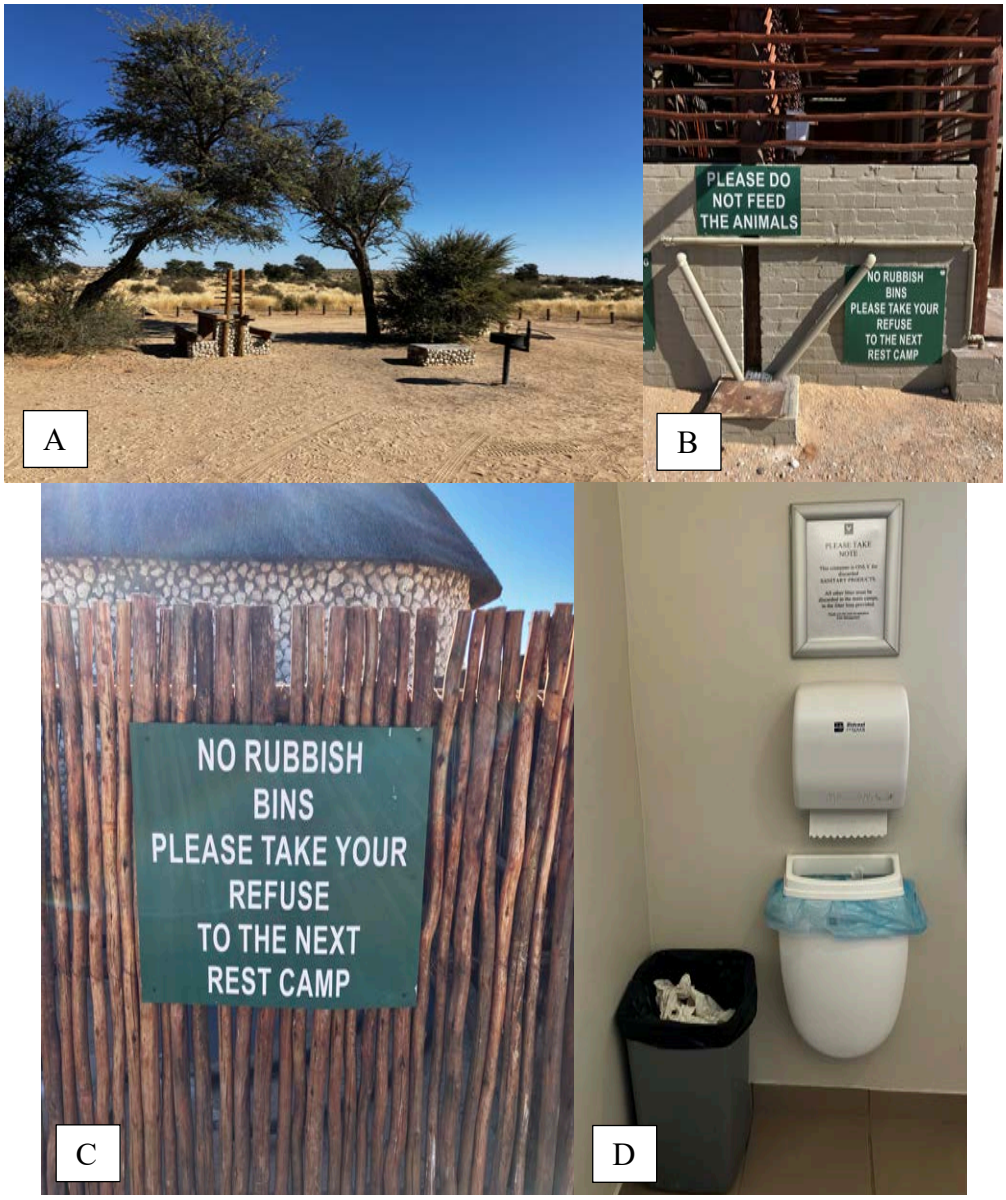

Figure 37. Kgalagadi Transfortier Park has a no bins policy at picnic sites (See for example Lijersdraai picnic site (a) with facilities, without bins). Notices at Dikbaardskolk, Kamqua, Lijersdraai and Melkvlei picnic sites (b & c), and additional notice in bathroom at Auchterlonie picnic site (d) encourage guest to take their refuse to the next camp.

The park's *waste management programmes* reflect a clear institutional commitment to waste prevention rather than infrastructure-heavy solutions. The widely advertised and consistently enforced "pack-it-out" initiative demonstrates strong management intent and visitor engagement, earning an acceptable (B) rating for waste management programmes and initiatives. However, the limited scope of recycling infrastructure indicates that waste diversion efforts remain secondary to prevention, with room for gradual improvement should logistical capacity allow.

Overall, the park exemplifies a context-driven approach to waste management; one that prioritises simplicity, visitor responsibility, and environmental protection in a remote and sensitive landscape.

5.2.10 Kruger National Park

As South Africa's largest national park (at nearly 2 million hectares), the Kruger National Park operates an extensive and highly complex waste management system across an exceptionally large and ecologically diverse landscape. The sheer scale of the park presents ongoing logistical challenges, particularly in achieving consistent infrastructure standards and servicing across regions. As a result, waste management performance varies noticeably between the well-developed southern and central sections of the park and the more rudimentary systems in the north.

In the southern and central regions of the park, Kruger National Park has implemented *a "separation at source"* strategy using two-compartment bins for recyclables and non-recyclables. This infrastructure is widely visible at chalet and camping areas in Malelane, Crocodile Bridge, Berg-en-Dal, Orpen, Tamboti, Satara, Biyamiti (including specialised metal bins for ash), Pretoriuskop, Lower Sabie, Skukuza, and Talamati (Figure 38). However, the effectiveness of separation bins is inconsistent. At camps such as Satara (Figure 38e), clear labelling supports correct visitor use, while in others, including Talamati and Lower Sabie (Figure 38d) many bins lack adequate guidance, reducing their practical effectiveness. Moreover, separation infrastructure is entirely absent from all northern rest camps, including Olifants, Letaba, Mopani, Bataleur, Shingwedzi, Sirheni, and Punda Maria (Figure 39). This sharp regional divide resulted in an acceptable (B) rating for the availability of bins for waste separation. At picnic sites and day visitor areas, a similar pattern emerges. Two-compartment separation bins are limited to higher-use locations such as Muzandzeni, Nhlanguleni, Timbavati, Tshokwane, Nkuhlu, and the Skukuza Day Visitors Area. Other picnic sites, including Makhadzi, Mooiplaas, and N'wanetsi, rely on standard single-stream bins (Figure 39).

Despite these disparities, the overall *availability of waste bins* across Kruger National Park was rated as good (A). Bins are widely provided across all major rest camps, bushveld camps and numerous picnic and day visitor sites, an impressive achievement given the park's size and visitor volumes. The *condition* of waste bins was assessed as acceptable (B). Most infrastructure is functional and well maintained, particularly in southern and central camps. However, shortcomings were observed at specific locations, notably the Punda Maria picnic site, where bins were missing or of poor quality, and at sites where open-top utility bins remain in use. These localised issues detract from an otherwise robust infrastructure network.

Wildlife protection is a dominant design consideration across Kruger's waste management infrastructure. Metal and black plastic bins fitted with secure metal arms to prevent animal access are standard across a wide range of camps, including Crocodile Bridge, Tamboti, Berg-en-Dal, Biyamiti, Pretoriuskop, Orpen, Olifants, Letaba, Mopani, Bataleur, Shingwedzi, Sirheni, Punda Maria, and Skukuza (Figure 39). In addition, specialised monkey-proof bins are strategically placed at high-risk, high-traffic locations such as the Orpen shop and the Shingwedzi swimming pool (Figure 40a&b). Nkuhlu picnic site has recently introduced upgraded animal-proof bin designs (Figure 40c), further strengthening containment in a known problem area. Despite these strengths, *animal-proofing* is not applied consistently across the park, resulting in an acceptable (B) rating. Babalala and Punda Maria picnic sites were observed to have bins lacking animal-resistant features, and open-top bins remain in use at Skukuza, Shingwedzi, Afsaal, and Punda Maria (Figure 42). For high-

volume waste containment, particularly at busy picnic sites, the park makes use of waste cages at Afsaal, Babalala, and the Orpen picnic site lookout (Figure 41). These structures provide an additional layer of protection where bin capacity alone would be insufficient.

Figure 38. Two-compartment bins for the separation of recyclables and non-recyclables (a). These bins are present at chalets and camping areas of Malelane-, Crocodile Bridge-, Berg-en Dal-, Orpen-, Tamboti-, Satara-, Biyamiti- (with metal bin for ash) (b), Pretoriuskop- (c) (with some evident monkey activity), Lower Sabie- (d), Skukuza-, Talamati without clear labelling of recyclable- and non-recyclable compartments. Clearly labelled two-compartment bins at Satara Rest Camp (e). No two compartment bins for waste separation were available at the northern rest camps: Olifants-, Letaba-, Mopani-, Bataleur-, Shingwedzi-, Sirheni-, Punda Maria Rest Camps. Two-compartment bins were available at the following picnic sites only: Muzandzeni-, Nhlanguleni-, Timbavati-,Tshokwane picnic site, Nkuhlu picnic site with labelling (f), and Skukuza Day Visitors Area (g).

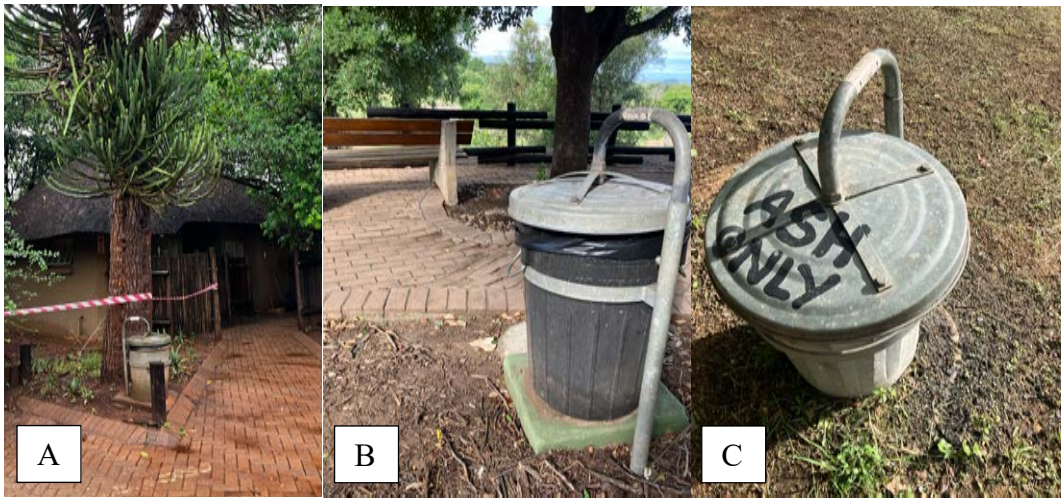

Figure 39. Metal- and black plastic refuse bins with arm. These bins are present in Crocodile Bridge- (a), Tamboti-, and Berg-en-Dal- (b), Biyamiti-, Pretoriuskop-, Open-, Olifants-, Letaba-, Mopani-, Bataleur-, Shingwedzi-, Sirheni-, Punda Maria-, and Skukuza- (c) Rest Camps. Picnic sites had similar bins at Makhadzi-, Mooiplaas-, N'wanetsi-, Nkuhlu picnic sites, and Skukuza Day Visitors area.

