

### INTRODUCTION

The Kanifing Municipal Council (KMC) faces a variety of challenges in their pursuit of closing the Bakoteh dumpsite and opening a sanitary landfill. Warrior Consulting has designed an actionable, attainable, and affordable solution to achieving this goal.

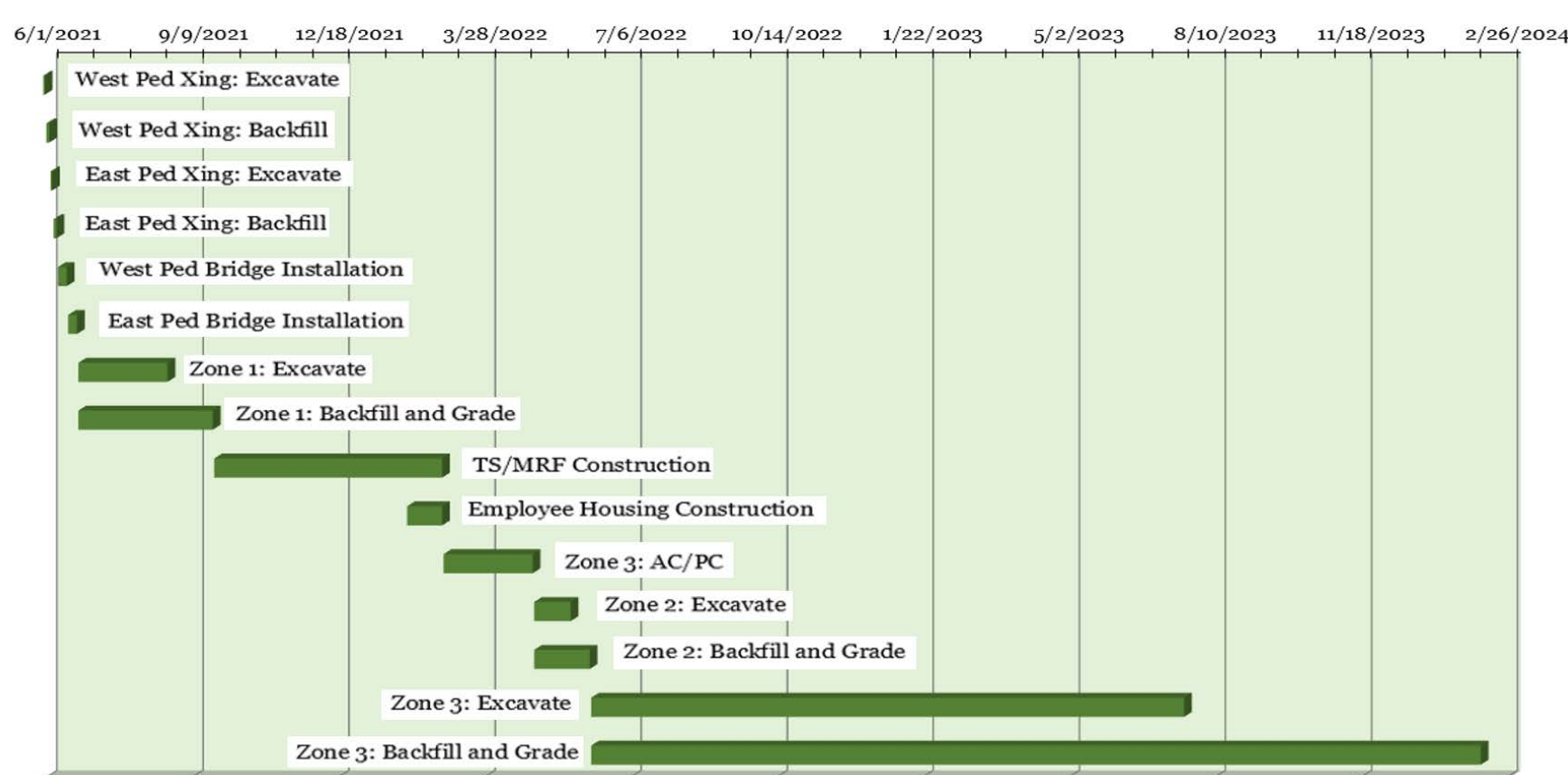
### OBJECTIVES

1. Close the Bakoteh dumpsite in a way that protects people and the environment, while taking care not to displace residents.
2. Design a new landfill with modern waste safety measures, including leachate management, gas collection, and daily cover

