UNDP/PAPP *Gaza Insights* Series

Impact of the War on Solid Waste Management in the Gaza Strip

Executive Summary

October 2024

This Executive Summary provides an overview of key findings from an assessment on the **impact of the ongoing war on solid waste management in the Gaza Strip**, recently carried out by UNDP's Programme of Assistance to the Palestinian People (PAPP) as part of its *Gaza Insights* series.

The Gaza Insights series is a **UNDP/PAPP initiative**, working in **close collaboration with relevant local, international, and UN partners** to gain insights and perspectives on different aspects of the situation in Gaza, to inform immediate and medium-term responses on the ground.

The Gaza Insights are developed through various qualitative and quantitative research methods that can be applied within the current security conditions and access limitations in Gaza, which do not allow for large samples or validation of information.

INTRODUCTION

The ongoing war in the Gaza Strip has resulted in a humanitarian crisis of unprecedented scale, with the entire population of 2.1 million people needing urgent assistance, now more than ever. Between 7 October 2023 and 2 October 2024, at least 41,689 Palestinians have been killed in the Gaza Strip – with around 70% being women, children, and the elderly [1]. Over 96,625 more were injured [2], while thousands more are still missing under the rubble. Homes, healthcare facilities, schools, electricity and water networks, and other critical infrastructure have been damaged and whole neighbourhoods have been destroyed, while the humanitarian aid currently being allowed into Gaza represents only a drop in the ocean compared to the enormous needs on the ground, particularly since the closure of the Rafah crossing in early May.

Since the beginning of the war, approximately 1.9 million people (i.e., 90% of Gaza's population) have been forced to flee their homes and have become internally displaced, including many families being displaced multiple times in search for safety [3]. Hundreds of thousands of internally displaced persons (IDPs) have been forced to seek refuge in overcrowded shelters and makeshift tented camps, struggling to survive in extremely unsanitary conditions and with little to no access to basic necessities.

Local capacities and infrastructure for solid waste management have been crippled by the ongoing war, including the inaccessibility of the two main sanitary landfills (i.e., Al-Fukhary/Sofa and Johr Al-Deek), thus leading to the proliferation of temporary waste dumping sites and the accumulation of solid waste (including hazardous medical waste) in the streets and around IDP shelters and makeshift camps. These unregulated dumping sites, containing almost half a million tons of solid waste often contaminated with a range of hazardous materials, have been acting as breeding ground for disease vectors – such as mosquitoes and rats. A further serious risk is posed by hazardous medical waste, which is contaminating solid waste because of the medical waste treatment facilities being destroyed during the war.

The risks associated with these unregulated temporary dumping sites will be further amplified during the rainy season when hazardous substances within the waste, including untreated feces, will be mobilized and will leach into the soil and possibly into the shallow aquifer. Inevitably, the war-induced collapse of solid waste management in the Gaza Strip is further compounding the already dire humanitarian and public health crisis, as well as having longer-term environmental and economic implications. The severe impact on public health and the longer-term environmental risks can only be mitigated through urgent restoration of solid waste management systems and capacities, including proper management of the proliferating temporary dumpsites across the Gaza Strip.

1. OCHA. Reported Impact Snapshot | Gaza Strip. Available at: https://www.ochaopt.org/content/reported-impact-snapshot-gaza-strip-2-october-2024
2. Ibid.
3. Ibid.

Against this backdrop, UNDP's Programme of Assistance to the Palestinian People (PAPP), together with a team of national and international experts, carried out an assessment to shed light on the impact of the war on solid waste management in the Gaza Strip, with an end view to inform immediate emergency interventions addressing the worsening solid waste crisis and mitigating its public health and environmental consequences. It is relevant to highlight that the findings of this assessment informed UNDP/PAPP's ongoing support to solid waste management in the Gaza Strip, which is enabling the collection of approximately 680 tons of solid waste per day in Rafah, Khan Younis, and Middle Area, including by engaging the private sector. Such assessment has also been instrumental in shaping UNDP/PAPP's proposed interventions to restore and scale up solid waste management capacities and services in the immediate to short-term (i.e., over an 18-month period) – resulting in a comprehensive offer of $62 million, which encompasses proper waste collection, adequately managed disposal sites, medical waste treatment (including hazardous waste), and operational capacities of Joint Service Councils (JSCs).