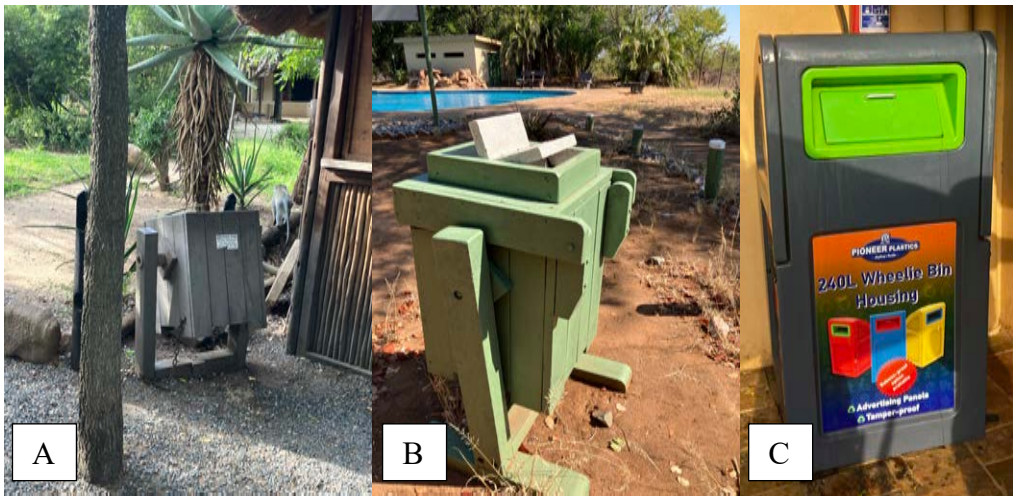

Figure 40. Monkey-proof bins (with monkey attempting access) at Orpen Rest Camp shop (a) and Shingwedzi Rest Camp swimming pool (b). New animal-proof waste bins at Nkuhlu picnic site (c).

Figure 41. Waste cages at Afsaal (a) and Babalala (b) picnic sites, and Orpen picnic site lookout (c).

Cleanliness across Kruger National Park was rated as acceptable (B). Most camps, picnic areas, and visitor facilities were generally clean, reflecting effective waste collection routines and widespread availability of disposal options. However, localised issues persist. Toilet paper litter was observed at lookout points without facilities, and scattered waste was noted at certain picnic and camping sites, often linked to delayed collection or animal interference. While not widespread, these issues indicate pressure points where infrastructure or servicing frequency may be insufficient.

Waste diversion and prevention practices represent one of Kruger's strong performance areas and were rated as acceptable (B). The extensive use of two-compartment bins in the southern and central regions supports separation at source, while waste cages at busy picnic sites help prevent overflow and dispersal. Innovative mobile cages for plastic bottle collection have been introduced at the Skukuza chalet area and the Letaba camping area (Figure 43). Although their placement away from shops and restaurants may limit participation, these initiatives demonstrate a willingness to trial adaptive solutions.

The park actively promotes waste awareness through information boards at Pretoriuskop and Skukuza receptions, as well as "no littering" signage at Afsaal and other picnic sites (Figure 44). This messaging reinforces expectations of visitor responsibility and complements the physical infrastructure.

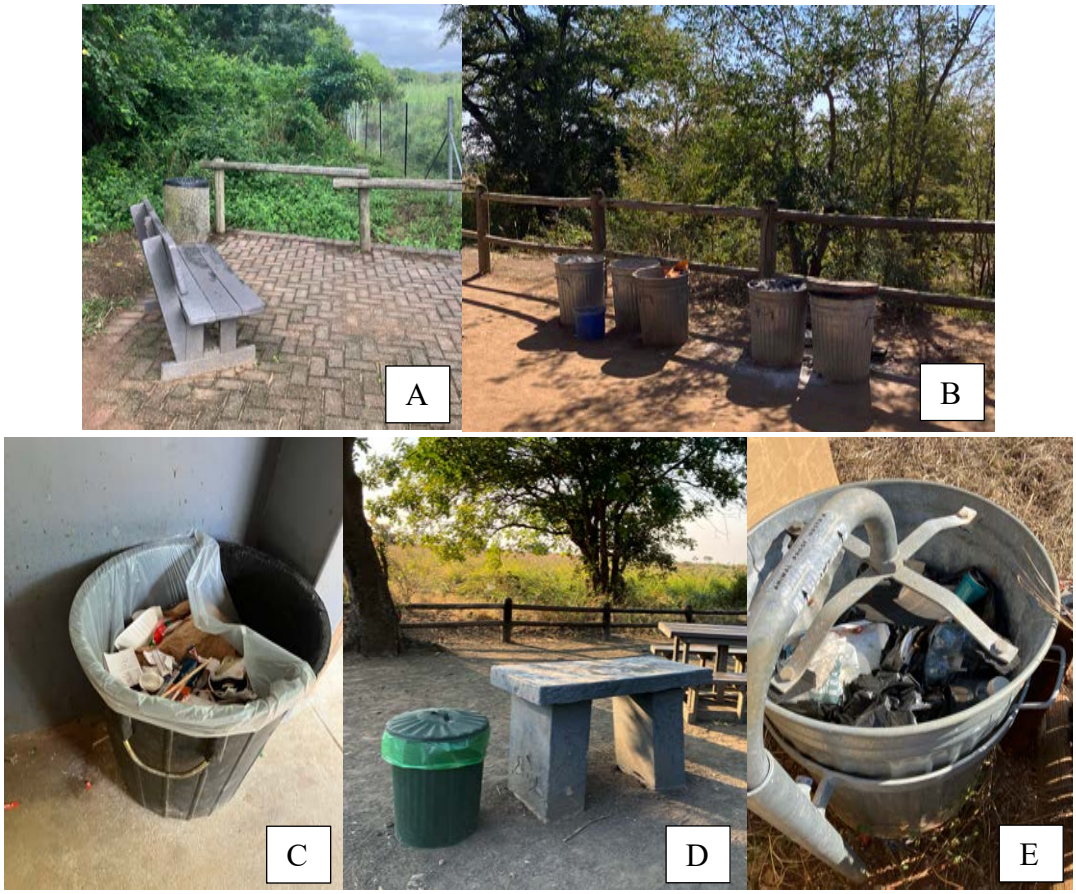

Figure 42. Open waste bins (no lid) at Skukuza Rest Camp close to the river (a), open waste/ash bins for collection at Shingwedzi Rest Camp (b) and Afsaal picnic site (c). Waste bins at Babalala picnic site (d) without animal proofing. Open waste bin at Punda Maria picnic site (e). Several waste bins at this picnic site were missing or in a poor condition.

Figure 43. Mobile cage for the collection of plastic bottles at the Skukuza Rest Camp chalet area (a) and the Letaba Rest Camp Camping area (b).

Figure 44. Information about a waste separation and recycling initiative of the Kruger National Park at Pretoriuskop Rest Camp (a) and Skukuza Rest Camp (b) at the reception area. No littering signage at Afsaal picnic site (c), and examples of no littering signs (d&e) at picnic sites.

Kruger National Park's *waste management programmes and initiatives* were rated as good (A). The visibility of recycling information some camps (Figure 44a&b), the scale of separation infrastructure in high-use regions, and the deployment of specialised collection systems such as waste cages and mobile bottle cages all point to strong institutional commitment. While implementation is uneven across regions, the underlying programme framework is well developed and actively maintained.

In summary, Kruger National Park operates a large-scale and multifaceted waste management system under significant logistical constraints. While Kruger's waste management system performs well in its more developed regions, targeted investment and standardisation, particularly in the northern camps, will be essential to achieving more uniform performance across the park's vast landscape.

5.2.11 Mapungubwe National Park

Mapungubwe National Park, a UNESCO World Heritage Site renowned for its cultural significance and diverse riverine and sandstone landscapes, faces a complex challenge in managing waste within a sensitive ecological and heritage context. While the park maintains a generally high standard of

cleanliness, shortcomings in infrastructure condition, maintenance, and placement introduce risks that could compromise long-term waste containment if left unaddressed.

Waste bins are present at all major accommodation and public-use areas, resulting in an acceptable (B) rating for *availability*. In Leokwe Rest Camp, metal bins with lids secured by metal arms are installed in the parking areas in front of chalets (Figure 45) . Similar animal-resistant bins are provided at Limpopo Forest Camp (Figure 46), also concentrated in parking zones. While these designs are appropriate for local wildlife pressures, their placement away from individual chalets or tented units is sub-optimal and may reduce convenience for guests, potentially increasing the risk of improper disposal. Mazhou Rest Camp presents a more user-friendly arrangement, with a mix of metal and animal-proof bins provided directly at each campsite (Figure 47). In addition, key public areas, including the Bird Hide, Confluence Picnic Area and Viewing Deck, Interpretive Centre, and Tree Top Boardwalk, are well serviced with refuse bins (Figure 48). This ensures that day visitors have adequate opportunities to dispose of waste responsibly.

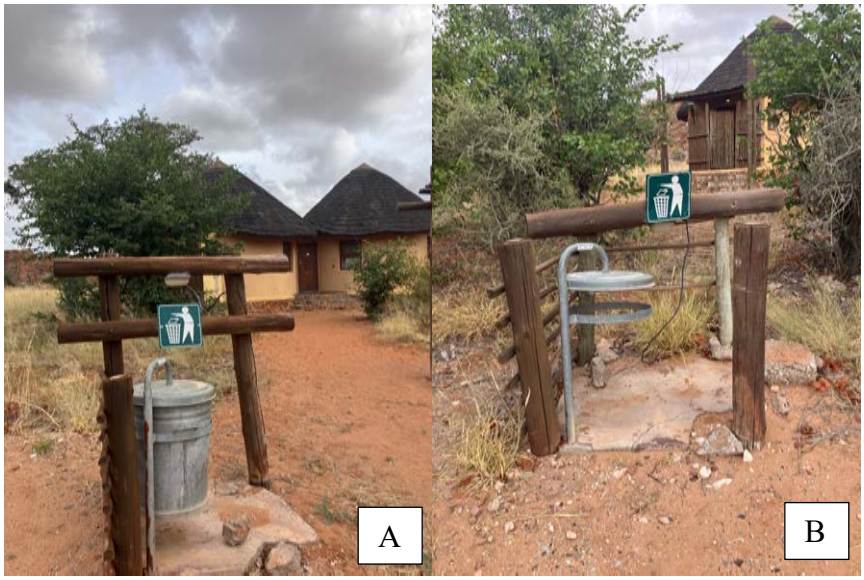

Figure 45. Metal refuse bins with arm at Leokwe rest camp located at the parking area in front of chalets (a), with some missing bins (b).

Figure 46. Animal-proof refuse bins at Limpopo Forest Camp in the parking area (a&b). Several bins had missing lids (c) or were toppled over (d).

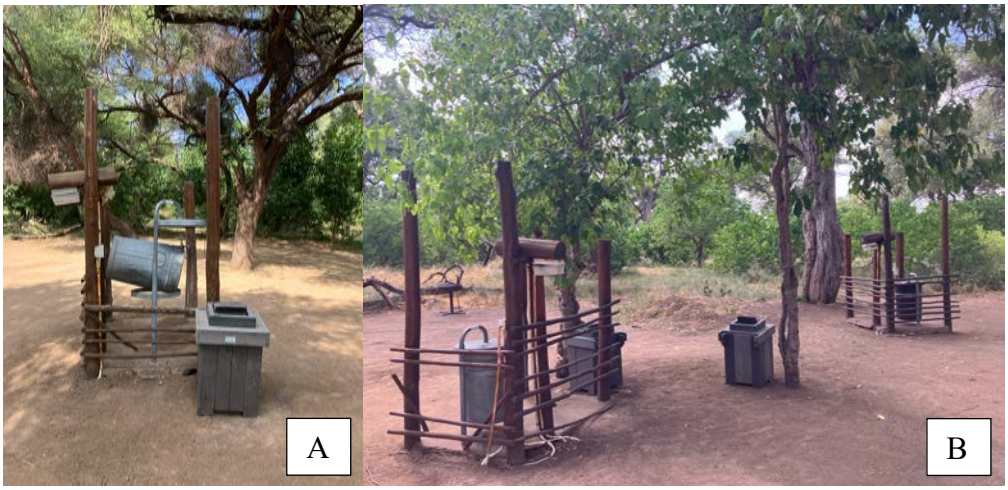

Figure 47. Combination of metal refuse bins and animal-proof refuse bins (a) in Mazhou Rest Camp, with bins available at each camp site (b).