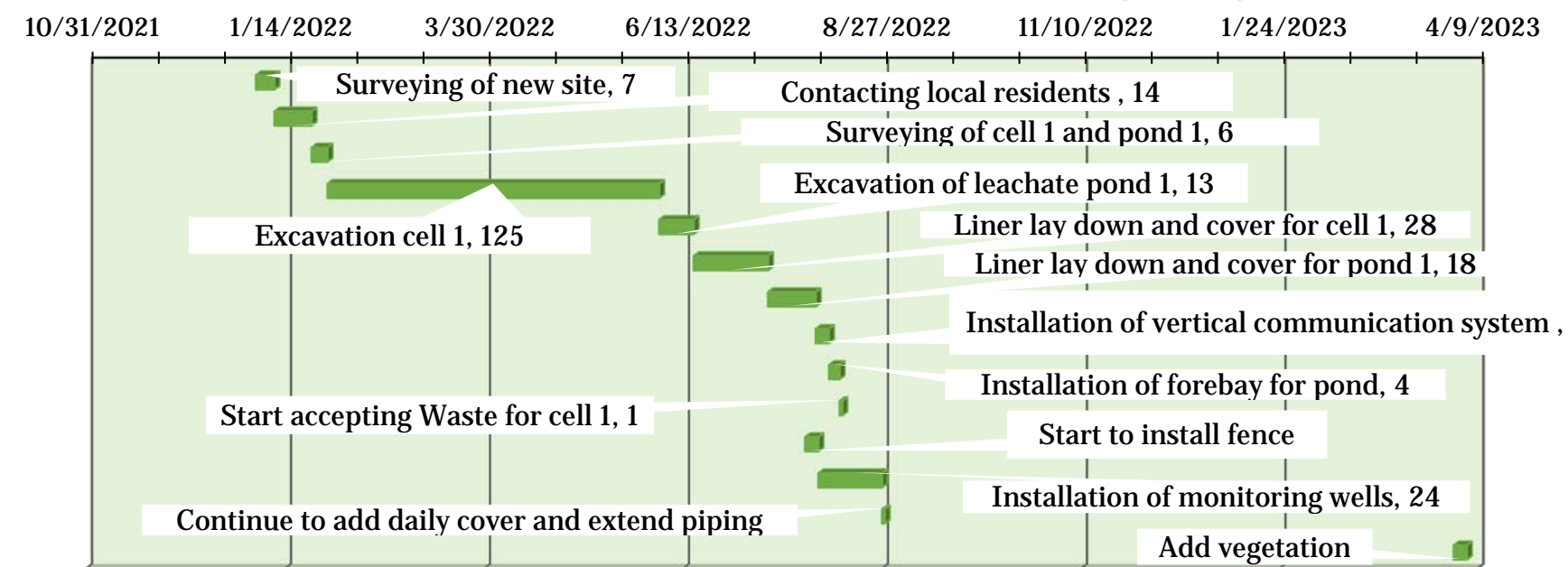
### RECOMMENDATION

The Bakoteh dumpsite shall be closed using an incremental mining approach: three zones shall be mined one at a time. The East area (Zone 1) will be first and the largest, middle area (Zone 3) last. A Transfer Station and Material Recovery Facility (TS/MRF) shall be constructed in Zone 1. The new landfill construction shall follow a similar approach of cell-by-cell construction and is sized to accommodate the needs of the KMC as well as the surrounding municipalities.

