



Community-led waste disposal in the Umkhomazi Catchment in KwaZulu-Natal, South Africa:

A situational analysis and embedded awareness-raising campaign for nappy pollution.

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Executive Summary

Disposable nappies are a widespread environmental health concern, especially in developing countries such as South Africa (SA), where the distribution of basic services such as waste collection and safe water supply, i.e., public service delivery, is often inadequate. Nappy waste pollution was recognised by stakeholders engaged during the Local Sense Workshop as part of the Reducing Pollution Through Partnership project as a serious solid waste problem in SA. This motivated the Institute of Natural Resources NPC (INR, SA), the Joint Nature Conservation Committee (JNCC, United Kingdom) and the Department for Environment, Food & Rural Affairs (DEFRA, United Kingdom) to initiate a community-led project aimed at understanding and mitigating nappy waste pollution in the uMkhomazi Catchment, a Strategic which is located in Water Source Area in KwaZulu-Natal, SA. The project followed a case study approach that was implemented in two rural communities, Amangwane and Impendle. These two villages are located outside towns and cities, are without access to basic public service delivery, and are without formal local authority. The communities are generally characterised by poor infrastructure, low income, unreliable water availability and poor public service delivery. As a result, residents of these communities need urgent help in findings solutions to solid waste challenges, particularly nappy waste.

This report represents a rapid review of literature on disposable nappy waste and pollution, with a specific focus on SA, as part of the *status quo* analysis for the project. The rapid literature review was conducted using the Search, Appraisal, Synthesis and Analysis (SALSA) framework to understand disposable nappy waste management, particularly in South African rural environments. In summary, the review revealed several factors that influence and govern the management of disposable nappies in South African rural areas: lack of waste infrastructure and services, limited knowledge on the impacts of solid waste, and nappy pollution, specifically, and an absence of nappy repurposing options. A review of selected global case studies was useful in identifying methods and approaches to repurposing nappy waste. The repurposing methods reviewed include the mechanical valorisation of nappies to produce cement and steel products, the use of anaerobic digestion to produce biofuels and the repurposing of nappy waste through biological degradation to produce compost and biochar.

To ensure that the project remained community-centred, a series of facilitated workshops were conducted within each pilot community to understand the community's waste disposal practices in relation to pollution and nappies. The community engagements were implemented using focus group discussions, transect walks and participatory mapping exercises to garner information on nappy waste management within the communities. Based on the engagements with the community, it was agreed that a nappy waste awareness campaign is imperative and is the first step towards seeing a change in waste practices within the communities. As a result, an awareness campaign was co-designed with the community to raise awareness of the importance of safe nappy waste disposal. The community also proposed that future efforts must focus on developing a central location for collecting and storing nappy waste to use this as a hub for repurposing nappies for agriculture and furniture-based products. Given the responses obtained through engaging with community members and literature on nappy waste management, the following recommendations are offered:



- ✚ Holding the space – The momentum of safe nappy waste management must be maintained.
- ✚ Stakeholder collaboration – Partnerships between government, non-profit and private entities are required for the implementation of nappy waste interventions.
- ✚ Action research for change – A feasibility analysis and scientific inquiry on proposed nappy waste interventions is essential.
- ✚ Capacity development – Communities must be capacitated to lead and maintain nappy waste interventions for sustainable change.
- ✚ Resource mobilisation – Financial and human resources need to be invested in the communities to aid the implementation of nappy waste interventions.

This project presents an opportunity to encourage a country-wide approach to mitigating nappy pollution impacts, possibly through a country-wide awareness campaign and capacity-building initiatives around nappy pollution mitigation, particularly at the community level. Furthermore, the methodological approach and findings from this project could be potentially adopted by countries across the developed and developing world.



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Abbreviations

AWARD	Association for Water and Rural Development
DEFRA	Department for Environment, Food & Rural Affairs
GBCSA	Green Building Council South Africa
INR	Institute of Natural Resources NPC
JNCC	Joint Nature Conservation Committee
LCA	Life Cycle Assessment
M & E	Monitoring and Evaluation
NEMA	National Environmental Management Act
NEMA: WA	National Environmental Management: Waste Act
NWMS	National Waste Management Strategy
RESILIM	Resilience in the Limpopo Basin Program
RPTP	Reducing Pollution Through Partnership
SA	South Africa
SWOT	Strengths, Weakness, Opportunity and Threat
USAID	United States Agency for International Development



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1. Introduction

1.1 Background and Problem Statement

Waste disposal is a growing crisis in many developing countries (Ferronato and Torretta, 2019). In South Africa (SA), the lack of access to reliable and efficient waste disposal systems continues to pose human and environmental health risks. As in many rural communities in the developing world (Muranko *et al.*, 2021), disposal of nappies (or children's faecal waste) continues to be a major environmental health issue in low-income communities and particularly informal settlements in SA (Haywood *et al.*, 2021).

The Association for Water and Rural Development (AWARD) has reported that in SA, roughly 54.2 million tons of general (municipal, commercial, and industrial) waste per year is generated. Of this 54.2 million tons of waste, a maximum of only 10% is recycled or recovered for other uses, whilst at least 90% is landfilled or dumped (AWARD, 2019). Nappies are one of the waste streams contributing to increasing landfill inputs in urban areas, but in areas where there are poor or no formal waste management systems, such as many informal settlements, nappies contribute to the pollution of terrestrial and aquatic habitats. Nappy waste is a public health issue that is aesthetically unpleasant and leads to a bad odour. Additionally, nappy waste affects ecosystem health and function, especially when it enters rivers and streams. It is described as 'offensive/hygiene waste' or 'human hygiene waste,' and there are a number of legislative guidelines around nappy waste disposal already in place to ensure that it is properly disposed of (DEA, 2008; Hall, 2019). However, in many catchments in SA, such as the uMkhomazi Catchment in KwaZulu-Natal, the implementation of the legislation is hampered by the inadequate roll-out of waste management infrastructure and poor awareness of the environmental risks posed by nappy waste pollution of rivers.

This has motivated a number of projects aimed at promoting proper nappy waste disposal in SA, such as the United States Agency for International Development (USAID)/Southern Africa's Resilience in the Limpopo Basin Program (RESILIM), Knowaste and the Green Building Council South Africa (GBCSA) (Infrastructure News, 2017; GBCSA, 2018; EMG, 2021). These projects emphasise that in trying to address the issue of nappy waste disposal, awareness-raising must be at the forefront of nappy waste pollution mitigation interventions. The communities must be made aware of the issues around waste disposal in their respective areas; their actions that contribute to the pollution of the rivers as well as the risks posed by the dumping of nappies in the rivers before trying to approach and co-design potential interventions that would work to address the issues. Even though there is some level of open defecation within communities, it is believed that it is not linked to nappy waste as the common cultural belief within households is to dispose of waste far away outside the home.

Nappy waste pollution was identified as a major concern in SA by stakeholders consulted as part of the stakeholder engagement sessions held for the Reducing Pollution Through Partnership (RPTP) Project. These workshops aimed to garner expert opinions and perspectives on pollution impacts and mitigation strategies in South Africa. This motivated the



Institute of Natural Resources NPC (INR) and JNCC to initiate a project aimed at mitigating the improper disposal of nappy waste in uMkhomazi Catchment, specifically into the uMkhomazi River tributaries located in Amangwane and Impendle rivers, by supporting community-led nappy waste disposal interventions in two rural communities within the catchment, viz. Amangwane and Impendle. In addressing the nappy disposal challenges, the INR focused on conducting a situational analysis and status quo to get a better understanding of the status of nappy pollution in the South African context and understand the perceptions of the Amangwane and Impendle communities on the pollution of their aquatic environments by improper nappy disposal. The project also focused on awareness-raising around the impacts and mitigation of nappy pollution. The project explored a community-led and participatory approach toward addressing the issues of nappy pollution and to co-design potential interventions and mitigation measures.

1.2 Project Rationale and Aim

Catchments in South Africa are characterised by a number of informal settlements, rural communities and low-income/marginalised communities that exhibit poor waste disposal practices owing largely to the lack of solid waste disposal infrastructure and services. Solid household waste, such as nappies, is finding its way into rivers through improper disposal methods within these communities (Haywood *et al.*, 2021). The aquatic and terrestrial ecosystems suffer the consequences of the dumping of nappies and other waste into the rivers, where the nappies become an aesthetic nuisance (Ayalon *et al.*, 2009; Meallem *et al.*, 2010; Sepadi, 2021), and they increase the amount of human excreta in these environments (Remigios, 2014). Soiled nappies also expose people to pathogens that could cause serious illnesses (Mathe, 2018). Studies have also confirmed that nappy waste is hazardous to wildlife when digested, as well as acting as potential vectors of diseases and pathogens (Benskin *et al.*, 2009; Northrup, 2015; Sepadi, 2021). Therefore, engagements on these topics and interventions must be implemented urgently to mitigate the knock-on effects of improper nappy disposal in rural areas. The community members must be involved in developing the solutions to these problems and, ultimately, must take responsibility for and lead the interventions that will help them develop an efficient and sustainable system for nappy disposal (Remigios, 2014). It is important to ensure that communities are involved in the decision-making and planning processes related to the use and management of natural resources. The more involved such people are in decisions, the better and more sustainable pollution mitigation interventions will be (UNHCR, 2021). The role communities play in decision-making is quite pivotal, for it is the local communities that are most affected by the repercussions of factors that threaten their environment (Law Teacher, 2019).

Awareness-raising is important during the initial stages and throughout the process of implementing waste and pollution management interventions. In this context, awareness campaigns can focus on addressing groups of people in an area and/or sector affected by a particular set of pollution issues, groups of stakeholders, the general public, etc. Ultimately, these campaigns aim to achieve long-term behavioural change; which can be achieved through involving communities in the design and implementation of the awareness campaign to help encourage ownership. In terms of nappy pollution awareness-raising, it is important that the campaign is designed to address the knowledge of individuals and organisations. This is to ensure that all relevant individuals and households understand the impacts of, and act to adapt to and/or mitigate pollution. Awareness-raising can encourage a change in



nappy disposal behaviour, decision-making and disposal practices within communities. It finds its purpose in the fact that not all individuals, households, or communities may be aware and informed about their vulnerability to improper waste disposal in rivers, as well as the measures they can take to correctly dispose of or reuse (repurpose) nappies for other purposes, for example composting.

The project, therefore, aimed to try and address the nappy waste disposal issues in the Amangwane, and Impendle by engaging with and supporting the communities to co-develop solutions for the proper disposal and possible repurpose of solid waste, specifically nappies. Furthermore, the project capacitated the communities to address waste management and pollution issues in the future through an awareness-raising campaign.

1.3 Methodological approach

1.3.1 Status quo analysis: Rapid screening of literature

The Search, Appraisal, Synthesis and Analysis (SALSA) framework was used to conduct a rapid review of literature on disposable nappy waste management, particularly in South African rural environments (Grant and Booth, 2009). The review was based on academic and grey literature searches using Google Scholar to acquire literature from various sources. The literature search was based on a set of keywords (nappy 'OR' diaper 'AND' waste 'AND' impacts 'AND' management "AND recycling 'OR' repurposing) placed in the title and abstract context tabs and Boolean operator symbols; a mathematical language to represent 'AND', 'OR' and 'NOT', were used to avoid any duplication. The publications emerging from the Google Scholar search were screened manually for relevant information. Articles that met the criteria were analysed to extract information on disposable nappy waste management in the Global South and North. Grey literature on nappy waste repurposing approaches, such as case studies, was also reviewed, using a Google search. A total of 85 academic articles, policy documents and grey literature documents meeting the search criteria were found, with 61 of these being relevant to the foci of the rapid review.

1.3.2 Situational analysis: Community engagement

The situational analysis focused on understanding community waste disposal practices in relation to pollution and nappies, specifically and assessing their knowledge of the risks posed by nappy pollution. This component of the project was implemented and achieved through engagements with the community-based monitors already in place as part of the Restoration and Conservation of the upper uMkhomazi Catchment Project (Appendix A). Community-based monitors are citizen scientists who work closely with the INR and other environmental/conservation agencies in SA to implement environmental monitoring projects and assist with community engagement. Even though the engagements allowed the communities to point to broader waste challenges in the area, the schedule was designed to focus on nappy waste management and interventions (Appendix B). The community engagements used the following data collection methods: focus group discussions, transect walks and participatory mapping exercises. The transect walks and participatory mapping assisted in identifying nappy waste hotspots (Appendix C).



Community-based monitors, with whom the INR is already working, were engaged in each area to gain an initial understanding of the pollution issues faced by the communities and to understand the community members' households/ audience that the community engagement and awareness-raising activities should target.

This information was used to design two community engagement activities in each of the two study areas. The first activity (Activity 1) involved a transect walk with community members through their respective communities to generate a spatial understanding of the people-environment-pollution interactions and identify pollution hotspots. The transect walk was followed by focus group discussions (Activity 2) with the community groups to discuss their understanding of the impacts posed by nappy pollution, particularly in the context of freshwater habitats. The focus group discussions incorporated a participatory mapping exercise where participants mapped out the different types of pollution in their community, specifically nappies, and identified pollution hotspots (Activity 3).