The assessment focused on the following key elements:

- The current quantities and locations of waste generation being accumulated, as well as the damage to solid management infrastructure and its repercussions, including the disposal of waste in temporary and unregulated dumping sites;
- The current municipal capacities for solid waste management, identifying gaps and priority needs in terms of equipment as well as workforce; and
- The current resources of relevant private sector actors, and their capacity to participate in and contribute to the restoration and continuity of operations in the solid waste management sector.

A mix of quantitative and qualitative data collection and analysis tools were deployed as part of this assessment, leveraging the extensive experience of the team of experts/consultants in environmental assessments. All primary and secondary information obtained by the team of experts/consultants has been through a process of triangulation – whereby all data gleaned through the initial Desk Study was crossed referenced and corroborated through stakeholder interviews, the latest satellite imagery, and data generated from site visits and inspections. Structured interviews were carried out with representatives of both Joint Service Councils (JSCs), solid waste management engineers from twenty-five municipalities, representatives from five hospitals and Gaza's contractors' community for the solid waste management sector.

KEY FINDINGS

Despite various investments in recent years to expand and improve solid waste management, prior to the war the Gaza Strip was already faced with significant solid waste-related challenges and was struggling to manage the estimated 1,700 tonnes of solid waste generated each day. Eleven months of war have significantly worsened the already serious situation. The destruction of waste containers, collection vehicles, transfer stations and landfill equipment has left the municipalities and JSCs unable to cope. As early as October 2023, the war-related breakdown of solid waste management systems was already evident and by November the transfer of waste to landfills was halted - primarily due to fuel scarcity, as well as security concerns impeding access (UN-OCHA 2023; UN-OCHA 2024b).

The entire range of solid waste management equipment and infrastructure, including containers, vehicles, transfer-stations, landfills, and equipment for the treatment of hazardous medical waste, has been decimated. Thus, the war has resulted in the **collapse of solid waste management systems and capacities** in the Gaza Strip, leading to a solid waste crisis – evidenced by the unprecedented accumulation of solid waste in the streets and the proliferation of unregulated temporary dumping sites. This, in turn, **further exacerbates the already alarming public health crisis**, with solid waste cumulating in the streets and in uncontrolled temporary dumping sites, often situated in close proximity to IDP shelters and makeshift camps and acting a breeding ground for disease vectors.

In addition to the alarming public health crisis, the collapse of solid waste management capacities and services in the Gaza Strip comes with **serious environmental consequences and risks**. Contaminants within the festering dumping sites are migrating into the soil, ultimately affecting the groundwater and coastal marine environment as well. If not urgently addressed, the solid waste crisis in the Gaza Strip will profoundly disrupt the natural ecosystem, leading to long-term environmental damage that will take decades to remediate.

Amount, composition and location of solid waste

Between October 2023 and May 2024, the amount of waste generated in the Gaza Strip is estimated to vary from 1,400 to 1,500 tons per day. According to UNDP/PAPP's estimates in 2022, organic food waste used to account for 74% of the average municipal waste generated in the Gaza Strip. However, since the onset of the war, the average composition of solid waste has changed significantly, with organic food waste reducing and tin cans considerably increasing. This is due to the limited availability of fresh produce and the increased reliance on canned food.

Moreover, with the war-induced collapse of solid waste management systems and capacities as well as the inaccessibility of the Al-Fukhary (Sofa) and Johr Al-Deek landfills, the Gaza Strip has seen a proliferation of unregulated temporary dumping sites. The North and Middle Area governorates account for the highest number of large (i.e., more than 2,000m2) temporary dumping sites (figure 1).