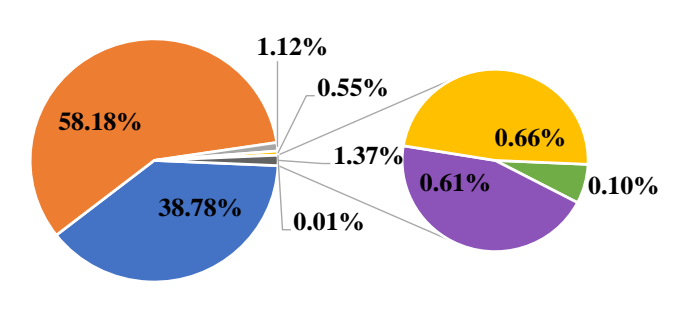
### Closure Schedule



### New Landfill Construction Schedule (Cell 1)

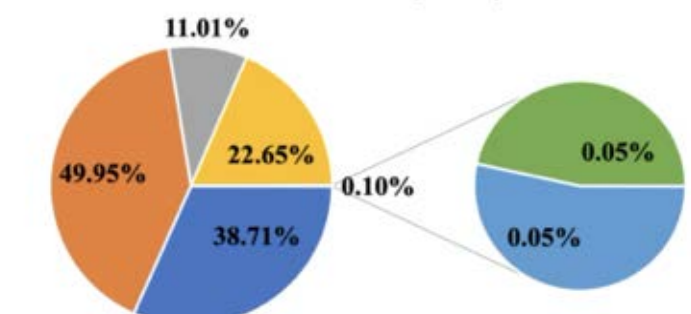


### Cost Estimate (Dalasi)



Closure & TS/MRF Cost

### Cost Estimate (Dalasi)



New Landfill Cost

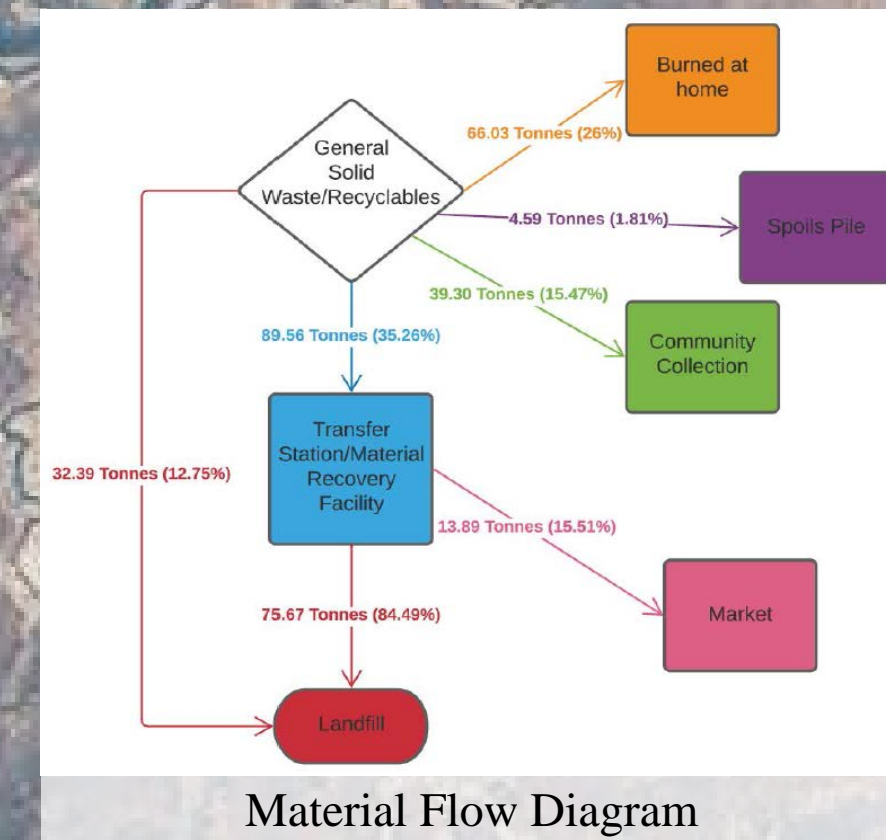
### CONCLUSION

The recommended solution is a balance of immediate relief for Bakoteh with long-term risk mitigation and minimizing the current waste management limitations in The Gambia through capacity-building. The technology selections were made with limited infrastructure in mind, utilizing accessible solutions like passive solar vent flares for landfill gases and existing wells for groundwater monitoring. The stepwise plans will make meaningful changes quickly while working toward a long-term solution. The mining of Zone 1 will immediately reduce groundwater contamination while medium- and long-term plans like the Apiary and opening for agricultural development provide economic benefits. Cell-by-cell construction provides an immediate alternative to the Bakoteh dumpsite and piecing together future cells will provide relief for other Gambian dumpsites.

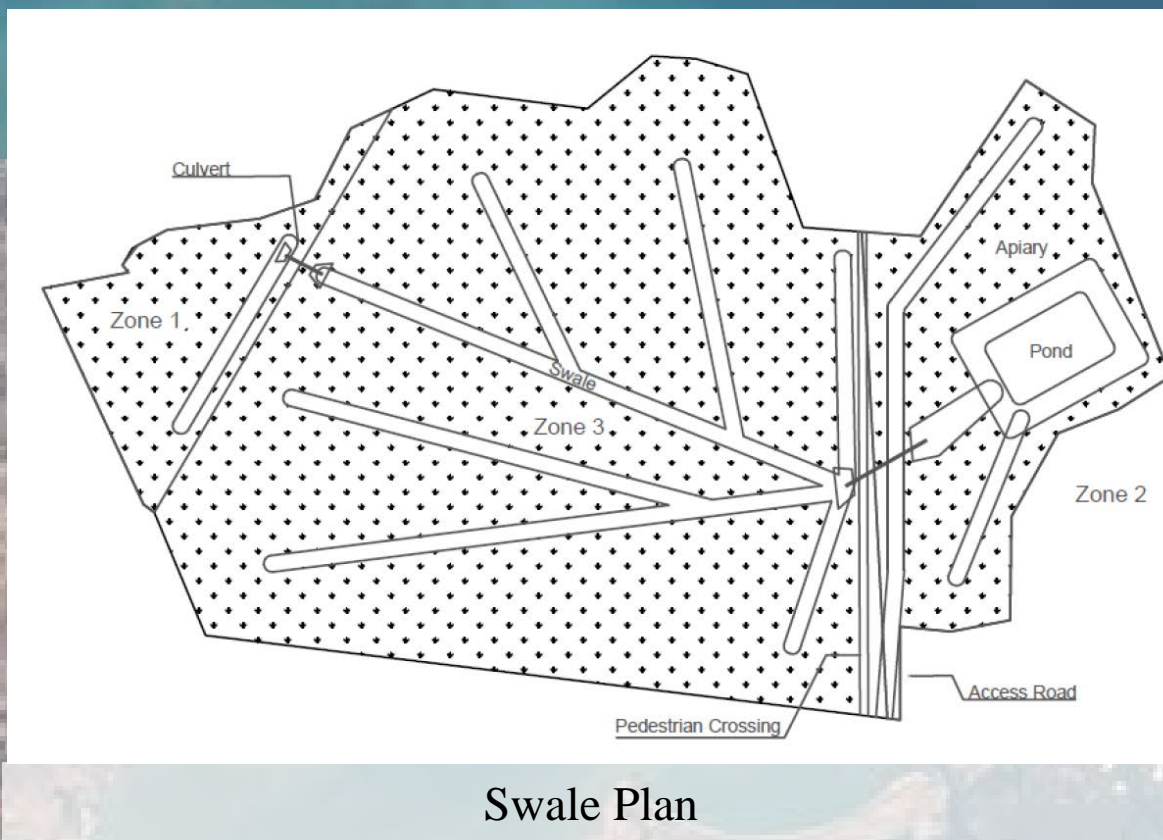
## BAKOTEH DUMPSITE

### PRE-CLOSURE PLAN

1. Ensure site security and restrict waste placement to Zone 3.
2. Ensure pedestrian safety by protecting existing pathways and bridges over Kotu Highway.
3. Ensure child safety by partnering with the ISWA Scholarship Programme.
4. Time the completion of the Transfer Station with the opening of the new landfill.



