Ministry of Environment, Science, Technology and Innovation (MESTI)

Town and Country Planning Department (TCPD)

THE STUDY

ON

THE COMPREHENSIVE URBAN

DEVELOPMENT PLAN

FOR

GREATER KUMASI

IN

THE REPUBLIC OF GHANA

FINAL REPORT

VOLUME 2

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The Study on the Comprehensive Urban Development Plan for Greater Kumasi in the Republic of Ghana

Final Report

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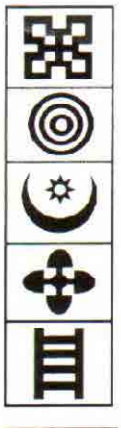
List of Abbreviations

AFD	Agence Française de Développement French Agency for Development
AGI	Association of Ghana Industries
BOST	Bulk Oil Storage and Transportation
BPO	Business Processing Outsourcing
BRRI	Building and Road Research Institute
BRT	Bus Rapid Transit
BSP	Bulk Supply Point
CAP 84	Town and Country Planning Ordinance, 1945
CAPEX	Capital Expenditure
CBD	Central Business District
CHPS	Community-based Health Planning and Services
CSIR	Council for Scientific and Industrial Research
CWSA	Community Water and Sanitation Agency
DFR	Department of Feeder Roads
DMU	Drain Maintenance Unit
DPCU	District Planning Co-ordinating Unit
DUR	Department of Urban Roads
DVLA	Driver Vehicle License Authority
EAP	Economically Active Population
EC	Energy Commission
ECG	Electricity Company of Ghana
EHD	Environmental Health Department
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPA	Environmental Protection Agency
EPO	Economic Planning Officer
FIRR	Financial Internal Rate of Return
FRHP	Focus Region Health Project
GCNet	Ghana Community Network Services Limited
GDP	Gross Domestic Product
GHA	Ghana Highway Authority
GHC	Ghana Cedi
GHS	Ghana Health Service
GIS	Geographical Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit German International Cooperation

GNFS	Ghana National Fire Service
GoG	Government of Ghana
GPRTU	Ghana Private Road Transport Union
GRDP	Gross Regional Domestic Product
GRIDCo	Ghana Grid Company Limited
GSGDA	Ghana Shared Growth and Development Agenda
GSS	Ghana Statistical Service
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit German Technical Cooperation Agency
GUMPP	Ghana Urban Management Pilot Project
GWCL	Ghana Water Company Limited
HOV	High Occupancy Vehicles
HSD	Hydrological Service Department
IBRD	International Bank for Reconstruction and Development
ICT	Information and Communication Technology
IEE	Initial Environmental Examination
IMF	International Monetary Fund
IPP	Independent Power Producers
IRI	International Roughness Index
ISPs	Informal Service Providers
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
KATH	Komfo Anokye Teaching Hospital
KBTH	Korle Bu Teaching Hospital
KCRP	Kumasi Composting & Recycling Plant
KMA	Kumasi Metropolitan Assembly
KMA-WMD	Kumasi Metropolitan Assembly Waste Management Department
KNUST	Kwame Nkrumah University of Science and Technology
KVIP	Kumasi Ventilated-Improvement Pit
LAP	Land Administration Project
LP	Local Plan
LUSPA	Land Use and Spatial Planning Authority (Proposed)
MCI	Millennium Cities Initiative
MDA	Ministry, Department and Agency
MDGs	Millennium Development Goals
MESTI	Ministry of Environment, Science, Technology & Innovation
MLGRD	Ministry of Local Government and Rural Development
MMDA	Metropolitan, Municipality, District Assembly
MMT	Metro Mass Transit

MoFEP	Ministry of Finance and Economic Planning
MOH	Ministry of Health
MOU	Memorandum of Understanding
MRF	Materials Recovery Facility
MSL	Mean Sea Level
MTDP	Medium Term Development Plan
MTHS	Medium Term Health Strategy
MTTU	Motor Transport Transit Unit
MVA	Mega Volt Ampere
MWRWH	Ministry of Water Resources, Works and Housing
NDPC	National Development Planning Commission
NGO	Non-Governmental Organization
NPV	Net Present Value
NRW	Non-Revenue Water
O&M	Operation and Maintenance
OASL	Office of the Administration of Stool Lands
OMC	Oil Marketing Companies
OPEX	Operating Expense
PAPs	Project Affected Persons
PCU	Passenger Car Unit
POW	Program of Work
PPMED	Policy, Planning, Monitoring and Evaluation Division
PSS	Primary Substation
PURC	Public Utility Regulator Company
RCC	Regional Co-ordinating Council
RED	Roads Economic Decision Model
ROW	Right of Way
RPCU	Regional Planning Co-ordinating Unit
S/W	Scope of Work
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SIP	Strategic Investment Programme
SP	Structure Plan
SRTM	Shuttle Radar Topography Mission
SSP	Strategic Sanitation Plan
SWM	Solid Waste Management
TCPD	Town and Country Planning Department
TDM	Transportation Demand Management

UESP	Urban Environmental Sanitation Programme
UGB	Urban Growth Boundary
UN	United Nations
UNDAF	United Nations Development Assistance Framework
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UPTUs	Urban Passenger Transport Units
VIP	Ventilated Improved Pit
VOC	Vehicle Operating Cost
VRA	Volta River Authority
WC	Water Closet
WD	Works Department
WEDC	Water, Engineering and Development Centre
WHO	World Health Organization
WPA	Wildlife Protected Area
WRC	Water Resources Commission
WRS	Water Resources Science
WTP	Water Treatment Plant



PART VI

Infrastructure Sector Plans and Programmes for Greater Kumasi Sub-Region

Chapter 12 Transport Sector Plan and Programme

12.1 Objectives for Transportation Sector Development

12.1.1 Objectives for Transportation Sector Development

The objectives of the transport infrastructure strategy discussed in Chapter 9 are the following:

- To provide high quality transportation infrastructure to strengthen the socioeconomic linkage of Kumasi to surrounding districts and other regions
- To establish efficient public transportation along the key corridors of Greater Kumasi Sub-Region to facilitate mass movement of people and goods efficiently
- To support socioeconomic development of Greater Kumasi Sub-Region and induce development along key corridors and surrounding districts

These objectives guided the formulation of policy and strategy which subsequently directed the list of transport sub-sector programmes. The objectives of each programme are discussed individually in the later part of the chapter.

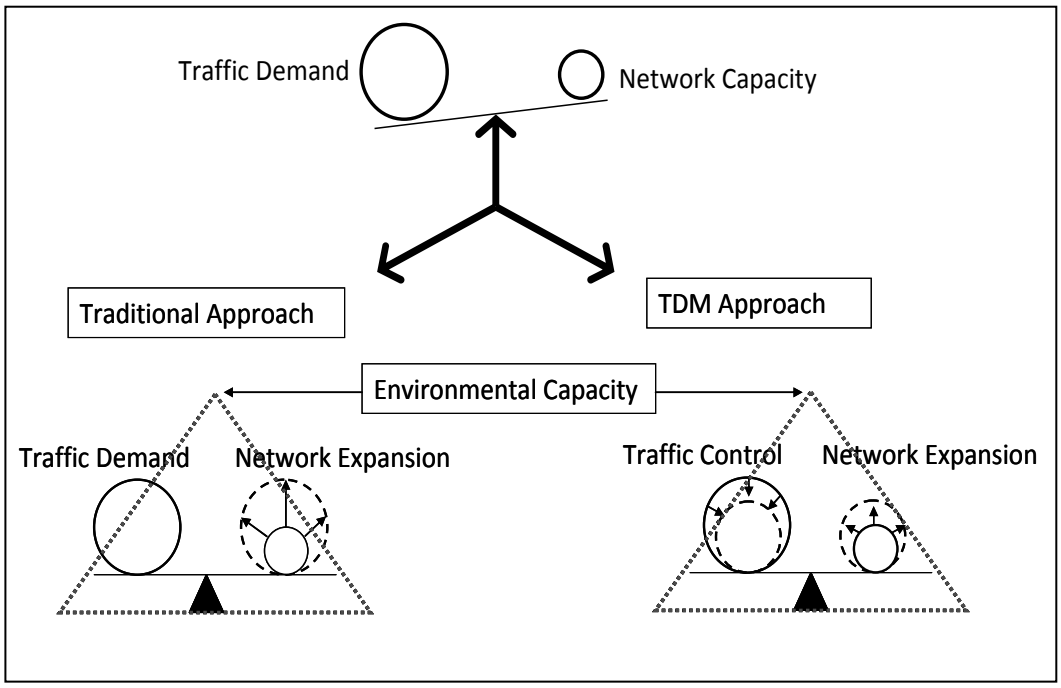
12.1.2 Policy for Transportation Sector Development

The two policies adopted to meet the objectives above took into account the need to find a way to balance infrastructure supply and traffic demand. Obviously, the serious problems of the transportation system of Greater Kumasi Sub-Region indicate that there is a need to expand the capacity of the network to accommodate demand for mobility as well as to shape a policy and strategy to ensure efficient use of existing infrastructure. The idea is to build the backbone of the network to create a mass transit system that would become the main carrier of passengers. This effort to expand the network is complemented by deploying Transportation Demand Management (TDM) measures that would lead to efficient use of transport infrastructure.

Lessons from the past indicate that when an effort is made to increase capacity of infrastructure; traffic demand also tends to increase. The new roads become a temptation to those who have financial resources to own a car or for companies to increase their fleets. Likewise, as income increases, the ability to own a car increases. Once a car is acquired, it leads to an increase in activities (car trips) which utilize road space. Demand therefore will continue to increase and supply of infrastructure has to be kept in pace to maintain or improve traffic flow. This approach is illustrated in Figure 12.1.1.

On one hand, the traditional approach addressed increased demand by supplying more infrastructures to increase capacity of the transportation system. This approach failed to address the problem because demand keeps on increasing and authorities find it difficult to increase infrastructure supply at a pace with demand due to the difficulty of securing financial resources. Environmental constraints also come into play when infrastructure size is expanded.

On the other hand, a TDM-based approach intervenes in the growth of traffic by increasing the efficiency of the infrastructure instead of increasing road supply. In essence, TDM works to make efficient use of the current transportation resources as well as making limited expansion to remove bottlenecks of the network or to complete the backbone of the network. This approach has gained wide support among planners and authorities in view of the difficulty in securing financial resources for transport projects. This policy is adopted to address the transportation challenges of Greater Kumasi Sub-Region. The plan is to complete the backbone of the network and to restrain traffic demand by application of several TDM measures. This policy is further discussed below.



Source: Modified by JICA Study Team based on Ohta, K. (1998), TDM Measures Toward Sustainable Mobility, IATSS research. Vol. 22, no. 1

Figure 12.1.1 Infrastructure-based and TDM-based approach

Transportation countermeasures are categorized based on the infrastructure-based / TDM-base approach above and transportation mode / infrastructure type. The Table 12.1.1 explained the transportation countermeasures clarification. Based on this clarification, the policies and strategies for the transportation sector development are discussed.

Table 12.1.1 Transport Countermeasures; Infrastructure and TDM-based Approach

Sub-programme	Infrastructure-Base Approach	TDM-Base Approach
Road Network	✓ New Construction ✓ Road Widening ✓ Upgrade and Surfacing	✓ Park and Ride ✓ One-way / Traffic Control System ✓ Rideshare / Car sharing ✓ HOV Priority ✓ Road pricing
Intersection	✓ Flyover Construction ✓ Geometry Improvement	✓ Signalizing ✓ Centralized Traffic Signal
Public Transport	✓ Segregated Bus Lane	✓ BRT ✓ Type B Bus
Freight Transport	✓ Railway Upgrade ✓ Railway New Construction ✓ Truck Terminal Construction ✓ Bulk Breaking Point Construction	✓ Time Window Scheme ✓ Truck Access Control
Others		✓ Flexible Working hours ✓ Commuter financial incentive ✓ Mobility management

Source: JICA Study Team

(1) Policy on Transport Corridor Development (Infrastructure Development)

The policy will underscore the important role of public transport where the majority of commuters are relying on its services. Thus the objective for urban transport policy shall be:

- Develop a transport system that contributes to realization of the national transport vision of the country which is to make Ghana the hub for the West African Sub-Region
- Prioritize creation of mass transportation services along strategic corridors to improve mobility
- Integrate land use and transportation planning (e.g. by ensuring that high traffic attracting/generating developments are well located within the transportation system or by requiring traffic impact assessment to be carried out for large scale developments)
- Create a framework where participation of the private sector in transport infrastructure development is encouraged
- Strengthen the link between Kumasi and surrounding districts by expanding the network capacity (e.g. widening of key arterial roads like Mampong Road, Lake Road, Sunyani Road, etc.)

(2) Policy on Transportation Demand Management (TDM)

In view of the limited resources to fund infrastructure development, it is necessary to explore other measures which have potential to contribute in addressing the transportation problems of Greater Kumasi Sub-Region. Transportation Demand Management (TDM) is a general term for strategies that result in more efficient use of transportation resources, as opposed to increasing transportation system supply by expanding roads, parking facilities, airports and other motor vehicle facilities (Mobility Management, GTZ, 2003). TDM operates through legislative, traffic engineering, and operational measures to attain the goal of a better traffic environment. Unlike infrastructure-based (or hard measures), TDM does not require

huge capital investment making it an attractive option to policy makers. Table 12.1.2 shows the two different approaches in addressing transportation issues, supply-side measures (infrastructure-based measures) and demand-side measures (TDM-based measures). Likewise,

Table 12.1.3 presents some examples of TDM measures that can be adopted for Greater Kumasi Sub-Region.

Table 12.1.2 Examples of Transport System Management Measures

Increase Supply	Demand Management
Add roads and road lanes	Road/ Congestion pricing
More bus service	Fuel pricing
More light rail service	Parking policies and pricing
More commuter rail service	Vehicle use restrictions
More frequent bus or tram corridors	Priority for bus and non-motorized modes
Dedicated bus or tram corridors	Priority for bus and non-motorized modes
Bike lanes and bike parking	Clustered land uses
Sidewalks and crosswalks	Flexible work hours and telecommuting
Bridges and tunnels for bicyclists and pedestrians	Travel planning information

Source: Transportation Demand Management, April 2009, GTZ

Table 12.1.3 Examples of TDM Travel Impacts

TDM Measures	Mechanism	Travel Changes
Traffic calming	Roadway design	Reduces traffic speeds, improves pedestrian conditions
Flexible work hours	Improved transport choice	Shift travel time (when trips occur)
Road/congestion pricing	Pricing	Shifts travel time, reduces number of vehicles on a particular roadway
Distance-based charges	Pricing	Reduces overall vehicle travel
Transit improvement	Improved transport choice	Shifts mode, increases transit use
Ridesharing (carpool, vanpool)	Improved transport choice	Increases vehicle occupancy, reduces vehicle trips
Pedestrian and bicycle improvements	Improved transport choice, roadway design	Shifts mode, increases walking and cycling
Car sharing	Improved transport choice	Reduces vehicle ownership and trips
Compact land use (Smart Growth)	Improved transport choice	Shifts mode, reduces vehicle ownership and trip distances.

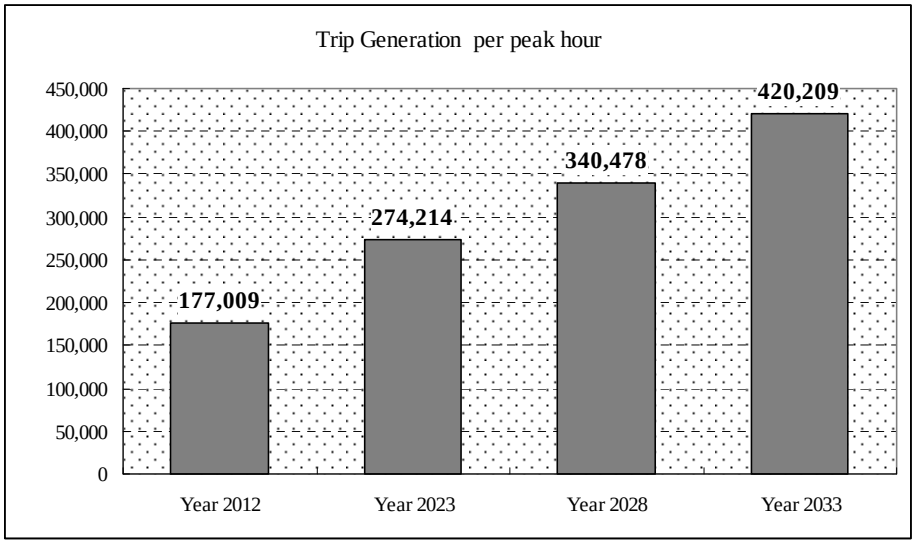
Source: Transportation Demand Management, April 2009, GTZ

12.2 Future Transport Demand Analysis

By utilizing the transportation models developed in the past studies for Kumasi, especially the World Bank assisted Kumasi Transport Plan in 2011-2012, future transportation demands will be forecast using proposed socio-economic frameworks and new urban spatial structures.

(1) Trip Generation

The forecasting results of trip generation in peak one hour are as shown in the Figure 12.2.1.



Source: JICA Study Team

Figure 12.2.1 Present and Future Trip Generation per peak one hour

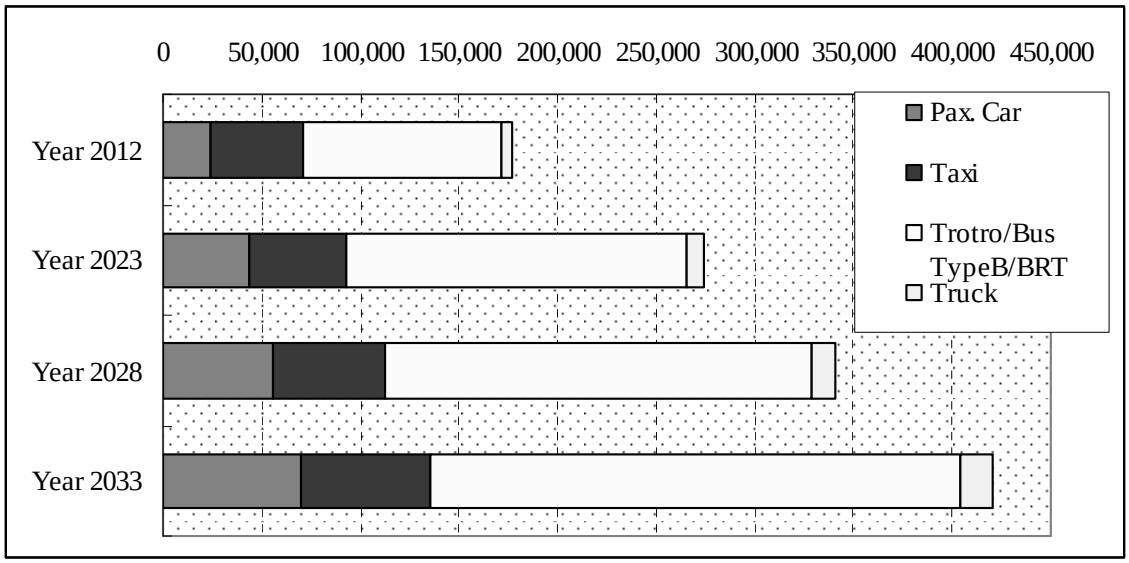
(2) Modal Share

The forecasting results of modal share in peak one hour are shown in Table 12.2.1.

Table 12.2.1 Existing and Future Trips by Travel Mode in With Project Case

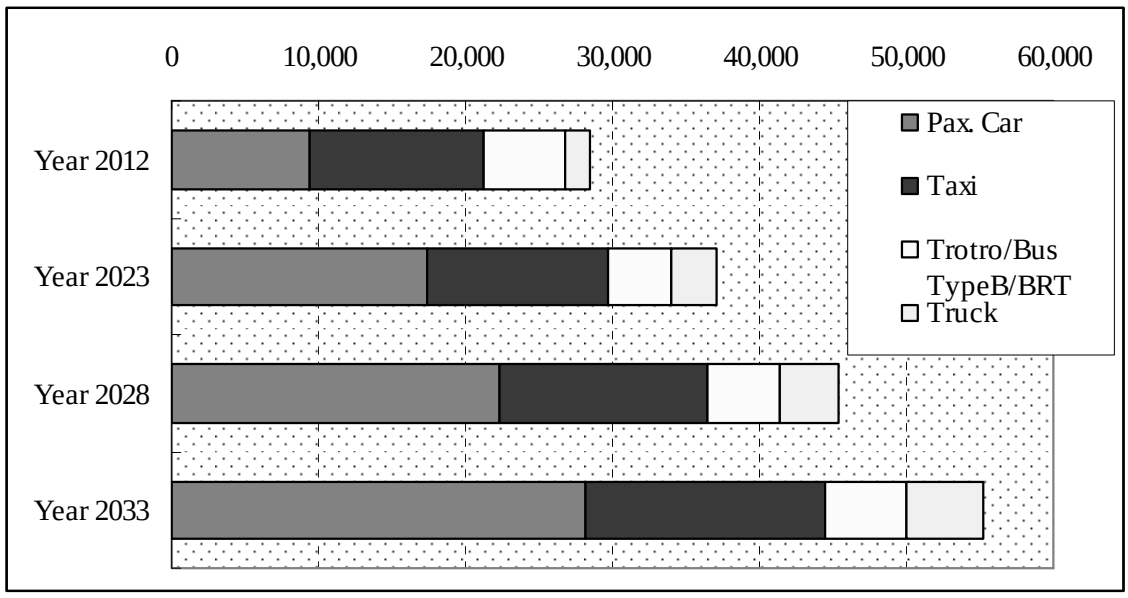
Person Trip in peak hour					
Year	Pax. Car	Taxi	Trotro/Bus Type B/BRT	Truck	Total
Year 2012	23,620	46,832	101,313	5,244	177,009
	13.3%	26.5%	57.2%	3.0%	100%
Year 2023	43,438	49,373	172,403	9,079	274,293
	15.8%	18.0%	62.9%	3.3%	100%
Year 2028	55,867	56,532	216,051	11,967	340,417
	16.4%	16.6%	63.5%	3.5%	100%
Year 2033	70217	65444	268713	15762	420,136
	16.7%	15.6%	64.0%	3.8%	100%
Vehicle Trip in peak hour					
Year	Pax. Car	Taxi	Trotro/Bus Type B/BRT	Truck	Total
Year 2012	9,448	11,708	5,629	1,748	28,533
	33.1%	41.0%	19.7%	6.1%	100%
Year 2023	17,375	12,343	4,310	3,026	37,055
	46.9%	33.3%	11.6%	8.2%	100%
Year 2028	22,347	14,133	4,910	3,989	45,379
	49.2%	31.1%	10.8%	8.8%	100%
Year 2033	28,087	16,361	5,598	5,254	55,300
	50.8%	29.6%	10.1%	9.5%	100%

Source: JICA Study Team



Source: JICA Study Team

Figure 12.2.2 Person Trips in One-Hour Peak Time by Travel Mode

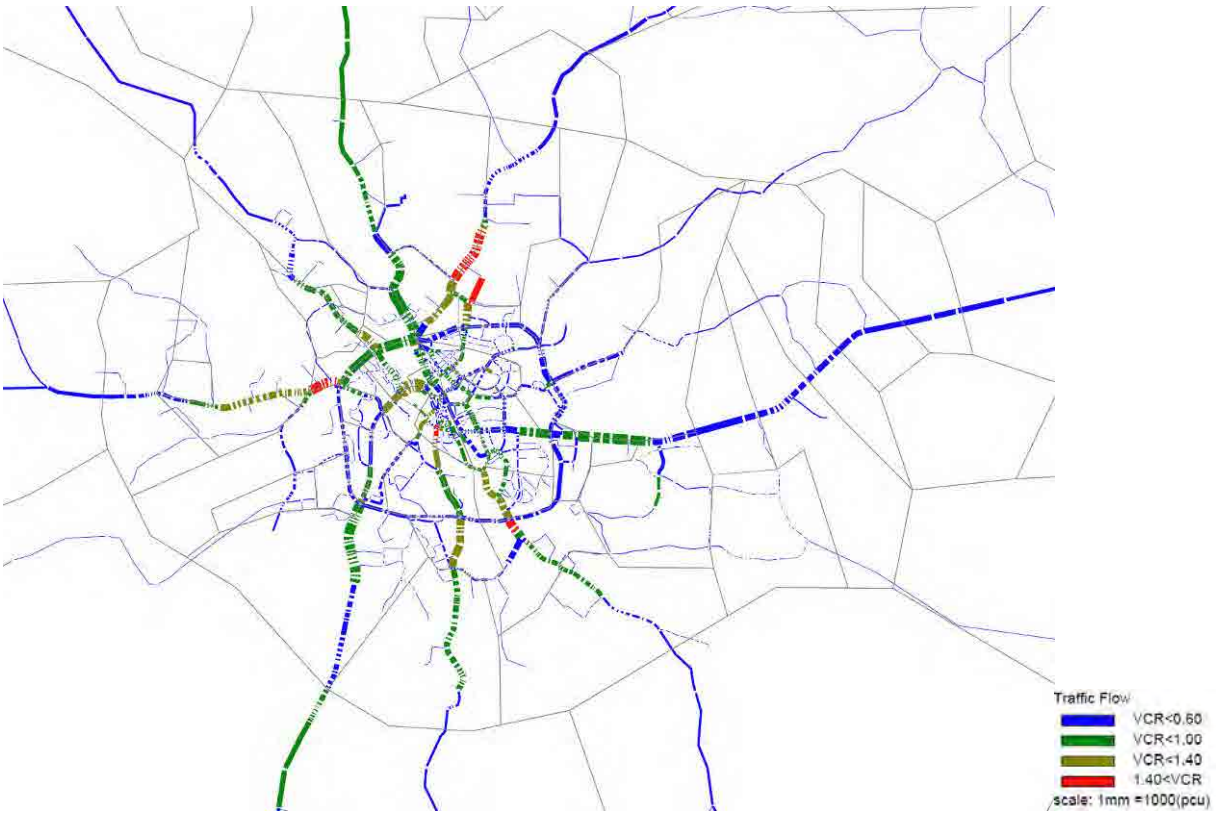


Source: JICA Study Team

Figure 12.2.3 Vehicle Trips in One-Hour Peak Time by Travel Mode

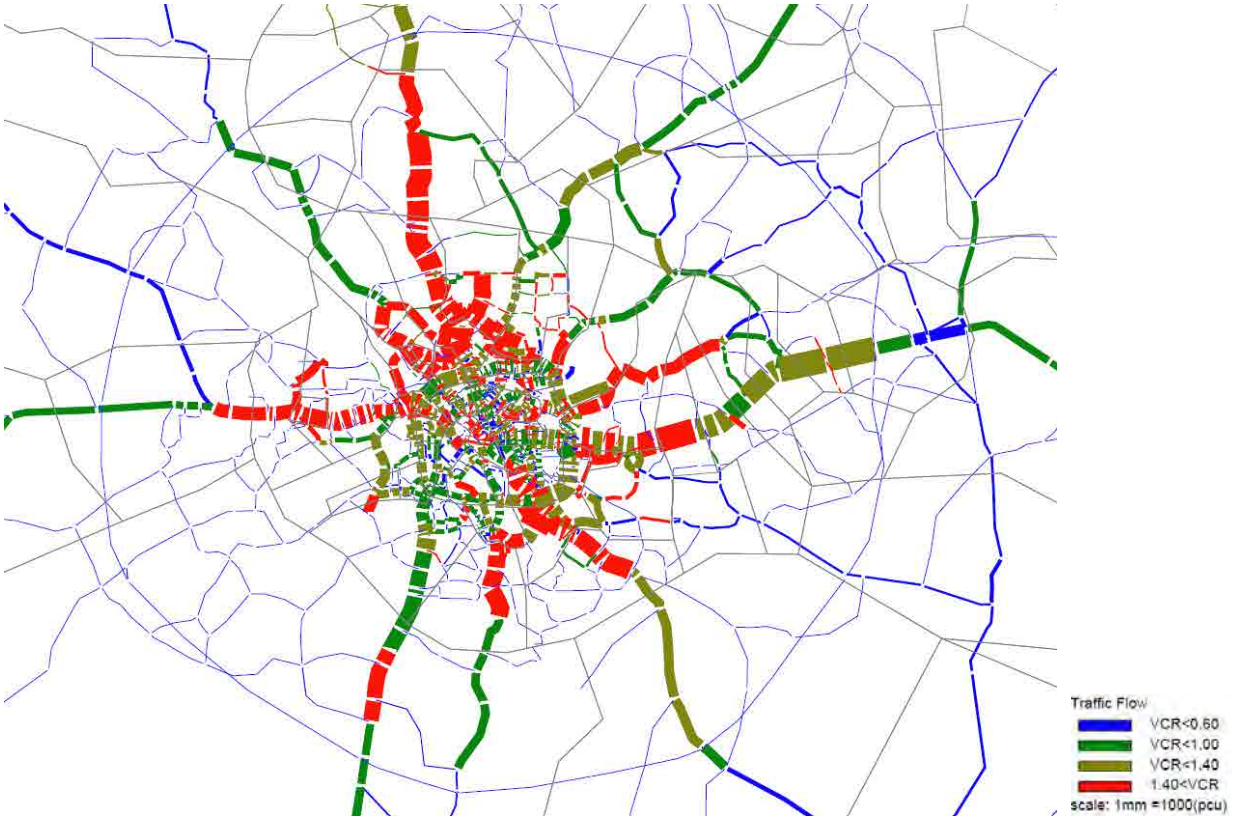
(3) Traffic Assignment Results

The Figures below indicated the results of Traffic Assignment for the existing 2012, future 2033 without and with cases.



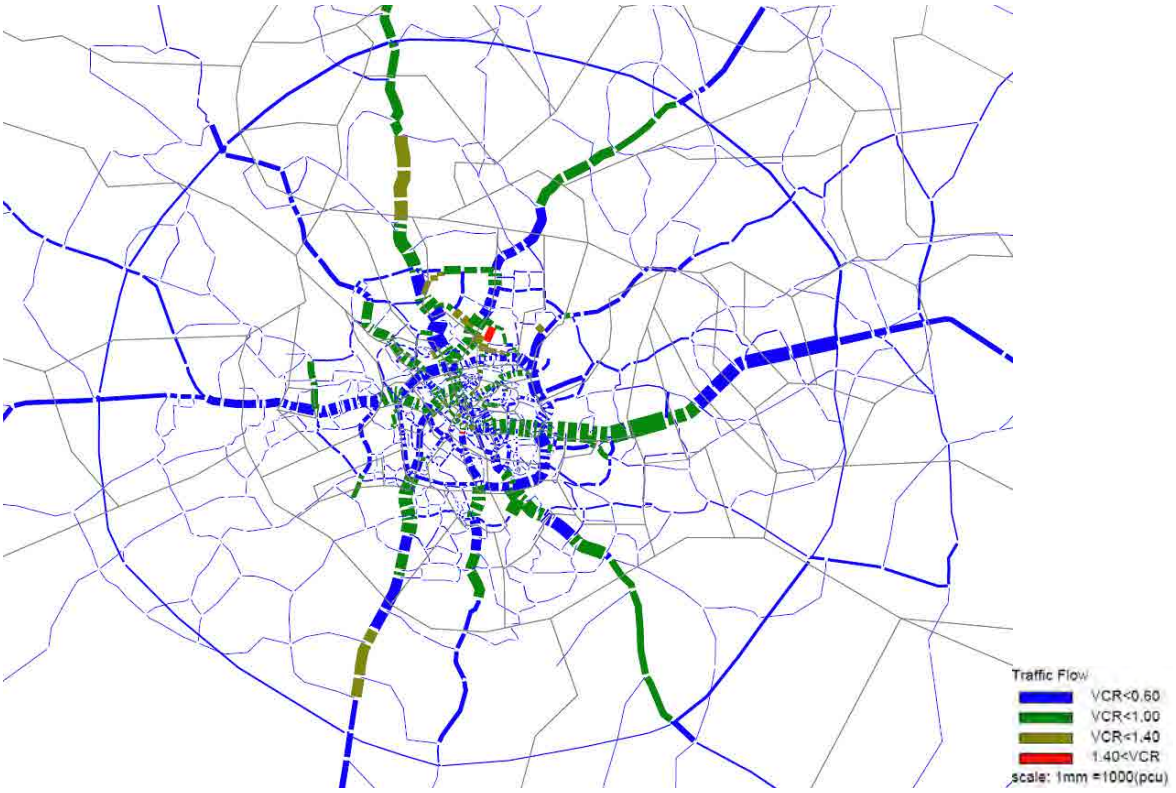
Source: JICA Study Team

Figure 12.2.4 Traffic Assignment of Existing 2012 Case



Source: JICA Study Team

Figure 12.2.5 Traffic Assignment results of Future 2033 Without Case



Source: JICA Study Team

Figure 12.2.6 Traffic Assignment Results of Future 2033 With Case

12.3 Strategies for Transportation Sector Development

The policies of transport sector development in Greater Kumasi, as mentioned above, to balance the supply and demand of transportation sector, aim at (1) transportation infrastructure capacity development, and (2) transportation demand side management (TDM). The policies are further interpreted into the following six strategies and measures to be taken, which are further described in detail as plans in Section 12.4.

12.3.1 Improvement of Road Network Function

In order to meet traffic demand, it is imperative to improve the function of the road network of Greater Kumasi Sub-Region by the following:

- Establishment of road network hierarch,
- Development of mass transportation network, and
- Expansion of road capacity, including ring roads, new roads, and expansion of the existing roads.

12.3.2 Improvement for Intersection and Signalization Improvement

Intersections in the central area that often cause traffic congestion shall be improved by the following:

- Coordinate traffic signals in the whole network,

- Segregate traffic conflicts at major intersections,
- Optimize traffic light signals, and
- Assess other critical intersections and enforce necessary measures.

12.3.3 Enhancement of Public Transport Development

Public Transport is used very much by travellers in Greater Kumasi Sub-Region. It is desirable to enhancement of public transport to create a truly public transport oriented Greater Kumasi Sub-Region by the following:

- Shift from low capacity (trotro) to high capacity public transport system (bus) as the backbone of the transportation system.,
- Develop public transport corridors where large buses or BRTs run, and
- Develop Transfer Points/Interchange Hubs

Utilization of the existing railway lines is one of the possible options for improving public transportation. In fact, the Railway Development Authority has a plan to rehabilitate the Kumasi-Ejisu section of the Eastern Line for providing suburban commuter railway services. However, its impact might be small.

Establishment of BRT Routes on the major radial roads and within the Kumasi City Centre is a major public transportation policy by 2033. However, rail-based urban public transportation could be developed by using the BRT dedicated lanes in the very long term (beyond 2033).

On the other hand, railway cargo transport should be maintained from the medium and long terms, by utilizing the Eastern Line and the Western Line. The Eastern Line should be extended to the north from Ejisu or Boankra. The Western Line should be extended from Awaso to Nyinahin.

12.3.4 Introduction of Traffic Control in CBD

Parking control like paid parking system, particularly in high density areas will contribute reduction of illegal parking hamper smooth traffic and safe and comfortable walking of pedestrians. Further the following are required to improve the parking situation and pedestrians' walking space:

- Expand parking space, and
- Secure pedestrians' walking space and bike lane.

12.3.5 Introduction of Transportation Demand Management

Transportation Demand Management (TDM) measures play significant roles in restraining traffic demand particularly in the city centre. The following are to be taken to restrain traffic in Kumasi:

- Promotion of public transport,
- Promotion of high occupancy vehicles,
- Distribution of traffic,
- Discouragement of private car use, and
- Truck access restrictions.

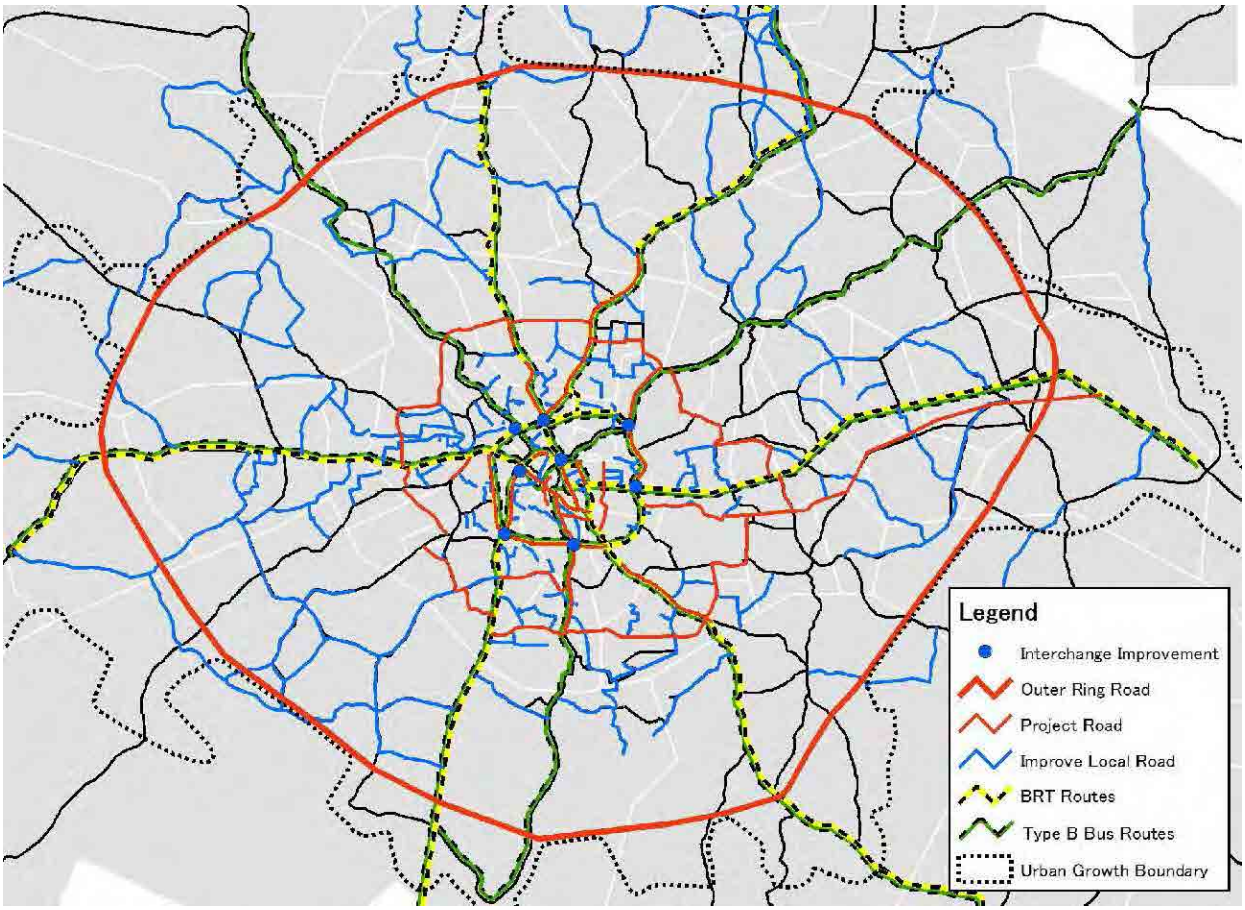
12.3.6 Development of Freight Transport Management

The freight industry in Kumasi is facing the problems including traffic congestion, lack of parking space, and lack of terminals. To solve them, the following strategies are to be pursued:

- Reorganize freight delivery in the city,
- Strengthen cooperation among the stakeholders of the freight industry,
- Reduce the number of trips of large trucks at the middle ring road, and
- In the long term, reduce the number of trips of large trucks in the outskirts of the city

12.4 Transportation Sector Plan

The Transportation Sector Plans are designed to achieve the objectives and strategies enumerated above. The major plans are illustrated as Figure 12.4.1. The transportation plans are divided into six categories which touches both the infrastructure and operational aspects of the transportation system.



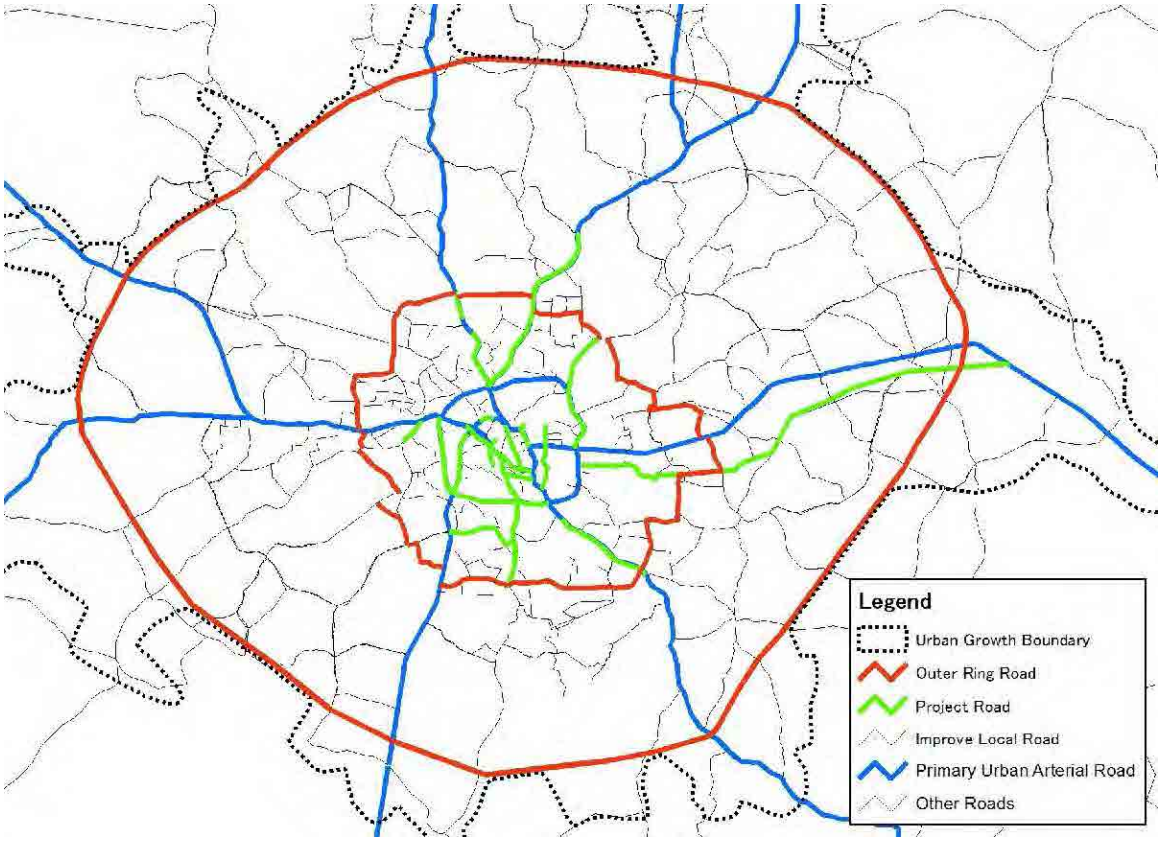
Source: JICA Study Team

Figure 12.4.1 Major Projects for Transportation Sector Plan

(1) Plans for Road Network Development

The road network of Greater Kumasi Sub-Region has shown stress in some areas due to the volume of users exceeding the limited capacity of some junctions. The road network of the core of the city is well developed and capacity expansion might be difficult due to built up areas. However, there are some areas where capacity expansion is crucial and also possible. The following are necessary to improve the function of the road network.

- Reorganize the hierarchy of roads within the Greater Kumasi Sub-Region/ Greater Kumasi Conurbation (see Figure 12.4.2):
  - By identifying "Urban Arterial Roads" composing major roads/streets for Greater Kumasi Sub-Region/Greater Kumasi Conurbation.
  - By upgrading minor local roads to regional roads, which should serve as connections between major radial roads within a 10 km radius from the city centre
  - By identifying collectors/distributors among small roads
- Develop the mass transportation network's infrastructure composed of the following corridors: Mampong Road, Offinso Road, Sunyani Road, Bekwai Road, Lake Road, Accra Road, Antoa Road, Abrepo Road, Old Bekwai Road and the inner ring road. Widening of these corridors to at least two-lanes per direction to accommodate dedicated lanes for a mass transportation system is desirable.
- In addition to the inner ring road and outer ring road, promote the realization of a middle ring road for better traffic circulation by upgrading existing roads that can be improved to form a middle ring road.
- Develop a new arterial road from Ejisu to Kumasi that runs parallel to Accra road to provide an alternative route and to further strengthen the connection between the two key towns.
- Recognize the necessity to increase the road capacity by widening critical roads for traffic such as the Western bypass section, Southern bypass section, Lake Road, Mampong Road, Harpor Road, New Bekwai Road, Antoa Road, etc. Couple this effort with construction of missing links like connecting Lake Road to Century Hall Road, Old Bekwai road to New Bekwai road, etc. to provide more direct routes.



Source: JICA Study Team

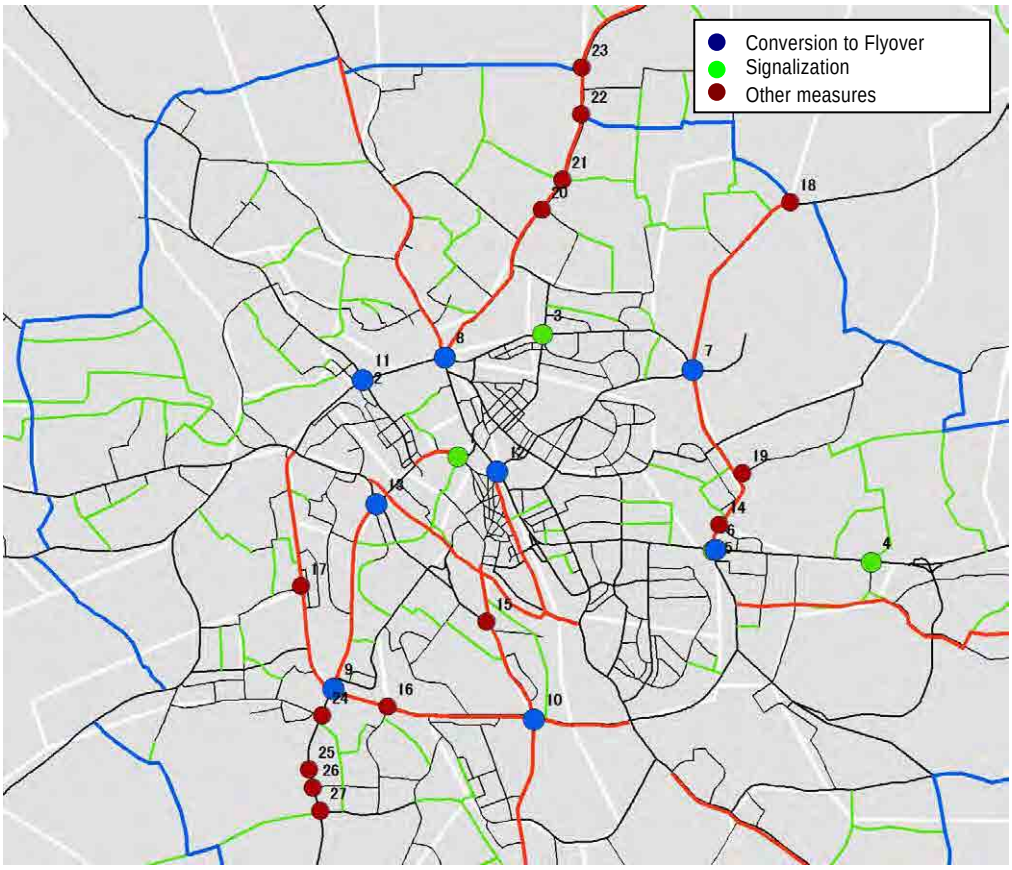
Figure 12.4.2 Proposed Urban Arterial Roads for KMA

(2) Plans for Intersection and Signalization Improvement

Intersections are often times the bottlenecks of the network because in this area traffic conflict occurs. As mention in the 2012 WB-assisted study, significant congestion in the network occurs at the intersections on the approach to the city centre area. The following will be crucial in this direction:

- Coordinate traffic signals in the whole network to respond to actual conditions on the ground (from static to dynamic/intelligent traffic signals)
- Remove traffic bottlenecks by segregating traffic conflicts at major intersections like Suame, Abrepo, Sofoline, Anloga, Bewai, etc.
- Improve traffic operation at other intersections by optimizing traffic light signals.
- Assess other critical intersections and enforce necessary measures

The figure below shows the critical junctions for intervention.



Source: JICA Study Team

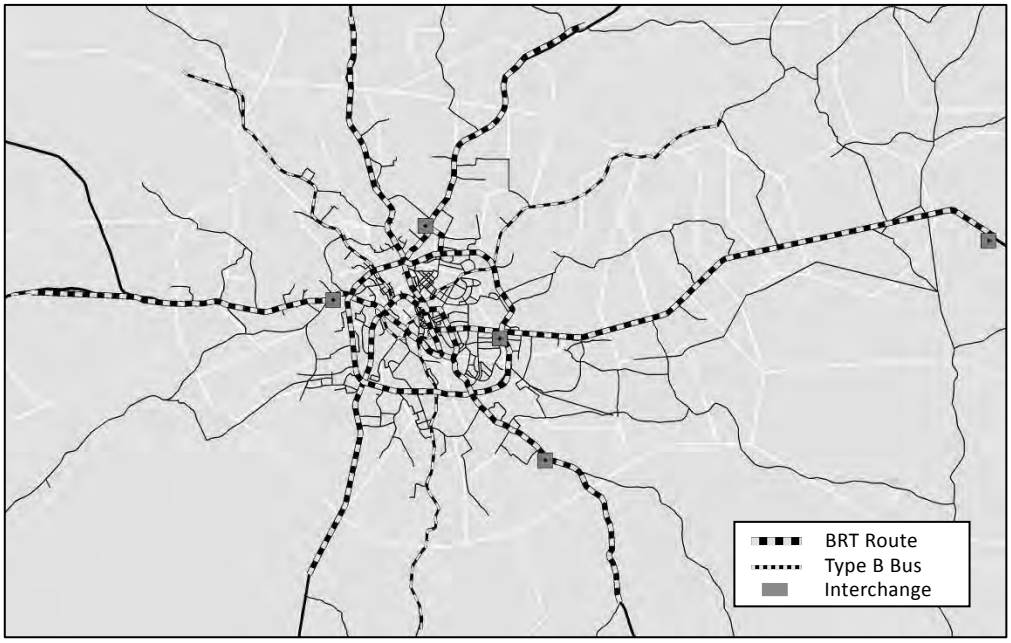
Figure 12.4.3 Location of Projects under Signalization and Intersection Improvement

(3) Plans for Public Transport Development

Public Transport is the mobility means of the majority of travellers in Greater Kumasi Sub-Region. Enhancement of the system to make it a truly public transport oriented system is therefore desirable. The following will be crucial in this direction:

- Promotion of a shift from low capacity (trotro) to high capacity public transport system (bus) as the backbone of the transportation system.
- Development of a BRT and bus network that covers the nine radial roads and inner ring road.
- Development of Transfer Points/Interchange Hubs in Tafo, Anloga, Kwadaso, Chirapatri Estate, and Ejisu where long distance trips terminate. Trips to their final destinations will be facilitated by another transport mode.

The Figure 12.4.4 shows the routes of BRT as well as Type B bus, which are envisioned as being the backbone of public transportation. As explained in Section 12.3.3, railway will play a minor role in the urban public transportation for the Greater Kumasi Sub-Region at least by 2033.



Source: JICA Study Team

Figure 12.4.4 BRT Routes and Type B Bus Routes

(4) Plans for Traffic Control in CBD

To aid the positive impact on traffic flow of infrastructure improvement, there is a need for a strategy to control traffic in the CBD. Provision of paid parking spaces particularly in high density areas like Adum and Central Market will reduce the problem of illegal parking on the road shoulder which affects traffic flow. Paid parking is already implemented in the CBD of Kumasi (793 slots for off-street and 1,278 slots for on-street) and has been successful. Further measures that can be considered are:

- Recover and improve pedestrian space to contribute to people's mobility
- Provision of walkways and cycle lanes
- Expansion of paid parking (both off-street and on-street) in other areas in the CBD
- In view of the limited space, consider multi-storey car parking in the CBD
- Integration of parking facilities in local plans
- Development of a framework for participation of the private sector in parking provision
- Apply vehicle access restrictions (e.g. one-way restrictions) in areas with a high density of pedestrians like Adum and central market.

(5) Plans for Transportation Demand Management

Transportation Demand Management (TDM) measures play significant roles in restraining traffic demand particularly in the city centre. The impact of a single TMD measure might be limited. However when TDM measures are grouped together, their impact is substantial. Some of the policies that might be helpful to restrain traffic in Kumasi include:

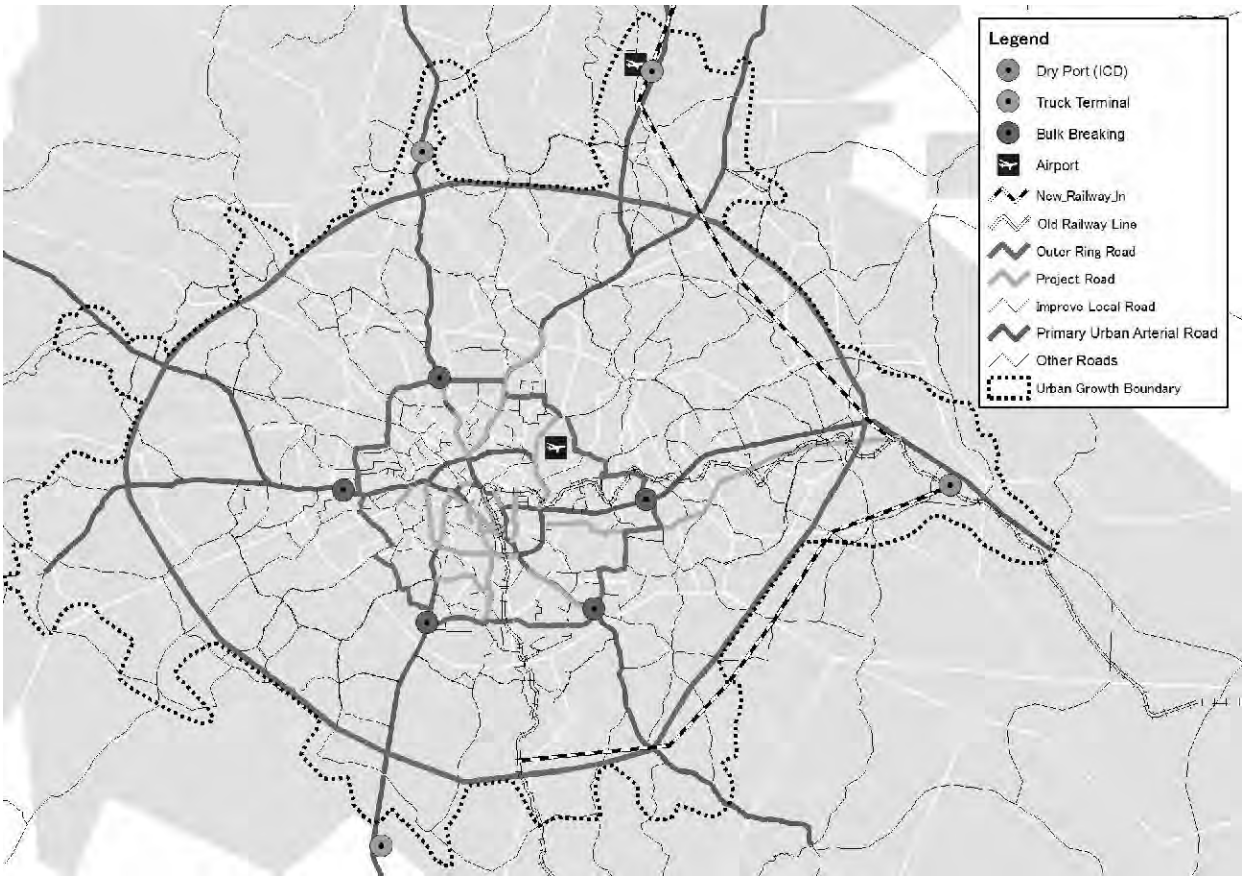
- Integrate public transport services – physical integration and operational integration (e.g. coordinated arrival schedule between BRT and feeder services for smooth mobility)
- Prioritize public transport over private by provision of priority lanes for buses particularly BRT
- Prioritize high occupancy vehicles at intersections to improve service reliability
- Distribute traffic demand by exploring TDM measures such as flexible working hours
- Consider other measures which discourage use of private cars such as fuel tax increase, road pricing.
- Explore other measures which could make public transport more attractive such as financial incentives (e.g. monthly discount tickets) and education campaigns.
- In the future, consider implementing truck access restrictions (truck bans) for heavy trucks (e.g. 3.5 ton) from entering the inner ring road to contribute to decongestion.

(6) Plans for Freight Transport Management

The freight industry in Kumasi is experiencing several challenges that affect their operation. This includes traffic congestion, lack of parking space particularly in the city centre, and lack of terminals, among others. In view of the above, the following strategies should be pursued:

- Reorganization of freight delivery particularly inside the city
- Strengthening of cooperation among the stakeholders of the freight industry.
- Reduce the number of trips of large trucks on the middle ring road by establishing Bulk Breaking Points
- In the long term, reduce the number of trips of large trucks in the outskirts of the city by building truck terminals that will also serve as bulk breaking points.
- Rehabilitate the railway line from Takoradi to Kumasi and Tema to Kumasi to realize efficient goods movement. Realignment to connect with Baonkra port and extension further north should also be considered.

Figure 12.4.5 shows the location of the Dry Port, Truck Terminals and Bulk Breaking Points and the proposed new routes for the railway.



Source: JICA Study Team

Figure 12.4.5 Location of Dry Port, Truck Terminals and Bulk Breaking Points

12.5 Projects for Transportation Sector Development

12.5.1 Projects on Road Network Development Sub-Programme

(1) Background

The projects under this sub-programme are considered necessary to increase the capacity of the network and remove bottleneck sections which could not cope up with the current traffic demand. The projects are composed of widening of critical sections of the road network and construction of new roads (missing links) and the outer ring road.

The road improvement and development projects (1 to 19) were actually proposed by the 2005 AFD-assisted Transport Study and reiterated in the 2011 WB-assisted Transport Plan for Kumasi Study but have not yet been implemented. The additional projects (20 and 21) were identified by this JICA-assisted study. These improvements to the network will ensure that both current and future traffic demand will fall within the capacity of the network.

(2) Objective of the Projects

The objectives for the projects under the sub-programme are:

- To improve traffic circulation by expanding the capacity of the network and by removing bottleneck sections of the network
- To support socioeconomic development of Kumasi and surrounding districts by improving the movement of people and goods
- To strengthen socioeconomic integration between Kumasi and the surrounding districts and among the districts themselves

(3) Scope of the Projects

The scope of the identified projects is summarized in the Table 12.5.1. The Department of Urban Roads is expected to be the implementing agency.

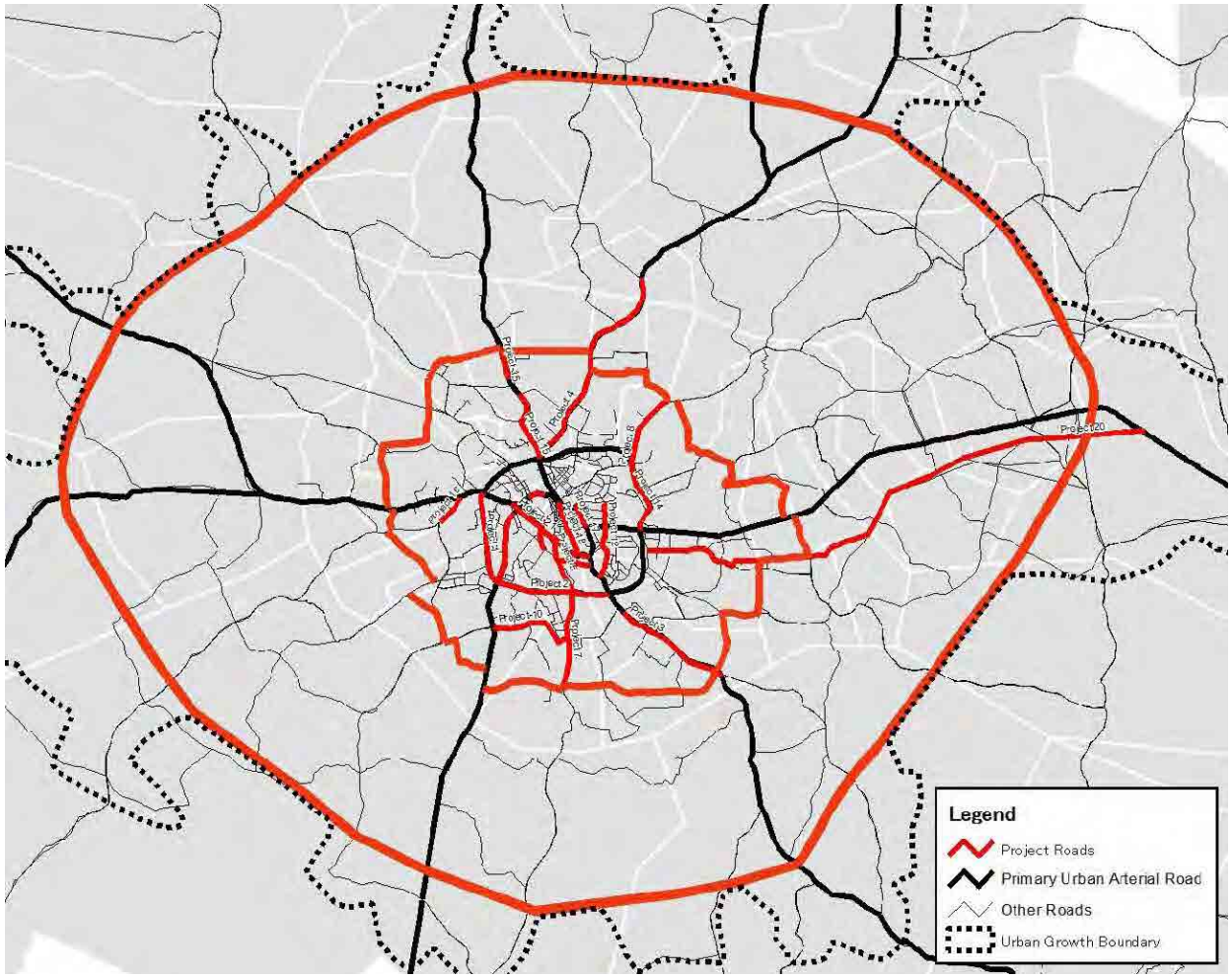
Table 12.5.1 List of Projects under Road Network Development Sub-Programme

No.	Measures	Length (km)
	Road Network Scheme	
1	Widening of Western bypass to 4 lanes in certain sections	3.60
2	Widening of southern bypass to 4 lanes in certain sections	3.40
3	Widening of Lake Road to 4 lanes (Phase 2)	4.15
4	Widening of Mampong Road to 4 lanes in certain sections	5.50
5	Widening of Harper Road to 4 lanes from Ahodwo RB to Prempeh I Street	2.12
6	Widening of New Bekwai Road to 4 lanes from Santasi RB to Bekwai RB	2.53
7	Widening of Old Bekwai Road to 4 lanes from Ahodwo RB to Daban	3.48
8	Widening of Antoa Road to 4 lanes from Airport RB to Buokrom estate	2.64
9	New link connection of Lake Road and Century Hall Road, 4 lanes	1.20
10	New link Old Bekwai Road and New Bekwai Road, 2 lanes	3.10
11	New Outer Ring Road	91.49
12	Yaa Asantewaa Rd widening to 4 lanes in certain sections	3.11
13	Bantama Road widening to 6 lanes in certain sections	0.63
14	Eastern bypass widening to 6 lanes in certain sections	2.60
15	Offinso Road widening to 6 lanes from Suame RB to New Magazine Rd	3.62
16	Kwadaso Road widening to 4 lanes from Sunyani Rd to Ohwimase Rd	1.12
17	Maxwell Rd and Zongo Rd widening to 4 lanes	1.09
18	Guggisberg Rd widening to 4 lanes	2.35
19	Government Rd widening to 4 lanes	1.24
20	New link connection between Ejisu and Kumasi (2 lane)	17.21
21	New CBD Road (2 lane)	3.01
22	New Middle ring road by upgrading local roads (2 lane)	48.23
23	Local Road Upgrade in future urbanized area (2 lane)	468.89
	Total	676.31

Source: Transport Plan for Kumasi, WB (2012) and JICA Study Team

(4) Location of Projects

The location of identified projects is presented in Figure 12.5.1.



Source: JICA Study Team

Figure 12.5.1 Location of Projects under Road Network Development Sub-Programme

(5) Impact of the Projects

a) Positive Impacts

It is expected that travel speed in Kumasi will improve which would be translated into economic gains after the execution of the projects. As a result, it will reduce vehicle-km and vehicle operating cost. Less vehicle km means less source of pollution thus less greenhouse gas emissions. Likewise passenger hours spent on board the vehicle will also decreases thus they can use the time for more productive activities. The Table 12.5.2 presents the likely benefits derived from the projects.

Table 12.5.2 Possible Impact of the Projects

	Positive Impacts
Direct Effects	Improvement of travel speed Reduction of transport cost Reduction of traffic accidents Improvement of traveller's amenity and increase of travel's comfort
Indirect Effects	Transport cost reduction (commodity Prices) Mitigation of load to environment (traffic pollution) Facilitating regional development Settlement of people and increase in population Expansion of community activities Improve access to public facilities Strengthening of exchange and cooperation among districts and city Growth of production and income Increase in employment by the growth of production Increase in revenue by the growth of production

Source: JICA Study Team

b) Negative Impacts (Land Acquisition, Resettlement, Environment)

Particular attention should be paid to construction of new roads. A number of negative impacts such as acquisition of private land, involuntary resettlement, cutting of trees, slope modification, disruption of service utilities and infrastructures are expected. In essence the following negative impacts are expected thus mitigation measures shall be put in place.

- ROW Acquisition particularly for construction of new roads
- Involuntary Resettlement
- Increase in noise level during construction especially those inside the city center
- Slope modification
- Disruption of service utilities and infrastructures in some cases
- Demolition of structures
- Construction wastes
- Noise due to pile driving
- Dust caused by construction work
- Increased housing requirements for transient workers and project management staff
- Increased hazards due to construction activities
- Cutting trees

12.5.2 Projects on Intersection and Signalization Improvement Sub-Programme

(1) Background

The measures identified for the intersection improvement program are critical to ensure smooth flow of traffic in the whole network. Road junctions are often cited as bottleneck areas of the transportation network which prevent smooth flow of traffic.

In the short term, modification of signal timing of the five signalized intersections is necessary to respond to actual traffic conditions on the ground. Likewise, conversion of another five major intersections is recommended to accommodate the high volume

of traffic converging in these intersections. The fourteen intersections on the other hand need to apply some measures to reduce vehicle delay and improve pedestrian safety.

(2) Objectives

The objectives are:

- To improve traffic circulation by removing traffic bottlenecks at the intersections
- To improve traffic safety by designating suitable traffic signals and by separating traffic conflicts in the major intersections
- To support socioeconomic development of Kumasi and surrounding districts by improving movement of people and goods

(3) Scope of the Projects

The scope of the projects is summarized in the Table 12.5.3. The Department of Urban Roads is expected to be the implementing agency.

Table 12.5.3 List of Projects under Intersection and Signalization Improvement Sub-Programme

Junction Signalization Scheme	1	Signal optimisation – Zoo junction
	2	Signal optimisation – Abrepo junction
	3	Signal optimisation – Kroform junction
	4	Signal optimisation – Top High junction
	5	Signal optimisation – Anloga junction
Intersection Improvement by Conversion to Flyover	6	Anloga Intersection
	7	Airport Roundabout
	8	Suami Roundabout
	9	Santase Roundabout
	10	Ahodwo Roundabout
	11	Abrepo Intersection
	12	Central Marker Junction
	13	Bekwai Roundabout
KMA Intersection Improvement	14	Osei Tutu II Blvd. at KNUST
	15	Harper Road / James E. Bandoh Drive
	16	Southern Bypass / Adiembra Road
	17	Western Pypass / Edwenase Road
	18	Atoa Road / Buokrom Estate Road
	19	Aboabo / St. Patrick Road
	20	Mampong Road / Cemetery Road
	21	Mampong Road / New Suame Road
	22	Mampong Road / Tafo Hospital Road
	23	Mampong Road / Pankrono Estate Road
	24	Obuasi Road / Odeneho Kwadaso
	25	Obuasi Road / Fankyenbra Road
	26	Obuasi Road / Adiembra Road
	27	Obuasi Road / Santasi New Site

Source: JICA Study Team based on various documents

(4) Location of the Projects

The location of identified projects is presented in Figure 12.4.4. Type of particular measures to implement for each intersection is provided in Table 12.5.4.

Table 12.5.4 Countermeasures for Intersection Improvement

No	Location	Countermeasures						
		Signal	Round -about	Pedestrian Walkway	Road line Markings	Road Signs	U-Turns	Others
1.	Zoo junction	◎						
2.	Abrepo junction	◎						
3.	Kroform junction	◎						
4.	Top High junction	◎						
5.	Anloga junction	◎						
6.	Anloga junction							Convert to Flyover
7.	Airport Roundabout							Convert to Flyover
8.	Suami Roundabout							Convert to Flyover
9.	Santase Roundabout							Convert to Flyover
10.	Awodho Roundabout							Convert to Flyover
11.	Abrepo junction							Convert to Flyover
12.	Central Market Junction							Convert to Flyover
13.	Bekwai Roundabout							Convert to Flyover
14.	Osei Tutu II Blvd. at KNUST			◎	◎	◎		Pedestrian Overpass
15.	Harper Road / James E. Bandoh Drive	◎		◎	◎	◎	◎	
16.	Southern Bypass / Adiembra Road		◎	◎	◎	◎		
17.	Western Pypass / Edwenase Road		◎	◎	◎	◎		
18.	Atoa Road / Buokrom Estate Road		◎	◎	◎	◎		
19.	Aboabo / St. Patrick Road	◎		◎	◎	◎	◎	
20.	Mampong Road / Cemetery Road	◎		◎	◎	◎	◎	
21.	Mampong Road / New Suame Road		◎	◎	◎	◎		
22.	Mampong Road / Tafo Hospital Road	◎		◎	◎	◎		
23.	Mampong Road / Pankrono Estate Road	◎		◎	◎	◎	◎	
24.	Obuasi Road / Odeneho Kwadaso	◎		◎	◎	◎	◎	
25.	Obuasi Road / Fankyenbra Road	◎		◎	◎	◎	◎	
26.	Obuasi Road / Adiembra Road	◎		◎	◎	◎	◎	
27.	Obuasi Road / Santasi New Site	◎		◎	◎	◎	◎	

Source: DUR, Intersections Improvement Project

(5) Impact of the Projects

a) Positive Impacts

It is expected that the projects when executed will contribute to improvement of travel speed in Kumasi which can be translated into economic gains. As a result, it will reduce vehicle-km and vehicle operating cost. Fewer vehicle km means less source of pollution thus less greenhouse gas emissions. The positive impacts of the projects include:

- Improvement of travel speed
- Reduction of transport cost
- Reduction of traffic accidents
- Improvement of traveller's amenity and increase of traveller's comfort

b) Negative Impacts

Projects under the Junction Signalization Scheme and KMA Intersection Improvement will not cause much negative impact. However, the project under the Intersection Improvement by converting to flyover will have notable negative impacts since these projects are big in scale and located in a very congested environment. Expected negative impacts include:

- ROW Acquisition particularly space for on-ramps and off-ramps
- Involuntary Resettlement
- Increase in noise level during construction especially those inside the city center
- Disruption to traffic and riding public
- Construction wastes
- Noise due to pile driving
- Dust caused by construction work
- Increased housing requirements for transient workers and project management staff
- Increased hazards due to construction activities

12.5.3 Projects on Public Transport Development Sub-Programme

(1) Background

The projects identified for public transport development are significant to gradually shift the mode of public transportation from a low capacity (trotro) to a high capacity public transport system (bus) as the backbone of the transportation system.

The proposed Type-B bus routes cover all important corridors of Greater Kumasi Sub-Region and the inner ring road. The central idea is to initially have these Type-B buses serve these corridors. Some of these Type-B bus corridors will be replaced by BRT in the future in the selected six corridors are where traffic is very high.

Interchange hubs and Park & Ride facilities are an integral part of an efficient public transportation network. These facilities give passengers travel options and as such make it possible to spread passengers among the different modes.

The Sustainable Transit Corridor allows better access to public transport to the city centre by the effective use of the former railway line. Part of the area will be redeveloped as a public bus terminal including its access that will connect directly to Asafo Interchange.

(2) Objectives

The objectives of this sub-program are:

- To contribute to the decongestion of the road network of Greater Kumasi Sub-Region
- To reduce green house gases emitted from transportation in the Greater Kumasi Sub-Region
- To improve the efficiency, safety and quality of public transpiration services in Greater Kumasi Sub-Region.
- To contribute to the socioeconomic development of Kumasi and the surrounding districts by improving movement of people and goods

(3) Scope of the Projects

The scope of the projects is summarized in the Table 12.5.5. The Department of Urban Roads is expected to be the implementing agency.

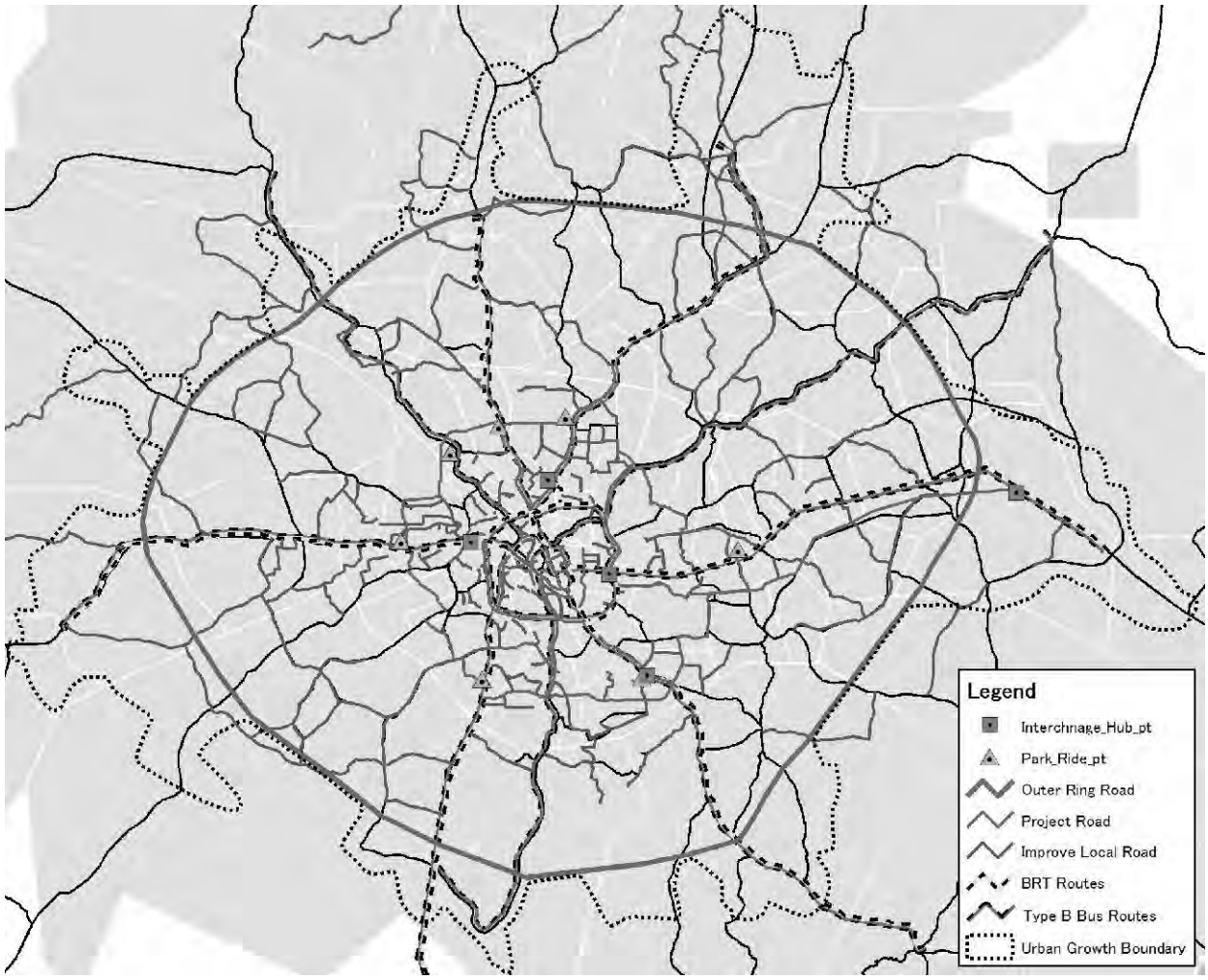
Table 12.5.5 List of Projects under Public Transport Development Sub-Programme

	Type B Transit Routes Scheme	**Length (Km)**
1	Antoa Road Type B Routes	8.80
2	Mampong Road Type B Routes	8.80
3	Offinso Road B Routes	8.20
4	Abrepo Road B Routes	7.40
5	Sunyani Road B Routes	8.30
6	Bekwai Road B Routes	8.40
7	Old Bekwai B Routes	9.90
8	Lake Road B Routes	10.40
9	Accra Road B Routes	15.30
10	Orbital Route Type B Route	18.30
	BRT Routes Scheme	**Length (Km)**
1	BRT Mampong Road	8.80
2	BRT Offinso Road	8.20
3	BRT Sunyani Road	8.30
4	BRT Bekwai Road	8.40
5	BRT Accra Road	15.30
6	BRT Lake Road	10.40
	Other Public Transport Scheme	
1	Interchange Hubs	
2	Park & Ride (7 sites)	

Source: JICA Study Team

(4) Locations of Projects

The locations of the identified projects are presented in the Figure 12.5.2.