Figure 48. Refuse bins in public use areas, such as the bird hide (a), Confluence picnic area (b), Confluence viewing deck (c), Mapungubwe Interpretive Centre (d), Tree Top Boardwalk (e) and Western entrance gate (f).

Despite the generally adequate distribution of bins, the physical *condition of waste infrastructure* across the park was rated as moderate (B) to poor (C). Several bins were observed to be missing critical components, with only base frames remaining in some locations (Figure 45b). Others were toppled over or lacked lids entirely (Figure 46c&d), significantly reducing their effectiveness. These maintenance gaps undermine the otherwise sound design of the bins and pose a risk to containment, particularly in a park with high wildlife activity and exposure to wind and weather.

Figure 49. "Keep our park clean" signage at the Confluence picnic area.

Notwithstanding the infrastructure challenges, *overall cleanliness* within Mapungubwe National Park was assessed as good (A). Visitor areas were generally clean and free from scattered litter. This suggests that operational effort is currently compensating for failing infrastructure, rather than cleanliness being the result of well-functioning waste infrastructure alone. While commendable, this reliance on staff intervention may not be sustainable over the longer term without infrastructure upgrades.

Where bins are intact and functional, their design is well suited to wildlife management needs. Many units incorporate metal arms (Figure 48c-f) or wheel mechanisms (Figure 48a) that restrict access by animals, which is particularly important given the park's high primate activity. As a result, *animal-proofing* was rated as acceptable (B). However, the effectiveness of these designs is significantly reduced when bins are missing lids, damaged, or overturned (Figure 46c&d), highlighting the critical link between design quality and ongoing maintenance.

Waste separation at source is entirely absent from the visitor-facing waste management system, resulting in a poor (C) rating for the availability of recycling infrastructure. No bins for separating recyclables were observed in accommodation areas or public-use sites. Similarly, *waste diversion and prevention practices* were rated as poor (C). Visitor awareness messaging is limited, with "Keep our park clean" and "no littering" signage largely confined to the Confluence picnic area (Figure 49). There is little visible encouragement for waste minimisation, responsible packaging choices, or recycling.

Beyond basic waste collection, there are few visible public-facing *waste management programmes or initiatives* in place, leading to a poor (C) rating for this criterion. While staff efforts clearly play a significant role in maintaining cleanliness, this commitment is not strongly reflected in formalised programmes, interpretive messaging, or infrastructure that engages visitors as active participants in waste management.

5.2.12 Marakele National Park

Marakele National Park manages waste in a landscape characterised by ecological diversity and active primate populations. Waste bins are consistently available across accommodation areas, picnic sites, and visitor facilities, resulting in a good (A) rating for *bin availability*. In Bontle Rest Camp, the camping area is serviced by standard black refuse bins secured with metal arms (Figure 50a), while the chalets are equipped with more specialised animal-proof bins (Figure 50b). Similarly, Tlopi Tented Camp (Figure 51a) and the Tsetsebe picnic site (Figure 51b) are both serviced by animal-proof bins, ensuring consistent containment standards across different accommodation types. Overall, the physical *condition* of bins was assessed as acceptable (B). While most units were functional and intact, some rely on improvised securing mechanisms to remain effective.

Figure 50. Black refuse bins with metal arm (a) in camping area, and animal-proof bins (b) at chalets in Bontle Rest Camp.

Figure 51. Animal-proof bins at safari tents in Tlopi Tented Camp (a) and Tsetsebe picnic site (b).

Cleanliness across Marakele National Park was rated as good (A). Visitor areas, including rest camps, picnic sites, and activity nodes, were generally free from litter, indicating that the combination of adequate bin provision and effective animal-proofing is successfully preventing waste dispersion.

Animal-proofing at Marakele National Park was assessed as acceptable (B). Across most accommodation areas and picnic sites, the park makes effective use of metal arms and purpose-built animal-resistant bins, which significantly reduce wildlife access in high-use visitor zones. These measures contribute positively to waste containment and help limit animal habituation in much of the park. However, at the Marakele Educational Centre, an area experiencing particularly intense monkey activity, standard infrastructure has proven insufficient. While staff have implemented creative, low-tech solutions such as securing bin lids with wire and weighting them with bricks (Figure 52 a&b), these measures were observed to be only partially effective. Monkeys were still able to interfere with bins under certain conditions, highlighting the limitations of improvised deterrents in the absence of fully secure, purpose-built infrastructure. As a result, while animal-proofing is generally sound across the park, its inconsistent effectiveness at key high-risk sites justifies a B rather than an A rating.

Figure 52. Separation of food waste (a) and paper, plastic and glass (b) at the Marakele Educational Centre. Separated waste is stored in an enclosed, covered waste cage (c) for collection.

Waste separation at source is currently very limited in scope and was rated as poor (C) in terms of availability to general visitors. Separation was observed only at the Marakele Educational Centre (Figure 52), where waste is divided into food waste and a combined stream for paper, plastic, and glass. This initiative demonstrates technical feasibility but remains inaccessible to most tourists.

Despite its limited reach, *waste diversion* at the Educational Centre was assessed more positively, earning an acceptable (B) rating. Separated waste streams are stored in an enclosed, covered waste cage, protecting materials from scavengers until collection and removal from the park. This system reflects a thoughtful and functional approach to both recycling and organic waste management.

The presence of structured waste separation, secure storage, and staff-led innovation at the Educational Centre indicates an active and organised *waste management programme*, resulting in an acceptable (B) rating for this criterion. However, these practices remain localised. While effective at the centre, they have not yet been scaled to other camps or visitor nodes, contributing to a somewhat decentralised overall system.

5.2.13 Meerkat National Park

Meerkat National Park was not visited for waste-related observations, since the park did not have any tourism-related facilities and activities at the time of the research.

5.2.14 Mokala National Park

Mokala National Park applies a waste management philosophy that prioritises prevention over collection. Situated within the semi-arid transition zone of the Northern Cape, the park has adopted a deliberately minimalist approach that limits waste infrastructure in sensitive areas while investing in robust, wildlife-resistant containment where visitor use is concentrated.

The *availability of waste bins* at Mokala was assessed as good (A). Bin provision aligns closely with management intent and site sensitivity, with infrastructure supplied wherever waste disposal is appropriate and intentionally withheld where prevention is prioritised. Within accommodation areas, bins are sufficient in number and strategically positioned to minimise environmental risk. At Lillydale Rest Camp, purpose-built animal-resistant bins are provided at chalets (Figure 53a), while communal areas such as the swimming pool are serviced by black refuse bins (Figure 53b) housed within steel frames to deter wildlife interference. At Motswedi Campsite and the Mosu Lodge chalets (Figure 54), the park applies an “internal bins only” policy. In public-use areas such as lookout points, bird hides, and picnic sites (including Kameeldoring and Motopi), the absence of bins reflects a deliberate “no dustbin / no waste disposal” policy rather than a lack of infrastructure (Figure 55). This approach is clearly communicated to visitors (Figure 55b) and forms a core component of the park’s waste prevention strategy.

Animal-proofing at Mokala represents one of the park’s strongest performance areas and was rated as good (A). The use of purpose-built animal-resistant bins, steel protective frames (Figure 53), and internal-only disposal strategies effectively prevents wildlife access to refuse. These measures are particularly appropriate in a park where prevention is prioritised over reactive collection.

Figure 53. Animal proof bins at chalets (a) and black refuse bin covered with steel frame at public area next to swimming pool (b) at Lillydale rest camp.

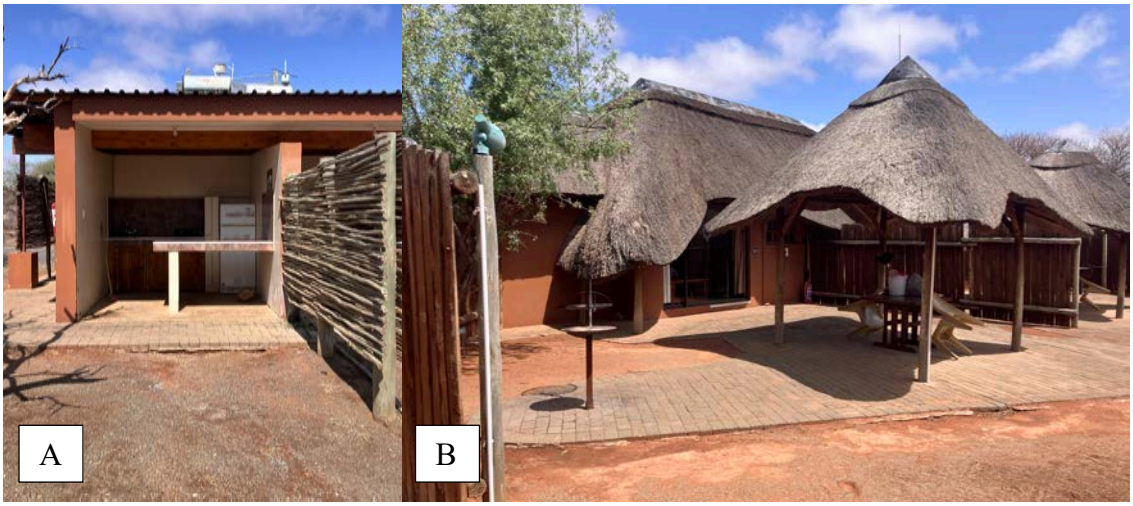

Figure 54. No external bins (internal bins only) at Motswedi Camp site (a) and Mosu Lodge chalets (b).

Figure 55. No bins at Lookout Points (a), bird hides, and picnic areas such as Kameeldoring- and Motopi picnic area (see no dustbin notice in b).

The *condition of waste bins* across Mokala National Park was rated as good (A). All observed bins were intact, functional, and well maintained. No damaged, overflowing, or unsecured units were noted.

Cleanliness across Mokala National Park was also rated as good (A). Visitor areas were consistently clean and free from litter, an outcome strongly linked to the park's prevention-focused approach. The intentional absence of bins in sensitive public areas reduces the risk of overflow and litter accumulation, while reinforcing responsible visitor behaviour and preserving the park's open, uncluttered landscape.

In remote and ecologically sensitive areas, Mokala implements a strict "pack-it-in, pack-it-out" approach. The absence of bins at lookout points, bird hides, and picnic areas is supported by prominent "no dustbin" signage, ensuring visitors are aware of their responsibility to remove all refuse. These *waste prevention/diversion* measures were assessed as acceptable (B), as the measures in place significantly reduce servicing requirements and maintain high environmental standards in low-access areas.

Waste separation infrastructure is present but remains centralised, resulting in an acceptable (B) rating for the availability of bins for waste separation. Visitors can separate glass at the Lillydale Rest Camp reception (Figure 56a), while more comprehensive separation options are available at the Mokala Interpretation Centre (Figure 56b) and the Mosu Lodge reception (Figure 56c). However, separation infrastructure is not provided at the primary points of waste generation, such as campsites and chalets. While consistent with the park's minimalist philosophy, this limits broader visitor participation in recycling and constrains overall diversion potential.

Figure 56. Bins for waste separation for glass at Lillydale Rest Camp Reception (a) and Mokala Interpretation Cente (b), as well as bins for the separation of waste at Mosu Lodge reception (c).

Waste management programmes and initiatives were assessed as acceptable (B). While organised waste separation facilities are in place at key hubs such as the Lillydale Rest Camp reception, Mokala Interpretation Centre, and Mosu Lodge reception, these initiatives remain centralised and are not yet accessible at all points of waste generation.