Material Flow Diagram



Swale Plan



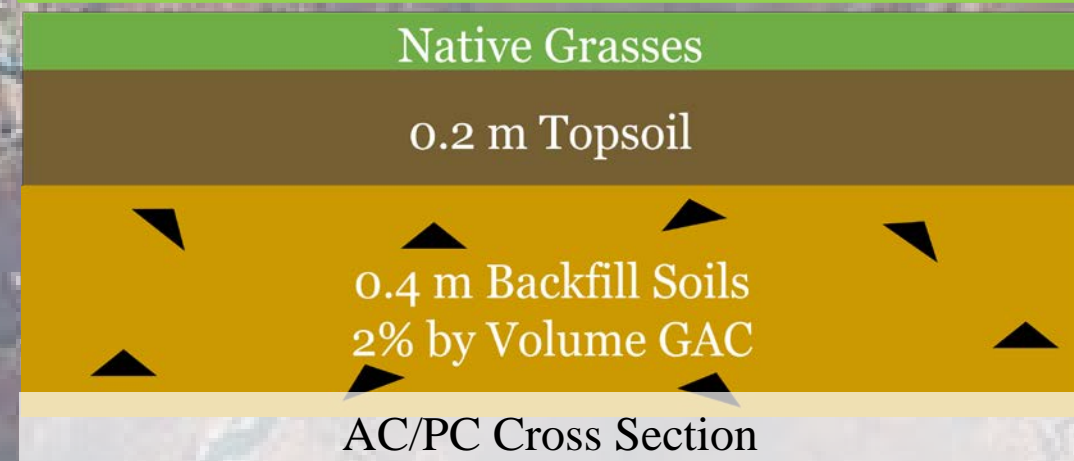
Zone Delineation

### CLOSURE PLAN

The closure method that best protects the people and the environment is waste excavation and backfill with clean material. The incremental excavation plan provides immediate benefit with the TS/MRF and steadily improves site conditions as funding is secured.

### GAS CONTROL ACTIVATED CARBON PHYTO CAP (AC/PC)

An array of passive solar flares and granular activated carbon in the soil cap work together to prevent methane build-up and curb emissions.



AC/PC Cross Section

### LEACHATE PREVENTION

The combination of a soil cap with native vegetation and a swale system is intended to minimize stormwater infiltration over the waste mass and mitigate leachate prevention.

### CONTAMINATION MONITORING

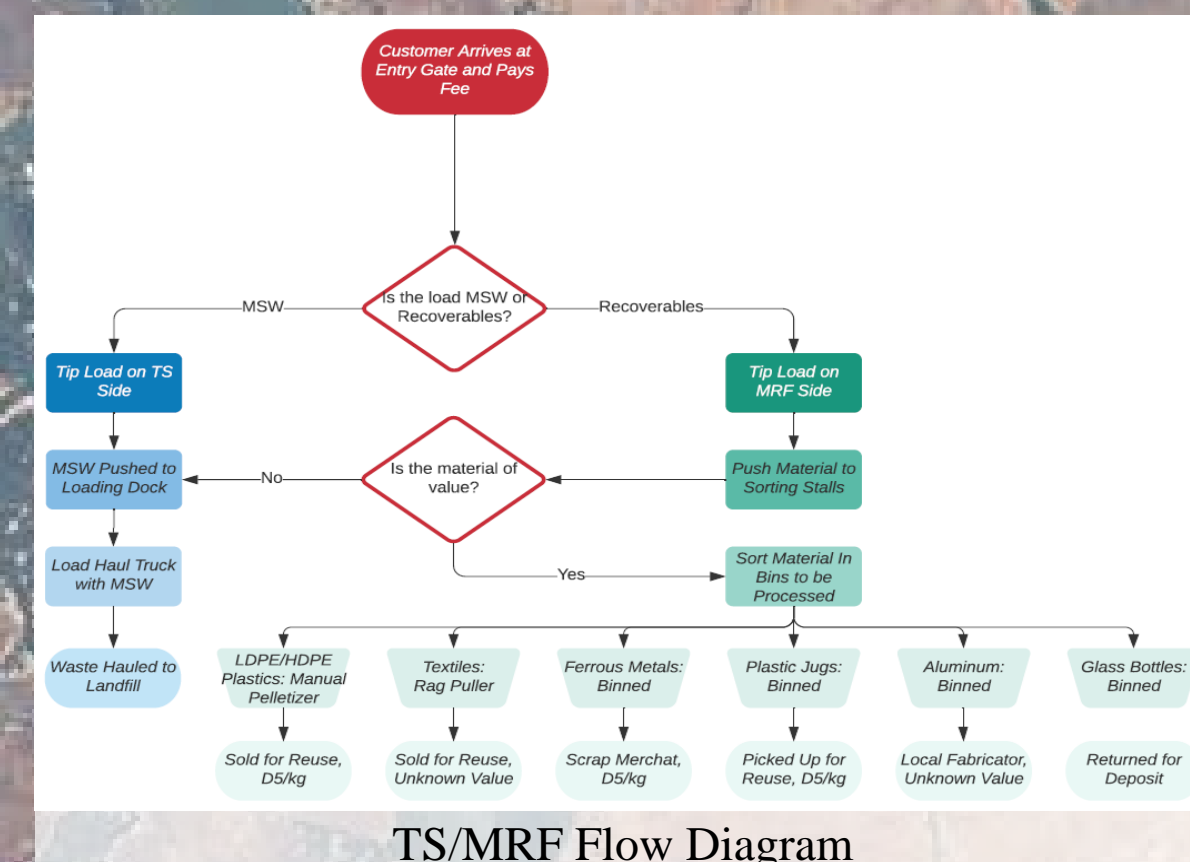
With permission, residential drinking wells shall be tested as surrogate groundwater sampling wells to provide baseline data for contaminant dilution after excavation is complete, to be processed at the national water lab in Abuko.