Source: JICA Study Team

Figure 12.5.2 Location Map of Projects under Public Transport Development Sub-Programme

(5) Impact of the Projects

a) Positive Impacts

When completed, the projects will have multiple impacts. First, they will improve the quality of public transport and thus passengers comfort will be ensured. This means that departure and arrival will be more predictable and journey time is expected to be shorter than existing. Likewise, transport infrastructure is much better where terminal buildings are equipped with basic facilities like toilets, urinals, and other necessities of the riding public. At the bus stops, sheds and benches are to be erected for the comfort of bus users.

Second, they will contribute to reduction of congestion of the road network since a single trip of a mass transit vehicle is equivalent to replacing several cars/trotro on the road. Travel speed in the network will improve thus vehicle hours and vehicle kilometres will decrease. These savings can be translated into monetary savings for all road users.

Third, environmental benefits will be enormous. Reduced vehicle kilometres translates to less source of pollution. Likewise, better traffic flow leads to further reductions in fuel consumption thus less greenhouse gas emissions.

Fourth, better public transport network connections mean less time spent on board public transport which is an unproductive hour. The fewer hours spent on public transport due to congestion, the more time there is to spend for economic activities thus opportunity to increase income is increased.

b) Negative Impacts

The ideal operational environment of bus transit is exclusive lanes. Therefore acquisition of land and a number of structures will be affected during the road widening works. Relocation plans for affected families and compensation shall be planned and timely executed. In addition, the removal and relocation of trees may be necessary in some cases.

12.5.4 Projects on Sub-Programme of Traffic Control in the CBD

(1) Background

The projects identified for traffic control in the central business district is needed to restrain and organize the high volume of vehicles accessing the heart of the city. Modification of traffic operation from existing two-way into one-way will contribute to improvement of traffic circulation and therefore contribute to reduction of traffic congestion. Likewise, provision of pay parking will ensure that parked vehicles will not disrupt the traffic flow.

Improvement of pedestrian walkways by removing structures and illegal occupants of pedestrian space will bring back the pleasure of walking. Walking and to a lesser extent cycling are the main modes within the CBD. Improvement and expansion of pedestrian and cycling infrastructure should be given attention.

Likewise, the centralized traffic signal project will result in better distribution of traffic in the network and thus contribute to decongestion. Number plate restriction contributes to reducing the number of vehicles in the CBD. This measure restricts car use on alternate days depending on the plates ending in odd or even numbers.

(2) Objectives

The objectives of this sub-programme are:

- To contribute to traffic decongestion of the CBD by improvement of traffic circulation.
- To promote modal shift to walking and cycling to balance the modal split among different modes of transport.
- To contribute to the improvement of environmental conditions as a result of reduced traffic volume.

(3) Scope of the Projects

The scope of the projects is summarized in the Table 12.5.6. The Department of Urban Roads is expected to be the implementing agency.

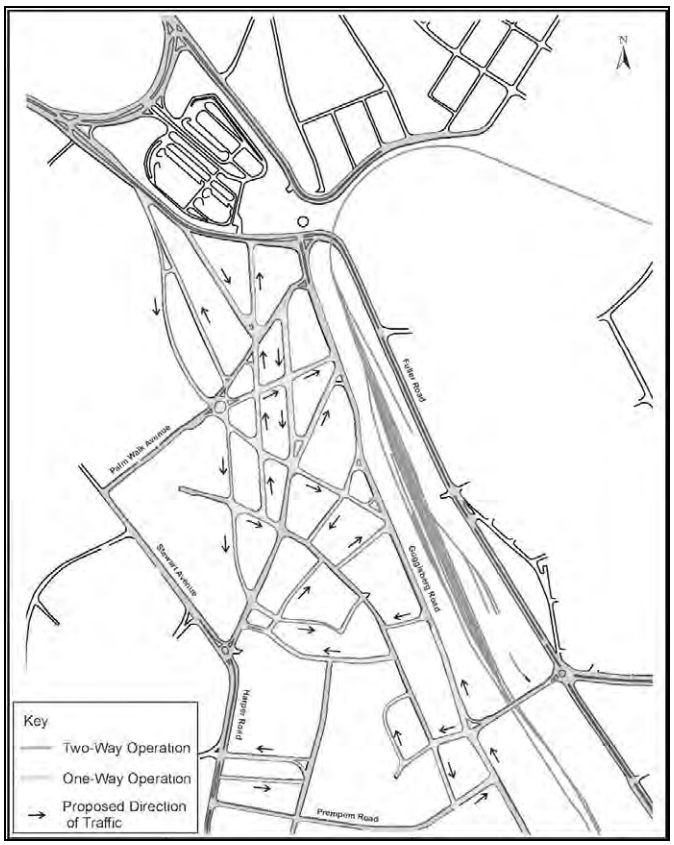
Table 12.5.6 List of Projects under Traffic Control in CBD

	Traffic Control in CBD Scheme
1	One-Way Traffic Operation
2	Provision of Pay Parking
3	Improvement of Existing Pedestrian Walkways
4	Provision of New Walkways
5	Provision of Cycle Lanes
6	Kumasi Centralized Traffic Signal Project
7	Number plate restriction inbound CBD

Source: JICA Study Team

(4) Location of the Projects

The proposed traffic operation in the city centre under One-Way Traffic Operation is illustrated in Figure 12.5.3.



Source: WB, 2012, Transport Plan for Kumasi

Figure 12.5.3 Proposed City Centre Traffic Operation

(5) Impact

a) Positive Impacts

The positive impacts include contribution to reduction of traffic congestion and contribution to mode shift in favour of walking and bicycles.

b) Negative Impacts

There might be some resistance from shop owners in the CBD to the one-way scheme. Some of them might hold the impression that a one-way scheme might discourage shoppers by car to come. Likewise, resistance from the current illega users of pedestrian spaces might be encountered during the clearing of pedestrian space.

12.5.5 Projects on Traffic Demand Management Sub-Programme

(1) Background

The impact of a single TMD measure might be limited. However, when TDM measures are grouped together, their impact is substantial. The programs identified under the TDM program would produce substantial impacts in reducing traffic congestion when bundled together and complimented by other transportation programs. The central theme of this program is the efficient use of existing transport resources which can be put into operation mode through legislative and traffic engineering. Table 12.5.7 presents a brief description of each measure. One of the keys to its successful implementation is effective public educational campaigns to create a climate which fosters public awareness and acceptance of the program.

Table 12.5.7 Brief Description of TDM Schemes

TDM Scheme	Description
Flexible Working Hours	Employees are allowed some flexibility in their daily work schedules
Rideshare programs	Includes carpools, vanpools, ride matching services and other techniques for reducing commute trips, whether to work or school. These techniques are useful for commuters that don't like to use mass transit or because of location and/or work schedule find it difficult to use mass transit.
Car sharing	Refers to automobile rental services intended to substitute for private vehicle ownership. It makes occasional use of a vehicle affordable, even for low-income households, and by allowing households to reduce their vehicle ownership it provides an incentive to reduce driving and rely more on alternative modes.
High Occupancy Vehicles Priority	Grade separate transit lines so they are not delayed by cross-streets and traffic congestion
Road pricing	Charging drivers for the use of roads particularly those very congested like in the CBD.
Fuel tax increases	Increasing vehicle operating costs via fuel tax tends to reduce vehicle travel. For this reason, fuel tax increases are sometimes proposed as a way to reduce driving and increase transport system efficiency. Fuel taxes can be increased to help finance transportation programs, including alternative modes and TDM programs.
Commuter financial incentives	Giving incentives to use transit such as discounted monthly tickets etc.
Education Campaigns on Mobility Management	Public education complements every other TDM strategy by creating a climate that fosters public acceptance and awareness of alternative transportation modes. For example, campaigns to use BRT, dissemination of bike maps and other TDM measures should be implemented.

Source: JICA Study Team based on various documents

(2) Objectives

The objectives of this program are:

- To maximize the efficiency of the transportation system by rationalizing the use of transport infrastructure

- To contribute to the decongestion of the road network of Greater Kumasi Sub-Region by distributing traffic demand throughout the day.
- To promote a shift from private vehicles to public transportation use by implementing affirmative measures
- To contribute to the improvement of environmental conditions as a result of reduced traffic volume

(3) Project List and Scope

The scope of the projects is summarized in the Table 12.5.8. The Department of Urban Roads is expected to be the implementing agency in collaboration with other concerned agencies.

Table 12.5.8 List of Projects under Traffic Demand Management Sub-Programme

	TDM Scheme
1	Flexible Working Hours
2	Rideshare programs
3	Car sharing
4	HOV Priority
5	Road pricing
6	Fuel tax increases
7	Commuter financial incentives
8	Education Campaign on Mobility Management

Source: JICA Study Team

(4) Impact

a) Positive Impacts

TDM has multiple benefits (see Table 12.5.9) of which the most significant is the reduction of total vehicle traffic. Reduced number of vehicles means there would be improvement of traffic flow which could bring down the total vehicle kilometres. Although not every TDM strategy achieves all of the benefits presented in the table, most strategies help achieve most of these benefits in most situations.

Table 12.5.9 Typical TDM Benefit

Benefit	Description
Congestion Reduction	Reduces traffic congestion delays and associated costs.
Road & Parking Savings	Reduces road and parking facility costs.
Consumer Savings	Helps consumers save money by reducing their need to own and operate motor vehicles.
Transport Choice	Improved travel options, particularly for non-drivers.
Road Safety	Reduced crash risk
Environmental Protection	Reduced air, noise and water pollution, wildlife crashes and other types of environmental damages.
Efficient Land Use	Supports strategic land use planning objectives, such as reduced sprawl, urban redevelopment and reduced habitat fragmentation.
Community Liveability	Improved local environmental quality and community cohesion.
Economic development	Supports a community's economic objectives, such as increased productivity, employment, wealth, property values and tax revenues.
Physical Fitness and Health	Improved public fitness and health due to more physical activity, usually through increased daily walking and cycling.

Source: GTZ, April 2009, Transportation Demand Management

b) Negative Impacts

Some of the measures might meet resistance from private car drivers and other affected stakeholders at the beginning. Public education campaigns will play an important role to raise public awareness and acceptance.

12.5.6 Projects on Freight Transport Management Sub-Programme

(1) Background

The projects identified under this program can contribute to improvement of traffic flow in the network by reduction of truck numbers particularly in the city center. The construction of truck terminals and bulk breaking points will lead to a more organized way of distributing goods in the city. Likewise, truck access restriction is enforced where traffic congestion is serious. The central idea is to remove trucks out of major thoroughfares during peak hours. Trucks are slow moving and consumed large space on the road thus their contribution to congestion is significant. Likewise, breakdown of trucks along roads are often observed in the network of Kumasi which creates a significant disturbance to traffic flow.

In view of the emergence of critical issues encountered by stakeholders of the freight industry (shippers, carriers, authorities, residents), there is a need to create a platform where ideas could be exchanged and problems are solved. This kind of forum has been observed to be effective in countries in Europe in finding solutions.

(2) Objectives

The objectives of the sub-programme are:

- To reduce number of trucks accessing the city center and to organize freight distribution within the Greater Kumasi Sub-Region.
- To contribute to traffic decongestion of the network particularly in the day time.
- To reduce the negative externalities of trucks (air pollution, vibration, noise pollution, etc) to the residents and physical environment of the city
- To create a platform where close working relationships among freight stakeholders is possible

(3) Scope of the Projects

The scope of the projects is summarized in the Table 12.5.10. The Department of Urban Roads is expected to be the implementing agency in collaboration with other concerned agencies.

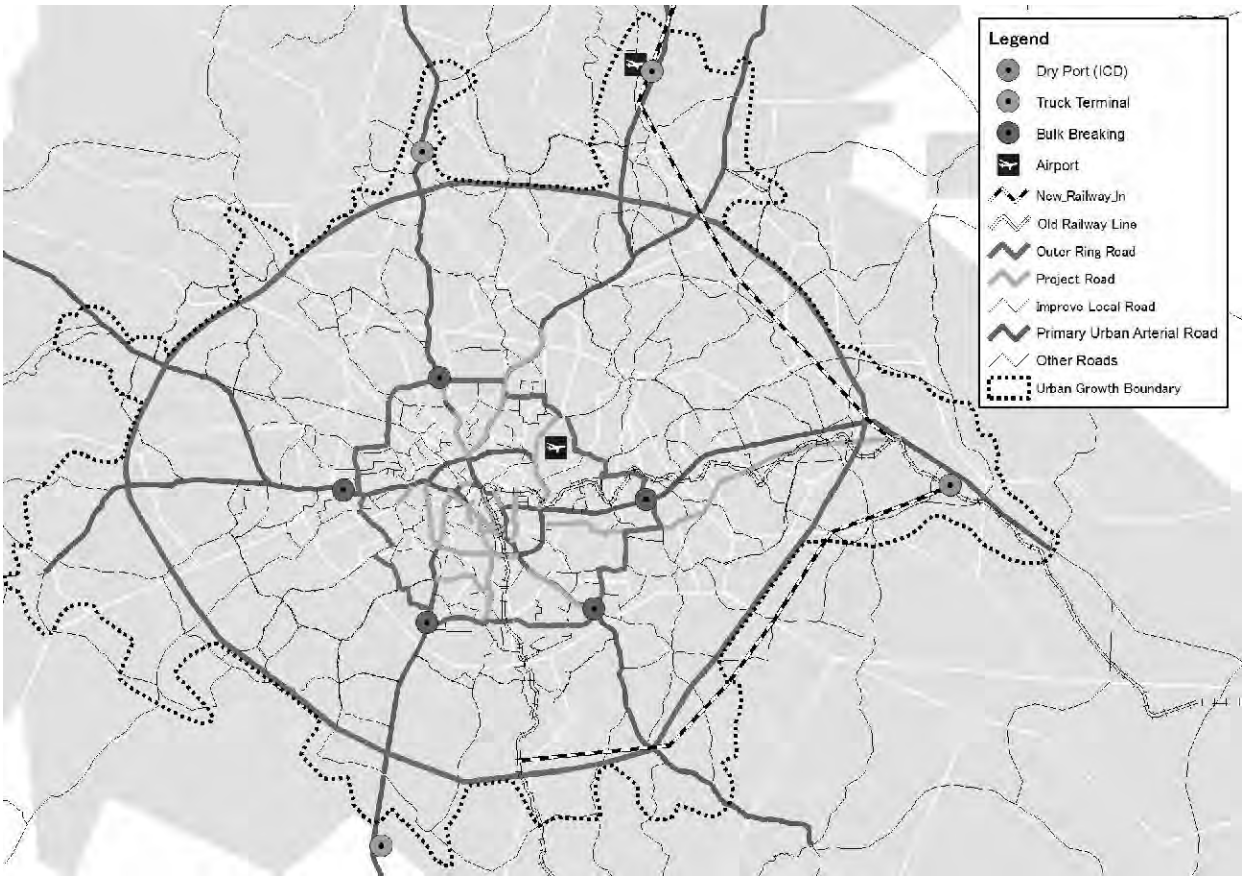
Table 12.5.10 List of Projects under Freight Transport Management Sub-Programme

No.	Freight Transport Measures
1	Dry Port at Boankra
2	Truck Terminal at Kodie
3	Truck Terminal close to New International Airport
4	Truck Terminal at Bekwai Road
5	Bulk Breaking Point at Offinso Road
6	Bulk Breaking Point at Accra Road
7	Bulk Breaking Point at Lake Road
8	Bulk Breaking Point at Bekwai Road
9	Bulk Breaking Point at Sunyani Road
10	Time Window for Truck Delivery within the inner ring road
11	Truck Access Control (Total Truck Ban after completion of outer ring road)
12	Establishment of Forum on Freight Transportation
13	Railway Upgrade Tema
14	Railway New Construction Kumasi

Source: JICA Study Team

(4) Project Location

The locations of identified projects are presented in Figure 12.5.4.



Source: JICA Study Team

Figure 12.5.4 Location Map of Projects under Freight Transport Management Sub-Programme

(5) Impact of the Projects

a) Positive Impacts

The positive impacts include contribution to improvement of traffic flow, reduction of greenhouse gases from vehicles, contribution to reduction of noise and vibration and enhancement of liveability of the city.

b) Negative Impacts

Construction of Truck Terminals might involve acquisition of private land, cutting of trees, slope modification and other activities that might disturb the natural environment. Likewise, since bulk breaking points are envisioned to be closer to the city centre compared to the truck terminals, candidate locations might be partially inhabited. As such, aside from acquisition of private land and modification of the natural environment, involuntary resettlement might have to be carried out.

Regarding truck access restriction measures, night driving if not monitored might increase traffic accidents due to over speeding. Likewise, probability of committing driving errors might increase due to the sleepiness of the drivers.

12.6 Costs for Transportation Sector Projects

The costs for all Transportation Sector Projects are estimated as shown in Table 12.6.1 .

Table 12.6.1 Costs for Transportation Sector Projects

Sub-Programmes	No	Projects	2033 Demand Per day	Length (km)	Cost ($ M)
Road Network Scheme	1	Widening of Western bypass to 4 lanes in certain sections	17,400 PCU	3.60	5.59
	2	Widening of southern bypass to 4 lanes in certain sections	14,500 PCU	3.40	6.89
	3	Widening of Lake Road to 4 lanes (Phase 2)	38,900 PCU	4.15	5.56
	4	Widening of Mampong Road to 4 lanes in certain sections	37,700 PCU	5.50	9.03
	5	Widening of Harper Road to 4 lanes from Ahodwo RB to Prempeh I Street	24,900 PCU	2.12	3.61
	6	Widening of New Bekwai Road to 4 lanes from Santasi RB to Bekwai RB	25,300 PCU	2.53	4.61
	7	Widening of Old Bekwai Road to 4 lanes from Ahodwo RB to Daban	36,800 PCU	3.48	5.43
	8	Widening of Antoa Road to 4 lanes from Airport RB to Buokrom estate	22,400 PCU	2.64	8.21
	9	New link connection of Lake Road and Century Hall Road, 4 lanes	1,600 PCU	1.20	0.82
	10	New link Old Bekwai Road and New Bekwai Road, 2 lanes	5,000 PCU	3.10	4.61
	11	New Outer Ring Road	8,200 PCU	91.49	190.60
	12	Yaa Asantewaa Rd widening to 4 lanes in certain sections	9,000 PCU	3.11	2.46
	13	Bantama Road widening to 6 lanes in certain sections	62,500 PCU	0.63	0.66
	14	Eastern bypass widening to 6 lanes in certain sections	36,400 PCU	2.60	3.29
	15	Offinso Road widening to 6 lanes from Suame RB to New Magazine Rd	52,600 PCU	3.62	5.43
	16	Kwadaso Road widening to 4 lanes from Sunyani Rd to Ohwimase Rd	10,900 PCU	1.12	2.14
	17	Maxwell Rd and Zongo Rd widening to 4 lanes	27,800 PCU	1.09	1.64
	18	Guggisberg Rd widening to 4 lanes	10,500 PCU	2.35	1.64

	19	Government Rd widening to 4 lanes	9,600 PCU	1.24	1.48
	20	New link connection between Ejisu and Kumasi (2 lane)	800 PCU	17.21	25.59
	21	New CBD Road (2 lane)	4,400 PCU	3.01	4.48
	22	New Middle ring road by upgrading local roads (2 lane)	5,600 PCU	48.23	71.72
	23	Local Road Update in future urbanized area (2 lane)	1,900 PCU	468.89	159.42
Junction Improvement Scheme	1	Signal optimisation – Zoo junction (on-going)			0.05
	2	Signal optimisation – Abrepo junction (on-going)			0.05
	3	Signal optimisation – Kroform junction (on-going)			0.05
	4	Signal optimisation – Top High junction (on-going)			0.05
	5	Signal optimisation – Anloga junction (on-going)			0.05
	6	Anloga Intersection Improvement by Conversion to Flyover			50.00
	7	Airport Roundabout Improvement by Conversion to Flyover			50.00
	8	SuameRoundabout Improvement by Conversion to Flyover			50.00
	9	Santase Roundabout Improvement by Conversion to Flyover			50.00
	10	Ahodwo Roundabout Improvement by Conversion to Flyover			50.00
	11	Abrepo Junction Improvement by Conversion to Flyover			50.00
	12	Central Market Junction (Antoa-Bantama-Fuller) Improvement by Conversion to Flyover			50.00
	13	Bekwai Roundabout Improvement by Conversion to Flyover			50.00
	14	Osei Tutu II Blvd. at KNUST			0.60
	15	Harper Road / James E. Bandoh Drive			0.49
	16	Southern Bypass / Adiembra Road			0.23
	17	Western Pypass / Edwenase Road			0.28
	18	Atoa Road / Buokrom Estate Road			0.16
	19	Aboabo / St. Patrick Road			0.51
	20	Mampong Road / Cemetery Road			0.36
	21	Mampong Road / New Suame Road			0.37
	22	Mampong Road / Tafo Hospital Road			0.37
	23	Mampong Road / Pankrono Estate Road			0.48
	24	Obuasi Road / Odeneho Kwadaso			1.24
	25	Obuasi Road / Fankyenbra Road			1.24
	26	Obuasi Road / Adiembra Road			1.24
	27	Obuasi Road / Santasi New Site			0.71
Type B Transit Routes Scheme	1	Antoa Road Type B Routes		8.80	3.68
	2	Mampong Road Type B Routes		8.80	2.18
	3	Offinso Road Type B Routes		8.20	2.12
	4	Abrepo Road Type B Routes		7.40	2.04
	5	Sunyani Road Type B Routes		8.30	2.13
	6	Bekwai Road Type B Routes		8.40	3.64
	7	Old Bekwai Type B Routes		9.90	2.29
	8	Lake Road Type B Routes		10.40	2.34
	9	Accra Road Type B Routes (Feasibility study has been done in 2011)		15.30	4.38
	10	Orbital Route Type B Route		18.30	7.53
BRT Routes Scheme	1	BRT Mampong Road		8.80	20.22
	2	BRT Offinso Road		8.20	19.08
	3	BRT Sunyani Road		8.30	19.27
	4	BRT Bekwai Road		8.40	19.46
	5	BRT Accra Road (Feasibility study has been done in 2011)		15.30	34.57
	6	BRT Lake Road		10.40	23.26
	7	BRT Inner Ring Road		7.96	18.30
	8	BRT CBD New Road		1.31	3.00
Other Public Transport Scheme	1	Interchange Hubs (5 locations)			5.00
	2	Park & Ride (7 sites)			4.90

Traffic Control in CBD Scheme	1	One-Way Traffic Operation		NULL
	2	Provision of Pay Parking (some components has been done and on-going)		NULL
	3	Improvement of Pedestrian Walkways		NULL
	4	Provision of New Walkways		2.38
	5	Provision of Cycle Lanes		7.15
	6	Kumasi Centralized Traffic Signal Project (Feasibility Study is on-going)		NULL
	7	Number plate restriction inbound CBD		NULL
TDM Scheme	1	Flexible Working Hours		10.00
	2	Rideshare programs		
	3	Car sharing		
	4	HOV Priority		
	5	Road pricing		
	6	Fuel tax increases		
	7	Commuter financial incentives		
	8	Education Campaign on Mobility Management		
Freight Transport Scheme	1	Dry Port at Boankra (Feasibility study has been done in 2011, and some components is on-going)		NULL
	2	Truck Terminal at Kodie		5.00
	3	Truck Terminal close to New International Airport		5.00
	4	Truck Terminal at Bekwai Road		5.00
	5	Bulk Breaking Point at Offinso Road		2.00
	6	Bulk Breaking Point at Accra Road		2.00
	7	Bulk Breaking Point at Lake Road		2.00
	8	Bulk Breaking Point at Bekwai Road		2.00
	9	Bulk Breaking Point at Sunyani Road		2.00
	10	Time Window for Truck Delivery within the inner ring road		NULL
	11	Truck Access Control (Total Truck Ban after completion of outer ring road)		NULL
	12	Establishment of Forum on Freight Transportation		NULL
	13	Railway Upgrade Tema – Kumasi (Master Plan Study has been done in 2012)	303.90	NULL
	14	Railway New Construction Kumasi – Paga (Feasibility and design study is on-going by Chinese donor)	617.80	NULL
Air Port	1	Kumasi International Airport (Pre feasibility study has been done in 2004)		NULL

Source 1: JICA Study Team
Source 2: WB, 2012, Transport Plan for Kumasi

12.7 Preliminary Economic Analysis

(1) Methodology

The total economic impact of the transportation sector programme is analysed assuming that each programme element (project) will be implemented as scheduled. The implementation schedule developed in the previous section is preconditioned to identify each term for project investment. The benefits generated by the programme are calculated as savings in Vehicle Operating Cost (VOC) and Travel time cost when analysing the two cases of "With" and "Without" for each year until year 2043.

The economic evaluation is carried out by calculating the Economic Internal Rate of Return (EIRR) and Net Present Value (NPV) of the total programme. For the NPV, a discount rate of 12% is applied. In order to achieve the objective of the sector programme, the following steps are carried out:

Step 1: Traffic demand forecasts with and without the programme,

Step 2: Estimation of economic benefits based on the traffic demand after implementation of the Programmes and unit vehicle operating cost,

Step 3: Estimation of economic costs based on the estimated capital investment cost mentioned in the previous section,

Step 4: Estimating the indirect effects, and

Step 5: Economic evaluation using economic benefits and economic costs.

(2) Vehicle Operation Cost (VOC)

This is one of the main economic benefits in implementing a transport development project. The VOC is composed of the savings in cost of the following items:

- Saving in running cost: This cost of vehicle operation depends on travelled distance in vehicle-km and consists of costs for fuel, lubricants, tires, maintenance and repairs.
- Saving in fixed cost: This cost of vehicle operation depends on travelled time of vehicle in vehicle-hours and consists of costs for capital, crew, overhead and depreciation.
- The VOC was calculated for cars, taxis, buses, and trucks by applying the World Bank study for "Preparation of Transport Plans for Kumasi of June, 2012", which is a popular model of VOC calculation for economic evaluation as shown in Table 12.7.1

Table 12.7.1 Vehicle Operating Costs

	Running Cost (GHC/v-km)	Fixed Cost (GHC/v-hour)
Car	1.40	2.54
Taxi	1.42	2.18
Bus	1.58	9.10
Truck	2.50	1.14

Source: World Bank Report in 2012

(3) VOC by Surface Condition and Traffic Flow

Condition of the surface and road roughness are very important factors to calculate the VOC. The empirical studies carried out have already determined the relationship between International Roughness Index (IRI) and VOC. Based on these relationships, VOC by travel speed related to road roughness and saturation of traffic flow is computed by the Roads Economic Decision Model (RED)-HDM 4VOC workbook and shown in Table 12.7.2 The study team assumed that the terrain is hilly and the surface is paved.

Table 12.7.2 VOC by Travel Speed

Travel Speed	5-10 km	10-15 km	15-20 km	20-25 km	25-30 km	30-35 km	35-40 km above
Car	1.80	1.70	1.60	1.55	1.50	1.45	1.40
Taxi	2.30	2.00	1.87	1.73	1.60	1.50	1.42
Bus	3.10	2.60	2.25	2.00	1.85	1.70	1.58
Truck	5.20	4.50	4.00	3.50	3.00	2.70	2.50

Source: JICA Team and WB RED-HDM 4 VOC workbook (Ratio of VOC)

(4) Saving in Travel Time Cost

The travel time cost also referred to as Value of Time is an important component of road user costs. The concept of travel time cost is based on the premise that the time spent in traveling has an 'opportunity cost" and could be used in an alternative activity which also produces or may produce some significant benefit.

The unit traffic cost by vehicle type is estimated based on the traffic survey in the "World Bank study for Preparation of Transport Plans, Socio-Economic Assessment of Urban Travel in Kumasi in November, 2011" as shown in Table 12.7.3.

Time cost for cargo was not estimated due to the difficulty in estimation at this time.

Table 12.7.3 Travel time cost

	Travel time cost (GHC/vehicle)
Car	4.38
Taxi	1.36
Bus	0.40
Truck	4.48

Source: JICA Study Team

(5) Estimation of Economic Cost

The financial cost of the programme is estimated at GHC 2,175 million in total. In this study the economic cost was estimated by deducting the government taxes and import duty from the financial cost so that a conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 1,849 million as shown in Table 12.7.4.

Maintenance cost is also added to economic cost. The study team assumed 1% of capital cost for the "Road Network Scheme" accordingly in every year and 20% of rehabilitation cost for each road every ten years.

Table 12.7.4 Economic Cost of Transport Sector Programme

(Unit: GHC Thousand)

	Financial Cost	Conversion Factor	Economic Cost
Road Network Scheme	969,400	0.85	823,990
Junction Improvement Scheme	817,100	0.85	694,535
Type B Transit Routes Scheme	64,680	0.85	54,842
BRT Routes Scheme	314,400	0.85	267,240
Other Public Transport Schemes	10,000	0.85	8,500
Total	2,175,580	0.85	1,849,107

Source: JICA Study Team

(6) Economic Analysis

Based on the above mentioned benefits and costs estimation, the economic analysis of the sector programmes was undertaken. Table 12.7.5 shows the benefit cost stream. The results of the economic analysis show a Net Present Value (NPV) of GHC 2,138 million and BCR of 3.76 over the 30 year life of the sub-programmes using a discount date of 12.0 %. The Economic Internal Rate of Return (EIRR) was compiled at 39.9%.

Table 12.7.5 Benefit-Cost Stream of Transport Sector Programme

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0		65,642	65,642	0	-65,642	65,642	0	-65,642
2014	25,523	556	65,642	66,198	25,523	-40,675	59,106	22,789	-36,317
2015	51,047	1,112	68,417	69,529	51,047	-18,482	55,428	40,694	-14,734
2016	76,570	1,669	68,417	70,085	76,570	6,485	49,885	54,501	4,616
2017	102,094	2,225	69,796	72,021	102,094	30,073	45,770	64,883	19,112
2018	127,617	2,781	98,692	101,473	127,617	26,144	57,579	72,414	14,835
2019	153,141	4,181	98,692	102,874	153,141	50,267	52,119	77,586	25,467
2020	178,664	5,581	95,918	101,499	178,664	77,165	45,913	80,819	34,906
2021	207,591	6,982	95,918	102,899	207,591	104,691	41,559	83,842	42,283
2022	229,711	13,944	94,868	108,812	229,711	120,900	39,239	82,836	43,598
2023	348,266	15,344	87,157	102,502	348,266	245,764	33,003	112,132	79,129
2024	466,820	15,873	87,157	103,030	466,820	363,790	29,619	134,200	104,581
2025	585,374	16,402	87,157	103,559	585,374	481,815	26,581	150,251	123,670
2026	703,928	16,930	87,157	104,088	703,928	599,841	23,854	161,322	137,468
2027	889,726	25,898	87,157	113,055	889,726	776,671	23,133	182,056	158,922
2028	941,233	26,427	118,264	144,690	941,233	796,542	26,434	171,960	145,525
2029	992,986	27,237	118,264	145,501	992,986	847,485	23,734	161,978	138,243
2030	1,044,740	28,048	118,264	146,312	1,044,740	898,428	21,310	152,160	130,851
2031	1,096,494	28,859	118,264	147,123	1,096,494	949,370	19,132	142,588	123,456
2032	1,103,413	26,518	118,264	144,782	1,103,413	958,631	16,810	128,114	111,304
2033	1,126,635	27,329		27,329	1,126,635	1,099,306	2,833	116,795	113,961
2034	1,149,857	27,329		27,329	1,149,857	1,122,528	2,530	106,430	103,901
2035	1,173,078	27,329		27,329	1,173,078	1,145,749	2,259	96,946	94,688
2036	1,196,300	27,329		27,329	1,196,300	1,168,971	2,017	88,273	86,256
2037	1,219,522	38,590		38,590	1,219,522	1,180,932	2,542	80,345	77,802
2038	1,242,743	38,590		38,590	1,242,743	1,204,153	2,270	73,102	70,832
2039	1,265,965	38,590		38,590	1,265,965	1,227,375	2,027	66,489	64,463
2040	1,289,186	38,590		38,590	1,289,186	1,250,596	1,810	60,455	58,645
2041	1,312,408	38,590		38,590	1,312,408	1,273,818	1,616	54,950	53,334
2042	1,335,630	27,329		27,329	1,335,630	1,308,300	1,022	49,930	48,909
2043	1,358,851	32,892		32,892	1,358,851	1,325,960	1,098	45,356	44,258
	22,995,115	629,056	1,849,107	2,478,163	22,995,115	20,516,952	777,873	2,916,194	2,138,321

B / C	3.7489
EIRR %	39.85
NPV (GHc)	2,138,321

Source: JICA Study Team

(7) Indirect Benefits

1) Promotion of Desirable Form of Development

The proposed Sector Programme is designed to provide access to the planned development areas. This improved access is expected to promote the development of the planned areas and increase the commercial value of the land in these areas. As a result, uncontrolled sprawl of the urbanized area is prevented and a desirable form of development is promoted. At the same time, the areas which are developed in desirable form are expected to attract people and businesses, and to mitigate the undesirable increase of population in the present urbanized area.

2) Promotion of Economic/Industrial Activities

Smooth traffic reduces the time and cost of both persons and cargo transportation. With less transportation cost, products and services become competitive. As a result, growth of the economy/industry will be accelerated.

12.8 IEE of Transportation Sector Programme

This Section of the chapter discusses the Initial Environmental Examination (IEE) for this Sector programme at the early level of planning regarding impacts caused by the implementation of the sector programme. Such assessment is drawn based on the results of the analysis of the existing conditions and on the initial screening process undertaken by the Project Team using the Environmental Impact Matrix. The detailed analyses of environmental impacts such as the Environmental Impact Assessment (EIA) will be conducted at the feasibility study phase. The conduct of an IEE study under the sector programme is done in the following manner:

(1) Targets of the IEE Study

This Sector Programme consists of six components. The targets of IEE study are shown in Table 12.8.1.

Table 12.8.1 Targets of IEE Study for Transport Sector

- ☐ Road Network Development Sub-Programme
- ☐ Intersection and Signalization Improvement Sub-Programme
- ☐ Public Transport Development Sub-Programme
- ☐ Sub-Programme of Traffic Control in the CBD
- ☐ Traffic Demand Management Sub-Programme
- ☐ Freight Transport Management Sub-Programme

(2) Phasing of the IEE Study

To study the IEE, programme components are divided into three phases, namely Pre-Construction Phase, Construction Phase, and Operation and Maintenance Phase. The activities of each phase are as follows:

- **Pre-construction Phase**: which includes land acquisition, resettlement, mobilization of heavy equipment, transport of construction materials, construction of office buildings and labour camps, etc.
- **Construction Phase**: consisting of the setting up of equipment, demolition of the existing structures, implementation of construction works, generation of construction waste etc.
- **Operation and Maintenance Phase**: which includes the operation and maintenance of facilities, maintenance works, etc.

(3) Result of the IEE Study

In Ghana, there are 4 pillars in an environmental impact study as follows:

- Institutions
- Natural resources
- Socio-culture
- Economy

The environmental impacts on the above parameters are identified in the Pre-construction Phase, Construction Phase and Operation and Maintenance Phase using an Environmental Impact Matrix. The Environmental Impact Matrix shows the identified positive and negative environmental impacts caused by implementation of the programme. The Environmental Impact Matrix of transportation sector is shown in Table 12.8.2.

Table 12.8.2 Environmental Impact Matrix for the IEE Study of the Transport Sector

Environmental Parameters		Institution		Natural Resources																Socio-Culture												Economy	
Components	Phases	Existing policy	Legal basis	Topography/Geology	Soil	Ground subsidence	Air quality	Hydrology	Water quality	Groundwater	Noise/Vibration	Offensive odor	Terrestrial flora and fauna	Aquatic flora and fauna	Biodiversity	Terrestrial ecosystem	Aquatic ecosystem	Natural disaster	Climate change factors	Population	Land use	Water use	Landscape	Human health	Involuntary resettlement	Cultural heritage	Material assets	Transportation	Power supply	Water supply	Solid waste	Other infrastructure	Local economy
TR Sub-Programme 1: Road Network Development Sub-Programme	Pre-construction																				-2				-3								
	Construction			-1	-1	-1	-1	-1	-1	-1	-2																	-2			-2	-2	+1
	Operation & Maintenance						+2				-2								+2	+1	+1		-1	-1				+3					+3
TR Sub-Programme 2: Intersection and Signalization Improvement Sub-Programme	Pre-construction																				-2				-2								
	Construction			-1	-1	-1	-1	-1	-1	-1	-2												-1					-2			-1	-1	+1
	Operation & Maintenance						+2				-2								+2	+1	+1		-1					+2					+3
TR Sub-Programme 3: Public Transport Development Sub-Programme	Pre-construction																																
	Construction																																+1
	Operation & Maintenance						+2				+2								+1									+2					+3
TR Sub-Programme 4: Sub-Programme of Traffic Control in the CBD	Pre-construction																																
	Construction																											-1					
	Operation & Maintenance						+2				+2								+1									+2					+2
TR Sub-Programme 5: Traffic Demand Management Sub-Programme	Pre-construction		-1																														
	Construction																																
	Operation & Maintenance																							+1									-1
TR Sub-Programme 6: Freight Transport Management Sub-Programme	Pre-construction																				-1				-2								
	Construction			-1	-1	-1	-1	-1	-1	-1	-1																	-1				-1	-1
	Operation & Maintenance						-1				-1									+1				-1				+2					+2

+1: Negligible Positive Impact
+2: Moderately Positive Impact
+3: Significant Positive Impact
-1: Negligible Negative Impact
-2: Moderately Negative Impact
-3: Significant Negative Impact
+/-: Likely to have both positive and negative environmental impact
?: Uncertain or unpredictable environmental effect

Source: JICA Study Team

Chapter 13 Water Resources Sector Plan and Programme

13.1 Objectives for Water Resources Development

The objectives of water resources development are as follows:

a) To make use of the existing reservoirs' capacity for water supply by rehabilitation of the dams

The Barekese and Owabi Dams have been underutilized in terms of their original yield. After the capital dredging of 10,000,000 m^3 is conducted in Barekese Dam reservoir, a certain increase of the yield is expected.

b) To materialize new water sources in and around Greater Kumasi Sub Region

Even if the existing dams are successfully refurbished to their full capacity, if the people in Kumasi seek a more comfortable lifestyle, it is anticipated that the yield of the existing dams will not be able to meet the water demand in the near future. It is necessary for the GoG to put a new water source into the future project list as soon as possible.

c) To consolidate a hydrological monitoring system

In some urban areas in and around Greater Kumasi Sub Region, groundwater has been used as supplemental source together with pipe-borne water supply (surface water). From the viewpoint of geological features in the area, the groundwater potential is quite limited compared with surface water. However, in and around Greater Kumasi Sub Region, because of insufficient hydrological data it is still difficult to evaluate the water budget among rainfall, evapotranspiration, surface water and groundwater. Consequently it is difficult to make long term plans for water resources usage.

d) To enhance access to safe water supply in rural areas

Access to safe water supply is a universal need and essential for human development. The availability of a safe water supply contributes positively to enhance public health and economic development.

13.2 Water Resources Potential

(1) Introduction

The major rivers in and around Greater Kumasi Sub-Region are the following river

basins.

- Offin River System
- Oda River System
- Anunu River System including Bosomtwe Lake closed system

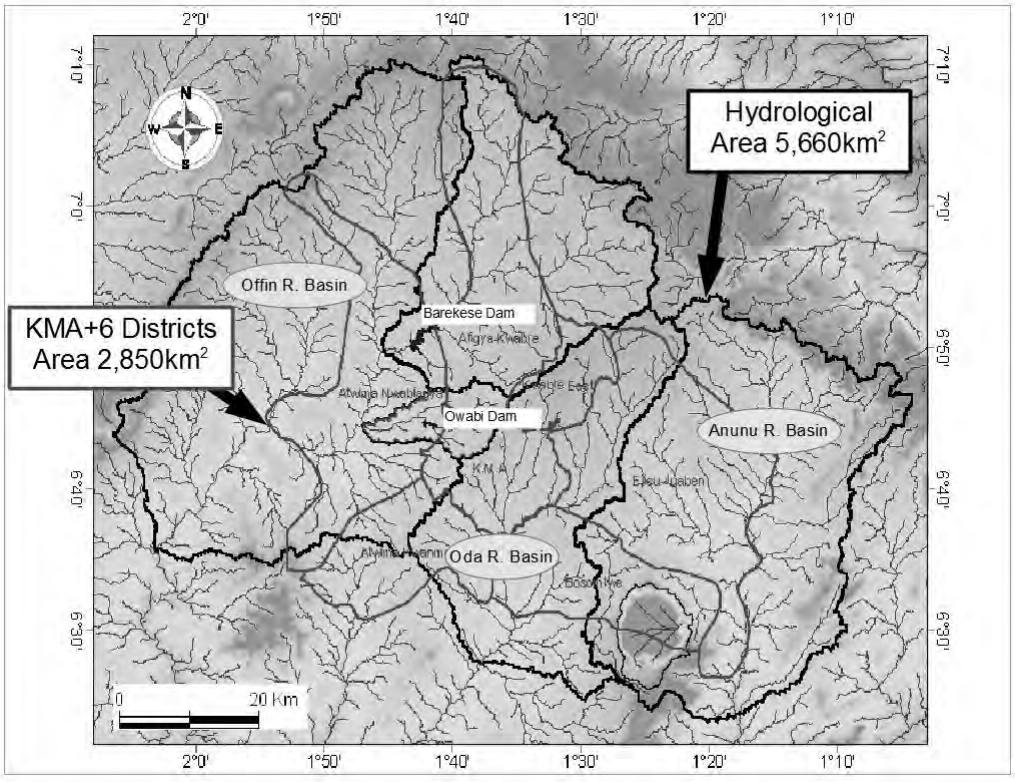
The catchment of Barekese Reservoir and Owabi reservoir are included in the Offin river basin. The catchment area of the above river systems is summarized in Table 13.2.1.

Table 13.2.1 Catchment Areas of Major River Systems in and around Greater Kumasi Sub-Region

Main River System	Catchment Area (km^2)	Sub Basin	Catchment Area (km^2)
Offin River System at Adiembra	3,074	Barekese Reservoir Basin	941
		Owabi Reservoir Basin	118
		Offin main stream	2,015
Oda River System at Bekwai	953		
Anunu River System	1,633	Anunu River Main	1,528
		Bosumtwi Lake	105
Total	5,660		5,660

Source: JICA Study Team

The catchment area in the above table was computed from GIS using digital elevation data called SRTM3. The delineated watershed boundary of the main river system is shown in Figure 13.2.1.



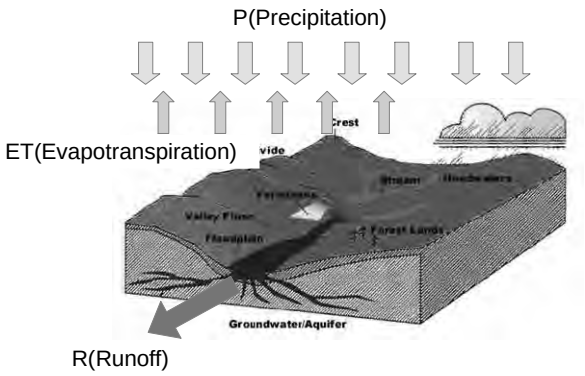
Source: JICA Study Team

Figure 13.2.1 River Basins with related Water Sources in and around Greater Kumasi Sub-Region

(2) Water Resources Potential

In this chapter, water resources potential is defined as the usable water amount (Runoff) over a certain area which can be calculated as Rainfall amount minus Evapotranspiration. This is illustrated in Figure 13.2.2. It should be noted that runoff includes surface water and groundwater on an annual basis.

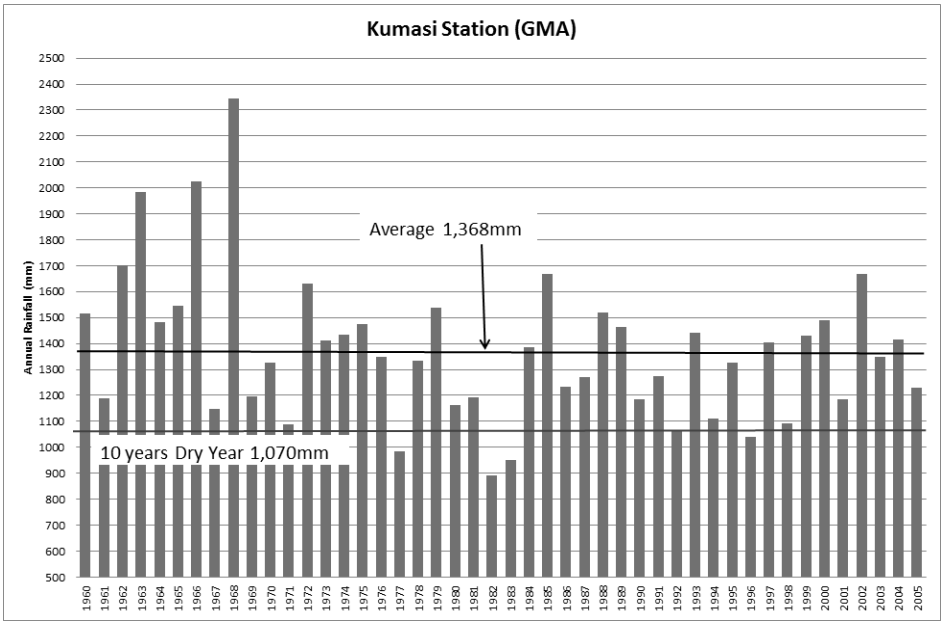
$$R = P - ET$$



Source: JICA Study Team

Figure 13.2.2 Relation among Precipitation, Evapotranspiration and Runoff over Watershed Precipitation (Rainfall)

The annual rainfall in Kumasi is about 1,400mm. Figure 13.2.3 shows the annual rainfall at Kumasi (GMA) from 1960 to 2005. As shown in this Figure, the annual rainfall amount has wide variation year by year. While the average between 1960 and 2005 was 1,368 mm, dry years with a 10 year return period have 1,070 mm according to statistical analysis. This means the water resources potential also changes as the annual rainfall amount varies.



Source: JICA Study Team based on Water Resources Study Kumasi 2009

Figure 13.2.3 Variation of Annual Rainfall in Kumasi

(3) Evapotranspiration

Provided that there is rainfall over a watershed, a part of the rainfall is lost as evapotranspiration. Generally the quantitative evaluation of evapotranspiration is difficult even at present having advanced technology. Conventionally, evapotranspiration has been calculated based on the ratio of evaporation to evapotranspiration. Evaporation is the water that is evaporated from a water surface such as Evaporation Pans and natural lakes.

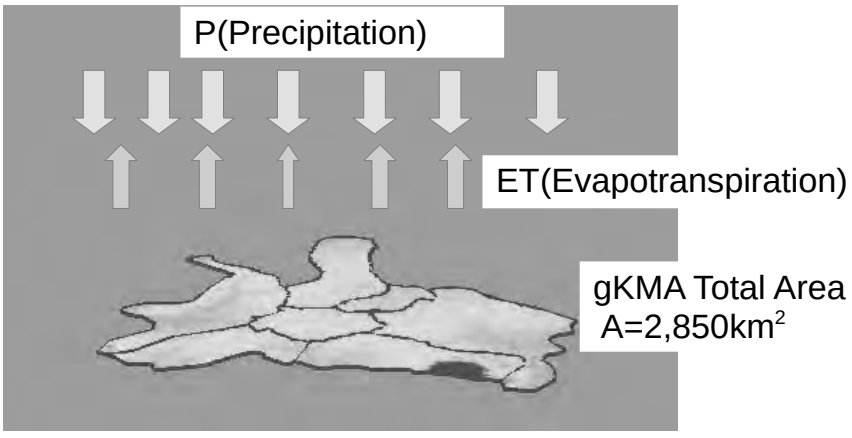
In Ashanti Region, there is very practical measurement of evaporation. Lake Bosomtwe is a hydrologically closed basin, the water budget of Lake Bosomtwe is extremely sensitive to changes in the precipitation/evapotranspiration balance.

Lake Bosomtwe is a closed basin, which means there are no inflow streams and no outflow stream. But the lake level (the water volume in the lake) has been kept constant over years. From this fact, it can be said that the evaporation from the lake surface is balanced with the annual rainfall amount (1,400 mm per year).

The ratio of evaporation to evapotranspiration is not easy to fix, but in order to proceed the quantitative discussion, 1.4 is selected according to literatures. Therefore, the evapotranspiration can be assumed to be 1,000mm a year in Greater Kumasi Sub-Region.

(4) Estimation of Water Resources in Greater Kumasi Sub-Region

The water resources potential is expressed as water volume over a certain area as illustrated in Figure 13.2.4. Regarding the subjective area, there are 2 cases to be considered, Greater Kumasi Sub Region (A=2,850km^2) and the Major River Systems in and around Greater Kumasi (A=5,660km^2). The estimated water resources potential for these 2 cases are shown in Table 13.2.2 and Table 13.2.3.



Source: JICA Study Team

Figure 13.2.4 Concept of Water Resources Potential

Table 13.2.2 Water Resources Potential for Greater Kumasi Sub Region A=2,850km^2

	Average Year	Dry Year	Remark
Precipitation (P)	1,368 mm	1,070 mm	
Evapotranspiration (ET)	1,000 mm	1,000 mm	
Runoff (R)	368 mm	70 mm	
Water Resources Potential A*(P-ET)	1.0*10^9 m^3/year	2.0*10^8 m^3/year	A=2,850km^2
-ditto-	2,873,000 m^3/day	550,000 m^3/day	

Source: JICA Study Team

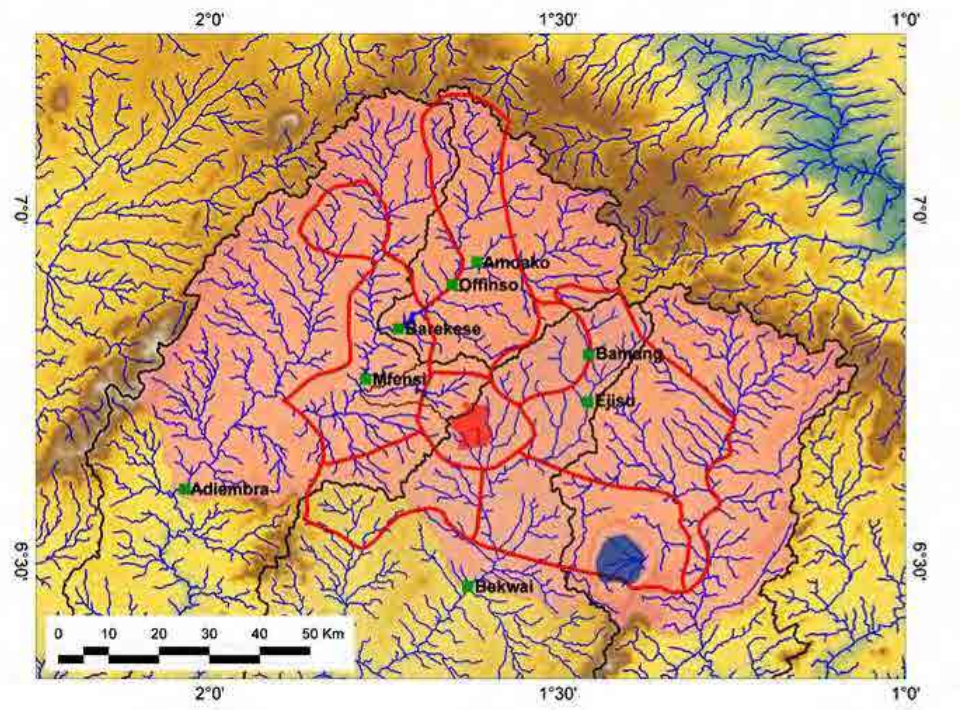
Table 13.2.3 Water Resources Potential for Catchment Area of Major River Systems in and around Greater Kumasi A=5,660km^2

	Average Year	Dry Year	Remark
Precipitation (P)	1,368 mm	1,070 mm	
Evapotranspiration (ET)	1,000 mm	1,000 mm	
Runoff (R)	368 mm	70 mm	
Water Resources Potential A*(P-ET)	2.1*10^9 m^3/year	4.0*10^8 m^3/year	A=5,660km^2
-ditto-	5,706,000 m^3/day	1,085,000 m^3/day	

Source: JICA Study Team

(5) Measured River Discharge

In and around Greater Kumasi Sub Region, there are several hydrological stations operated by the Hydrological Services Department. Figure 13.2.5 shows the location map of those stations.



Source: JICA Study Team

Figure 13.2.5 Location Map of Hydrological Stations

The following Figure 13.2.6 shows the specific measured river discharges on an annual basis. The “average” and “minimum” mean the average and minimum values of annual discharge during a certain period, respectively. These data were referred from Water Resources Study Kumasi (2009) by GWCL.

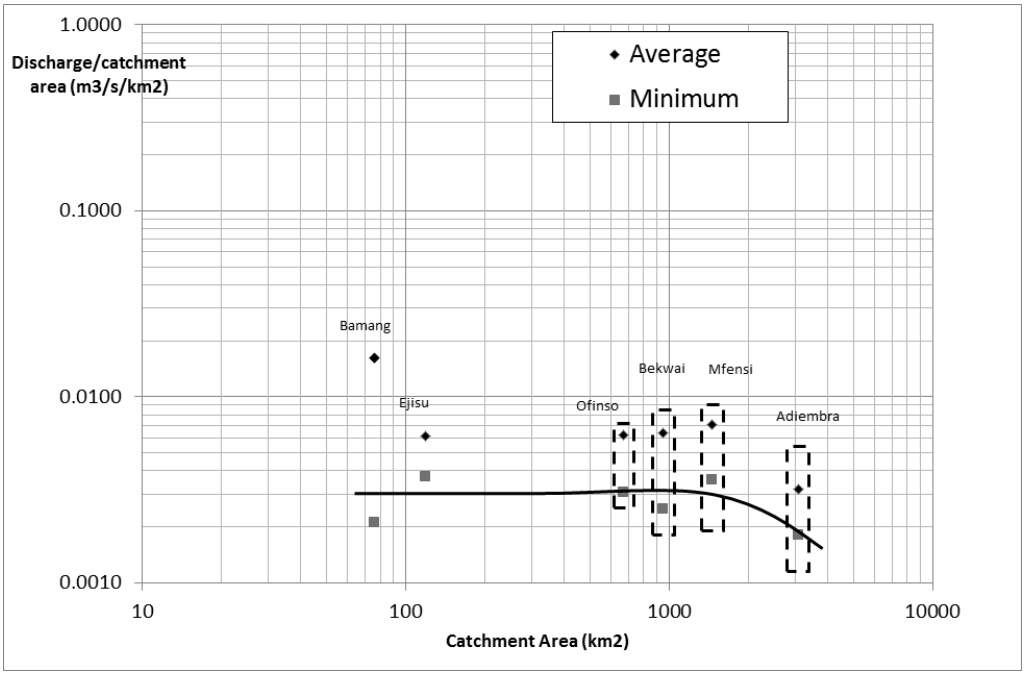
While the measurement period of each station varies and is not very long, the minimum value on record for each station should be taken into consideration for water resources potential. As known from the figure, the minimum specific discharge for a catchment area of 1,000 km^2 is 0.003 $m^3/s/km^2$. If you consider the total area of the catchment in and around Greater Kumasi Sub Region 5,660 km^2, the annual runoff volume is calculated as follows:

0.003 $m^3/s/km^2$ × 5,660 km^2 × 86400 s × 365 = 5.3×10^8 m^3/year

(Equivalent = 1,400,000 m^3/day)

From the above, the water resources potential can be set at 1,400,000 m^3/day for 5,660 km^2 in dry year.

Here it should be confirmed that the above water resources potential including surface water and groundwater is referential only, the total amount of runoff in a year. If huge dams are constructed in each main river in order to trap all the runoff that flows into the rivers, this volume could be used for water use. But this is impossible, so it is important to determine how much water out of that 1,400,000 m^3/day can be used practically.



Note: "Average" means an average value of annual discharge. "Minimum" means a minimum value of annual discharge.
Source: JICA Study Team made based on Water Resources Study Kumasi 2009

Figure 13.2.6 Specific Measured River Discharge

(6) Current Surface Water Sources

Currently the Kumasi area is dependent on reservoirs (dams) and groundwater for its water supply. As surface water sources, there are two water intake points: one at Owabi (located 10 km from the city); the other at Barekese (located 19 km from the city).

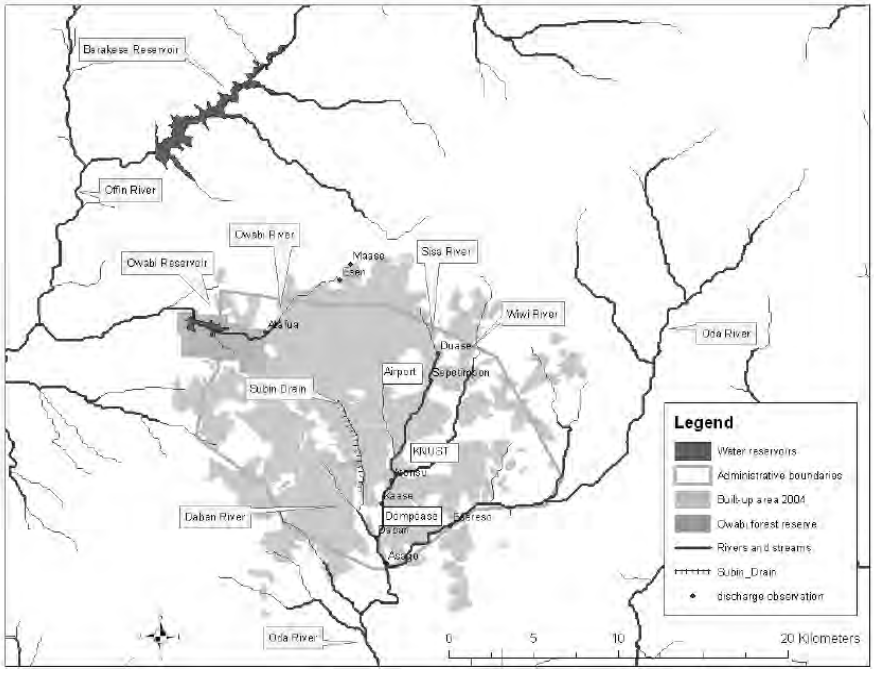
Salient Features of Owabi Dam

Dam Completion Year	1928
River Name	Owabi
Catchment Area	69 km^2
Altitude	229 MSL Crest Level
Dam Type	Composite. Central concrete gravity spillway with earthfill embankment
Dam Height	7.4 m
Dam Length	135 m
Reservoir Storage Capacity	Not known, but 6.2 million m^3 in Design usable
Spillway Type	Mass concrete free overflow (80 m long)
Spillway Crest Level	MSL 227.5 m
Normal Retention Water Level	MSL 227.5 m
Maximum Flood Water Level	MSL 228.3 m
Draw-off/Intake/Outlet Pipework	7.3 m deep 1.2 m*2.4 m wet well with 3 draw-offs into 2.9 m*2.4 m dry well valve shaft
Installed Treatment Capacity	13,636 m^3/day

Salient Feature of Barekese Dam

Dam Completion Year	1971
River Name	Offin
Catchment Area	906 km^2
Altitude	MSL223.69 m Crest Level
Dam Type	Composite. Central concrete spillway (14 siphons & free overflow) with earth-filled embankments
Dam Height	15 m (MCI 2009)
Dam Length	603 m (including spillway)
Reservoir Storage Capacity	35.3 million m^3 as initial value and 22 million m^3 in 2005
Spillway Type	Mass concrete gravity block incorporating 14 air regulated siphons (each 4.6 m long) & central open spillway (6.1 m long)
Spillway Crest Level	MSL 220.9 m
Normal Retention Water Level	MSL 220.9 m
Maximum Flood Water Level	MSL 222.4 m
Draw-off/Intake/Outlet Pipework	Draw-off tower adjacent to spillway section
Installed Raw Water Intake Capacity	218,000 m^3/day as designed (WRS pp.37) or 181,000 m^3/day actual (pp.134)

It should be noted that in Barekese Dam the reservoir sedimentation should be taken into account. The annual sedimentation is estimated to be about 0.33 million m^3 (WRS pp.38).



Source: WRS (2009), pp.7 Figure 2.3

Figure 13.2.7 Location of Surface Water Sources for Greater Kumasi

(7) Capacity of Barekese Dam and Owabi Dam

The document "ASHANTI REGION – BARIKESE System Profile System R02/S01 No 6" states the capacity of the Barekese dam is 181,000m^3/day and that of Owabi is 13,636m^3/day resulting in a combined capacity of 194,636m^3/day.

On the other hand, MCI (2009) states that average water production at Owabi and Bakerese headworks is 122,638 m^3/day, or 27 million gallons per day (GWCL, 2010). However, given that the design capacity of Bakerese is about 220,000 m^3/day and that of Owabi is 13,600 m^3/day, the total water produced by the two waterworks amounts to just over half the design capacity. Low electrical power voltage is a factor contributing to this deficit in water production.

Table 13.2.4 Reported Yield of Barekse and Owabi Dam

Name of Dam	Yield (m^3/day)	Meaning of yield	sources
Barekese Dam	181,000		1
	220,000	Design Capacity	2
	218,000	Design Capacity	3
Owabi Dam	13,636		1
	13,600		2

Source 1: ASHANTI REGION – BARIKESE System Profile System R02/S01 No 6
Source 2: MCI Report
Source 3: GWCL(2009), Water Resources Study Kumasi, p.37

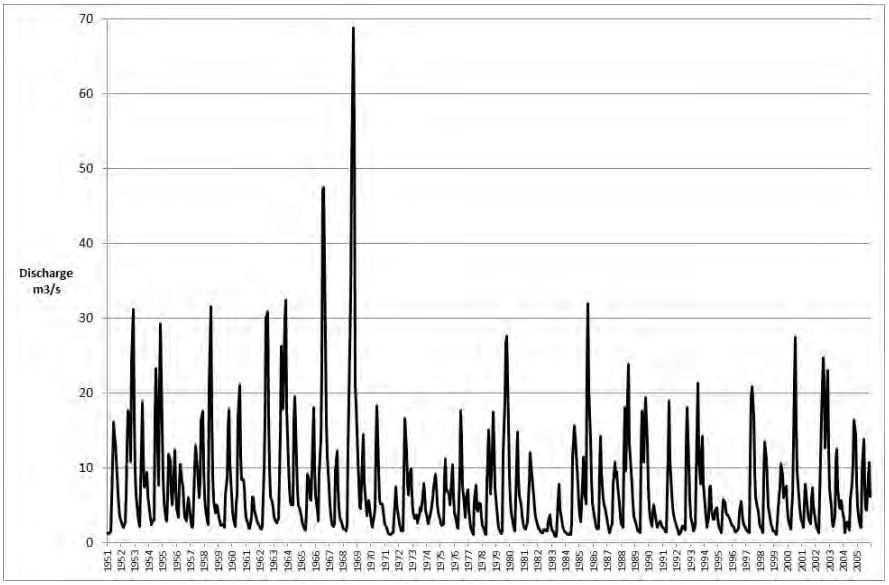
(8) Simulation of Barekese Dam Operation

In order to confirm the capacity of Barekese Dam and effect of sedimentation dredging in the future, JICA Project Team simulated the operation of Barekese Dam using monthly the inflow hydrograph from 1951 to 2005. The monthly inflow hydrograph at the dam site is referred to the simulation results in the Water

Resources Study Kumasi (GWCL, 2009). The basic features of the monthly hydrograph are as follows.

Table 13.2.5 Monthly Hydrograph at Barekese Dam (m^3/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Average (1951-2005)	3.7	2.9	2.7	4.1	6.7	11.6	13.2	10.4	9.3	10.2	9.2	5.7	7.5
1982 (driest year)	2.02	1.98	1.61	1.35	1.42	1.81	1.79	1.61	1.58	2.91	3.78	2.5	2.0



Source: Water Resources Study 2009

Figure 13.2.8 Monthly Hydrograph at Barekese Dam(1951-2005)

The simulation was done as follows,

- Reservoir starts its impoundment from empty condition in January 1951 and reaches its design storage in May 1951.
- Water intake starts in May 1951
- Dam Operation period is 51 months (May 1951 to December 2005)
- When the reservoir volume and inflow becomes less than the assumed intake water volume in a month, the intake water volume decreases and this is regarded as an "intake water control month".

The simulation results are as follows:

Table 13.2.6 Simulated Result for Reservoir Volume 33,750,000 m^3 as Designed

Intake Water (Yield)	Number of Months for Intake Water Control	Year/Month for Intake Water Control
200,000 m^3/day	0	-
220,000 m^3/day	2	1983 Apr , May
240,000 m^3/day	7	1983, 1984

Source: JICA Study Team

As a reference, the case of without dredging is as follows:

Table 13.2.7 Simulated Result for Reservoir Volume 23,750,000 m^3 as Existing (Without Dredging)

Intake Water (Yield)	Number of Month for Intake Water Control	Year/Month for Intake Water Control
180,000 m^3/day	0	-
200,000 m^3/day	2	1983 Apr , May
220,000 m^3/day	10	1971, 1982, 1983, 1984

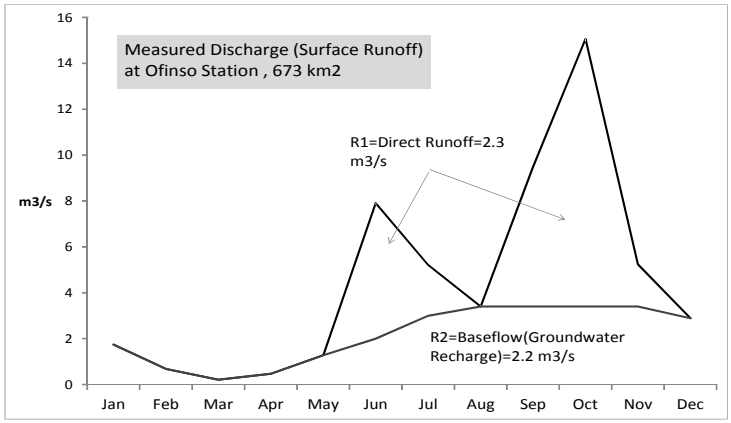
Source: JICA Study Team

From the above results, it can be said that the capacity of Barekese is 200,000 m^3/day for the storage volume 33,750,000 m^3 as Designed. In the case of 220,000 m^3/day, 2 months in 1983 suffer from intake control. However, this is an event of once in 55 years according to this simulation.

If the dredging is not conducted, the present capacity is 180,000 m^3/day. This means the implementation of dredging (10,000,000 m^3) corresponds to an increase in capacity of about 20,000 m^3/day.

(9) Groundwater Potential

The percentage of groundwater runoff out of the total runoff is 50 % as shown in Figure 13.2.9. Therefore the groundwater potential for 5,660 km^2 is 700,000 m^3/day. However, this amount must be considered as a theoretical maximum value because under natural conditions it becomes a part of total runoff (water resources potential) in a year.



Ofinso Station
-Surface Area A=673km^2

Annual Rain P=1400 mm

Total Rainfall Volume
Vr=A*P=9.4*10^8 m^3

Baseflow Volume
Vb=2.2*86400*365
=0.7*10^8 m^3

Groundwater Recharge Ratio
Vb/Vr=0.07 (7%)

Basically 50% of Total Runoff

Source: JICA Study Team

Figure 13.2.9 Percentage of Groundwater Runoff in Total Runoff

Generally, groundwater exists locally, which means that the available amount in an area can be used in the same area. Therefore, assuming the future urban area in 2033 is 858 km^2, the groundwater potential in such urban area can be calculated as follows:

700,000 m^3/day × (858 / 5,660) =106,000 m^3 /day

(10) Environmental Flow

In order to assure proper environmental conditions in a river, a certain amount of flow should be kept as a part of runoff. This is called environmental flow. The usage of groundwater could affect the amount of base flow in a river.

(11) Water Budget for 5,660 km^2 in Dry Year

The water budget for 5,660 km^2 is shown in Figure 13.2.10. The naturally available water is 1,400,000 m^3. Among this, the existing dams are developing 230,000 m^3 and a certain amount of environmental flow is required. Also the rural water supply and the groundwater usage in the urban areas are developing to some extent. Therefore, it is assumed that approximately 900,000 m^3/day could be newly developed. However, attempts to develop this amount would encounter difficulty because of the topography, geology and social-environmental issues in and around Greater Kumasi Sub-Region.

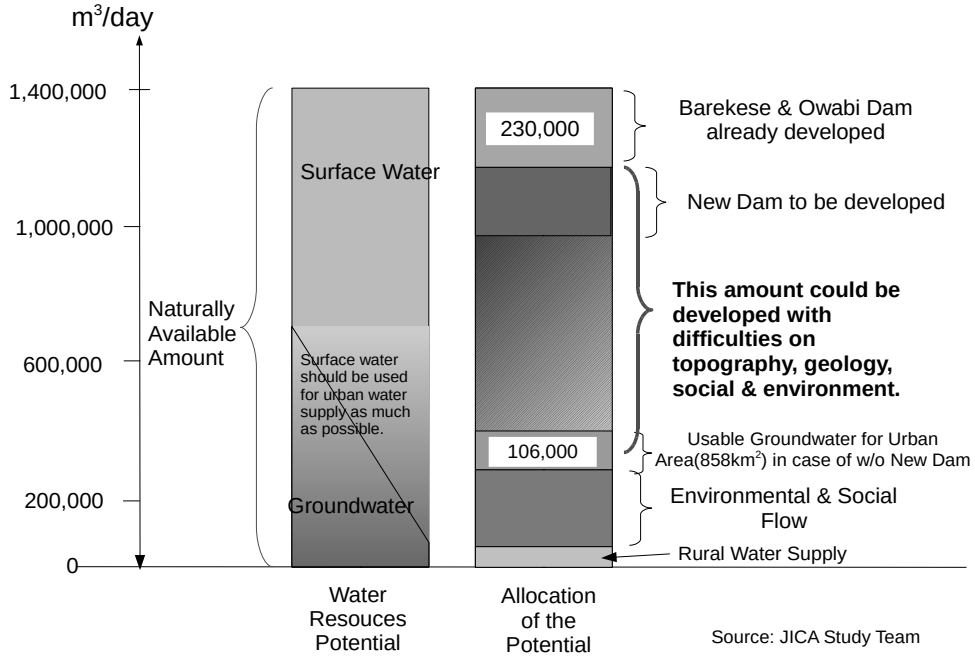


Figure 13.2.10 Allocation of Water Resources Potential for Dry Year (1,400,000m^3/day, Area=5,660km^2)

13.3 Strategies for Water Resources Development

The strategies for water resources development are as follows:

- Dredging of Barekese and Owabi Dam reservoirs
- Feasibility study on new water sources
- Consolidation of hydrological monitoring
- Enhancement of rural water supply
- Construction of dams

(1) Dredging of Barekese and Owabi Dam reservoirs

As described in the background, the designated hydrological area in and around Greater Kumasi Sub Region has water resources potential of 1,400,000 m^3/day in a dry year. The existing dams for water supply have the yield capacity of about 230,000 m^3 /day. In order to meet the future water demand, this dam capacity should be made use of fully.

(2) Feasibility Study on New Water Sources

As discussed in the Water Supply section, Greater Kumasi Sub Region would encounter water supply shortage due to the increase in water demand due to rapid population increase in the near future. If people in Kumasi use more water per capita per day than at the present, new water sources should be materialized as soon as possible.

(3) Consolidation of Hydrological Monitoring

The above mentioned water resources potential was estimated based on the limited hydrological data from Ghana Meteorological Agency, Hydrological Service Department, CWSA and GWCL. A more precise water budget should be studied, especially about groundwater usage and environmental flow.

(4) Enhancement of Rural Water Supply

Regarding water resources in rural areas, rural water supply coverage is lower than the coverage in the urban areas. The low water supply coverage level is in spite of efforts by the Government of Ghana (GoG) and its development parties to improve on the situation. The low coverage levels, therefore, puts pressure on consumers to find their own solution to cope with the poor water situation.

(5) Construction of Dams

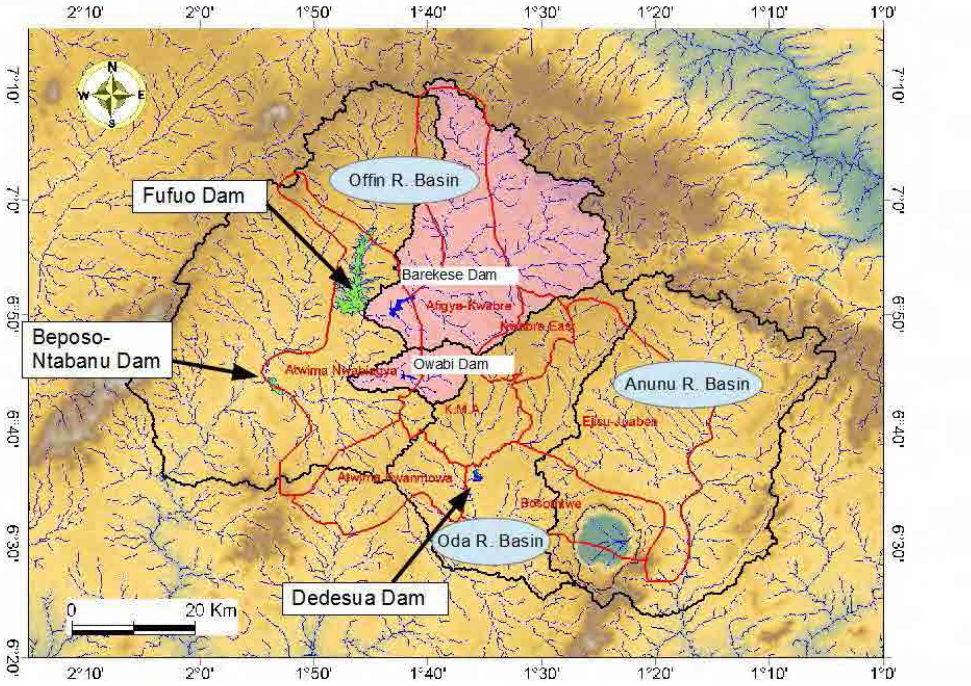
Here, Candidate Locations for New Dams for Surface Water Sources is introduced as the Structure Plan for Water Resources.