5.2.15 Mountain Zebra National Park

Mountain Zebra National Park employs a waste management approach that combines conventional containment in high-use areas with a firm "pack-it-in, pack-it-out" philosophy at picnic sites. The *availability of waste bins* within the park was rated as good (A). In the Mountain Zebra Rest Camp, waste infrastructure is robust and varied to respond to differing levels of wildlife pressure. The camping area is serviced by a combination of standard metal bins (with lids weighted by bricks) (Figure 57a), black refuse bins fitted with metal locking arms in communal areas (Figure 57b), and specialised monkey-proof bins that use a wheel mechanism to close the opening (Figure 57c). A similar standard of containment is evident at the reception area, which is also equipped with monkey-proof bins (Figure 57d). In contrast, chalets are intentionally kept free of external bins and rely entirely on internal waste disposal. This strategy effectively reduces the attraction of animals to accommodation areas. The *condition of waste bins* across Mountain Zebra National Park was assessed as *good (A)*. All observed bins were intact, functional, and appropriately maintained.

Figure 57. Metal bins with lid secured by bricks (a), black refuse bin with metal arm in communal area (b) and monkey-proof bins (with wheel to cover opening) (c) in the Mountain Zebra Rest Camp camping area, and monkey-proof bins at reception (d). Chalets only had internal bins.

At picnic sites, the park adopts an intentionally minimalist approach. No bins are provided, and the absence of infrastructure reflects a deliberate “no dustbin” policy rather than a service gap. This policy was clearly communicated through on-site signage and forms a core component of the park’s waste management strategy (Figure 58).

Figure 58. No refuse bin policy at picnic sites and lookout points with signage to guests.

Animal-proofing represents one of the park’s strongest performance areas and was rated as good (A). The use of multiple containment mechanisms, including heavy bricks, metal arms, and specialised wheel-based monkey-proof bins, demonstrates a high level of responsiveness to local wildlife behaviour. The internal-only bin policy at chalets further strengthens this approach by eliminating opportunities for animal access at accommodation units.

Overall cleanliness within the park was rated as acceptable (B). Most visitor areas, including the rest camp and picnic sites, were generally clean and free from scattered litter. However, a recurring issue was observed at lookout points without bathroom facilities, where toilet paper litter was present. While localised, this detracts from the visual integrity of these otherwise pristine viewpoints.

Mountain Zebra National Park currently has no infrastructure in place to support *waste separation at source* for visitors, and this criterion was therefore rated as poor (C). All refuse generated within the park is collected as a single waste stream, with no provision for the separation of recyclables such as glass, plastic, or cans at camps, picnic sites, or public facilities. *Waste diversion and prevention practices* were assessed as acceptable (B). The “no bin” policy at picnic sites is an effective prevention measure that reduces waste accumulation, limits servicing requirements, and minimises ecological disturbance. However, the absence of any recycling or separation-at-source infrastructure for visitors constrains the park’s ability to divert waste away from landfill, limiting overall performance in this category.

Lastly, *waste management programmes and initiatives* at the park were rated as acceptable (B). The “pack-it-out” policy is clearly communicated and consistently applied through signage at picnic sites and public areas, indicating an organised and enforceable programme. While effective in prevention, the lack of complementary recycling or educational initiatives focused on waste

diversion suggests scope for further development. Introducing even limited, well-secured separation facilities at the main rest camp could improve diversion outcomes without undermining the park's effective wildlife management strategies.

5.2.16 Namaqua National Park

Waste management at Namaqua National Park is defined by a deliberate dual-zone strategy, balancing centralised waste collection in accommodation and high-use visitor areas with a strict "pack-it-in, pack-it-out" philosophy in culturally and ecologically sensitive zones. As a relatively small national park with modest visitor numbers, Namaqua operates with intentionally simple and low-intensity waste infrastructure, which is broadly appropriate to its scale and setting. Overall *cleanliness* across the park is rated A, with visitor areas generally well maintained and little evidence of litter, suggesting that the existing infrastructure and visitor compliance are largely effective.

The Skilpad section functions as the park's primary visitor hub and the focal point for waste management infrastructure. At Skilpad Rest Camp, refuse generated is managed through standard black wheelie bins (Figure 59), which serve as the main waste collection points. The *availability of waste bins* in this core area is rated B; adequate for current visitor volumes, but limited to centralised locations rather than being distributed throughout the camp, reflecting the park's intentionally minimalist approach. For day visitors, the picnic site located between the reception area and the rest camp is equipped with black refuse bins (Figure 61). However, the *condition* of waste bins at this site is also rated B, as several units were observed to have loose-fitting lids. In the windy conditions typical of the Namaqualand escarpment, this presents a potential containment weakness and increases the risk of windblown litter.

Figure 59. Black wheelie bins at Skilpad Rest Camp in Namaqua National Park.

Figure 60. Koeroebees Cultural Picnic Area without any waste bins. Guests are requested to take their litter with them (a&b).

In contrast, the Koeroebees Cultural Picnic Area is intentionally bin-free (Figure 60). This site relies entirely on visitor responsibility, reinforced through clear signage requesting that guests remove all litter when they leave. From a prevention perspective, this approach is highly effective and contributes to an B rating for *waste diversion and prevention practices*. The absence of bins protects the cultural and aesthetic integrity of the heritage site and reduces the likelihood of wildlife becoming habituated to scavenging in a remote and sensitive landscape. The cleanliness observed at Koeroebees indicates strong visitor compliance with the “leave no trace” message.

Figure 61. Picnic site between the reception area and Skilpad Rest Camp. Black bins with loose lids were available for waste disposal.

Animal-proofing measures across the park are rated B. While the bin-free policy at Koeroebees offers protection against wildlife interaction, the reliance on standard wheelie bins with loose lids at Skilpad picnic site provides only moderate resistance to animals and environmental exposure. Although wildlife pressure in Namaqua is lower than in many other national parks, improved lid security would strengthen containment and better align with best practice in arid and windy environments.

The park currently lacks any guest-facing infrastructure for *waste separation*, resulting in a C rating for the availability of bins for waste separation. All visitor waste is managed as a single stream, with no opportunities for source separation at accommodation facilities, picnic sites, or reception areas. While this simplified system is consistent with the park's small scale and limited infrastructure footprint, it constrains broader waste diversion outcomes. *Waste management programmes and initiatives* are rated B, reflecting clear and effective communication at culturally sensitive sites, but a largely basic, collection-focused approach elsewhere.

Overall, Namaqua National Park's waste management system is proportionate to its size, visitor pressure, and operational context. Incremental improvements, such as better bin lid design at Skilpad and selective introduction of recycling at central visitor nodes, could further strengthen performance without undermining the park's low-impact management philosophy.

5.2.17 Richtersveld Transfrontier Park

Richtersveld Transfrontier Park (also referred to as |Ai-|Ais/Richtersveld) operates within one of South Africa's most remote and environmentally extreme protected areas, where waste management is constrained by aridity, long transport distances, and persistent pressure from wildlife, particularly baboons. Within this context, the park has adopted a minimalist and prevention-focused waste management strategy.

Despite limited infrastructure and the challenges associated with desert environments, the park was observed to be *generally clean and free from widespread litter* (rated A). This suggests effective operational oversight and a relatively high level of visitor compliance with disposal guidelines. The absence of overflowing bins or windblown refuse indicates that the park's conservative approach to bin provision does not compromise environmental quality.

Across the park, the *availability of waste bins* is best described as acceptable (B). Infrastructure is intentionally limited rather than comprehensive, particularly outside of main visitor nodes. However, where bins are provided, they are strategically located and scaled appropriately to visitor numbers. This approach is well illustrated at Sendelingsdrif Rest Camp, the administrative and tourism hub of the park, which services ten chalets and twelve campsites. Rather than distributing numerous bins throughout the camp, Sendelingsdrift relies on a small number of public refuse units supplemented by a central enclosed waste trailer located between the fuel station and retail shop (Figure 62 a&b). While this requires visitors to actively transport waste, the short distances involved and the small size of the camp make the system functional and appropriate.

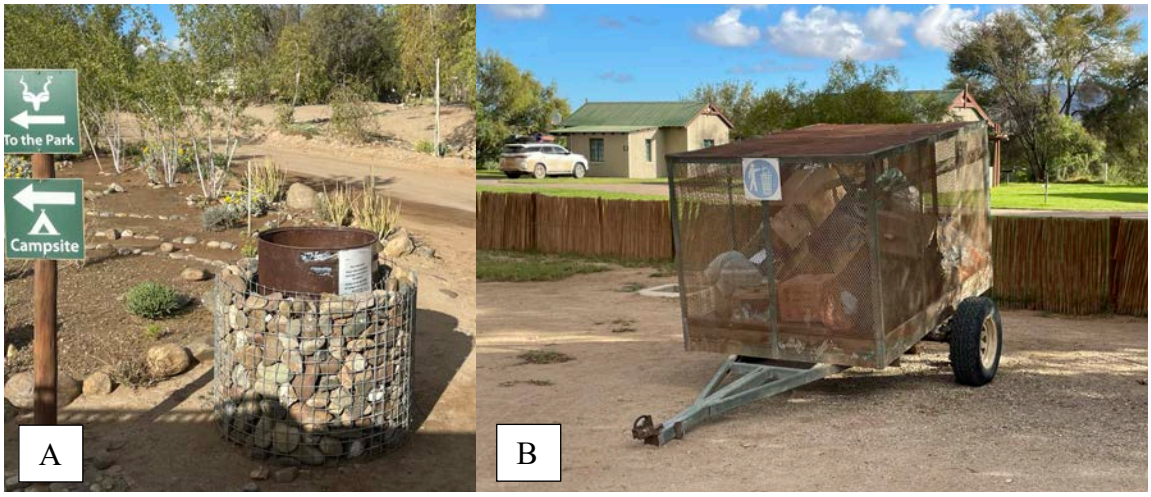

Figure 62. Reinforced waste disposal unit and directional signage at Sendelingsdrif Rest Camp. The unit utilises a gabion-style rock base to prevent displacement by wildlife (a). The attached instructional notice requires that visitors refrain from disposing of black refuse bags within this receptacle to prevent opportunistic foraging by local baboon populations; instead, users are directed to a centralised, secure waste facility (trailer) located between the site's fuel station and retail outlet (b). Chalets (see Figure 62b background) had no external bins.

The *condition of waste infrastructure* throughout the park was rated as good (A). Bins are generally well-maintained, and specifically designed to withstand both environmental stressors and wildlife interference (see Figure 62a&b). This emphasis on durability compensates for the limited number of bins and contributes directly to the park's high cleanliness rating.

Figure 63. "Do not litter" signage and wheelie bin at the Sendelingsdrif Rest Camp reception area.

Animal-proofing measures were assessed as acceptable (B). Across the park, infrastructure design clearly prioritises reducing wildlife access to waste, but effectiveness varies depending on correct use by visitors. At Sendelingsdrift, baboon pressure is mitigated through a combination of heavy, reinforced bins and behavioural controls. Instructional signage requests visitors not to place full black refuse bags into public bins, which could lead to overfilling and animal access, and instead

directs them to the secure central waste trailer (Figure 62a&b). While this system is generally effective, it relies on visitor compliance.

Waste separation at source and recycling infrastructure are absent throughout Richtersveld National Park and were therefore rated as poor (C). All waste is collected as a single stream, with no guest-facing facilities for separating recyclables or organic waste. Although this limitation is understandable given the park's remoteness and the logistical challenges associated with waste recovery, it represents a clear gap in alignment with broader sustainability and diversion objectives. *Waste diversion and prevention practices* were rated as acceptable (B). The park focuses on preventing waste proliferation rather than diverting materials. Centralised disposal, internal-only bin policies at chalets (as seen at Sendelingsdrift), and the deliberate absence of bins in sensitive areas reduce opportunities for littering and wildlife interaction. While effective from a containment perspective, these measures are not complemented by active separation or waste minimisation campaigns.

