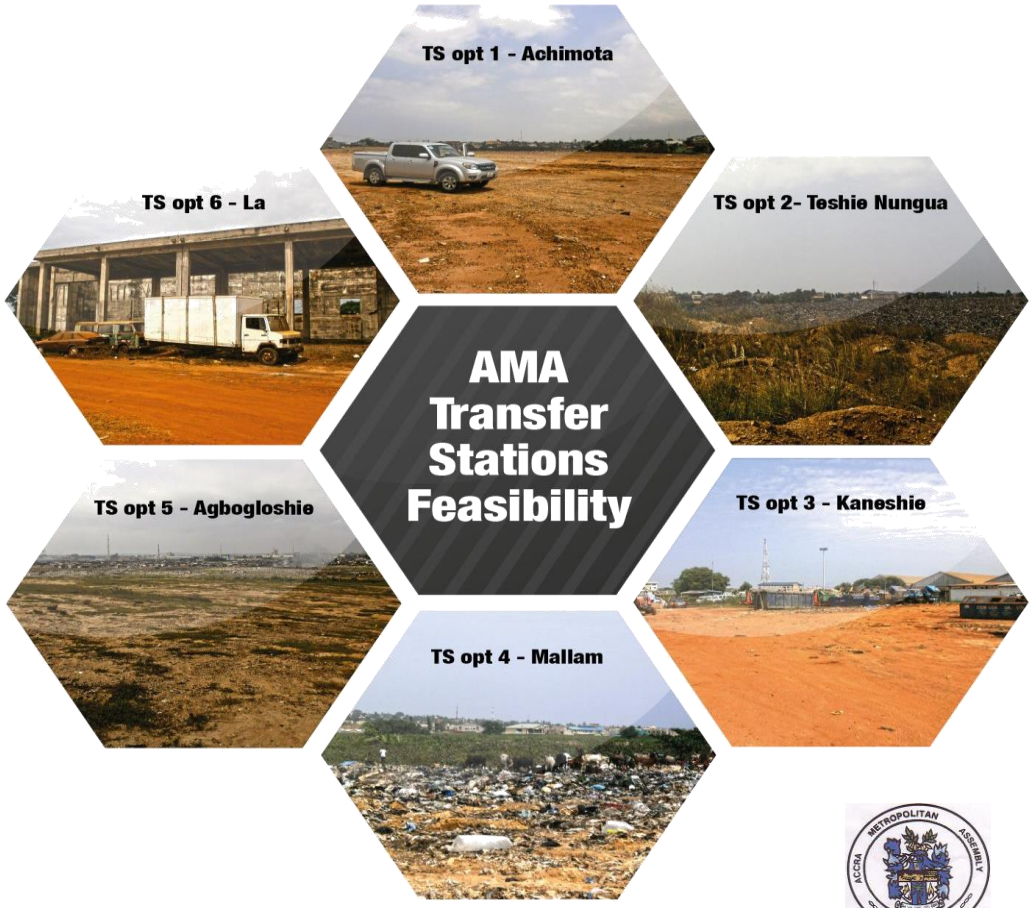
REPUBLIC OF GHANA

ACCRA METROPOLITAN ASSEMBLY

FEASIBILITY STUDY FOR ACCRA METRO WASTE TRANSFER STATIONS



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ACRONYMS AND ABBREVIATIONS

AMA	-	Accra Metropolitan Assembly
EPA	-	Environmental Protection Agency
GAMA	-	Greater Accra Metropolitan Area
GoG	-	Government of Ghana
LGS	-	Local Government Service
MDG	-	Millennium Development Goal
MINT*		Materials in Transition
MLGRD	-	Ministry of Local Government, Rural Development
MMDA	-	Metropolitan, Municipal and District Assembly
MoFEP	-	Ministry of Finance and Economic Planning
MRF	-	Material Recovery Facility
MSW	-	Municipal Solid Waste
MSWM	-	Municipal Solid Waste Management
MSW	-	Municipal Solid Waste
MSWM	-	Municipal Solid Waste Management
NESSAP	-	National Environmental Sanitation Strategy and Action Plan
RCV	-	Refuse Collection Vehicle
SWM	-	Solid Waste Management
TS	-	Transfer Station
TST	-	Transfer Station Technology
WMD	-	Waste Management Department

EXECUTIVE SUMMARY

1. Project Background

The Accra Metropolitan Area has an estimated population of 4.5 million residents. The city generates between 2,000 and 2,500 tonnes of municipal solid waste (MSW) a day. The city has been demarcated into 11 waste collection zones which are allocated to private sector service providers on a franchise basis. The waste contractors haul the collected garbage directly to the final disposal sites due to the lack of transfer stations within the Accra metropolis. This feasibility study for installing 4 Transfer Stations at strategic locations within GAMA is a direct response to the urgent need for improving the Municipal Solid Waste Management System (MSWM) for Accra and its adjoining districts making up the Greater Accra Metropolitan Area (GAMA) in line with the officially approved Government of Ghana (GoG) strategic plan[1] for improving environmental sanitation services.

The three existing final disposal facilities including the Abloradjei (Abokobi) dumpsite, Kpone Landfill and the treatment/material recovery plant (Accra Compost and Recycling Plant, ACARP at Adjen Kotoku) are all located beyond the geographical boundaries of the metropolis. The average round–trip travelling time of a haulage truck is approximately 62 km which is an increment of 15 km compared to when the final disposal sites were within the metro boundaries.

The Accra Metropolitan Assembly in June 2013 commissioned WasteCare Associates to undertake a Transfer Station Technical Feasibility Study. The scope of this consultancy assignment includes conducting a transfer station needs assessment, selection of appropriate transfer station technology, conceptual design of proposed facilities, identification of suitable locations and preliminary cost estimates. The following work activities were conducted during this study:

1. **Transfer Station Needs Assessment:** Conducting a transfer station break even analysis and GIS-based spatial analysis to determine economic justification of the proposed project intervention.
2. **Transfer Station Technologies Assessment:** Utilization of multi-criterion decision analysis to determine an appropriate technology option for the metropolis taking into consideration the peculiar waste management characteristics.
3. **Conceptual Engineering Designs:** Development of conceptual designs for the proposed transfer stations including operational capacity, site layout and infrastructure and equipment requirements.
4. **Transfer Station Locations Assessment:** Utilization of a GIS-based multi-criterion spatial analysis to select four suitable locations taking into consideration the appropriate waste transfer station technology that will be adopted and the potential for multi-functional use of the location.

[1] National Environmental Sanitation Strategy and Action Plan (NESSAP) 2010 – 2015, MLGRD 2010.

5. **Preliminary Cost Estimation:** Determination of preliminary construction cost estimates for site preparation, buildings and equipment at prevailing market rates based on the conceptual designs.

2. Transfer Station Needs Assessment

A transfer station needs assessment was done to determine if there was justification for the construction of transfer station(s) in the Accra Metropolitan Area. It involved the use of a transfer station break-even point analysis and a GIS-based spatial analysis. The following findings were from the analysis:

- Direct haulage of waste generated in the Accra Metropolitan Area is uneconomical for travel distance in excess of 17.7 km and 25.9 km for the skip trucks and compaction trucks respectively.
- Direct haulage waste haulage to the Abokobi is justified for suburbs in Ayawaso West and Okaikoi North collection zones.
- Direct haulage to the Kpone landfill and the Accra Compost Plant is not justified for any of the waste collection zones in the metropolis.

3. Transfer Station Technologies Assessment

A comparison of the six alternative transfer station technology options was done using a multi criteria analysis methodology to determine the suitability with respect to the Accra metropolis. A 10-point assessment scale was used for the evaluation of each criterion i.e. rated on a scale from one (least suitable) to ten (most suitable). A ranking of the alternative technologies based on the aggregated score shows that the 2 –level unloading to storage system without compaction is the most suitable option.

4. Conceptual Engineering Designs

Each transfer station would have the following features:

- Operational Capacity (Throughput) : 1,200 metric tpd
- Land Area : 2.6 hectares
- Tipping Floor Area : 2,560 m^2
- Site Infrastructure – enclosed transfer building (portal frame), office block, workshop, guardhouse and security wall/fence, concrete paved area, street lighting, drainage and other utilities
- Equipment- front end loaders, excavators, weighbridge, storage containers and conveyor sorting system.

5. Transfer Station Locations Assessment

A comparison of the six proposed transfer station locations was done using a GIS –based multi criteria analysis. A 10-point assessment scale was used for the evaluation of each criterion i.e. rated on a scale from one (least suitable) to ten (most suitable). A ranking of the suitability of the proposed locations based on the aggregated score is as follows:

1. **Achimota – behind the lorry terminal**
2. **Agbobloshie – adjoining old disposal site at informal recycling station**
3. **Mallam – behind market**
4. **Teshie-Nungua – at old demolished compost plant**

5. **La Dadekotopon – at abandoned Incinerator plant near Municipal Assembly**
6. **Kaneshie – within premises of the AMA-WMD**

6. Preliminary Cost Estimation

The total construction cost for each transfer station including land acquisition, site works, buildings and equipment is estimated at $3,048,681. Table 1.1 shows the various cost elements both in local currency and the dollar equivalent..

Description	**Cost ($)**	**Cost (GHC)**
Land acquisition	-	-
Building construction costs	$1,469,246	GHC 2,923,800
Site works costs	$305,893	GHC 608,727
Equipment costs	$570,000	GHC 1,134,300
Total Cost	**$2,345,139**	GHC 4,666,827
Contingency (15%)	$351,771	GHC 700,024
Engineering Design (8%)	$187,611	GHC 373,346
Construction Supervision (7%)	$164,160	GHC 326,678
Total Cost	**$3,048,681**	GHC 6,066,875

Table E1: Summary construction costs for a single transfer station

1 INTRODUCTION

1.1 Project Scope

The Accra Metropolitan Assembly is seeking to construct and make operational 4 new Transfer Stations at strategic locations within the GAMA area. The objectives of this strategic intervention include:

i. To increase daily collection and evacuation of solid waste to final disposal sites to 100%
ii. To improve productivity and efficiency in the haulage of waste materials within the management chain of generation to final disposal
iii. Increase the application of refuse as materials- in-transition through thorough sorting and packaging into supply of goods.

The Accra Metropolitan Assembly in June 2013 authorized Waste Associates to undertake a Transfer Station Technical Feasibility Study. The scope of this consultancy assignment includes conducting a transfer station needs assessment, selection of appropriate transfer station technology, conceptual design of proposed facilities, identification of suitable locations and preliminary cost estimates. This report presents the results of the following work activities:

6. **Transfer Station Needs Assessment:** Conducting a transfer station break even analysis and GIS-based spatial analysis to determine economic justification of the proposed project intervention.
7. **Transfer Station Technology Assessment:** Utilization of multi-criterion decision analysis to determine an appropriate transfer station technology option for the Accra metropolis taking into consideration the peculiar waste management characteristics.
8. **Conceptual Engineering Designs:** Development of conceptual designs for the proposed transfer stations including operational capacity, site layout and infrastructure and equipment requirements.
9. **Transfer Station Locations Assessment:** Utilization of a GIS-based multi-criterion spatial analysis to select four suitable locations taking into consideration the appropriate waste transfer station technology that will be adopted.
10. **Preliminary Cost Estimation:** Determination of preliminary construction cost estimates for site preparation, buildings and equipment at prevailing market rates based on the conceptual designs.

1.2. Overview of Existing Solid Waste Collection and Transfer System

Waste Management and Sanitation in Accra is the responsibility of the Accra Metropolitan Assembly (AMA). The Assembly is mandated by Act, 462, Local Government Act 1993, to be responsible for the development, improvement and management of human settlements and the environment of the Accra. The AMA provides infrastructure and oversight of solid and liquid waste management within its jurisdiction for about 4.5 million residents. The Waste Management Department (WMD) of the Assembly is responsible for waste management.

The current waste management strategy in Accra is based on a public-private-partnership (PPP) model with private operators given franchise for zones and responsible for house-to-house

collection, haulage and management of final disposal sites under the supervision of AMA-WMD. Payment for city-wide public services like collection from markets, public and lorry parks as well as street and drain cleansing is by the City Authority.

The Accra Metropolitan Area has been demarcated into collection zones where private sector waste collection companies collect the waste and subsequent haul to the final disposal sites.

Table 2.1 shows the various collection zones in the metropolis. Figure 2.1 depicts the boundaries of the various suburbs in the metropolis. Statistics provided by the AMA indicates that 2,200 of the 2,500 metric tons of waste generated per day is collected by the service contractors.

The core part of Accra under the jurisdiction of AMA is completely built up with mixed residential, commercial and light-industrial land uses that preclude the sitting of final disposal facilities, particularly landfills. The city now depends on final disposal and treatment facilities located in adjoining districts. With increasing congestion and dense traffic conditions the average round-trip travelling distance and time of haulage taken by trucks to these sites, are approximately 62 km and 4.5 – 6.5 hours, respectively per direct haul trip and getting worse.

Table 1-1: Waste collection zones in Accra metropolis (2012)

Collection Zone	**City Suburbs**
Okaikoi North	Awudome, Bubuashie, Achimota
Okaikoi South	Nii Boiman, Akweteman
Ayawaso East	Kanda, Nima, Mamobi
Ayawaso West	Abelenkpe, Roman Ridge, Airport Residential, Dzorwulu, Okponglo, Legon
Ayawaso Central	Kokomemle, Kotobabai, Alajo, Nima East
Ablekuma Central	Laterbiokoshie, Abossey Okai, Mataheko,
Ablekuma North	Darkuman, Odorkor, Kwashieman
Ablekuma South	Mamprobi, Chorkor, Korle Bu, Korle Gonno, Dansoman
Osu Clottey	Ringway Estates, Osu, Adabraka, Tudu, Asylum Down, Odorna
Ashiedu Keteke	Korle Wokon, Kinka, Ngleshie, Kantamanto
La	Labadi

Three disposal and/or treatment facilities are currently in use including the Abloradjei (Abokobi) dumpsite, Kpone Landfill and the Accra Compost Plant. The current waste collection and transfer system in the Accra metropolis is fraught with many challenges such as:

i. High cost of haulage - Due to long distances distance from the generation point to final dumping sites, capital investment and recurrent costs have increased for the service providers.
ii. Operational difficulties due to heavy daytime vehicular traffic along. Day time traffic congestion in Accra has increased travelling time of hauling the waste to the final dumping sites.
iii. Unavailability of final disposal sites within the jurisdiction of the AMA. The average travelling time of a haulage truck is about 62 km (fro and to generation point); which is an increment of 15 km when the AMA had landfill sites within its jurisdiction and control.