### ZONE DEVELOPMENT

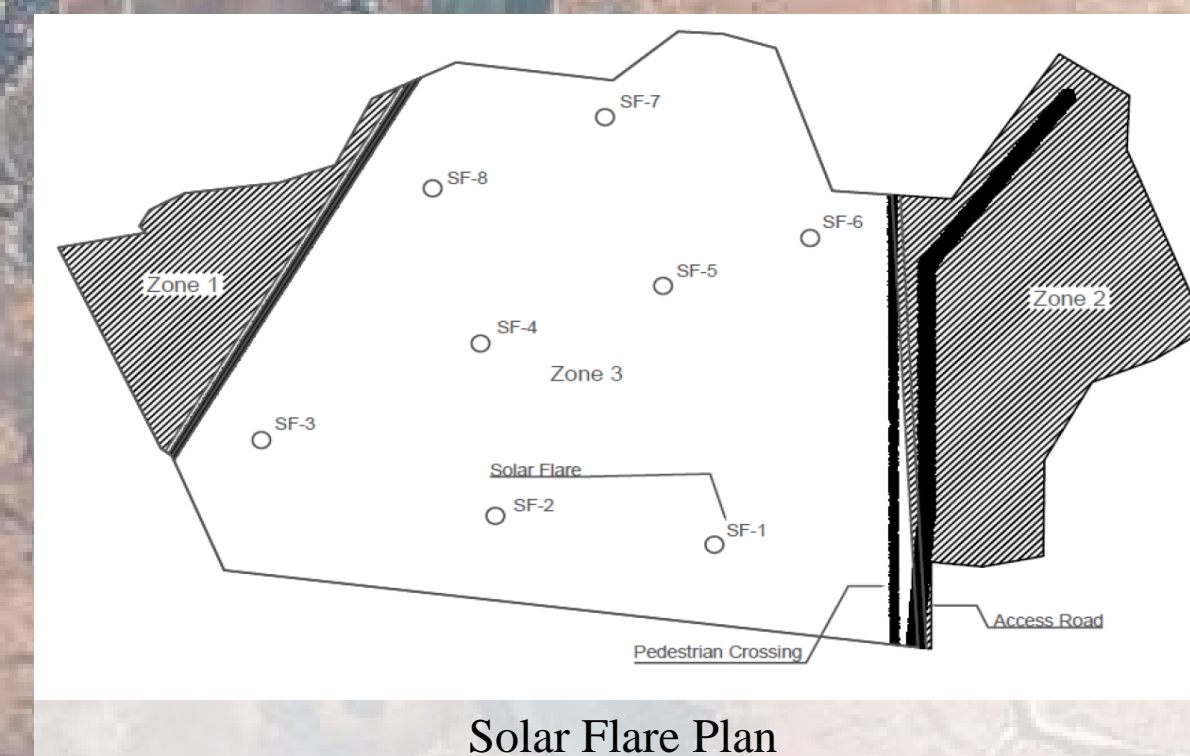
Zone 1: Transfer Station and Material Recovery Facility, Employee Housing

Zone 2: Stormwater Management and Co-Op Apiary

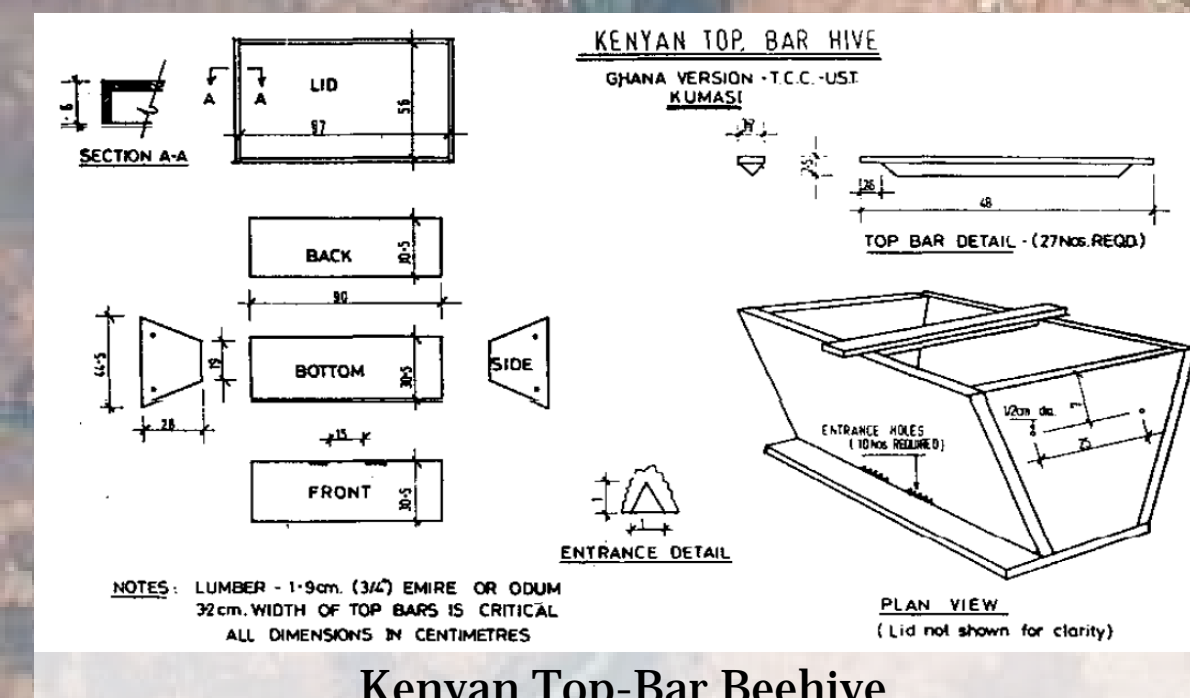
Zone 3: Apiary Expansion, Future Greenspace or Agricultural Development



TS/MRF Flow Diagram



Solar Flare Plan



Kenyan Top-Bar Beehive

## NEW LANDFILL

### DEVELOPMENT PLAN

The new site is proposed to be a regional landfill to make best use of space and secure additional funding. Solving a wider solid waste problem in a more sustainable manner.