1.3.3 Co-designing potential interventions and framework for an awareness-raising campaign

The second set of community engagements occurred a few days after the first engagement and involved the same community members within each community. This was deliberate to allow for a process of reflection on the ideas/information/observations that formed part of the first engagement. This second engagement took place in the form of a workshop to co-design potential mitigatory measures and the framework (e.g., messaging, tone, platforms, etc.) for the associated awareness campaign. Social Environmental Enterprise & Design (SEED), which involves co-design (or 'collaborative design', 'co-production' and 'participatory design', as it is also known) as a way of designing services or solutions to complex issues faced by communities was employed. SEED further notes that co-design can be used to help with the introduction of a new service, possible changes to an existing service, as well as addressing difficulties people may be experiencing with an existing service (e.g., waste disposal) (DEFRA, 2009).

1.3.4 Awareness campaign refinement and implementation

The communities of Amangwane and Impendle are exposed to the harmful and potentially irreversible impacts of improper disposal of nappies in the water sources. There is, therefore, a need to educate and inform the communities of potential risks and mitigation strategies that can be applied to dealing with this issue. We believe that this can be achieved to a large extent through an awareness campaign, with the aim of guiding and educating the communities on the harms and risks of solid waste and, more specifically, nappy pollution.

The framework for an awareness-raising campaign, designed during the co-design workshop, was used to design and implement such a campaign in two communities (Amangwane and Impendle). The awareness campaign was designed with specific target audiences, messaging and dissemination platforms in mind and was based on the knowledge garnered during the status quo and situational analysis phase.

The awareness-raising materials were designed with community-based monitors. Their inputs were used to assist in designing the awareness messaging, the key themes and



messages, target audiences, communication mediums and communication barriers. Some initial considerations in this regard are expanded on below.

Message design is a key element in making an impactful awareness campaign. The style, tone, structure and language are as important as the message itself. A way of ensuring that the message resonates with the audience is to have a good understanding of who your target audience is. The following considerations guided the message design for the awareness campaign:

- ✚ **Visual communication:** This is just as important as verbal or written communication. Most often, it is the images and headlines that attract peoples' attention. Images and videos aid in connecting with the audience on an emotional level, creating a powerful impact.
- ✚ **Structure:** This is important as the information needs to be presented in a narrative form to be clearly understood by a broader audience. Personal accounts and experiences have the ability to motivate and encourage further, as opposed to data-heavy materials. Storytelling can help people connect with the information.
- ✚ **Language:** There is importance in framing the message in a language and level that the audience finds relatable, bearing in mind that this will be different for different community groups. In this instance, the message needed to be translated into isiZulu, which is the main spoken and written language in the rural areas of the uMkhomazi Catchment.
- ✚ **Tone:** The tone should be one that portrays optimism and connects with the readers' core values and inspires the audience. People often filter information through a 'political ideology' or 'personal value' lens. For the message to be receptive, the tone should be tailored to suit these aspects.

Aside from the above, it was important for the key themes and messaging to take cognisance of people's worldviews, values and social norms, as these influence the way in which information is received, how it is understood and how it is applied. It is important to include real-world examples as people are more likely to understand and accept a message if they can relate to a particular or common issue or event. Visual communication methods (pictures, videos, etc.), as mentioned above, are also essential when developing the messaging for a pollution awareness campaign.

To develop a successful awareness campaign, an understanding of the audience/target community members is imperative. This allows for the development of structured and targeted messages to each community group that aligns with their needs, activities, and potential for changed behaviour. As such, considerable effort must be placed on the identification and understanding of relevant individuals and households. The selection of communication mediums (posters, video posters, images, infographics, etc.) for the dissemination of information for each community is equally important and must be based on what is accessible and easy to use or disseminate in each community.

In order for an awareness campaign to be effective and successfully implemented, the barriers that prohibit communication need to be addressed. The rapid literature review and focus group discussions held will provide insight into these barriers and mitigating measures. Ways to avoid communication barriers were discussed with the community-based monitors



to ensure that the message of the awareness campaign was disseminated effectively and efficiently. In this project, the awareness-raising campaign developed was implemented in both the communities (Amangwane, and Impendle) through the community-based monitors who were its champions.

2. Situational Analysis

Solid waste generation is an intensifying problem resulting in global environmental pollution and ecological degradation (Espinosa-Valdemar *et al.*, 2014). The continuous growth in population, uncontrolled urbanisation, economic activities, and community living standards have accelerated the solid waste production rate (Yang *et al.*, 2018; Phonchi-Tshekiso *et al.*, 2020; Haywood *et al.*, 2021). Solid waste is a problematic and rising issue of concern worldwide (Espinosa-Valdemar *et al.*, 2014; Haywood *et al.*, 2021). Solid waste generation, including waste generated through municipal, hazardous, industrial, agricultural and biomedical sources, poses a significant threat to human health and the environment if not repurposed, upcycled or properly disposed of (Khanyile *et al.*, 2020). Globally, very few municipal waste items are recycled, resulting in approximately 70% of this waste being disposed of in landfill sites (Abdel-Shafy and Mansour, 2018). Appropriate waste disposal is a critical challenge, as the improper disposal of solid waste can endanger human health and lead to detrimental impacts on terrestrial and aquatic habitats.

Of the variety of solid waste that contributes to the waste burden, disposable nappies are a universal environmental health concern, particularly in developing nations where service delivery is often inadequate (Jesca and Junior, 2015; Tsigkou *et al.*, 2020; Wernli, 2021). Despite this, disposable nappies are a booming industry in the global north, projected to exceed 71 billion US dollars by 2022 (Hadland, 2021). In SA, more than 3.5 billion diapers are discarded annually, thus posing a significant threat to terrestrial and aquatic ecosystems if inappropriately disposed of (Khanyile *et al.*, 2020; Sepadi, 2021). Global studies have shown that the unsafe discarding of disposable nappies containing organic waste can present various bacterial diseases that can lead to a chronic health hazard, mainly if deposited into natural water systems (Khanyile *et al.*, 2020; Sepadi, 2021). Furthermore, research has shown that the degradation of disposable nappies is a crucial source of primary microplastics and toxic chemical compounds (Ntekpe *et al.*, 2020; Chen *et al.*, 2022). The decomposition of organic waste produces methane gas, which is released into the atmosphere, contributing to greenhouse gas emissions and climate change (Tsigkou *et al.*, 2020).

Internationally, the common practice of managing disposable nappy waste is landfilling (Khoo *et al.*, 2019). Even though this waste management technique is heavily criticised for concentrating on waste treatment rather than waste reuse and recycling, studies confirm that nappy waste management in developed countries is often safely disposed of in well-designed landfills that operate under compliance control (Khoo *et al.*, 2019; Chowdhury and Wijayasundara, 2021). Although landfilling practices have been adopted in developing nations, the safe and efficient disposal of nappy waste at landfill sites remains an unprecedented challenge (Kimani *et al.*, 2015; Godfrey and Oelofse, 2017; Haywood *et al.*, 2021). In SA, rural communities indiscriminately discard disposable nappies at illegal dumping sites, along rivers and unoccupied land irrespective of the impact on the



environment (Haywood *et al.*, 2021; Sepadi, 2021). Regardless of the adverse effects of improper nappy waste disposal, the practice is still common in rural areas and even in peri-urban or informal settlements, primarily due to poor service delivery, financial means and the lack of law enforcement (Makgae, 2011; Khanyile *et al.*, 2020; Haywood *et al.*, 2021). The illegal dumping of disposable nappy waste along roadsides and on vacant land creates favourable conditions for the survival and growth of microbial pathogens such as *Listeria*, coliforms and *E.coli* (Mathe, 2018; Sepadi, 2021). The unpleasant smell from diapers attracts disease vectors such as flies and stray dogs that rip apart disposable nappies, spreading pathogens and creating an aesthetic nuisance (Remigios, 2014). Tsega and Reddy (2013) confirm that the visually unpleasing state of street nappy waste is the most apparent environmental damage that significantly infringes on the beauty of cities and rural landscapes.

The environmental sustainability of disposable nappy use is highly questionable. In SA, as in many developing countries, it appears that insufficient information is available on the repurposing of disposable nappies (Jesca and Junior, 2015; Sepadi, 2021). Implementing waste reuse, recycling and repurposing measures can minimise the adverse environmental and health impacts associated with the unsafe discarding of disposable nappies (Khanyile *et al.*, 2020). There is, however, limited research available on disposable nappy repurposing methods and technologies in the context of South African waste management. In this regard, this rapid review seeks to (1) review the socio-political and economic factors governing disposable nappy waste management in SA, (2) understand the environmental and human health impacts of improper nappy waste disposal (3) review current disposable nappy waste management practices and lastly (4) review a selection of case studies to establish the feasibility of nappy waste management interventions related to direct repurposing and valorisation of nappies in the context of SA.

2.1 Factors influencing effective nappy waste management in South Africa

Disposable nappies were first introduced in the Global North in the late 1950s, and since the 1970s have progressively entered African markets' (Khanyile *et al.*, 2020). Disposal nappies were initially a luxury to the majority of South Africans as they were expensively unaffordable (Sibiya *et al.*, 2018). As a result, parents resorted to cloth diapers, which consisted of a single layer of natural fibres and absorbent material (usually a cotton cloth) wrapped around a baby's waist and fastened with pins (Khoo *et al.*, 2019; Khanyile *et al.*, 2020). The main advantage of these diapers was that they were washable, reusable and biodegradable, hence having a lesser impact on the natural environment (Aishwariya and Priyanka, 2020). However, with the improvement in the post-apartheid South African economic status and the increase in disposable nappy manufacturers, more people could afford disposable nappies. With an increasing number of women receiving higher education and playing a more prominent role in the workplace, mothers are shifting towards the use of disposable nappies to accommodate their "demanding" lifestyles. In modern society, more than 95% of families prefer using disposable nappies as compared to traditional cloth nappies (Aishwariya and Priyanka, 2020).



The extensive use and management of disposable nappies are governed by several social, cultural, political, financial and technical factors. The majority of South African households utilize disposable nappies, with estimates confirming that approximately 2.4 tonnes of disposable nappies are generated per day in SA, with almost 864 tonnes of used nappies expected to be disposed of per annum (Smout, 2021). The Green Buildings Council of South Africa (GBCSA) indicates that the impact of disposable nappies on landfills and the environment is devastating (GBCSA, 2018; Chimhandamba, 2019). Discarding disposable nappies in landfill sites pollutes the environment by releasing harmful methane gases, endangers biodiversity, and presents possible groundwater contamination (Makgae, 2011; Godfrey and Oelofse, 2017). Literature states that the implementation of a methane gas recovery and a leachate treatment system helps reduce some of the associated environmental impacts (Khoo *et al.*, 2019). However, SA has seen a proliferation of illegal landfills that have gone untreated, affecting the groundwater reserves, aquatic and terrestrial environments and human wellbeing (Godfrey and Oelofse, 2017; Chimhandamba, 2019). The situation is often worse in rural and informal communities, where disposable nappies are discarded in rivers and open areas (Sepadi, 2021). This is mainly attributable to the lack of infrastructure and service delivery coupled with the lack of nappy repurposing and valorisation interventions, resulting in the indiscriminate dumping of soiled disposable nappies (Govender and Reddy, 2019; Sepadi, 2021). The factors that govern the use and disposal of nappies in rural communities are further discussed below.

2.1.1 Socio-cultural belief systems

Previously, due to African cultural beliefs and traditional practices, nappy waste in rural communities was never disposed of outside the household or on the streets, as they believed this provided an opportunity for witchcraft (Sibiya *et al.*, 2018). This cultural practice restricted people from discarding nappies through municipal services, even when safer disposal options were available (Sepadi, 2021). Initially, families preferred to dispose of used nappies in toilets; however, they soon became aware of the extensive nappy degradation period (Ntekpe *et al.*, 2020; Sepadi, 2021). As a result, people resort to alternative measures, including disposing of nappies on vacant land far away from homesteads and often into rivers that carry away waste (Sibiya *et al.*, 2018; Khanyile *et al.*, 2020).

In addition, rural communities' lack of public awareness of the seriousness of improper disposal of nappies and their waste has significantly influenced the effectiveness of nappy waste management in SA (Haywood *et al.*, 2021). The life cycle and associated environmental and health risks of the unsafe discarding of disposable nappies are not adequately understood by community members who lack knowledge and interest in the importance of safe nappy waste disposal (Sibiya *et al.*, 2018; Sepadi, 2021). Furthermore, the perception that waste management is the sole duty and responsibility of the local municipality is a critical element limiting SA's nappy waste management system (Godfrey and Oelofse, 2017; Haywood *et al.*, 2021). As a result, there is a need for the collaboration of rural communities with local authorities to participate in the safe management of disposable nappies to maintain a clean and healthy environment (Remigios, 2014).

Furthermore, social research confirms that modern society perceives cloth nappies as outdated and unhygienic (Sibiya *et al.*, 2018; Khanyile *et al.*, 2020). The extensive use of disposable nappies is now a social construct of being “fashionable” and they are regarded as



a symbol of status within local communities (Sepadi, 2021). Remigios (2014) conducted a qualitative analysis of women's perceptions of nappies and found that modern-day women preferred using disposable nappies as they indicated privilege and gave the impression that they were moving with the changing times. As a result, it is evident that families view disposable nappies as a means of “convenience” without considering the negative impacts associated with the use of this product (Khanyile *et al.*, 2020; Haywood *et al.*, 2021; Sepadi, 2021). The table below summarises some of the barriers preventing parents from returning to cloth nappies.