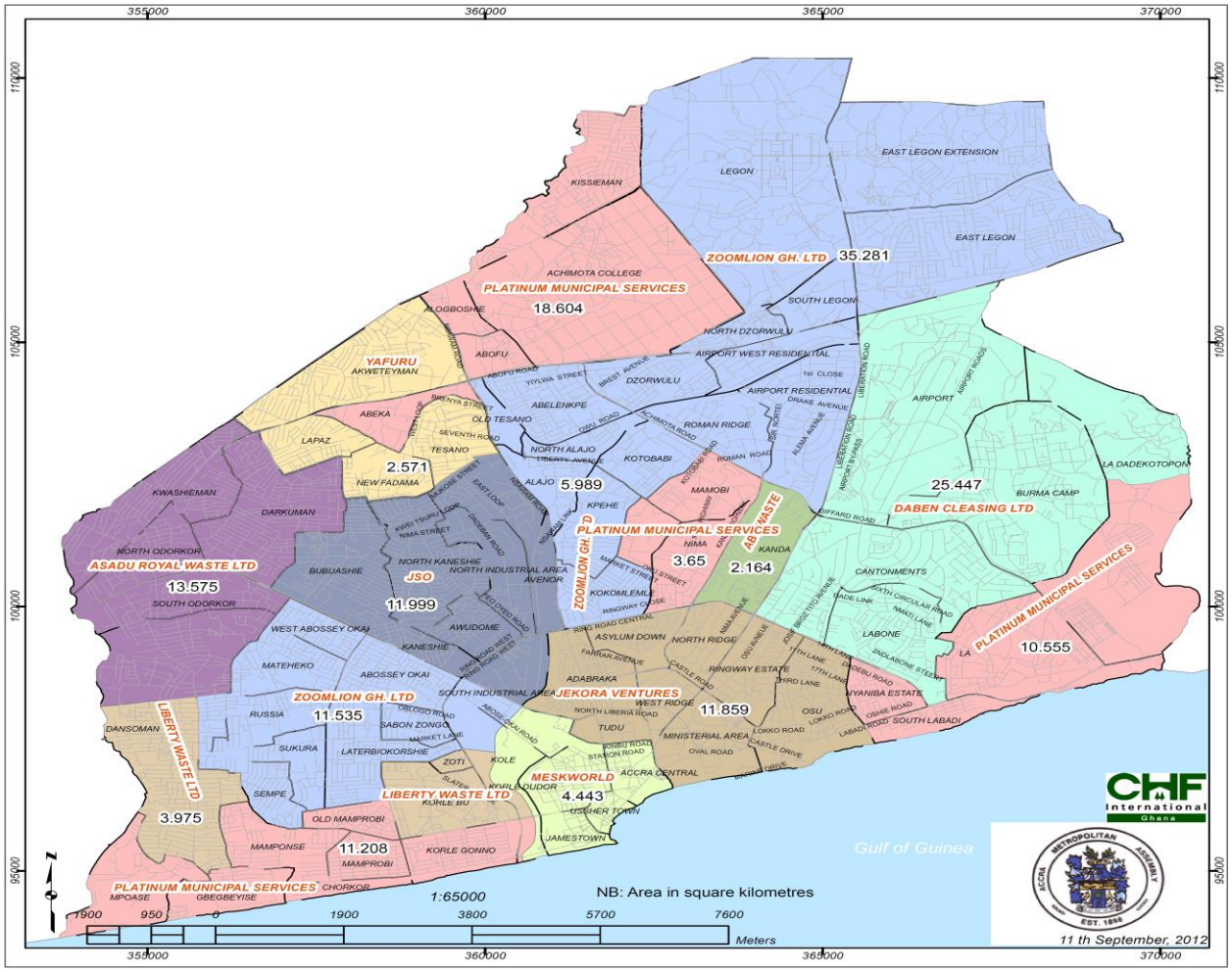


Figure 1-1: AMA-WMD Operational Areas

2 Transfer Station Needs Assessment

2.1 Methodology and Assumptions

A critical analysis of the MSWM system pointed to the urgent need for transfer stations as vital missing links to improving productivity of key MSW management system components. A transfer station needs assessment was done to determine if there was justification for the construction of transfer stations in the Accra Metropolitan Area and if so at which locations. It involved the following procedures:

- Transfer station break-even point analysis - used to determine the minimum round trip distances for which transfer haulage is justified in the Accra metropolis.
- GIS-based spatial analysis - used to determine relative travel distances to and from various locations in the Greater Accra Region.

2.2 Break Even Analysis Results

Two scenarios that were investigated included the following:

- Comparison of direct haulage using a 15 m^3 refuse collection vehicle (compaction) with transfer haulage
- Comparison of direct haulage using a 10 m^3 skip truck with transfer haulage

The general assumptions used in this analysis are based on industry experience, communication with industry experts and research regarding facilities and operations in other jurisdictions. Table 3.1 and Table 3.2 present the underlying assumptions for cost and facility/equipment specification respectively. The detailed cost data are provided in Appendix A.

The round trip haulage distances used in the analysis are based on estimates provided by the AMA–WMD. The results of the break even analysis for the refuse truck and skip truck are shown in Fig. 3.1 and Fig. 3.2 respectively. The results shown that direct haulage of waste generated in the Accra Metropolitan Area is uneconomical for travel distance in excess of 17.7 km and 25.9 km for the skip trucks and compaction trucks respectively.

2.3 GIS Spatial Analysis Results

Fig. 3.4, Fig. 5 and Fig 3.6 shows the relative single trip travel distances from the Abloradjei (Abokobi) dumpsite, Kpone landfill and the Accra Compost Plant (Adjen Kotoku) respectively. The following inferences, for example, can be made:

- Direct haulage waste haulage to the Abokobi is justified for suburbs in Ayawaso West and Okaikoi North collection zones.

Table 2-1: Unit costs for break even analysis

Description	Unit	Value
Transfer Trailer Cost	$	122,200
Refuse Truck Cost	$	76,700
Skip truck Cost	$	65,000
Transfer Station Cost	$	2,500,000
Average Trucking Cost (Compaction Truck)	GHC/km	5.7
Average Trucking Cost (Skip Truck)	GHC/km	4.5
Dumping Cost	GHC/trip	10

Table 2-2: Facility and equipment specifications for break even analysis

Description	Unit	Value
Transfer Truck Capacity	tonnes	20
Compaction Truck Capacity	tonnes	7
Skip Truck Capacity	tonnes	4.5
Transfer Station Throughput	Tones/yr	438,000
Average Direct Haul Distance(Round trip)	km	62
Fuel Costs	GHC/litre	3.11
Fuel Consumption(Compaction Truck)	(litre/100km)	65
Fuel Consumption(Skip Truck)	(litre/100km)	55

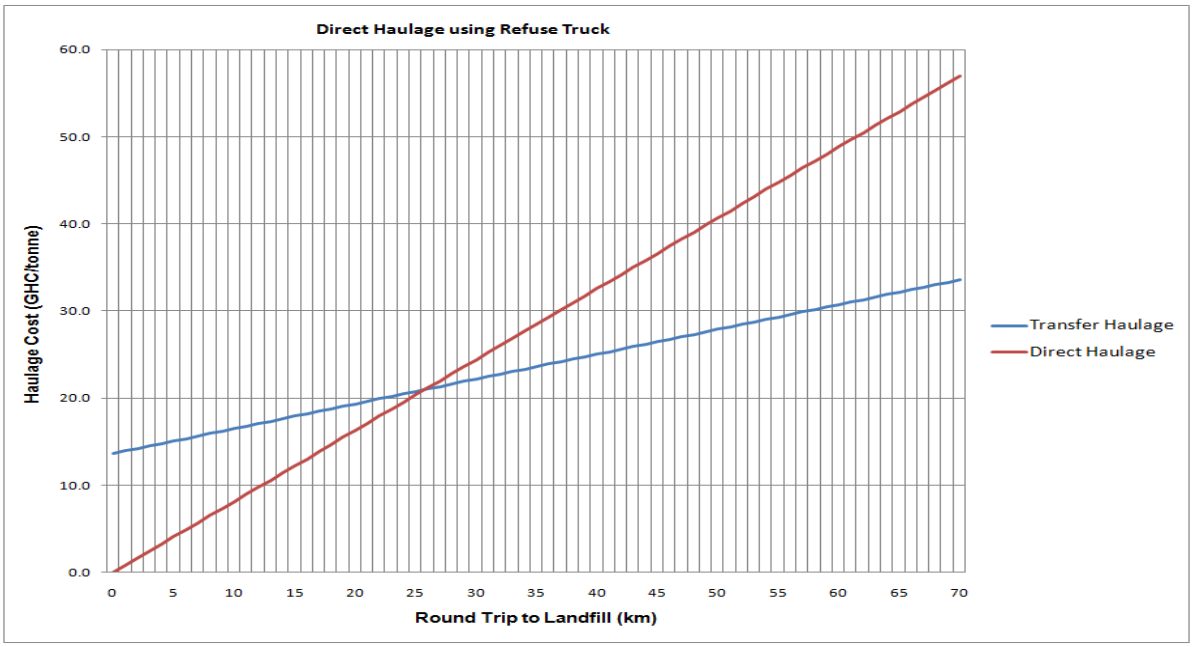


Figure 2-1: Refuse collection vehicle (compaction) break-even results

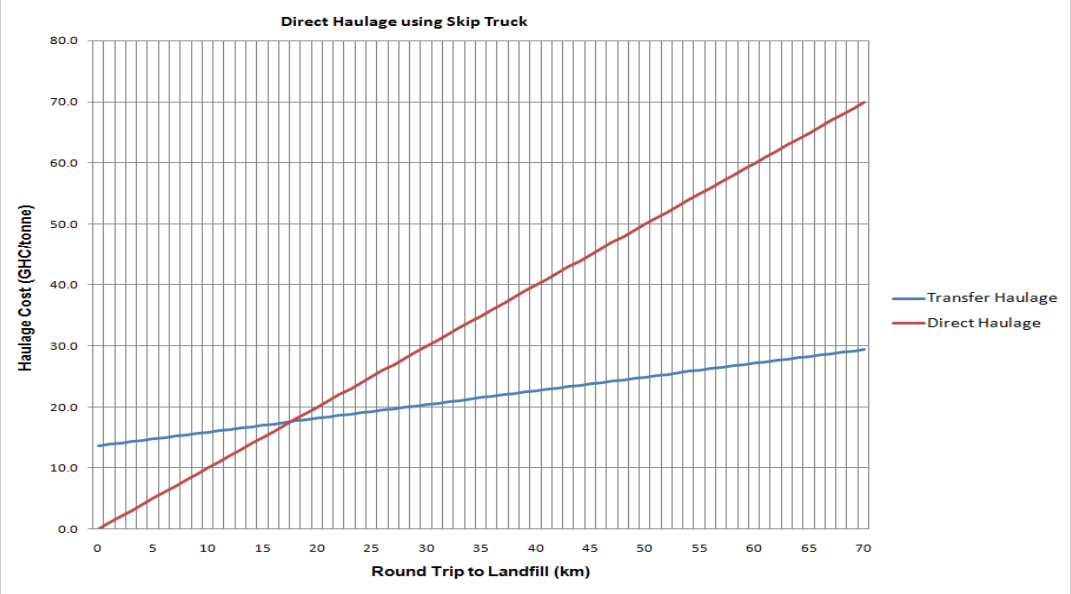


Figure 2-2: Skip truck break-even results

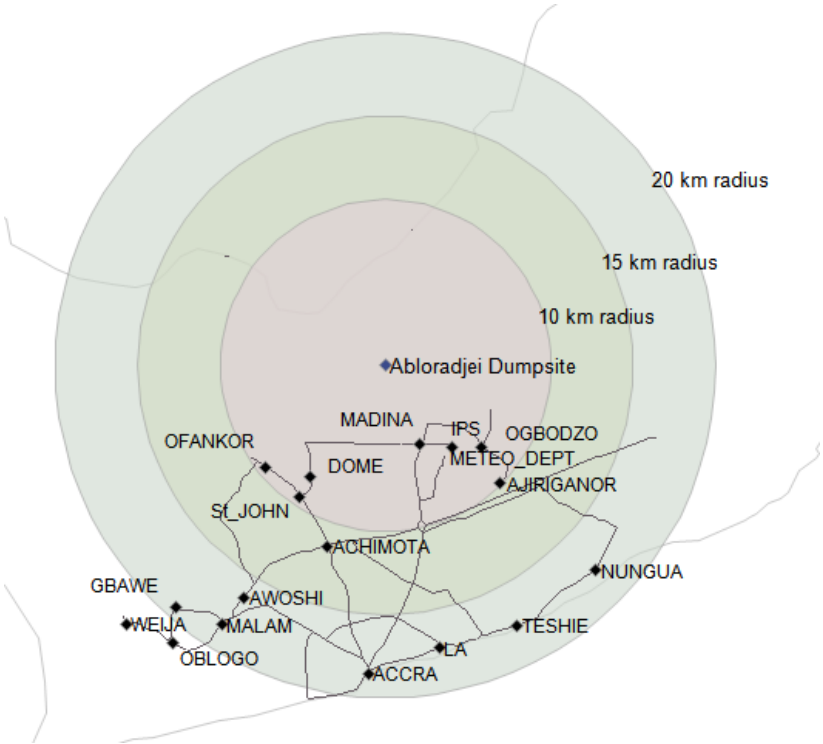


Figure 2-3: Relative single trip distances from collection zones to Abloradjei (Abokobi) dumpsite

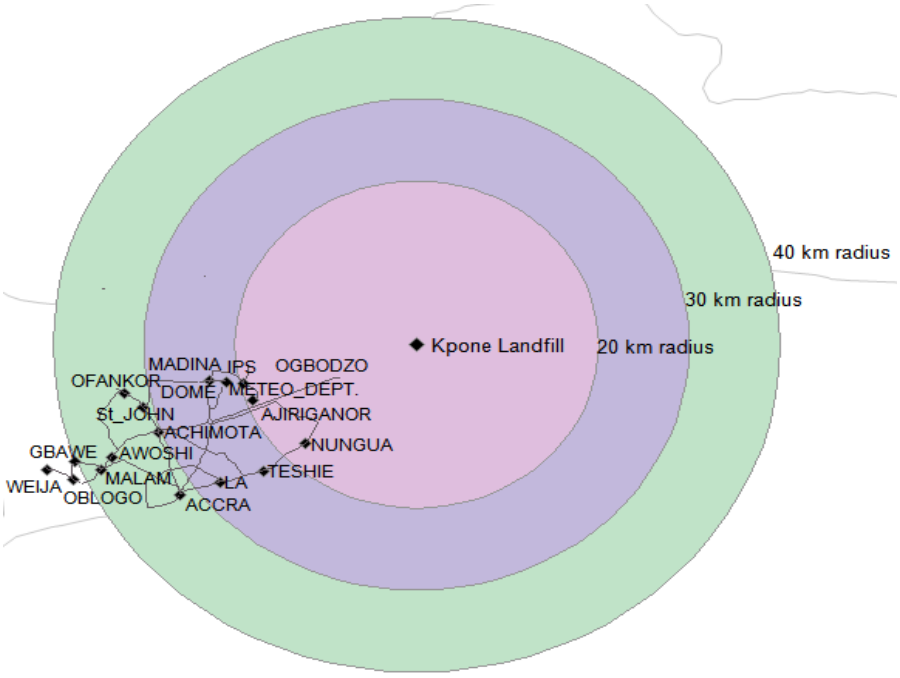


Figure 2-4: Relative single trip distances from collection zones to Kpone Landfill

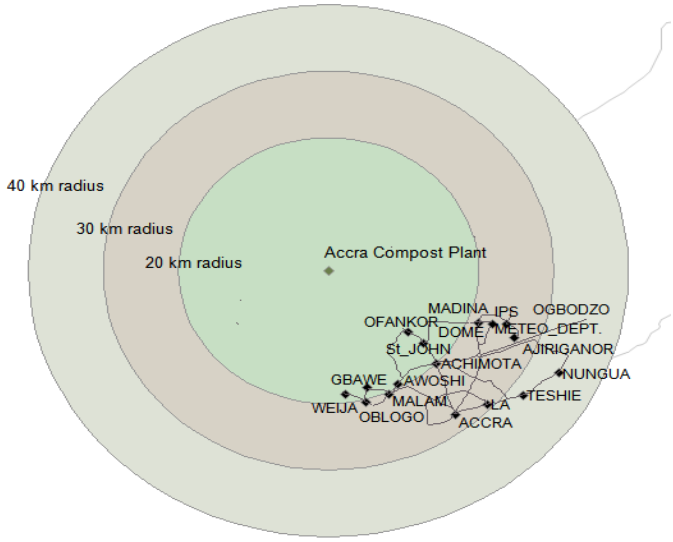


Figure 2-5: Relative single trip distances from collection zones to Accra Compost Plant (Adjen Kotoku)

3 Transfer Station Technologies Assessment

3.1. Transfer Station Performance Requirements

The transfer stations to be constructed in the city of Accra would have multi-purpose function and are to be used:

- To receive domestic and commercial waste from sections of the city for onward transportation to final disposal sites;
- As sorting points for recyclable materials for processing and/or reuse
- As intermediate intervention for waste-to-energy strategy of the Accra Metropolitan Area

3.2. Alternative Technology Options

Six transfer station technology (TSTs) options were considered for the Accra Metropolitan Area.