According to a Water Resources Study in Kumasi by GWCL (2009), the following 3 dams were studied preliminarily (Table 13.3.1). Their locations are indicated in Figure 13.3.1. In the study of GWCL, Fufuo Dam is not recommended because of the huge submerged area which could affect local communities. However, in order to assure an urban water supply with safe and good accessibility in Greater Kumasi Sub Region, new water sources (surface water) must be studied to consider all possible options.

Table 13.3.1 Basic Features of New Dams Considered by GWCL

Name of Dam	River Name	Dam Size	Reservoir Area	Storage Volume
Fufuo	Offin R.	H=8m	36.2 km^2	246.3*10^6 m^3
Beposo-Ntabanu	Offin R.	H=10m	3.3 km^2	30*10^6 m^3
Dedesua	Oda R.	H=12m	2.0 km^2	15*10^6 m^3

Source: GWCL, Water Resources Study Kumasi, 2009, pp.55-56



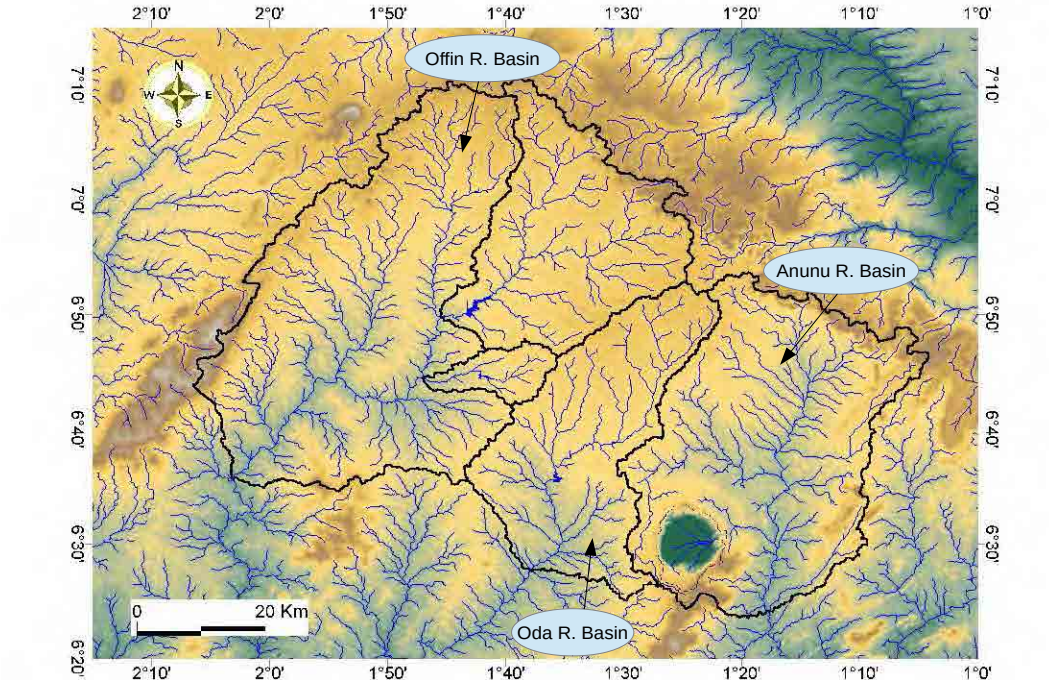
Source: JICA Study Team

Figure 13.3.1 Location of Candidate New Dam Sites

According to a communication with GWCL officers, at present the water source for Greater Kumasi relies on the western part of Greater Kumasi Sub Region such as the Barekese and Owabi Dams. GWCL prefers to develop new water sources in the eastern part of KMA as well as in the areas not as far from KMA if possible.

Regarding the topography of the western part of Greater Kumasi Sub Regions, the following topographic relief (Figure 13.3.2) should be looked at. There is Anunu river basin. However, it has flat and wide valleys along the main streams which are similar to the downstream part of the Offin river basin. In order to supply water with the increased demand in the future it is said that another dam similar to Barekese Dam scale is needed in terms of its yield. Assuming that the specific discharge ($m^3/s/km^2$) is 0.003 in Greater Kumasi Sub Regions, the necessary catchment area to produce 200,000 m^3 per day is 770 km^2.

Further detailed investigation (geology and topography, hydrology and social – environmental aspects) is immediately required in order to materialize new water sources for Greater Kumasi Sub Region.



Source: JICA Study Team

Figure 13.3.2 Topographic Relief for Candidate New Dam Sites

13.4 Water Resources Sector Plan and Programme

Based on the strategies proposed in the previous section, the Water Resources Sector Plan and Programme are composed of the following projects:

- Dredging of Barekese and Owabi Dam reservoirs
- Feasibility study on new water sources
- Consolidation of hydrological monitoring
- Enhancement of rural water supply
- Construction of dams

(1) Dredging of Barekese and Owabi Dam Reservoirs

Of the 2 dams, most of the yield is coming from Barekese Dam, so that the dredging for Barekese Dam should be prioritized.

The sedimentation volume in Barekese Reservoir is estimated at about 10,000,000 m^3 while the original water storage capacity was 33,750,000 m^3. The capital dredging of 10,000,000 m^3 would contribute to the increase of 20,000 m^3/ day as the dam yield capacity.

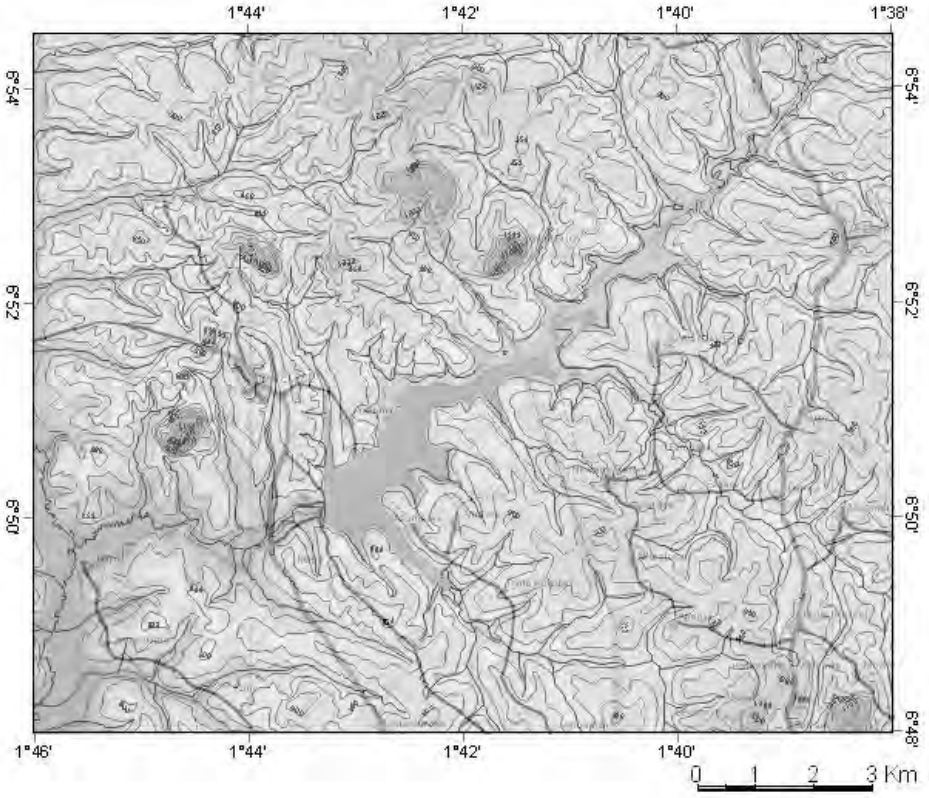
The outline of the Project is as follows.

a) Dredge Site (Sediment to be removed)

The dredge site is the reservoir of Barekese Dam and its major part is located in Afigya Kwabre District. The location and the topography surrounding the reservoir are shown in Figure 13.4.1.

The material to be dredged is basically fine sand and silt-clay which has been

deposited on the bottom of the reservoir. The water depth of the reservoir is less than 15 m because the dam height is 15m.



Source: JICA Study Team

Figure 13.4.1 Location of Barekese Reservoir

b) Dredger (Equipment to remove and lift the sediment)

Generally, reservoir dredging is done with conventional hydraulic dredges. Special situations that may require more specialized equipment (and warrant higher unit costs) include removing contaminated sediment, dredging gravel and larger sediment, and digging at depths exceeding about 15m.

Figure 13.4.2 introduces the general configuration of a hydraulic dredge for reservoirs. The hydraulic dredge with a rotating cutter-head at the end of the suction line is the most widely used type of dredge in reservoirs. Advantages of hydraulic dredges include low unit cost for sediment removal, high rates of production, and ability to work in a reservoir without interfering with normal impounding operations. A slurry pipeline is a clean and convenient method to transport sediment from the dredging site to the containment area. Hydraulic dredges are widely available and versatile, can pump long distances with the aid of booster pump stations, and can efficiently handle materials from fine sediment through coarse sand. The principal disadvantages of hydraulic dredging are the bulking of fine sediment and the requirement for sediment dewatering.

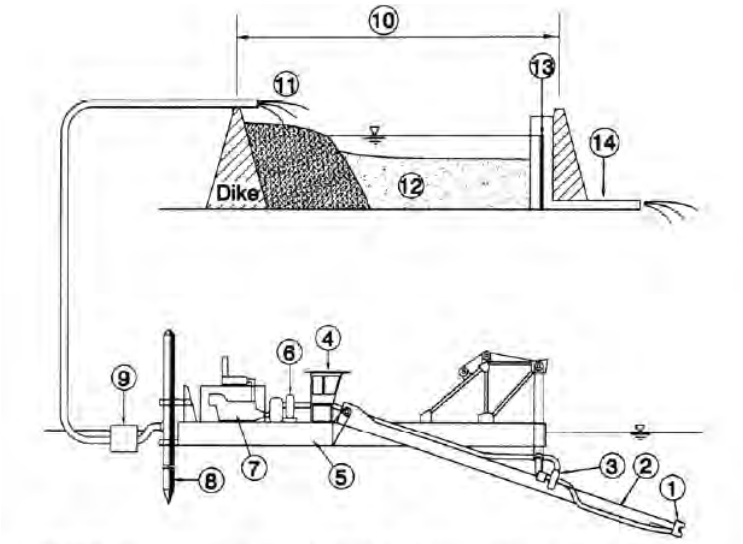


FIGURE 16.3 Schematic diagram of a hydraulic dredge and disposal area illustrating: (1) cutterhead, (2) ladder, (3) ladder pump, (4) controls, (5) hull, (6) main pump, (7) engine, (8) spud, (9) float and discharge pipeline, (10) disposal or containment area with perimeter dike, (11) inlet zone where coarse sediment tends to accumulate and mound, (12) fine sediment deposits, (13) adjustable effluent weir, (14) discharge of clarified effluent.

Source: Gregory L, Reservoir Sedimentation Handbook

Figure 13.4.2 General Image of Hydraulic Dredge

The dredge size required will depend on factors including the desired production rate, digging depth, and distance and elevation change between the dredge and the point of discharge. Figure 13.4.3 may be used to obtain a preliminary idea of the relationship between dredge size and production rate for a conventional cutter-head dredge without a ladder or booster pump.

Assuming that the length of the pipeline is 1 km and a production rate 300 m^3 / hour as an example, the required dredge is of 35 cm diameter.

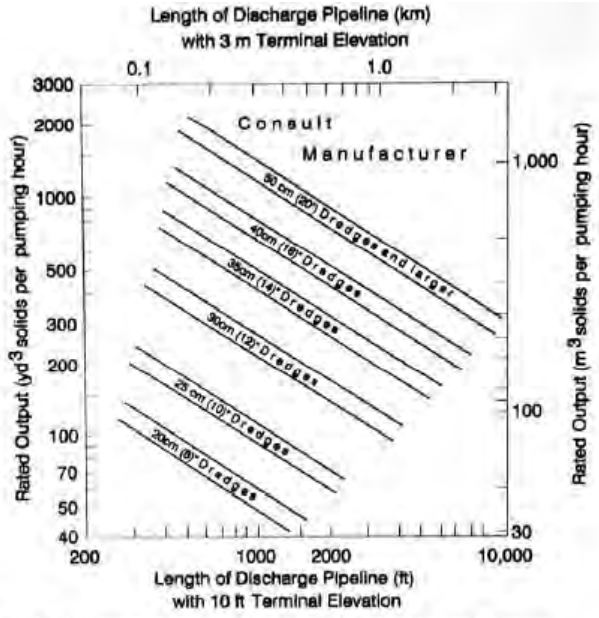


FIGURE 16.8 Approximate relationship between dredge size and production rate *(redrawn from Herbich, 1992)*.

Source: Gregory L, Reservoir Sedimentation Handbook

Figure 13.4.3 Approximate Relationship between Dredge Size and Production Rate

c) Pipeline for Hydraulic Dredging (Means to transport the dredged material)

The pipeline transports the sediment slurry from the dredging site to the point of discharge. The pipeline may be made of steel and supported on pontoons, or it may be made of sections of heat-welded high density polyethylene pipe. The pipeline needs floats in the reservoir.

d) Disposal Site of the Dredged Materials

There are two basic strategies for the disposal of dredged sediment: riverine disposal to the channel below the dam, or off-stream disposal into a diked upland containment area.

The riverine disposal to the downstream of the dam is not recommended because of adverse downstream effects.

For the off-stream disposal, hydraulically dredged sediment is pumped into an upland diked containment area where the sediments are allowed to settle, and the supernatant water is discharged into the environment, often back into the reservoir being dredged.

e) Implementation Period

Assuming a production rate of 300 m^3 / hour and 24 hours operation 6 days a week, the monthly production is 172,800 m^3 / month. By this rate, it takes 57 months to dredge 10M m^3. Since the Barekese reservoir is less than 15 m depth, it is assumed that operation in the rainy season is possible. Therefore the implementation period is set to be 6 years with 1 dredge.

f) Project Cost

According to the Master Plan for Kumasi Water Capacity Extension (2010), the unit cost per 1 m^3 of dredging is about 2 Euro. The capital dredging cost is estimated at about 36 million GHC.

The annual maintenance cost is about 3 million GHC as 10% of the capital cost.

g) Environmental Issues

It is necessary to study the dredging plan prior to commencing the actual dredging in Barekese and Owabi reservoirs. Special attention is to be paid to the confirmation of characteristics of the dredged material from the viewpoint of chemical and hazardous materials. If special or hazardous materials are anticipated in the dredged material, special treatment for those materials is necessary as an additional, not small cost.

(2) Feasibility Study on New Water Sources

A feasibility study on new water sources should be conducted in order to materialize new water sources in the future. The result of the study would contribute to the promotion of water supply planning.

The feasibility study should focus on the following items.

- Hydrological measurements (Surface water and groundwater)

- Clarification of water budget in and around Greater Kumasi Sub-Region
- Topographic and geological investigations for the candidate dam sites
- Basic design of dams and appurtenant works and water treatment plant
- Social and environmental impact study
- Project justification considering the dam cost and water treatment plant cost.

The cost for the Study is estimated as follows, based on the remuneration and man-months of engineers and necessary surveys.

Table 13.4.1 Example of Remuneration for Local Engineers

Item	Description	Unit	Unit Cost in Ghana
Senior Consultant	More than 10 years' experience	US$ / day	300 – 400 US$
Junior Consultant	More than 10 years' experience	US$ / day	150 US$
Field Supervisor		US$ / day	100 US$

Source: JICA Study Team

The necessary surveys are topographical & geological surveys around the candidate dam and reservoir sites and water treatment plant sites. The cost of these surveys is tentatively to be set at GHC 300,000.

In order to conduct a study to grasp the appropriate ground water usage, it is essential to first collect data of ground water usage.

- Inventory of existing boreholes
- Water level and water quality monitoring (monthly)
- Recording of abstracted water volume for each borehole

Also the electrical prospecting method shall be applied for the designated areas in order to study the possible aquifer.

- Hydrogeological survey to clarify aquifer conditions in designated area (electrical prospecting method)

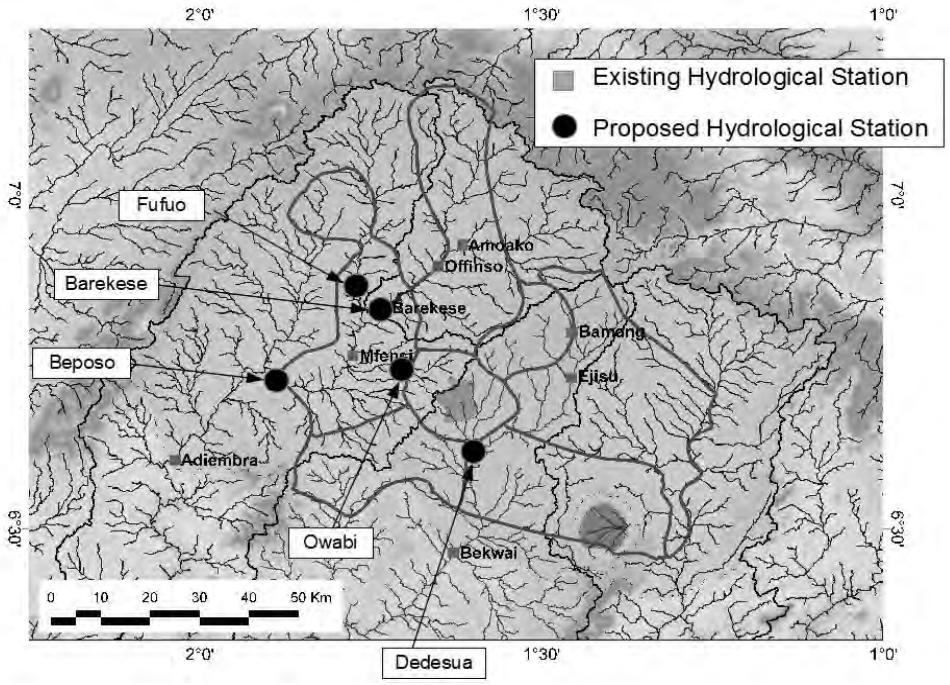
The total cost for the study is about 3,000,000 GHC.

(3) Consolidation of Hydrological Monitoring

In any event, the dam yield potential should be evaluated based on more hydrological data such as inflow and outflow through intake and spillway. The consolidation of the hydrological monitoring network is required at present. In the short term, while the urban water supply is expanded for KMA, the hydrological monitoring system should be developed and the dam capacity is to be re-evaluated based on the actually measured data in order to decide the future action.

The following locations are to be prioritized for daily discharge measurement. They should be owned and operated by the Hydrological Service Department (HSD).

- Barekese Dam outflow
- Owabi Dam outflow
- Dedesua
- Beposo-Ntabanu
- Fufuo



Source: JICA Study Team

Figure 13.4.4 Location of Proposed Hydrological Stations

Table 13.4.2 General Specifications of Hydrological Stations

Station	Description	Unit cost	Qty.	Total Cost
Barekese, Owabi Dam outflow	Ultra sonic water level sensor with data logger and staff gauge	US$ 10,000.	2	US$20,000
Fufuo, Beposo, Dedesua	Staff gauge	US$ 1,000	3	US$3,000

Source: JICA Study Team

(4) Enhancement of Rural Water Supply

Responding to the population increase in rural areas, Informal Service Providers (ISPs) are playing a very important role in water supply delivery in the communities. Their supply system such as Hand dug wells with hand pumps, mechanized hand dug wells, and mechanized boreholes should be implemented continuously in collaboration with CWSA.

The target of rural water supply is set as follows,

- One (1) borehole for every 300 persons in communities up to 2,000 persons
- Provision of a mechanized borehole (submersible pump, a reservoir and one or several standpipes) for 2,000 to 5,000 persons
- Provision of a mechanized borehole including house connections for over 5,000 persons

The cost of the borehole with hand pump and borehole with mechanized pump is as shown in Table 13.4.3.

Table 13.4.3 General Cost for Rural Water Supply Scheme

Scheme	Report from CWSA official	Other
Borehole with Hand Pump	2,500-3,500 GHC each	
Borehole with mechanized pump	7,000-10,000 GHC each	

Source: JICA Study Team

Generally, rural water supply in Ghana has been implemented with consideration of the community size. According to the 2000 census, the number of communities and population by community size are as follows.

Table 13.4.4 Number of Communities and Population by Size in 2000

Number of Community by size

Pop. Size	Afigya Kwabre	Atwima Nwabiagya	Bosomtwe	Kwabre East	Ejisu-Juaben	KMA	Atwima Kwanwoma	Total	
0-100	13	35	3	1	170	0	2	224	32%
100-500	25	25	20	5	28	7	11	121	17%
500-1000	10	18	15	7	16	7	12	85	12%
1000-2000	15	10	19	8	18	9	15	94	13%
2000-3000	6	10	5	4	7	14	5	51	7%
3000-4000	4	3	1	5	3	12	6	34	5%
4000-5000	3	4	1	1	4	8	0	21	3%
5000-	1	5	1	5	4	62	1	79	11%
Total	77	110	65	36	250	119	52	709	100%

Popoulation (2000) by community size

Pop. Size	Afigya Kwabre	Atwima Nwabiagya	Bosomtwe	Kwabre East	Ejisu-Juaben	KMA	Atwima Kwanwoma	Total	
0-100	642	1,108	78	57	2,600	0	99	4,584	0.3%
100-500	7,516	5,981	5,686	944	7,044	2,639	3,195	33,005	1.9%
500-1000	7,456	13,474	10,779	5,096	11,624	5,523	8,807	62,759	3.6%
1000-2000	19,499	14,100	24,868	12,010	25,737	13,001	20,574	129,789	7.4%
2000-3000	13,417	23,049	10,820	10,301	17,554	35,286	11,787	122,214	7.0%
3000-4000	13,633	11,253	3,024	17,816	9,751	40,145	19,954	115,576	6.6%
4000-5000	13,178	17,249	4,871	4,851	16,963	34,998	0	92,110	5.3%
5000-	14,017	41,595	7,368	50,025	32,903	1,038,678	5,023	1,189,609	68.0%
Total	89,358	127,809	67,494	101,100	124,176	1,170,270	69,439	1,749,646	100.0%

Source: JICA Study Team

According to this census, the percentage of small communities (population less than 2000 persons) is 74%, however, the total population in the small communities is only 13 % (230,000 persons).

In order to get a preliminary cost estimation for the future rural water supply, the following assumptions were made in this report.

- Population to be served by rural water supply in 2033: 325,000 persons
- Community size is less than 2,000 persons
- The number of communities by size in 2033 is the same as 2000.
- The population by community size in 2033 follows the same ratios as in 2000.

Regarding the above assumptions, it should be certain that all communities whose population is larger than 2000 shall be supplied by GWCL with pipe-borne water or a borehole system. The figure below should be revised when the detailed population frame is set.

The total cost for rural water supply is GHC 4 million.

Table 13.4.5 Cost Estimation for Rural Water Supply in 2033

Pop. Size	2000 Census		2033		Population subjective to rural water supply	Necessary Scheme		Cost
	Number	Population	Number	Population		BH+HDW	BH+P	
		(A)		(B)	(A)*0.2+(B-A)	(3,000GHC)	(8,500GHC)	GHC
0-100	224	4,584	224	6,474	2,806	45		135,000
100-500	121	33,005	121	46,610	20,206		67	569,500
500-1000	85	62,759	85	88,628	38,421		128	1,088,000
1000-2000	94	129,789	94	183,288	79,457		264	2,244,000
Total	524	230,137	524	325,000	140,890			4,036,500

Source: JICA Study Team

(5) Construction of Dams

Since the Feasibility Study for the new dams and reservoirs has not been conducted yet, it is not possible to describe the project for dam construction. Here are some assumptions based on the currently available information, the probable dam construction is outlined. However all things below should be studied in the F/S.

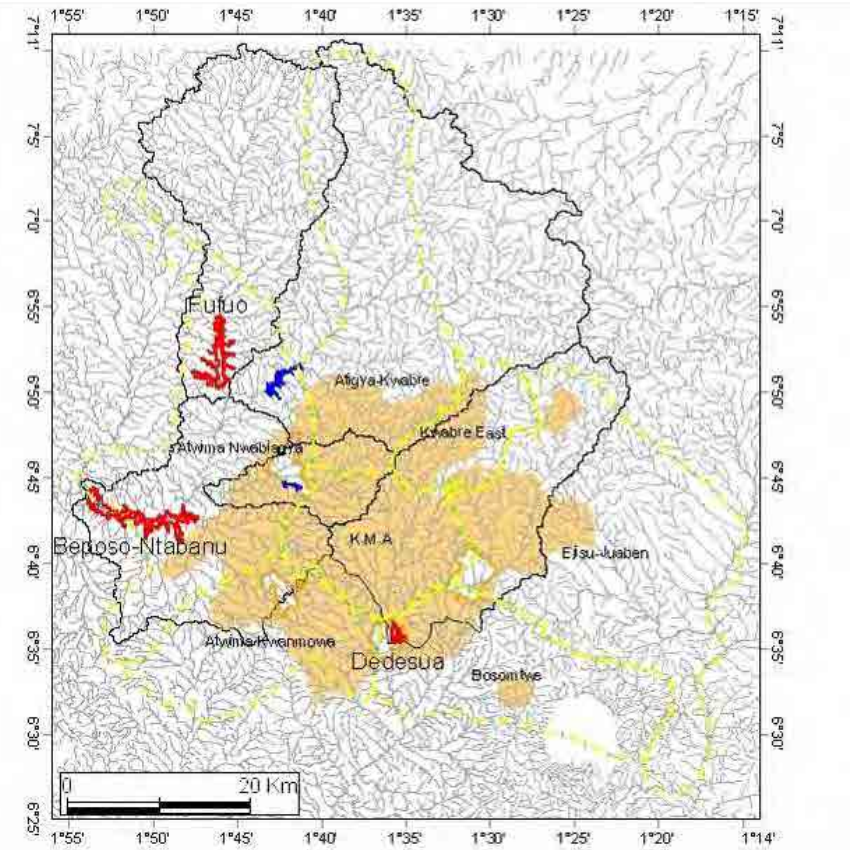
As shown in Table 13.4.6, there are at least 3 feasible dam sites. The assumptions are as follows,

- Topography is examined by using SRTM3.
- Expected yield: 200,000 m^3 / day
- Inflow hydrograph is converted from Figure 13.2.8 by ratio of catchment area to Barekese dam basin. The ratio refers to Table 13.4.6.
- The catchment area of Beposo-Ntabanu does not include those of Barekese and Owabi assuming all the runoff is already consumed.
- The reservoir storage volume is decided in order to assure no more than 2 months intake water control in 55 years.

Table 13.4.6 Catchment Areas of Candidate New Dams

Name of Dam	Catchment Area at Dam Site	Ratio of Catchment Area to Barekese Dam Basin(941 km^2)
Fufuo	497 km^2	0.53
Beposo-Ntabanu	920 km^2	0.98
Dedesua	530 km^2	0.56

Source: JICA Study Team



Source: JICA Study Team

Figure 13.4.5 Delineation of Basin Boundaries for Proposed Dam Locations

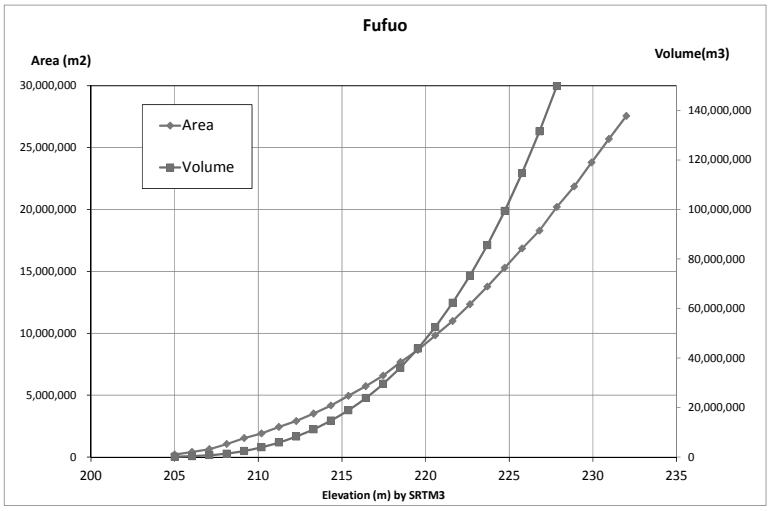
Based on the above assumptions, the necessary storage volume of each dam site is estimated preliminarily as shown in Table 13.4.7. Since Fufuo and Dedesua dam sites have smaller catchment areas (around 500 km^2) than that of Barekese Dam, their necessary storage volumes have to be very large. Dedesua dam site seems to be unable to store the necessary storage volume. Beposo-Ntabanu site is better in terms of reservoir area size, while future urbanized areas are expected to occupy larger part of the catchment of Beposo-Ntabanu reservoir.

It is recommended to examine the feasibility of the proposed 3 dam sites at a detailed level by considering the revised future socio-economic framework proposed by the SDF/SP for the Greater Kumasi.

The figures of dam parameters (storage volumes, dam heights and reservoir areas) shown in Table 13.4.7 were estimated by using SRTM3 (digital elevation data), while the GWCL study was using more rough contour line data. This is the reason why they (dam parameters) are different from those in the Water Resources Study Kumasi (2009) by GWCL.

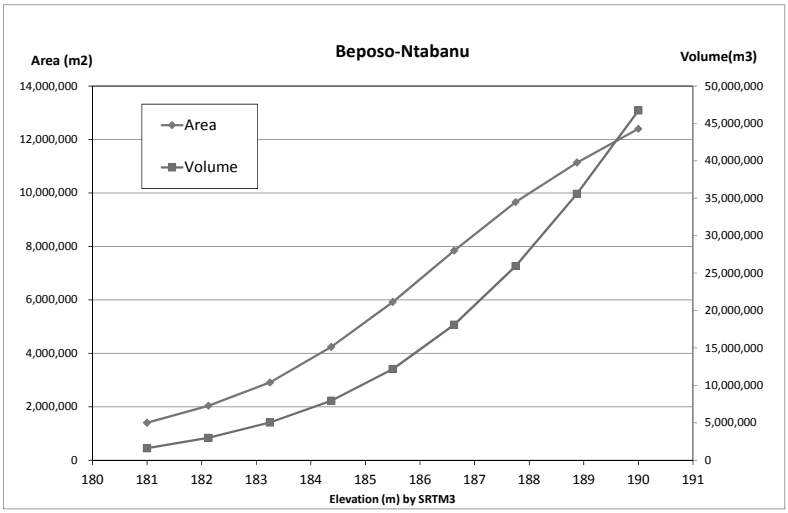
Table 13.4.7 Necessary Storage Volume to Assure no more than 2 Months intake Water Control in 55 Years (200,000 m^3 /day intake)

Name of Dam	Necessary storage volume	Corresponding Dam Height	Corresponding Reservoir Area
Fufuo	94,000,000 m^3	19 m	14 km^2
Beposo-Ntabanu	25,000,000 m^3	7 m	9.5 km^2
Dedesua	90,000,000 m^3	Topographically not possible to store the required volume.	



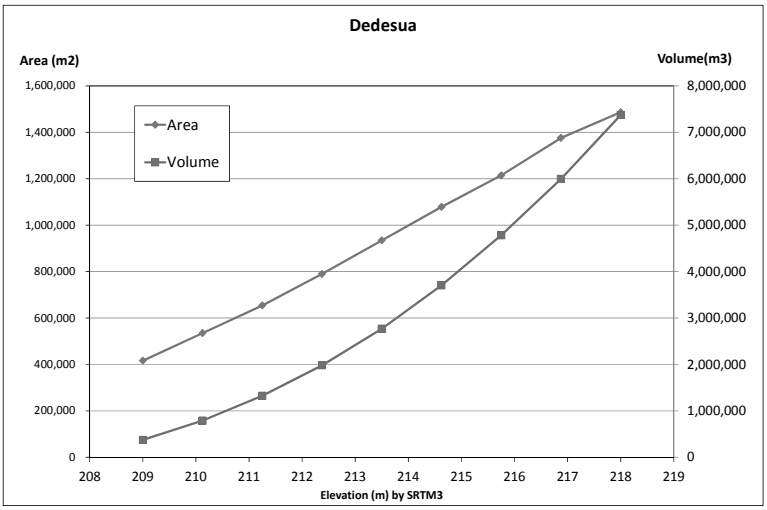
Source: JICA Study Team

Figure 13.4.6 Elevation-Area-Volume Curves of Fufuo Dam Site



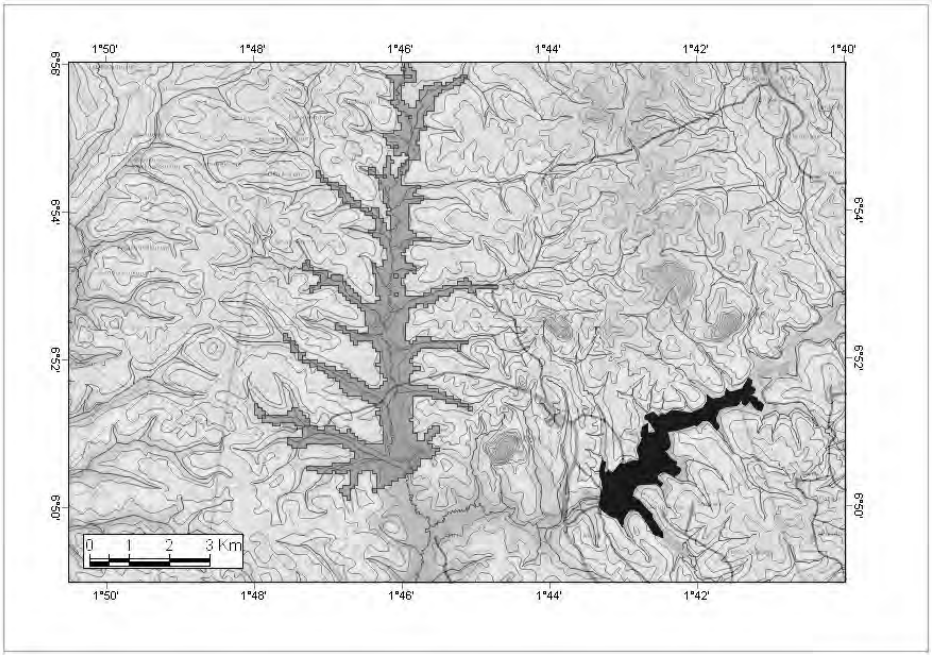
Source: JICA Study Team

Figure 13.4.7 Elevation-Area-Volume Curves of Beposo-Ntabanu Dam Site



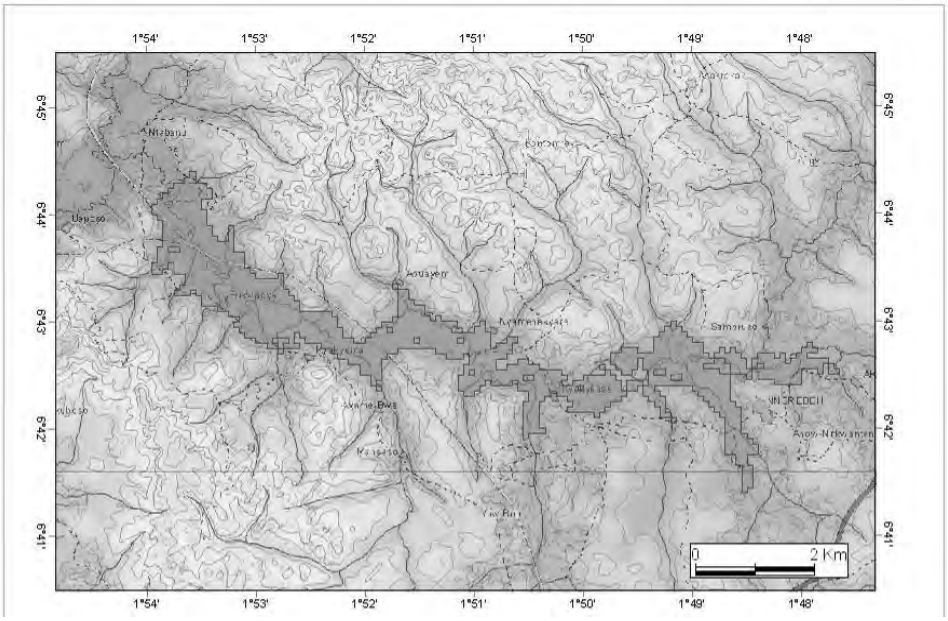
Source: JICA Study Team

Figure 13.4.8 Elevation-Area-Volume Curves of Dedesua Dam Site



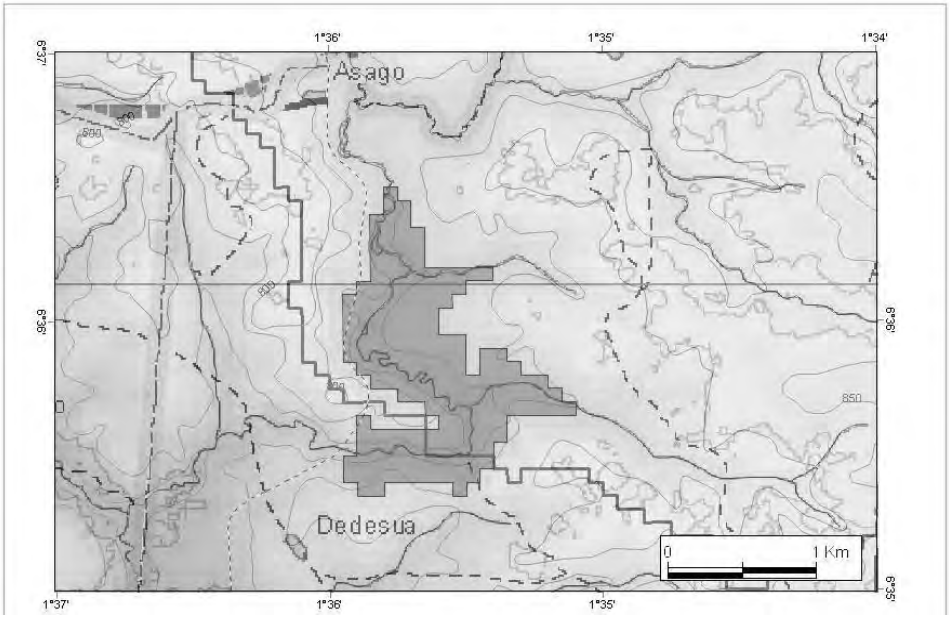
Source: JICA Study Team

Figure 13.4.9 Reservoir Area of Fufuo Dam (H=224m, SRTM3)



Source: JICA Study Team

Figure 13.4.10 Reservoir Area of Beposo-Ntabanu Dam (H=188m, SRTM3)



Source: JICA Study Team

Figure 13.4.11 Reservoir Area of Dedesua Dam (H=218m, SRTM3)

The project cost for new dams is to be decided by the feasibility study in the future. Therefore, it is not possible to show the construction cost at this moment.

As a reference, according to the Master Plan for Kumasi Water Capacity Extension (2010), the cost for a new dam (assuming Dedesua dam) is 108 million GHC as capital expenditure and 2.7 million GHC as operating expense.

Since the dam scales of Dedesua in the GWCL study and Beposo-Ntabanu in this estimation are similar, the cost for a new dam is set at 108 million GHC as capital expenditure and 2.7 million GHC as operating expense for further discussion.

13.5 Costs of Water Resources Sector Programme

The preliminary cost estimation and implementation schedule for the Water Resources Sector are summarized as follows.

Table 13.5.1 Cost and Implementation Schedule

Unit: million GHC

No.	Project/Programme		Short Term						Mid Term										Long Term					Total
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
1)	Dredging of Barakese and Owabi Dam Reservoirs	CAPEX		6	6	6	6	6	6															36
		OPEX		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	60
2)	Feasibility Study on New Water Source	CAPEX		1.5	1.5																			3
		OPEX																						0
3)	Consolidation of Hydrological Monitoring	CAPEX	0.1					0.1					0.1					0.1					0.1	0.25
		OPEX																						0
4)	Enhancement of Rural Water Supply	CAPEX	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		4
		OPEX																						0
5)	Constrcution of Dam for Water Supply	CAPEX													36	36	36							108
		OPEX																2.7	2.7	2.7	2.7	2.7	2.7	16.2
	Total		0	11	11	9	9	9	9	3	3	3	3	3	39	39	39	6	6	6	6	6	6	227

Source: JICA Study Team

13.6 Preliminary Economic and Financial Analysis of Water Resources Development and Water Supply Sectors Programme

13.6.1 Economic Analysis

(1) Methodology

With the implementation of the sector programme, significant benefits, both direct and indirect, could be attained. Direct benefits are the delivery of water in greater quantity on a more reliable basis, better water quality, and improved health and environmental conditions. On the other hand, indirect benefits are increased productivity of the residents in the service area, and employment and livelihood opportunities for the residents of the service area as well.

In order to estimate the figure for economic benefit, the following steps are carried out;

Step 1: Identification of "with" and "without" cases,

Step 2: Assumption of parameters for direct benefits such as affordability to pay and time cost savings,

Step 3: Estimation of economic costs based on the estimated capital investment cost mentioned in the previous section,

Step 4: Assuming the indirect effects, and

Step 5: Economic evaluation using economic benefits and economic costs.

(2) "With" and "Without" cases

The programme inputs and outputs should be identified, quantified and valued by comparing the "Without Case" with that of the "With Case" to derive the economic benefit.

1) "With Case"

The water supply facilities will be constructed to be an investment. The identification and quantification of the relevant costs and benefits will be estimated in this study. The evaluation period of the Sector Programme is assumed to be 30 years taking into account the service life of the water supply sector programme.

2) "Without" Case

The "Without " case is that the current water service coverage ratio, such as ratio of house connections, communal boreholes for domestic use and privately constructed boreholes for nondomestic use, will continue to be used without expansion or improvement in the future.

(3) Assumptions

1) Benefit

Affordability to pay and Willingness to pay

One method for benefit estimation is to derive the affordability to pay. In accordance with the "Project appraisal manual" issued by IBRD, the ratio of water consumption cost (domestic water) in household budgets is 3% so that the monthly affordability to pay for this sector in households is GHC 13.6/month. This figure is derived based on the expected level of per capita water use, 130 litre/day, in accordance with the "Strategic Investment Programme (SIP)". However, the current realistic supply volume is only 60 litre/capita/day, therefore, the assumption of affordability to pay is GHC 6.3/month for the benefit calculation.

On the other hand, industrial or commercial businesses (non-domestic water) consume a huge amount of water. The ratio of consumption for industrial and commercial consumption is 35.5% of total water demand in accordance with JICA Study Team survey. In order to obtain a reliable supply of water, companies and factories are willing to pay "Willingness to pay" 1.75 times larger than the current water charge in accordance with a willingness survey result.

Time Cost Savings

Time saved by new customers in collecting water is also assumed. In the without case, time spent in collecting water from the nearest source of water supply (e.g., wells, tank, river, stand posts on the road) may be considerable. An important benefit from piped water supply and provision of public taps is that it brings the source of water very near to the households. The value of time saved is calculated on the basis of daily minimum wage rate in Ghana (GHC 4.48) which is referred to in the "Handbook for the Economic Analysis of Water Supply Projects", issued by the Asian Development Bank. The JICA Study Team assumed that time savings that could be devoted to economic activities should be valued at 50 % of this minimum wage rate.

2) Water Consumption Volume

The estimated consumption volumes for the "With" and "Without" cases are shown in Table 13.6.1 and 13.6.2.

Table 13.6.1 Estimated Consumption Volume "With" Case

Consumption Group	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Domestic Consumers	45,900	81,000	110,700	201,100	269,100
Non-Domestic Consumers	25,300	44,600	60,900	110,700	148,100
Total (m^3/day)	71,200	125,600	171,600	311,800	417,200
Population that uses Ground Water from Boreholes	836,000	627,000	736,000	769,000	910,000

Source: JICA Study Team

Table 13.6.2 Estimated Consumption Volume "Without" Case

Consumption Group	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Domestic Consumers	45,900	45,900	45,900	45,900	45,900
Non-Domestic Consumers	25,300	25,300	25,300	25,300	25,300
Total (m^3/day)	71,200	71,200	71,200	71,200	71,200
Population that uses Ground Water from Boreholes	1,210,000	1,408,000	1,651,000	1,909,000	2,224,000

Source: JICA Study Team

(4) Estimation of Economic Cost

The capital investment cost of the programme is estimated at GHC 1,125 million. In this study the economic cost was estimated by deducting the government taxes and import duty from the financial cost. A conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 956 million as shown in Table 14.5.3.

Operational cost and maintenance cost were also estimated based on the "Master Plan for Kumasi Water Capacity Extension" of December, 2010. Operational cost was GHC 0.66/m^3. Maintenance costs for dredging is about 10% per annum maintenance costs for the dam structure is 2.5% of capital investment cost per annum.

Table13.6.3 Economic Cost of Investment (GHC Thousand)

Project	Financial Cost	Conversion Factor	Economic Cost
Water Resources			
Dredging of Barekese and Owabi Dam Reservoirs	36,000	0.85	30,600
Feasibility Study on New Water Sources	3,000	0.85	2,550
Consolidation of Hydrological Monitoring	500	0.85	425
Enhancement of Rural Water Supply	4,000	0.85	3,400
Construction of Dam for Water	108,000	0.85	91,800
Water Resources Total	151,500		128,775
Water Supply			
Programme 1: Effective Utilization of Existing Facilities	135,000	0.85	114,750
Programme 2: Development of Boreholes with Elevated Tank and Pipe System	147,200	0.85	125,120
Programme 3: Increase of Revenue for Building Foundation for Sound Management	36,400	0.85	30,940
Programme 4: Stable Supply of Clean Water for Greater Kumasi Sub-Region	655,000	0.85	556,750
Water Supply Total	973,600		827,560
Total	1,125,100		956,335

Source: JICA Study Team

(5) Result of Economic Analysis

The estimated flow projection based on the above assumptions is presented in Table 13.6.4.

The whole Sector Programme will have an EIRR of 28.23%. The proposed Sector Programmes are economically viable. The NPV of all the Sector Programmes is GHC 295 million using 12% discount rate.

Table 13.6.4 Economic Flow of Water ResourceSector Programme

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	8,840	8,840	0	-8,840	8,840	0	-8,840
2014	29,561	22,637	29,920	52,557	29,561	-22,996	46,926	26,394	-20,532
2015	40,088	25,298	29,920	55,218	40,088	-15,131	44,020	31,958	-12,062
2016	46,135	27,960	28,645	56,605	46,135	-10,470	40,290	32,838	-7,452
2017	52,182	30,622	28,645	59,267	52,182	-7,085	37,665	33,163	-4,502
2018	58,229	33,283	28,730	62,013	58,229	-3,784	35,188	33,041	-2,147
2019	81,298	35,533	17,935	53,468	81,298	27,830	27,089	41,188	14,100
2020	89,508	37,783	12,835	50,618	89,508	38,890	22,897	40,489	17,592
2021	97,717	40,033	12,835	52,868	97,717	44,850	21,352	39,466	18,114
2022	105,926	42,282	12,835	55,117	105,926	50,809	19,876	38,198	18,322
2023	114,136	44,532	12,835	57,367	114,136	56,769	18,471	36,749	18,278
2024	122,649	51,394	70,380	121,774	122,649	875	35,007	35,259	251
2025	147,090	58,256	100,980	159,236	147,090	-12,146	40,872	37,754	-3,117
2026	171,531	65,117	100,980	166,097	171,531	5,434	38,065	39,311	1,245
2027	195,973	71,979	100,980	172,959	195,973	23,013	35,391	40,100	4,709
2028	220,414	81,136	70,465	151,601	220,414	68,813	27,697	40,269	12,572
2029	244,680	86,293	57,715	144,008	244,680	100,672	23,491	39,913	16,422
2030	263,060	91,450	57,715	149,165	263,060	113,895	21,725	38,313	16,588
2031	281,439	96,607	57,715	154,322	281,439	127,118	20,068	36,598	16,530
2032	299,819	101,764	57,715	159,479	299,819	140,340	18,517	34,811	16,294
2033	318,199	106,921	57,715	164,636	318,199	153,563	17,067	32,987	15,919
2034	336,578	112,078	0	112,078	336,578	224,500	10,374	31,154	20,780
2035	354,958	117,235	0	117,235	354,958	237,723	9,689	29,335	19,646
2036	373,338	122,392	0	122,392	373,338	250,946	9,031	27,548	18,517
2037	391,717	127,549	0	127,549	391,717	264,168	8,403	25,807	17,404
2038	410,097	132,706	0	132,706	410,097	277,391	7,806	24,123	16,317
2039	428,477	137,863	0	137,863	428,477	290,614	7,241	22,504	15,263
2040	446,856	143,020	0	143,020	446,856	303,836	6,707	20,955	14,248
2041	465,236	148,177	0	148,177	465,236	317,059	6,204	19,479	13,275
2042	483,615	153,334	0	153,334	483,615	330,281	5,732	18,079	12,347
2043	533,056	158,491	-216,183	-57,692	533,056	590,749	-1,926	17,792	19,718
	7,203,563	2,503,724	740,152	3,243,876	7,203,563	3,959,687	669,774	965,573	295,799

B / C	1.4416
EIRR %	28.23
NPV (GHc)	295,799

(6) Indirect Benefits

1) Industrial Development

It is expected that manufacturing and commercial establishments will increase production activities. At present they are using their own supply systems, boreholes, in each manufacturing site. If a stable and sufficient supply of water is available, manufacturing and commercial activities will increase and influence the Ghana economy.

2) Pleasant Livelihood Environment

People's welfare will be improved. A reliable water supply system will be required due to the increasing demand, which is the nature of people.

3) Reduction of Water Borne Disease

Reduction of water borne disease, part of the social impact, is assumed to be a qualitative benefit. Based on a census survey, people of the study area are afflicted with waterborne disease at such a high rate that more than 50% of household spending on medical expenses goes to treat such diseases according to disease the report of Health Facilities in Kumasi for 2005 to 2010. After clean water is obtainable that rate of figure will improve.

13.6.2 Financial Analysis

The Sector Programmes for the water supply sector shall involve a large amount of capital investment for the operation body. A financial analysis has therefore been undertaken to determine the financial viability of the proposed programme. The following form some of the assumptions:

- An identified possible source of funding is not considered
- The current tariff structure and level has been analysed
- Non-revenue water (NRW) can be reduced from 35% to 10%
- A detailed financial projection and analysis was conducted to examine the financial viability of the proposed programme; and the Financial Internal Rate of Return (FIRR) was calculated.

(1) Financial Costs

Financial costs of the programme are summarized in Table 13.6.5. Operational cost and maintenance cost were also estimated based on the calculation of the economic cost in the above section.

Table 13.6.5 Financial Costs of Water Resource Secotor Programme

(GHC Thousand)

Description	Cost	Remarks
Capital Investment Cost	1,125,100	See Table 14.5.3
Operation Cost	2,812,358	
Maintenance Cost	133,200	

Source: JICA Study Team

(2) Financial Benefit

The revenue from the increase sales of water derived from the Sector Programme is calculated as the financial benefit. The average tariff level of GHC 0.85/m3 for households and GHC1.81/m3 for non-domestic use is applied, which are the same as those given in the "Publication of Water Tariffs" of 2012 issued by Ghana Water Co., Ltd. The water sales volume is computed (see Table 13.6.6) based on the demand capacity as presented in the Sector Programmes.

Table 13.6.6 Water Demand Volume

(m^3/day)

	2013	2018	2023	2028	2033
Domestic Water Demand	45,900	81,000	110,700	201,100	269,100
Non-domestic Consumption	25,300	44,600	60,900	110,700	148,100
Total Water Demand	71,200	125,600	171,600	311,800	417,200

Source: JICA Study Team

(3) Result of Financial Analysis

The cash flow projection based on the above assumptions is presented in Table 13.6.7. Revenue from households was assumed in accordance with total demand for piped water. The computed Financial Internal Rate of Return (FIRR) for the programme is 3.87%. This value for the Sector Programme is not very high. However, the assumption regarding the revenue and expenses of O & M contain a great deal of uncertain data therefore, the JICA Study Team indicated that the figure is only preliminary.

Table13.6.7 Financial Flow of Water Resource Sector Programme

Unit: GHc 1,000

Year	Revenue	COST		COST TOTAL C	Revenue TOTAL B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	10,400	10,400	0	-10,400	10,400	0	-10,400
2014	35,806	26,632	35,200	61,832	35,806	-26,026	55,207	31,969	-23,238
2015	40,550	29,763	35,200	64,963	40,550	-24,413	51,788	32,326	-19,462
2016	45,294	32,894	33,700	66,594	45,294	-21,300	47,400	32,240	-15,161
2017	50,038	36,025	33,700	69,725	50,038	-19,687	44,312	31,800	-12,511
2018	54,783	39,157	33,800	72,957	54,783	-18,174	41,398	31,085	-10,312
2019	58,793	41,803	21,100	62,903	58,793	-4,110	31,869	29,786	-2,082
2020	62,803	44,450	15,100	59,550	62,803	3,253	26,938	28,409	1,472
2021	66,814	47,097	15,100	62,197	66,814	4,617	25,120	26,985	1,865
2022	70,824	49,744	15,100	64,844	70,824	5,980	23,383	25,540	2,157
2023	74,834	52,391	15,200	67,591	74,834	7,244	21,762	24,095	2,332
2024	87,066	60,463	82,800	143,263	87,066	-56,198	41,185	25,029	-16,155
2025	99,297	68,536	118,800	187,336	99,297	-88,039	48,084	25,487	-22,597
2026	111,528	76,609	118,800	195,409	111,528	-83,880	44,783	25,559	-19,223
2027	123,760	84,681	118,800	203,481	123,760	-79,722	41,636	25,324	-16,313
2028	135,991	95,454	82,900	178,354	135,991	-42,363	32,585	24,845	-7,740
2029	145,183	101,521	67,900	169,421	145,183	-24,238	27,636	23,683	-3,954
2030	154,376	107,588	67,900	175,488	154,376	-21,112	25,559	22,484	-3,075
2031	163,568	113,655	67,900	181,555	163,568	-17,987	23,609	21,270	-2,339
2032	172,761	119,722	67,900	187,622	172,761	-14,861	21,784	20,059	-1,725
2033	181,954	125,789	67,800	193,589	181,954	-11,636	20,069	18,863	-1,206
2034	191,146	131,856		131,856	191,146	59,290	12,205	17,692	5,488
2035	200,339	137,923		137,923	200,339	62,415	11,398	16,556	5,158
2036	209,531	143,991		143,991	209,531	65,541	10,625	15,461	4,836
2037	218,724	150,058		150,058	218,724	68,666	9,886	14,410	4,524
2038	227,916	156,125		156,125	227,916	71,791	9,184	13,407	4,223
2039	237,109	162,192		162,192	237,109	74,917	8,518	12,453	3,935
2040	246,301	168,259		168,259	246,301	78,042	7,890	11,550	3,660
2041	255,494	174,326		174,326	255,494	81,168	7,299	10,697	3,398
2042	264,686	180,393		180,393	264,686	84,293	6,744	9,895	3,151
2043	273,879	186,460	-254,333	-67,873	273,879	341,752	-2,265	9,142	11,407
	4,261,148	2,945,558	870,767	3,816,324	4,261,148	444,824	787,991	658,102	-129,889

B / C	0.8352
FIRR %	3.87
NPV (GHc)	-129,889

13.7 IEE of Water Resources Sector Programme

This Section of the chapter discusses the Initial Environmental Examination (IEE) for this Sector programme at the early level of planning regarding impacts caused by the implementation of the sector programme. Such assessment is drawn based on the results of the analysis of the existing conditions and on the initial screening process undertaken by the Project Team using the Environmental Impact Matrix. The detailed analyses of environmental impacts such as an Environmental Impact Assessment (EIA) will be conducted at the feasibility study phase. The conduct of an IEE study under the sector programme is done in the following manner:

(1) Targets of the IEE Study

This Sector Programme consists of five components. The targets of the IEE study are shown in Table 13.7.1.

Table 13.7.1 Targets of IEE Study for Water Resource Secotor

☐ Dredging of Barekese and Owabi Dam Reservoirs
☐ Feasibility Study on New Water Sources
☐ Consolidation of Hydrological Monitoring
☐ Enhancement of Rural Water Supply
☐ Construction of Dams

(2) Phasing of the IEE Study

To study the IEE, programme components are divided into three phases, namely the Pre-Construction Phase, Construction Phase, and Operation and Maintenance Phase. The activities of each phase are as follow:

- **Pre-construction Phas**e: which includes land acquisition, resettlement, mobilization of heavy equipment, transport of construction materials, construction of office buildings and labour camps, etc.
- **Construction Phase**: consisting of the setting up of equipment, demolition of the existing structures, implementation of construction works, generation of construction waste etc.
- **Operation and Maintenance Phase**: which includes the operation and maintenance of facilities, maintenance works, etc.

(3) Result of the IEE Study

In Ghana, there are 4 pillars in an environmental impact study as follows:

- Institutions
- Natural resources
- Socio-culture
- Economy

The environmental impacts on the above parameters are identified at the Pre-construction Phase, Construction Phase and Operation and Maintenance Phase using an Environmental Impact Matrix. The Environmental Impact Matrix shows the identified positive and negative environmental impacts caused by implementation of the programme. The Environmental Impact Matrix of the water resources sector is shown in Table 13.7.2.

Table 13.7.2 Environmental Impact Matrix for the IEE Study of Water Resource Sector

Environmental Parameters		Institution		Natural Resources															Socio-Culture													Economy	
Components	Phases	Existing policy	Legal basis	Topography/Geology	Soil	Ground subsidence	Air quality	Hydrology	Water quality	Groundwater	Noise/Vibration	Offensive odor	Terrestrial flora and fauna	Aquatic flora and fauna	Biodiversity	Terrestrial ecosystem	Aquatic ecosystem	Natural disaster	Climate change factors	Population	Land use	Water use	Landscape	Human health	Involuntary resettlement	Cultural heritage	Material assets	Transportation	Power supply	Water supply	Solid waste	Other infrastructure	Local economy
WR Sub-Programme 1: Dredging of Barekese and Owabi Dam Reservoirs	Pre-construction																															
	Construction						-1	-2	-3		-1			-2	-2		-2				-1									-1	-3		
	Operation & Maintenance								+2					-1			-1				+3			+2						+3			+2
WR Sub-Programme 2: Feasibility Study on New Water Sources	Pre-construction		+1																													
	Construction																															
	Operation & Maintenance																															
WR Sub-Programme 3: Consolidation of Hydrological Monitoring	Pre-construction		+1																													
	Construction																															
	Operation & Maintenance																															
WR Sub-Programme 4: Enhancement of Rural Water Supply	Pre-construction																															
	Construction				-1	-1		-1	-1	-1																				-1		+1
	Operation & Maintenance																			+1		+2		+2						+2			+2
WR Sub-Programme 5: Construction of Dams	Pre-construction																				-1				-3								
	Construction			-2	-2		-1	-1	-1	-1	-1		-2	-2	-2	-2	-2					-1	-1					-1			-3	-2	
	Operation & Maintenance																			+1		+3		+3						+3			+2

+1: Negligible Positive Impact
+2: Moderately Positive Impact
+3: Significant Positive Impact
-1: Negligible Negative Impact
-2: Moderately Negative Impact
-3: Significant Negative Impact
+/-: Likely to have both positive and negative environmental impact
?: Uncertain or unpredictable environmental effect

Source: JICA Study Team

Chapter 14 Water Supply Sector Programme

14.1 Objectives for Water Supply Sector Development

The objectives of water supply development are as follows:

a) Corresponding to the increase in water demand due to population growth and urbanization

At present there are still many residents the use water from unprotected wells, springs and rivers. And many users of piped water and protected wells can't get enough water.

Besides, the quality of piped water does not always comply with Ghana's Standards especially for Turbidity and Total iron. And regarding the quality of groundwater, there is no information about sampling tests.

The target in this aspect for 2033 is that all residents should have access to clean water that complies with Ghana's Standards from pipes or protected wells, and get enough water.

b) To provide stable water supply depending on the condition of each area

The expansion of the piped water supply area is planned along with the seeking of new water sources and etc.

But it is difficult to satisfy the demand, because the speed of population growth is too great for the expansion of the piped water supply area to keep up with and it is also necessary to find and construct new water sources.

Therefore, in the near future, it will be necessary to select water supply methods in accordance with the conditions of each area.

c) To improve the management of the water supply business

At present, GWCL cannot provide a stable and adequate supply of clean water. Moreover GWCL has not been able to ensure a proper income because of the large amount of non-revenue water. It is necessary to seek to improve the management of the water supply business by 2033 by increasing the volume of water supply and by reducing the volume of non-revenue water by 2033.

14.2 Forecast of Water Demand in Year 2033

14.2.1 Present Situation of Water Supply System

In order to analyse the current situation regarding how much water that was delivered by water supply systems was used for domestic purposes, the following conditions are set.

- Populations using water supply systems are set by 2010 census data
- Capacity of existing water treatment plant and other systems is set as actual condition of the year 2010.
- The rate of non-domestic water demand and NRW are set in the Master Plan for Kumasi Water Capacity Extension

In these conditions, the current situation is assumed to be 20 lcd for the average water consumption for domestic use and is summarized in the table below;

Table 14.2.1 Current Situation of Water Supply

		Pop	Rate (%)						Population (Nr)					
			Pipe supply			Protected well		Others	Pipe supply			Protected well		Others
			Insid-Pipe	Out-Pipe	Stand-Pipe	Borehole	Well		Insid-Pipe	Out-Pipe	Stand-Pipe	Borehole	Well	
KMA	Urban	2,035,064	42.3	24.8	8.0	12.2	6.2	6.5	861,051	504,633	162,083	248,147	127,185	131,965
Afigya-Kwabre	Urban	36,799	4.0	4.7	2.6	8.2	5.9	74.6	1,474	1,748	950	3,001	2,164	27,462
	Rural	99,341	6.2	14.9	6.6	35.8	4.1	32.5	6,119	14,816	6,549	35,585	4,031	32,241
Kwabre East	Urban	66,643	2.0	8.6	8.2	24.3	10.9	46.1	1,310	5,738	5,472	16,163	7,246	30,714
	Rural	48,913	1.2	3.7	2.7	24.8	7.3	60.3	599	1,789	1,320	12,117	3,585	29,503
Ejisu-Juaben	Urban	41,319	1.1	4.1	3.6	15.9	2.8	72.5	473	1,691	1,470	6,580	1,137	29,968
	Rural	102,443	0.8	5.4	9.2	45.0	4.9	34.7	802	5,575	9,418	46,118	5,017	35,513
Bosomtwe	Urban	29,308	0.5	1.4	0.4	13.5	13.2	70.9	142	416	127	3,962	3,872	20,789
	Rural	64,602	0.9	4.8	13.0	40.6	4.9	35.8	578	3,112	8,375	26,208	3,183	23,146
Atwima Kwanwoma	Urban	19,056	0.5	2.6	3.2	8.5	3.8	81.4	87	489	618	1,619	733	15,510
	Rural	71,578	0.8	3.8	4.7	52.0	11.7	27.0	583	2,717	3,387	37,201	8,368	19,322
Atwima-Nwabiagya	Urban	47,871	7.3	7.3	2.7	5.1	7.0	70.6	3,496	3,481	1,307	2,435	3,353	33,799
	Rural	101,154	9.2	15.8	5.0	24.7	9.1	36.2	9,307	16,016	5,040	24,963	9,189	36,639
Total	Urban	2,276,060	38.1	22.8	7.6	12.4	6.4	12.8	868,033	518,196	172,027	281,907	145,690	290,207
	Rural	488,031	3.7	9.0	7.0	37.3	6.8	36.1	17,988	44,025	34,089	182,192	33,373	176,364
Greater Kumasi Sub-Region		2,764,091	32.1	20.3	7.5	16.8	6.5	16.9	886,021	562,221	206,116	464,099	179,063	466,571
			59.9			23.3		16.9	1,654,358			643,162		466,571

Source: Census 2010 and JICA Study Team

Table 14.2.2 Assumption of Current Situation for Average Water Consumption

	unit	2010
Total Service Area		
Pipe supply for House Connections	Nr	886,021
Pipe supply for Outside Pipe or Standpipes	Nr	768,337
Water Production Capacity after WPT Expansion	**m^3/day**	122,800
Under Utilization	%	30.0
Net Water Production Capacity	**m^3/day**	86,000
NRW (part of production)	%	35.0
In-plant Losses (e.g.Backwashing)	%	5.0
Net Supplied Water Volume	**m^3/day**	52,000
Non-domestic Consumption	%	35.5
Non-domestic Consumption	m^3/day	18,500
Domestic Consumption	m^3/day	33,500
Average Per capita in Domestic Water Demand	**lcd**	20.2

Source: JICA Study Team

14.2.2 Future Prospect for Water Demand

For the purpose of designing water supply systems, total water demand in the target years 2028 and 2033 are estimated by using some parameters such as per capita water demand. In order to estimate total water demand, the following conditions are set.

- Future population predicted by the JICA study team is adopted
- The piped water supply area is set to include the entire conurbation area
- The rate of non-domestic water demand and NRW are set in the Master Plan for Kumasi Water Capacity Extension
- The parameters of per capita water demand is set at 60 lcd

In these conditions, future projections for total water demand are assumed to be 440,000m^3/day in 2028 and 510,000m^3/day in 2033 as shown in the table below.

Table 14.2.3 Future Projections for Total Water Demand

		2028					2033				
		Population	Domestic		Non-Domestic	Total Demand	Population	Domestic		Non-Domestic	Total Demand
		Nr	lcd	m3/day	%	m3/day	Nr	lcd	m3/day	%	m3/day
KMA	In Conurbation	3,816,007	60	228,960	35.5	354,977	4,226,860	60	253,612	35.5	393,197
Afigya-Kwabre	In Conurbation	160,065	60	9,604	35.5	14,890	204,694	60	12,282	35.5	19,042
	Outside Conurbation	57,445					55,197				
Kwabre East	In Conurbation	162,251	60	9,735	35.5	15,093	207,490	60	12,449	35.5	19,301
	Outside Conurbation	13,375					12,832				
Ejisu-Juaben	In Conurbation	251,615	60	15,097	35.5	23,406	357,524	60	21,451	35.5	33,257
	Outside Conurbation	84,900					81,416				
Bosomtwe	In Conurbation	79,658	60	4,779	35.5	7,409	101,869	60	6,112	35.5	9,476
	Outside Conurbation	65,971					63,404				
Atwima Kwanwoma	In Conurbation	120,530	60	7,232	35.5	11,212	171,262	60	10,276	35.5	15,932
	Outside Conurbation	28,566					27,367				
Atwima-Nwabiagya	In Conurbation	156,407	60	9,384	35.5	14,549	200,017	60	12,001	35.5	18,606
	Outside Conurbation	53,632					51,531				
Total	In Conurbation	4,746,533		284,791		441,536	5,469,716		328,183		508,811
	Outside Conurbation	303,889					291,747				
Greater Kumasi Sub-Region		5,050,422		284,791		**441,536**	5,761,463		328,183		**508,811**

Source: JICA Study Team

If the current 35% rate of NRW and 5% In-plant losses are not improved , the required water production is estimated to be 736,000m^3/day in 2028 and 849,000m^3/day in 2033 as shown in the table below.

Table 14.2.4 Required Water Production

		2028	2033
Total Water Demand	m3/day	441,536	508,811
NRW (part of production)	%	35.0	35.0
In-plant Losses (e.g.Backwashing)	%	5.0	5.0
Required Water Production Capacity	m3/day	**736,000**	**849,000**

Source: JICA Study Team

14.2.3 Designation of Piped Water Supply Area

It is necessary to find new water sources since the water demand will be larger than net water production capacity by 2023.

First it is necessary to designate the areas of piped water supply.

Generally high density areas are set for piped water supply, and rural areas in which population densities are low are set for groundwater.

Therefore in this study, the areas in which population density is expected to be more than 30pop/ha in 2033 are set for piped water supply.

14.2.4 Future Prospect for Water Supply Systems by 2028

Future water demand will not be satisfied until new water sources are developed and a new water treatment plant constructed, but this will take a long time, at least 10 years or more.

Therefore, regarding water supply systems, it is necessary to consider the strategies for the period up to the year 2028.

In this study, two scenarios are proposed, (1) is to increase the available volume of domestic water per capita and scenario (2) is to expand the area of the piped water supply systems. And both scenarios have the same conditions as shown below;

- NRW will be reduced gradually by pipe rehabilitation
- In-plant losses will be the same as the current situation
- Barekese water treatment capacity will be increased
- The currently under utilized water treatment plant will be operated at capacity in the future

(1) Scenario (1)

Scenario (1) aims to increase the volume of domestic water available to each customer, so the expansion of water pipes will not be needed.

In this scenario, domestic water consumption per capita will increase from 20 lcd to 50 lcd for house connections, and to 30 lcd for standpipes.

Major parameters of Scenario (1) are summarized in Table 14.2.5.

(2) Scenario (2)

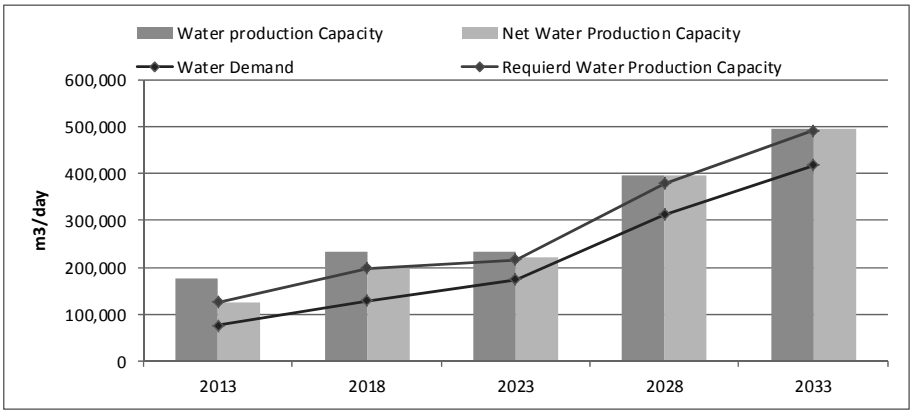
Scenario (2) aims to increase number of customers that have access to piped water supply systems.

In this scenario, domestic water consumption per capita will increase only slightly from 20 lcd to 35 lcd for house connections.

Major parameters of Scenario (2) are summarized in Table 14.2.6.

Table 14.2.5 Major Parameters of Scenario (1)

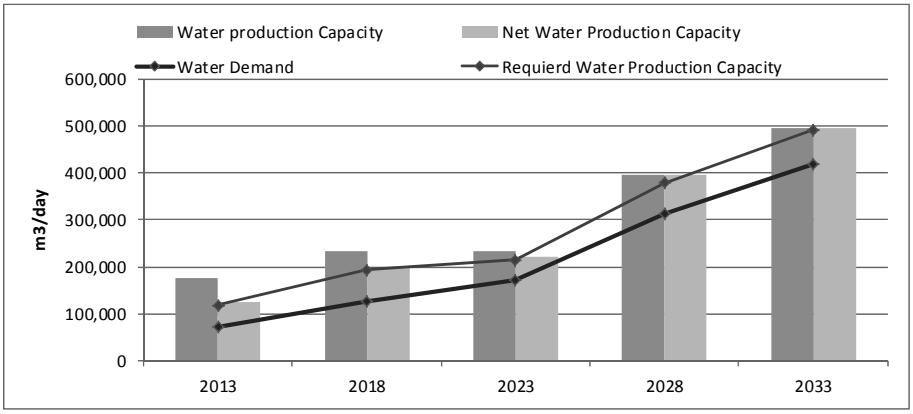
	unit	2013	2018	2023	2028	2033
Total Service Area						
Pipe supply for House Connections in KMA	Nr	998,957	1,220,159	1,425,752	2,671,205	3,804,174
Pipe supply for Outside Pipe or Standpipes in KMA	Nr	773,499	944,776	1,103,968	1,144,802	422,686
Pipe supply for House Connections outside of KMA	Nr	28,686	35,063	42,133	229,721	308,542
Pipe supply for Outside Pipe or Standpipes outside of KMA	Nr	115,784	141,522	170,056	247,898	331,257
Pipe supply for House Connections in KMA	%	42.3	42.3	42.3	70.0	90.0
Pipe supply for Outside Pipe or Standpipes in KMA	%	32.8	32.8	32.8	30.0	10.0
Pipe supply for House Connections outside of KMA	%	5.9	5.9	5.9	24.7	24.8
Pipe supply for Outside Pipe or Standpipes outside of KMA	%	23.7	23.7	23.7	26.6	26.7
Average Per capita in Domestic Water Demand	**lcd**					
Pipe supply for House Connections in KMA	lcd	30	40	50	55	60
Pipe supply for Outside Pipe or Standpipes in KMA	lcd	20	30	30	30	30
Pipe supply for House Connections outside of KMA	lcd	30	40	50	55	60
Pipe supply for Outside Pipe or Standpipes outside of KMA	lcd	20	30	30	30	30
Total Water Demand						
Total Domestic Water Demand for Piped Water Supply	m3/day	48,700	82,800	111,700	201,400	269,400
Non-domestic Consumption	%	35.5	35.5	35.5	35.5	35.5
Total Water Demand	m3/day	75,500	128,400	173,200	312,200	417,700
Required Water Production Capacity						
NRW (part of production)	%	35.0	30.0	15.0	12.5	10.0
In-plant Losses (e.g.Backwashing)	%	5.0	5.0	5.0	5.0	5.0
Required Water Production Capacity	m3/day	125,900	197,600	216,500	378,500	491,500
Water Production Capacity						
Water production capacity after WPT expansion	m^3/day	177,400	232,000	232,000	232,000	232,000
Water production capacity new WPT	m^3/day				165,000	264,000
Under Utilization	%	30.0	15.0	5.0		
Net Water production capacity	m^3/day	124,200	197,200	220,400	397,000	496,000



Source: JICA Study Team

Table 14.2.6 Major Parameters of Scenario (2)

	unit	2013	2018	2023	2028	2033
Total Service Area						
Pipe supply for House Connections in KMA	Nr	1,180,500	1,730,283	2,358,801	2,671,205	3,804,174
Pipe supply for Outside Pipe or Standpipes in KMA	Nr	944,400	1,153,523	1,010,915	1,144,802	422,686
Pipe supply for House Connections outside of KMA	Nr	52,513	119,200	143,233	234,413	314,542
Pipe supply for Outside Pipe or Standpipes outside of KMA	Nr	112,769	119,200	143,232	230,693	309,256
Pipe supply for House Connections in KMA	%	50.0	60.0	70.0	70.0	90.0
Pipe supply for Outside Pipe or Standpipes in KMA	%	40.0	40.0	30.0	30.0	10.0
Pipe supply for House Connections outside of KMA	%	10.8	20.0	20.0	25.2	25.3
Pipe supply for Outside Pipe or Standpipes outside of KMA	%	23.1	20.0	20.0	24.8	24.9
Average Per capita in Domestic Water Demand	**lcd**					
Pipe supply for House Connections in KMA	lcd	20	30	35	55	60
Pipe supply for Outside Pipe or Standpipes in KMA	lcd	20	20	20	30	30
Pipe supply for House Connections outside of KMA	lcd	20	30	35	55	60
Pipe supply for Outside Pipe or Standpipes outside of KMA	lcd	20	20	20	30	30
Total Water Demand						
Total Domestic Water Demand for Piped Water Supply	m3/day	45,900	81,000	110,700	201,100	269,100
Non-domestic Consumption	%	35.5	35.5	35.5	35.5	35.5
Total Water Demand	m3/day	71,200	125,600	171,600	311,800	417,200
Required Water Production Capacity						
NRW (part of production)	%	35.0	30.0	15.0	12.5	10.0
In-plant Losses (e.g.Backwashing)	%	5.0	5.0	5.0	5.0	5.0
Required Water Production Capacity	m3/day	118,700	193,300	214,500	378,000	490,900
Water Production Capacity						
Water production capacity after WPT expansion	m^3/day	177,400	232,000	232,000	232,000	232,000
Water production capacity new WPT	m^3/day				165,000	264,000
Under Utilization	%	30.0	15.0	5.0		
Net Water production capacity	m^3/day	124,200	197,200	220,400	397,000	496,000



Source: JICA Study Team

(3) Future Prospect for Water Supply Systems before 2028

Both of these scenarios have advantages and disadvantages.