Table 1: Barriers preventing parents from returning to cloth nappies.

Barrier	Influence
Awareness and knowledge	The research suggests that one of the foremost barriers preventing parents from returning to cloth nappies is a lack of awareness with regard to the negative impacts on the environment as a result of disposable nappy waste. Many individuals are not knowledgeable about the components, such as plastic, which is harmful when disposed of in the environment.
Normalisation	Using disposal nappies has now become the 'new normal' in society. Even though there are people who still use fabric nappies, the majority of parents have normalised the use of disposable nappies. Furthermore, media and advertising have promoted the use of disposable nappies among modern-day parents.
Practicality and convenience	It is often perceived by parents that the environmental benefits of returning to cloth nappies are outweighed by the practical considerations. Disposable nappies are recognised as convenient and easy to use in comparison to cloth nappies. Cloth nappies require additional laundry to remove stains of soiled nappies, which is an inconvenience, especially for working parents.
Social contrast	Social research confirms that modern society perceives cloth nappies as outdated, unhygienic and only utilised by those who are poor. Disposable nappies are now a “fashionable” social construct and are regarded as a symbol of status within local communities.

2.1.2 Legislation, regulations and policies

South African governance is through the Constitution, which not only brought about democracy but also led to various changes and transformations within communities (Zhakata *et al.*, 2016). As such, policy and legislation, including environmental waste management planning, are based on Section 24 of the South African Constitution: "everyone has the right to an environment that is not detrimental to his or her health or well-being" (Khumalo, 2016; DFFE, 2020). This constitutional right underpins all South African environmental policies and legislation, specifically the National Environmental Management Act (NEMA) (Act 107 of



1998), which is the statutory framework to enforce Section 24 of the Constitution (Sango *et al.*, 2014; Zhakata *et al.*, 2016). Nonetheless, the NEMA was criticised for not adequately regulating waste disposal and not accounting for waste hierarchy alternatives such as recycling and recovery (Zhakata *et al.*, 2016). However, the promulgation of the National Environmental Management: Waste Act (NEMA: WA) (Act 59 of 2008) presented a more holistic approach to waste management and emphasis on integrated waste planning systems through the promotion of waste reduction, reuse and recycling (Sango *et al.*, 2014; Zhakata *et al.*, 2016).

In addition, the National Waste Management Strategy (NWMS), a legislative requirement of NEMWA, stipulates goals for municipalities to adhere to NEM: WA (DFFE, 2020). In particular, these include the effective and efficient delivery of waste services, reduction of waste generation and the promotion of waste recycling (Sango *et al.*, 2014). To fulfil the objective of this policy, the Municipal System Act (Act 32 of 2000) was developed to address service delivery within local communities and ensure environmentally sustainable waste management (Rabaj, 2019). This act holds municipalities accountable for the removal, transportation, treatment and disposal of solid waste, while the provincial and national government is responsible for ensuring that local government completes these functions effectively (Khumalo, 2016). Despite the distinct responsibilities and guiding legislation given to the government, waste management in SA remains uncoordinated and unsatisfactory (Zhakata *et al.*, 2016; Roberts *et al.*, 2018; Sepadi, 2021).

The primary limitation of South African policy and regulatory systems of efficient waste management is the existing fragmentation between statutory measures and designated authorities of waste management (Sango *et al.*, 2014). The uncoordinated development of legislation resulted in the promulgation of separate laws, some of which deal with the institutional arrangements of waste disposal in different ecosystems, whereas other regulatory tools have been developed to address the specific source of waste generation (Khumalo, 2016; Zhakata *et al.*, 2016; Godfrey and Oelofse, 2017). This is a severe challenge in the case of nappy waste, as nappies disposed of on land are often in close proximity to water sources and are usually discharged into surrounding rivers (Sepadi, 2021). As such, legislation should address nappy waste and pollution holistically. Furthermore, due to poor law enforcement and governance of municipalities, low-income settlements, including rural communities, have the highest number of illegal dumping sites containing mostly disposable nappy waste (Roberts *et al.*, 2018; Khanyile *et al.*, 2020; Haywood *et al.*, 2021).

The challenge in the disposal practices of nappies in South African rural areas is largely influenced by the ripple effects of the apartheid era (Godfrey and Oelofse, 2017; Rabaj, 2019). Despite the redistributive promises of the South African Constitution and the rearrangement of national and local governance, the inequality remains visible even after almost 30 years of post-apartheid (Zhakata *et al.*, 2016). The impact of apartheid legislation, such as the Group Areas Act that formalised geographic and racial segregation by preventing Africans' permanent relocation to urban or previously referred to as "white only" areas, has significantly shaped waste management practices in SA (Govender and Reddy, 2019). White communities were characterised by high infrastructure and service delivery standards, while African townships and rural areas were deprived of basic infrastructure and limited waste disposal services (Govender and Reddy, 2019). As such, service delivery remains a critical challenge for most South Africans, especially rural communities, as these



areas are still characterised by unsatisfactory roads, limited infrastructure, and no legal landfill sites, hence restricting waste service delivery enormously (Rabaj, 2019; Sepadi, 2021). Consequently, this has exacerbated poor waste management and increased unregulated waste disposal into illegal dumping sites and nearby rivers in rural communities (Govender and Reddy, 2019).

2.1.3 Financial and technical constraints

A primary challenge of waste management in SA, specifically nappy pollution, is financial and technical constraints (Khumalo, 2016). Municipalities are often limited by financial resources to address the environmental and health impacts of improper nappy disposal in rural areas (Haywood *et al.*, 2021). Such budgetary constraints result in local municipalities' inadequate waste collection and removal capacity and little to no emphasis on waste repurposing and valorisation (Sango *et al.*, 2014; Khumalo, 2016). The financial pressure is further exacerbated because rural communities are often characterised by low-income households and do not pay municipal property rates to assist local municipalities in performing essential service delivery in the area. Due to this non-availability of financial resources, implementing effective nappy waste collection by the municipality and innovative repurposing techniques is a significantly challenging task, hence the current nappy waste pandemic in SA.

Such financial constraints have further restricted the technical capacity of nappy waste management. In SA, there is a critical lack of technical facilities such as modern waste disposal equipment, acceptable landfill sites, operational waste vehicles and highly trained and informed waste management personnel (Khumalo, 2016; Haywood *et al.*, 2021). Therefore, the government should make available adequate funding to purchase and install proper waste removal and collection systems, especially if the country seeks to move up the waste hierarchy to achieve nappy waste repurposing, which requires innovative methods and smart technologies.

2.2 The environmental consequences of nappy waste and pollution

Despite the perception of convenience and comfort for disposable nappy consumers, numerous environmental and health issues are associated with the unsafe disposal of used nappies (Sibiya *et al.*, 2018; Khanyile *et al.*, 2020). Various studies have been conducted to evaluate the impact of disposable nappies on the environment (O'Brien *et al.*, 2009; Mirabella *et al.*, 2013; Cordella *et al.*, 2015; Itsubo *et al.*, 2020). Life cycle studies show that disposal nappies have detrimental impacts, particularly during the manufacturing and disposal and treatment stages (Colon *et al.*, 2011; Cordella *et al.*, 2015). The environmental health impacts of disposable nappies are described below.

2.2.1 Excessive use of natural resources

Approximately 35% of the disposable nappy weight is cellulose pulp, a fibrous material prepared through chemical and mechanical separation of cellulose fibres from coniferous wood and fibre crops (Colon *et al.*, 2011; Ntekpe *et al.*, 2020). This requires an enormous amount of deforestation of natural forests and plantations, therefore, contributing to the loss of biodiversity, carbon sequestration and ultimately climate change (Colon *et al.*, 2011).



Furthermore, pulp manufacturing requires the use of chlorine and alkaline solutions that often end up as toxic effluents discharged into rivers (Aishwariya and Priyanka, 2020; Tsigkou *et al.*, 2020). In addition, super absorbent polymers (SAP) account for nearly 33% of diaper weight (Colon *et al.*, 2011; Cordella *et al.*, 2015; Ntekpe *et al.*, 2020). SAP is a water-absorbing synthetic polymer with the ability to absorb up to 1000 times its mass (Castrillon *et al.*, 2019; Zekry *et al.*, 2020; Chen *et al.*, 2022). The production of SAP requires an excessive amount of water and oil and results in the emission of carbon, methane and sulphates, subsequently having a high carbon footprint (Colon *et al.*, 2011; Aishwariya and Priyanka, 2020).

2.2.2 Contamination of water resources and pathogen exposure

Water resource contamination and pollution are among the most significant impacts of improper nappy waste disposal, particularly in water-scarce regions such as SA (Makgae, 2011; Sackey and Meizah, 2015). Disposable nappies containing faecal matter have great potential to contaminate groundwater, especially in South African rural areas, where the majority of the community practices unsafe disposal of nappies (Sepadi, 2021). Surface water contamination poses a significant challenge mainly because rural societies still rely on rivers to collect drinking water and wash clothes and vehicles. According to Ntekpe *et al.* (2020), the unsafe discarding of disposable nappy waste can result in the transmission of infectious diseases, particularly cholera, typhoid, hepatitis, polio, cryptosporidiosis, ascariasis, and schistosomiasis. Therefore, the unsafe disposal of nappy waste may lead to the leaching of toxic chemicals into nearby water sources, especially in the case of illegal dumping sites, which are often nearby river systems (Ali *et al.*, 2017). Furthermore, it is argued that biological vectors also play a role in transmitting pathogens from disposable nappy waste to humans (Remigios, 2014; Ali *et al.*, 2017). Disposable nappies, especially those discarded in illegal dumping sites, are disintegrated by dogs with the faecal matter left exposed to houseflies and rats that later visit nearby households (Remigios, 2014).

2.2.3 Source of microplastics

In recent years, microplastics have been widely detected in sea and freshwater habitats and are listed as the second most crucial ecological issue (Harrison *et al.*, 2018; He *et al.*, 2018; Henry *et al.*, 2019; Yuan *et al.*, 2020). Research has shown that microplastic debris from plastic materials, including disposable nappies, has been found in aquatic and terrestrial habitats (Henry *et al.*, 2019; Aishwariya and Priyanka, 2020). Plastic fibres from disposable nappies threaten aquatic communities and result in coral and fish mortality (Naidoo *et al.*, 2020; Chen *et al.*, 2022). An Indonesian study by Buwono *et al.* (2022) confirmed that microplastic pollution-induced digestive tract disorders occurred in mosquitoes as a reaction to contaminated freshwater. A local study in SA by Naidoo *et al.* (2020) quantified and characterised the microplastic ingested by four juvenile fish species in urban estuaries. The study revealed that juvenile fish consume significant quantities of microplastics, some of which could be the break-down products of discarded nappies (Naidoo *et al.*, 2015). In SA, research has established that approximately 1.1 million tons of disposable nappy waste is discarded annually, with an estimate of only 700 000 tonnes of absorbent hygiene waste being directed to legal landfills (GBCSA, 2018; Sepadi, 2021). The remaining used disposable nappies are informally dumped near rivers, with the waste ultimately being



carried down to the sea and significantly contributing to marine plastic debris (Roberts *et al.*, 2018; Sadan and De Kock, 2020). Furthermore, research on microplastics in soil ecosystems has found that plastic debris can influence soil biota at different trophic levels and threaten human health through the food chain (He *et al.*, 2018).

2.3 Mitigation technologies/methods for nappy waste disposal

2.3.1 Conventional methods of nappy waste disposal

2.3.1.1 Landfilling

Landfilling is a widespread and commonly used waste management approach in both developed and developing nations (Chowdhury and Wijayasundara, 2021). In SA, more than 90% of the generated waste is disposed of at landfill sites (Godfrey and Oelofse, 2017). Ideally, landfills should be well-engineered soil pits lined with high-density polyethylene to prevent groundwater leachate, where waste is deposited in thin layers and then compacted and covered with soil at regular intervals (Khoo *et al.*, 2019). However, a significant challenge in developing countries, including SA, is that even though there are a large number of landfill sites, many of them are unlicensed and non-compliant (Godfrey and Oelofse, 2017). A critical challenge of non-compliant landfills is that soil cover is not regularly applied as per the requirements and is often located too close to human settlements and water resources (Njoku *et al.*, 2018). Furthermore, due to poor landfill maintenance, there is a high risk of groundwater pollution from leachates (Makgae, 2011). As such, the landfilling approach to waste management is arguably not sustainable in SA, especially in the case of disposable nappies which require approximately 500 years to decompose fully (Velasco Perez *et al.*, 2021; Chen *et al.*, 2022). Essentially, disposable nappy waste will accumulate in these non-compliant and poorly managed landfills for an extended period and breed bacteria that could expose surrounding animal and human communities to pathogens (Khoo *et al.*, 2019). Attributable to such environmental health hazards, SA must consider sustainable alternatives for disposable nappy waste management.