These include the following:

- TST 1 - Direct unloading (1-level)
- TST 2 - Direct unloading (2-level)
- TST 3 - Unloading to storage without compaction (1-level)
- TST 4 -Unloading to storage without compaction (2-level)
- TST 5 - Unloading to storage with compaction (2-level)
- TST 6 - Unloading to surge pit (3-level)

Fig. 3.1 shows schematic diagrams of the various technological options.

3.3. Comparison of Technology Options

A comparison of the technology options was done using a multi criteria analysis methodology to determine the suitability with respect to the project area. Criteria were broadly categorized under the following groupings:

- Technical – technical suitability of the technology type with respect to the peculiar characteristics of the project area
- Economic - affordability of the technology type
- Socio-cultural - potential community resistance to technology type
- Environmental – qualitative assessment of potential environmental impact of technology type.

Table 3.1, Table 3.2, Table 3.3 and Table 3.4 present the lists of the criteria under the respective groupings. A 10-point assessment scale was used for each of the evaluation metrics. The summary results from the various individual categories of criterion are presented in Fig. 3.2, Fig. 3.3, Fig. 3.4 and Fig 3.5. Fig 3.6 shows a comparison of all the technological options with the individual criterion categories. The detailed results are provided in Appendix B.

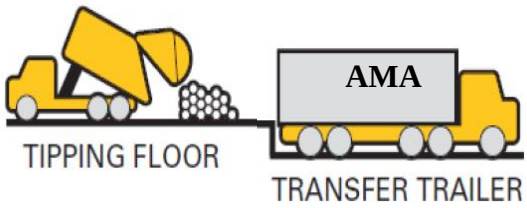


Figure 3-1: Direct unloading (1-level)

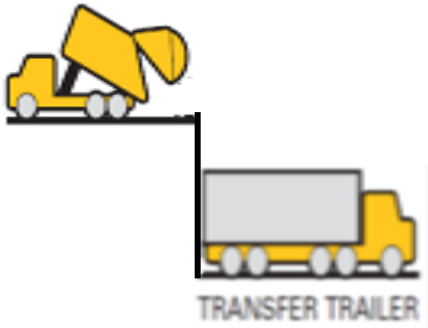


Figure 3-2: Direct unloading (2-level)

Figure 3-3: Unloading to storage without compaction (1- level)

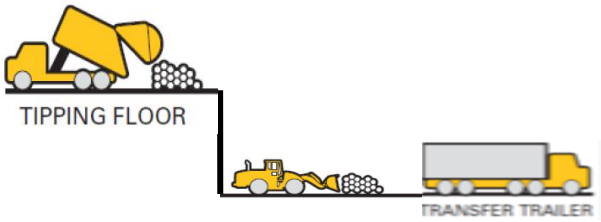


Figure 3-4: Unloading to storage without compaction (2-level)

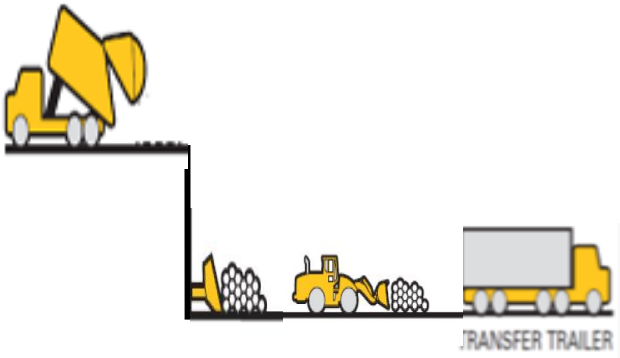


Figure 3-5: Unloading to storage with compaction (2-level)

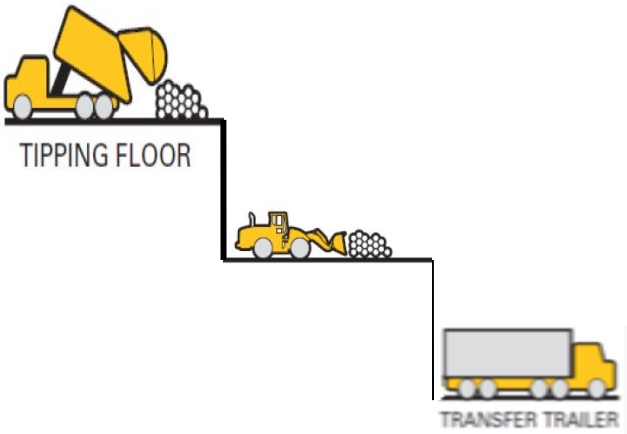


Figure 3-6: Unloading to surge pit (3-level)

Table 3-1: Technical assessment criterion

ID	Technical Criterion
T1	Adequate storage space for peak waste flow
T2	Ease of unloading refuse trucks
T3	Ease of uploading trailer trucks
T4	Waste handling equipment requirements
T5	Waste compaction equipment requirements
T6	Ease of waste screening, sorting and material recovery

Table 3-2: Economic assessment criterion

ID	Economic Criterion
E1	Capital costs – Buildings
E2	Capital costs – Equipment
E3	Operational costs including utilities
E4	Labour costs
E5	Equipment maintenance and replacement costs

Table 3-3: Socio-cultural assessment criterion

ID	Socio-cultural Criterion
S1	Public acceptance
S2	Land use compatibility

Table 3-4: Environmental assessment criterion

ID	Environmental Criterion
N1	Air pollution risks
N2	Surface water pollution risks
N3	Groundwater pollution risks
N4	Soil contamination risks
N5	Ease of nuisance control(odour, nouse, litter and vectors)
N6	Occupational health and safety risks for employees

The summary results show that the best option in terms of technical suitability for the project area was TST 4. TST 1 was observed to be the most affordable and having the least environmental impact. No distinction could be made for any of the technology options with respect to public acceptance.

A ranking of the transfer station technology options was done by use of an aggregated scoring of all four criterion categories as depicted in Fig. 4.7. A higher weighting factor was given to the high priority categories. The order of decreasing priority was technical, economic, environmental and socio-cultural criterion. The ranking obtained is as follows:

1. TST 4 - Unloading to storage without compaction (2 level)
2. TST 5 – Unloading to storage with compaction (2 level)
3. TST 2 – Direct unloading (2 level)
4. TST 6 - Unloading to surge pit (3 level)
5. TST 1 - Direct unloading (1 level)
6. TST 3 - Unloading to storage without compaction (1 level)