Waste management programmes were also rated as acceptable (B). The system relies on clear, site-specific signage and visitor education to function effectively. At Sendelingsdrift, for example, signage plays a critical role in directing visitors to use the central waste facility correctly and in preventing misuse of public bins. While these programmes are relatively basic and largely operational in nature, they are appropriate to the park's scale and constraints and demonstrably effective in maintaining cleanliness.

5.2.18 Table Mountain National Park

Waste management at Smitswinkel Bay Tented Camp is strongly shaped by Table Mountain National Park's philosophy of "touching the earth lightly" and by the need to manage waste responsibly in an area frequented by baboons. The camp is intentionally small, comprising only six tents with a maximum capacity of twelve guests, and its waste system is correspondingly compact.

Cleanliness at the camp was rated as good (A). During observations, the site was generally clean, well-maintained, and free from litter. The *availability of waste bins* was rated as acceptable (B). Bin provision is intentionally limited to avoid attracting baboons and to minimise visual and physical disturbance to the landscape. Each tent contains only small bins in the en-suite bathrooms, intended for personal hygiene waste rather than food refuse. All other waste disposal is centralised in communal kitchen/living area (Figure 64).

Figure 64. Waste-separation system at Smitswinkel Bay Tented Camp communal kitchen-living area. The infrastructure utilises internal wooden chutes for source-separation [paper, glass, tins, plastic and other waste (a-c)] which gravity-feed into an external, baboon-proof central cage (d). This design minimises the "attraction-risk" for baboons by securing waste behind a physical barrier.

The *condition of waste infrastructure* was also rated as good (A). The wooden sorting chutes are well-integrated into the building design and were observed to be functional and well-maintained. These chutes feed directly into a secure, external waste cage located outside the communal kitchen area. This cage is fit for purpose, ensuring that sorted recyclables and residual waste remain contained until collection.

Animal-proofing performance at the camp was rated as good (A). Given the presence of baboons in the area, the centralised and fully secured cage system is critical. By funnelling all waste streams into a single, reinforced containment point and limiting waste storage elsewhere on site, the camp effectively prevents wildlife access and reduces the risk of habituation or conflict.

Separation of waste at source, and waste diversion and prevention practices were rated as good (A). The clear separation of food waste from recyclable materials, combined with the absence of unnecessary bins and the emphasis on shared disposal points, actively encourages guests to engage with waste reduction and diversion practices. Finally, waste *management programmes* and initiatives at Smitswinkel Bay were rated as moderate (B). While there are no formal educational displays, the waste system itself functions as an embedded management programme.

5.2.19 Tankwa Karoo National Park

Waste management at Tankwa Karoo National Park, as observed at Elandsberg Wilderness Camp and the Perdekloof and Langkloof campsites, reflects a thoughtful and environmentally conscious response to the challenges of managing waste in a remote, arid landscape. With long transport distances, limited infrastructure, and the need to avoid attracting scavenging wildlife, the park has adopted a system that prioritises organic waste diversion, strict containment, and carefully restrained infrastructure.

Cleanliness across the assessed areas of the park was rated as good (A). Despite the presence of a public district road running through parts of the park, a feature that can often contribute to litter in protected areas, the surrounding environment was observed to be generally clean and well maintained.

The *availability of waste bins* was rated as acceptable (B). Rather than providing numerous disposal points, the park has opted for a deliberately conservative approach that reduces both visual intrusion and opportunities for wildlife access. At Perdekloof Campsite (Figure 66), standard wheelie bins are provided but are kept inside a locked area, ensuring they remain inaccessible to animals. Langkloof Campsite (Figure 67) takes this approach a step further, with no external bins at all; guests dispose of waste only inside the communal kitchen area. While this requires visitors to be more mindful of how they manage their waste, the system is well suited to the park's remote setting and low visitor density.

Waste separation infrastructure was also rated as acceptable (B), reflecting a focused but partial approach to separation at source. At Elandsberg Wilderness Camp, each unit is equipped with a clearly marked indoor container for food waste (Figure 65). This enables kitchen scraps to be separated from general refuse at the point of generation, supporting a specialised organic waste

stream. Although facilities for separating dry recyclables such as plastic, glass, and paper are not provided to guests, the emphasis on organic waste reflects a deliberate prioritisation of the waste fraction most likely to cause odour, attract wildlife, and generate methane if landfilled.

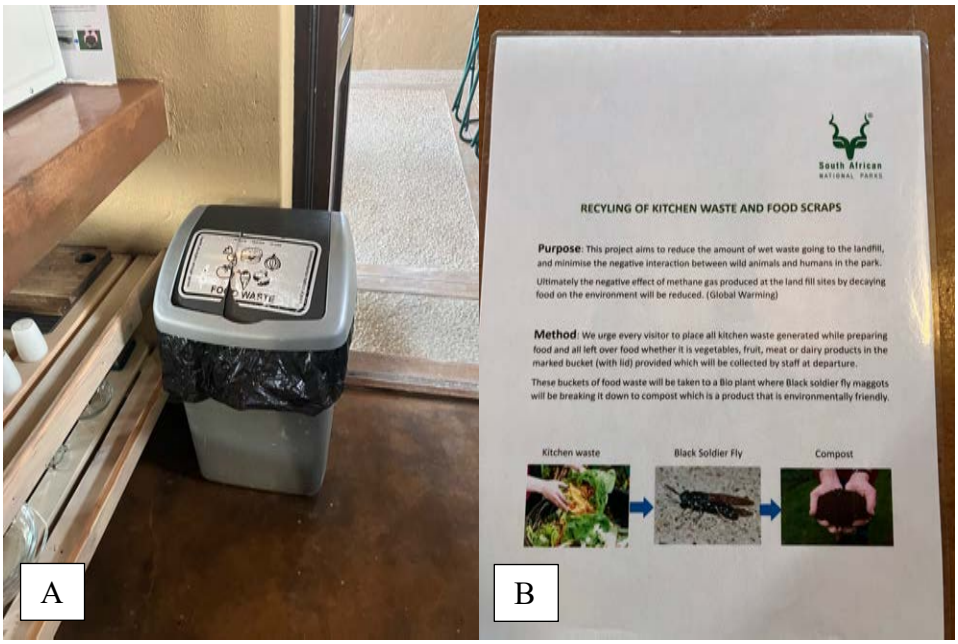

Figure 65. Dedicated indoor organic waste receptacle labeled for "Food Waste"at Elandsberg Wilderness Camp (a). This point-of-source collection is the first step in the park's diversion strategy, ensuring that kitchen scraps are separated from dry recyclables and general refuse to facilitate downstream composting (b).

Figure 66. Wheelie bins at Perdekloof camp site secured in an internal, locked storage area to prevent animal access.

Figure 67. The Langkloof camping site is free from any external waste disposal infrastructure. Waste bins were only available inside of the communal kitchen.

The *condition of waste infrastructure* across the assessed sites was rated as good (A). Bins and storage areas were observed to be in good working order and appropriately designed for the harsh Karoo environment. The reliance on indoor bins and enclosed storage further protects infrastructure from extreme temperatures, wind, and animal interference.

Animal-proofing measures performed particularly well and were rated as good (A). Rather than relying solely on reinforced external bins, the park's strategy largely removes waste from the outdoor environment altogether. Locked storage rooms, indoor-only bin placement, and the absence of external bins at certain sites effectively eliminate access points for scavenging animals and reduce the risk of habituation.

Waste diversion and prevention practices represent one of the park's most notable strengths and were rated as good (A). The organic waste collected at Elandsberg Wilderness Camp is processed using Black Soldier Fly larvae, a biological composting method that diverts food waste from landfill and reduces methane emissions. This approach is innovative and well suited to a remote protected area where conventional waste treatment options are limited.

Finally, *waste management programmes and initiatives* were rated as acceptable (B). Clear signage, consistent food-waste separation protocols, and a functioning downstream composting system indicate an organised and actively managed programme rather than an informal or *ad hoc* solution. While the waste management system at Tankwa Karoo National Park is generally effective and well aligned with the park's environmental context, more active and visible visitor communication could further strengthen its performance.

5.2.20 West Coast National Park

Waste management at West Coast National Park follows a largely conventional model, characterised by frequent bin placement in high-use public areas (rated A for *availability*) and a deliberate "no-bin" policy in selected sensitive zones. This approach generally functions well in the park's inland, terrestrial areas, which were observed to be clean and well maintained. However, when assessed holistically, overall *cleanliness* is rated B, as the coastal interface presents persistent challenges. Some scattered litter was observed along sections of the shoreline, likely resulting from a combination of visitor-related refuse and marine debris deposited by ocean currents, both of which negatively affect the visual quality of these areas.

Waste infrastructure performance varies across different visitor nodes. At picnic and braai sites such as Preekstoel and Tsaarsbank, waste management relies on high-visibility signage and a mix of pole-mounted plastic drums and standard black refuse bins (Figure 69 and 71). While the pole-mounted design successfully prevents bins from being moved or overturned, the *condition of waste bins* is rated B due to loose-fitting lids observed at several sites, particularly at Preekstoel. In a high-wind coastal environment, this represents a significant limitation, as unsecured lids reduce containment effectiveness and increase the risk of windblown litter.

Public use areas such as the Langebaan Entrance Gate, Seeberg Viewpoint, and Seeberg Bird Hide (Figure 68) are serviced with standard refuse bins or pole-mounted drums, contributing positively to bin availability and supporting appropriate disposal behaviour. In contrast, the Atlantic Viewpoint is intentionally bin-free, reflecting a conscious management decision aligned with landscape protection principles. This targeted use of "no-bin" zones supports *waste prevention practices,* which are rated B, as they encourage visitor responsibility but are not supported by broader diversion mechanisms. The Geelbek precinct (Figure 70), particularly around the cafeteria and retail areas, demonstrates stronger alignment between waste generation and infrastructure design. Smaller, sturdier bins with secure lids are used in these high-volume food areas and were observed to be well suited to managing the type and quantity of waste generated. These bins are generally functional and appropriately placed, reinforcing the B rating for bin condition across the park.

A key weakness in the system relates to *animal proofing*, which is rated C. Although large mammals and primates are not a primary concern in West Coast National Park, the widespread use of open-top bins or bins with loose lids leaves waste highly vulnerable to wind dispersal and access by smaller scavengers such as Cape grey mongooses, and coastal birds. In coastal conditions, wind is a critical vector for waste loss, and insufficiently sealed bins increase the likelihood of litter entering dune systems and the marine environment.

The park currently provides no guest-facing infrastructure for *waste separation* or recycling, resulting in a C rating for availability of bins for waste separation. Consequently, waste *diversion practices* remain limited, despite some positive prevention-oriented measures such as signage and bin-free zones. Waste *management programmes and initiatives* are therefore rated B, reflecting clear communication around litter prevention but an absence of formal recycling or diversion systems accessible to visitors.

Figure 68. Waste bins in public use areas: Black refuse bins at the Langebaan entrance gate (a) and plastic drum affixed to poles with opening at Seeberg Viewpoint (b) and Seeberg Bird Hide (c). The Altantic Viewpoint (d) had no waste disposal bins. Standard black refuse bin in the braai area of Joanne's Beach Cottage (e).

Figure 69. Waste infrastructure at Preekstoel picnic site and braai area. No littering sign in the parking area (a) with waste bins affixed to poles to keep them in place (b). There are several waste bins (plastic drums with openings affixed to poles) on the beach (c). The Preekstoel braai faciliies has black refuse bins with loose lids (d).

Figure 70. Geelbek picnic site had a small cafeteria/shop selling food. Small, sturdy waste bins with lids were available within this area (a).

Figure 71. Waste infrastructure at Tsaarsbank picnic site and braai area. No littering sign in the parking area (a). There are several waste bins (plastic drums with openings affixed to poles) located close to the coastline (b & c).

Overall, West Coast National Park demonstrates strong performance in bin availability and basic cleanliness management, but structural limitations in bin design, particularly in coastal areas, combined with the absence of waste separation infrastructure, constrain overall system effectiveness. Targeted improvements in wind-resistant containment and the introduction of selective waste separation opportunities could substantially strengthen the park's waste management performance.