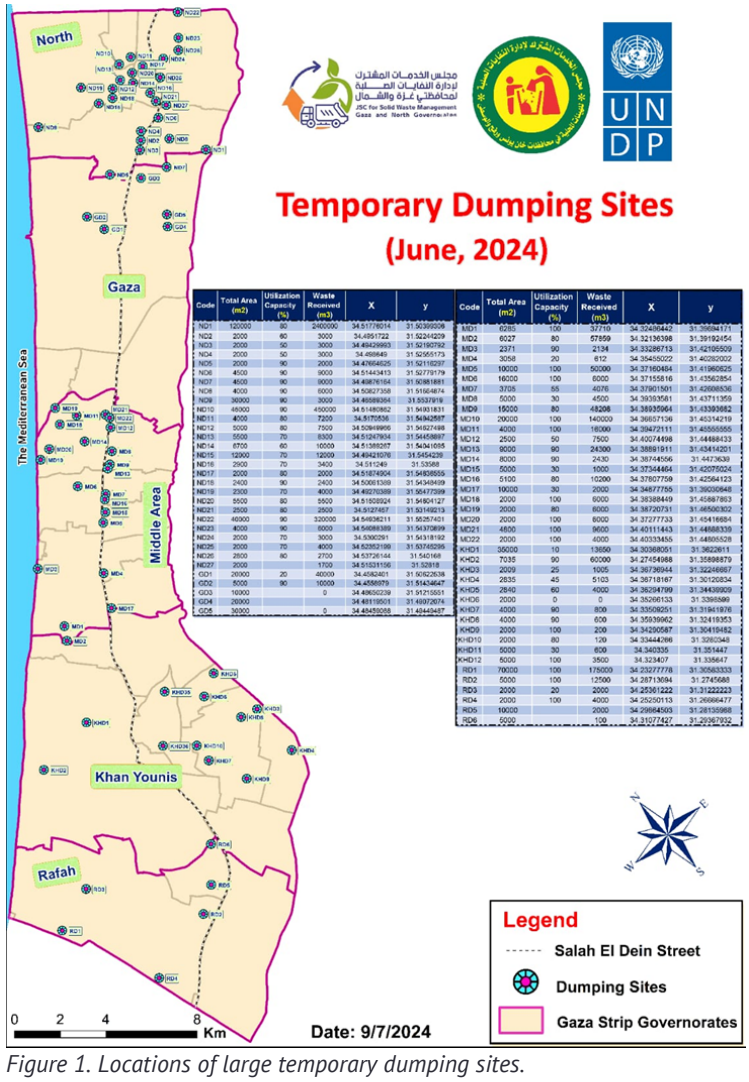

Figure 1. Locations of large temporary dumping sites.

Damage to municipal infrastructure for solid waste management

UNDP/PAPP's team of experts/consultants estimated that the solid waste management sector has suffered approximately **$60 million in damages**, up to end of May 2024. These figures are expected to be further increasing as the war continues, with additional infrastructure being damaged and/or destroyed. This includes damage to waste collection and transfer vehicles, waste containers, landfill equipment, landfill components and units, waste transfer stations, solid waste management facilities (including furniture and spare parts), operational vehicles used in waste management, as well as the medical waste collection and treatment system, and waste sorting facilities. **Waste collection vehicles** account for the highest share of damage costs (35%), followed by **waste management facilities** (17%) and **waste containers** (16%).

Table 1. Overview of damage costs by type of solid waste management infrastructure.

Solid Waste Management Infrastructure	Damage Cost (US$)	Percentage
Waste Collection and Transport Vehicles	21,276,000	35%
Waste Containers	9,673,000	16%
Movement Vehicles	1,778,000	3%
Waste Management Facilities	10,418,000	17%
Transfer Stations	182,000	0.3%
Medical Waste collection and treatment	3,943,000	6%
Landfill Damage	3,610,000	6%
Landfill Equipment	6,535,000	11%
Sorting Facilities	1,000,000	2%
Other Damages	2,298,800	4%
Total	**60,713,800**	**100%**

An estimated **206 waste collection vehicles** have been directly impacted by the war, with 107 vehicles fully destroyed and 99 damaged yet with possibility of being repaired. Furthermore, some **61 waste transfer vehicles** have been affected, out of which 32 were fully destroyed and 29 have been damaged. Overall, as of end May, some 80 - 90% of all waste collection and transfer vehicles in the Gaza Strip were either destroyed or seriously damaged. Moreover, about 6,156 waste containers of various sizes were damaged during the ongoing war.

With regards to the **waste transfer station facilities** (i.e., El-Yarmouk waste transfer station – Gaza City; Rafah waste transfer station; and Khan Younis waste transfer station, which was modified to contain a hazardous medical waste treatment facility), the JSC-KRM believes that the entire Rafah facility has been destroyed, and the Khan Younis transfer station has suffered severe damage, though this has not yet been confirmed. Moreover, the El-Yarmouk transfer station has been almost totally damaged.

Furthermore, the team of experts/consultants assessed a **comprehensive range of waste management facilities**, including JSC administration buildings, municipal buildings, control rooms, maintenance workshops, garages, spare parts, and fuel storage locations.

In the northern Gaza Strip, 100% of these facilities were destroyed, while in the southern governorates 50% of facilities were destroyed and the remaining 50% have been severely or partially damaged.