Scenario (1) will require many wells and boreholes in the areas beyond the piped water supply area and there is a risk that groundwater will be depleted.

Scenario (2) will require a large investment for construction of the water supply pipes and there is a risk that the new or existing consumers of piped water will use less than the projected amount of water because of changing water pressure and flow volume.

Considering the risk of both scenarios, scenario (1) is adopted in this study.

This is because residents will develop ground water sources by constructing wells and boreholes in order to obtain an adequate water supply if scenario (2) is adopted. The development of ground water should be conducted properly as public works.

Moreover, scenario (2) has a risk that by constructing new pipe lines, the existing consumers will not be able to use the same amount of water they are currently using,

14.3 Strategies for Water Supply Development

14.3.1 Effective Utilization of Existing Facilities

It is necessary to extend, upgrade and rehabilitate existing facilities such as water treatment plants and water pipes in order to respond to the rapidly increasing demand for piped water supply and comply with Ghana's water quality Standards. The work should include the following:

- Increase the capacity of the existing water treatment plant and water tanks
- Improvement in operational management of the existing water treatment plant
- Upgrade the capacity of the water transportation lines
- Rehabilitate and replace water pipelines with problems

14.3.2 Development of Boreholes in Periphery Areas in Lower Population Density Areas in the Conurbation

It is not possible to supply piped water to all the residents inside the conurbation areas because of shortage of surface water sources, as well as shortage of GWCL's capacity to extend the piped water distribution system. Therefore, it is necessary to supply water from boreholes in lower population density areas to serve as community water supply systems.

14.3.3 Increase of Revenue for Creating a Foundation for Sound Management

It is important secure the basis for sound management of the water supply company (GWCL). For this purpose, it is essential to reduce the amount of Non-Revenue Water by installing water meters.

14.3.4 Stable Supply of Clean Water for Greater Kumasi Sub-Region

In order to satisfy the rapidly increasing demand for piped water, it is necessary to develop new water sources. Then in response to the new water sources to be developed, it is necessary to develop the water supply facilities as follows;

- To develop water treatment facilities in accordance with the development of new water sources
- Investigation of a more efficient distribution network from the view point of the locations of the new water sources
- To develop and upgrade the water distribution system based on a thorough investigation

14.4 Water Supply Sector Plan

A Water Sector Plan was formulated based on the following policies on water supply for spatial development:

(1) Effective Utilization of Existing Facilities

It is necessary to extend, upgrade and rehabilitate the existing facilities such as the water treatment plant and water pipes in order to respond to the rapidly increasing demand for piped water supply as follows:

- Extension of water treatment plant modules in Barekese
- Investigation of the necessity of new water tanks and the volume and locations with consideration of the distribution and construction of the new water tanks
- Installation of transport lines to Suame water tank from Barekese water treatment plant
- Investigation of causes of NRW and replace pipelines based on the investigation results
- Replace aged pipe with large-diameter pipes for preventing water leakage

(2) Development of Boreholes in Lower Population Density Periphery Areas in the Conurbation

It is not possible to supply piped water to all residents inside the conurbation areas because of shortage of surface water resources, as well as shortage of GWCL's capacity to extend the piped water distribution system. Therefore, it is necessary to supply water from boreholes in the lower population density areas for community water supply systems including:

- Construction of new boreholes with elevated tanks and pipe systems
- Groundwater data collection and monitoring (not only groundwater level but also groundwater quality)

(3) Increase of Revenue for Creating a Foundation for Sound Management

It is important to secure the basis for sound management of the water supply company (GWCL). For this purpose, it is essential to reduce the amount of Non-Revenue Water by installing water meters.

- Installation of water meters for present customers that do not have working water meters
- Installation of water meters for new customers

(4) Stable Supply of Clean Water for Greater Kumasi Sub-Region

In order to satisfy the rapidly increasing demand for piped water, it is necessary to develop new water sources. Then in response to the new water sources to be developed, it is necessary to develop water supply facilities as follows;

- To develop water treatment facilities in accordance with the development of the new water sources

- Investigation of a more efficient distribution network from the view point of the locations of the new water sources
- To develop and upgrade the water distribution system based on a thorough investigation

14.5 Water Supply Sector Programme

(1) Outline of Programme for the Water Supply Sector

An implementation plan for the prioritized actions and projects composing the Water Supply sector programme was prepared. There are 4 sub-programmes for the water supply sector for the Greater Kumasi Sub-Region.

- Sub-Programme 1: Effective utilization of the existing water supply facilities
- Sub-Programme 2: Development of boreholes for water supply in the periphery areas of lower population density in the Greater Kumasi Conurbation
- Sub-Programme 3: Increase of revenue for creating a foundation for sound management of Ghana Water Company Ltd.
- Sub-Programme 4: Stable supply of clean water for the Greater Kumasi Sub-Region

The detailed plans for each Programme are as follows:

1) Sub-Programme 1: Effective Utilization of Existing Water Supply Facilities

- Extension of water treatment plant modules in Barekese
- Improvement in the operational management of the existing water treatment plant
- Installation of transport lines to Suame water tank from Barekese water treatment plant
- Investigation of the necessity of new water tanks and the volume and locations with consideration of the distribution and construction of the new water tanks
- Investigation of the causes of NRW and replace pipelines based on the investigation results
- Replacement of aged pipes by large-diameter pipes for preventing water leakage

2) Sub-Programme 2: Development of Boreholes for Water Supply in Periphery Areas of Lower Population Density in Greater Kumasi Conurbation

- Construction of new boreholes with elevated tanks and pipe systems
- Groundwater data collection and monitoring (not only groundwater level but also groundwater quality)

3) Sub-Programme 3: Increase of Revenue for Creating a Foundation for Sound Management of Ghana Water Company Ltd.

- Installation of water meters for present customers that do not have working water meters
- Installation of water meters for new customers

4) Sub-Programme 4: Stable Supply of Clean Water for Greater Kumasi Sub-Region

- To develop water treatment facilities in accordance with the development of new water sources
- Investigation of a more efficient distribution network and develop and upgrade the water distribution system

(2) Sub-Programme for Effective Utilization of Existing Facilities

1) Extension of Water Treatment Plant Modules in Barekese

At present, Barekese water treatment plant has 5 treatment modules and each treatment module has a capacity of 27,300m^3/day. So the total capacity of Barekese water treatment plant is 136,500m^3/day. On the other hand, yield capacity of Barekese reservoir is designed at 220,000m^3/day.

Therefore, three more treatment modules should be constructed in order to efficiently use the Barekese reservoir capacity.

The current production efficiency of Barekese water treatment plant appears to be low, so improvement of production efficiency must be carried out simultaneously with the expansion of the water treatment plant modules.

2) Improvement in Operational Management of the Existing Water Treatment Plant

At present, the water varies in quality and does not always comply with Ghana's Standard. But the water qualities that do not comply with Ghana's Standard are water qualities that basically can be treated by the existing water treatment facilities.

Therefore, it is necessary to improve the operational management of the existing water treatment plant.

Table 14.5.1 Treated Water Quality

Parameters	Unit	Ghana Standards Treated water	Raw water Barekese	Raw water Owabi	Treated Water Barekese	Treated Water Owabi
pH	(-)	6.5-8.5	6.4-8.2	5.2-7.2	6.0-8.8	6.3-7.7
Colour	HZ	<15	98-400	7-1250	1-22	2-13
Turbidity	NTU	<5	13-72	5.1-1041	0.0-12.0	0.2-11.7
Total iron	mg/l	<0.3	1.2-7.8	0.4-1.6	0-0.3	0-0.4

Source: Master Plan for Kumasi Water Capacity Extension (2010)

3) Installation of Transport Lines to Suame Water Tank from Barekese Water Treatment Plant

At present there is a transport line to Suame water tank from Barekese water treatment plant with a diameter of 900mm. But the capacity of this transportation line will be inadequate after completion of the new treatment modules at Barekese water treatment plant.

Therefore, new 900mm transport lines should be constructed to Suame water tank

from Barekese in order to flow properly. Regarding this project, it is planned to start construction in 2013 by GWCL.

4) Investigation of Necessity of New Water Tanks and the Volume and Locations with Consideration of the Distribution and Construction of the New Water Tanks

At present there is only Suame water tank with a volume of 19,090m3 in the water supply system and the reserve time of Suame water tank is assumed to be only 3 hours. After expansion of Barekese water treatment plant, the reserve time of Suame water tank will decrease to less than 3 hours. But it is desirable that a water tank should have at least 6 hours of storage in order to supply water efficiently.

Therefore, new water tanks should be constructed in order to efficiently distribute the water supply.

However, investigation of the volume and locations with consideration of distribution is necessary before construction of any new water tanks.

5) Investigation of Causes of NRW and Replace Pipelines Based on the Investigation Results

Regarding "Master Plan for Kumasi Water Capacity Extension", Non-revenue water is currently in the magnitude of 35%due to pipe breaks, illegal connections and etc.

In Kumasi it is observed that every two and one half days pipes greater than 7.6cm burst and bursts in pipes with diameters less than 7.6cm occur every other day.

Therefore, replacement of the pipelines should be conducted based on a thorough investigation.

The actual length and type of pipe that should be replaced cannot identified before the investigation, but in this study the JICA study team assumed that the 30% of the asbestos cement, cast iron and PVC pipes with diameters less than 150mm should be replaced.

6) Replace Aged Pipe with Large-Diameter Pipes for Preventing Water Leakage

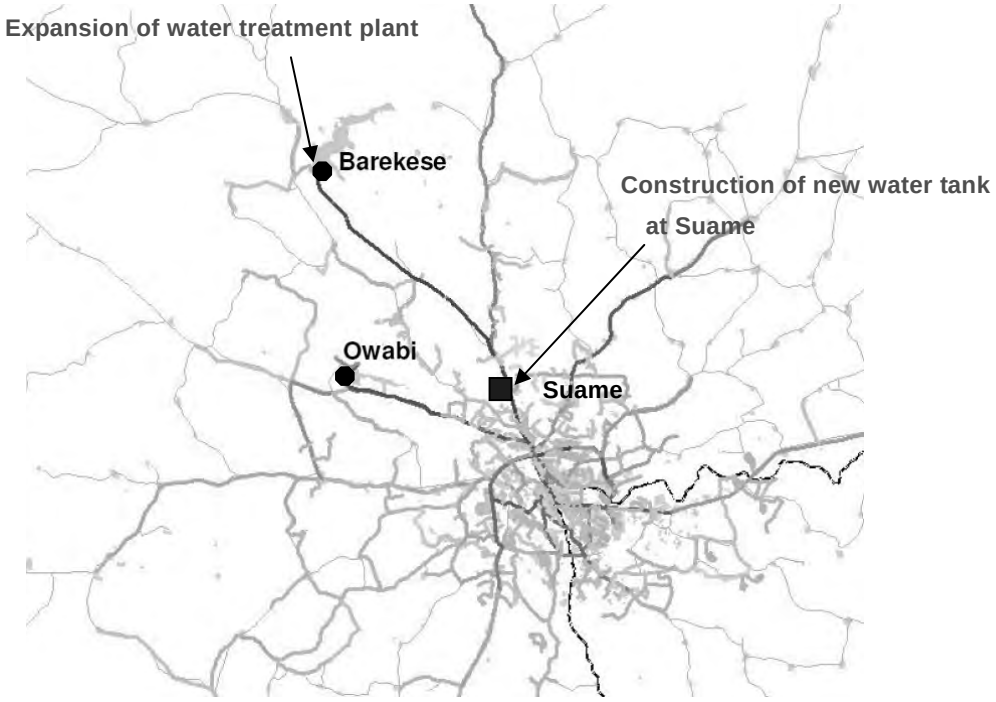
There are no data for when the pipelines were constructed, but the ageing of the pipe might be the cause of the pipe breaks.

Therefore, replacement of pipelines should be conducted depending on their age.

The JICA study team assumed that all asbestos cement and cast iron pipes with diameters greater than 200mm should be replaced.

7) Locations of Main Facilities for Sub-Programme 1

The locations of the main facilities for Sub-Programme 1 are shown in Figure 14.5.1.



Source: JICA Study Team

Figure 14.5.1 Locations of Main Facilities for Programme 1

(3) Sub-Programme for Development of Boreholes for Water Supply in Periphery Areas of Lower Population Density in Greater Kumasi Conurbation

1) Construction of New Boreholes with Elevated Tanks and Pipe Systems

In2028 after new water sources have been developed high population density areas in the conurbation should be supplied by water pipes. But before developing the new water sources, it will be necessary to provide water from the ground water.

Therefore, boreholes with elevated tanks and pipe systems should be constructed in the areas in which the population density is more than 30 pop/ha.

A single water supply system with one borehole, an elevated tank and pipe distribution system can supply about 4,000 residents. Based on the above, 210 new systems should be constructed.

2) Groundwater Data Collection and Monitoring

In the future it will be necessary to use groundwater for domestic use, but the potential is unknown due to insufficient data. More data and analyses are required, and particularly for the deeper groundwater.

So the groundwater data collection and monitoring have to be conducted. The details of the required study are mentioned in the Water Resource Sector Plan and Programme.

Moreover, it is necessary to check that the water quality meets the Ghana Standards Board criteria for drinking water before using groundwater.

Table 14.5.2 Ghana Standards Board Criteria for Drinking Water

Parameter	GSB Level
pH	6.5 – 8.5
Chloride	250 mg/L
Total Dissolved Solids	1000 mg/L
Sulphate	250 mg/L
Total Hardness	500
Manganese	0.4 mg/L
Iron	0.3 mg/L
Fluoride	1.5 mg/L
Calcium	0.003 mg/L
Nickel	0.02 mg/L

Source: Ghana Standards Board drinking water guidelines (GS 175-1:2009)

3) Effective Development of the Piped Water Supply System in the Future

In 2028 after the new water sources have been developed the systems will be used as part of the piped water supply system.

New water transport and distribution pipes will connect to the pipe distribution systems that were previously fed by boreholes and elevated tanks and then the boreholes will be retired from service. This future project will produce effective development of the water supply system.

(4) Sub-Programme for Increase of Revenue for Creating a Foundation for Sound Management of Ghana Water Company Ltd.

1) Installation of Water Meters for Present Customers without Working Water Meters

Regarding the “Master Plan for Kumasi Water Capacity Extension”, over 40% of the domestic customers do not have a working water meter and there are many illegal connections.

Therefore, installation of water meters is necessary in order to increase revenue.

The 40% of present customers supplied by water pipelines are assumed to total about 0.7 million residents, so 33,000 new water meters should be installed.

2) Installation of Water Meters for New Customers

New customers will have to install water meters before receiving service.

By 2028 1.1million residents new customers are expected so 53,000 water meters should be installed.

(5) Sub-Programme for Stable Supply of Clean Water for Greater Kumasi Sub-Region

1) Development of Water Treatment Facilities in Accordance with the Development of New Water Sources

The capacity of the existing water treatment facilities is only half of the forecast future demand in 2028, so new water treatment facilities should be constructed before then.

The capacity of 264,000m3/day is assumed for the new water treatment facility based on the result of water demand forecasting (see Table 14.2.5).

2) Investigation of More Efficient Distribution Network and Development and Upgrade of the Water Distribution System

In the future, water demand and consumption will increase and new facilities will be constructed in order to satisfy future demand. Furthermore, an increase in the number of high-rise buildings is expected due to the development of the Kumasi.

Therefore, considering above condition, it is necessary to investigate and review the water distribution network plan. The new water distribution network plan must ensure the appropriate amount of water flow and water pressure.

Based on the investigation, develop and upgrade the water distribution systems that include water tanks and distribution pipes.

In the future, it is assumed that water tanks with a total capacity of 66,000m^3 and 2,200km of distribution network pipes will be required.

(6) Implementation Plan for Water Supply Sector Programme

An implementation plan for the prioritized actions and projects composing the Water Supply Sector Programme is prepared. The detail of the plan is in Chapter 22.

The goals of the Sector Programme for the water supply sector of the project are outlined in Table 14.5.1 with prospective target levels to be achieved by the year 2018 for the Short-Term Plan, year 2028 for the Mid-Term Plan and year 2033 for the Long-Term Plan.

Table 14.5.3 Programme Outline for Water Supply Sector

	Short-Term Plan						Mid-Term Plan										Long-Term Plan				
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Sub-Programme 1: Effective utilization of existing facilities																					
Extension of water treatment plant modules in Barekese			●	→	→	→	→														
Improvement in operational management of existing water treatment plant	●	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Installation of transport lines to Suame water tank from Barekese water treatment plant	●	→																			
Investigation of necessity of new water tanks and the volume and locations with consideration of distribution and construction of the new water tanks			●	→	→	→	→														
Investigation of causes of NRW and replace pipelines based on the investigation results			●	→	→	→	→														
Replace aged pipe with large-diameter pipes to prevent water leakage							●	→	→	→	→	→	→	→	→	→					
Sub-Programme 2: Development of boreholes in lower population density periphery areas in the conurbation																					
Construction of new boreholes with elevated tanks and pipe systems			●	→	→	→	→	→	→	→	→	→	→	→	→	→					
Groundwater data collection and monitoring			●	→	→	→	→	→	→	→	→	→	→	→	→	→					
Sub-Programme 3: Increase of revenue for creating a foundation for sound management																					
Installation of water meters for present customers that do not have working water meters	●	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→					
Installation of water meters for new customers												●	→	→	→	→	→	→	→	→	→
Sub-Programme 4: Stable supply of clean water for Greater Kumasi Sub-Region																					
Development of water treatment facilities in accordance with the development of new water sources												●	→	→	→	→	→	→	→	→	→
Investigation of a more efficient distribution network and develop and upgrade the water distribution system												●	→	→	→	→	→	→	→	→	→

Source: JICA Study Team

14.6 Cots of Sector Programme

Project costs of the water supply sector sub-programmes are shown in Table 14.6.1.

Table 14.6.1 Costs for Water Supply Sector Programmes

		Cost ($x10^3$ GHC)
Sub-Programme 1: Effective utilization of existing facilities		
	Extension of water treatment plant modules in Barekese	41,000
	Improvement in operational management of existing water treatment plant	-----
	Installation of transport lines to Suame water tank from Barekese water treatment plant	12,000
	Investigation of necessity of new water tanks and the volume and locations with consideration of the distribution and construction of the new water tanks	20,000
	Investigation of causes of NRW and replace pipelines based on the investigation results	13,900
	Replace aged pipe with large-diameter pipes to prevent water leakage	48,400
Sub-Programme 2: Development of boreholes in lower population density periphery areas in the conurbation		
	Construction of new boreholes with elevated tanks and pipe systems	147,000
	Groundwater data collection and monitoring	-----
Sub-Programme 3: Increase of revenue for creating a foundation for sound management		
	Installation of water meters for present customers that do not have working water meters	14,000
	Installation of water meters for new customers	22,000
Sub-Programme 4: Stable supply of clean water for Greater Kumasi Sub-Region		
	Development of water treatment facilities in accordance with the development of new water sources	132,000
	Investigation of more efficient distribution network and develop and upgrade the water distribution system	523,000

Source: JICA Study Team

14.7 Preliminary Economic and Financial Analysis

14.7.1 Economic Analysis

(1) Methodology

With the implementation of the sector programme, significant benefits, both direct and indirect, could be attained. Direct benefits are the delivery of water in greater quantity on a more reliable basis, better water quality, and improved health and environmental conditions. On the other hand, indirect benefits are increased productivity of the residents in the service area, and employment and livelihood opportunities for the residents of the service area as well.

In order to estimate the figure for economic benefit, the following steps are carried out;

Step 1: Identification of “with” and “without” cases,

Step 2: Assumption of parameters for direct benefits such as affordability to tay and time cost savings,

Step 3: Estimation of economic costs based on the estimated capital investment cost mentioned in the previous section,

Step 4: Assuming the indirect effects, and

Step 5: Economic evaluation using economic benefits and economic costs.

(2) "With" and "Without" Cases

The programme inputs and outputs should be identified, quantified and valued by comparing the "Without Case" with that of the "With Case" to derive the economic benefit.

1) "With Case"

The water supply facilities will be constructed to be an investment. The identification and quantification of the relevant costs and benefits will be estimated in this study. The evaluation period of the Sector Programme is assumed to be 30 years taking into account the service life of the water supply sector programme.

2) "Without" Case

The "Without " case is that the current water service coverage ratio, such as ratio of house connections, communal boreholes for domestic use and privately constructed boreholes for nondomestic use, will continue to be used without expansion or improvement in the future.

(3) Assumptions

1) Benefit

Affordability to Pay and Willingness to Pay

One method for benefit estimation is to derive the affordability to pay. In accordance with the "Project appraisal manual" issued by IBRD, the ratio of water consumption cost (domestic water) in household budgets is 3% so that the monthly affordability to pay for this sector in households is GHC 13.6/month. This figure is derived based on the expected level of per capita water use, 130 litre/day, in accordance with the "Strategic Investment Programme (SIP)". However, the current realistic supply volume is only 60 litre/capita/day, therefore, the assumption of affordability to pay is GHC 6.3/month for the benefit calculation.

On the other hand, industrial or commercial businesses (non-domestic water) consume a huge amount of water. The ratio of consumption by non-domestic sector is 35.5% of the whole consumption. In order to obtain a reliable supply of water, companies and factories are willing to pay 1.75 times larger than the current water charge, based on responses to the survey "Willingness to Pay for Improved Service Delivery for the Water Supply Sector".

Time Cost Savings

Time saved by new customers in collecting water is also assumed. In the without

case, time spent in collecting water from the nearest source of water supply (e.g., wells, tank, river, stand posts on the road) may be considerable. An important benefit from piped water supply and provision of public taps is that it brings the source of water very near to the households. The value of time saved is calculated on the basis of daily minimum wage rate in Ghana (GHC 4.48) which is referred to in the "Handbook for the Economic Analysis of Water Supply Projects", issued by the Asian Development Bank. The JICA Study Team assumed that time savings that could be devoted to economic activities should be valued at 50 % of this minimum wage rate.

2) Water Consumption Volume

The estimated consumption volumes for the "With" and "Without" cases are shown in Tables 14.7.1 and 14.7.2.

Table 14.7.1 Estimated Consumption Volume "With" Case

Consumption Group	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Domestic Consumers	45,900	81,000	110,700	201,100	269,100
Non-Domestic Consumers	25,300	44,600	60,900	110,700	148,100
Total (m^3/day)	71,200	125,600	171,600	311,800	417,200
Population that uses Groundwater from Boreholes	836,000	627,000	736,000	769,000	910,000

Source: JICA Study Team

Table 14.7.2 Estimated Consumption Volume "Without" Case

Consumption Group	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Domestic Consumers	45,900	45,900	45,900	45,900	45,900
Non-Domestic Consumers	25,300	25,300	25,300	25,300	25,300
Total (m^3/day)	71,200	71,200	71,200	71,200	71,200
Population that uses Groundwater from Boreholes	1,210,000	1,408,000	1,651,000	1,909,000	2,224,000

Source: JICA Study Team

(4) Estimation of Economic Cost

The capital investment cost of the programme is estimated at GHC 1,125 million. In this study the economic cost was estimated by deducting the government taxes and import duty from the financial cost. A conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 956 million as shown in Table 14.7.3.

Operational cost and maintenance cost were also estimated based on the "Master Plan for Kumasi Water Capacity Extension" of December, 2010. Operational cost was GHC 0.66/m^3. Maintenance cost for dredging and dam construction was about 10% per annum and 2.5% of capital investment cost per annum.

Table 14.7.3 Economic Cost of Investment

Unit: GHC Thousand

Project	Financial Cost	Conversion Factor	Economic Cost
Water Resources			
Dredging of Barekese and Owabi Dam Reservoirs	36,000	0.85	30,600
Feasibility Study on New Water Sources	3,000	0.85	2,550
Consolidation of Hydrological Monitoring	500	0.85	425
Enhancement of Rural Water Supply	4,000	0.85	3,400
Construction of Dam for Water	108,000	0.85	91,800
Water Resources Total	151,500		128,775
Water Supply			
Programme 1: Effective Utilization of Existing Facilities	135,000	0.85	114,750
Programme 2: Development of Boreholes with Elevated Tank and Pipe System	147,200	0.85	125,120
Programme 3: Increase of Revenue for Building Foundation for Sound Management	36,400	0.85	30,940
Programme 4: Stable Supply of Clean Water for Greater Kumasi Sub-Region	655,000	0.85	556,750
Water Supply Total	973,600		827,560
Total	**1,125,100**		**956,335**

Source: JICA Study Team

(5) Result of Economic Analysis

The estimated flow projection based on the above assumptions is presented in Table 14.7.4.The whole Sector Programme will have an EIRR of 28.23%. The proposed Sector Programmes are economically viable. The NPV of all the Sector Programmes is GHC 295 million using 12% discount rate.

Table 14.7.4 Economic Flow of Water Supply Sector Programme

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	8,840	8,840	0	-8,840	8,840	0	-8,840
2014	29,561	22,637	29,920	52,557	29,561	-22,996	46,926	26,394	-20,532
2015	40,088	25,298	29,920	55,218	40,088	-15,131	44,020	31,958	-12,062
2016	46,135	27,960	28,645	56,605	46,135	-10,470	40,290	32,838	-7,452
2017	52,182	30,622	28,645	59,267	52,182	-7,085	37,665	33,163	-4,502
2018	58,229	33,283	28,730	62,013	58,229	-3,784	35,188	33,041	-2,147
2019	81,298	35,533	17,935	53,468	81,298	27,830	27,089	41,188	14,100
2020	89,508	37,783	12,835	50,618	89,508	38,890	22,897	40,489	17,592
2021	97,717	40,033	12,835	52,868	97,717	44,850	21,352	39,466	18,114
2022	105,926	42,282	12,835	55,117	105,926	50,809	19,876	38,198	18,322
2023	114,136	44,532	12,835	57,367	114,136	56,769	18,471	36,749	18,278
2024	122,649	51,394	70,380	121,774	122,649	875	35,007	35,259	251
2025	147,090	58,256	100,980	159,236	147,090	-12,146	40,872	37,754	-3,117
2026	171,531	65,117	100,980	166,097	171,531	5,434	38,065	39,311	1,245
2027	195,973	71,979	100,980	172,959	195,973	23,013	35,391	40,100	4,709
2028	220,414	81,136	70,465	151,601	220,414	68,813	27,697	40,269	12,572
2029	244,680	86,293	57,715	144,008	244,680	100,672	23,491	39,913	16,422
2030	263,060	91,450	57,715	149,165	263,060	113,895	21,725	38,313	16,588
2031	281,439	96,607	57,715	154,322	281,439	127,118	20,068	36,598	16,530
2032	299,819	101,764	57,715	159,479	299,819	140,340	18,517	34,811	16,294
2033	318,199	106,921	57,715	164,636	318,199	153,563	17,067	32,987	15,919
2034	336,578	112,078	0	112,078	336,578	224,500	10,374	31,154	20,780
2035	354,958	117,235	0	117,235	354,958	237,723	9,689	29,335	19,646
2036	373,338	122,392	0	122,392	373,338	250,946	9,031	27,548	18,517
2037	391,717	127,549	0	127,549	391,717	264,168	8,403	25,807	17,404
2038	410,097	132,706	0	132,706	410,097	277,391	7,806	24,123	16,317
2039	428,477	137,863	0	137,863	428,477	290,614	7,241	22,504	15,263
2040	446,856	143,020	0	143,020	446,856	303,836	6,707	20,955	14,248
2041	465,236	148,177	0	148,177	465,236	317,059	6,204	19,479	13,275
2042	483,615	153,334	0	153,334	483,615	330,281	5,732	18,079	12,347
2043	533,056	158,491	-216,183	-57,692	533,056	590,749	-1,926	17,792	19,718
	7,203,563	2,503,724	740,152	3,243,876	7,203,563	3,959,687	669,774	965,573	295,799

B / C	1.4416
EIRR %	28.23
NPV (GHc)	295,799

(6) Indirect Benefits

1) Industrial Development

It is expected that manufacturing and commercial establishments will increase production activities. At present they are using their own supply systems, boreholes, in each manufacturing site. If a stable and sufficient supply of water is available, manufacturing and commercial activities will increase and influence the Ghana economy.

2) Pleasant Livelihood Environment

People's welfare will be improved. A reliable water supply system will be required due to the increasing demand, which is the nature of people.

3) Reduction of Water Borne Disease

Reduction of water borne disease, part of the social impact, is assumed to be a

qualitative benefit. Based on a census survey, people of the study area are afflicted with waterborne disease at such a high rate that more than 50% of household spending on medical expenses goes to treat such diseases according to disease the report of Health Facilities in Kumasi for 2005 to 2010. After clean water is obtainable that rate of figure will improve.

14.7.2 Financial Analysis

The Sector Programmes for the water supply sector shall involve a large amount of capital investment for the operation body. A financial analysis has therefore been undertaken to determine the financial viability of the proposed programme. The following form some of the assumptions:

- An identified possible source of funding is not considered
- The current tariff structure and level has been analysed
- Non-revenue water (NRW) can be reduced from 35% to 10%
- A detailed financial projection and analysis was conducted to examine the financial viability of the proposed programme; and the Financial Internal Rate of Return (FIRR) was calculated.

(1) Financial Costs

Financial costs of the programme are summarized in Table 14.7.5. Operational cost and maintenance cost were also estimated based on the calculation of the economic cost in the above section.

Table 14.7.5 Financial Costs of Water Supply Sector Programme

Unit: GHC Thousand

Description	Cost	Remarks
Capital Investment Cost	1,125,100	See Table 14.5.3
Operation Cost	2,812,358	
Maintenance Cost	133,200	

Source: JICA Study Team

(2) Financial Benefit

The revenue from the increase sales of water derived from the Sector Programme is calculated as the financial benefit. The average tariff level of GHC 0.85/m^3 for households and GHC1.81/m^3 for non-domestic use is applied, which are the same as those given in the "Publication of Water Tariffs" of 2012 issued by Ghana Water Co., Ltd. The water sales volume is computed (see Table 14.7.6) based on the demand capacity as presented in the Sector Programmes.

Table 14.7.6 Water Demand Volume

Unit: m^3/day

	2013	2018	2023	2028	2033
Domestic Water Demand	45,900	81,000	110,700	201,100	269,100
Non-domestic Consumption	25,300	44,600	60,900	110,700	148,100
Total Water Demand	71,200	125,600	171,600	311,800	417,200

Source: JICA Study Team

(3) Result of Financial Analysis

The cash flow projection based on the above assumptions is presented in Table 14.7.7. Revenue from households was assumed in accordance with total demand for piped water. The computed Financial Internal Rate of Return (FIRR) for the programme is 3.87%. This value for the Sector Programme is not very high. However, the assumption regarding the revenue and expenses of O & M contain a great deal of uncertain data therefore, the JICA Study Team indicated that the figure is only preliminary.

Table 14.7.7 Financial Flow of Water Supply Sector Programme

Unit: GHc 1,000

Year	Revenue	COST		COST TOTAL C	Revenue TOTAL B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	10,400	10,400	0	-10,400	10,400	0	-10,400
2014	35,806	26,632	35,200	61,832	35,806	-26,026	55,207	31,969	-23,238
2015	40,550	29,763	35,200	64,963	40,550	-24,413	51,788	32,326	-19,462
2016	45,294	32,894	33,700	66,594	45,294	-21,300	47,400	32,240	-15,161
2017	50,038	36,025	33,700	69,725	50,038	-19,687	44,312	31,800	-12,511
2018	54,783	39,157	33,800	72,957	54,783	-18,174	41,398	31,085	-10,312
2019	58,793	41,803	21,100	62,903	58,793	-4,110	31,869	29,786	-2,082
2020	62,803	44,450	15,100	59,550	62,803	3,253	26,938	28,409	1,472
2021	66,814	47,097	15,100	62,197	66,814	4,617	25,120	26,985	1,865
2022	70,824	49,744	15,100	64,844	70,824	5,980	23,383	25,540	2,157
2023	74,834	52,391	15,200	67,591	74,834	7,244	21,762	24,095	2,332
2024	87,066	60,463	82,800	143,263	87,066	-56,198	41,185	25,029	-16,155
2025	99,297	68,536	118,800	187,336	99,297	-88,039	48,084	25,487	-22,597
2026	111,528	76,609	118,800	195,409	111,528	-83,880	44,783	25,559	-19,223
2027	123,760	84,681	118,800	203,481	123,760	-79,722	41,636	25,324	-16,313
2028	135,991	95,454	82,900	178,354	135,991	-42,363	32,585	24,845	-7,740
2029	145,183	101,521	67,900	169,421	145,183	-24,238	27,636	23,683	-3,954
2030	154,376	107,588	67,900	175,488	154,376	-21,112	25,559	22,484	-3,075
2031	163,568	113,655	67,900	181,555	163,568	-17,987	23,609	21,270	-2,339
2032	172,761	119,722	67,900	187,622	172,761	-14,861	21,784	20,059	-1,725
2033	181,954	125,789	67,800	193,589	181,954	-11,636	20,069	18,863	-1,206
2034	191,146	131,856		131,856	191,146	59,290	12,205	17,692	5,488
2035	200,339	137,923		137,923	200,339	62,415	11,398	16,556	5,158
2036	209,531	143,991		143,991	209,531	65,541	10,625	15,461	4,836
2037	218,724	150,058		150,058	218,724	68,666	9,886	14,410	4,524
2038	227,916	156,125		156,125	227,916	71,791	9,184	13,407	4,223
2039	237,109	162,192		162,192	237,109	74,917	8,518	12,453	3,935
2040	246,301	168,259		168,259	246,301	78,042	7,890	11,550	3,660
2041	255,494	174,326		174,326	255,494	81,168	7,299	10,697	3,398
2042	264,686	180,393		180,393	264,686	84,293	6,744	9,895	3,151
2043	273,879	186,460	-254,333	-67,873	273,879	341,752	-2,265	9,142	11,407
	4,261,148	2,945,558	870,767	3,816,324	4,261,148	444,824	787,991	658,102	-129,889

B / C	0.8352
FIRR %	3.87
NPV (GHc)	-129,889

Chapter 15 Liquid Waste Treatment Sector Plan and Programme

15.1 Objectives for Liquid Waste Treatment Sector Development

For Liquid Waste Treatment Sector Development, the following three benefits have been found:

- Better access to hygienic toilets
- Adequate treatment of liquid waste
- Gradual improvement of the sanitation environment including treatment of grey water

1) Better Access to Hygienic Toilets

At present there are still many residents defecating indiscriminately. The target in this aspect for 2033 is that all households should have access to hygienic toilets, public toilet facilities at least.

2) Adequate Treatment of Liquid Waste

There are some cases of treatment for Liquid Waste in KMA, and surrounding Districts / Municipality, so the target for 2033 is that appropriate treatment methods should be applied based on the type of wastewater, population density and etc.

3) Gradual Improvement of the Sanitation Environment including Treatment of Grey Water

In the short term, it is recommended to treat industrial effluent and Black water discharged from domestic and commercial sources. But in the future all waste water, including Grey water, should be treated, so the target for 2033 is preparation of conventional sewerage systems.

15.2 Future Demand Analysis

15.2.1 Present Situation of Liquid Waste Treatment

According to the 2010 population and housing census, the condition of toilet facilities of households by district is shown in the table below.

Table 15.2.1 Condition of Toilet Facilities of Households

		Pop	Rate (%)			Population (Nr)		
			Household Toilet	Public Toilet	No Facilities	Household Toilet	Public Toilet	No Facilities
KMA		2,035,064	58.7	38.8	2.5	1,193,846	789,814	51,404
Afigya-Kwabre		136,140	55.2	34.7	10.1	75,138	47,209	13,792
Kwabre East		115,556	52.3	40.5	7.2	60,411	46,781	8,364
Ejisu-Juaben		143,762	44.8	48.8	6.4	64,453	70,112	9,196
Bosomtwe		93,910	46.3	48.1	5.7	43,450	45,128	5,332
Atwima Kwanwoma		90,634	50.0	39.1	10.9	45,278	35,451	9,905
Atwima-Nwabiagya		149,025	52.6	42.2	5.2	78,439	62,882	7,704
Average	KMA	2,035,064	58.7	38.8	2.5	1,193,846	789,814	51,404
	Districts	729,027	50.4	42.2	7.4	367,169	307,563	54,293
Greater Kumasi Sub-Region		2,764,091	56.5	39.7	3.8	1,561,015	1,097,377	105,697

Source: 2010 Population and Housing Census

Less than 10% of households in KMA are connected to one of the simplified sewerage systems, which includes the Asafo sewerage system, Ahinsan sewerage system and Chirapatre sewerage system. The remaining household toilets in KMA, all household toilets in the Districts and all public toilets are on W.C., Pit latrine, KVIP, and etc. Septage from septic tanks and pits is delivered to the Oti Septage Treatment Pond or discarded in the vicinity.

Grey water (generated from washing dishes, laundry and bathing) is not treated but rather is discharged into water bodies.

Moreover, the percentages of people that defecate indiscriminately are 2.5% for KMA and 7.4% for surrounding districts and municipalities.

15.2.2 Future Prospect for Liquid Waste Volume

In order to estimate the future prospects for liquid waste volume, the following conditions are set:

- Future population predicted by the JICA Study Team is adopted
- Consumption of water is adopted from the Water Supply Sector Programme
- Percentage of black water (from toilets) is 40% of total water consumption

Based on these conditions, future projections for liquid waste volume are summarized in the table below.

Table 15.2.2 Future Projections for Liquid Waste Volume

		Unit	2013	2018	2023	2028	2033
Population of Greater Kumasi Sub-Region		Nr.	3,127,010	3,749,705	4,393,019	5,050,422	5,761,463
Water Supply through Pipeline for Hose Connections							
	Population	Nr.	1,027,643	1,255,222	1,467,885	2,900,926	4,112,716
	Per Capita	Lcd	30	40	50	55	60
	Black Water Volume	m^3/day	12,330	20,080	29,360	63,820	98,710
	Gray Water Volume	m^3/day	18,500	30,130	44,040	95,730	148,060
	Total Volume	m^3/day	30,830	50,210	73,400	159,550	246,770
Water Supply from Standpipe or Borehole							
	Population	Nr.	2,099,367	2,494,482	2,925,134	2,149,496	1,648,747
	Per Capita	Lcd	20	30	30	30	30
	Black Water Volume	m^3/day	16,790	29,930	35,100	25,790	19,780
	Gray Water Volume	m^3/day	25,190	44,900	52,650	38,690	29,680
	Total Volume	m^3/day	41,980	74,830	87,750	64,480	49,460
Total Liquid Waste Volume							
	Black Water Volume	m^3/day	29,120	50,010	64,460	89,610	118,490
	Gray Water Volume	m^3/day	43,690	75,030	96,690	134,420	177,740
	Total Volume	m^3/day	72,810	125,040	161,150	224,030	296,230

Source: JICA Study Team
Note: The volume of liquid waste assumes domestic use only.

For septage from septic tanks and pits, it is difficult to assume an actual average daily generation volume per capita, due to lack of data for Oti treatment pond. The average daily volume of septage generation per capita varies by type of toilet facilities such as WC septic tank, VIP latrines or etc. However, the septage generation rate of 0.15 litres/capita/day is applied in this study, based on the capacity of Oti Septage Treatment Pond ($300m^3$/day) and population of KMA in 2010 (2 million). Future septage amounts are estimated as shown in the table below;

Table 15.2.3 Future Projections for Septage Amount

Unit: ton/day

	2013	2018	2023	2028	2033
KMA	349	415	482	523	577
Afigya-Kwabre	21	24	29	33	39
Kwabre East	18	21	24	26	33
Ejisu-Juaben	23	26	30	50	66
Bosomtwe	15	17	20	22	25
Atwima Kwanwoma	14	16	19	22	30
Atwima-Nwabiagya	23	27	31	32	38
Greater Kumasi Sub-Region	463	546	635	708	808

Source: JICA Study Team

From the above future projections for liquid waste volumes and septage amounts, the following situations are assumed for the future:

- The construction of household toilets and public toilets is necessary due to population growth.

- The capacity of Oti Septage Treatment Pond might be insufficient due to the increasing amount of septage.
- The volume of grey water generated from washing dishes, laundry and bathing will increase, and non-treated grey water will be discharged into and contaminate water bodies.

15.3 Strategies for Liquid Waste Treatment Sector Development

15.3.1 Increase of Access to Hygienic Toilets

Firstly, it is important and essential to educate the people regarding the importance of hygienic toilets.

Secondly, construct public toilet facilities to reduce the percentage of the population which defecate indiscriminately, although, according to the UNICEF / WHO Joint Monitoring Programme on sanitation, public shared toilets (and home toilet facilities shared by more than one household) are not considered as improved sanitation.

Thirdly, provide financial support to residences for the construction of household toilets.

In order to increase the access rate to hygienic toilets, these above three strategies are the most important in the short term.

15.3.2 Construction of Simplified Sewerage System in Selected Highly Populated Areas

In the areas with high density population, construction of simplified sewerage systems is the only viable option as there is insufficient open space for WC / septic tank drain fields, inadequate room on the ground floor for VIP latrines, and interference from the multi-storey buildings themselves with the wind flow needed for proper ventilation of VIP latrines.

Liquid waste collected will be treated at the stabilization pond. Thus, it is essential to reserve land (relatively low lying areas) for the stabilization pond near to the highly populated areas to collect liquid waste efficiently.

15.3.3 Enforcement of Environmental Policy and Regulations

To enforce laws to ensure industry, commercial enterprises and individuals comply with the environmental sanitation policy is an essential strategy.

15.3.4 Construction of Septage Treatment Ponds in Each District

In the solid waste management sector plan, it is recommended to construct small-scale final landfill sites in each district. Since in this case final landfill sites should treat leachate, it is recommended to construct septage treatment ponds along with final landfill sites and treat the septage from septic tanks in each district.

Construction of a final landfill site and a septage treatment pond in the same site will reduce the transport cost of septage.

15.3.5 Create a New Organization for Liquid Waste and Commence a Comprehensive Study for Establishing Conventional Sewage Systems

Stabilization ponds occupy extensive spaces. In the future, a shortage of land is expected for treatment ponds and treatment capacity is also considered to be in shortage due to population growth and increase of water volume.

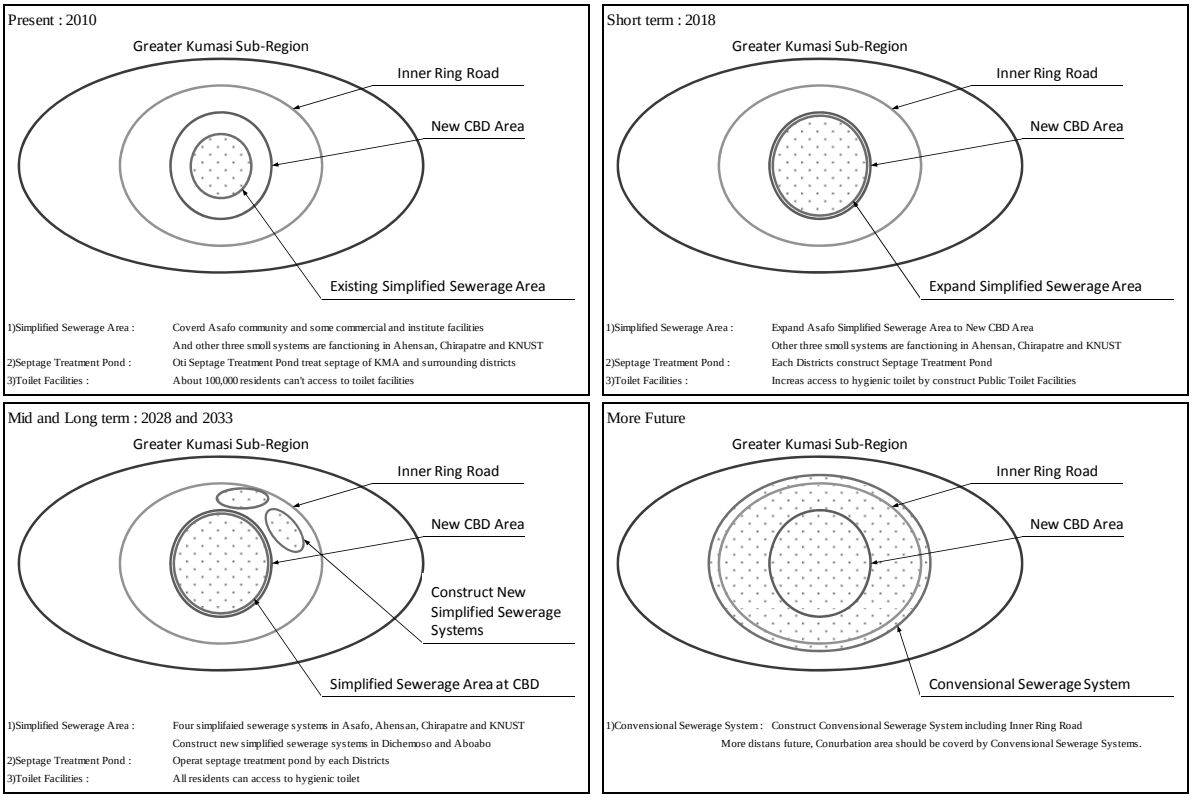
Therefore, it is recommended to construct a conventional sewerage system sometime in the future. Construction of a large-scale conventional sewerage system is required for reduction of construction and maintenance costs and for efficient operation.

In this recommendation on the establishment of large-scale sewerage systems, it is essential to determine the sewerage service areas ignoring administrative boundaries of KMA and surrounding districts and municipalities, but rather considering geographical conditions.

It is necessary to commence a comprehensive study regarding liquid waste and sewerage systems for Greater Kumasi Sub-Region. In order to construct and operate a large-scale conventional sewerage system, a new organization should be founded covering different local government areas.

15.4 Liquid Waste Treatment Sector Plan

A Liquid Waste Treatment Sector Plan is prepared and the plan shown in Figure 15.4.1 is recommended for Greater Kumasi Sub-Region.



Source: JICA Study Team

Figure 15.4.1 Liquid Waste Treatment Sector Plan

15.4.1 Increase of Access to Hygienic Toilets

Firstly, it is important and essential to educate the people regarding the importance of hygienic toilets.

Secondly, construct public toilet facilities to reduce the percentage of the population which defecate indiscriminately.

According to the 2010 population and housing census, in KMA, 59% have access to household toilets, about 39% rely on public toilets and the remaining defecate indiscriminately, for surrounding districts and municipalities, 50% have access to household toilets, about 42% rely on public toilets and the remaining defecate indiscriminately.

In the future, the above percentages should be improved by implementing strategies in order to achieve the objectives. Numerical targets for toilet facilities are shown in Table 15.4.1, these numerical targets are set based on the following policies:

- Before 2023 (in ten years), all residents will be able to access hygienic toilets.
- Household toilets will be additionally constructed for the houses where toilets are currently not available.
- The 10% of households that relied on public toilets will have new household toilets constructed in conjunction with the move to the suburbs based on urban planning.

Table 15.4.1 Numerical Target for Toilet Facilities

		2013	2018	2023	2028	2033
KMA	Household toilet	59%	66%	72%	76%	80%
	Public toilet	39%	33%	28%	24%	20%
	Defecate indiscriminately	2%	1%	0%	0%	0%
Surrounding Districts and Municipalities	Household toilet	51%	58%	65%	71%	76%
	Public toilet	42%	39%	35%	29%	24%
	Defecate indiscriminately	7%	3%	0%	0%	0%

Source: JICA Study Team

Thirdly, provide financial support to residences for the construction of household toilets.

15.4.2 Construction of Simplified Sewerage System in Selected Highly Populated Areas

In the areas with high density population, construction of simplified sewerage systems is the only viable option, as there is insufficient open space for WC / septic tank drain fields, inadequate room on the ground floor for VIP latrines, and interference from the multi-storey buildings themselves with the wind flow needed for proper ventilation of VIP latrines.

Liquid waste collected will be treated at the stabilization pond. Thus, it is essential to reserve land (relatively low lying areas) for the stabilization ponds near to the highly populated areas to collect liquid waste efficiently.

Of all the communities in KMA, about 620 households and some commercial facilities are connected to the simplified sewerage systems at Asafo, Ahinsan and Chirapatre.

In the future, the simplified sewerage system should be expanded in order to achieve the objectives. Targets for the simplified sewerage system are set that cover other communities which centre on the KMA and high population density areas.

15.4.3 Enforcement of Environmental Policy and Regulations

To enforce laws to ensure industry, commercial enterprises and individuals comply with the environmental sanitation policy is an essential strategy.

15.4.4 Construction of Septage Treatment Ponds in Each District

In the solid waste management sector plan, it is recommended to construct small-scale final landfill sites in each district. Since in this case final landfill sites should treat leachate, it is recommended to construct septage treatment ponds along with final landfill sites and treat the septage from the septic tanks in each district.

Construction of a final landfill site and a septage treatment pond in the same site will reduce the transport cost of septage.

15.4.5 Create a New Organization for Liquid Waste and Commence a Comprehensive Study for Establishing Conventional Sewerage Systems

There are no conventional sewerage system plans in KMA or the surrounding districts and municipalities.

In the meantime, adequate treatment for liquid waste (black water only) such as septage treatment and the simplified sewerage system is sufficient. But in the more distant future, it will be necessary to construct conventional sewerage systems and treat all waste water including grey water because of the lack of capacity of septage treatment ponds and contamination of ground water and water bodies by grey water.

Therefore, in the future after 2033, conventional sewerage systems should be constructed in the conurbation area.

15.5 Liquid Waste Treatment Sector Programme

(1) Outline of the Programme for the Liquid Waste Treatment Sector

The JICA Study Team will prepare an implementation plan for the prioritized actions and projects composing the Liquid Waste Treatment sector programme.

There are 5 sub-programmes for the liquid waste treatment sector for the Greater Kumasi Sub-Region.

- Sub-Programme 1: Increase access to hygienic toilets
- Sub-Programme 2: Construction of simplified sewerage systems
- Sub-Programme 3: Enforcement of environmental policy and regulations
- Sub-Programme 4: Construction of septage treatment ponds in adjoining districts
- Sub-Programme 5: Construction of conventional sewerage systems.

The detailed plans for each Programme are as follows:

1) Sub-Programme 1: Increase Access to Hygienic Toilets

- Hold meetings regarding the importance of hygienic toilets in each community and school.
- Construct public toilets

2) Sub-Programme 2: Construction of Simplified Sewerage Systems

- Expand the existing Asafo simplified sewerage system
- Construct new simplified sewerage systems

3) Sub-Programme 3: Enforcement of Environmental Policy and Regulations

- Enforce the Environmental Sanitation Policy, laws and regulations for existing industries which have no treatment facilities.
- Enforce the Environmental Sanitation Policy, laws and regulations for planned industries prior to commencement of operation.

4) Sub-Programme 4: Construction of Septage Treatment Ponds in Adjoining Districts

- Formulate septage treatment ponds and final landfill construction plans for each district and municipality, and identify suitable sites for construction of septage treatment ponds in each district and municipality.
- Implement septage treatment pond and final landfill plans for each district and municipality

5) Sub-Programme 5: Development of Conventional Sewerage Systems

- Formulate a comprehensive conventional sewerage plan
- Found a new organization for conventional sewerage systems beyond exiting local governments (MMDAs)

(2) Sub-Programme fro Increase Access to Hygienic Toilets

1) Hold Meetings Regarding the Importance of Hygienic Toilets in Each Community and School

The Environmental Health Departments (EHD) of all assemblies in Greater Kumasi are in charge of the environmental sanitation education, inspection and enforcement of sanitary regulations regarding the liquid waste.

The EHD should continue the education regarding the importance of hygienic toilets by holding meetings in each community and school.

Moreover, training shall be provided to all household latrine owners on the operation and maintenance of the latrine facility. Continuing health education and technical assistance shall be provided for owners/managers of all latrines to enable them to function properly.

2) Construction of Public Toilets

The population that defecate indiscriminately in 2010 are assumed to be 51,400

people in KMA and 54,300 people in surrounding districts and municipalities (see Table 15.5.1). There is no evidence regarding how many people using one public toilet is appropriate, because public toilets are not recommended in some policies. So in this study, it is assumed that 300 people can use one public toilet. Then the number of public toilets that should be constructed is assumed as shown in the table below.

Table 15.5.1 Assumed Number of Public Toilets

	Population that defecate indiscriminately	Population per public toilet	Number of public toilets required
KMA	51,404	300	172
Afigya-Kwabre	13,792	300	46
Kwabre East	8,364	300	28
Ejisu-Juaben	9,196	300	31
Bosomtwe	5,332	300	18
Atwima Kwanwoma	9,905	300	34
Atwima-Nwabiagya	7,704	300	26
Outside KMA	54,293		183
Greater Kumasi Sub-Region	105,697		355

Source: JICA Study Team

(3) Sub-Programme for Construction of Simplified Sewerage System in Some Highly Populated Areas

1) Simplified Sewerage System Areas

The current population density is calculated using the 2010 census as shown in Figure 15.5.1.

Source: JICA Study Team based on Population and Housing Census 2010 data

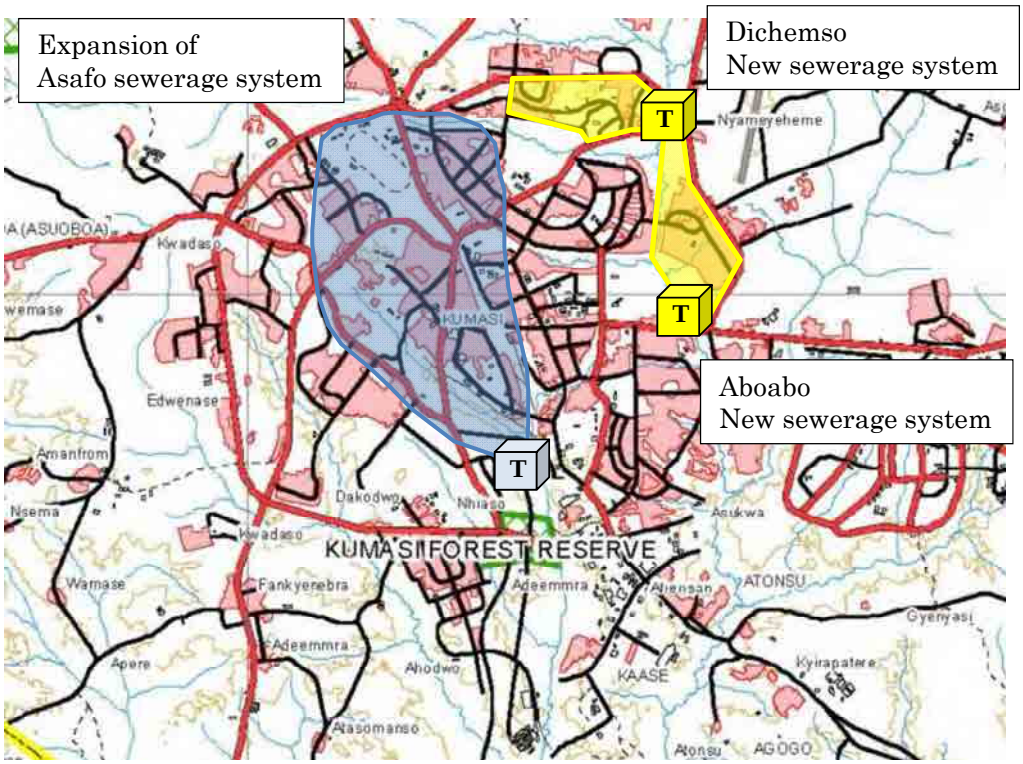
Figure 15.5.1 Population Density in 2010

It is assumed that the most highly populated areas have more than 300 people per hectare. According to the Strategic Sanitation Plan for Kumasi (SSP-Kumasi) of 1995, simplified sewerage systems are recommended in high density tenement areas (300 – 600 person/ha).

Therefore, it is recommended that the simplified sewerage system areas include the city centre of KMA, including Bantama, Dichemso, Ashtown, Aboabo, Adum, Fante New Town, Central Market, Mbron and Sun City, in accordance with the concept of KMA-WMD.

Bantama, Ashtown, Adum, Fante New Town, Central Market, Mbron and Sun City are areas for expansion of the exiting Asafo sewerage system, and the others are areas for construction of new sewerage systems.

Figure 15.5.2 shows the projected area for expansion and new construction of simplified sewerage systems.



Source: JICA Study Team

Figure 15.5.2 Project Areas for Simplified Sewerage Systems

2) Various Specifications for Simplified Sewerage Systems

a) Future Volume of Liquid Waste

Future volume of liquid waste generation by the year 2033 is projected based on the following considerations:

- Population
- Average daily generation volume per capita

The population of Greater Kumasi Sub-Region by the year 2033 is expected to be

more than 5 million people and the population using simplified sewerage systems is assumed as shown in the table below.

Table 15.5.2 Population using Sewer Systems

	Coverage Area (ha)	Population using Sewer Systems (persons)
Expansion area of Asafo sewer system	465	242,000
New sewer system for Dichemso	100	73,000
New sewer system for Aboabo	130	92,000
Total	695	407,000

Source: JICA Study Team

In accordance with the water supply plan, average daily volume of liquid human waste (Black water) is assumed to be 24 litres/capita/day. Water supply demand is 60 litres/capita/day and the percentage of black water (from toilets) is 40% of total consumption. In this assumption, the liquid waste volume that is treated in each sewerage system is assumed to be as shown in the table below.

Table 15.5.3 Liquid Waste Volume

	Population using Sewer Systems (persons)	Liquid Waste Volume (m^3/day)
Expansion area of Asafo sewer system	242,000	5,810
New sewer system for Dichemso	73,000	1,750
New sewer system for Aboabo	92,000	2,210
Total	407,000	9,770

Source: JICA Study Team

b) Size of Stabilization Ponds

In general, the size of a stabilization pond depends on water quantity and quality, but in this study it is difficult to set the quality of liquid waste. So in this study, the size of the stabilization ponds is assumed based on the retention time of 20 days and pond depth of 1.5m. The land area necessary for constructing a stabilization pond is considered to be 1.5 times larger than that of the stabilization pond size.

In these conditions, the size of the stabilization ponds is assumed as shown in the table below.

Table 15.5.4 Size of Stabilization Ponds

	Liquid waste volume (m^3/day)	Size of Stabilization pond (m^2)
Expansion area of Asafo sewer system	5,810	117,000
New sewer system for Dichemso	1,750	35,000
New sewer system for Aboabo	2,210	45,000

Source: JICA Study Team

3) Concerns about Construction of Simplified Sewerage System

Regarding construction of simplified sewerage systems, there are some concerns.

a) Treatment Method

In this study, stabilization ponds are recommended for the simplified sewerage systems, and the predicted size of the ponds and locations with lower elevations near rivers are chosen.

But in this prediction, some figures are assumed because of insufficient data such as waste water quality. If the actual waste water condition contain much pollutants and the volume of waste water is large, it will be impossible to construct stabilization ponds because of the lack of available land space near rivers.

Therefore, in the planning, it is necessary to select the appropriate treatment method by caring out a comprehensive evaluation including water quality.

b) Connection to Simplified Sewerage System

In order to properly use simplified sewerage systems, W.C. toilet facilities are recommended. But it is predicted that the water supply will be insufficient and W.C. toilet facilities are not widely used.

In the worst case, the new simplified sewerage system will not be properly utilized even after construction of the facilities for the following reasons.

- Lack of water
- Improvement of toilet facilities is not implemented
- Residents won't connect to the sewerage system due to lack of affordability

Therefore, in the planning, it is necessary to confirm the condition of the water supply, type of toilet facilities and willingness.

c) Construction Period

Regarding the new simplified sewerage systems at Dichmso and Aboabo, they are defined as re-development areas. So it is recommended to construct new simplified sewerage systems after re-development. Because if new simplified sewerage systems are constructed before re-development, it will be possible that the simplified sewerage systems would have to be constructed again at the time of re-development.

(4) Sub-Programme for Enforcement of Environmental Policy and Regulations

1) For Existing Industries without Treatment Facilities

In order to enforce the environmental policy, laws and regulations for exiting industries which have no treatment facilities, the EHD should conduct a field survey and provide instructions for improvement of sanitation.

Moreover, the EHD should conduct an investigation of effluent quality for the industries which have pre-treatment facilities.

2) For Planned Industries

The EHD should verify installation of pre-treatment facilities and conduct a survey of pre-treatment facilities to determine if they comply with the environmental Sanitation Policy, laws and regulations, prior to commencement of operation.

(5) Sub-Programme for Construction of Septage Treatment Ponds in Adjoining Districts

1) Future Liquid Waste Amount

Future liquid waste amount by the year 2033 is projected based on the following:

- Population
- Average daily generation volume per capita

Due to the lack of data for Oti treatment pond, it is difficult to assume an actual average daily generation volume per capita and the average daily generation volume per capita varies by type of toilet facilities such as WC septic tank, VIP latrines etc. Therefore, the septage generation rate of 0.15 litres/capita/day is applied in this study, based on the capacity of Oti septage treatment pond (300 m^3/day) and population of KMA in 2010 (2 million).

Future liquid waste amount estimated by the year 2033 for the surrounding districts and municipalities is shown in the table below:

Table 15.5.5 Forecast of Future Liquid Waste Amount

Districts	Population In 2033 (persons)	liquid Waste Amount (m^3/day)
KMA	3,843,741	577
Afigya-Kwabre	259,891	39
Kwabre East	220,322	33
Ejisu-Juaben	438,940	66
Bosomtwe	165,273	25
Atwima Kwanwoma	198,629	30
Atwima-Nwabiagya	251,548	38

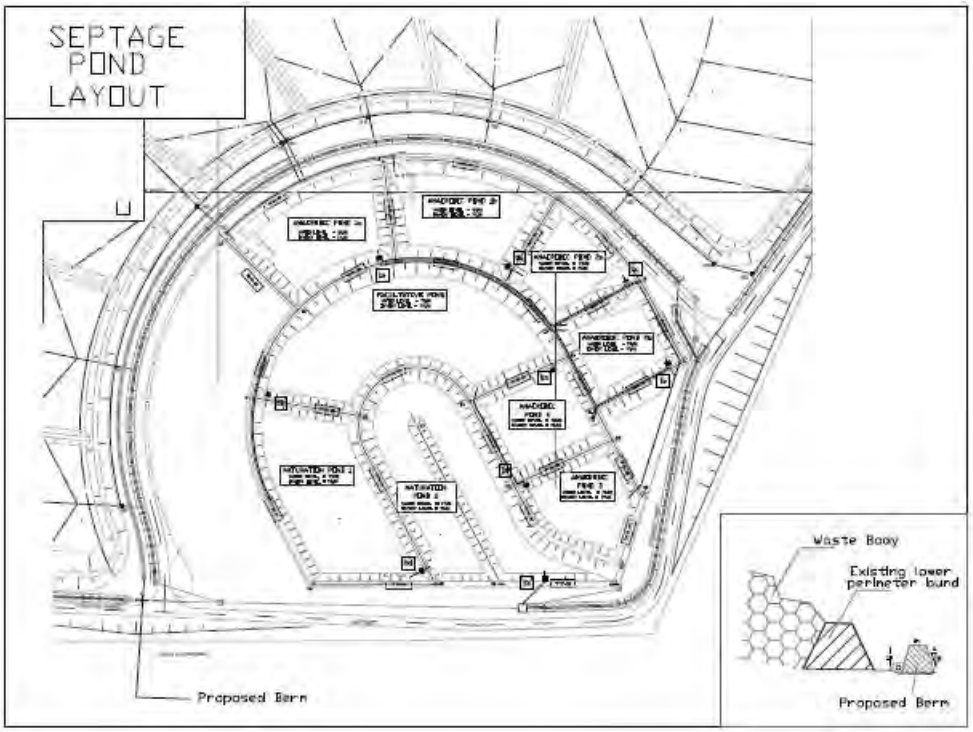
Source: JICA Study Team

2) Construction Plan for Septage Treatment Ponds

The size of the septage treatment ponds is assumed based on the amount of liquid waste and the layout of the septage treatment ponds is assumed based on the Oti septage treatment pond (see Figure. 15.5.3).

In the solid waste management sector plan and programme, it is also recommended to construct a small-scale sanitary landfill site in each District and Municipality, since in this case the final landfill sites should treat leachate, it is recommended to construct the septage treatment ponds along with the final landfill sites and treat the septage discharged from the district.

Therefore, the site for a septage treatment pond is dependent upon the site of the small-scale sanitary landfill site.



Source : KMA-WMD

Figure 15.5.3 Layout of Oti Septage Treatment Pond

3) Septage Treatment Pond for KMA

Regarding Oti septage treatment pond for KMA, the amount of septage will be increase due to population growth, and shortage of capacity will be expected.

But the assumption of shortage of capacity is based on an uncertain daily generation volume of 0.15 litres/capita/day and on a collection rate of 100%. Moreover, pumping septage from septic tanks should be conducted each 5-10years, so the increase in septage volume will begin after a few years of population growth.

Therefore, it is recommended to identify the period of construction of the new septage treatment pond for KMA based on the amount of septage to be transported to Oti septage treatment pond.

(6) Sub-Programme for Development of Conventional Sewerage Systems

1) Outline of this Sub-Programme

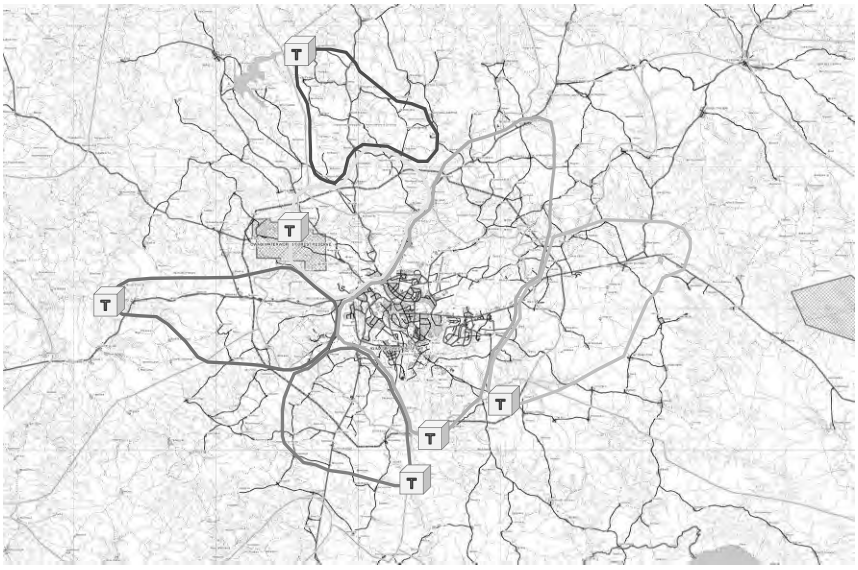
The conurbation area is recommended as the target area of a comprehensive study for conventional sewerage systems, because this area will be developed and urbanized.

Based on the comprehensive study, it is recommended to create a new organization for Liquid Waste and sewerage systems for Greater Kumasi Sub-Region, and the new organization should be founded covering different local government areas.

2) Recommendation Plan for Conventional Sewerage Systems

Considering the areas in which population density will be more than 60 pop/ha in

2033, the surface gradient of the Conurbation area and future land use plan, it is recommended to divide the system into six conventional sewerage systems as shown in figure 15.5.4. Regarding these sewerage systems, the highest priority system is the sewerage system including the centre of KMA.



Source: JICA Study Team

Figure 15.5.4 Preliminary Plan for Conventional Sewerage Systems

The various specifications for the conventional sewerage systems are assumed as bellows:

- Position of Treatment Plant

  For conventional sewerage systems, it is better to locate them away from residential areas. Conventional treatment plants, therefore, should be constructed outside of the conurbation area as far as possible. Or conventional treatment plants should be constructed in areas of low population density at least.

- Treatment Method

  For conventional sewerage systems, all waste water, including grey water, should be treated properly, which means that a large amount of waste water should be treated. Therefore, some kind of activated sludge method is recommended in order to efficiently treat the sewage and reduce the area required for the treatment plant.

- Position of Pipe Line

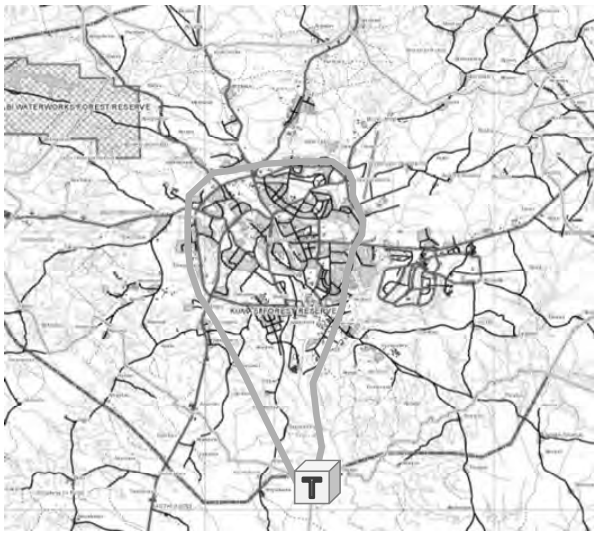
  For the sewerage systems, it is important to minimize the construction cost for the pipe lines, because the construction cost of pipe lines is considerably high. Therefore, the position of the pipe lines should not be limited to under roads only. Locations in the backs of houses and in the riverbeds should be considered as well.

3) Priority Area for Conventional Sewerage Systems

A high priority area for conventional sewerage systems is the area including the

centre of KMA. But in this preliminary draft of conventional sewerage systems, the planned area is still very large. So it is necessary to construct the conventional sewerage systems in a stepwise manner.

In that case, the first area for construction should be set as shown in Figure 15.5.5 because of population density, its function as city centre, water supply conditions and etc.



Source: JICA Study Team

Figure 15.5.5 High Priority Area for Conventional Sewerage Systems

In the year of 2033, the liquid waste volume of the highest priority area is assumed to be as shown in the table below. Based on this assumption, in the future, it will be necessary to treat the effluent by some kind of activated sludge method due to the large amount of liquid waste including gray water.

Table 15.5.6 Liquid Waste Volume of the Highest Priority Area in 2033

	unit	
Area	(ha)	3,500
Population	(Nr)	1,350,000
Average Generation	(lcd)	60
Domestic Liquid Waste Volume	(m3/d)	81,000
Non-Domestic rate	(%)	50
Non-Domestic Liquid Waste Volume	(m^3/d)	81,000
Total Liquid Waste Volume	(m^3/d)	162,000

Source: JICA Study Team
Note: Non-Domestic rate applied is 50%, because the area is in the city centre.

(7) Implementation Plan for Liquid Waste Treatment Sector Programme

An implementation plan for the prioritized actions and projects composing the Liquid Waste Treatment Sector Programme is prepared as in Chapter 22.

The goals of the sector programme for the liquid waste treatment sector of the project are outlined in Table 15.5.7 with prospective target levels to be achieved by the year 2018 for the short-term plan, year 2028 for the mid-term plan and year 2033 for the long-term plan.

Table 15.5.7 Programme Outline for Liquid Waste Treatment Sector

	Short-Term Plan						Mid-Term Plan										Long-Term Plan				
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Project 1: Increase access to hygienic toilets																					
a) Hold meetings in communities and schools		●	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▶
b) Construct public toilets		●	▬	▬	▬	▬	▬	▬	▬	▬	▶										
Project 2: Construction of sewerage systems																					
a) Expand the existing Asafo sewerage system		●	▬	▬	▬	▬	▬	▬	▬	▬	▶										
b) Construct new simplified sewerage systems												●	▬	▬	▬	▬	▬	▬	▬	▬	▶
Project 3: Enforcement of environmental policy and regulations																					
a) Existing industries without treatment facilities		●	▬	▶																	
b) Planned industries, prior to commencement of operation		●	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▬	▶
Project 4: Construction of septage treatment ponds																					
a) Formulate implentation plans		●	▶																		
b) Implement plans for each district and municipality			●	▬	▶																
Project 5: Construction of conventional sewerage systems.																					
a) Formulate a comprehensive conventional sewerage plan																	●	▬	▶		
b) Find a new organization																			●	▬	▶

Source: JICA Study Team

15.6 Cost of Sector Programme

Project costs of the liquid waste sector programmes are shown Table 15.6.1. The costs are estimated based on the Strategic Sanitation Plan for Kumasi.

Table 15.6.1 Project Costs for Liquid Waste Treatment Sector Programmes

		Cost ($x10^3$ GHC)	Remarks
Programme 1: Increase access to hygienic toilets			
	a) Hold meetings at each community and school.	---	
	b) Construct public toilets	3,550	
Programme 2: Construction of sewerage systems			
	a) Expand the existing Asafo sewerage system	16,200	
	b) Construct new sewerage systems	12,200	
Programme 3: Enforcement of environmental policy and regulations			
	a) To exiting industries without treatment facilities	---	
	b) To planned industries, prior to commencement of operation	---	
Programme 4: Construction septage treatment ponds			
	a) Formulate construction plan	620	10% of Construct
	b) Implement plans by each district and municipality	6,170	
Programme 5: Prepare construction of conventional sewerage systems			
	a) Formulate a comprehensive conventional sewerage plan	---	
	b) Find a new organization	---	

Source: JICA Study Team

15.7 Preliminary Economic and Financial Analysis

15.7.1 Economic Analysis

(1) Methodology

With the implementation of the sector programme, significant benefits, both direct

and indirect, could be attained. Liquid waste treatment is necessary as a basic social infrastructure in towns. The programme effect shall be considered to be the reduction in the disposal cost and the improvement of the public sanitation. It is quite hard to quantify the benefits, therefore, the following steps were used to assume the quantifying benefits:

Step 1: Identification of "with" and "without" cases,
Step 2: Assumption of parameters for direct benefits such as affordability to pay and reduction of disposal cost,
Step 3: Estimation of economic costs based on the estimated capital investment cost mentioned in the previous section, and
Step 4: Economic evaluation using economic benefits and economic costs.

(2) "With" and "Without" Cases

The programme inputs and outputs should be identified, quantified and valued by comparing the "Without" situation with that of "With" case to derive the economic benefits.

1) "With" Case

The expansion of the liquid waste treatment facilities and future waste stream are implemented in accordance with the proposed Sector Programme.

2) Without Case

The current facilities, waste stream and the capacity of the disposal area shall continue unchanged in the future.

(3) Assumptions

1) Benefits

Application of Affordability to Pay

To estimate the value of the impact the affordability to pay based on the ratio of disposable income is quantified. According to the "Project appraisal manual" issued by IBRD, the ratio of sewage cost in the household budget is 1% so that the monthly affordability to pay for this sector in households is GHC 4.5/month. The beneficiaries may be only those covered by the Asafo simplified sewerage system and those who are covered by the new sewerage system.

Saving on Liquid Waste Disposal Cost

The average unit rate of current disposal cost is calculated at GHC 80-100 per trip based on the "Tariff Systems for Public Toilets in the Kumasi Metropolis: The Ghana Case Study" of 2011. After the septage treatment ponds and sewage pipe lines are constructed, the disposal cost and number of trips will be reduced.