### LANDFILL SIZING & SITING

The landfill size is designed for a lifespan of 20 years to receive waste from surrounding municipalities. The sizing of the landfill was determined by estimating population growth, waste compaction, waste volumes, and excavation/airspace capacity. The new site location was assessed by the topography, proximity of local towns and residences, distance from the transfer station and airport, and land hectares.

### WASTE COLLECTION, DIVERSION AND COMPOST

The waste collection plan starts at the individual household and business level and will encourage separation of compost, waste, and recyclables. The plan will divert a large portion of the current waste composition, provide the TS/MRF employees with more sanitary conditions, disincentivize waste burning, and promote integrated and sustainable solid waste management in the country. Before material reaches the TS/MRF, the organic waste will be separated and sent to a series of community composting centers.

### LANDFILL GAS (LFG) COLLECTION

The LFG from the new site will be collected via a vertical communication system to drain landfill fluids. This passive system will connect the landfill with high permeability pathways to mitigate fluid build-up and migration. Once the airspace is maximized, a solar flare will be installed to treat LFG through thermal degradation.

### LEACHATE TREATMENT

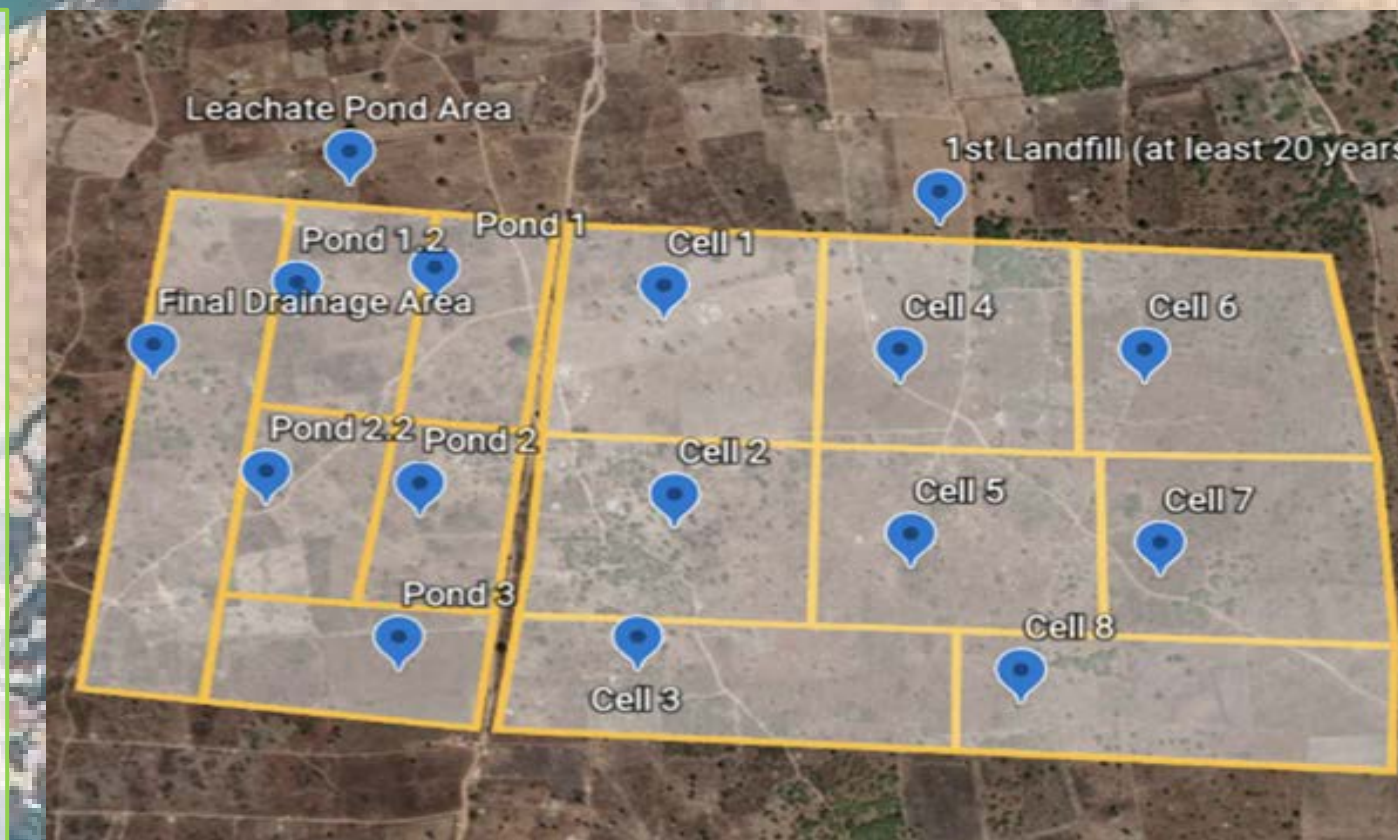
Leachate will be collected by a geo-composite liner and routed through a series of connected lined wetlands to enhance evaporation and treatment. Leachate will drain by gravity to a wind powered sump that drains into the wetland area. A forebay will be constructed at the leachate entrance to promote settling and water quality with a pH adjusting barrier. This passive system is a low-cost alternative to a treatment plant and will require less maintenance.