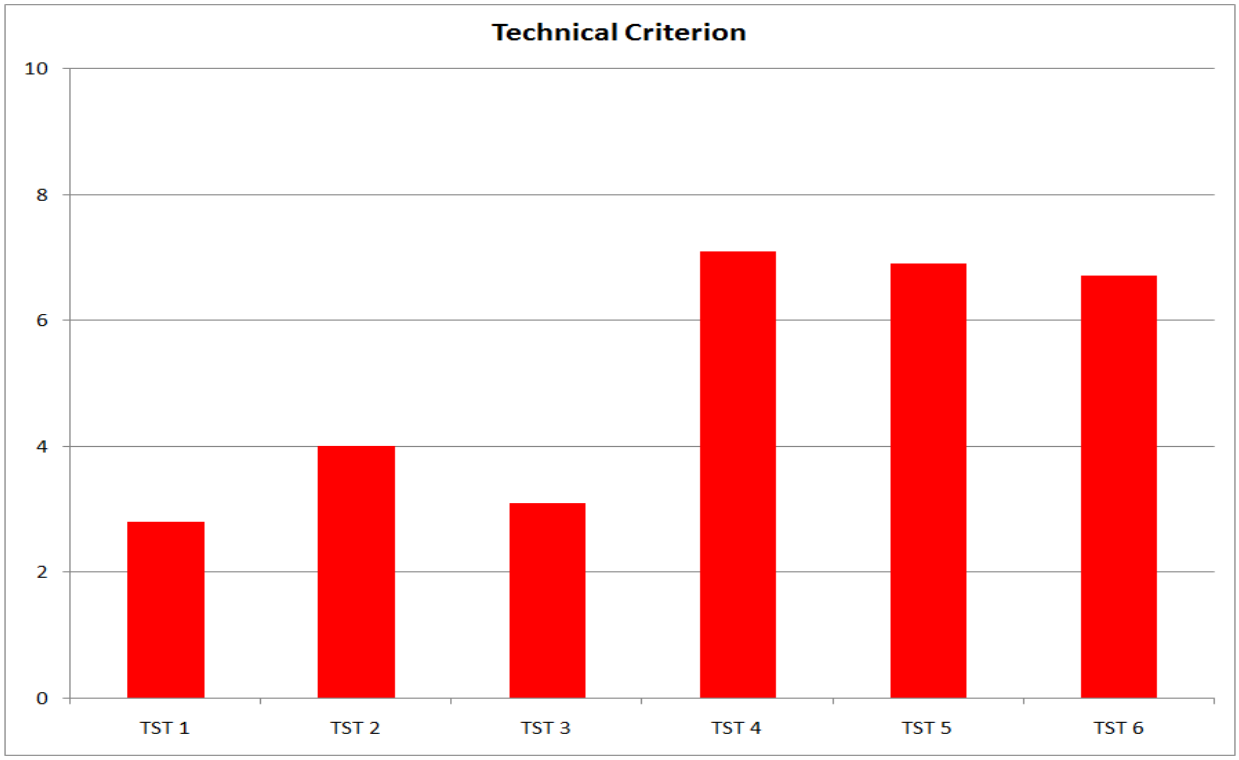


Figure 3-7: Comparison of technology options using technical criterion

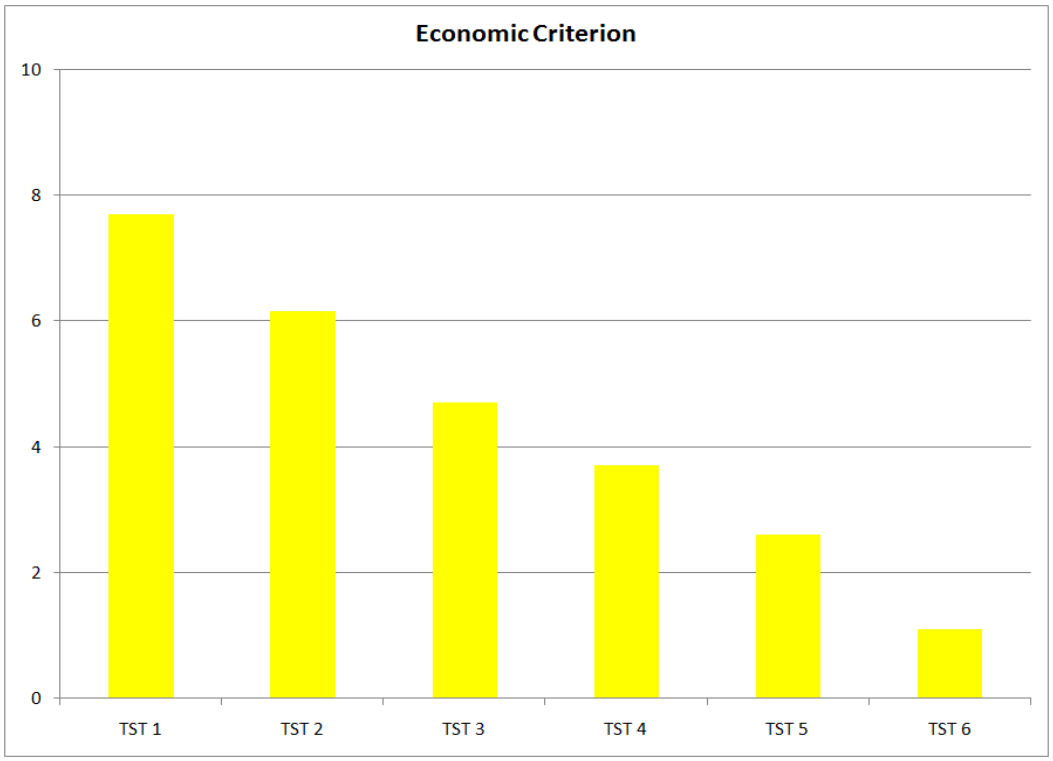


Figure 3-8: Comparison of technology options using technical criterion

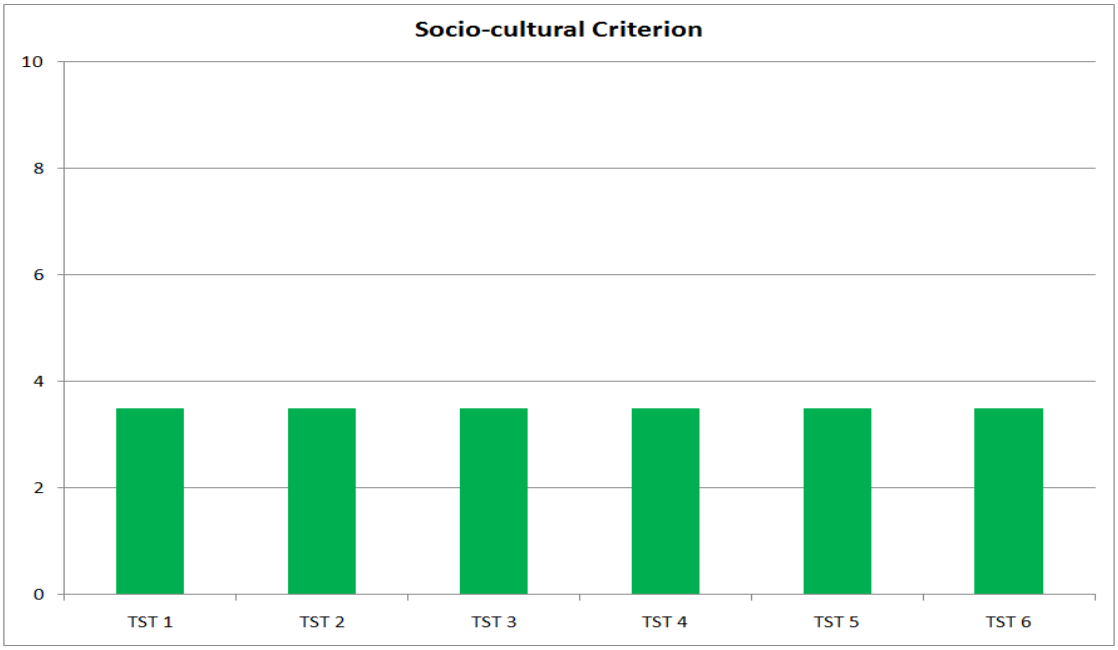


Figure 3-9: Comparison of technology options using socio-cultural criterion

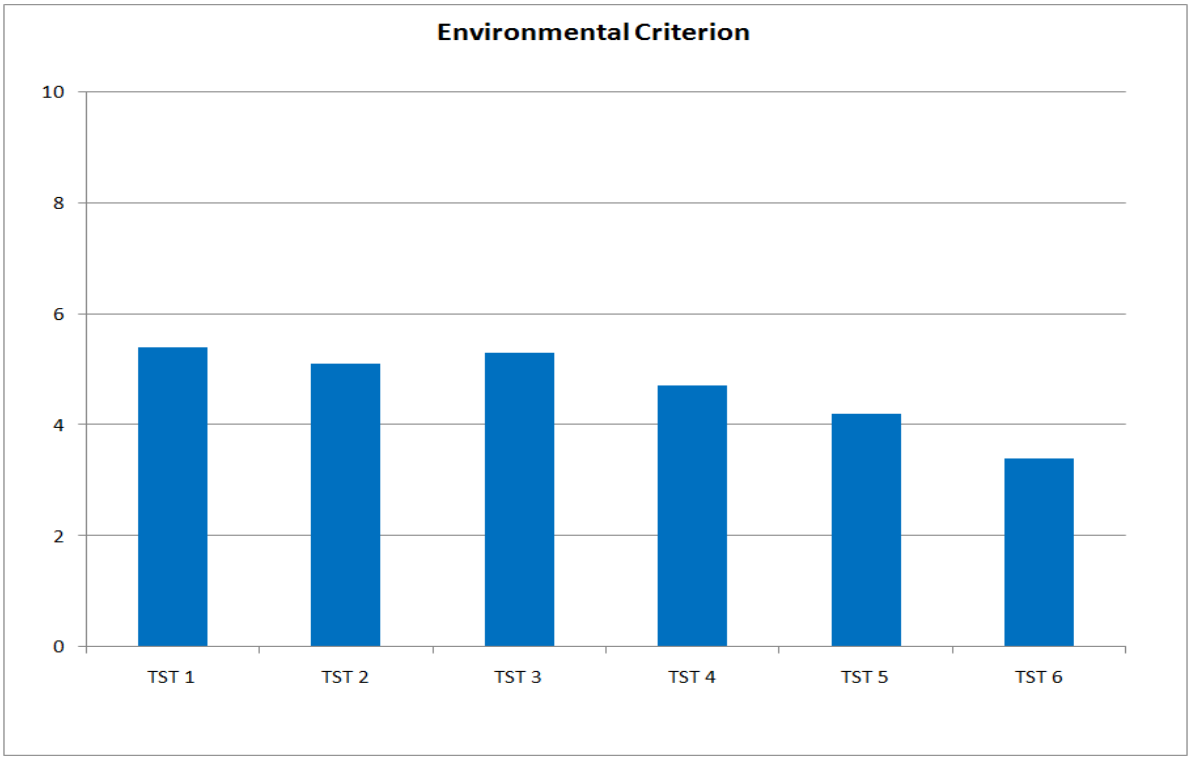


Figure 3-10: Comparison of technology options using environmental criterion

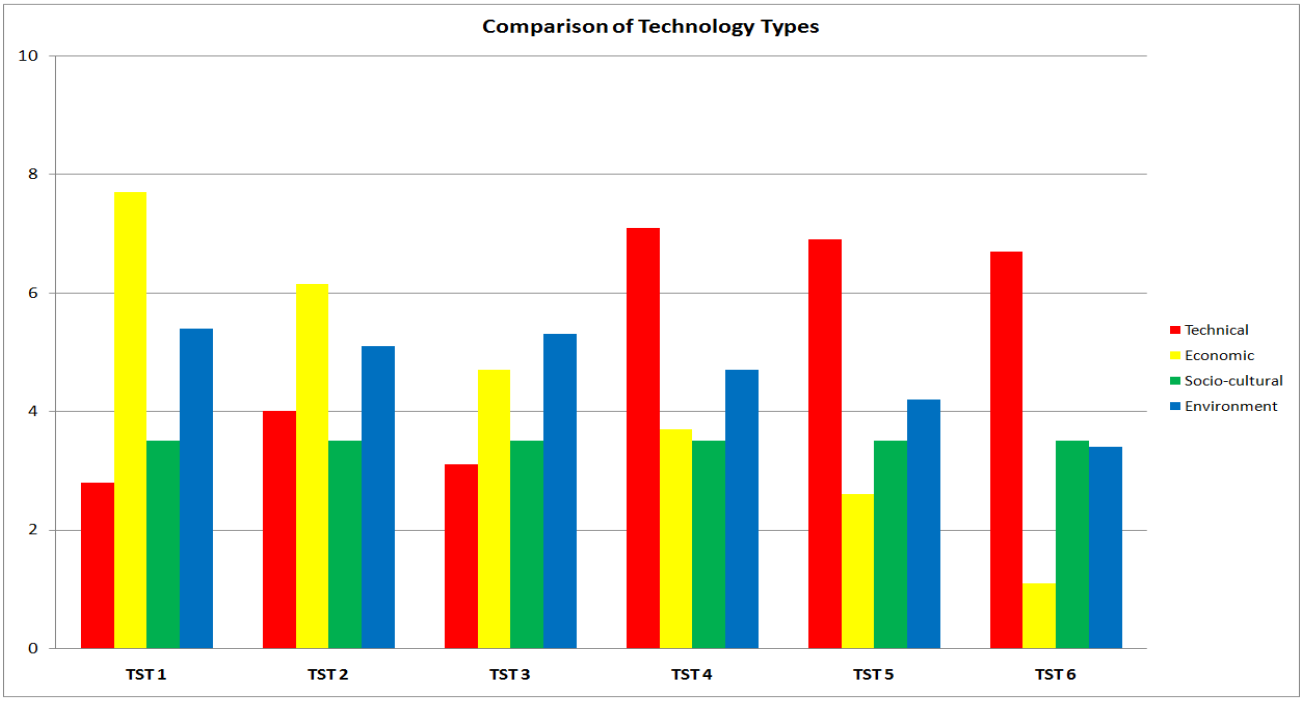


Figure 3-11: Best technology options for various criterion categories

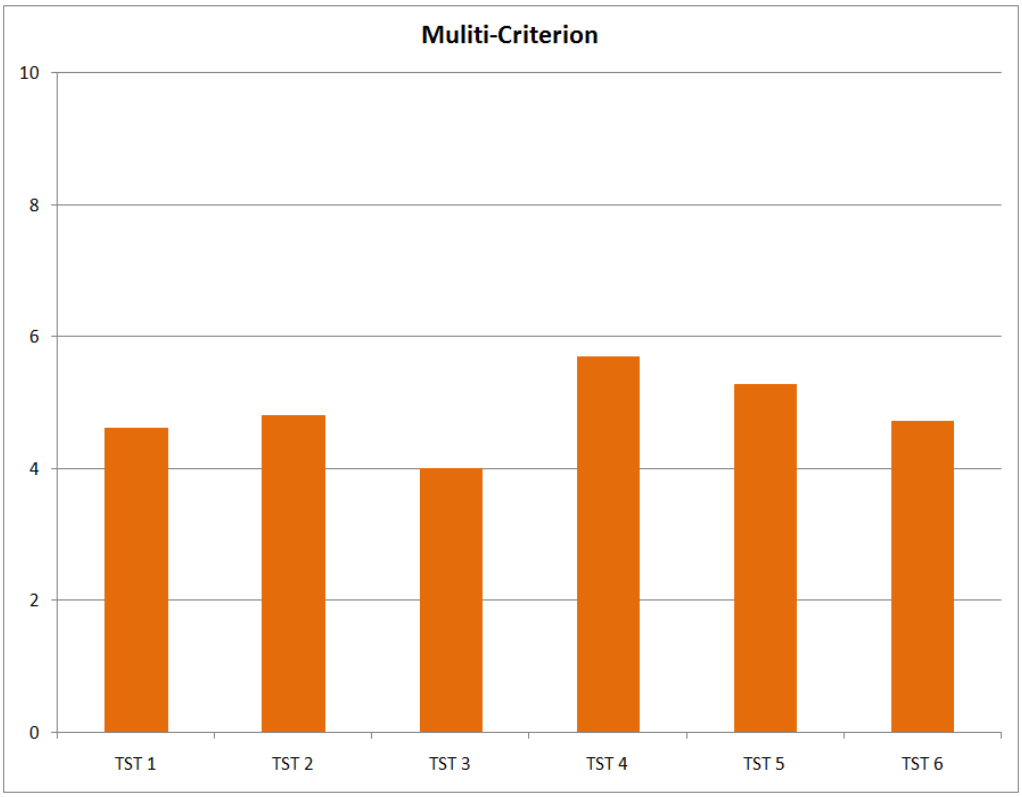


Figure 3-12: Comparison of transfer technology options using aggregated criterion

4 Conceptual Engineering Designs

4.1 Design Parameters

The parameters used in the conceptual design of the transfer station are presented in Table 4.1.

Table 4-1: Conceptual design assumptions and factors

Description	Value
Design Life	15 – 20 yrs
Daily Handling Capacity	1200 tonnes/day
Estimated Tipping Floor Area	2560 m^2
No. of levels	2
Building to Land to building ratio	10:1
Estimated Land Area	25,600 m^2
Site Dimensions	260 m X 100 m
Unloading method	Unloading to storage
Reloading method	Loading to open trailer vehicles
Additional functionality	Waste sorting, material recovery

The tipping floor area, approximately 2.6 ha, was calculated using industry practice methodology.

4.2 Site Infrastructure

The following minimum infrastructure facilities are required for the transfer station:

- Transfer building – includes a raised unloading platform, loading, storage area and unloading areas
- Office block – toilet, shower, generator room
- Workshop
- Guardhouse and security wall/fence around the entire site
- Concrete paved area for parking
- Street lighting, drainage and other utilities

Fig. 4.1 depicts a conceptual site layout for the proposed facility.

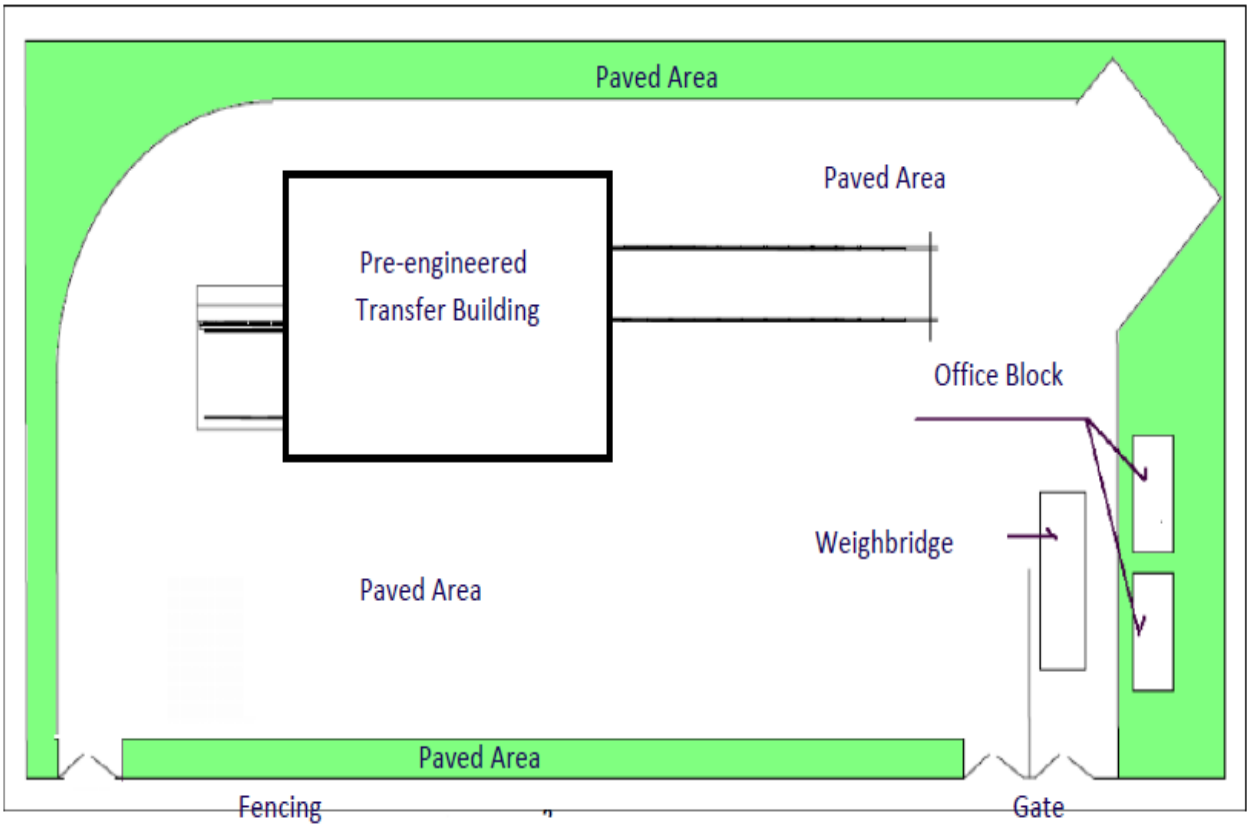


Figure 4-1: Conceptual layout of the facility

4.3 Transfer Station Equipment

The following minimum equipment is required for a 2-lvel unloading to storage transfer station : front end loaders (2), excavators (1), weighbridge (1), storage containers (20) and conveyor sorting system (1).

5 Transfer Station Locations Assessments

5.1 Identification of Locations

Six different potential locations shown in Fig. 5.1were identified through the following:

- Identification by AMA WMD – Achimota, Teshie-Nungua, Kaneshie and Mallam
- Identification by the project consultants i.e. WasteCare Ltd – Agbogbloshie and La.

Table 5.1 presents a description of the proposed locations. Plates 5.1 – 5.6 shows aerial photographs of these locations.

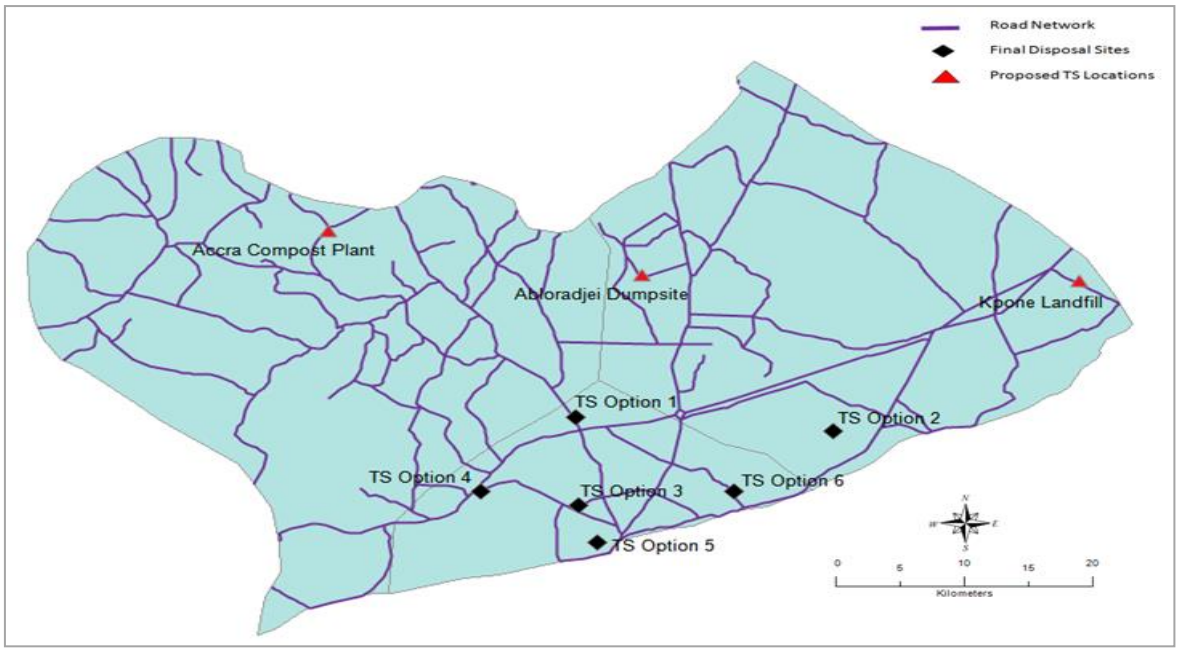


Figure 5-1: Location of proposed transfer station sites

Table 5-1: List of proposed locations for transfer stations

Site ID	Location	Administrative Area	Current land use
TS Option 1	Achimota	AMA	Closed dumpsite
TS Option 2	Teshie-Nungua	Ledzokuku-Krowor	Abandoned compost plant
TS Option 3	Kaneshie	AMA	AMD-WMD yard
TS Option 4	Mallam	Ga South	Behind Mallam market
TS Option 5	Agbobloshie	AMA	Closed dumpsite
TS Option 6	La	La-Dadekotopon	Abandoned incinerator site

Plate 5-1: Aerial photograph of TS Option 1 (Achimota)

Plate 5-2: Aerial photograph of TS Option 2 (Teshie-Nungua)

Plate 5-3: Aerial photograph of Site TS Option 3 (Kaneshie)

Plate 5-4: Aerial photograph of TS Option 4 (Mallam)

Plate 5-5: Aerial photograph of TS Option 5 (Agbobloshie)

Plate 5-6: Aerial photograph of TS Option 6 (La)

5.2 Siting Criteria

The siting criteria used for selection of locations were categorized under the following:

- Accessibility
- Technical
- Economic
- Environmental and Socio-cultural

Table 5.2, Table 5.3, Table 5.4 and Table 5.5 present the list of the criteria for various categories.