2.3.1.2 Incineration and uncontrolled burning

Incineration is a waste treatment method that involves the oxidative combustion of waste products (Khoo *et al.*, 2019), and in SA, it is used in the medical sector for waste treatment (Godfrey and Oelofse, 2017; Velasco Perez *et al.*, 2021). Developed countries like Sweden and Switzerland incinerate 50% of municipal waste, while Japan has fully adopted waste incineration for electricity generation (Khoo *et al.*, 2019). While incineration attends to the global waste crisis and eliminates any pathogen risk, it is argued to be uneconomical due to high investment and operation costs, as well as leading to increased consumption of fossil fuels and atmospheric pollution (Makgae, 2011). In addition, uncontrolled burning is prevalent in South African rural and informal communities with restricted waste collection services (Sepadi, 2021). Uncontrolled burning is a communal activity that usually occurs within household gardens and on waste dumped on roadsides and in open spaces (Kimani *et al.*, 2015). This waste management approach presents various disadvantages, as nappies burned under low temperatures result in incomplete combustion, producing toxic greenhouse gases such as carbon monoxide and nitrogen oxides that are health hazards and environmentally unfriendly (Makgae, 2011; Sepadi, 2021). Additionally, the burning of



disposable nappies emits dioxins and furans, and the toxic ash by-product is often dispersed by wind or leaches into surface and groundwater together with toxic contaminants (Sepadi, 2021).

2.3.2 Recent approaches for repurposing disposal nappies

The environmental health concerns associated with landfilling and uncontrolled burning have led developers, engineers and government decision-makers to consider alternative disposable nappy waste methods (Table 1) (Godfrey and Oelofse, 2017; Chowdhury and Wijayasundara, 2021). The international norms and standards have encouraged the adoption of cleaner technologies and recycling waste deposits (Makgae, 2011; Espinosa-Valdemar *et al.*, 2014; Tsuji, 2019). In 2001, SA began its transition from “The Age of Landfilling” toward “The Emergence of Recycling” (Godfrey and Oelofse, 2017). This promoted waste management to move up the waste hierarchy from waste disposal to waste reuse, recycling, and recovery (Makgae, 2011; Godfrey and Oelofse, 2017). Various disposable nappy waste repurposing techniques have been developed and implemented worldwide (Karimi *et al.*, 2020). The recent technologies and methods for the repurposing and valorisation of disposable nappies are discussed below and summarised in Table 2.

2.3.2.1 Repurposing disposable nappy waste through mechanical processing

Disposable nappies contain various constituents, including cellulose pulp, plastics and SAP, that can be reused as raw materials (Velasco Perez *et al.*, 2021). Mechanical valorisation of nappy waste involves the separation of different nappy fractions through mechanical processes such as sorting, shredding, washing, regranulation and compounding (Jesca and Junior, 2015). A recent study by Karimi *et al.* (2020) confirmed that shredded disposable nappies are suitable for manufacturing cement grouts and concrete (Karimi *et al.*, 2020). A key advantage is that this approach did not require nappies to be further processed but instead, were used as inputs in the manufacturing process (Karimi *et al.*, 2020; Chowdhury and Wijayasundara, 2021). Furthermore, Knowaste Ltd. is a European company established in 1989 that specialises in disposable nappy waste valorisation through mechanical processing methods (Kim and Kim, 2018). Knowaste operates by collecting disposable nappy waste from consumers on a weekly basis, shredding and dehydrating the contents and ultimately separating into reusable plastic and cellulose fibre (Kim and Cho, 2017; Knowaste, 2021). The recovered plastic can be used as raw materials for concrete and steel, while the produced fibre can be used in pet litter, insulation products and brick manufacturing (Khoo *et al.*, 2019). A life cycle assessment (LCA) confirmed that the Knowaste valorisation process significantly reduces 71% of carbon emissions in comparison to landfilling and incineration (Khoo *et al.*, 2019; Knowaste, 2021). However, the Knowaste process is associated with high water consumption, which when discarded, could potentially contaminate water resources if not treated. Furthermore, there is a high cost associated with transporting disposable nappies to a recycling plant (Kim and Cho, 2017; Kim and Kim, 2018). Nonetheless, the recent expansion of Knowaste to SA, Gauteng, provides a promising solution to dealing with the current nappy waste crisis (Knowaste, 2021). Finally, although the mechanical repurposing of nappy waste is a viable option, its applicability to SA is limited by the continuous need for financial support and the extensive use and maintenance of machinery required in the mechanical process.



2.3.2.2 Repurposing of disposable nappy waste through composting

Since the early 1990s, various research and laboratory experiments have been conducted on the applicability of nappy composting (Colon *et al.*, 2011; Kim and Cho, 2017).

Composting is a natural process involving a mixture of organic matter such as leaves and food scraps, which can then be combined with nappy materials (Ferronato *et al.*, 2020; Velasco Perez *et al.*, 2021). Espinosa-Valdemar *et al.* (2014) conducted a phytotoxicity test of composting disposable nappies with yard waste, including grass, leaves and mulch. The authors found that the final compost product was of exceptional quality and suggest this method as ideal for small-scale composting at a community level. Furthermore, Velasco Perez *et al.* (2021) confirmed that combining disposable nappy waste with organic waste at the correct proportions will allow for the complete elimination of pathogens, hence producing high-quality compost. Research confirmed that the composting process allowed for the reduction of 87% of disposable nappies with only the plastic fragments being recovered at the end of the process, prior to using the compost (Espinosa-Valdemar *et al.*, 2014). Espinosa-Valdemar *et al.* (2014) go on to suggest that these plastic fragments can further be recycled, decreasing the environmental impact of used disposable nappies even more.

A recent study by Kusumawati and Mangkoedihardjo (2021) investigated the potential of using *Cyanobacteria* to enhance the nappy composting process. Research confirms that using *Cyanobacteria* can reduce the composting period, increase the decomposition rate of compost and eliminate pathogens while degrading microplastics contained in disposable nappy waste (Yuan *et al.*, 2020; Kusumawati and Mangkoedihardjo, 2021). Furthermore, Ferronato *et al.* (2020) confirmed that a combination of earthworms, cow manure and activated bacteria could be used as a catalyst in the disposable nappy waste composting process. Research by Khoo *et al.* (2022) elevated disposable nappy waste composting by cultivating mushrooms. A study by Khoo *et al.* (2019) stated that mushrooms, which are saprophytes, feed on cellulosic material, a component of disposable nappies. A study by Espinosa-Valdemar *et al.* (2015) confirmed that mushroom cultivars were free from human diseases and had a similar nutrient concentration and appearance as commercial mushrooms. In Europe, Dycle is a small-scale disposable nappy repurposing company that converts nappy waste into nutritious soil that is used for fruit tree planting (Matzusaka, 2015). The Dycle process includes the combination of disposable nappies, charcoal and kitchen waste to produce high-quality black fertile soil called Terra Preta (Khoo *et al.*, 2019). Similarly, in Scotland, a recent project has been initiated with the aim of repurposing nappy waste using a high-temperature low-oxygen process to produce biochar, which is used to absorb contaminants from wastewater and can also be used to improve the quality of compost (Khoo *et al.*, 2019; Nageler, 2022).

Despite the triumph of disposable nappy composting, research has found that the final compost product often has high zinc and pH concentrations attributable to the skincare products used in nappies (Colon *et al.*, 2011; Khanyile *et al.*, 2020; Velasco Perez *et al.*, 2021). Furthermore, there is a rising concern about the presence of pathogens in compost and the impact of SAP and microplastics on the soil (Khanyile *et al.*, 2020). Nonetheless, a study by Zekry *et al.* (2020) confirmed that the high water absorbency characteristics of SAP found in disposable nappies present an opportunity to enhance the water retention properties of soil. Additionally, a LCA by Mirabella *et al.* (2013) recommends disposable nappy composting for the end of life as it significantly reduces the environmental and health



impact of nappies. Nonetheless, the approach of nappy waste repurposing through composting is highly applicable to the South African setting, as the method does not require extensive financial investment and if successfully implemented, has the potential to contribute to the growth of the agricultural sector in SA.

2.3.2.3 Repurposing of disposable nappy waste through anaerobic digestion

Similar to the composting process, disposable nappy waste can be combined with expired food products and organic matter to produce compost and biofuels (Colon *et al.*, 2011). Through anaerobic digestion, microorganisms break down nappies and organic waste contents to produce biogas in the absence of oxygen (Tsigkou *et al.*, 2021). The resulting product of this process is then treated aerobically to form compost (Colon *et al.*, 2011). Torrijos *et al.* (2014) designed a new separation technique that segregated the biodegradable fractions of disposable nappies from the non-biodegradable through anaerobic digestion, finally producing biodegradable materials and reusable plastic. However, the repurposing of nappy waste via this method is not common, with its practice only being recorded in developed countries such as Canada and Belgium (Colon *et al.*, 2011). Additionally, a significant disadvantage of this repurposing method is its high water consumption and absorbent cost associated with the treatment process (Torrijos *et al.*, 2014). As such, the applicability of this repurposing technique will most likely be incompatible with the South African economy and will not prove viable for nappy waste management, especially in rural and informal communities.



Table 2: Types of disposable nappy waste repurposing and valorisation technologies/methods reported worldwide, and their applicability to the South African setting.

Methods of nappy waste repurposing and valorisation	Country	Advantages	Disadvantages	Applicability to the South African setting	Reference
Mechanical shredding of disposable nappies for manufacturing cement grouts and concrete	Europe, Netherlands	Presents a sustainable alternative to viscosity modifying admixture in the concrete and cement industry; allows for a circular economy with possible financial benefit.	Associated with high manufacturing costs; Requires the collection and transportation of nappy waste to a valorisation plant.	A viable option for nappy waste management in SA, provided that there are qualified and skilled personnel to engineer this technique and the availability of financial reserves.	(Karimi <i>et al.</i> , 2020).
Mechanical Processing: Knowaste Ltd	Europe and SA	Mechanically separates disposable nappy waste into reusable materials; Potential to reduce waste disposal in landfill sites by 84%.	Accompanied by high water consumption and cost of transporting disposable nappies to a recycling plant.	Knowaste has been established in SA. However, their recycling plant is currently only in Gauteng, though there are future plans to develop into three other regions of the country.	(Khoo <i>et al.</i> , 2019; Knowaste, 2021).
Combining disposable nappies with yard and kitchen waste to produce compost	Mexico	Reduction of 87% of disposable nappies with only the plastic fragments being recovered.	Slightly high PH and Zinc concentrations; Concern for risk of pathogens and diseases.	Highly adaptable to South African rural areas as the method requires limited financial support and readily available materials.	(Espinosa-Valdemar <i>et al.</i> , 2014).
Biological degradation of disposable nappies	Asia, Indonesia, Italy, Bolivia	Suitable for small-scale composting; Microorganisms increase the decomposition rate and	Concern for risk of pathogens and diseases.	Suitable for rural areas due to low implementation cost.	(Ferronato <i>et al.</i> , 2020; Kusumawati and



with microorganisms		decrease the composting period.			Mangkoedihardjo, 2021).
Methods of nappy waste repurposing and valorisation	Country	Advantages	Disadvantages	Applicability to the South African setting	Reference
Using disposable nappy compost for the cultivation of mushrooms	Asia, Malaysia	Evidence of circular economy as the nappy compost is used for the growing of cultivars; Harvested mushrooms had a good appearance and protein content and were free of pathogens.	A phytotoxicity test might still be required.	Appropriate for SA and also provides the emergence of local businesses for the sale of mushrooms.	(Khoo <i>et al.</i> , 2022).
Converting disposable nappy waste into Terra Preta for the planting of fruit trees	Europe, Germany	Contributes to a circular economy; Innovative as it solves the nappy waste crisis and contributes to food security.	Relatively long composting period.	Highly applicable to the South African setting as there is a good market for fruit sales.	(Matzusaka, 2015).
Recovery of SAP from disposable nappies for soil water retention	Africa, Egypt	Improves agricultural practices.	Unknown impact of SAP on the soil.	Applicable to SA as it will improve agricultural water management. Also adaptable for smallholder farmers in rural communities.	(Zekry <i>et al.</i> , 2020).



Anaerobic digestion of disposable nappies for biofuel production	Allows for the circular economy of disposable nappies; Permits the separation of disposable nappies into different valuable biodegradable and non-biodegradable products.	High water consumption and absorbent cost are associated with the treatment process.	Possible incompatibility within the South African context due to the high operational cost.	(Torrijos <i>et al.</i> , 2014).
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3. Key findings and Results

3.1 Situational analysis: Community engagement

3.1.1 Initial engagements with community-based monitors

A preliminary workshop was held with a total of 12 community-based monitors to garner an initial understanding of the pollution challenges present within each of the two communities (Figure 1). The workshop was administered in the form of focus group discussions and participatory mapping exercises (Appendix B). From these engagements, it was noted that community-based monitors are educated on waste and pollution and can identify the general causes and impacts of unsafe waste disposal. This may be explained by the fact that the community-based monitors have had a prior understanding of solid waste through workshops, conferences, and courses they have attended as part of their employment with the INR. It was indicated that the impacts of improper waste disposal result in multiple types of pollution, with prominent effects on people and biodiversity. Specifically, the community-based monitors expressed concern about poor water quality, loss of livestock, degradation of landscape aesthetics and the blockage of drainage systems leading to sewer overflow and contributing to flash floods within the communities. As part of the participatory mapping exercise, community-based monitors were able to identify waste hotspot areas within the communities, with the prominent waste hotspot locations associated with rivers, streams and forests. When introduced to the RPTP project, it was also observed that the community-based monitors were slightly sceptical about the project; however, they grew increasingly optimistic about its potential for improving waste management within the communities as they became more familiar with the rationale and motivation behind its design and the methods selected.