5.3 Interview results

Section 5.3 presents the findings derived from semi-structured interviews and complementary observational data collected across multiple South African national parks. Using the Seven Questions foresight methodology (Section 4.3.3) and inductive thematic analysis (Section 4.4.1), the results highlight both the current operational realities of waste management and the perceived trajectories of future practice within protected areas.

5.3.1 Interview respondent profile

To preserve participant anonymity while contextualising the depth and relevance of expertise represented, a composite profile of the thirteen interview respondents is presented in Table 6. Participants were purposively selected based on their direct involvement in waste management, environmental compliance, tourism operations, or conservation governance within South African National Parks.

Several formal efforts were made to invite and involve park managers and relevant role-players from all South African national parks, including repeated email invitations, and follow-up correspondence. Despite these efforts, the overall response rate was limited, resulting in a final sample of thirteen (13) participants. Low response rates among senior conservation and management personnel are widely reported in organisational and qualitative research, particularly where participants occupy demanding operational roles and face competing institutional priorities (Baruch and Holtom, 2008; Bryman, 2016).

Table 6. Interview participant profile summary (n = 13).

Category	Summary of Data
Total participants	13
National parks represented	Augrabies Falls, Bontebok, Golden Gate Highlands, Kgalagadi Transfrontier, Kruger, Mapungubwe, Marakele, Mokala, Mountain Zebra, Namaqua, Richtersveld, Table Mountain, West Coast, and Other (Head Office/Groenkloof/Overall SANPARKs responsibility)
Professional roles	Park Management (n=3), Scientific Services (n=1), Technical & Ranger Services (n=3), Hospitality & Socio-Economic Transformation (n=2), and Environmental Compliance/Sustainability Management (n=4).
Years of experience	1-6 years (n = 3, 23%); 11-20 years (n = 7; 54%); Over 20 years (n = 3, 23%).
Qualifications	All participants hold tertiary qualifications, with 54% (n = 7) possessing postgraduate degrees (Honours, Master's, or Doctorate).

The respondents who did participate were drawn primarily from twelve individual national parks (Table 6), including Augrabies Falls, Bontebok, Golden Gate Highlands, Kgalagadi

Transfrontier, Kruger, Mapungubwe, Marakele, Mokala, Mountain Zebra, Namaqua, Table Mountain, West Coast, and Richtersveld National Parks (with regional roleplayers being responsible for more than one park, in some cases), as well as respondents based at SANParks Head Office (Groenkloof), with cross-cutting organisational responsibility. The inclusion of both park-based and head-office perspectives enabled the integration of site-specific operational insight with organisation-wide strategic and governance considerations. The participating parks reflect a range of park types and operational contexts, including flagship high-tourism destinations, smaller or more remote parks with logistical constraints, transfrontier conservation areas, and parks with significant coastal or marine tourism components. This diversity strengthens the transferability of the findings by capturing waste management challenges across varying scales of operation and institutional complexity.

Although the sample comprised thirteen participants, this number is considered methodologically appropriate and sufficient for the qualitative, exploratory nature of the study. Qualitative research emphasises depth, contextual richness, and the achievement of thematic saturation, rather than statistical representativeness (Patton, 2015). Saturation is reached when additional data collection yields no new substantive themes or insights (Guest, Bunce and Johnson, 2006). Empirical studies have demonstrated that saturation in homogeneous or expert samples often occurs within a relatively small number of interviews. Guest *et al.* (2006) found that thematic saturation frequently emerges within the first ten to twelve interviews, while Hennink *et al*. (2017) distinguish between code saturation (identification of issues) and meaning saturation (depth of understanding), both of which may be achieved with modest sample sizes in focused studies. Creswell and Poth (2018) similarly suggest that qualitative interview-based studies typically include between five and twenty-five participants, depending on scope and complexity.

In this study, respondents were information-rich participants with direct operational or strategic responsibility for waste management within protected areas. Strong convergence was observed across interviews, particularly regarding institutional capacity constraints, leadership and governance challenges, behavioural issues, and the need for circular economy approaches. No substantively new themes emerged during the final interviews, indicating that thematic saturation had been achieved. As such, the sample size is considered sufficient to support the analytical claims made and aligns with established qualitative research standards.

In terms of professional roles, participants spanned multiple organisational levels, including park management, scientific services, technical and ranger services, hospitality and socio-economic transformation, and environmental compliance or sustainability management (Table 6). This vertical- and horizontal representation enabled triangulation of strategic, managerial, and operational perspectives, further enhancing the credibility of the findings.

5.3.2 Thematic analysis of interview responses: A futures-oriented perspective

An inductive thematic analysis of the interview data was conducted using the Seven Questions framework as a futures-oriented analytical lens. Rather than focusing solely on current conditions, the analysis examined how participants interpreted present practices as signals of change, structural drivers, or constraints shaping possible future trajectories of waste management in South African national parks. Five dominant and interrelated themes emerged (Table 7), collectively illustrating a spectrum of plausible futures ranging from systemic transformation to institutional stagnation.

Table 7. Summary of emergent themes and representative responses from interviews (n = 13).

Theme	Core issues identified	Representative participant perspectives	Frequency of mention
Institutional and resource capacity	Lack of dedicated staff, equipment, infrastructure, transport and budgets for waste management	Waste management is under-resourced and treated as an afterthought despite increasing visitor numbers	11
Behavioural and cultural mindsets	Poor compliance by staff and visitors; lack of ownership and accountability	Infrastructure exists but is undermined by inappropriate use and a “not my responsibility” culture	8
Leadership and strategic priority	Limited senior management commitment; waste not viewed as core business	Change is perceived to stall due to insufficient top-down support and strategic direction	6
Circular economy integration	Limited implementation of waste reduction, recycling and composting initiatives	Strong conceptual support exists, but practical constraints hinder system-wide adoption	6
Environmental and ecological risk	Wildlife interactions with waste; plastic pollution; water contamination	Waste poses direct risks to biodiversity, ecosystem health and park reputation	4

Institutional and resource capacity as a structural driver

The analysis of interviewee responses indicates that institutional and resource capacity constitutes the predominant theme (n = 11) and a fundamental structural driver influencing prospective outcomes in waste management. Respondents recurrently highlighted existing constraints in resources, encompassing staffing shortages, inadequate infrastructure, insufficient equipment, and limited dedicated budgets. If these deficiencies remain unresolved, they are likely to perpetuate scenarios characterised by heightened operational challenges and environmental degradation.

One respondent characterised this as an escalating risk: *“Proper waste management is not a priority… no budget allocated, no human capital, no transport, no equipment and no facilities, yet we constantly work at increasing visitor numbers.”* Additional responses reinforced these concerns,

with one identifying *"funding and development"* as primary impediments to system upgrades, such as stormwater infrastructure, and another emphasising *"Funding is the biggest problem and commitment from top management, Staff issues, Training, Proper Infrastructure."*

From a futures-oriented viewpoint, the discord between tourism expansion strategies and under-resourced waste systems exemplifies path dependency, wherein contemporary decisions constrain the organisation to progressively unsustainable pathways. Multiple respondents cautioned that, absent targeted investments, waste management would persist in a reactive state, impeding the transition to regenerative or circular models. This observation aligns with the conclusions of Roos *et al*. (2025), who advocate for comprehensive integrated waste management frameworks in South African national parks to mitigate capacity deficiencies and avert enduring ecological impacts.

Behavioural and cultural mindsets as enablers or barriers to change

Behavioural and cultural mindsets were recurrently identified as factors that could either facilitate or obstruct future transformations (n = 8). Respondents observed that, even in the presence of adequate physical infrastructure, human conduct frequently determined the efficacy of initiatives. This was often attributed to pervasive disengagement rather than technical limitations.

As articulated by one respondent: *"My biggest concern is the attitude toward waste. As my colleague mentioned, not many people are consistently hands-on when it comes to waste management."* Another elaborated on organisational dynamics: *"Inside, attitudes and priorities, at this stage waste management and sustainability is still just a buzz word, like GBVF. It is a corporate gimmick rather than a priority on the ground."* A further response extended this to broader perceptual issues: "*people's mentality regarding waste, i.e. they, don't want to deal with waste, staff are not particularly keen on good waste management practices."*

In a futures context, these mindsets indicate limited readiness for systemic change, as stakeholder alignment is indispensable for adopting practices such as source separation or zero-waste protocols. Respondents underscored that, without strategic interventions in organisational culture and behaviour, prospective waste systems would remain susceptible to inefficacy, irrespective of technological enhancements. This is corroborated by Nuojua *et al*. (2024), whose global scoping review demonstrates the efficacy of behavioural interventions, including education and incentives, in diminishing plastic waste within conservation settings.

Leadership and strategic priority as a leverage point

Leadership and strategic prioritisation surfaced as a pivotal leverage point (n = 6) with the potential to redirect systemic trajectories toward favourable futures. Respondents consistently asserted that substantive organisational shifts are improbable without overt endorsement from senior levels and coherence between strategic directives and operational execution.

One respondent expressed this succinctly: *"Organisational change has to start from the top… we've been raising these issues at ground level for a long time, but because they haven't been properly heard or taken seriously by top leadership, nothing has changed."* Another reinforced the imperative for prioritisation*: "The 'critical issue' is one of priority: we must elevate waste management so that*

it is 'in your face' and recognised as a high-priority strategic pillar, supported by the right people in the right roles with the authority to drive change."

Within futures thinking, leadership serves as a horizon-defining mechanism, ascertaining whether waste management is relegated to a marginal operational matter or elevated to a strategic imperative encompassing risks and opportunities. The lack of leadership involvement was invariably associated with adverse futures marked by impeded projects, perfunctory adherence, and reputational vulnerabilities. This aligns with sustainability leadership paradigms delineated by Ferdig (2007), who posits leadership as instrumental in steering actions that ensure long-term viability in protected areas.

Circular economy integration as an emerging future opportunity

Circular economy integration was framed by participants as an aspirational yet achievable future pathway (n = 6). Interviewees demonstrated a good understanding of waste as a reclaimable asset, pinpointing actionable avenues for reduction, reuse, composting, and recycling.

One respondent envisaged a comprehensive transformation: "*Every person entering or working in the park would understand the definition of waste and participate in sorting at source… moving away from reactive management to proactive recovery."* Another outlined an operational framework: *"There would be almost zero waste to landfill, as there will be a fully functional recycling system with staff to sort and SANParks transport to take the recyclables… There will be composting in parks to utilize the wet/organic waste."* A third emphasised repurposing: *"Full circular re-use of waste generated in National Park, willing to invest into waste repurposing and turning waste products into other products that can be used in society."*

Nevertheless, respondents recognised that such concepts necessitate institutional scaffolding to transcend aspiration. From a futures lens, circular practices signify promising indicators of a desirable trajectory, demanding enablers like funding, collaborations, and knowledge dissemination to expand beyond pilot scales. This is substantiated by Kirchherr *et al.* (2017), who examine how circular economy methodologies can alleviate biodiversity strains in protected areas through diminished waste and resource demands.

Environmental and ecological risk as a future warning signal

Environmental and ecological risks stemming from suboptimal waste management were frequently portrayed as precursors to undesirable futures (n = 4). Respondents delineated interactions between wildlife and waste, plastic ingestion, and contamination of aquatic systems as manifestations of systemic deficiencies rather than discrete occurrences.

A respondent from a coastal area cautioned: "*Macro and microplastics from stormwater and sewage outfalls are going to be one of our biggest future problems if nothing changes."* Similar concerns from inland contexts included: *"Plastic pollution, especially nappies and illegal dumping, is clogging rivers and attracting animals."* And: *"If the infrastructure cannot cope with the waste, the windblown waste ends up in the ocean and on our beaches."*

In futures analysis, these risks represent cascading effects wherein present inadequacies precipitate wider ecological, reputational, and functional disruptions. They were uniformly positioned as impending hazards capable of compromising conservation mandates and diminishing the credibility of protected areas. This perspective is consistent with Abubakar *et al*. (2022), who discuss the consequences of inadequate solid waste management, including pollution, habitat degradation, and climate-related exacerbations in conservation domains.