The expenditure for the conventional system mainly consists of transportation cost, (approximately 80% of cost). The differences in distance between the various

MMDAs and the existing landfill and the MMDAs and the future facilities, which are to be located adjacent to the solid waste landfill site are estimated as shown in the following Table 15.7.1. The reduction in cost is GHC 2.5/km based on the calculation of Vehicle Operation Cost (VOC) for trucks.

Table 15.7.1 Distance to Landfill

(Unit: km)

MMDAs	Existing Location	Proposed Site
KMA	10	10
Afigya Kwabre	30	7 to 10
Kwabre East	25 to 30	6 to 10
Ejisu-Juaben	25 to 30	7 to 10
Bosomtwe	15	7 to 10
Atwima Kwanwoma	30	7 to 12
Atwima Nwabiagya	30 to 35	7 to 13
Average Distance	24.5 km	9 km

Source: JICA Study Team

2) Septage Volumes

The estimated septage volumes for the "With Case" and "Without Case" are shown in Table 15.7.2.

Table 15.7.2 Estimated Septage Volumes

(Unit: Ton/day)

	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
"With Case"	463	546	635	708	808
"Without Case"	463	557	653	752	859

Source: JICA Study Team

(4) Estimation of Economic Cost

The capital investment cost of the proposed sector programme is estimated at GHC 35.1 million. In this study the economic cost was estimated by deducting government taxes and import duty from the financial cost. A conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 29.9 million as shown in Table 15.7.3. O &M cost applied is 2% of investment cost.

Table 15.7.3 Economic Cost of Liquid Waste Sector

	Financial Cost (GHC Thousand)	Conversion Factor	Economic Cost
Programme 2 Construction of Sewerage Systems	28,400	0.85	24,140
Programme 4 Construction of Septage Treatment Pond	6,790	0.85	5,771
Total	35,190		29,911

Source: JICA Study Team

(5) Result of Economic Analysis

The analysis flow projection based on the above assumptions is presented in Table 15.7.4.

All the sub-programmes together will have an EIRR of 13.48%. The hurdle rate for an EIRR is difficult to determine. In a previous study, 10% was used, while the Asian Development Bank uses a 12% cut-off rate for all projects that apply for a loan. The results show that all the sub-programs together exceed these hurdle rates. Therefore, the plan is economically viable. The NPV of all the sub-programs is GHC 3.5 million using a 12% discount rate.

Table 15.7.4 Economic Flow of Liquid Waste Sector Programmes

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	1,426	1,426	0	-1,426	1,426	0	-1,426
2014	-7	25	1,427	1,452	-7	-1,459	1,297	-7	-1,303
2015	28	50	2,738	2,788	28	-2,760	2,222	22	-2,200
2016	743	101	2,563	2,664	743	-1,921	1,896	529	-1,368
2017	796	153	2,564	2,716	796	-1,920	1,726	506	-1,220
2018	1,906	204	2,564	2,767	1,906	-862	1,570	1,081	-489
2019	2,033	255	1,252	1,507	2,033	526	764	1,030	266
2020	2,160	262	1,252	1,514	2,160	646	685	977	292
2021	2,288	305	1,252	1,557	2,288	730	629	924	295
2022	2,415	330	1,252	1,582	2,415	833	571	871	300
2023	2,542	355	1,252	1,607	2,542	935	518	819	301
2024	3,028	380	1,037	1,417	3,028	1,610	407	870	463
2025	3,513	401	1,037	1,438	3,513	2,075	369	902	533
2026	3,998	422	1,037	1,459	3,998	2,540	334	916	582
2027	4,484	443	1,037	1,480	4,484	3,004	303	917	615
2028	4,969	463	1,037	1,500	4,969	3,469	274	908	634
2029	5,151	484	1,037	1,521	5,151	3,630	248	840	592
2030	5,333	505	1,037	1,542	5,333	3,792	225	777	552
2031	5,515	525	1,037	1,562	5,515	3,953	203	717	514
2032	5,697	546	1,037	1,583	5,697	4,114	184	661	478
2033	5,879	567	1,036	1,603	5,879	4,276	166	609	443
2034	6,061	588		588	588	0	54	54	0
2035	6,243	588		588	6,243	5,655	49	516	467
2036	6,425	588		588	6,425	5,837	43	474	431
2037	6,607	588		588	6,607	6,019	39	435	397
2038	6,789	588		588	6,789	6,201	35	399	365
2039	6,971	588		588	6,971	6,383	31	366	335
2040	7,153	588		588	7,153	6,565	28	335	308
2041	7,335	588		588	7,335	6,747	25	307	282
2042	7,517	588		588	7,517	6,929	22	281	259
2043	7,699	588		588	7,699	7,111	20	257	237
	131,273	12,656	29,911	42,567	125,799	83,233	16,361	18,297	1,936

B / C	1.1183
EIRR %	13.63
NPV (GHc)	1,936

15.7.2 Financial Analysis

The sector programme for the liquid waste treatment sector shall require an adequate amount of capital investment for the operation body. A financial analysis, therefore, has been undertaken to determine the financial viability of the proposed programme. The following are some of the considerations:

- An identified possible source of funding is not considered
- Current tariff structure and level have been analysed
- Private sector, public-private partnership agreements with KMA, turnover and expenses are not considered
- A detailed financial projection and analysis has been conducted to examine the financial viability of the proposed programme; the Financial Internal Rate of Return (FIRR) has been calculated.

(1) Financial Costs

Financial costs of the sector programme are summed up in Table 15.7.5, consisting of: i) capital investment cost and ii) operation and maintenance.

Table 15.7.5 Financial Costs of Liquid Waste Sector

Description	Cost (GHC Thousand)	Remarks
Capital Investment Cost	35,190	See Table 15.5.3
O & M	14,883	2% of each project

Source: JICA Study Team

(2) Financial Benefits

The revenue from the increase in the number of beneficiaries that utilize the new facilities that are derived from the sector programme by switching from simple sewerage systems will produce a financial benefit. The average beneficiary household tariff level of GHC 3/month in 2012 is applied as the unit treatment price and revenue from non-domestic sources, factories and commercial businesses are assumed to produce 35.5 % of all effluent based on the survey for the water supply sector.

In addition, it is also assumed that the improvement of septage facilities would be undertaken. The beneficiaries may be assumed to include most of the residents. Septage volume was calculated based on the "Tariff Systems for Public Toilets in the Kumasi Metropolis: The Ghana Case Study" of 2011. The collection businesses from the private sector are required to pay a flat tax of GHC 3 per tanker (4 ton truck) trip to the KMA. This is taken into account in the estimation of the expected revenue in this study.

Table 15.7.6 Beneficiaries of Liquid Waste Treatment Systems

	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Sewerage Systems[1)]	36,000	119,700	157,900	331,400	383,000
Septage Treatment Systems[2)]	3,091,010	3,630,004	4,235,119	4,719,022	5,378,463

Source: JICA Study Team
Note 1): Simplified Sewerage System for central part of KMA
Note 2): Septage Treatment Systems treating septage transported from septic tanks to stabilization ponds

(3) Result of Financial Analysis

The cash flow projection based on the above assumptions is presented in Table 15.7.7 below. The computed Financial Internal Rate of Return (FIRR) for the sector programme is 9.32%. This value for the sector programme is not very high. However, assumptions of revenue and expenses for O & M contain a great deal of uncertain data therefore these figures are preliminary.

Table 15.7.7 Financial Flow of Liquid Waste Sector Programme

Unit: GHc 1,000

Year	Revenue	COST		COST TOTAL C	Revenue TOTAL B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	1,678	1,678	0	-1,678	1,678	0	-1,678
2014	709	29	1,679	1,708	709	-1,000	1,525	633	-893
2015	896	59	3,221	3,280	896	-2,384	2,615	714	-1,900
2016	1,084	119	3,015	3,134	1,084	-2,050	2,231	771	-1,459
2017	1,271	179	3,016	3,195	1,271	-1,924	2,031	808	-1,223
2018	1,459	240	3,016	3,256	1,459	-1,797	1,847	828	-1,020
2019	1,548	300	1,473	1,773	1,548	-226	898	784	-114
2020	1,636	308	1,473	1,781	1,636	-145	806	740	-66
2021	1,725	359	1,473	1,832	1,725	-107	740	697	-43
2022	1,813	388	1,473	1,861	1,813	-48	671	654	-17
2023	1,902	418	1,473	1,891	1,902	11	609	612	4
2024	2,286	447	1,220	1,667	2,286	618	479	657	178
2025	2,670	472	1,220	1,692	2,670	978	434	685	251
2026	3,053	496	1,220	1,716	3,053	1,337	393	700	306
2027	3,437	521	1,220	1,741	3,437	1,696	356	703	347
2028	3,821	545	1,220	1,765	3,821	2,056	322	698	376
2029	3,939	569	1,220	1,789	3,939	2,150	292	643	351
2030	4,057	594	1,220	1,814	4,057	2,244	264	591	327
2031	4,176	618	1,220	1,838	4,176	2,338	239	543	304
2032	4,294	643	1,220	1,863	4,294	2,432	216	499	282
2033	4,413	667	1,220	1,887	4,413	2,526	196	457	262
2034	4,531	691		691	4,531	3,839	64	419	355
2035	4,649	691		691	4,649	3,958	57	384	327
2036	4,768	691		691	4,768	4,077	51	352	301
2037	4,886	691		691	4,886	4,195	46	322	276
2038	5,004	691		691	5,004	4,313	41	294	254
2039	5,123	691		691	5,123	4,432	36	269	233
2040	5,241	691		691	5,241	4,550	32	246	213
2041	5,359	691		691	5,359	4,668	29	224	195
2042	5,478	691		691	5,478	4,787	26	205	179
2043	5,596	691		691	5,596	4,905	23	187	164
	100,823	14,883	35,190	50,073	100,823	50,750	19,249	16,320	-2,929

B / C	0.8479
FIRR %	9.32
NPV (GHc)	-2,929

15.8 IEE of Liquid Waste Sector Programme

This Section of the chapter discusses the Initial Environmental Examination (IEE) for this Sector programme at an early level of planning regarding impacts caused by the implementation of the sector programme. Such assessment is drawn based on the results of the analysis of the existing conditions and on the initial screening process undertaken by the Project Team using the Environmental Impact Matrix. The detailed analyses of environmental impacts such as an Environmental Impact Assessment (EIA) will be conducted at the feasibility study phase. The conduct of an

IEE study under the sector programme is done in the following manner:

(1) Targets of the IEE Study

This Sector Programme consists of five components. The targets of the IEE study are shown in Table 15.8.1.

Table 15.8.1 Targets of IEE Study for Liquid Waste Sector

☐ Increase Access to Hygienic Toilets
☐ Construction of Sewerage Systems
☐ Enforcement of Environmental Policy and Regulations
☐ Construction of Septage Treatment Ponds
☐ Construction of Conventional Sewerage Systems

(2) Phasing of the IEE Study

To study the IEE, the programme components are divided into three phases, namely the Pre-Construction Phase, Construction Phase, and Operation and Maintenance Phase. The activities of each phase are as follows:

- **Pre-construction Phase**: which includes land acquisition, resettlement, mobilization of heavy equipment, transport of construction materials, construction of office buildings and labour camps, etc.
- **Construction Phase**: consisting of the setting up of equipment, demolition of the existing structures, implementation of construction works, generation of construction waste etc.
- **Operation and Maintenance Phase**: which includes the operation and maintenance of facilities, maintenance works, etc.

(3) Result of the IEE Study

In Ghana, there are 4 pillars in an environmental impact study as follows:

- Institutions
- Natural resources
- Socio-culture
- Economy

The environmental impacts on the above parameters are identified at the Pre-construction Phase, Construction Phase and Operation and Maintenance Phase using an Environmental Impact Matrix. The Environmental Impact Matrix shows the identified positive and negative environmental impacts caused by the implementation of the programme. The Environmental Impact Matrix of liquid waste sector is shown in Table 15.8.2.

Table 15.8.2 Environmental Impact Matrix for the IEE Study of Liquid Waste Sector

Environmental Parameters		Institution		Natural Resources																Socio-Culture												Economy	
Components	Phases	Existing policy	Legal basis	Topography/Geology	Soil	Ground subsidence	Air quality	Hydrology	Water quality	Groundwater	Noise/Vibration	Offensive odor	Terrestrial flora and fauna	Aquatic flora and fauna	Biodiversity	Terrestrial ecosystem	Aquatic ecosystem	Natural disaster	Climate change factors	Population	Land use	Water use	Landscape	Human health	Involuntary resettlement	Cultural heritage	Material assets	Transportation	Power supply	Water supply	Solid waste	Other infrastructure	Local economy
LW Sub-Programme 1: Increase Access to Hygienic Toilets	Pre-construction		+1																														
	Construction							-1	-1	-1																							
	Operation & Maintenance								+1	+1		-1								+1			-1	+2							-1		
LW Sub-Programme 2: Construction of Sewerage Systems	Pre-construction																																
	Construction							-1	-1	-1																		-1					
	Operation & Maintenance								+2	+2		-1		-1			-1			+1	-1		-1	+2					-1		-2		+1
LW Sub-Programme 3: Enforcement of Environmental Policy and Regulations	Pre-construction		+1																														
	Construction																																
	Operation & Maintenance								+1	+1														+1									-1
LW Sub-Programme 4: Construction of Septage Treatment Ponds	Pre-construction																								-1								
	Construction				-1			-1	-1	-1			-1			-1												-1					
	Operation & Maintenance							-1				-1								+1	-1		-1	+1							-2		
LW Sub-Programme 5: Construction of Conventional Sewerage Systems.	Pre-construction																																
	Construction																																
	Operation & Maintenance		+1																														+1

+1: Negligible Positive Impact
+2: Moderately Positive Impact
+3: Significant Positive Impact
-1: Negligible Negative Impact
-2: Moderately Negative Impact
-3: Significant Negative Impact
+/-: Likely to have both positive and negative environmental impact
?: Uncertain or unpredictable environmental effect

Source: JICA Study Team

Chapter 16 Solid Waste Management Sector Plan and Programme

16.1 Background of Solid Waste Management Sector for Greater Kumasi Sub-Region

16.1.1 Background

The Greater Kumasi Sub-Region is composed of KMA and seven adjoining districts, and is a socially, economically and physically integrated area. A contiguously urbanizing area centring on Kumasi (Greater Kumasi Conurbation) is expanding beyond the boundary of KMA.

The Spatial Development Framework (SDF) integrates socio-economic development policies and spatial development strategies. The SDF is an official document for an integrated spatial plan of land use and infrastructures in response to future socio-economic frameworks and development policies. The Structure Plan (SP) is for the Greater Kumasi Conurbation.

Validity of the development strategies and spatial plans to be formulated is verified from the solid waste management perspectives not only by considering the existing conditions and on-going/planned projects, but also by forecasting future capacity required for managing future solid waste volumes to be generated towards the future population increase.

From the viewpoints of the proper solid waste management implementation in the Greater Kumasi Sub-Region by 2033, the present waste treatment system of collection, transportation, intermediate treatment (composting and recycling) and final disposal being conducting by MMDAs through the private service providers, should be emphasized systematically. In particular, it is found that the MDAs of the Sub-Region should be required to take more realistic actions in terms of SWM disposal landfilling at the final sanitary landfill sites towards the year of 2033.

As a consequence, the development strategies and spatial plans formulated under the SDF and SP for the Greater Kumasi Sub-Region will be verified for the solid waste management sector sub-programme under the programme formulation and implementation/ construction of the small-scaled final sanitary landfills at each district of the Sub-Region towards 2033, so that the MMDAs of the Sub-Region will be able to be kept clean and healthy through proper management of solid waste. The following are the needs of the SWM sector sub-programme in the future:

- The smooth operation of the Phase 2 area of the existing Oti sanitary landfill for

KMA

- The proper preparation and implementation (construction and operation) of the proposed final small-scaled sanitary landfills scheme for MDAs
- "Primary responsibility for solid waste management rests with the Assembly" and "the polluter-pays-principle". Based on "the Environmental Sanitation Policy (Revised 2009), Ghana"

16.1.2 Goal of Sanitation Policy

In this context, a government sanitation policy and urban environmental sanitation Bye-Laws in relation to solid waste management should be transformed and are introduced to support the validity of the SDF and SP for the Greater Kumasi Sub-Region for SWM perspectives below:

The policy documents which are the basis for the basic national government policy of sanitation and the MMDAs (Sanitation) Bye-Laws for Solid Waste Management include; the "Environmental Sanitation Policy" of Ghana (Revised 2009) by the Ministry of Local Government and Rural Development (MLGRD), the Government of Ghana (April 2010), and Kumasi Metropolitan Assembly (Sanitation) Bye-Laws, 2011. These policies are general conceptual frameworks for solid waste management. Annex 3: Definitions of Components of Environmental Sanitation, defines "Solid Waste Management" mainly as follows:

- Solid wastes comprised all solid waste material generated by households, institutions (including health-care waste from hospitals and clinics), commercial establishments and industries, and discharged from their premises for collection.
- Hazardous wastes comprise those wastes that are toxic, flammable, corrosive, radioactive, explosive or otherwise dangerous as defines by the EPA.
- Primary responsibility for solid waste management rests with the Assembly.

(1) Goal

The overall goal of the Environmental Sanitary Policy of Ghana is to develop a clear and nationally accepted vision of environmental sanitation as an essential social service and major determinant for improving the health and quality of life in Ghana." The policy is based on the polluter-pays-principle.

(2) Mission Statement and Vision for KMA

The KMA-WMD has a Mission Statement and Vision as follows:

"To keep Kumasi clean and healthy through the provision and delivery of cost effective and environmentally acceptable waste management services in collaboration with all stakeholders to promote development and healthy living."

"Vision: To make Kumasi one of the top five cleanest cities in Africa by 2025."

16.2 Objectives for Solid Waste Management of Greater Kumasi Sub-Region

Considering the current situation and issues and National Sanitation Policy, the

following objectives are set for solid waste management sector development for Greater Kumasi Sub-Region:

- To provide the healthy public hygiene area, strengthening the solid waste management (collection, transportation, disposal) in the Greater Kumasi Sub-Region
- To be responsible for (or to secure the ability to do) the solid waste management within not only the areas of the KMA, the Municipal and District Assemblies but also the entire area of Greater Kumasi Sub-Region
- At the same time, to arrange the order of so as to carry out the solid waste management by the cooperation among the KMA, the Municipal and District Assemblies in the Greater Kumasi Sub-Region
- To consider effects carefully on the environment and deepen the understanding of residents regarding the importance of construction of a new final landfill
- In the long-term future, to reduce the solid waste generation amount

16.3 Forecast Solid Waste Volume to be generated for the Target Year 2033

For the purpose of designing solid waste management systems (consisting of a series of elements, namely collection, transport, recycling, intermediate treatment and final disposal), the total amounts of solid waste to be generated in the target year 2033 are estimated by using parameters of solid waste disposal per capita per day (an average daily waste generation per capita) and by considering the following future socio-economic aspects.

16.3.1 Future Population and Distribution

The latest population census was carried out by the Ghana National Census of Statistics in 2010. It is projected that the Greater Kumasi Sub-Region has an extended future population of 3,607,766 in 2018, 4,265,645 in 2023, and 5,761,463 in 2033 as shown in Table 16.3.1, and the future population distribution framework in the MMDAs is estimated in Table 16.3.2 based on the proportion of the local type of urban and rural areas in each MDA from the 2010 population census as follows.

Table 16.3.1 Forecast of Future Population of MMDAs of Greater Kumasi Sub-Region (2013-2033)

(Unit: persons)

MMDAs		Year				
		2013	2018	2023	2028	2033
1.	KMA (incl. Asokore Mampong)	2,259,869	2,691,071	3,204,551	3,816,007	4,226,860
2.	Afigya Kwabre	148,447	171,482	198,090	228,828	259,891
3.	Kwabre East	124,515	141,017	159,706	180,871	220,322
4.	Ejisu-Juaben	164,552	206,096	258,128	323,297	438,940
5.	Bosomtwe	101,273	114,851	130,249	147,711	165,273
6.	Atwima Kwanwoma	99,010	114,727	132,937	154,039	198,629
7.	Atwima Nwabiagya	156,057	168,522	181,984	196,520	251,548
	Greater Kumasi Sub-Region	3,053,725	3,607,766	4,265,645	5,047,272	5,761,463

Source: JICA Study Team, 2012

Table 16.3.2 Local Type of Urban and Rural Population Census in MMDAs of Greater Kumasi Sub-Region (2010)

Locality	KMA	Six Adjoining Districts						
		Afigya Kwabre	Kwabre East	Ejisu-Juaben	Bosomtwe	Atwima Kwanwoma	Atwima Nwabiagya	Average
Urban	100%	26%	58%	28%	30%	20%	32 %	32 %
Rural	0%	74%	42%	72%	70%	80%	68%	68 %

Source: GSS, 2010 Population and Housing Census

16.3.2 Future Waste Amount

The most direct influence on waste generation is the change in population. Future solid waste generation amount by the year 2033 is projected based on the results obtained from the following considerations in the updating of future waste amounts:

- Projected population (see Table 16.3.1)
- Gross Domestic Product (GDP) per capita
- Average daily generation amount per capita

To estimate the future waste amounts a correlation between the annual growth rate of GDP per capita (%) and an average daily generation amount per capita (kg/capita/day) is expected to have a larger impact on the waste amount per capita of a developing country. Based on the data from the MMDAs and the considerations above, the following are employed for calculation of the future waste amount:

- 4% is assumed as the annual increase growth rate per capita of waste generation for the SWM sector
- the current 0.60kg/capita/day for KMA and 0.45kg/capita/day for MDAs in 2013, which are assumed the same as those of 2012, are estimated to increase to about 1.31kg/capita/day for KMA and 0.99kg/capita/day for MDAs in 2033

Future waste amounts generated estimated for the year 2033 for the Greater Kumasi Sub-Region are shown in Table 16.3.3. As shown in Figure 6.4.1, the waste discharge amount is made up of the collected amount, uncollected amount and self-disposal, and calculated by subtracting the self-disposal amount from the generation amount. The self-disposal amount is estimated based on the interview survey with the service provider by the JICA Study Team. It is assumed that the waste amount of commercial businesses is included in the domestic waste, according to KMA-WMD.

Table 16.3.3 Forecast of Future Waste Amounts generated in the Greater Kumasi Sub-Region

Unit: t/day

MMDAs	Year				
	2013	2018	2023	2028	2033
KMA (incl. Asokore Mampong	1,662	2,302	3,219	4,535	6,012
Afigya Kwabre	73	102	143	202	278
Kwabre East	67	92	127	175	259
Ejisu-Juaben	81	123	188	286	473
Bosomtwe	50	69	95	132	179
Atwima Kwanwoma	48	67	94	133	209
Atwima Nwabiagya	78	102	134	176	274
Greater Kumasi Sub-Region	**2,058**	**2,858**	**4,001**	**5,639**	**7,685**

Notes: Waste amounts for KMA includes waste markets.
Source: KMA, JICA Study Team, 2012

Table 16.3.4 Forecast of Unit Waste Amount in the Greater Kumasi Sub-Region

Unit: kg/person/day

MMDAs	Year				
	2013	2018	2023	2028	2033
KMA (incl. Asokore Mampong)	0.60	0.73	0.89	1.08	1.31
Surrounding Districts of KMA	0.45	0.55	0.67	0.81	0.99

Source: JICA Study Team, 2012 based on data from KMA

Table 16.3.5 Market Waster Amount Collected in KMA in Greater Kumasi Sub-Region (2013-2033)

Target Year	2013	2018	2023	2028	2033
Projected market waste amount (t/day)	306	338	373	412	455

Source: JICA Study Team, 2012

16.4 Future Solid Waste Management System for Greater Kumasi Sub-Region

16.4.1 Solid Waste Management Systems

The general features of the Solid Waste Management System for KMA have already been developed and will be enhanced to improve their performance. On the other hand, the Solid Waste Management System for adjoining districts (See Figure 16.4.1), which is still underdevelopment, is composed of different service areas as follows:

- Self-disposal areas
- Collection service areas
  - Uncollected areas
  - Collected areas

The Greater Kumasi Conurbation Area should be within the Collection Service Area.

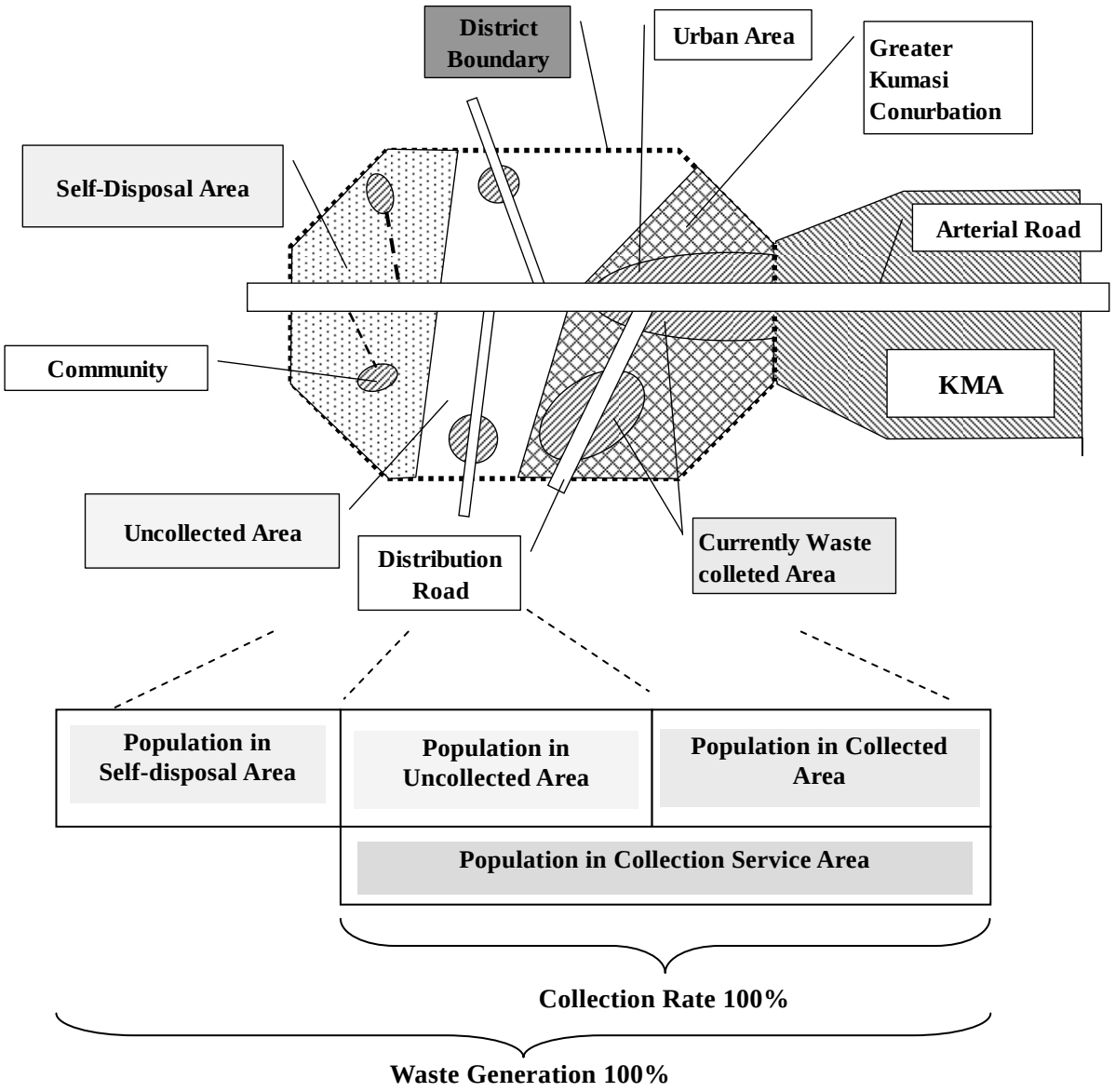


Figure 16.4.1 Systematic Diagram of Self-Disposal, Uncollected and Collected Areas in MDAs of Greater Kumasi Sub-Region (2013-2033)

16.4.2 3R and Intermediate Treatment System

The term 3R as defined herein stands for reduce, reuse and recycling, while the intermediate treatment system consists of composting and incineration. The current state of 3R and intermediate treatment systems in the Greater Kumasi Sub-Region are not very activate. In the collection, transportation and disposal system, it is recommended that sorting of wastes is to be carried out at the source, collection points, transfer stations, and final landfill site. The 3R and intermediate treatment systems are as discussed below.

(1) Waste Reduction

Waste generation amount per capita is currently not very high in the Greater Kumasi

Sub-Region and it may be to conduct the waste reduction plan. However, there are still some spaces to reduce waste generation amount through avoiding excessive use or saving consumable goods, and repairing and reuse of commodities.

(2) Waste Recovery

The major items of resource recovery are paper, plastic, glass and metals. The waste composition survey by KMA shows that about 30% of the total waste was recyclable materials such as paper, plastics, glass and metals. It is essential that if the waste composition by weight in 2033 is assumed to be to the same as that in 2010 there will be high potential for recovery of the materials in the Greater Kumasi Sub-Region.

(3) Reuse

People in the Sub-Region, especially the lower income group families, are practicing reuse as a natural daily activity. Domestic or imported second hand clothes and shoes are usually sold at the markets such as Central Market, and other markets. Hard plastics and metals are being reused as major recyclable materials in KMA. However, there still exist groups to promote reuse or use of items over and over again, even the repaired ones, for the reduction of waste discharge amount.

(4) Recycling

The recycling of paper, glass and metals is not being practiced in KMA or the 6 MDAs much. It is noted that the distribution channel system for recycling does not yet expand well in the market. Accordingly, the resource recovery and recycling plan will be formulated in line with the policy of waste utilization in industry as a potential material resource in the future.

(5) Composting

With the high ratio of organic waste composition of more than 40% in KMA, composting of biodegradable waste is considered as the most practical way for intermediate treatment. It is proposed to promote composting by utilizing the private sector as well as local governments, because of the following advantages:

1) The residents of KMA and the surrounding regional areas of the Greater Kumasi Sub-Region do not have much experience with composting activities; it is thus better that the private sector such as the Kumasi Compost Recycling Plant (KCRP) and NGOs undertakes to compost organic solid waste collected from general households because according to the KMA.

2) Treatment of a large amount of organic waste by utilizing the plant for intermediate treatment contributes to deducing total amount of solid waste produced in the Greater Kumasi Sub-Region. The existing Accra Composting & Recycling Plant in Greater Accra is presently under operation and the on-going Kumasi Composting & Recycling Plant (KCRP) will be under land preparation in Bosomtwe District. It is therefore highly expected that the private sector

experienced in composting for the KCRP will be helpful for agricultural and gardening uses in the Sub-Region and reduction of disposal amounts to not only the existing Oti sanitary landfill in KMA but also small-scale landfills in adjoining districts. And it will be expected in future that composting will become popular among farmers and agriculture-related companies in not only the Greater Kumasi Sub-Region but also outside Greater Kumasi.

3) Separating solid waste at households is important; and organic waste composted jointly with relevant NGOs could be used for agriculture and gardening.

As for dissemination of such compost by the private sector, a market for the compost project is expected to be expanded to rural area as well as KMA in future,

16.5 SWM Sector Plan for the Target Year 2033

Based on the study results above, a solid waste management system will be designed for the target year of 2033 by clarifying the following aspects.

(1) Gross Amount of Solid Waste

Gross amount of solid waste to be generated, gross amount of solid waste to be recycled, gross amount of solid waste to be collected and gross amount of solid waste for final disposal are estimated as below. The projected waste stream in 2013 and 2033 for KMA is shown in Figure 16.5.1.

By the year of 2033, it is estimated that in the Sub-Regional level the gross amount of solid waste generated will be 7,085 t/day including market waste of 455 t/day, the gross amount of solid waste for composting and recycling will be 600 t/day, and the gross amount of solid waste for final landfilling will be 7,400 m^3/day.

The collection rate of 100% was set in the Project as a goal to realize the respective current SWM situation of the collection rates in the Greater Kumasi Sub-Region, and for the visible improvement of the environmental and sanitary condition at the target year of 2033.

The total waste amounts projected in the Greater Kumasi Sub-Region for the years 2013, 2018, 2023, 2028 and 2033 are summarized in Table 16.5.1, and the breakdown amounts of the total waste amounts for KMA and for MDAs are shown in Table 16.5.2 and Table 16.5.3, respectively.

Table 16.5.1 Waste Amount Generated in Greater Kumasi Sub-Region (2013 -2033)

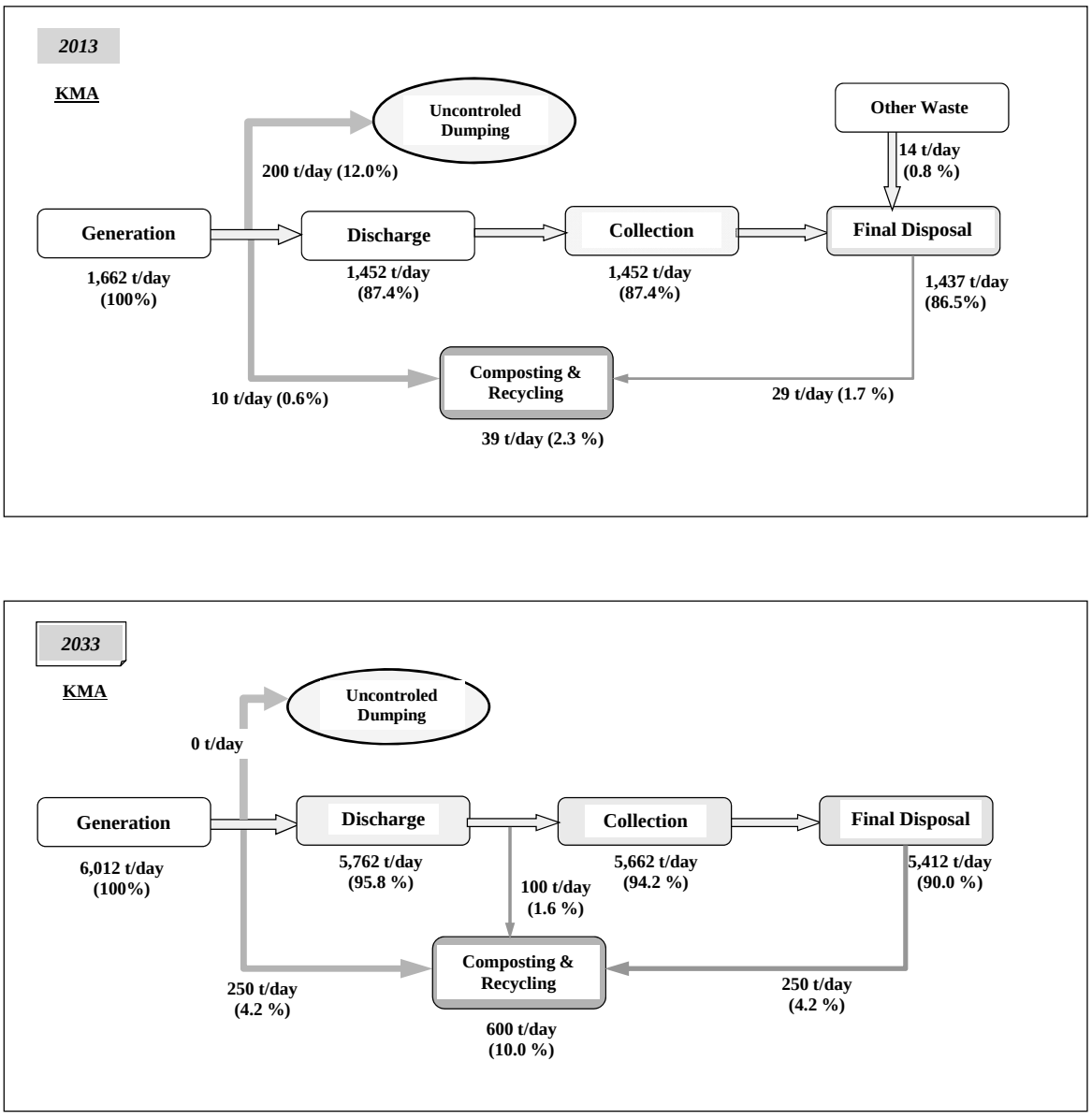
Target Year	2013	2018	2023	2028	2033
Projected waste amount in KMA including market waste (t/day) (1)	1,662	2,302	3,219	4,535	6,012
Projected waste amount in MDAs urbanized (t/day) (2)	396	556	782	1,104	1,674
Total waste amount in Greater Kumasi Sub-Region (t/day) (3) = (1) + (2)	2,058	2,858	4,001	5,639	7,685

Source: KMA-WMD, JICA Study Team, 2012

Table 16.5.2 Target Collection Rate and Waste Amount Collected in KMA in Greater Kumasi Sub-Region (2013-2033)

Target Year	2013	2018	2023	2028	2033
KMA- Target Collection Rate (%)	87	90	93	97	100
Projected waste amount in KMA (t/day) (1)	1,356	1,964	2,846	4,123	5,557
Projected market waste amount (t/day) (2)	306	338	373	412	455
Total in KMA (t/day) (3) = (1) + (2)	1,662	2,302	3,219	4,412	6,012

Source: JICA Study Team, 2012



Source: KMA-WMD, JICA Study Team, 2012

Figure 16.5.1 Waste Stream in KMA in 2013 and 2033

Table 16.5.3 Target Collection Rate and Waste Stream of MDAs in Greater Kumasi Sub-Region (2013-2033)

Target Year	2013	2018	2023	2028	2033
Afigya Kwabre District/ Collection rate (%)	45	59	73	86	100
Total waste generated (t/day)	73	102	143	202	278
Self-disposal waste (t/day)	13	21	33	49	69
Uncollected waste (t/day)	33	17	11	6	0
Collected waste (t/day)	27	61	100	148	209
Kwabre East District / Collection rate (%)	62	72	82	92	100
Total waste generated (t/day)	67	92	127	175	259
Self-disposal waste (t/day)	2	6	12	22	35
Uncollected waste (t/day)	25	12	8	4	0
Collected waste (t/day)	40	74	110	153	224
Ejisu-Juaben Municipality/ Collection rate (%)	59	70	80	90	100
Total waste generated (t/day)	81	123	188	286	473
Self-disposal waste (t/day)	8	34	64	107	182
Uncollected waste (t/day)	30	11	7	5	0
Collected waste (t/day)	43	83	125	178	291
Bosomtwe District/ Collection rate (%)	78	83	89	95	100
Total waste generated (t/day)	50	69	95	132	179
Self-disposal waste (t/day)	13	14	25	36	48
Uncollected waste (t/day)	8	5	3	1	0
Collected waste (t/day)	29	50	68	96	131
Atwima Kwanwoma District/ Collection rate (%)	60	71	81	91	100
Total waste generated (t/day)	48	67	94	133	209
Self-disposal waste (t/day)	4	10	32	49	85
Uncollected waste (t/day)	17	10	5	3	0
Collected waste (t/day)	26	45	61	80	123
Atwima Nwabiagya District/ Collection rate (%)	26	45	64	82	100
Total waste generated (t/day)	78	102	134	176	274
Self-disposal waste (t/day)	7	10	27	46	86
Uncollected waste (t/day)	63	37	23	11	0
Collected waste (t/day)	22	55	85	120	189
Greater Kumasi Sub-Region Waste amount generation in MDAs (t/day)	**396**	**556**	**782**	**1,104**	**1,674**

Source: JICA Study Team, 2012

(2) Required Capacity Necessary for Final Disposal Sites for Target Year of 2033

It is expected that the Phase 2 area of the existing Oti sanitary landfill will be open and in operation in the beginning of 2013 and will start waste land filling. The required waste amounts to be disposed of at the Oti sanitation landfill between 20 3 and 2033 are calculated as shown in Table 16.5.4. About 43.3 million m3 of landfill capacity will be required by the year of 2033. Considering the available waste

capacity at the existing Oti landfill, it is very important to find another new sanitary landfill site for KMA. In the case of the MDAs in the Greater Kumasi Sub-Region, the projected solid waste to be collected and disposed of is estimated at about 2,100 t/day as shown in Table 16.5.5.

Table 16.5.4 Landfill Site Capacity Requirements in KMA in Greater Kumasi Sub-Region

Year		Waste Amount (t/day) C/R=100% (1)	Composting & Recycling (t/day) (2)	Collection Rate (%) 100% (3)	Waste Amount (m^3/day) (4)=((1)-(2)) x(3)%/(Bulk Density) 0.60	Waste Amount (m^3/year) (5)=(4) x 365	Cover soil (m^3/year) (6)=(5)/3	Total Waste Amount (m3) (7)=(5)+(6)	Total Accumulated Waste Amount (m^3) (8)
2012	0	**1,609**	39	**87**	2,277	**831,124**	**277,041**	**1,108,166**	**1,108,166**
2013	1	**1,662**	**39**	**87**	**2,353**	**858,931**	**286,310**	**1,145,241**	**2,253,407**
2014	2	1,790	95	88	2,472	902,180	300,727	1,202,907	3,456,314
2015	3	1,918	151	**88**	2,591	**945,868**	315,289	**1,261,157**	4,717,471
2016	4	2,046	207	89	2,717	991,857	330,619	1,322,476	6,039,948
2017	5	2,174	263	89	2,845	1,038,431	346,144	1,384,574	7,424,522
2018	6	**2,302**	**320**	**90**	**2,974**	**1,085,588**	**361,863**	**1,447,450**	**8,871,972**
2019	7	2,486	376	91	3,200	1,168,100	389,367	1,557,467	10,429,439
2020	8	2,669	432	**92**	3,431	**1,252,161**	417,387	1,669,549	12,098,988
2021	9	2,852	488	92	3,639	1,328,181	442,727	1,770,908	13,869,896
2022	10	3,036	544	93	3,849	1,404,717	468,239	1,872,956	15,742,852
2023	11	**3,219**	**600**	**93**	**4,060**	**1,481,769**	**493,923**	**1,975,692**	**17,718,544**
2024	12	3,482	600	94	4,516	1,648,227	549,409	2,197,636	19,916,179
2025	13	3,746	600	**95**	4,981	**1,817,887**	605,962	2,423,850	22,340,029
2026	14	4,009	600	96	5,435	1,983,838	661,279	2,645,117	24,985,146
2027	15	4,272	600	96	5,896	2,151,924	717,308	2,869,232	27,854,378
2028	16	**4,535**	**600**	**97**	**6,362**	**2,322,145**	**774,048**	**3,096,193**	**30,950,571**
2029	17	4,831	600	98	6,875	2,509,248	836,416	3,345,664	34,296,235
2030	18	5,126	600	**98**	7,392	**2,698,147**	899,382	3,597,530	37,893,765
2031	19	5,421	600	99	7,928	2,893,731	964,577	3,858,308	41,752,073
2032	20	5,716	600	99	8,470	3,091,709	1,030,570	4,122,279	45,874,352
2033	21	**6,012**	**600**	**100**	**9,019**	**3,292,083**	**1,097,361**	**4,389,444**	**50,263,795**
Total						**37,697,847**	**12,565,949**	**50,263,795**	

Source: KMA-WMD, JICA Study Team

Notes: C/R= Collection Rate

(3) Willingness to Pay, Possibility of Privatization and Final Disposal

People's willingness to pay for solid waste collection and possibility of privatization of solid waste collection, transport and final disposal are addressed as follows.

In both the KMA and MDAs in the Greater Kumasi Sub-Region, the solid waste collection, transportation and final disposal services are presently conducted through

private contractors as service providers for each Sub-Metropolitan Area for KMA and each MDAs. There are the seven service provides for the Sub-Metropolitan Area of KMA and one service provider for the 6 adjoining districts.

In line with the Assembly's Fee Fixing Resolution, there are presently two collection service systems with waste charges as follows.

Table 16.5.5 Waste Charge History (2008-2011)

Year	2008	2009	2010	2011
Collection System	No charge	Starting to charge for waste collection in 2 systems (house-to-house/ communal collection)	House-to-house collection/ Communal collection	House-to-house collection/ Communal collection
Remarks		55,000 households participated in the house-to-house waste collection scheme (WMD-KMA, 2010). Low-income households generally rely on the pay-as-you-dump system, whereby communal containers / skips are placed at designated sites, and households pay between GH₵0.10 - GH₵0.20 per load.	GH₵3.0- GH₵5.0 High income residential class : GH₵10.00 Middle-income residential class: GH₵8.00 Low-income class: GH₵5.00 GH₵0.10 - GH₵0.30 could be charged per person and the average number of individuals contributing refuse that fill each of the containers (at the communal containers of $10m^3$, $12m^3$, $14m^3$ and $23m^3$) was determined during the survey exercise.	Charge for communal collection per head load of waste of GH₵0.30 while for the house-to-house collection system charge was GH₵10 per month.

Source: KMA-WMD

Table 16.5.6 Waste Collection Cost, Cost Recovery and Subsidy (2010)

Item	Total Cost for Solid Waste Collection (GH₵/year)	Cost Recovery (GH₵/year)	Subsidy Paid by the Central Government
Cost	3,800,000 (100%)	1,400,000 (37%)	2,400,000 (63%)
Remarks	The total cost of waste collection for the year stands at the above amount.	The service providers were able to recover this amount from the waste charges from house-to-house collection and pay-as-you-dump from the communal sites.	The outstanding cost which constitutes the subsidy to be paid by the KMA.

Source: KMA-WMD

(4) Possibility of the Solid Waste Reduction

In the KMA, composting and recycling of waste materials have not yet been conducted as mentioned in Sub-section 15.2.3 3R and Intermediate Treatment System. However, the on-going new MRF, Kumasi Composting and Recycling Plant (KCRP) at Adagya organized by Zoomlion Ghana Ltd., is planned to be opened and be commissioned in 2014. According to the KCRP plan it is expected that about 600 tonnes will be processed at the MRF plant operation daily under two-shifts a day operation and the disposal amount at the final sanitary landfill site will be drastically

reduced.

16.6 SWM Sector Programme

The JICA Study Team will prepare a Solid Waste Management Programme which is composed of four sub-programmes including schedules and costs, and possible financial sources for implementation.

There are four action programmes to be established in the implementation plan for the solid waste management sector sub-programmes for the Greater Kumasi Sub-Region.

- Sub-Programme 1: Expansion of Oti Sanitary Landfill Site
- Sub-Programme 2: Continuation of Kumasi Composting and Recycling Plant (KCRP) Project at Adagya
- Sub-Programme 3: Enhancement of SWM Unit of EHD, MMDAs especially MDAs
- Sub-Programme 4: Construction of Final Sanitary Landfill Sites in MDAs

The detailed plans of each Programme for realization of the SWM sector are as follows:

1) Sub-Programme 1: Expansion of Oti Sanitary Landfill Site
   a) Implementation (Operation/ Maintenance) of Phase 2
   b) Implementation (Preparation/ O-M) of Phase 3

2) Sub-Programme 2: Continuation of Kumasi Composting and Recycling Plant (KCRP) Project at Adagya
   a) Formulation of 3R (reduce, reuse, recycling) Implementation Plan
   b) Construction of Plant
   c) Operation of Plant
   d) Implementation of Waste Reduction Plan
   e) Preparation of New Landfill Site
   f) Operation of New Landfill Site

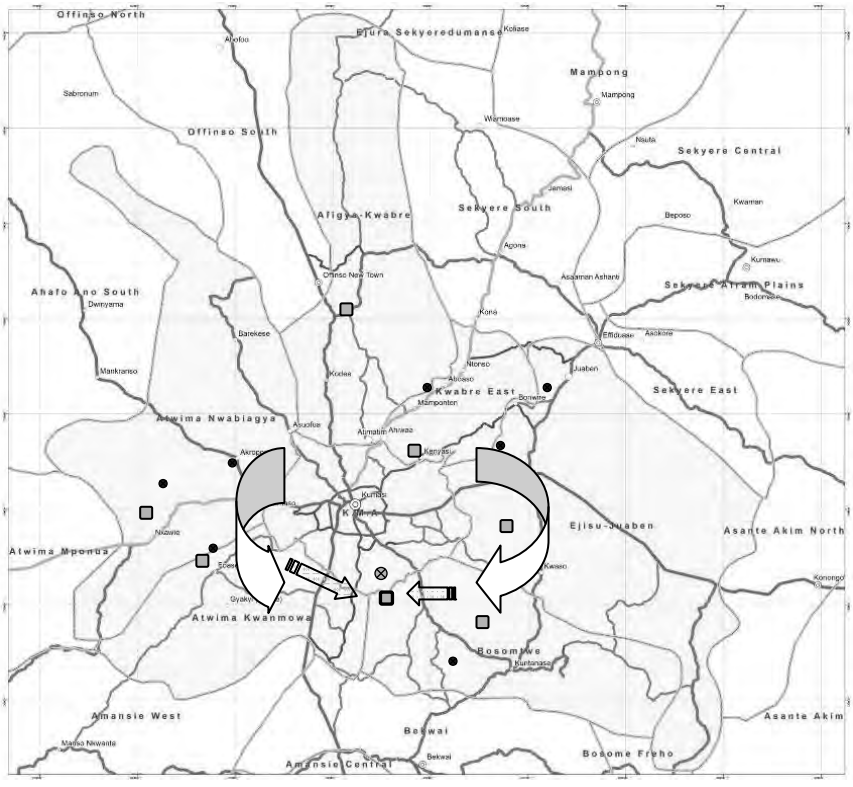
3) Sub-Programme 3: Enhancement of SWM Unit of EHD, MMDAs especially the surrounding Districts of KMA
   a) Formulation of 3R (reduce, reuse, recycling) & Composting Implementation Plan
   b) Construction of 3R & Composting Plant
   c) Preparation of MDAs' SWM Plans
   d) Preparation of Small-Scale Sanitary Landfill Plan
   e) Preparation of Land Acquisition Process for Landfills
   f) Implementation of IEC Campaign on SWM
   g) Capacity Development

4) Sub-Programme 4: Construction of Final Sanitary Landfill Sites in MDAs
   a) Formulation of Final Small-Scale Landfill Construction Plans

b) Implementation of Final Small-Scale Sanitary Landfill

The goals of the action programmes of the solid waste management sector of the Project are outlined in Table 16.6.1 with prospective target levels to be achieved by the year 2018 for the Short-Term Plan, year 2023 for the Mid-Term Plan, year 2028 for the Long-Term Plan, and .year 2033 for Extra Long-Term Plan. Sub-Programme 1 is now under operation by KMA and Sub-Programme 2 is an on-going project for implementation (preparation and operation) including a possibility study on a succeeding sanitary landfill site for KMA, and Sub-Programme 3 and Sub-Programme 4 are newly proposed action plans under this Project.

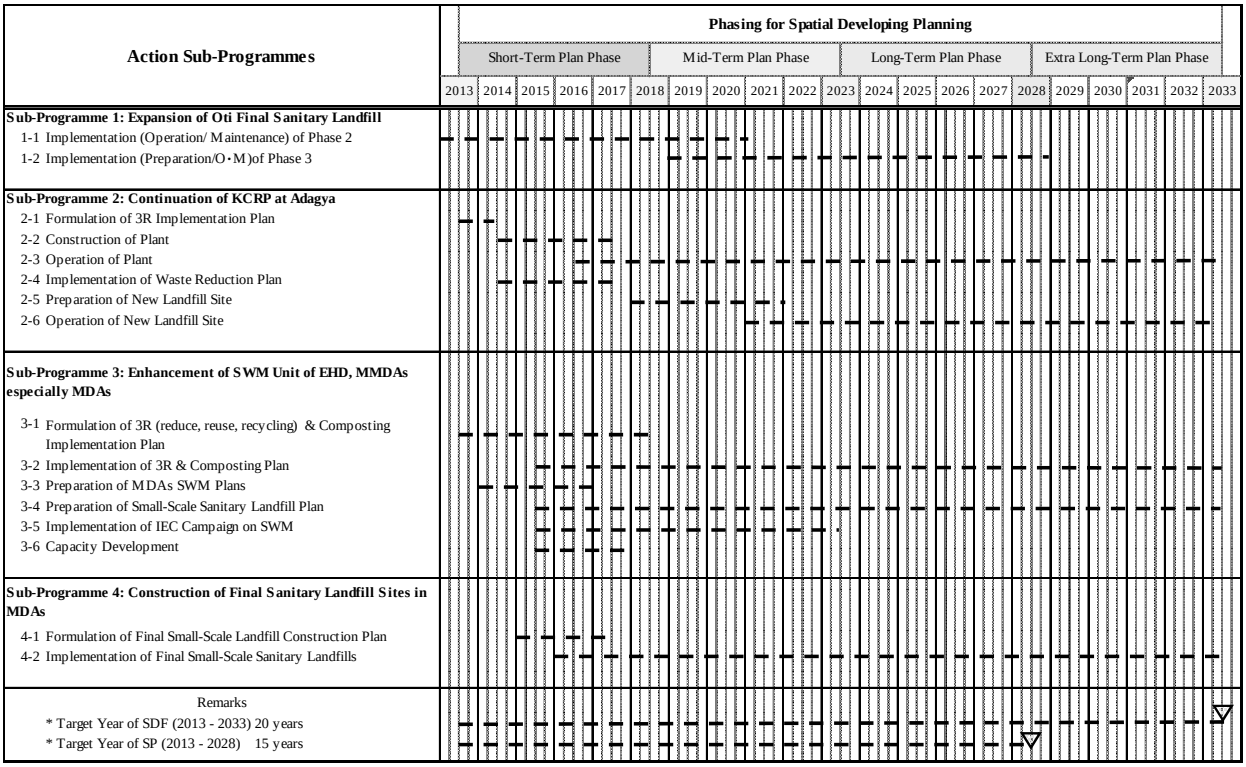
Figure 16.6.1 shows some potential landfill sites for small-scale sanitary landfill sites as of 2012, which are obtained from the EHD of MDAs and KMA-WMD in the Greater Kumasi Sub-Region. It is recommended that this kind of diagram map will be upgraded and marked with more promising sites with the concerned parties such as landowners, local government offices and residents for a study on the succeeding proposed sites for small-scale sanitary landfills for MDAs for not only the periods of Short-Term and Mid-Term Plan Phases, but also the period of the Long-Term Plan Phase.



Source: JICA Study Team, 2012

Figure 16.6.1 Proposed Final Disposal Sites for Sanitary Landfill in Greater Kumasi Sub-Region (2033)

Table 16.6.1 Implementation Plan for SWM Sector Programme for Greater Kumasi Sub-Region



Sources: KMA-WMD, Zoomlion Ghana Co. Ltd.

Notes: Kumasi Composting and Recycling Plant (KCRP), Bosomtwe District Assembly (BDA), Municipality and Districts Assemblies (6 MDAs)
Spatial Development Frameworks (SDF), Structure Plan (SP), Environmental Health Department (EHD), Information Education and Communication (IEC)

16.7 Preliminary Economic and Financial Analysis

16.7.1 Economic Analysis

(1) Methodology

With the new and increasing supply of solid waste management services, the benefits of the Sector Programme will be positive regarding health and social impact. The JICA Study Team estimated the significant benefits, both direct and indirect, due to the Sector Programme with the following steps:

Step 1: Identification of "with" and "without" cases,

Step 2: Assumption parameters for direct benefit such as affordability to pay, and saving on waste disposal cost,

Step 3: Estimation of economic costs based on the estimated capital investment cost,

Step 4: Estimating the indirect effects and

Step 5: Economic evaluation using economic benefits and economic costs.

(2) "With" and "Without" cases

The project inputs and outputs should be identified, quantified and valued by comparing the "Without case" with that of the "With case" to derive the economic benefit.

1) "With" Case

The proposed increase in solid waste management facilities and future waste stream are described in the Sector Programme.

2) "Without" Case

The current facilities, the waste stream and current location of landfill shall be unchanged in the future.

(3) Assumption of Benefit

1) Application of Affordability to Pay

To estimate the value of the impact, the JICA Study Team assumed to quantify the affordability to pay based on the ratio of disposable income. According to project appraisal manual issued by IBRD, the ratio of solid waste management cost in the household budget is 2% so that the monthly affordability to pay for this sector in households is GHC 9/month.

In accordance with Table 16.5.6, there are presently two collection service systems with waste charges. However, current revenue is very poor, because only about 10% households pay waste charges. Thus, the estimated affordability to pay can be considered to represent the value of the positive impact, which is the project benefit, when the landfill project is done and issues in management are solved.

2) Saving on waste disposal cost

The average unit rate of current waste disposal cost is assumed to be GHC 14/ton of disposed waste. After the proposed landfill sites are completed in each district by year 2033, the disposal cost is estimated to reduce to GHC 12.5/ton by considering the waste volume to be transported to the intermediate treatment systems in the projected waste stream as presented in the previous section.

(4) Estimation of Economic Cost

The capital investment cost of the Sector Programme is estimated as shown in Table 16.7.1. In this study the economic cost was estimated by deducting government taxes and import duty from the capital investment cost and O/M cost so that a conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 23.8million as shown in Table 16.7.2. Operation and maintenance (O&M) applied cost is 10% of each investment cost.

Waste disposal cost is also added to the cost estimation. The cost is based on waste generated in KMA and 7 adjoining districts in accordance with Table 16.7.2 and

Table 16.7.3.

Table 16.7.1 Capital Investment Cost and O&M Cost

MMDAs	Capital Investment Cost			O & M Cost (Thousand GHC/year)
	Cost of Each Landfill Site (Thousand GHC /year)	Number of Landfills	Total Cost (Thousand GHC /year)	
Afigya Kwabre	800	7	5,600	560
Kwabre East	600	7	4,200	420
Ejisu-Juaben	800	7	5,600	560
Bosomtwe	500	7	3,500	350
Atwima Kwanwoma	500	7	3,500	350
Atwima Nwabiagya	800	7	5,600	560
Total	4,000		28,000	2,800

Source: JICA Study Team

Table 16.7.2 Economic Cost of Small-Scale Landfills in 7 Adjoining Districts

	Financial Cost (GHC Thousand)	Conversion Factor	Economic Cost
Capital Investment Cost	28,000	0.85	23,800
O&M Cost (per/year)	2,800	0.85	2,380

Source: JICA Study Team

Table 16.7.3 Disposal Cost

Year	Disposal Cost	
	Financial Cost (Thousand GHC/year)	Economic Cost (Thousand GHC/year)
2013	9,390	7,982
2018	13,040	11,084
2023	18,255	15,517
2028	25,167	21,392
2033	35,067	29,807

Source: JICA Study Team

(5) Result of Economic Analysis

The cash flow projection based on the above assumptions is presented in Table 16.7.4. Project life is 30 years after the start of project implementation. The Economic Internal Rate of Return (EIRR) of the Sector Programmes is 35.36% which is above the hurdle rate of 12.0%. The computed Net Present Value (NPVs) for the Sector Programme using 12% discount rate is GHC 230 million.

Table 16.7.4 Economic Flow of Solid Waste Management Sector Programmes

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M, Disposal	Investment						
2015	0	9,222	3,400	12,622	0	-12,622	12,622	0	-12,622
2016	6,418	10,183		10,183	6,418	-3,765	9,092	5,730	-3,361
2017	6,664	10,803		10,803	6,664	-4,139	8,612	5,313	-3,300
2018	6,915	11,424	3,400	14,824	6,915	-7,908	10,551	4,922	-5,629
2019	20,462	12,648		12,648	20,462	7,814	8,038	13,004	4,966
2020	21,211	13,532		13,532	21,211	7,679	7,678	12,036	4,357
2021	21,982	14,416	3,400	17,816	21,982	4,166	9,026	11,137	2,110
2022	37,423	15,641		15,641	37,423	21,783	7,075	16,928	9,853
2023	31,920	16,536		16,536	31,920	15,384	6,679	12,892	6,213
2024	37,780	17,711	3,400	21,111	37,780	16,669	7,613	13,624	6,011
2025	57,772	19,227		19,227	57,772	38,545	6,190	18,601	12,411
2026	67,970	20,402		20,402	67,970	47,568	5,865	19,540	13,675
2027	70,358	21,577	3,400	24,977	70,358	45,381	6,411	18,059	11,648
2028	93,316	23,092		23,092	93,316	70,224	5,292	21,386	16,094
2029	96,015	24,775		24,775	96,015	71,240	5,069	19,647	14,577
2030	98,797	26,458	3,400	29,858	98,797	68,939	5,455	18,050	12,595
2031	123,841	28,481		28,481	123,841	95,360	4,646	20,201	15,555
2032	127,398	30,164		30,164	127,398	97,234	4,393	18,555	14,162
2033	131,069	31,847	3,400	35,247	131,069	95,822	4,584	17,044	12,461
2034	154,462	32,187		32,187	154,462	122,274	3,737	17,934	14,197
2035	154,462	32,187		32,187	154,462	122,274	3,337	16,013	12,676
2036	154,462	32,187		32,187	154,462	122,274	2,979	14,297	11,318
2037	154,462	32,187		32,187	154,462	122,274	2,660	12,765	10,105
2038	154,462	32,187		32,187	154,462	122,274	2,375	11,397	9,022
2039	154,462	32,187		32,187	154,462	122,274	2,121	10,176	8,056
2040	154,462	32,187		32,187	154,462	122,274	1,893	9,086	7,193
2041	154,462	32,187		32,187	154,462	122,274	1,691	8,112	6,422
2042	154,462	32,187		32,187	154,462	122,274	1,509	7,243	5,734
2043	154,462	32,187		32,187	154,462	122,274	1,348	6,467	5,120
2044	154,462	32,187		32,187	154,462	122,274	1,203	5,774	4,571
2045	154,462	32,187		32,187	154,462	122,274	1,074	5,156	4,081
	2,910,850	744,385	23,800	768,185	2,910,850	2,142,664	160,819	391,089	230,269

B / C	2.4319
EIRR %	35.36
NPV (GHc)	230,269

(6) Indirect Benefits

1) Increase in production and job creation

The term 3R, as defined stands for reduce, reuse and recycle, while the intermediate treatment system is composting and incineration. Accordingly, the resource recovery and recycling plan will be formulated in line with the policy of waste utilization in industry as a potential material resource in the future. It is highly expected that growth of industrial production and job creation will be accelerated in this proposed development area.

2) Avoidance of illegal dumping

The delay of a new disposal landfill may also encourage the illegal dumping of waste due to the inhabitants having no proper destination for its final disposal. Such improper dumping of waste, as already found in some areas, causes various negative impacts upon the living environment e.g. flood due to blockage of water flow by dumped waste, river pollution, aggravation of urban sanitation and damage to the

urban landscape. Table 16.7.5 shows the estimated amounts that will be collected in the "With" and "Without" cases in 2033 for indication. Development and operation of a new disposal site will prevent an increase in illegal dumping of waste.

Table 16.7.5 Amount to be collected in the "With" and "Without" cases in 2033

(Unit: Ton/day)

MMDAs	"With"	"Without"	Balance of unknown Waste
KMA	6,012	5,318	694
Afigya Kwabre	278	125	153
Kwabre East	259	161	98
Ejisu-Juaben	473	279	194
Bosomtwe	179	140	39
Atwima Kwanwoma	209	125	84
Atwima Nwabiagya	274	71	203
Total	7,685	5,843	1,842

Source: JICA Study Team

16.7.2 Financial Analysis

The proposed Sector Programme for the solid waste management sector shall involve an adequate amount of capital investment for the operation body. A financial analysis, therefore, has been undertaken to determine the financial viability of the proposed facilities. The following form some of the assumptions:

- A possible source of funding is not considered
- The current tariff structure and level have been analysed
- Operation profit to be implemented by the private sector is not considered
- Income from selling compost materials produced in the compost plant is not considered
- A detailed financial projection and analysis to examine the financial viability of the proposed programme has been conducted; the Financial Internal Rate of Return (FIRR) has been calculated.

(1) Financial Costs

Financial costs of the Sector Programme are summarized in Table 16.7.6, consisting of: i) capital investment cost, ii) operation and maintenance cost (O&M) and iii) disposal cost. Facilities will be constructed every 3 years in the proposed Sector Programme. And O&M cost is assumed to be 10% of the investment cost every year.

Table 16.7.6 Financial Costs for Capital

	Year						
	2015	2018	2021	2024	2027	2030	2033
Capital Investment Cost (GHC Thousand)	4,000	4,000	4,000	4,000	4,000	4,000	4,000

Source: JICA Study Team

(2) Financial Benefit

The revenue from the increase in the number of users who are currently utilizing their own disposal facilities is also calculated as a financial benefit. The average tariff level of GHC 10/month per household in 2012 is applied as the unit treatment price and the number of households is shown in Table 16.7.7 based on the "Forecast of Future Population of MMDAs of Greater Kumasi Sub-Region."

The average household size in Greater Kumasi Sub-Region was 5.1 persons in 2000 and 4.1 persons in 2010 while that of Greater Accra Region in 2010 is 3.8 persons, according to Populaiton and Household Census 2000 and 2010 by Ghana Statistical Serivices. Future household size in Greater Kumasi Sub Region is assumed to decrease to 3.8 persons in 2033, at the same level as the current size of that of the Greater Accra Region.

Table 16.7.7 Users of Proposed Treatment Facilities

	Year				
	2013	2018	2023	2028	2033
Number of Households	752,139	904,202	1,085,406	1,307,583	1,516,174

Source: JICA Study Team

(3) Result of Financial Analysis

The cash flow projection based on the above assumptions is presented in Table 16.7.8. The computed Financial Internal Rate of Return (FIRR) for the sector programme is 27.16%. The capital investment is not very high for the proposed programme and this has contributed to the relatively reasonable FIRR.

However, revenue from households was assumed in accordance with the existing charge of house-to-house collection and communal collection so the study team adjusted the level to reflect the current collection situation.

Table 16.7.8 Financial Flow of Solid Waste Management Sector Programmes

Unit: GHc 1,000

Year	Revenue	Cost		Cost Total C	Revenue Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2015	0	10,850	4,000	14,850	0	-14,850	14,850	0	-14,850
2016	6,726	11,980		11,980	6,726	-5,254	10,696	6,005	-4,691
2017	9,949	12,710		12,710	9,949	-2,760	10,132	7,932	-2,200
2018	10,302	13,440	4,000	17,440	10,302	-7,137	12,413	7,333	-5,080
2019	10,668	14,880		14,880	10,668	-4,212	9,456	6,780	-2,677
2020	22,093	15,920		15,920	22,093	6,172	9,034	12,536	3,502
2021	22,876	16,960	4,000	20,960	22,876	1,916	10,619	11,590	971
2022	23,688	18,401		18,401	23,688	5,287	8,324	10,715	2,392
2023	36,793	19,455		19,455	36,793	17,338	7,857	14,860	7,003
2024	38,098	20,837	4,000	24,837	38,098	13,261	8,956	13,739	4,782
2025	39,450	22,619		22,619	39,450	16,831	7,283	12,702	5,419
2026	54,467	24,002		24,002	54,467	30,465	6,900	15,658	8,758
2027	64,842	25,384	4,000	29,384	64,842	35,458	7,542	16,643	9,101
2028	83,930	27,167		27,167	83,930	56,763	6,226	19,234	13,009
2029	69,527	29,147		29,147	69,527	40,380	5,964	14,227	8,263
2030	88,724	31,127	4,000	35,127	88,724	53,597	6,418	16,210	9,792
2031	90,578	33,507		33,507	90,578	57,071	5,466	14,775	9,310
2032	92,472	35,487		35,487	92,472	56,985	5,169	13,468	8,300
2033	113,287	37,467	4,000	41,467	113,287	71,820	5,392	14,732	9,339
2034	115,657	37,867		37,867	115,657	77,790	4,397	13,429	9,032
2035	134,934	37,867		37,867	134,934	97,066	3,926	13,988	10,063
2036	134,934	37,867		37,867	134,934	97,066	3,505	12,489	8,984
2037	134,934	37,867		37,867	134,934	97,066	3,129	11,151	8,022
2038	134,934	37,867		37,867	134,934	97,066	2,794	9,956	7,162
2039	134,934	37,867		37,867	134,934	97,066	2,495	8,890	6,395
2040	134,934	37,867		37,867	134,934	97,066	2,227	7,937	5,710
2041	134,934	37,867		37,867	134,934	97,066	1,989	7,087	5,098
2042	134,934	37,867		37,867	134,934	97,066	1,776	6,328	4,552
2043	134,934	37,867		37,867	134,934	97,066	1,585	5,650	4,064
2044	134,934	37,867		37,867	134,934	97,066	1,416	5,044	3,629
2045	134,934	37,867		37,867	134,934	97,066	1,264	4,504	3,240
	2,478,397	875,748	28,000	903,748	2,478,397	1,574,650	189,199	335,591	146,391

B / C	1.7737
FIRR %	27.16
NPV (GHc)	146,391

16.8 IEE of Solid Waste Sector Programme

This Section of the chapter discusses the Initial Environmental Examination (IEE) for this Sector programme at an early level of planning regarding impacts caused by the implementation of the sector programme. Such assessment is drawn based on the results of the analysis of the existing conditions and on the initial screening process undertaken by the Project Team using the Environmental Impact Matrix. The detailed analyses of environmental impacts such as an Environmental Impact Assessment (EIA) will be conducted at the feasibility study phase. The conduct of an IEE study under the sector programme is done in the following manner:

(1) Targets of the IEE Study

This Sector Programme consists of four components. The targets of the IEE study are shown in Table 16.8.1.

Table 16.8.1 Targets of IEE Study for Solid Waste Management Sector Programmes

- ☐ Expansion of Oti Sanitary Landfill
- ☐ Continuation of Kumasi Composting and Recycling Plant (KCRP) Project at Adagya
- ☐ Enhancement of the SWM Unit of EHD, MMDAs especially MDAs
- ☐ Construction of Final Sanitary Landfill Sites in MDAs

(2) Phasing of the IEE Study

To study the IEE, programme components are divided into three phases, namely the Pre-Construction Phase, Construction Phase, and Operation and Maintenance Phase. The activities of each phase are as follows:

- **Pre-construction Phase:** which includes land acquisition, resettlement, mobilization of heavy equipment, transport of construction materials, construction of office buildings and labour camps, etc.
- **Construction Phase**: consisting of the setting up of equipment, demolition of the existing structures, implementation of construction works, generation of construction waste etc.
- **Operation and Maintenance Phase**: which includes the operation and maintenance of facilities, maintenance works, etc.

(3) Result of the IEE Study

In Ghana, there are 4 pillars in an environmental impact study as follows:

- Institutions
- Natural resources
- Socio-culture
- Economy

The environmental impacts on the above parameters are identified at the Pre-construction Phase, Construction Phase and Operation and Maintenance Phase using an Environmental Impact Matrix. The Environmental Impact Matrix shows the identified positive and negative environmental impacts caused by implementation of the programme. The Environmental Impact Matrix of the solid waste sector is shown in Table 16.8.2.

Table 16.8.2 Environmental Impact Matrix for the IEE Study of Solid Waste Management Sector Programmes

Environmental Parameters		Institution		Natural Resources																Socio-Culture												Economy	
Components	Phases	Existing policy	Legal basis	Topography/Geology	Soil	Ground subsidence	Air quality	Hydrology	Water quality	Groundwater	Noise/Vibration	Offensive odor	Terrestrial flora and fauna	Aquatic flora and fauna	Biodiversity	Terrestrial ecosystem	Aquatic ecosystem	Natural disaster	Climate change factors	Population	Land use	Water use	Landscape	Human health	Involuntary resettlement	Cultural heritage	Material assets	Transportation	Power supply	Water supply	Solid waste	Other infrastructure	Local economy
SW Sub-Programme 1: Expansion of Oti Sanitary Landfill	Pre-construction																				-1												
	Construction			-1	-2		-1	-1	-1	-1	-1		-2		-2	-2						-1						-1		-1	-2		
	Operation & Maintenance						-2	-1	-2	-2		-2											-1	+2				-1		-1	-2		+2
SW Sub-Programme 2: Continuation of Kumasi Composting and Recycling Plant (KCRP) Project at Adagya	Pre-construction																								-1								
	Construction						-1						-1	-1		-1	-1											-1					+1
	Operation & Maintenance								-1	-1		-2												+2					-1	-1	+1	+1	+2
SW Sub-Programme 3: Enhancement of SWM Unit of EHD, MMDAs especially MDAs	Pre-construction																				-1												
	Construction			-1	-1		-1	-1	-1	-1	-1		-1		-1	-1						-1						-1		-1	-2		
	Operation & Maintenance							-1	-1	-1		-1											-1	+2				-1		-1	-2		+2
SW Sub-Programme 4: Construction of Final Sanitary Landfill Sites in MDAs	Pre-construction																				-1												
	Construction			-1	-2		-1	-1	-1	-1	-1		-2		-2	-2						-1						-1		-1	-2		
	Operation & Maintenance						-2	-1	-2	-2		-2											-1	+1				-1		-1	-2		+2

+1: Negligible Positive Impact
+2: Moderately Positive Impact
+3: Significant Positive Impact
-1: Negligible Negative Impact
-2: Moderately Negative Impact
-3: Significant Negative Impact
+/-: Likely to have both positive and negative environmental impact
?: Uncertain or unpredictable environmental effect

Source: JICA Study Team

Chapter 17 Drainage Sector Plan and Programme

17.1 Objectives for Drainage Sector Development

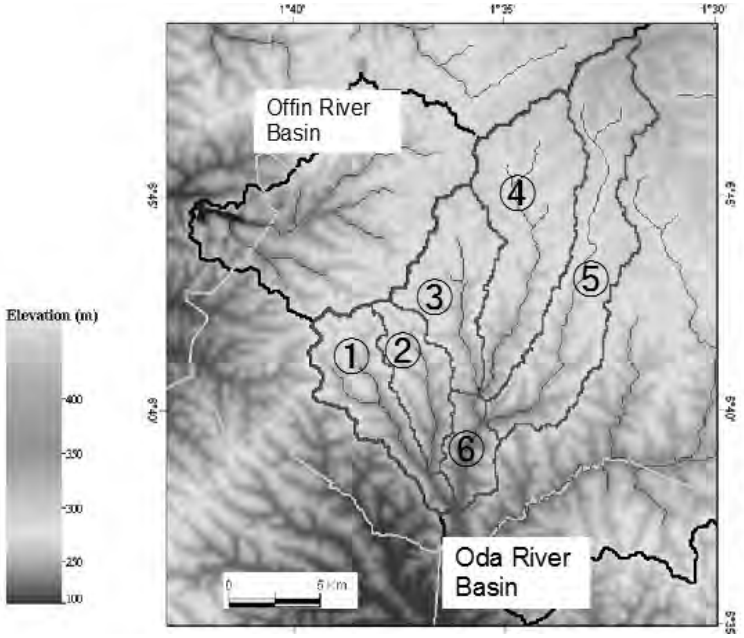
For development of the Drainage Sector in the Greater Kumasi Sub-Region, the following objectives are set:

- To limit sanitary nuisances and vector breeding
- To prevent rainwater stagnation and erosion
- To prevent serious flooding in downstream river sections

1) To Limit Sanitary Nuisances and Vector Breeding

There are 5 main drainage basins in the Kumasi Metropolitan Area, namely Aboabo, Kwadaso, Nsuben, Sisai and Wiwi drainage basins, which generally run in a north to south direction.

The target for 2033, in order to limit sanitary nuisances and vector breeding, the lined drainage rate should be up to 40%, in other words Primary Drainage with a length of 60 km should be lined.



Name of Drainage Basin	Basin Area (km2)
①Kwadaso	20.3
②Nsuben	13.9
③Aboabo	22.4
④Sisai	39.9
⑤Wiwi	44.8
⑥Wiwi Downstream	8.8
TOTAL	150.1

Source: JICA Study Team, The basin area was calculated based on GIS using SRTM3.