Table 5-2: Accessibility assessment criterion

ID	Accessibility Criterion
A1	Proximity to waste collection zones
A2	Proximity to final disposal sites
A3	Access from major road network
A4	Access from existing rail network
A5	Condition of existing access roads to location
A6	Level of traffic congestion

Table 5-3: Technical criterion

ID	Technical Criterion
T1	Adequate land space
T2	Gently sloping topography
T3	Site geotechnical conditions
T4	Availability of utilities – sewers, water, electricity
T5	Land use compatibility
T6	Potential usage as a multi-purpose SWM facility

Table 5-4: Economic assessment criterion

ID	Economic Criterion
E1	Land acquisition costs
E2	Land compensation costs
E3	Site remediation costs

Table 5-5: Environmental and socio-cultural assessment criterion

ID	Environmental and Socio-cultural Criterion
N1	Proximity to cultural, heritage or religious sites
N2	Presence of threatened and endangered species
N3	Community resistance towards waste facilities (NIMBY)
N4	Air pollution risks
N5	Groundwater pollution risks
N6	Surfacewater pollution risks

5.3 Evaluation of Proposed Locations

A comparative analysis of the locations was done using the criterion listed in the previous section. Each criterion was assigned a weighting factor which was established based on pre-determined objectives. The individual locations were then rated on a scale from one (least suitable) to ten (most suitable).

The summary results of the multi-criterion analysis are presented in Fig. 6.3, Fig. 6.4, Fig 6.5 and Fig. 6.6 for the respective categorizations. The summary results show that the best location in terms of:

- Accessibility is TS Option 1
- Technical suitability with respect to physical features is TS Option 5
- Least site remediation and compensation costs are TS Option 1, TS Option 1 and TS Option 5
- Minimum environmental and socio-cultural impacts are TS Option 3 and TS Option 5

A ranking of the proposed locations was done by use of aggregated scoring of all four criterion categories as depicted in Fig. 6.7 and Fig. 6.8. The order of decreasing priority was technical, accessibility, environmental and economic criterion. In other words the technical suitability was considered as the most important factor, followed by accessibility, the environmental impact and then site remediation/compensation costs.

The ranking obtained is as follows:

7. TS Option 1 - Achimota
8. TS Option 5 - Agbobloshie
9. TS Option 4 - Mallam
10. TS Option 2 - Teshie-Nungua
11. TS Option 6 - La
12. TS Option 3 - Kaneshie