### CAPACITY BUILDING AND EDUCATION

The construction of the new site will serve as an opportunity to train local workers and educate the community on solid waste. By partnering with companies and universities, The Gambia's capacity to operate these systems will be improved.

### COST ESTIMATE

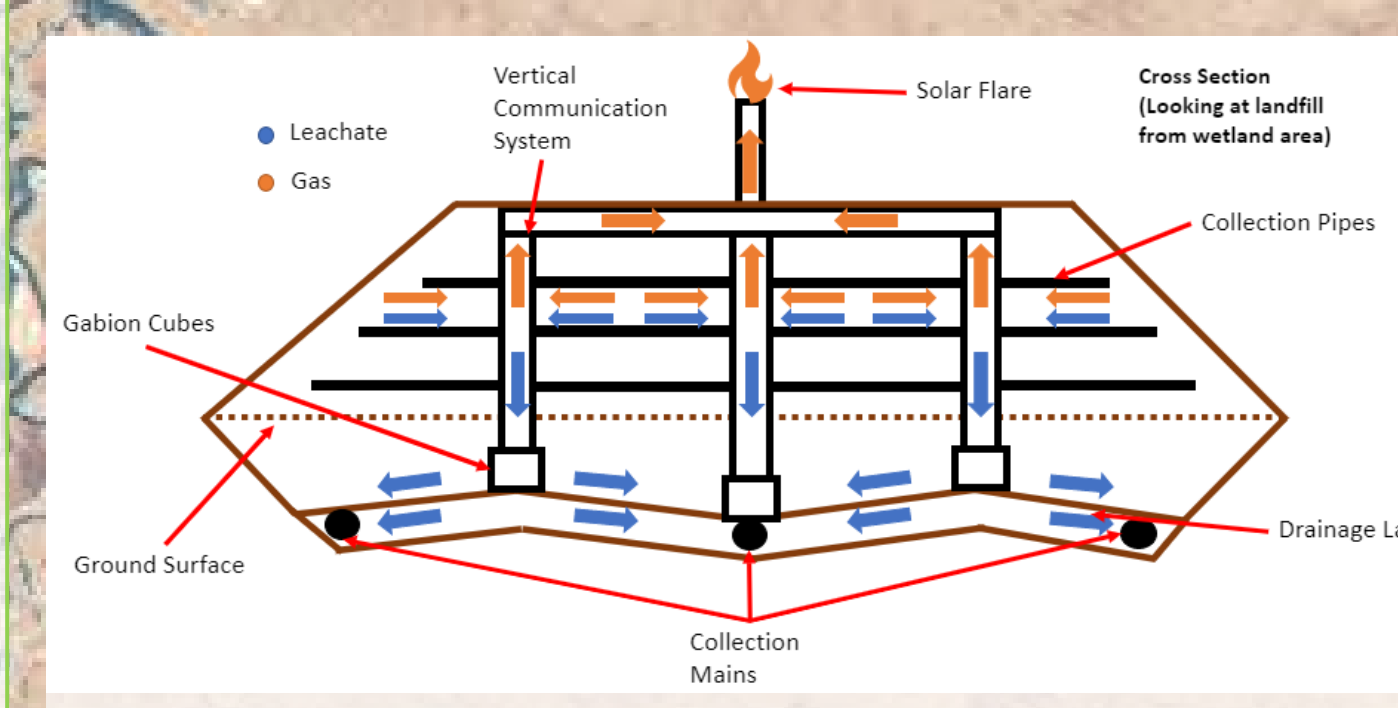
The total cost of initial construction for the cell, wetland, and piping system is estimated to cost D1,140,500,000 (\$22.1M USD) & at least 2.5 years. The landfill is designed to hold 8 cells and will likely have a lifespan greater than 20 years with proper waste diversion. The total cost was designed to be funded by the national government, multiple municipalities, the KMC, and international organizations.