Figure 17.1.1 Primary Area for Drainage Basins and Areas

Maintenance is generally lacking in all basins resulting in overgrown weeds and a high degree of siltation along channel beds. Refuse dumping along drain banks is

common in all five basins, but most serious in the Aboado, Nsuben and the Sisai.

2) To Prevent Rainwater Stagnation and Erosion

As the target for 2033 responding to the expansion of the urban areas, the pavement of streets in not only business areas but also residential areas should be implemented.

Refuse eventually gets washed into the drains. The effect of refuse and siltation is even worse at culvert entrances where they sometimes get completely blocked. Utility lines crossing drains are sometimes laid within flood levels. These also tend to obstruct debris transport and impede flow. The net effect of these factors is flooding at critical locations.

3) To Prevent Serious Flooding in Downstream River Sections

As the paving of streets and the street drainage facilities progress, in order to prevent flooding in downstream river sections it will be necessary to implement lining works and enforce laws to ensure that the existence of Buffer Zones around the water bodies will be secured.

Source: JICA Study Team

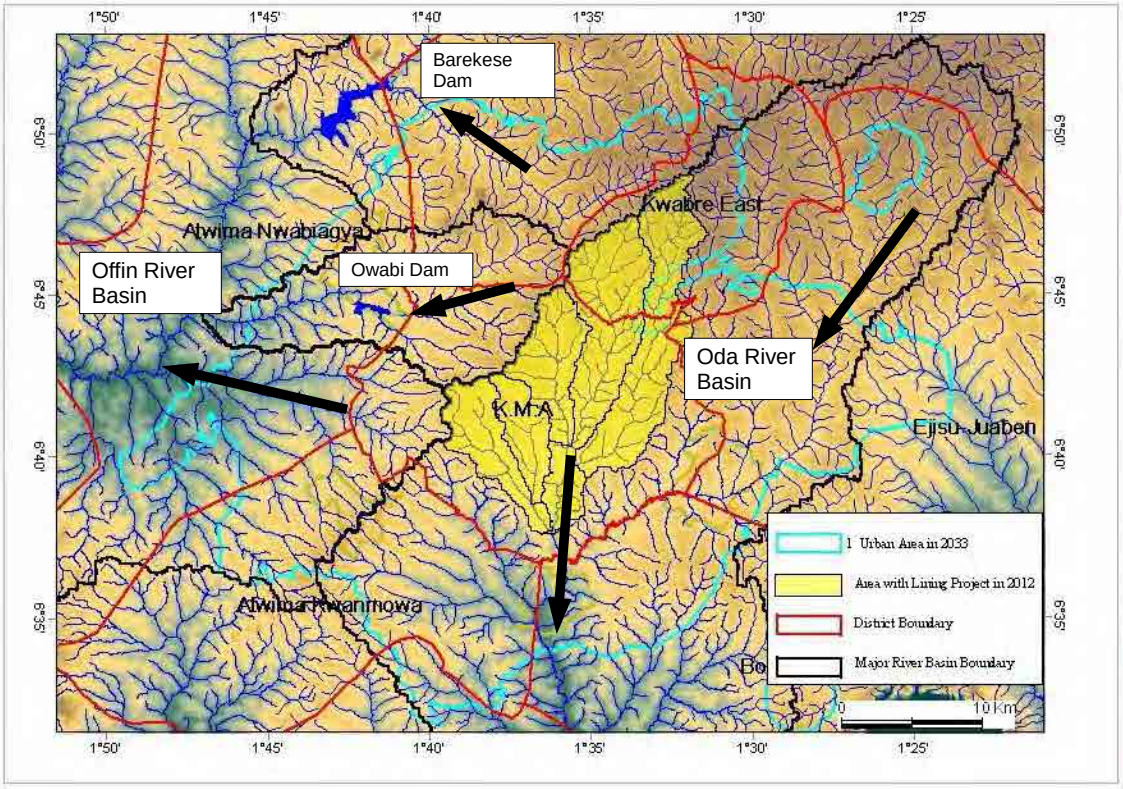
Figure 17.1.2 Lining and Buffer Zone

17.2 The Future of the Drainage Sector

KMA is located in the upper most part of the Pra River basin on the catchment divide between the Offin and Oda Rivers. In this topographical sense, the KMA is free from danger of prolonged flooding due to high water in the rivers.

But KMA and her surrounding Districts and Municipalities have few lined drains. Due to insufficient drains, erosion occurs and buildings might collapse if the erosion continues.

The limits of the future urbanized areas are shown in Figure 17.2.1 as a light blue line, and the area is 858 km^2. It is clear that the rainwater runoff will discharge into the KMA's surroundings due to its topography.



Source: JICA Study Team

Figure 17.2.1 Future Urban Extent and Major River Basin Boundaries

Consequently, the new urbanized area should have proper drainage infrastructure as well as wastewater sewerage as soon as possible in order to assure an appropriate water-related environment.

Therefore, in terms of the drainage sector, Greater Kumasi Sub-Region, especially KMA, has to prepare for a huge amount of investment in the future.

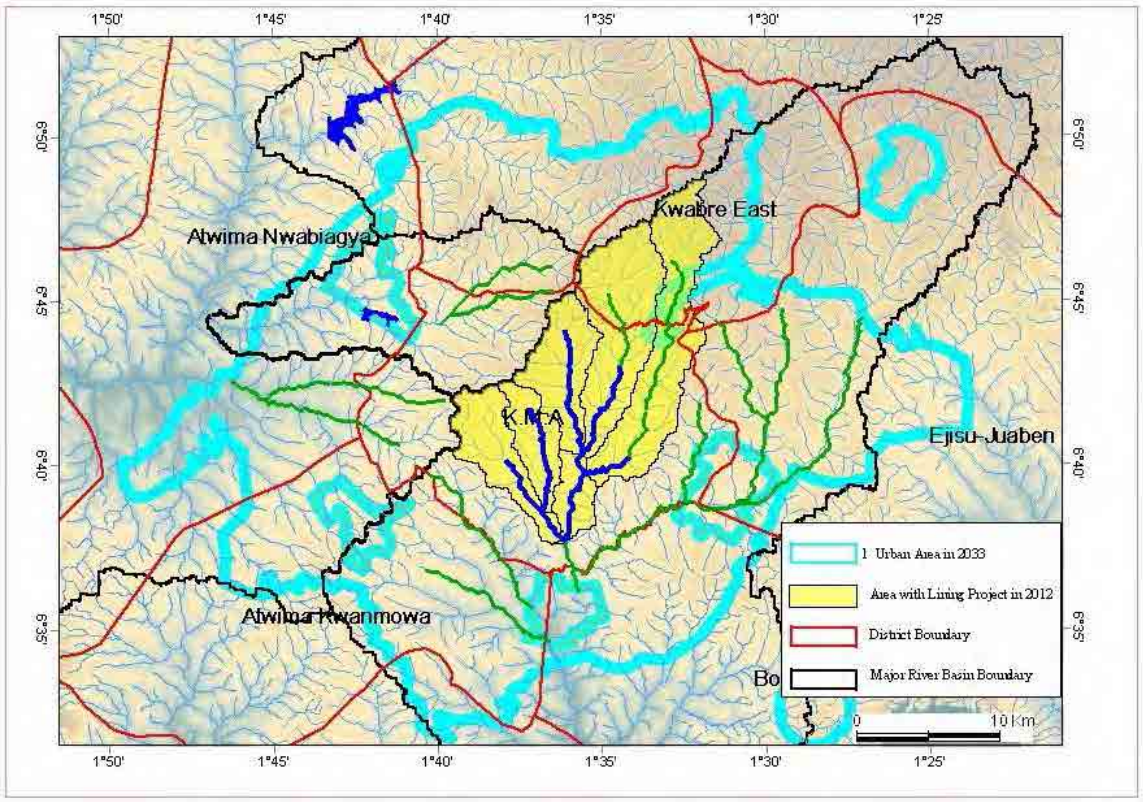
The preliminary cost for the future drainage work is estimated as follows,

Table 17.2.1 Preliminary Cost Estimation for Future Drainage

Typical Lengths of Drainage Channels in Residential Areas	Urbanized Area in 2033	Cost for 1 km of Drainage	Total Cost
20 km / km^2	858 km^2	20,000 GHC	343 million GHC

Source: JICA Study Team

Regarding the lining works, the extension of the lined sections is necessary according to the future urbanization in the Greater Kumasi Sub-Region. Candidate sections for future lining are shown in Figure 17.2.2. It should be certain that these lining sections must be decided based on further studies under the concept of comprehensive storm water management. The preliminary cost estimation for future lining work is shown in Table 17.2.2 just as a reference.



Source: JICA Study Team

Figure 17.2.2 Candidate Lining Sections According to Future Urbanization

Table 17.2.2 Preliminary Cost Estimation for Future Lining Work

Candidate Length of Lining Sections According to Future Urbanization	Cost for 1 km Drainage	Total Cost
200 km	4,000,000 GHC	800 million GHC

Source: JICA Study Team

The above cost for drainage and lining is 1,143 million GHC and this is about 57 million GHC annually. Considering the annual budget of KMA (97 million GHC in 2012), this investment is not realistic.

The actual implementation volume would be limited. The preliminary cost for the drainage sector is estimated tentatively.

17.3 Strategies for Drainage Sector Programme

(1) Adequate Drainage Maintenance

In order to limit sanitary nuisances and vector breeding, drainage management should be integrated and continuous improvement of the drainage systems should be conducted and a Drain Maintenance Unit (DMU) should be established.

From another aspect, assemblies are making efforts to provide containers for solid

waste in the communities so that people will not dump rubbish into the drains. It is also essential to educate people for not littering by presenting educational campaigns.

(2) Continuous Lining of Drainage and Erosion Control

Lining of the remaining sections of the drainage channels that have already been proposed by KMA should be continuously conducted by KMA (DMU) to limit sanitary nuisances, vector breeding, and the physical hazards of flooding and to reduce the future maintenance cost.

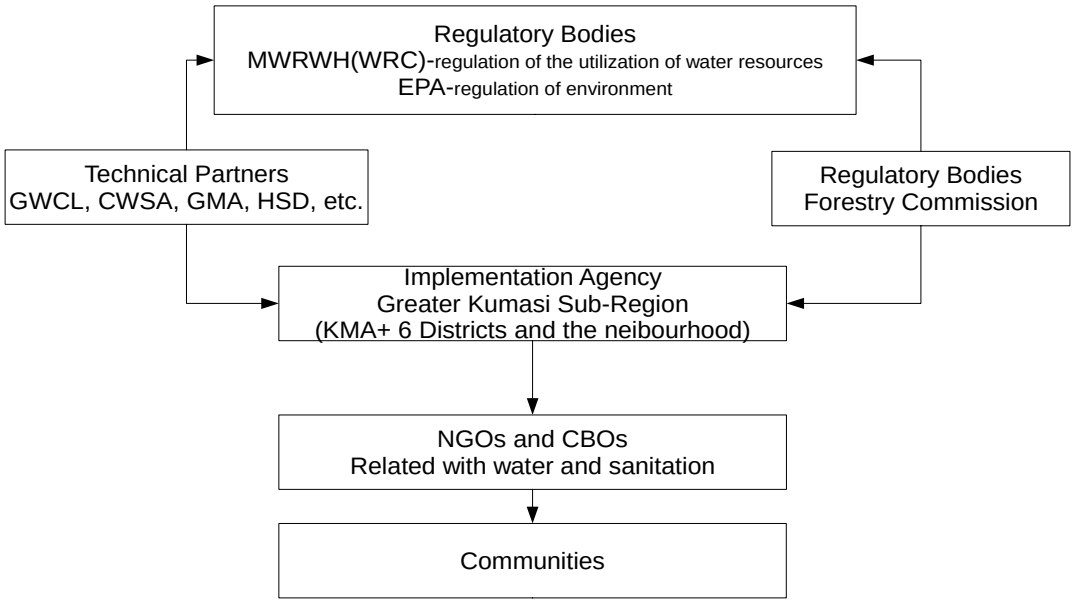
(3) Prevent Flooding in Downstream River Sections

The lined river sections in the Oda River catchment could basically accept the flood flow from upstream urban areas. As the expansion of the current urban area progresses, comprehensive storm water management planning should be conducted by KMA with coordination by the Water Resources Commission.

The comprehensive storm water management shall include the following,

- Introduction of an integrated watershed management concept coordinated by WRC.
- Basin-wide flood control based on hydrological analysis
- Rainwater storage in urban areas
- Lining and applying a Buffer Zone Policy for Managing River Basins in Ghana

The institutional framework for comprehensive storm water management for Greater Kumasi Sub-Region is shown in Figure 17.3.1.



Source: JICA Study Team

Figure 17.3.1 Institutional Framework for Comprehensive Storm Water Management in Greater Kumasi Sub-Region

17.4 Drainage Sector Programme

(1) Outline of Programmes for the Drainage Sector

There are 3 sub-programmes for the drainage sector for the Greater Kumasi Sub-Region.

- Sub-Programme 1: Adequate drainage maintenance
- Sub-Programme 2: Continuous lining of drainage systems and erosion control
- Sub-Programme 3: Prevention of flooding in downstream river sections

The detailed plans of each project are as follows:

a) Sub-Programme 1: Adequate drainage maintenance
- Prevent solid waste from being dumped into the drainage
- To integrate drainage management

b) Sub-Programme 2: Continuous lining of drainage systems and erosion control
- Acceleration of drainage lining work for primary drains
- Paving of streets in residential areas

c) Sub-Programme 3: Prevention of flooding in downstream river sections
- Formulate plan preventing flooding
- Enforce laws to ensure Buffer Zones

(2) Sub-Programme for Adequate Drainage Maintenance

1) Prevent Solid Waste from being Dumped into the Drainage

Assemblies are making efforts to provide containers for solid waste in the communities so that people will not dump rubbish into the drains, and educate people for not littering. Moreover, assemblies are making efforts to implement some projects in the solid waste management sector programmes.

2) Integrate Drainage Management

In order to aid in the establishment of the Drain Maintenance Unit (DMU), KMA has conducted a drainage inventory survey and prepared a maintenance program. Therefore, KMA should establish and run the DMU, and integrate drainage management.

The drainage maintenance includes the following:

- Dredging the main, the secondary and the tertiary drains (weed clearing, refuse removal, drain dredging and desilting)
- The dredged/desilted material should be carried away from the drain banks.
- Culvert outfalls should also be protected against scouring and erosion using rip-rap for example.

(3) Sub-Programme for Continuous Lining of Drainage systems and Erosion Control

1) Acceleration of Drainage Lining Work for Primary Drains

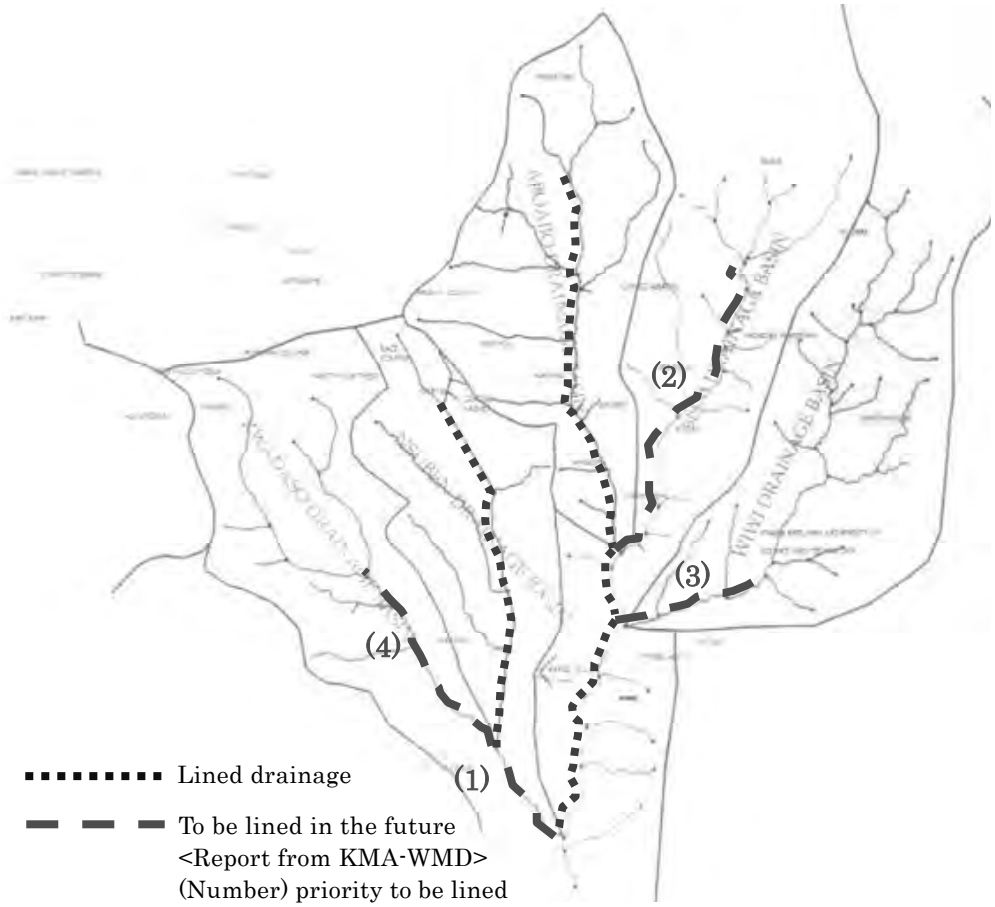
There are 5 main drainage basins in Kumasi Metropolitan Area, namely Aboabo, Kwadaso, Nsuben, Sisai and Wiwi drainage basins, which generally run in a north to south direction. Each basin is drained by a number of tributaries categorized into primary, secondary and tertiary drains as shown in the table below.

Table 17.4.1 Lengths (in meters) of Drains in KMA, as of October 2012

Drain	Primary	Secondary	Tertiary	Total	Lined*[1]	Unlined*[2]
Aboabo	11,299	15,608	1,969	28,876	9,999	18,877
Kwadaso	13,746	11,419	2,000	27,165	0	27,165
Nsuben	8,060	8,653	2,020	18,733	6,670	12,063
Sisai	15,532	20,174	805	36,511	7,166	29,345
Wiwi	11,461	15,897	3,300	30,658	0	30,658
Total	60,098	71,751	10,094	141,943	23,835	118,108
Percentage	42.3%	50.5%	7.1%	100.0%	16.8%	83.2%

Source 1: <Definition of Drainage> KMA (2007), Preparation of a storm water drain maintenance programme - Drainage Inventory Report, Volume I - Main Report
Source 2: Lined/Unlined lengths are calculated based on Figure 17.4.1
Note*1: drain that is open or covered which is concreted / piped
Note*2: drain that has been created by runoff water or sludge from nearby homes and follows the natural low points of the topography of the area

It is recommended that KMA (DMU) conducts lining works for primary drainage based on Figure 17.4.1.



Source 1: <Drainage Network > KMA (2007), Preparation of a storm water drain maintenance programme - Drainage Inventory Report, Volume I - Main Report
Source 2: <Lined / Urgent to be lined sections > report from director of KMA-WMD

Figure 17.4.1 Drainage Network in KMA

2) Pavement of Streets in Residential Areas

Erosion is also a serious issue in KMA. Erosion has degraded some settlements leaving many building hanging. This is mainly due to inadequate drainage systems.

In order to prevent erosion, the paving of residential roads and construction of small roadside drains are necessary.

Therefore, the paving and construction of roadside drains should be conducted gradually, according to the development of the city.

As described in section 16.2, the subject area should be prioritized in a practical sense. Here, tentatively, it is proposed that drains in an additional 150 km^2 should be implemented. The preliminary cost for the drainage is as follows.

Table 17.4.2 Preliminary Cost Estimation for Future Drainage

Typical Length of Drainage Channel in Residential Area	Subject Area by 2033	Cost for 1 km of Drain	Total Cost
20 km / km^2	150 km^2	20,000 GHC	60 million GHC

Source: JICA Study Team

(4) Sub-Programme for Prevention of Flooding in Downstream River Sections

1) Formulation of a Flooding Prevention Plan

In the future, surface penetration of rainwater will be reduced by urbanization. As a result, the amount of storm water runoff will be increased. Then the risk of flooding will increase.

It is also necessary to enter into discussions in terms of effective use of rainwater such as rainwater harvesting.

Based on the above, it is necessary to formulate a plan for preventing flooding including effective use of stored storm water.

2) Enforcement of Laws to Ensure Buffer Zones

Assemblies are making efforts to enforce laws to ensure the Buffer Zones around the water bodies will be secured.

Take measures to prevent houses from being built in the drains

The land to be secured from the water bodies shall include a buffer in accordance with relevant policies/laws such as the "Buffer Zone Policy for Managing River Basins in Ghana".

The necessary actions are as follows:

- Protect, restore and maintain riparian buffers and flood plains as natural and long term defences against the harmful effects of floods
- Enforce zones of no development around streams and water bodies by the removal, demolition and the prohibition of unauthorised structures and incompatible land use practices on flood plans, fringes and corridors
- Manage runoff as close to the source as possible by trapping rain water or by directing runoff to natural infrastructure such as gardens, and green parks
- Promote the development/establishment of green spaces with native grass along waterways and protect them from future development and environmental damage by prohibiting the removal of soil, trees and other natural features except for purposes of conservation, research, recreation or uses accessory to permitted uses
- Encourage approved edge gardening and flood recession farming only for the purposes of mitigating erosion and water pollution and for sustenance of livelihoods
- Encourage a sense of municipal and community ownership of green spaces and provide local communities access to green space facilities (recreational parks, walkways etc.) at all times
- Ensure that economically important trees such as bamboo and fruit trees (e.g., mango, coconut, palm nut, pawpaw and rubber) are planted along and within the buffer for the benefit of local communities

In order to implement the buffer zone policy it is necessary to formulate a plan to prevent flooding, including effective use of the stored storm water, under the coordination of a regulatory body such as WRC. In the course of discussion of the

flood control plan, the future lining sections can be prioritized.

17.5 Implementation Plan for the Drainage Sector Programme

The JICA Study Team will prepare an implementation plan for the Drainage Sector Programme.

The goals of the Sector Programme for the drainage sector of the project are outlined in Table 17.5.1 with prospective target levels to be achieved by the year 2018 for the Short-Term Plan, year 2028 for the Mid-Term Plan and year 2033 for the Long-Term Plan.

Table 17.5.1 Project Outline for Drainage Sector Programme

	Short-Term Plan						Mid-Term Plan										Long-Term Plan				
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Sub-Programme 1: Adequate drainage maintenance																					
a) Prevent solid waste from being dumped into the drainage	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	→
b) Integrate drainage management	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	→
Sub-Programme 2: Continuous lining of drainage and erosion control																					
a) Acceleration of drainage lining work for primary drains	●	-	-	-	-	-	-	-	-	-	→										
b) Paving of streets in residential areas	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	→
Sub-Programme 3: Prevent flooding in downstream river sections																					
a) Formulate plan for preventing flooding												●	-	-	-	→					
b) Enforce laws to ensure Buffer Zones	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	→

Source: JICA Study Team

17.6 Cost of Sector Programme

Preliminary cost estimation for the program is as follows.

Table 17.6.1 Preliminary Cost for Drainage Sector Programme

(Unit: Million GHC)

	Short term	Mid term	Long term	Total
Sub-Programme 1: Adequate drainage maintenance				
Sub-Programme 2: Continuous lining of drainage and erosion control	20	20	20	60
Sub-Programme 3: Prevent flooding in downstream river sections				

Source: JICA Study Team

Chapter 18 Electricity Sector Plan and Programme

18.1 Objective for Electricity Sector Development

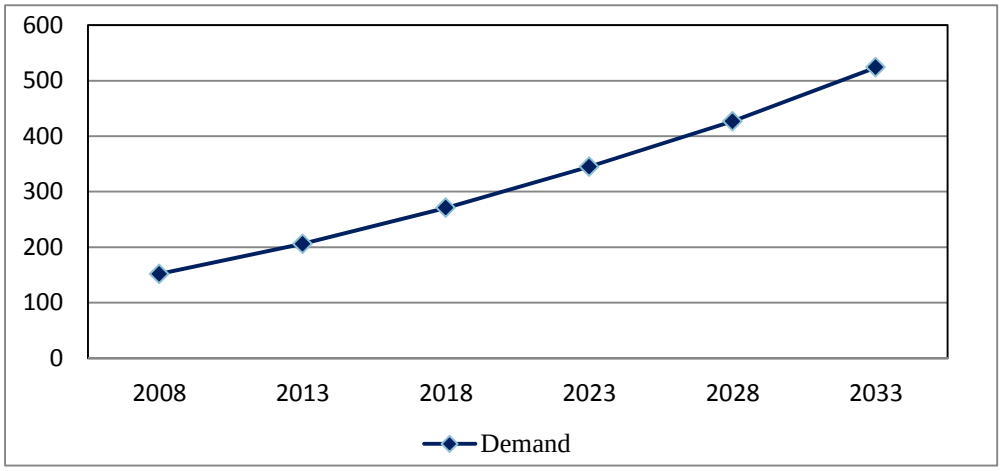
The objective of the Electrical Sector is "Stable and Reliable Power Supply" to the consumers. And especially industrial developing areas require "Stable and Reliable Power Supply" for their competitive operation.

18.2 Future Demand Analysis

In 2033, the maximum demand of Kumasi Sub-Regions is forecast to reach 528MVA, while total generation capacity of Ghana is expected to be about 4200MW by 2021 according to Ministry of Energy. Therefore, generation capacity in Ghana will be able to cover the demand of Ghana for the mean time.

(1) Future Maximum Demand Forecast

The following chart shows forecast maximum demand based on the record of the past 9 years maximum demand for electricity and the growth of population and GDB, and forecast growth of population and GDP.



Source: JICA Study Team Unit: MVA

Figure 18.2.1 Forecast Future Maximum Demand for Electricity

Table 18.2.1 Past 9 Years Data on Electricity

Year	Unit	2003	2004	2005	2006	2007	2008	2009	2010	2011
Past 9 years Max. Demand	MVA	110	103	120	142	130	152	157	178	175
Population	Thousand	2,014	2,107	2,204	2,307	2,413	2,525	2,642	2,764	2,885
GDP	Million GHC	329,510	347,020	367,920	390,440	415,660	450,710	468,700	504,870	573,560

Source: ECG and JICA Study Team

Table 18.2.2 Forecast Future Maximum Demand

Year	Unit	2008	2013	2018	2023	2028	2033
Future Max. demand -1	MVA	152	206	271	345	427	524
Future population	Thousand	2,525	3,127	3,749	4393	5,050	5,761
Future GDP	Million GHC	450,710	623,990	848,770	121399	177,147	286,216

Source: JICA Study Team

A regression analysis was used for forecasting the above Future Max Demand for Electricity. The future population and GDP shown in the above table are forecast in another chapter.

In almost all countries, the growth of electrical demand is linked with the growth of population and GDP, therefore the electrical future demand is forecast based on the growth of population and GDP.

The following formula is used:

$$Di = K \times GDPi^{e} \times Pi^{p}$$

Di : Maximum Demand for Electricity
K: Constant Term
GDPi: Gross Domestic Product
Pi: Population
e: Value of elasticity related to GDP
p: Value of elasticity related to Population

(2) Spot Demand

According to the Future Land Use Plan, many areas in Greater Kumasi Sub-Regions will be developed as industrial areas, urban and city centers, especially the industrial area is estimated to have a high demand, therefore spot demand will be considered in addition to the above forecast demand.

Table 18.2.3 Spot Demand for Electricity

Unit: MVA

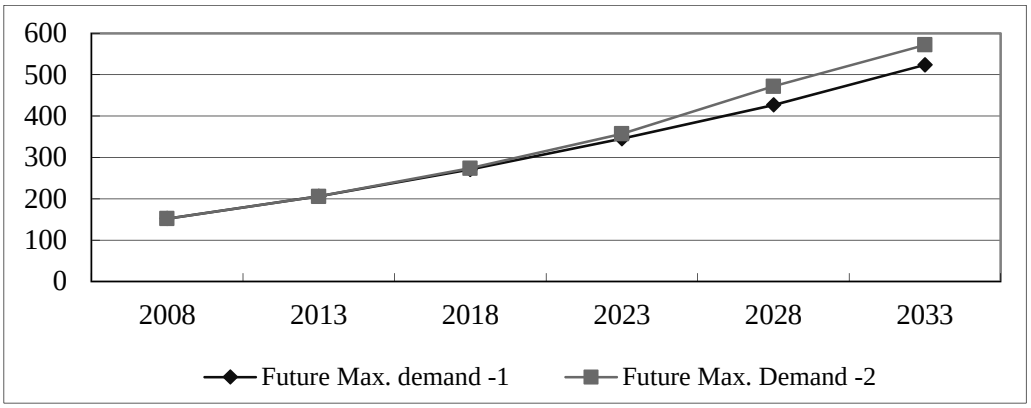
Year	2008	2013	2018	2023	2028	2033
Future Max. Demand -1	152	206	271	345	427	524
Spot Demand	0	0	3	12	45	49
Future Max. Demand -2	152	206	274	357	472	573

Source: JICA Study Team

(3) Future Demand of Greater Kumasi Sub-Regions

The following graph shows the relationship between future demand-1 and demand-2 of Greater Kumasi Sub-Region. The value of Future Max. Demand-2 (MVA) is

adjusted based on the spot demand shown in (2) above.



Source: JICA Study Team Unit: MVA

Figure 18.2.2 Relationship between Future Max. Demand-1 and -2

18.3 Strategies for Electricity Sector Development

(1) Power Generation Capacity

As mentioned in 9.7.1 (1) Power Generation Capacity in Ghana, if planed power stations will be constructed on schedule, the power generation capacity is deemed enough for the mean time.

(2) 161kV Transmission Line and Bulk Supply Point (BSP)

Two 161kV Transmission Lines are connected to a BSP and the expected capacity of transformer will cover the forecast maximum demand of Greater Kumasi Sub-Regions. Further expansion of the BSP would not be required in the near future.

(3) Stable and Reliable Power Supply

Enhancement of the quality of power supply and Improvement of Sub-transmission and low voltage distribution systems for stable and reliable power supply.

1) Improve and Modernize Sub-transmission and Low Voltage Distribution Systems

Small size overhead wires should be replaced by proper size, then technical loss will be decreased.

The clearance between the overhead wires and obstacles such as trees should be monitored and if the clearance is less than ECG standard, actions such as tree trimming/replacing overhead poles should be carried out in a focused and planed manner. By this measure, distribution trouble such as short-circuits and earth faults should be decreased.

Power factor on low voltage distribution system is also one of the major factors that reduces the current in low voltage distribution lines. ECG should manage and instruct consumers such as commercial and office buildings to provide power factor correction devices.

2) Replacement of Deteriorated Equipment

Deteriorated equipment such as insulators, overhead wires and cables should be replaced with new ones.

3) Electrification in Rural Areas

As per the “Energy Sector Strategy and Development Plan" (by the Ministry of Energy, 2010) and the National Energy Policy (by the Ministry of Energy, 2010), the rating of access to electricity for communities with more than 500 population is to increase to 80% by 2015 and to 100% by 2020.

4) Expansion of Sub-transmission and Distribution Systems

Sub-transmission/distribution systems will be expanded for supplying stable and reliable power to the areas that are shown in the Future Land Use Plan.

In the beginning, expansion of Sub-transmission/distribution lines will be proposed according to the above Future Land Use Plan and transformers will be installed based on the demands of the consumers.

(4) Management of ECG

To reduce the commercial losses, the following measures will be proposed:

- Reduce the number of consumers that are in arrears by providing pre-paid meters, according to ECG, currently 20% of residential consumers are provided with pre-paid meters.
- Strict control of consumers involved in illegal connections
- Instruct non residential consumers such as commercial/office buildings to provide power factor correction devices.

18.4 Electricity Sector Plan

(1) Enhancement and Improvement of Sub-transmission and Distribution Systems

To achieve stable and reliable power supply, enhancement and improvement of Sub-transmission and Distribution Systems needs to be taken care of first. Therefore, the following sector plans are considered:

- Replacement of small size wires of sub-transmission and distribution systems
- Replacement of deteriorated equipment

(2) Electrification in Rural Areas

The target for electrification in rural areas is to increase access rating to electricity for communities with more than 500 population to 80% by 2015 and to 100% by 2020.

(3) Expansion of 33kV Sub-Transmission and Distribution Systems

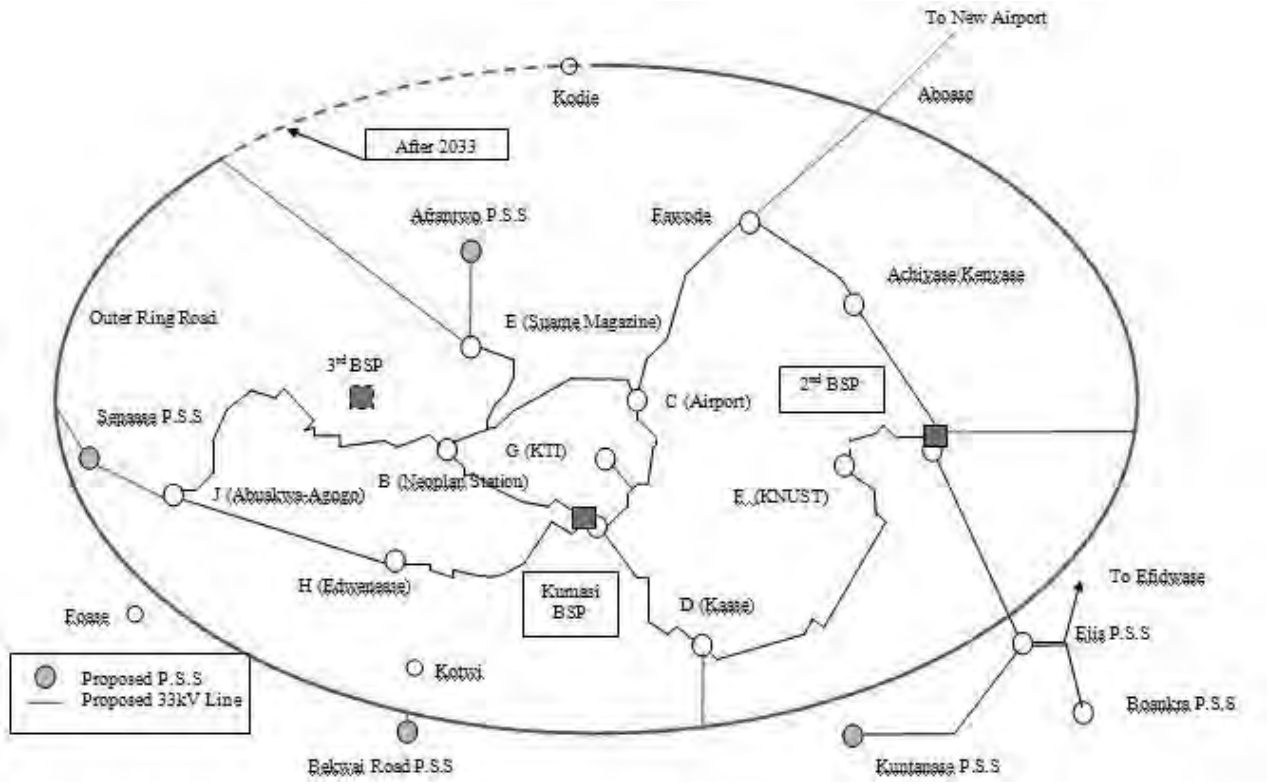
Sub-transmission and distribution lines are to be expanded based on the electrical demand shown in the Future Land Use Plan.

(4) Future Sub-Transmission System

Expanding the 33kV sub-transmission system based on the demand in the above Future Land Use Plan is deemed to create a more reliable system compared to the current 33kV Sub-transmission system.

Since the 33kV sub-transmission system is a key system of electrical power supply, a 33kV ring main system will be planed. The ring main system will result in increased distribution capacity and supply reliability to the consumers.

Future Sub-Transmission systems including the ring main system are shown in Figure 18.4.1.



Source : JICA Study Team

Figure 18.4.1 Future 33kV Sub-Transmission and Ring Main Systems

18.5 Electricity Sector Programme

(1) Modernization of Sub-Transmission and Low Voltage Distribution Systems

To improve and modernize sub-transmission and low voltage distribution systems, the following programme will be offered during the period of 2013 to 2017:

- Replace small size overhead wires with proper size wires

- Realignment of distribution lines to meet the ECG standard by tree trimming/replacing overhead poles
- Replacement of deteriorated equipment
- Deteriorated equipment such as overhead wires, insulators and cables should be replaced with new ones.
- Installation of new Sub-transmission lines based on forecast demand.
- In the year of 2017, the maximum demand of Great Kumasi Sub-Region will reach 270MVA. To prevent over current and considering redundancy of 33kV Sub-transmission line, the following additional 33kV sub-transmission lines will be proposed:
  a) A to KTI, Installation of 670sq. mm AL/XLPE 1- Line
  b) A to C, Installation of 240sq.mm AL/XLPE 1- Line
  c) A to B, Installation of 240sq.mm AL/XLPE 1- Line
  d) B to E, Installation of 240sq.mm AL/XLPE 1- Line
  e) A to D, Installation of 400 AL Bare 1- Line

  The above additional 33kV lines were proposed in the "Power Distribution System Master Plan Study for Ghana, 2008" prepared by JICA technical assistance.

(2) Electrification in Rural Areas

Installation of the 11kV distribution overhead lines and transformers for currently non electrified communities in Rural Areas to increase access to electricity to 80% by 2015 will be undertaken.

(3) Expansion of Sub-transmission and Distribution Systems

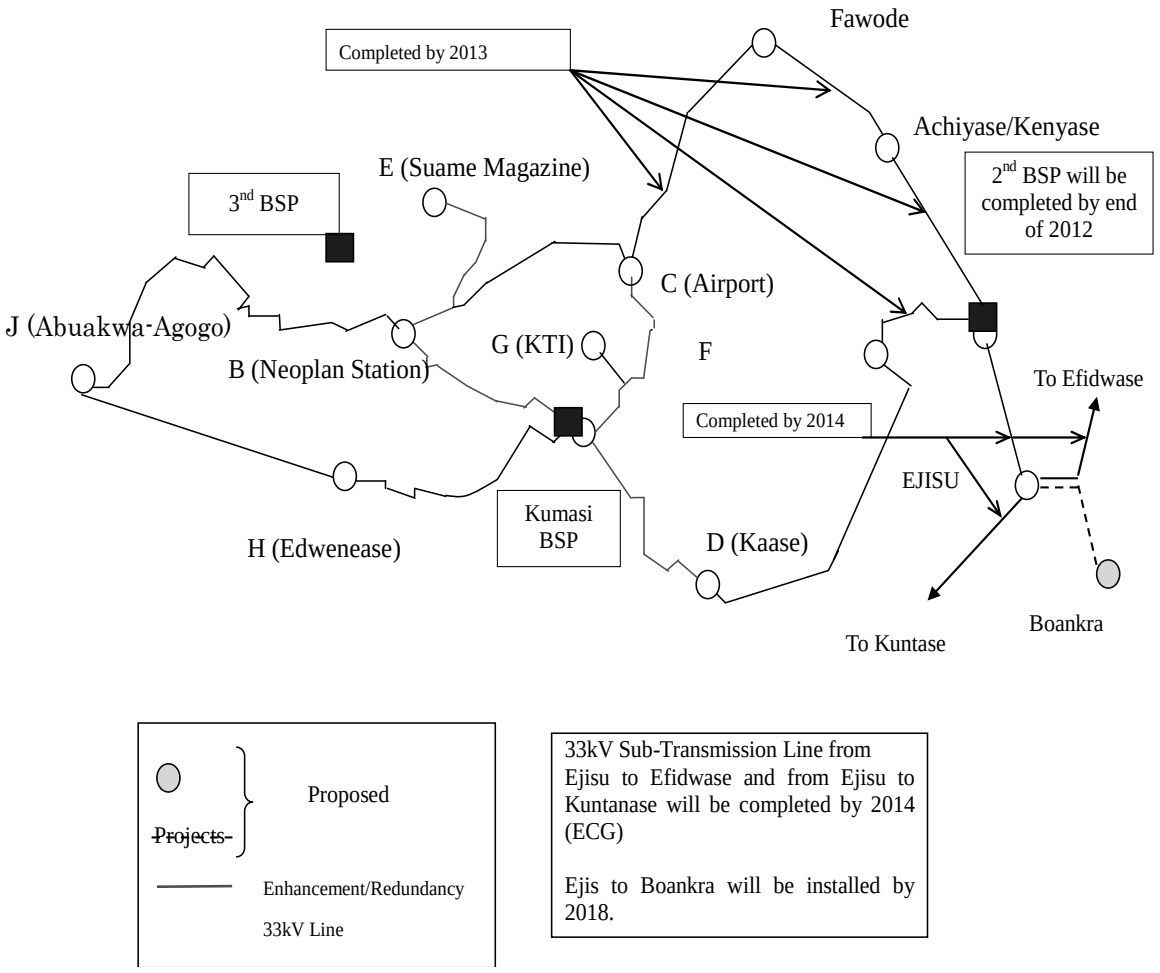
Sub-transmission/distribution systems will be expanded to supply stable and reliable power to the areas shown in the Future Land Use Plan.

The following projects are proposed for the Sector Programme:

<u>From 2013 to 2018</u>

- Installation of 11kV underground distribution lines in KNUST campus area for future demand. Primary cables will be connected to 2nd BSP
- Currently the 33kV Sub-transmission line from 2nd BSP to Ejisu and 33kV switching station in Ejisu are under construction and will be completed by 2014.
- Therefore, installation of a 33kV Sub-transmission line from the above switching station in Ejisu to Boankra (length : 9km) and a 33/11kV sub-station at Boankra (capacity : 10MW-2 unit) will be proposed.
- Installation of distribution lines and transformers for non electrified communities in Rural Areas

Conceptual diagram of 33kV Sub-transmission system in the year 2018 is shown below:



Source: JICA Study Team

Figure 18.5.1 Conceptual Diagram of 33kV Sub-transmission Line in the Year 2018

From 2018 to 2023

- The area along Ejisu to Kuntanase road will be developed for industry. Currently ECG is installing a 33kV switching station in Ejisu and 33kV Sub-transmission lines to Kuntanase are under construction, and this project will be completed by 2014.

Therefore, installation of a 33/11kV substation in Kuntanase is proposed.

- Installation of 11kV/433V transformers (500kVA- 2) in Kodie and connect existing 11kV distribution line
- Installation of 11kV/433V transformers (500kVA- 2) at Kumasi-Manpong Road.
- Installation of 11kV/433V transformers (500kVA- 2) at Ejisu City Centre
- Installation of distribution lines and transformers for non electrified communities in Rural Areas

From 2023 to 2028

- Installation of P.S.S in Afrantwo (industrial area) and 33kV Sub-transmission from E (Suame Magazine) to the above P.S.S.

- Installation of P.S.S in Kotwi (along New Bekwai Road) and 33kV Sub-transmission line from the above P.S.S. to new 33kV Sub-transmission line along the ring road.
- Installation of P.S.S. in Sepaase (industrial area) and 33kV Sub-transmission line from J (Abuakwa-Agogo) to the above P.S.S. and the P.S.S. in Sepaase to a new 33kV Sub-transmission line along the ring road.
- Installation of 33kV Sub-transmission line along the outer ring road between Ejisu and Kodie
- Installation of 11kV/433V transformers (500kVA-1) at Ahwiaa, Fumesua, Aputuogya, Kotwi, and Foase for future demand as Suburban Centres
- Installation of 11kV/433V transformers (100kVA -10) for future Atwima New Town

2028 to 2033

- Installation of 33kV Sub-transmission line along the outer ring road between Kotowi, Foase and Sepaase
- Installation of 33kV Sub-transmission line along the outer ring road (between Ejisu, Aputuogya and Kotwi)
- Installation of 33kV Sub-transmission line between the Sub-Transmission line along the outer ring road (near by Aboaso) to New Airport for the future logistic center
- Installation of 33kV Sub-transmission line for redundancy between 33kV Sub-transmission line along the outer ring road and the following substations:
  a) E (Suame Magazine)
  b) D (Kaase)
  c) 2nd BSP
  d) Fawode

(4) Management of ECG

To reduce the commercial losses, the following measures is proposed:

- Reduce the number of consumer that are in arrears by providing pre-paid meter
- Strict control of consumers involved in illegal connections

18.6 Cost of Electricity Sector Programme

Preliminary Electricity Sector Programme cost is shown below:

Table 18.6.1 Cost of Electricity Sector Programme

Phase	Sector Programme	Cost (US$ 1,000)
2013 to 2018	Replace small size overhead wires with proper size wires Realignment of distribution lines to meet the ECG standard by tree trimming/replacing overhead poles Replacement of deteriorated equipment • Deteriorated equipment such as overhead wires, insulators and cables should be replaced with new ones.	23,365

Phase	Sector Programme	Cost (US$ 1,000)
	Installation of new Sub-transmission lines • A to KTI, 1- Line • A to C, 1- Line • A to B, 1- Line • B to E, 1- Line • A to D, 1- Line Installation of 11kV underground distribution system in KNUST campus area for future demand. Primary cables will be connected to 2nd BSP Installation of 33kV Sub-transmission line from the Ejisu switching station to Boankra and 33/11kV sub-station at Boankra Installation of distribution lines and transformers for non electrified communities in Rural Areas (Target:80% electrification of communities with more than 500 population)	
2018 to 2023	Installation of 33/11kV substation in Kuntanase Installation of 11kV/433V transformers (500kVA- 2) in Kodie and connect existing 11kV distribution line Installation of 11kV/433V transformers (500kVA- 2) at Kumasi-Manpong Road. Installation of 11kV/433V transformers (500kVA- 2) at Ejisu City Centre Installation of distribution lines and transformers for non electrified communities in Rural Areas (Target:100% electrification of communities with more than 500 population)	14,381
2023 to 2028	Installation of P.S.S in Afrantwo (industrial area) and 33kV Sub-transmission line from E (Suame Magazine) to the above P.S.S. Installation of P.S.S in Kotwi (along New Bekwai Road) and 33kV Sub-transmission line from the above P.S.S. to new 33kV Sub-transmission line along the ring road. Installation of P.S.S. in Sepaase (industrial area) and 33kV Sub-transmission line from J (Abuakwa-Agogo) to the above P.S.S. and the P.S.S. in Sepaase to new 33kV Sub-transmission line along the ring road. Installation of 33kV Sub-transmission line along the outer ring road between Ejisu and Kodie Installation of 11kV/433V transformers (500kVA-1) at Ahwiaa, Fumesua, Aputuogva, Kotwi, and Foase for future demand as Suburban Centres Installation of 11kV/433V transformers (100kVA -10) for future Atwima New Town	6,512
2028 to 2033	Installation of 33kV Sub-transmission line along the outer ring road between Kotwi, Foase and Sepaase Installation of 33kV Sub-transmission line along the outer ring road between Ejisu, Aputuogya and Kotwi) Installation of 33kV Sub-transmission line between the Sub-Transmission line along the outer ring road (near Aboaso) to New Airport for the future logistic center Installation of 33kV Sub-transmission line for redundancy between 33kV Sub-transmission line along the outer ring road and the following substations: • E (Suame Magazine) • D (Kaase) • 2nd BSP • Fawode	2,840
	Total	47,098

Source: JICA Study Team
Note: Most unit prices of electrical equipment were quoted from the cost shown in the "Power Distribution System Master Plan Study for Ghana", Sep. 2008, JICA

18.7 Preliminary Economic and Financial Analysis

18.7.1 Economic Analysis

(1) Methodology

The economic analysis including the determination of EIRR is based on streams of benefits and costs resulting from the construction, installation and operation of the Sector Programme components. For those components where the benefits are not easily quantifiable, the benefits have been presented in qualitative terms employing usual practice. However, the JICA Study Team estimated the quantifiable economic benefits by equating the increase in economic benefits in monetary terms using the willingness to pay analysis and estimating the non-supply cost of power in this sector. The following steps shall be applied to quantify the benefit;

Step 1: Identification of “with” and “without” cases,

Step 2: Assumption of parameters for direct benefits such as willingness to pay and saving on non-supply cost of power,

Step 3: Estimation of economic costs based on the estimated capital investment cost

Step 4: Economic evaluation using economic benefits and economic costs.

(2) “With” and “Without” Cases

To test the economic viability, the EIRR shall be calculated based on the increase in the cost and benefit streams associated with the whole investment. The economic analysis evaluates the economic performance of the proposed components by comparing the "With " and "Without” cases.

Thus, the proposed Sector Programme inputs and outputs should be identified, quantified and valued by comparing the “Without” situation with that of the “With” case to derive the economic benefit.

1) “With” Case

The proposed increase in the power transmission facilities and distribution system are described in the Sector Programme.

2) “Without” Case

The current facilities and system shall continue to operate in the future.

(3) Assumption of Benefits

1) Application of Willingness to Pay

In its effort to analyse the benefits the JICA Study Team applied the willingness to pay survey conducted in the socio economic survey based on the “Power Distribution System Master Plan Study for Ghana of September, 2008”. According

to this survey, the monthly willingness to pay for electricity supply per household was GHC 19.60/month. The JICA Study Team assumes that the present value of willingness to pay in 2012 is GHC 27.05/month based on the rate of GDP growth.

On the other hand, industrial or commercial companies also answered regarding the "Respondent's Willingness to Pay for Improved Service Delivery". The figure was more than 2.25 times that of the current electricity bill. The reason for the high rate of willingness to pay is to avoid the loss incurred by the respondents due to supply interruptions. The JICA Study Team quantified the damage or loss in case of unreliable supply and occurrence of outage in the industrial area based on the report the "Power Distribution System Master Plan Study for Ghana" as the "Without" case. The non-supply cost by the production loss method is calculated by dividing the value of total loss by the duration time of the power supply shortfall (in terms of the hours of using stand-by generators).

2) Reduction of the Overall Distribution Losses

This sector would allow improved reconciliation of the electricity flows and help reduce the losses in the distribution network. The propose system can reduce losses in the distribution networks by installing a metering system at the distribution level. ECG can establish the basis for accurate tracking of power flows, identify areas of high losses, implement internal controls and maintain an accountable operational environment.

The target for reduction of distribution losses is shown in Table 18.7.1.

Table 18.7.1 Reduction of Ratio of Distribution Losses

	Unit	Year 2012	Year 2015	Year 2033
Ratio of Losses	%	25%	18%	15%
Annual Losses of Power Supply	GWh	153	133	250

Source: JICA Study Team

(4) Estimation of Economic Cost

The whole Sector Programme cost is estimated at GHC 94.2 million. In this study, the economic cost was estimated by deducting government taxes and import duty from project cost so that a conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 80.0 million as shown in Table 18.5.2. Operation and maintenance (O&M) cost is applied based on 95% of revenue in accordance with the "Power Distribution System Master Plan Study for Ghana".

Table 18.7.2 Economic Cost of Distribution and Sub-Transmission

Phase	Financial Cost (GHC Thousand)	Conversion Factor	Economic Cost (GHC Thousand)
Year 2013 – 2018	46,730	0.85	39,720
Year 2018 – 2023	28,762	0.85	24,448
Year 2023 – 2028	13,024	0.85	11,070
Year 2028 – 2033	5,680	0.85	4,828
Total	94,196	0.85	80,066

Source: JICA Study Team

(5) Result of Economic Analysis

The analysis flow projection based on the above assumptions is presented in Table 18.7.3. All the sub-programs together will have an EIRR of 28.3%. The Sector Programme is economically viable. The NPV of the whole Sector Programme is GHC 247 million using a 12% discount rate.

Table 18.7.3 Economic Flow of Electricty Sector Programmes

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013			7,944	7,944	0	-7,944	7,944	0	-7,944
2014	124,088	147,532	7,944	155,476	124,088	-31,388	138,818	110,792	-28,025
2015	142,024	156,384	7,944	164,328	142,024	-22,303	131,001	113,221	-17,780
2016	160,447	164,516	7,944	172,460	160,447	-12,013	122,753	114,203	-8,551
2017	180,572	173,235	7,944	181,179	180,572	-607	115,143	114,757	-385
2018	197,299	182,070	4,889	186,959	197,299	10,340	106,086	111,953	5,867
2019	214,648	190,809	4,889	195,698	214,648	18,950	99,147	108,747	9,600
2020	232,540	199,396	4,889	204,285	232,540	28,255	92,408	105,189	12,781
2021	251,367	208,169	4,889	213,058	251,367	38,309	86,051	101,523	15,472
2022	270,881	216,912	4,889	221,801	270,881	49,080	79,984	97,682	17,699
2023	285,934	225,589	2,214	227,803	285,934	58,132	73,346	92,063	18,717
2024	301,469	234,387	2,214	236,601	301,469	64,868	68,017	86,665	18,648
2025	309,216	236,965	2,214	239,179	309,216	70,037	61,391	79,368	17,977
2026	324,939	245,496	2,214	247,710	324,939	77,229	56,769	74,468	17,699
2027	341,392	254,333	2,214	256,548	341,392	84,845	52,495	69,856	17,361
2028	355,488	263,235	966	264,201	355,488	91,287	48,268	64,946	16,678
2029	370,151	272,448	966	273,414	370,151	96,737	44,600	60,380	15,780
2030	385,406	281,984	966	282,950	385,406	102,457	41,210	56,132	14,922
2031	401,275	291,853	966	292,819	401,275	108,456	38,078	52,182	14,104
2032	418,426	302,068	966	303,034	418,426	115,392	35,184	48,582	13,398
2033	433,071	312,641		312,641	433,071	120,430	32,410	44,895	12,485
2034	433,071	312,641		312,641	433,071	120,430	28,938	40,085	11,147
2035	433,071	312,641		312,641	433,071	120,430	25,837	35,790	9,953
2036	433,071	312,641		312,641	433,071	120,430	23,069	31,955	8,886
2037	433,071	312,641		312,641	433,071	120,430	20,597	28,532	7,934
2038	433,071	312,641		312,641	433,071	120,430	18,391	25,475	7,084
2039	433,071	312,641		312,641	433,071	120,430	16,420	22,745	6,325
2040	433,071	312,641		312,641	433,071	120,430	14,661	20,308	5,647
2041	433,071	312,641		312,641	433,071	120,430	13,090	18,132	5,042
2042	433,071	312,641		312,641	433,071	120,430	11,688	16,190	4,502
2043	433,071	312,641		312,641	433,071	120,430	10,435	14,455	4,020
	10,031,340	7,686,426	80,066	7,766,492	10,031,340	2,264,849	1,714,229	1,961,272	247,043

B / C	1.1441
EIRR %	28.31
NPV (GHc)	247,043

18.7.2 Financial Analysis

The financial analysis of the Electricity Sector Programme is straight forward. The investment has been identified along with the increase in demand that the proposed Sector Programme satisfies. The Sector Programme for the electricity sector shall require an adequate amount of capital investment for the operation body. A financial analysis, therefore, has been undertaken to determine the financial viability of the proposed facilities. The followings are part of the assumptions made for

financial analysis:

- A possible source of funding is not considered
- Current tariff structure and level have been analysed
- A detailed financial projection and analysis have been conducted to examine the financial viability of the proposed programme; the Financial Internal Rate of Return (FIRR) has been calculated.

(1) Financial Costs

Financial costs of the sector programme are summarized in Table 18.7.4, consisting of capital investment cost and operation and maintenance (O & M) cost.

O & M cost is assumed based on 95 % of revenue level. This figure comes from the "Power Distribution System Master Plan Study for Ghana of September, 2008".

Table 18.7.4 Financial Costs of Electricity Sector Programmes

Description	Cost (GHC Thousand)	Remarks
Project Cost	94,196	See Table 18.5.2

Source: JICA Study Team

(2) Financial Benefits

Revenue

The average tariff level is GHC 0.18/kWh for non-industrial users and GHC 0.28/kWh for industrial. Revenue collection is applied based on the actual records of the ECG account book in the year 2010 and 2011 operational period. The JICA Study Team assumed the ratio of increase according to future demand of Greater Kumasi Sub-Region from year 2012 onwards.

Another benefit comes from the decrease in loss. It is assumed that the improvement of the primary substations will bring a 0.2 % improvement in the loss, and the reinforcement of the distribution network will also bring a 3.1% improvement in the loss of the affected system. This will result in the cost savings for the bulk power purchase, which would bring huge financial and economic benefits. The figures for the reduction in loss are in accordance with the "Power Distribution System Master Plan Study for Ghana of September, 2008".

Table 18.7.5 Revenue Projection

	2010	2011	2013	2018	2023	2028	2033
Amount of Revenue Non-Industrial (GHC Thousand)	72,597	99,899	112,246	146,558	181,589	211,892	251,661
Amount of Revenue Industrial (GHC Thousand)	39,091	53,792	60,440	78,916	97,778	114,095	135,510
Total	111,688	153,691	172,686	225,474	279,367	325,987	387,171

Source: JICA Study Team

(3) Result of Financial Analysis

The cash flow projection based on the above assumptions is presented in Table 18.7.6 below. The computed Financial Internal Rate of Return (FIRR) for the programme is 18.08%. The figures, however, depend heavily on the profit margin assumptions. It can be seen that a level of operation and administration cost, a maximum of 95% of revenue, is required to make the sub-programs financially viable. Otherwise, utilities will have a hard time sustaining the facilities.

Table 18.7.6 Financial Flow of Electricty Sector Programme

Unit: GHc 1,000

Year	Revenue	COST		COST TOTAL C	Revenue TOTAL B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2013	0	0	9,346	9,346	0	-9,346	9,346	0	-9,346
2014	182,702	177,221	9,346	186,567	182,702	-3,865	166,577	163,127	-3,451
2015	193,664	187,854	9,346	197,200	193,664	-3,536	157,207	154,388	-2,819
2016	203,734	197,622	9,346	206,968	203,734	-3,234	147,316	145,014	-2,302
2017	214,532	208,096	9,346	217,442	214,532	-2,910	138,189	136,339	-1,849
2018	225,473	218,709	5,752	224,461	225,473	1,012	127,365	127,940	574
2019	236,296	229,207	5,752	234,959	236,296	1,337	119,038	119,715	677
2020	246,930	239,522	5,752	245,274	246,930	1,656	110,949	111,698	749
2021	257,794	250,061	5,752	255,813	257,794	1,982	103,318	104,119	800
2022	268,622	260,563	5,752	266,315	268,622	2,307	96,036	96,868	832
2023	279,367	270,986	2,605	273,591	279,367	5,776	88,089	89,949	1,860
2024	290,262	275,749	2,605	278,354	290,262	11,908	80,020	83,443	3,423
2025	293,455	278,782	2,605	281,387	293,455	12,068	72,225	75,323	3,097
2026	304,019	288,818	2,605	291,423	304,019	12,596	66,787	69,673	2,887
2027	314,964	299,216	2,605	301,821	314,964	13,143	61,759	64,448	2,689
2028	325,988	309,688	1,136	310,824	325,988	15,163	56,786	59,557	2,770
2029	337,397	320,527	1,136	321,663	337,397	15,734	52,470	55,037	2,567
2030	349,206	331,746	1,136	332,882	349,206	16,324	48,482	50,860	2,378
2031	361,428	343,357	1,136	344,493	361,428	16,935	44,798	47,000	2,202
2032	374,078	355,374	1,137	356,511	374,078	17,567	41,393	43,433	2,040
2033	387,171	367,813		367,813	387,171	19,359	38,130	40,137	2,007
2034	387,171	367,812		367,812	387,171	19,359	34,045	35,836	1,792
2035	387,171	367,812		367,812	387,171	19,359	30,397	31,997	1,600
2036	387,171	367,812		367,812	387,171	19,359	27,140	28,569	1,428
2037	387,171	367,812		367,812	387,171	19,359	24,232	25,508	1,275
2038	387,171	367,812		367,812	387,171	19,359	21,636	22,775	1,139
2039	387,171	367,812		367,812	387,171	19,359	19,318	20,335	1,017
2040	387,171	367,812		367,812	387,171	19,359	17,248	18,156	908
2041	387,171	367,812		367,812	387,171	19,359	15,400	16,211	811
2042	387,171	367,812		367,812	387,171	19,359	13,750	14,474	724
2043	387,171	367,812		367,812	387,171	19,359	12,277	12,923	646
	9,518,794	9,089,036	94,196	9,183,232	9,518,794	335,561	2,041,723	2,064,848	23,125

B / C	1.0113
FIRR %	18.08
NPV (GHc)	23,125

18.8 IEE of Electricity Sector Programme

This Section of the chapter discusses the Initial Environmental Examination (IEE) for this Sector programme at an early level of planning regarding impacts caused by the implementation of the sector programme. Such assessment is drawn based on the results of the analysis of the existing conditions and on the initial screening process undertaken by the Project Team using the Environmental Impact Matrix. The

detailed analyses of the environmental impacts such as an Environmental Impact Assessment (EIA) will be conducted at the feasibility study phase. The conduct of an IEE study under the sector programme is done in the following manner:

(1) Targets of the IEE Study

This Sector Programme consists of four components. The targets of the IEE study are shown in Table 18.8.1.

Table 18.8.1 Targets of IEE Study for Electricity Sector Programme

- ☐ Improvement and Modernization of Sub-Transmission and Low Voltage Distribution Systems
- ☐ Electrification in Rural Areas
- ☐ Expansion of Sub-Transmission and Distribution Systems
- ☐ Management of ECG

(2) Phasing of the IEE Study

To study the IEE, the programme components are divided into three phases, namely the Pre-Construction Phase, Construction Phase, and Operation and Maintenance Phase. The activities of each phase are as follows:

- **Pre-construction Phase**: which includes land acquisition, resettlement, mobilization of heavy equipment, transport of construction materials, construction of office buildings and labour camps, etc.
- **Construction Phase**: consisting of the setting up of equipment, demolition of the existing structures, implementation of construction works, generation of construction waste etc.
- **Operation and Maintenance Phase**: which includes the operation and maintenance of facilities, maintenance works, etc.

(3) Result of the IEE Study

In Ghana, there are 4 pillars in an environmental impact study as follows:

- Institutions
- Natural resources
- Socio-culture
- Economy

The environmental impacts on the above parameters are identified at the Pre-construction Phase, Construction Phase and Operation and Maintenance Phase using an Environmental Impact Matrix. The Environmental Impact Matrix shows the identified positive and negative environmental impacts caused by implementation of the programme. The Environmental Impact Matrix of the electricity sector is shown in Table 18.8.2.

Table 18.8.2 Environmental Impact Matrix for the IEE Study for Electricity Sector

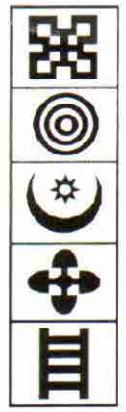
Environmental Parameters		Institution		Natural Resources																Socio-Culture												Economy	
Components	Phases	Existing policy	Legal basis	Topography/Geology	Soil	Ground subsidence	Air quality	Hydrology	Water quality	Groundwater	Noise/Vibration	Offensive odor	Terrestrial flora and fauna	Aquatic flora and fauna	Biodiversity	Terrestrial ecosystem	Aquatic ecosystem	Natural disaster	Climate change factors	Population	Land use	Water use	Landscape	Human health	Involuntary resettlement	Cultural heritage	Material assets	Transportation	Power supply	Water supply	Solid waste	Other infrastructure	Local economy
EL Sub-Programme 1: Improvement and Modernization of Sub-Transmission and LV Distribution Systems	Pre-construction																				-1				-1		-1						
	Construction				-1						-1											-1	-1					-2	-2	-1	-1	-1	
	Operation & Maintenance																		+2				-1						+3				-1
EL Sub-Programme 2: Electrification in Rural Areas	Pre-construction																				-1				-1								
	Construction				-1		-1		-1	-1	-1											-1	-2					-2				-1	
	Operation & Maintenance																		+2										+3				+2
EL Sub-Programme 3: Expansion of Sub-Transmission and Distribution Systems	Pre-construction																								-2								
	Construction				-1		-1	-1	-1	-1	-1										-1	-1	-2					-2	-2			-1	
	Operation & Maintenance										-1								+2										+3				+2
EL Sub-Programme 4: Management of ECG	Pre-construction																																
	Construction																																
	Operation & Maintenance																																

+1: Negligible Positive Impact
+2: Moderately Positive Impact
+3: Significant Positive Impact

-1: Negligible Negative Impact
-2: Moderately Negative Impact
-3: Significant Negative Impact

+/-: Likely to have both positive and negative environmental impact
?: Uncertain or unpredictable environmental effect

Source: JICA Study Team



PART VII

Implementation Plan

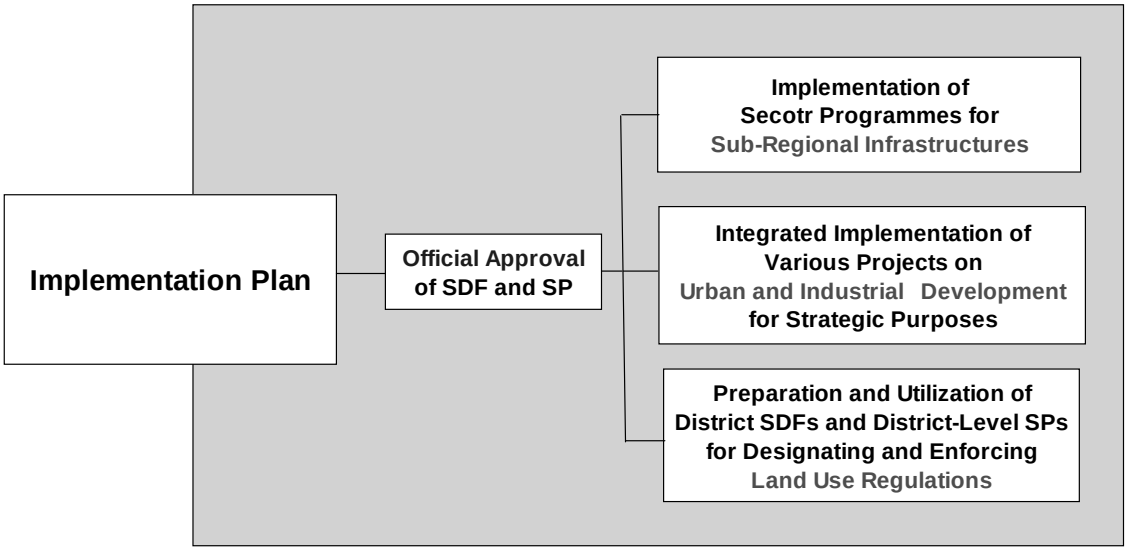
Chapter 19 Introduction: Implementation Plan

19.1 Four Key Types of Actions for Implementation of Greater Kumasi Sub-Regional SDF and Greater Kumasi Conurbation SP

For implementing the Greater Kumasi Sub-Regional SDF and Greater Kumasi Conurbation SP, the following four key types of actions are required:

- Official approval of the SDF for Greater Kumasi Sub-Region and the SP for Greater Kumasi Conurbation (In fact, based on this recommendation, the master plan for Greater Kumasi Sub-Region was approved by the Regional Co-ordinating Council (RCC) of Ashanti Region)
- Implementation of sector programmes for sub-regional infrastructures
- Integrated implementation of various projects for strategic purposes
- Preparation and utilization of district-level SDFs and SPs for designating and enforcing land use regulations.

The SDF and SP, once approved, have three broad kinds of development proposals. The first is sub-regional level infrastructures, such as the outer ring road and dams. The second is related to the promotion of integrated development of different sectors and different levels of actors for strategic projects, such as Kumasi-Ejisu Urban Corridor Development and Boankra Industrial-Logistics Centre Development. The third is district-level land use administration, including development control and building permission using district-level SDFs and SPs.



JICA Study Team

Figure 19.1.1 Framework of Implementation Plan

19.2 Official Approval of the SDF for Greater Kumasi Sub-Region and the SP for Greater Kumasi Conurbation

While the sub-regional level SDF has legal status in the new draft land use law (which is undergoing due process through parliament), the sub-regional SP does not have legal status. The sub-regional SP has detailed plans for land use and infrastructure, which will guide district-level SDFs and SPs. Therefore, their official approval, which should be administered by planning authorities (NDPC and TCPD at the national level and RPCU under RCC at the regional level), is very important so that the sub-regional SDF and SP can gain the official status to be used to officially and formally guide development and land administrations in the Greater Kumasi Sub-Region and Conurbation.

The process for the official approval of the SDF for Greater Kumasi Sub-Region and the SP for Greater Kumasi Conurbation should be started immediately after the completion of this planning study.

The SDF and SP should be sent to NDPC and TCPD for further examination and official approval at the national level. Once approved, they will be sent to the RCC of Ashanti Region for official approval by the RCC at the regional level.

Currently, a Spatial Development Framework (SDF) at the national level is being prepared under TCPD in collaboration with the NDPC. The Greater Kumasi Sub-Regional SDF and Conurbation SP should be incorporated into the national-level SDF.

With official approval, the SDF and SP could gain official power to technically and financially help and guide the RCC and the assemblies of participating MMDAs in promotion of various development proposals and land use plans at national, regional and district levels.

However, at the same time, it is important for national, regional and district institutions to begin to take necessary actions for implementation of priority proposals in the SDF and SP, while waiting for official approval.

19.3 Implementation of Sector Programmes for Sub-Regional Infrastructures

The sub-regional infrastructures proposed in the Greater Kumasi Sub-Regional SDF and Conurbation SP are compiled into the following sector programmes for infrastructure, as shown in Chapters 12 through 18 of Part V.

- Transportation Sector
- Water Resources Sector
- Water Supply Sector
- Liquid Waste Treatment Sector
- Drainage Sector
- Solid Waste Management Sector
- Electricity Sector

The main, distinctive difference between the sub-regional SDF/SP and district-level SDF/SP is the large-scale infrastructure. The sub-regional SDF/SP deals with relatively large-scale infrastructure which serves the sub-region beyond the district level. District-level SDF/SPs deal with infrastructure only for their own districts, which is relatively small-scale infrastructure.

Since the regional-level departments are effectively branch offices of national-level departments and agencies, they do not have the power for decision-making and financing for actual implementation. The implementation of sub-regional infrastructure needs decisions and financial arrangements to be made at the national level.

For this kind of national-level decisions and resources allocation, the following two types of actions are required:

- Incorporation of sub-regional infrastructure proposed by the sub-regional SDF and SP into national-level sector policies and development plans by the relevant national ministries, departments and agencies
- Collective appeal by regional and district institutions (through the RPCU or a regional platform for the Greater Kumasi) to the national-level ministries, departments and agencies for implementation of proposed sub-regional infrastructures

The priority projects for infrastructure for Greater Kumasi Spatial Development are as follows:

- Construction of the Outer Ring Road for providing high-speed roads for bypassing Kumasi City as well as for creating new Suburban Residential Areas and Developing Multi-Nucleus Urban Centres.
- Upgrading of the Middle Ring Road for promoting suburban development
- Establishment of Bus Rapid Transit (BRT) routes covering the Greater Kumasi Conurbation
- Intersection Improvement by Signalization for Kumasi City for traffic congestion reduction
- Water Resources Development for long term sustainable urban development
- Short-Term increase of the water supply capacity for satisfying basic needs for urban livelihood
- Short-Term Improvement of the Electricity Distribution for Kumasi City for reducing power outages.

19.4 Integrated Implementation of Various Actions for Strategic Purposes

For achieving the vision for the Greater Kumasi Sub-Region, it is essential to pursue the integrated implementation of certain actions for the following high-priority strategic initiatives for industrialisation and encouraging modern developments:

- Redevelopment of Kaase Industrial Area
- Development of Boankra Industrial-Logistics Centre

- Development of Kumasi-Ejisu Urban Corridor
- Redevelopment of Kumasi City Centre
- Development of New Towns
- Modernization of Informal Sectors

These strategic initiatives are very important for revitalizing and modernizing the economy of Greater Kumasi Conurbation. At the same time, these require committed and collaborative efforts of both government and private sectors.

These initiatives could be promoted by multi-sector collaboration and should be supported not only by regional and district levels, but also by national resources.

To pursue these development initiatives by combining efforts of government and private sectors, collaboration of multi-sectors and mobilizing different levels of resources and commitments is a very challenging necessity.

19.5 Preparation and Utilization of District-Level SDFs and SPs for Designating and Enforcing Land Use Regulation

Any spatial and physical development requires use of land. In accordance with the new land use law being introduced in Ghana, land uses including construction of buildings and infrastructures should be regulated by district assemblies and by district-level SDFs and SPs.

However, for a large urban area composed of a central city like KMA and adjoining districts, the formulation of individual districts' SDFs and SPs in a separated manner tends to cause unordered and inefficient spatial situations. Therefore, it is necessary to prepare a SDF for the sub-region by combining individual MMDAs and furthermore to formulate a SP for the conurbation covering future urban areas.

The SDF for Greater Kumasi Sub-Region and SP for Greater Kumasi Conurbation should be used for guiding the formulation of individual SDFs and MTDPs for the MMDAs within the Greater Kumasi Sub-Region and individual SPs for specific MMDAs' urban areas within the Greater Kumasi Conurbation.

The actual SDF for Greater Kumasi Sub-Region and SP for the Greater Kumasi conurbation can functionally and partially substitute for the individual district-level SDFs and SPs while these are being prepared. However, in order to have legal status of those district-level SDFs and SPs, for law enforcement, it is necessary for each MMDA to prepare a district SDF and SPs and to get those SDF and SPs approved by the district assembly.

Under the new land use law (to be introduced in the near future), each District must prepare a district SDF and SPs and its assembly should approve them officially. Otherwise, under the prospective land use law, they are legally punishable.

19.6 Development of Implementation Measures for Urban Development

The preparation of spatial development plans including SDF and SP does not assure

the possibility of plan implementation. Implementation plans and capacity development for implementation are required for smooth and efficient implementation of the spatial development plan. Furthermore, it is necessary to develop implementation measures for urban development, such as urban redevelopment and new town development.

In various countries, measures for implementing urban redevelopment and new town development have been discussed and experimented. Ghana needs to learn principles and experiences on those implementation measures. Implementation measures would include laws, financial arrangement and institutional aspects.

For this purpose, pilot projects are proposed for the Programme for Redevelopment of Kumasi City Centre and designing of models and financial arrangements are also proposed for the Programme for Development of New Towns (See Sections 21.2.5 and 21.2.6).

In Ashanti Region, traditional authorities under the leadership of Asantehene have been heavily engaged in land maters. For studying models and conducting pilot projects, traditional authorities should be involved from early stages of such studies and projects.

19.7 Financial Arrangements for Implementation of Programmes and Projects

In addition to the four aspects discussed above, financial arrangements for implementing programmes and projects are also very important. Different financial arrangements are proposed for different economic sectors and infrastructures/services as shown in Table 19.7.1.

Table 19.7.1 Financial Arrangements suitable for Different Types of Programmes and Projects

Sectors	Subjects of Investment	Recommended Financial Arrangement
Economic Sectors		
Industry	Industrial Parks	The first industrial park should be constructed by public investment. Subsequent industrial park development should be done by private developers with land arrangement by government and traditional authorities.
Commerce	Industrial Operation	Private investment should be promoted.
	Satellite Market Places	Private investment is necessary.
	Shopping Centres	Private investment should be promoted.
Agriculture	Mid-Scale and Large-Scale Plantations	Private investment should be promoted, while the arrangement of lands for agricultural investment should be assisted by public sectors.
Infrastructure Sectors		
Roads	The first section of Outer Ring Road	It is strongly recommended to construct the first section of the Outer Ring Road by public investment including development partners' assistance.
	The other sections of Outer Ring Road	It is desirable to seek the possibility of arranging a PPP.
	Other Major Roads	Pubic investment is necessary.
BRT	BRT Dedicated Lanes	Pubic investment should be sought in order to prevent delaying the implementation of the project.
	BRT Operation	BRT operation should be done by the private sector.
Water Resources	New Dams	Although Ghana Water Company Limited (GWCL) is a privatized company, it is necessary to assist with the development of a new dam for water supply because the financial situation of GWCL is not very good and it provides basic public
Water Supply	Water Treatment Plant Expansion	Although Ghana Water Company Limited (GWCL) is a privatized company, it is necessary to assist with the development of a new dam for water supply because the financial situation of GWCL is not very good and it provides basic public
Liquid Waste Treatment	Liquid Waste Treatment Pond	Public investment is necessary.
	Septage Treatment Pond	Public investment is necessary.
Solid Waste Treatment	Final Disposal Sites	Public investment is necessary.
	Recycling Plants	Private companies should invest in and operate recycling plants.
	Solid Waste Collection, Transport and Final Disposal	Outsourcing to private companies has been done and will be continued.
Drainage	Drainage Lining	Public investment is necessary.
Electricity Supply	Overhead Wires and Transformers	Electricity companies need assistance from development partners because their financial situation is not very good and they are providing basic public services.
	Substations and Sub-Transmission	Electricity companies should invest in these facilities.
Services Sectors		
Health Sector	District Hospitals outside Kumasi City	Public investment is necessary.
	Private Hospitals outside Kumasi City	Private investment should be promoted.
	Clinics outside Kumasi City	Private investment should be promoted.
Education Sector	Senior High Schools outside Kumasi	Both public investment and private investment are necessary.
	Universities outside Kumasi City	Private universities should be encouraged to operate outside Kumasi City.