5.4 Different futures (scenarios) of waste management in national parks

In addition to thematic analysis, interview responses structured through the Seven Questions Method were used to develop three scenarios describing the future of waste management in South African national parks by 2040.

As explained in Section 4.4.2, the scenarios do not represent predictions, but rather structured narratives that illuminate alternative pathways for waste governance, material flows, and conservation outcomes. They integrate stakeholder perspectives on current waste challenges, including limited separation at source, inadequate infrastructure for organic waste, dependence on landfill disposal, escalating plastic pollution, and uneven institutional accountability. Together, they offer a framework for identifying risks, opportunities, and strategic intervention points.

The optimistic (Blue Skies) scenario depicts a transformative shift toward circular waste systems, where waste is minimised at source, organic and recyclable streams are effectively treated, and waste management actively supports conservation and community benefits. The realistic (Glass Half) scenario reflects incremental progress, with partial improvements in recycling and waste reduction concentrated in better-resourced parks, but persistent reliance on landfills and uneven implementation across the system. The pessimistic (Doom and Gloom) scenario illustrates systemic decline, in which inadequate resourcing and leadership result in uncontrolled waste accumulation, increased pollution, and escalating risks to biodiversity, human-wildlife interactions, and the credibility of protected areas as “clean” conservation spaces.

Table 8 (supported by Figure 72) synthesises the three waste management scenarios by comparing their core characteristics, anticipated waste outcomes, key risks, and required near-term actions. It provides a summative overview of how different governance and resource pathways could shape waste trajectories in South African national parks, while linking each future to the key actions needed in the present. In doing so, Table 8 functions as a decision-support tool, highlighting where intervention is most critical to either achieve transformative circularity, avoid stagnation, or prevent systemic decline in waste management

Table 8. Summary of scenarios and strategic implications

Scenario	Core characteristics	Waste outcomes	Risks	What needs to happen now
Optimistic *Blue skies* / Transformative circularity	Strong leadership, dedicated waste governance, circular economy embedded in operations	Near-zero waste to landfill; effective source separation; on-site organic waste treatment; minimal wildlife interaction	High upfront investment; coordination complexity	Appoint dedicated waste managers; secure long-term funding; invest in decentralised infrastructure; institutionalise behaviour change; implement waste monitoring
Realistic *Glass Half* / Incremental adaptation	Partial reform; uneven capacity across parks; project-based initiatives	Moderate waste reduction; limited recycling; continued landfill dependence	Stagnation; regression during budget or market setbacks	Implement system-wide planning; support remote parks; improve data collection; integrate waste performance into monitoring and reporting systems
Pessimistic *Doom and Gloom* / Systemic decline	Institutional weakness; rising tourism pressure; leadership disengagement	Uncontrolled waste accumulation; landfill overflow; pollution and cleanliness issues; animal access to waste	Biodiversity loss; reputational damage; high recovery costs	Protect basic waste services; monitor early-warning indicators; enforce accountability; strengthen municipal coordination and partnerships with other roleplayers

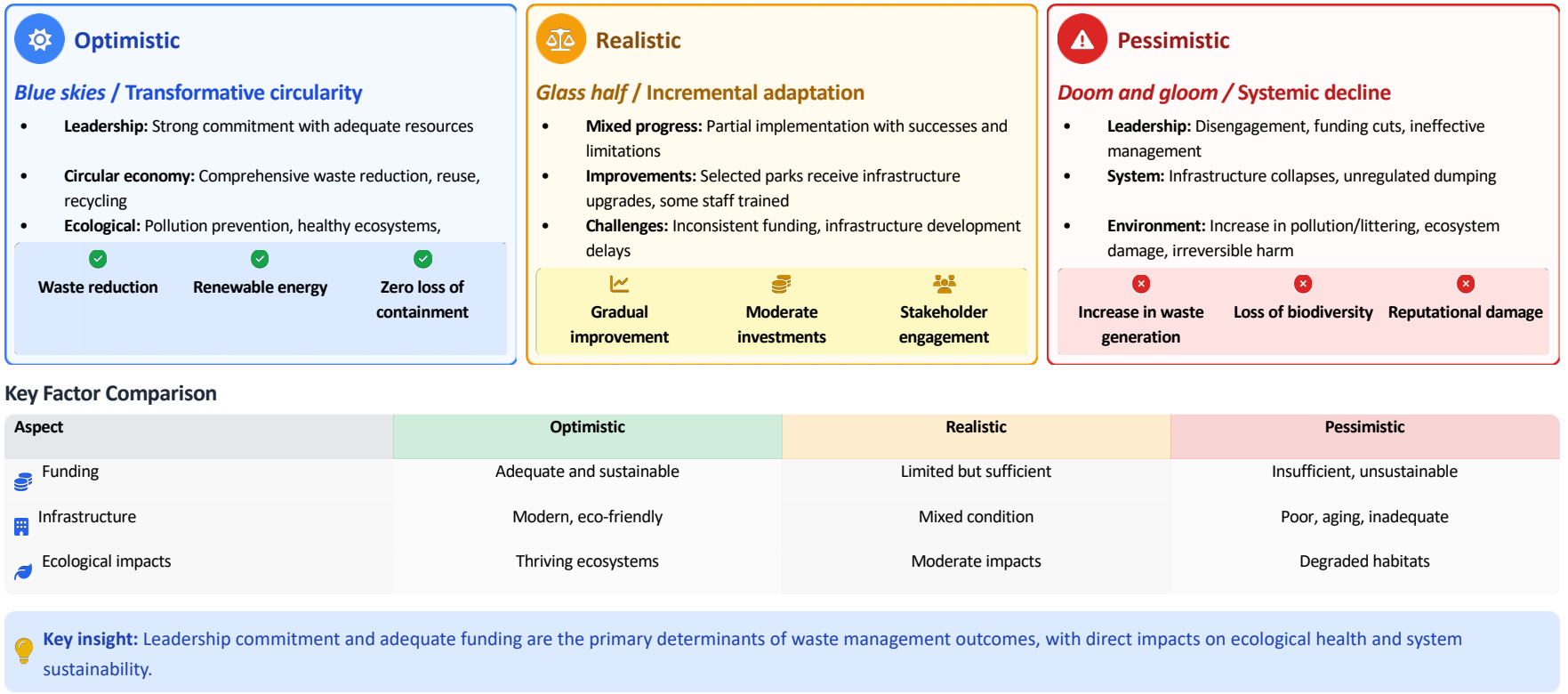

Figure 72. Three possible scenarios for waste management in South African national parks.

Scenario 1: Optimistic (Blue Skies / Transformative Circularity)

In this scenario, waste management is recognised as a core conservation function, embedded within the operational and strategic contexts of South African National Parks by 2040. Strong leadership commitment and sustained funding enable a transition from linear waste disposal practices to a circular economy model, aligned with the waste hierarchy of avoidance, reduction, reuse, recycling, and recovery.

Waste generation is significantly reduced through procurement reforms (i.e. problematic plastics policy) that eliminate unnecessary packaging, phase out single-use plastics, and prioritise reusable and refill-based systems in tourism facilities, shops, and staff operations. Clear separation of waste streams at source becomes standard practice across all park activities, supported by consistent infrastructure, signage, visitor education/awareness and staff training. Where possible, organic waste from camps, lodges, and staff villages is treated through composting and/or bio-digestion, producing compost and energy that are reintegrated into park operations. Recyclable materials are consolidated, baled, and transported through coordinated logistics systems, while residual waste is minimal and managed responsibly. Importantly, waste systems are designed to minimise ecological risk. Secure containment prevents animal access to waste, littering and illegal dumping are eliminated, and potential pollution pathways into terrestrial, freshwater, and marine ecosystems are actively monitored.

Interview participants articulated a strong alignment with this future, emphasising shared responsibility and proactive recovery rather than reactive clean-up. One respondent noted that *"every person entering or working in the park would understand the definition of waste and participate in sorting at source"*, while another envisioned *"almost zero waste to landfill"* supported by in-park composting and functional waste separation systems.

This outcome can only be achieved through decisive action in the present. Dedicated waste management positions must be established at SANPARKs (national), regional and park levels, supported by long-term operational budgets and clear accountability structures. Investment in decentralised waste infrastructure, particularly for organic waste, is essential to reduce reliance on (mostly distant) landfills. Behavioural change must be institutionalised through visitor communication and awareness, staff training, incentives, and enforcement, supported by routine waste audits and data-driven monitoring. Partnerships with municipalities, recyclers, and neighbouring communities play a critical role in closing material loops and preventing leakage beyond park boundaries. International evidence suggests that such circular approaches can significantly reduce pollution pressures and biodiversity risks in protected areas (Ellen MacArthur Foundation, 2021; IUCN, 2022; Bergmann *et al.,* 2019).

Scenario 2: Realistic (Glass Half / Incremental Adaptation)

This scenario represents a middle-ground future in which waste management improves incrementally but remains constrained by structural and resource limitations. By 2040, some parks, particularly flagship or high-revenue destinations, have implemented basic waste separation systems, partial recycling programmes, and targeted awareness campaigns. Certain single-use plastics are restricted, and visible waste problems (such as loss of containment, littering and illegal dumping) in tourist areas are reduced.

However, these gains are uneven. Many parks, especially remote or smaller ones, continue to struggle with high transport costs, limited access to recycling markets, and insufficient infrastructure for organic waste treatment. As a result, large volumes of food waste and mixed recyclables are still landfilled. Recycling systems are vulnerable to market fluctuations and fuel price increases, leading to periods of stockpiling or suspension of recycling programmes. Waste initiatives often remain project-based rather than SANPARKS/system-wide, with limited monitoring and inconsistent enforcement.

Interview participants were cautiously optimistic, but realistic. While interviewees expressed support for waste reduction and plastic restrictions, many acknowledged that entrenched behaviours, competing operational priorities, and funding uncertainty would slow progress. A few participants mentioned that gains in visitor behaviour do not always extend to staff housing, contractor activities, or back-of-house areas.

Moving away from this scenario will require targeted action to address the structural barriers that limit growth. Waste planning must shift from isolated pilot projects to coordinated, organisation-wide strategies. Greater investment is needed to reduce dependence on landfill disposal of waste. Strengthening internal coordination between conservation, tourism, and supply-chain units is essential to align incentives and reduce conflicting priorities. Improved waste data collection and performance indicators would support adaptive management and more defensible budget allocations. Without these measures, the system risks remaining locked in a cycle of modest progress followed by stagnation.

Scenario 3: Pessimistic (Doom and Gloom / Systemic Decline)

In the pessimistic scenario, waste management capacity deteriorates significantly by 2040 due to compounding pressures, including financial austerity, leadership disengagement, and increasing tourism volumes. Waste generation rises sharply, particularly plastics, packaging, and food waste, while infrastructure, staffing, and institutional oversight fail to keep pace.

Waste separation collapses, and mixed waste accumulates in camps, staff villages, picnic sites, and informal dumping areas near park boundaries. Landfill sites reach or exceed capacity, resulting in open dumping, waste burning, and wind-blown litter. Poorly secured waste attracts wildlife, intensifying human-wildlife conflict and increasing risks of ingestion, entanglement, and disease transmission. Plastic pollution becomes prevalent in rivers, wetlands, and coastal systems, with microplastics infiltrating soils and aquatic food webs.

Interview participants expressed concern about this trajectory, particularly the absence of dedicated waste managers and the risk of remaining trapped in a *"cycle of talk"* without implementation. As municipal waste services weaken, parks are forced to absorb external waste burdens beyond their mandate and capacity. The reputation of national parks as pristine conservation spaces is eroded, undermining tourism value.