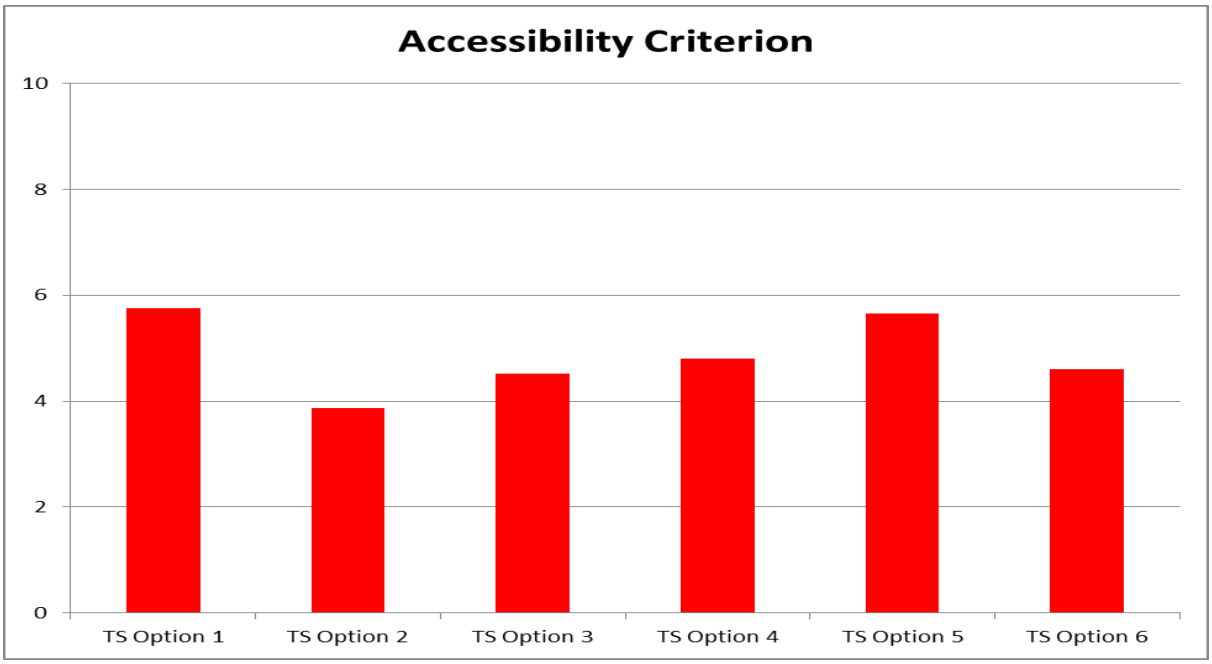


Figure 5-2: Comparison of proposed locations using accessibility criterion

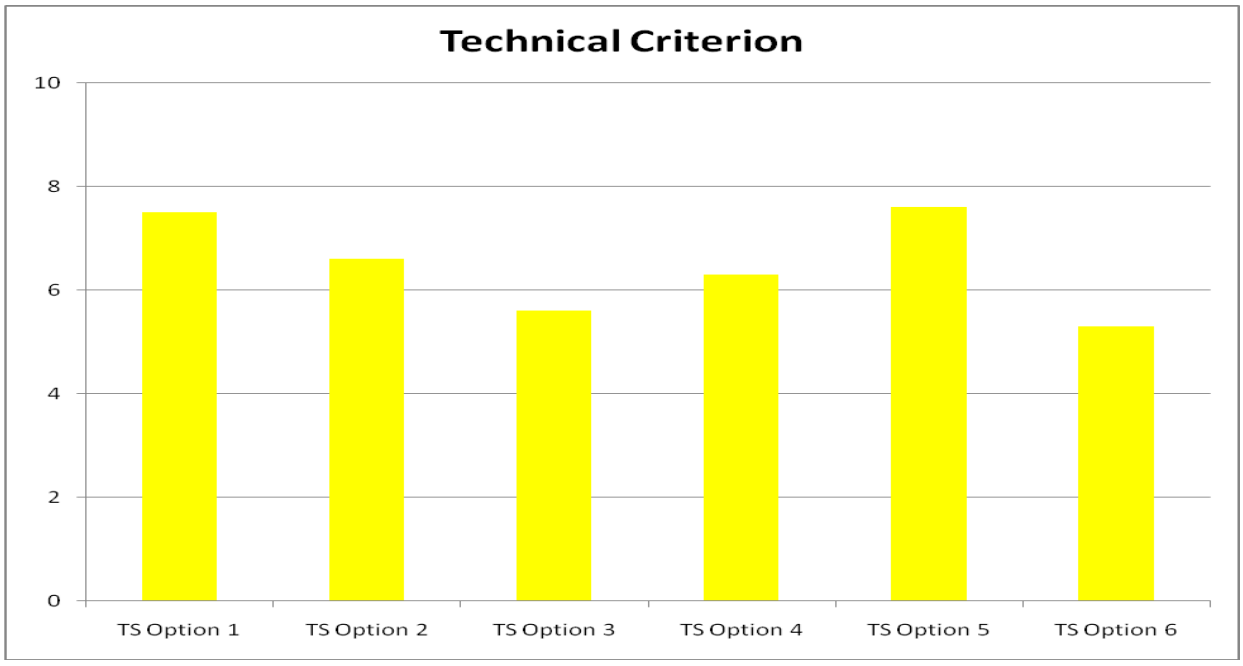


Figure 5-3: Comparison of proposed locations using technical criterion

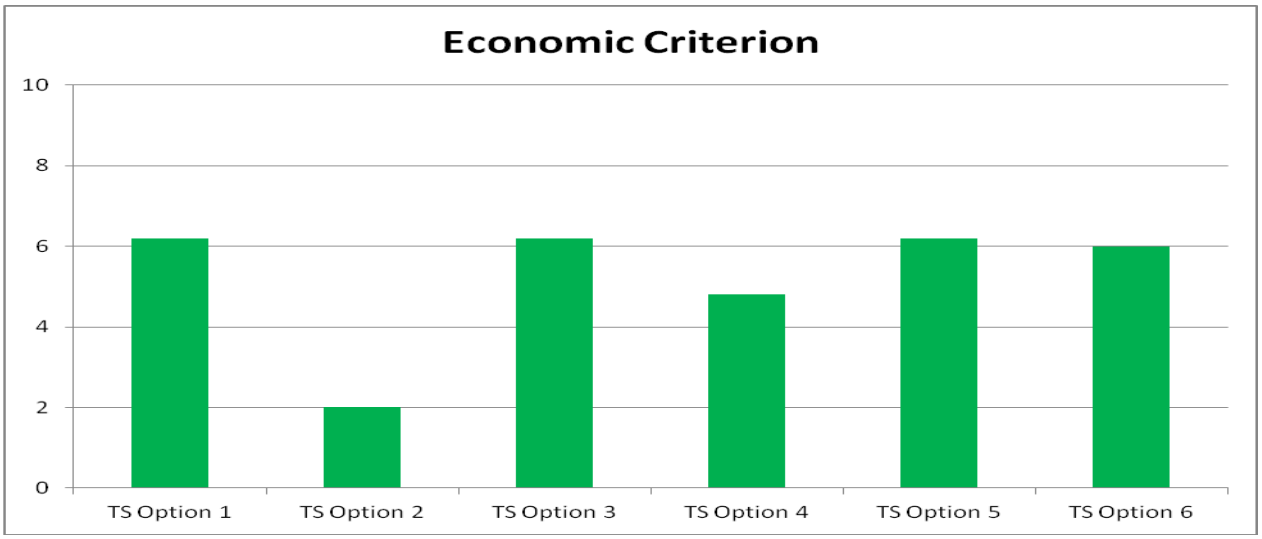


Figure 5-4: Comparison of proposed locations using economic criterion

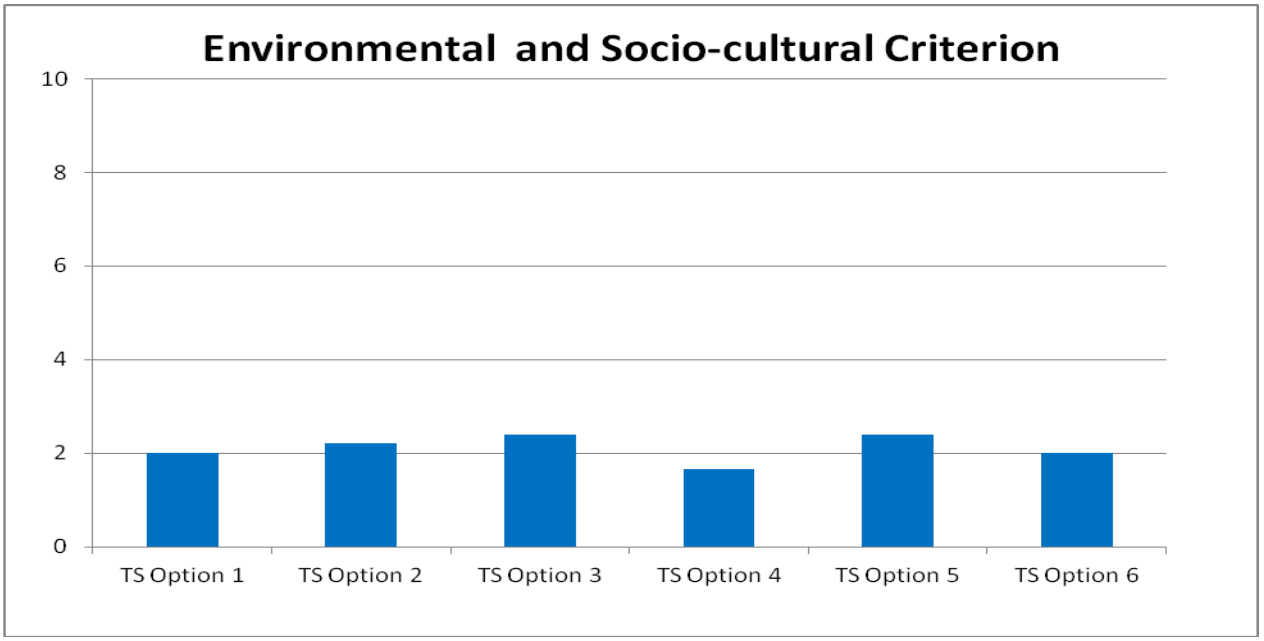


Figure 5-5: Comparison of proposed locations using environmental criterion

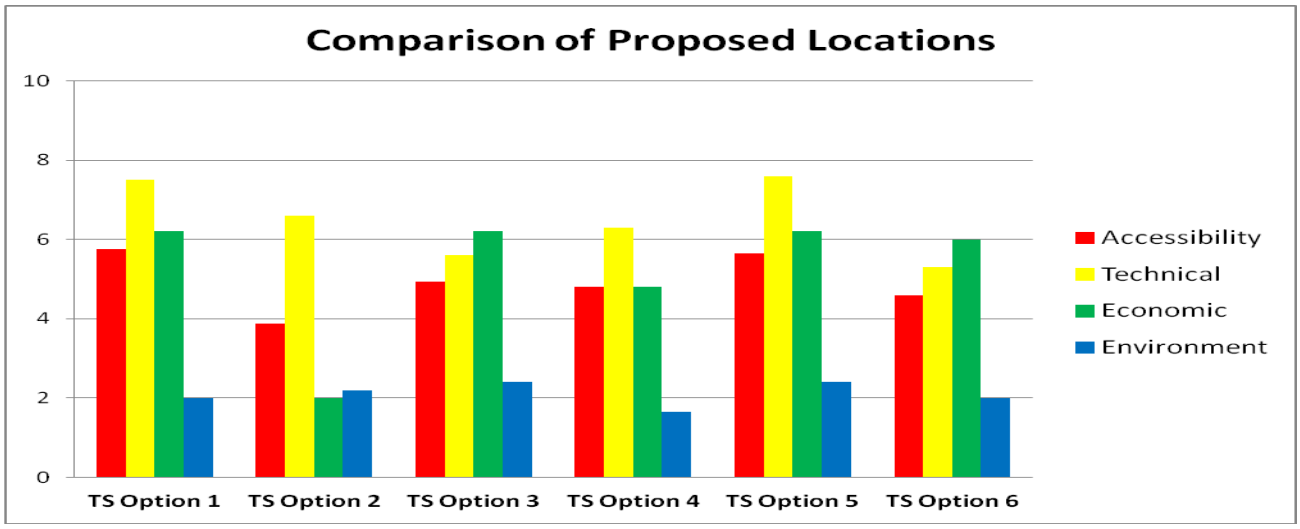


Figure 5-6: Best locations for various criterion categories

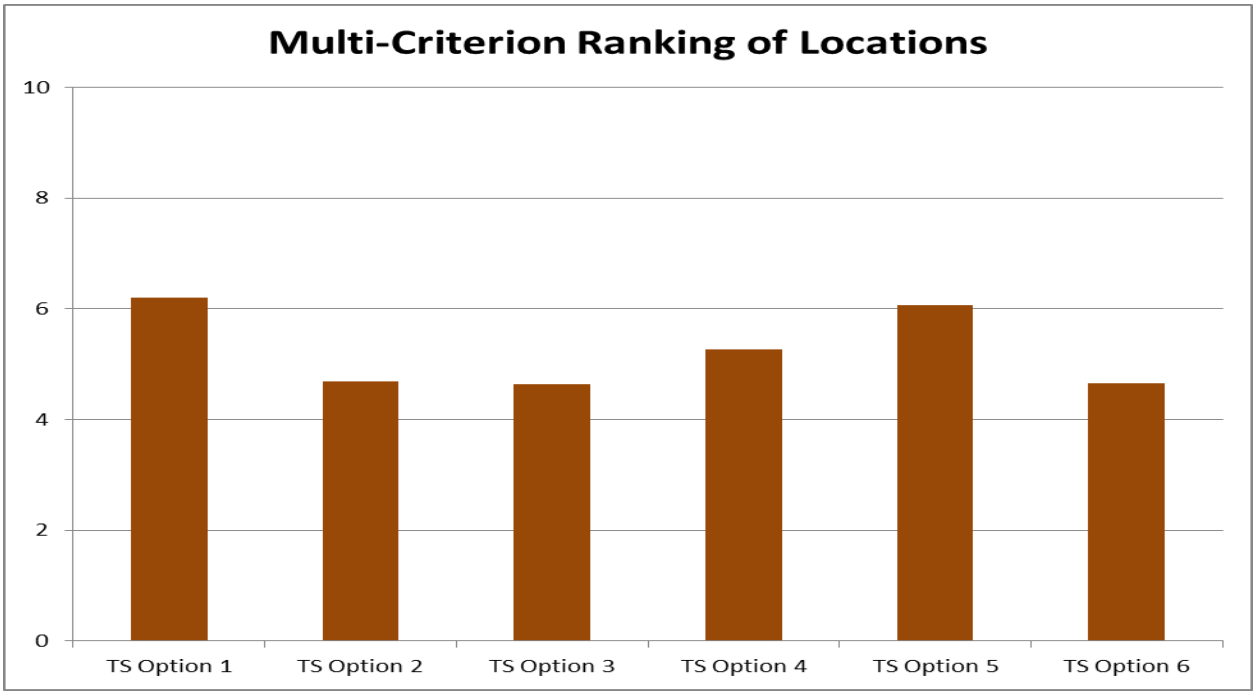


Figure 5-7: Comparison of proposed locations using aggregated scoring

6 Transfer Station Preliminary Costs Assessment

6.1 Cost Components

The cost components used in the preliminary costing of the proposed facility are categorized under the following headings:

- Land acquisition costs
- Building construction costs
- Site works costs
- Equipment costs

Table 6.1 presents the summary construction costs for a single transfer station. It assumed that there will be no costs incurred for land acquisition. The detailed estimates are presented in Appendix D.

Table 6-1: Summary construction costs for a single transfer station

Description	Cost ($)	Cost (GHC)
Land acquisition	-	-
Building construction costs	$1,469,246	GHC 2,923,800
Site works costs	$305,893	GHC 608,727
Equipment costs	$570,000	GHC 1,134,300
Total Cost	**$2,345,139**	GHC 4,666,827
Contingency (15%)	$351,771	GHC 700,024
Engineering Design (8%)	$187,611	GHC 373,346
Construction Supervision (7%)	$164,160	GHC 326,678
Total Cost	**$3,048,681**	GHC 6,066,875

7 Appendices

APPENDICES

Needs Assessment Data

WCV Costs – Compaction Truck			
Running Costs	**GH¢/yr**	**GH¢/month**	**$/yr**
Fuel and lubricants	21,856	1,821	10,928
Tyres	2,302	192	1,151
Repairs & Maint.	5,753	479	2,876
Overtime	2,079	173	1,040
SUB TOTAL	**31,990**	**2,666**	**15,995**
Fixed Costs			
Personnel	12,230	1,019	6,115
Financing cost	26,514	2,209	13,257
Overheads	7,073	589	3,537
SUB TOTAL	**45,817**	**3,818**	**22,909**
TOTAL COST	**77,807**	**6,484**	**38,903**
Profit	11,671	973	5,836
Dumping fees	2,652	221	1,326
GRAND TOTAL	**92,130**	**7,677**	**46,065**

MINT*ESAA 2.0 RESULTS

Compaction Truck Performance	
WCV Type	Refuse Truck
km/yr travelled	16,442
Trips/yr	265
Mean load/trip (T)	6.75
Persons served	5,163
HH served	1,033
Tonnage/Year	1,790

WCV Costs – Skip Truck			
Running Costs	**GH¢/yr**	**GH¢/month**	**$/yr**
Fuel and lubricants	18,222	1,519	9,111
Tyres	2,302	192	1,151
Repairs & Maint.	4,875	406	2,438
Overtime	1,154	96	577
SUB TOTAL	**26,554**	**2,213**	**13,277**
Fixed Costs			
Personnel	6,790	566	3,395
Financing cost	22,469	1,872	11,235
Overheads	5,581	465	2,791
SUB TOTAL	**34,841**	**2,903**	**17,420**
TOTAL COST	**61,394**	**5,116**	**30,697**
Profit	9,209	767	4,605
Dumping fees	2,652	221	1,326
GRAND TOTAL	**73,255**	**6,105**	**36,628**

MINT*ESAA 2.0 RESULTS

Skip Truck Performance	
WCV Type	Skip Truck
km/yr travelled	16,442
Trips/yr	265
Mean load/trip (T)	2.7
Persons served	2,065
HH served	413
Tonnage/Year	716

General Financial Data	
Item	**Value**
Exchange rate (GH¢/$)	2.000
Interest rate (GH¢)	28%
Fuel price per lt (GH¢)	2.00
Oil price per lt (GH¢)	1.50
Tyre price (GH¢)	700
Overheads	10%
Repairs and maint.	7.5%
R&M (second hand)	15.0%
R&M (container)	7.5%
Profit	15%
Driver salary (GH¢/m)	300
Labourer salary (GH¢/m)	200
Employee Social security (%)	12.5%
Clothing (cost/yr)	20

Technologies Assessment Data

Individual category evaluation - Sub-category weighting

Technical		
ID	*Sub criteria*	*Sub-Category Weight*
T1	Adequate storage space for peak waste flow	30%
T2	Ease of unloading refuse trucks	20%
T3	Ease of uploading trailer trucks	20%
T4	Waste handling equipment requirements	5%
T5	Waste compaction equipment requirements	5%
T6	Ease of waste screening, sorting and material recovery	20%
	TOTAL	100%

Economic		
ID	*Sub criteria*	*Sub-Category Weight*
E1	Capital costs - Buildings	45%
E2	Capital costs - Equipment	30%
E3	Operational costs including utilities	10%
E4	Labour costs	5%
E5	Equipment maintenance and replacement costs	10%
E6		0%
	TOTAL	100%

Socio-cultural		
ID	*Sub criteria*	*Sub-Category Weight*
S1	Public acceptance	70%
S2	Land use compatibility	30%
S3		0%
S4		0%
S5		0%
S6		0%
	TOTAL	100%

Environment		
ID	*Sub criteria*	*Sub-Category Weight*
N1	Air pollution risks	10%
N2	Surface water pollution risks	10%
N3	Groundwater pollution risks	10%
N4	Soil contamination risks	10%
N5	Ease of nuisance control (odour, litter, noise and vectors)	50%
N6	Occupational health and safety risks for employees	10%
	TOTAL	100%

Individual category evaluation - Performance ratings of technology options

	ID	Sub criteria	Alternative Transfer Station Technology					
			TST 1	TST 2	TST 3	TST 4	TST 5	TST 6
Technical	T1	Adequate storage space for peak waste flow	1	2	2	7	7	9
	T2	Ease of unloading refuse trucks	5	5	5	5	5	5
	T3	Ease of uploading trailer trucks	3	7	3	7	7	9
	T4	Waste handling equipment requirements	7	9	7	9	9	9
	T5	Waste compaction equipment requirements	7	7	7	7	3	3
	T6	Ease of waste screening, sorting and material recovery	1	1	1	9	9	3
Economic	E1	Capital costs - Buildings	9	3	5	3	3	1
	E2	Capital costs - Equipment	6	9	4	4	2	1
	E3	Operational costs including utilities	9	8	6	5	3	2
	E4	Labour costs	7	8	5	5	3	1
	E5	Equipment maintenance and replacement costs	6	9	4	4	2	1
	E6							
Socio-cultural	S1	Public acceptance	5	5	5	5	5	5
	S2	Land use compatibility	5	5	5	5	5	5
	S3							
	S4							
	S5							
	S6							
Environment	N1	Air pollution risks	5	5	5	4	4	4
	N2	Surface water pollution risks	5	5	5	4	4	4
	N3	Groundwater pollution risks	5	5	5	4	4	4
	N4	Soil contamination risks	5	5	5	4	4	4
	N5	Ease of nuisance control (odour, litter, noise and vectors)	5	5	5	5	4	3
	N6	Occupational health and safety risks for employees	9	6	8	6	6	3

Composite category evaluation - Category weighting

Category	Weighting
Technical	50%
Economic	25%
Socio-cultural	15%
Environment	10%

Aggregated Score

Category	TST 1	TST 2	TST 3	TST 4	TST 5	TST 6
Technical	1.4	2	1.55	3.55	3.45	3.35
Economic	1.925	1.5375	1.175	0.925	0.65	0.275
Socio-cultural	0.75	0.75	0.75	0.75	0.75	0.75
Environment	0.54	0.51	0.53	0.47	0.42	0.34
TOTAL	**4.615**	**4.7975**	**4.005**	**5.695**	**5.27**	**4.715**

Locations Assessment Data

Preliminary performance ratings

PROXIMITY TO WASTE COLLECTION ZONES – COMPOSITE SCORES						
Collection Zone	**TS Option 1**	**TS Option 2**	**TS Option 3**	**TS Option 4**	**TS Option 5**	**TS Option 6**
Okaikoi North	9	3	4	4	3	4
Okaikoi South	9	3	4	6	3	4
Ayawaso East	8	4	4	4	3	8
Ayawaso West	8	4	4	3	4	7
Ayawaso Central	9	3	4	4	4	4
Ablekuma Central	4	3	9	9	9	3
Ablekuma North	4	3	9	9	9	3
Ablekumab South	3	3	8	88	9	3
Osu Klottey	5	7	4	3	5	8
Ashiedu Keteke	4	8	3	3	5	9
La	3	3	7	6	9	4
TOTAL	**66**	**44**	**60**	**59**	**63**	**57**

Individual category evaluation - Sub-category weighting

Accessibility		
ID	*Sub criteria*	*Sub-Category Weight*
A1	Proximity to waste collection zones	30%
A2	Proximity to final disposal sites	30%
A3	Access from major road network	15%
A4	Access from existing rail network	5%
A5	Condition of existing access roads to location	5%
A6	Level of traffic congestion	15%
	TOTAL	100%
Technical		
ID	*Sub criteria*	*Sub-Category Weight*
T1	Adequate land space	40%
T2	Gently sloping topography	10%
T3	Site geotechnical conditions	10%
T4	Availability of utilities – sewers, water, electricity	10%
T5	Land use compatibility	20%
T6	Potential usage as a multi-purpose SWM facility	10%
	TOTAL	100%
Economic		
ID	*Sub criteria*	*Sub-Category Weight*
E1	Land acquisition costs	10%
E2	Land compensation costs	20%
E3	Site remediation costs	70%
E4		0%
E5		0%
E6		0%
	TOTAL	100%
Environment		
ID	*Sub criteria*	*Sub-Category Weight*
N1	Proximity to cultural, heritage or religious sites	20%
N2	Presence of threatened and endangered species	5%
N3	Community resistance towards waste facilities (NIMBY)	25%
N4	Air pollution risks	20%
N5	Groundwater pollution risks	10%
N6	Surfacewater pollution risks	20%
	TOTAL	100%

Individual category evaluation - Performance ratings of proposed locations

	ID	Sub criteria	Alternative TS Locations					
			TS Option 1	TS Option 2	TS Option 3	TS Option 4	TS Option 5	TS Option 6
Accessibility	A1	Proximity to waste collection zones	6	4	3	5	6	5
	A2	Proximity to final disposal sites	8	5	3	7	5	5
	A3	Access from major road network	8	5	8	9	9	7
	A4	Access from existing rail network	9	8	6	4	6	4
	A5	Condition of existing access roads to location	8	5	8	8	8	5
	A6	Level of traffic congestion	7	4	4	6	7	4
Technical	T1	Adequate land space	9	9	7	8	9	6
	T2	Gently sloping topography	9	6	5	6	9	5
	T3	Site geotechnical conditions	5	3	6	6	6	7
	T4	Availability of utilities – sewers, water, electricity	7	7	7	7	7	7
	T5	Land use compatibility	9	7	5	6	9	5
	T6							
Economic	E1	Land acquisition costs	3	3	3	3	3	3
	E2	Land compensation costs	5	5	5	5	5	4
	E3	Site remediation costs	7	1	7	5	7	7
	E4							
	E5							
	E6							
Environment	N1	Proximity to cultural, heritage or religious sites	3	3	2	1	1	2
	N2	Presence of threatened and endangered species	5	5	5	5	5	5
	N3	Community resistance towards waste facilities (NIMBY)	1	1	3	2	3	1
	N4	Air pollution risks	2	1	1	2	3	1
	N5	Groundwater pollution risks	1	3	2	1	2	3
	N6	Surfacewater pollution risks	2	3	3	1	2	3