Concerning the two **landfills**, the majority of **equipment and machinery** therein was found to have been destroyed or severely damaged, including bulldozers, wheeled-loaders, sheep-foot compactors, Bobcats, backhoe-loaders, tippers, water and leachate pumps and gas-flaring units. **Landfill infrastructure**, including access roads, leachate collection systems and lagoons, stormwater channels and lagoons, fences, control-rooms and weighbridges, have also been either destroyed or severely damaged.

Despite various emergency cash-for-work interventions to help restore solid waste collection, there continues to be a serious war-induced **gap in workforce** for solid waste management, including due to death, injuries, and the recurrent waves of internal displacement. In total, 935 municipal workers were involved in waste collection and disposal during the assessment period (May – June 2024), comprising 410 core municipal staff and 525 temporary workers hired through cash-for-work programs. It is worth noting that all administrative, technical, and operational staff at the two JSCs have not received their salaries since October 2023.

With regards to **medical waste**, the significant investments and progress made during 2020 - 2023 - including the establishment of two main medical waste treatment facilities, with a capacity to treat about 2.5 tons per day of infectious waste and benefiting more than 140 healthcare facilities - have been lost, with most treatment units (autoclaves, incinerators, and microwaves) destroyed, along with collection vehicles and treatment buildings. Where limited equipment does remain functional, its use is seriously impeded by lack of fuel and frequent power cuts. Thus, large quantities of medical waste (including hazardous materials) are now being routinely dumped along with municipal waste, further compounding public health risks particularly to sanitation workers and waste-pickers.

Public health and environmental risks

The collapse of the solid waste management systems and the resulting solid waste crisis directly threatens the health of over 2 million people in the Gaza Strip, increasing the risk of more disease outbreaks and straining an already overwhelmed healthcare system. Key **public health risks** associated with the deteriorating solid waste crisis include:

- increasing spread of **infectious diseases**, including vector-borne diseases;
- increasing **water contamination and air pollution**, which in turns increases risks of water-borne diseases and respiratory infections;
- further **deteriorating psychological distress and trauma**, as people struggle for survival and are faced with inhumane living conditions, surrounded by piles of waste;
- higher risks of **adverse birth and neonatal outcomes** for pregnant women living near solid waste dumping sites [4].

5. Vinti, G.; Bauza, V.; Clasen, T.; Medlicott, K.; Tudor, T.; Zurbrügg, C.; Vaccari, M. Municipal Solid Waste Management and Adverse Health Outcomes: A Systematic Review. Int. J. Environ. Res. Public Health 2021, 18, 4331. https://doi.org/10.3390/ijerph18084331

Furthermore, the ongoing war and the resulting collapse of solid waste management in the Gaza Strip significantly threatens the **occupational health and safety of waste management workers**, who are faced with multiple compounding risks. These include the risk of being exposed to physical hazards - including exposure air and artillery bombardment, as well as to unexploded ordnance (UXO) – as well to biological and chemical hazards, including infectious diseases contracted from solid waste and exposure to toxic substances. The lack of Personal Protective Equipment (PPE) further compounds all such risks for waste management workers.

In addition to workers handling collection of solid waste, **several population groups face additional compounded health risks** in light of the deteriorating solid waste crisis, including immunocompromised individuals, pregnant women and malnourished children, and elderly with chronic diseases (e.g., diabetes), as well as internally displaced persons (IDPs) sheltering in healthcare facilities and those in close proximity to temporary dumping sites.

The solid waste crisis also comes with **multifaceted environmental impact and risks**, from already increasing pollution to lasting damage to the ecosystem and degradation of natural resources in the long run.

Table 2. Overview of environmental risks associated with the solid waste crisis.

	Impact
Destruction of Infrastructure	The breakdown of the SWM services and infrastructure has resulted in a proliferation of countess dumpsites. The waste therein contains a range of hazardous materials including chemicals, hydrocarbons, asbestos, human waste (faeces) which will mobilize into the local environment - impacting the quality of soil and ground water.
Air Pollution	Burning dumpsites and using waste for combustion in food preparation release pollutants such as particulate matter, chemicals, and toxic gases into the air, leading to poor air quality.
Soil and Water Contamination	The use of munitions and explosives contaminates soil and water with chemicals and heavy metals. These can persist in the environment for the long-term and affect agri-food production, as well as migrate into the marine environment.
Agriculture	Bombardments and military operations, plus uncontrolled dumping of waste, damages and pollutes agricultural land and drainage infrastructure - making the land unfit for cultivation. These factors affect food security as well as the livelihoods of farmers.
Biodiversity	The proliferation of uncontrolled dumping sites, some of which are routinely set on fire, destroy natural habitats, affecting biodiversity. Wildlife is displaced or killed, and ecosystems are disrupted.
Marine Environment	Run-off (containing a cocktail of pollutants) from uncontrolled dumpsites can leach into the marine environment, via surface and groundwater – polluting the coastal environment and harming marine life.
Long-term Environmental Degradation	Pollutants and chemical residues from waste can persist in the environment for years, causing long-term environmental degradation.