Figure 1: Workshopping the awareness campaign with community-based monitors during the initial community engagements.

3.1.2 Community engagements with community members

Community workshops were conducted within each of the two communities to introduce the RTPP project and understand the current status of waste and pollution within each of the two communities (Figure 2). The workshops were administered in the form of focus group discussions with guideline questions that were facilitated by INR staff (Appendix B). Furthermore, the participants present at the workshops represented a diversity of age groups and gender, with a mixture of youth, parents, and grandparents.

Both communities displayed some level of knowledge regarding waste and pollution. When asked whether there is an issue with waste and pollution in the area, all participants indicated yes. The problem of solid waste appears to be a consequence of the lack of infrastructure and basic service delivery. The participants were further asked to describe the types of waste affecting each of the two communities and identify waste sources that significantly contribute to pollution in the area. Nappy waste was regarded as the source of pollution that unsettled the community the most. There was a clear indication that both communities were angered and frustrated about the problem of nappy waste and pollution in the area.

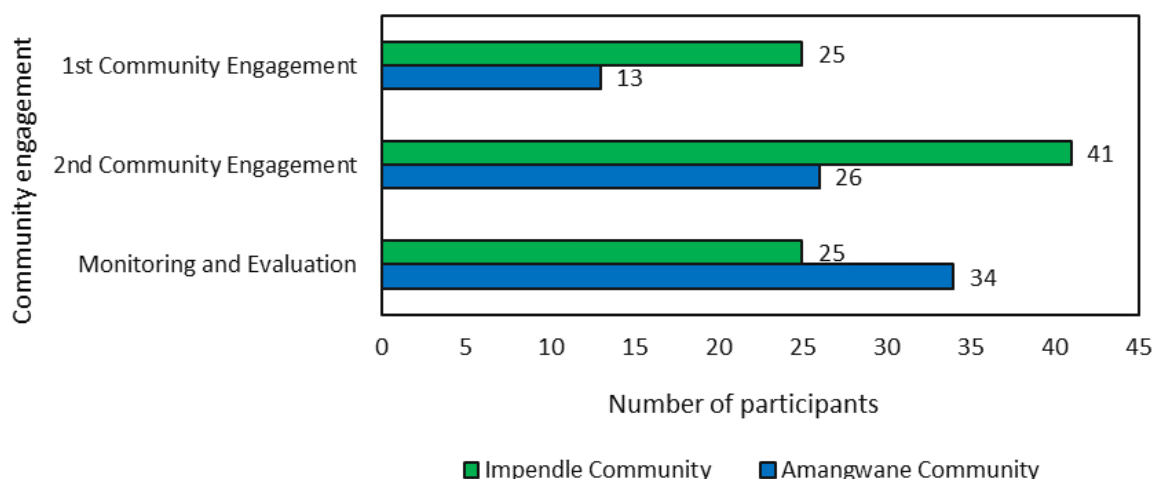


Figure 2: Number of participants that attended the community engagements.

Through a participatory mapping exercise, both communities were able to identify nappy waste hotspot areas. It was determined that there are high levels of nappy pollution in rivers and streams and that these hotspot areas are located in close proximity to households within each of the two communities. The community members used large orange circles to illustrate areas perceived to have high nappy waste pollution in comparison to areas with less, represented by smaller orange circles (Appendix C). In addition, a transect walk was conducted with the community members through their respective communities to generate a spatial understanding of the people-environment-pollution interactions. Figure 3 illustrates some of the pictures of nappy waste hotspot areas captured during the transect walks within each of the two communities. As represented, nappy waste hotspots are primarily located in streams, alongside rivers and in open grasslands. Even though there is existing knowledge of potential nappy pollution impacts, the communities believe there is a lack of options and intervention methods to mitigate nappy pollution. Community members appear to not know what to do with nappy waste except discard it in rivers and streams with the belief that the waste will be transported and carried away by the water in the river.



Figure 3: Examples of nappy waste hotspot areas identified within the communities during the transect walks with the community members and community-based monitors.

The second set of community engagements was conducted to understand potential solutions and interventions for addressing the current nappy waste pollution issue within each of the two communities. There was general consensus on the urgent need for mitigation and intervention measures. A few of the older generation mothers suggested that the communities return to using cloth nappies that were used in the past as they are washable and reusable. While 60% of the participants agreed to the suggestion, new generation mothers rejected the suggestions arguing that they are now playing an active role in the workplace while others are working towards receiving a higher education; hence, they expressed a need for disposable nappies to accommodate their demanding lifestyles. It was further suggested that nappy waste must be collated and left for the municipal waste trucks to remove from each household. However, the communities soon rejected this suggestion as



there is poor basic service delivery in the area; as a result, municipal waste services are not reliable. Participants also suggested that the communities adopt the can and bottle recycling method for nappy waste by collecting used nappies and selling them to recycling companies. However, a challenge raised was that the market for such recycling initiatives currently does not exist within the communities.

It was further suggested that nappies be integrated with other kitchen and yard waste to produce compost to cultivate fruit and vegetables. This suggestion innovated participants, who began to think of how the agricultural repurposing of nappies could develop into a social enterprise, with the potential of addressing unemployment and food security within each of the two communities. A group of participants in the Impendle community also proposed that the cotton fibre in nappies could be used to make household furniture products such as pillows, mattresses and couches. However, the community raised that even though these are valid ideas, they have limited knowledge on processing nappies for such purposes and this would require experts and specialists who can assess the viability of these options and research the market niche opportunities. It was also agreed that nappy waste must be collated to a nappy kraal, which is a central location that is secure and fenced off, for any of these interventions to succeed. This location would act as a central hub where nappies could be extracted for repurposing.

Both the communities also proposed that a compliance system be introduced to fine people who illegally dispose of nappies in unauthorised locations such as rivers, streams and grasslands. However, it was further discussed that such a practice would not change the community's perspective of nappy waste and pollution as similar methods have been used and proven to be unsuccessful. For example, the local municipality issues fines to those found guilty of illegally dumping waste. Although there are signs warning people against illegal dumping within some communities, improper waste disposal continues, and the culprits are never prosecuted. The participants proposed that community members need to be educated about the negative impacts of improper disposal of nappy waste and expressed the need for the community to practice safe nappy waste disposal. As a result, the community agreed that a nappy waste awareness campaign is imperative and is the first step towards seeing a change in waste practices within the communities. In summary, the community was asked to rank the proposed intervention methods in order of priority (Figure 4).

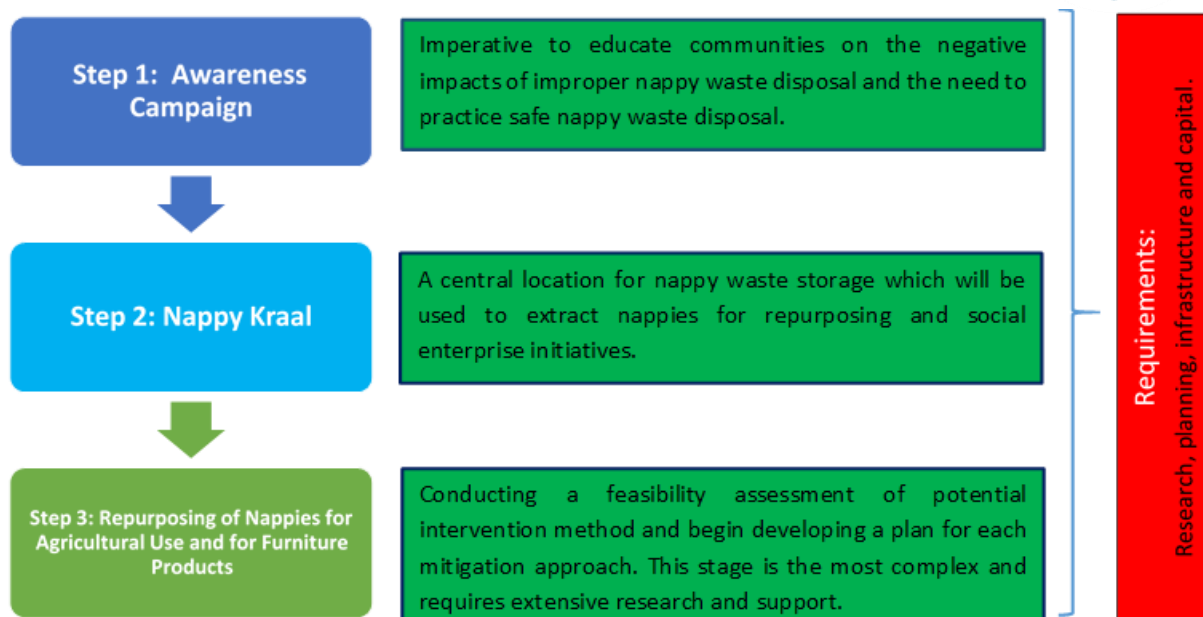


Figure 4: The framework adopted for the proposed nappy pollution mitigation interventions within the communities engaged.

3.2 Co-designing framework for an awareness-raising campaign

As part of the engagements with community members, it was determined that the first step towards improving nappy waste management and reducing pollution should be through an awareness campaign. It finds its purpose in the fact that not all community members are aware and informed about the impacts that result from nappy waste pollution and the measures they can take to pro-actively adapt to safe nappy waste disposal. The awareness campaign aimed to educate the community on the negative impacts of improper nappy waste disposal and the need for mitigation and intervention measures to combat nappy waste pollution. The awareness campaign was community-led and followed a bottom-up approach toward improving nappy waste management. As a result, the awareness campaign was co-designed with the community-based monitors, using knowledge and suggestions proposed by community members during the engagement workshops. A final workshop was then conducted with the community-based monitors to finalise the target audience, key themes, messages and the communication platforms used for implementing the awareness campaign. The overall message design of the awareness campaign is described in Table 3.



Table 3: Message design elements that were used for implementing the awareness campaign.

Element	Influence on the awareness campaign
Visual communication	A hybrid of physical and digital communication mediums was used to implement the awareness campaign. Communication was done in-person during house visits and interactions with community members within the community, as well as over online media platforms such as WhatsApp and Facebook.
Structure	Both verbal communication and graphical illustrations were used to relay the message of the awareness campaign. A combination of print media, electronic media and direct media was implemented.
Language	IsiZulu is the main spoken and written language in both communities. Hence, all verbal and written communication for the awareness campaign was presented in IsiZulu.
Tone	The awareness campaign followed a tone of optimism in order to connect with the audience. The tone also incorporated an empowering and uplifting tone to encourage the audience to improve and achieve safe disposal of nappy waste.
Materials	Posters, a pamphlet and a video (Appendix D, E, F and G).

3.3 Awareness campaign refinement and implementation

Based on the message design, the community-based monitors identified the following techniques as the key strategies and platforms used to implement the awareness campaign in the different communities.

3.3.1 Door-to-Door Canvassing

The community-based monitors split into pairs for safety reasons and systematically engaged with community members (youth, parents, and grandparents) within the area, either at their homes, shops, taxi ranks, clinics and sports grounds. When engaging with the community members, the community-based monitors introduced the purpose of the awareness campaign and shared information regarding the human health and environmental impacts of the improper disposal of nappy waste. Pamphlets were used to frame and supplement the conversations between community-based monitors and community members. Community members were further asked whether there was a baby (0-3 years old) within the household. If so, they were also given a pack of refuse bags together with a waste bucket to store their used nappies for safe disposal (Figure 5). Lastly, community-based monitors answered any questions and distributed printed pamphlets with relevant information and contact details.



Figure 5: *Nappy waste buckets and refuse bags distributed to the community.*

3.3.2 Displaying Posters

Two posters (appendix E and F), designed by community-based monitors with the help of the INR team, were used to raise awareness within the communities. The first version of the poster narrated the impact of improper nappy waste disposal, while the second version alerted the community to say no to unsafe nappy waste disposal. Both visual and verbal illustrations were used on the posters to relay the message. The verbal information was presented in isiZulu using slogans with an optimistic tone to connect with the audience. These posters were displayed at schools, clinic waiting areas, community offices/halls, local shops, crèches, and public transport and ranks. Finally, the posters were printed in A0 and A1.

3.3.3 Social Media

A video designed to raise awareness on unsafe nappy waste disposal was created by the community-based monitors. Rather than hiring an external video production crew, the community-based monitors wanted to take ownership of the process of producing the video and were involved in shooting the video and acting in the scenes themselves. The video was in the form of a skit acted by the community-based monitors to relay the message against nappy waste pollution. The video incorporated an element of humor to tell their story and to make it easy for the community to relate to. The video was shared with community members through social media platforms such as WhatsApp and Facebook. Finally, the video was narrated in isiZulu.

Finally, the awareness campaign was simultaneously implemented within each of the communities over a period of one month. Community members who engaged with the



community-based monitors during the door-to-door canvassing were expected to sign a register acknowledging their receipt of a pamphlet and refuse bags, together with a waste bin if they had a baby in the household. The register format was represented in English (Appendix D) and in isiZulu languages.

3.4 Awareness Campaign: Monitoring and Evaluation

Public awareness can increase enthusiasm and support, aid in mobilising local knowledge and resources, as well as stimulating self-mobilisation and action. The success of awareness-raising, i.e., the degree to which the desired outcome is achieved, is based on the efficacy of communication strategies. When communication strategies for a targeted audience are combined for a given period to achieve the desired outcome, this can be broadly described as an 'awareness raising campaign.' Awareness campaigns can be context-specific but are generally designed to increase concern, inform the targeted audience and change their behaviour. As part of understanding the success of the awareness campaign, a monitoring and evaluation (M & E) workshop was conducted in each of the communities (Figure 6).