Chapter 20 Institutional Frameworks for Implementation of Greater Kumasi Sub-Regional SDF and Greater Kumasi Conurbation SP

20.1 Present Institutional Issues on Implementing Greater Kumasi Sub-Regional SDF and Greater Kumasi SP

The current Ghanaian development planning system does not demand the regional level to prepare its own development plans (socio-economic plans). The current Ghanaian budgetary system does not provide the regional level any development budget to be spent for its own regional initiatives. The main function and responsibility of the regional level administration is to harmonize different department programmes/projects and bundle district initiatives within the region.

No strong regional-level leadership has been expressed partly because no regional-level development budgets are available and partly because no important decision-making power is necessary. As a result, no development plans for a region have been prepared.

However, it is essential to make concerned efforts at the regional level in collaboration with districts for achieving efficient, effective and sustainable development. It is important especially for the purpose of mobilizing national resources for regions or sub-regions.

20.2 Alternative Ways to Achieve the Vision and Overall Objectives of Greater Kumasi Sub-Regional Development

(1) Alternative Institutional Strategies

There are broadly, the following four alternative ways (institutional strategies) to promote the implementation of Greater Kumasi Sub-Regional SDF and Conurbation SP:

- **Town Development Project**
  - Implementing a Town Development Project under the prospective Land Use and Spatial Planning Authority under the New Land Use Law and New Spatial Planning System for the purpose of Managing Actual Land Use Permits or Construction Permits by guiding District SDFs and SPs.
  - The board of the New Land Use and Spatial Planning Authority is to have key infrastructure agencies, which might be able to mobilize necessary resources to implement sub-regional infrastructures.
- **Regional Platform**
  - Managing a Regional Platform consisting of various Entities (Regional

Departments and District Assemblies) for the purpose of making an effort to mobilize national-level resources for implementing various projects, as well as monitoring land use management at the district level.
  - The capacity for this type of regional collective effort should be developed for sustainable development.
  - However, this effort might result in implementation of projects in a fragmented way.
- **Component of Forest Belt Development Initiative**
  - Implementing the Greater Kumasi Sub-Regional SDF and Conurbation SP, as a Component of the Forest Belt Development Initiative.
  - It is necessary to wait for the establishment of the Forest Belt Development Authority.
  - However, this might have a low priority at the national level.
- **Stand-alone National Programme for Greater Kumasi**
  - Implementing a Stand-alone National Program for Greater Kumasi Sub-Regional Development for the purpose of mobilizing a larger volume of resources for implementing various projects in an integrated manner.
  - For this purpose, the establishment of an independent authority for Greater Kumasi with special budgetary arrangements is required.
  - This way might be suitable for implementing various projects in an integrated manner.

(2) Recommended Institutional Strategy

Considering the current and past situations of sub-national, regional and sub-regional development efforts, the JICA Study Team recommends the following method by combining the first and second options above for implementing the Greater Kumasi Sub-Regional SDF and Conurbation SP:

- To manage a Regional Platform under the RCC of Ashanti Region, and
- At the same time, to rely on national-level coordination by the board members of the prospective Land Use and Spatial Planning Authority (to be established after the new Land Use Law is approved by the parliament).

In addition to this combined institutional strategy of regional platform and national-level coordination, it might be necessary to create another instrument for promoting the implementation of critical infrastructures. It is the national-level infrastructure agencies that should play the role of promoter from the side of infrastructure development.

20.3 Institutional Framework Necessary for Implementing Greater Kumasi SDF and Greater Kumasi SP

This section describes the institutional frameworks which the JICA Study Team recommended in the previous section.

(1) Regional Platform

It is necessary to organize a regional platform for carrying out collective efforts at the regional level. Such a regional platform should be established as a government unit under the Regional Co-ordinating Council (RCC) of Ashanti Region. The existing Regional Planning Coordinating Unit (RPCU)[1] could perform the function of the regional platform for the Greater Kumasi Sub-Regional SDF and Conurbation SP. Or the Regional Spatial Planning Committee, to be established under the RPCU in accordance with the new Land Use Law, could perform the function of the regional platform.

1) Proposed Members of Regional Platform

The proposed member institutions of the regional platform are as follows:

- RCC (as Chairperson)
- Physical Planning Department, RCC (as Secretariat, currently Regional Office of TCPD)
- Physical Planning Department (Town Planning Department), KMA (as co-secretariat)
- Economic Planning Department, RCC
- Manhiya Palace
- Kumasi Traditional Council
- Department of Urban Roads, KMA
- Department of Feeder Roads, KMA
- Ashanti Regional Office, Ghana Highway Authority
- Kumasi Branch, Ghana Water Company Ltd.
- Ashanti West, Electricity Company of Ghana (ECG)
- Land Commission
- Office of Administrator for Stool Land
- Department of Trade and Industry, Ministry of Trade and Industry
- Department of Food and Agriculture, Ministry of Food and Agriculture
- Department of Health, Ministry of Health

[1] In accordance with the NDCP's Guidelines for the Preparation of District Medium-Term Development Plan under the Medium-Term Development Policy Framework 2010-2013 (October 2009), the members of the Regional Coordinating Planning Unit (RCPU) are as follows:

- The Regional Coordinating Director as head
- The Regional Economic Planning Officer as the Secretary
- Regional Budge Officer
- Regional Local Government Inspector
- Regional Director of Health
- Regional Director of Education
- Regional Director of Agriculture
- Chief Works Superintendent
- Regional Town and Country Planning Officer
- Regional Statistical Officer
- Regional Coordinating Council Nominee
- Representatives of NGOs, Private Sector and Other Relevant Regional Departments and Agencies (one each)

- Department of Education, Ministry of Health
- Assemblies of KMA and Adjoining Municipalities/Districts

2) Regular Monitoring & Evaluation Meetings

Regularly, every two months or so, official meetings of the Regional Platform should be held for monitoring and evaluating the activities and results of implementation promotion by the members of the Regional Platform.

In these regular meetings, the chairman of the Regional Platform is to keep encouraging members to promote the implementation of the SDF and SP in the following three directions:

- To appeal to the national-level institutions (departments and authorities) for implementing priority projects and other sub-programmes
- To attract private investment in strategic sub-programmes/projects
- To manage land use and development at the district level

3) Working Groups for Implementing High-Priority Strategic Actions

For active promotion for implementation of the following selected strategic purposes, flexible, action-oriented Working Groups should be formed and their activities should be managed. Private groups should be included as formal members of the Working Groups. Even the appointment of private sector persons as leaders for the Working Groups should be encouraged.

- Redevelopment of Kaase Industrial Area
- Development of Boankra Industrial-Logistics Centre
- Development of Kumasi-Ejisu Urban Corridor
- Redevelopment of Kumasi City Centre
- Development of New Towns
- Modernization of Informal Sectors

Different working groups for these thematic implementation purposes should be organized. Members of these thematic implementation “working groups” should include private sector entities and non-governmental groups.

(2) National-Level Coordination Functions for Implementation of Greater Kumasi Sub-Regional SDF and Greater Kumasi Conurbation SP

At the national level, some national-level organizations should play coordinating roles for promoting the implementation that the Greater Kumasi SDF and SP require.

Such national-level coordination should be complementary with the function of the regional platform to be established for implementing the Greater Kumasi SDF and SP.

One of the candidate organizations is the National Development Planning Commission (NDPC), by which a national infrastructure master plan has being formulated in consultation with infrastructure sector agencies.

Another of the candidate organizations is the prospective “Land Use and Spatial

Planning Authority" to be established under the new law on Land Use and Spatial Planning. The board for the Land Use and Spatial Planning Authority should have the representatives from the following organizations:

- Ministry of Local Government and Rural Development
- Ministry of Environment, Science, Technology & Innovation
- Ministry of Lands and Natural Resources
- Ministry of Roads and Highways
- Environmental Protection Agency
- Lands Commission
- Office of the Administrator of Stool Lands
- Ministry of Water Resources, Works and Housing
- National Development Planning Commission
- Three persons from the private sector appointed by the President being persons appointed from the built environment, the business community, the Ghana Institute of Planners, or from the class of retired physical planners.
- National House of Chiefs.

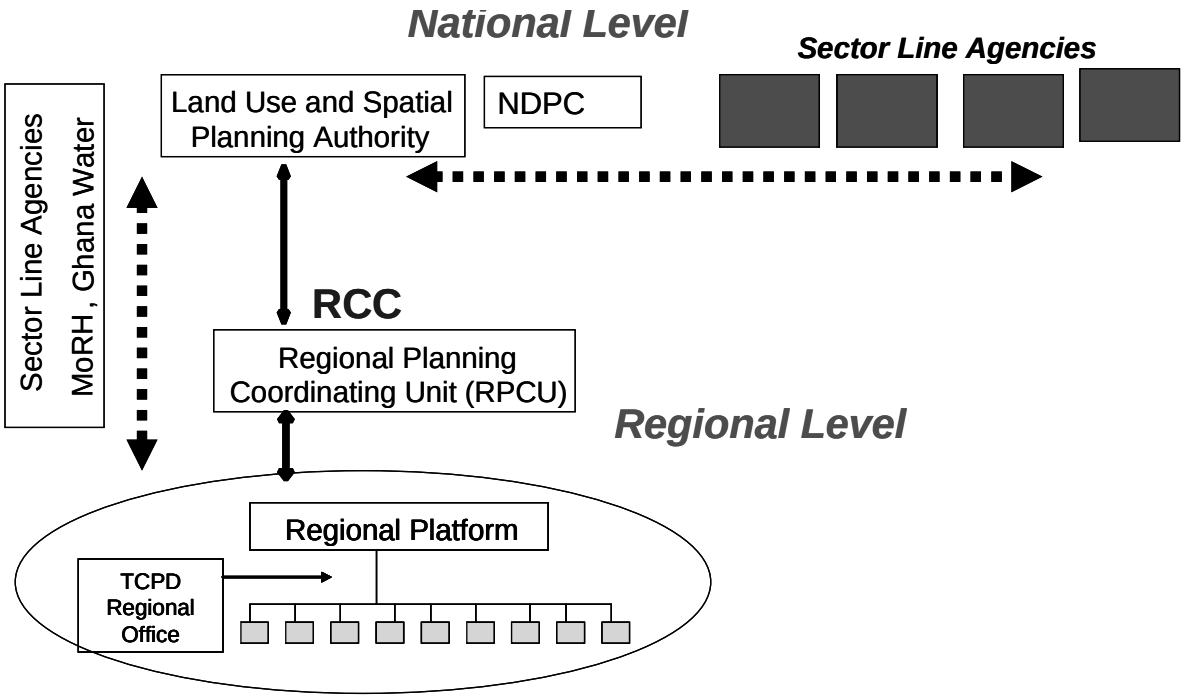
(3) Key National Infrastructure Agencies for Greater Kumasi Sub-Region

In addition to the regional platform and national-level coordination function, the vertical relation of certain infrastructure sector agencies should be utilized for promoting the implementation of important infrastructures.

This is because certain infrastructures, for example, the Outer Ring Road and water resources development and water supply, are very critical in the future development of Greater Kumasi's urban and industrial development.

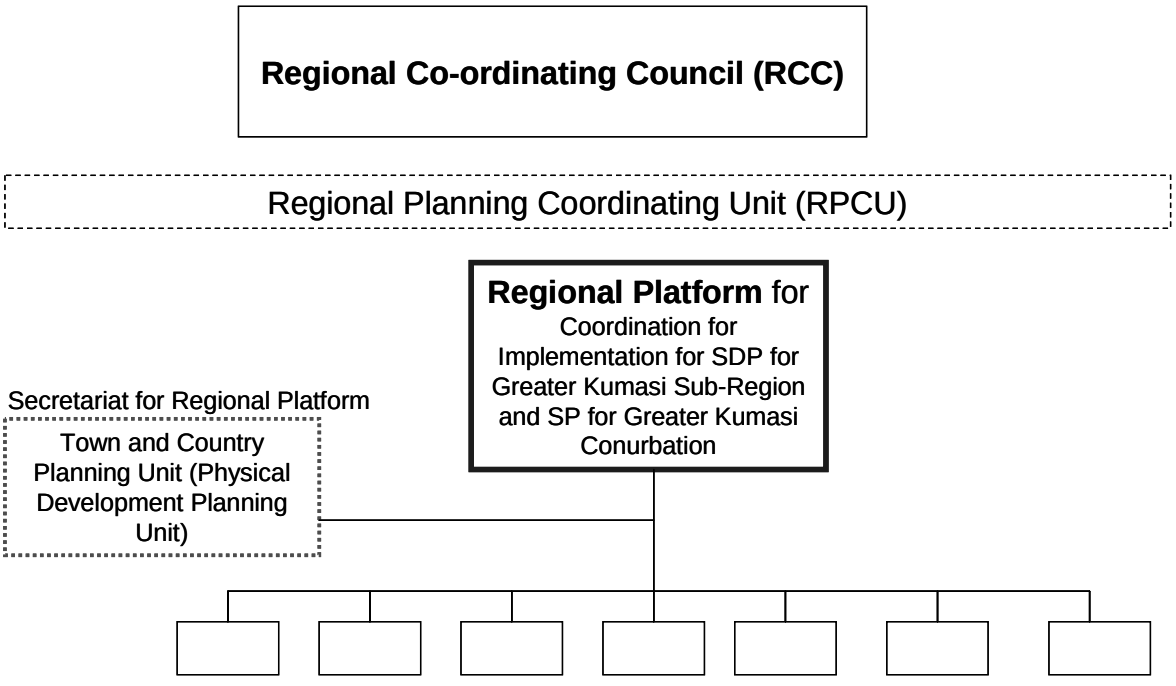
The following two infrastructure agencies are selected as Key national infrastructure agencies:

- Ministry of Roads and Highways for implementing the Outer Ring Road Project
- Ghana Water Company Ltd. for implementing a long-term New Water Resources Dam Project, as well as short-term water supply capacity upgrading project



Source: JICA Study Team

Figure 20.3.1 Relationship between Regional Level and National Level in the Proposed Institutional Framework for Implementation



Source: JICA Study Team

Figure 20.3.2 Regional Platform for the Proposed Institutional Framework for Implementation

Chapter 21 Priority Strategic Programmes for Urban and Industrial Development

21.1 Introduction

The urban and industrial development efforts needed for Greater Kumasi Sub-Region are multi-sector and private-public collaboration efforts. The following programmes are priority strategic efforts to be made for promoting urban and industrial development for Greater Kumasi Sub-Region:

- Programme for Investment Promotion for Greater Kumasi
- Programme for Revitalization of Kaase Industrial Area
- Programme for Development of Boankra Industrial-Logistics Centre
- Programme for Development of Kumasi-Ejisu Urban Corridor
- Programme for Redevelopment of Kumasi City Centre
- Programme for Development of New Towns
- Programme for Modernization of Informal Sectors

As recommended in Chapter 21 on the institutional framework, the establishment and operation of Working Groups by the Spatial Planning Subcommittee of the RPCU of the RCC is important for mobilizing multi-sector efforts and private sector contribution.

Profiles of these programmes are provided in this chapter.

21.2 Priority Strategic Programmes for Urban and Industrial Development

21.2.1 Programme for Investment Promotion for Greater Kumasi

(1) Objectives

- To promote private investment in strategic areas within Greater Kumasi Sub-Region for revitalizing the economy of Greater Kumasi

(2) Main Executive Agencies

- Ghana Investment Promotion Centre

(3) Sub Executive Agencies

- RCC of Ashanti Region
- KMA
- Adjoining Districts including Afigya-Kwabre District, Kwabre East District, Ejisu-Juaben Municipality, Asokore-Mampong Municipality, Bosomtwe District,

Atwima-Kwanwoma District and Atwima-Nwabiagya District
- Ghana Free Zones Board
- Regional Department, Ministry of Trade and Industry
- Ashanti Branch, Ghana Association of Industries
- Ghana Real Estate Developers Association
- Possible investors such as SNIT and Ghanaian banks

(4) Steps of Actions
- Establishment of Working Group for investment promotion for Greater Kumasi
- Discussion on investment promotion strategies for Greater Kumasi
- Preparation of pamphlets for investment promotion for Greater Kumasi
- Holding of investment seminars for Greater Kumasi in Accra and Overseas

21.2.2 Programme for Revitalization of Kaase Industrial Area

(1) Objectives
- To reactivate industrial sectors in KMA
- To promote private investments in industrial sectors in Kaase Industrial Area
- To promote industrial sector production in Kaase Industrial Area

(2) Main Executive Agencies
- KMA

(3) Sub Executive Agencies
- Regional Department, Ministry of Trade and Industry
- RCC of Ashanti Region
- Ghana Investment Promotion Centre
- Ghana Association of Industries

(4) Steps of Actions
- Establishment of Working Group for Redevelopment of Kaase Industrial Area
- Discussion on redevelopment strategies of Kaase Industrial Area by involving land owners and stakeholders
- Identification of possible sites and changing land use regulations for attracting industries within Kaase Industrial Area
- Preparation of pamphlets for attracting investments in Kaase Industrial Area
- Participation in investment seminars to be organized for Greater Kumasi in Accra and Overseas
- Identification of necessary rehabilitation of infrastructures for Kaase Industrial Area
- Promotion of mobilizing funds for infrastructure rehabilitation for Kaase Industrial Area

21.2.3 Programme for Development of Boankra Industrial-Logistics Centre

(1) Objectives
- To promote the development of Boankra Industrial-Logistics Centre (not only the Dry Port and Export Processing Zone, but also surrounding areas)

- To promote the development of Ashanti Technology Centre (Export Processing Zone)
- To promote the development of Boankra Dry Port
- To promote infrastructure provision (including roads, electricity and water supply) for the Boankra Industrial-Logistics Centre

(2) Main Executive Agencies

- Ghana Free Zones Board

(3) Sub Executive Agencies

- Ejisu-Juaben Municipality
- Ghana Shippers' Authority
- Regional Department, Ministry of Trade and Industry
- Ghana Investment Promotion Centre
- RCC of Ashanti Region
- Ghana Real Estate Developers Association
- Ghana Association of Industries

(4) Steps of Actions

- Establishment of Working Group for Boankra Industrial-Logistics Centre
- Sharing with participants of the Working Group of information on the current situation for Boankra area development
- Preparation of layout plans/local plans for Boankra area including suburban centres and feeder roads
- Monitoring of electricity supply to Boankra area
- Speed up of electricity supply projects to Boankra area including Boankra Industrial-Logistics Centre
- Preparation of pamphlets to promote private investments in Boankra Industrial-Logistic Centre
- Participation in investment seminars to be organized for Greater Kumasi Sub-Region

21.2.4 Programme for Development of Kumasi-Ejisu Urban Corridor

(1) Objectives

- To create a Knowledge-Based Urban Corridor between Kumasi and Ejisu and further to Boankra
- To provide advanced infrastructures for supporting the development of knowledge industries
- To promote private investment in knowledge industrial development in the urban corridor
- To promote urban mixed development of residential, business-commercial and industrial sectors

(2) Main Executive Agencies

- KMA
- Ejisu-Juaben Municipality

- KNUST
- CSIR
- Kumasi Polytechnic

(3) Sub Executive Agencies

- RCC of Ashanti Region
- Ghana Investment Promotion Centre
- Department of Urban Roads, Ministry of Roads and Highways
- Department of Urban Roads, KMA
- Urban Transportation Project, KMA
- Urban Transportation Project, Ejisu-Juaben Municipality
- Regional Department, Ministry of Trade and Industry
- Ghana Real Estate Developers Association
- Ghana Association of Industries

(4) Steps of Actions

- Establishment of Working Group for Development of Kumasi-Ejisu Urban Corridor
- Discussion on strategies for Kumasi-Ejisu Urban Corridor
- Securing Space for Widening of Accra Road to accommodate BRT route
- Determination of upgrading of parallel road along Accra Road within the urban corridor
- Preparation of layout plans/local plans including land use plans for economic development
- Encouragement of KNUST to prepare a business plan for developing Knowledge City within the urban corridor
- Preparation of pamphlets for promoting private investment in Kumasi-Ejisu Urban Corridor
- Participation in investment seminars for Greater Kumasi
- Private investment promotion for knowledge industries and hotel-conference facilities within the urban corridor

21.2.5 Programme for Redevelopment of Kumasi City Centre

(1) Objectives

- To promote the development of advanced urban functions within Kumasi City Centre for widely serving Greater Kumasi Sub-Region, as well as Ashanti Region and northern areas
- To attract private investment in real estate development within Kumasi City Centre

(2) Main Executive Agencies

- KMA

(3) Sub Executive Agencies

- Asantehene
- Kumasi Traditional Council

- Office of the Administrator of Stool Lands (OASL)
- Land Commission
- RCC of Ashanti Region
- Ghana Investment Promotion Centre
- Ghana Real Estate Developers Association
- Major corporate entities either present or planning to locate in Kumasi City Centre

(4) Steps of Actions

- Establishment of Working Group for Redevelopment of Kumasi City Centre
- Discussion on redevelopment strategies of Kumasi City Centre
- Designing of pilot projects for redeveloping within Kumasi City Centre
- Encouragement of involvement of Asantehene for land arrangement for redevelopment projects
- Encouragement of involvement of Kumasi Traditional Council
- Encouragement of involvement of private real estate developers
- Discussion on financial strategies by involving banks and private real estate developers

21.2.6 Programme for Development of New Towns

(1) Objectives

- To promote the speedy development of well-ordered suburban residential areas
- To promote the development of infrastructures for suburban residential areas

(2) Main Executive Agencies

- Ghana Real Estate Developers Association

(3) Sub Executive Agencies

- Private real estate developers
- Banks and finance companies (e.g. Ghana Home Loans, HFC) providing Housing Loans
- Asantehene
- Traditional Council
- State Housing Corporation
- Lands Commission
- Department of Urban Roads
- Department of Feeder Roads
- District Assemblies where New Towns are located

(4) Steps of Actions

- Establishment of Working Group for new town development in suburban areas of Greater Kumasi Conurbation
- Designing of models for new towns in suburban areas of Greater Kumasi Conurbation
- Discussion of financial arrangements for private real estate developers for new town development

- Establishment of financial schemes for new town development

21.2.7 Programme for Modernization of Informal Sectors

(5) Objectives

- To promote the modernization of informal sectors, such as car and machine repairing industries
- To promote the modernization of logistics sectors, such as trucking and warehouse sectors
- To promote the modernization of commercial sectors
  - By making linkage between universities/polytechnic and informal sectors
  - By making linkage between formal sectors and informal sectors

(6) Main Executive Agencies

- Regional Office for Ministry of Trade and Industry
- KMA

(7) Sub Executive Agencies

- Suame Association
- Trucking Association
- Association for Small Scale Industries
- KNUST
- Kumasi Polytechnic
- Association of Ghana Industries
- Banks and finance companies

(8) Steps of Actions

- Establishment of Working Group for informal sector modernization
- Investigation on potential technologies to be utlilized for informal sectors
- Designing of models for linkages between formal sectors and informal sectors
- Discussion of financial arrangements for informal sectors
- Implementation of pilot projects

21.3 Implementation Schedule for Priority Strategic Programmes

The priority strategic programmes requires an integrated effort at implementation of the priority strategic programmes for urban and industrial development. The time framework for implementation is proposed as shown in Figure 21.3.1.

Urban and Industrial Development	2013-2015	2015-2018	2018-2023	2023-2028	2028-2033
(1) Approval of Greater Kumasi Sub-Regional SDF and Greater Kumasi Conurbation SP	Approval by the End of 2013				
(2) Establishment of Regional Platform for Promoting Implementation of Greater Kumasi Sub-Regional SDF, SP and Sector Programmes	Kick Off by th End of 2013 and Operation of 1st Phase	1st Phase	2nd Phase		
(3) Establishment of National Mechanism for Promoting Implementation of Greater Kumasi Sub-Regional SDF, SP and Sector Programmes	Kick Off by th End of 2013 and Operation of 1st Phase	1st Phase	2nd Phase		
(4) Programme for Investment Promotion	Kick Off and 1st Phase	1st Phase	2nd Phase	3rd Phase	4th Phase
(5) Programme for Revitalization of Kaase Industrial Area	Preparation	Investment Promotion	Investment Promotion		
(6) Programme for Development of Boankra Industrial-Logistic Centre	Preparation	Construction of Industrial Park	Investment Promotion	Construction of Dry Port	Investment Promotion
(7) Programme for Development of Kumasi-Ejisu Urban Corridor (Knowledge City)	Preparation	Construction of Parallel Road	Widening of Accra Road	Introductio of BRT	Introduction of BRT
(8) Programme for Redevelopment of Kumasi City Centre	Preparation for Pilot Project	Implementation of Pilot Project and Preparation for Other Projects	Implementation of Full-Scale Projects	Implementation of Full-Scale Projects	Implementation of Full-Scale Projects
(9) Programme for Development of New Towns	Preparation	Preparation	Construction	Construction	Construction
(10) Programme for Modernization of Informal Sectors	Preparation incl. Preparation of Pilot Projects	Implementation of Pilot Projects	Implementation of Full-Scale Projects	Implementation of Full-Scale Projects	Implementation of Full-Scale Projects
(11) Development of the Outer Ring Road and its Surrounding Areas	FS, BD, Land Acquisition (1st Phase)	Land Acquisition (1st Phase) and DD	Construction for North-Eastern Section	Construction for South-Western Section	Construction for South-Eastern Section

Figure 21.3.1 Implementation Schedule for Priority Strategic Programmes for Urban and Industrial Development

Chapter 22 Priority Projects and Actions for Infrastructure Sectors

22.1 Introduction: Priority Projects and Actions for Infrastructure Sectors

In addition to the SDF and SP, sector programmes for infrastructure sectors are formulated for the following seven infrastructure sectors:

- Transportation Sector
- Water Resources Sector
- Water Supply Sector
- Liquid Waste Treatment Sector
- Drainage Sector
- Solid Waste Management Sector
- Electricity Sector

These sector programmes are important elements of the SDF for Greater Kumasi Sub-Region and SP for Greater Kumasi Conurbation. These are tools for implementing the SDF and SP.

Under each sector programme, sub-programmes are prepared. Each sub-programme is composed of several projects and actions.

The following 10 priority projects are identified within the projects composing the infrastructure sector programmes.

- Outer Ring Road Project
- Middle Ring Road Project
- Project for Introduction of Type B Bus and Establishiment of BRT System
- Feasibility Study on Water Resources Development for Greater Kumasi Sub-Region
- Project for Expansion of Water Supply Capacity of Barekese Water Treatment Plant
- Project for Effective Use of Existing Distribution Pipes
- Project for Development of Septage Treatment Ponds in Adjoining Districts/Municipalities within Greater Kumasi Sub-Region
- Expansion of Asafo Simplified Sewerage System for CBD Area
- Project for Solid Waste Management Improvement in MDAs Adjoining KMA within Greater Kumasi Sub-Region
- Project for Replacement of Small-Sized Wires and Deteriorated Equipment, and Realignment of Distribution Lines

In this chapter, selected priority projects and actions out of the formulated sub-programmes are shown in the form of profiles of projects and actions. These profiles are important tools for preparing for implementation of necessary projects and actions.

22.2 Priority Projects and Actions for Transportation Sector

22.2.1 Outer Ring Road Project

(1) Background

The Department of Urban Roads (DUR) proposed the construction of a 70 kilometre long Outer Ring Road based on the Kumasi Transport Study 2005. This will re-direct traffic away from the city centre as well as improving access to the planned dry inland port at Boankra. The Outer Ring Road was expected to enhance the function of the road network to eliminate vehicle flow though urban areas of Kumasi and also to disperse traffic coming into the urban centre.

A project for a feasibility study and preliminary design for the Outer Ring Road was commenced in 2008, but it was stopped because urbanization pressure along the original proposed alignment of the Outer Ring Road made land acquisition and property compensation very difficult.

Considering this situation, the DUR have requested TCPD to revise and select an appropriate corridor for the Outer Ring Road from the viewpoint of future spatial development of the Greater Kumasi Sub-Region.

(2) Objectives of the Project

- To improve traffic circulation by expanding the capacity of the road network and by removing bottleneck sections of the road network
- To support socioeconomic development of Kumasi and surrounding districts by improving movement of people and goods
- To strengthen socioeconomic integration between Kumasi and surrounding districts and among the districts themselves

(3) Location of the Project

The engineering route study normally should be conducted at the alignment study level at a scale of 1: 2,500-5,000. But the control checkpoint study could be carried out based on information from the following perspectives:

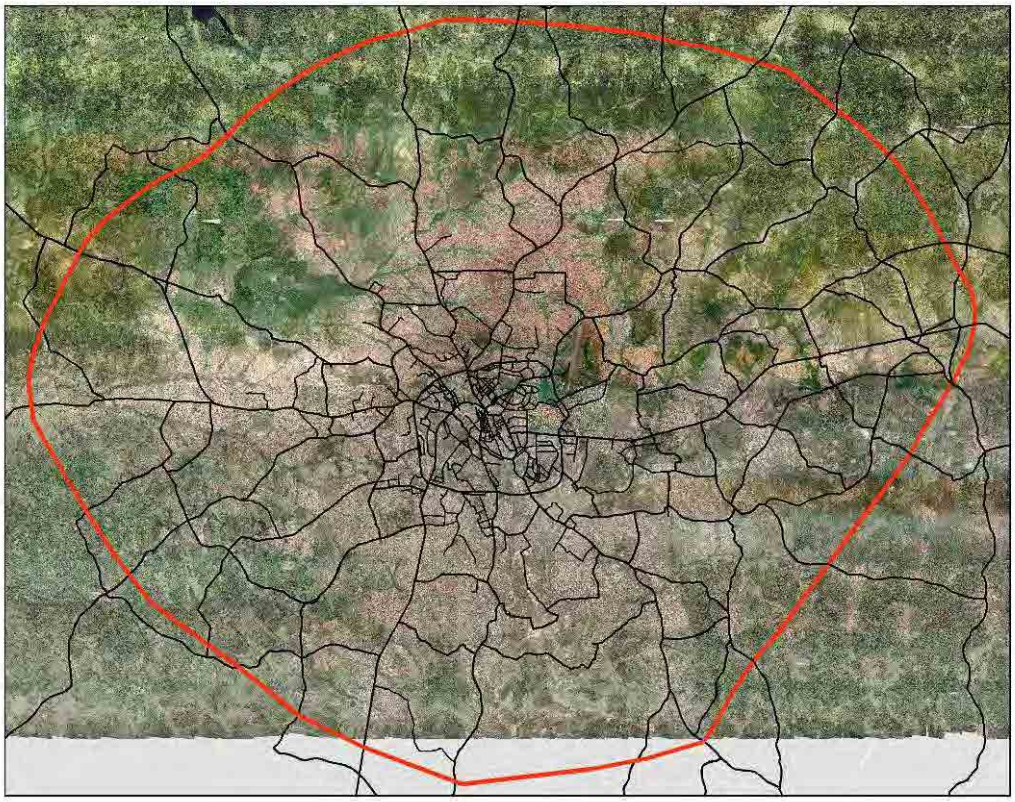
- Future city structure, development plan and land use plan
- Natural conditions (topography, geology, soil, weather)
- Social environmental conditions and impacts (schools, hospitals and other residential areas)
- Natural environmental conditions and impacts (nature conservation area, cultural sites and monuments)
- Public facilities (airports, railway stations, port facilities, radio antenna towers, water reservoirs, power plants and so on)

- Public works Projects (road and rail intersections, housing estates, industrial Parks, other development projects)

An Outer Ring Road route study was carried out by using satellite imagery because detailed topographic maps are not available. After that a field study was carried out to adjust the route and to avoid unnecessary resettlement due to road construction.

The result of route selection for the Outer Ring Road is shown in Figure 22.2.1. The total length is about 98.9 km, located about 15 km radius from the Kumasi centre. The scope of the Outer Ring Road project is summarized as follows:

- Length: 98.9 km
- Design speed: 100 km/h
- No. of driving Lanes: 4 (based on this study's demand forecast)
- No. of Ramps: 11 locations with arterial roads
- Intersection type: roundabout (up to 2033), grade separation (after 2033 depending on future traffic demand)
- Future demand: 8,200 PCU per day in 2033



Source: JICA Study Team

Figure 22.2.1 Proposed Route of the Outer Ring Road

(4) Scope of the Project

1) Road Classification

The Ghana Highway Authority has jurisdiction over national trunk roads, which are classified into national road, inter-regional road, or regional road base on their

functions.

The Department of Urban Roads (DUR) administers roads in urban areas, which are functionally classified into arterial roads, distributer/collector roads, and small roads.

The road classification system in Ghana is basically a jurisdictional system rather than functional classification and it is not a unique system across road management bodies. From the road planning and engineering viewpoints, it is necessary to clarify the functional classifications and road hierarchy system on roads in Greater Kumasi Sub-Region.

The WB assisted "2011 Kumasi Transport Plan Study" proposed a road functional hierarchy for strategic access routes (national highway), urban corridors, district collectors, local collectors, access roads, and non-motorized (NMT) streets. This JICA Study Team proposed a clearer functional hierarchy system as follows:

- Primary Urban Arterial Road (including National Road, Inter-Regional Road and Regional Road)
- Major Urban Arterial Road (including Urban Corridor)
- Minor Urban Arterial Road
- Urban Collector Road
- Urban Local Road

These roads of the functional hierarchy system are characterized as shown in Table 22.2.1. In this system, the Outer Ring Road is classified as a primary urban arterial road.

Table 22.2.1 Proposal for Road Functional Hierarchy for Greater Kumasi Sub-Region

Road Classification	Desired Grid Distance	Access	Transit	Desirable (Minimum) Speed (km/h)
Primary Urban Arterial	5,000m – 10,000m	No plot access, No intersections with local roads	City-wide transit, and link to higher networks, No Non-motorised transits allowed	100 (80) or 80 (60)
Major Urban Arterial	2,000m – 5,000m	No plot access, No intersections with access roads	City-wide transit, and link to higher networks, Non-motorized transits are separated	80 (60)
Minor Urban Road	1,000m – 2,000m	Access to plots and buildings, connection to Local roads	Transit to/from/in city districts. Limited use for city-wide transit traffic	60 (40)
Urban Collector Road	500m – 1,000m	Access to plots and buildings, connection to Access roads	Strongly discourage Motorized transitesT, by the type of traffic calming measures that are used	40 (30)
Urban Local Road	100m – 500m	Access to plots and buildings	No MT transit and Eliminate MT through-traffic, Can be part of main NMT network	30 (20)

Source: JICA Study Team

2) Road Design Elements

The key elements of road design criteria are determined by its design speed from engineering aspects. By reference to the British Standard and Japanese Road Structure Ordinance, design elements are arranged by design speed as shown in Table 22.2.2. The design elements for the Outer Ring Road are those of 100km/h

design speed.

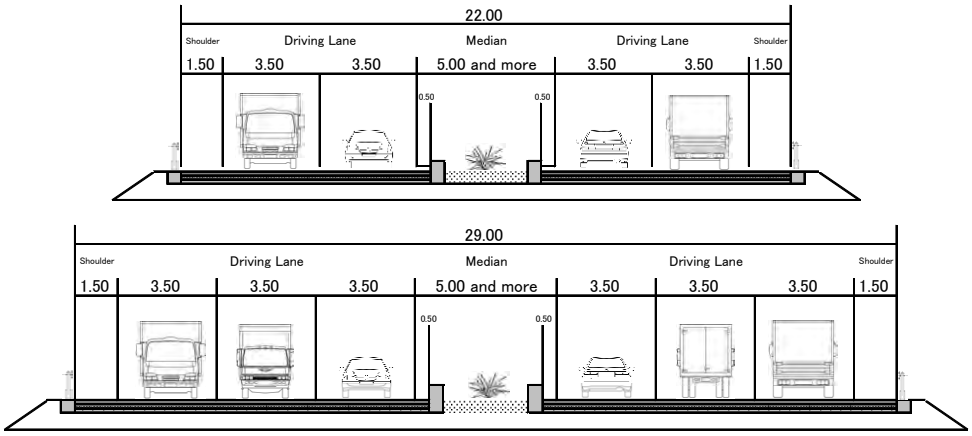
Table 22.2.2 Road Design Criteria by Design Speed

Design Speed (km/h)	Minimum curve radius (m)		Maximum longitudinal slope (%)	
	Standard	Exceptional	Standard	Exceptional
120	710	570	2	5
100	460	380	3	6
80	280	230	4	7
60	150	120	5	8
50	100	80	6	9
40	60	50	7	10
30	30	-	8	11
20	15	-	9	12

Source: JICA Study Team

3) Standard Cross Section

Ghana does not have his own road design criteria document, the design consultant on road projects has set up their project design criteria and standard road cross section plan by reference to the British Standard. The JICA Study has proposed the following standard cross section plan for the Outer Ring Road as shown in Figure 22.2.2, with reference to the British Standard and Japanese Road Structure Ordinance.



Source: JICA Study Team

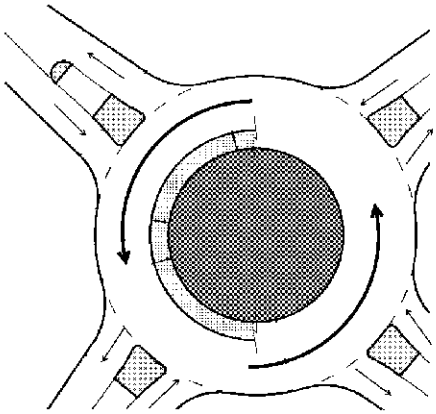
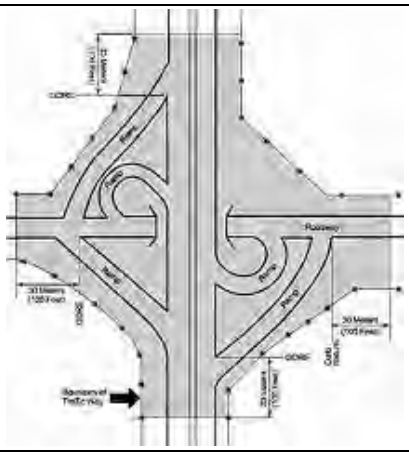
Figure 22.2.2 Standard Cross Section for Outer Ring Road

The access road to/from primary arterials and secondary arterial roads will be limited to access from lower hierarchal roads. When primary arterial roads pass through urbanized areas additional service roads along or behind the primary arterial roads should be prepared. Then direct access from urbanized roadsides with primary arterial/ secondary arterial roads can be prohibited. The criteria of the number of driving lanes, 4 or 6 lanes, will be determined based on the forecast traffic demand.

4) Crossing with Other Arterial Roads

The Outer Ring Road is allowed to have junctions with primary arterial and secondary arterial roads. It is not allowed to cross lower hierarchical roads directly, with the only permitted access via service roads. The intersection method with the Outer Ring Road and primary and secondary arterial roads is by a roundabout or grade separation. The choice between a grade separation or roundabout depends on traffic demand, whether or not the hourly traffic volume flowing into the intersection is 2000-2200 PCU per hour.

Judging from the predicted traffic demand estimation conducted in the study, the intersections in short and medium term until 2033 should be roundabouts, the long term after 2033 should be upgraded to a grade separation system. The outer diameter of the roundabout in the case of a total four-lane road, two lanes in both directions is approximately 40-60m.

	
(Roundabout Type)	(Grade Separation Type)

Source: JICA Study Team from various documents

Figure 22.2.3 Type of Intersection on Outer Ring Road

(5) Agencies Responsible

- Land Acquisition and Property Resettlement DUR
- Project Implementation DUR
- Maintenance DUR

(6) Estimated Cost

- Construction cost: about US$190.6 million (based on DUR unit cost)

(7) Financial Sources Expected

- Land Acquisition and Property Resettlement DUR
- Project Implementation DUR with International Organization Aid
- Maintenance DUR

(8) Implementation Schedule

The high-priority section of North-East arc should be constructed by 2023, the South-West Arc by 2028, South-East Arc by 2033, but the North-West Arc will be

installed after 2033 depending on the situation.

	Year				
	2014-2018	2019-2023	2024-2028	2029-2033	2034-
New Outer Ring Road (North-East Arc)		■			
New Outer Ring Road (North-West Arc)					■
New Outer Ring Road (South-West Arc)			■		
New Outer Ring Road (South-East Arc)				■	
Legend:	■	: Implementation			

(9) Relationship with Other Projects

- Related land use plans development projects proposed in this Master Plan
- Highway development project, especially the radial road network improvement

(10) Effects and Evaluation of the Projects

The Outer Ring Road enhances the function of the road network and to eliminate transit traffic through urban areas of Kumasi and also to disperse incoming traffic to urban centers.

It is also recognized that the importance of constructing the first section of the Outer Ring Road between Ejisu and Kodie to accelerate new development in Mampongteng and Kodie.

1) Positive Impacts

It is expected that travel speed in Kumasi will improve which would be translated into economic gains after the execution of the projects. As a result, it will reduce vehicle-km and vehicle operating cost. Less vehicle km means less source of pollution thus less greenhouse gas emissions. Likewise passengers' hour spent on board the vehicle will also decreases thus they can use the time to more productive activities. The table below presented the likely benefits derived from the projects.

Direct Effects	–	Improvement of travel speed
	–	Reduction of transport cost
	–	Reduction of traffic accident
	–	Improvement of traveller's amenity and increase of travel's comfort
Indirect Effects	–	Transport cost reduction (commodity Prices)
	–	Mitigation of load to environment (traffic pollution)
	–	Facilitating regional development
	–	Settlement of people and increase in population
	–	Expansion of community activities
	–	Improve access to public facilities
	–	Strengthening of exchange and cooperation among districts and city
	–	Growth of production and income
	–	Increase in employment by the growth of production
	–	Increase in revenue by the growth of production

2) Negative Impacts (Land Acquisition, Resettlement, Environment)

Particular attention should be paid to construction works of new roads. A number of negative impacts such as acquisition of private land, involuntary resettlement,

cutting of trees, slope modification, disruption of service utilities and infrastructures are expected. In essence the following negative impacts are expected thus mitigation measures shall be put in place.

- ROW Acquisition particularly to construction of new roads
- Involuntary Resettlement
- Increase in noise level during construction especially those inside the city center
- Slope modification
- Disruption of service utilities and infrastructures in some cases
- Demolition of structures
- Construction wastes
- Noise due to pile driving
- Dust caused by construction work
- Increased housing requirement for transient workers, and project management staff
- Increased hazards due to construction activities
- Cutting trees

(11) External Condition

- Peace and order is maintained
- Responsible agency for implementation and maintenance has sufficient capacity

(12) Precondition

- The Project should be committed and kept the necessary fund
- Clear Right of the Way (ROW)
- The development project proposed in this Master plan should be committed and implemented along the schedule

22.2.2 Middle Ring Road Project

(1) Background

The imbalance of road development between Kumasi and surrounding districts was noted. Although road connections and road surface are good in Kumasi City Centre (within the Inner Ring Road) and its surrounding areas within KMA, road conditions are bad in the surrounding districts. The road network of neighbouring districts is characterized by deteriorated road surfaces and missing links. Most areas rely on radial arterial roads, since there are no connecting roads between radial roads. Due to the missing links, some areas lacked good access and vehicles are forced to take long routes. Traffic congestion is also prevalent due to convergence of vehicles into limited road network and limited capacity.

To solve this status, the Outer Ring Road project had been proposed in various transportation studies, located 10 km from Kumasi CBD, then a revised route and design criteria were studied. Since the previous route ran over the developed and urbanized area and would have had difficulty with land acquisition, the outer ring road project did not progress.

Considering this situation the Outer Ring Road is newly proposed 20 km from Kumasi CBD. In addition to the inner ring road and the newly proposed Outer Ring

Road, a new circular road should be promoted for a Middle Ring Road for better traffic circulation by upgrading existing roads that can be improved to form a Middle Ring Road.

(2) Objectives of the Project

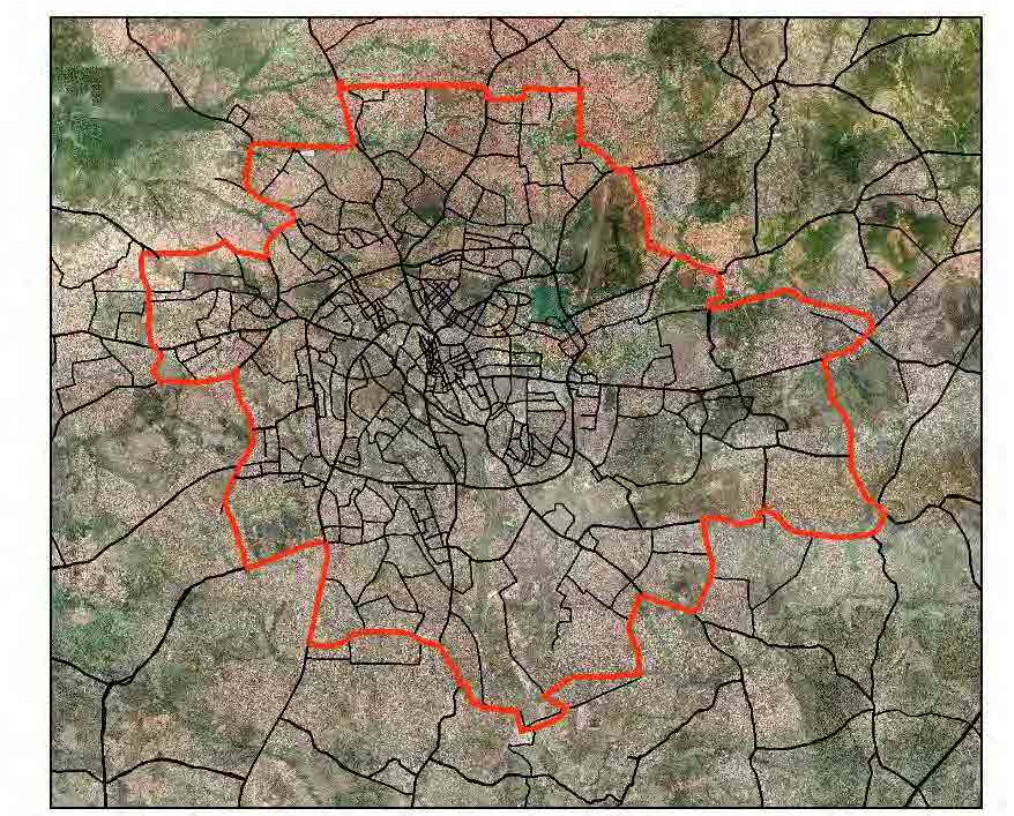
- To improve traffic circulation by expanding the capacity of the road network and by removing bottleneck sections of the road network
- To support socioeconomic development of Kumasi and surrounding districts by improving movement of people and goods
- To strengthen socioeconomic integration between Kumasi and surrounding districts and among the districts themselves

(3) Location of the Project

The basic route of the Middle Ring Road entails upgrading of the existing local roads and constructing the missing links between the existing local roads. Throughout the discussions with TCPD and the District planner, the Middle Ring Road route study was carried out using satellite image maps because adequate topographic information is not available. The result of route selection for the Middle Ring Road is shown in blow Figure. The total length is about 48 km located about 10 km from the Kumasi CBD.

Source: JICA Study Team

Figure 22.2.4 Existing Situation of Middle Ring Road Route



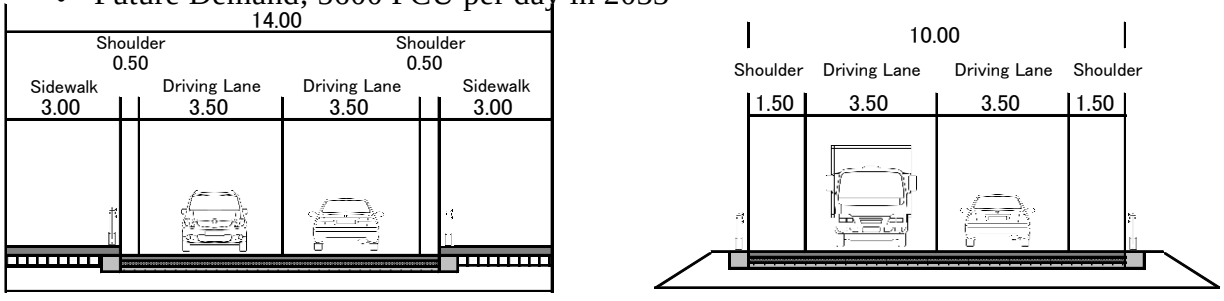
Source: JICA Study Team

Figure 22.2.5 Proposed Route for Middle Ring Road

(4) Scope of the Project

The Middle Ring Road is defined as a collector road connecting between the radial arterial roads. Based on the road functional classifications shown in Table 22.2.1 and Table 22.2.2, the design criteria and the standard cross section for the Middle Ring Road are proposed as follows.

- Length; 48 km
- Design Speed; 60 km/h
- No. of Driving Lanes: 2
- Intersection Type; Roundabout or signalized with arterial road
- Future Demand; 5600 PCU per day in 2033



(Urbanized Section) (Un-urbanized Section)

Source: JICA Study Team

Figure 22.2.6 Proposed Cross Section for Middle Ring Road

(5) Agencies Responsible

- Land Acquisition and Property Resettlement DUR
- Project Implementation DUR
- Maintenance DUR

(6) Estimated Cost

- Construction Cost; 72 million US$ (Based on DUR unit cost)

(7) Financial Sources Expected

- Land Acquisition and Property Resettlement DUR
- Project Implementation DUR
- Maintenance DUR

(8) Implementation Schedule

The high-priority section of North-East Arc should be constructed by 2016, the other sections should be constructed by 2023.

(9) Relationship with Other Projects

- Related land use plans development projects proposed in this Master Plan
- Highway Development Project, especially the radial road network improvement

(10) Effects and Evaluation of the Projects

The Middle Ring road is constructed by upgrading minor local roads to regional roads, which should serve as the connections between major radial roads within a 10 km radius from the city centre. In addition, the Middle Ring Road promotes the better traffic circulation by identifying existing roads that can be improved to form a Middle Ring Road.

1) Positive Impacts

It is expected that travel speed in Kumasi will improve which would be translated into economic gains after the execution of the projects. As a result, it will reduce vehicle-km and vehicle operating cost. Less vehicle km means less source of pollution thus less greenhouse gas emissions. Likewise passengers' hour spent on board the vehicle will also decreases thus they can use the time to more productive activities. The list below presented the likely benefits derived from the projects.

Direct Effects	–	Improvement of travel speed
	–	Reduction of transport cost
	–	Reduction of traffic accident
	–	Improvement of traveller's amenity and increase of travel's comfort
Indirect Effects	–	Transport cost reduction (commodity Prices)
	–	Mitigation of load to environment (traffic pollution)
	–	Facilitating regional development
	–	Settlement of people and increase in population
	–	Expansion of community activities
	–	Improve access to public facilities
	–	Strengthening of exchange and cooperation among districts and city

- Growth of production and income
- Increase in employment by the growth of production
- Increase in revenue by the growth of production

2) Negative Impacts (Land Acquisition, Resettlement, Environment)

Particular attention should be paid to construction works of new roads. A number of negative impacts such as acquisition of private land, involuntary resettlement, cutting of trees, slope modification, disruption of service utilities and infrastructures are expected. In essence the following negative impacts are expected thus mitigation measures shall be put in place.

- ROW Acquisition particularly to construction of new roads
- Involuntary Resettlement
- Increase in noise level during construction especially those inside the city center
- Slope modification
- Disruption of service utilities and infrastructures in some cases
- Demolition of structures
- Construction wastes
- Noise due to pile driving
- Dust caused by construction work
- Increased housing requirement for transient workers, and project management staff
- Increased hazards due to construction activities
- Cutting trees

(11) External Condition

- Peace and order is maintained
- Responsible agency for implementation and maintenance has sufficient capacity

(12) Precondition

- The Project should be committed and kept the necessary fund
- Clear Right of the Way (ROW)
- The development project proposed in this Master plan should be committed and implemented along the schedule

22.2.3 Project for Introducing Type B Bus and BRT System

(1) Background

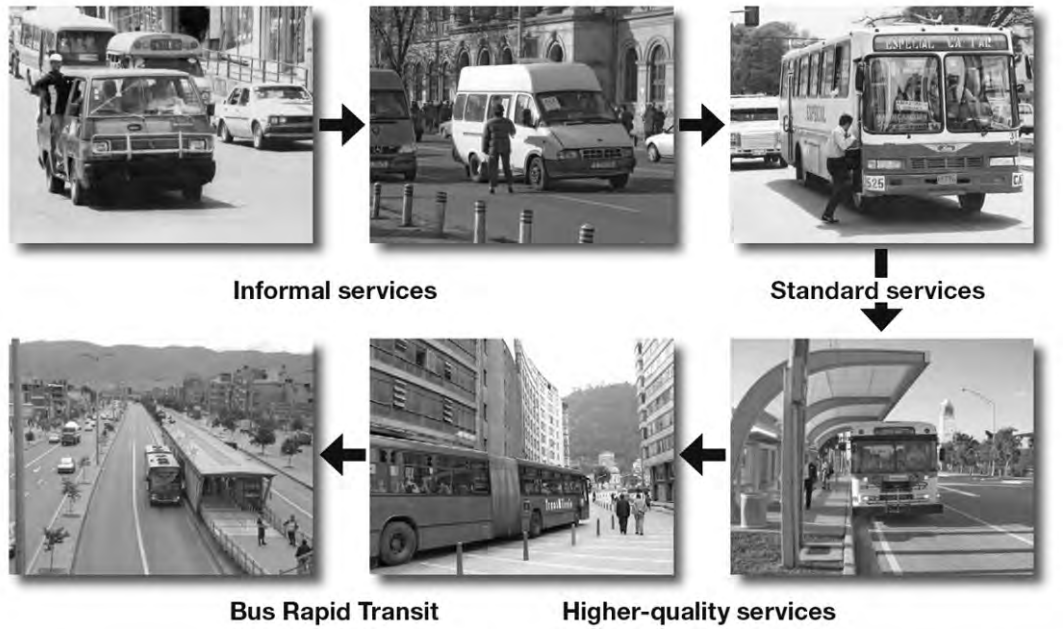
Conventional transit systems can vary significantly in size and quality, even within the same city. Transit service can range from relatively modest van services to bus systems approaching the performance of a BRT system. The quality of public transit can be seen as a spectrum of possibilities ranging from customer unfriendly informal operations to full-feature mass transit systems that achieve mass transit speeds and capacities (Figure 22.2.7) It is worth noting that this spectrum can encompass both road and public transit options. In general, most developing cities should be attempting to move towards higher-quality services. The BRT has provided a means to enter the higher-quality, higher-capacity end of the spectrum but at a substantially

reduced cost in comparison to other options.

Table 22.2.3 Spectrum of Public Transit Transport Possibilities

	Informal Transit service	Standard Transit Service (Type A and B Bus)	Higher-quality Transit Service (Hyper Type B Bus)	Bus Rapid Transit (BRT)
Characteristic	Non-regulated operators Taxi-like services Poor quality customer service Relatively unsafe and insecure Very old, smaller vehicles	Publicly-owned Often Subsidised On-board fare collection Stops with basic shelters Relatively infrequent service Older vehicles	Pre-board fare system On-board fare verification Higher quality shelters Marketing Identity	Metro-quality service Closed station Pre-board fare collection and fare verification Modern, clean vehicles Integrated Transfer stations

Source; GTZ, 2007, Bus Rapid Transit



Source: GTZ, 2007, Bus Rapid Transit

Figure 22.2.7 Public Transport Evolution.

Mini-buses and vans, both formal and informal, are quite evident in the cities of Ghana. While these services are sometimes of relatively low quality, they often provide transit options for communities with few other choices. Standard bus services encompass the conventional 70 passenger buses (12 metres long). These conventional services are typically safer than informal mini-buses, but nevertheless still are not an attractive, comfortable, or convenient option. The next stage in transit evolution is towards more organised and higher-quality bus services. Such services may feature newer and cleaner vehicles, more sophisticated fare collection systems, bus lanes, and improved stations. Higher -quality conventional bus services, while not BRT, can be a significant improvement for residents. The conventional bus systems have achieved considerable success without the full application of BRT attributes.

(2) Existing Situation of Public Transport

In Greater Kumasi Conurbation, the public transport services are provided

predominantly by the private sector, which operates a mix of buses, Trotro and taxis. Trotro is defined as an efficient and inexpensive, minibus used for short distance travel. The services being provided are usually unscheduled and often, on demand-responsive routes, filling gaps in informal transit provision, resulting in overcrowding, undependable, and insufficient services. Furthermore the vehicles used for service are old and poorly maintained buses and minibuses. The unreliable nature of public transport services has resulted in the gradual increase in cars, which further congest the roads in the CBD and the major radial roads and worsen air pollution, noise, and safety problems.

This passenger transport is largely provided by private operators that have organized themselves into unions, associations and cooperatives. The Government has also set up the Metro Mass Transit (MMT) Company together with other public sector investors to operate large buses in the cities. These operators largely regulate themselves with very limited input from the assemblies. The Government intends to support the participating assemblies to take over their responsibility to regulate urban passenger transportation.

(3) Concept of Type B Bus Scheme

Urban Passenger Transport Units (UPTUs) in DUR have been set up in both Accra and Kumasi to plan, register, license, monitor and enforce urban public transport operations. An early role has been to collect information on existing routes operated in each city, with the progression to route licensing to move to a planned and regulated public transport network. Type A permits will be given to the operators on existing routes who fulfil the minimum requirements for operations (vehicle roadworthiness, correct driving license etc.). These licenses will be of one year duration.

In addition, an enhanced type of license will be piloted on selected routes exhibiting the appropriate attributes. The Type B license will permit operators using large buses to operate on these high demand corridors, offering higher quality and more efficient public transport on these routes.

The initial steps in the process are to register and rationalise, and determine the best regulatory environment for each route. Operators will require either a Permit Type A or Permit Type B for commercial activities along a route. Initially a Permit Type A is likely to be issued to all eligible operators.

(4) Concept of BRT Scheme

The BRT is a bus-based mass transit system that delivers fast, comfortable, and cost -effective urban mobility. Through the provision of exclusive ROW lanes and excellence in customer service, the BRT essentially emulates the performance and amenity characteristics of a modern rail-based transit system but at a fraction of the cost. While the BRT utilises rubber -tyre vehicles, it has little else in common with conventional urban bus systems. The following is a list of features found on some of the most successful BRT systems implemented to date:

- Exclusive right-of-way lanes
- Rapid boarding and alighting
- Free transfers between lines
- Pre-board fare collection and fare verification
- Enclosed stations that are safe and comfortable
- Clear route maps, signage, and real-time information displays
- Automatic vehicle location technology to manage vehicle movements
- Modal integration at stations and terminals
- Clean vehicle technologies
- Excellence in marketing and customer service

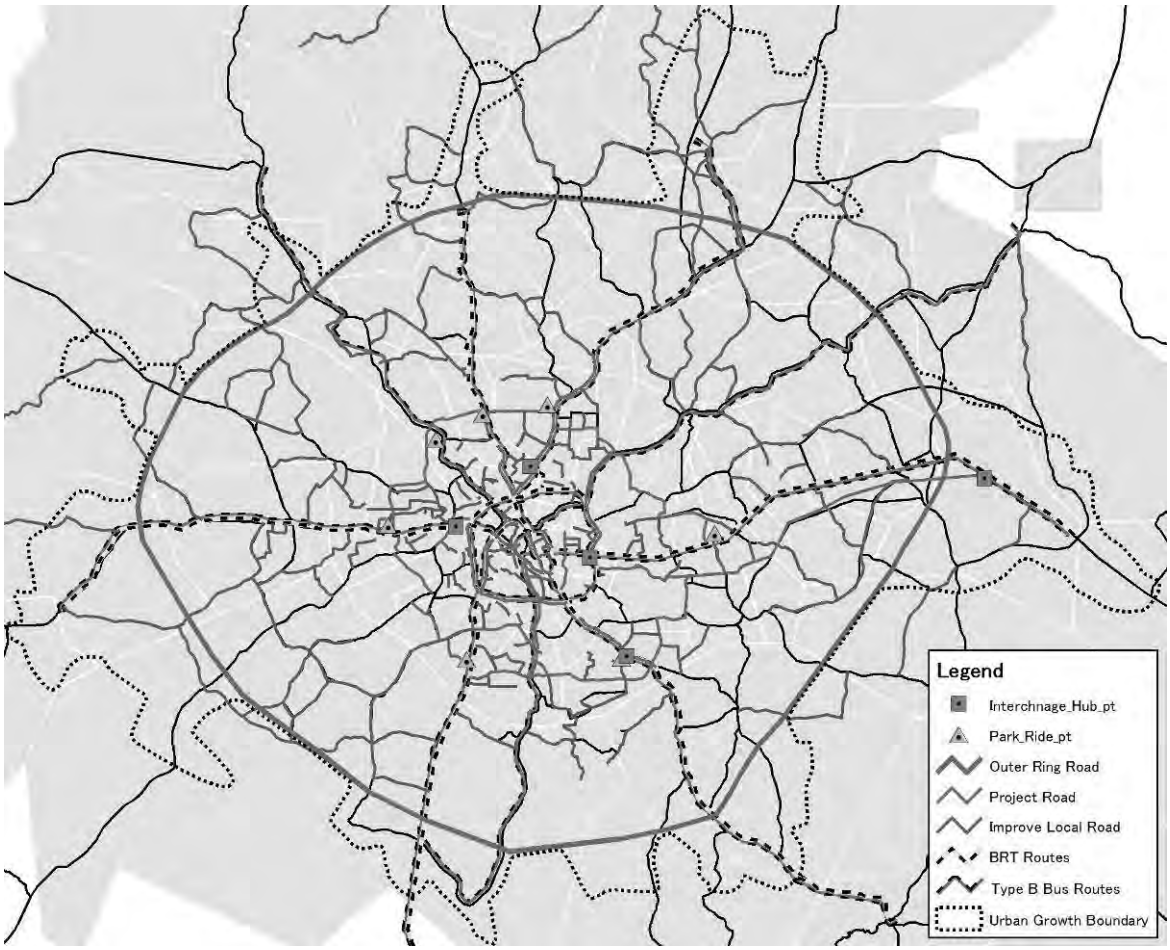
(5) Location of the Project

The proposed Type B and BRT network consists of a combination of radial and circumferential routes that together will form a network of routes that cover most major development areas. Due to the capital costs involved in providing the Type B and BRT running-ways and transit terminal /stops, the proposed Type B and BRT network is restricted to major corridors of demand. Based upon the general criterion of hourly peak passenger bi-directional flows greater than 10,000 passengers in 2012 and 2033, and the need to provide an integrated public transport network, the following routes were identified as routes on which the BRT services should operate in an exclusive running-way:

Table 22.2.4 Proposed Type B Bus and BRT

Scheme	No	Route Name	2023 Demand Person per day	2033 Demand Person per day	Length (km)	Cost (M$)
Type B Bus	1	Antoa Road Type B Routes	31,500	40,700	8.80	3.68
	2	Mampong Road Type B Routes	160,000	-	8.80	2.18
	3	Offinso Road Type B Routes	177,000	-	8.20	2.12
	4	Abrepo Road Type B Routes	98,600	117,900	7.40	2.04
	5	Sunyani Road Type B Routes	124,000	-	8.30	2.13
	6	Bekwai Road Type B Routes	172,000	-	8.40	3.64
	7	Old Bekwai Type B Routes	111,000	161,400	9.90	2.29
	8	Lake Road Type B Routes	132,000	-	10.40	2.34
	9	Accra Road Type B Routes	179,000	-	15.30	4.38
	10	Orbital Route Type B Route	59,000	-	18.30	7.53
BRT Route	1	BRT Mampong Road	-	208,300	8.80	20.22
	2	BRT Offinso Road	-	240,800	8.20	19.08
	3	BRT Sunyani Road	-	175,000	8.30	19.27
	4	BRT Bekwai Road	-	208,600	8.40	19.46
	5	BRT Accra Road	-	216,100	15.30	34.57
	6	BRT Lake Road	-	156,700	10.40	23.26
	7	BRT Inner Ring Road	-	83,400	7.96	18.30
	8	BRT CBD New Road	-	25,000	1.31	3.00

Source: JICA Study Team



Source: JICA Study Team

Figure 22.2.8 Location of Type B Bus Route

(6) Scope of the Projects

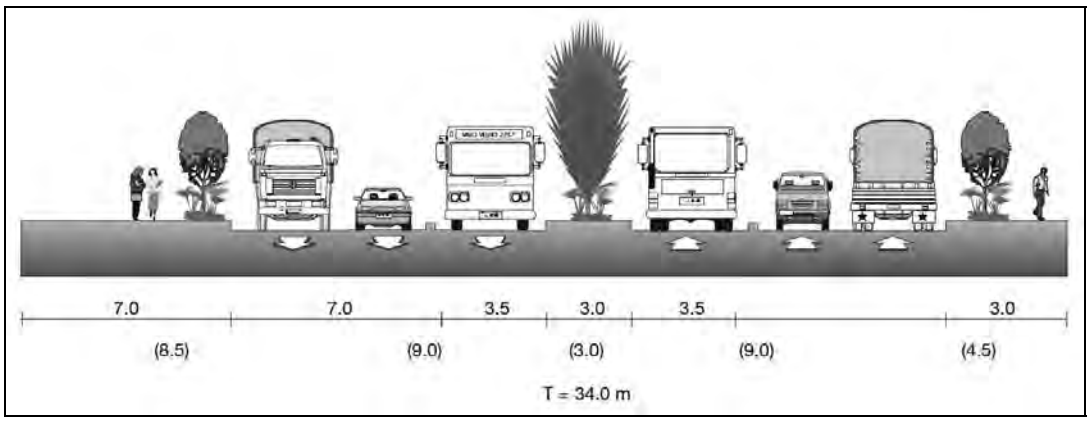
1) BRT Busway dimensions

The availability of road space will likely be a significant design consideration in the development of the runway. Providing space for runways, pedestrian and bicycle access areas, and mixed traffic lanes can be a challenge when given the inherent limitations of existing road widths. However, typically solutions can be found for even the most space-limited streets.

Most buses are approximately 2.6 metres in width. To provide safe manoeuvring space for the vehicles, a standard lane of 3.5 metres is typically provided. As lanes narrow, the safe operating speed of the vehicle will likely be reduced. The width of a median station will vary depending on customer flows, but, in general, a median station will range from 2 metres to 5 metres in width. A typical roadway cross-section is presented in Figure 22.2.9.

If sufficient road space is not available to meet a preferred design option, there are still options for municipal officials to consider. Eliminating some mixed traffic lanes may seem politically difficult to achieve, but by doing so, the resulting design

provides a strong incentive for shifting to the new system. Further, the promise of a new, high-quality mass transit system can help stem concerns over reduced space for private vehicles.

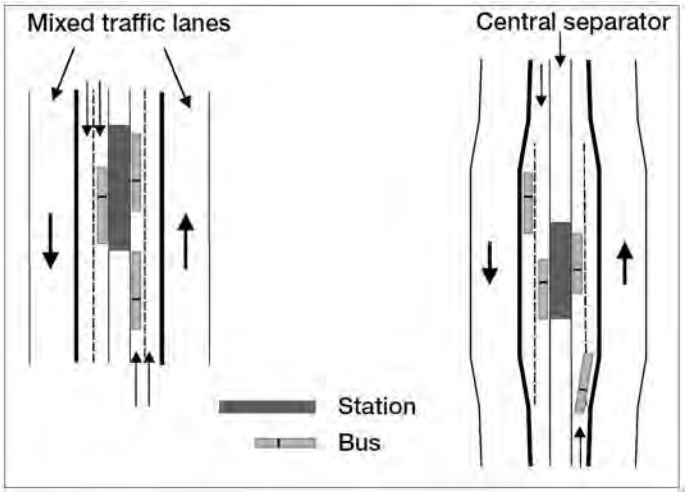


Source: GTZ, 2007, Bus Rapid Transit

Figure 22.2.9 Typical Roadway Configuration for a Median Busway

2) Passing lanes

With a single busway lane in each direction, a BRT system will reach a capacity limit at approximately 14,000 passengers per hour per direction (pphpd). This capacity level can be increased with the platooning of vehicles and multiple stopping bays, but such a configuration is relatively complex to manage and control. Instead, for capacities above 14,000 pphpd the best option may be to consider a passing lane at stations or even a second lane throughout the full corridor as in Figure 22.2.10. By permitting a passing lane at stations, buses can comfortably overtake other buses. Thus, multiple stopping bays and express services can be accommodated with a passing lane. A passing lane also gives a system considerable flexibility in terms of future ridership growth.

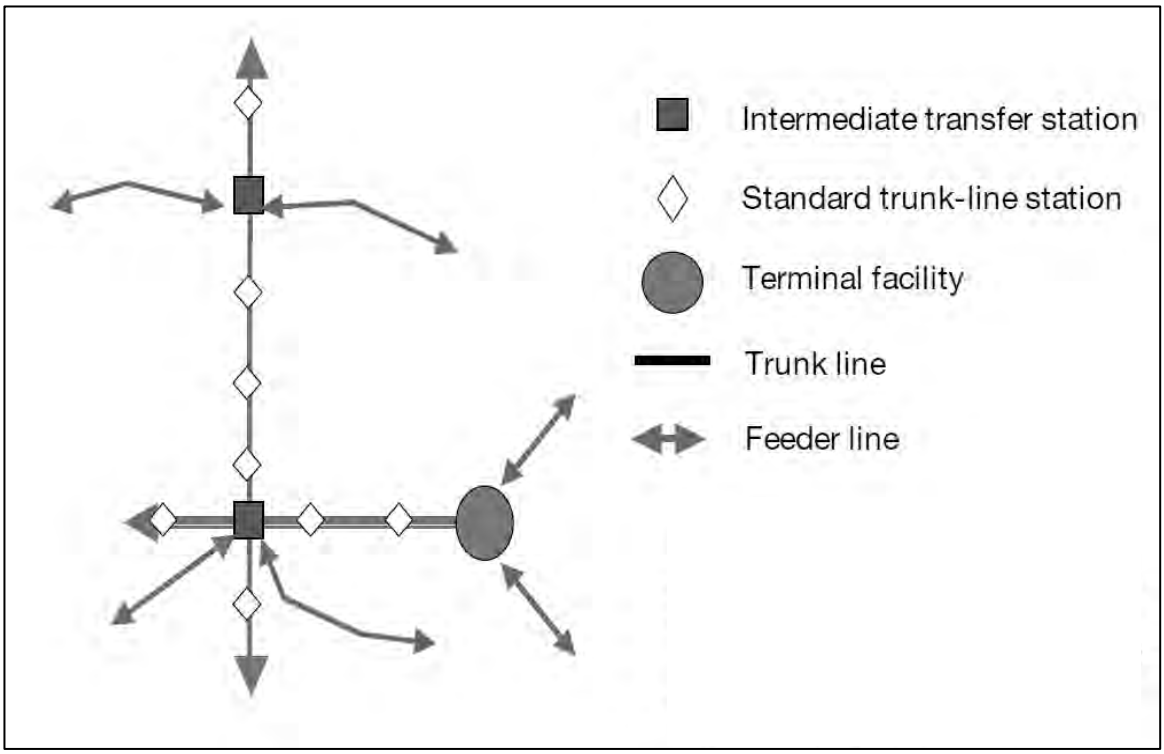


Source: GTZ, 2007, Bus Rapid Transit

Figure 22.2.10 Provision of Passing Lane System for BRT Stations

3) Transfer Stations Connecting to Feeder Transit Systems

Feeder connections to the trunk lines do not necessarily occur only at major terminal facilities. Feeders can also intersect the trunk corridors at what are known as intermediate transfer stations. These stations are somewhat a hybrid facility between ordinary local stations and terminal facilities. Figure 22.2.11 provides an overview of the relationship between standard stations, intermediate stations, and terminal facilities



Source: GTZ, 2007, Bus Rapid Transit

Figure 22.2.11 Intermediate Transfer station and Feeder Transit Service

Unlike terminal sites, intermediate transfer stations may not have the luxury of space to easily accommodate both feeder platforms and trunk-line platforms. Thus, a bit of creativity is required to design and control the transfer process. Ideally, the feeder vehicles can enter a "closed" space in which a fare-free transfer can take place without concerns over fare evasion. However, this ideal is typically not the case. Instead, feeder vehicles arrive from a smaller side street, and passengers must walk from the feeder station to the trunk-line station. A crosswalk or pedestrian bridge will often link the two stations.

(7) Agencies Responsible

- Land Acquisition and Property Resettlement — DUR
- Project Implementation (Infrastructure) — DUR
- Operation (Bus and BRT) — Private Bus Operators
- Maintenance (Infrastructure) — DUR
- Maintenance (Bus and BRT) — Private Bus Operators

(8) Estimated Cost

The infrastructure project costs are shown in Table 22.2.4 for each Type B and BRT routes. This does not cover the road widening for Type B bus and BRT routes. This does not cover the cost for bus and BRT vehicles for operation.

(9) Financial Sources expected

• Land Acquisition and Property Resettlement	DUR and Local Governments along the Routes
• Project Implementation (Infrastructure)	DUR and Local Governments with International Organization Aids
• Operation (Bus and BRT)	Private Bus Operators
• Maintenance (Infrastructure)	DUR and Local Governments
• Maintenance (Bus and BRT)	Private Bus Operators

(10) Implementation Schedule

Type B Bus System should be installing by 2023, and then the BRT routes should be implemented by 2033.

(11) Relationship with Other Projects

- Related land use plans development projects proposed in this Master Plan
- The radial road network improvements where are overlapped Type B bus and BRT routes

(12) Effects and Evaluation of the Projects

An effective public transit system can underpin a city's progress towards social equality, economic prosperity, and environmental sustainability. By leap-fogging past a car-dependent development path, cities can avoid the many negative costs associated with uncontrolled growth that ultimately disrupts urban coherence and a sense of community.

Table 22.2.5 outlines some of the direct benefits that BRT has provided to developing cities. Beyond these benefits, though, there exist multiplier impacts that can further increase the value of BRT to a municipality. For example, BRT can lead to reduced public costs associated with vehicle emissions and accidents. Such impacts include costs borne by the health care system, the police force, and the judicial system. In turn, by reducing these costs, municipal resources can be directed towards other areas such as preventative health care, education, and nutrition.