Barriers to the restoration of solid waste management

Immediate interventions are urgently needed to address the solid waste crisis and restore solid waste management in the Gaza Strip, to mitigate public health impact and longer-term environmental implications. However, there are various **financial factors and operational complexities** that create obstacles to the timely and at-scale restoration of solid waste management systems and capacities, which can only be addressed through a coordinated approach involving international support.

Table 3. Overview of key barriers to the restoration of solid waste management.

	Key obstacles
Operational Costs	The operational costs for solid waste management services are excessively high due to fuel shortages and inflated prices for spare parts. These operational costs are a continuous burden on the already strained financial resources of the Joint Service Councils and municipalities.
Inaccessibility of Landfills	The continued inaccessibility of the two main landfills (Al-Fukhary – Sofa and Johr Al-Deek) is one of the major barriers hindering the restoration and continuity of effective solid waste management services at scale.
Limited Funding and Donor Fatigue	Financial aid from international donors for Gaza has been inconsistent over the years, with the current funding being insufficient compared to the massive humanitarian needs. "Donor fatigue" might also become a concern, potentially reducing the inflow of essential funds required for restoring solid waste management services.
Restricted Access to Resources	Due to the further tightened blockade on the Gaza Strip, there are significant restrictions on the entry of necessary fuel, equipment and materials required for the restoration of solid waste management services. This will further delay recovery and increase the costs.
Damage to Solid Waste Management Infrastructure	The ongoing war has caused extensive damage to essential infrastructure for solid waste management, as outlined in previous sections. The cost of repairing and/or replacing these will be substantial, and the limited donor funding for Gaza will likely create competition between addressing the solid waste crisis and other pressing humanitarian needs (e.g., access to clean water, food aid, healthcare).
Economic Instability	The overall economic situation in Gaza is dire, with extremely high unemployment and poverty. This limits the ability of municipalities to generate financial resources through the collection of taxes or service fees, further reducing the already limited budget available for solid waste management services.
Dependency on External Aid	Reliance on inconsistent donor aid makes the financial planning for the restoration and sustainability of solid waste management extremely challenging. When aid is frozen, delayed or reduced, it directly impacts the ability to provide solid waste management services.
Limited Private Sector Engagement	The economic and political environment in Gaza deters private sector engagement with the solid waste management sector. Targeted measures are needed to incentivize private sector's engagement and support towards the recovery and continuity of solid waste management services.

Private sector's role in solid waste management

Since the onset of the war, a small number of local private sector companies experience in solid waste management have exhibited effective crisis management models, by offering limited waste collection and waste transfer services under extremely hostile circumstances – although at limited scale compared to the enormous needs on the ground. Such private sector entities have also expressed willingness and interest in participating in and supporting future solid waste management activities, namely primary collection and transferring waste to designated dumping sites/landfills.

However, each of these companies expressed concern over the serious challenges encountered as a result of drastically higher operating costs. For instance, fuel costs are reported to have increased ten-fold since the onset of the war. Another factor constraining private sector engagement in solid waste management activities is that of increased labor costs, which are partly a reflection of the hazardous working conditions.

RECOMMENDATIONS

Against the backdrop of an unprecedented solid waste crisis in the Gaza Strip as a result of the ongoing war, several conditions need to be in place to enable accelerated restoration and at-scale delivery of solid waste management services. These include first and foremost an **immediate ceasefire**, enabling alleviation of the suffering of civilians across the Gaza Strip through at-scale humanitarian assistance and early recovery efforts – including with regards to mitigating the public health, environmental and socioeconomic impact of the solid waste crisis. **Entry of required material, equipment, spare parts, and fuel** into the Gaza Strip is also essential for further scaling up solid waste collection, transportation, and proper disposal, as well as proper treatment of hazardous and non-hazardous medical waste. Last but not least, dedicated support to restore and strengthen the **institutional and operational capacities of service providers** is essential to ensure at-scale and sustained delivery of solid waste management services in the Gaza Strip.