Figure 6: Monitoring and Evaluation workshop with community members expressing their views of the awareness campaign.

It was observed in both communities that people were aware and had been exposed to the awareness campaign. All the participants agreed that they had seen or heard of the nappy waste awareness campaign. Using a focus group methodology, community members were asked whether they perceive themselves to have a greater understanding of the impacts of



nappy waste pollution having participated in the project. From their answers, it was gathered that the community members were now more knowledgeable about the negative impact of nappy waste and the importance of mitigation and intervention measures to combat nappy pollution. It was further noted that the majority of the participants, both in Amangwane and Impendle, are community members who have participated in the community engagements from the beginning of the RPTP project. As a result, it was noticed that participants have become more passionate about managing nappy waste and have adapted a sense of ownership for the role they play in achieving proper nappy waste disposal.

Community members were asked whether the awareness campaign met their expectations and whether they felt that the community's ideas and suggestions were well reflected in the campaign. In response, the community expressed their gratitude for the project as it was community-led in nature; as such, they felt that their suggestions were valued and carried through exactly how they expected during the implementation of the awareness campaign. The community further expressed their appreciation of the community-based monitors stating that they championed the project exceptionally well and have been positive role models to the broader youth in the community.

As part of the M & E, community members were asked to reflect on the materials created for the awareness campaign and their effectiveness in raising awareness against nappy waste pollution. The majority of the community (Amangwane= 56 %; Impendle= 60 %: Figure 7) considers the pamphlet and waste buckets and bags the most effective for raising awareness and changing the community's perception of nappy waste. The community confirms that the pamphlets were not only well designed but also very informative, containing essential information that is easy to read and understand. Furthermore, the waste buckets and bags provided a solution to the current nappy waste issue in the community. A participant stated that the waste buckets protect nappy waste against flies and stray dogs that rip apart nappies, spreading pathogens and creating an aesthetic nuisance. Another community member also confirmed the importance of waste buckets and hopes that community members who did not receive them (don't have a baby in the household) use this as a symbol for the future if they have to manage nappy waste.

According to the community, the second most impactful awareness material was the posters (Amangwane= 32 %; Impendle= 28 %: Figure 7). The lower value may be explained by the fact that some of the community members, especially the elderly, are unable to go to the local shops and community halls where the posters were displayed. Nonetheless, the posters were well received by the youth and children within the community. The community also expressed that the graphics and visual illustrations used in the posters were appealing and relevant to the community. The community also mentioned that they could recognise their community through the landscape design of the poster (Appendix E); as a result, the poster was very relatable to the community. Once again, the community saw evidence of co-creation of the awareness materials, as the poster design and slogans were all community-led.

As reported by the community, the least impactful awareness campaign material was the video (Amangwane= 12 %; Impendle= 12 %: Figure 7). The community members expressed that, unlike the other materials, the video was digital and hence did not reach a large audience as the other material. This is mainly due to the fact that technology is not as advanced in the communities and many individuals are not in possession of a smartphone.



Furthermore, some of the participants highlighted that video viewing and sharing consume considerable mobile data.

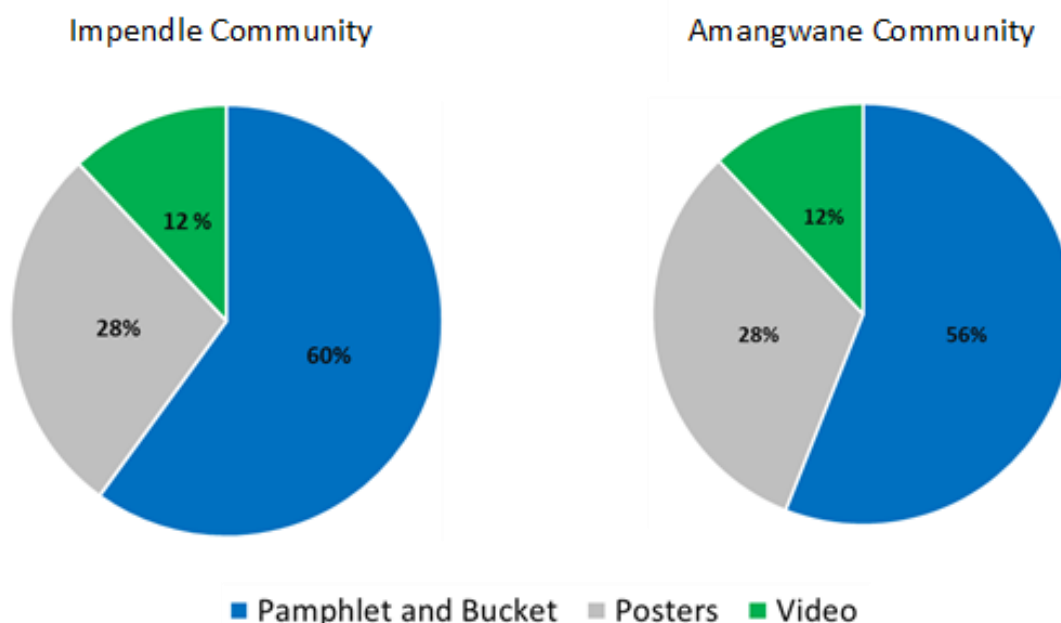


Figure 7: Community's preference for awareness campaign materials (Amangwane $n=34$ and Impendle $n=25$).

The most effective communication platform was door-to-door canvassing (Figure 8). Participants stated that this form of communication was the most interactive and the community could be individually exposed to the topic of nappy waste and pollution. The participants also agreed that engaging with children and youth at creches and schools was highly impactful as kids took the message home to share with their families. An elder of the community mentioned that her grandchildren came home with a pamphlet that they read to her about the negatives of nappy pollution and the importance of practicing safe nappy waste disposal. The community further mentioned that it is essential that the youth be part of the nappy waste management movement as they are tomorrow's future parents and grandparents. The community rated the displaying of posters as the second most effective method of communication. Most of the participants (Amangwane= 74 %; Impendle= 77 %), specifically the youth, had engaged with at least one of the posters displayed at the local shops and community halls. Finally, the least impactful method of communication was social media, as the community felt that not everyone had access to social media and hence did not reach a broad audience. Nonetheless, the community-based monitors stated that social media was effective to some extent as it allowed them also to raise awareness in other communities. For example, the awareness materials shared through social media were seen by individuals of a community 221 km away who expressed the need for a similar campaign in their community due to the high levels of nappy waste in their area.



Figure 8: Nappy waste awareness-raising: a) at a mobile clinic, b) via house visits and c) at a local school.

At the beginning of the RTPP programme, the community members expressed that they had conflicting views on the importance of managing waste and pollution in general and highlighted the need for the community to change their waste disposal practices. However, through the progression of the community engagements, the community shared that their perception of the topic began to evolve as they became more aware of the negatives associated with the improper disposal of nappies into streams, rivers and open areas. The participants expressed a need for an awareness campaign to educate community members on nappy waste and change their perception of its disposal. All the participants present at the workshop revealed that they had witnessed a noticeable change in the perception and practice of the community towards nappy waste disposal. Community members confirmed that areas that were originally hotspot locations for nappy waste are no longer polluted. According to the community-based monitors, more than 75% of the community is aware of nappy waste and pollution, which is regarded as the tipping point for change. This suggests that improving nappy waste disposal has become a normal conversation that remains in people's subconscious; hence if intervention and mitigation methods were to be introduced, it is highly likely that such projects would be successful.

When community members were asked about the next step towards managing nappy waste, their response was action. The community expressed that they are ready to move forward with implementing some of the intervention and mitigation measures that were suggested in



previous engagements. The participants also shared that the awareness campaign has impacted the community so much that they believe they are ready to implement sustainable change for the future. As part of the next step, the community shared that they need to begin engaging with the traditional authorities of the communities and other stakeholders such as the municipality, research organisation, and keystone individuals from the community that can assist with the implementation of nappy waste intervention methods. Finally, the community expressed that even though they are ready for action, they must continue raising awareness and keep the momentum of safe nappy waste disposal at its optimum.

4. Concluding remarks and recommendations

In SA, rural and informal communities are characterised by poor waste collection and disposal service delivery. As a result, community members resort to the illegal dumping of nappy waste near rivers and through unauthorised landfills or through uncontrolled burning. Such activity has significant implications for both terrestrial and aquatic ecosystems and on affected communities' health and well-being. Therefore, there is an urgent need for interventions and repurposing technologies for managing disposable nappy waste. To date, there has not been a consensus on the best method for repurposing nappies or absorbent hygiene products; however, a suitable method may be selected based on its applicability to the South African context. Changing the regulatory environment by introducing regulations to encourage producers of disposable nappies to consider alternative and more environmentally friendly materials for manufacturing nappies is a potential solution to the nappy waste crisis. However, there is a need for participatory and bottom-up approaches to managing nappy waste and pollution by developing nappy repurpose and upcycling solutions that promote the circular economy of disposable nappies. The approaches present in the literature could be valuable in managing the nappy waste crisis as they promote circular economy practices and contribute to improved crop production, both of which are challenging in SA. Despite the opportunities presented in the literature for repurposing disposable nappies, the risk of pathogens remains, especially for nappy waste composting. Furthermore, there is a lack of peer-reviewed literature on the long-term effects of disposable nappy waste components on soil and the receiving environment. Therefore, it is recommended that future research investigate the impacts of repurposing nappy waste on the environment, particularly in terms of its potential use for composting/ biochar production and the impacts that repurposing processes could give rise to, such as the release of microplastics into soil/water, associated risk of pathogens and the health impacts of consuming produce cultivated from nappy waste-based compost.

Given the responses obtained through engaging with community members and literature on nappy waste management, the following recommendations are offered:

Holding the space

To achieve lasting impacts and ensure that the community continues practicing safe nappy waste disposal, there must be an opportunity to hold the space and keep the momentum of safe nappy waste management high. It is essential that the community's perception and importance of improving their nappy waste disposal continue for any proposed intervention methods to be successful. Hence, we recommend a dissemination workshop within each of



the communities where the final report of the project is shared, and the key findings and recommendation are discussed with the community members.

Stakeholder collaboration

As suggested by the community, it is vital to involve other stakeholders to be part of the conversation. The RPTP project provided the community with an opportunity to conduct grassroots analysis and understand the issues of nappy waste and pollution on the ground. With that being successfully achieved, the community is now at the stage where they can approach other stakeholders, including government entities, non-profit organisations and private institutions, to be part of the conversation, especially around implementing the proposed nappy waste mitigation and intervention measures. It is, however, vital that the community remains at the forefront of any initiatives and the project on reducing nappy waste and pollution remains community-led.

Action research for change

Research is mandatory and is a key theme going forward. A feasibility analysis of each of the proposed nappy waste mitigation measures needs to be conducted. This will allow the community to identify gaps that require further inquiry and the feasibility of implementing the intervention. Scientific research and a life cycle analysis are at the forefront of understanding the effectiveness of each nappy waste intervention approach.

Capacity development

The community must be capacitated to lead and maintain nappy waste interventions for sustainable change. This also provides an opportunity for social business enterprise and employment opportunities for the community members. As such, there must be knowledge-updating and creation through workshops and seminars aimed at capacitating community members towards achieving sustainable nappy waste management.

Resource mobilisation

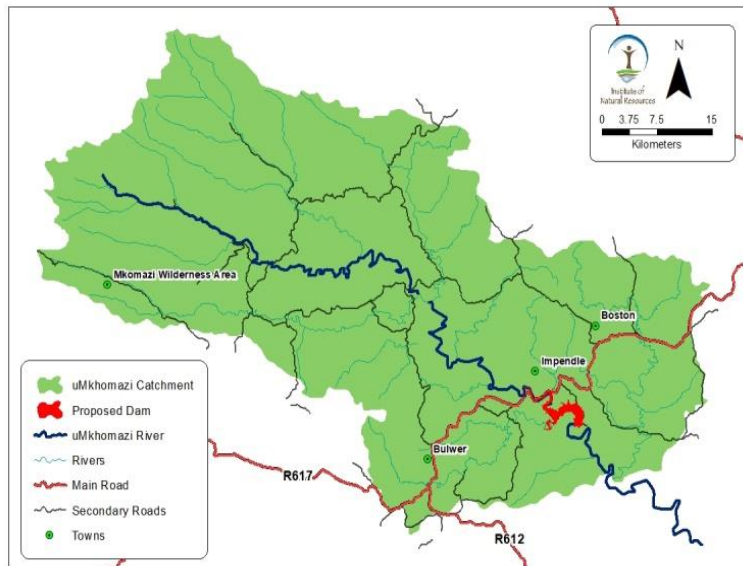
Operationalising any intervention will require government, development partners, private sector and civil society actors to mobilise and allocate resources so that the priority interventions proposed can be implemented within a realistic timeframe. Based on the community engagements, the main resources required are research, skills and training and financial resources for implementing nappy waste mitigation measures. While community members displayed a sense of shared responsibility for implementation, based on the perceived need and value of nappy waste interventions, they were also aware of the potential resource constraints that could hamper implementation.