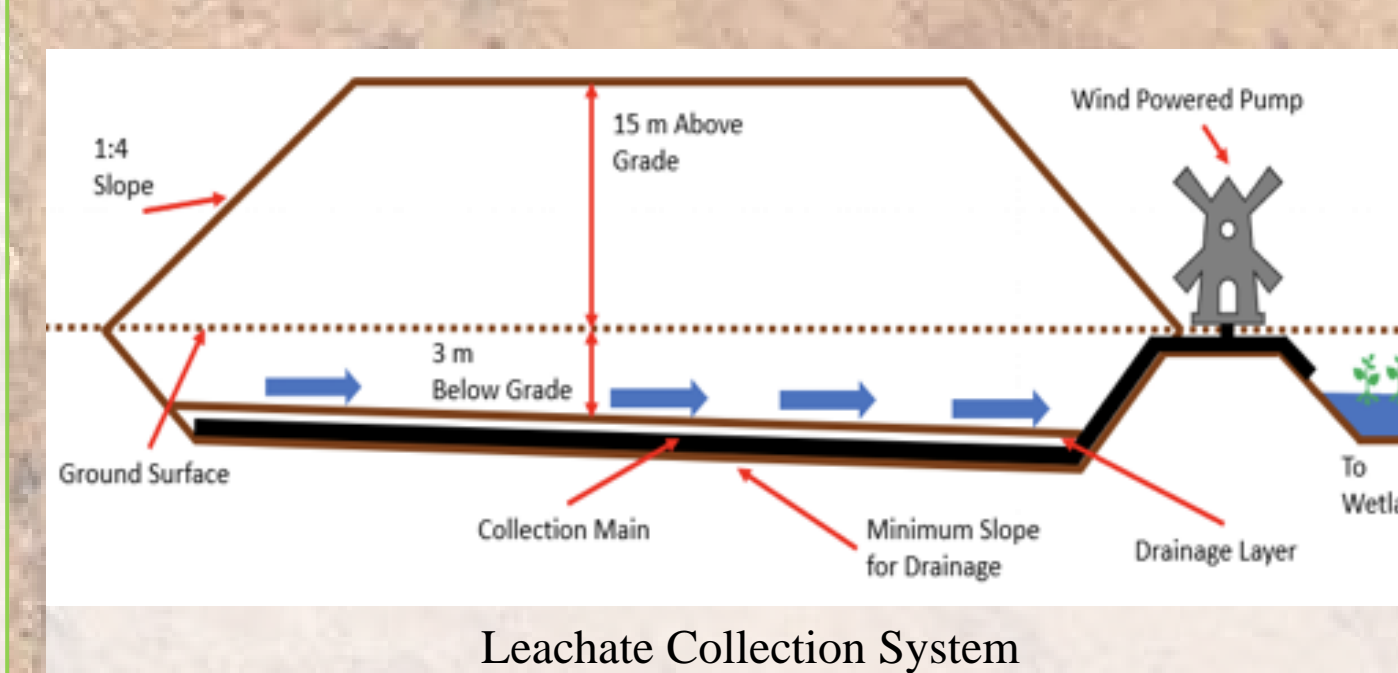
Plan View of New Site



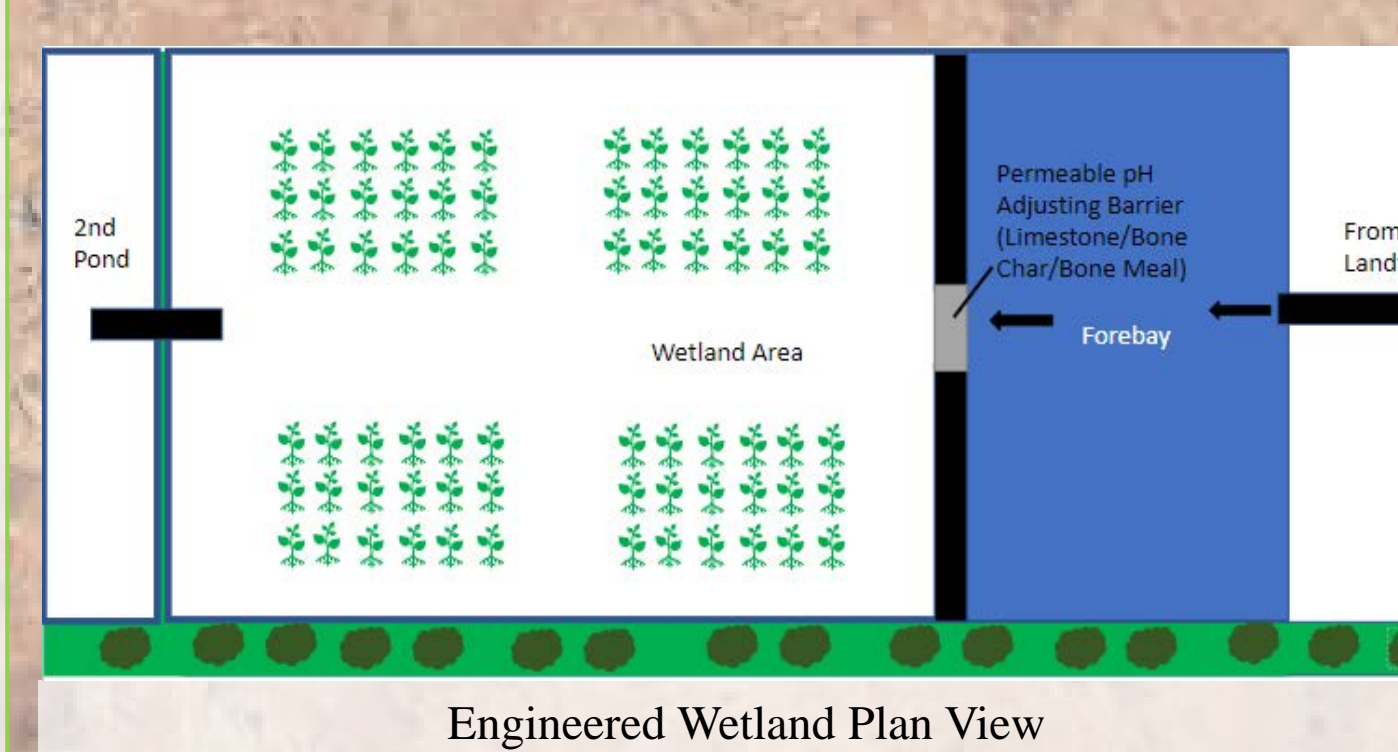
New Site Topography and Elevation Key



Vertical Communication and Fluid Flow



Leachate Collection System



Engineered Wetland Plan View