While stressing the criticality of such enabling conditions, UNDP/PAPP has already been developing an **immediate and medium-term interventions plan** to restore and support continuity of solid waste management in the Gaza Strip, in collaboration with the Ministry of Local Government, and technical experts from municipalities and Joint Service Councils (JSCs), as well as in consultation with other relevant actors as part of the Solid Waste Management Taskforce, co-led by UNDP/PAPP together with the WASH Cluster. The proposed plan focuses on the following four priority areas:

1. **Enhance Waste Collection and Transportation Capacity**

   While municipalities, JSCs and the United Nations Relief and Works Agency (UNRWA) continue to play a critical and leading role in managing waste, efforts to address the solid waste management crisis and challenges could be complemented by engaging the private sector to handle 25% of waste collection and transport in 2024, increasing to 50% in 2025. This includes rental of vehicles from the private sector to support and expand capacity of local service providers for waste collection. Such approach can alleviate the burden on local service providers, which will continue to manage the remaining waste with existing vehicles - although these are requiring significant maintenance.

Additionally, the proposed plan involves the removal of waste from 72 temporary dumping sites to landfills, the procurement of 324 new and second-hand waste collection vehicles, and the supply of personal protective equipment (PPE) for workers.

2. Improve Existing Waste Disposal Practices

The proposed plan prioritizes the rehabilitation and proper operation of temporary dumping sites, which are currently posing significant public health risks due to their close proximity to Internally Displaced Persons (IDPs). Key mitigation measures include partially covering the waste with protective layers, fencing off the sites to limit access, and ensuring waste slopes are maintained at safe angles and heights. Emergency operations will include deployment of heavy machinery, including wheel loaders and excavators, to level the waste and ensure safe operation at these sites until access to the two main landfills, Al-Fukhari (Sofa) and Johr Al-Deek, is restored. Both landfills will undergo detailed damage assessments to identify rehabilitation needs and expand capacity by up to 30%, supported by the supply of bulldozers, wheel loaders, excavators, and other essential machinery. Private sector involvement will be leveraged by renting tipper trucks and loaders for 12 months. Additionally, compacting machines for baling tin cans will be supplied to improve waste recovery efforts, alongside pest control tools and pesticides to manage disease risks near IDP shelters.

Moreover, as part of the UN's winterization plan, UNDP/PAPP conducted a solid waste assessment in collaboration with UNICEF, which identified 21 temporary dumping sites - out of the 141 created during the war - as being located in flood-prone areas, where 30,000 cubic meters need to be removed from 7 sites as first priority. These sites are at high risk of being impacted by the upcoming rainy season, potentially affecting the surrounding environment and the IDPs, with significant public health risks. It is recommended to focus on removing waste from these and other temporary dumping sites, particularly in flood-prone areas and streams.

3. Improve Existing Medical Waste Management

Recognizing the critical need for effective management of hazardous and non-hazardous medical waste, the plan proposes the supply and installation of autoclaves (70-90 liters) across healthcare facilities for pre-treating biological waste from laboratories. This will be supported by providing sharps boxes (5L and 10L), small bins, and nylon bags for safe segregation and disposal. Additionally, metallic trolleys (150-200 liters capacity) and electrical generators will need to be supplied to facilitate waste transport and autoclave operation. The proposed interventions plan also includes the provision of laundry machines (50-60 kg capacity) and dryers (70-80 kg capacity) to maintain hygiene. Four new medical waste collection vehicles will also need to be supplied to replace damaged ones, while the existing facility in Khan Younis will need to be rehabilitated. The plan also includes installing two microwaves (1.5 tonnes/day each) and two incinerators for treating infectious waste. Furthermore, healthcare workers and staff of local service providers shall receive training, supported by the provision of PPE, sanitizers, and cleaning materials to ensure the safe handling and processing of medical waste.

4. Strengthen Operational Capacities of Service Providers

The proposed plan aims to ensure the sustained operation of waste management services, supporting service providers in covering operational costs, rehabilitating partially damaged facilities, as well as renting new offices. The rehabilitation activities and support to operational capacities of service providers entail restoring solid waste management infrastructure in the Gaza Strip, including landfills, transfer stations, and maintenance workshops. UNDP/PAPP will establish a Technical Operations Unit (TOU) to manage assets and ensure regulatory compliance. The proposed priority interventions also include developing a winter plan for waste management, deploying workers to support waste collection at IDP shelters, and providing capacity-building for staff of service providers. Additionally, community outreach and awareness will focus on waste reduction, waste sorting, and waste-related hazards, as well as UXO/ERW awareness for IDPs and host communities.

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