Appendix A. Restoration and Conservation of the upper uMkhomazi Catchment

Land degradation in the Upper uMkhomazi catchment is a serious problem that threatens local people's livelihoods, infrastructure (e.g. houses, roads, bridges) and results in poor water quality, with high sediment loads. The high sediment loads affect downstream users and will also affect dams that are to be built in the catchment in the future. For example, one scenario suggests that the proposed Smithfield Dam in the upper uMkhomazi catchment could lose two thirds of its storage volume over a period of 100 years as a result of sedimentation. Recognising this challenge, Umgeni Water in partnership with the Institute of Natural Resources is initiating actions in the catchment that will help to limit and reverse degradation in the catchment.



Most sediment comes from the degradation of natural resources that result in soil erosion that is washed into streams and rivers. This can be caused by a variety of factors, but is mainly as a result of farming practices (grazing and ploughing) and infrastructure (e.g. housing and roads) that increase loss of soil cover. Projected climate change impacts, with more intense storms can potentially make this problem worse.



This project aims to work with local stakeholders to share ideas and find ways to reduce degradation while at the same time creating opportunities for improved livelihoods. This can be done through conserving natural resources in a way that helps to improve livelihoods. In this way, both the communities living in the catchment derive benefits from improved landscape

management through increased productivity of land and cleaner, more reliable water resources in wetlands, rivers and streams. Communities who receive water from the dams are also ensured of more secure water supply.

Objectives of the restoration project:

1. To work with communities in the Upper uMkhomazi to co-develop and implement restoration activities in the catchment;
2. To create value through the establishment of local enterprises that can support restoration activities;
3. To monitor the impact of the interventions by capacitating local citizen scientists to document key variables with support from scientists;
4. To create awareness of the importance of good management of natural resources through sharing knowledge and information with stakeholders in the catchment, practitioners, researchers and policy makers.

Letting wattle invade your land -
This reduces water and takes away important grazing and wetland areas.



Burning the grass every year -
This makes the soil more susceptible to erosion



Overgrazing - This reduces the vegetation cover and exposes the soil to erosion. There is also less food for cattle.



Letting water erode gullies -
This causes loss of valuable soil that could support cropping or grazing. Gullies can also damage houses and roads.

Not taking steps to stop erosion when harvesting trees on steep slopes – This can lead to sediment entering rivers.

Exposing cropping field soil to wind and rain - If the soil isn't covered, it can erode. It can also lose water and nutrients that are important for crop production.



WHAT ARE SOME BAD LAND USE PRACTICES?

WHAT SORT OF INTERVENTIONS ARE WE IMPLEMENTING WITH COMMUNITIES?

Slowing down run-off and capturing sediment with brushpacks



Planting Vetiver grass to slow runoff and capture sediment



Stopping erosion by building stone walls to capture sediment



Managing livestock and better grazing, for example, rotational resting of grasslands.



Cropping practices that protect the soil – such as using cover crops and minimum tillage methods



Clearing alien invasive plants from grazing lands and riparian areas



This phase of the project will run from October 2020 to September 2023 and we will keep you updated on our progress and share our experiences and outcomes of this action research on a regular basis.

Contact information: If you have any questions, please contact Jon McCosh - Institute of Natural Resources,
Tel: 033 346 0796, jmccosh@inr.org.za



TOWARDS COMMUNITY-LED WASTE DISPOSAL IN THE UMKHOMAZI CATCHMENT IN KWAZULU-NATAL, SOUTH AFRICA: A SITUATIONAL ANALYSIS AND EMBEDDED AWARENESS-RAISING CAMPAIGN ON NAPPY POLLUTION

Appendix B. Towards community-led waste disposal in the uMkhomazi Catchment

Schedule for community engagements

This document lists the questions/conservation catalysts that will be used for the three sets of community engagements planned for this component of this project. This document should be read in combination with the project proposal.

1. Engagements with Community-Based Monitors: Amangwane and Impendle

- Introduce the Reducing Pollution Through Partnership Project and the aim and objectives of the engagements with the group and broader community

[The following questions will be addressed using participatory exercises, conducted as word clouds, i.e. sticking key cards on flip chart paper]

1A) Defining waste

- i. What does the terms or concepts “waste” and “pollution” mean to the group?
- ii. When does waste become pollution?
- iii. Is waste polluting the environment in your areas, if so, which areas?
- iv. Would you say there is an issue with waste and pollution in your area?

1B) Identifying causes of waste

- i. How would we define waste?
- ii. Why is there an issue with waste?
- iii. Who are the biggest contributors to waste in the area (households, individuals)
- iv. What type of waste is produced? and How is the waste produced?
- v. Where are the waste hotspots? (what kind of environments and habitats are impacted by the waste?)
- vi. When is most of the waste produced (seasonal, events etc.)

1C) What are the impacts of waste

- i. What are the impacts of waste?
- ii. Which areas/environments are most impacted by waste? (do these environments contain animals/wildlife and flora?)
- iii. Are the people who live closer to the waste the most impacted and how? If not, why?

- Introduce the Reducing Pollution through Partnership and Nappy Waste project

[Discussion will focus on one type of solid waste, nappies, based on the aim of the project]

1D) Focusing on nappy waste

- i. Is nappy waste an issue in the area?
- ii. What are the causes of nappy waste?
- iii. Who are the main contributors to the nappy waste?

- iv. Do you believe that nappies are contributing pollution in the area and, if so, in aquatic and terrestrial habitats (habitats can also be marked on the aerial photo)?
- v. Where are the nappy waste hotspots [Participatory Mapping Exercise- using an aerial photo]?

1E) Potential solutions to waste issues

[These aspects will be briefly discussed in these initial engagements but will be discussed in more depth at the engagements with the broader communities]

- i. What are some of the potential solutions to waste issues – general waste and nappy waste? Is recycling and repurposing disposable biodegradable nappies a potential solution?
- ii. Who would be the main individuals/households/groups that will take responsibility for developing and implementing the potential solutions and interventions?
- iii. Who would derive benefit from the recycling/reuse of the nappies?
- iv. At what scale should the interventions be implemented?
- v. Who else outside of the community can we bring in to assist with implementing the interventions?
- vi. Are there any cultural barriers to the reuse of the nappies? If so, what are they and how can they be addressed?

2. Discussions with community-based monitors on awareness campaign

[Focus for this component will be on the target audience, messaging, tone, language, communication platform, dissemination platforms, communication barriers and challenges]

2A) In terms of implementing a campaign aimed at raising awareness on nappy waste:

- i. Who would we consider targeting with this campaign (e.g. households, schools, etc.)?
- ii. What type of messages would we try and convey in these campaigns?
- iii. How do we structure the messages: language, tone etc.?
- iv. How do we design and make these campaigns (i.e. materials and formats): images, posters, videos, story-telling etc.?
- v. How and where would we run these campaigns and how do we disseminate the information (e.g. schools, churches, community halls, awareness days etc.)?
- vi. What are some of the communication barriers and challenges that may be faced when trying to disseminate the information?
- vii. How would we overcome these barriers and challenges?

3. Schedule for 1st engagements with community members (X 3 communities)

- Introduce the Reducing Pollution Through Partnership Project and the aim and objectives of the engagements with the community

3A) Transect walks through the community

- This will involve walking with community members through their respective community to generate a spatial understanding of the people-environment-pollution interactions, identify pollution hotspots and note where most solid waste (particularly, nappy waste) is generated and concentrated.

3B) Participatory Mapping exercise

- Initial mapping exercise will be conducted to understand how the communities perceive their landscape in relation to pollution.
- GIS Map with grid overlay will be used to mark where waste hotspots are located and where pollution risks are.
- Focus Group Discussions

3C) Defining waste

- i. What do the terms or concepts “waste” and “pollution” mean to the group?
- ii. When does waste become pollution?
- iii. Is waste polluting the environment in your areas, if so, which areas?
- iv. Would you say there is an issue with waste and pollution in your area?

Identifying causes of waste

- vii. How would we define waste?
- viii. Why is there an issue with waste?
- ix. Who are the biggest contributors to waste in the area (households, individuals)?
- x. What type of waste is produced? and How is the waste produced?
- xi. Where are the waste hotspots? (What kind of environments and habitats are impacted by the waste?)
- xii. When most of the waste is produced (seasonal, events etc.)

1C) What are the impacts of waste

- iv. What are the impacts of waste?
- v. Which areas/environments are most impacted by waste? (do these environments contain animals/wildlife and flora?)
- vi. Are the people who live closer to the waste the most impacted and how? If not, why?

- Introduce the Reducing Pollution through Partnership and Nappy Waste project

[Discussion will focus on one type of solid waste, nappies, based on the aim of the project]

1D) Focusing on nappy waste

- vi. Is nappy waste an issue in the area?
- vii. What are the causes of nappy waste?
- viii. Who are the main contributors to the nappy waste?
- ix. Do you believe that nappies are contributing pollution in the area and, if so, in aquatic and terrestrial habitats (habitats can also be marked on the aerial photo)?
- x. Where are the nappy waste hotspots [Participatory Mapping Exercise- using an aerial photo]?

1E) Potential solutions to waste issues

[These aspects will be briefly discussed in these initial engagements but will be discussed in more depth at the second engagements with the broader communities]

- vii. What are some of the potential solutions to waste issues – general waste and nappy waste? Is recycling and repurposing disposable biodegradable nappies a potential solution?
- viii. Who would be the main individuals/households/groups that will take responsibility for developing and implementing the potential solutions and interventions?
- ix. Who would derive benefit from the recycling/reuse of the nappies?
- x. At what scale should the interventions be implemented?
- xi. Who else outside of the community can we bring in to assist with implementing the interventions?
- xii. Are there any cultural barriers to the reuse of the nappies? If so, what are they and how can they be addressed?

4. Schedule for 2nd Engagements with Community

- Reflect on discussions from 1st community engagement

- Reflect on mapping exercises (additions and edits to the maps provided)
- In depth discussions on potential solutions to waste issues

4A) Potential mitigatory interventions

- i. What are some of the potential solutions to waste issues – general waste and nappy waste? Is recycling and reusing a potential solution?
- ii. Who would be the main individuals/households/groups that will take responsibility for developing and implementing the potential solutions and interventions?
- iii. At what scale should the interventions be implemented?
- iv. Who else outside of the community can we bring in to assist with implementing the interventions?

4D) Process of co-designing interventions suggested by the community: Participants identify up to 5 potential interventions for mitigating nappy pollution at the community scale and then select 1 or 2 interventions that can be realistically implemented.

[If not suggested by participants, suggest nappy containment structures and the possibility of planting fruit trees].

4E) Facilitate discussion around implementation of the prioritised/selected interventions via a ranking exercise.

4F) Awareness Campaign: Subject awareness campaign suggestions made by community-based monitors to interrogation and mock test the awareness materials if possible

5. Design and Implementation of awareness-raising campaign around nappy pollution.

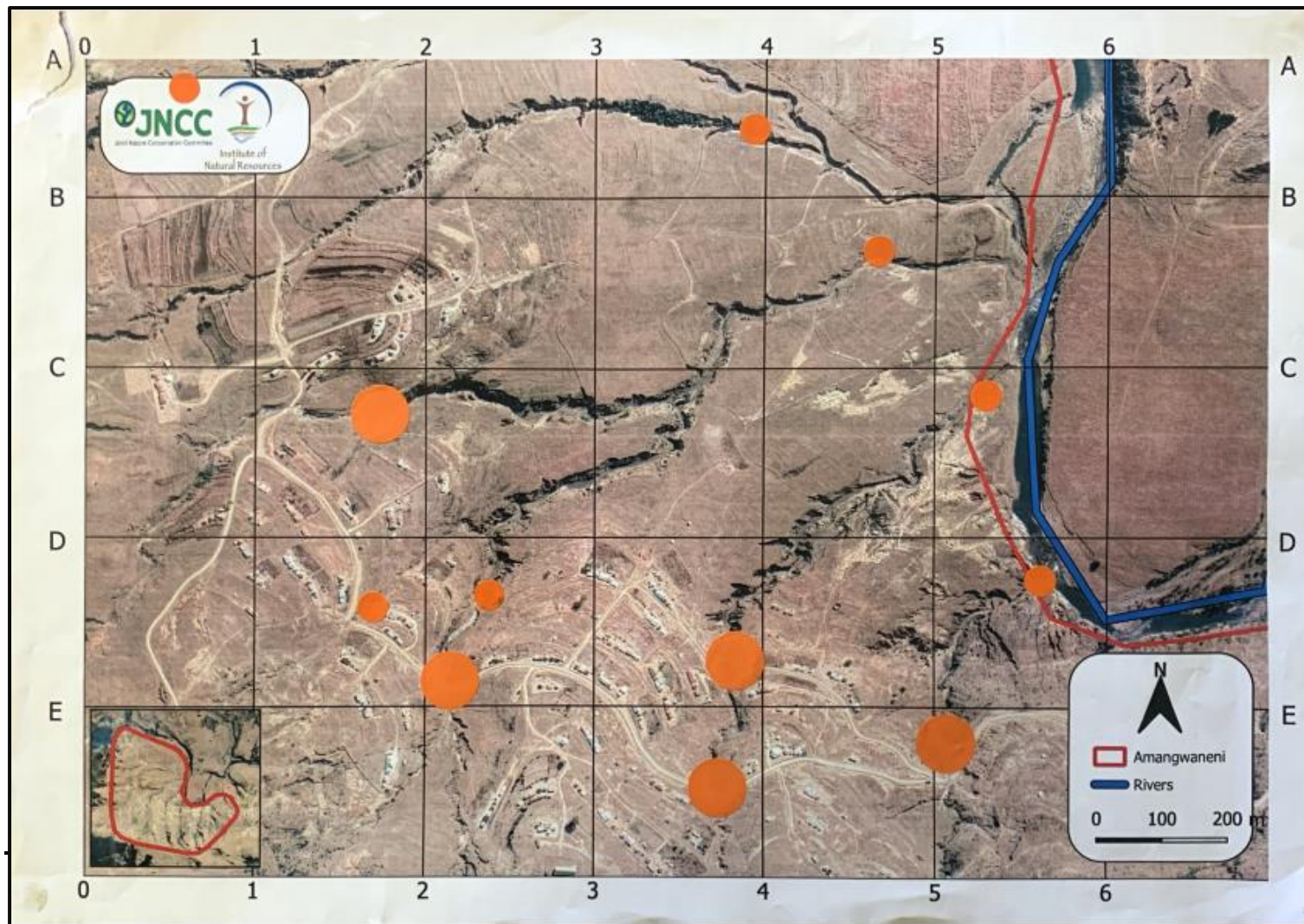
The design and implementation of the awareness campaign will be led by Snethemba Ndlovu and Lunga Dlungeane from the INR. The community-based monitors will champion the designing of the materials used in the campaign – based on the inputs received from the communities – and rolling out of the awareness campaign.