Table 22.2.5 Benefits of BRT

Category	Description
Economic	・ Reduced travel times ・ More reliable product deliveries ・ Increased economic productivity ・ Increased employment ・ Improved work conditions
Social	・ More equitable access throughout the city ・ Reduced accidents and illness ・ Increased civic pride and sense of community
Environmental Urban form	・ Reduced emissions of pollutants that impact on human health (CO, SOx, NOx, particulates, CO_2) ・ Reduced noise levels ・ More sustainable urban form, including densification of major corridors ・ Reduced cost of delivering services such as electricity, sanitation, and water
Political	・ Delivery of mass transit system within one political term ・ Delivery of high-quality resource that will produce positive results for virtually all voting groups

Source: JICA Study Team

(13) External Condition

- Peace and order is maintained
- Responsible agency and Bus operation companies for implementation and maintenance has sufficient capacity

(14) Precondition

- The Project should be committed and kept the necessary fund
- Clear the Right of Way (ROW) for keeping Bus Priority lanes and segregated lanes.
- The development project proposed in this Master plan should be committed and implemented along the schedule
- On-going Bus Licensing system project by DUR and WB should be completed and Bus Company and their operation should be well-organized and unified.

22.3 Priority Projects and Actions for Water Resources Sector

22.3.1 Feasibility Study on Water Resources Development for Greater Kumasi Sub-Region

(1) Background, Present Situation and Rationale of the Project

Greater Kumasi Sub-Region is located on the most upper part of the watershed of Pra River. Consequently the available water resources of both surface water and groundwater are quite limited in Greater Kumasi in terms of the possible volume of water utilization.

The Greater Kumasi Sub-Region depends on 2 dams (Owabi and Barekese) and a number of existing shallow wells and deep boreholes for supplying urban water and

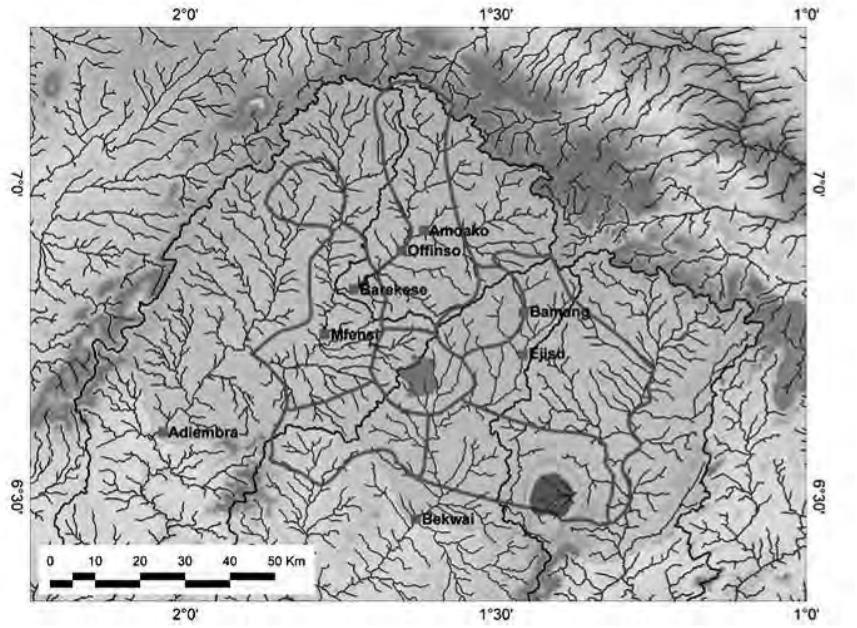
rural water. However, water supply is insufficient in terms of volume and quality at present.

Considering the expected rapid increase in population and increasing water demand per capita, the water supply capacity will be in shortage and unstable to satisfy the increase in water demand. This is because water resources would become insufficient in volume and quality for Greater Kumasi Sub-Region, if the inhabitants in the region continue to depend only on the currently used water resources (surface water from 2 dams and groundwater).

This is because the present heavy and increasing utilization of groundwater without proper monitoring would create a risky and unstable situation of groundwater utilization in the future, considering topographical positions that Greater Kumasi Sub-Region occupies the upper streams of rivers and the capacity of groundwater resources is limited.

Moreover, the data on river water discharge is sparse in that the period of data collection is not long enough and the locations of stations for river water discharge too few to scientifically prepare water resources development plans.

It is clear that water resources should be developed somehow by finding new water sources for Greater Kumasi Sub-Region in the future. Therefore, it is necessary to conduct a full-scale feasibility study on water resources development for Greater Kumasi Sub-Region, based on field data collection on surface water and groundwater.



Source: JICA Study Team

Figure 22.3.1 Location Map of Existing Hydrological Stations

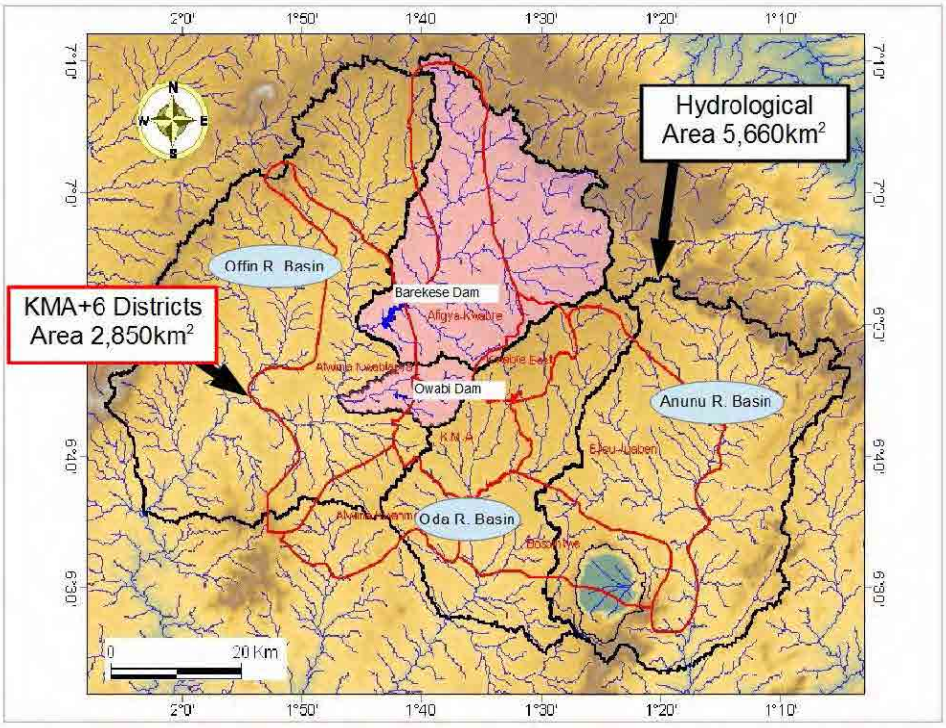
(2) Objectives of the Project

- To obtain more hydrological data for planning of water resources development during the study project

- To examine the water balance between water demand and water supply considering both surface water and groundwater resources
- To identify additional surface water sources to be developed, such as those by constructing new dams
- To prepare a basic design for surface water sources development
- To prepare necessary actions to mitigate impacts of water resources development on the natural and social environments

(3) Study Area for the Project

The study should not only cover the administrative areas of MMDAs of the Greater Kumasi Sub-Region, but also the hydrological areas in relation to the Greater Kumasi Sub-Region.



Source: JICA Study Team

Figure 22.3.2 Study Area for the Proposed Feasibility Study

(4) Scope of the Project

A feasibility study on water resources development should be conducted in order to design plans to satisfy future demand for water supply in the Greater Kumasi Sub-Region. The feasibility study should cover the following items:

- Hydrological measurement of surface water and groundwater
- Clarification of water budget in and around the Greater Kumasi Sub-Region
- Topographic and geological investigation for candidate dam sites
- Basic design of Dams and appurtenant works
- Consideration of social and environmental impacts and preparation of mitigation measures for social and environmental impacts

- Economic and financial analyses for examining economic and financial feasibility

The necessary surveys are as follows:

- Topographical & geological surveys around the candidate dam sites and reservoir sites

In order to conduct the study to recommend appropriate usage of groundwater in terms of volume and location, it is essential to collect data regarding current groundwater usage by the following:

- Inventory of existing boreholes
- Monitoring of groundwater levels and groundwater quality (monthly)
- Recording of the volume of groundwater extracted from each borehole
- Hydrogeological survey to clarify the aquifer conditions in the designated areas (using electrical prospecting methods)

(5) Agencies Responsible

Ghana Water Company Limited under the Ministry of Water Resources, Works and Housing

(6) Estimated Cost

US$ 3 million

(7) Financial Sources Expected

GOG should prepare the financial source.

(8) Implementation Schedule

Prior to the conducting of the main items of this feasibility study, the hydrological monitoring should be started first and continued for at least for 5 years (for example, 2014-2018) in order to accumulate the basic hydrological data. That is, other study items in the feasibility study should be conducted after the hydrological data has been accumulated.

(9) Relationship with Other Projects

GWCL undertook the Master Plan for Kumasi Water Capacity Extension, whose final report was issued in December 2010, which includes a pre-feasibility study on some new surface water sources. However, this 2010 master plan study did not use the results of the 2010 population and housing census. As a result, the 2010 master plan study was based on greatly underestimated future populations.

The above proposed feasibility study can be regarded as a supplemental and updated version of the 2010 master plan in respect to the component for water resources development.

22.4 Priority Projects and Actions for Water Supply Sector

22.4.1 Project for Effective Use of Barekese Water Treatment Plant

(1) Background, Present Situation and Rationale

1) Background

The water treatment capacity of the existing facilities is not able to provide sufficient water supply. Moreover, it will not be able to supply water for the rapidly growing populations. In the future, the water supply situation will become worse in Greater Kumasi Conurbation.

On the other hand, the Barekese dam reservoir has had its original water storage capacity greatly reduced due to sedimentation. The Barekese Water Treatment Plant currently only has the capacity to treat about 60% of the volume of water that could be provided by the Barekese dam reservoir.

Therefore, immediate action is necessary for urgent increase in the water supply.

2) Existing and Future Situation

The present capacities of Barekese dam reservoir and Water Treatment Plant are about 180,000m^3/day and 136,500m^3/day respectively. The average per capita water consumption for domestic household use is estimated to be just 20 litres per day.

If Barekese dam and Water Treatment Plant are not improved and expanded in the future, the average water consumption must decrease due to the increase in population growth.

If this project is implemented the capacity of Barekese water treatment plant will be increased to about 218,400m^3/day. The average per capita water consumption for domestic household use is predicted to rise to 40-50 litres per day.

3) Rationale of the Project

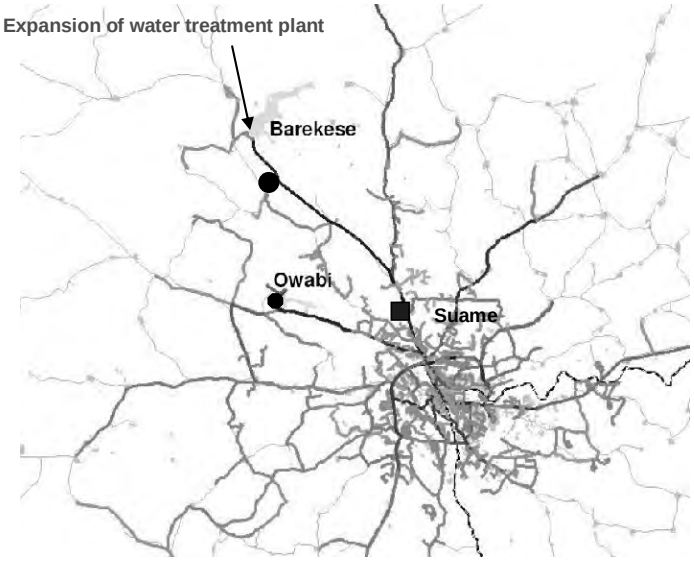
The current piped water supply area covers the CBD and high density population areas. These areas will continue to develop as residential areas and as a main commercial area. Therefore, stable water supply to these areas is essential for the development of Greater Kumasi Sub-Region.

(2) Objectives of the Project

- To upgrade the water supply capacity in response to an increasing water demand.
- To supply water in response to increasing water demand

(3) Location of the Project

- The location of the Barekese Dam and Water Treatment Plant is shown below.



Source: JICA Study Team

Figure 22.4.1 Location of Barekese Dam and Water Treatment Plant

(4) Scope of the Project

- Feasibility study, basic design services
- Detailed design, tendering and contracting services
- Dredging of the reservoir for Barekese Dam
- Construction of water treatment modules at Barekese Water Treatment Plant

(5) Agencies Responsible

- Project Implementation: Ghana Water Company Lt. (GWCL)
- Operation: Ghana Water Company Lt. (GWCL)
- Maintenance: Ghana Water Company Lt. (GWCL)

(6) Estimated Cost

- Dredging: GHC 36.0 million
- Construction:
  Water treatment modules: GHC 41.0 million
- Total Cost: GHC 77.0 million

(7) Financial Sources Expected

Basically, it should be carried out by funding of GWCL. However, the construction of the fifth module used funding from the Netherlands. Considering this situation it is considered that funding from donor agencies is necessary.

(8) Implementation Schedule

	2013	2014	2015	2016	2017	2018
Dredging						
Water treatment module						

Lead time (feasibility study, basic design, financial arrangement, detailed design, tendering and contracting)
Construction/ implementation

(9) Relationship with Other Projects

- This project is the first step in order to achieve a stable water supply. For further stable water supply, other projects are necessary such as rehabilitation and replacement of aged pipes and construction of new water tanks.

(10) Effects of the Project

1) Target Beneficiaries:

- The 1.9million residents that live in existing piped water supply area in year 2013.
- The 2.7million residents that will live in the existing piped water supply area in year 2023.

2) Effects:

- Increase in the number of residents who are able to obtain clean water from a water supply pipeline.
- Increase in water consumption volume per capita

(11) Evaluation of the Project

1) Economic Viability

Although no economic analysis has been done, it is expected that the Project is economically viable because of the great amount of benefits that are expected through the increase in the water volume available for non-domestic as well as domestic use.

2) Financial Soundness

In order to improve the financial soundness, it is desirable to carry out the other projects such as rehabilitation and replacement of aged pipes and installation of water meters.

3) Environmental Impacts

- Positive Impacts
  Improvement of the sanitary living environment
  Decrease in waterborne infections
- Negative Impacts
  Deterioration of water quality of water bodies due to increase of non-treated grey water

(12) External Conditions

- Peace and order is maintained.
- Responsible agency for operation and maintenance has sufficient capacity.

(13) Preconditions

- Disposal site for dredged sand is assured.
- Necessary fund is prepared.

22.4.2 Effective Use of Existing Distribution Pipes Project

(1) Background, Present Situation and Rationale

1) Background

The water supply capacity of existing facilities is insufficient due to population growth and changes in demand. In the future, it will not be able to respond further.

On the other hand, Non-revenue water is currently in the magnitude of 35%. One of the causes of NRW is pipe breaks. This means that 35% of the clean water produced has been wasted.

Therefore, it is necessary to take immediate action for reduction of NRW by replacing the existing distribution pipes.

2) Existing and Future Situation

In Kumasi it is observed that there are bursts in which pipe breaks of diameters greater than 7.6cm occur every two and one half days and leaks in which pipe breaks of diameters less than 7.6cm occur every other day.

In the future, the frequency of pipe breaks will increase due to the increase in the proportion of aged pipes.

The target of ratio of NRW is 10% by replacing aged pipes.

3) Rationale of the Project

The current piped water supply area covers the CBD and high density population areas. These areas will continue to develop as residential areas and as a main commercial area. Therefore, stable water supply to these areas is essential for the development of Greater Kumasi Sub-Region.

(2) Objectives of the Project

- To correspond to the increase in water demand.
- To provide water supply

(3) Location of the Project

Existing piped water supply area

(4) Scope of the Project

- Investigation of causes of NRW
- Replace pipelines based on the investigation results

- Replace aged pipelines

(5) Agencies Responsible

- Project Implementation: GWCL
- Operation: GWCL
- Maintenance: GWCL

(6) Estimated Cost

- Construction:
  - Replacement of small-diameter pipes: GHC 13.9mil.
  - Replacement of large-diameter pipes: GHC 48.4 mil.
- Total Cost: GHC 62.3 mil.

Note: Replacement volume is estimated in this study. So as a result of further investigation, the amount of pipes to be replaced is likely to increase or decrease significantly.

(7) Financial Sources Expected

Basically, it should be carried out through the funding of GWCL.

On the other hand, some support for Ghana water supply system from China and US is planned for replacement and renewal of the distribution systems. Therefore, the appropriate use of these funding sources is preferred.

(8) Implementation Schedule

	2013-15	2016-18	2019-23	2024-28
Investigation				
Replacement of small-diameter pipes				
Replacement of large-diameter pipes				

Lead time(financial arrangement, feasibility study, basic design, detailed design, tendering contracting)
Construction/Implementation

(9) Relationship with Other Projects

This project is important in order to achieve a stable water supply. For further stable water supply, the other projects are necessary such as the expansion of water treatment plant modules in Barekese and installation of transport lines to the Suame water tank from Barekese water treatment plant.

(10) Effects of the Project

1) Target Beneficiaries:

- The 1.9million residents that live in the existing piped water supply area in year 2013.
- The 2.7million residents that will live in the existing piped water supply area in year 2023.

2) Effects:

- Increase in the number of residents who are able to obtain clean piped water.
- Increase in the water consumption volume per capita
- Increase in revenue by reduction of NRW

(11) Evaluation of the Project

1) Economic Viability

Although no economic analysis has been done, it is expected that the Project is economically viable because a great benefit is expected whereby the volume of non-domestic water use is increased as well as the domestic use.

2) Financial Soundness

- No financial problem is anticipated.
- Reduction of NRW will increase the revenue, so the financial situation of GWCL would be improved.
- In order to improve the financial soundness, it is desirable to carry out the other projects such as the expansion of the water treatment plant modules in Barekese and installation of transport lines to the Suame water tank from Barekese water treatment plant.

3) Environmental Impacts

- Positive Impacts
  Improvement of the sanitary living environment
  Decrease in waterborne infections
- Negative Impacts
  Deterioration of water quality of water bodies due to increase of non-treated grey water
  Traffic restrictions and congestion will be expected in the construction period for the replacement of distribution pipelines.

(12) External Conditions

- Peace and order is maintained.
- Responsible agency for operation and maintenance has sufficient capacity.

(13) Preconditions

- Documentation is required to verify the status of the existing pipes.
- Necessary fund is prepared.

22.5 Priority Projects and Actions for Liquid Waste Treatment Sector

22.5.1 Project for Development of Septage Treatment Ponds in Adjoining Districts/Municipalities within Greater Kumasi Sub-Region

(1) Background, Present Situation and Rationale

Oti septage treatment pond is the only facility to treat septage in Greater Kumasi Sub-Region. The septage treatment pond was constructed under the Urban

Environmental Sanitation Project in 2004.

The capacity of Oti septage treatment plant is 600m^3/day (assuming 300m^3/day of septage and 300m^3/day of leachate).

An average daily generation volume of septage per capita is assumed to be 0.15 litres/capita/day. Based on this figure the future septage amounts are estimated as shown in the table below.

Table 22.5.1 Future Septage Volume in Year 2033

Unit: ton/day

	2013	2018	2023	2028	2033
KMA	349	415	482	523	577
Afigya-Kwabre	21	24	29	33	39
Kwabre East	18	21	24	26	33
Ejisu-Juaben	23	26	30	50	66
Bosomtwe	15	17	20	22	25
Atwima Kwanwoma	14	16	19	22	30
Atwima-Nwabiagya	23	27	31	32	38

Source: JICA Study Team

When the percentage of toilet facilities is still high like in Greater Kumasi, septage treatment ponds are more desirable than the modern sewerage system, because construction costs for septage treatment ponds are relatively low.

Due to the rapid population growth in the future, the amount of septage generated is expected to increase rapidly in Greater Kumasi Conurbation. Then the amount of septage generated will exceed the capacity of Oti septage treatment pond.

At present, septage generated from adjoining districts and municipalities are transported to Oti septage treatment pond through KMA. Vacuum trucks passing through Kumasi City cause problems such as odour.

Therefore, construction of septage treatment ponds in the districts and municipalities is also useful for the improvement of the urban environment.

Considering the above conditions, it is recommended to construct new septage treatment ponds in each district/municipality.

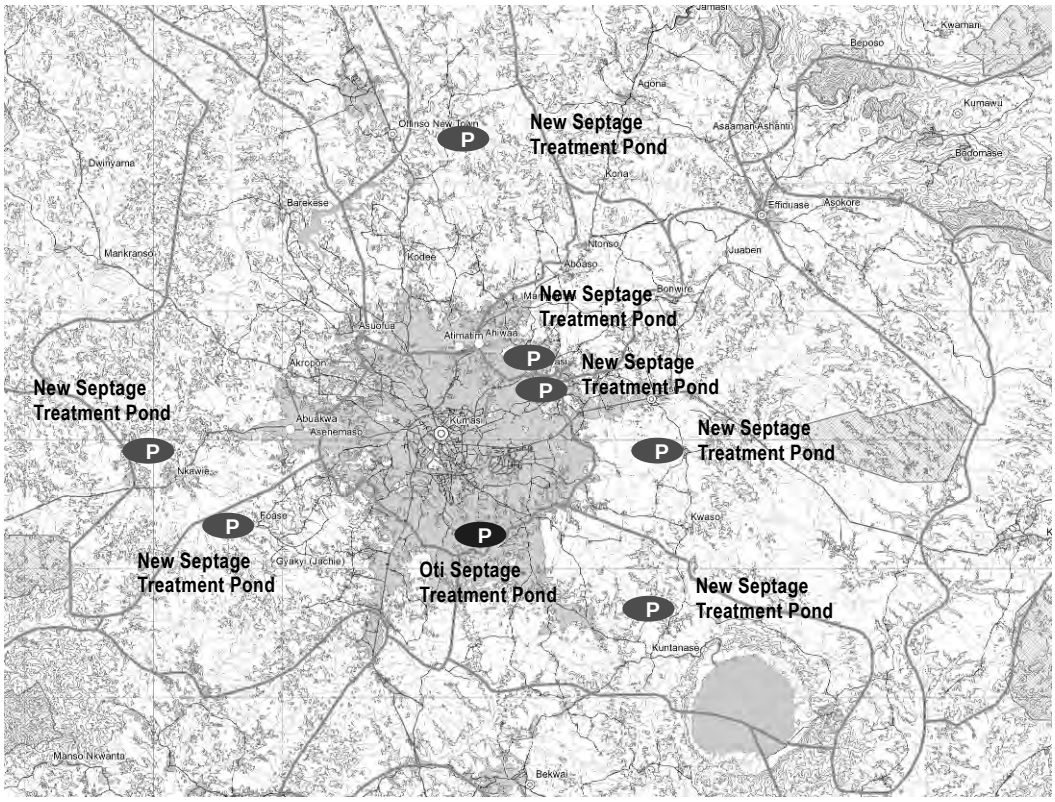
It is also recommended that the septage treatment pond should treat leachate generated from solid waste final disposal sites, like Oti septage treatment pond.

(2) Objectives of the Project

- To create a clean living environment in Greater Kumasi Conurbation
- To provide a hygienic environment in Greater Kumasi Conurbation
- To reduce the occurrence of infectious diseases caused by uncontrolled liquid waste

(3) Location of the Project

The sites for the project are located in suburban areas of the districts and municipalities as shown in the figure below.



Source: JICA Study Team

Figure 22.5.1 Locations of Proposed Septage Treatment Ponds

(4) Scope of the Project

- Feasibility study including site selection of septage treatment ponds and basic design1
- Land acquisition
- Detailed design, tendering and contracting
- Construction of new septage treatment ponds and small-scale final land fill sites

(5) Agencies Responsible

- Project Implementation: Works Department (WD) of District/Municipality
- Operation: Works Department (WD) of District/Municipality
- Maintenance: Works Department (WD) of District/Municipality

(6) Estimated Cost

- Planning and Design: GHC 0.65 million
- Construction:

  Afigya-Kawbre : GHC 1.04 million

[1] Sites proposed for new septage ponds are still tentative. The site selection should be done considering the SDF for Greater Kumasi Sub-Region and SP for Greater Kumasi Conurbation.

Kwabre East:	GHC 0.89 million
Ejisu-Juaben:	GHC 1.76 million
Bosomtwe:	GHC 0.67 million
Atwima Kwanwoma:	GHC 0.80 million
Atwima-Nwabiagya:	GHC 1.01 million

- Subtotal Cost of Construction: GHC 6.17 million
- Total Cost: GHC 6.82 million

(7) Financial Sources Expected

The land acquisition and construction of septage treatment ponds should be financed by each District Assembly. However, the capacity development for planning and management of the liquid waste treatment should be assisted by national-level government agencies and/or development partners.

(8) Implementation Schedule

	2013	2014	2015	2016	2017	2018
Development of Septage Treatment Ponds in Adjoining Districts/Municipalities						

Lead time (financial arrangement, feasibility study, basic design, detailed design, tendering and contracting)

Construction/implementation

(9) Relationship with Other Projects

This project (construction of septage treatment ponds) is related to the project of construction of solid waste final disposal sites in adjoining districts/municipalities.

(10) Effects of the Project

1) Target Beneficiaries

Residents living in Greater Kumasi Conurbation

2) Effects

- Improvement of sanitary living environment
- Creation of clean areas in suburban portions of adjoining districts and municipalities

(11) External Conditions

- Peace and order is maintained.
- Responsible agency for operation and maintenance has sufficient capacity.

(12) Preconditions

- Suitable land is secured for new septage treatment pond.
- Necessary fund is prepared.

22.5.2 Expansion of Asafo Simplified Sewerage System for CBD Area

(1) Background, Present Situation and Rationale

The Asafo simplified sewerage system which collects wastewater (black water) from the Asafo community including some hotels and educational institutions was constructed in 1994. The collected wastewater is treated by stabilization ponds in Asafo. The location of the stabilization ponds is shown in Figure 22.5.2.

Source: JICA Study Team

Figure 22.5.2 Location of Asafo Stabilization Pond

At present, the Asafo simplified sewerage system covers part of the city centre area (the CBD area) including 300 households, 6 hostels, 5 transport associations, 6 public toilets, 4 educational institutions and 6 hotels.

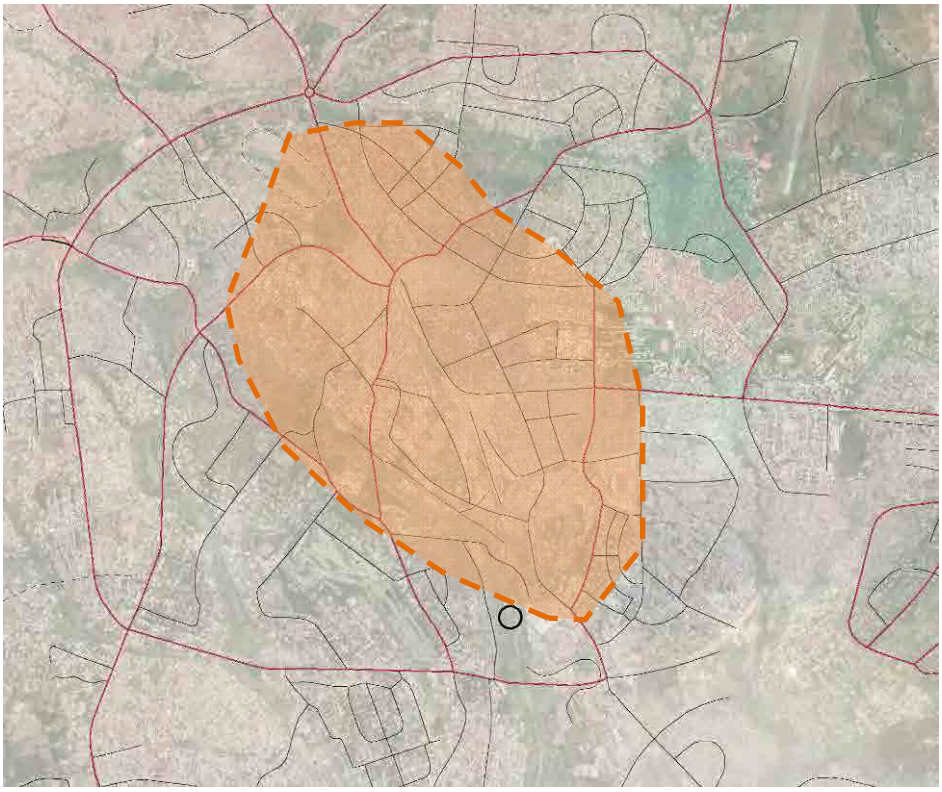
In accordance with the Greater Kumasi Sub-Regional SDF and Conurbation SP, the CBD will be expanded to enhance the urban functions in terms of quality and quantity. The new expanded CBD will have more space and accumulation of advanced urban functions. In response to this CBD expansion and upgrading, it is necessary to expand the capacity of the existing Asafo Simplified Sewerage System to provide sewerage services to the proposed new expanded CBD area of Kumasi City Centre.

(2) Objectives of the Project

- To create a clean city centre
- To provide a hygienic environment
- To reduce the occurrence of infectious diseases caused by uncontrolled liquid waste

(3) Location of the Project

The location of the project is around the proposed new CBD area



Source: JICA Study Team

Figure 22.5.3 Location of Expanded Coverage by the Simplified Sewerage System

(4) Scope of the Project

- Capacity Development for Planning and Management of Liquid Waste Treatment
- Feasibility study and basic design
- Detailed design
- Construction of new sewerage pipes and expansion of Asafo stabilization ponds

(5) Agencies Responsible

- Project Implementation: Waste Management Department of KMA
- Operation: Waste Management Department of KMA
- Maintenance: Waste Management Department of KMA

(6) Estimated Cost

- Construction: GHC 22 mil.

(7) Financial Sources Expected

Basically, the capital investment for the project should be carried out by KMA. On the other hand, the maintenance of the sewerage system should be done by using fees collected for the sewerage services.

(8) Implementation Schedule

	2013	2014	2015	2016	2017	2018
Expansion of Asafo simplified sewerage system						

Lead time (financial arrangement, feasibility study, basic design, detailed design, tendering and contracting)
Construction/Implementation

(9) Relationship with Other Projects

This simplified sewerage system project is to serve flush toilets, which require stable piped water supply. More water than at present should be supplied to houses and institutional buildings for proper operation of the simplified sewerage system. That is why that this project is closely related to the projects for improving and upgrading the water supply.

(10) Effects of the Project

1) Target Beneficiaries:

The residents and visitors in the CBD

2) Effects:

- Improvement of the sanitary environment
- Creation of a clean city

(11) External Conditions

- Peace and order is maintained.
- Responsible agency for operation and maintenance has sufficient capacity.

(12) Preconditions

- It is feasible to use the land on the south side of the existing Asafo stabilization pond for stabilization pond expansion.
- Necessary fund is prepared.

22.6 Priority Projects and Actions for Solid Waste Management Sector

22.6.1 Project for Solid Waste Management Improvement in MDAs Adjoining KMA within Greater Kumasi Sub-Region

(1) Background, Present Situation and Rationale

1) Background

A contiguously urbanizing area centring on Kumasi (Greater Kumasi Conurbation) is expanding beyond the boundary of KMA.

The present waste treatment system mostly depending on private service providers should be improved systematically. In particular, MDAs adjoining KMA will need to play more important roles in solid waste management in the Greater Kumasi Sub-Region.

It is necessary to enhance the institutional capacity of the Environmental Health Departments of MDAs in respect to solid waste management, including the formulation of 3R (reduce, reuse, recycle, a composting plan for pilot areas, and formulation of the final small-scale sanitary landfill sites.

2) Present Situation and Future Projection for SWM of the MDAs

Present major characteristics and issues to be addressed on solid waste management (SWM) for the MDAs adjacent to KMA are summarized in Table 22.6.1.

Table 22.6.1 Summary of Present Situation of MDAs Adjoining KMA in Greater Kumasi Sub-Region

Assembly	Afigya-Kwabre District	Kwabre East District	Ejisu-Juaben Municipality	Bosomtwe District	Atwima Kwanwoma District	Atwima Nwabiagya District
Population(2010)	136,140	115,556	143,762	93,910	90,634	149,025
Waste generation	61 t/day	52 t/day	65 t/day	42 t/day	41 t/day	67 t/day
Collection & transport system	Communal container collection only	Communal container collection only	Communal container collection only	Both house-to-house/ communal collection	Both house-to-house/ communal collection	Both house-to-house/ communal collection
Collection rate	45 %	62 %	59 %	78 %	60 %	26 %
Open dump site	Most communities have an open dump site.					
Final disposal site	No existing final disposal site (the last dump site was fully closed in 2011)	1 existing open dump site (1.5 ha)	2 existing open dump sites (one is almost full, and the other is far from the centre of the municipality)	1 existing open dump site (2 ha)	1 existing open dump site (1 ha)	3 existing open dump sites (2 are almost full, the other far from the centre of the district)
Waste disposal to final landfill	27 t/day	40 t/day	43 t/day	29 t/day	26 t/day	22 t/day
MRF/ Recycling	So far no plan					
For Future Greater Kumasi	Adequate final disposal site is required.					

Source: JICA Study Team

As shown in the table, current collection rates of solid waste in the MDAs are estimated to be more than 26% and the amounts of waste disposed vary from 20 to 40 t/day among the MDAs. Open dump sites are presently the major method at the community level. However, disposed wastes are not properly controlled or managed at the open dump sites.

The future collection rates and waste amounts during the periods between 2013 and 2033 are projected as shown in Table 22.6.2. The amount of waste generation is projected to increase from 429 t/day in 2013 to 2,049 t/day in 2033.

Table 22.6.2 Collection Rates and Waste Amounts Generated in MDAs in the Future (2013-2033)

MDAs/ Target Year	2013	2018	2023	2028	2033
Afigya Kwabre District/ Collection rate (%)	45	59	73	86	100
Total waste generated (t/day)	79	127	204	293	389
Kwabre East District / Collection rate (%)	62	72	82	92	100
Total waste generated (t/day)	73	117	186	267	355
Ejisu-Juaben Municipality/ Collection rate (%)	59	70	80	90	100
Total waste generated (t/day)	86	143	238	347	461
Bosomtwe District/ Collection rate (%)	78	83	89	95	100
Total waste generated (t/day)	53	81	124	175	233
Atwima Kwanwoma District/ Collection rate (%)	60	71	81	91	100
Total waste generated (t/day)	51	80	125	178	237
Atwima Nwabiagya District/ Collection rate (%)	26	45	64	82	100
Total waste generated (t/day)	87	139	221	315	419
Greater Kumasi Sub-Region Waste amount generation in MDAs (t/day)	**429**	**686**	**1,099**	**1,575**	**2,094**

Source: JICA Study Team

3) Rationale of the Project

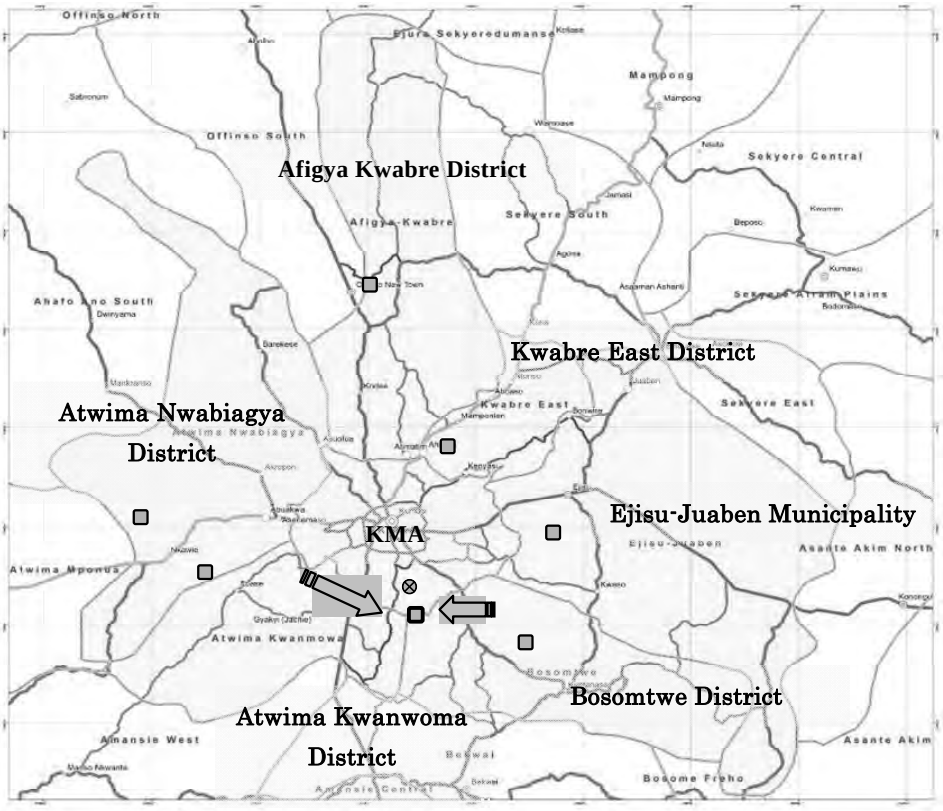
In the 6 MDAs adjoining KMA within Greater Kumasi Sub-Region, solid waste has not been properly treated, resulting in a poor hygienic environment. In order to improve the existing hygienic environment in the MDAs, it is necessary to upgrade the capacity of the Environmental Health Department of the MDAs, especially for the purpose of strengthening of 3R, composting by preparation of SWM plans, and small-scale sanitary landfill plans including the land acquisition process for the landfills.

(2) Objectives of the Project

To improve the environmental sanitation condition in MDAs Adjoining KMA by providing proper solid waste management

(3) Location of the Project

6 MDAs: Afigya Kwabre District, Kwabre East District, Ejisu-Juaben Municipality, Bosomtwe District, Atwima Kwanwoma District and Atwima-Nwabiagya District in Grater Kumasi Sub-Region



Composting & Recycling Waste Movement ⊗ : Oti Sanitary Landfill ▢ : Proposed Site

Source: JICA Study Team

Figure 22.6.1 Location of KMA & Adjoining MDAs

(4) Scope of the Project

To conduct capacity development on solid waste management for Environmental Health Departments of MDAs Adjoining KMA through conducting the following tasks on solid waste management:

- To formulate a 3R (reduce, reuse, recycle) and composting plan for pilot areas in MDAs Adjoining KMA
- To prepare a Solid Waste Management (SWM) plan for Adjoining MDAs
- To implement IEC campaign on SWM in MDAs, and
- To prepare development plans for small-scale sanitary landfill sites including a land acquisition process for the landfill sites

(5) Agencies Responsible

- Project Implementation: 6 MDAs of Greater Kumasi Conurbation and Ministry of Local Government and Rural Development (MLGRD)
- Operation: MDAs-EHD
- Maintenance: MDAs-EHD

(6) Estimated Cost

- Personnel Cost: US$ 1.5 million
- Direct Expenses: US$ 1.7 million

- Total Cost: US$ 3.2 million

(7) Financial Sources Expected

International or foreign agencies are expected to assist in the funding.

(8) Implementation Schedule

Action Programmes	Phasing for Spatial Developing Planning																				
	Short-Term Plan Phase						Mid-Term Plan Phase				Long-Term Plan Phase					Extra Long-Term Plan Phase					
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Enhancement of SWM Unit of EHD, MMDAs especially MDAs																					
1-1 Formulation of 3R (reduce, reuse, recycling) & Composting Implementation Plan																					
1-2 Implementation of 3R & Composting Plan																					
1-3 Preparation of MDAs SWM Plans																					
1-4 Implementation of IEC Campaign on SWM																					
1-5 Capacity Development																					
1-6 Preparation of Small-Scale Sanitary Landfill Plan with land acquisition process for landfills																					
Remarks * Target Year of SDF (2013 - 2033) 20 years * Target Year of SP (2013 - 2033) 15 years																					

Sources: JICA Study Team, 2012
Notes: Kumasi Composting and Recycling Plant (KCRP), Bosomtwe District Assembly (BDA), Municipality and Districts Assemblies (6 MDAs)
Spatial Development Frameworks (SDF), Structure Plan (SP), Environmental Health Department (EHD), Information Education and Communication (IEC)

(9) Relationship with Other Projects

This project on SWM is one of the preconditions for implementing urban and industrial development programmes and infrastructure sector programmes under the Comprehensive Urban Development Plan for Greater Kumasi Sub-Region, such as transportation, water resources/ water supply, sewerage, and electricity supply.

(10) Effects of the Project

1) Target Beneficiaries

The whole population of 1,917,000 in the 6 MDAs in year 2033

2) Effects

- Formation/induction of the planned solid waste management framework for the MDAs
- Formation of a 3R & compost plan for pilot areas
- Implementation of the formulated 3R & composting plan for pilot areas
- Implementation of IEC campaign on SWM and capacity development of MDA-EHD
- Preparation of small-scale sanitary landfill plans and a land acquisition process for the landfills

(11) Evaluation of the Project

1) Economic Viability

Although no economic analysis has been done, it is expected that the Project is economically viable because a great many benefits are expected to accrue from

environmental sanitation in the MDAs.

2) Financial Soundness

No financial problem is anticipated.

3) Environmental Impacts

a) Positive Impacts

- Betterment of the urban and rural environment
- Improvement of environmental sanitation with proper solid waste management for residents
- Improvement in the health environment due to cleanliness and proper SWM

b) Negative Impacts

- Increase in unhealthy environments such as uncleanliness, unhygienic environment, liquid and air pollution as a result of improper SWM (This will be mitigated by improvement of proper solid waste management by the Project)

(12) External Conditions

- Peace and order are maintained.
- Responsible agency for operation and maintenance has sufficient capacity.

(13) Preconditions

- Prohibition and closure of illegal open dump sites.
- Safety measures for scavengers at final disposal sites.

22.7 Project for Replacement of Small-Sized Wires and Deteriorated Equipment, and Realignment of Distribution Lines

(1) Background, Present Situation and Rationale

1) Background

The total power generation capacity of Ghana is about 2,000MW as of year 2012 and generation capacity will be increased to 4294 MW by 2021. This generation capacity will exceed the forecast electricity demand of 2021. And the capacity of 116kV transmission lines and bulk supply points (BSP) will be able to cover the increased demand.

From the above BSPs, 33kV sub-transmission lines are distributed in Greater Kumasi Sub-Region.

However, at present in Kumasi and its adjoining suburban areas, the reliability of power supply is low, and technical power loss is high due to deteriorated distribution lines/equipment and employing smaller-sized distribution wires than required.

2) Present Electrical Power Supply (Existing and Future Traffic Situation)

In 2011, approximately 900 power outages caused by distribution line breakdowns

were recorded[2] and the power loss of ECG/NED in 2008 was about 25%[3]. The power loss is one of the critical issues in Ghana.

3) Rationale of the Projects

Reliable/stable power supply is one of the essential infrastructures to achieve sustainable socio-economic development of Greater Kumasi Sub-Region. This reliable and stable power supply should be achieved at first in the already urbanized areas in order to satisfy basic human needs for urban people. The improved situation of electricity supply by this project could also attract private investments to the economic sectors of Greater Kumasi.

(2) Objectives of the Project

- To reduce the number of power outages in KMA and its adjoining suburban areas
- To reduce power loss in KMA and its adjoining suburban areas

(3) Location of the Project

KMA and its adjoining suburban areas of the Greater Kumasi Sub-Region

(4) Scope of the Project

- Feasibility study and basic design
- Detailed design, tendering and contracting
- Replacement of small-sized overhead wires with proper-sized wires
- Realignment of distribution lines to meet the ECG standard.
- Replacement of deteriorated equipment

(5) Agencies Responsible

- Project Implementation: ECG
- Operation: ECG
- Maintenance: ECG

(6) Estimated Cost

- Detailed Design & Supervision Cost: USD 0.96 million
- Construction:
  Replacement of small size overhead wires: USD 1.57 million
  Realignment of distribution lines: USD 0.39 million
  Replacement of deteriorated equipment: USD 1.17 million
- Total Cost: USD 4.09 million

(7) Financial Sources Expected

Basically, this project should be funded by ECG. However, since the current electricity prices are set at a relatively low level by the government, the financial situation of ECG is not good. Therefore, in order to improve the situation of basic needs, it is urgently necessary to rehabilitate the existing deteriorated electricity

[2] ECG
[3] Energy Commission Annual Report

supply infrastructures by utilizing financial (including grant aid) and technical assistances from development partners.

(8) Implementation Schedule

	2013	2014	2015	2016	2017	2018	2019
Key Project							

Lead Time (Financial arrangement, feasibility study, basic design, detailed design, tendering and contrac
construction/implementation

(9) Relationship with Other Projects

No other project

(10) Effects of the Project

1) Target Beneficiaries:

The whole population in Greater Kumasi of 3.5 million in year 2018

2) Effects:

- The number of power outages is reduced leading to productivity improvement.
- Operation time of private emergency generators is reduced leading to oil saving.
- By reducing power loss, the following effects are expected:
  - Reduction of energy loss
  - Lower operation cost and increased revenue

(11) External Conditions

- Peace and order is maintained.
- Responsible agency for operation and maintenance has sufficient capacity.

(12) Preconditions

- Distribution line right-of way is secured.
- Squatters and trees within the right-of-way are removed.
- Necessary fund is prepared.

Chapter 23 High Priority Projects for the Infrastructure Sector

23.1 Selection of High Priority Projects

Each infrastructure sector programme consists of several sub-programmes. Each sub-programme is composed of two or more projects. Out of the projects composing the 6 infrastructure sector programmes, 10 priority projects are identified as shown in Chapter 22. .

Out of the 10 priority projects, 3 projects are selected as high priority projects, so that economic and financial evaluation is conducted for the 3 selected projects.

This selection of high priority projects is done using the following criteria:

- The cost for implementing the project is relatively greater than other projects.
- There have been no committed funds available for implementing the project.
- The project is neither for planning studies nor for capacity development.
- The executive agency for the project has adequate implementation capacity.
- The project is mature and ready for implementation.

The following 3 projects that satisfy these conditions are selected for economic and financial evaluation:

- Outer Ring Road Project
- Middle Ring Road Project
- Project for the Expansion of the Water Supply Capacity of Barekese Water Treatment Plant

23.2 Economic and Financial Analysis for High Priority Projects

23.2.1 Project for Expansion of Barekese Water Treatment Plant

(1) Presumption of Economic Evaluation

The costs and benefits are calculated as the differences between “with” and “without” the Project. The “with” case denotes a situation of how to correspond to an increase in water demand and to provide the water supply to the residents. While, in the “without” case nothing is done and the current situation continues into the future. The share of piped water and other sources is unchanged.

1) Water Consumption Volume

The estimated consumption volume for “With” and “Without” cases are shown in

Table 23.2.1 and 23.2.2.

Table 23.2.1 Estimated Consumption Volume "With" Case

Consumption Group	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Domestic Piped Water	38,400	53,900	54,900	53,400	53,100
Non-Domestic Consumers	21,100	29,700	30,200	29,400	29,200
Total (m^3/day)	59,500	83,600	85,100	82,800	82,300

Table 23.2.2 Estimated Consumption Volume "Without" Case

Consumption Group	Year 2013	Year 2018	Year 2023	Year 2028	Year 2033
Domestic Consumers	38,400	38,400	38,400	38,400	38,400
Non-Domestic Consumers	21,100	21,100	21,100	21,100	21,100
Total (m^3/day)	59,500	59,500	59,500	59,500	59,500

Source: JICA Study Team

2) Evaluation Period

The evaluation Period is assumed to be 30 years from 2014 to 2044.

3) Estimated Benefit

Affordability to Pay and Willingness to Pay

Benefit estimation is to be derived from affordability to pay or willingness to pay in this study. The ratio of domestic of water consumption cost in the household budgets is 3% so that the monthly affordability to pay for this sector in households is GHC 13.6/month. This figure is derived based on the expected level of per capita water use, 130 litre/day, in accordance with the "Strategic Investment Programme (SIP)". However, current realistic supply volume is only 60 litre/capita/day so that the assumption of affordability to pay is GHC 6.3/month, which is used in the base calculation for affordability to pay to compare with the existing tariff rate.

On the hand, industrial or commercial businesses (non-domestic water) also consume a huge amount of water. The calculation shall be done the same as in the Master Plan in Chapter 14.5. In order to obtain a reliable supply of water, the companies and factories would consider to pay, "Willingness to Pay", 1.75 times the current water bill.

4) Estimation of Economic Cost

The capital investment cost of the project is estimated as described in Table 23.2.3. A conversion factor of 0.85 is assumed.

Operational cost and maintenance cost are also estimated based on the "Master Plan for Kumasi Water Capacity Extension" of December, 2010. Maintenance cost for dredging is estimating based on Table 13.5.1 in Chapter 13. And operational cost is GHC 0.66 of the revenue of GHC1.0.

Table 23.2.3 Economic Cost of Investment

(GHC Thousand)

Project	Financial Cost	Conversion Factor	Economic Cost
Water Resources			
Dredging of Barekese and Owabi Dam Reservoirs	36,000	0.85	30,600
Maintenance Cost of Dredging	93,000	0.85	79,050
Water Supply			
Extension of water treatment plant modules in Barekese	41,000	0.85	34,850

Source: JICA Study Team

5) Result of Economic Analysis

The analysis flow projection based on the above assumptions is presented in Table 23.2.4. The priority project has an EIRR of 15.2%. The NPV of the project is GHC 36 million using a 12% discount rate. The project is economically feasible in the current projection. However, expenses of O & M contained a great deal of uncertain data. Thus, a feasibility study will be required.

Table 23.2.4 Benefit-Cost Stream Flow of Barekese Water Treatment Plant Project

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2014	0	17,103	12,070	29,173	0	-29,173	29,173	0	-29,173
2015	0	17,103	12,070	29,173	0	-29,173	26,048	0	-26,048
2016	0	17,103	12,070	29,173	0	-29,173	23,257	0	-23,257
2017	0	17,103	12,070	29,173	0	-29,173	20,765	0	-20,765
2018	0	17,103	12,070	29,173	0	-29,173	18,540	0	-18,540
2019	52,954	18,357	5,100	23,457	52,954	29,498	13,310	30,048	16,738
2020	53,225	19,610		19,610	53,225	33,615	9,935	26,965	17,030
2021	53,495	20,863		20,863	53,495	32,632	9,437	24,198	14,761
2022	53,765	22,116		22,116	53,765	31,649	8,932	21,715	12,782
2023	54,035	23,370		23,370	54,035	30,666	8,427	19,486	11,058
2024	54,306	23,258		23,258	54,306	31,048	7,488	17,485	9,997
2025	53,889	23,146		23,146	53,889	30,744	6,654	15,492	8,838
2026	53,473	23,034		23,034	53,473	30,439	5,912	13,725	7,813
2027	53,057	22,922		22,922	53,057	30,135	5,253	12,159	6,906
2028	52,641	22,810		22,810	52,641	29,831	4,667	10,771	6,104
2029	52,225	22,785		22,785	52,225	29,440	4,163	9,541	5,379
2030	52,133	22,759		22,759	52,133	29,373	3,713	8,504	4,791
2031	52,041	22,734		22,734	52,041	29,307	3,311	7,579	4,268
2032	51,949	22,709		22,709	51,949	29,240	2,953	6,755	3,802
2033	51,857	22,683		22,683	51,857	29,174	2,634	6,021	3,387
2034	51,765	22,658		22,658	51,765	29,107	2,349	5,366	3,017
2035	51,765	22,633		22,633	51,765	29,133	2,095	4,791	2,697
2036	51,765	22,607		22,607	51,765	29,158	1,868	4,278	2,410
2037	51,765	22,582		22,582	51,765	29,183	1,666	3,820	2,153
2038	51,765	22,556		22,556	51,765	29,209	1,486	3,410	1,924
2039	51,765	22,531		22,531	51,765	29,234	1,325	3,045	1,720
2040	51,765	22,506		22,506	51,765	29,259	1,182	2,719	1,537
2041	51,765	22,480		22,480	51,765	29,285	1,054	2,427	1,373
2042	51,765	22,455		22,455	51,765	29,310	940	2,167	1,227
2043	51,765	22,430		22,430	51,765	29,335	838	1,935	1,097
2044	51,765	22,404		22,404	51,765	29,361	748	1,728	980
	1,364,460	666,514	65,450	731,964	1,364,460	632,497	230,126	266,133	36,007

B / C	1.1565
EIRR %	15.20
NPV (GHc)	36,007

(2) Financial Analysis

"The Dredging of Barekese and Extension of Water Treatment Plant Modules in Barekese" is a high priority to satisfy basic human needs. Financial analysis has therefore been undertaken to determine the financial viability of the project. The following form part of the assumptions:

- An identified possible source of funding is not considered,
- The current tariff structures and levels (both domestic and non-domestic) have been analysed,
- Total water demand will be considered as the consumption amount,
- A detailed financial projection and analysis will be conducted to examine the financial viability of the proposed project; and the Financial Internal Rate of Return (FIRR) will be calculated.

1) Financial Costs

Financial costs of the project are summarized in Table 23.2.5. Operational cost and maintenance cost were also estimated based on the calculation of economic cost in the above section.

Table 23.2.5 Financial Costs of Barekese Water Treatment Plant Project

(GHC Thousand)

Description	Cost	Remarks
Capital Investment Cost	77,000	See Table 23.5.3
Operation and Maintenance cost	93,000	

Source: JICA Study Team

2) Result of Financial Analysis

Revenue from households is assumed in accordance with total water demand for the piped water system. The computed Financial Internal Rate of Return (FIRR) for the project is 13.77%. The value of project is financially feasible in current projections. However, the assumptions of revenue and expenses for O & M contain a great deal of uncertain data so that the study team indicated the figure is only preliminary. Thus, a feasibility study will be required.

The cash flow projection based on the above assumptions is presented in Table 23.2.6.

Table 23.2.6 Financial Flow of Barekese Water Treatment Plant Project

Unit: GHc 1,000

Year	Revenue	COST		COST TOTAL C	Revenue TOTAL B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2014	25,942	20,122	14,200	34,322	25,942	-8,380	34,322	25,942	-8,380
2015	25,942	20,122	14,200	34,322	25,942	-8,380	30,644	23,163	-7,482
2016	25,942	20,122	14,200	34,322	25,942	-8,380	27,361	20,681	-6,680
2017	25,942	20,122	14,200	34,322	25,942	-8,380	24,430	18,465	-5,965
2018	25,942	20,122	14,200	34,322	25,942	-8,380	21,812	16,487	-5,325
2019	28,176	21,596	6,000	27,596	28,176	580	15,659	15,988	329
2020	30,410	23,070	0	23,070	30,410	7,339	11,688	15,407	3,718
2021	32,644	24,545	0	24,545	32,644	8,099	11,103	14,766	3,664
2022	34,878	26,019	0	26,019	34,878	8,858	10,509	14,086	3,578
2023	37,111	27,494	0	27,494	37,111	9,618	9,914	13,383	3,468
2024	36,912	27,362	0	27,362	36,912	9,550	8,810	11,885	3,075
2025	36,712	27,230	0	27,230	36,712	9,482	7,828	10,554	2,726
2026	36,513	27,099	0	27,099	36,513	9,414	6,956	9,372	2,416
2027	36,314	26,967	0	26,967	36,314	9,347	6,180	8,322	2,142
2028	36,114	26,835	0	26,835	36,114	9,279	5,491	7,390	1,899
2029	36,069	26,805	0	26,805	36,069	9,263	4,897	6,590	1,692
2030	36,024	26,776	0	26,776	36,024	9,248	4,368	5,876	1,509
2031	35,979	26,746	0	26,746	35,979	9,233	3,895	5,240	1,345
2032	35,933	26,716	0	26,716	35,933	9,217	3,474	4,673	1,199
2033	35,888	26,686	0	26,686	35,888	9,202	3,098	4,167	1,068
2034	35,843	26,656	0	26,656	35,843	9,187	2,763	3,716	952
2035	35,798	26,626	0	26,626	35,798	9,171	2,465	3,313	849
2036	35,753	26,597	0	26,597	35,753	9,156	2,198	2,955	757
2037	35,707	26,567	0	26,567	35,707	9,140	1,960	2,635	674
2038	35,662	26,537	0	26,537	35,662	9,125	1,748	2,349	601
2039	35,617	26,507	0	26,507	35,617	9,110	1,559	2,095	536
2040	35,572	26,477	0	26,477	35,572	9,094	1,391	1,868	478
2041	35,527	26,448	0	26,448	35,527	9,079	1,240	1,666	426
2042	35,481	26,418	0	26,418	35,481	9,064	1,106	1,486	379
2043	35,436	26,388	0	26,388	35,436	9,048	986	1,325	338
2044	35,391	26,358	0	26,358	35,391	9,033	880	1,181	302
	1,047,172	784,134	77,000	861,134	1,047,172	186,039	270,736	277,024	6,288

B / C	1.0232
FIRR %	13.77
NPV (GHc)	6,288

23.2.2 Middle Ring Road Improvement Project

(1) Presumptions of Economic Analysis

The costs and benefits are calculated as the differences between "with" and "without" the Project. The "with" case denotes a situation of how the road conditions could be improved as given in the revised Master Plan Network or Projects. While in the "without" case there is no change in the current situation.

1) Evaluation Period

Evaluation period is assumed to be 30 years from 2019 to 2049

The following benefits are estimated:

- Saving in vehicle operation costs (VOC)
- Saving in travel time costs

2) Estimation of Economic Cost

The financial cost of the project is estimated at GHC 18.1 million in total. In this study the economic cost was estimated by deducting government taxes and import duty from the financial cost so that a conversion factor of 0.85 was assumed. Hence, the total economic cost is estimated at GHC 15.38 million as shown in Table 23.2.7.

Maintenance cost is also added to economic cost. The study team assumed 5% capital cost every year and 20% rehabilitation cost for each road every ten years.

Table 23.2.7 Economic Cost of Middle Ring Road Project

(Unit: GHC Thousand)

Project	Financial Cost	Conversion Factor	Economic Cost
Road Network Scheme	18.100	0.85	15,385
Routine Maintenance Cost (per year)	905	0.85	769
Rehabilitation Cost (in ten years)	3,620	0.85	3,077

Source: JICA Study Team

(2) Economic Analysis of the Proposed Roads

The economic analysis of the improvement of the Middle Ring Road was made based on the above mentioned benefits and costs estimation. Table 23.2.8 shows the benefit cost stream. The results of the economic analysis show a Net Present Value (NPV) of GHC 276 million and BCR of 17.4 over the 30 year life of the road using a discount date of 12%. The Economic Internal Rate of Return (EIRR) is calculated at 45.1% which indicates that the high priority project is economically feasible.

The benefits from this project are great and cost can be reduced by upgrading the existing unpaved roads that are in poor condition. Moreover, generated traffic will arise from the saturated condition of the radial roads because this road improvement makes a journey more attractive as a result of travel cost and time reduction.

Table 23.2.8 Benefit-Cost Stream Flow of Middle Ring Road

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2019			3,077	3,077	0	-3,077	3,077	0	-3,077
2020			3,077	3,077	0	-3,077	2,747	0	-2,747
2021			3,077	3,077	0	-3,077	2,453	0	-2,453
2022			3,077	3,077	0	-3,077	2,190	0	-2,190
2023			3,077	3,077	0	-3,077	1,955	0	-1,955
2024	4,551	769		769	4,551	3,782	436	2,583	2,146
2025	9,103	769		769	9,103	8,334	390	4,612	4,222
2026	13,655	769		769	13,655	12,885	348	6,177	5,829
2027	18,206	769		769	18,206	17,437	311	7,353	7,042
2028	22,758	769		769	22,758	21,988	277	8,207	7,929
2029	33,037	769		769	33,037	32,268	248	10,637	10,389
2030	43,317	769		769	43,317	42,547	221	12,452	12,231
2031	53,596	769		769	53,596	52,827	197	13,757	13,559
2032	63,876	769		769	63,876	63,106	176	14,639	14,462
2033	74,537	3,077		3,077	74,537	71,460	630	15,252	14,622
2034	84,816	769		769	84,816	84,047	141	15,496	15,355
2035	95,096	769		769	95,096	94,326	125	15,512	15,387
2036	105,375	769		769	105,375	104,606	112	15,347	15,235
2037	115,655	769		769	115,655	114,885	100	15,040	14,940
2038	125,934	769		769	125,934	125,165	89	14,622	14,532
2039	136,214	769		769	136,214	135,444	80	14,121	14,041
2040	146,493	769		769	146,493	145,724	71	13,559	13,488
2041	156,773	769		769	156,773	156,003	64	12,956	12,893
2042	167,052	769		769	167,052	166,283	57	12,326	12,270
2043	177,332	3,077		3,077	177,332	174,255	203	11,683	11,480
2044	187,611	769		769	187,611	186,842	45	11,036	10,991
2045	197,891	769		769	197,891	197,121	40	10,393	10,353
2046	208,170	769		769	208,170	207,401	36	9,762	9,726
2047	218,450	769		769	218,450	217,680	32	9,146	9,114
2048	228,729	769		769	228,729	227,960	29	8,551	8,522
2049	239,009	769		769	239,009	238,239	26	7,978	7,952
	2,927,234	24,616	15,385	40,001	2,927,234	2,887,233	16,907	293,196	276,288

B / C	17.3415
EIRR %	45.10
NPV (GHc)	276,288

23.2.3 Outer Ring Road Improvement Project

(1) Presumptions of Economic Analysis

The costs and benefits are calculated as the differences between "with" and "without" the Project. The "with" case denotes the situation of a new ring road being constructed as given in the sub-programmes. While, the "without" case means that there is no change in the current situation.

1) Evaluation Period

The evaluation period is assumed to be 30 years from 2019 to 2049

The following benefits are estimated:

- Saving in vehicle operation costs (VOC)
- Saving in travel time costs

2) Estimation of Economic Cost

The financial cost of the project is estimated at GHC 50.55 million in total. In this study the economic cost is estimated by deducting government taxes and import duty from the financial cost so that a conversion factor of 0.85 is assumed. Hence, the total economic cost is estimated at GHC 42.96 million as shown in Table 23.2.9.

Maintenance cost is also added to the economic cost. The study team assumed 5% for capital cost accordingly every year and 20% rehabilitation cost for each road every ten years.

Table 23.2.9 Economic Cost of Outer Ring Road Project

(Unit: GHC Thousand)

Project	Financial Cost	Conversion Factor	Economic Cost
Road Network Scheme	50,550	0.85	42,968
Routine Maintenance Cost (per year)	2,528	0.85	2,148
Rehabilitation Cost (in ten years)	10,110	0.85	8,594

Source: Study Team

(2) Economic Analysis of the Proposed Road

The economic analysis of the improvement of the Middle Ring Road is made based on the above mentioned benefits and costs estimation. Table 23.2.10 shows the benefit cost stream. The results of the economic analysis show the Net Present Value (NPV) of GHC 237 million and BCR of 6.06 over the 30 year life of the road using a discount date of 12%. The Economic Internal Rate of Return (EIRR) is calculated at 32.2% which indicates the high priority project is economically feasible.

The rate of through traffic from outside will be three times that of the existing volume in the period from year 2012 to year 2033. Thus, the improvement to the road may cause existing traffic to divert to another route, this ring road. The benefits arising from such diversion must be included in the benefit calculation and this would indicate that the economic figure is very high in this project.

Table 23.2.10 Benefit-Cost Stream Flow of Outer Ring Road

Unit: GHc 1,000

Year	Benefit	Cost		Cost Total C	Benefit Total B	B-C	Dis. Cost (12%)	Dis. Benefit (12%)	Dis. B-Dis. C (12%)
		O & M	Investment						
2019			8,594	8,594	0	-8,594	8,594	0	-8,594
2020			8,594	8,594	0	-8,594	7,673	0	-7,673
2021			8,594	8,594	0	-8,594	6,851	0	-6,851
2022			8,594	8,594	0	-8,594	6,117	0	-6,117
2023			8,594	8,594	0	-8,594	5,461	0	-5,461
2024	5,808	2,148		2,148	5,808	3,660	1,219	3,296	2,077
2025	13,044	2,148		2,148	13,044	10,896	1,088	6,609	5,520
2026	20,280	2,148		2,148	20,280	18,131	972	9,174	8,202
2027	27,515	2,148		2,148	27,515	25,367	868	11,113	10,245
2028	36,178	2,149		2,149	36,178	34,029	775	13,046	12,271
2029	43,414	2,148		2,148	43,414	41,266	692	13,978	13,287
2030	50,651	2,148		2,148	50,651	48,502	618	14,561	13,943
2031	57,887	2,148		2,148	57,887	55,739	551	14,858	14,307
2032	65,124	2,148		2,148	65,124	62,975	492	14,925	14,432
2033	72,773	8,594		8,594	72,773	64,180	1,758	14,891	13,132
2034	80,010	2,148		2,148	80,010	77,862	393	14,618	14,225
2035	87,246	2,148		2,148	87,246	85,098	350	14,232	13,881
2036	94,483	2,148		2,148	94,483	92,335	313	13,761	13,448
2037	101,719	2,148		2,148	101,719	99,571	279	13,228	12,948
2038	108,956	2,149		2,149	108,956	106,807	249	12,651	12,401
2039	116,192	2,148		2,148	116,192	114,044	223	12,045	11,823
2040	123,429	2,148		2,148	123,429	121,281	199	11,425	11,226
2041	130,665	2,148		2,148	130,665	128,517	178	10,799	10,621
2042	137,902	2,148		2,148	137,902	135,754	159	10,176	10,017
2043	145,138	8,594		8,594	145,138	136,545	566	9,562	8,996
2044	152,375	2,148		2,148	152,375	150,227	126	8,963	8,837
2045	159,612	2,148		2,148	159,612	157,463	113	8,383	8,270
2046	166,848	2,148		2,148	166,848	164,700	101	7,824	7,723
2047	174,085	2,148		2,148	174,085	171,936	90	7,289	7,199
2048	181,321	2,149		2,149	181,321	179,172	80	6,778	6,698
2049	188,558	2,148		2,148	188,558	186,409	72	6,294	6,222
	2,541,214	68,749	42,968	111,717	2,541,214	2,429,498	47,219	284,475	237,256

B / C	6.0246
EIRR %	32.32
NPV (GHc)	237,256

Chapter 24 Monitoring and Evaluation Plan

24.1 Objectives of Monitoring and Evaluation

Monitoring and evaluation during implementation of the formulated SDF and SP are essential parts of the implementation plan and activities for promoting execution of the formulated SDF and SP. As proposed in Chapter 20, the Regional Platform's major activities are monitoring and evaluation for promoting implementation of the SDF and SP.

The monitoring and evaluation plan has two major elements. One is monitoring of the activities of efforts aimed towards implementing the SDF and SP. The other is the evaluation of major aspects of implementation of the SDF and SP.

The objectives of the monitoring and evaluation plan for implementation of SDF and SP are also two-fold, including objectives for both monitoring and evaluation.

The objectives of monitoring of the plan are as follows:

- To encourage key stakeholders to continue conducting activities for implementation of the SDF and SP, as well as infrastructure programmes.
- To collect and share information on actualization and difficulties of implementation of the plan.
- To make minor modifications to efforts made for implementing the SDF and SP using the collected information.

The objectives of evaluation of the plan are as follows:

- To analyze collected information on actualization and difficulties of implementation of the plan.
- To measure impacts or outputs from the implementation of the plan.
- To make recommendations for changing methods of implementation of the SDF and SP
- To make recommendations for revising proposed strategies in the SDF and SP, as well as the infrastructure plans themselves.

24.2 Five Components of Monitoring and Evaluation of Implementation Activities

To implement the Greater Kumasi Sub-Regional SDF and Greater Kumasi Conurbation SP, the following five key types of activities are required:

(A) Official approval of the SDF for Greater Kumasi Sub-Region and the SP for Greater Kumasi Conurbation
(B) Institutional preparation for activities for implementation of the SDF and SP
(C) Implementation of sector programmes for sub-regional infrastructures
(D) Integrated implementation of various priority strategic projects for urban and industrial development
(E) Preparation and utilization of district-level SDFs and SPs for designating and enforcing land use regulations.

Therefore, monitoring and evaluation also should cover these five types of actions.

24.2.1 Monitoring and Evaluation Activities for (A) on Official Approval of the Plan

The agency in charge of the monitoring and evaluation for (A) on official approval of the plan is TCPD. TCPD should report the monitoring and evaluation results to RCC.

The monitoring and evaluation activities for (A) on official approval of the plan are as follows:

- Monitoring of the process for official approval of the SDF and SP every two months at regular Regional Platform meetings.
  - Have any actions been taken for official approval?
  - Which organization or who should take action to obtain the official approval?
  - Are there any conditions to be satisfied to get official approval?
  - What kinds of actions are required to satisfy the conditions?
- Evaluation of the process and progress for official approval of the SDF and SP at the end of calendar year 2013.
  - Has the official approval been completed?
  - If no, why not?
  - What kinds of actions should be taken to solve the difficulties toward obtaining official approval?
- Monitoring of the announcement after receiving official approval of the SDF and SP
  - Has the official approval of the SDF and SP been announced to the public?
  - Have the official plan documents for SDF and SP been opened to the public for utilization?

24.2.2 Monitoring and Evaluation Activities (B) on Institutional Frameworks for Implementation

The agency in charge of the monitoring and evaluation for (B) on institutional frameworks for implementation is TCPD. TCPD should report the monitoring and evaluation results to RCC.

The monitoring and evaluation activities for (B) on institutional preparation for implementation are as follows:

- Monitoring of establishment of a regional platform for implementation of the SDF and SP, as well as sub-regional infrastructure programmes at the end of calendar year 2013 and in June 2014.
- Monitoring of establishment of any national-level mechanism for implementation of the SDF and SP, as well as sub-regional infrastructure programmes at the end of calendar year 2013 and in June 2014.
- Monitoring of operation of the established regional platform for implementation of the SDF/SP and sub-regional infrastructure programmes in June 2014 and December 2014.
- Monitoring of operation of the established national-level mechanism for supporting the implementation of the SDF/SP and sub-regional infrastructure programmes in June 2014 and December 2014.
- Evaluation of establishment of the regional platform and national level mechanism for supporting the implementation of SDF/SP and sub-regional infrastructures

24.2.3 Monitoring and Evaluation Activities for (C) on Sub-Regional Infrastructures

The agencies in charge of the monitoring and evaluation for (C) on sub-regional infrastructures are regional departments or KMA departments, which should report monitoring and evaluation results to the RCC.

The implementation component (C) should focus on the following priority projects:

- Outer Ring Road Project
- Middle Ring Road Project
- Project for Introduction of Type B Bus and Establishment of BRT System
- Feasibility Study on Water Resources Development for Greater Kumasi Sub-Region
- Project for Expansion of Water Supply Capacity of Barekese Water Treatment Plant
- Project for Effective Use of Existing Distribution Pipes
- Project for Development of Septage Treatment Ponds in Adjoining Districts/Municipalities within Greater Kumasi Sub-Region
- Expansion of Asafo Simplified Sewerage System for CBD Area
- Project for Solid Waste Management Improvement in MDAs Adjoining KMA within Greater Kumasi Sub-Region
- Project for Replacement of Small-Sized Wires and Deteriorated Equipment, and Realignment of Distribution Lines

Monitoring of implementation of each priority project should take the following aspects into account:

- Incorporation of the priority project by the national-level sector plan or programme

- Efforts made towards appealing to the national agency for implementation of the priority project
- Completion of feasibility study of the priority project
- Commitment of development partners to the priority project
- Acquisition of land required for implementing the priority project

24.2.4 Monitoring and Evaluation Activities for (D) on Priority Strategic Programmes for Urban and Industrial Development

The agencies in charge of the monitoring and evaluation for (D) on priority strategic programmes for urban and industrial development are various executive agencies responsible for different programmes as explained in Chapter 21. The proposed executive agencies for the priority strategic programmes are as follows:

- Programme for Investment Promotion for Greater Kumasi (Executive Agency: Ghana Investment Promotion Centre)
- Programme for Revitalization of Kaase Industrial Area (Executive Agency: KMA)
- Programme for Development of Boankra Industrial-Logistics Centre (Executive Agency: Ghana Free Zones Board)
- Programme for Development of Kumasi–Ejisu Urban Corridor (Executive Agencies: KMA, Ejisu-Juaben Municipality, KNUST and CSIR)
- Programme for Redevelopment of Kumasi City Centre (Executive Agency: KMA)
- Programme for Development of New Towns (Executive Agency: Ghana Real Estate Developers Association)
- Programme for Modernization of Informal Sectors (Executive Agency: Regional Office for Ministry of Trade and Industry and KMA)

Monitoring for each of these priority strategic programmes should focus on the proposed actions (See Chapter 21) for the priority strategic programme, whether proposed actions have been conducted or not.

24.2.5 Monitoring and Evaluation Activities for (E) District-Level SDFs and SPs

The agency in charge of the monitoring and evaluation for (E) on district-level SDFs and SPs is the TCPD Regional Office of Ashanti Region.

The monitoring for Implementation Component (E) should take the following points into account:

- Whether the district has a planning officer or not.
- Whether the planning officer and technical officers of the district have participated in training courses for preparing district-level SDFs and SPs.
- Whether the planning officer and technical officers of the district have the ability to use GIS for preparing district-level SDFs and SPS.

24.3 Evaluation of Outputs of Implementation of the Greater Kumasi Sub-Regional SDF/SP and Sub-Regional Infrastructures

The evaluation of the outputs of implementation of the Greater Kumasi Sub-Regional SDF/SP and Sub-Regional Infrastructures is useful and important for revising the formulated Sub-Regional SDF/SP.

24.3.1 Evaluation of Outputs of Enforcement of Sub-Regional SDF/SP and District SDFs/SPs

The proper utilization and enforcement of the Greater Kumasi Sub-Regional SDF/SP and district-level SDFs/SPs can have a positive effect on preventing overly expansive urban sprawl, while at the same time, promoting urbanization outside KMA within the Greater Kumasi Conurbation boundary.

The output or impact of the utilization or enforcement of Greater Kumasi Sub-Regional SDF/SP and district-level SDFs/SPs can be measured by the following indicators:

- The number of layout plans or local plans prepared and approved outside the Urban Growth Boundary or Greater Kumasi Conurbation boundary.
- The population within the Urban Growth Boundary or Greater Kumasi Conurbation boundary increased at higher rates than KMA.

This evaluation becomes possible when population census data is available. Therefore, this kind of evaluation should be done in years 2022 and 2032. Based on this kind of evaluation, the Sub-Regional SDF/SP should be revised or modified.

24.3.2 Evaluation of Outputs of Implementation of Housing Strategies of Sub-Regional SDF/SP

The outputs of effective implementation of proposed housing strategies can be measured by the following indicators:

- The percentage of separate houses will increase.
- The percentage of multi-storey apartments will increase.
- The percentage of compound houses will decrease.
- The number of multi-storey apartments within Kumasi City Centre will increase.

Data on the first three indicators can be obtained by studying the population and housing census. Therefore, this kind of evaluation should be done in years 2022 and 2032.

24.3.3 Evaluation of Outputs of Implementation of Industrial Development Strategies of Sub-Regional SDF/SP

The outputs of implementation of proposed industrial development strategies can be measured by the following indicators:

- The number of economically active population of the manufacturing sector within KMA.

- The number of economically active population of the manufacturing sector in adjoining districts.

These indicators can be measured by population and housing censuses. Such data will be available in 2022 and 2032.

24.3.4 Evaluation of Outputs of Implementing of Strategies for Open Space and Sports Facilities

The strategies for open space and sports facilities should be evaluated by measuring the following:

- Areas of primary and secondary school grounds that could be opened for the public
- Areas of parks constructed and utilized by the public
- Number of parks constructed and utilized by the public
- Areas of buffer zones designated along rivers and prepared for the public

In addition, a questionnaire survey on demand for utilization of open space and/or sports facilities should be conducted to understand real demand for open space and sports facilities.

24.4 Evaluation of Impacts of Implementation of the Greater Kumasi Sub-Regional SDF/SP and Sub-Regional Infrastructures from SEA Perspectives

The negative impact of implementation of the Greater Kumasi Sub-Regional SDF/SP and Sub-Regional Infrastructures should be evaluated from SEA perspectives. The indicators proposed in Section 26.7 should be used.

The years 2022 and 2032 are times when population and housing census data will become available.