Avoiding this scenario requires urgent preventative action. At a minimum, basic waste services, staffing, secure containment, and reliable collection, must be maintained even under financial

constraint. Early-warning indicators such as rising waste volumes per visitor, landfill capacity thresholds, and animal-waste interactions should be systematically monitored. Executive leadership plays a decisive role in recognising waste mismanagement as a direct threat to conservation outcomes. Once degradation becomes normalised and infrastructure decays, recovery becomes costly and politically difficult, as documented in global assessments of pollution impacts on biodiversity (UNEP, 2021; Bergmann *et al*., 2019).

5.5 Integrated discussion: Bridging policy, practice, and future pathways

Considered jointly, the findings from the review of protected area management plans (Section 5.1), field observations (Section 5.2), and stakeholder interviews (Section 5.3) reveal a systemic misalignment between the stated conservation mandate of South African protected areas and the practical realities of waste management implementation. While most parks succeed in maintaining a level of cleanliness (largely through staff commitment and routine operational effort) this outcome masks deeper structural weaknesses. As has been observed more broadly in developing-country contexts, visible cleanliness does not necessarily reflect the presence of an integrated or sustainable waste management system (Wilson *et al*., 2006). Instead, waste management systems across the South African national park network remain largely fragmented, and insufficiently embedded within long-term strategic planning frameworks, leaving them poorly equipped to respond to increasing tourism pressures and evolving sustainability expectations.

The analysis of protected area management plans (Section 5.1) highlights a critical policy-level gap in this regard. Waste management is rarely conceptualised as a core conservation function, despite the well-documented links between waste, ecosystem degradation, and biodiversity loss (Brownlie & Treweek, 2018; Przydatek, 2019). That only one of the twenty reviewed national parks explicitly linked waste management to ecosystem and biodiversity protection underscores a disconnect between environmental legislation, conservation science, and operational planning. Although several plans reference the waste management hierarchy, these references remain largely aspirational. The absence of measurable targets, monitoring mechanisms, or performance indicators suggests that the hierarchy functions more as a symbolic commitment than as a practical tool for guiding transitions away from disposal and towards prevention, reuse, and recycling (DEFF, 2020). This reflects a broader challenge in environmental governance, where policy intent often fails to translate into operational action (Roos *et al*., 2025).

Field observations (Section 5.2) illustrate how these policy-level shortcomings manifest unevenly on in the field. Infrastructure condition/quality and effectiveness vary markedly across parks, reflecting differences in local management capacity, historical investment, and environmental context rather than a coherent, system-wide strategy. In arid and inland parks such as Augrabies Falls and Karoo National Park, well-designed, animal-proof waste infrastructure demonstrates that context-appropriate solutions can successfully reduce human-wildlife conflict and maintain environmental and aesthetic standards (Rodríguez-Rodríguez, 2012; Przydatek, 2019). Conversely, in coastal parks such as Agulhas National Park, design failures, particularly the use of open or poorly secured bins in high-wind environments, exacerbate litter dispersion and increase the risk of marine and coastal pollution. These findings emphasise the need for waste management infrastructure in protected

areas to be informed by site-specific ecological and environmental conditions rather than standardised design assumptions (Belsoy *et al*., 2012).

The observations further reveal that cleanliness outcomes are most inconsistent in spaces that fall outside conventional visitor management areas, particularly where public roads traverse protected areas. Along these transport corridors, littering and sporadic illegal dumping were more evident, especially at informal pull-off points, and unfenced areas. Unlike rest camps and picnic sites, these spaces are used not only by park visitors but also by through-traffic, limiting the effectiveness of signage, infrastructure placement, and enforcement. Golden Gate Highlands National Park illustrate how roadside litter persists despite “no littering” signage, and relatively high cleanliness standards elsewhere in the same park. This highlights a structural vulnerability in the waste management system, where existing operational approaches are insufficient to address the challenges presented due to high thoroughfare.

In parallel, the observations confirm that separation at source remains in its infancy across much of the national park system. While waste separation infrastructure has been introduced in selected rest camps and reception areas (particularly in larger parks such as Kruger and Karoo National Park) these initiatives remain localised and uneven. Separation facilities are often absent from picnic sites, lookout points, and tourism routes, and in some cases are undermined by unclear labelling, inconsistent bin design, or evidence of mixed waste streams during collection. In smaller or more remote parks, waste management continues to prioritise containment and removal, with little emphasis on diversion, minimisation or recycling/recovery. Even where innovative separation systems were observed, their effectiveness appeared highly dependent on local initiative rather than embedded organisational practice, suggesting that separation at source has not yet matured into a standardised, system-wide operational norm.

Importantly, the observations also demonstrate that waste prevention and behavioural interventions can, in certain contexts, outperform infrastructure-intensive approaches. The effective implementation of “pack-in, pack-out” policies in parks such as Mokala, Kgalagadi and Mountain Zebra National Park illustrates how clear rules, consistent messaging, and visitor responsibility can significantly reduce waste generation in remote or ecologically sensitive areas. This aligns with broader evidence that pro-environmental behaviour is more likely to be sustained when responsibility is clearly assigned and behavioural expectations are reinforced through institutional norms and communication strategies (Steg & Vlek, 2009; Marion *et al*., 2016). These cases challenge the assumption that increased infrastructure is always the most effective solution and instead highlight the importance of waste avoidance and minimisation at source.

Insights from stakeholder interviews (Section 5.3) provide a deeper explanation for the persistence of these patterns, identifying institutional capacity, organisational culture, and leadership prioritisation as decisive factors shaping waste management outcomes. Across interviews, waste management was frequently described as an operational necessity rather than a strategic priority; an “afterthought” competing for limited budgets, personnel, and logistical support. Such capacity constraints are well recognised as key barriers to effective waste management, particularly in remote or resource-constrained contexts where service provision is limited, complex and/or costly (Cointreau, 2001). These challenges are further compounded by entrenched organisational and

behavioural mindsets, where waste is perceived as someone else's responsibility, undermining even well-designed infrastructure and systems (Appleton, 2016).

At the same time, the interview findings point to a credible alternative future. The Blue Skies (Optimistic) scenario reflects a pathway in which waste management is repositioned as a strategic lever for conservation, innovation, and socio-economic benefit, rather than a purely operational burden. Under this scenario, waste is treated as a resource, with circular economy principles embedded in procurement practices, concessionaire agreements, and partnerships with surrounding communities. Systems-based approaches to waste management emphasise that such transitions require not only technological solutions, but also institutional alignment, leadership commitment, and coherent governance frameworks (Marshall & Farahbakhsh, 2013). Without these enabling conditions, efforts to pursue recycling or recovery risk remaining fragmented.

Bearing this in mind, it becomes evident that South African protected areas are currently caught in a "cycle of talk," where policy intent, operational effort, and future aspirations are insufficiently aligned. Clean parks are achieved through short-term diligence rather than through resilient systems capable of adapting to growing visitor numbers and increasingly complex waste streams. As systems thinking literature makes clear, reactive collection-focused approaches are unlikely to remain viable under conditions of growth and constraint, and may ultimately entrench inefficiency and cause environmental risk (Marshall & Farahbakhsh, 2013). Without a fundamental shift toward prevention-oriented, integrated, and circular waste management frameworks (as envisaged in the Blue Skies scenario) the system remains vulnerable gradual decline.

6 Conclusions and recommendations

6.1 Conclusion

This project explored perspectives on the future of waste management in South African national parks, examined the challenges and opportunities shaping alternative future trajectories, and identified actions required to support more responsible waste management in protected areas. Drawing on management plan reviews, field observations, and stakeholder interviews, the findings indicate that the current system is positioned at a crossroads between divergent futures.

Under present conditions, waste management outcomes are largely maintained through reactive operational effort rather than through integrated, forward-looking systems. Waste remains marginal within strategic planning, uneven in implementation across parks, and constrained by limited institutional capacity and leadership prioritisation. These characteristics align closely with the dynamics of the Worst-Case ("Doom and gloom") scenario identified in the futures analysis, in which growing tourism pressure, infrastructural strain, and institutional disinterest progressively erode environmental performance and conservation credibility.

At the same time, the findings also reveal the plausibility of a more positive future. The "Blue Skies" scenario reflects a trajectory in which waste management is repositioned as a strategic conservation function, supported by strong leadership, coordinated planning, and the integration of circular

economy principles. Importantly, this scenario does not rely on idealised assumptions or technological breakthroughs, but on governance decisions, behavioural change, and institutional alignment. The futures analysis, therefore, underscores that the direction taken by South African protected areas will be shaped by decisions made in the present, rather than by external pressures alone.

6.2 Recommendations: Strategic levers for achieving the "Blue Skies" future

The recommendations below are framed as interventions designed to shift the system away from the Worst-Case trajectory and toward the Blue Skies scenario. Collectively, they aim to strengthen resilience, improve coherence, and embed waste management within the long-term stewardship of protected areas.

6.2.1 Reposition waste management as a strategic driver of conservation outcomes

To enable the Blue Skies trajectory, waste management must be elevated from a marginal operational concern to a recognised pillar of conservation management. Protected area management plans should explicitly link waste management to biodiversity protection, ecosystem health, and visitor experience, supported by clear objectives, indicators, and accountability structures. This strategic repositioning counters the drift toward reactive, short-term responses characteristic of the Worst-Case scenario.

6.2.2 Embed futures-oriented planning and system-wide coordination

A key feature of the Blue Skies scenario is proactive, coordinated governance. To support this, a system-wide waste management framework or strategy should be developed that aligns park-level actions with organisational strategy and national waste policy. Futures-oriented planning tools, including scenario thinking and adaptive management approaches, should be used to anticipate growth in tourism, changing waste streams, and logistical constraints, rather than responding only once pressures become severe.

6.2.3 Shift the emphasis from waste disposal to waste prevention and behaviour change

Preventing waste generation is a defining characteristic of a positive future trajectory. Expanding behaviour-based interventions, such as "pack-in, pack-out" policies, targeted visitor education, and clear behavioural norms, reduces reliance on infrastructure-intensive solutions and limits long-term environmental risk. These approaches help decouple increasing visitor numbers from increasing waste volumes, a critical distinction between the Blue Skies and Worst-Case scenarios.

6.2.4 Develop realistic and phased separation-at-source systems

While circularity is central to the Blue Skies scenario, premature or poorly supported waste separation and recycling initiatives risk reinforcing the failure dynamics of the Worst-Case future. Separation at source should, therefore, be implemented in a phased and context-sensitive manner, prioritising high-volume and logistically feasible sites. Clear labelling, tourism

communication/education, staff training, and reliable downstream processing are essential to ensure that separation systems build confidence and deliver real environmental benefits.

6.2.5 Invest in institutional capacity and leadership as future-enabling conditions

Across all scenarios, leadership commitment and institutional capacity emerge as decisive variables shaping future outcomes. Achieving the Blue Skies scenario requires sustained investment in staffing, budgeting, and logistical support for waste management, as well as clear role definition and performance accountability. Senior leadership must actively champion waste management as a strategic priority, signalling its importance across the organisation and to external partners.

6.2.6 Enable circular economy partnerships aligned with conservation objectives

The Blue Skies scenario envisions waste as a resource rather than a liability, but this transition must be carefully governed. Protected areas should selectively pursue circular economy partnerships with recyclers, producer responsibility organisations (PROs), social enterprises, and local communities where these align with conservation objectives and operational realities. Such partnerships can generate socio-economic benefits while reinforcing environmental stewardship, provided that ecological risk remains the primary decision-making criterion.

In closing, the futures analysis presented in this report makes clear that the trajectory of waste management in South African protected areas is not predetermined. Incremental decisions taken today, regarding leadership priorities, planning approaches, and institutional investment, will shape whether the system converges toward a resilient, integrated Blue Skies future or drifts toward fragmentation and decline. By acting on the recommendations outlined above, protected area authorities can actively steer waste management toward a future that supports both conservation integrity and responsible tourism.

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