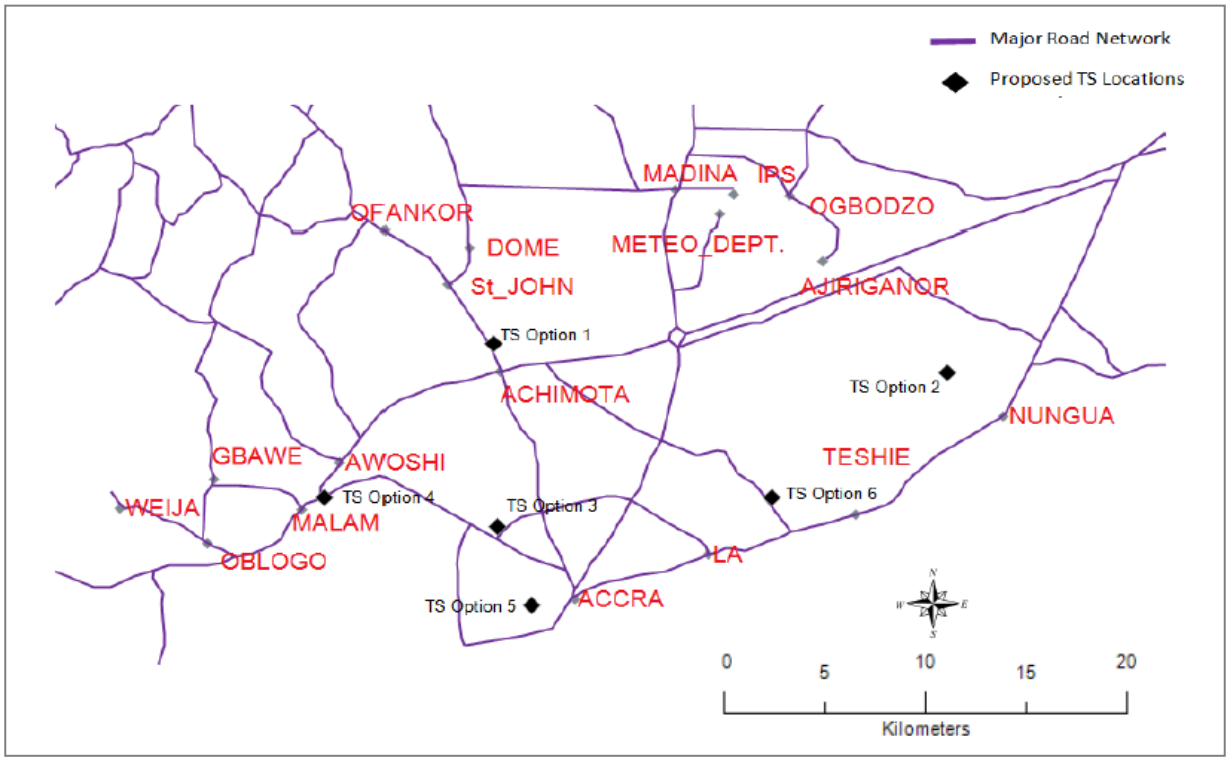
Composite category evaluation - Category weighting

Category	Weighting
Technical	40%
Accessibility	30%
Environmental	20%
Economic	10%

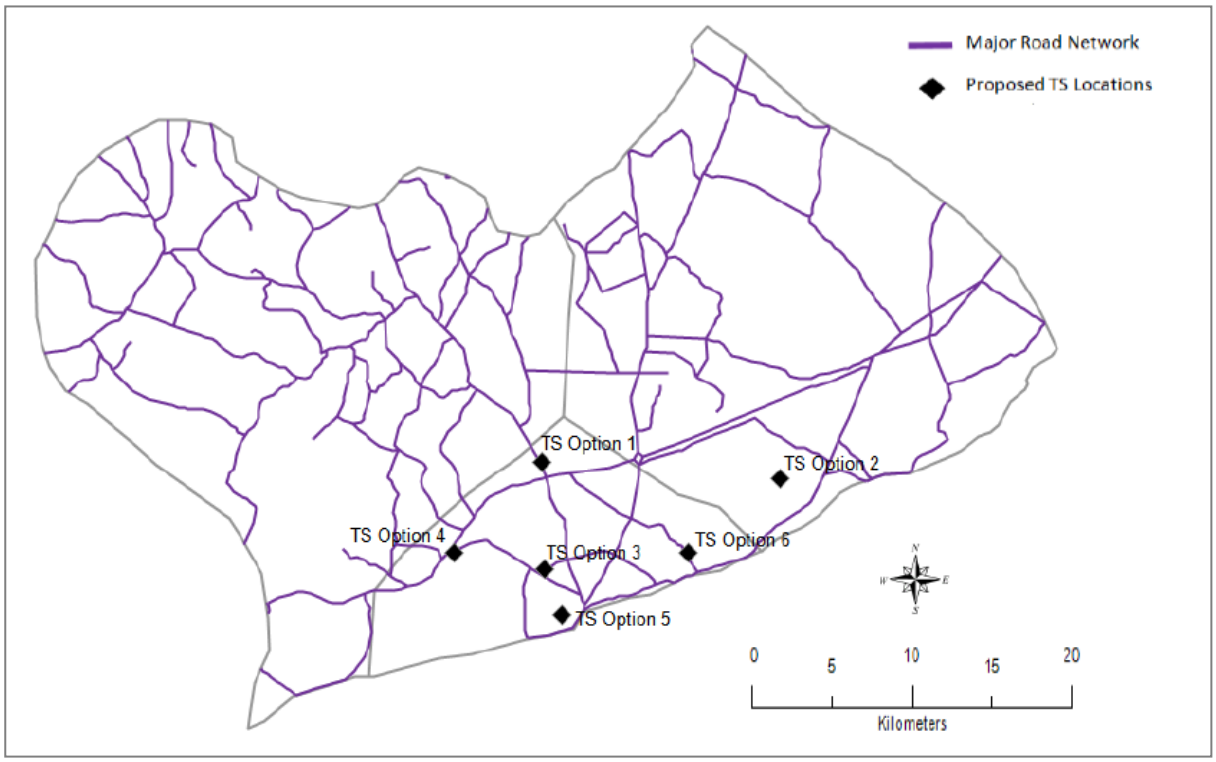
Aggregated Score

Category	TS Option 1	TS Option 2	TS Option 3	TS Option 4	TS Option 5	TS Option 6
Technical	2.19	1.41	1.29	1.935	1.92	1.53
Accessibility	3	2.64	2.24	2.52	3.04	2.12
Environmental	0.62	0.2	0.62	0.48	0.62	0.6
Economic	0.4	0.44	0.48	0.33	0.48	0.4
TOTAL	***6.21***	***4.69***	***4.63***	***5.265***	***6.06***	***4.65***