The materials that will be used in rolling out this component will include:

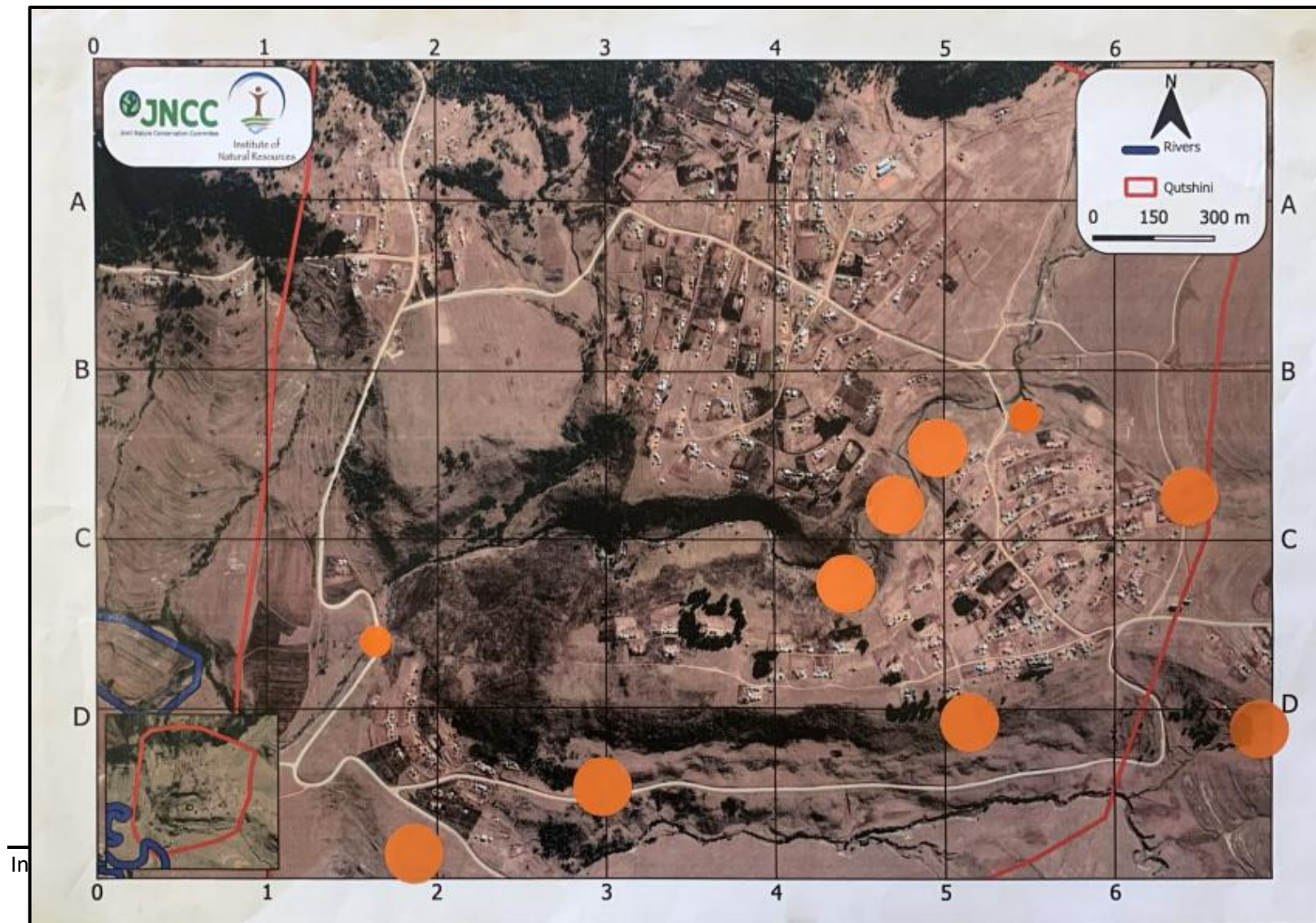
- Posters: Printed hard copies and digital
- Videos: These will be shot by the community-based monitors and edited with the assistance of the INR team. The videos will have the participants included in them as well as the activities (transect walks, participatory mapping exercises, group discussions etc.)
- Schools, youth groups and community clubs/committees will be target.

Appendix C. Nappy waste hotspot locations identified during the participatory mapping exercise

1. Amangwane Community




2. Impendle Community





Appendix D. Pamphlet used in the nappy waste awareness campaign

Lets stop nappy waste pollution together



HEALTHY ENVIRONMENT - HEALTHY COMMUNITY


Supported by:
 Institute of Natural Resources NPC


DID YOU KNOW?
 Nappies require approximately 500 years to decompose fully. If nappies are unsafely discarded along rivers and open veld, they can cause long lasting environmental health impacts.

THE NEGATIVE IMPACTS OF NAPPY WASTE POLLUTION


UNHEALTHY ENVIRONMENT

Dumping nappies can create an unhealthy environment. This includes unpleasant smells, flies and dogs, leading to unhygienic conditions and diseases.




POLLUTES WATER RESOURCES

Nappies discarded into rivers and streams can contaminate water resources. If people consume nappy contaminated water, they can get sick.




ENDANGERS LIVESTOCK


Livestock that drink water from nappy polluted rivers and streams can get sick. Animals that are in contact with nappies could spread pathogens and transmit diseases to the community.




WHAT CAN WE DO TO STOP NAPPY WASTE POLLUTION




NEVER DISCARD NAPPIES INTO RIVERS AND STREAMS



NEVER DISCARD NAPPIES IN OPEN VELTS, BUSH CLUMPS, FOREST OR ON MOUNTAINS




INSTEAD, COLLECT USED NAPPIES AND PLACE THEM IN REFUSE BAGS




OR, FAMILIES CAN USE REUSABLE CLOTH NAPPIES INSTEAD OF DISPOSABLE NAPPIES

LET'S WORK TOGETHER AS A COMMUNITY TO OVERCOME NAPPY WASTE

HEALTHY ENVIRONMENT - HEALTHY COMMUNITY

Produced by
 Institute of Natural Resources NPC

In collaboration with
Community of Amagwane and Impendle

Supported by


For help with stopping nappy waste pollution in your community, contact info@inr.org.za

Appendix E. Poster A used in the nappy waste awareness campaign



Appendix F. Poster B used in the nappy waste awareness campaign



[Click here to access](#)



Appendix H. Disposable nappy waste pollution awareness campaign: Door-to-door canvassing register

 <p>Institute of Natural Resources</p>	<p>Disposable Nappy Waste Pollution Awareness Campaign</p> <p>Door to Door Canvassing Register</p>	 <p>Joint Nature Conservation Committee</p>
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No.	Name	Surname	Community	Contact Number	Receipt of Pamphlet	Receipt of bin bags/waste buckets	Signature
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							

TOWARDS COMMUNITY-LED WASTE DISPOSAL IN THE UMKHOMAZI CATCHMENT IN KWAZULU-NATAL, SOUTH AFRICA: A SITUATIONAL ANALYSIS AND EMBEDDED AWARENESS-RAISING CAMPAIGN ON NAPPY POLLUTION

Appendix I. Schedule for Community Engagements that fed into Monitoring and Evaluation

This document contains a list of themes and questions that will guide the monitoring the community engagements that for part of the monitoring and evaluation process for the nappy pollution awareness campaign.

1. Engagement with Community Members and Community-Based Monitors: Amangwane and Implendle

- Community engagements will be conducted in each community using focus group discussions to ascertain the effectiveness and success of the awareness campaign.
- Re-introduce the Reducing Pollution Through Partnership Project and summarize the community engagements held with the citizen scientist and the broader community. Provide a synopsis of the co-design workshop and the implementation of the nappy waste awareness campaign.

[The following questions will be addressed using participatory exercises, conducted as word clouds, i.e., sticking key cards on flip chart paper]

1A) Reflection on the implementation of the awareness campaign

- i. How would you describe the success of the awareness campaign?
- ii. Do you feel that the community's ideas and suggestions were well reflected in the campaign (design, structure, materials, and format)?
- iii. Did your expectations and actual implementation of the campaign match? If not, why?
- iv. Were the community-based monitors effective at championing the awareness campaign on behalf of the community? (only applicable to community members)

1B) Reflection on materials used in the awareness campaign

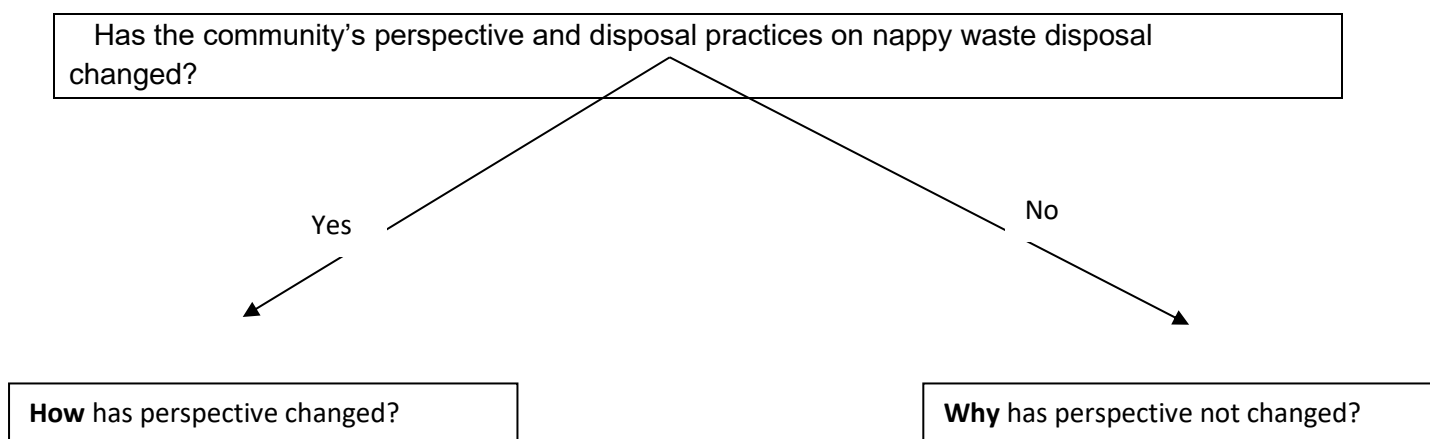
- i. How would you describe the design of the awareness campaign materials?
- ii. Can you recall seeing any awareness campaign materials? If yes, where?
- iii. How impactful was the pamphlet in raising awareness about the existing nappy waste problem in the community?
- iv. How impactful were the posters in raising awareness about the current nappy waste problem in the community?

- v. How impactful was the video in raising awareness about the existing nappy waste problem in the community?
- vi. How impactful were the waste buckets and refuse bags in assisting the community manage nappy waste?
- vii. Which platforms of communication were most effective at conveying the message of the awareness campaign (e.g., door-to-door canvassing, WhatsApp, local shops, schools, churches, community halls, etc.)
- viii. If you could change anything about the campaign materials, what would it be?

NB: In addition to the discussions, a scale will be applied to measure the effectiveness of the materials used in the awareness campaign. The scale parameters are: 1 -Not impactful, 2 - Slightly impactful, 3 -Impactful and 4- Very Impactful.

1c) Evaluating the effectiveness of the awareness campaign

[This section will be facilitated through focus group discussions using a flow diagram to guide discussions between community members.]



1d) Holding the space: Community involvement and way forward

Facilitated discussions of how the community can hold the space to keep the momentum of managing nappy waste disposal through active involvement and communication. Also, reflect on what the community expects going forward and embarking on the next step of managing nappy disposal and implementing the community-led nappy waste interventions suggested at previous community engagements. Finally, reflect on the structure and process of community engagements and aspects that were facilitated well compared to those that need to be improved going forward.

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