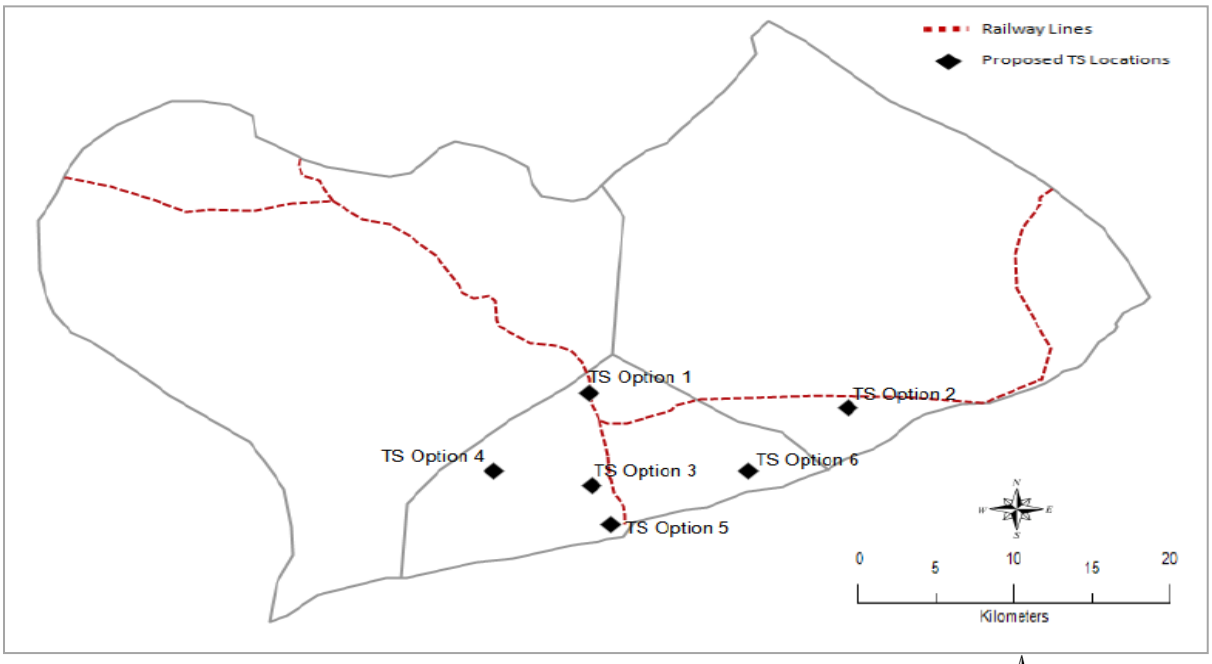
PROXIMITY TO ACCRA METRO SUBURBS



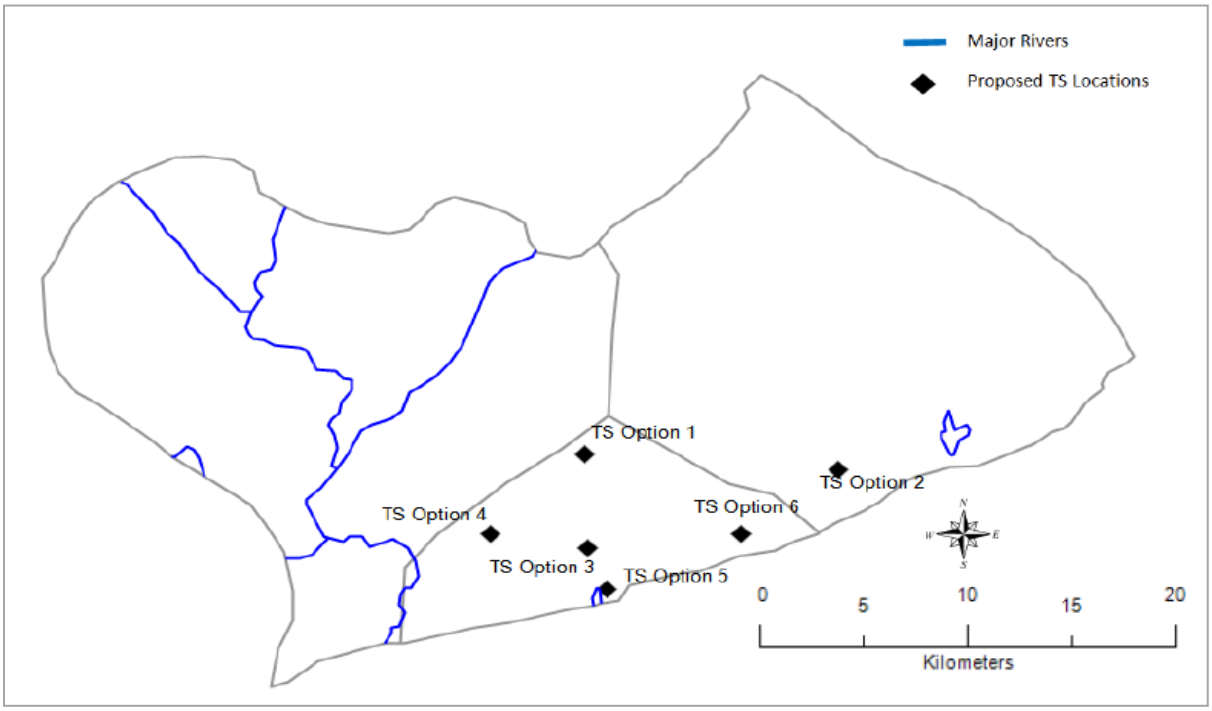
PROXIMITY TO MAJOR ROAD NETWORK



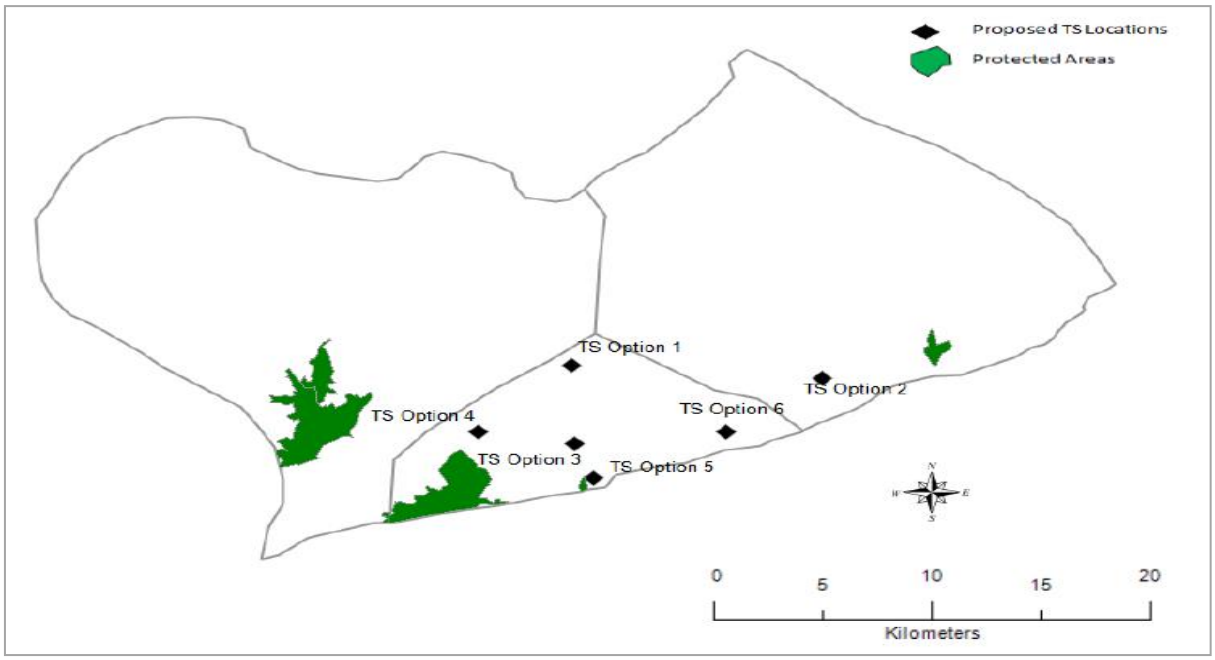
PROXIMITY TO EXISTING RAILWAY LINES



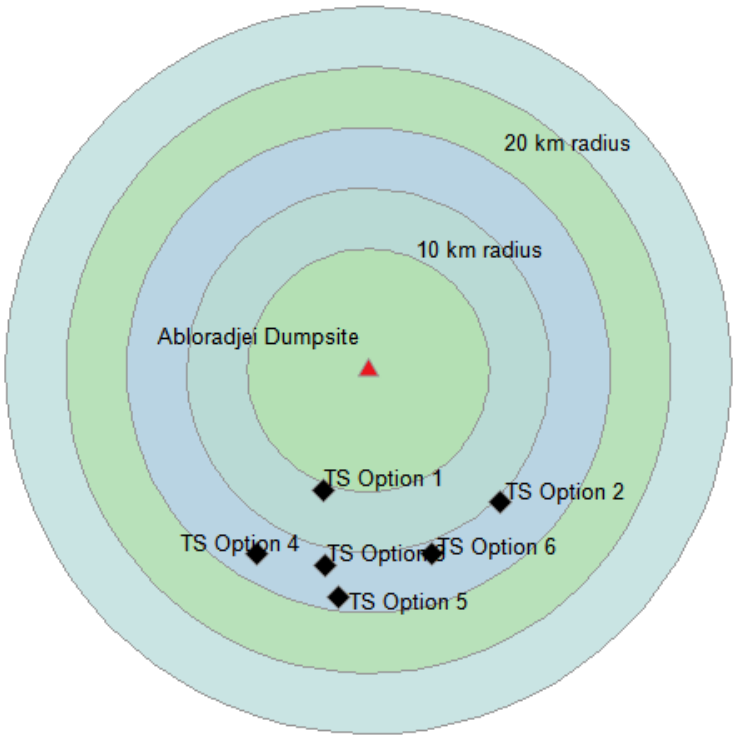
PROXIMITY TO MAJOR RIVERS AND LAGOONS



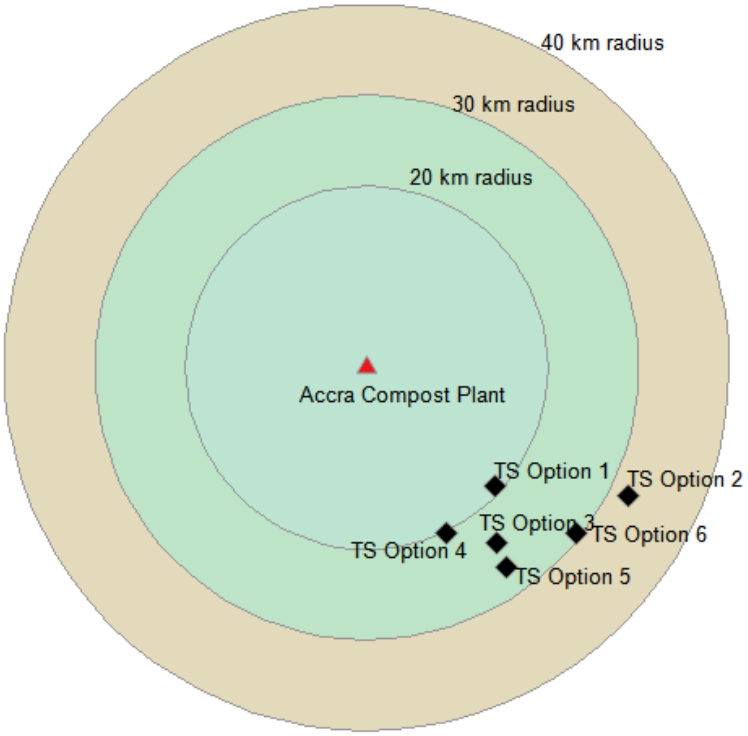
PROXIMITY TO PROTECTED AREAS



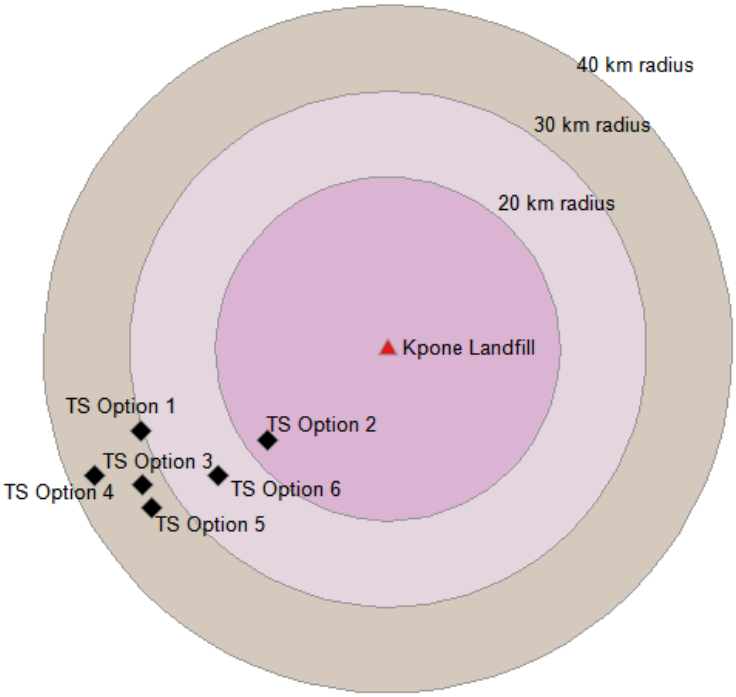
PROXIMITY TO ABLORADJEI DUMPSITE



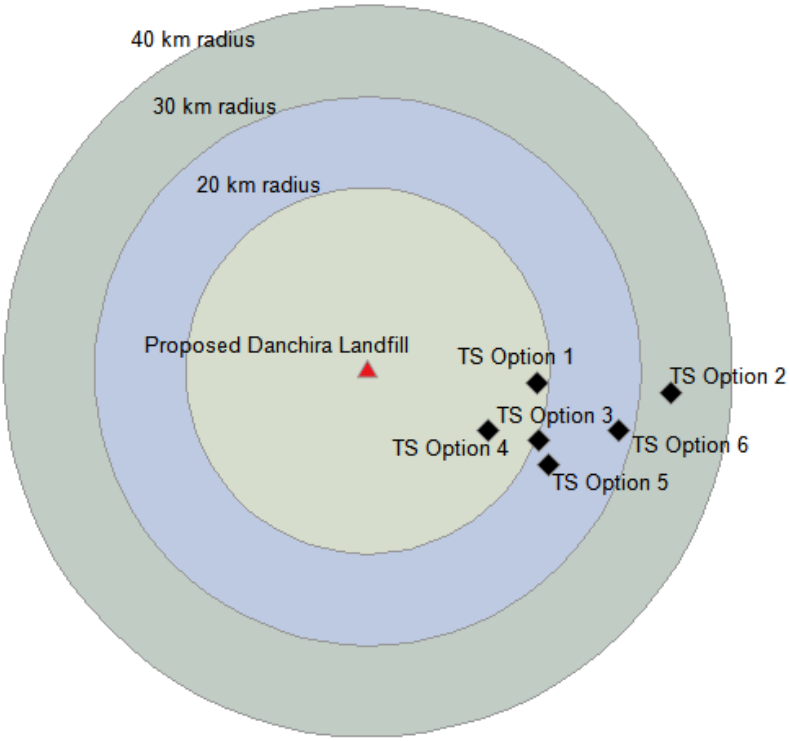
PROXIMITY TO ACCRA COMPOST PLANT



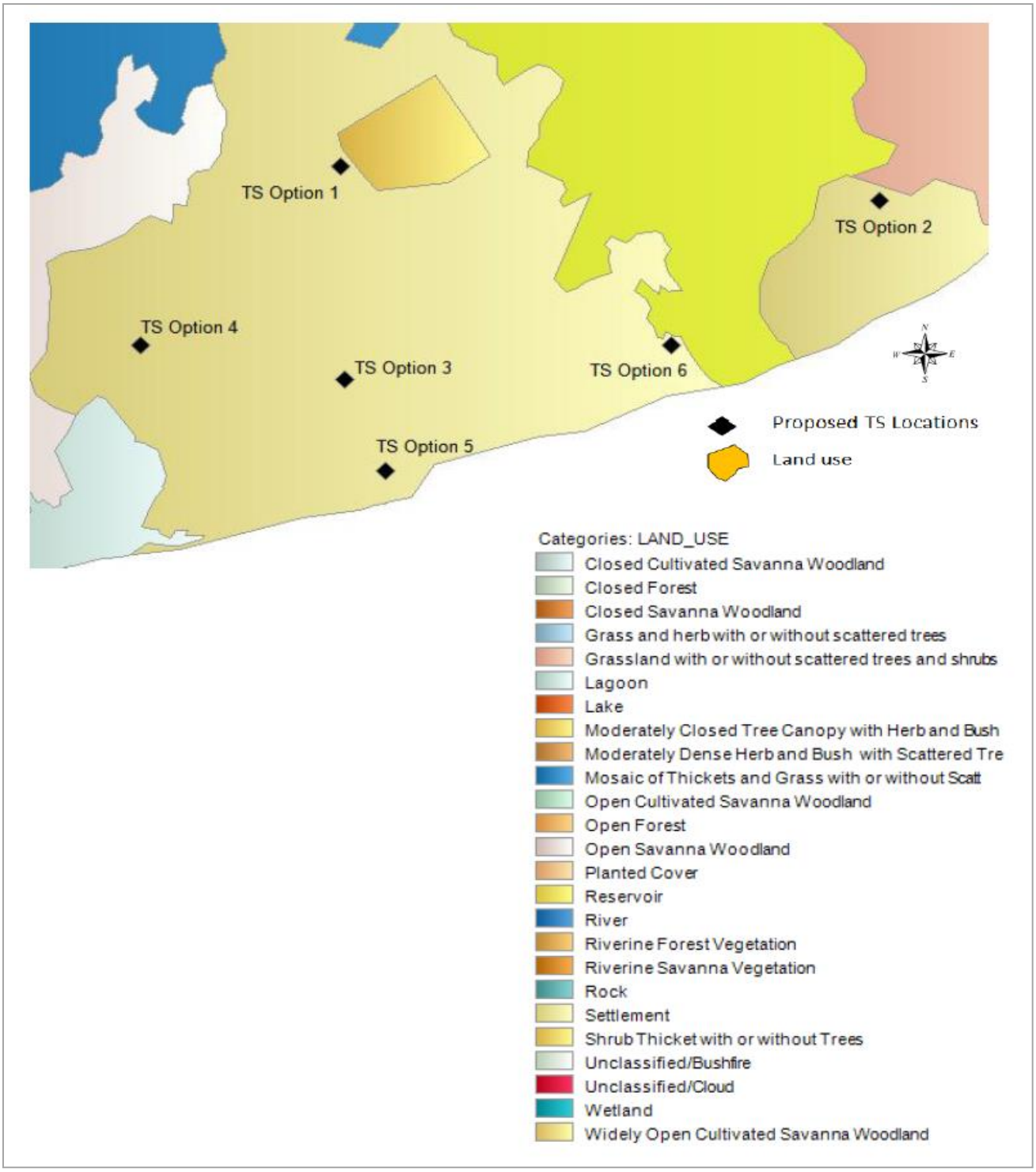
PROXIMITY TO KPONE LANDFILL



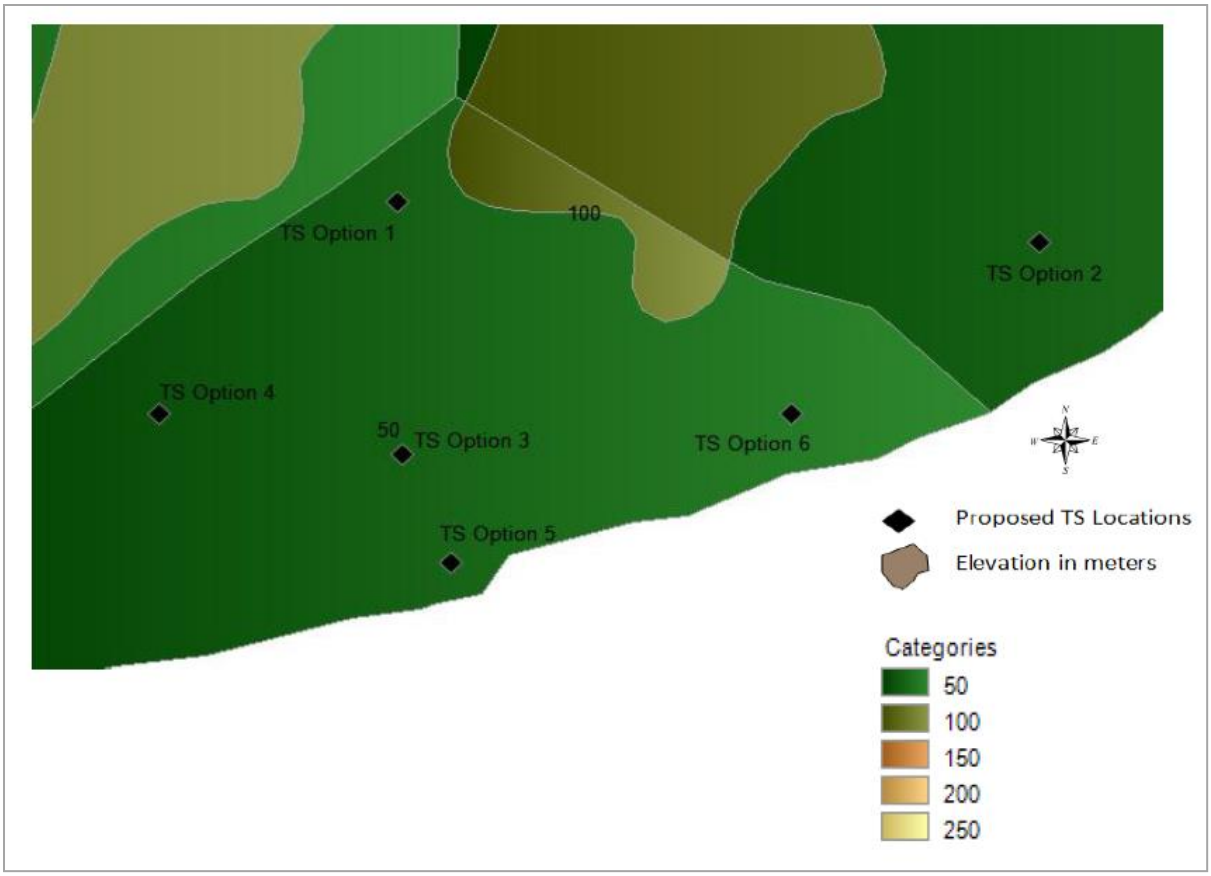
PROXIMITY TO PROPOSED DANCHIRA DISPOSAL SITE



LAND USE


TS Option 1
TS Option 2
TS Option 4
TS Option 3
TS Option 6
TS Option 5
N
W
E
S
Proposed TS Locations
Land use
Categories: LAND_USE
Closed Cultivated Savanna Woodland
Closed Forest
Closed Savanna Woodland
Grass and herb with or without scattered trees
Grassland with or without scattered trees and shrubs
Lagoon
Lake
Moderately Closed Tree Canopy with Herb and Bush
Moderately Dense Herb and Bush with Scattered Tre
Mosaic of Thickets and Grass with or without Scatt
Open Cultivated Savanna Woodland
Open Forest
Open Savanna Woodland
Planted Cover
Reservoir
River
Riverine Forest Vegetation
Riverine Savanna Vegetation
Rock
Settlement
Shrub Thicket with or without Trees
Unclassified/Bushfire
Unclassified/Cloud
Wetland
Widely Open Cultivated Savanna Woodland

TOPOGRAPHY


TS Option 1
100
TS Option 2
TS Option 4
50
TS Option 3
TS Option 6
TS Option 5
Proposed TS Locations
Elevation in meters
Categories
50
100
150
200
250

Preliminary Cost Estimation Data

Building Cost Estimates			
Description	**Qty**	**Unit Cost ($)**	**Total Cost ($)**
Pre-engineered Steel Frame Building	2600 m^2	$ 300 /m^2	$1,040,000
Office Building	30 m^2	GHC 150 /m^2	$2,261
Concrete slab work	2560 m^2	GHC 300 /m^2	$385,930
Retaining walls (Up to 2m high)	200 m	GHC 350/m	$35,176
Foundation (Excavation & backfilling)	780 m^3	GHC 15 /m^3	$5,879
Total			**$1,469,246**

Equipment Cost Estimates			
Description	**Qty**	**Unit Cost ($)**	**Total Cost ($)**
Wheeled Excavator	2 No.	$75,000	$150,000
Front end Loader	2 No.	$60,000	$120,000
Sorting Conveyor	1 No.	$100,000	$100,000
Storage Containers (10m^3)	10 No.	$7,500	$75,000
Storage Containers (1m^3)	10 No.	$2,500	$25,000
Weighbridge	1 No.	$100,000	$100,000
Total			**$570,000**

Site Works Cost Estimates			
Description	**Qty**	**Unit Cost (GHC)**	**Cost ($)**
Site Development			
Site Clearance	26,000 m^2	GHC 0.50 /m^2	$6,533
Earthworks	20,000 m^2	GHC 1.50 /m^2	$19,598
Paving blocks	20,000 m^2	GHC 25 /m^2	$251,256
Total			**$277,387**
Fencing and Gate			
Barbed wire 3 rows	720 m	GHC 2.60 /m	$941
Chain link mesh	720 m	GHC 30.50 /m	$11,035
Galvanised poles @ 3.0 m intervals	230 No.	GHC 37.00 /m	$8,510
Gate	1 No.	GHC 2800	$1,407
Gate posts	2 No.	GHC 480	$482
Total			**$22,375**
Landscaping			
Provision and placement of topsoil	26,000 m^2	GHC 0.25 /m^2	$3,266
Establishment of green areas	6,000 m^2	GHC 0.35 /m^2	$1,055
Tree planting around periphery	720 m	GHC 5/ m	$1,809
Total			**$6,131**
Grand Total			**$305,893**